

Alaskan Way Viaduct & Seawall Replacement Project

SR 99

Construction Corridor Analysis

INTRODUCTION AND PURPOSE

The purpose of this analysis in this report is to set a construction design speed for the portion of SR 99 that lies within the program limits during construction activities for the Alaskan Way Viaduct & Seawall Replacement Program. The mile posts that correspond to this analysis on SR 99 are MP 29.26 to MP 33.08. Refer to Figure 1 for a display of the limits of this report. This report will also document design elements for the South End Temporary Bridge Structure that don't meet 50 mph UMA-1 standards and require lower speeds while the program is in construction near. The construction required to build the single bored tunnel and the applicable moving forward projects are the basis of analysis for this report.

Refer to the SR 99 Corridor Analysis (2004) and corresponding addendums for any additional background information

EXISTING ALASKAN WAY VIADUCT

Through most of the set program area, SR 99 has three through lanes in each direction. The existing lane widths range from 9.5 ft to 12 ft. Shoulder widths range from 0 to 3 feet. When compared to current standards, many aspects such as stopping sight distance, horizontal curve radius, and vertical curve lengths are designed to 40 mph or less. Refer to the Existing Alaskan Way Viaduct section in the SR 99 Corridor Analysis (2004) for information regarding the Existing Alaskan Way Viaduct Roadway, Existing Traffic and Operations, Safety, and Other Roadway Classifications. The below table summarizes corridor analysis decisions.

The existing SR 99 is classified as UMA -1. Refer to the SR 99 Corridor Analysis Addendums A, B, and C for the functional classifications for SR 99 within the set project limits.

CORRIDOR OPERATION AND CONNECTIVITY

Refer to Corridor Operation and Connectivity section in the SR 99 Corridor Analysis (2004) and SR 99 Corridor Analysis Addendums A, B, C for information regarding the North, Center, and South Project Areas.

PROGRAM DESCRIPTION

The goal of this program is to replace the Viaduct and increase safety while accommodating forecasted design year traffic volumes. Improvements stated in the Draft Environmental Impact Study (DEIS) include improvements to north/south mobility as well as improvements in connectivity to other state and major local routes that are necessary to meet the project goals. All of this is accomplished while prudently limiting environmental and socioeconomic impacts to the local area.

In January 2009, a decision had been agreed upon by the Governor, King County, and City of Seattle to recommend replacing the Viaduct with a single bored tunnel. The tunnel will be a 54 foot diameter bore that includes stacked lanes within the bore. The stacked roadways will consist of two northbound lanes and shoulders above two southbound lanes and shoulders. The south portal to the tunnel will start at Royal Brougham Way S and travel north, generally under 1st Ave, until reaching Mercer Street where the north portal will emerge and connect to the existing SR 99 route near the northern project limits of Ward Street. At the north and south portals of the new tunnel alignment there will be fully directional interchanges that will be designed to current WSDOT standards and will increase access to the Central Business District. New surface streets and urban design elements will be constructed by the City of Seattle on the waterfront after the existing Viaduct and detours are removed.

Other projects within the program consist of the Column Safety Repairs (already completed), Early Electrical Line Relocation, Battery Street Tunnel (shelved project), ITS projects, and S. Holgate Street to S King Street Viaduct Replacement. The S. Holgate Street to S King Street Viaduct Replacement will replace about 40% of the southern portion of the Viaduct with a six lane bridge structure that crosses over S Atlantic Street and the SIG (Seattle International Gateway) tail track and will connect to the south portal of the tunnel.

Refer to Figure 1 for a layout of the projects that will be constructed in the Alaskan Way Viaduct and Seawall Replacement Program.

Maintenance of Traffic

Although construction of a tunnel has limited impacts to the existing tunnel, the south and north portal construction and the south end bridge construction will still effect the traffic operations of the corridor.

In order to (1.) construct the south end bridge structure, (2.) remove the Viaduct from S Holgate St to S King St, (3.) construct the south portal of the tunnel from S Royal Brougham Way to S King St, (4.) maintain construction and operation space for tunnel construction, (5.) maintain at least two lanes of traffic on SR 99 without large full closures, (6.) and maintain a south-off and north-on movement in near current the

Railroad Way South Ramps, a transition bridge structure will be constructed at Royal Brougham to connect to the Existing Viaduct near Dearborn Ave while heavy construction activities take place. The north portal footprint is still being developed and the maintenance of traffic strategies in this area will be developed. An alignment for the north portal will likely be near or on the existing SR 99 alignment in this area because ROW is highly limited. This will require a detour on the existing SR 99 route to maintain through traffic. Once the final roadway facilities are completed, the tunnel will be open to traffic on the final roadway alignment and the rest of the Viaduct and long duration detours will be removed.

