

Draft SR 99 Bored Tunnel Alternative Design Deviation No. 3: SR 99 Length of Grade MP 30.40 to MP 32.83

Submitted to:

Washington State Department of Transportation
Urban Corridors Office
401 Second Avenue S, Suite 560
Seattle, WA 98104

Submitted by:

Parsons Brinckerhoff

Prepared by:

Parsons Brinckerhoff
Jacobs Engineering Group Inc.

April 2009

The Alaskan Way Viaduct & Seawall Replacement Program
Draft SR 99 Bored Tunnel Alternative Design Deviation No.
3:
SR 99 Length of Grade

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:

Parsons Brinckerhoff

999 Third Avenue, Suite 2200
Seattle, WA 98104

In association with:

Arthur G. Bendelius
Berger/ABAM Engineers Inc.
Bolima Drafting & Design
David Evans and Associates, Inc.
Entech Northwest, Inc.
EnviroIssues, Inc.
HDR Engineering, Inc.
Hough, Beck and Baird, Inc.
Jacobs Engineering Group Inc.
Mimi Sheridan, AICP
Parametrix, Inc.
Power Engineers, Inc.
Roma Design Group
RoseWater GHD
Sequana Environmental
Shannon & Wilson, Inc.
So-Deep, Inc.
Telvent Farradyne, Inc.
Tetra Tech, Inc.
William P. Ott

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

**Design Deviation No. 3: Length of Grade
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.
Ed Barry, Assistant State Design Engineer for
UCO

Deviation Approval:

Date _____

By _____, P.E.
Randy Everett., Federal Highway
Administration



Table of Contents

1.0	PROJECT OVERVIEW.....	1
2.0	EXISTING CONDITIONS IN VICINITY OF SR 99	3
3.0	PROPOSED ROADWAY CONFIGURATION.....	7
3.1	South Segment.....	7
3.2	Central Segment	8
3.3	North Segment	8
4.0	DEVIATION DESCRIPTION – LENGTH OF GRADE	11
5.0	ALTERNATIVES CONSIDERED.....	13
5.1	Alternative 1: Nonstandard Length of Grade.....	13
5.2	Alternative 2: Full Design Standards.....	13
6.0	JUSTIFICATION	17
7.0	RECOMMENDATION.....	19

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.

List of Tables

Table 1: Length of Grade.....	11
-------------------------------	----

List of Figures

Figure 1. Proposed Project Corridor (Project limits per 2004 Corridor Analysis).....	5
Figure 2. Alternative 1 and 2 Vertical Profiles.....	15

Draft SR 99 Bored Tunnel Alternative Design Deviation No. 3: SR 99 Length of Grade

MP 30.40 to MP 32.83

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 reduced length of grade.

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.

DRAFT

1

2 **2.0 Existing Conditions in Vicinity of SR 99**

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

Draft

1



2

3

4

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

Draft

1

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 matches the S. Holgate Street to S. King Street Project
17 structure at S. Royal Brougham Way (RBW). SR 99 includes two lanes northbound
18 and two lanes southbound, with shoulder widths of 4 feet on the left and 8 feet on
19 the right (see Figure 2).

20 Access to and from the north would be via an interchange at RBW and the Alaskan
21 Way frontage road. The northbound on-ramp would enter a retained cut section
22 north of RBW and merge with the two SR 99 northbound lanes from the right side.
23 The southbound off-ramp would diverge from the left side of SR 99 (see Deviation
24 No. 2) and enter a retained cut section as it approaches RBW from the north.

25 Access to and from the south would be via an interchange at Alaskan Way north of
26 RBW. The southbound on-ramp would enter the two SR 99 southbound lanes from
27 a retained fill section as an added third southbound lane on the right. The
28 northbound off-ramp would exit SR 99 as right-side drop lane with two lanes
29 remaining on the SR 99 mainline, and would approach Alaskan Way on a retained fill
30 section.

