Puget Sound Gateway Project

SR 509, I-5 and SR 167 Funding and Phasing Study: Strategic Corridor Design Review

Appendix E: Roadway Summary

Washington State Department of Transportation

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Contents

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1. PURPOSE

In October 2012, the Washington State Department of Transportation (WSDOT) initiated a strategic corridor design review for the Puget Sound Gateway (Gateway) Project. The Gateway Project integrates three corridor projects that had previously been studied independently: the SR 167 Completion Project, I-5 Express Toll Lanes (ETL), and the I-5/SR 509 Corridor Completion and Freight Improvement Project. WSDOT initiated the study to identify integrated, sustainable approaches to completing the critical SR 167 and SR 509 connections to I-5 while relieving congestion and improving mobility between Tacoma and Seattle. Specifically, the Puget Sound Gateway Project study:

- Developed a proposal that would integrate the SR 167 and SR 509 completion projects with I-5 express toll lanes for improved traffic performance and viable funding options
- Utilized national and local experts to develop phasing concepts, cost estimates, project delivery and financing strategies
- Built stakeholder support by identifying a phased approach that addresses regional and local priorities and needs
- Developed an implementation plan to assist in advancing the Gateway Project

The study focused on developing compatible alternatives that incorporate the previous design work with new project phasing and design concepts. The objective of the study was to develop possible construction and phasing concepts that maximize mobility and connectivity, help manage demands on the system, and provide alternatives that are attainable within a range of funding investment levels.

The Roadway Summary focuses on the effort to reassess the design criteria, roadway alignments, roadway sections, earthwork, and retaining walls to identify opportunities to lower project cumulative costs through design optimization and reducing initial right of way needs. This effort included reassessing the assumptions related to forward compatibility and looking at options that assume less than the full corridor right of way needs to be acquired and preserved in advance for the full build preferred alternatives.

Similar study efforts were completed to identify opportunities to reduce new bridge structure and existing bridge widening costs and propose lower cost structure types. The stormwater design was reviewed to reassess forward compatibility assumptions for permanent stormwater facilities, including opportunities to reduce impervious surface footprints and earthwork. These other elements are summarized in separate Final Report appendices.

In parallel with the civil engineering effort, traffic demand modeling was completed to assess the operational benefits and trade-offs of tolling scenarios for packaged SR 167/I-5/SR 509 improvements. The modeling effort level of detail and modeling tools utilized is commensurate with the schedule constraints, improvement options considered, and questions it intends to answer, particularly related to I-5 operation strategies.

2. BACKGROUND

The Gateway Project will complete SR 167 and SR 509, providing new regional connections to I-5 and completing critical freight routes. The Gateway Project is structured around an investment in I-5 express toll lanes between Tacoma and Seattle, which would improve mobility and could contribute revenue toward completing SR 167 and SR 509 and funding I-5 maintenance and preservation. Each of the corridors has a long history of development and study.

2.1 SR 167 Completion

The SR 167 Completion Project is based on more than two decades of project planning and development. The current SR 167 freeway corridor from Renton to Puyallup was completed in the late 1980s. Since that time, additional engineering, right of way acquisition, and construction were completed in an effort to complete the corridor connections between Puyallup and I-5.

The SR 167 corridor alignment from SR 161 across I-5 to SR 509 at the Port of Tacoma was selected in a Tier I Environmental Impact Statement (EIS) completed in 1999. Based on the Tier I EIS, an Access Point Decision Report (APDR) was developed and issued in 2005. Following the Tier I EIS and APDR, the preferred, six-lane roadway section and alignment were developed and set in the Tier II EIS and Record of Decision (ROD) completed in 2007. The Tier II preferred roadway section included two general-purpose (GP) lanes and one high occupancy vehicle (HOV) lane northbound and southbound, for a six-lane basic roadway section. Late in 2007, after the Tier II ROD was issued, the preferred alignment was further refined to reduce project complexity, costs, right of way impacts, risks and environmental impacts. The resultant alignment and roadway sections are the Refined Alignment, which were developed to approximately a 30 percent level of design. An APDR Amendment was also issued in 2010 based on the alignment revisions.

