

Tunnel Cost Estimating & Validation Approach

Throughout the evolution of the bored tunnel cost estimates, the WSDOT project management team has consistently engaged highly experienced professionals in the world of underground construction and tunnels. The initial estimate was for a dual bore tunnel, and was developed by the lead estimator for the General Engineering Consultant Parsons Brinkerhoff (PB), Ken Fiorentino, who is with Jacobs Engineers. Ken has over 32 years of tunneling experience, including 27 years as a contractor estimating and building tunnels in the US and around the world. In order to ensure confidence in the initial estimate, the owner's Program Management Consultant Hatch Mott MacDonald (HMM) was asked to prepare a parallel independent estimate for the dual bore tunnel design. HMM are involved in tunnel planning, design and construction around the world, and utilized staff not directly involved with the project, ultimately producing an independent estimate that was within 5% of the PB estimate. WSDOT's lead Program Estimator, Mike Morrison, independently reviewed and validated the estimates prepared by both PB and HMM, in order to ensure consistency in approach and key assumptions. Mike is an independent consultant with over 43 years of experience specializing in estimating and value engineering, including 14 years as the chief estimator at CH2M HILL.

In December, WSDOT developed a single bore tunnel proposal as a way to save time and money over the dual bore proposal, along with an estimate that accounted for changes from the previous design. This occurred very close to the time that the Stakeholder Advisory Committee (SAC) announced their preference towards a bored tunnel. In announcing their preference, the SAC consulted with the Cascadia Center for Regional Development, a regional transportation policy organization who had retained a number of independent bored tunneling experts and had issued a letter advocating that a bored tunnel could be built for less cost and time than had been initially presented by WSDOT. This led to a mid-December SAC workshop on bored tunnel construction where WSDOT engaged John Reilly and Harvey Parker, in addition to PB and HMM. John and Harvey are both independent consultants with over 45 years of underground construction and tunneling experience across the world, with Harvey being a past president of the International Tunneling Association and John being a past president of the national Underground Construction Association. At the SAC workshop, Cascadia and their primary independent tunneling experts from Arup, who are an international consulting firm specializing in tunneling, shared their thoughts on the bored tunnel planning and estimates with WSDOT, focusing on areas where they said our estimates appeared high. After review of the dual and single bore tunnel estimates at the workshop, all parties agreed to the approximate overall expected construction cost of the bored tunnel.

Subsequent to the SAC workshop, in early January WSDOT held a bored tunnel estimate review and validation workshop focused on the single bore tunnel plan. Present at this workshop were WSDOT management and all of WSDOT's bored tunnel experts previously referenced (Ken Fiorentino from Jacobs, Mike Morrison, Don Phelps from HMM, John Reilly, and Harvey Parker). The focus of the workshop was specifically to review the detailed estimate, including all critical assumptions behind the baseline estimate and the risk, contingency, and escalation components that added to the baseline estimate comprise the basis for the current \$1.9 billion tunnel estimate. Don Phelps from HMM was present at this point, bringing over 35 years of tunneling experience to the estimate review. As advisory consultants to WSDOT, Don, John and Harvey had Ken and his team break down the estimate for them, reviewed risk and contingency specific to each key component of the estimate, then they built the estimate back up to the summary level, concurring as a group that the single bored tunnel could be built within the \$1.9 billion allocated (assuming that the scope is adequately maintained and the schedule is not allowed to extend significantly).

In mid-March WSDOT commissioned an independent panel of seven tunneling experts from around the nation and world, all of whom had between 30 and 50 years of experience in tunneling and underground construction, with most of the panel having worked as contractors responsible for building hundreds of existing tunnels around the nation and world (including more recent 47 to 50 foot diameter tunnels in Germany and China that compare well with the proposed single bore tunnel). They were specifically tasked with providing input towards WSDOT's implementation plan (number and types of contracts, schedule, risks, important considerations, etc), and not asked to review and weigh in on the detailed construction estimate. The basics of the \$1.9 billion estimate, key assumptions, and the estimate review and validation process and participants were presented to them. Per Dr. Brenda Bohlke, who chaired the panel and is the current President of the national Underground Construction Association: "During the construction strategy workshop, the expert industry panel had the opportunity to learn about the projected project cost and the basis of its development. They were confident in the approach that had been used, and that those instrumental in the development of the costs had the experience and proper estimating methods for large complex urban tunneling programs. Three separate reviews of the cost estimates lent additional confidence to the cost estimates."