Review
of
Select Project Documents
SR 99 – Bored Tunnel Alternative
Design-Build Project (WSDOT)

Prepared
for
Seattle Department of Transportation
Seattle, WA

Prepared
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EXECUTIVE SUMMARY

The Alaskan Way Viaduct (AWV) is nearing the end of its useful life and is subject to catastrophic collapse during an earthquake event. Since the 2001 Nisqually earthquake, which damaged the AWV, and the adjacent seawall, WSDOT has undertaken a series of studies to repair or replace these structures. Over these 9+ years, WSDOT has created an 'army' of consultants (both firms and individual experts), and jointly with them conducted studies of at least 8 possible alternatives. This review focuses on the: SR – 99 Bored Tunnel Alternative, Design-Build Project (WSDOT).

Dr. Thom L. Neff was hired by Mayor McGinn to conduct a review and risk assessment, with particular attention to residual uncertainty in the current project documents as it might apply to the possibility of cost overruns and/or schedule extensions. Dr. Neff is an independent strategic infrastructure management consultant, with 40 years experience in the infrastructure industry (as a designer, construction manager, and contractor), having worked on numerous complex urban projects, including tunnels throughout the US and overseas. His review consisted of two site visits to Seattle, and meetings with the Mayor and his staff, SDOT, WSDOT, and WSDOT's consultants. He reviewed a number of select projects documents, including the project RFP, Contract, Cost Estimate, Schedule, several MoAs, the Geotechnical Baseline Report, etc.

During the last 9 years, WSDOT has had the assistance a large group of firms (major international companies) and a group of internationally known experts to carry out the studies and evaluations. They have also involved various stakeholders and other interested 3rd parties in the process. The studies have followed both conventional, and best practice, criteria for such works. Late in 2009, WSDOT pre-qualified 4 Design-Build Teams to bid the job, with bids due on 10/28/10. They have given these teams a 'concept' design, and extensive criteria, on which to base their bids. WSDOT's Cost Estimate utilized the CEVP process (and other outside experts) to arrive at an overall project estimate of $3.1 billion. The Cost Estimate is also based upon the concept design. The project schedule was set for completion in December 2015, but that date was extended by one year within the last month.

The key issues related to uncertainty appear to be: the record setting tunnel diameter (largest soft-ground bored tunnel in the world), the adverse geologic setting (including flowing sands, abrasive soils and boulders up to eight feet in diameter), and the relatively high water pressures at the deepest portion of the tunnel. Collectively, these elements combine to create a situation where accurate predictions of outcomes remain problematic.

As an added note, two of the pre-qualified Design-Build Teams have stopped taking part in talks with WSDOT, and are unlikely to submit bids.

Given the level of current design and the risks identified in constructing a tunnel of this magnitude, there is a reasonable expectation that costs and schedule could exceed current estimates. The recommendations offer several suggestions to improve both the process and the eventual project.

1.0 INTRODUCTION AND REPORT OBJECTIVES

Representatives of the Seattle Department of Transportation (SDOT) approached OckhamKonsult (Thom L. Neff, President) on June 16, 2010 to discuss assistance with a review of residual risk that may remain in the current project documents for the SR 99 – Bored Tunnel Alternative. A dialogue between SDOT and Dr. Neff regarding qualifications, availability, etc., took place, culminating in a signed contract (effective June 28, 2010), Agreement No. 10-21. The Scope of Work for this contract is depicted in Appendix A.

Given the lateness in the planning and concept design phases of this project, the primary objectives of this review will be: (a) to review portions of select project documents with a focus on any remaining risks that could significantly affect the project budget or schedule; (b) offer a professional opinion on the results of the review, and, (c) offer comments on possible mitigation measures for the residual risks.

In conducting this review, the author will make two site visits to Seattle to examine the physical project setting, etc., and meet with many of the project 'players,' to include WSDOT staff, SDOT and other City staff, and staff from some of the numerous consulting firms assisting WSDOT (as well as some their individual expert consultants). The author will also review a similar review report, being prepared currently by a consultant for the Seattle City Council.

2.0 PROJECT HISTORY

The SR 99 Alaskan Way Viaduct was constructed in the 1950s. The right-of-way is owned by the City of Seattle, and WSDOT owns the structure. These two entities have shared maintenance and capital costs over the years. As traffic increased, numerous studies were carried out to repair, replace, or otherwise enhance the structure. This process was brought into sharp focus with the Nisqually earthquake of February 2001, which caused significant damage to both the Viaduct, and the Seawall along the adjacent waterfront.

