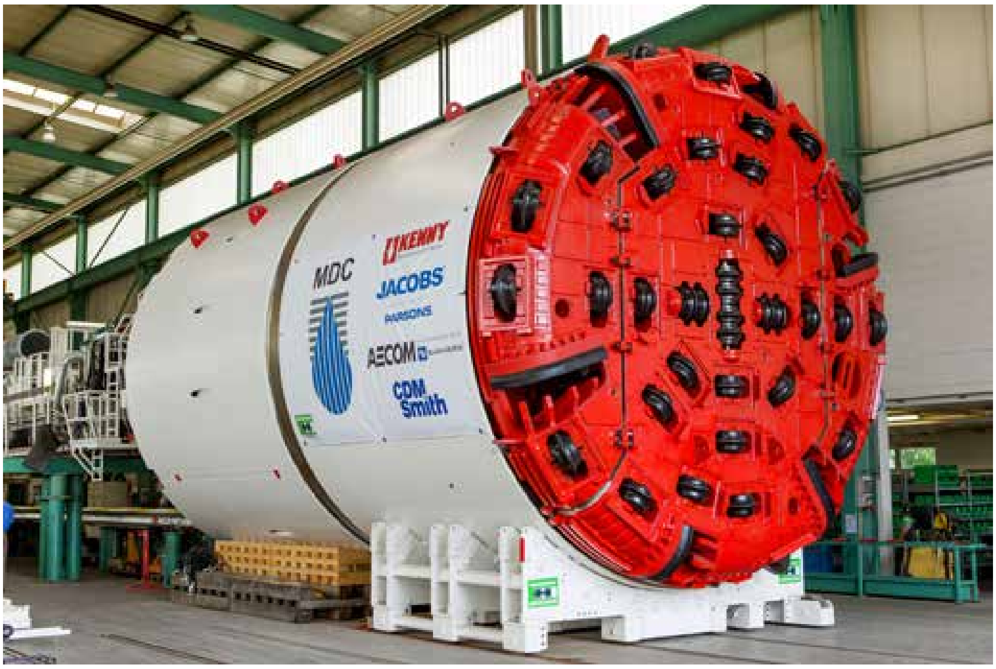
Forewarned and forearmed in CONNECTICUT

The MDC is constructing a 4-mile tunnel to reduce and eliminate combined stormwater sewer overflows in Hartford, Connecticut. The tunnel drive through bedrock had to tackle a regional fault that stranded a TBM 40 years ago, reports Nicole Robinson



The Herrenknecht TBM

The new year saw a major milestone in Hartford, Connecticut. On January 4th a Herrenknecht TBM broke through into its retrieval shaft after over three years of mining. It's a momentous accomplishment for a state that sees far fewer tunneling projects compared to neighbouring New York.

Hartford did make headlines in 2011 for having the first curved microtunnel in the US, the mile-long Homestead Avenue Interceptor project. However, this newer project, the South Hartford Conveyance and Storage Tunnel (SHCST), is significantly larger.

SHCST is a deep rock tunnel stretching four miles (6.4km) across south Hartford and into the town of West Hartford at depths of approximately 200ft (61m) to store and convey sewer overflows for treatment. When completed the 18ft- (5.5m) diameter tunnel will minimise pollution overflowing into local waterways including the Connecticut River and Long Island Sound.

Owner Metropolitan District (MDC) provides water and wastewater services to the Hartford area and has been implementing its Clean Water Project over the last two decades. This $2bn program responds to a consent order addressing combined sewer overflows (CSOs) and includes projects like the Homestead Interceptor and the SHCST.

MDC awarded the $279M construction contract—the largest in the organization's history—to a JV of Kenny/Obayashi. There are four other contracts as part of the SHCST for building consolidation conduits via microtunneling and a pump station, among other work. In total this part of the system costs $500M.

Ground report

James Sullivan, project manager with AECOM, which is the SHCST's design engineer, says the Homestead project provided useful information for the project's microtunneling contract because the soft ground clay conditions are very similar. However, for the main tunnel, the Kenny Obayashi JV is working down in bedrock along with the excavated launch and reception shafts.

The alignment is designed first and foremost to collect and intercept the CSO locations. With those identified the MDC then created a risk register to find the best way to connect all these sites. "We looked at housing, right of way, any facilities we needed to stay away from, what impacts we'd have with noise and disruption to traffic, and all these factors came into play when we picked the alignment," explains Susan Negrelli MDC's Director of Engineering.

