



Tunneling & Underground Construction

The Official Publication of UCA of SME

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**Workforce and education challenges
Long distance tunneling
George A. Fox conference**

Includes:
NAT2022
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Tunneling & Underground Construction Magazine (TSUC) is the official publication of the Underground Construction Association, a Division of SME. UCA is the fastest growing division within the world's largest professional mining society.

TSUC brings together owners, contractors, designers and suppliers with an interest in tunneling and underground construction, and provides a critical resource for best practices, current projects and case studies. Each issue of **TSUC** features the Tunnel Demand Forecast, a comprehensive overview of many of the largest underground projects taking place across North America.

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In This Issue

Tunneling and underground construction is a dynamic and challenging industry with great career opportunities; however, attracting and retaining qualified people to work in the industry is a challenge. On page 16 experts from a range of sectors talk with T&UC associate editor Nancy Profera about the challenges and possible solutions.

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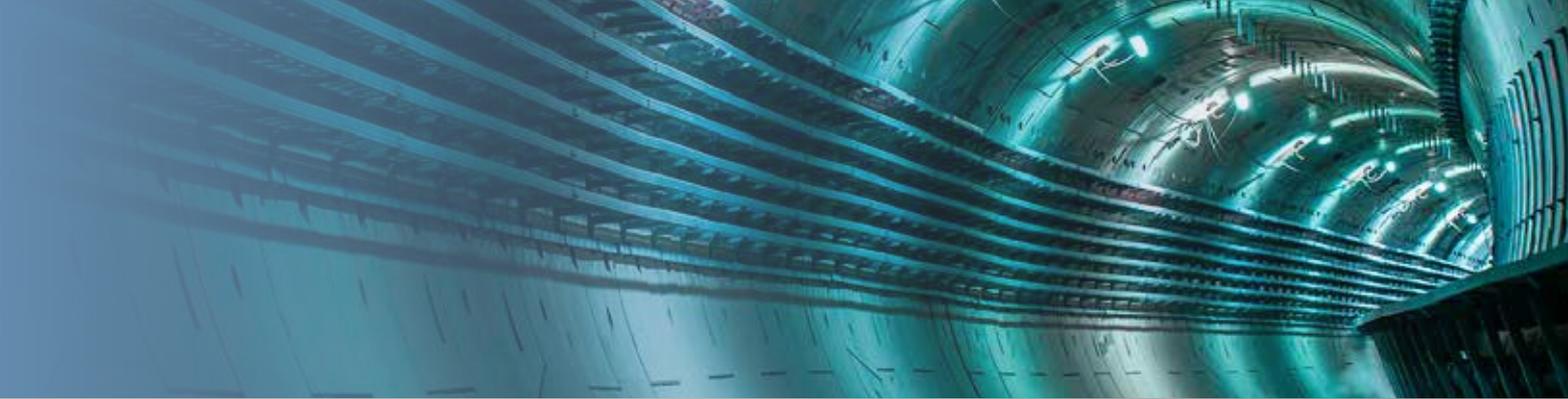
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Stakeholder awareness for the tunneling industry – Part two

Last issue, I started my column with the following concepts: “The benefits that tunnels and underground infrastructure bring to people the world over are indisputable. We in the industry know that our solutions — performance-wise, environmentally, economically — are the right ones in a long-term context and deliver huge value, whether in transportation, water, sewer or other applications. The industry is growing globally at around a 10 percent CAGR for a reason ... the world needs tunnels, and they are a good investment.

We need to focus on the decision makers who make infrastructural investments — owner organizations, legislators — and get the message to them, help ensure that they have all the facts at their disposal when they make their decisions for or against underground investment.”

So, this issue, let’s talk more about this. I’m going to lay out some thoughts, but I am really hoping that, once you read this, you reach out to me with feedback or ideas for moving forward.

How do we best and realistically continue to get access to and raise the level of awareness and educate the decision makers about underground infrastructure? As a nonprofit organization, we cannot actively lobby for specific legislation in the way that professional lobbyists or other related organizations do. But that limitation is a minor one. We can still, as an industry, have a very significant impact in a structured and systematic way, if we set our collective minds to it.

UCA’s parent body, the SME, is effective in the mining industry. While the lobbying per se is left to the National Mining Association and similar organizations, SME is nonetheless linked to and supportive of the effort by being active with a Government and Political Affairs



Michael Rispin
2022-2023 UCA Chair

Committee (GPAC). These groups work side by side in providing facts, figures and materials that all help to educate decision makers on the importance of investment in the mining industry. You may have recently seen in media that a national strategy for minerals policy is an important issue for our country right now.

Personally, I believe that investment in underground infrastructure is very important as well. We’re not nearly as big an industry as mining. However, does that mean we shouldn’t be educating and enlightening just as assiduously? I think many of us feel the same way.

The UCA’s participation with the American Society of Civil Engineers (ASCE) Legislative Fly-In completed recently and the feedback was good. Various UCA members met their respective state representatives, both in Congress and the Senate, and had the opportunity to speak about the industry. Members were able to use the “History of Tunneling in the United States” book as a reference to the important contributions that have been made by the industry to the nation’s development, and to explain how these types of asset investments need to continue and accelerate into the future.

The UCA Executive Committee
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Los Angeles County Sanitation Districts constructing 11-km (7-mile) tunnel

The Clearwater Project in Los Angeles County will create an 11-km (7-mile) tunnel to protect the waterways in Los Angeles, CA.

The Los Angeles County Sanitation Districts operate and manage 11 wastewater treatment plants, 47 pumping plants and 1,269 km (1,410 miles) of sewers to serve about 5.6 million people. Treated wastewater is conveyed to the Pacific Ocean by two outfall tunnels, 60 and 80 years old, respectively. The tunnels, which cross two earthquake faults, cannot be taken out of service for repair and maintenance. In 2006, the districts began planning, environmental studies and geotechnical investigations to develop alignment alternatives for a new outfall tunnel, built to current earthquake standards and with the necessary capacity to protect against overflows from major rainstorms.

Brierley Associates' Sean Harvey, Dave Sackett, Patrick Smith, Nathan Stublely and Alan

Howard were all part of the early on marine and land based geotechnical investigations that were crucial to understanding subsurface characteristics for the design and subsequent construction of this new vital asset. After several years of assessment, investigation, analysis and regulatory approvals, Los Angeles County Sanitation Districts has undertaken the Clearwater Project.

The Clearwater Project is being delivered by conventional design-bid-build methods and groundbreaking occurred in 2019. Selected from more than 21 options, the new tunnel will extend from the Joint Water Pollution Control Plant and connect to a manifold structure at Royal Palms State Beach. The total length of the tunnel is approximately 11 km (7 miles) with a nominal internal diameter of 5.4 m (18 ft).

Excavation of the tunnel commenced in the fall of 2021 using a new Herrenknecht slurry tunnel

boring machine named Rachel after Rachel Carson, author of *Silent Spring*. The TBM was launched from a sequentially excavated starter tunnel and corresponding tail tunnel at the bottom of a 17-m (55-ft)-diameter, approximately 43-m (140-ft)-deep shaft located adjacent to the Joint Water Pollution Control Plant.

Numerous geotechnical challenges will be encountered throughout the length of the tunnel. The deep shaft and first portion of the tunnel are encountering alluvial sediments consisting of silt, sand, gravel, cobbles and boulders below the water table. Further along the alignment, the tunnel will pass through two active fault zones, the Palos Verdes fault zone and the Cabrillo fault zone. The fault zones present their own set of challenges, which may include the potential for squeezing ground. Eventually the geology will transition from alluvial

(continued on page 13)

Tunnel boring machines arrive in Vancouver

The first shipment of parts for the tunnel boring machines (TBM) that will be used for Vancouver's Broadway subway line arrived in the province in late April. Tunneling for the project that is an extension of the existing Millennium Line will begin this summer.

The Ministry of Transportation said the equipment was shipped out of Germany in late February, passed through the Panama Canal and arrived at the Fraser Surrey Docks on April 15.

A second and final shipment was expected to arrive in the following weeks.

The heavy equipment will then be assembled into two 6-m (19-ft)-wide and 150-m (190-ft)-long

boring machines at a staging area in Vancouver before being put to work.

The machines, which when complete will each weigh about a million kilograms, require a crew of eight to 12 people to operate and can cut about 18 m (60 ft) of tunnel per day.

The work is expected to pull about 200,000 cubic meters of soil out of the ground, which will be removed by a conveyor belt.

Global News reported that the boring machines will be named later this spring.

The Ministry of Transportation said the TBMs will both be launched from the future site of the Great Northern Way-Emily Carr station near Main Street and will carve

new tunnels to Cypress Street, near the subway's terminus at Arbutus Street.

Work is already underway on the subway's six stations, which will be connected by the new tunnels.

The boring work is expected to take about a year to complete.

The Broadway subway station will extend the SkyTrain Millennium Line an additional 5.7 km (3.5 miles) west to Arbutus Street, at a projected cost of at least \$2.8 billion.

TransLink and the city of Vancouver have both said they want to extend the line all the way to the University of British Columbia's Point Grey campus; however, funding for a second stage of the line has not been secured. ■

Gateway Program completes geotechnical study

The Gateway Program has completed geotechnical investigation work, a necessary part of entering the engineering phase of the \$5.6 billion Federal Transit Administration Capital Investment Grant (CIG) it is seeking for the Hudson Tunnel Project.

New Jersey Business reported that the project completed a total of 75 geotechnical investigations. The borings included 64 borings in New Jersey and New York over several years, 37 of which were during the recently completed Phase 2 Supplemental Geotechnical Boring Program plan based on input from the private sector. The samples obtained from the borings will inform the design and engineering planning for full construction of the project.

The borings were completed in

Secaucus, along the future above-ground alignment, in Union City, along the future Palisades Tunnel alignment, at the Hoboken Project Site, along the future Hudson River Tunnel alignment under the Hudson River, and in Manhattan, at the Hudson River Park, and at the 12th Avenue Project Site. Samples were taken at depths ranging from 14 m to 154 m (48 ft to 505 ft).

The project also completed five cone penetration tests, four seismic cone penetration tests, a marine geophysical survey in the Hudson River, and a surface-based geophysical survey along the Hudson Bergen Light Rail (HBLR) tracks in New Jersey.

In a joint statement, Gateway Development Commission co-chairs Steven M. Cohen of New York and Balpreet Grewal-Virk of New Jersey,

along with vice chair Tony Coscia of Amtrak, said: “Finishing geotechnical investigations to reduce risk and provide certainty on where and how to dig the first rail tunnel under the Hudson River in a century is a major accomplishment. This work is another example of our partners working together to advance the tunnel project as far as we possibly can in preparation for full funding and construction.

“From building two sections of the tunnel casing in Manhattan, to advancing the design of the project to 30 percent, to achieving all the project’s regulatory approvals, to completing this geotechnical work, we and our partners have shown over and over that no obstacle will stand in the way of finally delivering 21st Century rail transportation between New York and New Jersey.” ■



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Tunneling work completed on London's super sewer

A tunnel boring machine (TBM) named Annie completed its 4.5-km (2.7-mile) journey to create the final major connection tunnel into London's Tideway super sewer, a 25-km (15.5-mile) tunnel connecting east and west London.

TBM Annie, named after Annie Scott Dill Russell, the first female scientist to work at the Greenwich Observatory, broke into the shaft at Tideway's Chambers Wharf site on April 4.

On April 29, Tideway announced that tunneling on the project was officially complete, four years after it started.

Robert Margariti-Smith, tunnel manager, said of the final major connection, "This is a fantastic moment for the Tideway team as

TBM Annie arrives safely at her destination.

"The team at Greenwich, where the journey began, and at Chambers Wharf, where it's now finished, have done a superb job in getting us to this point. Although there is much work to be done, it's great to have reached this milestone – bringing London ever closer to a cleaner Thames."

TBM Annie began her journey at the end of 2020, passing Tideway's sites at Deptford Church Street and Earl Pumping Station along the drive.

Despite being smaller than the TBMs used to create the main tunnel, TBM Annie, manufactured by Herrenknecht, is still an impressive 6.4 m (20 ft) wide.

Much of the excavated spoil from the tunneling operation was removed from site by barge; Tideway has

invested in new marine infrastructure to use Deptford Creek as a transport artery in order to keep lorries off local roads.

The Tideway project celebrated the completion of tunneling with a live performance by London-based composer and musician Rob Lewis, who performed 70 m (230 ft) below ground.

"Completion of tunneling for London's new super sewer is testament to the hard work and contributions of thousands of people and organizations, over many years – and it brings us closer to the ultimate goal of a cleaner River Thames. This performance celebrates a significant milestone in our efforts to create a more sustainable London for our growing population and we are pleased to commemorate the end of tunneling in such a unique way," said Sir Neville Simms, chair of Tideway.

Once operational in 2025, the new super sewer will dramatically reduce sewage pollution of River Thames.

The project is being delivered in three sections. The central section is being overseen by a joint venture of Ferrovial and Laing O'Rourke. Meanwhile, Bam Nuttall, Morgan Sindal and Balfour Beatty teamed up to deliver the west section, and the east section is being delivered by Costain, Vinci Grand Projects and Bachy Soletanche.

Overall, the Tideway project involves a 25-km (15.5-mile) tunnel to intercept, store and ultimately transfer sewage waste away from the River Thames.

Remaining work includes secondary lining, connection and testing works. ■

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EPA awards LA County with money for water project

The Los Angeles County Sanitation Districts Clearwater project that will replace a pair of aging wastewater tunnels in Los Angeles, CA with an 11-km (7-mile)-long precast concrete tunnel got a financial boost of \$441 million from the U.S. Environmental Protection Agency (EPA).

EPA is providing a Water Infrastructure Finance and Innovation Act (WIFIA) loan to the Los Angeles County Sanitation Districts for the Clearwater project.

The 5.4-m (18-ft) diameter tunnel will carry treated water from the joint water pollution control plant in Carson, CA, to ocean outfalls in Los Angeles' San Pedro neighborhood. The new tunnel will have a greater capacity for high flows than the existing tunnels, which were built in

1937 and 1958, *ENR* reported.

County sanitation district officials say major storms almost pushed the tunnels past their capacity twice. Those aging tunnels also cross two earthquake faults, but do not meet modern seismic standards. If the capacity is exceeded or the tunnels fail, sewage may discharge into surrounding waterways. After the completion of the new tunnel, the two existing tunnels will be used as backups.

The project has been in the works for several years. Design work with tunneling experts from engineering firms Parsons Corp. and McMillen Jacobs Associates plus geotechnical firm Fugro Consultants was completed in 2018. In 2019, the sanitation districts awarded a \$630-million contract to Dragados USA Inc. for the project. Tunneling began in 2021. Officials

expect work to complete in 2027.

WIFIA loans are low cost and long term, and are given for significant water infrastructure projects. EPA says Los Angeles County will save about \$76 million by financing with the WIFIA loan.

"This loan will help us build infrastructure that is critical for the region and minimize the financial impact on our rate payers," Robert Ferrante, chief engineer and general manager of the sanitation districts, said in a statement.

EPA is financing more than \$31 billion in water infrastructure upgrades with WIFIA loans, according to the agency. On May 9, EPA also announced that it would provide \$65 million in loans for two projects that will increase groundwater treatment capacity in Multnomah County, OR. ■

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The Boring Co. valued at \$5.7 billion

The Boring Co. (TBC) announced that it has raised \$675 million in a new funding round, valuing the company at \$5.675 billion. It plans to use the funds to build many new tunnel boring machines (TBM) and to dig tunnels under more cities.

“Our Series C funding round of \$675 million is led by Vy Capital and Sequoia Capital, with participation from Valor Equity Partners, Founders Fund, 8VC, Craft Ventures and DFJ Growth. The financing now values the Boring Co. at \$5.675 billion,” the company wrote in a press release.

It disclosed that the primary use of the funds is going to be accelerating hiring in order to scale current and upcoming loop projects.

The funds from the round will be used to significantly increase hiring across engineering, operations and production to build and scale loop

projects, including the Vegas Loop and others, in addition to accelerating the research and development of Prufrock and future products.

TBC’s loop is an all-electric, zero-emissions, high-speed underground public transportation system using Tesla vehicles in tunnels.

Its first application is at the Las Vegas Convention Center, but the city of Las Vegas recently approved a major expansion of the system throughout the whole strip and to the airport.

In the release about the new funding, TBC boasted that a fleet of its latest tunnel boring machines is going to soon enable it to build about 965 km (600 miles) of tunnels per year or 30 times more tunnels than in the last 20 years combined: “Prufrock is a next-generation tunnel boring machine designed to construct mega infrastructure projects in a

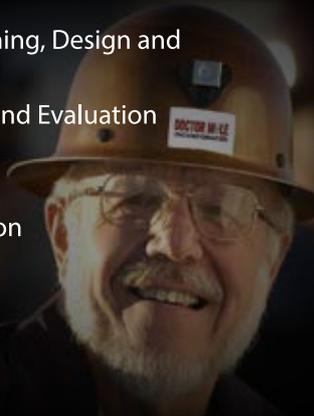
matter of weeks instead of years, and at a fraction of the cost. The current iteration of Prufrock, called Prufrock-2, is designed to mine at up to 1.6 km/week (1 mile/week), meaning a tunnel the length of the Las Vegas Strip (approximately 6.4 km or 4 miles) can be completed in a month. Prufrock-3 is designed to be even faster, with the medium-term goal of 1/10 human walking speed, or 7 miles/day. In the short term, if each Prufrock-2 mines at 1 mile/week, and TBC produces one new Prufrock machine per month, then TBC will be introducing 965 km/a (600 miles py) of capacity. As a point of reference, less than 32 km (20 miles) of underground subway tunnel has been constructed in the United States in the last 20 years.”

On top of the project in Las Vegas, TBC is already in talks with several municipalities in California, Texas and Florida for new loop systems. ■

Dr. Gary S. Brierley, P.E.

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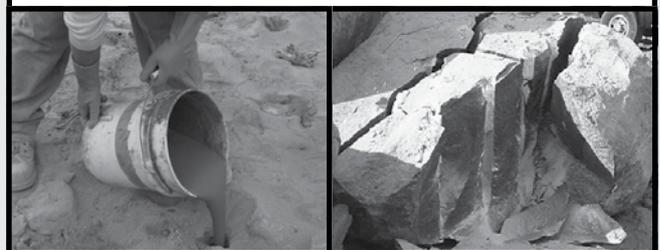
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Autonomous TBMs to be used in Sydney tunnel

The Sydney Metro West tunnel project in New South Wales, Australia will employ the use of autonomous tunnel boring machines (TBM), the New South Wales (NSW) government announced.

The Sydney Metro West tunnel project consists of two 9-km (5.6-mile) tunnels that are part of a 24-km (15-mile) project.

ZDNet reported that the autonomous machines are being built as part of an AU\$2.16 billion Western Tunnelling Package that was awarded to the Gamuda Australia and Laing O'Rourke consortium, which has contracted manufacturer Herrenknecht to design, build and deliver the machines.

According to the government, the machines will feature artificial-intelligence software, developed by Gamuda, that will be used to automatically steer, operate and

monitor various TBM functions.

"While an operator remains in control, the autonomous system takes on all repetitive tasks from the operator with greater accuracy," Minister for Transport David Elliot said, claiming that the use of autonomous TBMs will be an Australian first.

"The technology also allows the TBMs to be more accurate and precise, reducing the time required to excavate the 9-km (5.6-mile) tunnels, therefore saving project costs."

The autonomous machines are expected to be delivered by the end of 2023 where they will be used to construct the metro rail tunnels from Sydney Olympic Park to Westmead.

Each machine will be designed to excavate through sandstone and shale and are expected to each weigh 1,266 t (1,400 st) and be 165 m (541 ft) long. They will tunnel an average

of 200 m (656 ft) per week with a team of 15 workers per shift, the NSW government said.

"While these machines look the same as others used on Sydney Metro projects, this technology means exact tunneling speed and force is used. This lessens the impact on the equipment, which reduces the amount of downtime for maintenance," Elliot said.

The autonomous machines will join a fleet of TBMs that are set to build 24 km (15 miles) of tunnels.

The state government has also announced that following a trial with more than 1,400 tradies, the digital contractor license is now available to all individual contractor license holders statewide on the service NSW app. This will enable tradies to access their work licenses and contractors, as well as provide consumers with the chance to quickly check a tradies' credentials. ■

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Chair's column

(continued from page 4)

is currently examining options for enhancing efforts in the GPAC environment. Where there's a will, there's a way. As Yogi Berra once said: "If you don't know where you're going, you'll end up somewhere else." Let's decide where we want to go, how we want to get there, what it's going to take to do it, then screw up our courage to the sticking point, start executing, and get on with it. Sounds simple, right? It honestly does not have to be complicated, just structured.

How about the idea of a UCA member being a "state rep" for their state, and having 50 of these to cover all the states? ... or at least starting with the most important ones where investment in tunneling infrastructure is a going concern or an imminent need. I believe that a future state can exist where each member of Congress and the Senate (or more local bodies) could have knowledge of, and their staff have access to, an underground expert that can be a resource for them. I can also see that there would be reciprocal benefit.

I'll hopefully have seen you at George Fox and maybe The Moles Awards Dinner, and hopefully will see you at the North American Tunneling conference (June 19-22, Philadelphia, PA), and I look forward to engaging with you on this topic of stakeholder awareness. I'm hopeful of getting individual feedback but also look to the Corporate and Sustaining Members of the Association to weigh in. We all, as members of the industry, stand to benefit, as does society as a stakeholder.

Tunnel on! ■

Clearwater: tunneling will take four years

(continued from page 6)

sediments to faulted and uplifted sedimentary bedrock consisting of claystone, siltstone and sandstone. Additionally, the tunnel alignment will pass through the Wilmington Oil Field, the third largest petroleum field in the United States, where naturally occurring hydrocarbons are anticipated to be encountered.

The contractor, Dragados, selected the slurry type of TBM to help mitigate many of these geotechnical challenges. A comprehensive automated geotechnical instrumentation program and real-time monitoring of the TBM data have also been deployed to observe the performance of the TBM and the surrounding ground. The TBM has excavated close to 335 m (1,100 ft) to date.

Brierley Associates served as a specialty tunneling/geotechnical subconsultant beginning with the planning phase, continuing through final design. Sean Harvey, Nathan Stuble and Patrick Smith are providing construction management services to the sanitation districts in the lead geotechnical role. “We’re providing interpretation and analysis of instrumentation data to assess TBM performance and ground behavior. Having real-time data allows the construction management team and the contractor to understand and anticipate ground behavior in order to adjust TBM operations to optimize overall performance,” the team said.