The initial construction phase of the Refined Alignment was defined as one lane northbound and southbound located on the northbound SR 167 alignment, with auxiliary lanes between the I-5 interchange and 54th Avenue E (creating a two-lane section both directions). Where possible, elements of the 30 percent design for the Refined Alignment were carried forward into the first phase of construction. The initial phase of construction, labeled SR 167 Phase 1 is the starting point for this study. Phase 1 also includes:

- Full directional interchange at I-5 (without HOV direct connections)
- Diamond interchange at Valley Avenue E
- Half single point urban interchange at 54th Avenue E
- Single point urban interchange at SR 161/N Meridian Avenue
- Replace Porter Way bridge and 70th Avenue E connection
- Hylebos Creek and Wapato Creek mitigation

As directed by the 2009 Washington State Legislature, WSDOT conducted a SR 167 toll feasibility study that concluded in 2010. Subsequent to the 2010 study, the Legislature directed WSDOT to prepare a comprehensive tolling study for SR 167, which was completed in January

2013. Both of these studies and this study are based on tolling all lanes of the new roadway segments.

2.2 I-5 Express Toll Lanes

I-5 is a major regional commuting route that was completed in the 1960s. Construction of widening and improvement projects along I-5 have attempted to match the growing demands on this interstate corridor. With the increasing cost and limited space along this well-developed corridor, new efforts to address the increasing demands include studying other means to operate more efficiently, managing demand and adding capacity strategically. The efforts included in this study focus on these goals.

In 2009, the Federal Value Pricing Pilot Program awarded WSDOT $1.28 million to study the design and implementation of a regional network of dynamically priced express toll lanes along various corridors in the Puget Sound Region through the Express Lane System Pre-Design Project. The Express Lane System Pre-Design Project includes studying the implementation of express toll lanes (ETLs) on the I-5 corridor. The concepts included both conversion of the existing inside HOV lanes to ETLs and addition of a second ETL through roadway widening. The region currently has one high occupancy toll (HOT) lane in operation on the north section of SR 167 as a pilot project, and has started construction of a 17-mile ETL project on I-405 between Bellevue and Lynnwood.

For this study, the baseline project configuration is conversion of the I-5 northbound and southbound HOV lanes to an ETL from the vicinity of SR 16 in Tacoma to the beginning of the I-5 reversible lane (Express Lanes) in downtown Seattle. A second phase would add a second ETL in between the new I-5/SR 167 interchange and the new I-5/SR 509 interchange.

2.3 SR 509

Similar to SR 167, the I-5/ SR 509 Corridor Completion and Freight Improvement Project is based on more than two decades of project planning and development. The current SR 509 corridor that extends from south Seattle to the City of SeaTac was completed in 1979. Since that time, additional engineering, right of way acquisition, and construction were completed in an effort to complete the original corridor connections to I-5.

The SR 509 corridor alignment from S 188th Street to I-5 was recommended in the Tier I Corridor Draft Environmental Impact Statement (DEIS) released in 1995. The DEIS recommended extending SR 509 to connect with I-5 and adding a spur roadway, the South Access Road, connecting to Seattle-Tacoma International Airport (Sea-Tac Airport). Within this corridor, three routes and a no-build alternative were evaluated in a project level (Tier II) Supplemental Draft EIS (SDEIS) issued in 1998. The Final EIS (FEIS) and ROD issued in 2003 identified a six-lane Preferred Alternative that included two general-purpose (GP) lanes and one HOV lane northbound and southbound on SR 509. The related Access Point Decision Report (APDR) was completed in 2003.

At the 2009 Washington State Legislature's direction, WSDOT conducted a toll feasibility study that examined a fully tolled SR 509 Extension as a first phase of the Preferred Alternative roadway configuration. Completed in 2010, this study examined an initial phase of construction for a two-lane roadway with one lane northbound and one lane southbound. The alignment would follow the southbound SR 509 alignment, with auxiliary lanes between the I-5 interchange and the new 28th/24th Avenue S undercrossing. Subsequent to the tolling study, WSDOT completed a scoping study that included further refinements to the roadway geometry resulting in SR 509 Option C, which was accepted by the corridor SR 509 Executive and Steering Committees. The scoping study developed approximately a 30 percent design for SR 509 Option C, and is the baseline for this study. The other components of Option C include:

- HOV/ETL direct connections between the I-5 median HOV lanes and SR 509
- New diamond interchange at S 188 Street and SR 509
- Half-diamond interchange to/from east at 28th/24th Avenue S
- New connection to S 231st Way via new I-5 collector-distributor roadways
- Reconstruct I-5 SR 516 interchange to include the new I-5 collector-distributor roadways

3. GENERAL APPROACH

In addition to the project focus to find alternatives that operate more efficiently, managing demand and adding capacity strategically, the study team focused on taking a consistent general approach for all three corridors. This was accomplished by using the same evaluation methodology and criteria for all corridors. Consistency was achieved by having one team review and develop the alternatives for all three corridors in parallel, consulting with local and national technical specialists. The overall study approach is documented in Final Report Appendix B, Study Approach, and supplemental information is in included in the design workshops summarized in Appendices C, Initial Design Workshop Summary, and D, Second Design Workshop Summary.

