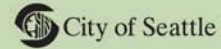
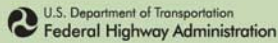


## Alaskan Way Viaduct & Seawall Replacement Program



# Draft SR 99 Bored Tunnel Alternative

## Design Deviation No. 2: SR 99 Left Off/On-Ramps

### MP 30.40 to MP 32.83

Submitted to:

**Washington State Department of Transportation**  
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April 2009



**The Alaskan Way Viaduct & Seawall Replacement Program**  
**Draft SR 99 Bored Tunnel Alternative Design Deviation No.**  
**2:**  
**SR 99 Left Off/On-Ramps**

**SR 99 MP 30.40 to MP 32.83**

**Agreement No. Y-9715**

**Task CE.04**

The Alaskan Way Viaduct & Seawall Replacement Program is a joint effort between the Federal Highway Administration (FHWA), the Washington State Department of Transportation (WSDOT), and the City of Seattle. To conduct this project, WSDOT contracted with:

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William P. Ott



**SR 99: Alaskan Way Viaduct & Seawall Replacement Program  
Draft SR 99 Bored Tunnel Alternative**

**Design Deviation No. 2: SR 99 Left Off/On-Ramps  
MP 30.40 to MP 32.83**

XL-3237 PIN-809936D

April 2009

**WASHINGTON STATE DEPARTMENT OF TRANSPORTATION**

Northwest Division  
Urban Corridors Office  
Seattle, Washington

**XXXXXX, P.E.**

Project Engineer

Deviation Recommended for Approval:

Date \_\_\_\_\_

By \_\_\_\_\_, P.E.  
Matt Preedy, Deputy Project Director

Deviation Approval:

Date \_\_\_\_\_

By \_\_\_\_\_, P.E.  
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Deviation Approval:

Date \_\_\_\_\_

By \_\_\_\_\_, P.E.  
Randy Everett., Federal Highway  
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**DRAFT - Internal Working Document - Not for Public Release.** This material is conceptual in nature and should be used for planning and discussion purposes only. It is subject to change and will be further developed and refined as part of the Project Process.

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# Draft SR 99 Bored Tunnel Alternative Design Deviation No. 2: SR 99 Left Off/On-Ramps

MP 30.40 to MP 32.83

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## 1.0 Project Overview

The Alaskan Way Viaduct and Seawall Replacement Program (AWVSRP) design team has been working since 2001 to develop alternatives for the replacement of the Alaskan Way Viaduct. The team prepared and published a Draft Environmental Impact Statement (Draft EIS) in March 2004 and a Supplemental Draft Environmental Impact Statement (Supplemental Draft EIS) in September 2006. The team also prepared and submitted a Design Approval Package (DAP) to the Washington State Department of Transportation (WSDOT) for the preferred tunnel alternative in February 2007; however, the approval of that package was deferred while the project partners (City of Seattle, WSDOT, King County, and the U.S. Federal Highway Administration (FHWA)) re-evaluated the preferred configuration of State Route (SR) 99 in Seattle's waterfront area.

On March 14, 2007, the Project Team was directed by WSDOT to advance portions of the program that would contribute to improving safety and mobility, and that have fundamental consensus among the project partners. The Governor and WSDOT then identified six "Moving Forward: Early Safety and Mobility Projects" that are currently being implemented while the preferred SR 99 configuration in the central waterfront area was re-evaluated. One of these projects is the South Holgate Street to South King Street Viaduct Replacement, which is currently under design and scheduled for construction in fall 2009.

In January 2009 a letter of agreement between WSDOT, King County, and the City of Seattle identified a four-lane, single-bore tunnel as the recommended alternative for replacing the Alaskan Way Viaduct. The Single-bore Tunnel Alternative (Tunnel Alternative) connects to the proposed South Holgate Street to South King Street Viaduct Replacement Project (South Project) at approximately S. Royal Brougham Way (M.P. 30.40) in the south with a cut-and-cover section that runs to First Avenue and S. King Street. From here a tunnel boring machine would be used to construct the tunnel, following First Avenue to approximately Stewart Street, then veering east to the area of John Street and SR 99. The alternative includes another cut-and-cover section that connects to SR 99 near Mercer Street (M.P. 32.83) in the north. Interchange ramps are provided at both the north and south sections. Additionally,

1 a street connection between Alaskan Way and Elliott and Western Avenues is  
2 included (see Figure 1).

