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Malcolm Drilling Installs Secant Pile Wall for Seattle Tunnel

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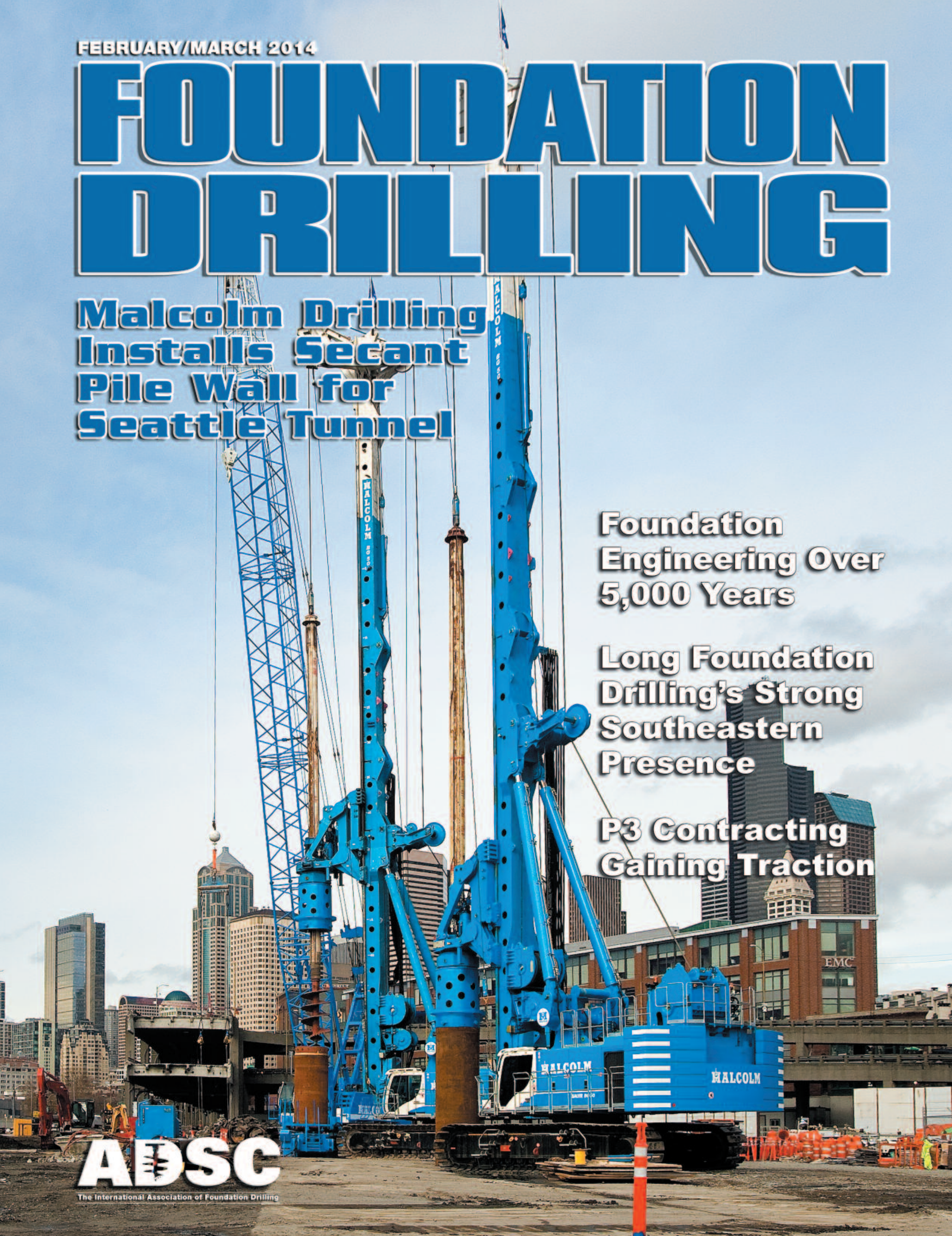

ADSC
The International Association of Foundation Drilling

Malcolm Drilling

Installs Secant Pile Wall for Seattle's SR-99 Tunnel Project

By Lance Rasband, Project Manager, Malcolm Drilling Co., Inc.

The SR-99 Tunnel Replacement Project along the picturesque Seattle waterfront has been headline news for some time. The $3.1 billion dollar project calls for a 1.7 mile tunnel to be constructed below grade along the right-of-way of the existing Alaska Way Viaduct. The project was scheduled to begin in 2009 and completed in 2015. The article that follows focuses on that part of the project that directly relates to the kind of work undertaken by ADSC members, and the challenges faced, and met by ADSC Contractor Member, Malcolm Drilling, Kent, Washington. (Editor)

The original SR-99 Alaska Way Viaduct was constructed in 1953 and provided the main west access through the City of Seattle. The existing Viaduct which was a double–decked roadway served the city for many years with north bound lanes above and south bound below. Over the years as the viaduct aged it was kept in the best possible repair. Several maintenance contracts were executed during this timeframe. However, in 2001 the 6.8 Nisqually earthquake hit the region resulting in significant damage to the viaduct. While emergency repairs were implemented, it was clear that the serviceable life of the structure had come to an end. The only question was what to do to replace this critical infrastructure artery?