Tunneling will take four years. The outfall tunnel is expected to be online in 2027. ■



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Tunnel boring machine completes largest outfall in Canada

On March 3, 2022, a 7.95-m (26.1-ft)-diameter Robbins single-shield tunnel boring machine (TBM) completed a record-setting run below Lake Ontario. The machine, for the Southland/Astaldi joint venture, bored 3.5 km (2.2 miles) in sedimentary rock for the Ashbridges Bay Outfall in Toronto, Ontario, Canada.

The machine launched in March 2021 from an 85-m (280-ft)-deep, 16-m (53-ft)-diameter shaft and began its bore in predominantly shale, with limestone, siltstone and sandstone. During its excavation, the TBM and its experienced crew bored a city-wide record of 30 rings in one day, or about 47 m (154 ft) of advance. The machine and crew surpassed a previous best day of 21 rings at a project with similar specifications. “We are proud to have completed another successful tunnel with Robbins and greatly appreciate their field service support,” said

Joe Savage, project manager for Southland.

“This is a wonderful type of geology for our machines. During the entire excavation, a total of seven cutters were changed. The wear behavior is incredible, between 2 and 5 mm, and everyone is amazed by the cutter performance,” said Alfredo Garrido of Robbins Field Service.

The crew had been operating the machine in two shifts of 12 hours from Monday to Friday. A Robbins continuous conveyor system, including vertical conveyor, transported muck behind the machine. “Every 25 machine cycles, it was necessary to stop the excavation to probe drill holes in front of the cutterhead to check for possible water. This drilling was done basically every day, stopping the machine for a few hours, but it was very necessary,” said Garrido.

The last kilometer of tunnel,

bored below a series of 50 risers under Lake Ontario, was challenging but ultimately successful. “The team really worked together to overcome some tough ground conditions and high water inflows in the tunnel,” said Savage.

The project won accolades from the Tunnelling Association of Canada (TAC) in late 2021 for its all-remote machine acceptance enacted due to the COVID-19 pandemic. The machine acceptance, the first of its kind, enabled communication and confirmation between the machine’s assembly location in Mexico, suppliers in the United States and those involved in Canada.

The completed outfall will connect to the 50 in-lake risers to enable efficient dispersion of treated effluent over a wide area of the lake, making it the largest outfall in the country. The project for the City of Toronto will improve the city’s shoreline and Lake Ontario’s water quality by replacing a 70-year-old existing outfall. ■



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Excavation of Purple Line tunnels completed

Two tunneling boring machines (TBMs) have completed the excavation of tunnels between Century City and the Wilshire/Rodeo station under downtown Beverly Hills as part of Section 2 of the Purple (D Line) Extension project in Los Angeles.

In early February, the TBMs were anticipated to start digging the tunnels between Wilshire/Rodeo and Wilshire/La Cienega stations. The tunnels on a 6.2-km (3.9-mile) Section 1 of the project — between Wilshire/Western and Wilshire/La Cienega — were completed in 2021.

The Source reported that construction is also underway on

Section 3 of the project between Century City and the Westwood VA Hospital, including a key station at Wilshire and Westwood boulevards that will provide access to Westwood Village and the UCLA campus.

The vital stats on the tunneling on Section 2 include:

- The two TBMs — named Harriet and Ruth — began digging at Century City on April 30, 2020, and traveled to the east.
- Both TBMs excavated for 1,771 m (5,811 ft) between Century City and the Wilshire/Rodeo station.

- The first TBM, Harriet, reached Wilshire/Rodeo on Jan. 11. The second TBM, Ruth, made it to the station box on Jan. 28.

The Purple (D Line) Extension project is extending Metro's D Line subway from its current terminus at Wilshire/Western for nine miles to the Westwood VA Hospital in Westwood. The project is funded mostly by Measure R, Measure M and federal grants. Section 1 is forecast to open in 2024, section 2 in 2025 and section 3 in 2027. Travel time between Westwood and downtown Los Angeles is expected to take about 25 minutes. ■

\$235 million BART extension contract awarded

The joint venture Kiewit Shea Traylor (KST) was awarded a \$235 million contract for tunnel and trackwork (CP2) of the BART Silicon Valley Phase II (BSVII) Project in Santa Clara, CA. It is the first of a series of contracts that will be awarded for the project.

Contract package (CP2) will be carried out in stages with stage 1 activities including investigation of innovations, engineering and design, open book cost estimates and the work schedule. Stage 1 activities are anticipated to occur from May 2022 through approximately December

2023, setting the stage for major construction (stage 2), which includes boring the tunnel under downtown San Jose.

Three other contracts to be considered in the future will be for the systems, stations and the Santa Clara Station and maintenance yard.

The Santa Clara Valley Transportation Authority's (VTA) BSVII Project is a 10-km (6-mile), four-station extension that will bring BART service from Berryessa/North San José through downtown San José to the City of Santa Clara. It includes three stations with underground

platforms (28th Street/Little Portugal, Downtown San José and Diridon), one ground-level station (Santa Clara), a train maintenance and storage facility at Newhall yard and additional facilities. Five miles of the six-mile alignment are planned to be constructed in a large diameter single-bore tunnel, with the remaining one mile at-grade rail.

The VTA board of directors also approved a request to review previously completed assessments comparing single and twin-bore tunnel methodologies, in a parallel track moving forward with the initial contract work. ■

Coming Events

NAT2022
NORTH AMERICAN
TUNNELING CONFERENCE

June 19-22, 2022
Philadelphia, PA

**Cutting Edge
Conference**
Advances in Tunneling Technology

Nov. 13-16
Long Beach, CA

More information:

Meetings Department, SME
phone 800-763-3132, 303-948-4200,
email sme@smenet.org

Tunneling shortcourse returns to Colorado School of Mines

After a pandemic pause, the Center for Underground resumes its in-person tunneling short course for professionals Oct. 17-20 at the Colorado School of Mines in Golden, CO. Tunneling Fundamentals, Practice and Innovations includes presentations by top industry experts

and attendees participate in labs and workshops in state-of-the-art testing and research facilities while networking with peers. Hands-on labs and workshops include: EPB Soil; Conditioning; Rock cutting; Abrasivity and wear; Shotcrete; Grouting, and Slurry. Learn more and register at learn.mines.edu/tunneling/. ■

The state of education and workforce in tunneling and underground construction

The tunneling and underground construction industry is challenged with raising awareness of the industry to young engineers and students considering engineering careers.



The May 6, 2022 federal jobs report shows the U.S. economy continues to strengthen with nonfarm payroll employment increasing by 428,000 jobs in April. Job growth was widespread, with gains in leisure and hospitality, in manufacturing, and in transportation and warehousing. Mining added 9,000 jobs in April, with a gain in oil and gas extraction of 5,000 jobs. Mining employment is 73,000 higher than a low reported in February 2021. The unemployment rate is now at 3.6 percent, the lowest number since the start of the COVID-19 pandemic.

In a tight labor market, what does this mean for the tunneling and underground industry? Research shows those numbers are trickier to find as the U.S. Bureau of Labor Statistics does not single out tunneling and

underground occupations. One must look under mining, oil and gas, and construction jobs to try and extract these numbers.

To better understand what UCA members are facing on the ground with hiring and retention, *T&UC* magazine recently conducted two interview panel sessions with members of UCA. This article is designed to share their insights and perspective from different-size firms and locations in the United States and abroad. Panelists included UCA chair Mike Rispin, who is vice president of tunneling for Strata Worldwide, Mike Roach of Traylor Bros. Inc., Vojtech Ernst Gall of Gall Zeidler Consultants (GZ), Elisa Comis of McMillen Jacobs Associates, Paul Schmall, vice president for Keller and Mike Mooney, a professor at the Colorado School of Mines.

New world order

There has been a tremendous amount of research conducted on the post-COVID-19 economy. Remote work, flexibility, the great resignation and inflation are

By Nancy Profera, Associate Editor

Elisa Comis of McMillen Jacobs Associates leads a tour of a tunneling sight to raise awareness of the industry with the general public.



all factors in the fast-changing landscape. Although these are certainly considerations the panelists are addressing in their workplaces, some of the back-to-basics approaches of hiring and retaining employees were discussed: internships, onboarding, reverse mentoring, continuous employee engagement and getting boots-on-the-ground experience; none of these has gone away, and may be more important than ever for both workers and employers.

According to Roach, who is the UCA representative to the SME Workforce Committee, although it is difficult to find people with relevant industry experience, when he travels to career fairs, there is no shortage of entry-level engineers looking for jobs. However, “finding people willing to get a little dirty, sweat a little, and build these beautiful things we’ve built, that’s a little harder to find today,” he said, adding that on the other hand, “if we get them early enough, they’re hooked.”

One of the major difficulties in recruiting continues to be developing awareness that the tunneling and underground industry even exists, and that these jobs can be rewarding, pay well, have stability, and can in fact offer a positive work-life balance.

The panelists addressed these hurdles, and Mooney shared his perspective from the college environment. He is involved in the “Teach the Professors” program spearheaded by SME and UCA that aims to get more professors understanding and teaching underground concepts.

Academics

Mooney said that there are two pieces to the puzzle: the curriculum and professors. On a broad scale, looking at the education of civil engineers, which is the largest group of engineers who go into tunneling and underground, he said this area has slipped through the cracks, without professors trained in underground, so they are not comfortable teaching it.

Further, most of the civil engineering curriculum caters toward geotechnical and structural engineering, and doesn’t include underground. “We graduate close to 50,000 civil engineers a year in the U.S., and if you did a survey, it would be shocking how many students don’t even know underground construction is an option,” said Mooney.

According to Schmall, who is the “Down for That” initiative lead for the UCA, this is spot on. “There’s a general lack of awareness in the engineering schools about what goes on in underground construction. We’ve been working hard to promote it, and expose the professors too,” said Schmall, whose firm specializes in geotechnical construction. “Professors have a tremendous influence with students as they decide where they want to work.”

The reasons why professors aren’t prepared to teach

underground concepts are varied and include the fact that there hasn’t been enough state and federal funding for related underground programs because the tunneling and underground construction industry isn’t big or broad enough, and so these professors were funded in other areas for their research while they worked on Ph.Ds. The vast majority were brought up through the academic ranks, and they do their doctoral work in areas that are not in tunneling. “The areas of civil infrastructure that are funding research are not in underground. That’s the way it’s been for 20 to 40 years,” said Mooney.

If you contrast this to foundational engineering, for example, which involves deep piling and drilled shafts, although it is somewhat a specialty area, it is a much bigger area in terms of what is done and practiced. “Professors are trained in these areas. They’ve done research in this area. They’ve written textbooks in this area. So now you’ve got curriculum and foundations, entire courses devoted to the subject. It becomes self-fulfilling, because every civil engineering student goes through these courses and learns from the people who were trained in it, and so you’ve got an entire industry,” said Mooney.

This is not the case in tunneling. Although there are a few courses offered here and there, they are mostly electives, taken by a handful of students, and only offered at a few universities, according to Mooney.

“That’s one of the big drivers. We don’t have the curriculum in place. We’d like to create this kind of infrastructure in tunneling so that every student goes through it, gets more exposure to the topic. We are also working to get more professors trained in it so they are comfortable teaching these topics. This is the goal of the UCA Teach the Professors program,” said Mooney. “I think more broadly, we just need to grow that. As tunneling grows, you could envision a day when it’s as popular as foundational engineering.”



Mooney also pointed out that the trend he sees for students is toward more mechanical engineering degrees. “This seems to have become the de facto engineering degree. At the same time, the kind of sophistication, automation and mechanization of tunneling today, these two trends need to come together with more outreach to the mechanical engineering students.”

He thinks this is evolving and changing with awareness campaigns in underground construction and tunneling jobs and as funding from the Biden administration’s bipartisan infrastructure law starts to trickle in because colleges will be funded in those areas where the work will be done, and that too will help create awareness of these types of jobs.

There was agreement among the panelists that members of the industry must continue to create awareness among the public about all that underground construction work can offer, that there are exciting jobs in this field, and that they are open to people with diverse backgrounds and experiences. Schmall is convinced the most effective way to increase student interest is to reach young people directly. “To me, the most exciting thing you can do with a civil engineering degree is go into underground construction and tunneling. We have to wow them directly to peak their interest, then connect them to places to work,” said Schmall.

Spreading the word

Comis shared an experience she had with spreading this awareness. She is the Women in Tunneling lead for the UCA and with her firm she was involved in the construction of the Ohio Canal Interceptor Tunnel, one of the most significant projects of the Akron Waterways Renewed! program in Akron, OH. Prior to the tunnel boring machine (TBM) launch, the public was invited to visit the site and to see the fully assembled TBM. They had hoped for a few hundred people to attend, and instead they got close to 1,500 people. Out of all the networking that happened that day, Comis was invited to join the advisory board of the women in engineering at the University of Akron.

The outreach program at the university was involved in local STEM efforts, especially related to getting girls interested in engineering careers. Over time, through these connections, Comis’ firm, McMillen Jacobs, has hired two female engineering graduates directly out of this program. They are now working in McMillen’s Cleveland office. “This was a city that had never seen a major tunneling project before. The more tunnel projects that happen, the more awareness is created. I am hopeful that the more people know about these careers, the more there will be a chain effect,” said Comis.

Image of underground careers

Comis is a member of the newly formed SME Inclusion and Diversity Committee and her work in this area has made her realize that it is not just an awareness issue that is keeping people out of this industry, but one of image that must be clarified. “Today, I find prospective hires interview me instead of the other way around. They want to know and ask me right away about work-life balance,” said Comis. “If I work in underground, will I be able to have a family?” she’s asked. “Most of us are working long hours in underground, and so it can be difficult to perceive, but you can have great work-life balance in this field, and we just don’t promote it properly.”

The panelists said young people are generally very savvy today when it comes to asking for what they want and being direct in questions pertaining to employment.

Rispin, who is the UCA chair, recently lectured at the construction management program at Purdue University and said he can’t contain his excitement when he talks to students about careers in underground. These students are looking for internships too. “I talk to them about all the different facets. There’s engineering, there’s contracting, there’s suppliers, there’s owners. Underground construction definitely has some elements of theoretical, but it’s practical, and it offers a lifestyle that’s different from what kids may traditionally be thinking about. It may not be for everybody, I’m always honest about that,” he said.

What does the lifestyle of a tunneling and underground construction career offer? One major draw

for some may be the ability to travel the world. “You’ve got to be prepared to move where the projects are. There are a lot of people the world over in the tunneling industry who are nomadic. They’ll go on a project for three, four, five years and then take a break and then ... go on to the next project. If they’re attuned to wanting to see different lifestyles, cultures, see different places and challenges, then it fits them to a T, they love it,” said Rispin.

Getting to students earlier

There was also agreement that outreach needs to happen earlier, either in middle or high school. Trying to get students interested in underground construction and tunneling when they are already in college is too late. “We have great experiences talking with kids in elementary school and we see their eyes light up. We need to make these jobs as well known as those of a firefighter or police officer,” said Comis.

“We also need to recruit for a variety of populations. It’s not just about gender, but also race,” said Comis. The larger companies like Stantec are moving faster in these efforts, understanding and engaging with a broader audience for recruiting and retention.

“We have to reach them younger. Right now we’re kind of in panic mode, aiming for the college students because that’s where we think we will see immediate results,” said Schmall. “Invariably, when we do present to young people, we knock their socks off, because the work is incredibly exciting and challenging. We just need to get in front of the students and do that.” COVID has made that difficult in recent years, but the in-person outreach has started again.

“When students enter the pipeline for STEM from middle school is really the place to address the diversity issue, that’s how you change the mix and create an available pool of talent,” said Mooney.

In Comis’ experience, there is really no midpoint on how people feel about working in tunneling once they start. “They either run away or love it to death,” she said. Comis has worked in remote and difficult locations, but had realized early on she wanted a career that involved travel. “I’ve been to Africa, India, Turkey. It is often difficult; you have to be committed to sustaining the work. Being on location is part of the deal; it’s a talent or skill that you have to have in this industry,” she added.

Rispin said, “It can be tough on individuals, relationships, families. At the same time, if you’re the right people, you can make very good coin doing it and live a great lifestyle. In a lot of cases for people who go to



remote and foreign places, the compensation is very good, and a lot of R&R is built into the contract.”

Hiring

For Gall, the UCA Young Members lead, the difficulty is finding the right people at the right time. This can range from finding qualified or senior engineers to field staff. Often, the firm finds qualified field staff internationally to fulfill their staffing needs. They try and hire and train engineers in what they need to do, because there is often a gap in knowledge.

Traylor Bros. has a strong mentoring program, and Roach feels this is instrumental in their hiring the right people and keeping them on. “We try to get them early with internships, keep them engaged, and give them a reason to stay. We have a tremendous amount of training. Even 15 years on, you have to keep all employees engaged,” said Roach.

Gall feels the big design firms in New York City have a leg up when it comes to recruiting. Some of this is because they are so well known, similar to the case of a technical person first thinking of working at Google or Apple. “A lot of the young talent that we do attract is from overseas,” said Gall, whose firm has hired from Southeast Asia, the Middle East, Latin America and China, which he said does help create a more diverse workforce.

In his experience, Gall said, “A lot of the times you have people that come to the industry wanting to be a civil engineer and then end up working on an underground project because that’s the project they get assigned to and that’s what creates their interest in the industry, rather than them actually searching for a project in the underground industry. To a certain degree, tunneling is a

Careers in tunneling offer a wide variety of challenges and benefits.



small fish in a big pond,” said Gall.

“If young students knew the advantages of going to a smaller firm, as opposed to a big firm, whether it’s on the design side or the contractor side, they would jump on it,” Roach said. “You go to work for them, and there’s 300 cubicles of people in there and then you realize, that’s just their class of 2022, and you wonder, how am I going to make my mark in this environment?”

Gall said, “I love working with people who have contractor and on-site backgrounds. In the end, the physics is what it is, the rock, the structure behaves how it does, and you learn that as a design engineer. But the logistics. The nitty gritty, that you don’t learn. Sometimes things don’t go as planned, and you’ve got to make some on-the-fly decisions on site. You can’t just sit on a submittal for days because your shotcrete’s coming in and you’ve got to use it, or you don’t use it...”

He added, “You start on site and then you have an idea of how things happen on site. Then you move to the back of the house, so you can actually understand what’s going on.”

For Roach, as far as retaining people in the industry, “What we do as contractors really isn’t taught in colleges and universities. They don’t teach you how to build tunnels. You can get a course here and there on general tunneling techniques, but to get into it, to get into the weeds, it’s just not there. So what we have to do is we have to teach these students what we do and how we do it. And what we’re looking for in new graduates is people who have the basic tools in their toolbox, civil, mechanical, electrical engineering degrees, and from there we know we have to teach them what we do and how we do it.”

Conclusion

Rispin said, “I didn’t know what I wanted to do until probably the last year of college. I was studying mining engineering and was leaning toward the sales and marketing side because of the fit with my personality. After going out and doing summer jobs, I knew I didn’t want an air-conditioned office. I wanted to be on the road. I wanted to see different projects and get my hands dirty. I never wanted to do calculus again. I wanted to do practical and observational engineering, and that’s how it worked out for me.”

He added, “I think a lot of young people don’t necessarily know what they want to do. Coming back around full circle, we have an issue with making people aware of what kind of wonderful careers we can offer in our industry, but we also fight a battle to make it look attractive against some of the other options that they may be considering.”

Going back to his experience at Purdue, Rispin said, “So many of these students are looking for internships. I wonder if there’s a way we can become more systematic with that? I know there’s a lot of kids out there looking for it, and if we get to them early, we can keep them engaged.”

Gall said, “I don’t hear young people complaining too much. Most people who study civil engineering and are working in our industry are relatively content. I don’t see any issues there.”

As for the future of the industry, the International Tunneling Association’s last triannual report forecast that global tunneling is going to grow at a 7 to 9 percent compound annual growth rate.

“My international colleagues and I feel that’s conservative. It’s in the double digits. The industry is very healthy. It’s growing. Society needs tunneling. It’s going to need more tunneling, and in order to do that, you’ve got technology, but you’re still going to need more people. This number is also looking really good domestically as well,” said Rispin.

Roach predicts the same. “Last year, the Tunneling Association of Canada reached out and was inviting U.S. contractors to come up to their annual meeting because they have so much work to build up there and not enough Canadian contractors to do the work. They’re going to need outside contractors to come in.” ■

Long-distance tunneling; Challenges and trends of large projects in Europe

Mechanized tunnel construction has enormous potential to drive innovative developments and technologies in underground mining in the future. One factor is the steadily increasing need for mobility around the world, and the trend toward urbanization that makes it necessary to move more infrastructure underground and to connect the surrounding regions with central points and cities, and to create corridors of connectivity.

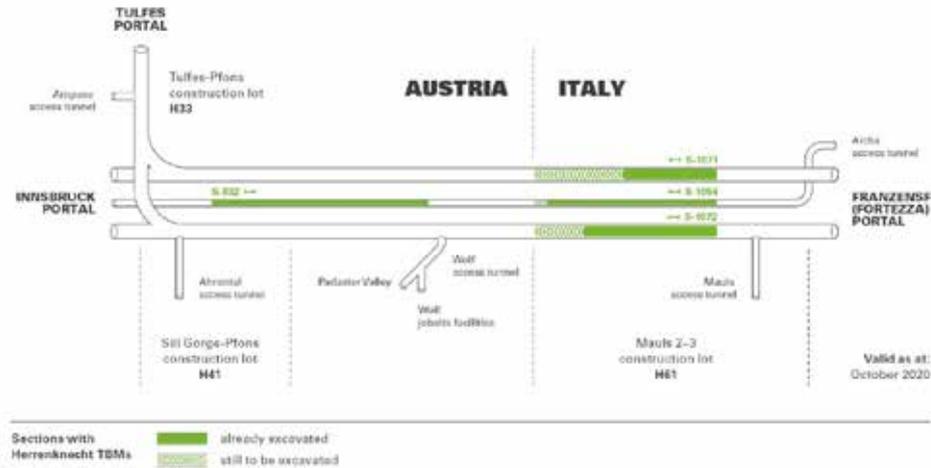
On the basis of highly specialized solutions, know-how and value-creating interaction between humankind and technology, technological progress in the planning, construction and implementation of modern infrastructure in varied and difficult terrain is constantly striving for new records. New tunneling length records are set with mega infrastructures such as the railway projects Gotthard Base Tunnel, Brenner Base Tunnel and the High Speed Two railway systems currently under construction in Europe. These are corridors of connectivity and transnational supply chains that reshape our social and physical worlds toward a borderless world. Numerous ambitious, long-distance tunnel drives are in the planning and implementation phases. This article focuses on challenges, current trends and innovations in mechanized tunneling, with exemplary projects that represent a multitude of specific geological and hydrogeological challenges at the highest level, and with regard to safety of operation.