3 The SR 99 roadway for the SR 99 Bored Tunnel Project is functionally classified as a  
4 Principal Arterial Highway by WSDOT; its geometric design classification is that of a  
5 Principal Arterial P-1 Urban, per current *WSDOT Design Manual* Figure 440-6 (see  
6 approved *SR 99 Corridor Analysis Addendum C*). The project corridor has a WSDOT  
7 freight tonnage designation of T-1 (more than 10 million tons per year), and the City  
8 of Seattle classifies the roadway as a Major Truck Street.

9 Design Matrix 3, lines 3-7 (WSDOT Design Manual Figure 325-5) **May be Matrix 3,**  
10 **lines 3-11** is most applicable to the project, which requires a Full design level. This  
11 document requests a deviation for ramps on left side of traffic.

12 The AWVSRP is partially funded through a combination of state funds from the  
13 2003 Nickel Funding Package and the 2005 Transportation Partnership Account  
14 Package. It has also received funding from FHWA and the City of Seattle.

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2 **2.0 Existing Conditions in Vicinity of SR99**

3 The existing SR 99 urban route within the project vicinity is located along the  
4 waterfront between S. King Street and Pine Street before turning northeast to the  
5 Battery Street Tunnel (BST) at First Avenue and Battery Street. It exits the BST at  
6 Denny Way and then turns north, crossing John, Thomas, Harrison, Republican, and  
7 Mercer Streets. The majority of the existing SR 99 runs along the waterfront and  
8 therefore parallels Alaska Way directly to the west. To the east, the viaduct closely  
9 shadows downtown buildings and Western Avenue with general parking directly  
10 underneath.

11 The existing SR 99 through the project vicinity is generally configured as a 40-foot-  
12 wide viaduct stacked structure. The number of existing lanes ranges from three to  
13 four in each direction, with lane widths varying from 9 to 12 feet and shoulder  
14 widths ranging from 0 to 3 feet. The SR 99 roadway width narrows to 25 feet with  
15 two lanes in each direction through the BST, and then widens to three to four lanes  
16 each approximately 10 feet wide north of the BST. WSDOT currently considers the  
17 BST a high accident location. The vertical alignment of the viaduct varies from 0  
18 percent to 4 percent slope up to the BST, and then SR 99 adjusts to approximately -2  
19 percent north of the BST to Mercer Street before transitioning to a positive slope  
20 northward. The rolling terrain between Union and Ward Streets has a posted speed  
21 of 40 miles per hour (mph), while the southern portion of the route from S. Royal  
22 Brougham Way to Union Street is level and posted as 50 mph.

23 Many aspects of the existing horizontal and vertical curves do not meet today's  
24 roadway design standards for the posted speed limit. When compared to current  
25 design standards for stopping sight distance, horizontal curve radius, and vertical  
26 curve length, about two-thirds of the horizontal and vertical curves would coincide  
27 with a design speed of less than 40 mph.

28 A number of on-and off-ramps are located along the corridor. A northbound on-  
29 ramp and southbound off-ramp are located at Railroad Way S.; a southbound on-  
30 ramp is located at Columbia Avenue; and a northbound off-ramp is located at  
31 Seneca Street. Northbound and southbound on- and off-ramps occur near the  
32 BST's south portal at Elliott and Western Avenues and Bell Street. A northbound  
33 on-ramp and southbound off-ramp is located at Denny Way, and a northbound off-  
34 ramp and southbound off-ramp are located at Broad Street. A number of "right on"  
35 and "right off" intersections are located north of the BST that function more like a  
36 city street layout than actual ramps. All ramps are on the right side of traffic, with  
37 the exception of the southbound on-ramp at Columbia Street and the southbound  
38 off-ramp at Railroad Way S.

1 The average daily traffic (ADT) peaks along the existing central waterfront mainline  
2 at 52,500 for the northbound direction and 50,500 for the southbound direction. In  
3 this area, the level-of-service (LOS) for northbound and southbound mainline traffic  
4 varies between LOS D and LOS E. Existing ADT truck traffic volumes are  
5 approximately 3 percent to 5 percent of total traffic. At the northern end of the  
6 project corridor, two existing High Accident Locations have been identified at  
7 northbound MP 31.9 to 32.1 and southbound MP 32.0 to 32.4 (see *SR 99 Corridor*  
8 *Analysis*, October 2004).