Several options were considered. The first was to tear down and replace it with another viaduct. This was discarded due to the valuable real estate situated on streets below the elevated roadway. A cut and cover structure incorporated with the seawall repair was also considered. Funding confusion

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and a questionable timeframe made this option unrealistic. Even a cable stay bridge constructed above the existing viaduct was discussed. This option would allow the existing traffic to remain on the viaduct while con-

Original viaduct construction image circa 1952.

Advanced technology in tunneling machines made a tunnel the viable solution

struction took place. Ultimately the viaduct could be removed and traffic would then flow on the bridge. Ground conditions, vertical easements and city redevelopment made this option unworkable as well. What was agreed upon was that the redevelopment of the west side of the city could result in a completely new look for an already beautiful city. The question became, what was the solution? The answer was a tunnel. Early on a tunnel was considered and then rejected based upon the existing technology at the time. However, over the ten years that alternatives were under consideration,

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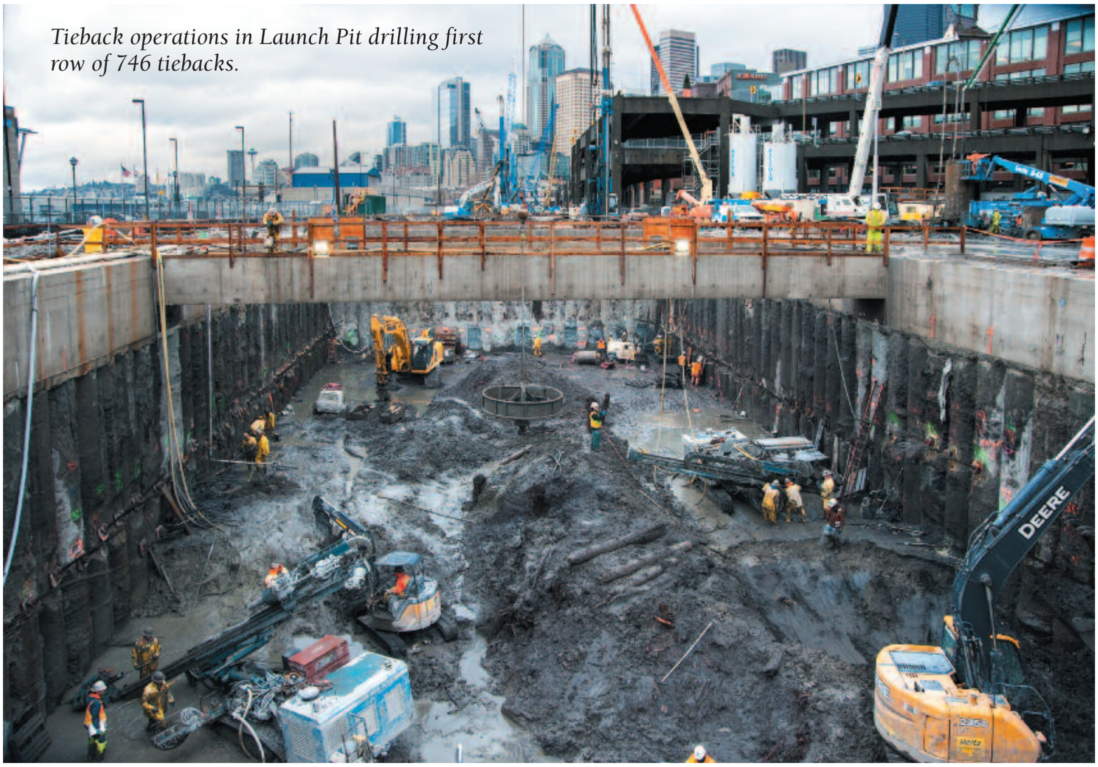
Bauer BG-50 works near headwall of Tunnel Boring Machine (TBM) Launch Pit.



Tieback operations in Launch Pit drilling first row of 746 tiebacks.

and with input from consultants, the technology in tunneling machines and the diameters that they could excavate was advanced making a tunnel the viable solution and desirable choice. In order to meet the requirements of the project construction of a 58 ft diameter tunnel was called for. Once the alignment was decided upon the next critical chal-

Final prep for cradle of TBM in Launch Pit.

lenge was how to launch a 58 ft diameter, 364 ft long tunnel boring machine in some of the most challenging ground conditions possible. At the same time it was necessary to deal with how to accommodate traffic entering and exiting the tunnel. Accomplishing this feat given the configuration of the structure, and the varying grade and geologic conditions, was a daunting task.