Long-distance tunneling projects

Brenner Base Tunnel. The Brenner Base Tunnel (BBT) with a total length of 64 km (40 miles) will be another “project of a century” and the longest railway tunnel in the world since the 57-km (35-mile)-long twin tube Gotthard Base Tunnel (rail connection between Switzerland and Italy) that was commissioned in 2017.

The BBT will be the centerpiece of the Scandinavian-Mediterranean TEN-T Corridor from Helsinki (Finland) to Valetta (Malta) and will contribute to sustainable transnational mobility. It is a twin-tube single-track rail

FIG. 1
BBT - Overview of the TBM tunneling lots.



tunnel (internal diameter, ID = 8.1 m or 26 ft) with a service and drainage gallery (ID = 5 m or 16 ft) in between that is about 12 m (40 ft) below the main tunnel tubes over its entire length. The service gallery enables ground improvement measures to be carried out for the construction of the main tunnels and reduces the extent of preexploration measures from the main tunnel tubes. The rail link, connecting the countries of Austria and Italy, follows the highest safety standards for tunnels with the main tubes linked every 333 m (1,100 ft). In emergencies, these cross passages will be used as escape routes.

Construction of the transnational century project started in 2007. More than 75 km (46 miles) are being built using a total of four tunnel boring machines (TBMs) designed and manufactured by Herrenknecht in Germany.

One gripper TBM with a diameter of 7.91 m (26 ft) has been excavating the exploratory tunnel from Austrian Ahrental toward the Italian border in predicted loose to friable rock mass with squeezing rock zones. The gripper TBM started tunneling on Sept. 26, 2015 and excavated

Karin Böppler

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FIG. 2

Exploratory tunnel Tulfes-Pfons, gripper TBM, and rock support due to prevailing convergence.



about 16.7 km (10.3 miles) southward toward Italy, completing its work on July 6, 2019. In solid rock, the gripper TBM performed with daily top performances of 61 m (200 ft) and monthly performances of 825 m (2,706 ft), while regular weekly performances of around 200 m (650 ft) were standard over many months. Extremely difficult rock formations with highly squeezing and swelling rock conditions with extensive invert heave along with encountering fault zones, sometimes with large-volume rock collapses, were some of the challenges along the exploratory tunnel section. The TBM advance rates were determined in these conditions largely by the high degree of rock support required in the L1 and L2 area of the gripper TBM. In the L1 area directly behind the gripper TBM anchors and steel mesh were standard except in extremely difficult rock formations that required shotcrete and 360° TH arches as initial rock support that were replaced with U-profiles in the course of further advances. The shotcrete equipment in the L2 area was used regularly and required greater availability. The applied gripper TBM technology for that exploratory tunnel section was proven technology and was already successfully used in numerous

other complex projects in the Alps such as the Lötschberg rail tunnel with a bored tunneling length of 20 km (12 miles) and Gotthard Base tunnel with a total of 85 km (52 miles) of bored tunnel length. New in the evolutionary stage of this technology were systems such as the disc cutter rotation monitoring (DCRM) that helped to optimize tool maintenance intervals and thus improvements in tunneling in terms of performance, safety and quality.

For the excavation of the 48-km (30-mile) main tunnel tubes of the BBT, two large-diameter double-shield TBMs (Ø10.65 m or 35 ft) were employed. One smaller diameter double-shield TBM (Ø6.82 m or 22.3 ft) excavated an additional section of the exploratory (and later drainage and maintenance) tunnel over a length of 14 km (8.7 miles). The three double shields were applied to excavate and line part of the Italian construction lot “Mauls 2-3.” TBM supply for the mechanized tunneling lot of Mauls 2-3 is supported by train and mucking out by tunnel belt. In March 2021, a new record was set by one of the double-shield TBMs (Ø10.65 m) that tunneled a section of 14 km (8.7 miles) in geology that is mainly characterized by Bünderschiefer with locally unstable tunnel face conditions.

The TBM is operated by the contracting joint venture BTC S.c.a.r.l. (Astaldi S.p.A., Ghella S.p.A., P.A.C. S.p.A. and Cogeis S.p.A.). The team achieved performances of up to 860 m (2,821 ft) in one month with an average daily advance rate of 27.7 m (90.1 ft) and peak performances of up to 36.75 m/d (120.5 ftd).

FIG. 3

High Speed Two railway line. Overview of alignments, phase one.



High Speed Two (HS2). High Speed Two (HS2) is a new national high-speed rail network north of London currently under construction in the United Kingdom. The new railway line will address the rising demand for intercity journeys, commuting and freight rail transport. Phase one of HS2 is currently under construction and will run between London and Birmingham. Phase one comprises more than 100 km (62 miles) of tunneling. It is built to ease congestion on the West Coast Main Line. Phase two of the new high-speed rail line will focus on the connections further north, from Birmingham to Manchester and Leeds.

Phase one comprises six twin running tunnels

FIG. 4

Chiltern Tunnel, variable density TBMs (Ø10.24 m) with hydraulic mucking.



with inner diameters of 8.8 m (29 ft) spaced approximately 20 m (65 ft) apart (center line to center line). Tunnel sections were introduced to improve the environmental impact and were thus defined beneath built-up areas where disruption at the surface would be severe. The tunnels connect to portal structures at either end and are connected along their lengths by cross-passages and ventilation shafts. The route alignment of Phase one comprises long tunneling sections such as the twin-bore Chiltern Tunnel that extends over a length of approximately 16 km (10 miles) and is thus one of the longer tunneling sections along the route. Two variable-density TBMs (Ø10.24 m or 33.6 ft) are being used to excavate the twin tunnels that are mainly driven through firm to hard chalk. Locally very high permeability in chalk and the likelihood of karst formation were predicted as well as the presence of minor layers of marl and nodular flint.

The design and construction work for the Chiltern Tunnel was contracted to the Align Joint Venture (JV) of Bouygues Travaux Publics, S.A.S, Sir Robert McAlpine Ltd. and Volkerfitzpatrick Ltd. The JV decided to use variable-density TBMs with hydraulic mucking instead of a mixshield or earth pressure balance (EPB) TBM to deal with the variable and locally highly permeable chinks along the 16-km (10-mile)-long tunnel sections and with hydrostatic pressures of up to 5 bar at TBM axis. It is considered that the chosen variable density technology has less impact on the nearby potable water stratum as less slurry flow to the face is required than with a standard slurry or mixshield TBM. This will reduce the risk of losing slurry in the highly fractured chalk that could possibly pollute drinking water wells. The 10.24-m (33.6-ft) diameter variable-density TBMs used for the Chiltern Tunnel are designed with only one muck transportation system in the tunnel, with a slurry circuit that functions in the corresponding closed operating mode. The muck is extracted from the pressurized excavation chamber by a 20-m (65.6-ft) long screw conveyor. At the discharge end of the screw conveyor, the excavated soil is transported into a slurryfier box where the muck is liquefied. The slurryfier box is fitted with a rotary sizer that can deal with the predicted flint nodules and processes the material to a size suitable for hydraulic mucking through the slurry circuit.

An additional two variable-density TBMs are used by the Balfour Beatty Vinci Joint Venture for the northern tunnel sections closer to Birmingham, the N1 Long Itchington Wood Tunnel (TBM-Ø 9.92 m or 32.5 ft) and the Bromford Tunnels (TBM-Ø 8.56 m or 28 ft). The N1 Long Itchington Wood Tunnel is a twin bore (ID = 8.8 m or 28.8 ft) of 1.58 km (1 mile) in length and the Bromford Tunnels (ID = 7.55 m or 24.7 ft) comprise twin bores of 5.7 km (3.5 miles) in length. Both tunnel sections are being built in Mercia mudstone. In its unweathered state, the Mercia mudstone may be described as an intact, jointed, weak rock, whereas in its fully weathered state, it is a reddish-brown, very soft to hard silty clay, but frequently containing less weathered mud-rock clasts.

The specific added value of variable density TBM

application for these tunnel sections had been based on the predicted geological conditions, environmental sensitivity around the tunnel and muck-out management. The variable density TBM technology shows the advantages regarding the excavation through soils of different behavior in respect to face-pressure control, especially in areas where ground cover is limited, or in areas where the TBM passes beneath or close to sensitive assets and residential properties. The technology also shows advantages regarding achievable performances in ground conditions with high fines content, and shows an added value with regard to muck management. Hydraulic mucking out of the excavated material and related slurry treatment plant enables, through the filter press process, cakes with a reduced moisture content. Muck treatment with a high percentage of lime addition in urban environments can thus be avoided and reduces transportation due to limited weight by about 10 percent with better opportunities to reuse excavated muck for landscape fill.

The tunnel sections for Lot S2 Northolt Tunnels comprise twin tunnels (ID = 8.8 m or 28.8 ft) of about 8 km (5 miles). This contract was awarded to the Skanska Costain Strabag JV that will use two EPB TBMs with a shield diameter of 9.82 m (32.3 ft). The subsurface conditions along the tunnel sections comprise clay of the Lambeth Group and mixed face conditions with chalk containing flints. Hydrostatic pressures of up to 5.5 bar at tunnel invert will be faced. Another EPB shield (Ø7.08 m or 23.2 ft) is applied to the 850-m (2,770-ft)-long section of lot S1 Atlas RLT.

As most of the defined tunneling sections within phase one of HS2 are characterized by long tunneling drives, innovative systems such as partially or fully automated subsystems in the TBM supply chain were designed that support the TBM supply logistics. The Chiltern TBMs, for example, are designed to operate in a semicontinuous advance mode. The tunnel lining for Chiltern comprises 2-m (20-ft)-long segment rings, and the TBM is equipped with

FIG. 5

Assisted segment ring building.



14 thrust cylinders pairs. All pairs have a stroke of 3,200 mm (125 in.) and are equipped with stroke measurement systems. In semicontinuous advance mode, the excavation cycle starts with excavation in standard mode for 1,200 mm (47 in.), allowing a 400 mm (15.7 in.) clearance to insert the two first segments while the machine is stopped. Then the excavation continues in semicontinuous mode with the operator setting the advance speed. The thrust force is thereby regulated by the programmable logic controller.

The Northolt TBMs are designed with innovative packages such as fully automatic segment transfer and assisted segment ring building. The fully automatic segment transfer, for example, starts with the pickup of the first segment stack by the segment stack transfer wagon from the quick unloading system and ends at the position where the erector picks up the first segment from the segment feeder. The automatic segment transfer system includes a segment scan system that can evaluate, with the help of artificial intelligence, possible defects to the segments such as spallings on segment edges or missing dowels or defects to the segment gaskets. This information is visualized in the control cabin.

The benefits of such a fully automatic process are improvements in safety and quality and a more economical operation with savings in personnel costs and time. In countries with high labor costs, such technological innovations gain more in importance. The assisted ring building system is another major advantage with respect to safety. This assistance system consists of segment picking and segment positioning that support the erector driver placing the segments in their correct positions. Live camera pictures help to assist the erector operator during picking up the segment, and sensors support the operator while placing the segment in its correct position.

Santa Lucia Tunnel. The Santa Lucia project is a 7.5-km (4.6-mile)-long twin-tube highway tunnel north of Florence in Italy. Apart from long tunneling drives, the project is also unique due to the TBM size applied for this highway section between Bologna and Florence crossing the Apennine mountains. The twin tunnels each carry three traffic lanes with a width of 3.75 m (12 ft) and

two 0.7-m (2.3-ft) wide side-strips. With a diameter of 15.87 m (52 ft) the EPB TBM is Europe's largest TBM, and in combination with long tunnel sections, the project was an unprecedented logistical and technical challenge that was successfully mastered within less than three years. Extraordinary challenges in addition to the tunneling length and machine diameter also include project specifically defined ground conditioning limitations, alternating geology with sedimentary rock mass and slope deposits, and gassy soil conditions (radon, carbon dioxide and methane). This demanded a specific TBM solution affecting,

for example, the design of the shield structure, main bearing and its seal system, thrust forces, mucking and equipment for interventions. The applied EPB TBM was designed for 6 bars. The tunnel has an inner diameter of 14.3 m (47 ft) and consists of a segmental lining with an outer diameter of 15.4 m (50.5 ft). The precast reinforced concrete rings of 2.2 m (7.2 ft) in length are 550 mm (20 in.) thick and are fitted with gaskets to guarantee watertightness.

The EPB TBM had to cope with sections characterized by instable tunnel face conditions, sections with potential gas presence in the rock mass and fault, fractured and/or transition zones with locally low cover. The overburden along the tunnel alignment was characterized by mainly a cover of more than 48 m (158 ft) with up to 270 m (886 ft) as a maximum. In these conditions, the EPB operated in closed mode with the excavation chamber completely filled with excavated and conditioned material to actively support the tunnel face and to avoid possible explosion hazards in the gassy ground conditions. The 130-m (426-ft)-long TBM was designed with a nominal thrust force of 314,218 kN. A total of 25 electric motors generated a maximum torque of 123,000 kNm. The cutting wheel rotated at speeds of up to two revolutions per minute. It was fitted with 78 face and gauge 500 mm (19-in.) single disc cutters, six double discs in the center, 156 soft ground tools and 16 buckets.

A special TBM design feature to counteract the potential risk of gases and thus explosions was a special double-walled enclosure of the 70-m (230-ft)-long conveyor belt that was permanently ventilated. This double-walled structure included the section from the screw conveyor discharge gate to a transverse conveyor belt on the TBM backup. Possible gas emission was avoided by keeping this double-shell structure in overpressure. This was supplemented by the continuous supply of large quantities of fresh air that would dilute any gas presence within this encapsulated system before reaching the transfer belt conveyor and the loading chute to the tunnel belt. All the equipment in that area is fully explosion proof, and the air quality and the tightness of the systems are permanently monitored. The system comprised an elaborate gas detection, alert and shutdown scheme that was developed by Herrenknecht to meet specific regulations and to

FIG. 5

Encapsulated conveyor belt to avoid gas emission.



ensure the safety of personnel on the TBM and behind it at any time. Depending on the sensor position, the equipment reacted with different sensitivity. For example, the detection of a low methane concentration of 10 percent of the lower explosive limit (LEL), would not cause an advance stop if detected in the belt conveyor enclosure. On the other hand, if detected outside this channel, an immediate shutdown would have been triggered. The TBM also had a duplicated ventilation system installed that circulated fresh and clean air supplied by two air ducts installed from the portal. They worked independently of each other and guaranteed the supply of fresh air to the TBM. Key information from the ventilation and gas monitoring systems was transmitted to the control cabin along with the other current tunneling parameters so that the TBM operator could monitor the data on the display screens and could take corrective action if needed.

Rubber-tired multiservice vehicles are used for the tunnel supply logistics that carry one complete tunnel ring. The 2.2 m (7.2 ft) long precast reinforced concrete rings (9+0 elements) have a weight of 123 t (135.7 st).

The EPB TBM for the Galleria Santa Lucia highway tunnel project was designed and manufactured by Herrenknecht in Germany. After a one-year predesign and manufacturing period, the TBM was accepted in August, 2016 at the manufacturer's factory in Germany. The company Pavimental S.p.A started excavation in early May 2017. It took less than three years to construct the 7.5-km (4.6-mile)-long twin tubes. The tunneling team achieved an overall average performance of five rings per day, respectively 11 m/d (36 ftd). A best daily performance of 10 rings or 22 m (72 ft) was achieved with a best weekly performance of 55 rings (121 m or 397 ft). The overall project duration was impacted by numerous factors. This comprised regular planned maintenance stops for cutting wheel and tailskin refurbishments due to abrasive geology and long tunnel drives, logistics impacts, probe drilling for geological exploration, and jobsite closures. During the COVID-19 pandemic, the project region was heavily hit between March 2020 until the TBM breakthrough on June 8, 2020 that made it also necessary to close down the jobsite for a period of time. Nevertheless, the project was successfully completed safely and in time with the EPB TBM that mastered challenges such as a very large TBM diameter, long-distance tunneling, permanently variable geological conditions, cover, abrasiveness and gas potential.

Conclusion

The mega infrastructure projects highlighted in this article are all comprised of long tunneling sections. The projects are remarkable corridors of connectivity and differ in terms of their complexity, risk sensitivity and requirements. This, in combination with the tunneling

lengths, sets an impulse in the technological development to construct corridors, respectively foundations of social mobility and economic resilience with the help of mechanized tunneling technology.

Long tunneling drives demand resilient equipment to construct the infrastructure. All mentioned projects involve TBM technology that has already proven its reliability and dependability in a multitude of complex projects worldwide. When supporting projects of this kind with particularly long tunneling drive challenges such as uncertainties in ground conditions, rock burst and squeezing phenomena, gassy soil or rock conditions are common and demand robustness and durability of applied technology and the logistics of the supply chain. This, in combination with an experienced tunneling team, is the key to project success.

Part of the evolutionary stage of mechanized technology and with the focus on long tunneling drives is the trend to have systems on board of the machines that help to optimize tool maintenance intervals. The DCRM and DCLM systems provide information to help with assessments about the nature of the tunnel face. This in combination with camera systems in future real-time preliminary exploration will be possible. Innovative packages such as semicontinuous operation, automatic segment transfer and assisted segment ring building complement innovative developments and trends and support to increase safety of workers and work processes, but they also positively impact performance rates, quality and on more economical operations, assist with savings in personnel costs and time. ■

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Fox Conference returns to New York City with record attendance

by William Gleason, Editor

In November 2021, President Joe Biden signed the bipartisan \$1 trillion infrastructure bill into law. The bill was written with the intention of rebuilding and improving the nation's roads, bridges, highways, tunnels and internet access.

Shortly after it was signed into law U.S. Transportation Secretary Pete Buttigieg called it “the most significant investment in jobs and infrastructure in my lifetime,” saying the bill will “rebuild and replace infrastructure that is decades, or even a century, old.”

On Tuesday, May 10, Federal Transit Administrator Nuria Fernandez spoke to more than 380 tunneling and underground construction professionals during the George A. Fox Conference at the New York Hilton Midtown. Fernandez, the 15th FTA administrator, spoke about the legislation that she said will make \$73 billion available for tunnel construction in the United States.

“The signing of the bipartisan infrastructure law was historic and necessary,” said Fernandez. “With the funding from this law we want to build and connect communities and that is what you do — your industry connects communities.”

The funding available from the bill for the construction of transit and water tunnels is enough to pay off eight current projects and put another seven in the pipeline, said Fernandez. Of particular interest is the \$13 billion Hudson Tunnel Project that will build two new tunnels and rehabilitate the existing 111-year-old tunnels connecting New York and New Jersey. In March, the project completed the geotechnical investigation work, a necessary part of entering the engineering phase of the \$5.6 billion Federal Transit Administration Capital Investment Grant (CIG) it is seeking for the Hudson Tunnel Project.

The infrastructure legislation includes at least \$12.3 billion for New Jersey's roads, bridges and transit, which would include billions of dollars that can be tapped to build the Gateway Tunnel under the Hudson River.

During her presentation, Fernandez assured the audience that the Biden administration supports the tunneling industry and is “working very closely with the Hudson Tunnel project sponsors.”

Fernandez, who was previously general manager and chief executive officer of the Santa Clara Valley Transportation Authority (VTA) said future projects will be considered with the people they will serve at top of mind.

“We support the work you do, and we are committed to your innovations, designs and thoughts,” said Fernandez. “We want to make sure what we are building will be sustainable, will connect communities and serve those communities, and will be there for centuries to come.”

The George A. Fox Conference celebrated its 20th anniversary; however, it opened with chair Robert Palermo asking for a moment of silence to honor two of the conference's founding members, Edward Plotkin and Ray

Fox Conference chairman Robert Palermo and FTA Administrator Nuria Fernandez.



Henn, both of whom died in early 2022. Palermo said they were giants in the industry (see pages 28 and 29).

The one-day conference included sessions focused on the challenges of rethinking and recalibration of the design-build process; a tunnel industry update and a panel focused on workforce sustainability in addition to a number of presentations about tunneling projects. The projects discussed included the Catskill Aqueduct construction; Crossings under the Hudson River; Amtrak Northeast corridor tunnel and station projects, I-64 Hampton Roads bridge tunnel expansion and Bergen Point Outfall.

The conference, held for the first time at the Hilton Midtown, included a special session on the history of the conference and the man it was named for, George A. Fox, who was president of Grow Tunneling and had a 50-year career in tunneling in the New York City area. He played key roles in the construction of 70 major public works projects valued at \$61 billion. Lonnie Jacobs interviewed David Goodman of Grow Tunneling in a video remembrance of Fox.

The conference included an interesting talk about the history of crossing under the Hudson River from Angus Gillespie, author of *Crossing Under the Hudson: The story of the Holland and Lincoln Tunnels*. ■

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Dr. Raymond W. Henn

An appreciation by William Warfield

Ray Henn was born Feb. 8, 1949, in Brooklyn, NY. He passed away suddenly in Centennial, CO on March 28, 2022.

One measure of a man can be determined by the honors and recognition bestowed upon him by his peers, which were many in Henn's case (president of the American Underground Association 2002-2004, a Distinguished Member of the SME, the Moles and the Beavers), and he was the author of more than two dozen professional papers and three American Society of Civil Engineers (ASCE) textbooks. However, the things that you won't learn about Henn from his published obituary are what many don't know about his early family history. He dropped out of Alexander Hamilton High School in Brooklyn at the age of 17 to join the U.S. Army in 1967 where he served with the Green Berets for two years in Vietnam.

One of Henn's passions in life was education, and he earned his GED while serving in the military. Upon returning home, he attended New York City Community College and earned a degree in geology from Queens College of the City University of New York. In 1973 he married Patricia Ann Donegan.

While working for Stone & Webster in Oswego, NY, Henn earned his

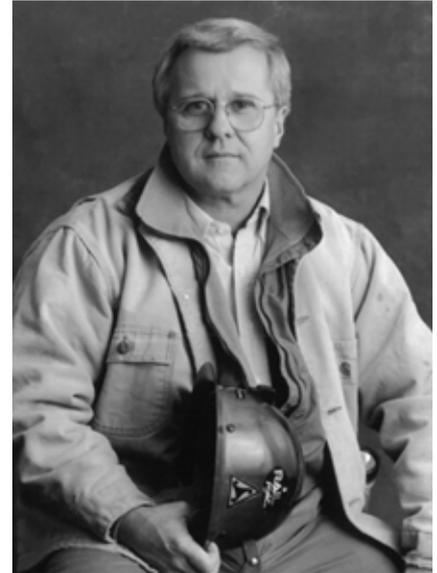
master's degree from State University of New York in association with Syracuse University.