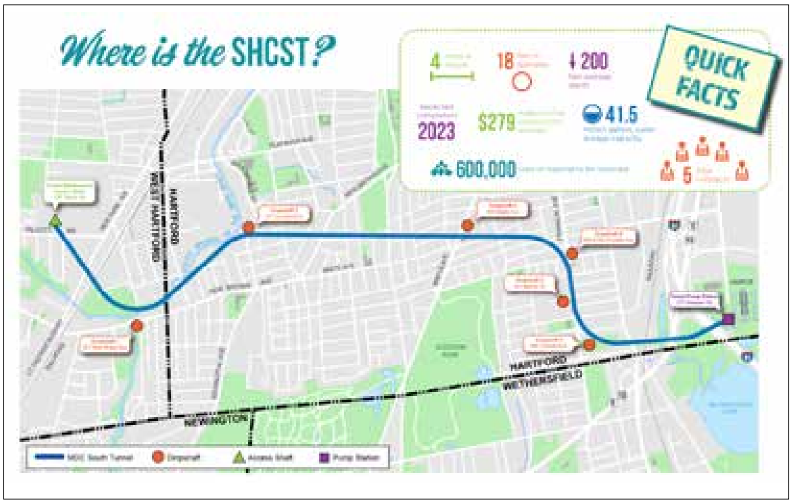
Through this exercise the project team had more than 15 possible solutions when factoring in all the different options for drop shafts and conduits. From here they scored and assessed in more detail for risk and cost, as well as potential impacts and disruptions to the public. "We were very fortunate in that we felt like we ended up with the lowest cost option but also the one that was the least impactful to the residents and communities," Negrelli stated.

To accommodate all the overflow locations the alignment has several curves, for which the design team specified 1,200ft radius for each one. It also had a fixed end point at the water pollution control plant in the east where all the combined stormwater and sanitary overflows will go to be treated, meaning all options for the alignment had to cross under highways, railways and the South Branch Park River, requiring permits and approvals from various stakeholders.

Along with requisite monitoring, the team made sure the design demonstrated that any surface impacts would be negligible, Sullivan explains. “We’re fully in bedrock. That is a risk mitigation strategy because there’s less risk for impacts on the surface.”

A final consideration for the design is another deep rock tunnel for flood control about two miles north of the project. “There are plans for a future connection to our tunnel and part of the reason we set this specific alignment and profile is to give future designers space to avoid that other tunnel,” Sullivan explains.

However, that other tunnel had an additional impact on the SHCST project’s design. The Park River Auxiliary Conduit (PRAC), a flood mitigation measure dating back to 1979, crossed a regional fault—one of 17 on the SHCST project. “This one gave us the biggest concern,” he says. “That project attempted to mine through that fault 40 years ago but the TBM got stuck.”



Plan map of the project alignment

One long TBM drive

The launch shaft is at the site of the future pump station on MDC property. This is near the local airport but not so close to require any major restrictions on construction operations. Initially the design team had concerns about widespread settlement during shaft excavation. The clay had depths as much as 65ft in places.

“The alluvium deposits below the clay get recharged very well and a lot of our geologic models showed that,” Sullivan says. “However we needed to be conservative.”

The design specified the contractor immediately concrete line the shafts in the overburden to cut down water leakage. “That’s exactly what they did, and we didn’t really see any issues with ground water levels.”

