# WSDOT HOV Feasibility Study
# I-5: JBLM to S 38th Street

Technical Report


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# Technical Report

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**Acronyms and Abbreviations**

| | |
|---|---|
| ATM | active traffic management |
| C-D | collector-distributor |
| DDI | diverging diamond interchange |
| GP | general purpose |
| HOV | high-occupancy vehicle |
| IJR | interchange justification report |
| M | million |
| mph | miles per hour |
| NB | northbound |
| PDO | practical design option |
| SB | southbound |

# Introduction

This Technical Report contains more detailed information supporting the findings outlined in the *WSDOT HOV Feasibility Study – I-5: JBLM to S 38th Street Summary Report*.

## Background and Study Purpose

The Washington State Department of Transportation (WSDOT) is planning to widen the I-5 corridor and add lanes (one in each direction) between Mounts Road and Thorne Lane in the JBLM area as part of the I-5 - JBLM Vicinity Congestion Relief Project. Additionally, WSDOT is extending an HOV lane in each direction on I-5 from 54th Avenue (Fife) to S 38th Street (Tacoma) as part of the I-5 - SR 16 Tacoma/Pierce County HOV Program. The added lanes through JBLM are intended to be opened as general purpose (GP) lanes, with the ability to convert to HOV lanes in the future, once the HOV system is extended to provide continuous HOV service between Tacoma and DuPont. The HOV lane to S. 38th St. and the added lanes through JBLM are expected to be opened by 2021. WSDOT's core HOV system plan extends south to SR 512, but the portion between S 38th Street and SR 512 is unfunded. As part of the Connecting Washington legislation, the State Legislature provided funding for WSDOT to conduct this study of the I-5 segment between the JBLM and Tacoma HOV lane expansion projects to assess the feasibility of providing an HOV lane on I-5 between Thorne Lane (M.P. 123.6) and S 38th Street (M.P. 131.9), as shown in **Figure 1**. The outcomes of this work can be used by elected officials to determine if further development of any of the identified alternatives should be funded.


**Figure 1: Study Corridor Map**

Because lane conversion and full design standards alternatives were largely defined and understood by the study team, the majority of the study effort focused on the practical design alternative for the corridor. A two-tiered evaluation process was used to derive the practical design alternative: an initial screening of possible options, and then a second evaluation of the options surviving the initial screening to select the components that would represent the Practical Design Alternative.

# Baseline Conditions

Before identifying and assessing potential HOV lane alternatives for the corridor, existing travel conditions, as well as likely near-term future “no build” conditions in the corridor were examined.

## Existing Travel Conditions

The existing lane configuration of I-5 through the corridor is schematically shown in **Figure 2** with four general purpose travel lanes in both directions between Thorne Lane and S 38th Street. There is no HOV lane in this section. On the south end of the study corridor at Thorne Lane, I-5 drops a lane southbound, becoming a three-lane section, and adds a lane northbound, going from a three-lane to four-lane section. On the north end of the study corridor, northbound I-5 drops a lane to the S 38th Street/SR 16 collector-distributer (CD) roadway, going from a four-lane to three-lane mainline section. In the southbound direction, the S 38th Street/SR 16 CD roadway adds a lane to become a four-lane section until the lane drop near Thorne Lane.

The corridor currently experiences peak period congestion on a regular basis, and travel can frequently be unreliable through this segment for both general purpose and HOV traffic. Most notably, in the southbound direction, the reduction in southbound capacity resulting from the lane drop near Thorne Lane frequently leads to southbound congestion and backups into the study corridor, particularly in the PM peak period. This is reflected in a review of PM peak period travel speeds as shown in **Table 1**. Conversely, in the northbound direction a lane is added at the Thorne Lane interchange, and because the constraint of the three-lane cross-section to the south effectively meters traffic, operations in the four-lane section north of Thorne Lane often reflects free-flow speeds.

On the north end of the corridor, at S 38th Street, northbound traffic can be volatile in the peak periods, sometimes backing up from congestion caused by the merging of heavy traffic volumes from SR 16 and SR 705 north of the study corridor. Traffic in the southbound direction is also typically congested through the segment north of the study area (i.e., Fife to SR 16) as indicated in **Table 1**, and begins to operate better south of 38th Street until it slows down again due to the back-ups from Thorne Lane.

