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THE OFFICIAL PUBLICATION OF UCA OF SME WWW.TUCMAGAZINE.COM VOLUME 11 N0. 3 September 2017

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DEPARTMENTS

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CHAIRMAN'S COLUMN

How UCA members impact the tunnel industry

Each year, at the conclusion of the RETC or NAT Conference, newly elected members of the UCA Executive Committee join returning members at the big square table to begin their four-year terms of service. We focus on providing a balance of leadership from all four facets of our industry — engineers, contractors, suppliers and owners/academia.

As of July 1, the executive committee's members include: Ted Downey, Pamela Moran (second term), Paul Schmall and Mike Vitale. Artie Silber has fulfilled his term as chairman but continues his service as past chairman. As I move into the chairman position, Robert Goodfellow has taken over my seat as vice chairman. Kellie Rutunno and Les Bradshaw have rotated off of the executive committee. I want to thank both Kellie and Les for their past and continued service to the UCA.

Our executive committee is dedicated to serving our membership and guiding activities designed for the betterment of the U.S. tunneling industry. We are some, but certainly not the only, volunteers actively involved in this ongoing process. I'd like to take this opportunity to highlight some of the individual and group members who generously give their time and energy to advance our organization and industry.

The membership of the UCA of SME is consistently growing and currently stands at 971. Additionally, we are at a record-high level of corporate and sustaining company memberships, at 28 each. These memberships are significant to our organization not only for their financial support, but also for their support of the volunteer efforts of their UCA member employees. We are appreciative of their continued commitment to the goals of the UCA.

UCA members currently sit on 15 International Tunneling and Underground Space Association (ITA) Working Group committees. Many of our members travelled to Bergen, Norway in June for the various committee workshops held in conjunction with the World Tunneling Conference. A strong U.S. presence in these working groups is imperative so that we remain fully informed of industry innovations worldwide, and so that we may accurately share our own advancements and achievements. The Norway meeting also included elections for the ITA Executive Committee. Congratulations to Randy Essex, who was selected as one of the three new committee members.

Sarah Wilson is leading the effort to update *Recommended Contract Practices for Underground Construction*. Edited by Bill Edgerton and first published in 2008, this book was the first industry-wide effort to improve contracting procedures in more than 30 years. The fast-paced world of creative project delivery models we now find ourselves in will make this revision not just interesting, but essential reading. Sarah and her team are focused on a timeline for distribution in 2019.

Everett Litton is now the chair of the UCA Young Members Committee (UCAYM). A primary goal of this committee is to increase awareness and visibility of the underground industry within younger generations through university outreach and networking opportunities. Additionally, UCAYM provides many events focused on the professional development of our younger members and serves as the U.S. representative to the ITA Young Members group.

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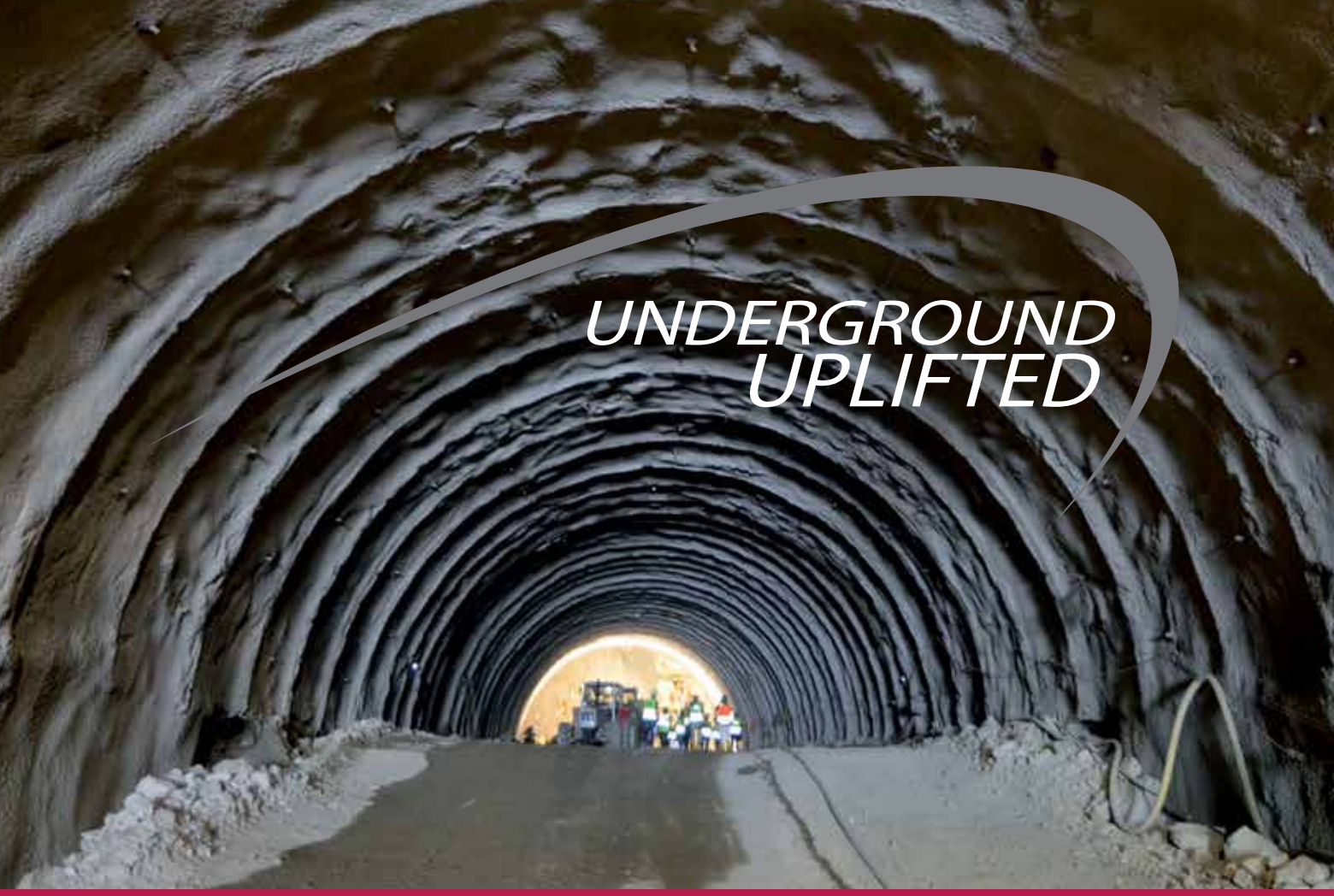

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TBM hits major milestone at Los Angeles' Regional Connector project

On June 1, one of the tunnel boring machines (TBM) working at the Regional Connector project in Los Angeles, CA achieved a major milestone when it broke through at the future site of a subway station at Second and Hope streets. That station will link the project's Blue, Expo and Gold lines in downtown Los Angeles.

The TBM, called Angeli began boring in October 2016 as part of the $1.75-billion Regional Connector project.

The 910 t (1,000-st), 122-m (400-ft) long machine began its subterranean journey in Little Tokyo. After breaking through a wall of earth at the planned Grand Avenue Arts/Bunker Hill Station the machine was to veer left and continue digging through downtown's Financial District.

When the entire $1.75-billion, 3-km (1.9-mile) Regional Connector project is completed in 2021, the S-shaped tunnel will allow commuters to use a single train to move from Long Beach to Azusa and from East L.A. to Santa Monica, linking some of the county's most far-flung residents without time-consuming transfers.

"The dream of connecting the Metro Rail system to the entire region is now becoming a reality with Angeli poised to continue her mission of completing the tunneling to Fourth Street and Flower in a few months," Metro Board chairman John Fasana said. "Today's milestone speaks volumes in completing this important work."

Metro officials said the connector will serve 88,000 riders daily, and save many travelers as much as 20 minutes by eliminating the need to transfer between lines.

The connector is expected to be open in 2021.

Los Angeles was once considered an unlikely place for such grand ambitions, the soil deemed too gassy and unpredictable.

A methane explosion in a water tunnel in Sylmar in 1971 killed 17 miners. In 1985, underground gas accumulated in a clothing store at 3rd and Fairfax streets, and when it blew up, nearly two dozen people were injured.

Gas wasn't the only problem for the city's first underground tunnel. In 1994, as Red Line crews burrowed beneath Hollywood, its star-studded boulevard sank 25 cm (10 in.) and two years later, the 101 Freeway dropped nearly 10 cm (4 in.).

By keeping steady pressure on the earth while excavating, operators minimized subsidence and heaving — sinking and bulging — the twin evils of tunneling. And with the miners enclosed in a capsule the diameter of the tunnel, dangerous gases could more easily be vented.

With the old equipment, the ground might move as much as an inch and a half, the project's chief mechanical engineer, Richard McLane, told *The Times*. On this project, he said, sensors have picked up movement of no more than 0.16 inch. ■

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Herrenknecht TBM completes Belchen rehabilitation tunnel in Switzerland

The shell of the Belchen rehabilitation tunnel has been completed.

Tunneling ended successfully in Eptingen in the Swiss canton of Basel-Country on June 21, 2017, three months ahead of schedule. The tunnel boring machine (TBM) designed and manufactured specifically for the project at the Herrenknecht plant in Schwanau, Germany, excavated 3.2 km (2 miles) of tunnel through complex geology in 16 months. The new structure is the prerequisite for rapid and economic rehabilitation of the two existing parallel road tunnel tubes.

The 13.91 m (45.7 ft) diameter TBM weighs 2 kt (2,200 st) and measures 75 m (246 ft). The single shield TBM is the largest of its kind. It bored and secured up to 90 m (295 ft) of tunnel per week through the complex and varied geology of the Belchen mountain range. Under the direction of Marti Tunnelbau AG, commissioned by the Swiss Federal Roads Office FEDRO, the tunneling crew took 16 months for the 3.2-km (2-mile) long drive, despite one-shift operation Mondays to Fridays. As a result, they navigated the TBM through the mountain three months faster than originally planned.

After jobsite assembly, excavation of the 3.2-km (2-mile) long Belchen rehabilitation tunnel began in February 2016 at the southern portal near Hägendorf (Canton of Solothurn).

After launching at the southern portal at Hägendorf (Canton of Solothurn) on Feb. 9, 2016, the project participants celebrated the successful breakthrough at the northern portal near Eptingen on June 21, 2017. FEDRO director Jürg Röthlisberger, the Baselbiet cantonal councilor Sabine Pegoraro and her Solothurn counterpart Roland Fürst among others congratulated the jobsite crew on the

(Continued on page 17)

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Tesla founder proposes large tunneling projects

In December of 2016, Elon Musk, the billionaire chief executive officer of Tesla, got the attention of the world of tunneling and underground construction when he tweeted a message that he was going "to build a tunnel boring machine and just start digging."

Since that tweet, Musk has reportedly created a company called The Boring Company, built a test tunnel in Los Angeles, CA on the grounds of his SpaceX property, released an animated video of his vision of a network of tunnels and has had what he called "promising conversations" with Los Angeles Mayor Eric Garcetti.

But Musk's visions are apparently not limited to the West Coast. This summer, Musk expanded his vision for The Boring Company with an ambitious plan to connect the cities of the Northeastern United States with a hyperloop that would link New York City, Philadelphia, Baltimore and Washington, D.C. via high speed rail.

Returning to Twitter, Musk on July 20 said he had received verbal approval from the government for the project.

Of course, everyone who works in the world of tunneling and underground construction knows that it takes much more than positive conversations and verbal approvals to begin any project, much less any as ambitious as those being proposed by Musk. But it is worth noting that Musk apparently has focused his efforts on creating a tunnel boring machine that can speed up projects.

So far, pictures have been released showing the digging equipment which Musk's firm will use to make the tunnels. And in May, the Boring Company released images of an electric mass transit system, which could potentially be developed. But so far, there have only been tests of the technology on private land.

It is also worth noting that Garcetti did say that he was interested in Musk's technology in a recent interview with *ABC*.

"And like many other cities have, I'd love to see, maybe with the new tunneling technology people like Elon Musk is looking at whether we can have a quick and direct route from LAX to Union Station," Garcetti said.

Musk's idea, as suggested by his tweet, is that the tunnels would not only be suitable for cars, but also bikes and pedestrians. ■

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First crossover tunnel boring machine to bore wastewater tunnel in Ohio

A Robbins Crossover (XRE) tunnel boring machine (TBM) measuring 9.26 m (30.4 ft) in diameter underwent factory acceptance on May 30, 2016. The machine was initially unveiled at Robbins' Solon, OH headquarters during a press day on May 25 before being shipped 40 km (25 miles) south for the construction of the Ohio Canal Interceptor Tunnel (OCIT) in Akron. Those present included Akron Mayor Daniel Horrigan, Robbins chief engineer Dennis Ofiara, and David Chastka, project engineer for contractor Kenny-Obayashi JV.

The TBM, which includes features of both earth pressure balance (EPB) and hard rock single shield TBM types, is the first crossover machine to be used in the United States. It will be launched from a 12-m (40-ft) deep portal site and build the first 68 m (226 ft) in soft ground, transitioning to a 183 m (600 ft) long zone of partial face shale before switching to hard-rock mode for the remainder of the drive in full face shale. Probe drilling will be done continuously using two probe drills to determine which mode the TBM should be in.

Project officials survey the Robbins Tunnel Boring Machine (TBM) during its factory acceptance in May 2017.

Unique aspects of the machine

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High-speed rail tunnel will cross under the Great Wall of China

The global tunneling industry has been responsible for many remarkable engineering feats as it has constructed tunnels under rivers, seas, cities and through mountains. Another one to add to the list will be a high-speed tunnel that passed beneath the Great Wall of China.

The 12-km (7-mile) long, high-speed train tunnel is being built in advance of the 2022 Winter Olympics to connect Beijing with Zhangjiakou City which is due to cohost 2022 winter games.