This tunnel would have to be constructed in ground conditions that varied from dense glacially overridden material to near zero blow count hydraulically-placed ground that was rife with historic debris composed of wood, concrete, and steel. In addition, there was the potential of encountering varied organic deposits, trestles, and railroad ties, as well as a water table 5 ft from the surface. Historically speaking, a major portion of the project site was in an area that housed many old timber mills. As a result excessive amounts of old wood debris were encountered through which Malcolm had to drill. At times the auger would come out of the hole filled with old saw dust. All of this work had to be accomplished according to a very aggressive schedule. During the bid process various shoring methods were discussed including Cutter Soil Mixed Walls and Slurry Walls. However, due to the existing ground conditions combined

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with satisfying the goal of utilizing that which was to be constructed as a permanent solution, and as part of the structure, the final decision was to construct a secant pile wall comprised of 5 ft diameter drilled piles. The lead contractor, Seattle Tunnel Partners chose to team up with ADSC Contractor Member, Malcolm Drilling Co., Inc. (MDCI). Based on Malcolm's experience taking on difficult construction projects, STP felt that teaming with MDCI would provide them with an advantage in the bidding

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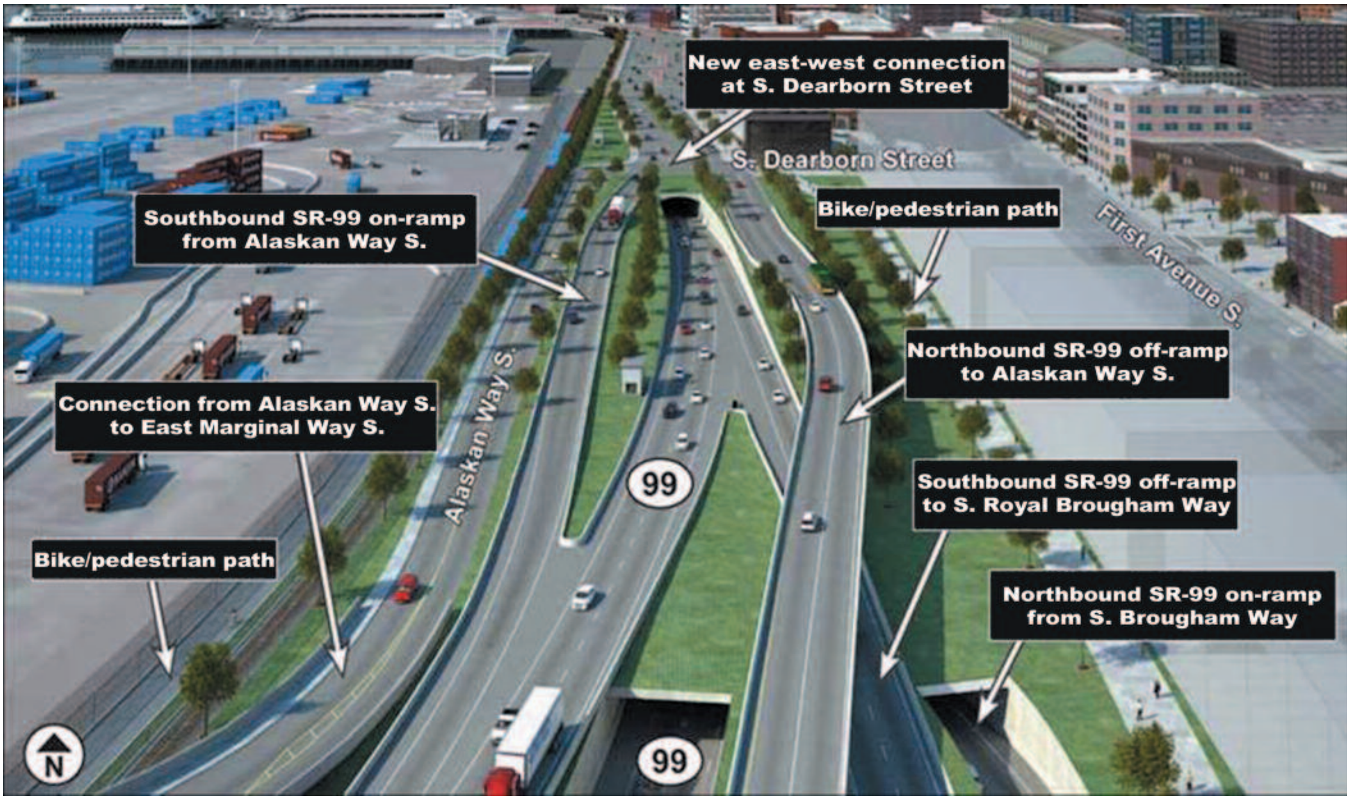
Tight access had to be orchestrated on a daily basis.