Immediately after this seismic event, Parsons Brinckerhoff (PB) was hired by WSDOT to begin a more detailed evaluation of alternatives to repair or replace the Viaduct and Seawall. In the intervening 9+ years, the consultants working with WSDOT on this issue

have grown to a large 'group.' A partial list of the major firms on board includes: PB, HDR, Jacobs Engineering, Shannon & Wilson, and Hatch Mott MacDonald, while a partial list of the respected international individual expert consultants includes Harvey Parker, John Reilly, Brenda Bohlke, and Dwight Sangrey. During this period, at least eight options were seriously considered, and two hybrid solutions brought to a vote in Seattle (both voted down). At a minimum, 1,000s of man-hours and millions of dollars have been expended to arrive at the current recommended approach. The process also included a Stakeholder Advisory Committee. After December 2008, WSDOT and their consultants began to concentrate on the Bored Tunnel Alternative.

Additional consultation with stakeholders and tunneling experts and supplementary evaluations, resulted in the Washington State Legislature, during its 2009 Session, to identify the Bored Tunnel Alternative as its preferred option to replace the central section of the Alaskan Way Viaduct (ESSB 5768). During the remainder of 2009, and continuing into the present, WSDOT's numerous consultants carried out extensive additional evaluations and meetings to refine the scope, schedule, and budget for the work. An RFQ process was carried out during late 2009 and early 2010, resulting in 4 qualified D-B teams. Two of the D-B teams have stopped participating in the process.

As an added note, both the Viaduct and the Seawall have been judged subject to a sudden and catastrophic failure in an earthquake event.

3.0 GENERAL COMMENTS ON APPROACH TO REVIEW

As noted above, it is late in the process of detailed planning and conceptual design for this work. Discussion in the following report sections will comment on select portions the vast array of studies undertaken by what amounts to an 'army' of experts in the myriad of disciplines involved in such a complex undertaking.

The author is a strategic infrastructure management consultant, *i.e.*, a generalist, but with extensive real project experience in large, complex projects, many of them in urban settings and many involving tunnels (open cut and bored). These projects ranged across the US, as well as overseas. The basic philosophy of OckhamKonsult is the STEPS Approach, a process created by the author, who has published articles on its basic principles. Simply stated, the STEPS Approach holds that the optimum solution to complex infrastructure problems requires the carefully integrated study and evaluation of Social, Technical, Economic, and Political aspects into a comprehensive end product. The second 'S' refers to the term Synergy which is defined as: "the interaction of discrete agencies, conditions, or elements such that the total effect can be greater than, or less than, the simple sum of the individual elements." In other words, it speaks to the difficulty of accurately predicting outcomes when dealing with complex situations.

Because of the lateness of this review in the overall process, and the limited time permitted for the review, the author will only review portions of select documents, along with those listed in the Work Scope (Appendix A). The emphasis will be on looking at

both individual elements, and more importantly, the dynamic potential interactions among and between these elements, to determine if significant uncertainty remains in the planned works. This review will be limited to the SR 99 Proposed Bored Tunnel and Systems (including North and South Portals). The review will focus on Technical and Economic aspects.

The conclusions and recommendations offered will be the professional opinion of the author, based on this review, and upon his personal experience with similar works.

4.0 DISCUSSION OF DOCUMENTS REVIEWED

4.1 Project RFP – Chapter 2 – Technical Requirements

This is a comprehensive, detailed document intended to give the bidding D-B Teams a complete technical understanding of the expectations of WSDOT regarding the proposals that will be submitted for this work. It contains 60 sections that discuss in much detail nearly all possible topics that such a complex project would entail, from General Conditions, through Roadway Design, Settlement Mitigation for Buildings, Construction Monitoring Programs, and Commissioning of the completed work. A draft version of the RFP was issued to the four prospective design-build teams on February 26th, 2010. The final RFP was issued on May 26, 2010, but meetings were held with the pre-qualified bidding teams, both before and after this date, in a good faith effort to jointly arrive at a the best possible proposals. This document covers items one would generally find in an RFP for such a project, and places the bidders on notice that a very detailed, complete, and comprehensive Proposal is expected.

4.2 Project Design-Build Contract (Instructions to Bidders)

This document contains 7 sections plus tables and appendices, intended to assist the bidders in preparing their proposals. Bids will be sealed, competitive, and the winner judged on 'best value.' The means to calculate 'best value' is clearly stated. Collaboration, including partnering, is encouraged for all parties as one means to better manage overall risk. The bidders are instructed to carefully examine the site, and make reasonable 'inferences' from same.