It took the Chinese engineers months to choreograph the best intersection point. In the end, the tunnel, deep below the Badaling section of the Great Wall, passed experts' appraisal, state-run *People's Daily* reported.

The line is designed for trains traveling up to 350 km/h (217 mph), which is expected to shorten the single-journey time from more than three hours to approximately one hour. The line is estimated to be completed in 2019, the *Economic Times* reported.

The depth of the tunnel will range from 4 m to 432 m (13 ft to 1,417 ft).

The concerns about the safety of the Great Wall were obvious. The Wall was built from the third century BC to the Ming Dynasty (1368-1644) and stretches more than 21,000 km (13,000 miles). In addition to its historic and cultural significance, it is the economic driver of China's tourism industry as more than four million tourists visit the Great Wall every year.

According to official statistics, about 30 percent of a 6,200-km (3,800-mile) section of the wall built in the Ming Dynasty has disappeared, and less than 10 percent is considered well-preserved.

The Great Wall has faced threats from both nature and humans. Earthquake rain, wind and other natural elements have left the wall with many decayed and crumbling bricks.

Luo Duhao, chief engineer of the

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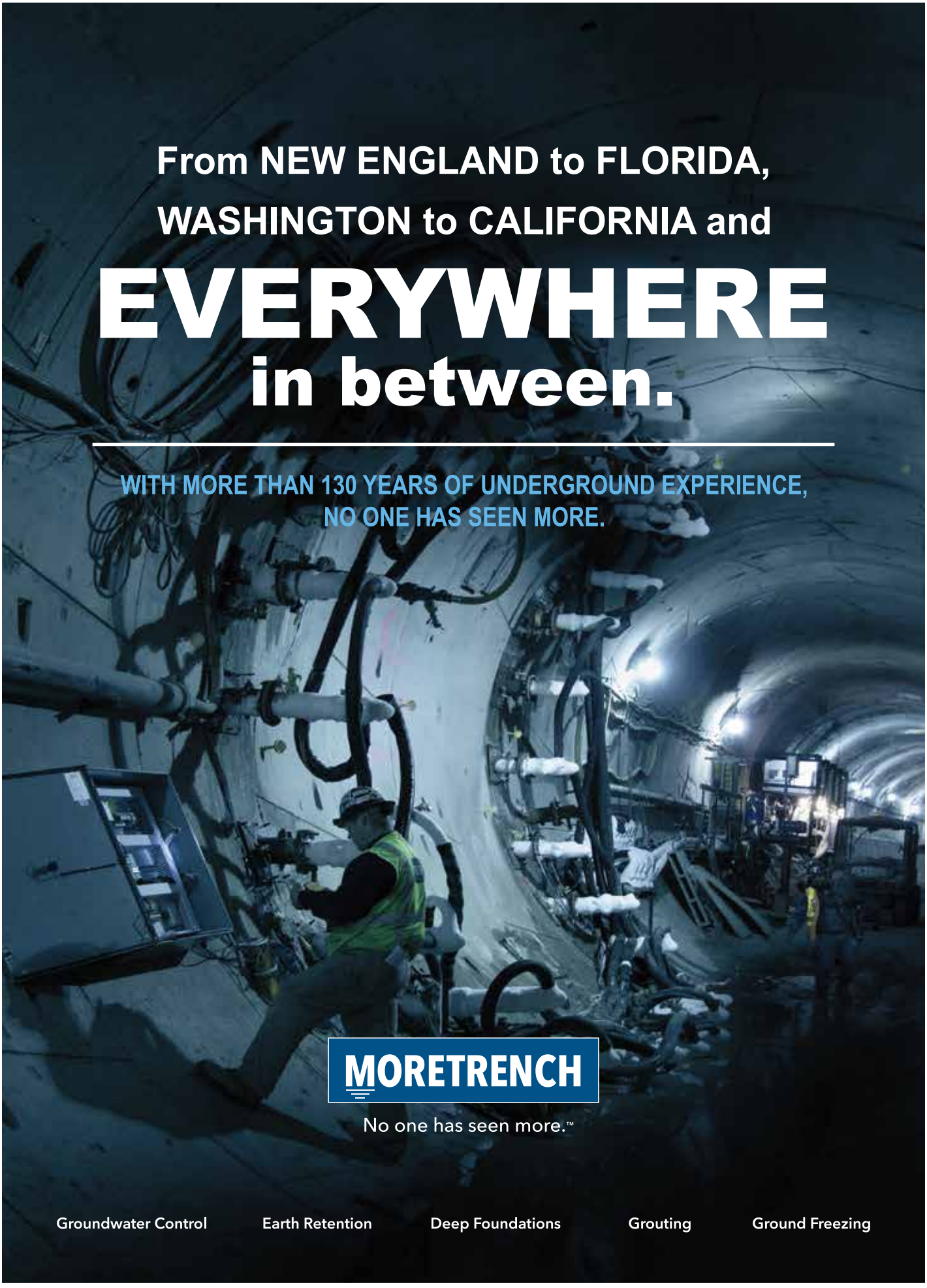
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California WaterFix gets approval from governor's office

The massive water tunnel project known as the California WaterFix achieved a major milestone in July when California Gov. Jerry Brown's administration gave the official go-ahead for the project that would see the construction of two large tunnels beneath the Sacramento-San Joaquin Delta.

The states Department of Water Resources (DWR) said it had finalized the lengthy environmental review of the $17.1 billion Delta tunnels project. In what's known as a "notice of determination," regulators said building and operating the tunnels complies with the California Environmental Quality Act and won't harm fish, wildlife or human health.

While the state has given its approval to the 56-km (35-mile) long twin tunnels, there is plenty of opposition that will attempt block the project from becoming a reality.

Supporters of the project, including Gov. Brown, have worked to bring it to life for more than a decade. By rerouting a portion of the Sacramento River's flow through the tunnels, Brown has said the federal and state pumping stations in the southern part of the estuary will do less harm to fish — and be able to deliver water more reliably to 25 million Southern Californians and Bay Area residents and millions of acres of San Joaquin Valley farmland.

DWR Acting Director Cindy Messer said the document is "a major milestone" that will "put WaterFix a step closer to construction, which could begin as early as 2018." Construction will take at least a decade.

However, Messer also told the *Sacramento Bee* that the state expects to get sued over the document by the project's numerous opponents, who include Delta landowners, environmentalists and others.

The notice of determination paves the way for a flood of litigation over the tunnels project. Legal experts said the state's strict environmental law, known as CEQA, can often serve as a powerful tool for opponents to stand in the way of a project, at least

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Jacobs to acquire CH2M

Jacobs Engineering Group Inc. announced that it has reached an agreement to acquire all of the outstanding shares of CH2M in a cash and stock transaction with an enterprise value of approximately $3.27 billion, including approximately $416 million of CH2M net debt.

CH2M, founded in 1946 and based in Douglas County, CO, has worked on projects such as the expansion of the Panama Canal and a 25-km (15.5-mile) tunnel designed to improve London's sewage system. It has around 20,000 employees and, in 2016, logged revenue of $5.2 billion.

"By increasing our industry reach and adding to our already extensive skills, this transaction enhances our value to our clients and bolsters Jacobs' position as a premier consulting, design, engineering, construction, and operations and maintenance technical services firm. CH2M brings to Jacobs a talented, engaged team with capabilities and values that are very complementary to our own. Together, we will bring more solutions to our clients, give more opportunity to our employees and create increased value for Jacobs' shareholders. In addition, this transaction is consistent with our M&A criteria, accelerating our ability to achieve our financial growth targets and propelling Jacobs toward our vision of providing innovative solutions for a more connected, sustainable world," said Steve Demetriou, Jacobs' chairman and chief executive officer.

"We are delighted about the prospects of combining CH2M with Jacobs," said CH2M chairman and chief executive officer Jacqueline Hinman. "Since late 2014, we've been transparent about our plans to pursue an ownership transition, providing sustained access to capital for growth. Considering all of the options, we focused on securing greater opportunities for our employees, delivering superior value to our clients and enhanced value for our stockholders, all while continuing to serve the higher purpose our company is known for, providing sustainable solutions for a better world. Throughout this

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Belchen Tunnel: Mountain tunnel is rehabilitated

(Continued from page 6)

project completion on site.

The Belchen Tunnel, which cuts through the Jura Mountains between Basel and Lucerne, is of great importance to the north-south road traffic via Gotthard as well as for domestic Swiss traffic. Currently, an average of 55,000 vehicles per day pass through the twin tube road tunnel of the A2 road tunnel with two lanes in each direction. As a result of increasing rock pressure, both tubes are urgently in need of repair to ensure operational safety.

The rehabilitation tunnel now completed was excavated through the mountain to the west of the two existing tubes at a distance of 40 to 116 m (131 to 380 ft) from the existing tunnel system.

Along the tunnel alignment, the miners from Marti Tunnelbau AG mastered the challenging geological conditions with the Herrenknecht single shield TBM with overburdens of up to 360 m (1,181 ft). Soft layers of rock alternated with up to 225 MPa hard layers, in places with karstified and water-bearing transition zones. In addition, long sections of squeezing opalinus clay and swelling gypsum keuper had to be passed through.

Site manager Sergio Massignani summarized after the breakthrough. "Thanks to the comprehensive knowledge of the ground conditions from the two existing tunnel tubes, coupled with our experience and Herrenknecht's know-how, the machine was optimally designed for the demanding requirements of the alignment of the Belchen rehabilitation tunnel."

After completion of the final works inside the tunnel and its commissioning in 2021, the two existing tubes dating from the 1970s will be renovated one after the other so that, as before, two lanes will be available in each direction, north and south, and the traffic can flow unimpeded.

When the TBM was launched in February 2016, Röthlisberger summarized the concept of the project with the words "construction without queues." ■

Chairman's Column: Volunteers drive the UCA

(Continued from page 2)

Paul Schmall leads the education and student outreach subcommittee. Preliminary activities include a series of presentations to ASCE student chapters at schools across the United States and development of a marketing campaign designed to attract civil engineering students to careers in underground construction.

The awards committee, chaired by Erika Moonin, reviews qualifying nominations before presenting these nominees to the executive committee for selection. The UCA presents biennial awards for Outstanding Individual, Outstanding Educator, Project of the Year and Lifetime Achievement.

Chairman of the 2017 Cutting Edge Conference is Joe O'Carroll. Showcasing the theme of "Advances in Tunneling Technology," this conference will be held in Seattle, WA November 13-15, and will include a tour of the Alaskan Way Viaduct Replacement Project.

Francis Arland is chairman of the 2018 George A. Fox Conference. This annual event in New York is known for its informative presentations and networking opportunities, and will take place on January 23, 2018.

Lonnie Jacobs and more than a dozen other volunteers are actively planning the 2018 North American Tunneling (NAT) Conference, scheduled for June 24-27 in Washington, D.C. Put this one on your calendars now, and watch for more information as details are confirmed.

As you can see, there are literally dozens of UCA members volunteering their time and energy to all aspects of the U.S. tunneling industry. Of course, there is always room for additional volunteers. Whatever your personal interests, I strongly encourage each and every one of you to find an opportunity to contribute in whatever way, and within whatever time frame, works best for you. We work best when we all pitch in together. Please feel free to contact me, or any of the individuals named above, and let us know how you'd like to get involved. Make this the year you take your UCA membership to the next level and become an industry-leading volunteer. ■

Mike Roach
Chairman, UCA of SME

WaterFix: Many hurdles remain for massive project

(Continued from page 14)

temporarily.

"It does slow things down for sure," said George Hartmann, a Stockton lawyer who represents Delta farmers opposed to the tunnels. He said litigation is likely to begin in short order.

Barbara Barrigan-Parilla of Restore the Delta, one of the project's fiercest opponents, added, "The bottom line is there are so many flaws in the project ... that we and other parties throughout the Delta and the state will prepare to litigate."

In spite of the official state approvals, the project is far from certain.

The south-of-Delta water agencies that would have to pay for the tunnels still haven't signed off on the project. The powerful Metropolitan Water District of Southern California and Kern County Water Agency appear ready to make financial commitments this fall. But at least one key water agency is wavering. Farmers at the Westlands Water District, an influential agency covering much of Fresno and Kings counties, said they remain unconvinced after hearing detailed projections on cost during a meeting in July.

DWR's document was released less than a month after two federal fisheries agencies gave their approvals to the project. In a pair of long-awaited decisions, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service said the tunnels aren't likely to jeopardize the continued existence of Delta smelt, Chinook salmon, steelhead and other fish protected by the Endangered Species Act. Days later, fishing groups and environmentalists sued in U.S. District Court.

The state took another legal step toward pushing the tunnels project forward by filing a "complaint for validation" in Sacramento Superior Court. That legal action paves the way for eventually borrowing the billions of dollars needed to build the tunnels. But no money will change hands until the south-of-Delta water agencies agree to participate. ■

Great Wall: Tunnel is being built for 2022 Olympics

(Continued from page 12)

Beijing-Zhangjiakou High-Speed Railway Line, being built by China Railway Number 5 Engineering Group Co. said the firm will employ precision micro-blasting technology, which has a velocity of 0.2 cm per second and is able to make the tremor weaker than the traditional firepower blasts that have a velocity of 5 cm per second.

Luo told the *Global Times* that the new technology will ensure that the Great Wall will not be affected by the blasts, as they will be barely felt.

"The new technology causes little damage to the geological environment, which will help protect the Great Wall," Dai Longzhen, deputy manager of the Beijing-Zhangjiakou High-Speed Railway Line, told the *Global Times*.

Zhang Xuehua, a blast expert at the construction site, told the People's Daily that the construction of the tunnel has completed 4,500 blasts since early February this year.

In the middle of the tunnel, workers will build a spacious and well-decorated station right under the Great Wall, with a record-breaking construction space of 36,000 m^2 (387,500 sqft), the X*inhua News Agency* reported.

The station will be 102 m (334 ft) below the surface of the Badaling Great Wall.