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Figure 1. Proposed Project Corridor (Project limits per 2004 Corridor Analysis)

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2 **3.0 Proposed Roadway Configuration**

3 The SR 99 Bored Tunnel Alternative would replace the existing viaduct and BST  
4 with a single bored tunnel east of the existing alignment. This project is comprised  
5 of a bored tunnel containing two stacked roadway decks with cut-and-cover sections  
6 at both the north and south ends. The tunnel would be constructed with an  
7 approximately 54-foot diameter tunnel boring machine (TBM). Southbound traffic  
8 would be on the top deck, and northbound traffic would be on the bottom deck.  
9 Enclosed roadways would meet or exceed current fire, life, and safety codes. The  
10 inside of the tunnel would be lined with an approximately 2-foot-thick concrete liner.  
11 The alignment would consist of a minimum of two northbound and two southbound  
12 lanes with shoulders varying on the left from 2 to 4 feet, and on the right from 3 to  
13 8 feet. Both the South and North Segments of the project would contain fully  
14 directional interchange movements connecting with the City's surface street grid.

---

15 **3.1 South Segment**

16 In the south, the alignment would match the S. Holgate Street to S. King Street  
17 Project structure, which is to be built to accommodate both a northbound off-ramp  
18 and a southbound on-ramp. SR 99 mainline includes two lanes northbound and two  
19 lanes southbound, with standard shoulder widths of 4' on the left and 10' on the  
20 right. An additional northbound on-ramp and southbound off-ramp would connect  
21 S. Royal Brougham Way to the mainline in the cut-and-cover section. Three of the  
22 four ramps would follow the typical "right off" design, as shown in the WSDOT  
23 Design Manual, with one ramp—the southbound-off—being a "left off" ramp. All  
24 ramps would end prior to the segment that would be constructed with the TBM.

25 Access to and from the north is via an interchange at South Royal Brougham Way  
26 and Alaskan Way Frontage Road. The northbound on-ramp enters a retained cut  
27 section north of RBW and merges with the two SR 99 northbound lanes from the  
28 right side. The southbound off-ramp diverges from the left side of SR 99 and enters  
29 a retain cut section as it approaches RWB from the north.

30 Access to and from the south is via an interchange at Alaskan Way north of RBW.  
31 The southbound on-ramp enters the two SR 99 southbound lanes from a retained fill  
32 section as an added 3<sup>rd</sup> southbound lane. The northbound off-ramp exits SR 99 as  
33 right side drop lane with two lanes remaining on mainline SR 99, and approaches  
34 Alaskan Way on a retained fill section.

35 Ramp design speeds, grades, and cross sections are within WSDOT Design Manual  
36 guidelines.

---

### 3.2 Central Segment

The bored tunnel's diameter of 54 feet was determined by setting two stacked roadway widths at 36 feet, with 16.5 feet of vertical clearance each, and building out structurally from there. Any additional clearance requirements would likely have a direct impact on the tunnel bore's outside diameter. The roadway cross-section is designed with a wall-to-wall width of 36 feet in both the northbound and southbound directions. Two 12-foot lanes take up 24 feet, leaving, 12 feet for shoulders and possible barriers. Assuming a width of 9 inches for each barrier, the remaining area allows for approximately 3 feet-3 inches for left shoulders and 7 feet-3 inches for right shoulders. Southbound traffic would be on the top roadway deck, and northbound traffic would be on the lower roadway deck.

As part of the fire and life safety requirements, emergency egress locations would be located at approximately 600-foot intervals. To provide sufficient space for safe egress, the current design would require the northbound shoulder to be reduced to 3 feet minimum. The egress structures would be approximately 100 feet long.

The horizontal and vertical design speed is 50mph, per *WSDOT Design Manual* guidelines.

There would be no on-or off-ramps in the Central Segment.

