

Trend C0004 Attachment #3
Bored Tunnel Alternative - Alignment Study

Pending Completion
Due from Alec Williamson
12/24/09

Placeholder: Replace with Study

ESTABLISHMENT OF SOUTH END ROADWAY CONFIGURATION – BORED TUNNEL ALTERNATIVE Page 10 of 14

ATTACHMENT 4- SOUTH END KEY ASSUMPTIONS

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General South End Configuration Assumptions

- Alaskan Way connects south to East Marginal Way which utilizes the Little “h” roadway configuration.
- The Bored Tunnel “eyewall” is located just north of King Street to just south of King Street at a depth of approximately 27 feet to tunnel crown to clear the major utilities in King Street.
- The SR 99 mainline grade within the cut and cover area is set at 5%
- The NB on-ramp grade is approximately 7 to 8%
- The SR 99 cut-and-cover tunnel and boat section roadway width matches the bored tunnel roadway width of 30 feet curb-to-curb.
- The RR Avenue ramps are utilized for the Maintenance of Traffic during construction
- Viaduct and seawall ground improvements were planned to mitigate the expected bored tunnel settlement at 0.5% ground loss.
- First Ave alternative surface street configuration can be maintained.

Cost Assumptions

- Viaduct and Seawall settlement mitigation north of the eyewall can be accomplished through ground improvements, with an additional Base Cost of \$15 M.
- Bored tunnel crown ground improvement can be accomplished with jet grouting at an additional Base Cost of \$3 M.
- No future relocation of SCL T&D and Communications duct banks are required at a Base Cost savings of \$2 M.
- Mainline Stacked cut and cover length and avg depth = 450 ft L & 75 ft avg D
- Mainline Braided cut and cover length and avg depth = 400 ft L & 50 ft avg D
- Ramp cut and cover length and avg depth = 620 ft L & 40 ft avg D
- Length of retained cut for mainline and ramps = 1400 ft
- Surface street improvement cost estimate = \$10 M Base Cost
- Existing viaduct protection within cut and cover section? None considered.



Memorandum

December 16, 2009

TO: Design Documentation File

FROM: Alec Williamson, P.E.
206-382-6366

SUBJECT: Mainline Bored Tunnel Profile Criteria

Introduction and Background

This memo is being written to establish a set of criteria to assist in the development of a mainline bored tunnel profile for SR 99 through downtown Seattle between Royal Brougham Way and Mercer Street. In addition this memo will document some of the factors and decisions that will serve to assist the reader in understanding how and why the design profile was established.

Two fundamentally incompatible factors influence the location of the tunnel profile. The construction of soft ground tunnels is typically less expensive and creates less ground loss and disruption to development above when conducted as deep underground as possible. Conversely, tunnel traffic operations are negatively impacted by steep and long grades. All other things being equal, long term operations would favor a shallower profile while construction impacts, risk and cost favor a deeper profile.

This document is preliminary in nature and considers only one of the alternatives to replacing the Alaskan Way Viaduct, the bored tunnel. Further, this document assumes the adoption of the Alaskan Way to 1st Avenue to 6th Avenue alignment as the preferred bored tunnel alignment.

Design Criteria

Mainline profile criteria are included in the attached spreadsheet. Other design criteria are included in the project Design Parameters document which will be included in the Design Approval Package. What follows is a brief discussion of the major constraints and considerations that have driven the profile design development.

Tunnel Headwall

Each portal must have a minimum depth of cover to the tunnel boring machine crown of at least 25 feet. This is shallow given the large diameter tunnel being considered for this project. Considerable ground improvement will be needed to minimize damage at the ground surface. The tunnel is to be bored from the south starting at the south edge of the Alaskan Way and King Street intersection.

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Alaskan Way Viaduct Piles

The bored tunnel alignment runs parallel and adjacent to the viaduct between King Street and Washington Street, then continues northward under the viaduct at Yesler Street. A minimum 10 feet of clearance must be maintained between the edge of the tunnel boring machine and the tips of any piles that are in the path of the tunnel. This clearance provides a margin of error in the event that the pile locations are not precisely known prior to construction. If the TBM were to strike a pile while excavating the tunnel, major damage would occur both to the TBM and to the viaduct, which is an unacceptable outcome. Some viaduct settlement is expected and mitigation will be required.

Columbia Street Vicinity Geology

Based upon preliminary sampling, it appears that softer soil layers may exist to a very deep elevation at the Columbia Street area. It is important for the tunnel to be below this soil layer if possible, so a constraint has been established to keep the top of the TBM at least 90 feet below the ground surface at this location to minimize risk.

Elliott Bay Interceptor (EBI) Large Diameter Sewage Pipe

The TBM will be crossing under the EBI as it crosses under 2nd Avenue and begins to rise toward the north portal. The EBI is very large and may be constructed of unreinforced concrete, and therefore is sensitive to settlement. The EBI also would be very difficult to mitigate if it were to settle or leak. A clearance of 30 feet from the outside of the TBM to the outside of the EBI was established as a minimum since at that clearance significant damage due to settlement was deemed unlikely.

Desirable Mainline Grade and Minimizing Length of Grade

WSDOT Design Manual standards allow up to a 7% grade, however length of grade combined with steep grades is the biggest issue in the case of this tunnel profile. The tunnel is well over 9000 feet long and from each portal to the low point is several thousand feet. These lengths of grade would require a truck climbing lane in both directions, however that is not possible due to the extraordinary costs of tunneling. A design deviation is in process for length of grade. To mitigate the truck speed reduction caused by length of grade, the profile is being designed with longer sections of flatter grades where possible, rather than shorter steeper grades. It would be desirable to have loaded truck speeds reduced by no more than 10 mph in the southbound direction because of a proposed southbound left off-ramp near the south portal.

Portal Locations

The south and north "eyewall" locations have been established at King Street and Thomas Street, respectively. The limits of cut and cover are established at Harrison in the north portal area. In the south portal area, the cut and cover limit will be located at either Dearborn Street or Charles Street, depending upon the surface street configuration

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ultimately selected. For the purposes of preliminary analysis the design team will be using Charles Street.

AW:aw
Attachment: profile criteria spreadsheet

cc:

Trend C0004 Attachment #5 Continued

Bored Tunnel Profile Criteria	
12/18/2009	
Criteria Element	Value
Design Speed South of Thomas St	50 MPH
TBM Outside of Shield Diameter	56 FT
Tunnel Inside Diameter	49 FT
Minimum Clearance from Ground Surface to TBM crown (South Portal)	25 Ft
Minimum Clearance from TBM Shield to Any Viaduct Pile Tips	10 Ft
Minimum Clearance from Top of TBM Shield to Ground Surface at Marion St. Vicinity	110 ft
Minimum Clearance from TBM Shield to Elliott Bay Interceptor Pipe	30 Ft
Minimum Clearance from Ground Surface to TBM crown (North Portal)	25 Ft
Minimum Elevation of Tunnel Crown Outside of Liner	Elevation 95
Maximum BT Desirable Mainline Grade	5%
Maximum Desirable Truck Speed Reduction on Upgrade	15 MPH
End of Mainline Cut and Cover Section - South (2 Intersection Option)	Charles St.
End of Mainline Cut and Cover Section - South (1 Intersection Option)	Dearborn St.
End of Mainline Cut and Cover Section - North	Harrison St.