

Linnwood to Riverside Water Conveyance Tunnel Milwaukee, WI

Greg Yankey, PE Associate
Joe Wiedemann, PE

This 7,100-ft by 9-ft diameter tunnel was constructed in 1920 and has been in service ever since with only a few interruptions. Brierley Associates was retained by the City of Milwaukee Water Works (MWW) to perform a detailed tunnel inspection and subsequently develop a scheme to repair cracks and other documented defects. Because the extent of repairs was unknown, those aspects to be repaired were to be mutually agreed upon after the inspection. Also, the six month time frame for project completion, prior to high demand late spring and summer months, posed a logistics challenge.

To accomplish this project and demanding schedule, Brierley assembled a solid team of in-house engineers and geologists as well as sub-consultants and constructors with specialized industry experience. Brierley's contracting partner, Engineering & Construction Innovations, Inc. (ECI) of Oakdale MN, initially dewatered the tunnel and performed an end-to-end pressure cleaning. ECI's Vice President, Robb Johnson, stated "The Brierley/ECI team worked well together on the Linnwood Tunnel Dewatering Project. We were able to work through several complex issues with the project owner's representative to facilitate the necessary engineering, material testing and construction tasks within the allotted time frame and exceed the client's expectations."

All entries into the tunnel were considered confined spaces, and all access was through drop-shafts that varied in depth from 80-ft to 120-ft. Subsequently, Brierley's experienced inspectors spent several days documenting and photographing defects consistent with agreed upon protocol founded upon Brierley's previous work in developing tunnel inspection procedures for other water utilities.

Given the need to document conditions and alignment of the tunnel, Brierley implemented a multi-crew



Injection grouting crew

approach. The crew following behind the inspectors performed a survey of the tunnel, establishing stationing and obtaining invert, springline and crown elevations at 50-ft intervals. The next crew performed video documentation to supplement the findings. Lastly, concrete cores were obtained to verify the actual tunnel thickness in selected areas. These cores were then augmented by Echo Pulse testing at an additional 40 locations to provide a thickness check.

At the conclusion of the inspection and documentation phase, Brierley met with MWW to discuss findings and assign urgency ratings to the observed defects. The goal of the follow-up repairs was to complete as much as possible before the tunnel was placed back into service. The prioritized repairs amounted to approximately 7,500 linear feet of cracks. Grout ports were installed along the entire length of the cracks to facilitate effective and efficient repairs. Completion and clean up was accomplished in 3 months and in time for the tunnel to be placed back in service for the summer season.

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