Dai said the construction area and the depth of the station is record-breaking.

He said that because the station is built underground, it will cause less damage to the plantation, and it also demonstrates China's top-notch railway construction capabilities. ■

CH2M: Will be one of the largest in engineering

(Continued from page 16)

time, we strengthened our business portfolio and performance, which put us in a position to deliver the best possible value and outcome for the future of the company. This was the unanimous choice of our board, and the value Jacobs will provide to our stockholders, reflects genuine appreciation for our employees and the world-class work we deliver to our clients."

Hinman will take over as chairwoman of the board.

In 2016, private-equity firm Apollo Global Management bought a minority stake in CH2M in a deal that valued the company at roughly $2 billion.

Jacobs is based in Dallas, TX. It serves the aerospace, infrastructure, industrial and energy sectors, building space-systems facilities for NASA and designing plans for highways, bridges, tunnels and airports, among other projects. It had $10.9 billion in revenue in 2016.

Engineering and construction companies are expected to get a lift from President Donald Trump's promised $1 trillion infrastructure-spending package. As a result, investors have plowed money into stocks of companies in the sector. Jacobs stock has nearly doubled this year, for example, giving it a market value of about $6.3 billion.

CH2M has exposure to fast-growing and profitable segments of the infrastructure and government-services sector that are attractive to Jacobs, which expects the acquisition to produce $150 million in annual cost savings.

If the deal is completed, it would be one of the largest ever in the engineering industry, after Aecom's roughly $4 billion deal to buy URS Corp. in 2014. There have been a number of other deals recently, including the acquisition of WS Atkins PLC by Canada's SNC-Lavalin Group. In March, Amec Foster Wheeler PLC and John Wood Group PLC also agreed to merge. ■

Robbins: TBM to bore wastewater tunnel

(Continued from page 10)

include a versatile cutterhead that will be configured with consideration for both the short soft ground section and the longer section (about 65 percent of the tunnel) in hard rock. A combination of disc cutters and sacrificial rippers will be used in case a cutter becomes blocked. The required rolling torque of the disc cutters has been reduced by 25 percent to encourage smooth rotation in soft ground. The motors of the XRE machine have been reworked from an original EPB configuration to permit higher motor speed at reduced torque for the open mode segments of the drive.

Muck removal will be achieved with a durable screw conveyor, the first flight of which is covered welded-in wear plates. The auger shaft is lined with hard facing in a crosshatch pattern, while the screw conveyor casing has been similarly lined in wear plates and hard facing. A wear monitoring plan has been prepared for the entire drive in order to maximize efficiency in the section of more abrasive rock. Robbins project manager Pablo Salazar is proud of the utilization of local jobs during the TBM construction and design process: "We have built good portion of the machine in the northeast Ohio area. Many components were fabricated locally with sub-suppliers, as well as in our own shop." The muck will be transported out of the tunnel using a Robbins continuous conveyor system — the setup will be the 100th such conveyor supplied by Robbins for operation behind a TBM.

The machine was dubbed "Rosie" in honor of Rosie the Riveter, an icon representing the American women who worked in factories and shipyards during World War II. Hundreds of "Rosies" including Akron resident Rose May Jacob worked in factories to turn out materials and armaments for the Allied war effort. The TBM will be shipped in truckloads to the jobsite, with the large cutterhead shipped in four pieces. "The entire process of assembly has allowed the contractor to follow very closely through the testing of the machine, so they are very familiar with the TBM at this point. At the jobsite, we will also provide immediate support for both spare parts and personnel," said Salazar. Jobsite supervisors from Robbins will assist in TBM assembly and excavation for at least the first 1,000 m (3,280 ft) of boring. Tunnel boring was scheduled to begin in August of 2017.

The OCIT Project for the city of Akron consists of the construction of a conveyance and storage tunnel system to control combined sewer overflows for several regulators in the downtown Akron area. The EPA-mandated project includes the 1.89 km (1.17 miles) conveyance and storage tunnel, as well as drop shafts, diversion structures, consolidation sewers, and related structures. The consent decree specifies that the tunnel must be operational by Dec. 31, 2018. ■

FEATURE ARTICLE

Suppressing dust during tunnel construction using automated mist technology

Descending several stories down a metal staircase into a shaft spanning a quarter city block -- soon to become Roosevelt Light Rail Station in Seattle, WA -- visitors are greeted with four perfectly round, precast concrete-lined horizontal holes leading deep into the earth. The sound of water trickling out from a small drainage trough can be heard over the faint echoes of construction within. Upon entering, the light is dim, but the air is clear with barely a dust particle flowing through the sunbeams. This type of air quality is only accomplished with diligent controls, and JCM Northlink, the company in charge of building the Northgate Link Extension Project, is taking those measures seriously.

A powerful fan propels the mist out in a long cone, covering a large area and improving tunnel airflow.

Commissioned by Sound Transit, JCM is a joint venture of three companies: Jay Dee Contractors, Frank Coluccio Construction Co. and Michels Corp. The tunnels JCM constructed are intended to provide fast, reliable underground rail service, as well as relieve one of the region's most congested traffic areas. The $440 million project will connect the Northgate, Roosevelt and University District neighborhoods north of Seattle to the downtown corridor and SeaTac airport further south.

The scope of this project includes excavation for two light rail stations, boring of two parallel 5 km- (3.3-mile) long light rail tunnels in six runs and the construction of 23 cross passages. Begun in 2014, Sound Transit estimates that crews excavated more than 382,000 m3 (500,000 cu yds) of soil and installed 7,352 precast concrete tunnel liner rings during the shaft construction and boring phase. Now that tunnel boring is complete, JCM is in the process of constructing the cross passages, which act as maintenance areas and escape routes for passengers. Throughout the entire process, the company has utilized atomized mist to control particle emissions.

"Our dust control needs change at every phase of the project and don't go away until the project is fully complete," said a JCM safety representative. "We found that different dust suppression technologies were needed at different intervals, but atomized mist seemed to fulfill our needs at every step."

Excavating shafts and boring tunnels

For the three sites, excavators dug 21-30.5 m (70-100 ft) down through primarily dense glacial tills and sands, creating an open vertical rectangular shaft held fast by diaphragm walls and secant pile walls. The shaft first serves as the staging area for the tunnel boring machine (TBM) and eventually becomes part of the rail station construction. Ground freezing was used to stabilize the ground at two launch and reception areas for the TBM.

The TBM (nicknamed "Brenda") has a 6.4-m (21-ft) diameter rotating cutting head in front that grinds and

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The tunnels are deep underground, and the station will extend to both sides of the block.

extracts homogenous, cohesive soil made up of sand, clay and solids, running the material through a 122-m (400-ft) long gantry system trailing directly behind. Advancing an average of 10-15 m/day (30-50 ftpd), as the TBM moved, precast concrete segmented liner rings were set in place along the tunnel path. This created the tunnel structure, providing stability and leverage for Brenda's hydraulic arms to produce forward pressure. Excavated material is conveyed through the tunnel, loaded onto trucks and transported to storage piles off-site. Even though there is dust mitigation technology on the TBM, there was still a large amount of dust created along the conveyor path, affecting visibility and air quality.

Surface suppression versus airborne suppression

Workers are required to wear breathing masks while engaged in (or in proximity to) dust-causing activities. Recorded by personal dust monitors, OSHA limits fugitive dust levels to 15 mg/m^3 (50 million particles/sq ft) of particulate material (PM) the size of 10 microns (PM10) or smaller (U.S. Department of Labor, 2017). A micron is 1 micrometer (1/1,000,000th of a meter).

According to the National Institute of Environmental Health Sciences (NIEHS), particles must be smaller than 200 microns to be light enough to become airborne and are generally not visible at less than 50 microns which is approximately the diameter of a human hair) (NIEHS, 2006). Particles classified as PM10 or smaller are able to penetrate the body's natural defenses and potentially cause serious respiratory issues. Areas at risk for long term or concentrated exposure require both a surface and airborne dust suppression solution to be completely effective.

Industrial sprayers like those found on TBMs provide surface suppression by spraying water on material loaded onto the conveyor, creating a damp protective barrier on top to prevent dust and fines from escaping. However, as the cargo travels quickly over idlers, it shifts and exposes enough dry material to cause fugitive dust emissions to billow down the entire length of the tunnel. Sprayers do not provide airborne suppression. Even when placed intermittently down the course, the droplet size of industrial sprayers is typically between 200 and 1,000 microns in size, which is too large to capture particles out of the air due to the slipstream effect.

A slipstream is created when the size and velocity of a moving droplet causes air to rapidly flow around it. This airflow, though small, is enough to affect miniscule airborne particles and deflect them away from the droplet. Conversely, atomized mist droplets are between 50 and 200 microns in size. This is light enough to linger in the air — creating virtually no slipstream — and collide with airborne particles, driving them to the ground. As atomized mist settles, it also offers surface suppression on conveyed material moving through the passage.

Suppressing airborne dust during boring

Seeking airborne dust control, JCM contacted BossTek and purchased two DustBoss 30 (DB-30) atomized mist cannons to provide a viable mobile solution. According to chief executive officer Edwin Peterson, "The DB-30 has a powerful fan-driven design that directs mist down the length of the conveyor. Along with providing dust suppression, it assists ventilation because it is pointed toward the tunnel's only opening during the boring phase."

Mounted on a mobile carriage, the heavy-duty cone-shaped barrel design has a powerful fan in back that is protected by a metal cage, with an atomized

One of six runs with specially engineeredprecast sections that retain the structural integrity.

misting ring in front containing 30 nozzles. A 7.5 hp fan running at 9200 CFM (260.50 CMM) creates enough thrust to introduce millions of tiny mist droplets in a 30-m (100-ft) cone. The droplets travel on air currents down the tunnel toward the mouth, absorbing airborne particles as they go.

The DB-30 puts less of a burden on water systems extending down the tunnel than large sprinklers, because it only requires 10 PSI (0.68 BAR) of water pressure from a standard 19 mm (0.75 in.) garden hose coupling. Equipped with a 30-m (100-ft) 10/4 electrical cord, all settings are accessed from a touch control panel housed in a NEMA 3R cabinet or by remote device. The unit is easily moved around a jobsite on its wheeled carriage and can be hooked up in minutes by a single worker.

Excavating cross passages

Each twin parallel tunnel run has a walkway extending the entire course, with perpendicular 4.8-m to 6-m (16- to 20-ft) long cross passages connecting them, set about 2,600 m (800 ft) apart. To construct the cross passages, the conveyors used with the TBMs were removed and replaced with rubber-tired debris haulers small enough to drive the length of the run. After the precast concrete tunnel liners are demolished in designated sections to allow access to excavate the cross passage, workers apply shotcrete to keep the ground in place.

"Due to the high water levels in the soil, some cross passages had to have their perimeters frozen before excavation could commence. We drill through the ground and place dozens of nearly horizontal pipes, then pump a chilled brine solution through them to reduce the temperature of the soil to 10° F (-12° C), freezing the area solid," said Mark Boyer, safety and security representative for JCM. "The frozen soil is like concrete, making it much safer to excavate."

Taking approximately seven to nine weeks to complete, mini-excavators dig through the frozen passages, which are then waterproofed and reinforced with rebar. Around 90 m^3 (100 cu yd) of fiber-reinforced concrete is poured to create the invert and headwalls. The entire process, from demolition of the tunnel wall to construction, created dust.

Because each tunnel run has been completed, instead of relying on a single opening for air as in the boring phase, there is now an entry (also known as an "adit") and exit for each tunnel, allowing ventilation to be unidirectional in each one. Air is drawn in at the adit of the tunnel using a ceiling-mounted industrial fan with a 65-m (20-ft) long duct and exhausted out the other end. This airflow also changes how fugitive dust travels.

"We liked the mobility and size

Twin tunnels run parallel underground and are connected by 23 cross passages.

of the DB-30s, as well as how efficiently they cleaned the air," a JCM safety representative said. "Once the boring phase ended and we were creating the cross passages, we discovered that they were too powerful and we needed a more compartmentalized solution that still utilized atomized mist. Something that could isolate specific dusty sections of the tunnel and prevent fugitive particles from migrating further down." JCM used the DustBoss M Mini misting system at strategic locations to do this.

Sectional dust control

The DB-M Mini's 0.6-m (2-ft) long boom is fitted at the end with a powerful misting head with nine atomizing nozzles. Having no moving parts, it does not require power to operate. The water is simply split off of the main supply and fed through a standard 19 mm (0.75-in.) swivel hose coupling.

Water travels through an in-line 75 mesh (200 micron) filter, up the boom and to the head. The atomizing nozzles fracture the flow into millions of droplets, which are distributed across the width of the tunnel like a shield. Air currents generated by the internal ventilation system carry the droplets as much as 6 m (20 ft) down the tunnel, creating a zone of mist through which few airborne particles can travel.

"It noticeably raises the humidity in the tunnel for only the section we need it to," said Boyer. "As you walk through the mist, the droplets are so fine, you don't quite realize that you're damp until after you come out of it."

Results

The project is on schedule and well within the time needed to construct the stations and begin operation in 2021. The finishing phase of creating cross passages is reported to be moving along swiftly, and JCM has ordered additional DB-M Mini units as more passages are being constructed.

Inspections on the tunnel have revealed no violations in airborne particulate concentrations during any phase of construction. Crews wear masks in zones where dust is actively created, but after having been conditioned by the atomized misting heads, the air is clear in the long course between cross passage excavation sections.

"The workers in the tunnel know the DustBosses by name and have commented on how they pull the particles straight out of the air," said a JCM safety representative. "The units not only keep us compliant with inspectors, they also raise morale. We would recommend this technology for every phase of a project."

