



Ballard Link Extension

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Date: March 1, 2024

Re: 4th Avenue Shallow Alignment Schedule Analysis Response - Summary

BACKGROUND:

Value Management Strategies, Inc. (VMS), an independent expert panel, conducted a workshop to support the Board Motion M2023-18 and prepared the 4th Ave Shallow Alignment - Schedule Analysis Study Report dated November 17, 2023. The objective of the workshop was to perform a schedule analysis for the 4th Avenue Shallow alignment, as well as the North and South of CID alignment, focusing on the following items:

- Item 1. Review and validate current schedule assumptions for the 4th Avenue Shallow alignment.
- Item 2. Review and validate the overall constructability and activity durations of the North and South of CID Alignment schedule.
- Item 3. Identify ways to minimize/eliminate construction effects to CID and to substantially reduce the duration of construction.

PURPOSE:

The purpose of this memo is to provide a response to the VMS Report that reviewed CID construction schedules for the 4th Shallow alternative as well as the North and South of CID alternative. The VMS Report identified three options for the 4th Shallow alternative to accelerate the project schedule and/or reduce community effects. The VMS Report also identified two options for the north of CID station alternative; however, these options did not provide any schedule savings and therefore, not discussed in this memo.



SUMMARY OF FINDINGS AND RESPONSES

The VMS team's assessment found that the estimated construction schedule for the CID 4th Avenue Shallow alignment (duration up to 12 years) was reasonable, adding that working adjacent to BNSF is a risk that could potentially increase the construction duration.

The VMS team also found that the estimated construction schedule for the North and South of CID alignment (duration 6-7 years) was also reasonable.

The VMS identified three options that could potentially reduce the construction durations for the 4th Avenue Shallow alignment; however, multiple challenges were identified that could likely increase risk and the construction duration. As noted below, only one of the three options was later assessed by the project team to be potentially viable (see Option 2 below).

Option 1: Create multiple construction access and combine multiple stages

A potential reduction in the construction duration from 12 years to 9.5 years was identified on the assumption that quicker construction access could be provided by constructing additional temporary access ramps from Seattle Blvd S. (savings of 1 year) and 4th Avenue S./S. Main Street (savings of 3 years) into the construction area (see Figure 1).

Subsequent assessment by the project team determined that these additional access points were either not practical or did not provide schedule savings for the reasons noted below:

- Access ramp from Seattle Blvd: An access ramp from Seattle Blvd is not practical because there is not sufficient length to ramp down without affecting existing light rail operations and the Union Station Garage access.
- Access ramp from 4th Ave S./S. Main Street: An access ramp would require a considerable amount of time to construct due to work adjacent to BNSF tracks, minimal available space for construction, potential conflict with S. Jackson Street Bridge, and the presence of the counterfort retaining wall that currently supports the 4th Avenue S. roadway. This would likely negate much of the schedule savings identified by the VMS team.
- Being in a constrained environment, both access points would also require time to reconstruct back to existing conditions, further reducing potential schedule savings.

In addition, VMS Report also cited two additional access points; these were not evaluated further because they do not offer schedule savings as stated in the VMS Report.



Ballard Link Extension

Figure 1: Create multiple construction access



The VMS team also suggested combining multiple stages by constructing one side at a time from the I-90 off-ramp to S. Main Street. Subsequent assessment by the project team determined that combining multiple stages, and thus construction along the entire length from the I-90 off ramp to S. Main Street, would take longer as it would require construction of the support of excavation (SOE) and dewatering of the entire length before starting the critical path work at the station location south of S. Jackson Street. In addition, the site has limited staging area and there would also be a limited capacity of crew and equipment to facilitate all the work in one stage.