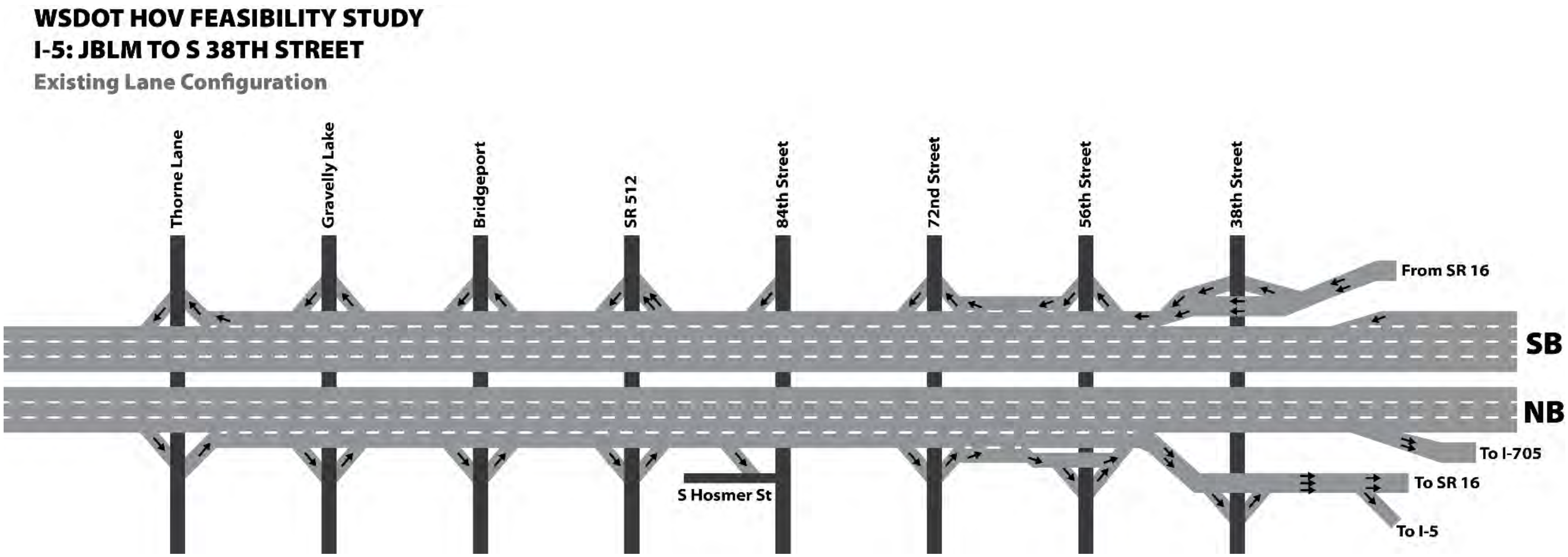


Figure 2: Existing Lane Configuration -- I-5 Thorne Lane to S 38th Street

### Table 1: Current I-5 PM Peak Period Travel Speeds* by Corridor Segment

| Southbound | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **From** | **To** | **3:00-3:30pm** | **3:30-4:00pm** | **4:00-4:30pm** | **4:30-5:00pm** | **5:00-5:30pm** | **5:30-6:00pm** | **6:00-6:30pm** | **6:30-7:00pm** |
| Puyallup River | S 38th St | 37 | 35 | 36 | 38 | 35 | 35 | 37 | 40 |
| S 38th St | Between S 72nd St & S 84th St | 60 | 60 | 61 | 61 | 61 | 62 | 63 | 64 |
| Between S 72nd St & S 84th St | Between SR 512 & Bridgeport Way SW | 58 | 54 | 53 | 49 | 44 | 50 | 60 | 64 |
| Between SR 512 & Bridgeport Way SW | N Thorne Ln SW | 47 | 38 | 29 | 24 | 23 | 26 | 33 | 51 |
| N Thorne Ln SW | JBLM (41st Divison Dr) | 51 | 41 | 36 | 30 | 27 | 28 | 39 | 49 |
| **Northbound** | | | | | | | | | |
| **From** | **To** | **3:00-3:30pm** | **3:30-4:00pm** | **4:00-4:30pm** | **4:30-5:00pm** | **5:00-5:30pm** | **5:30-6:00pm** | **6:00-6:30pm** | **6:30-7:00pm** |
| JBLM (41st Divison Dr) | N Thorne Ln SW | 51 | 39 | 32 | 26 | 26 | 29 | 38 | 53 |
| N Thorne Ln SW | Between Bridgeport Way SW & SR 512 | 63 | 62 | 61 | 55 | 50 | 52 | 61 | 65 |
| Between Bridgeport Way SW & SR 512 | Between S 84th St & S 72nd St | 61 | 60 | 58 | 53 | 49 | 53 | 61 | 63 |
| Between S 84th St & S 72nd St | S 38th St | 56 | 55 | 57 | 59 | 57 | 58 | 62 | 63 |
| S 38th St | Puyallup River | 33 | 28 | 25 | 26 | 28 | 30 | 50 | 60 |

**Estimated Average Existing Speeds (mph) based on existing data from Google Maps API*

*Red shading indicates areas of highest congestion, orange shading indicates areas of moderate congestion*

## Existing Safety Conditions

To establish baseline safety conditions, five years of crash data (2011 – 2015) for the I-5 study area were gathered from WSDOT records and reviewed for the project. This data is summarized in **Figure *3*** in terms of types of crashes by year. The total number of crashes per year has increased over this time period, from 468 crashes reported in 2011 to 637 crashes reported in 2015, an increase of 36%. The combination of rear end and sideswipe crashes comprises about 85% of the total crashes, with what appears to be a growth in crashes that is related to the growth in traffic volumes and congestion. Fixed object crashes make up 11% of the total crashes. Crashes in this corridor appear to be closely correlated to the high traffic volumes and congestion in the corridor and related also to the geometrics of the freeway where the corridor has a narrow median with concrete barrier through the study area. Over the five years surveyed, there were four fatal crashes, two involving fixed objects (concrete barrier and wood sign post) and two were rear end crashes.