BossTek has built a decade-long reputation providing dust solutions for controlling air quality during demolition, tunneling, mining and earth moving, as well as the storage and handling of clinker, petcoke, coal, rock and aggregate. As a global leader in atomized mist technology, the company's DustBoss, OdorBoss and KoolBossproduct lines can be used to capture fugitive dust particles, distribute odor control chemicals or cool large outdoor crowds. ■

References

Staff. "Particulates Not Otherwise Regulated (Total Dust)", United States Department of Labor, Occupational Safety and Health Administration. Jan. 25, 2017. https://www.osha.gov/dts/chemical-sampling/data/CH_259640.html

Staff. "Particles: Sizes Make All The Difference", National Institute of Environmental Health Sciences (NIEHS). Feb. 2006. https://www.niehs.nih.gov/health/assets/docs_a_e/ehp_student_edition_lesson_particles_size_makes_all_the_difference.pdf

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Underground construction industry is strong; 1,400 attend RETC in San Diego

The global underground construction and tunneling industry is in pretty good shape. Billions are being spent in shoring up aging infrastructure in the United States and other places, and new underground projects are being put out for bid.

With each new project, comes new equipment, technology and tunneling methods. So it is incumbent on tunneling professionals to constantly improve their knowledge of the profession. This is where spending a few days with other underground construction professionals can assist the tunneler in keeping up.

Every two years, tunnelers and underground construction engineers, contractors, suppliers, designers and owners from around the world gather for the Rapid Excavation Tunneling Congress (RETC). The 2017 conference was held in June in San Diego, CA. The UCA of SME puts on the conference.

This years' RETC attracted 1,400 attendees. The accompanying sold-out exhibit totaled 188 service and equipment suppliers. In addition, the conference had the UCA of SME bookstore, where the new *History of Tunneling in the United States* book was introduced. And a short course on tunnel rehabilitation was featured.

Technical programming

RETC 2017 featured nearly 100 technical presentations. Topics covered the breadth of the global underground construction industry. Here is a sampling of a few. The proceedings from the conference is available from SME, 303-948-4200, www.smenet.org.

Accomplishing extraordinary tasks as a machine supplier for Metro Doha: The construction of the Metro Doha in the State of Qatar established a modern, safe, efficient and integrated public transportation network. Upon final completion of multiple phases, the network will comprise four metro lines with a length of 216 km (83 miles) and 100 stations. Phase one comprises 112 km (43 miles of underground tunnels (56 km or 22 miles of twin-tube tunnels). Twenty-one earth pressure balance tunnel boring machines (TBM) were deployed by the four different joint ventures. The project was initiated, managed and supervised by the owner, Transport Authority Qatar Rail.

Phase two of the Doha Metro will start upon the completion of Phase One in 2019 (Qatar Vision 2030). The owner placed full faith in the manufacturer's abilities to deliver equipment of high quality, state of the art standards within the given time frame. This paper focused on the manufacturer's scope of delivery and on the supplier's

Steve Kral, Editor

high standards of quality in production, logistics and services.

California high-speed rail - Connecting and transforming California, design considerations for tunnels: Construction of the proposed California high-speed rail system will require extensive tunneling through mountain ranges in both the north and south regions of the state. Rail alignments under consideration could require between 116 and 129 km (45 and 50 miles) of tunnels that range in length from several thousand feet to more than 52 km (20 miles) under a cover exceeding 610 m (2,000 ft) at certain locations. Challenging geologic, hydrogeologic and seismic conditions are anticipated along potential tunnel routes. Geologic conditions range from unconsolidated alluvium to strong granitic rocks; tectonically sheared and deformed rock masses, high ground water pressures and in situ stresses, and active earthquake faults. In addition, the mountain ranges exhibit environmentally sensitive areas that will have to be protected during construction. This paper discussed the design and construction challenges associated with the tunnels in this statewide system.

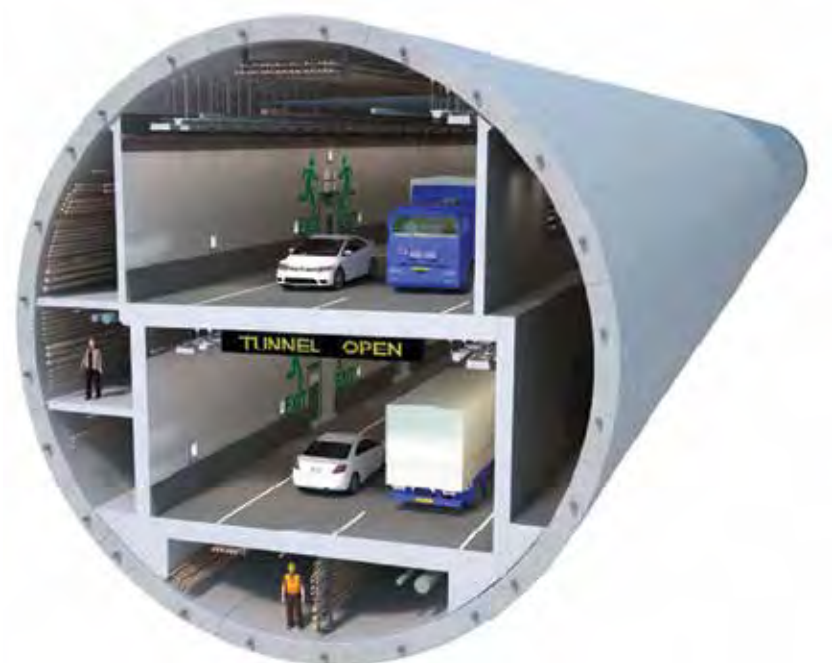
First large-diameter hard rock CSO chamber in St. Louis: The Maline Creek Tunnel (MCT) will be the first large diameter chamber to store combined sewer overflows in St. Louis, MO. The MCT is a key feature of Project Clear, Metropolitan St. Louis Sewer District's (MSD) Long Term Control Plan to address sanitary and combined sewer overflows to local streams and rivers. Project Clear's esti¬mated cost is more than $4 billion, making it the largest public works project for the state of Missouri. The MCT includes the construction of a 36-m (40-ft) diameter, a 43.3-ML/d (12.5-million gal/day) submersible pump station, a 26-m (28-ft) diameter by 823-m (2,700-ft) long cavern, a 177-m (580-ft) long by 1.8-m (6-ft) lined connecting tunnel, three deaeration chambers, three intake structures, a shallow connector sewer constructed by pipe jacking and 305 m (1,000 ft) of 305- to 760-mm) (12- to 30-in.) diameter near surface sewers.

Bids were opened on March 10, 2016. The successful bidder was SAK/Goodwin Joint Venture with a bid of $82.3 million. The engineer's estimate was $87.7 million. The project was awarded in May 2016. The contractor mobilized on site in June 2016. The project is allocated 1,567 calendar days to complete construction.

High cover TBM tunneling in the Andes Mountains: A comparative study of two challenging tunnel projects in Chile: The Andes Mountain range is among the youngest and most complex in the world, geologically speaking. Tunneling projects, particularly for hydroelectric and water transfer schemes, are not new to the range but their past history has met with mixed success. Two new projects using very different tunnel boring machines and excavation strategies are now providing a testing ground for modern underground construction equipment in the Chilean Andes.

This paper analyzed two projects: the Alto Maipo and Los Condores hydroelectric projects, located approximately 100 km (62 miles) apart in the Andes. One project is using an open-type main beam TBM plus extensive ground support, while the other is using a double shield TBM and segmental lining. The authors looked at TBM performance and ground conditions encountered in the two tunnels and what effects the TBM selection and ground support strategy may have had on each tunneling operation.

Tunnel cross section under the Alaskan Way Viaduct.



Large diameter and deep shafts: Unique design and construction challenges: During the past five to 10 years, there has been an increasing number of underground infrastructure projects worldwide using different geometries incorporating large diameter, deep shafts into their configuration. Example projects CH2M Inc. has direct design and construction experience with include shafts for the Blue Plains dewatering shafts (one of five shafts) for the District of Columbia Water and Sewer Authority's CSO Clean Rivers Project in Washington D.C. and the Matanza-Riachuelo catchment sanitation program, the La Plata River outfall.

The design, construction and critical instrumentation monitoring of such shafts brings unique challenges. These challenges can be dealt with in a number of ways, including the use of 3D structural models with a better understanding of soil structure interaction incorporated into the analyses of all loads on the shafts, with resulting savings in material and more flexibility in construction sequencing. The authors drew upon their global experience of design and construction of these large diameter and deep shafts to identify some key unique challenges. They suggested particular ways in which they can be overcome during design and/or construction.

Sewer tunnel excavated under and adjacent to treacherous terrain, including landfills, oil refinery, crowded streets and significantly contaminate material and utilities: A case study was presented of the 4-km (2.5-mile) long, 3.6-m (12-ft) diameter sewer tunnel undertaken by the sanitation districts of Los Angeles County, CA in two phases between 2009 and 2015. The sanitation sistricts of Los Angeles County are a federation of public agencies that serves the wastewater and solid waste needs of more than 5.1 million people in 78 cities in Los Angeles County. This includes the design, construction, operation and maintenance of 11 wastewater treatments plants, 36

pumping plants, landfills, recycling centers, gas-to-energy facilities, refuse-to-energy facilities, 2,125 km (1,320 miles) of main trunk sewer lines and other facilities.

The Joint Outfall "C" Phases on and two project was comprised of more than 4 km (2.5 miles) of 3-m (9.5-ft) outside diameter reinforced concrete pipe, to provide relief to the existing sewer system. The line was installed primarily through tunneling, with a relatively small opencut section. The project also included seven under¬ground structures, some of which were used to tie the new line into an existing parallel sewer.

The crossing under the Alaskan Way Viaduct: The 2001 Nisqually earthquake caused damages to the Alaskan Way Viaduct, (SR 99) in Seattle, WA. A bored tunnel was the solution to replace it, and for that, the largest TBM ever built was manufactured in Japan. The approach for the first 305 m (1,000 ft) of tunnel, running parallel to the viaduct, was to create a protected area by secant piles, jet grouting and more, allowing the mega TBM to excavate in and under nonengineered fill materials before crossing under the viaduct with minimal cover. This paper described the measures put in place to protect the viaduct and the results of those measures.

The Nisqually earthquake shook the city of Seattle with an intensity of 6.7 on the Richter scale. The existing Alaskan Way Viaduct, which runs along the Seattle shore, was severely damaged. From the three alternatives consid¬ered: repairing the viaduct, build a cut-and-cover tunnel or a bored tunnel, the bored tunnel was the selected option to replace it. This solution allowed building the new infrastructure while the viaduct continued in operation after some remedial works were implemented. The double-deck concept from the viaduct was transferred to the bored tunnel solution, thus, a single large bore concept was developed.

Upcoming UCA conferences

Next up for the UCA is the Sixth Annual Cutting Edge conference, Advances in Tunneling Technology. This annual conference is put on in partnership with North American Tunnelling Journal. The conference will take place in Seattle, WA Nov. 13-15.

The North American Tunneling Conference is set for June 2018 in Washington D.C. ■

FEATURE ARTICLE

Reduce urban tunnel utility relocation risk through early relocation by specialty contractor

The District of Columbia Water and Sewer Authority (DC Water) is implementing the $2.2-billion DC Clean Rivers Project (DCCR) to control combined sewer overflows (CSO) to the Anacostia and Potomac rivers and Rock Creek, and to provide flood relief to the Bloomingdale and LeDroit Park neighborhoods in the District of Columbia. The long-term control plan complies with the requirements of a Federal Consent Decree entered into by DC Water, the District of Columbia and the United States, as represented by the U.S. Environmental Protection Agency and the Department of Justice. The Northeast Boundary Tunnel, a design-build project, will store combined sewage and deliver it to a system of downstream tunnels and ultimately to the Blue Plains Advanced Wastewater Treatment Plant (Blue Plains), where it will be treated. In addition, the Northeast Boundary Tunnel (NEBT) is a major project associated with the mayor's task force to alleviate extreme flood events in Bloomingdale and LeDroit Park. The Northeast Boundary Tunnel Utility Relocations (NEBTUR) design-bid-build (DBB) project is an accelerated component of the Anacostia River System, as shown in Fig. 1.

FIG. 1

Extent of the DC Clean Rivers project in the District of Columbia.

Gordon Evans, Carlton Ray, Justin Carl, Steven Bealby and Aliuddin Mohammad

Gordon Evans, and **Carlton Ray**, member UCA of SME, are program manager tunnel design and Director of Clean Rivers, DC Water and Sewer Authority, respectively, and **Justin Carl, Steven Bealby** and **Aliuddin Mohammad**, are NEBT project manager, NEBTUR project manager and senior designer, respectively, DC Rivers, email gordon.evans@dcwater.com.

During dry weather conditions, the entirety of the sewage in the combined system is conveyed to Blue Plains. During storm events, when sewer pipe capacity is exceeded, the flow, which is a mixture of sewage and stormwater runoff, overflows into receiving waters through outfalls. There are a total of 47 active CSO outfalls along district waterways.

The influx of storm runoff into the combined sewer has an additional impact on the communities of Bloomingdale and LeDroit Park. The sewer system is outdated and undersized. In these neighborhoods, when the capacity of the sewer is exceeded, localized flooding occurs and backups into adjacent residences are prevalent. In any given year, there is a 50-percent chance that flooding will occur in these neighborhoods.

In order to meet the CSO control objectives and flood relief requirements for the Anacostia River sewershed, DC Water is constructing a 20-km (13-mile) long tunnel system, roughly 31 m (100 ft) below grade, to convey the combined sewage to Blue Plains. Diversion structures and other near-surface structures are used on the combined sewers, to divert flow to adjacent drop shafts and down into the tunnel. All utility infrastructure in conflict with the near-surface structures, diversion structures and drop shafts must be relocated prior to construction of the

tunnel facilities. As explained in the "Utility Protection While Tunneling in an Urban Environment for DC Clean Rivers Project," (Kottke, P. and Kantola, J.), DCCR is also concerned that tunneling under existing utilities in soft ground can lead to possible adverse impacts to these utilities. Thus, relocation of select utilities is required to prevent impacts from potential ground movement from tunneling activities.