It is forcefully stated that WSDOT and their consultants offer only a 'concept' design at this point, and that the D-B teams will be solely responsible for the design and construction of the project. WSDOT states its project goals as: on time, within budget, with a minimum of deformation to adjacent facilities, high quality and environmentally sound practices.

The bids are due on 10-28-10, but the NEPA process will not finish until July 2011. Alternate Technical Concepts (ATC) will be permitted, and technical credits will accrue

to the bidder if they show a completion date earlier than 12-31-16. It is noted that the completion date was extended one year by WSDOT within the last month or so, based upon input from the bidders. To allow for issues that may arise from the date of the FEIS approval, two NTPs will be used. A stipend of $4M will be paid to the unsuccessful bidders.

Detailed descriptions of contents of the proposal are given, with special emphasis on the Technical Proposal and the Risk Management Plan (RMP). The bidders are asked to critique the Initial Project Risk Register, identify other possible risks, and jointly with WSDOT prepare a Project Risk Register that will be used to manage and control risks going forward. Form T in the appendix lists WSDOT's settlement mitigation 'concepts' for all significant facilities along the proposed alignment.

4.3 Project Design-Build Contract

This document contains 26 sections plus appendices, and lays out the terms and conditions for the D-B teams. The situation of using 2 NTPs and the NEPA process not being completed until July 2011 is explained. Much of the language is standard for such contracts, noting that time is of the essence, limitations on funding, best value selection, etc. It is clearly stated that the D-B team is responsible for all design and construction services, and must mitigate delay to the Project and mitigate damages due to delay in all circumstances. The D-B team is not entitled to rely on Reference Documents, or other documents or information provided by WSDOT, and is to treat the Conceptual Design as preliminary (may contain errors). The D-B teams must obtain 3rd party approvals for any ATCs included in the Contract Documents.

Section 5 deals with allocation of certain risks. The D-B team has sole responsibility for construction means and methods, and must minimize the effect of its work on surrounding property and to the public. A lump sum amount and contract schedule for 1440 hours of Intervention Work on the TBM will be included in the contract. If the Shared Contingency is fully consumed, WSDOT will pay for costs of Extraordinary Intervention Work. Change orders for Differing Site Conditions are permitted, but the D-B team must first determine if any insurance proceeds may be available to cover any of its costs. Payment by WSDOT will only be made after the insurance company denies a claim. This clause will be very difficult to administer in a timely fashion during the active construction process.

Deformation mitigation by the D-B team needs to conform to the tolerances specified for each structure. Additional Deformation Work is controlled by the contract terms, and can be paid for from the Shared Contingency Fund. Effective control of this process, driven by field monitoring data and observations, will be complicated, and timely project management decisions will be required by the Monitoring Task Force to ensure that potential damage is limited. The Shared Contingency has been established at $40,000,000. WSDOT and the D-B team will share equally in any amount remaining in the Shared Contingency following Physical Completion of the Work.

Liquidated Damages can be triggered for the D-B team by a number of conditions described in the Contract (varying between $50,000 and $100,000 per day). The main triggers concern completion of work, and lane closures at times and in locations not consistent with the Contract Documents.

WSDOT expects a collaborative partnering work relationship among WSDOT, the D-B team and its subcontractors, and the City's representatives. This is described in Section 23, and directs that a 3rd party facilitator conduct workshops, etc. consistent with collaborative principles. In addition a Disputes Review Board will be established in a conventional manner to assist with resolving same. Appendix 4 describes the property acquisition that will be undertaken by WSDOT, with schedule dates noted for the numerous properties. Timely execution of this process will be critical to maintaining the Project schedule.

4.4 Project Risk Register and Risk Management Plan

A Risk Register (RR) is a document created to itemize, in a formal way, as many possible adverse activities and events that could occur during the final design and construction of this project. These events and activities are then analyzed for numerous details to help make judgments regarding their probability of occurrence, what might 'trigger' their occurrence, impacts on costs and schedule, etc. Outside experts were used, along with WSDOT and consultant staff, to help make the process complete and unbiased. An additional Strategic Technical Advisory Team (STAT) was employed by WSDOT to further refine and improve the process. Effort was made to ensure that the risk model was consistent with industry risk assessment practice, and that the active Risk Register events were mapped appropriately with the activities in the project schedule. The risk register was reviewed and updated throughout the conceptual design process. All of this is conventional practice for complex infrastructure projects.