Safety

The final roadways will eliminate the designated HAL's in the SR 99 Corridor Analysis (2004). This Construction Corridor Analysis will document design speeds and posted speeds through the corridor during construction. This is done to meet current design standards which maintain public safety.

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Figure 1 (Project Layout and MP limits)

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CONSTRUCTION DESIGN SPEED AS IT RELATES TO THE PROGRAM LIMITS

Existing Posted Speeds

South of the program mile post limits the current posted speed limit is 45 mph for 1.5 mile stretch of SR 99. SR 99 then increases speed to 50 mph at MP 29.23 and maintains this posted speed until it reaches the battery street tunnel which has a posted speed of 40 mph with a 35 mph advisory. The 40 mph posted speed is maintained to the northern project limits and further north. Although much of SR 99 within the program limits has some characteristics of a freeway, it has a functional classification best described as Principal Arterial – Expressway. The current SR 99 facility within the program limits is designated as Urban Managed Access 1. Refer to Figure 2 for a depiction of the current posted speed limits.

Refer to the SR 99 Corridor Analysis (2004) for additional information relating to current posted speeds and traffic operations

Design Speeds from SR 99 Corridor Analysis – Addendum C (2009)

The proposed design speeds for permanent roadways constructed in this program are the following table:

Table 1 SR 99 Design Speeds (Final)

SR 99	Recommended Design Speed	Anticipated Posted Speed
S. Spokane Street to S. Royal Brougham Way	55 mph	50 mph
S. Royal Brougham Way to Mercer Street	50 mph	45-50 mph
Mercer Street to Ward Street	45 mph	40 mph

The designation for SR 99 within the project limits will be changed from Urban Managed Access 1 to Limited Access – Principal Arterial 1. For additional information see SR 99 Corridor Analysis – Addendum C (2009).

Construction Design Speed

To maintain traffic on the existing corridor with minimal full closures, the transition bridge structure will be constructed which connects the permanent south end bridge to the side of the existing viaduct near S Dearborn Street. This structure will also have temporary south off ramp and north on ramp movements due to the closure of the Railroad Way Ramps for south portal and tunnel construction. The program cannot build this to current design standards and design speeds set in the SR 99 Corridor Analysis – Addendum C (2009) due to constraints and design considerations. To maintain safety,

the posted limits will be dropped while construction activities take place for the program and the south end temporary bridge is operational. The current speed limit at MP 29.23 will be kept at 50 mph. From S Lander Street to the northern project limits of Ward Street the speed limit will be dropped to 40 mph to safely drive on the transition bridge structure. It is unnecessary to bring the speed limit back up to 50 mph for a small length of roadway between the south-end temporary bridge and the battery street tunnel because it would confuse drivers and create an abrupt change in the traffic speed for the corridor while major construction activities for the program are taking place. The north portal area is currently has a 40 mph speed limit and it is expected that a detour can only be designed to 35 mph standards. This doesn't meet the 50 mph design speed set forth in the SR 99 Corridor Analysis – Addendum C (2009).

Refer to Figure 2 for a depiction of the proposed construction speed limits. The transition bridge structure is expected to be in use from summer 2011 to the end of 2015. The detour near the north portal is expected to be in use from the start of 2013 to the end of 2015.

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Figure 2 showing existing posted speed limits and proposed construction design speeds.

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CONSTRUCTION CORRIDOR DESIGN CONSIDERATIONS

Design Considerations listed in this section are not considered absolute constraints however they do include substantial impacts to the local area and public safety. As with any project, substantial impacts should only be permitted when they can be mitigated or offset by a corresponding benefit.

The existing SR 99 Viaduct has been in place for over 50 years and during that time, along much of its length, substantial development has occurred adjacent to the highway. With the recent recommended decision of the Single Bored Tunnel, the direct impacts to the central downtown area from construction activities have been greatly reduced. However, construction activities around the north and south portals for the tunnel along with construction of the south end bridge over S Atlantic Street can still impact the surrounding areas heavily without being properly mitigated. The southern project limits can be classified as industrial with major properties that include the following: the Port of Seattle, BNSF and Union Pacific Railroad tracks, United States Coast Guard, Seattle Ferry Terminal, Seattle Mariners and Seahawks Stadiums. The north portal area is more urban compared to the south end with numerous businesses and residences in the near vicinity. Limiting impacts of construction to the surrounding areas is of high importance to the program.