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### 3.3 North Segment

The stacked roadways of the bored tunnel section would begin to unbraided and unstack north of John Street, entering a cut-and-cover section between John and Harrison Streets, and a retained cut section north of Harrison Street. Northbound and southbound SR 99 would meet the existing vertical grade between Republican and Mercer Streets. SR 99 would follow and match the existing alignment from Mercer to Ward Streets. The existing SR 99 north of Mercer Street consists of three southbound lanes and three northbound lanes, with a fourth northbound auxiliary lane ending north of Aloha Street. The existing lane width varies from 10.5 feet to 11 feet, and there are no existing shoulders, only a gore stripe adjacent to a curb and a 6-foot sidewalk. The existing posted speed is 40 mph.

In the north, the alignment would connect to the existing SR 99 south of Mercer Street. This cut-and-cover section would provide on- and off-ramps for both the northbound and southbound directions. The northbound on-ramp and southbound off-ramp would be "left on" and "left off" to provide service to surface streets that are centered on the SR 99 alignment.

Access to and from north SR 99 is via ramps at Harrison Street. A northbound on-ramp joins to the two SR 99 mainline lanes as an additional third lane from the left



1 side at Republican Street. A southbound off-ramp exits from SR 99 as a left-side  
2 drop lane near Republican Street, leaving two southbound mainline lanes.

3 Access to and from the south is via ramps at Republican Street. A southbound on-  
4 ramp merges via an acceleration lane in to the two SR 99 mainline lanes from the  
5 right side of SR 99 in a retained cut section. A northbound off-ramp diverges from  
6 the two SR 99 mainline lanes in to a deceleration lane approaching Republican Street  
7 in a cut section.

8 SR 99 mainline horizontal and vertical design speed is 50 mph per *WSDOT Design*  
9 *Manual* guidelines. Ramp design speeds range from 10-45mph.

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## 2 4.0 Deviation Description – Left Off/On-Ramp

3 The proposed design matrix for the project indicates a “Full Design Level” for  
4 on/off connections. The *WSDOT Design Manual*, page 940-3, specifies “all freeways  
5 exits and entrances, except HOV direct access connections, are to connect on the  
6 right of through traffic. Deviations from this will be considered only for special  
7 conditions.”

8 This document proposes deviations for:

- 9 • a left side drop lane off-ramp for the southbound off-ramp to RBW in the  
10 South Segment (Ramp No. 1),
- 11 • a left side add lane on-ramp for the northbound on-ramp from Harrison  
12 Street in the North Segment (Ramp No. 2),
- 13 • a left side drop lane off-ramp for the southbound off-ramp to Harrison  
14 Street in the North Segment (Ramp No. 3),

15 Table 1 lists the standard design and proposed design for these ramps.

16 **Table 1: Left Off- and On-Ramps**

Ramp No.	Location Segment/Gore Station	Ramp Type	Standard Design	Proposed Design
No. 1 SB Off-Ramp	South Segment STA SB 188+50, RT	Taper	Design Manual, Figure 940-12a, May 2008	Left Off
No. 2 NB On-Ramp	North Segment STA NB 318+00, LT	Parallel	Design Manual, Figure 940-9b, May 2008	Left On
No. 3 SB Off-Ramp	North Segment STA SB 318+00, RT	Parallel	Design Manual, Figure 940-12b, May 2008	Left Off

17 The deviation is necessary in order to accommodate the proposed tunnel and City  
18 Street configuration and provide the required on and off connections.

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## 2 5.0 Alternatives Considered

3 The Project Team developed and assessed alternate alignments that would best meet  
4 WSDOT’s design standards, minimize impacts to properties, and allow for efficient  
5 traffic flow to the City’s street system. The alignment alternatives for the ramp  
6 configurations are summarized in the following sections.

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### 7 5.1 Alternative 1: Nonstandard Left On- and Off-Ramps

8 Alternative 1 would provide an alignment that best fits within the traffic scheme for  
9 the SR 99 corridor. The following constraints have been determined through  
10 preliminary design and discussion with the SR 99 Bored Tunnel Project Team:

- 11 • Adhere to 8 percent maximum ramp grade
- 12 • Minimize aerial structures north of S. Royal Brougham Way
- 13 • Provide access to the City grid east and west of SR99

#### 14 Ramp No. 1

15 The purpose of this ramp is to connect southbound traffic to S. Royal Brougham  
16 Way in the South Segment. A deviation of the on/off connection to a “left off”  
17 ramp would allow for a maximum grade of 5 percent and would avoid any additional  
18 aerial structures in the area north of S. Royal Brougham Way.