31 The South Segment alignment would match the H2K Project structure. The SR 99
32 mainline would configure into the stacked alignment for the cut-and-cover phase
33 before entering the single bore tunnel at approximately S. King Street and First
34 Avenue S. The vertical alignment through the cut-and-cover phase would descend at
35 a sustained -5 percent grade for distance of 1,300 feet.

1 Ramp design speeds, grades, and cross-sections are within *WSDOT Design Manual*
2 guidelines.

3 **3.2 Central Segment**

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

14 As part of the fire and life safety requirements, emergency egress locations would be
15 located at approximately 600-foot intervals. To provide sufficient space for safe
16 egress, the current design would require the northbound shoulder to be reduced to
17 3 feet minimum. The egress structures would be approximately 100 feet long.

18 The Central Segment's vertical alignment would continue the South Segment's
19 -5 percent grade for an additional 1,700 feet before reaching the desired depth of
20 approximately 130 feet below the surface. From this depth, the tunnel would
21 transition to a positive 1 percent grade thereby allowing the tunnel to avoid key
22 existing underground obstructions, such as the Burlington Northern-Santa Fe
23 (BNSF) railroad tunnel and the Elliott Bay Interceptor (EBI). This 1 percent grade
24 extends for approximately 3,000 feet before it would transition to a climbing grade of
25 5 percent for approximately 4,000 feet to match the North Segment's cut-and-cover
26 section.

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

29 **3.3 North Segment**

30 The stacked roadways of the bored tunnel section would begin to unbraid and
31 unstack north of John Street, entering a cut-and-cover section between John and
32 Harrison Streets, and a retained cut section north of Harrison Street. Northbound
33 and southbound SR 99 would meet the existing vertical grade between Republican
34 and Mercer Streets. SR 99 would follow and match the existing alignment from
35 Mercer to Ward Streets. The existing SR 99 north of Mercer Street consists of three
36 southbound lanes and three northbound lanes, with a fourth northbound auxiliary
37 lane ending north of Aloha Street. The existing lane width varies from 10.5 feet to

1 11 feet, and there are no existing shoulders only a gore stripe adjacent to the curb
2 and a 6-foot sidewalk. The existing posted speed is 40 mph.

3 Access to and from north SR 99 is via ramps at Harrison Street. A northbound on-
4 ramp joins to the two SR 99 mainline lanes as an additional third lane from the left
5 side at Republican Street (see Deviation No. 2). A southbound off-ramp exits from
6 SR 99 as a left-side drop lane (see Deviation No. 2) near Republican Street, leaving
7 two southbound mainline lanes.

8 Access to and from the south is via ramps at Republican Street. A southbound on-
9 ramp merges via an acceleration lane in to the 2 SR 99 mainline lanes from the right
10 side of SR 99 in a retained cut section. A northbound off-ramp diverges from the 2
11 SR 99 mainline lanes in to a deceleration lane approaching Republican Street in a cut
12 section.

13 The North Segment would be connected to the Central Segment by a cut-and-cover
14 tunnel before the alignment joins the existing SR 99 south of Mercer Street. At the
15 cut-and-cover connection point to the Central Segment, the North Segment's grade
16 would flatten, which is not considered part of this design deviation.

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

19

Draft

1

2 **4.0 Deviation Description – Length of Grade**

3 The proposed design matrix for the project indicates a “Full Design Level” for
4 length of grade. *WSDOT Design Manual* Figure 630-1 recommends a maximum 900-
5 foot length of grade for a 5 percent sustained upgrade.

6 A deviation for length of grades is proposed along the alignment between
7 northbound Sta. 246+00 and Sta. 286+00, and southbound Sta. 186+00 and Sta.
8 216+00, as shown on Figures 2. Table 1 lists the design standard and proposed
9 length of grades for the northbound and southbound directions along the mainline.