4. DESIGN REFINEMENT

4.1 General Alternatives Evaluated

The alternatives evaluated considered modifications to construction phasing, prioritizing construction of interchange elements, and refining core geometric elements. To maintain consistency across all three corridors, similar approaches and criteria were applied to each corridor when considering modifying phasing and geometry.

The study team reviewed each interchange, considering alternatives that provided all the interchange movements of baseline layout and also alternatives that phased the construction of the interchange connections, prioritizing the heaviest movements. In particular, the study team identified several alternate configurations at the I-5/SR 167 and I-5/SR 509 interchanges during the initial design workshop. These are documented in Appendix C, Initial Design Workshop Summary. Some of the interchanges considered at both I-5 system interchanges and at the other service interchanges were:

- Full directional
- Full and half single point urban interchanges
- Diverging diamond
- Full and half diamond interchanges
- Split diamond

These alternatives were screened based on the project goals, stakeholder input, forward compatibility, overall cost and benefits.

In parallel with the workshops and screening, the roadway sections and alignments were reviewed for design refinements that could provide additional cost, operational, or construction phasing benefits. The effort focused primarily on the following:

- Roadway section – lane count and width, shoulder width
- Alignment geometry (plan, profile and superelevation)
- Stopping sight distance (horizontal and vertical)
- Hard shoulder running (full-depth shoulder pavement)

The study team evaluated the geometric alternatives for alignments and roadway sections, considering the horizontal and vertical alignment coordination, checking the stopping sight distances, and noting variances. The baseline configuration roadway basic section included one 12-foot lane in each direction. In the alternatives, the 12-foot lane width was reduced to 11 feet to accommodate more lanes across bridge structures. The study team considered consistency and driver expectation where lane width varied along a corridor. Where possible, the study team held a constant roadway section to simplify transitions, maintaining a consistent section rather than narrowing and widening the section repeatedly along the corridor. The different roadway sections that were evaluated attempted to balance lane and shoulder width, and provide the greatest stopping sight distance.

The goals of this design effort were to provide consistency in the design and construction of the roadway section, provide safe refuge areas, reduce construction costs for the initial construction phase, and minimize rework of the roadway prism for future expansion. The initial construction phase should be forward compatible so future widening may be achieved by building parallel to the constructed roadway prism. This would reduce impacts to the traveling public and provide safer construction work zones.

The study team considered adding hard shoulder running, but this was not implemented in the alternatives carried forward. This is an opportunity that could be re-evaluated if future cost reduction is necessary in all three project areas. Hard shoulder running would allow vehicles to travel on a shoulder during peak demand periods, increasing the capacity of the road, reducing travel times and providing flexibility for dynamic assignment of interior lanes. A hardened shoulder would be built to handle full traffic loads. Presently, the use of hard shoulder running would require a variance from the WSDOT Design Manual.

4.2 Puget Sound Gateway Project Configuration

4.2.1 Puget Sound Gateway Phase 1

The initial phase of construction for the Puget Sound Gateway Project uses a prioritized approach that addresses freight mobility and the most critical connections first. Appendix A, Exhibits A-1, A-5 and A7 show the features of the proposed Phase 1 construction of the Puget Sound Gateway Project.

4.2.1.1 SR 167 Phase 1

This phase extends SR 167 from SR 161/N Meridian Avenue to I-5. Features are:

- One lane in each direction between SR 509 and SR 161 (N Meridian Ave)
- Add a second lane in each direction between Valley Ave E and 54th Ave E
- Replace Porter Way overpass on I-5
- New interchange at I-5 and SR 167
- New interchange to/from east at 54th Ave E
- New interchange to/from west at Valley Ave E
- New interchange to/from east at Freeman Road E
- Complete the SR 161 (N Meridian Ave)
- Replace 70th Ave E from 20th Street E to SR 99
- Construct environmental mitigation in the Hylebos and Wapato Creek Basins

4.2.1.2 I-5 Express Toll Lane Phase 1

The first phase of the I-5 Express Toll Lanes would convert the existing HOV lane to an express toll lane from Tacoma to Seattle.

4.2.1.3 SR 509 Phase 1

This phase extends SR 509 from S 188th Street in the City of SeaTac to I-5, and adds capacity to I-5 between the SR 509 interchange and S 272nd Street in Federal Way to accommodate forecast traffic volumes.