The RR notes such items as: a lack of qualified bidders, contract interface management, choice of an EPB or a Slurry TBM, delayed permits, and 3rd party concerns will need to be resolved in more detail, going forward. The end result of the Risk Register process is the creation of the Risk Management Plan (RMP), used by WSDOT to actively track these activities and events as the project moves forward. In its current form, the RMP runs to 15 pages of detailed information. It is important to keep in mind, these exercises were carried out on documents that are clearly stated as 'concept design' level, *i.e.*, less detailed than a Preliminary Design. The documents clearly state that the winning D-B Team is responsible for the final design and all construction, and that WSDOT has no 'control' over the D-B design. The documents further note items requiring more definition, *i.e.*, permits, archeology issues, interface management, etc.

The current plan is to have the winning D-B Team, review and further refine the RMP, and then collaboratively manage it with WSDOT and its consultants, going forward. The RR and the RMP are closely related to the Cost Estimate, which is discussed below in Section 4.6.

4.5 Project Schedule

The current project schedule represents a reasonable attempt to depict how the Final Design and Construction will unfold, going forward. As noted in other sections of this report, an effort was made by WSDOT and its numerous consultants to integrate the costs and schedule, especially by considering both these elements in the Risk Register, the Risk Management Plan, and other related evaluations. This is a good idea and follows conventional practice for complex projects. The level of detail seen to date is consistent with a 'concept' level design, which is what all the WSDOT documents refer to as the current level of design.

It is interesting to note that the draft RFP, which was the result of extensive efforts by WSDOT and its consultants, set the following key dates:

- NTP No. 1 to be given in early 2011
- Project Completion by December 2015

After comments by several of the pre-qualified D-B Teams, WSDOT extended the completion date to December 2016 as recently as May 2010, but with the opportunity to submit an earlier date in the proposals (and receive technical credit in the Best Value award process).

4.6 Project Draft Engineer's Cost Estimate (including CEVP Process)

The Cost Estimating Validation Process (CEVP) is a formal, risk-based estimating process. It was developed to provide a better means to create cost estimates for complex projects, and has been used for a number of years. It comprises two elements:

- a base estimate and schedule if the project goes as planned
- a risk register which lists risks and uncertainty

It uses independent subject matter experts to minimize bias, and results in a 'range' of result values. All experts bring some bias to the process that flows naturally from their respective unique backgrounds and experience. It also used Monte Carlo simulations in the process and claims to be statistically valid. The term 'statistically valid' is judged by some as a 'relative' term. There is no argument that the process helps create a potentially better understanding and feel for the project. The Bored Tunnel Alternative is an extremely complex, one-off, unique project in a specific physical setting. The CEVP

helps explain the 'probability' of what might happen as it unfolds. It is noted that CEVP is a continuous process, and will be applied going forward.

The Cost estimate reviewed was issued in January 2010. Exhibit 6 in this document lists the critical 26 project elements with significant risk, and notes specific risk elements. The first planning level estimate for the bored tunnel came out in January 2009, and was in a range of $1.4 billion to $2.2 billion, and included the tunnel and north and south portals and interior structures and systems. Strict State funding limits established during the 2009 Legislative Session, suggested a more intense focus on cost estimating and use of CEVP.

An extensive, nearly year-long process, involving workshops, expert input, Value Engineering, "Tiger Teams," computer runs of the risk model, and other elements produced a 'range' of costs in late 2009. The range was $1.54 billion at a 10% probability, to $2.25 billion at the 90% probability. WSDOT targeted the 60th percentile, *i.e.*, $1.96 billion for the tunnel.

Thus, the year-long 'refinement' process produced essentially the same value for the total project cost, $3.1 billion, and essentially the same cost for the tunnel, $1.96 billion. The key points to keep in mind are: WSDOT and their consultants have selected the 60th percentile as the target cost, *i.e.*, there is a 60% chance that the tunnel project will not exceed $1.96 billion; and this cost estimate is based upon a 'concept' design.

4.7 Draft Project MoA Between SDOT and the State, GCA 6486

This document deals with Property, Environmental Remediation, Design Review, Permitting, and Construction Coordination for the SR 99 Bored Tunnel Project. It notes the Bored Tunnel will replace portions of the AWV, and that the existing structure is near the end of its useful life and is subject to sudden and catastrophic failure in an earthquake. It references a long list of other documents and agreements, and lays out definitions and general responsibilities of the PARTIES. It notes that FHWA is involved in the process. The terms and conditions noted are relatively standard for documents of this type, and it covers most critical topic areas: *e.g.*, property acquisitions, environmental remediation, permits and ROW, assessing potential impacts of possible deformations (from tunneling and other construction), traffic control, 3rd party rights, liability, indemnification, and insurance. The mechanism proposed for dispute resolution is reasonable and conventional. Exhibit A further defines the PROJECT scope, Exhibit B lays out descriptions of design reviews, construction management, inspection, record drawing, and task order procedures, while Exhibit C shows a sample task order.

