

## TUNNEL COST ESTIMATING & VALIDATION APPROACH

Formatted: Heading 2

Throughout the evolution of the bored tunnel cost estimates, the WSDOT project management team has consistently engaged highly experienced professionals in the world of tunnels and underground construction, and is confident of the \$1.9 billion estimate for the SR99 Bored Tunnel. Following is a review of the evolution of the estimate and review process.

Deleted: 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 Engineering. Ken has over 32 years of tunneling experience, including 27 years as a contractor estimating, bidding 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 of the cost of construction for the dual bore tunnel design. HMM are involved in tunnel planning, design and construction around the world. HMM utilized estimating 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.

Deleted:

Deleted: s

Deleted: , and

In December, WSDOT developed a single bore tunnel proposal as a way to save time and money over the dual bore concept, 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, signed by these experts, 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 around the world, with Harvey being the immediate past president of the International Tunneling Association and John being a recent past president of the American 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 subsequent clarification, review and adjustment of the dual and single bore tunnel estimates, all parties agreed to the expected construction cost of the bored tunnel.

Deleted: proposal

Deleted: a

Deleted: cross

Deleted: a

Deleted: national

Subsequent to the SAC workshop, in early January, WSDOT held a bored tunnel estimate review and evaluation 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, John Reilly, and Harvey Parker). Don Phelps from HMM was present at this point. Don is a Vice-President at HMM and Deputy Practice Manager, Tunnels and brings over 35 years of tunneling experience to the estimate review. 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 estimate for the SR99 tunnel. As advisory consultants to WSDOT, Don, John and Harvey asked Ken and his team to break down the estimate into specific components. They reviewed risk and contingency specific to each key component of the estimate, then built the estimate

Deleted: at the workshop

Deleted: approximate overall

Deleted: validation

Deleted: Don Phelps from HMM,

Deleted: ing

Deleted: tunnel

Deleted: Don Phelps from HMM was present at this point, bringing over 35 years of tunneling experience to the estimate review.

Deleted: had

Deleted: for them

Deleted: ,

Deleted: they

back up to the summary level, concurring as a group that the single bored tunnel could be built within the \$1.9 billion allocated (on the condition that scope growth is controlled and the schedule is not allowed to extend significantly).

- Deleted: assuming
- Deleted: the
- Deleted: is adequately maintained

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 a large number of tunnels around the nation and world. One member worked on the 47 ft. diameter tunnel under the Elbe River in Hamburg, Germany and another has been actively involved since 2000 with the overall Chinese large-diameter tunneling program. The panel was specifically tasked with providing input regarding WSDOT's implementation plan (number and types of contracts, schedule, risks, important considerations, etc). They were not asked to review the detailed construction estimate. However, the key elements of the \$1.9 billion estimate, the key assumptions, and the estimate review and validation process and participants were presented to them. According to Dr. Brenda Bohlke, who chaired the panel and is the current President of the U.S. 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. The panel was confident in the approach that had been used, and that those instrumental in the development of the costs had the experience and used proper estimating methods for large complex urban tunneling programs. The two separate cost estimates and independent reviews by Arup and the tunnel professionals separate lent additional confidence to the cost estimates."

- Deleted: hundreds
- Deleted: existing
- Deleted: (including more
- Deleted: recent
- Deleted:
- Deleted: to 50 foot diameter tunnels in Germany and China that compare well with the proposed single bore tunnel).
- Deleted: They were
- Deleted: towards
- Deleted: , and
- Deleted: and weigh in on
- Deleted: T
- Deleted: basics
- Deleted: Per
- Deleted: national
- Deleted:
- Deleted: They were
- Comment [HWP1]: This sounds like the Panel itself did 3 separate reviews. I think Brenda means that since there were 3 separate reviews by WSDOT, it lends additional confidence, in the Board's eyes, to the cost estimates.
- Deleted: Three
- Deleted: reviews of the cost estimates