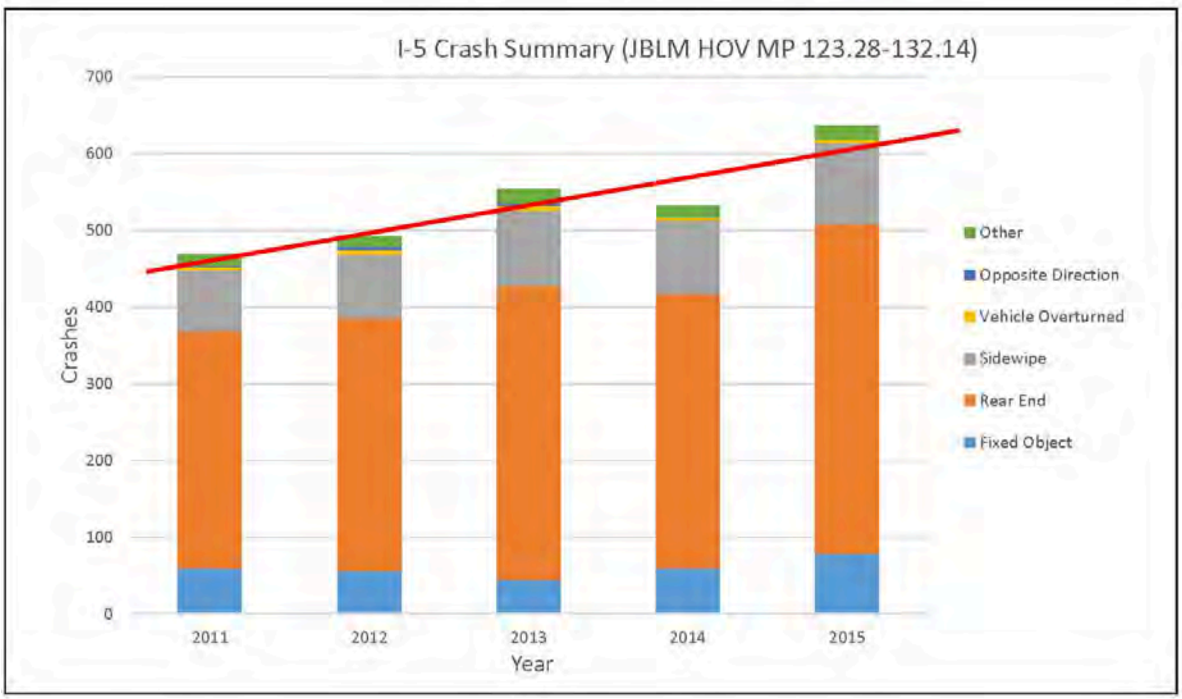


**Figure 3: I-5 Crash Summary Thorne Lane to S 38th Street Interchanges (MP 123.28 to MP 132.34)**

A plot of the crash locations by mile post, for both mainline and collector-distributor roadways reveals an almost regular pattern of crashes through this 8.8 mile segment of I-5 where crashes have occurred near interchanges and between, likely based on locations of recurring congestion (see **Figure 4**). The plot of crashes reveals a density of crashes near the loop ramps at SR 512, S 56th and S 38th Street interchanges and a density of crashes near high volumes off ramps such as the southbound off ramp to SR 512.