After the completion of the Raystown Hydro Project, Henn was transferred to Centennial, CO. Though he left New York behind him, he maintained the humor and speech common to that area. He continued with his education and received a PhD. from the Colorado School of Mines (CSM), Mining and Earth Systems Engineering. He wanted to give back and was proud of the fact that he was an adjunct professor in the mining department at CSM. He established the first student chapter of the UCA of SME at CSM and served as the faculty advisor for eight years. He was a mentor to many students.

Henn was also instrumental in establishing numerous short courses and being involved in others. He was an industry expert in the field of grouting and underground construction, having authored the three ASCE textbooks.

While working for Haley & Aldrich, Lyman Henn and later Brierley Associates, he found time to be involved with the American Underground Association (AUA), where he served as president from 2002 to 2004. The AUA later became the UCA of SME.

Another of his passions was collecting antique equipment from the mining/tunneling industry of Colorado



Dr. Raymond W. Henn

and the West. If you visited Henn at his home, the first thing you had to do was visit his museum in the basement.

Henn was a unique individual, a resident of Colorado for more than 35 years but always had some New York in him. He remained friends with many students after their graduations. Though he died at 73, he still had many things yet to accomplish. He leaves behind his wife of 48 years, Patricia, son Daniel and granddaughter Morgan. He was preceded in death by his son, Patrick. ■

ITA Tunnelling Awards nominations open

Since 2015, the international competition "the ITA Tunneling and Underground Space Awards" seeks and rewards the most groundbreaking innovation and outstanding projects in tunneling and underground construction.

Through eight categories, this competition aims to identify the most important ongoing underground works and technologies that help cities change and enable habits and ways of life to evolve in order to build smart and sustainable urban areas.

Nominations can be submitted for the following categories and must contain projects for which the major civil engineering work was completed between March 1, 2019 and April 1, 2022. The Young Tunneller of the Year rewards an individual born after Jan. 1, 1986 and who has brought an outstanding contribution to tunneling.

ITA Awards 2022 categories:

- Major Project of the Year (more than €500 million).

- Project of the Year (between €50 million and €500 million).
- Project of the Year (up to €50 million) including renovation.
- Technical Innovation of the Year.
- Beyond Engineering – Making underground works projects even better.
- Product/Equipment Innovation of the Year.
- Innovative Underground Spaces.
- Young Tunneller of the Year. ■

Edward Sheldon Plotkin

Edward Sheldon Plotkin passed away on April 21, 2022 in Silver Spring, MD at the age of 89. Ed, as he was commonly known, was born on Oct. 11, 1932 in the Bronx, NY to his parents Samuel and Anna. He lived most of his adult life in Dobbs Ferry, NY. He was married to Frances Plotkin for the last 30 years, after his wife and mother of his children, Pearlene Plotkin, passed away.

Plotkin obtained his bachelor of civil engineering in 1953 from City College of New York (CCNY). After serving in the U.S. Army from 1954 to 1956 he earned his master of civil engineering in 1958 from CCNY, and an M.B.A. in engineering management in 1966 from the City University of New York (CUNY) Baruch School of Business. He was awarded an honorary doctor of science in 2019 by CCNY for his engineering contributions to the city of New York.

Plotkin was the recipient of many honors, including Construction Engineer of the Year in 1986; the Engineer of the Year Award in 1991 by the NSPE Westchester Section; and the Engineer of the Year Award by the Municipal Engineers of the City of New York in 1998. The UCA of SME awarded Plotkin the 2010 Lifetime Achievement Award. CCNY awarded him with the Alumni Association Service Award. He was further honored in 2011 by CCNY with the Townsend Harris Medal that recognizes excellence in postgraduate achievement.

Plotkin worked in many facets of heavy construction and tunneling. Employed with a heavy construction contractor, he was vice president of the tunneling firm Maclean Grove. He was project manager for the 63rd Street Cross-town Subway section near Central Park in New York City; two cavern stations on the Washington, D.C. Metro; a station cavern on the Boston subway; and completion of a section of the 13 miles of the New York City Department of Environmental Protection City Water Tunnel No. 3 between the Yonkers

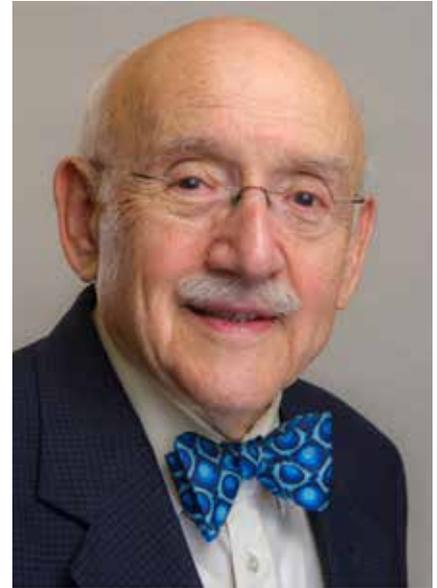
reservoir and the Queens connecting shaft passing under three New York City boroughs and two rivers.

As a designer, he was assistant director with engineering consultant firm DeLeuw Cather (now Parsons Transportation) for the 1970s plans for the 2nd Avenue Subway, and was later a consultant with the design team for the present 2nd Avenue Subway project. He served as co-chair, NYSSPE Task Force, Tappan Zee Bridge replacement study, from 2002 to 2012.

In government, he was Westchester County's Commissioner of Public Works for four years in the 1990s and was chair of the Planning Board in the Village of Dobbs Ferry for 50 years, actively reviewing, planning and approving land development and conservation projects.

Plotkin was still actively consulting on constructability issues, peer review, mediation and dispute board reviews.

He was a professional engineer registered in New York, New Jersey, Connecticut, Washington, D.C., and Massachusetts. He was a member of many professional organizations, including: the Municipal Engineers of the City of New York and the New York State Society of Professional Engineers (NYSSPE, Westchester Chapter), both of which he served as president; the American Society of Civil Engineers (ASCE), of which he was a fellow (he served as a director of the metropolitan section and chair of the geotechnical group); director in the Westchester Municipal Planning Federation; a member and past trustee of The Moles. Plotkin was also affiliated with UCA; the International Tunneling Association, where he served as their UN NGO representative; the Society of American Military Engineers and the New York State Highway Superintendents Association (President's Committee). He was chair of the Westchester County Professional Prequalification Board, appointed by the County Executive and approved by the County Board of Legislators.



Edward Sheldon Plotkin

In academia, Plotkin was an adjunct professor, taught physics at Manhattan College and environmental science at Mercy College. He has lectured on public works and urban construction at Pace University, NYU Real Estate School and University of Detroit. He is a past president of the CCNY Engineering School Alumni Board, and was an active member of the Civil Engineering Advisory Group (CEAG) of the CCNY Alumni, which organizes professional forums and field trips to construction sites for current students. For 12 years, he also taught environmental science college courses to incarcerated men and women at the NYS Sing Sing and Bedford Correctional Facilities in Westchester.

Plotkin is survived by his wife, Frances Plotkin, his brother Herman Plotkin, his children Robert Plotkin (Lisa Olsson), David Plotkin, stepchildren Terri Rosenblatt and Bernie Rosenblatt (Jean) and his grandchildren Emily Plotkin (Robert and Lisa) and Ian Lopez (Lisa) and step-grandchildren Megan Rosenblatt and Mathew Rosenblatt (Bernie and Jean).

He was predeceased by his first wife Pearlene Plotkin and his eldest brother Maurice Plotkin. ■

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/NYC	NJ/NY	Subway	14,600	24.5	2023	Under design
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	11,000	27	2024	Under study
Flushing Bay CSO	NYC_DEP	New York	NY	CSO	16,500	22	2026	Under study
Cross Harbor Freight Tunnel	NYC Reg. Develop. Authority	New York	NY	Rail	25,000	30	2025	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	RFQ 1Q 2022
Superconducting Maglev Project - Northeast Corridor	TNEM/BWRR	Washington	DC	Rail	146,520	43	2023	Under design
Alum Creek Relief Tunnel Phase 1	City of Columbus	Columbus	OH	Sewer	30,000	18	2023	Under design
Phase 2					21,000	14	2024	Under design
Southerly Storage Tunnel	NEORS	Cleveland	OH	CSO	18,000	23	2023	Under design
Big Creek Storage	NEORS	Cleveland	OH	CSO	22,450	20	2026	Under design
Northside Interceptor Tunnel	City of Akron	Akron	OH	CSO	6,850	24	2025	Under design
ALCOSAN CSO Ohio River	Allegheny Co. Sanitary Authority	Pittsburgh	PA	CSO	24,000	18	2023	Under design
Allegheny River					28,000	18	2027	Under design
Monongahela River					28,000	18	2030	Under design
DELORCA Wastewater Tunnel	DELORCA	Chester	PA	CSO	45,500	13	2023	Under Design
Enbridge Line 5 Tunnel	Enbridge	Traverse City	MI	Oil	23,760	12	2023	RFP issued
Minneapolis Central City Parallel Tunnel	City of Minneapolis	Minneapolis	MN	CSO	4,200	10-19	2022	Final planning

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
Stormwater Control Program	Harris Co. Flood Control District	Houston	TX	CSO	52,800	25-40	2022	Under design
Bushy Creek Phase 2 Water Delivery	Bushy Creek Regional Authority	Austin	TX	Water	8,780	12	2022	Thalle/SAK low bidder
Project Connect Subway Program	City of Austin	Austin	TX	Subway	8,500	20	2023	Under design
D2 Subway - 2nd Light Rail Alignment	Dallas Area Rapid Transit	Dallas	TX	Highway	7,230	22	2023	Under design
Mill Creek Trunk Improvements	City of Nashville	Nashville	TN	CSO	13,800	10	2023	Under design
I-70 Floyd Hill Highway Tunnel	Colorado Dept. of Transportation	Denver	CO	Highway	15,840	60x25	2022	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	43	2022	Shortlisted
California Waterfix 1 California Waterfix 2	Delta Conveyance Design and Const.	Sacramento	CA	Water	39,905 200,000	28 40	2025+ 2025+	Delayed Delayed
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	2022	Shortlist announced
Massey Creek Tunnel	City of Toronto	Toronto	ON	CSO	20,000	15	2022	Under design
Inner Harbour West	City of Toronto	Toronto	ON	CSO	18,400	19	2022	Under design
Yonge St. Extension	Toronto Transit Commission	Toronto	ON	Subway	24,300	20	2022	Under design
West Vaughn Sewage Servicing Project	York Region	Toronto	ON	Sewer	36,000	10	2022	RFP Q3 2022
Blue Line Extension	Societe de transport de Montreal	Montreal	QC	Subway	19,000	33	2022	Under design
REM-S Project	Societe de transport de Montreal	Montreal	QC	Subway	29,000	33	2022	Under design
Quebec City - Levis Tunnel	Quebec Transportation Ministry	Quebec City	QC	Highway/ Transit	27,230	60	2025	Under design
Green Line LRT	City of Calgary	Calgary	AB	Transit	8,500	40	2022	RFQ submitted
Nose Hill Project	City of Calgary	Calgary	AB	CSO	10,800	10	2023	Under design
Eagle Mt. Pipeline	Fortic BC Woodfibre	Vancouver	BC	Oil	29,500	13	2021	FKCI/Michels JV awarded
Stanley Park Water Supply Tunnel	City of Vancouver	Vancouver	BC	Water	5,000	15	2022	Under design

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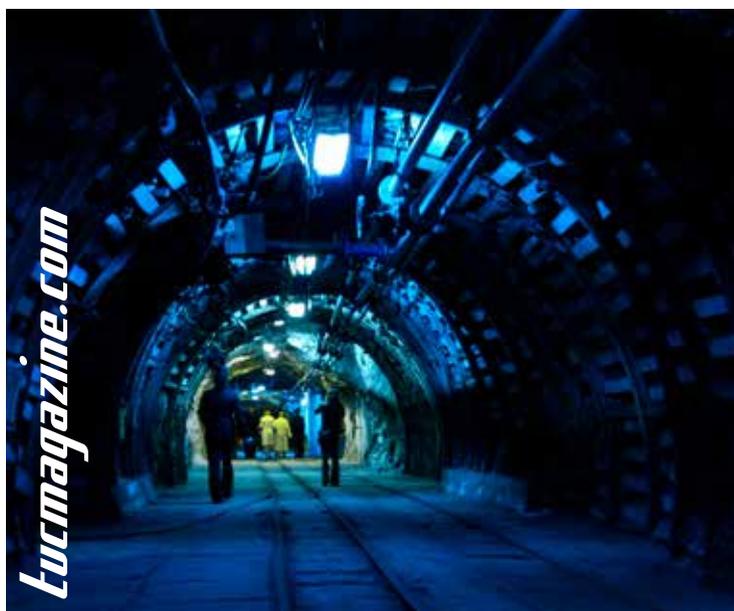
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NAT ShowGuide

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NAT2022
NORTH AMERICAN
TUNNELING CONFERENCE

JUNE 19-22, 2022

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HAMPTON ROADS BRIDGE TUNNEL (HRBT)

Machine type: Variable Density TBM

Diameter: 13,990mm

Tunnel length: 2 x 2,440m

Owner:

› Virginia Department of Transportation (VDOT)

Contractor:

› Hampton Roads Connector Partners (Joint Venture of Dragados USA, Vinci Construction Grands Projets, Flatiron Constructors, Dodin Campenon Bernard)

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Contractors, engineers, vendors and owners converge at the North American Tunneling Conference (NAT) to share solutions to complex problems.

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The comprehensive technical program features four tracks focusing on leading developments and issues that matter to you. Industry leaders share information about implementing best practices, successfully navigating design issues, and planning for project risk.

- Case Histories Track
- Design Track
- Planning Track
- Technology Track



NETWORKING

After a day of sessions, be sure to spend time building relationships at NAT at conference event favorites like:

- Owners Reception
- UCA Women in Tunneling Reception
- UCA Young Members Networking Event
- Mentoring Program



SHORT COURSES

NAT Short Courses take place Sunday, June 19 from 9:00 AM - 4:30 PM. Earn 7 PHD credits for attending one of these short courses:

- Big Data in Tunneling
- Support of Excavation, Design and Performance. Approach to Efficient and Safe Design



SHORT COURSES

Big Data In Tunneling

Sunday, June 19, 2022 | 9:00 am - 4:30 pm | Salon A, Level 5

Member \$400 | Nonmember \$510

This one-day workshop will introduce how “Big Data Analytics” can be used within the tunneling industry. Various technologies will be presented to show how the collection, management, and analysis of data can be used in the design, construction, construction management and operation of underground projects. The presenters will showcase various case studies, which will highlight the benefits and opportunities that can be achieved, and attendees will gain an understanding of the various software and equipment that is currently being used. The course is intended for anyone interested in an introduction to the use of “Big Data,” and the course will highlight benefits for Owners, Consultants and Contractors.

Part 1: Introduction to Big Data in Design Delivery

Showcasing how digital technologies such as BIM and the use of a Common Data Environment integrate design work processes and connect Owners, Engineers and Contractors working on the same project over its lifespan from the planning and design stages through to tunnel operation and maintenance.

Instructor: Jay Mezher, Mott MacDonald

Part 2: Big Data in Geotechnical Interpretation and Tunnel Design

Describing how the plethora of geotechnical investigation data collected during a projects planning and design stages can be effectively managed and presented by 3D geological models for use in tunnel design, reporting and procurement using tools such as Leapfrog.

Instructor: Dafydd Chandler, Mott MacDonald

Part 3: Big Data in Instrumentation & Monitoring

Examining how technology can be used to monitor the performance of tunnel construction, this session will describe how software is used to monitor TBM performance, ring build information and the interpretation of Geotechnical Instrumentation data.

Instructor: Rene Reichl, BabEng

Part 4: Big Data in Construction

Showcasing how software applications allow Owners, Contractors and Construction Management teams to more efficiently collaborate on large tunnel projects. Various software applications will demonstrate how tasks such as Document Control, Change Management, Field Inspection and Quality Control, can be streamlined.

Instructor: Paul Heslop, Mott MacDonald

Part 5: Big Data – Tying it All Together, What Can we Learn

Describing how the myriad of data collected by Owners can be better used to improve future industry performance including how monitoring data can be used for back analysis of numerical modelling work, to help to improve the future project accuracy and requirements.

Instructor: Youssef Hashash, University of Illinois

Support of Excavation, Design and Performance. Approach to Efficient and Safe Design

Sunday, June 19, 2022 | 9:00 am - 4:30 pm | Salon B, Level 5

Member \$400 | Nonmember \$510

Safe and efficient open excavations are critical parts of underground construction projects. Support of excavation (SOE) design impacts many aspects of the project. Combining the technical aspects, practical considerations, and meeting the project contractual requirements to achieve this goal is not an easy task. This course provides a road map for choosing and designing the appropriate SOE system that is right for your project. It also provides design methodology and details with some examples. In addition, SOE performance is a critical part of the design to protect existing structures, both above and underground. You will learn about optimizing the SOE performance to protect exiting structures and meeting third-party requirements. This course is a must for geotechnical and structural engineers specializing in the design of underground construction projects.

Introduction to SOE

- Public safety
- OSHA/Local regulations
- Contractual requirements
- Project requirements
- Ground Conditions
- Soft ground
- Soil classification (OHA)
- Groundwater
- Environmental considerations

Type of SOE Systems

- Soldier piles/lagging
- Sheetpiling
- Deep soil mixing
- Secant piles/tangent piles
- Diaphragm walls
- Soil nailing
- Jet grouting
- Bracing Systems
- Waler & struts
- Rakers
- Tiebacks
- Deadman
- Modular systems

SOE Design

- Identify project
- Constraint/requirements
- Design philosophy
- Ground conditions evaluations
- Groundwater control
- Design methodology
- Design example
- Performance
- Acceptable deformation

Protection of Structures/Conclusion

- Above ground structures
- Below ground structures
- Acceptable movements
- Conclusion

Instructors: Mohamed Younis, Principal, Subsurface & Tunnel Engineering LLC

Collin Connor, Engineering Manager, Sunbelt Shoring Solutions

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DELHI–GHAZIABAD-MEERUT RRTS PROJECT

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Wi-Fi

JENNMAR Civil is committed to supplying goods and services to the Civil Construction and Tunneling industries. We have integrated JENNMAR mining products into our civil, tunneling, and geotechnical services. We manufacture products in over twenty strategically located manufacturing facilities, ideally positioning us to satisfy our clients' industrial fabrication demands. In addition, we have formed strategic alliances that enable us to provide turn-key ground support solutions in the civil and geo-tech industries. We offer Steel Tunnel Ribs, Shaft Rings, Steel Sets, Lattice Girders, Rock Bolts, Liner Plate, Resin, Rail, Rail Ties, Rail Hardware, Ventilation, Cementitious & Chemical Grouts.

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Jacobs

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At Jacobs, we're challenging today to reinvent tomorrow by solving the world's most critical problems. Jacobs brings extensive design and construction management experience to all types of tunnel projects, and we have successfully delivered the design of some of the most challenging recent design-build/P3 tunnel projects in the U.S. With a talent force of more than 55,000, Jacobs provides a full spectrum of professional services including consulting, technical, scientific and project delivery for the government and private sector.



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Lanyards

Herrenknecht is a technology and market leader in the area of mechanized tunnelling technology. Herrenknecht is the only company worldwide to deliver cutting-edge tunnel boring machines for all ground conditions and in all diameters – ranging from 0.10 to 19 meters. The product range includes tailor-made machines for traffic, supply and disposal tunnels, technologies for pipeline installation as well as drilling equipment for vertical and inclined shafts and deep drilling rigs. As a reliable partner, Herrenknecht supports its customers with an extensive range of services from the initial project idea through manufacturing, transport, assembly, tunnelling support, spare parts service to disassembly.



WSP

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WSP is a leader in tunneling and underground construction, from San Francisco to Stockholm. The firm has participated in the design and construction of some of the longest, largest, deepest, and most complicated tunnels in the world, including tunnels built in hard rock, soft ground or mixed-face conditions, and using mining, boring, jacking, cut-and-cover, and immersed tunnel technology. Projects include the Second Avenue Subway in New York City; the Stockholm City Line; the Eurasia tunnel in Istanbul; and San Francisco's Central Subway. WSP employs 55,000 professionals globally.

HNTB

HNTB

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With over 5000 professionals, HNTB is a leader in providing solutions to infrastructure and transportation challenges, nationwide. The firm has a long history in design and engineering services for tunnels and complex underground structures and has completed award-winning projects in some of the country's largest transportation markets, including highways, transit, rail, aviation and water resources. HNTB's experts have the insights and knowledge toward providing state-of-the-art innovative solutions to tunneling challenges, from small diameter excavations to designing the largest bored tunnel in the world (Alaskan Way Tunnel).

HATCH

Hatch

Water Bottles

Our organization is passionately committed to the pursuit of a better world through positive change. We embrace your visions as our own and partner with you to develop better ideas that are smarter, more efficient, and innovative. Our experience spans over 150 countries around the world in the metals, energy, infrastructure, digital, and investments market sectors. Our exceptional, diverse teams combine vast engineering and business knowledge, working in partnership with our clients to develop market strategies, manage and optimize production, develop new game-changing technologies, and design and deliver complex capital projects. We are "entrepreneurs with a technical soul."



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Kiewit

Kiewit

Tuesday Coffee Break

As a construction, mining, and engineering leader, Kiewit is a FORTUNE 500 company consistently ranking in ENR's Top 10 Contractors. Kiewit has built some of the most complex tunneling and underground projects for over 60 years. We self-perform soft ground and hard rock TBM tunneling, conventional tunneling techniques including SEM and Drill and Blast, and trenchless technologies including MTBM and HDD. As one of North America's largest and most respected construction and engineering organizations, Kiewit's underground capabilities offer clients unique advantages to navigating complex, challenging projects from engineering and design, through construction.



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Sandvik Mining and Rock Solutions and Sandvik Rock Processing Solutions are business areas within the Sandvik Group. Sandvik Mining and Rock Solutions is a global leading supplier of equipment and tools, parts, service, digital solutions, and sustainability-driving technologies for the mining and construction industries. Application areas include rock drilling, rock cutting, loading and hauling, tunneling, and quarrying. Sandvik Rock Processing Solutions is a leading supplier of equipment, tools, parts, service and solutions for processing rock and minerals in the mining and construction industries. Applications include crushing, screening, breaking, and demolition.