10 **Table 1: Length of Grade**

Direction	Standard (<i>WSDOT Design Manual</i> Figure 630-1, May 2008)	Proposed	
	Maximum Length (for 5 percent grade)	Length	Location
Northbound	900 feet	4,000 feet	246+00 to 286+00
Southbound	900 feet	3,000 feet	186+00 to 216+00

11 The deviation is necessary to adhere to the proposed alignment for the bored tunnel.
12 This alignment was favored to achieve the preferred soil conditions, which are
13 located at increased depths, and maintain clearance from the BNSF Railway
14 Company tunnel and the Elliot Bay Interceptor combined sewer outfall, as well as
15 surrounding building foundations.

16

Draft

1

2 5.0 Alternatives Considered

3 The Project Team developed and assessed alternate alignments that would best meet
4 WSDOT design standards, minimize effects to adjacent underground structures, and
5 allow for more structurally suitable soil conditions to reduce potential settlement
6 caused by the TBM. The alignment alternatives for the mainline roadway are
7 summarized in the following sections.

8 5.1 Alternative 1: Nonstandard Length of Grade

9 Alternative 1 provides an alignment that would maintain maximum clearances from
10 existing underground structures and would avoid drilling through unsuitable loose
11 soils closer to the surface. The preferred tunnel profile is illustrated in Figure 2. This
12 preferred alternative includes a deviation for length of grade as described in
13 Section 4.0. The justifications for this deviation are provided below.

14 The following constraints have been determined through preliminary design and
15 discussion with the Project Team:

- 16 • Maintain a tunnel diameter clearance (54 feet) to adjacent underground
17 structures
- 18 • Avoid possible settlement and right-of-way issues by drilling too close to the
19 surface or near adjacent building foundations
- 20 • Maintain maximum 5 percent upgrade (actual classification maximum equals
21 7 percent)
- 22 • Due to the TBM drilling process, mitigate unknown inherent risks by
23 increasing depth from surface

24 A deviation in the length of grade would avoid a major reconfiguration of the
25 proposed tunnel alignment.

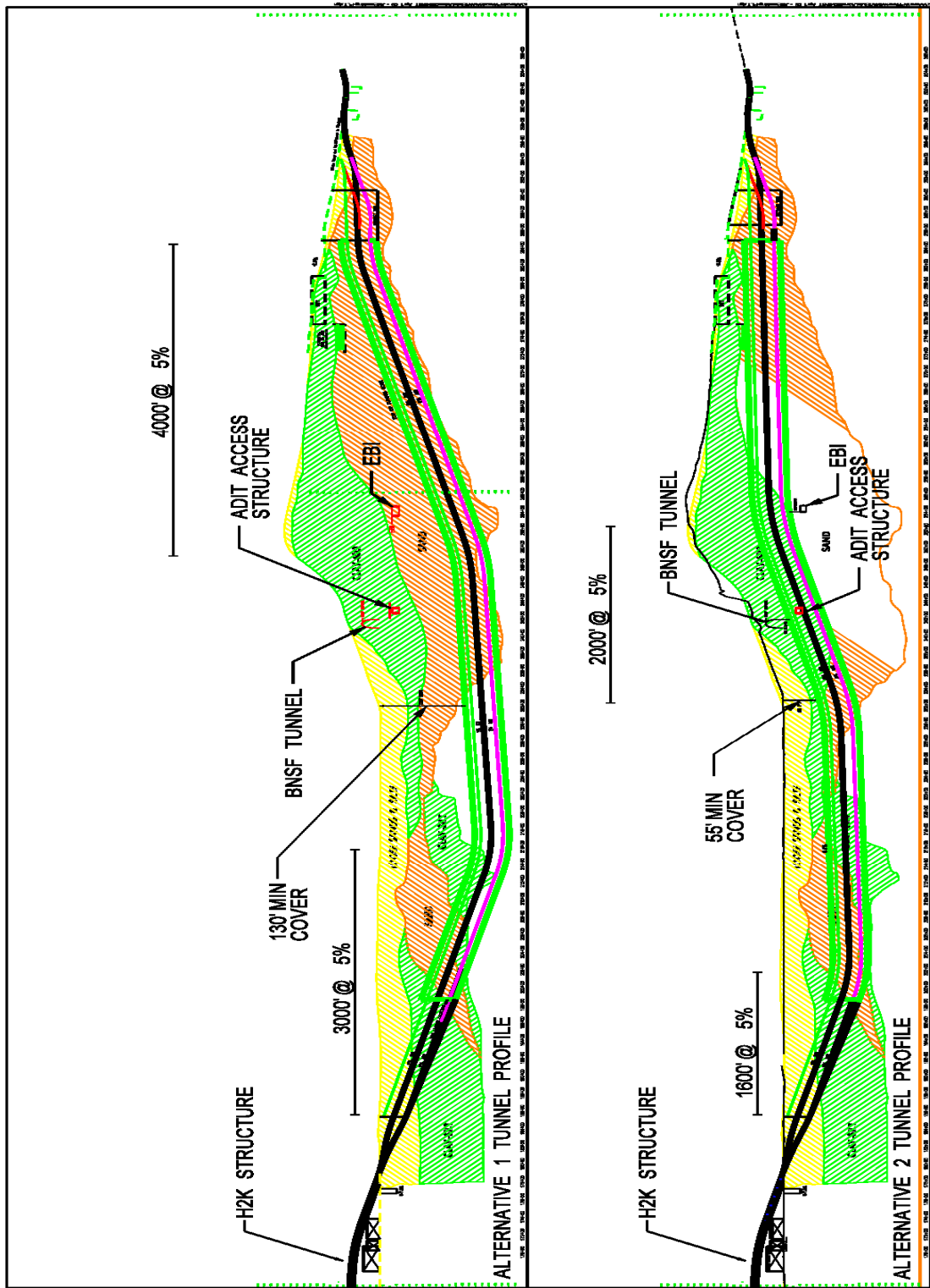
26 5.2 Alternative 2: Full Design Standards