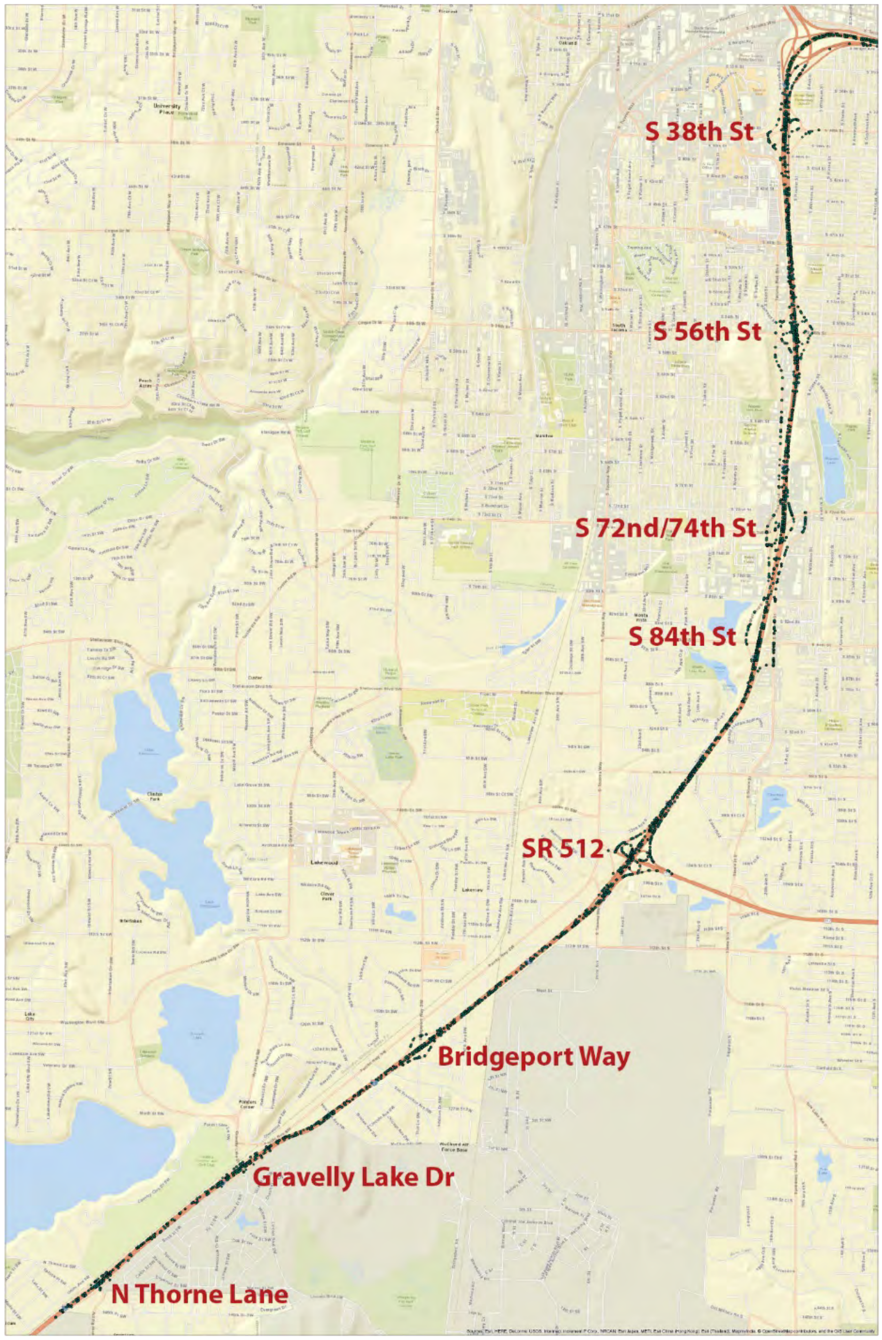


**Figure 4: Plot of Crashes along I-5 in the Study Corridor**

## Future Baseline Travel Conditions

**Figure 5** schematically shows the expected future configuration of the corridor and its end points. Two projects are currently underway which will affect I-5 both south and north of the study corridor. The *"I-5 - JBLM Vicinity Congestion Relief Project"* south of the corridor will add an additional through lane on I-5 between Mounts Road and Thorne Lane, increasing the cross-section from three to four lanes in both the northbound and southbound directions. North of the study corridor, the *"I-5 - SR 16 Tacoma/Pierce County HOV Program"* is adding an HOV lane in both directions to I-5 between the Fife area and S 38th Street. Both of these projects will have an effect on travel conditions within the study corridor.

At the south end of the study corridor, with the construction of an additional mainline lane as part of the JBLM project, a lane-drop southbound and lane-add northbound on I-5 will no longer exist north of Thorne Lane. This will have the effect of allowing more traffic to reach the study area corridor north of Thorne Lane, likely resulting in more congested conditions for both general purpose and HOV traffic in the northbound direction. However, in the southbound direction, conditions in the corridor will likely be improved as the lane drop at Thorne Lane is eliminated resulting in less peak period congestion southbound.

On the north end of the study corridor, the addition of an HOV lane will increase overall corridor capacity and result in higher levels of southbound traffic reaching the corridor, likely resulting in added congestion. Additionally, while HOVs will have a priority travel lane north of 38$^{th}$ Street, they will be forced to merge with all traffic south of 38$^{th}$ Street, resulting in their experiencing the same travel speeds as all traffic at that point. In the northbound direction the addition of an HOV lane north of 38$^{th}$ Street should improve conditions for all traffic in the northbound direction and decrease the potential for back-ups from this section reaching into the study corridor.

In addition to the changes in roadway lane configuration programmed for I-5 on either side of the study corridor, traffic through this corridor has been growing steadily and is expected to increase significantly over the next 10 to 20 years. WSDOT's website for the *I-5 - JBLM Vicinity Congestion Relief Project* notes:

> "A combination of factors have contributed to the traffic growth through the area. Large businesses have moved in. JBLM and Camp Murray have expanded, and the communities of Lakewood, DuPont and Steilacoom have continued to develop. Each change has added demand on the already-crowded I-5 corridor. Motorists now see traffic congestion on a daily basis, especially during peak commute hours. Because secured military bases are located on both sides of I-5, alternate routes involve using perimeter roads around the bases. Those routes are neither convenient nor able to manage high volumes of traffic."

Given this trend, traffic through the study area corridor is expected to continue to face frequent periods of congestion and unreliable travel despite the programmed improvements on either side of it.

WSDOT HOV FEASIBILITY STUDY
I-5: JBLM TO S 38TH STREET
Future Baseline Lane Configuration