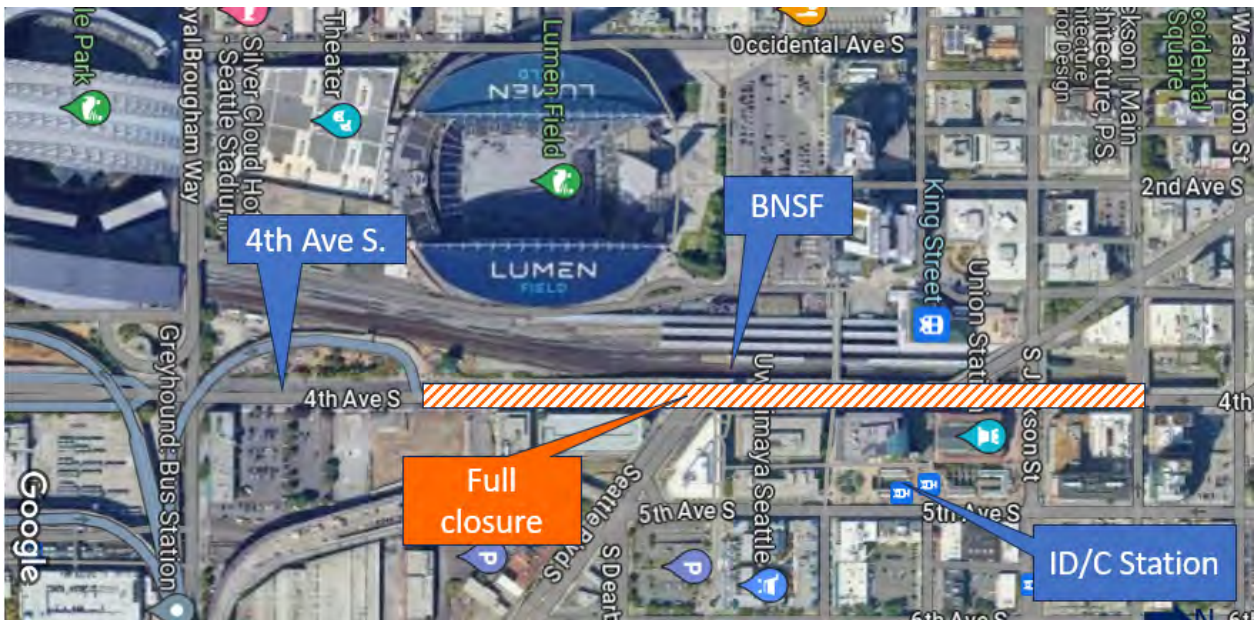


Ballard Link Extension

Option 2: Fully close 4th Avenue South and reconstruct the viaduct in one stage

The VMS team identified a potential to reduce the overall construction duration to approximately 8.5 years by fully closing 4th Avenue S. from the I-90 off-ramp to S. Main Street. It was noted that this would potentially result in severe traffic effects both regionally as well as locally in the CID and Pioneer Square neighborhoods which would need to be mitigated.

Figure 2: Fully close 4th Avenue South and reconstruct the viaduct in one stage





Ballard Link Extension

Option 3: Construct a pipe box tunnel under the 4th Avenue viaduct

The VMS team identified a potential to reduce the overall construction duration to approximately 7.5 to 8 years by constructing a pipe box tunnel under the existing 4th Avenue viaduct (see Figure 3). This option was found to be problematic for a number of reasons:

- To avoid substantially impacting the 4th Avenue S viaduct and to be able to construct the station box in competent soils, it would result in a station depth of 160 to 175 feet, resulting in elevator-only access to the station.
- The concept has high risks related to lack of precedence of the construction method and likelihood of encountering existing piles. The proposed interlocking (i.e., clutched) pipe box solution indicates lengths of approximately 490 feet to 590 feet; within North America the longest known pipe arch was performed above the groundwater table and at a length of up to 450 feet; this system did not use an interlocking pipe system. To date the longest clutched pipe box system (Singapore) was approximately 330 feet.
- As depicted in the VMS Report, the number of individual pipes that would need to be installed to create the completed box structure is very high (>90) thus taking a long time to construct and substantially affecting the construction schedule. At such long lengths and high number of pipes to install, there is also a risk that during installation the pipe interlocks become bound and the pipe unable to advance, or the interlocks separate, creating a weakness in the structural system.
- The risk potential for this solution is considered very high. If gaps in the system are encountered during the station excavation, ground and groundwater could enter the excavation, causing significant risk to the overall operation. Interlocked pipe gaps will not work reliably to arrest groundwater inflow and ground loss, which is a high risk to safety and may damage the existing piles and the viaduct structure. The application of ground treatment as mitigation against ground and groundwater intrusion into the excavated pipe box structure will be limited by access constraints, station depth, and obstructions from multiple closely spaced piles. The ability to do effective ground treatment at this depth is challenging and is exacerbated by the surface and subsurface obstructions.
- To accommodate the vertical shafts needed to construct the pipe box, as well as the station programming elements such as elevators, ventilation, and emergency egress, it would likely result in the need to rebuild the viaduct, resulting in schedule duration increase of approximately 3-4 years, thus diminishing any savings.



Ballard Link Extension

Figure 3: Construct a pipe box tunnel under the 4th Avenue viaduct
4th Ave S. Typical Section