Risk reduction

The NEBTUR project was identified as a means to help navigate challenges and reduce risks associated with the NEBT. Previous projects nationwide revealed the problems with incorporating utility relocations into larger tunnel contracts. Common risks included the following:

- Tunnel contractors not experienced with utility relocations.
- Extended work in busy streets creating angry neighbors.
- Prolonged work with public utility companies (electric, gas and communications).
- High probability of existing utilities failing due to age (e.g., 100-year cast iron water mains and brick sewers).
- Difficult maintenance of traffic (MOT).
- Major time delays associated with slower than anticipated utility relocations.

Risks associated specifically with the NEBT project included the following:

- 51-cm (20-in.) prestressed concrete cylinder pipe (PCCP) water main.
- 100-year old trolley tracks.
- Two 100-year old 122-cm (48-in.) cast iron water mains.
- Coordinating shutdowns for two different zones of a 122-cm (48-in.) water mains.
- High voltage (69 kV) transmission main.
- Contaminated and potentially hazardous soil.
- Electrical power transfer at Washington Metropolitan Area Transit Authority Red Line main tracking station.
- Replacement of lead water services.

A brainstorming team suggested the main risks experienced at other urban tunneling projects could be mitigated with the release of a separate DBB utility contract. Other risks such as coordinating shutdowns of 122-cm (48-in.) water mains required the design team planning and meeting at regular intervals with DC Water

TABLE 1

NEBTUR key milestone dates.

Milestone	Date
Request for qualifications	October 2015
90 percent design	August 2015
Final design	January 2016
NTP	May 2016
Construction completion	November 2017

to prepare for major disruption to water facilities.

A collaborative bidding process with shortlisted contractors allowed for changes during the request for proposals (RFP) stage and even after the project was awarded. One post award change was discovered during the collaboration process with shortlisted NEBT DB Proposers. Design build (DB) proposers warned about significant construction risk associated with the existing 51-cm (20-in.) PCCP water main lying adjacent to NEBT support of excavation. As explained in AWWARF/EPA 2008 paper, "Failure of Prestressed Concrete Cylinder Pipe," PCCP pipe installed between 1972-1978 has historically shown a high incidence of failure — sometimes sudden failure — resulting in considerable consequential damage. Nearby NEBT construction would cause earth movement disturbances which could cause a normally stable and safe PCCP installation to be placed under new stresses that could lead to premature PCCP failure.

As the NEBT DB contractor would be responsible for protecting and maintaining adjacent PCCP pipe during NEBT construction, DC Water decided that NEBT risks of delay, cost overruns and service interruptions to DC Water customers could be mitigated by scheduling the early removal and replacement of that PCCP pipe before the RFP stage of the NEBT. The task of removing the old PCCP and replacing it with new fully-restrained ductile iron water pipe was incorporated into the NEBTUR project. By early replacement of PCCP, DC Water eliminated risk of future breakage from its water distribution system. Thus, NEBT Proposers were able to lower their bid prices due to the lower construction risk.

Six key risk reduction elements are identified and discussed in the following sections.

Risk reduction measure 1 – Schedule. From a cost perspective, utility relocations may only be a small percentage of a tunneling project but can cause significant delays in the major portion of the project. Experience from other projects, both locally and from around the country, has shown that utility relocations can delay complicated tunneling activities and lead to major cost and time claims. Thus, it may be better to separately schedule tunneling and utility relocation

NEBTUR contract developed a complete schedule, which included both design and construction activities. The schedule accounted for utility design, coordination with private utility companies, the bidding process and construction. The most important element was to design and relocate utilities in advance of the NEBT to prevent future delays with utility relocations and with scheduling private utility companies, such as Pepco, Washington Gas and Verizon.

In September 2014, the decision was made to separate the utility relocation work into a separate DBB contract. Based on the schedule and anticipated construction duration, the goal is to have utility relocation completed by notice-to-proceed (NTP) for NEBT. The design for NEBTUR started three years prior to the anticipated NTP date for the NEBT. Key milestone dates were scheduled and adjusted as the design phase of the project progressed. The critical path utility work was identified at each site. Detailed site-by-site and overall schedules were developed based on the input from each utility agency. That schedule was further refined during the bidding phase. The allotted NEBTUR construction duration was 17 months.

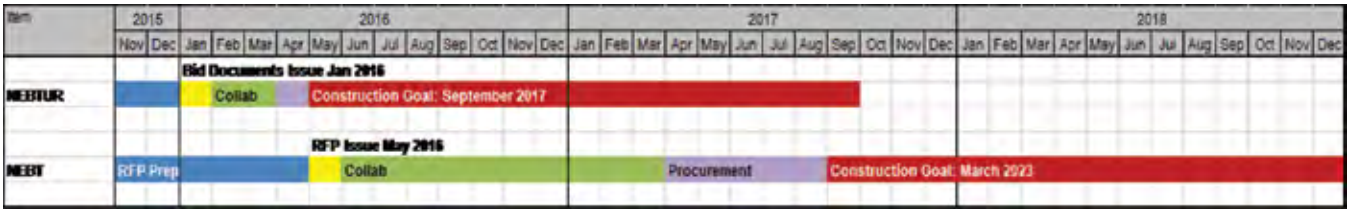
Based on the anticipated construction schedule, concurrent work at multiple sites is critical for the completion of the utility relocation work prior to NEBT NTP. This would necessitate multiple construction crews, allowing concurrent work at multiple sites, while complying with the allowed restrictions in the NEBT traffic study. Due to the close proximity of some of the sites, the NEBT traffic study was used to determine sites where concurrent work would be permitted. Table 1 provides key milestone dates for the NEBTUR project.

The NTP was provided on May 19, 2016. The scheduled completion date was set at Nov. 3, 2017. The contract documents require the contractor to provide a baseline schedule and a detailed contractor's construction schedule to plan, organize and execute work. This schedule is critical path method schedule and is required to be updated on a monthly basis to monitor and measure the progress of the project. The NEBTUR construction schedule revealed several potential problems in the early months of the contract. The most notable problem was that the contractor's schedule showed zero-float between critical path tasks. Any delay in one task would impact the completion.

Risk reduction measure 2 – Specialty contractor. Tunneling contractors are highly specialized in tunneling. Utility relocation may not be the strength, or the passion, of tunneling contractors. DC Water aimed to award the NEBT contract to a design-build contractor with a specialized expertise in tunneling-related construction to construct the largest tunneling project in the country in one of the busiest urban environments. Different construction skills and experience are required to perform the utility relocations in advance of the NEBT.

FIG.2

NEBT and NEBTRU schedules.



By separating the relocations from the tunneling work, DC Water was able to shortlist potential bidders based on their expertise and experience with utility work in the district. This allowed DC Water to identify and select the best contractors for the utility relocation project.

Key factors in selection of a specialty utility contractor included ability to work on multiple types of utilities, large firms with enough bonding capacity to perform the work, multiple crews to work at multiple sites simultaneously and knowledge of working conditions in DC, especially working with key agencies such DDOT, PEPCO and Verizon.

Risk reduction measure 3 – Completion incentive. On NEBT and NEBTUR, there are nine sites where utilities are being relocated. Varying amounts of utility relocations are required at each site. The NEBTUR contract was divided into two parts with separate completion dates. Three sites were identified for early completion based on the complexity of the utility relocations and importance of the sites relative to work for the NEBT. Traditional construction contracts have a completion date or time period for completion. If the time period is not met, liquidated damages are triggered as monetary inducement for the contractor completing the work in a timely manner. The project completion time for six of the NEBTUR sites was 489 days for substantial completion and 534 days for final completion. After 534 days, liquidated damages (LD) will be assessed at $5,000 per day.

An added incentive was proposed for the NEBTUR contractor to complete work early at three locations. The early completion sites were R Street NW, 4th Street NE and Rhode Island Ave NE. The early completion time period for the incentive is 352 days. All work was to be substantially completed at all three sites for the contractor to collect the incentive. This is a no-excuse incentive and the contractor must complete all work in the 352 days. The incentive is $300,000 lump sum. The NEBTUR contractor is sharply focused on the early completion deadline. The NEBTUR contractor accelerated the submittals for shop drawings and schedules. The contractor is making attempts to resolve issues as quickly as possible. If the work is not completed within 381 days, LDs will be assessed. LDs commence a month after the early completion date.

Figure 3 shows the schedules of both the NEBTUR and NEBT projects relative to each other. The figure illustrates the NEBTUR (top bar) ending just in time (Sept. 2017) for commencement of the NEBT (bottom bar) contract.

The completion of the project will take into consideration owner-caused delays, such as additional work added to the contract. The contractor will not be held responsible for delays considered Acts of God, such as weather delays that are beyond normal weather delays. The contractor will also not be held responsible from delays caused by potential archaeological findings. Typical archaeological findings encountered include trolley tracks as shown in Fig. 3.

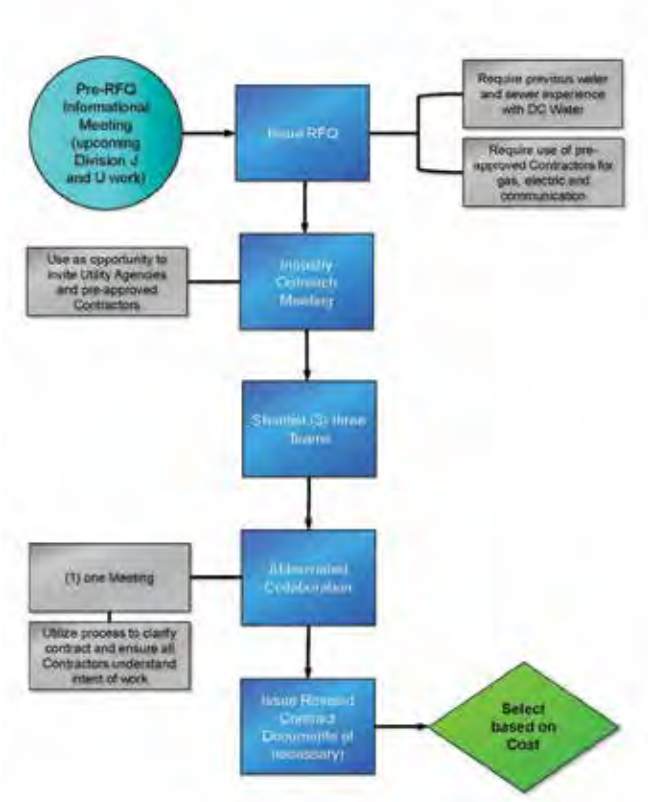
Risk reduction measure 4 – Hybrid procurement method. One of the biggest challenges for the NEBTUR is the selection of a qualified contractor to relocate multiple types of utilities, as well as managing subcontractors for the relocation of dry utilities. The contractor selection process involved utilizing both a traditional design-bid-build (DBB) approach, as well as DB approach. A typical utility project selection process

FIG.3

Trolley tracks.

FIG.4

Contracting methodology with prospective contractors for hybrid option.



is to advertise the project, accept bids and select the low bidder without prequalifying or meeting with perspective contractors. This procurement method was not considered to be an effective method for the selection of the best contractor for the completion of the NEBTUR project. A hybrid procurement process for selecting a qualified contractor capable of performing all the work in the time period allowed was utilized for the NEBTUR project.

The NEBTUR procurement process included the following steps; Request for qualifications (RFQ), shortlist of contractors for bidding based on RFQ criteria, bid documents given to selected contractors, collaboration meeting with each contractor after review of bid documents, bid opening, clarification and final contract agreement. Figure 4 shows a flow chart of the selection methodology.

The first RFQ for the NEBTUR project yielded only one response. A second RFQ was issued with some minor edits clarifying the scope of work required for the contract. After the second RFQ, five responses were submitted. DCCR formed an expert committee to review the responses to the RFQ packages and select contractors to bid on the project. The committee selected three shortlisted contractors to bid on the project.

Selected contractors were given the construction documents to review. Each contractor met with DCCR for a collaboration meeting. Nondisclosure forms were signed by the contractors before meeting to assure that the information discussed was not shared with the other firms. Based on the collaboration meetings, several changes to the bid documents were made as part of addenda to the original bid documents. Addenda items included changes to the contract time, adjustment in work to provide more defined items for bidding, and final maintenance of traffic (MOT) plans. This process was used to provide more defined documents and reduce overall risk.

The apparent NEBTUR lowest responsible responsive bidder was determined. Before the final NEBTUR contract was awarded, a clarification meeting was held to discuss any issues the low bidder and DCCR felt were outstanding. Based on the clarification meeting, a few items were added to the contract documents to provide a clear understanding for both DCCR and the contractor.

Risk reduction measure 5 – Permit assistance. DC Water identified all permits required for the NEBTUR project, with each permit given a designated party responsible for obtaining that permit. DCCR identified long lead permits that would have the greatest impacts to the project schedule and tried to obtain those permits before the project NTP was issued. Permit responsibilities are shown in Table 2.

The longest lead permit item is the District Department of Transportation (DDOT) construction permit. Early in the NEBTUR design phase DCCR met with DDOT and prepared maintenance of traffic plans (MOT plans) to assure that the DDOT construction permit would be issued in advance of construction. The permit would then be transferred to the contractor. This would enable to the contractor to quickly obtain the DDOT occupancy permit. This permit requires the contractor to resubmit monthly for as long as the contractor is at each site.

DCCR specialist assisted and facilitated obtaining of permits for the contractor. Permit specialist worked with the contractor to assist and assure that all minority business enterprise (MBE) women owned business enterprise (WBE) goals are maintained and meet DC Water requirements.