It is important to note that this document was created after careful review of the 'current' set of PROJECT DOCUMENTS' prepared by WSDOT and its large array of consultants. The Bored Tunnel has been under intense scrutiny by these entities for over two years, and pre-qualified D-B Teams are currently preparing their bids for the work (which are due on 10/28/10). Yet, the level of design at this point is termed, 'a concept.' This is less

than Preliminary Design. The D-B Teams are responsible for ALL design and construction. As the design advances, this MoA anticipates that the detailed scope and schedule will be identified and agreed to as the design progresses. The costs and schedule impacts of these anticipated impacts constitute uncertainty.

4.8 Draft Project MoA Between SPU and the State, UT 01474

This document is similar to the one discussed in Section 4.7, but more detailed because of the nature of the potential adverse effects to the large number of complex utilities that might exist within the project boundaries and potential 'movement' zones. Maximum total displacement criteria are given, pre-construction videos described, and reference is made to the Monitoring and Deformation Mitigation for the PROJECT.

All the comments in Section 4.7 apply here, but with the added emphasis of the criticality of many of these utilities to the safe operation of the CITY's other infrastructure.

4.9 Draft Project MoA Between SCL and the State, UT 01476

This document is also similar to the one discussed in Section 4.8, but is focused on the potential issues with Seattle City Light (SCL). The agreement will be managed by SCL, and as with the others, includes FHWA. All the key issues are duly noted, including Deformation Mitigation Work. It clearly states that the decommissioning of the Battery Street Tunnel and the AWV are not part of this agreement. The criticality of the facilities of SCL to the safe operation of Seattle's infrastructure cannot be overemphasized. Again, the fact that this document is based upon a 'concept' design holds concern for its updating and revision.

4.10 Geotechnical Baseline Report

The Geotechnical Baseline Report (GBR) is an important document for any infrastructure project, but particularly critical for a tunnel project. In general, the greatest uncertainty in these works arises from the subsurface conditions, *i.e.*, the geological setting. This document was completed in June 2010 by Parsons Brinckerhoff and Shannon & Wilson for WSDOT, but with significant input from 14 other consulting firms. Its form and content are typical for such documents, and it notes 6 primary goals, among which are: assisting WSDOT in administering differing site conditions clauses in the contract, and setting baselines for conditions 'expected to be encountered' by the successful D-B team. It recommends the D-B team implement additional investigations if they deems them necessary, and notes the many reference documents available are for information only and that the date, interpretation and assessments contained therein cannot be relied upon.

The regional setting is described as complex and glaciated, containing fault zones and subject to numerous earthquakes. The relevant ground conditions comprise highly

variable soils, to include non-cohesive flowing soils, fast raveling soils, sticky and clogging clay, and boulders up to 8 feet in diameter. Eight Engineering Soil Units (ESU) are defined and discussed. The soils in general have a pH greater than 7.0, contamination can occur, and high horizontal stresses remain in some ESUs from the glaciation process. In the South Portal area, there are logs, trees, and sawdust mixed in with the fill materials. At the deepest point, the tunnel will be below 215 feet of cover, and water pressures up to 4 bar will be encountered. The tunnel will be approximately 2 miles in length, with no access shafts between the portals. The concept design suggests that the bored tunnel diameter will be about 54 feet, making it the largest soft-ground bored tunnel in the world.

Concerns are raised regarding the need for ground improvement along the alignment to control potential deformation and damage to adjacent facilities, as well as for annulus stability behind the tunnel boring machine as it advances. It further notes that at no time during the 2 mile drive will the tunnel face be in a single soil type, and some of the soils contain highly abrasive material. At the portals, control of groundwater will be required, to include possible recharge, and to deal with contamination. Methane gas has been found in some soil units.

For most of the ESUs, both baseline values and 'ranges' of values were given. The number and size of expected boulders was baselined. It is noted that some of the 'ranges of baseline values were rather large, giving emphasis to the extreme variability of the materials through which the TBM must bore. Whether or not the six goals of the GBR have been fully achieved by its contents is a reasonable question. One could say it has:

- presented certain project geotechnical and construction considerations, etc.
- enhanced the D-B team's understanding of the key geotechnical features, etc.
- assisted the D-B team in evaluating the anticipated ground behavior, etc.
- guided WSDOT in administering the contract, etc.
- assisted in administering the DSC clauses
- set a 'baseline' for subsurface conditions expected to be encountered

NOTE: The 'baselines' and ranges of baselines strongly suggest a HIGHLY VARIABLE subsurface environment, and one that contains numerous factors generally thought to be adverse to conventional TBM tunneling methods.