- One lane in each direction between S 188th Street and I-5
- Add a second lane in each direction between S 200th Street and I-5
- Truck climbing lanes to provide freight bypass as needed where steep grades exist
- Complete the interchange at S 188th Street
- New interchange to/from east at 28th/24th Ave S
- New interchange at I-5 and SR 509
- New connection on I-5 to S 231st Way and the Kent Valley
- Improve the I-5 and SR 516 interchange to accommodate new I-5 collector-distributor lanes
- Build a new southbound I-5 general-purpose lane between SR 516 and S 272nd Street

4.2.2 Puget Sound Gateway Future Phase

In future phases, the Gateway Project would build two lanes in both directions of SR 509 and SR 167 and complete all planned interchanges and associated connections. Future phases of construction build upon the initial investment in Phase 1, allowing capacity to be strategically added over time to meet the needs of corridor users and support regional growth. Appendix A, Exhibits A-3, A-6 and A-8 show the features of the proposed future phase of construction of the SR 167 portion of the Puget Sound Gateway Project.

On I-5, building a second express toll lane between SR 167 and SR 509 would add capacity to I-5 and could help provide additional revenue for the final phases of construction.

4.2.2.1 SR 167 Future Phases

Features of the proposed future construction phase of the SR 167 portion of the Puget Sound Gateway Project are:

- Widen to two lanes in each direction between SR 161 (Meridian Street) and Valley Ave E
- Build the freeway-to-freeway direct-connection ramps
- Add ramps to/from I-5 express toll lanes
- Complete the Valley Ave E interchange

4.2.2.2 I-5 Express Toll Lanes Future Phase

The future phase would add a second express toll lane in both directions from SR 167 to SR 509, and build direct connections from the I-5 express toll lanes to both SR 167 and SR 509.

4.2.2.3 SR 509 Future Phase

Features of the proposed future construction phase of the SR 509 portion of the Puget Sound Gateway Project are:

- Widen to two lanes in each direction between S 188th Street and 28th/24th Ave S
- Add ramps to/from I-5 express toll lane
- Provide a direct access south connection to Sea-Tac Airport
- New interchange to/from the north at S 200th Street and SR 509
- Add capacity on I-5 as needed between SR 509 and S 272nd Street

4.3 General Design Criteria

To maintain consistency in the approach to developing alternative design concepts, the WSDOT Design Manual (M22-01.09, dated July 2012) was used as the roadway design standard. Table E-1 summarizes the roadway design criteria for all three mainline highways..

Table E- 1 Roadway Design Criteria

Criteria	SR 167	I-5	SR 509
Highway System (1)	National Highway System (NHS)	Interstate	National Highway System (NHS)
Design Matrix Lines	3 and 4 lines 3-8 and 4-7	1 and 2 Line 1-11 and 2-11	3 and 4 lines 3-8 and 4-7
Project Type	Mobility, Non-Interstate Freeway	New/Reconstruction	Mobility, Non-Interstate Freeway
Design Level	Full	Full	Full
Functional Classification	Urban-Principal Arterial	Urban-Interstate	Urban-Principal Arterial
Terrain Classification	Level	Rolling	Rolling
Design Speed	70	70	65 (2)
Lane width	12 ft	12 ft	12 ft
Shoulder Width	10 ft	10 ft	10 ft

Notes:
1. Design Matrix 1, DM Exhibit 1100-2 for Interstate Routes (Main Line)
   Design Matrix 2, DM Exhibit 1100-3 for Interstate Interchange Areas
   Design Matrix 3, DM Exhibit 1100-4 for Main Line NHS Routes
   Design Matrix 4, DM Exhibit 1100-5 for Interchange Areas, NHS and Non-NHS
2. As shown in Design Decision summary, dated 2/7/2012

The current WSDOT Design Manual does not provide ETL design criteria. For the purpose of this study, the design criteria for general purpose lanes and HOV lanes were applied, along with recommendations from the WSDOT Express Lane System Pre-Design Studies Project, Work Element 3.7, Geometrics.

4.4 Geometric Section

4.4.1 SR 167

The baseline roadway section for SR 167 is a two-way, two-lane highway, one lane northbound and one lane southbound. The highway will be constructed on the southbound Refined Alignment. The southbound alignment was chosen to reduce future construction impacts to SR 167 by the northbound bridge and roadway over I-5.

The basic roadway section is 60 feet wide, and provides one 12-foot lane, a 12-foot right shoulder, a 4-foot to 6-foot left shoulder in each direction and a 2-foot median barrier. The 12-foot shoulder provides an additional refuge area for large trucks as shown in WSDOT DM

Exhibit 1140-2. For SR 167 Phase 1, a 12-foot lane was added each direction between the 54th Avenue E and Valley Avenue E interchanges, creating a four-lane highway for the segment. The additional lane extends through the stop-controlled intersections at the new I-5/SR 167 interchange, providing additional capacity in a lower speed segment of the corridor.