Risk reduction measure 6 – Public utility relocations. Public utility agencies, such as gas (WGL), electricity (Pepco) and communications (Verizon), present special areas of concern when relocating utilities. Typically, these utilities require a purchase order to design relocations and a second purchase order to have crews relocate the utilities. The separate contracts can have long lead times for design and construction associated with them. The traditional practice of waiting for the contractor to set up contracts with these utility agencies, who in turn develop their own plans and perform construction, could lead to uncontrollable delays as experienced by other DCCR projects.

In order to mitigate the contractual issues previously experienced with the purchase order methodology, DCCR met with the utility agencies between September and November 2014 to discuss potential alternatives. During the meetings, DCCR presented a contracting methodology in lieu of the traditional work order (WO) methodology. The alternative methodology provided contracting means for design and construction of utility relocations to alleviate the disadvantages previously encountered. The goal of this alternative was to provide DCCR with a direct contractual relationship with the contractor, to coordinate design and construction efforts, to manage scope creep, to quickly resolve field conflicts, to reduce neighborhood construction fatigue, to control messaging and public outreach and, potentially, to realize savings due to comprehensive regulatory efforts and elimination of iterative site restorations.

In order to ensure conformance of public utility design and construction activities, the standard WO agreements between DC Water and each utility agency were revised to document individual responsibilities, schedules, deliverables and coordination between utility agencies and DCCR. Furthermore, DC Water general and supplementary conditions, as well as insurance requirements, were used, as DC Water would be holding the construction contract. The WO also addressed changes in design and construction, technical specifications, materials of construction, traffic control, permitting, restoration requirements and as-built information. Coordination of all utility work was transferred to the NEBTUR contractor.

This contracting methodology allows DCCR to maintain control of construction schedule, costs and permitting efforts through a single prime contractor, contracted by DC Water. The prime contractor will contract with subcontractors acceptable to each utility agency, potentially hiring fewer subcontractors — each acceptable to multiple utility agencies — and thereby reducing coordination requirements, improving schedule and realizing saving. Additionally, the single NEBTUR prime contractor will allow the enforcement of mitigation measures within the community. Each utility agency (Pepco,

TABLE 2

Permits and approvals.

Agency	Approval or permit	Responsibility	
		Owner	Contractor
District Department of Consumer and Regulatory Affairs	Building civil (BCIV) permit	X	
	Miscellaneous soil boring permit (helical pulldown micropiles)		X
	Support of excavation permit		X
	Building permit for site trailers		X
	Trade permit (MEP)		X
	After hours permit		X
	Environmental intake form	X	
District Department of Energy and Environment	Volume of cut fee	X	
	Generator registration		X
	Asbestos abatement		X
	Hazardous waste identification number		X
District Department of Transportation	Construction permit	X	
	Occupancy permit		X
	Construction permit for support of excavation		X
	Construction permit for soil boring		X
	Tree removal permit	X	
	Steel plate permit		X
Environmental Protection Agency	Notice of intent		X
	Stormwater pollution prevention		X
Washington Metropolitan Transit Authority	Letter of no conflict	X	
District of Columbia Water and Sewer Authority	Plan review	X	
	Availability certificate	X	
	Inspections invoice	X	
	Temporary discharge authorization		X
	Hydrant use permit		X
District Department of Public Works	W Street facility ease-ment	X	
	W Street facility right of entry agreement	X	

FIG.5

DC Water approved manhole with DC Water stamp.

WGL and Verizon) has agreed on this methodology for implementation, completing the design either internally or through a third party consultant. The utility agencies will be required to revise their WO agreement with DC Water regarding design criteria, deliverables and interrelationships between utility agencies. Each item considered paramount for project success.

All of the utility agencies, with the exception of Verizon, requested keeping the design in-house. DC Water was able to contract directly for the Verizon design. Where agreed-upon designs were incorporated into the NEBTUR bid documents, DC Water requested professional engineer sealed and signed plans from all the agencies. All agencies complied except Pepco, which does not provide a PE seal and signature on plans they produce.

Pepco allowed for the construction of the buried concrete duct by a Pepco-approved contractor. Pepco will furnish, pull the cable and make termination connections back into their existing systems, thereby requiring a second WO. All WOs for these services were agreed to and paid in advance by DC Water directly to Pepco. The NEBTUR contractor was required to coordinate the work required for these utilities during construction.

Pepco was the largest and most important public utility requiring coordination. At one point, talks were elevated between the chief executive officer of Pepco and DC Water to emphasize the importance of the project. Pepco design and construction generally has a long lead time. Many meetings with Pepco were held before a final design was agreed upon. Pepco did require that some of the work be performed in-house. During the construction process some unanticipated Pepco design changes were required, such as changing from 10-cm (4-in.) PVC conduit to 12-cm (5-in.) fiberglass conduit. These changes were handled by change orders with the NEBTUR contractor. It was also critical to look for interference with concurrent Pepco projects. Competing interests from larger projects, such as Buzzard Point Development and District of Columbia Power Line Undergrounding, were analyzed to make certain that these future projects did not steal scarce subcontractor resources needed by NEBT or NEBTUR.

Verizon and Verizon Business (MCI) allowed for the construction of the duct through a preapproved contractor. Both agencies will furnish, pull the cable and make termination connections back into their existing systems, thereby requiring a second WO All WOs for these services were agreed to and paid directly in advance by DC Water. The NEBTUR contractor was required to coordinate the work required for these utilities during construction.

Public outreach

The $2.7-billion DC Clean Rivers project, though mostly 31 m (100 ft) below ground, is a high-visibility project — the subject of many news interviews, tours, visitor tours and ribbon-cuttings. Former Vice President Joe Biden attended one ribbon-cutting, DC Mayor Muriel Bowser attended another. DCCR is a critical infrastructure asset that is designed to serve the community well for 100 years. DCCR managers strive to maintain a trusted reputation during the entire construction period through 2023.

Public outreach is a requirement for all contracts. Outreach programs include community notifications, attending ANC meetings, neighborhood meetings and a dedicated phone line for complaints. The NEBTUR contract also requires noise and vibration monitoring for nighttime work, as well as strict traffic control requirements for vehicles, bikes and pedestrians. Advance notification for any public transportation interruptions or relocations are another important requirement.

Each contract has hiring goals that are tracked and enforced. DCCR strives to be a good neighbor, assuring that local residents are able to contract for the work. DCCR projects have MBE/WBE goals of 32 percent and 6 percent, respectively. DC Water tracks these goals monthly on a project by project basis.

Safety assurance

Contributing to DCCR's position of public trust is the DCCR high safety standard on all projects. At a minimum, this contract requires the contractor to have a competent safety officer who shall be responsible for the supervision of the project safety requirements and be on the job at all times while work is in progress.

To ensure compliance with the requirements in the contract documents, the contractor is required to have a site safety and health plan (SSHP) that shall be maintained at all times at the project site. The SSHP shall address site hazards related to environmental requirements, construction safety and occupational health.

The SSHP also defines the protective measures that protect the environment, site personnel and the general public. Before the start of a specific activity, the contractor has to prepare a job hazard analysis that details the activity steps, hazards associated with the activity, control measures, equipment that would be used, and any training requirements to perform the activity.

DC Water has its own safety officer monitoring the work to assure that the contractor conforms to the safety standards. Safety meetings are held with the contractor every other week, and any other project related meetings start with the safety discussion. Since the NEBTUR project requires the contractor to work on multiple sites simultaneously, there is a need for the contractor's safety officer to travel from site to site throughout the day, or sometimes the contractor will have multiple safety officers to cover more than one site.

DC Water safety officers provide frequent jobsite safety inspections. Safety inspection and observation reports are issued to the contractor as required to report unsafe conditions. The contractor then must respond to each report with corrective measures that will be undertaken to assure that the condition is corrected and such incidents do not happen in future.

Quality assurance

Both the high public visibility of the DCCR and the 100-year design life of the DCCR Tunnel System require that quality construction be visible and assured during all stages of construction. DC Water requires full time field inspectors assigned to the project to assure that work conforms to the contract documents. Contractors are required to report their own quality missteps and correct them. Full time construction managers concurrently perform quality inspection and report variances from the contract documents. The inspectors perform review of the materials utilized on the job to assure the materials match approved submittals and the materials are installed to DC Water Standards. Any unapproved materials and procedures used are rejected and the contractor is notified to perform corrective measures. In the crowded urban setting of the NEBTUR, all material (pipe bedding, valves and all other material) is carefully reviewed to assure DC Water standards are being maintained. DC Water carefully inspects bedding and backfill material and compaction testing to assure proper backfill is achieved. Faulty construction may later result in leaking water lines or sinking roadways during the following NEBT project.

To assure the NEBTUR-installed infrastructure, such as concrete manholes, is in top shape and strength for the following NEBT construction, DC Water approves all precast concrete material as it is manufactured at approved plants. A DC Water inspector reviews the manufacturing of the material and will stamp the material before it is shipped to each site. If a concrete pipe or manhole is shipped to a site without a stamp, the field inspector will not allow the material to be installed. Figure 5 shows a manhole with a DC Water approved stamp.

Other NEBTUR inspectors responsibilities include field measurements of construction work as it progresses, redlining contract drawings to capture any field changes, and verifying that relocated utilities are outside the future NEBT support of excavation. Inspectors review the contractor's monthly as-builts submittal updates to assure the information is correct. This is important since the information from NEBTUR will be relied upon by the following NEBT project. Both hard copies and AutoCAD drawings of the as-builts are submitted, for ease of use by the NEBT contractor. ■

References

Kottke, P., Kantola, J, Ray, C. and Levy, W. 2014. Utility Protection While Tunneling in an Urban Environment for the DC Clean Rivers Project. North American Tunneling 2014 Proceedings, 424-431. Pub. Society for Mining, Metallurgy & Exploration.

Romer, A.E., Ellison, D., Bell, G.E.C., and Clark, B. 2008. Failure of Pre-stressed Concrete Cylinder Pipe. Denver: AWWA Research Foundation.

Coming Events

2017 Cutting Edge
Nov. 14-15, 2017
Renaissance Seattle Hotel
515 Madison Street Seattle Washington
website: smenet.org/full-calendar

2018 George A. Fox Conference
Jan. 23, 2018
Graduate Center City University of New York
365 Fifth Ave. New York, NY, USA
website: smenet.org/full-calendar

For additional information contact: Meetings Department, SME,
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email sme@smenet.org, http://www.smenet.org/full-calendar

COMPILED BY JONATHAN KLUG, DAVID R. KLUG & ASSOCIATES

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Gateway Tunnel	Amtrak	Newark	NJ	Subway	14,600	24.5	2018	Design study
2nd Ave. Phase 2	NYC-MTA	New York	NY	Subway	16,000	20	2020	Under design
2nd Ave. Phase 3-4	NYC-MTA	New York	NY	Subway	105,600	20	2017-22	Under study
Water Tunnel #3 Stage 3 Kensico	NYC-DEP	New York	NY	Water	84,000	20	2020	Under study
Bergen Point Wastewater Outfall	Suffolk Co., DPW	Babalon	NY	Sewer	14,200	12	2017	Judlau/OHL JV low bidder
Cross Harbor Freight Tunnel	NYC Reg. Develop. Authority	New York	NY	Rail	25,000	30	2022	Under study
Amtrak B&P Tunnel	Amtrak	Baltimore	MD	Rail	10,000	30	2018	Under design
Thimble Shoal Parallel Tunnel	Chesapeake Bay Bridge & Tunnel Dist.	Chesapeake	VA	Highway	5,700	45	2016	Dragados/ Schiavone awarded
Hampton Roads Bridge-Tunnel Project	Virginia DOT	Hampton Roads	VA	Highway	7,500	42	2018	Under design
Northeast Boundary Tunnel	DC Water and Sewer Authority	Washington	DC	CSO	17,500	23	2017	Impregilo/Healy JV awarded
Potomac River CSO Tunnel	DC Water and Sewer Authority	Washington	DC	CSO	4,500	33	2022	Under design
Olentangy Relief Sewer Tunnel	City of Columbus	Columbus	OH	Sewer	58,000	14	2017	Under design
Alum Creek Relief Tunnel Phase 1 Phase 2	City of Columbus	Columbus	OH	Sewer	 30,000 21,000	 18 14	 2018 2019	 Under design Under design
Doan Valley Storage Tunnel	NEORSD	Cleveland	OH	CSO	10,000/ 9,400	18/18.5	2017	Southland/ Johnson/Mole low bidder
Westerly Main Storage Tunnel	NEORSD	Cleveland	OH	CSO	12,300	24	2020	Under design
Shoreline Storage Tunnel	NEORSD	Cleveland	OH	CSO	16,100	21	2021	Under design
Shoreline Consolidation Tunnel	NEORSD	Cleveland	OH	CSO	11,700	9.5	2022	Under design
ALCOSAN CSO Ohio River Allegheny River Monongahela River	Allegheny Co. Sanitary Authority	Pittsburgh	PA	CSO	 10,000 41,700 53,900	 30 30 30	 2019 2020 2021	 Under design Under design Under design
Three Rivers Protection/Overflow	City of Fort Wayne	Fort Wayne	IN	CSO	26,400	12	2016	Salini Impreglio/ Healey low bid
Louisville MSD Tunnel	Lousville MSD	Lousville	KY	CSO	13,200	22	2018	Bid date 9/14/17
Deer Creek Sanitary Tunnel	St. Louis MSD	St. Louis	MO	CSO	21,000	19	2016	Bids under review
Blacksnake Creek Tunnel Project	City of St. Joseph	St. Joseph	MO	CSO	6,650	10	2017	Super Excavators awarded
KCMO Overflow Control Program	City of Kansas City	Kansas City	MO	CSO	62,000	14	2018	Under design