The GBR does discuss 11 case histories of tunnel projects in the general vicinity of this project, and describes their general results. All of these projects are much smaller in diameter than the planned tunnel, with the exception of the Mt. Baker Ridge Tunnel (which was a unique multiple drift excavation) These case histories did NOT mention the two current tunnel projects underway by King County, where two TBMs ran into major problems in similar geology. Both are less than 25 feet in diameter, and in one case, the TBM has been stopped for 9 months and has resulted in a major lawsuit.

4.11 Seattle City Council Consultant Report

This report has not been issued yet, but a detailed presentation of the current results of their study was presented to the Seattle City Council on July 12, 2010. Fifteen detailed Power Point slides, and an accompanying explanation, constituted the presentation. This report comments only on the content of the PP slides.

The City Council's consultants focused their evaluation only on the tunneling risks. They acknowledge the inherent risks in complex projects, particularly underground construction, and that these risks can lead to cost overruns. They suggest that WSDOT is doing 'the right things' to address and manage the risks. No mention is made of the army of consultants assisting WSDOT. Tunneling challenges are noted, to include the 'largest' TBM, and settlement and TBM wear are listed as the 'major' risks.'

They mention the Flyvbjerg study on cost overruns, but not its detailed conclusions. The CEVP process is discussed, along with comments on Design-Build, the extensive geotechnical investigations, studies of structures along the right of way, and technical requirements for control, monitoring, and mitigation of risks. They note that 'diligence' is required in monitoring and enforcement, and list some of the things WSDOT is doing in this regard (task forces, disputes resolution, etc). They compare Sound Transit's and WSDOT's approaches to project risk, noting differences, but not drawing any definitive conclusions. WSDOT is endeavoring to use best industry practices in preparing this project for bid.

The consultant clearly states that the Geotechnical Baseline Report puts a 'lot' of risk on the D-B Team. At no point in the presentation is it noted that WSDOT, and its consultants, have created only a "concept' design to this point, and that the contract documents state that the D-B Team will be fully responsible for all final design and construction. It goes without saying that the project cost estimate and project schedule are based on this concept design.

5.0 DISCUSSION OF SITE VISITS

5.1 Initial Site Visit (June 30- July 1, 2010)

The author arrived in Seattle at 11:30AM on June 29, and departed at 11:30PM on July 1, 2010. During the 2 days, he spent most of the time with SDOT staff who facilitated an extensive site tour, and arranged an attended multiple meetings with Mayor McGinn and his key staff, as well as other key SDOT staff, all of whom have a long history with the general local situation, and the Alaskan Way Viaduct Project in particular. Numerous maps and drawings were reviewed, and select project documents examined. Some documents were given the consultant to take back for more detailed review, to compliment the hard copy documents already sent to the consultant's office. An external hard drive was also loaned, that contained many project documents that could be looked at if necessary during the review.

The SDOT and Mayor's staff also arranged for a 5 hour meeting with WSDOT key personnel, and some of the senior staff of their key consultants, *e.g.*, PB and Hatch Mott MacDonald. During this meeting, detailed presentations were made, with graphics and visual aids, to summarize most of the key actions of the last several years that have brought the project to its current state, *i.e.*, the Bored Tunnel Alternative. These discussions were open and candid, with questions and comments from most attendees.

In total, the site visit and meetings were helpful in giving context to a better understanding the current situation.

5.2 2nd Visit (July 15 – 17, 2010

This visit was primarily intended to review a Draft of this report, attend additional meetings with the Mayor's staff, meet with SDOT staff, and further discuss the background and history of the project. Additional site inspections were also done.

6.0 GENERAL DISCUSSION

This review of portions of select project documents has been interesting and instructive. WSDOT and its consultants (firms and individual experts) are comprised of honorable, intelligent men and women, who have done a good job of bringing the Bored Tunnel Alternative Design-Build Project (and all the accompanying project documents) to its current state. They have employed both conventional and best industry practices in carrying out the numerous evaluations and studies, and have solicited input from certain interested 3rd parties. Despite these efforts, some uncertainty and resulting risk remains. The key question is how much risk?

The author prefers to categorize risk into one of five 'levels' as shown in Table 1, *i.e.*, from Low Risk to High Risk. The documents reviewed are sufficient to reveal a number of areas where significant project uncertainty remains; *e.g.*, NEPA process not complete, ROW and property acquisition process not complete, only a 'concept' level of design achieved, etc. A depiction of four major risk elements that could impede successful design and completion of the work is shown in Table 2. What is important to note about these elements is that ALL of them are near, at, or beyond PRECEDENT for such a project. Taken collectively, a prudent reviewer would must conclude that the 'success' of this bored tunnel (on time and at budget) is questionable. It is noted, however, that the earthquake issue is more severe DURING construction. Completed tunnels perform reasonably well (structurally) during seismic events.