27 Alternative 2 would apply a project design that used full design standards. This Full
28 Design Standards Alternative would shorten the length of grade to 900 feet. This
29 alternative was eliminated from further consideration because it would result in
30 increased right-of-way impacts, settlement and clearance issues to adjacent
31 properties, increased risk of damages, and increased cost. An alternative alignment
32 that reduces the upgrade even further could lengthen the overall tunnel, pushing out

1
2

the portal to the north into Mercer Street under the existing SR 99 profile, resulting in additional impacts and cost (See Figure 2).

Draft



1
2

Figure 2. Alternative 1 and 2 Vertical Profiles

Draft

1

2 **6.0 Justification**

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

- 5
- Northbound length of grade: 4,000 feet
 - Southbound length of grade: 3,000 feet
- 6

7 The justifications for this recommendation are as follows:

- 8
1. Application of full standard roadway design could result in significant
9 adverse impacts, including damages to or reinforcement for existing
10 underground structures, lengthening of the tunnel to the north thereby
11 impacting Mercer Street, drilling through unsuitable soils, and increasing the
12 risk of settlement.
 - 13 2. The proposed length of grades decreases settlement issues, avoids building
14 foundations and right-of-way, shortens the tunnel, and provides adequate
15 clearance to existing underground obstructions.
- 16

Draft

1

2 **7.0 Recommendation**

3 Alternative 1 proposes a roadway configuration that provides sufficient roadway
4 facilities to fully accommodate vehicular traffic. This alternative also considers the
5 conditions inherent to the drilling process for a 54-foot-diameter tunnel balanced
6 with appropriate roadway geometry. The proposed deviation would not adversely
7 affect the safety or functionality of the vehicular traveled way. Impacts to high-value
8 adjoining property would also be minimized.

9 This design requires that the length of grade deviate from design standards for the
10 SR 99 Bored Tunnel Project. The Project Team recommends approval of this
11 deviation based on the justifications discussed above.

12

Draft