Table E-2 summarizes the roadway sections for SR 167 Phase 1 mainline construction.

Table E- 2 SR 167 Phase 1 Roadway Sections by Highway Segment

Segment	Widths in Feet				
	Left Shoulder	Lane(s)	Right Shoulder	Total Roadway	Total Pavement including median
SR 509 to 54th Ave E (1)	4	15	8	27	56
54th Ave E to I-5/SR 167 Interchange (1)	12	12+12	12	48	98
I-5/SR 167 Interchange to Valley Ave E	4	12+12	11	39	80
Valley Ave E to SR 161/N Meridian Ave	6, NB 4, SB	12	12	30, NB 28, SB	60
SR 161/N Meridian Ave to SR 512	6, NB 10, SB	12	12	30, NB 34, SB	(2)

Notes:
(1) Designed as ramps from SR 509 near Port of Tacoma to the 54th Ave E interchange.
(2) Northbound and southbound are on separate alignments.

4.4.2 I-5 Express Toll Lanes

For I-5 ETL Phase 1, the existing HOV lane will be restriped into an express toll lane. The geometric cross section based on Full Design Level criteria produces a typical 12-foot lane and 10-foot left and right shoulders. An additional two feet of widening applied to the HOV lane converted to the express toll lane makes it 14 feet wide. One option for the restriping the HOV lane would reduce the inside shoulder width to provide the desired lane widths. This however impacts the opportunities for enforcement and observation areas. Another option would be to maintain the inside/left shoulder at 10 feet and reduce the two general purpose lanes to 11 feet width, which would provide an improved ability to enforce the ETL lane. This trade-off warrants project-specific analysis, taking into consideration volumes of trucks, stopping sight distance constraints, and other issues related to shoulder and lane width.

Where there are existing non-standard lane and shoulder widths, no additional widening to standard is anticipated. However, if the existing shoulder requires reconstruction to handle the traffic loads that will be present, it is recommended that incremental widening be considered to provide a shoulder width of at least 10 feet. Also, it is desirable to have an enforcement and observation area at each toll zone (toll equipment location). A shoulder width variance request would be required where the enforcement and observation areas are proposed where shoulder

widths are less than 10 feet. Enforcement and observation, and maintenance pullout areas would be considered where feasible based on the geometrics of I-5.

For the second phase of I-5 ETL construction, the Full Design Level section includes widening to provide current standard lane and shoulder widths. For continuous access to the ETLs, an additional two feet of lane width is shown in the lane adjacent to the general purpose lanes. As with the single-lane option, additional shoulder width would be desirable for periodic enforcement areas or in areas with high truck volumes. Lesser increments of widening by deviating lane and shoulder widths could be considered for projects with physical, fiscal, and/or environmental constraints.

4.4.3 SR 509

The roadway section for SR 509 Phase 1 is based on the roadway section developed during the scoping effort completed in June 2012. This section includes a two-way, two-lane (one northbound and one southbound) roadway that would be constructed on the northbound alignment of the design developed for the Tier II FEIS and ROD. The scoping roadway typical section provided an overall width of 56 feet, including a 12-foot lane, 10-foot outside/right shoulder, and a 4-foot to 6-foot inside/left shoulder each direction, separated by a 2-foot wide traffic barrier. For consistency with the SR 167 corridor, the study team widened the overall width from 56 feet to 60 feet, modifying the shoulder widths and adding a climbing lane.

Climbing lanes were incorporated on SR 509 to address long, steep grades. Two areas southbound and one area northbound warrant climbing lanes. The climbing lanes would allow separation of the slower, loaded truck traffic from passenger cars and light freight. This would give the faster moving vehicles the ability to pass the slower moving vehicles, maximizing capacity and benefit to the tolled users. The climbing lane is provided using the Continuous Three-Lane Section configuration as shown in DM Exhibit 1270-6(c), July 2011.

The shoulder widths were varied throughout the corridor for both directions of traffic to eliminate sightline obstructions and meet the stopping sight distance requirements. The proposed shoulder widths for SR 509 Phase 1 would provide a wider shoulder along the inside of the curve, increasing available sight distances, but they will still require a variance. Table E-3 summarizes the Phase 1 roadway sections by highway segment.