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

TUNNEL NAME	OWNER	LOCATION	STATE	TUNNEL USE	LENGTH (FEET)	WIDTH (FEET)	BID YEAR	STATUS
Mill Creek Peaks Branch Tunnel	City of Dallas	Dallas	TX	CSO	5,500	26	2014	Bid date 9/1/17
Ballard to Wallingford Tunnel	Seattle Public Utilities	Seattle	WA	CSO	14,250	14	2018	Under design
L.A. Metro Westside Phase 2 Phase 3	Los Angeles MTA	Los Angeles	CA	Subway	 26,500 26,500	 20 20	 2016 2017	Tutor Perini/O&G JV awarded Proposals 10/27/17
Speulvada Pass Corridor	Los Angeles MTA	Los Angeles	CA	High/Trans.	55,500	60	2018	Under study
Northeast Interceptor Sewer 2A	LA Dept. of Water and Power	Los Angeles	CA	Sewer	18,500	18	2014	Delayed indefinitely
River Supply Conduit - Unit 7	LA Dept. of Water and Power	Los Angeles	CA	Water	13,500	12	2015	Advertise 01/2018
JWPCP Effluent Outfall Tunnel project	Sanitation Districts of LA	Los Angeles	CA	Sewer	37,000	18	2015	Bid date 1Q 2018
Two Mile Bar Tunnel	Oakdale Irrigation	Oakdale	CA	Water	5,950	11.5x13	2017	SMCI low bidder
Freeway 710 Tunnel	CALTRANS	Long Beach	CA	Highway	26,400	38	2016	Under design
BDCP Tunnel #1 BDCP Tunnel # 2	Bay Delta Conservation Plan	Sacramento	CA	Water	26,000 369,600	29 35	2018 2019	Under design Under design
SVRT BART	Santa Clara Valley Trans Authority	San Jose	CA	Subway	22,700	20	2016	Redesign activated
Silicon Valley Clean Water Tunnel	Silicon Valley Clean Water	Silicon Valley	CA	CSO	17,500	13	2017	Shortlisted teams announced
Coxwell Bypass Tunnel program	City of Toronto	Toronto	ON	CSO	35,000	12	2015	Advertise 3Q 2017
Highway 401 Rail Tunnel	Metrolinx	Toronto	ON	Subway	580	35x28	2017	Shortlisted teams announced
Keswick Effluent Outfall	City of Toronto	Toronto	ON	CSO	11,600	23	2018	Under design
Yonge St. Extension	Toronto Transit Commission	Toronto	ON	Subway	15,000	18	2016	Under study
Taylor Massey Tunnel	City of Toronto	Toronto	ON	CSO	20,000	18	2018	Under design
Inner Harbour West	City of Toronto	Toronto	ON	CSO	18,400	19	2021	Under design
Scarborough Rapid Transit Extension	Toronto Transit Commission	Toronto	ON	Subway	25,000	18	2018	Under design
REM Transit Tunnel	City of Montreal	Montreal	QC	Subway	27,000	22	2017	Bidders selected
Newfoundland-Labrador Fixed Link	Gov. of Newfoundland/Lab	Newfoundland	NL	Transit	56,000	40	2020	Under study
Green Line LRT	City of Calgary	Calgary	AB	Transit	26,250	20	2018	Under design
Second Narrows Tunnel	City of Vancouver	Vancouver	BC	CSO	3,600	14	2013	Under design
Annacis Island Outfall	City of Vancouver	Vancouver	BC	Water	8,000	10	2017	Under design
Burnaby Mountain	Kinder Morgan	Vancouver	BC	Oil	8,000	12	2017	Under design
Broadway Sky train extension	Trans Link	Vancouver	BC	Subway	25,000	18	18	Under design
Northern Gateway Hoult Tunnel	Enbridge Northern	Kitimat	BC	Oil	23,000	20	2014	Under design

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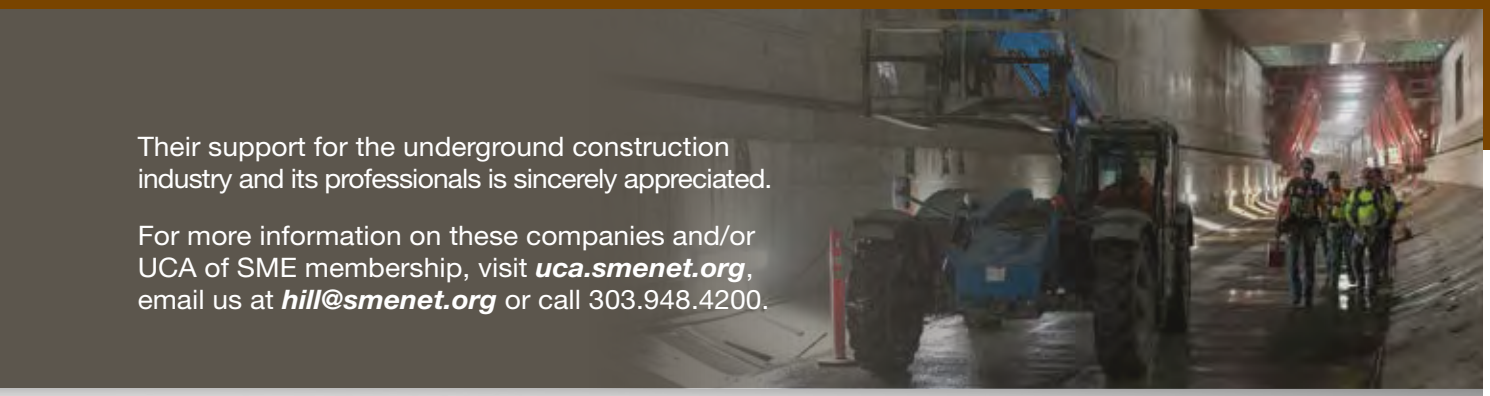

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UCA EXECUTIVE COMMITTEE MEETING

Highlights of the UCA Executive Committee meeting

The Executive Committee of the Underground Construction Association (UCA) of SME met on June 7, 2017 at the conclusion of the Rapid Excavation and Tunneling Conference (RETC) Conference in San Diego, CA. The new slate of officers was confirmed. It will include Michael Roach as chair, Robert Goodfellow as vice chair and Arthur Silber as past chair. New members to the executive committee will start a four-year term. They are Paul Schmall, Edward Dowey, Mike Vitale and Pamela Moran, who was elected for a second, four-year term. The biographies of each incoming member are on page 47.

The committee discussed activities critical to the UCA. Randy Essex, the UCA voting representative to the International Tunneling and Underground Space Association (ITA), was elected to the ITA Executive Council following the meeting. The executive committee determined that the sitting chair from the UCA will now act as the voting representative to the ITA. This person will be responsible for attending the General Assembly meetings and representing the United States on all matters that come before the ITA General Assembly.

The World Tunnel Congress (WTC) is a key activity of the ITA, and the location of the conference is determined by the ITA General Assembly. Future meetings of the WTC will be held in:

- Dubai, UAE — 2018.
- Naples, Italy — 2019.
- Kuala Lumpur, Malaysia — 2020.

RETC scholars

The UCA supported 12 students with a conference scholarship to attend the RETC. The scholarship provides transportation, housing and registration for each student to better understand and learn about the underground construction industry. It is designed to encourage the students to ask questions and look for opportunities in businesses associated with tunneling.

It was reported at the meeting that UCA has achieved an all-time high with nearly 60 corporate and sustaining members. These are companies that have committed to supporting UCA with a company membership.

The *History of Tunneling in the United States* became available on April 21, 2017. It has been distributed to more than 600 individuals and companies in the first few months. The 550-page book, with hundreds of pictures, current and past, is a well-documented history of the advances in tunneling over the past 150 years. Many thanks to all the authors and editors, with special thanks to Mike Roach, Colin Lawrence, Dave Klug and Brian Fulcher, for all their work on the book. It is an exceptional representation of the industry.

A new edition of *Better Contracting Practices* will be developed. The first edition, published nearly 10 years ago, will be updated and revised. The book is expected to be completed by 2019, and Sarah Wilson is leading the effort to rewrite the book with a committee of volunteer professionals.

The Young Members Committee held several activities in conjunction with RETC including a networking reception. The UCA agreed to support a reception at the 2018 North American Tunneling Conference (NAT) next year. If you are under 35, please let the Young Members Committee know so that you'll be included in the information on their activities. The UCA also supported a $50,000 allocation to the third group of student conference scholarships in conjunction with NAT 2018.

The Education and Student Outreach Committee reported that, during the past year, 10 underground presentations were made to American Society of Civil Engineers (ASCE) student clubs. The executive committee also debated additional working relationships with ASCE and believes that more opportunities for student interaction and education will take place in the near future. As a result, a $15,000 commitment was made to further develop marketing tools that will assist UCA members in discussions and presentations with students.

A professor-in-training program was discussed. This is a program designed to bring key professors from civil engineering schools to future NAT meetings for a one-day workshop. In the workshop, they will develop ways to integrate their knowledge of underground construction into their course material. Michael Mooney is developing the curriculum for the workshop, and UCA hopes to hold the first event just prior to 2018 NAT.

2018 Awards Committee

Finally, an awards committee was appointed to identify the winners of the following awards to be presented at the 2018 NAT:

- Lifetime Achievement Award.
- Outstanding Educator Award.
- UCA Outstanding Individual Award.
- UCA Project of the Year Award.

Committee members were appointed to solicit nominations and make recommendations to the executive committee for these awards. Look for more announcements and details in the near future. ■

UCA EXECUTIVE COMMITTEE

UCA seeks nominations for the Executive Committee

The UCA Division seeks recommendations and nominations from all UCA members for interested individuals to serve on the UCA Executive Committee for the term 2018 to 2022. Current bylaws call for a 19-person Executive Committee. Membership on the committee consists of three officers, chair, vice chair and past chair, and four directors from each of the following areas: engineers, contractors, owners and suppliers. The UCA Executive Committee seeks a balanced representation from the four areas, but it has the option to have more members in one or more areas and fewer members in others.

If you would like to nominate someone for consideration, forward your recommendation to Dave Kanagy (kanagy@smenet.org) at SME headquarters by Nov. 27, 2017. The individual nominated must be a member of the UCA of SME. Staff will compile all nominations for the UCA Nominating Committee's consideration.

A few items are requested to help with the committee's decision.

- Identify in which of the four areas the individual should be considered for service: engineer, contractor, owner or supplier.
- Provide a brief biography or résumé outlining the person's industry experience and service to UCA and other professional organizations.

Note for past submissions

If you have submitted candidates for consideration in the past three years, please resubmit or send a note to check on the status of your nominee. Traditionally, all nominees are resubmitted for consideration for three consecutive years if they have not been selected for the executive committee slate. Your diligence will ensure that all qualified candidates are reviewed. ■

Four directors join the UCA Executive Committee

Edward Dowey, Pamela Moran, Paul Schmall and Mike Vitale have been elected to serve on the UCA Executive Committee from July 1, 2017 to June 30, 2021. Moran was elected for a second, four-year term.

EDWARD DOWEY, PE, has worked on tunnels in every capacity for the New York City Department of Environmental Protection for more than 30 years. He presently serves as acting portfolio manager for the Gilboa Dam projects and bypass tunnel construction. Previously, he was the design manager for the $800 million bypass tunnel directing an in-house design and consultant staff of tunnel design engineers.

DOWEY

Dowey started as a construction inspector and geologist and then served as resident engineer and executive construction manager for the construction of subterranean chambers, thousands of feet of shafts and more than 24 km (15 miles) of tunnels for New York City Water Tunnel No. 3.

Dowey has a B.A. in geology and an M.S. in mining engineering from Columbia University, and is a professional engineer in New York.

PAMELA MORAN, PE, is managing director with Wisko America and is responsible for marketing, estimating and bidding all work in the United States and Canada, scheduling work crews, managing materials and invoicing. She prepares waterproofing construction work plans and shop drawings on numerous projects and assists design engineers who are writing flexible membrane specifications, developing details for challenging conditions and updating contractors and engineers about new developments in flexible waterproofing technology. Previously, she was vice president of engineering for Dr. G. Sauer Corp.

MORAN

Moran has been a member of the UCA of SME Executive Committee since 2013. She wrote the waterproofing section in the *History of Tunneling in the United States* and has served as a member of the Scholarship Committee. She has a B.S. in civil engineering from The Pennsylvania State University, is a professional engineer in nine states and is a member of the American Society of Civil Engineers.

PAUL C. SCHMALL, PE, is a senior vice president and chief engineer for specialty geotechnical contractor Moretrench. He is responsible for the engineering of the company's ground improvement services, including dewatering, grouting, ground freezing and artificial recharge for underground construction or tunneling. He has long played an active

SCHMALL

role in UCA of SME. He was a director upon the inception of the UCA in 2006 and currently leads the student outreach of the UCA. He is also proactive in advancing the state of the practice by sharing his experience and expertise with the engineering community through frequent seminar and conference presentations, the publication of technical papers and texts, and as an instructor for several tunneling-related short courses.

Schmall earned a B.S. in civil engineering from Bucknell University and a Ph.D. in civil engineering from the University of Nottingham.

He is the co-author of *Construction Dewatering and Groundwater Control: New Methods and Applications*, third edition.

MICHAEL VITALE is senior vice president and North American tunnel practice leader for Mott MacDonald. He has more than 34 years of extensive, diversified experience in underground design and construction for water/wastewater and transportation projects. His areas of expertise encompass geotechnical soil and rock engineering, tunnel and shaft lining systems, braced excavations, conventional tunnels, EPBM/slurry tunnels, geotechnical/tunnel instrumentation, microtunnels and shaft sinking methods. He has served as tunnel design manager for some of the largest combined sewer overflow projects in the world. Two of his recent projects introduced significant innovations and won international awards from NEC/ITA.


VITALE

Vitale is active on many national boards, technical committees and organizations and was one of the primary authors of the American Society of Civil Engineers' *Standard Guideline for Microtunneling*. He is the primary author of the chapter on wastewater tunnels in the *History of Tunneling in the United States*. He also lectures regularly on tunneling at the University of Illinois, where he serves on the civil engineering alumni board of directors. ■

UCA and RETC scholarships are presented at 2017 RETC

Every year, the Executive Committee of the UCA of SME awards several scholarships to the most qualified candidates who have applied. In June 2017, three awards were made at the UCA luncheon during the Rapid Excavation and Tunneling Conference (RETC) in San Diego, CA. In addition to the cash awards, winners received travel expenses and free registration to the RETC.