M M

MOTT MACDONALD

Mott Macdonald

Coffee Break

Mott MacDonald provides tunnel design and engineering solutions for rail and transit, road, water/wastewater conveyance, CSO storage, and cable and communications. With a reputation for technical excellence, Mott MacDonald identifies practical approaches to tunneling, equipment selection and contracting approaches. Expertise includes soft ground and rock tunneling, cut and cover, underground caverns, immersed tube tunnels, jacked tunnels, and micro-tunneling. Complementary skills in technical areas include tunnel rehabilitation, ground stabilization and treatment, tunnel systems, ventilation, and life safety and security. With 16,000 employees worldwide, Mott MacDonald is one of the world's largest employee-owned companies.

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People building for People. That's what we do at Barnard. Whether we're tunneling through the mountains of northern British Columbia or below the streets of downtown San Francisco, our people arrive at projects determined to do the best for their communities and be the best in the industry. We self-perform heavy civil and underground construction including TBM tunneling, drill and blast, and sequential excavation methods. Our work also encompasses power transmission, dams and reservoirs, pipelines, and environmental construction. We have built our reputation on skill, innovation, reliability, and safety. We live where we work and know our projects personally. We build for People.

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Tunneling and Underground Solutions

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McMillen Jacobs Associates specializes in delivering underground and water resources infrastructure, providing technical engineering design and construction expertise in the water, wastewater, transportation, transit, and energy/power industries. Offering a full range of design, design-build, self-performing construction, and construction management services, we work closely with our clients at every stage of a project, assisting them with planning, design expertise, project management, construction, start-up, and dispute resolution. McMillen Jacobs is also committed to the principles of sustainability in its design and construction practices. Our 22 offices in North America and Australasia and more than 500 staff serve clients locally and worldwide.

**Keller***Women in Tunneling Reception*

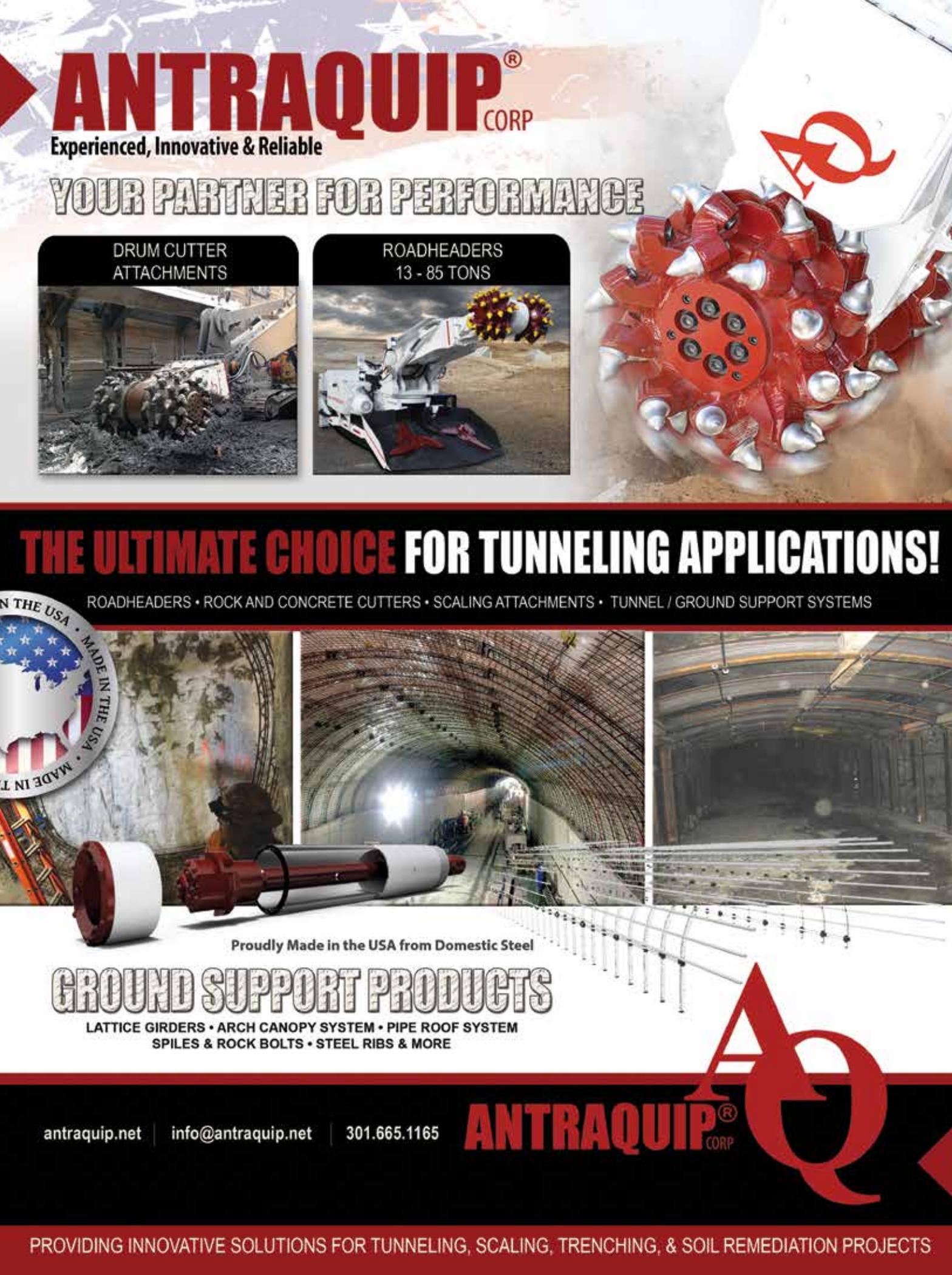
Facing challenging subsurface conditions is a familiar scenario for tunneling contractors, and as the leading geotechnical specialty contractor, Keller has provided solutions to these challenges for almost 100 years. Our solutions for tunneling include diaphragm walls, ground freezing, secant piles, dewatering, jet, permeation and compensation grouting, and instrumentation and monitoring. By connecting global resources and expertise with local knowledge and focus, Keller

develops innovative, practical, and cost-effective solutions to geotechnical challenges. Keller builds projects designed by others and offers full design-build services for any geotechnical construction application.

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Established in 1965, Jay Dee Contractors, Inc. has built an impressive project resume. Specializing in heavy underground construction, our work has been responsible for the successful execution of several noteworthy projects, known for both size and complexity. Most notably, the Little Calumet Leg, the Thornton Transitional Reservoir, Big Walnut Augmentation/Rickenbacker Interceptor, Brightwater Tunnel Section 3 Completion and the University Link Light Rail Contract U230.

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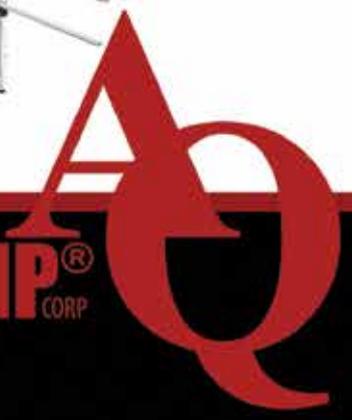
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EXHIBITORS

ABC Industries, Inc

Booth 215

For over 90 years, ABC Industries continues to be a leading supplier of high quality, customized ducting solutions in mine, tunnel and underground construction operations worldwide. As these operations continue to evolve, ABC proactively collaborates with industry professionals to engineer unique, premium ventilation products. A new innovative addition to ABC's arsenal, RigiVent™ is a flexible, interlocking ducting solution for positive pressure applications requiring minimal storage and ease of handling. Similar to RigiDuct®, RigiVent™ is constructed from filament wound fiberglass rovings and reinforced with polyester fibers for added strength and resiliency. Visit our website to see more innovative solutions.

Products & Services

Dust and Fume Control Technology
Mining Equipment
Tunnel Lining and Support Materials
Ventilation Systems, Materials and Equipment

Main Office

301 Kings Hwy
Winona Lake, IN 46590 United States of America
Phone: (574) 267-5166
www.abc-industries.net

ABC Ventilation Systems

Booth 113

ABC Ventilation Systems is one of the world's leading companies in underground ventilation. ABC Ventilation Systems provides complete turn-key tunnel ventilation design and systems from fan to face. Through vertically integrated manufacturing we are committed to the design, development and production of high performance Mine and Tunnel ventilation products.

Products & Services

Ventilation Systems, Materials and Equipment

Main Office

1802 Quebec Ave
Saskatoon, SK S7K 1W2 Canada
Phone: (306) 653-4303
abcventilation.com/



AECOM

Booth 209

With more than 2,000 miles of transit, roadway, water and energy tunnel projects worldwide, AECOM is at the forefront of the industry. Our 500 tunneling experts and 2,000 geotechnical engineers develop innovative, award-winning solutions for our clients' toughest challenges around the world. AECOM understands that specialized services are vital to a successful project. We bring extensive design and construction management expertise, including experience with alternative delivery projects.

We provide fully integrated services to each aspect of large-scale tunnel design, management, inspection, re-

habilitation and construction. We are driven by a common purpose to deliver a better world.

Products & Services

Consulting Engineers
Engineering Design and Services for Tunnels
Geological, Geotechnical Services and Equipment

Main Office

13355 Noel Rd, Ste 400
Dallas, TX 75240 United States of America
Phone: (843) 743-8355
Email: businessinquiry.americas@aecom.com
aecom.comtunneling

Aerix Industries

Booth 317

Aerix Industries (formerly Cellular Concrete Solutions), manufactures and supplies a dynamic product line of integrated engineered foam liquid concentrates, enabling its customers to produce and install high quality lightweight cellular concretes, ideal for annular grouting, tunnel arch backfill and flowable fill. The company's foams also allow its customers to transport tailings, sand, or other construction materials using minimal amounts of water. Aerix Industries dedication to research and technical support has allowed it to provide advanced engineered foam solutions to the construction and mining industries for more than 70 years.

Products & Services

Grouting Services, Equipment and Materials

Main Office

7020 Snowdrift
Allentown, VA 22853 United States of America
Phone: (804) 740-6772
Email: nsutmoller@aerixindustries.com
www.aerixindustries.com

AGRU America, Inc

Booth 311

AGRU America, Inc. is the world's leading manufacturer of flat die extrusion geomembranes, concrete protective liners and tunnel liners. The company also supplies vertical barrier systems and large diameter piping systems for the U.S. and international civil/environmental markets. AGRU America is part of the worldwide AGRU Group, an Austrian family-owned business since 1948 with production facilities in Austria, the U.S., Germany and China, and distribution in over 80 countries worldwide.

Products & Services

Microtunneling Equipment, Tools, and Supplies
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Tunnel Lining and Support Materials
Underground Utility Materials and Operations
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Main Office

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www.agruamerica.com

Alpine Equipment

Booth 800

For over 45-years Alpine has been a trusted supplier of equipment for the underground, construction, and mining sectors. Our Rockwheel line of hydraulic drum cutter attachments allow for rapid and precise removal of rock and concrete, filling the niche between bucket excavation and heavy hammers. Rockwheels are available for excavators in any class. We also supply innovative hydraulic rotary soil mixing attachments for use in remediation, stabilization, and solidification projects. All products are available on a rental basis with purchase option. Alpine's experienced team can help with job-specific customization and is always available for technical support, service and parts.

Products & Services

Roadheaders
Underground Excavation Services and Equipment

Main Office

801 Pleasant View Blvd
Bellefonte, PA 16823 United States of America
Phone: (814) 466-7134
Email: info@alpine-aec.com
www.alpinecutters.com

AMIX Systems Ltd

Booth 315

Amix Systems Ltd. is a design, engineering and fabrication team that solves problems for today's most challenging grout mixing & backfill projects. We take complex project needs and build automated, self-cleaning products and systems that simplify the grout mixing process.

If you are retrofitting existing plants, we're your solution. Our team has a deep expertise in systems design and control automation. It's not about selling systems, we're on a mission to help companies reduce their overall equipment costs and make significant advances in productivity.

We now have rental equipment available for all your grouting applications!

Contact us for more information.

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Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
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Pumps and Pumping Equipment

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Vancouver, BC V6B 1P1 Canada
Phone: (604) 746 0555
Email: Info@amixsystems.com
www.amixsystems.com

Antraquip Corp

Booth 505

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Antraquip continues to build on its reputation as the leading supplier of rock and concrete cutting attachments for excavators which are commonly used for scaling, profiling, mixing/remediation and tunnel en-

largement projects, as well as roadheaders for tunnel and mining applications. In the field of tunnel support, Antraquip offers lattice girders, steel ribs and complete casing systems for pipe roofing, anchoring and drainage. Other products offered include self drilling rock bolts, steel fibers, rock saw attachments and custom engineered shaft sinking equipment.

Products & Services

Roadheaders
Rotary Drum Cutters
Scaling
Tunnel Boring Equipment
Tunnel Lining and Support Materials
Underground Excavation Services and Equipment

Main Office

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Phone: (301) 665-1165
Email: info@antraquip.net
www.antraquip.net

Arup

Booth 812

Arup's approach to tunnel projects embraces all that is best in multidisciplinary design. From ground support, construction sequence and lining design to life safety, materials technology and lifecycle cost analysis, Arup's contribution to tunnel projects extends from concept to operation and beyond. Using a holistic approach based

on a strong core team of experienced tunnel designers, Arup draws on the capabilities of a wide array of allied disciplines to deliver innovative solutions to some of the world's most complex underground projects. These challenges are welcome and provide Arup the opportunity to implement integrated projects of real value to clients.

Products & Services

Consulting Engineers
Engineering Design and Services for Tunnels

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Email: tunnel-design@arup.com
www.arup.com

Avanti International

Booth 217

Avanti International is an experienced producer of high-quality injection grouts in the U.S. For decades, AvantiGrout has been used in geotechnical applications to stabilize soils and control groundwater before, during, and after construction. Injection grouts can be used: 1) Before tunnel break-ins/outs to stabilize surrounding soils, control groundwater inflow, and improve project productivity; 2) During tunnel construction to stabilize weak soils, control groundwater ahead of and behind TBMs, and create a safer work environment; and 3)

After project completion to create an impermeable water barrier. For more information on Avanti's injection grouts, visit our website www.avantigrout.com

Products & Services

Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
Pumps and Pumping Equipment
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Main Office

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Webster, TX 77598 United States of America
Phone: (281) 486-5600
Email: info@avantigrout.com
www.avantigrout.com

BabEng, LLC

Booth 309

Energy, enthusiasm, and knowledge – these are some of the qualities that drive our passion for understanding the world of underground works and making the most out of any TBM tunneling project. BabEng, is a worldwide engineering and consulting company specializing in underground works. Detailed knowledge about TBMs makes us a highly qualified project partner, able to complete critical tasks and solve problems from feasibility study to design and construction to contract closure. Tunnelsoft, a division of BabEng, offers software that is specifically tailored to the needs of TBM tunneling. It's everything you need for in-depth tunneling analysis and documentation.

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Email: contact@babeng.com
www.babeng.com

Ballard Marine Construction

Booth 112

A leader in tunnel, shaft, caisson and pipeline construction support services for premier tunneling and mining contractors, as well as joint ventures. Ballard has a reputation for managing highly complex tasks in a cost effective and efficient manner. We have experienced supervisory personnel and a full complement of experienced and qualified compressed air workers, dive medical technicians, hyperbaric nurses, hyperbaric physician assistants, and other specialty personnel. Ballard owns and maintains related equipment from shuttles to tunnel specific saturation systems (SAT).

Products & Services

Construction - Contracting Services
Tunnel Boring Equipment

Main Office

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Phone: (360) 695-5163
Email: liam.obrien@ballardmc.com
www.ballardmc.com/projects/tunnel-support/

BarChip Inc

Booth 715

Manufacturers of Barchip Macro Synthetic Fibers for cast in place tunnel linings, precast tunnel segments, shotcrete tunnel linings, track slabs, and underground support.

Products & Services

Concrete Reinforcement

Main Office

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Phone: (704) 843-8401
www.barchip.com

Bauer Foundation Corporation

Booth 410

Bauer Foundation Corp. (BFC), the US subsidiary of Bauer Spezialtiefbau of Germany, is a deep foundation and ground improvement contractor. BFC provides ground improvement and support of excavation services to the tunneling industry including slurry/diaphragm walls, secant walls, grouting, drilled shafts and ground freezing.

Products & Services

Ground Freezing
Grouting Services, Equipment and Materials

Main Office

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Odessa, FL 33556 United States of America
Phone: (727) 992-1769
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bauerfoundations.com

Bekaert

Booth 603

Bekaert Underground Solutions, your global partner for smart reinforcement of your tunnelling and mining project. We optimize your project by providing innovative, cost-effective and safe solutions. We offer a range of Dramix® Steel Fibers directly produced in the US to meet the buy America requirements in rebuilding the infrastructure. Check our website for our impressive reference list. We have a team of technical experts available, especially dedicated to the underground construction world.

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Shotcrete Equipment, Supplies, and Services
Tunnel Lining and Support Materials
Underground Excavation Services and Equipment

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Bessac

Booth 312

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Brokk Inc

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Booth 815

BROKK is the world leader in electrically powered remote controlled demolition machines, which are used extensively in tunneling, cross-passages, shaft sinking, micro-tunneling, scaling, and other underground construction applications. BROKK machines can be equipped with a variety of attachments, such as hydraulic breakers, rock drills, rotary drum cutters, digging buckets, beam manipulators, and shotcrete nozzles. Boasting an impressive power-to-weight ratio, these compact machines can operate effectively in limited access, confined spaces, with zero-emissions. Operators can remain at a safe distance while they maneuver BROKK machines in challenging areas underground.

Products & Services

Underground Excavation Services and Equipment

Main Office

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www.brokk.com



Brookville Equipment Corp

See our ad on p. 12

Booth 405

Brookville is a leading manufacturer of rail-mounted diesel and battery-powered tunneling locomotives and personnel carriers. Featuring planetary final drive gear reducers at each wheel end to divide driveline torque, shock loading for reduced stress and longer service life, and liquid-cooled internal wet disc brakes to extend brake life and provide maximum braking capacity for long, continuous grades, Brookville units are designed for dependability. Optional equipment features include explosion proofing and patented on-board rerailing systems to enhance safety in all work environments. Brookville also manufactures rubber-tired equipment, ideal for steep tunnel grades, inspections, and maintenance for non-tracked projects.

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Mining Equipment
 Rail Products
 Underground Locomotives and Rail Haulage Equipment

Main Office

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 Brookville, PA 15825 United States of America
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 Email: info@brookvillecorp.com
www.brookvillecorp.com

CAB

Booth 717

For over 45 years CAB has been supplying the tunneling and mining industry with high quality hangers and mine safety products. CAB hangers are widely recognized for their high strength, quality and important safety features. They are designed to safely support all types of sensor, data, control, communication and electrical cables in above and below ground operations. With the growing importance of Safety in the Industries, CAB has greatly expanded its line of Safety Products in recent years. This includes products such as high-visibility streamers, markers, tubes, bags, and apparel.

Products & Services

Electrical - Generator-Motor, Wire-Cable
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 Safety Products
 Tunnel Lining and Support Materials
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 Ventilation Systems, Materials and Equipment



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- Geotechnical engineering
- Risk management
- Cost estimating & life cycle cost analysis
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Phone: (814) 472-5077
www.cabproducts.com

Carroll Technologies Group

Booth 413

Carroll Technologies Group is a leading provider of Communications, Electronics, and Safety Equipment for the tunneling and mining sectors. We distribute products for over 80 manufacturers, repair/calibrate over 75% of those products, and have a service team on hand to help facilitate those needs. Our company is dedicated to give you a service model 24/7 and we focus on the individual needs of our customers by providing a robust stock of the products they need at all times. Our number one goal is taking care of our customers and building a strong relationship.

Products & Services

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Hoists and Headframes
Instrumentation Equipment and Services
Safety Products
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Phone: (865) 771-4074
Email: jj@carrollengineeringco.com
www.carrolltechnologiesgroup.com

CBE GROUP

Booth 511

CBE Group designs and manufactures segment moulds, automated plants for segment production and segment handling equipment for tunnel projects all over the world. The company ensures assembly of precast plants, staff training and maintenance worldwide. Its main offices are located in France, with two production sites in France and in China. Since its creation in 1987, the company has achieved more than 600 projects and produced more than 28 600 moulds. Recent achievements include: Grand Paris (France), High Speed 2 (UK), Mularroya (Spain), E05 Ravannstunnel (Norway), Los Angeles Outfall (USA), Snowy (Australia), and more.

Products & Services

Engineering Design and Services for Tunnels
Precast Concrete Linings
Segment Accessories
Tunnel Lining and Support Materials

Main Office

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Phone: +33247375364
Email: cbe@cbegroup.fr
www.cbe-tunnels.com

CDM Smith

CDM Smith

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Booth 117

CDM Smith provides lasting and integrated solutions in water, environment, transportation, energy and facilities to public/private clients worldwide. As a full-service engineering and construction firm, we deliver exceptional client service, quality results and enduring value across the entire project life-cycle. CDM Smith's underground construction staff includes geotechnical, structural, and civil engineers and geologists located across the globe. With a full range of tunnel-related services, we provide planning, feasibility and design - both 2D and 3D FEM analyses, construction services, program management, inspection and geotechnical instrumentation monitoring and data interpretation.

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ChemGrout, Inc*Booth 604*

With more than 55 years of experience, ChemGrout continues to manufacture the worlds largest selection of grouting equipment. ChemGrout's underground equipment offers exceptional productivity for contact grouting, water cut-offs, cable stays and rock bolts. Its patented pumps are industry standards offering reliability and durability, along with unique features simplifying clean up and maintenance. Offering many unique and innovative features, ChemGrout has remained the industry leader in underground grouting since 1963.

Products & Services

Grouting Services, Equipment and Materials
Pumps and Pumping Equipment

Main Office

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Email: cginfo@chemgrout.com
www.chemgrout.com

CJGeo*Booth 612*

Cellular concrete is an excellent material for annular space grouting, and the most common grout CJGeo uses for the purpose. Whether an annulus is just an inch or a few feet, and regardless of host pipe size, cellular concrete is an economical, reliable annular space grouting material. CJGeo has grouted dozens of annular spaces on welded HDPE, corrugated HDPE, mechanically-joined HDPE, concrete, spiral wound, corrugated metal and DI pipes throughout the Eastern United States.