Table E- 3 SR 509 Phase 1 Roadway Sections by Highway Segment

Segment	Widths in Feet				
	Left Shoulder	Lane(s)	Right Shoulder	Total Roadway	Total Pavement including median
I-5/SR 509 to 28th/24th Ave S	12	12+12	10	varies (1)	varies (1)
28th/24th Ave S to S 192nd St	Note 2 NB Note 3 SB	12 NB 12+12 SB	Note 2 NB Note 3 SB	24 NB 34 SB	60
S 192nd St to S 188th St	Note 2 NB Note 3 SB	12+12 NB 12 SB	Note 2 NB Note 3 SB	34 NB 24 SB	60
S 188th to ramp connections	Note 2 NB Note 3 SB	12 NB 12+12 SB	Note 2 NB Note 3 SB	24 NB 34 SB	60

Notes:
1. Pavement width varies with number of lanes and ramp gores.
2. 8-foot shoulder along inside of curve, 4-foot along outside.
3. 8-foot shoulder along inside of curve, 2-foot along outside.

The northbound bridge over Wetland B has been widened from the Preferred Alternative FEIS layout to meet the stopping sight distance requirements for the northbound SR 509 to S 188th Street ramp connection (FP LINE), and has been re-designed as a parallel off-ramp design to meet current design standards. The 2012 scoping design tapered off-ramp profile did not meet the necessary stopping sight distance requirements.

To limit the widening of the northbound bridge, the S 188th Street to southbound SR 509 ramp (FS LINE) would be built with Preferred Alternative FEIS southbound bridge alignment. Only enough of the southbound bridge would be constructed in SR 509 Phase 1 to accommodate the S 188th Street to southbound SR 509 ramp (FS LINE). The width built would be designed and constructed to be forward compatible with the Preferred Alternative FEIS bridge concept plan.

All ramps were design to comply with Design Manual Exhibit 1360-6, July 2010, and provide full roadway section.

4.5 Alignment and Profile

4.5.1 SR 167

The alignments created for SR 167 Phase 1 are based on the Refined Alignment for SR 167 with additional refinements to minimize impacts and reduce overall cost. The study team made limited changes to the majority of the SR 167 alignment, focusing more on I-5/SR 167 interchange and roadway section.

Starting at the SR 509 interchange near Port of Tacoma, northbound and southbound ramps to SR 167 will follow independent alignments, joining to form a two-lane, two-way ramp just before they cross the bridge over an un-named water body, east of the 54th Avenue E interchange. After

crossing over 54th Avenue E, the two-lane, two-way ramp will be joined by ramps to and from 54th Avenue E forming a four-lane highway.

Proceeding north along SR 167, the four-lane highway will cross I-5 at the new stop-controlled interchange, centered on the southbound SR 167 baseline. The four-lane highway will extend across I-5 to the Valley Avenue E interchange, where one lane each direction will end at the ramp connections to Valley Avenue E. The SR 167 mainline crossing at Valley Avenue E will consist of only a single lane in each direction. The lanes are shifted so that the inside edge of the northbound lane matches the southbound SR 167 baseline.

From the Valley Avenue E interchange, the SR 167 mainline continues to follow the southbound SR 167 baseline until the curve before the SR 161 interchange where the mainline shifts to the northbound SR 167 baseline. Following the shift, the inside edge of the southbound lane matches the northbound SR 167 baseline. The median barrier in the curve before the SR 161 interchange restricts the stopping sight distance for the northbound direction of travel so a design variance will be prepared.

From the SR 161 interchange to the SR 512 interchange, the SR 167 mainline divides between the northbound and southbound directions of travel. The northbound direction continues straight to the SR 512 Interchange where it connects with existing northbound SR 167. The southbound direction of SR 167 shifts across the median to match existing southbound SR 167 at the existing bridge over Milwaukee Avenue E.

The following are specific issues that were noted in developing the design concepts.

- The future SR 167 directional ramps in the I-5/SR 167 interchange have tight radii which would result in reduced design speeds due to superelevation and horizontal stopping sight distance constraints.
- The lane and shoulder widths for the future SR 167 directional ramps should be further reviewed. The two-lane, one-way ramps use two 15-foot lanes for a 30-foot traveled way width. WSDOT Design Manual (DM) Exhibit 1360-6, Ramp Widths, requires only a 25-foot width for two-lanes. This would need to be increased according to the requirements in DM Exhibit 1240-2a, Traveled Way Width for Two-Lane One-Way Turning Roadways. Also, consideration should be given to placing the wider shoulder on the inside of the curves to increase the horizontal stopping sight distance.
- The original design for the gore between the southbound I-5 to northbound SR 167 ramp and the northbound I-5 to northbound SR 167 ramp had approximately 14 feet of vertical separation at the back of gore at N5-N7 38+01+/-. The design was changed to use a 20:1 collector-distributor road taper which moved the back of gore station ahead approximately 450 feet to a point where the two ramp profiles more closely match vertically.
- The original design for the southbound I-5 to southbound SR 167 gore at southbound SR 167 uses a tapered entrance with a taper rate of approximately 20:1. In the future, this could be changed to a Single-Lane Parallel On-Connection with a 3,000-foot radius.
- The original design for the southbound I-5 HOV off-connection to northbound SR 167 gore uses a 6,000-foot radius curve to the right which would require superelevation

against the normal crown on I-5. In the future, this radius could be increased to greater than 8,315 feet which is the minimum radius for normal crown for 60 mph.