Working at, or beyond, precedent in engineering and construction is not often undertaken. When attempted, the safeguards; and risk definition, allocations, and mitigation schemes should also reach, or exceed, precedent. In a general sense, this does not appear to have happened yet in the process for the Bored Tunnel Alternative.

7.0 CONCLUSIONS

The replacement of the Alaskan Way Viaduct has been under serious study since 2001, while the Bored Tunnel Alternative has been included in the evaluations for the last 2+ years. The review and risk assessment described in this report was completed in three weeks. Of necessity, only certain documents, and portions of documents, were reviewed. Included in the review were two site visits, and meetings with SDOT, City of Seattle, WSDOT, and WSDOT consultants. The following conclusions are based upon the noted review, as well as the experience of the author on similar complex infrastructure projects throughout the world.

7.1 The collective evaluations and studies completed to date have resulted in a 'concept' level design (WSDOT's term), and all final design and construction activities remain the full responsibility of the winning D-B Team.

7.2 The suggestions in the contract documents for Risk Sharing between and among all project parties, but particularly between WSDOT and the winning D-B Team, does not appear defined in sufficient detail to promote efficient and cost-effective project management and control going forward.

7.3 The precedent-setting diameter of the proposed TBM, coupled with the adverse geologic setting, and relatively high expected water pressures, suggest that there may be significant changes and modifications going forward.

7.4 Additional incomplete project tasks, such as required NEPA approval, ROW and property acquisition actions, and permits yet to be obtained, suggest potential uncertainty going forward.

7.5 Since the basis of the current project budget and project schedule is a 'concept' design, it is prudent to consider the likelihood of additions to both going forward.

8.0 RECOMMENDATIONS

Bids from the pre-qualified D-B Teams are due on October 28, 2010. WSDOT is continuing confidential discussions with the teams during the bid process to assist in getting responsive bids, etc. It is noted, however, that two of the four pre-qualified D-B Teams are unlikely to submit bids. The Recommendations below follow logically from the author's review, and from the issues mentioned in the above Conclusions. They are offered in the spirit of good faith toward achieving a better bid process and resulting Design-Build contract.

8.1 The details of Risk Sharing in the Contract should be more clearly defined, to include what specific responsibility is held by WSDOT and by its many consultants (firms and individuals) who have brought the project documents to their current state.

NOTE: A Shared Contingency Fund of $40 million (about 2% of the current budget for the Bored Tunnel) appears low.

8.2 An attempt should be made to involve the selected TBM manufacturer in the Risk Sharing scheme in a meaningful way.

8.3 The proposed Monitoring Scheme (with the D-B Team having primary responsibility to produce timely real-time monitoring data) should be modified to place this critical responsibility with WSDOT and its consultants.

8.4 The contract documents should be modified to more clearly define exactly how cost overruns that exceed the Shared Contingency Fund will be dealt with; including who pays, the source(s) of funds, criteria for assigning payment responsibility, timing of payments, etc.

8.5 The WSDOT Project Management organization should be modified and better focused to reflect specific responsibilities for such critical tasks as: management of final design, management of construction, primary responsibility for generating the real-time deformation (and related) monitoring data (and carrying out the resulting required mitigation actions). This refinement needs to identify what specific responsibilities rest with the numerous WSDOT consultants (firms and individuals).

9.0 APPENDICES

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APPENDIX A

Contract Scope of Work

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Appendix A

EXHIBIT A

SCOPE OF WORK

On behalf of the City of Seattle, The Consultant will review portions of select project documents related to the:

SR 99
Bored Tunnel Alternative
Design-Build Project (WSDOT)

and provide a written report summarizing his professional opinion on the completeness and appropriateness of said documents for the purposes intended.

In general, the focus of the review will be to evaluate possible risks to the city as the project moves through final design and construction.

The Consultant shall review the following documents:

- Project RFP
- Project Design-Build Contract (instructions to bidders)
- Project Design-Build Contract
- Project Risk Register
- Project Schedule
- Project Draft Engineer's Cost Estimate
- Project Risk Management Plan
- Draft Project MoA between SDOT and the State, GCA 6486
- Draft Project MoA between SPU and the State, UT 01474
- Draft Project MoA between SCL and the State, UT 01476

In addition, the Consultant will review and provide written comment on a Seattle City Council commissioned report that reviews and provides analysis on WSDOT's approach to the contract and the risks and engineering challenges inherent to the deep bore tunnel.