Products & Services

Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials

Main Office

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Colorado School of Mines*Booth 508***Products & Services**

Educational

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Control International*Booth 803*

Control was established in 1976 for the purpose of designing, manufacturing, and marketing communication and control systems for the mining industry. After the initial product offering, we decided to enter the industrial market by introducing stainless steel systems.

Products & Services

Control Systems
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Tunnel Communication Systems and Equipment

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Crux Subsurface, Inc

See our ad on p. 14

Booth 601

Crux is a leader in geotechnical construction and exploration. With more than two decades in the tunneling industry, the company has provided solutions to some of the most difficult-access and geologically challenging projects in North America. Crux specializes in long range horizontal core holes, borehole surveying, optical and acoustical televiewer services, high-quality sampling, and instrumentation installation. Pre-excavation stabilization services include dewatering, permeation and compaction grouting, tube arch canopies, and cased horizontal boreholes. Crux provides design-build services and a fleet of custom designed equipment to ensure unique project needs can be met.

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Geological, Geotechnical Services and Equipment
Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
Instrumentation Equipment and Services

Main Office

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Phone: (509) 892-9409
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David R. Klug & Associates, Inc

See our ad on p. 15

Booth 903

David R. Klug & Associates, Inc. provides manufacturers representative services to the underground civil and mine construction industries. The company specializes in products and services for soft ground, conventional, and NATM/SEM tunnels. Expertise is offered in the supply of componentry used in precast tunnel linings



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EXHIBITORS

including EPDM gaskets, plastic and steel connectors, grout lifting assemblies and steel segment moulds plus forming systems for C-I-P applications. Their distribution company, Klug Construction Systems offers Nit-tetsu ultrafine cement, GFRP rock bolts and soft-eyes, steel and synthetic fiber reinforcement, prefabricated welded wire and rebar reinforcing panels, and specialty grout systems for tunnel backfill requirements.

Products & Services

Tunnel Lining and Support Materials

Main Office

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www.drklug.com



Derrick Corporation

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Booth 212

Derrick is a family-owned and operated company with a global presence focused on pioneering fine-separation technology. Since 1951, Derrick has manufactured fine separation and dewatering equipment for

the Mining and Aggregates industries. In 1988, Derrick branched out into the Civil Construction industry. From ruggedly dependable dewatering to slurry separation, Derrick's innovative technologies are applicable to a global customer base and many worldwide markets. Derrick has remained dedicated to complete in-house manufacturing of every machine, screen panel, and tank system. Each unit is created and assembled at Derrick's Buffalo, New York headquarters facility. To discover more, visit Derrick's website.

Products & Services

Drilling Services and Equipment
Microtunneling Equipment, Tools, and Supplies
Slurry Services and Machines
Wastewater Management Products
Water Treatment Plant and Materials

Main Office

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Houston, TX 77032 United States of America
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Email: info@derrick.com
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Dibit Measuring Technique USA, Inc.

Booth 907

Dibit Measuring Technique USA, Inc. is a worldwide operating engineering company specialized in tunnel-surveying and scanning. Through decades of experience,

hardware and software technologies have evolved steadily, enabling Dibit to provide high-skilled surveying services and sophisticated scanning solutions. Each scanning system and solution is specialized for different tasks, such as excavation scanning, as-built documentation or inspections. Independently of the various scanning systems, the result is always a true colour, high resolution 3D-model. This 3D-model builds the basis for any further analysis like volume and thickness calculations, geometry and clearance checks as well as mapping geological and geotechnical information.

Products & Services

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Engineering Design and Services for Tunnels
Geological, Geotechnical Services and Equipment
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Main Office

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Redmond, WA 98052 United States of America
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www.dibit-scanner.com

Dr. Sauer & Partners Corp

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Booth 213

Dr. Sauer & Partners has been in practice in the United States for over 30 years, and employs tunnel engineers at main offices located in Washington D.C., London and



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Backed by over 70 years of cost-effective solutions, Derrick has manufactured innovative technologies for numerous civil construction applications for over three decades. Derrick's separation technology offers unmatched solids removal performance. Our civil construction solutions are currently used worldwide by companies that require high-efficiency separation and slurry dewatering in environmentally sensitive and urban environments.



Site Video

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EXHIBITORS

Salzburg. The firm provides cost effective and innovative tunneling solutions using conventional mining approaches to owners and contractors. Dr. Sauer & Partners is recognized worldwide as one of the leading consultants for design and construction supervision of tunnels and underground structures. The application of innovative design solutions and high quality field supervision has led to the successful completion of numerous transportation and utility tunnels.

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Main Office

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Email: washington@dr-sauer.com
www.dr-sauer.com

Drill Tech Drilling & Shoring Inc

See our ad on p. 18

Booth 617

Drill Tech is a drilling, tunneling, and shaft sinking contractor. Recent drilling and shoring work includes foundations for high rise buildings in San Francisco, and station excavations for San Francisco's Central Subway and L.A. Metro's Crenshaw/LAX Line. Notable recent tunneling projects include a 2000' tunnel mined through sandstone uphill at 13% grade using a

Drill Tech shop built cog railroad. Drill and blast work includes a 1,000 foot deep shaft in Wyoming, and roadheader work includes 14,200 feet of mine access decline tunneling for Barrick Gold in Nevada. We also do pipe jacking and box jacking under freeways and railroads.

Products & Services

Construction - Contracting Services
Underground Excavation Services and Equipment

Main Office

2200 Wymore Way
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Phone: (925) 978-2060
www.drilltechdrilling.com



DSI Tunneling LLC

See our ad on p. 19

Booth 204

DSI (a Sandvik Company) has provided ground support products to the underground construction industry for over 100 years. With our signature 4 flange liner plate

and superior beam bending capabilities we are the premier supplier of steel supports to tunnels and mines. We also offer engineering services from design through bidding to stamped submittals. Our range of products include; chemical injection resins, Liner plates, Beam arches, rock bolts, pipe umbrellas, lattice girders, and forepoling. DSI also has a full line of TBM support products including drill consumables, large batch plants for back filling segment tunnels, and Condat TBM Lubricants.

Products & Services

Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
Tunnel Lining and Support Materials

Main Office

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www.dsiunderground.com

EC Applications - Tunnel Lining

Booth 716

EC Applications supplies and installs protective tunnel liner systems combining the advantages of thermoplastics (HDPE and LLDPE) with associated materials (geotextile, waterbar, injectable grout hose and components) required for a turnkey tunnel lining system. ECA's qualified installation technicians, project experience and Los Angeles based fabrication facility provide

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EXHIBITORS

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www.tunnelling.com

Ecovolve

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Englo, Inc, DBA Engart, Inc

Booth 608

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Epiroc

Booth 404

Epiroc is a leading global productivity partner for the mining and infrastructure industries. With cutting-edge technology, Epiroc develops and produces innovative, safe and sustainable drill rigs, rock excavation and construction equipment and tools. The company also provides world-class service and solutions for automation and interoperability. The company is headquartered in the US near Denver, Colorado. Employing approximately 450 people, it extends its reach through a nationwide network of service centers and drilling distributors. Learn more by visiting our website.

Products & Services

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Equipment Corporation of America

Booth 713

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Email: info@ecanet.com
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Everest Equipment Co

Booth 606

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Products & Services

Tunnel Lining and Support Materials

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Ayer's Cliff, QC JOB 1C0 Canada
Phone: (819) 838-4257
www.everestconstructionforms.com

Fiori Group S.p.A

Booth 805

Fiori Group is an Italian Company founded in 1942 with its headquarters in Finale Emilia in the Province of Modena, and is leader in the design, development and production of self-loading concrete batching vehicles, silos, mixers, and dumpers for the construction industry.

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Main Office

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FPT Infrastructure

Booth 710

FPT Infrastructure manufactures and markets a portfolio of integrated solutions that expertly restore existing structures and maximizes the life of new construction. Serving bridge and highway, rail, aviation, transit, water

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Grouting Services, Equipment and Materials
Microtunneling Equipment, Tools, and Supplies
Soil Conditioning Equipment and Materials
Tunnel Lining and Support Materials

Main Office

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Mt Airy, NC 27030 United States of America
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Email: info@fptinfrastructure.com
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Gall Zeidler Consultants

See our ad on p. 21

Booth 313

Gall Zeidler Consultants (GZ) is an international engineering consultancy firm specialized in solutions for tunnel and underground schemes. We provide geotechnical and tunnel engineering services along with consultancy in tunnel construction as well as program and construction management. We use our wide range of expertise in transportation, infrastructure, water conveyance, and mining projects to help our clients overcome difficult ground conditions and to provide a superior product from its first conceptual phases to its turn-key completion. We are a global leader in our field and have successfully completed over 300 miles of tunnels worldwide.

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www.gzconsultants.com

GCP Applied Technologies

Booth 809

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Products & Services

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Shotcrete Equipment, Supplies, and Services
Tunnel Lining and Support Materials

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 Alpharetta, GA 30009 United States of America
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Gehrig, Inc

Booth 610

Products & Services

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 Geological, Geotechnical Services and Equipment

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Geocomp Corp/GeoTesting Express, Inc

Booth 1000

Celebrating more than 35 years of managing risk for infrastructure. Geocomp designs, installs, and manages comprehensive, web-based performance monitoring

programs for all types of civil engineering structures. We provide instrumentation and real-time monitoring services on projects from small to large. Geocomp also helps identify, assess, and mitigate risks associated with construction by providing quantitative identification of risks and the potential impact to project cost, schedule, and quality. Our laboratory division, GeoTesting Express, is a fully accredited world-class laboratory that provides high-quality results with fast turnaround time for mechanical and physical properties testing on soils, rocks, and geosynthetics.

Products & Services

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 Geological, Geotechnical Services and Equipment
 Instrumentation Equipment and Services
 Soil Conditioning Equipment and Materials

Main Office

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 Acton, MA 01720 United States of America
 Phone: (978) 635-0012
 Email: info@geocomp.com
 www.geocomp.com

Geo-Instruments

Booth 307

GEO-Instruments provides automated solutions for monitoring the safety and stability of buildings, excavations, bridges, railways, roads, tunnels, dams, embank-

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 Instrumentation Equipment and Services

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 Email: sales@geo-instruments.com
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GEOKON

Booth 504

GEOKON is a specialist in the supply of instruments for the NATM method of tunnel support. In addition to almost all major cities in the USA, the company has instrumented subway systems in Seoul, Taipei, Guangzhou, Istanbul, Hong Kong, Singapore and Lon-

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EXHIBITORS

don. Geokon also has instruments in the Channel Tunnel. Call Geokon for a quote or with questions on an application. The company is prompt and courteous in its replies.

Products & Services

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Instrumentation Equipment and Services

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Gomez International, Inc

Booth 804

GOMEZ INTERNATIONAL INCORPORATED, WBE/WOSB/
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in Tunneling, Mining, Heavy Civil Construction Industries. LICENSED ENGINEERING/CONSULTING DIVISION providing services from project conception to completion. MANUFACTURING/REBUILD DIVISION, Certified welders manufacture/refurbish custom equipment including Shaft Safety Ladders/fencing, Conveyor supports, Gantries, Utility Brackets, etc. EQUIPMENT SALES DIVISION, for sale/lease a variety of equipment including Mobile Power Centers, Ventilation fans/duct, Conveyors, VFDs, Substations, Transformers, Light Stringers, Mine Power Centers, etc. OEM REPRESENTATIVE: General Cable; GIW Slurry Pumps; Mitsubishi Rubber Tunnel Entrance/Exit/Omega Seals; Sagami Servo Grout/Slurry Plants, Peristaltic Pumps; Shin-Tomoe Battery Locomotives, Starloy TBM Cutters, Tail Brushes, TJB Couplers, Toshiba Motors, Tsurumi Pumps.

Products & Services

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Main Office

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Grydale USA

Booth 513

Products & Services

Dust and Fume Control Technology
Ventilation Systems, Materials and Equipment

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H+E Logistik USA, Inc

Booth 912

H+E Logistik USA Inc. located in Sumner, WA is the subsidiary of H+E Logistik GmbH, with its headquarter based in Bochum, Germany.

H+E has earned an international reputation as an expert in conveyor technology; our company designs versatile conveyor systems for companies with a lot to move in the tunnelling, mining industrial industry.

Products & Services

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Mining Equipment

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HAGER-RICHTER GEOSCIENCE, INC.

Hager-Richter Geoscience, Inc

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Booth 512

Products & Services

Consulting Engineers
Consulting Environmental
Geological, Geotechnical Services and Equipment

Main Office

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Hatch

Booth 412

Hatch is an international engineering consulting firm offering multi-disciplinary, full-service, design engineering and construction management in the transportation, water, energy, mining/metals sectors. With 65 offices and 10,000 staff worldwide, Hatch has 21 offices and 1,000 staff in the US. We have deep roots in the North American tunneling industry for 65 years. Hatch has designed and delivered complex tunnels and

EXHIBITORS

underground infrastructure projects such as LA Regional Connector, Minneapolis Central City Parallel Tunnel, Niagara Tunnel, Lesotho Highlands Water, Scarborough Subway Extension, Ashbridges Bay Outfall, and Kemanot2. We are passionately committed to the pursuit of a better world through POSITIVE CHANGE.

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Herrenknecht Tunnelling Systems USA, Inc

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Booth 900

Herrenknecht is a technology and market leader in the area of mechanized tunnelling technology. Herrenknecht is the only company worldwide to deliver cutting-edge tunnel boring machines for all ground conditions and in all diameters – ranging from 0.10 to 19 meters. The product range includes tailor-made machines for traffic, supply and disposal tunnels, technologies for pipeline installation as well as drilling equipment for vertical and inclined shafts and deep drilling rigs. As reliable partner, Herrenknecht supports its customers with an extensive range of services from the initial project idea through manufacturing, transport, assembly, tunnelling support, spare parts service to disassembly.

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Rock TBM's
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Phone: (253) 447-2300
www.herrenknecht.com

HNTB Corp

See our ad on p. 25

Booth 913

With 3800 professionals, HNTB is a leader in providing

solutions to infrastructure problems nationwide. The firm has a long history in design and engineering services for tunnels and underground construction. HNTB has completed award-winning projects on some of the country's most complex projects, including highway, transit, rail, aviation and water resources. HNTB's experts have the insight and knowledge to provide state of the art innovative solutions to tunneling challenges, from small diameter excavations to designing the largest bored tunnel in the world (Alaskan Way Tunnel)--utilizing both conventional tunneling methods (sequential excavation) or mechanized tunneling for variety of ground conditions.

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Tunnel Lining and Support Materials
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HOBAS Pipe USA

Booth 706

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HyperSciences, Inc

Booth 801

Products & Services

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HYTORC

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Innovative Wireless Technologies

See our ad on p. 27

Booth 614

Innovative Wireless Technologies, Inc. (IWT) is the leading supplier of wireless communication and tracking systems for underground applications. IWT's SENTINEL™ system is easy to install and maintain and provides crystal clear voice communications for maximum productivity and low cost of ownership. Continuous tracking is also supported – all in one system. IWT offers line-powered, battery backed-up, mesh networking infrastructure for long term construction projects, or battery-powered infrastructure for shorter term inspections. In either case, IWT equipment is 100% recoverable and reusable once the project is completed.

Products & Services

Environmental Control Equipment and Supplies
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Main Office

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IoT Automation

Booth 703

IoT Automation proudly owns the FireFly Smart Lighting System. FireFly enables Real Time Situational Awareness in underground mines and tunnels through connecting current safety and productivity solutions to the Smart Lighting network. The FireFly System reinforces safety procedures in the event of emergencies such as seismic events, gas leaks, fires, ground movement, and other mine/tunnel-wide emergencies. FireFly is purposely built for underground mining and tunneling—utilising industry-standard cabling and connectors and IP66 rated modules, the FireFly System is IoT-enhanced through onboard Wi-Fi and Bluetooth radios for wireless device integration such as asset tracking and proximity alerts.

Products & Services

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Lighting Systems
Safety Products
Tunnel Communication Systems and Equipment

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www.iotautomation.com.au

Ischebeck USA Inc

Booth 615

Ischebeck USA Inc. is the North American subsidiary of the German Friedr. Ischebeck GmbH, well known throughout the construction industry as innovators in formwork, trenching and geotechnical solutions. Founded in 1881, it's owned and operated today by the fifth Ischebeck generation. Ischebeck USA Inc. was incorporated in 2009. With support from our parent company, we are able offer original, high quality solutions that are manufactured in the United States. Contact us directly for information and material purchasing for our domestic hollow bar anchors!

Products & Services

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Ground Improvement Equipment and Services
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Steel Pipe
Tunnel Lining and Support Materials

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Naples, FL 34104 United States of America
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J.H. Fletcher & Co

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Booth 1006

Since 1937, Fletcher has been engineering and manufacturing custom solutions for underground mining. Today, Fletcher products expand into a variety of industries. Through the decades, Fletcher has operated with a singular vision: to work with a vigilant focus on finding ways to improve mining and industrial processes and reducing risk for the people who work in those industries.

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JCK Underground, Inc

Booth 817

JCK Underground provides Owner Advisor, Engineering and Construction Management services for tunnel and underground projects. We deliver public and private project owners and consultants specialized underground expertise and support throughout the entire project life cycle, including early planning, design, procurement, construction and asset management. Our experts have spent entire careers in the underground and tunneling business as planners, designers, construction managers, and contractors. This breadth of varied experience and resources help our clients properly manage the risks associated with implementing their program.

Products & Services

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Main Office

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JENNMAR Civil

See our ad on p. 31

Booth 105

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Sanja Zlatanic

Chair, National Tunnel Practice
szlatanic@hntb.com
(646) 652-9440

Mark Stephani

National Tunnel Practice Lead – Central
mstephani@hntb.com
(917) 334-2731

Raymond Sandiford

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(917) 710-3395

Mike Wongkaew

National Tunnel Practice Lead – West
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located manufacturing facilities, ideally positioning us to satisfy our clients' industrial fabrication demands. In addition, we have formed strategic alliances that enable us to provide turn-key ground support solutions in the civil and geo-tech industries. We offer Steel Tunnel Ribs, Shaft Rings, Steel Sets, Lattice Girders, Rock Bolts, Liner Plate, Resin, Rail, Rail Ties, Rail Hardware, Ventilation, Cementitious & Chemical Grouts.

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Tunnel Lining and Support Materials
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Main Office

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Kayden Industries

Booth 414

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Keller

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Booth 305

Facing challenging subsurface conditions is a familiar scenario for tunneling contractors, and as the leading geotechnical specialty contractor, Keller has provided solutions to these challenges for almost 100 years. Our solutions for tunneling include diaphragm walls, ground freezing, secant piles, dewatering, jet, permeation and compensation grouting, and instrumentation and monitoring. By connecting global resources and expertise with local knowledge and focus, Keller develops innovative, practical, and cost-effective solutions to geotechnical challenges. Keller builds projects designed by others and offers full design-build services for any geotechnical construction application.

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Ground Improvement Equipment and Services
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Jet Grouting Equipment and Services
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Line Power

Booth 211

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Malcolm Drilling Co Inc

Booth 807

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Products & Services

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Grouting Services, Equipment and Materials
Jet Grouting Equipment and Services
Shotcrete Equipment, Supplies, and Services
Slurry Services and Machines

Main Office

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MAPEI Corp

See our ad on p. 33

Booth 415

MAPEI's Underground Tunneling Technology (UTT) category offers a complete line of products and associated technologies for use in and on underground construction projects, including shotcrete accelerators and admixtures for concrete, as well as products for injection and consolidation, mechanized tunneling (TBM), engi-

neering and soil stabilization, coating and protection, maintenance, repair and waterproofing.

Products & Services

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Grouting Services, Equipment and Materials
Lubricants for TBM
Shotcrete Equipment, Supplies, and Services
Slurry Services and Machines
Soil Conditioning Equipment and Materials

Main Office

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Deerfield Beach, FL 33442 United States of America
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Master Builders Solutions

Booth 304

Through its Master Builders Solutions brand, BASF is a leading supplier of underground construction solutions that help tunneling customers to become more successful, even in highly challenging ground conditions. BASF has the largest range of products and services available to meet needs and solve problems in TBM and conventional tunneling, whether in soft ground or hard rock conditions. We offer a full range of MasterRoc® tunneling products such as soil conditioning foams and polymers, anti-clay agents, tail sealants, anti-abrasion agents, dust suppressants, bearing seal greases, EP2 greases and annulus grouts, plus product for sprayed concrete and injection for ground consolidation.

Products & Services

Earth Pressure Balance Machines
Ground Improvement Equipment and Services
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Lubricants for TBM
Precast Concrete Linings
Shotcrete Equipment, Supplies, and Services

Main Office

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McDowell Equipment Ltd

Booth 708

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McMillen Jacobs Associates

See our ad on p. 28

Booth 901

McMillen Jacobs Associates is an employee-owned engineering and construction firm serving the heavy civil, underground, and water resource markets. We offer comprehensive design, design-build, self-performing construction and construction management capabilities. Our services include environmental studies, licensing, permitting, hydraulics, hydrology, and dam safety, as well as civil, structural, geotechnical, mechanical, and electrical engineering. We also provide claims and dispute resolution services. McMillen Jacobs Associates maintains offices covering North America and Australasia.