- The Phase 1 vertical alignment for southbound SR 167 was developed based on new assumptions for structure depths and a goal of lowering the profile to reduce embankment volumes.

4.5.2 I-5 Express Toll Lanes

The I-5 express toll lanes would follow the existing mainline I-5 roadway, and would be constrained by the existing horizontal and vertical alignments. No profile changes are proposed for mainline I-5 as part of the Phase 1 I-5 express toll lane construction.

4.5.3 SR 509

The alignments created for SR 509 Phase 1 are based on Option C which is an initial phase of construction for the Preferred Alternative FEIS alignment for northbound SR 509. While reviewing and further refining the I-5/SR 509 alignments, four differences between the Preferred Alternative FEIS and Option C were identified:

- **I-5 alignments between SR 516 and S 208th Street** – The FEIS Preferred Alternative roadway relocates both northbound and southbound I-5 roadways outward, while Option C retains all existing southbound I-5 concrete pavement by pushing the northbound I-5 roadway further outward.
- **Basic I-5 lane configuration (SR 16 in Tacoma to I-405 in Southcenter)** – The FEIS Preferred Alternative roadway configuration of four general purpose lanes and one HOV lane in each direction matches the plans for the Fife to Tukwila HOV and Tacoma HOV projects. The baseline Option C configuration of four general purpose and two HOT/ETL lanes in each direction between SR 16 and I-405 is consistent with the Puget Sound Regional Council (PSRC) Transportation 2040 plan. The FEIS Preferred Alternative roadway configuration should be updated (realigned) to be compatible with the PSRC Transportation plan of two express tolled lanes in each direction.
- **SR 509 profile gradient between SR 99 and I-5** – The FEIS Preferred Alternative has a maximum of 4 percent, while Option C has a 5 percent maximum. The 4 percent grade would set the southbound SR 509 profile lower than southbound I-5, which works well for a southbound braid and the ramps approaching SR 516. The 5 percent grade would set southbound SR 509 in line with the southbound I-5 profile and provide a longer weave grade. The 5 percent grade would require a design variance since it is steeper than the desirable 4 percent for rolling terrain on a freeway-to-freeway ramp with a design speed of 60 mile per hour (see DM Exhibit 1140-5).
- **SR 509 Superelevation Design** – The superelevation design is based on the 56-foot roadway width for the three lanes each direction of the six-lane FEIS Preferred Alternative roadway. This would require longer transition lengths than would be expected for the reduced roadway sections for SR 509 Phase 1.

In the analysis of the SR 509 roadway profile, three sections of the profile warrant adding climbing lanes. There are two southbound sections: approaching the crest over the S 188th Street bridge; and the uphill approach to the I-5 collector-distributor system. The one northbound section is the approach to the crest over the S 188th Street bridge. For both the uphill approaches to the bridge over S 188th Street, the combination of grade and length of grade is enough to warrant climbing lanes. The approach to I-5 also warrants a climbing lane, part of which is provided by the two-lane section between the 28th/24th Avenue S interchange and I-5 already incorporated into the design.

Two alternative designs of the I-5 northbound to SR 509 northbound freeway-to-freeway connection have been evaluated. Both alternatives kept the same number of lanes, lane widths and shoulder widths as the baseline design, but varied the curve radius and bridge skew relative to I-5.

1. The first alternative reduces the curve radius from 2,590 feet to 900 feet. This shortens the length of the bridge and reduces the bridge area by about 35 percent. On the east side of this ramp, the right of way acquisition required to build the proposed design is reduced. This alternative also reduces the wall area by approximately 30 percent.
2. The second alternative is a T-intersection with stop control at the connection. This allows a perpendicular bridge crossing on I-5 and reduces the bridge area by about 45 percent. The T-intersection increases the right of way impact beyond that required for the baseline Option C alternative since the ramp needs to extend further north to cross perpendicular to I-5.

Neither alternative would meet the DM 1360.05(1) 60 miles per hour design speed requirement of freeway-to-freeway ramps. The bridges that would be constructed would not facilitate higher design speeds for future phases without additional construction.