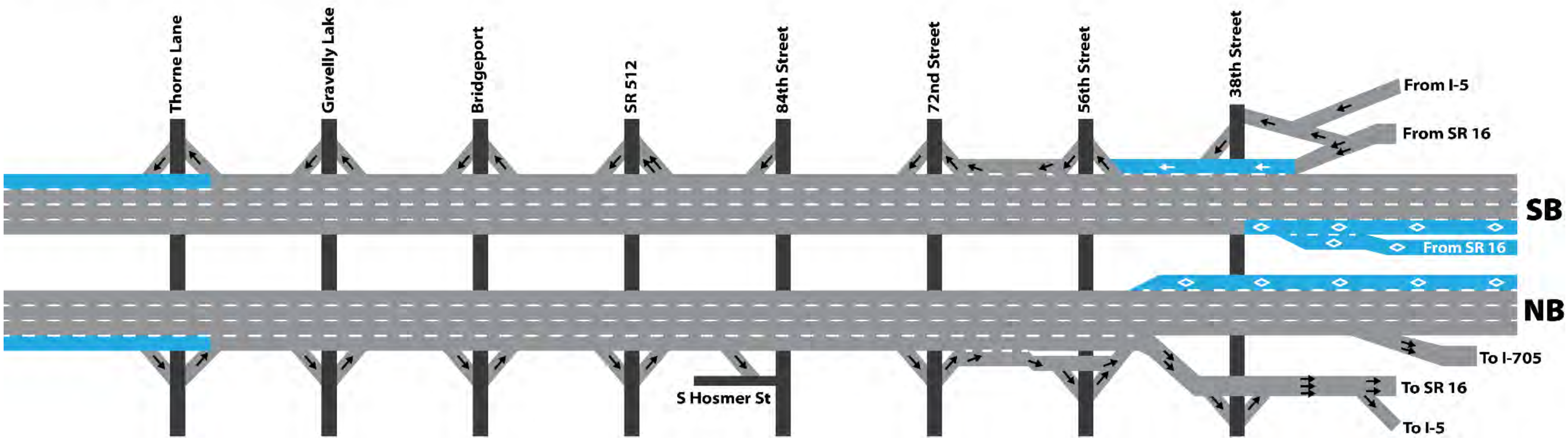


Figure 5: Future Baseline Lane Configuration – I-5 Thorne Lane to S 38th Street.

## Stakeholder Agency Participation

In addition to internal WSDOT participation in this study, agency stakeholders were invited to participate in this study consisting of representatives from the following agencies/jurisdictions: Federal Highway Administration (FHWA), City of Lakewood, City of Tacoma, Pierce Transit, Sound Transit, Intercity Transit, and the Puget Sound Regional Council (PSRC). A list of individual participants is included in the appendix. Three work sessions were conducted throughout the process of the study to review materials and provide input at key junctures. The information gathered and outcomes from these meetings were critical to developing reasonable alternatives that affected stakeholder agencies could support.

### Project Team Meetings

Stakeholders were invited to gather input at key points of the study at the following three meetings/work sessions:

- **October 13 – Defining Baseline Conditions and Evaluation Measures Meeting**, in which the following was presented and discussed:
    - A walk through of the current geometric configuration of the corridor as well as the programmed changes on I-5 segments adjacent to both ends of the corridor
    - An assessment of current and future "No-Build" conditions in the corridor, including traffic volumes on I-5 and its ramps, peak period travel speeds on I-5, and a summary of crash data over the past five years
    - Proposed evaluation criteria for corridor HOV lane alternatives

- **October 28 – Alternatives Definition Workshop**, which included:
    - A review and confirmation of the three basic categories of alternatives for the study: Lane Conversion, Practical Design, and Full Standards Design
    - Identification and refinement of practical design options through the corridor
    - Identification and refinement of locations within the corridor that are too constrained physically to allow for adding an HOV lane by restriping
    - Discussion of options for addressing specific constrained locations, including at the:
        - BNSF Bridge (north of the 47$^{th}$ Avenue SW undercrossing)
        - S Tacoma Way/Union Avenue Bridge
        - SR 512 Interchange
        - S 56th Street Interchange

- **December 12 – Evaluation Workshop**, which included:
    - A review of the HOV lane alternatives and a preliminary assessment of their performance and cost including:
        - Review and discussion of the methodology for developing "opinions of cost" for each of the alternatives

  - Clarification of the Lane Conversion alternative to not include active traffic management (ATM) strategies
  - Identification of the elements of the Full Standards alternative between SR 512 and Thorne Lane
- Review of an initial assessment of practical design options for specific locations along the corridor, with a particular focus and discussion on the following:
  - SR 512 Interchange – with options ranging from retaining the existing bridge and reconfiguring the interchange, to rebuilding the bridge and maintaining a cloverleaf interchange or reconfiguring to a Diverging Diamond interchange
  - S 56th Street Interchange – with options including:
    - retaining the existing bridge and reconfiguring the interchange
    - rebuilding the bridge and maintaining a cloverleaf interchange
    - rebuilding the bridge and reconfiguring to a Diverging Diamond interchange
    - developing a northbound and southbound collector-distributor (CD) roadway system between S 72$^{nd}$ Street and SR 16
- Screening out all options that retained the existing bridges at SR 512 and S 56$^{th}$ Street, as well as the CD roadway system.
- Presentation and discussion of conceptual "opinion of cost" estimates for all alternatives
- Review and refinement of an initial assessment matrix comparing the representative full corridor HOV lane alternatives

# Practical Design Alternative Development

## Development of Practical Design Options

The development of practical design options for this segment of I-5 began with the concept of adding an HOV lane by widening the existing mainline pavement by the minimum amount necessary. Mainline pavement widening, however, would be accomplished with the premise that design deviations or compromises are applied to reduce the cost in a "practical design" manner for adding an HOV lane. The basic corridor section assumed shoulder and lane width deviations creating a four-foot inside shoulder, 11-foot travel lanes and a 10-foot outside shoulder cross section as illustrated in **Figure 6**. Numerous bridge crossings in the project corridor created physical constraints to the amount of pavement widening that could be accomplished at each bridge location. Bridge plans were reviewed to assess the amount of widening that could be accomplished without reconstruction of the bridge. Available space dimensions between median barrier and column or abutment were derived from the bridge plans. The review findings are presented in **Table 2** with the column labeled, "Potential Excess Space" indicating whether sufficient space exists (zero or positive numbers) or not (negative numbers), to accommodate the proposed cross section. The negative numbers highlighted in yellow were assumed to be acceptable given the level of accuracy of the investigation and that further reduction of the inside and outside shoulder widths to two feet in the vicinity of the bridge is acceptable. If the Practical Design Alternative is selected for further study, a field survey at each bridge location is needed to confirm the available widths and could ultimately produce different conclusions, including the possible need to replace more bridges than indicated here. The review of plans for the existing structures found that if a width reduction to two-foot inside and outside shoulders is acceptable for short distances[1] (e.g., through an undercrossing), then the majority of the corridor can accommodate an additional lane.