The Consultant will make two (2) site visits to Seattle to observe the project setting, and meet with various City of Seattle officials. The second site visit may include a Seattle City Council presentation.

Deliverables

- Draft written report with executive summary
- Final written report with executive summary, presentation materials, and (potentially) verbal presentation

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Appendix A

APPENDIX B

Tables

TABLE 1 – Definition of Level of Risk

Numerical Value	Definition
5	High Risk
4	Above Average Risk
3	Average Risk
2	Below Average Risk
1	Low Risk

TABLE 2 – Key Risk Factors for Bored Tunnel Alternative
SR 99 – Design-Build Project

Key Risk Factor	Level of Risk
Excavated tunnel diameter: 53 – 55 feet World's largest Beyond precedent	(5) High
Geologic setting: Highly complex; sticky clays, flowing sands, abrasive materials, large boulders At precedent	(5) High
Water level: Up to 4 bar pressure Near precedent	(4) Above Average
Seismic Situation: Nisqually 2001, considered a High Risk Seismic Zone Near precedent *NOTE: This risk is high during construction.*	(5) High

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APPENDIX C

One-page release

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Appendix C

Risks Associated with the Proposed SR-99 Bored Tunnel

Prepared by Thom L. Neff, PE, PhD
President, OckhamKonsult
for the Seattle Department of Transportation

PHOTO: WSDOT

Conclusions

The collective evaluations and studies completed to date have resulted in a "concept" level design. Concept is a WSDOT term for designs that have not advanced to a "preliminary" state of design.

Measures for the sharing of risk between the concerned parties do not appear defined in sufficient detail to promote efficient and cost-effective project management and control.

The precedent-setting diameter of the proposed tunnel boring machine, coupled with an adverse geologic setting and relatively high expected water pressures, suggest that there may be significant changes and modifications going forward.

The unfinished state of several key project tasks, such as NEPA approval, right of way and property acquisition, as well as permitting, suggest potential uncertainty.

Since the basis of the current project budget and project schedule is a 'concept' design, there is a significant possibility of future additions to both.

Risk Element	Level of Risk
Excavated tunnel diameter:53 – 55 feet World's largest Beyond precedent	**5** High
Geologic setting: Highly complex; sticky clays, flowing sands, abrasive materials, large boulders At precedent	**5** High
Water level: Up to 4 bar pressure Near precedent	**4** Above Average

TABLE 1: Risk Elements

Risk Elements

A depiction of three major risk elements that could impede successful design and completion of the work is shown in Table 1. What is important to note about these elements is that ALL of them are near, at, or beyond PRECEDENT for such a project. Taken collectively, a prudent reviewer would be hard pressed not to conclude that the "success" of this bored tunnel (on time and on budget) is questionable.

Working at, or beyond, precedent in engineering and construction is not often undertaken. When attempted, the safeguards: e.g., risk definition, allocations, and mitigation schemes should also reach or exceed precedent. In a general sense, this does not appear to have happened for the Bored Tunnel Alternative.

"...a prudent reviewer would be hard pressed not to conclude that the "success" of this bored tunnel (on time and on budget) is questionable."

Schedule

After consultation with several of the pre-qualified design-build teams WSDOT extended the project timeline to December 2016.

Geotechnical Conditions

The relevant ground conditions comprise highly variable soils, to include non-cohesive flowing soils, fast raveling soils, sticky and clogging clay, and boulders up to eight feet in diameter.

At no time during its two mile drive will the tunnel face be in a single soil type, and some of the soils contain highly abrasive material.

The Geotechnical Baseline Report discusses eleven case histories of tunnel projects in the general vicinity of this project. All of those projects are much smaller than the planned tunnel, with the exception of the Mt. Baker Ridge Tunnel, which was a unique multiple-drift operation. The Brightwater tunnel project was not included in this selection of relevant case histories.

Cost Estimation

The extensive, nearly year-long Cost Estimate Validation Process produced essentially the same values for tunnel and project costs as WSDOT's initial estimate of January 2009. The CEVP was undertaken after the adoption of strict funding limits by the legislature, and produced estimates within those limits.

WSDOT and its consultants have selected the 60th percentile of the range identified by the CEVP as the target cost. The CEVP was based upon a "concept" design.

Memoranda of Agreement

The agreements between the City and the State are based on the current "concept"-level project design. The design-build team is responsible for all design and construction. The MoAs anticipate that as design advances, these documents will be modified and updated to properly protect the parties' intended interests. Such updates and modifications will have to take into account the critical nature of much of the utility infrastructure located within the project area.