Applicants are required to be enrolled in an undergraduate or graduate academic program related to tunneling or underground infrastructure. Hands-on experience in the underground environment is also a plus. The Scholarship Committee of the UCA evaluates all applicants based on categories that include, but are not limited to, the candidates' passion for underground work, their potential for success and academic achievements to date, the strength of the candidates' recommendations from educators or employers, any prior UCA involvement and their financial need as presented in the application.

The UCA Executive Committee and the Scholarship Committee ask all UCA members to promote and disseminate the availability of the scholarship and the application process within their organizations — especially to relatives and friends.

Any prior experience, such as internships or summer jobs in the tunneling or underground industry in the planning, design, construction or operation of tunnels and shafts, is a benefit to the applicant being considered. The application is available online at www.smenet.org/students/grants-scholarships from Sept. 15 to Dec. 8, 2017.

UCA Division scholars

ARMEN B. AVANESSIAN is a graduate student studying geotechnical engineering at New Mexico Tech in Socorro, NM. He earned a master's degree in mining engineering from the Science and Research Branch of Islamic Azad University in Tehran, Iran. He is a member of SME and ARMA. He worked for Passillo Consulting Engineers as a geomechanics and tunnel engineer, where he gathered field data, prepared geological reports, did numerical studies and simulations of underground structures and tunnels, and studied and analyzed slope stability.

OWEN JAMES is pursuing a master's degree in geotechnical engineering at the University of California, Berkeley. He is a member of UCA of SME and the Society of Petroleum Engineers. James worked as a staff engineer for Berkel and Co. contractors and performed value engineering to develop a grout admixture that doubled pumpability time for pile grout. He also worked on developing a monitoring system to provide real-time pile capacity results and as-builts for geotechnical consultants and general contractors. He previously worked as a project engineer intern for Malcolm Drilling in Seattle, WA.

BRADLEY J. MEYER is a graduate student at the Colorado School of Mines (CSM) pursuing an M.S. in underground construction and tunneling. He has served as the vice president and treasurer of the student chapter of UCA of SME at CSM and is a research assistant and teaching assistant.

He has worked as an engineering intern for Brierley Associates in Denver, CO, where he aided in construction monitoring for a pipe-jacked wastewater tunnel, including launch shaft, tunnel progress and breakthrough. He is a member of the American Society of Civil Engineers and received the Order of the Engineer in 2013. ■

RETC SCHOLARSHIPS

The Rapid Excavation and Tunneling Conference (RETC) Executive Committee also awards scholarships to students who wish to develop their skills in the rapid excavation and tunneling field. The committee awarded 11 scholarships at the June 2017 RETC in San Diego, CA. Each scholar also received a stipend for expenses to attend the conference.

RETC scholars

HAMED ZAMENIAN is a Ph.D. candidate in civil engineering/underground infrastructure at Purdue University. His doctoral research is related to the socioeconomic assessment of water-main breaks in water supply and distribution systems. He is also studying in the Environmental Policy Certification Program in Purdue's Department of Political Science and is working toward an M.B.A. at Indiana University. He is president of the student chapter in the Center for Underground Tunneling Education and Research, vice president of the North American Society for Trenchless Technology, co-chair of the research roundtable of Tau Beta Pi, and chair of social activities for EPICS — engineering projects in community service. He has worked for Durable Infrastructure Systems as an assistant site supervisor on an LCB microtunneling project.

KERWIN HIRRO is a junior majoring in civil engineering at the Colorado School of Mines (CSM) and a member of the UCA of SME student chapter. He has also served as a member of the Student Advisory Committee in the Civil and Environmental Engineering Department. He has worked for Skanska Traylor Shea as an underground engineering intern and is currently working as a co-op student on the Westside Purple Line Subway Extension in Los Angeles, CA assisting with planning, commissioning and maintenance of the dewatering, ventilation and gas monitoring systems.

ARMEN BALASAN AVANESSIAN, New Mexico Tech, also received a UCA scholarship. See his biography on page 48.

FATEMEH MOLAEI is a graduate student studying mineral engineering at the New Mexico Institute of Mining and Technology. She works as a teaching assistant and as a research assistant.

YUANLI WU is a graduate student studying geotechnical engineering at the Colorado School of Mines, where she is a member of the UCA of SME Student Chapter. She received an Edna Bailey Sussman internship and participated in a collaborative research between the U.S. Geological Survey-Landslide Hazards Program and CSM to investigate the mechanics and hydrologic conditions that trigger shallow landslides. She performed fieldwork on site and laboratory work on soil testing.

JEREMY DIEHLMANN is a sophomore at West Virginia University majoring in mining engineering. He is a member of the mine rescue team, the SME Student Chapter, ISEE and is a Statler College Student Ambassador. He has worked as a summer building engineering intern, where he assisted with the installation and maintenance of commercial air conditioning units and rerouted utilities.

BRAD MCDONALD is a sophomore at Green River College in Auburn, WA majoring in mechanical engineering. He has worked for Herrenknecht Tunnelling Systems USA on its engineering team, using computer-assisted design programs to model and draft.

BRADLEY MEYER is a graduate student in underground construction and tunneling at CSM. See his biography on page 48.

GABRIELA GARCA SALDIVAR is a sophomore at the Universidad Nacional Autnoma de México studying underground works and tunnels. She is currently writing a thesis entitled, "Comparative study of the behavior of shotcrete in tunnels from different constitutive approaches."

ALI NAZEM is a graduate student at the Colorado School of Mines studying underground construction and tunneling. Nazem has worked for Hatch Mott MacDonald as a tunnel engineer II. He was involved in planning the soil conditioning for a sewer project to be excavated by the earth pressure balance method and did concrete calculations for the segmental lining. He has served as vice president of the UCA of SME student chapter at CSM.

ZOHEIR KHADEMIAN is majoring in mining and earth systems engineering at the Colorado School of Mines. He is president of the Iranian Students Association at CSM, a member of the SME Student Chapter, a member of the American Rock Mechanics Association Student Chapter and a member of the Denver Mining Club of the International Order of Ragged Ass Miners. He has served as a reviewer for the *Journal of Natural Gas and Science Engineering*. He also worked for ARUP as a tunneling and geotechnics group intern. ■

RETC ATTENDANCE AWARDS

RETC and UCA Young Members give attendance awards

The RETC Attendance Award is administered by the RETC Executive Committee in conjunction with SME. The goal is to provide students with career and networking opportunities.

Applicants for RETC Attendance Awards must be full-time sophomore, junior, senior or graduate students with a designated major in an applicable field of engineering (civil, mechanical, mining, electrical, geological) or construction/project management.

Each 2017 recipient received RETC conference registration, round-trip airfare to San Diego, CA, hotel accommodations at a conference hotel, conference proceedings and social function tickets. Recipients were responsible for their own ground transportation and for any other expenses, including meals, other than those provided by the social functions.

Application forms for RETC scholarships and attendance awards can be found on the SME website at www.smenet.org/scholarships. The application consists of demographic and contact information, school and university information, work history and a few short-answer questions. Up to 12 recipients will be selected.

The 2017 award recipients are:

- Bartlomiej Dziuban, Columbia University.
- Ahmed Ebeido, University of California, San Diego.
- Kevin Alfonso Aldana, Universidad Nacional de Colombia.
- Yovani Achata Flores, Universidad Nacional del Altiplano.
- Ricardo Luna Valverde, Universidad Nacional De San Antonio Abad Del Cusco.
- Ritika Sangroya, University of Texas, Austin.
- Bradley Meyer, Colorado School of Mines.
- Eduardo Alvarez, Universidad Nacional Autonoma de Mexico.
- Muthu Vinayak Thyagarajan, Colorado School of Mines.
- Jeff Wallace, University of Illinois, Urbana-Champaign.
- Ali Nazem, Colorado School of Mines.
- Yiqiu Leigh Anne Zhang, University of California, Berkeley. ■

UCA YOUNG MEMBERS SCHOLARSHIP

UCA of SME Young Members Scholarship for RETC Attendance provides selected students with an opportunity to attend the RETC Conference and to experience the challenges, opportunities and rewards of a career in the field of tunneling and underground construction. The goals of the scholarship are to increase exposure to career opportunities in the underground industry and to provide educational and networking opportunities to future underground industry professionals.

The 2017 award recipients are:

- Muhammad Ishaq, Columbia University.
- Kevin Tse, New York University.
- Ayushi Tiwari,University of Texas, Austin.
- Udit Dasgupta, University of Texas, Austin.
- Jese Vance, University of Illinois, Urbana-Champaign.
- Armen B. Avanessian, New Mexico Tech.
- Jean Gamarra, University of Texas, Arlington.
- Wei Hu, Colorado School of Mines.
- Ahmed Ebeido, University of California, San Diego.
- Juan Monsalve, Universidad Nacional de Colombia.
- Ritika Sangroya, University of Texas, Austin.
- Deniz Ranjpour, Tufts University.
- Alejandro Ortiz Pizzoglio, University of Texas, Austin.
- Varun Maruvanchery, Colorado School of Mines.
- Hu Lu, Colorado School of Mines.
- Deepanshu Shirole, Colorado School of Mines.
- Muthu Vinayak Thyagarajan, Colorado School of Mines.
- Michael Morano, University of Massachusetts.
- Anthony E.L. Hachem, University of Texas, Austin.
- Christopher Nelsen, University of Texas, Austin.
- Jakob Walter, University of Texas, Austin.
- Amanda Parry, Tufts University.
- Kamran Jahan Bakhsh, Colorado School of Mines.
- NikolaosMachairas, New York University.
- Shrey Arora, Colorado School of Mines.
- Yuanl Wu, Colorado School of Mines.
- John Hinton, Colorado School of Mines.
- Yufan Jin, Colorado School of Mines.
- Zoheir Khademian, Colorado School of Mines.
- Jonathan Cracolici, University of California, Berkeley.
- Bradley Meyer, Colorado School of Mines.
- Tamir Epel, Colorado School of Mines. ■

PERSONAL NEWS

BRIAN FULCHER (SME), PE, recently joined McMillen Jacobs as a principal tunnel engineer based in the Pasadena, CA office. In this role, he will support existing tunnel and underground design and construction projects and several major pursuits. Fulcher is a licensed mechanical engineer with almost 40 years of experience on design-bid-build and design-build projects located in the United States, Canada, Taiwan and Puerto Rico. Prior to joining McMillen Jacobs, he was an executive with Kenny Construction engaged in complex projects throughout the United States and Canada.

FULCHER

BROWN

DARLENE BROWN recently joined McMillen Jacobs Associates as chief financial officer. She is a CPA with more than 30 years of experience, with 20 of those in the engineering and construction industries. Her overall responsibilities include guiding the day-to-day financial decisions and working with senior leadership to develop long-term financial strategies for the company.

LAUZON

DONALD P. LAUZON is McMillen Jacob's new director of federal programs. He has more than 33 years of experience in project engineering, project management, engineering analysis and engineering operations with the U.S. Army Corps of Engineers. Lauzon will build on the firm's current federal/civil works successes.

Normet announced that **HIMANSHU KAPADIA** is head of its Ground Control and Construction Technologies' business line and that **ODD-BJÖRN KLEVEN** has moved to a new role as head of solutions development. Most recently, Kapadia managed market operations for BASF Construction Chemicals. He has experience in mining and tunneling and has a strong track record for driving growth in the markets. Kleven will serve Normet's customer base with end-to-end process solutions. ■

NEW PRODUCTS

Normet offers improved spray boom

Normet's Spraymec Norrunner 140 DC improves the mechanization and automation of the most demanding underground work phases and sets the new standard for sprayed concrete, charging and lifting and installation works in hard rock tunnelling. The long-reach spray boom is designed to meet the highest production-capacity requirements for sprayed concrete with an average spraying capacity up to 26 m^3/h (34 cu yd/h). It is also capable of accurately spraying water and frost protection linings in a thin layer of less than 80 mm (3.14 in.). Routine service is made easy, as all operational access points are reachable from ground level. The optional smart boom is a new tool to help the spray operator attain better results with less rebound, since its coordinated motion control is linked to concrete pump output.

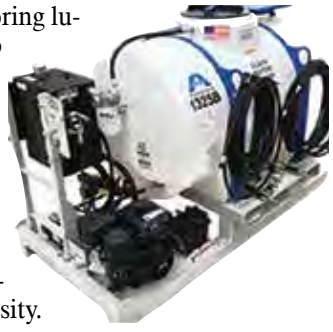
Spraymec Norrunner 140 DC.

www.normet.com

Akkerman adds new lubrication and bentonite pump

Akkerman has added the 1325B lubrication and bentonite pump to its line of guided boring lubrication solutions. The 1325B is a hydraulically driven, high-pressure bentonite pump for effective pilot tube lubrication and flushing of cuttings, particularly on long bores and downward slope alignments. The robust pump is ideal for guided boring, guided auger boring and soft-rock projects using the rock-drill adapter and tri-hawk drill bit as well as pressure cleaning applications.

The unit will displace a Marsh funnel viscosity as high as 50 seconds to flush cuttings with impressive pump flow up to 22.7 L/min (6 gpm) at 17,926 kPa (2,600 psi). The pump meets a full spectrum of project requirements to handle a viscosity range of slurry up to 50 Marsh funnel seconds. The 1,230-L (325-gal) tank features in-tank agitation for aggressive and continuous mixing. The 1325B can independently agitate or agitate and pump to maintain mud viscosity. The tank presents enough fluid capacity for the average 122-m (400-ft) bore. ■



The 1325B is powered by an electric-start Kohler gasoline engine.

www.akkerman.com

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