However, even with the lane and shoulder width deviations, three bridge crossings were deemed to require reconstruction as part of the practical design alternative: South Tacoma Way, SR 512 and S 56th Street. South Tacoma Way is a simple overcrossing, not an interchange, with vertical clearance issues that are exacerbated by the addition of another lane. The practical design option at South Tacoma Way is reconstruction of the overcrossing bridge. Various design options were suggested and evaluated for the SR 512 and S 56th Street interchange bridges. A summary of these options as well as proposed solutions for the other bridge locations may be found in **Table 3**.

**PRACTICAL DESIGN**

Practical design is an approach to making project decisions that focuses on the specific problem the project intends to address. This performance-based approach looks for lower-cost solutions that meet outcomes that WSDOT, partnering agencies, communities, and stake-holders have identified. Practical design is a fundamental component to the Vision, Mission, Values, Goals, and Reforms identified in Results WSDOT, the department's Strategic Plan. The primary objectives of the practical design approach are: (1) focusing on project need, and (2) seeking the most reasonable low-cost solution to meet that need.

*-Section 1100.01(1)(b), WSDOT Design Manual*

## Practical Design Option Descriptions

### SR 512 Interchange

Two practical design options were assessed at the SR 512 Interchange. Both options assumed replacement of the existing I-5 main line undercrossing structure with a bridge that can accommodate four general purpose (GP) lanes and one HOV lane with full-design width lanes and shoulders. Construction of temporary structures is assumed in order to maintain traffic while the existing bridge is demolished and a new structure is constructed in its place.

[1] This was deemed acceptable based on input received from both FHWA and WSDOT representatives in the study stakeholder meetings.