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Booth 214

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Michels Corp

See our ad on p. 30

Booth 409

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See our ad on p. 32

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Minova

Booth 711

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Booth 104

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Booth 314

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Booth 611

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Booth 1008

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Booth 308

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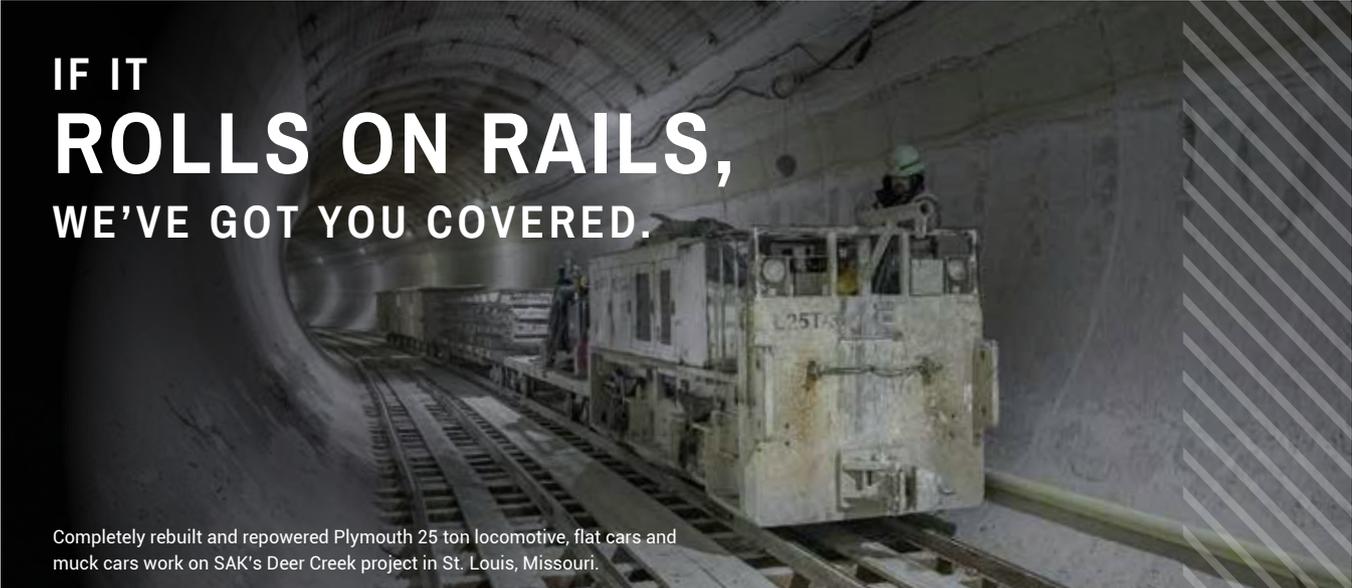
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Booth 507

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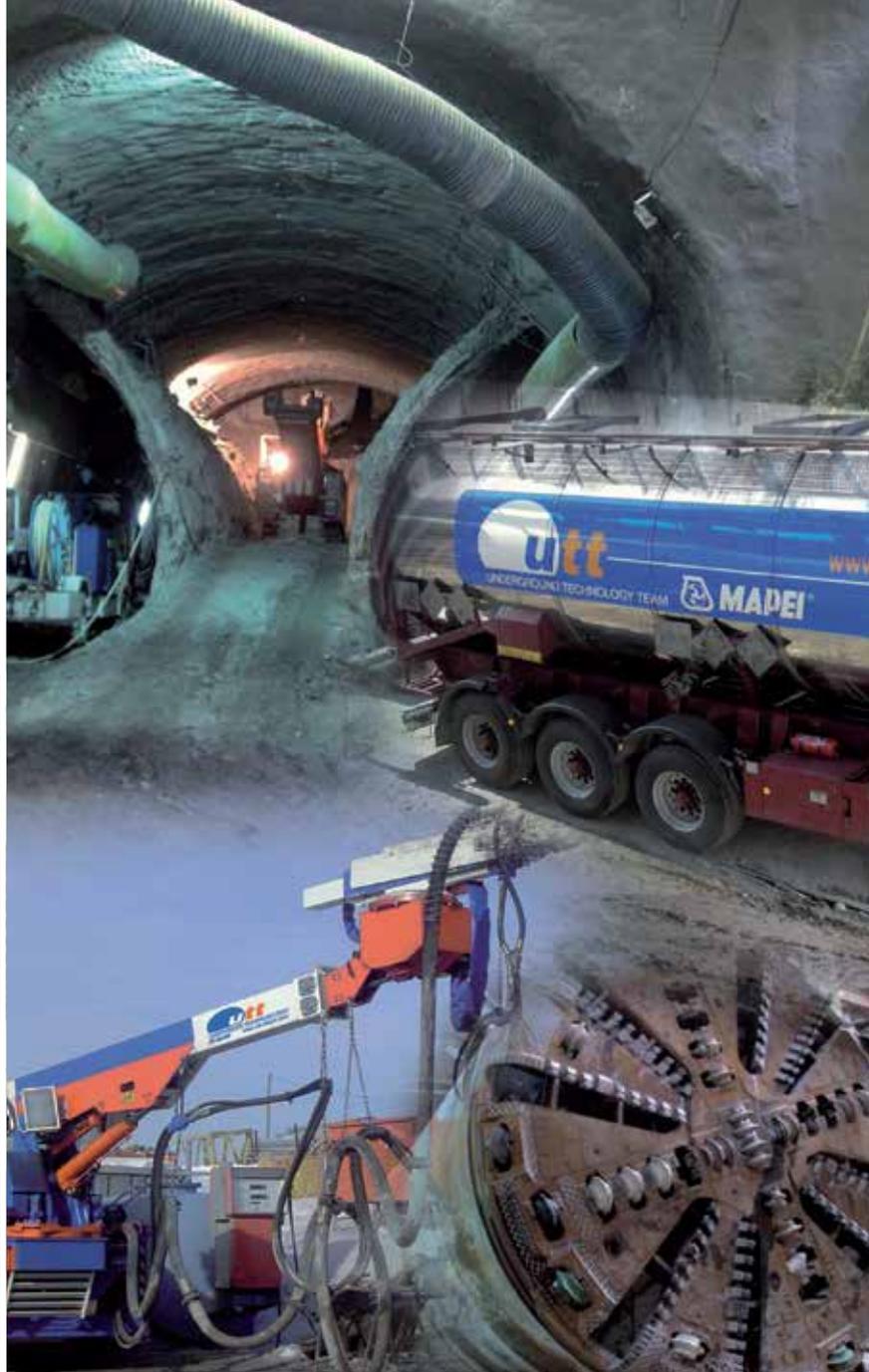
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Northwest Laborers-Employers Training Trust

See our ad on p. 39

Booth 515

The Safety and Hazard Awareness for Tunnels (SHAFT) courses are designed to teach skills for working safely in tunnels constructed using a tunnel boring machine (TBM). The program was developed by the Northwest Laborers-Employers Training Trust with input and consultation from several organizations. In addition to classroom lecture and discussion, participants have the experience of training in a simulated, lifelike tunneling environment.

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Booth 115

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Sandvik Mining and Rock Solutions

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Booth 208

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Booth 830

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SEALABLE Solutions GmbH (formerly Datwyler Sealing Technology)

Booth 216

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Booth 114

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Sika Corporation

Booth 701

Sika Corporation is a global specialty chemicals company with over 100 years of experience. Our Sika Shotcrete, Tunneling and Mining (STM) team incorporates the credibility of King Shotcrete with the global experience of Sika. Speak to one of our technical representatives today regarding our comprehensive portfolio of products which include pre-packaged shotcrete, fibers, liquid accelerator, grout, paste backfill, Sika® Aliva® equipment, asset maintenance and infrastructure repair. Sika specialists and our technical support team can advise and help meet challenges with the right solution.

Sika has subsidiaries in 101 countries with 25,000 employees and manufactures in over 300 factories.

Products & Services

Concrete Reinforcement
Grouting Services, Equipment and Materials
Lubricants for TBM
Precast Concrete Linings
Shotcrete Equipment, Supplies, and Services
Soil Conditioning Equipment and Materials

Main Office

201 Polito Ave
Lyndhurst, NJ 07071 United States of America
Phone: (201) 933-8800
usa.sika.com

Simem Underground Solutions, Inc

Booth 416

The team at Simem Underground Solutions has over 30 years experience providing fully automated material handling systems for TBM bi-component grout, hydrated bentonite, lightweight cellular grout, shotcrete, concrete, mining backfill, and water filtration. SUG manufactures colloidal mixers, pumping and delivery systems, as well as the automation and controls package. Concepts are specifically tailored to the customer's needs and include complete engineering, design and fabrication of all mechanical, structural and electrical systems. Services range from preliminary engineering and case studies through to hands-on commissioning and field training with complete CAD documentation and support.

Products & Services

Concrete Mixing and Transportation Equipment
Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
Precast Concrete Linings
Pumps and Pumping Equipment
Shotcrete Equipment, Supplies, and Services

Main Office

1A - 30528 Great Northern Ave
Abbotsford, BC V2T 6H4 Canada
Phone: (604) 621-7008
Email: information@simemug.com
www.simemug.com

SIXENSE**Booth 310**

Sixense is a leading provider of automated real-time instrumentation and monitoring for geotechnical, structural and environmental projects. With over 25 years of international experience, Sixense has demonstrated expertise in prominent urban tunnel projects in cities including Seattle, Washington DC, Los Angeles, Norfolk, Amsterdam, London, Budapest, Barcelona, Toronto, Paris, Hong Kong and more.

Sixense has built its reputation on client care and technical expertise while performing work safely, with high ethical standards and a constant environmental focus. Sixense is a recognized partner, locally and internationally, optimizing the value of small, medium and large monitoring projects.

Need peace of mind? Call Sixense!

Products & Services

Computer Hardware and Software
Consulting Environmental
Engineering Design and Services for Tunnels
Geological, Geotechnical Services and Equipment
Instrumentation Equipment and Services

Main Office

11812 N Creek Pkwy N, Ste 104
Bothell, WA 98011 United States of America
Phone: (206) 588-1691
Email: Inquiry-USA@sixense-group.com
www.sixense-group.com/en/

SoilFreeze Inc*See our ad on p. 43***Booth 514**

SoilFreeze Inc. provides temporary frozen soil shoring systems to support excavations and provide ground-water cut-off. Our technology can be used for; ground-water cut-off, in situ-isolation barriers, foundation excavation shoring, cross passages, adits, ground stabilization, and more...

We design, fabricate, install and maintain customized freeze systems for each client's needs. We serve both the private and public sectors and have a substantial list of successful projects and satisfied clients. SoilFreeze Inc. has advanced and refined freeze technology to create freeze systems that are mobile, reusable, and expandable to address the needs of any sized project and urban locations.

Products & Services

Ground Freezing

Main Office

5931 238th St SE, Ste 201
Woodinville, WA 98072 United States of America
Phone: (206) 261-0733
Email: info@soilfreeze.com
www.soilfreeze.com

Spendrup Fan Co/CFT**Booth 816**

Since 1968, Spendrup Fan Co. has designed and manufactured quality vane axial fans and accessories for all types of mining and industrial applications. Spendrup fans are designed to withstand the harshest environments. Fan casings are made of 5/16" steel. Impeller hubs are fabricated from mild steel. Impeller blades are 356-T6 hardness, to resist highly abrasive conditions. Spendrup Fan Co. designs fans to meet client specifications. Spendrup Fan can meet client needs, from MSHA Sch. 2-G, U/L approved explosion proof, marine duty, to fans that provide trouble-free service in high-temperature or corrosive environments.

Products & Services

Dust and Fume Control Technology
Tunnel Boring Equipment
Ventilation Systems, Materials and Equipment

Main Office

PO Box 4308
Grand Junction, CO 81502 United States of America
Phone: (970) 243-3429
www.spendrupfanco.com

Northwest Laborers Training

nwlett.edu/SHAFT



SHAFT was developed by the Northwest Laborers-Employers Training Trust with input from a team of industry experts and stakeholders. The SHAFT program provides quality, comprehensive safety training for both new and experienced tunnel professionals.

The curriculum is comprised of a blend of classroom discussion and use of materials and mockups in classes focusing on all aspects of tunnel safety.

Our facility, located in Elma, Washington, features a TBM mockup, loci, and access to 1,400' of 12' diameter tunnel, providing students with a unique, interactive educational experience.



EXHIBITORS

Stantec

Booth 908

The Stantec community unites approximately 22,000 employees working in over 400 locations across six continents. We have successfully delivered more than 1,200 underground projects in the past five years. Our portfolio includes tunnels up to 33 feet in diameter and shafts up to 110 feet in diameter. Our recent experience includes the City of Atlanta's Raw Water Delivery System with 5 miles of 10-foot diameter tunnels, City of Ottawa's CSST project with 3.7 miles of 9.8-foot diameter tunnels, and Metro Crenshaw/LAX Transit Corridor with three underground stations connected by four reaches of twin-bored, 21-foot diameter tunnels totaling 2 miles.

Products & Services

Consulting Engineers
Consulting Environmental
Engineering Design and Services for Tunnels

Main Office

1340 Treat Blvd, Ste 300
Walnut Creek, CA 94597 United States of America
Phone: (925) 941-1400
www.stantec.com/tunneling



Strata Worldwide | Tunneling

See our ad on p. 45

Booth 509

Products & Services

Safety Products
Shotcrete Equipment, Supplies, and Services
Tunnel Communication Systems and Equipment

Main Office

8800 Roswell Rd, Ste 145
Sandy Springs, GA 30350 United States of America
Phone: (770) 321-2500
Email: info@strataworldwide.com
www.strataworldwide.com

TBM Supply

Booth 808

Supplier factory new, used and surplus, carbon, stainless and PVC: pipe, valves, fittings. Grooved, Threaded, Flanged, Welded.
Domestic, DIN, JIS replacement including actuation.

Products & Services

Steel Pipe
Underground Utility Materials and Operations

Main Office

3301 Zachary Ave
Shafter, CA 93263 United States of America
Phone: (855) 535-1555
www.tbmsupply.com

Technical Tunnelling Components LTD (TTC)

Booth 613

Technical Tunnelling Components has over 40 years of experience manufacturing and supplying segment accessories such as connection bolts, grout/lifting sockets, segment packers and grommets along with the award winning Dowelock connection and alignment system, now with high shear options. TTC truly is the one stop shop for all precast segmental connections and grouting systems. The in-house design and manufacturing capabilities that TTC have can offer bespoke products for challenging situations as well as the standard segment accessories. TTC are supplying components worldwide with an impressive product portfolio along with an excellent service record.

Products & Services

Grouting Services, Equipment and Materials
Precast Concrete Linings
Segment Accessories
Tunnel Lining and Support Materials

Main Office

Unit K Radius Ct, Tungsten Pk
Hinckley, Leicestershire LE10 3BE United Kingdom
Phone: +44 0 1455 234401
www.ttctd.org

Terra Insights

Booth 834

Terra Insights' monitoring technology can measure areas of interest at scale, from high-production mine sites to entire networks, such as railways, highways, and pipelines with a combination of geospatial, ground-based, and structural-based instrumentation. Our platform is also used to measure movement in airports, bridges, water dams, tailings dams, mines, and tunnels. Powered by the trusted and experienced brands RST Instruments, Measurand, 3vGeomatics, and Syscom Instruments, Terra Insights is a comprehensive platform of geotechnical, structural, and geospatial monitoring technology, along with purpose-built data delivery solutions.

Products & Services

Engineering Design and Services for Tunnels
Geological, Geotechnical Services and Equipment
Instrumentation Equipment and Services
Mining Equipment
Tunnel Communication Systems and Equipment

Main Office

11545 Kingston St
Maple Ridge, BC V2X 0Z5 Canada
Phone: (604) 540-1100
Email: victoria.hitchcock@measurand.com
www.terrainsights.com



Terratec / Kelley Engineered Equipment

See our ads: p. 3 Terratec, p. 23 Kelley

Booth 1004

Incorporated in 1990, TERRATEC is the world renowned Australian designer and manufacturer of Tunnel Boring Machines, Raise Boring Machines, Conveyor Systems and other custom-made products for tunneling and mining applications. TERRATEC is Always Advancing! KELLEY ENGINEERED EQUIPMENT (KEE) celebrates their 15th anniversary of supplying custom equipment and professional engineering services to the tunneling and underground construction industry. KEE provides innovative, efficient designs optimized for safety and productivity. KEE is proud to represent Terratec TBMs in the USA and Canada along with Roxard Industries' TBM Cutters and Soft Ground Tools in North and South America.

Products & Services

Conveyor Equipment and Systems
Earth Pressure Balance Machines
Engineering Design and Services for Tunnels
Microtunneling Equipment, Tools, and Supplies
Mining Equipment
Tunnel Boring Equipment

Main Office

22010 Fowler Dr
Gretna, NE 68028 United States of America
Phone: (206) 412-4234
Email: tyler.sandell@keellc.com
www.terratec.co & www.keellc.com

TLT-Turbo

Booth 207

TLT-Turbo Inc. is an industrial ventilation fan manufacturer, including engineering, development, manufacturing, repair, and service. Experience and specialization in Tunnel & Metro, Mining, Wind tunnel, Industrial, MVR Fans, Power station, and Aftermarket service.

Products & Services

Ventilation Systems, Materials and Equipment

Main Office

2693 Wingate Ave
Akron, OH 44314 United States of America
Phone: (330) 776-5115
Email: Sales@tltfan.com
www.tlt-turbo.com

Towill, Inc.

Booth 714

Towill offers a wide array of surveying and mapping services to the tunneling and underground construction community, including owners, designers, construction managers, and contractors. As a full-service company, Towill addresses all project surveying and mapping needs, ranging from large-scale digital mapping prior to design to final as built surveys at project completion.



DEPENDABILITY DEFINED

SANDVIK DR412i ROTARY BLASTHOLE DRILL

The Sandvik DR412i blasthole drill is designed to improve conservation and deliver dependable penetration in the world's harshest mining conditions. Constructed for rotary or down-the-hole drilling with first pass capability of 12.3m (multipass) and 18m (single pass), the DR412i is automation-ready and built to deliver reliability while bringing a new level of safety and productivity to any operation.

The optional Compressor Management System solves the inherent inefficiencies of rotary blasthole drills by isolating the compressor to reduce emissions and enhance durability. Reduce costs and increase safety with automated features like auto rod handling and auto leveling. Crafted to suit your needs, the DR412i is built with an open design 360-degree catwalk system for safe and easy maintenance.

To learn more, visit [ROCKTECHNOLOGY.SANDVIK/DR412i](https://rocktechnology.sandvik.com/dr412i)
or email us at SurfaceMining@Sandvik.com



PRODUCTS & SERVICES

Towill offers the DMT Gyromat-5000 which is the most accurate gyro-theodolite available.

Products & Services
Consulting Engineers
Engineering Design and Services for Tunnels

Main Office
2300 Clayton Rd., Ste 1200
Concord, CA 94520 United States of America
Phone: (925) 682-6976
www.towill.com

TPH & GEOFORM NORTH AMERICA

Booth 705

Products & Services
Ground Freezing
Ground Improvement Equipment and Services
Grouting Services, Equipment and Materials
Jet Grouting Equipment and Services
Soft Ground Shields
Soil Conditioning Equipment and Materials

Main Office
1 - 2165 Buckingham Rd
Oakville, ON L6H 0W7 Canada
Phone: +1 833 GEOFORM
Email: info@geoforming.com
www.geoforming.com

TRE ALTAMIRA Inc

Booth 810

TRE ALTAMIRA is the recognized global leader in ground monitoring using SAR (Synthetic Aperture Radar) satellite data providing detailed surface motion information for engineering activities during tunneling operations. Using our proprietary SqueeSAR™ algorithms the group analyses images, captured by radar satellites to measure ground deformation to millimeter accuracy: detecting and monitoring ground subsidence, uplift, landslides, surface expression of faults, and for verifying the stability of individual structures. TRE ALTAMIRA produces dynamic maps and a database of surface deformation that provides a quantitative understanding of ground response to natural and anthropogenic activities. We have offices in Vancouver, Melbourne, Milan and Barcelona.

Products & Services
Consulting Engineers
Consulting Environmental
Engineering Design and Services for Tunnels
Geological, Geotechnical Services and Equipment

Main Office
475 W Georgia St, Ste #410
Vancouver, BC V6B 4M9 Canada
Phone: (604) 331-2512
Email: info.canada@tre-altamira.com
www.tre-altamira.com

Tsurumi Pump

Booth 802

Tsurumi Pump is a submersible pump manufacturer that supplies pumps worldwide for many projects including tunneling. Tsurumi pumps are capable of handling flows from 50-5000 gpm @ heads up to 750 feet. Wear parts are made of wear resistant materials capable of handling entrained solids commonly found in tunneling applications. Pump features such as dual inside mechanical seals that do not require cooling from or come in contact with the abrasive liquid being pumped is just one of the reasons Tsurumi Pump has become the pump of choice in mines throughout the world.

Products & Services
Mining Equipment
Pumps and Pumping Equipment
Wastewater Management Products
Water Treatment Plant and Materials

Main Office
1625 Fullerton Ct
Glendale Heights, IL 60139 United States of America
Phone: (630) 793-0127
Email: info@tsurumipump.com
www.tsurumipump.com

Tunnel Business Magazine (TBM)

Booth 506

TBM: Tunnel Business Magazine provides the North American tunneling industry with a trade magazine focusing on North American topics, projects and news. From large diameter tunneling to microtunneling, Tunnel Business Magazine, published by Benjamin Media, Inc., reports on the issues and topics important to the North American tunneling contractor, engineer and owner. Free subscriptions are available.

Products & Services
Educational
Publishers

Main Office
10050 Brecksville Rd
Brecksville, OH 44141 United States of America
Phone: (330) 467-7588
www.tunnelingonline.com

Tunnel Radio of America, Inc

Booth 828

Underground Wireless Communications Company

Products & Services
Dust and Fume Control Technology
Safety Products
Tunnel Communication Systems and Equipment

Main Office
6435 Hyslop Rd
Corvallis, OR 97330 United States of America
Phone: (541) 758-5637
Email: trsales@tunnelradio.com
www.tunnelradio.com

Tunneling Journal

Booth 605

Tunneling Journal delivers unrivalled editorial quality that features contemporary, lively, cutting edge articles with specific and unparalleled relevance to the tunneling contractor, consultant, client and machine manufacturer. Published six times a year, the print copy is partnered with a constantly updated website and a fortnightly newsletter. We also publish Breakthrough, ITA Activity Report, Australasian & New Zealand Tunneling Society Journal, and Canadian Tunneling. We're organizers of the British Tunneling Society Conference, and the Cutting Edge Conference in partnership with UCA of SME. Visit our booth to pick up complimentary copies of all our magazines and meet the team.

Products & Services
Educational
Publishers

Main Office
The Old Library, Dudley Rd
Tunbridge Wells, Kent TN1 1LE United Kingdom
Phone: +44 (0) 1892 522 585
Email: gary@tunnelingjournal.com
www.tunnelingjournal.com

Tunnels & Tunneling

Booth 709

Celebrating 50 years of service to the tunneling industry, and packed with information about the business its customers are in, Tunnels & Tunneling remains the leading underground construction magazine worldwide. Since 1999 T&T offers T&T North America, a bi-monthly magazine dedicated to its customers' regional market, and the official publication of the Tunneling Association of Canada (TAC). Each edition of T&T informs tunneling professionals on every aspect of underground construction in five continents. Readers include consulting engineers, clients, contractors and manufacturers in 90 countries. Stay abreast of all developments in the tunneling industry by subscribing to T&T.

Products & Services
Educational
Publishers

Main Office
John Carpenter House
London EC4Y 0BS United Kingdom
Phone: +44 (0) 20 7406 6584
www.tunnelsonline.info

TunnelTalk

Booth 408

Welcome to www.TunnelTalk.com - your gateway to tunneling on the web. Designed specifically as a web publication, TunnelTalk brings industry news, views and video reports directly to your internet device. A comprehensive editorial Archive is complimented by our industry Directory, Diary Dates, Job Opportunities, Equipment Sales and Procurement notices. Free weekly e-Alerts drive traffic to the site and, for industry advertisers, our readers are your next customers!