Two overall milestones have been set for the Alaskan Way Viaduct Program. These dates are 2011 (Removal of the Viaduct) and 2015 (substantial completion of the program). Though it would not be feasible to remove the existing Viaduct and complete the program by 2011, the program will still remove 40% of the existing Viaduct in the south end projects. These milestones create an aggressive delivery schedule for a program that won't start heavy construction until early 2010. Also, one reason the Single Bored Tunnel was chosen was to limit the impacts to the SR 99 as much as possible. Major closures and traffic impacts to SR 99 should be minimized. City street impacts from construction activities are also of concern. The balance of program scheduling constraints and maintenance of traffic is of great importance to the corridor.

Constructability of the tunnel, the tunnel portals, and the south end bridge structure requires large constructing staging areas and efficient operations in an urban/industrial environment. Limiting staging areas and efficiency increases the risk of longer durations for construction activities, unsafe conditions, and a larger construction budget. Also, the existing Viaduct itself is designed to outdated standards and poses safety problems (both operational and structural) and design/construction constraints as well. Construction activities near or on the Viaduct could create additional or enhanced safety problems if not mitigated properly.

Problematic areas where construction will affect the Viaducts operations are expected to occur are at the south and north portals. The following examples show some constraining corridor design considerations while in construction:

Removing the existing viaduct between S Holgate St to S King St and maintaining the WOSCA site for south portal construction and tunnel operations creates little space for detours in the area to connect to the future bridge over the S Atlantic St until the tunnel is open. Creating a safe detour with the limited space constrains vertical curves to a 40 mph on the south end detour structure.

The limitations on shoulder width, number of lanes, and horizontal stopping sight distance on the south end detour structure is limited by the existing viaduct columns. Without making major structure modifications, which would require some major closures on SR 99, only 40 mph standards can be met.

Although this area is still in early stages of design, limited ROW near the north portal area is very limited and a large constraint to the overall design. This only allows for an alignment on or near the current SR 99 roadway. A full detour will likely have to be implemented so that construction of the north portal can take place and it is expected that this can only be designed to a 35 mph design speed with a possible 25 mph design speed where the detour ties into the existing Battery Street Tunnel. Limiting factors to this detour's design speed stem from limitations to the super-elevation and horizontal curves.

Much of the roadway design criteria including roadway width is dependent, at least in part, of design speed. Selection of the design speed for an Expressway should include a process that balances traffic capacity needs, roadway cross-section needs, right of way requirements, environmental impacts, socioeconomic impacts, driver expectation, and public safety among other considerations.

SOUTH END TEMPORARY BRIDGE

This section documents design elements on the south end transition bridge structure that are deviated from Urban Managed Access 1 with a design speed of 50 mph. Figure 3 and Figure 4 are used to help reference these deviations.

1. Vertical Clearance - The current upper-deck side beam on the existing Viaduct limits that amount of vertical clearance for the south bound movement on the temporary bridge. Measurements from surveyed data and InRoads analysis give a vertical clearance of about 14' 4". However, the limiting vertical clearance on the existing viaduct occurs at the bent 120 where the cross beam bottom elevation

matches the bottom elevation of the upper deck side beam. Since the current vertical clearances of the cross beam at Bent 120 match the vertical clearance for the south end temporary bridge structure, the limiting vertical clearance within this area will not be changed. It would be unnecessary to construct a full standard vertical clearance of 15' 5" for the south end temporary bridge structure when the existing viaduct vertical clearance is only 14' 4" at bent 120 and 14' 6" for many other cross beams further north of this area. See Number 1 on Figure 3 and Figure 4 for reference.

2. **Shoulder Width (Right and Left)** - The proposed right and left shoulders for the south end temporary bridge structure is 2 feet. The current standard for a UMA -1 roadway is a 10 foot right shoulder and 4 foot left shoulder. ROW, construction staging area, and spacing of the existing viaduct columns limit the amount space for left and right shoulders. This matches or exceeds current conditions on the Viaduct. See Number 2 on Figure 4 for reference.
3. **Horizontal Stopping Sight Distance** - The horizontal stopping sight distance is limited on the south bound movement to 40 mph. This is limited by the spacing of the existing columns and the traveled way of the Viaduct. This is the limiting factor of design speed for the south bound movement. See Number 3 on Figure 3 for reference.
4. **Vertical Stopping Sight Distance** - Vertical Stopping Sight Distance is limited on the north bound lanes where the vertical crest curve connects to the existing lanes on the upper deck of the Viaduct. This only meets 40 mph ASHTO with a 2 ft object height. Limited space with a change of grade from 7 to 0 % creates this condition. See Number 4 on Figure 3 for reference.
5. Still researching this and I will have to look at the ramps as well. Will take a significant amount of time!