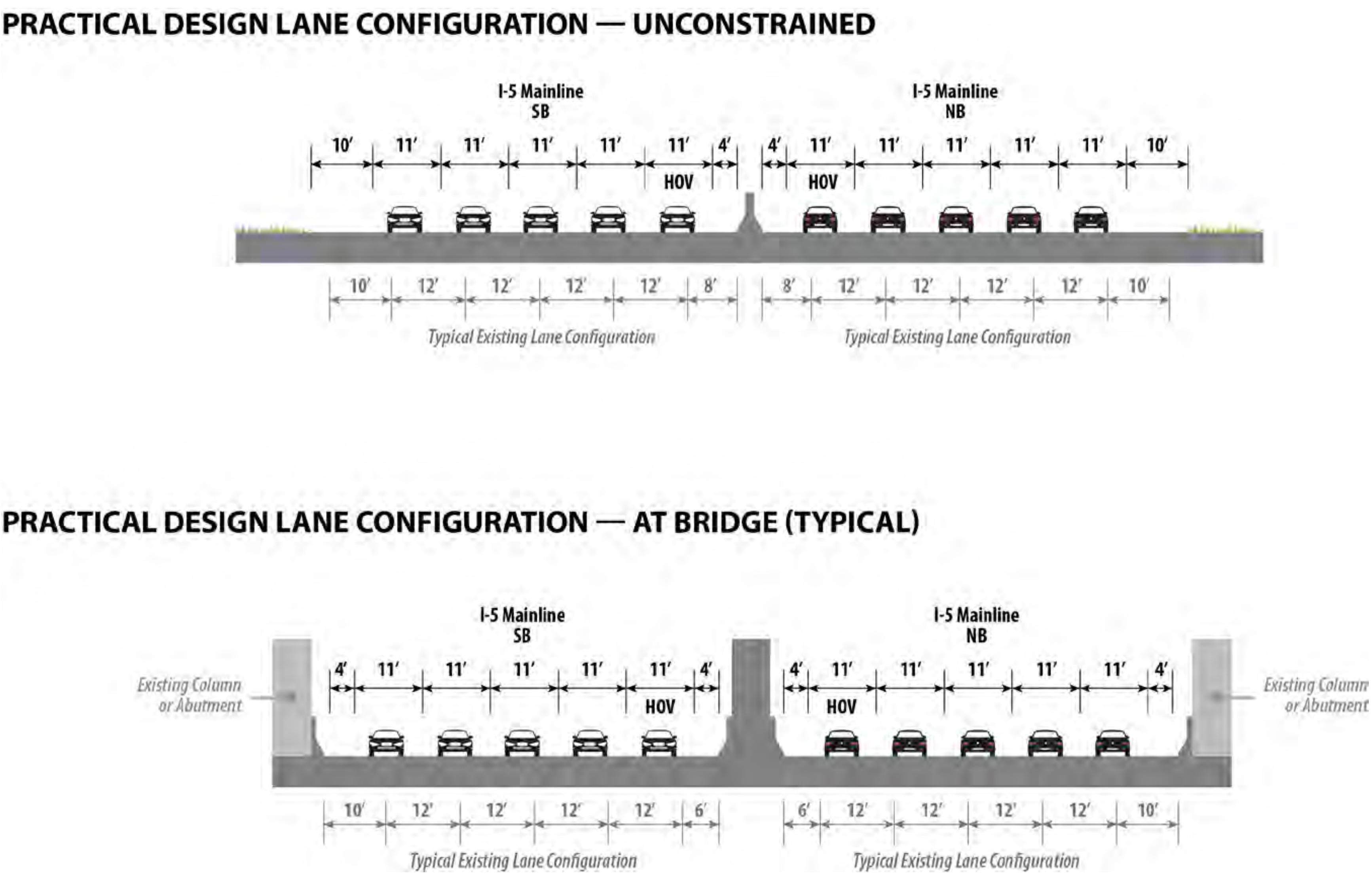


**Figure 6: Practical Design Alternative -- Typical Cross Sections***

(* Note: At some existing bridges that will remain, shoulder widths may be reduced to two feet.)

## Table 2 Pavement Width Dimensions from Design Drawings

| Direction | Description | Potential Available Pvt Width | Future No. of Lanes | Future Lane Width | Future Inside Shoulder | Future Outside Shoulder | Future Pvt Width Req'd EOP to EOP | Potential Excess Space | Notes |
|---|---|---|---|---|---|---|---|---|---|
| NB | I-5, Thorne Lane - Gravelly Lake | 0 | | | | | | | |
| SB | I-5, Thorne Lane - Gravelly Lake | 0 | | | | | | | |
| NB | I-5 under Gravelly Lake Dr | 64 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 1.0 | |
| SB | I-5 under Gravelly Lake Dr | 64 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 1.0 | |
| NB | I-5 under McChord Dr SW | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| SB | I-5 under McChord Dr SW | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| NB | I-5 over Clover Creek | 79 | 6 | 11.0 | 4.0 | 4.0 | 74.0 | 5.0 | Add'l lane for off-ramp |
| SB | I-5 over Clover Creek | 81 | 6 | 11.0 | 4.0 | 4.0 | 74.0 | 7.0 | Add'l lane for on-ramp |
| NB | I-5 under Bridgeport Way | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| SB | I-5 under Bridgeport Way | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| NB | I-5 under 47th Ave SW | 60 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -3.0 | |
| SB | I-5 under 47th Ave SW | 60 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -3.0 | |
| NB | I-5 under BNRR | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| SB | I-5 under BNRR | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | |
| NB | I-5 under South Tacoma Way | 67 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 4.0 | Vert. clr issues 10/28/16 |
| SB | I-5 under South Tacoma Way | 62 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -1.0 | Vert. clr issues 10/28/16 |
| NB | I-5 under SR 512 - mainline | 52 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -11.0 | |
| SB | I-5 under SR 512 - mainline | 52 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -11.0 | |
| NB | I-5 under SR 512 - CD | 40 | 3 | 11.0 | 4.0 | 0.0 | 37.0 | 3.0 | To avoid bridge reconstruction move 1 M.L. lane to CD |
| SB | I-5 under SR 512 - CD | 40 | 2 | 11.0 | 4.0 | 0.0 | 26.0 | 14.0 | To avoid bridge reconstruction move 1 M.L. lane to CD |
| NB | I-5 over S 96th St | 65 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 2.0 | |
| SB | I-5 over S 96th St | 65 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 2.0 | |
| NB | I-5 under S 84th St | 63 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 0.0 | |
| SB | I-5 under S 84th St | 63 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 0.0 | |
| NB | I-5 under S 74th - S 72nd St | 64 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 1.0 | |
| SB | I-5 under S 74th - S 72nd St | 64 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 1.0 | |
| NB | I-5 under S 56th St - mainline | 52 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -11.0 | |
| SB | I-5 under S 56th St - mainline | 52 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | -11.0 | |
| NB | I-5 under S 56th St - CD | 42 | 3 | 11.0 | 4.0 | 4.0 | 41.0 | 1.0 | To avoid bridge reconstruction move 1 M.L. lane to CD |
| SB | I-5 under S 56th St - CD | 42 | 3 | 11.0 | 4.0 | 4.0 | 41.0 | 1.0 | To avoid bridge reconstruction move 1 M.L. lane to CD |
| NB | I-5 under S 48th St | 64 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 1.0 | |
| SB | I-5 under S 48th St | 63 | 5 | 11.0 | 4.0 | 4.0 | 63.0 | 0.0 | |

| | |
|---|---|
| Yellow | within the range of accuracy |
| Red | requires pavement widening |
| Orange | requires bridge reconstruction |