Products & Services
Educational
Publishers



SoilFreeze
ENGINEERING SOLID GROUND

Structural Shoring. Groundwater Cutoff.



Access Shafts



Cross Passages

Break In/Out



5931 238th ST SE #201 • Woodinville, WA 98072

(206) 420-2759 • www.soilfreeze.com

EXHIBITORS

Main Office

21001 N Tatum Blvd, Ste 1630-274
Phoenix, AZ 85050 United States of America
Phone: (602) 399-7184
Email: tunneltalk@tunneltalk.com
www.TunnelTalk.com

VMT USA

Booth 910

As a driving technological force for more than 25 years, VMT has the experience, the capacities and the know-how to develop innovative system and product solutions that support construction companies all over the world to build tunnels and shafts of every size for ever more complex infrastructure projects: VMT's navigation systems for driving equipment, its production and logistics management system for segment production and further innovative system solutions for safety, monitoring and data management play key roles here. VMT products can be combined into efficient, modern, networked solutions that ensure streamlined processes and seamless quality assurance for every tunnel project.

Products & Services

Instrumentation Equipment and Services
Laser Guidance Systems
Microtunneling Equipment, Tools, and Supplies
Roadheaders
Survey Equipment and Lasers
Tunnel Boring Equipment

Main Office

1613 132nd Ave E, Ste 200
Sumner, WA 98390 United States of America
Phone: (253) 447-2399
Email: info@vmt-us.com
www.vmt-us.com

V-ROD

Booth 510

V•ROD composite rebar has been manufactured by Pultrall since 1987. Pultrall manufactures V•ROD re-bars by combining the pultrusion process and an in-line coating process for the outside, sanded surface. The company's manufacturing processes meet ISO 9001 and ISO 14001 standards. In addition, in-house quality control tests are routinely performed along with tests performed by independent laboratories.

Products & Services

Tunnel Lining and Support Materials

Main Office

700 9E Rue Nord
Thetford Mines, QC G6G 6Z5 Canada
Phone: (418) 335-3202
Email: service@pultrall.com
www.fiberglassrebar.com

Williams Form Engineering Corp

Booth 700

Williams Form Engineering Corporation has been providing threaded steel bars and accessories for rock, soil and concrete anchors, post-tensioning systems, and concrete forming hardware systems in the construction industry for over 100 years. Our rock and soil anchor product line includes our Spin-Lock mechanical rock anchors, polyester resin anchors, multiple corrosion protection anchors, soil nails, strand anchors, Manta Ray soil anchors, Geo-Drill Hollow-Bar anchors, micro piles. For concrete anchoring we offer Spin-Lock anchors, undercut anchors, reusable anchors and cast-in-place anchors. We also have a full line of All-Thread Rebar for tie backs, micro piles and post-tensioning.

Products & Services

Concrete Reinforcement
Geological, Geotechnical Services and Equipment
Ground Improvement Equipment and Services
Soil Conditioning Equipment and Materials

Main Office

8165 Graphic Dr
Belmont, MI 49306 United States of America
Phone: (616) 866-0815
Email: williams@williamsform.com
www.williamsform.com

WSP

Booth 1002

WSP is a leader in tunneling and underground construction, from San Francisco to Stockholm. The firm has participated in the design and construction of some of the longest, largest, deepest, and most complicated tunnels in the world, including tunnels built in hard rock, soft ground or mixed-face conditions, and using mining, boring, jacking, cut-and-cover, and immersed tunnel technology. Projects include the Second Avenue Subway in New York City; the Stockholm City Line; the Eurasia tunnel in Istanbul; and San Francisco's Central Subway. WSP employs 55,000 professionals globally.

Main Office

One Penn Plz, 2nd Floor
New York, NY 10119 United States of America
Phone: (212) 465-5000
www.wsp.com

x-Glo North America Inc

Booth 712

Products & Services

Control Systems
Lighting Systems
Safety Products
Tunnel Communication Systems and Equipment

Main Office

15 Rita St
Markstay, ON P0M 2G0 Canada
Phone: (705) 698-0441
Email: don@x-glo-na.com
www.x-glo.ca

Zitron USA

Booth 704

Zitron USA is a ventilation fan manufacturing subsidiary of Zitron Spain. With nearly 60 years' experience in designing, manufacturing and supplying custom-made ventilation systems for underground mines, road and railway tunnels, and metro systems, Zitron is acknowledged as a global industry leader. Zitron has increasingly been chosen as the preferred supplier of the ventilation systems that such infrastructure demands, during both the construction and operational stages, to ensure the safety of workers, commuters and all users alike.

Products & Services

Control Systems
Dust and Fume Control Technology
Ventilation Systems, Materials and Equipment

Main Office

PO Box 2668
Beckley, WV 25802 United States of America
Phone: (304) 253-0777
Email: Caleb@zitron.com
www.Zitron.com/us



/strata tunneling



/strata connect



- Automation
- Telemetry
- Communication
- Tracking
- Machine Digitalization

/strata protect



- Proximity Detection
- Collision Avoidance
- Emergency Refuge Chambers
- Gas Detection

/strata geotech



- Ground Conditioners and TBM Tail Sealant
- Shotcrete
- Resins & Grouts
- Waterproofing
- Water Control
- Pneumatic Pumps

PRODUCTS & SERVICES

Abrasion and Impact Resistant Materials

FPT Infrastructure – Booth 710

Computer Hardware and Software

BabEng, LLC – Booth 309

Rocscience, Inc – Booth 115

SIXENSE – Booth 310

Concrete Mixing and Transportation Equipment

Fiori Group S.p.A – Booth 805

McDowell Equipment Ltd – Booth 708

Simem Underground Solutions, Inc – Booth 416

Concrete Reinforcement

BarChip Inc – Booth 715

Bekaert – Booth 603

GCP Applied Technologies – Booth 809

MAPEI Corp – Booth 415

Sika Corporation – Booth 701

Williams Form Engineering Corp – Booth 700

Construction - Contracting Services

Ballard Marine Construction – Booth 112

Crux Subsurface, Inc – Booth 601

Dibit Measuring Technique USA, Inc. – Booth 907

Drill Tech Drilling & Shoring Inc – Booth 617

EC Applications - Tunnel Lining – Booth 716

Hatch – Booth 412

HYTORC – Booth 824

Michels Corp – Booth 409

MILLER – Booth 607

Mueser Rutledge Consulting Engineers PLLC – Booth 611

Parsons – Booth 316

PSC Crane and Rigging – Booth 822

Consulting Engineers

AECOM – Booth 209

Arup – Booth 812

BabEng, LLC – Booth 309

Dr. Sauer & Partners Corp – Booth 213

Gall Zeidler Consultants – Booth 313

Gehrig, Inc – Booth 610

Geocomp Corp/GeoTesting Express, Inc – Booth 1000

Gomez International, Inc – Booth 804

Hager-Richter Geoscience, Inc – Booth 512

Hatch – Booth 412

JCK Underground, Inc – Booth 817

McMillen Jacobs Associates – Booth 901

Mott MacDonald – Booth 104

MSP Structures Inc – Booth 314

Mueser Rutledge Consulting Engineers PLLC – Booth 611

Parsons – Booth 316

Schnabel Engineering – Booth 830

Shannon & Wilson, Inc – Booth 114

Stantec – Booth 908

Towill, Inc. – Booth 714

TRE ALTAMIRA Inc – Booth 810

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Hatch – Booth 412

Schnabel Engineering – Booth 830

Shannon & Wilson, Inc – Booth 114

SIXENSE – Booth 310

Stantec – Booth 908

TRE ALTAMIRA Inc – Booth 810

Control Systems

Control International – Booth 803

IoT Automation – Booth 703

x-Glo North America Inc – Booth 712

Zitron USA – Booth 704

Conveyor Equipment and Systems

Carroll Technologies Group – Booth 413

H+E Logistics USA, Inc – Booth 912

Robbins – Booth 205

Terratec / Kelley Engineered Equipment – Booth 1004

Drilling Services and Equipment

Crux Subsurface, Inc – Booth 601

Derrick Corporation – Booth 212

HyperSciences, Inc – Booth 801

Malcolm Drilling Co Inc – Booth 807

McDowell Equipment Ltd – Booth 708

Palmieri S.p.A. – Booth 811

Ruen Drilling, Inc – Booth 110

Sandvik Mining and Rock Solutions – Booth 208

Dust and Fume Control Technology

ABC Industries, Inc – Booth 215
AMIX Systems Ltd – Booth 315
Englo, Inc, DBA Engart, Inc – Booth 608
Geo-Instruments – Booth 307
Grydale USA – Booth 513
Rocvent Inc – Booth 826
Spendrup Fan Co/CFT – Booth 816
Tunnel Radio of America, Inc – Booth 828
Zitron USA – Booth 704

Earth Pressure Balance Machines

Herrenknecht Tunnelling Systems USA, Inc – Booth 900
Master Builders Solutions – Booth 304
Robbins – Booth 205
Terratec / Kelley Engineered Equipment – Booth 1004

Educational

Colorado School of Mines – Booth 508
Northwest Laborers-Employers Training Trust – Booth 515
Tunnel Business Magazine (TBM) – Booth 506
Tunneling Journal – Booth 605
Tunnels & Tunnelling – Booth 709
TunnelTalk – Booth 408

Electrical - Generator-Motor, Wire-Cable

CAB – Booth 717
Carroll Technologies Group – Booth 413
Gomez International, Inc – Booth 804
Line Power – Booth 211

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AECOM – Booth 209
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Bekaert – Booth 603
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Dr. Sauer & Partners Corp – Booth 213
Gall Zeidler Consultants – Booth 313
Geocomp Corp/GeoTesting Express, Inc – Booth 1000
Gomez International, Inc – Booth 804

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HNTB Corp – Booth 913
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JCK Underground, Inc – Booth 817
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MSP Structures Inc – Booth 314
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Stantec – Booth 908
Terra Insights – Booth 834
Terratec / Kelley Engineered Equipment – Booth 1004
Towill, Inc. – Booth 714
TRE ALTAMIRA Inc – Booth 810

Environmental Control Equipment and Supplies

Innovative Wireless Technologies – Booth 614
IoT Automation – Booth 703

Fabrication Materials

Gomez International, Inc – Booth 804

Geological, Geotechnical Services and Equipment

AECOM – Booth 209
Crux Subsurface, Inc – Booth 601
Dibit Measuring Technique USA, Inc. – Booth 907
FPT Infrastructure – Booth 710
Gehrig, Inc – Booth 610
Geocomp Corp/GeoTesting Express, Inc – Booth 1000
Geo-Instruments – Booth 307
GEOKON – Booth 504
Hager-Richter Geoscience, Inc – Booth 512
IoT Automation – Booth 703
Ischebeck USA Inc – Booth 615
JENNMAR Civil – Booth 105
McMillen Jacobs Associates – Booth 901
Mott MacDonald – Booth 104
Mueser Rutledge Consulting Engineers PLLC – Booth 611

PRODUCTS & SERVICES

Parsons – Booth 316
Schnabel Engineering – Booth 830
Shannon & Wilson, Inc – Booth 114
SIXENSE – Booth 310
Terra Insights – Booth 834
TRE ALTAMIRA Inc – Booth 810
Williams Form Engineering Corp – Booth 700

Ground Freezing

Bauer Foundation Corporation – Booth 410
CDM Smith – Booth 117
Keller – Booth 305
Mueser Rutledge Consulting Engineers PLLC – Booth 611
SoilFreeze Inc – Booth 514
TPH & GEOFORM NORTH AMERICA – Booth 705

Ground Improvement Equipment and Services

AMIX Systems Ltd – Booth 315
Avanti International – Booth 217
CJGeo – Booth 612
Crux Subsurface, Inc – Booth 601
DSI Tunneling LLC – Booth 204
Ischebeck USA Inc – Booth 615
Keller – Booth 305
Malcolm Drilling Co Inc – Booth 807
Master Builders Solutions – Booth 304
Mueser Rutledge Consulting Engineers PLLC – Booth 611
Shannon & Wilson, Inc – Booth 114
Simem Underground Solutions, Inc – Booth 416
TPH & GEOFORM NORTH AMERICA – Booth 705
Williams Form Engineering Corp – Booth 700

Grouting Services, Equipment and Materials

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AMIX Systems Ltd – Booth 315
Avanti International – Booth 217
Bauer Foundation Corporation – Booth 410
ChemGrout, Inc – Booth 604
CJGeo – Booth 612
Crux Subsurface, Inc – Booth 601
DSI Tunneling LLC – Booth 204
Fiori Group S.p.A – Booth 805
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Master Builders Solutions – Booth 304
Minova – Booth 711
Nicholson Construction Co – Booth 308
Normet Americas, Inc – Booth 507
Renesco Inc – Booth 702
Richway Industries – Booth 516
Sika Corporation – Booth 701
Simem Underground Solutions, Inc – Booth 416
Technical Tunnelling Components LTD (TTC) – Booth 613
TPH & GEOFORM NORTH AMERICA – Booth 705

Hoists and Headframes

Carroll Technologies Group – Booth 413
MILLER – Booth 607
PSC Crane and Rigging – Booth 822

Hydraulic Hammers and Drills

Epiroc – Booth 404

Instrumentation Equipment and Services

Carroll Technologies Group – Booth 413
Crux Subsurface, Inc – Booth 601
Dibit Measuring Technique USA, Inc. – Booth 907
Geocomp Corp/GeoTesting Express, Inc – Booth 1000
Geo-Instruments – Booth 307
GEOKON – Booth 504
Schnabel Engineering – Booth 830
Shannon & Wilson, Inc – Booth 114
SIXENSE – Booth 310
Terra Insights – Booth 834
VMT USA – Booth 910

Jet Grouting Equipment and Services

AMIX Systems Ltd – Booth 315
Keller – Booth 305
Malcolm Drilling Co Inc – Booth 807
TPH & GEOFORM NORTH AMERICA – Booth 705

Laser Guidance Systems

VMT USA – Booth 910

Lighting Systems

IoT Automation – Booth 703

x-Glo North America Inc – Booth 712

Lubricants for TBM

MAPEI Corp – Booth 415

Master Builders Solutions – Booth 304

Sika Corporation – Booth 701

Microtunneling Equipment, Tools, and Supplies

AGRU America, Inc – Booth 311

Derrick Corporation – Booth 212

FPT Infrastructure – Booth 710

Herrenknecht Tunnelling Systems USA, Inc – Booth 900

HyperSciences, Inc – Booth 801

McDowell Equipment Ltd – Booth 708

Palmieri S.p.A. – Booth 811

Terratec / Kelley Engineered Equipment – Booth 1004

VMT USA – Booth 910

Mining Equipment

ABC Industries, Inc – Booth 215

AMIX Systems Ltd – Booth 315

Brookville Equipment Corp – Booth 405

CAB – Booth 717

Epiroc – Booth 404

H+E Logistics USA, Inc – Booth 912

J.H. Fletcher & Co – Booth 1006

Line Power – Booth 211

McDowell Equipment Ltd – Booth 708

Minova – Booth 711

Robbins – Booth 205

Sandvik Mining and Rock Solutions – Booth 208

Terra Insights – Booth 834

Terratec / Kelley Engineered Equipment – Booth 1004

Tsurumi Pump – Booth 802

Precast Concrete Linings

AGRU America, Inc – Booth 311

CBE GROUP – Booth 511

Master Builders Solutions – Booth 304

MSP Structures Inc – Booth 314

SEALABLE Solutions GmbH (formerly Datwyler Sealing Technology) – Booth 216

Sika Corporation – Booth 701

Simem Underground Solutions, Inc – Booth 416

Technical Tunnelling Components LTD (TTC) – Booth 613

Publishers

Tunnel Business Magazine (TBM) – Booth 506

Tunneling Journal – Booth 605

Tunnels & Tunnelling – Booth 709

TunnelTalk – Booth 408

Pumps and Pumping Equipment

AMIX Systems Ltd – Booth 315

Avanti International – Booth 217

ChemGrout, Inc – Booth 604

Gomez International, Inc – Booth 804

HYTORC – Booth 824

McDowell Equipment Ltd – Booth 708

Minova – Booth 711

Simem Underground Solutions, Inc – Booth 416

Tsurumi Pump – Booth 802

Rail Products

Brookville Equipment Corp – Booth 405

JENNMAR Civil – Booth 105

SEALABLE Solutions GmbH (formerly Datwyler Sealing Technology) – Booth 216

Roadheaders

Alpine Equipment – Booth 800

Antraquip Corp – Booth 505

Sandvik Mining and Rock Solutions – Booth 208

VMT USA – Booth 910

Rock Drills

Epiroc – Booth 404

Ischebeck USA Inc – Booth 615

J.H. Fletcher & Co – Booth 1006

McDowell Equipment Ltd – Booth 708

Palmieri S.p.A. – Booth 811

Sandvik Mining and Rock Solutions – Booth 208

Rock TBM's

Herrenknecht Tunnelling Systems USA, Inc – Booth 900

Palmieri S.p.A. – Booth 811

Robbins – Booth 205

Rotary Drum Cutters

Antraquip Corp – Booth 505

Epiroc – Booth 404

PRODUCTS & SERVICES

Safety Products

CAB – Booth 717
Carroll Technologies Group – Booth 413
Control International – Booth 803
HYTORC – Booth 824
Innovative Wireless Technologies – Booth 614
IoT Automation – Booth 703
Strata Worldwide | Tunneling – Booth 509
Tunnel Radio of America, Inc – Booth 828
x-Glo North America Inc – Booth 712

Scaling

Antraquip Corp – Booth 505
J.H. Fletcher & Co – Booth 1006

Segment Accessories

CBE GROUP – Booth 511
MSP Structures Inc – Booth 314
SEALABLE Solutions GmbH (formerly Datwyler Sealing Technology) – Booth 216
Technical Tunnelling Components LTD (TTC) – Booth 613

Shaft Drilling and Raiseboring Equipment

Herrenknecht Tunnelling Systems USA, Inc – Booth 900
JENNMAR Civil – Booth 105
Keller – Booth 305
MILLER – Booth 607
Palmieri S.p.A. – Booth 811

Shotcrete Equipment, Supplies, and Services

Bekaert – Booth 603
GCP Applied Technologies – Booth 809
Malcolm Drilling Co Inc – Booth 807
MAPEI Corp – Booth 415
Master Builders Solutions – Booth 304
McDowell Equipment Ltd – Booth 708
Minova – Booth 711
Sika Corporation – Booth 701
Simem Underground Solutions, Inc – Booth 416
Strata Worldwide | Tunneling – Booth 509

Slurry Services and Machines

Derrick Corporation – Booth 212
Keller – Booth 305
Malcolm Drilling Co Inc – Booth 807
MAPEI Corp – Booth 415

Soft Ground Shields

Herrenknecht Tunnelling Systems USA, Inc – Booth 900
Robbins – Booth 205
TPH & GEOFORM NORTH AMERICA – Booth 705

Soil Conditioning Equipment and Materials

FPT Infrastructure – Booth 710
Geocomp Corp/GeoTesting Express, Inc – Booth 1000
MAPEI Corp – Booth 415
Minova – Booth 711
Sika Corporation – Booth 701
TPH & GEOFORM NORTH AMERICA – Booth 705
Williams Form Engineering Corp – Booth 700

Steel Pipe

Ischebeck USA Inc – Booth 615
JENNMAR Civil – Booth 105
Naylor Pipe Co – Booth 1008
TBM Supply – Booth 808

Survey Equipment and Lasers

Dibit Measuring Technique USA, Inc. – Booth 907
VMT USA – Booth 910

Tunnel Boring Equipment

Antraquip Corp – Booth 505
Ballard Marine Construction – Booth 112
Bessac – Booth 312
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Gomez International, Inc – Booth 804
Herrenknecht Tunnelling Systems USA, Inc – Booth 900
HNTB Corp – Booth 913
HyperSciences, Inc – Booth 801
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Palmieri S.p.A. – Booth 811
Richway Industries – Booth 516
Robbins – Booth 205
Spendrup Fan Co/CFT – Booth 816
Terratec / Kelley Engineered Equipment – Booth 1004
VMT USA – Booth 910

Tunnel Communication Systems and Equipment

Carroll Technologies Group – Booth 413
Comtrol International – Booth 803
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Innovative Wireless Technologies – Booth 614
IoT Automation – Booth 703
Strata Worldwide | Tunneling – Booth 509
Terra Insights – Booth 834
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Tunnel Haulage Systems

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Tunnel Lining and Support Materials

ABC Industries, Inc – Booth 215
AGRU America, Inc – Booth 311
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Bekaert – Booth 603
Bessac – Booth 312
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David R. Klug & Associates, Inc – Booth 903
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MSP Structures Inc – Booth 314
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Shotcrete Technologies, Inc – Booth 407
Technical Tunnelling Components LTD (TTC) – Booth 613
V-ROD – Booth 510

Underground Excavation Services and Equipment

Alpine Equipment – Booth 800

Antraquip Corp – Booth 505
Bekaert – Booth 603
Brokk Inc – Booth 815
Drill Tech Drilling & Shoring Inc – Booth 617
Englo, Inc, DBA Engart, Inc – Booth 608
Fiori Group S.p.A – Booth 805
McDowell Equipment Ltd – Booth 708
Michels Corp – Booth 409
Parsons – Booth 316
Richway Industries – Booth 516

Underground Locomotives and Rail Haulage Equipment

Brookville Equipment Corp – Booth 405
McDowell Equipment Ltd – Booth 708
PSC Crane and Rigging – Booth 822

Underground Utility Materials and Operations

AGRU America, Inc – Booth 311
Avanti International – Booth 217
CAB – Booth 717
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TBM Supply – Booth 808

Ventilation Systems, Materials and Equipment

ABC Industries, Inc – Booth 215
ABC Ventilation Systems – Booth 113
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Englo, Inc, DBA Engart, Inc – Booth 608
Epiroc – Booth 404
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Mining Equipment Ltd – Booth 914
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Spendrup Fan Co/CFT – Booth 816
TLT-Turbo – Booth 207
Zitron USA – Booth 704

Wastewater Management Products

AGRU America, Inc – Booth 311
Derrick Corporation – Booth 212
HOBAS Pipe USA – Booth 706
Tsurumi Pump – Booth 802

Water Treatment Plant and Materials

AGRU America, Inc – Booth 311
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