Figures 3 through 7 (11 x 17's) showing plans, profiles of alignment, and cross-section

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RECOMMENDATION

In summary, the goal of this construction corridor analysis was to specify a recommended design speed for the corridor within the project limits while the construction of the program takes place. This is done to look at design standards relating to interim facilities that will be built and operational within the time frame of major construction and demolished once the permanent facilities are completed. The permanent facilities will be designed to the SR 99 Corridor Analysis and corresponding addendums.

In order to prevent long duration closures, maintain safety, maintain traffic, and create efficient and constructible projects, the program cannot meet the permanent design speeds stated in the SR 99 Corridor Analysis and Addendums A, B, and C while the construction takes place. A lower design speed is requested for the south end temporary bridge structure and the north portal detour for reasons stated in previous sections and will ultimately affect traffic throughout the corridor limits. This recommendation accommodates the speed limits just outside of the project limits, construction speed limits near the south end temporary bridge structure, and construction speed limits for a possible detour near the north portal.

The WSDOT Design Manual Supplement title Design Speed, dated May, 2008, includes an updated Desirable Design Speed table. This table states that for non-freeways (which would include Expressways) the desirable design speeds for posted speed of 45 mph or less be not less than the posted speed.

The recommended design speeds for SR 99 in the project area are while construction of the program takes place is the following:

- 1.) Southern project limits (MP 29.23) to the S. Lander Street should use a 55 design speed.**
- 2.) S. Lander Street to the southern limits of the Battery Street Tunnel should use a design speed of 40 mph.**
- 3.) The southern limits of the Battery Street Tunnel to Mercer Street should use a design speed of 35 mph.**
- 4.) Mercer Street to northern project limits (MP 33.08) should use a design speed of 40 mph.**

CONCLUSION

The purpose of this construction corridor analysis is to set a design speed for the entire project during construction phases and to document the geometric criteria for the south end transition bridge. When the construction has been completed the design speed and geometric criteria will revert to the SR Corridor Analysis and Addendum C for permanent conditions.

The current design speed of 50 mph in the south project limits will be reduced to a design 40 mph near Lander Street and maintain this design speed through the transition structure up to the Battery Street Tunnel. Then a design speed of 35 mph will be implemented through the north portal detour to Mercer Street. Then the design speed will be brought up to 40 mph to match existing conditions of a 40 mph speed limit at the northern project limits. Once the permanent roadways are completed the design and posted speeds will uphold permanent requirements set forth in the SR 99 Corridor Analysis and SR 99 Corridor Analysis Addendums. The table below summarizes the design speeds and posted speed limits in operation while construction for the program takes place.

Table 2: Recommended Design Speeds During Construction

SR 99	Recommended Design Speed	Anticipated Posted Speed
From southern project limits to the S. Lander Street.	55	50
From S. Lander St to the southern portion of the Battery Street Tunnel	40	40
Southern Portion of the Battery Street Tunnel to Mercer Street	35	35
Mercer Street to northern project limits.	40	40

This analysis and recommended construction design speed balance public safety, impacts to public, constructability of large scale projects, the constraints set by the existing viaduct and SR 99 route, and maintenance of traffic. The south end temporary bridge structure between S Royal Brougham Way and S King St and a north portal detour cannot be designed to the 50 mph design speed set by the SR 99 Corridor Analysis and SR 99 Corridor Analysis Addendums.

Some constraints limiting a design of the south end temporary bridge structure and the north portal detour to current a UMA -1 50 mph design are the following: ROW and impacts to public/industries in or near the construction areas, scheduling of program for substantial completion and opening to public by 2015, area for construction of south and north end portals along with tunnel operations, limitations of complete closures of SR 99, and current conditions of the SR 99 route within the designated mile posts.

Using these recommended design speeds through any detours will give the driver time to properly slow down. It is unnecessary to bring the design speed back up to 50 mph in the central waterfront area because the Battery Street Tunnel is currently designed to a 40 mph design speed.

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