The ramp alignments are designed for the SR 509 Phase 1 construction widths, gore locations and intersection locations. For a future widening phase, these connections would need to be re-evaluated for compliance with the future configuration. The ramp profiles are designed to meet current design standards for stopping sight distance and superelevation.

4.6 Retaining Walls

4.6.1 SR 167

Retaining walls on SR 167 are predominantly retained fill walls used to limit the project footprint and reduce the overall impacts to adjacent features. Approximately 75 percent of all the wall construction is located between Valley Avenue E and SR 512. The remaining 25 percent is located west of I-5, toward SR 509. Much of the main SR 167 and I-5 interchange is on either structure or embankment, thus limiting wall construction to wingwalls on abutments and approaches.

4.6.2 I-5 Express Toll Lanes

For the I-5 Express Toll Lanes, no walls are anticipated for the conversion of the HOV lanes to express toll lanes for I-5 Phase 1. For the future phase, retaining walls with an average height of 6

feet would be constructed to separate the I-5 northbound and southbound lanes during widening to add the second express toll lane.

4.6.3 SR 509

The baseline SR 509 corridor has 17 walls. Each was re-evaluated by the study team and updated based on the design revisions incorporated in the Phase 1 layout. In general, the design revisions were minor, relating to small changes in the alignment and roadway section width. Wall 1 (west side, near SR 516) and Wall 3 (east side, northbound collector-distributor) were revised more significantly to reduce costs.

Wall 1 is on the west side to the southbound collector-distributor as it approaches the ramp intersection with the SR 516 roadway. The initial layout of this wall was a full height cut, without an earthwork backslope above the wall. A backslope was added above and behind the wall to reduce overall wall height and reduce cost.

Wall 3 is on the east side of the northbound collector-distributor between S 216th Street and S 211th Street and was reviewed and revised to reduce cost. The profile of the northbound collector-distributor roadway is dropping to provide required vertical clearance under the northbound and southbound I-5 overcrossing. The profile of the northbound collector-distributor through this section is 30 to 50 feet below the existing ground surface. During initial evaluation of the walls in this vicinity, walls that limited right of way impacts were very costly. In re-evaluation of the baseline design, and in discussion with the WSDOT scoping team who had evaluated the walls previously, the cost of the wall was more than the adjacent property based on the available right of way data presented in mid-2012. In order to reduce the overall project cost estimate, 13 additional parcels were identified for purchase to reduce the overall wall heights and limits. With this impact the wall area is reduced by 75 percent. This saved approximately 50 percent of the wall cost, including the right of way costs. This approach was consistent with the approach considered and evaluated by the WSDOT scoping team engineer.

4.7 Design Variations

During the alternatives design development, a few design variances were identified and incorporated into the Puget Sound Gateway Project Phase 1 construction for each of the three corridors: SR 167; I-5 ETL; and SR 509. Where feasible, these design variances would be removed in the full Puget Sound Gateway Project. The Phase 1 design variances have been identified for:

- Shoulder width
- Lane width
- Ramp gore configuration
- Stopping sight distance
- Profile grade approaching I-5 on southbound SR 509 (identified during the 2012 SR 509 project scoping effort)

As mentioned previously, the initial phase of SR 509 does not meet stopping sight distance sightline obstruction requirements as well as shoulder width requirements. Therefore, the Phase 1 design requires variances to current design standards.

The initial phase of SR 509 requires design variance for superelevation transition length.

I-5 ETL Phase 1 of the Puget Sound Gateway Project is the conversion of the current HOV lane into an ETL, including construction of the toll equipment that would accommodate the second future lane. The conversion includes pavement upgrades, but limited widening, so existing design variances are not removed.

The I-5 ETL second phase would construct a second express toll lane between the I-5 SR 167 and SR 509 interchanges with direct connections at these interchanges. Widening of I-5 for the second express toll lane would require reconstruction or widening of several bridges along the corridor. One notable difference is at the existing S 317th Street I-5 median direct access in Federal Way. Here, a variance is required for the inside shoulder width on I-5 and the gore layout at southbound off ramp to S 320th Street to preserve the existing direct access ramp completed in 2006.

5. DEFINITIONS

Left	left side when looking in direction of travel
Right	right side when looking in direction of travel
Option C	formerly Option 3A for SR 509. Option C was endorsed by the SR 509 Executive and Steering Committee for the SR 509 Corridor Completion and Freight Improvement Project.
Preferred Alternative EIS alignment	alignment for SR 509 from EIS
Preferred Alignment	SR 167 alignment
Collector-Distributor	A parallel roadway designed to remove weaving from the main line and reduce the number of main line entrances and exits.

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