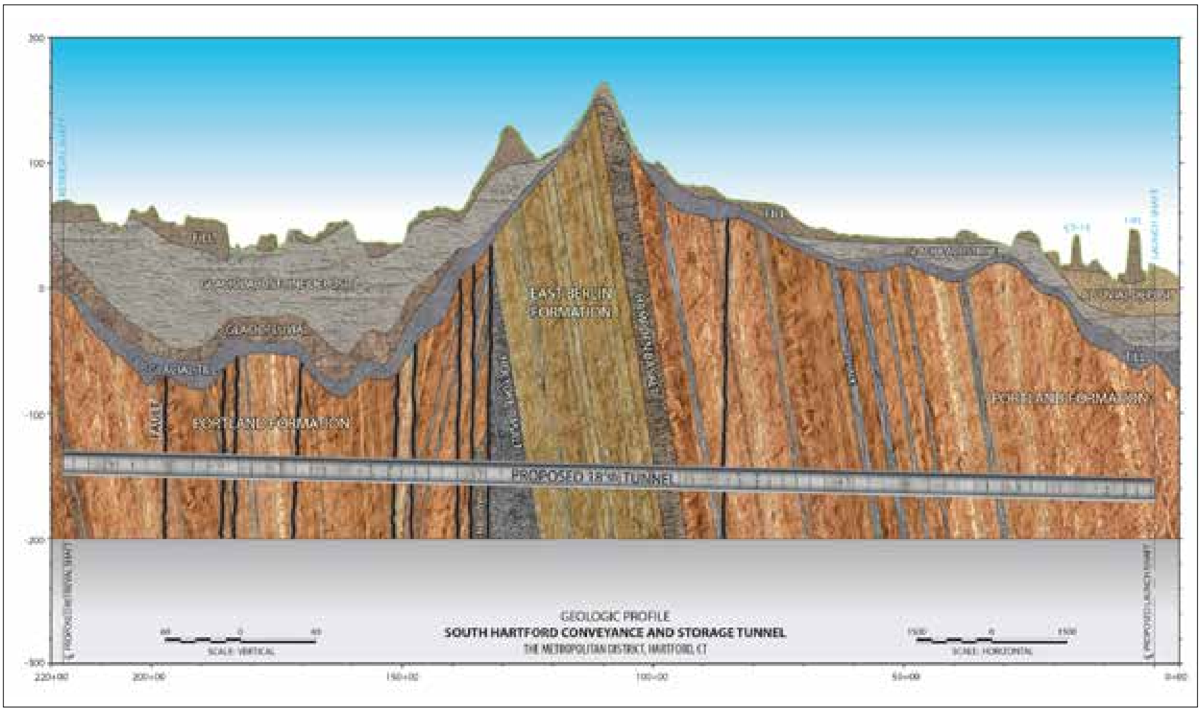
They took the same approach with the smaller-diameter reception and found even lower levels of water inflow.

The contractor launched the TBM in Fall 2018. The geology is predominantly sedimentary rock with most of the drive in the Portland formation. There are also two basalt sills, an igneous rock that is more resistant to weathering, and another formation of sedimentary siltstone.

With 17 faults mapped during the geologic investigation the team had concerns about water inflow and higher permeability zones of the bedrock. “We were able to characterise those and one of our primary mitigations was specifying probing ahead of the TBM in the zones of concern, and then specifying pre excavation grouting,” Sullivan explains.

A significant amount of pre-excavation grouting was anticipated, but the major faults did not present any significant

The cutterhead and gantry at the launch shaft



Long section of the tunnel

issues thanks to the grouting and the segmental lining. "We would see bedrock groundwater measurements near the TBM face drop as the TBM advanced through a zone and then recover after the TBM had left the zone," Sullivan says.

This included the challenging regional fault that had left the PRAC TBM stranded 40 years ago. "TBM technologies and construction technologies have improved," Negrelli says. However, the designers were still hesitant. "In the geotechnical investigations, they specifically targeted to try to penetrate the fault zone at the location the TBM would mine through, to really get a good handle on the conditions of the fault zone."

The geotechnical investigation showed, for the SHCST specific crossing location, that the regional fault contained fractured and shear zones with highly weathered rock but did not contain extensive soil like conditions that were encountered in the PRAC tunnel 2 miles north of the project.

This helped decide the TBM specifications for a shielded machine and pre-excavation grouting programme in the construction contract—all of it approached with the mindset of the worst case conditions at the fault. "The TBM did have slow downs in other locations along the drive, but the regional fault

Lowering the cutterhead

zone was not one of them," says Sullivan. He jokes, "all that concern you wrack your brain about for months in design and the regional fault was a 'blink and you miss it moment."

Mining took longer than expected, while also marking a best day with 135ft (41m). "They had long stretches where they were getting good, consistent 40-50ft [12-15m] per day on average," he says, adding that "grouting ahead of the TBM is more art than science."

Construction during Covid

The project team had anticipated and mitigated many challenges in advance—such as monitoring the local real estate market so they could purchase properties for sale for drop shaft sites, rather than relocating residents and businesses. They secured special permits for construction equipment at the shaft in order to work near the airport. However, nothing compares to the unforeseen challenges of the pandemic.

Crews worked 24 hours a day Monday through Friday with Saturday for maintenance, and Connecticut did not mandate construction stop during the pandemic. However, in autumn 2021 the virus hit the project and they had to stop for two weeks. "That was quite challenge," Negrelli says. "But it's a construction project. You can have the best plan out there but it's not going to go exactly as planned."

Now that TBM mining is completed the project will move forward with other contracts for the 7,300ft of surface level work and drop shafts. The launch shaft will be converted to into a screening shaft and later connected to a larger shaft nearby for the pump station.

SHCST TUNNEL FACTS

Length: 4 miles (6.4km)
Internal diameter: 18ft (5.5m)
Depth: up to 300ft (91m)
Lining: 5+1, 5ft (1.5m) long
Lining reinforcement: steel fibre
Capacity: 41.5 million gallons
Material to be removed: 900,000 tons