process, which included "scoring" the proposing teams. The final layout included 1,551, 5 ft, fully cased interlocking secant piles averaging over 92 ft in length, and up to 138 ft deep. The launch pit for the tunnel machine required installing 746 temporary tieback anchors. This required employing challenging installation techniques made necessary by having to construct the secant cut-off wall in such a way as to mitigate water and soil infiltration. Many steps were taken to ensure settlement outside the launch pit did not occur. To ensure that the stringent verticality requirements were met the secant piles were installed through 5,240 lineal feet of guide wall. Each secant pile was also constructed with full length temporary segmental casing to produce a quality final product that was vertically in place and maintained shape and overlap.

To accelerate the completion of the Launch Pit for the arrival of the TBM, some double shifting was performed.

Each secant pile was constructed with 4,000 psi concrete and alternating rectangular and circular reinforcing steel cages. There were difficulties associated with placing the rectangular cages and maintaining their alignment. It was crucial to not have the cages twist during concrete placement. This was especially important as the alignment of the block-outs for tiebacks in the launch pit were critical. There could be no interference with the adjacent tiebacks. Secant piles on the head wall at the place where the tunnel machine was to penetrate included five levels of shafts to a depth of 120 feet. These piles required fiberglass reinforcing which made lifting and the placement of concrete quite a challenge.

To meet the schedule requirements a significant amount of drilling and support equipment was required. These included two Bauer BG 50 and three Bauer BG 40 drill rigs* with multiple Leffer Oscillators*, as well as crawler cranes of every imaginable capacity, and miles of Leffer reusable casing. At the height of Malcom's work, each day anywhere from 700 to 900 cubic yards of tremie-placed concrete was placed, each requiring CSL testing in order to meet QA/QC requirements.

Crews drilling tiebacks in Launch Pit near headwall. Native soils posed access problems for drill benches.

Quality control was a major area of focus and required stringent coordination. With multiple cages being placed, concrete being poured, and CSL testing being done the Malcolm field staff had to coordinate with STP personnel, WSDOT, and suppliers to ensure certificates were received, steel was inspected, concrete tested, and specifications were being followed. There was an orchestra of events happening in up to five different locations at any time during a typical work day. At the height of the work up to 50, 5 ft diameter drilled shafts were drilled and poured in a given week.

Other areas of work included ground improvement. This was due to the loose soil conditions at the head wall of the launch pit. The tunneling machine would be starting in a "mixed face" condition meaning it would be mining through the lower half of glacially consolidated material, and the upper half would be in loose low blow count fill. To mitigate this condition a 75 ft wide x 600 ft long x 55 ft deep improved-jet-grout-treated-area was constructed. And finally a dewatering component was employed in order to aid in the excavation of this saturated material. This phase included installing 50 deep dewatering wells to draw down the ground water.

Working in difficult geologic conditions, tight working spaces, meeting robust tolerance parameters, and working under a rigorous time schedule required great teamwork and coordination.

A small amount of contract work remains. MDCI's contract is scheduled to be completed in the summer of 2014.

Epilogue

What has recently caught the attention of international media is not the amazing nature of the project itself but of problems associated with advancing the Tunnel Boring Machine, which became stuck in early December. There have been numerous theories put forth as to why this occurred. These include the TBM encountering debris of a variety of types including steel pipes, old timbers, and other obstructions. The most recent thinking is that the problem stems from dirt clogging the TBM's cutter heads and thereby compromising the machine's seals around the main bearings. One of the unfortunate results of the current problems is that it detracts from the overall project itself. Recent comparisons with the problems associated with Boston's 1990's Big Dig do not help. In that instance a project that was expected to cost in the neighborhood of $2.8 billion wound up coming in at $22 billion. Started in 1991 and projected to be completed in 1998, the Big Dig was completed in 2007. It is far too early in the process to make comparisons between these two projects, with the SR-99 Tunnel being on a much smaller scale than the massive Big Dig.

According to WSDOT, the Seattle Tunnel Project has a $200 million Risk-Reserve Fund to cover exigencies. WSDOT authorities have stated that they do not expect that Washington State taxpayers will be asked to come forth with additional funds to complete the project. At this writing "fingers are not being pointed" in any direction and all hands are on deck to come up with a resolution to the issues faced. (Editor)

**Denotes ADSC Member*

Project Team

Owner:	Washington Department of Transportation
Specialty Foundation Contractor:	Malcolm Drilling Co., Inc.*
General Contractor:	Seattle Tunnel Partners (Dragados USA – Tutor Perini, Joint Venture)
Design Engineer:	HNTB Corporation*
Geotechnical Engineer:	Hart Crowser Inc.

**Indicates ADSC Member*