#### 19 Ramp No. 2

20 The purpose of this ramp is to connect northbound traffic from Harrison Street to  
21 SR 99 in the North Segment. A deviation of the on/off connection to a “left on”  
22 ramp would allow for access from city streets to SR 99 without interfering with the  
23 off-ramp from the tunnel onto Republican Street. The off-ramp to Republican  
24 Street provides a crucial connection to Mercer Street and the South Lake Union  
25 neighborhood.

#### 26 Ramp No. 3

27 The purpose of this ramp is to connect southbound traffic from SR 99 to Denny  
28 Way in the North Segment. A deviation of the on/off connection to a “left off”  
29 ramp would allow for access from SR 99 to city streets without interfering with the  
30 on-ramp from Republican Street to the tunnel. The on-ramp at Republican Street  
31 provides a crucial connection from Mercer Street and the north downtown Seattle  
32 neighborhoods to southbound SR 99.

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1    **5.2    Alternative 2: Full Design Standards Alternative**

2            Alternative 2 would apply a project design that would use full design standards. This  
3            alternative was eliminated from further consideration because it would result in grade  
4            and right-of-way impacts to adjacent properties and diminish the traffic efficiency of  
5            the project.

6            **Ramp No. 1**

7            Alternative 2 would require that the ramp climb at a grade of approximately 10  
8            percent and cross over the mainline in the area just north of S. Royal Brougham  
9            Way. This movement would interfere with the northbound off-ramp and would  
10           require grade separation for this ramp as well. This option would introduce an  
11           additional aerial structure north of S. Royal Brougham Way.

12           **Ramp No. 2**

13           Alternative 2 would construct an on-ramp on the right side of traffic and require the  
14           northbound off-ramp to be relocated to the north. Providing the proper weaving  
15           distance would shift this ramp about 2,000 feet, requiring traffic to back-track to  
16           access Mercer Street and downtown Seattle.

17           **Ramp No. 3**

18           Alternative 2 would construct an off-ramp on the right side of traffic and require the  
19           southbound on-ramp to be relocated to the north. Providing the proper weaving  
20           distance would shift this ramp about 2,000 feet, affecting the connection to Mercer  
21           Street and access for the north downtown Seattle neighborhoods.

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2 **6.0 Justification**

3 Alternative 1 (Preferred Alternative) proposes nonstandard design elements for the  
4 SR 99 Bored Tunnel Project as follows:

- 5
  - On/off connection – left off- and on-ramps

6 The justifications for this recommendation are as follows:

7 Ramp 1:

- 8 1. Maintains an acceptable up-grade of 5 percent
- 9 2. A relatively low percentage of trucks using the ramp is approximately  
10 X percent
- 11 3. Alleviates the need for additional aerial structures
- 12 4. All other design components (gore characteristics and deceleration length)  
13 meet standards

14 Ramp 2:

- 15 1 Ramp is an add lane and should be free flowing
- 16 2 Best fit with City's street grid
- 17 3 Does not interfere with northbound off-ramp at Republican Street.
- 18 4 Allows for an northbound off-ramp from the tunnel south of Mercer Street

19 Ramp 3:

- 20 1 Ramp is a drop lane and is less of an impact to adjacent through lanes
- 21 2 Best fit with Mercer Street connection and City's street grid
- 22 3 Does not interfere with southbound on-ramp to tunnel at Republican
- 23 4 Allows for a southbound access to the tunnel south of Mercer Street

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2 **7.0 Mitigation**

3 Provide additional signage where feasible.

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2 **8.0 Recommendation**

3 Alternative 1 proposes a ramp configuration that provides sufficient acceleration and  
4 deceleration lengths to fully accommodate vehicular traffic. This alternative also  
5 considers the urban environment and other users of the facilities, and balances traffic  
6 requirements to and from the tunnel with appropriate roadway geometry.

7 The Project Team recommends that the on/off connections of the mainline  
8 roadways be deviated from design standards per Alternative 1 for the SR 99 Bored  
9 Tunnel Project. The Project Team also recommends approval of these deviations  
10 based on the above justifications.

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