**Table 3 Proposed Practical Design Solutions at Constrained Locations**

| Location | Reduce lane & shoulder widths[2] | Replace bridge | Retain Bridge/ 4th GP lane on CD | Retain loop ramps | Modify loop ramps* | Convert to other interchange configuration |
|---|---|---|---|---|---|---|
| **SOUTH SEGMENT** | | | | | | |
| Gravelly Lake Drive Bridge | X | | | | | |
| McChord Drive SW Bridge | X | | | | | |
| Clover Creek Bridge | X | | | | | |
| Bridgeport Way | X | | | | | |
| 47th Ave SW Bridge | X | | | | | |
| BNSF Bridge | X | | | | | |
| S Tacoma Way Bridge | | X | | | | |
| SR 512 Bridge | | | | | | |
| Option 1 | | X | | X | | |
| Option 2 | | X | | | | X |
| Option 3 (*remove NE loop) – GP lane on CD | | | X | | X | |
| Option 4 (*remove SE loop) – GP lane on CD | | | X | | X | |
| Option 5 | | | X | | | X |
| **NORTH SEGMENT** | | | | | | |
| 96th Street S Bridge | X | | | | | |
| 84th Street S Bridge | X | | | | | |
| S 72nd Street Bridge | X | | | | | |
| S 56th Street Bridge | | | | | | |
| Option 1 | | X | | X | | |
| Option 2 | | X | | | | X |
| Option 3 (*remove NE & SW loops) | | | X | | X | |
| Option 4 | | | X | | | X |
| S 48th Street Bridge | X | | | | | |

**The following CD alternative is a part of the above "56th Street Option 3" or "56th Street Option 4"**

**Collector-Distributor NB: 72nd–SR 705**
SR 16/56th/38th/SR 705 traffic exits to 2-3 lane CD north of 72nd. 72nd on-ramp braids with CD off-ramp. Convert inside mainline lane to HOV for 3+1 configuration.

**Collector-Distributor SB: SR 16–72nd**
CD begins as 1-lane with 38th St off traffic, collecting SR 16 on- and 56th on- traffic before joining ML north of 72nd St off-ramp. 56th off- traffic weaves across the CD to exit. Inside mainline lane converted to HOV for 3+1 configuration through 56th Street Bridge. ML is 4+1 configuration south of where CD joins.

[2] All of the bridges marked in this column except S 48th Street currently do not meet the 16 foot minimum vertical clearance for existing bridges. This would remain so with any associated practical design solution, which would require a design deviation to implement.

SR 512 Option 1 also assumes retention of the existing partial clover leaf interchange configuration (see **Figure 7**). This requires the bridge over I-5 to be longer than required under the full design scenario that does not include the collector-distributor (C-D) and loop ramps. Main line widening requires the C-D and loop ramps to be realigned to fit within the existing right of way.

The SR 512 Option 2 assumes reconfiguration of the existing partial clover interchange into a diverging diamond interchange (DDI) (see **Figure 8**). Because the DDI does not retain the C-D and loop ramps a shorter bridge is required to span I-5. All of the ramps, however, are realigned and new intersection operations are established on SR 512.

Main line cross sections were developed (**Figure 9**) to illustrate the channelization concepts associated with retaining the existing interchange (partial or full clover leaf) or reconfiguring the interchanges at SR 512 and S 56$^{th}$ Street.

## S 56th Street Interchange

Three practical design options were assessed at the 56$^{th}$ Street interchange. The first two options are very similar to the SR 512 options. 56$^{th}$ Street Option 1 and Option 2 replaces the existing I-5 undercrossing structure and like the SR 512 Options 1 and 2, retains the existing clover leaf interchange or assumes reconfiguration into a DDI, respectively. See **Figure 10** and **Figure 11**.

The 56$^{th}$ Street Option 3 (see **Figure 12**) retains the existing undercrossing bridge by removing 56$^{th}$ St, 38$^{th}$ St, and SR 16 traffic from the NB main line at the 74$^{th}$ Street interchange. In the SB direction, traffic from SR 16, 38$^{th}$ Street and 56$^{th}$ Street are kept on a 2-lane C-D until south of 56$^{th}$ Street. This allows the main line to retain its current 4-lane cross section under the existing 56$^{th}$ Street bridge. The 56$^{th}$ Street interchange is either retained in its current full clover design or reconfigured as a DDI. Cross sections illustrating the I-5 main line and C-D roadway configurations are found in **Figure 13** and **Figure 14**.

The NB C-D exits the main line after the 72$^{nd}$/74$^{th}$ Street Bridge as a two-lane ramp. It is grade separated with the 72$^{nd}$ Street on-ramp traffic headed for I-5. A separate ramp is provided for 72$^{nd}$ Street traffic to connect with the C-D for traffic wanting to exit at 56$^{th}$ St, 38$^{th}$ Street or SR 16. The addition of this 74$^{th}$ Street ramp creates a 3-lane C-D section up to the 56$^{th}$ Street interchange. One C-D lane drops at the exit to 56$^{th}$ St. The remaining two C-D lanes continue under 56$^{th}$ Street and provides exits to 38$^{th}$ St, SR 16, SR 705 or entry onto NB I-5. The 56$^{th}$ Street NB on-ramp merges with the 2-lane C-D with no immediate access to I-5. Retaining walls are required at the 48$^{th}$ Street undercrossing bridge to accommodate more pavement between the bridge abutments.

In the SB direction, traffic from SR 16 and S 38$^{th}$ Street wishing to enter I-5 are directed to a 2-lane C-D that carries them south of 56$^{th}$ Street before allowing merging with the I-5 main line. At the 72$^{nd}$/74$^{th}$ Street interchange, the two-lane C-D would drop one lane to the 74$^{th}$ Street exit and the other C-D lane would merge with the I-5 main line. Traffic on I-5 wishing to exit to S 56$^{th}$ Street or S 74$^{th}$ Street would do so using a directional slip ramp to the C-D.

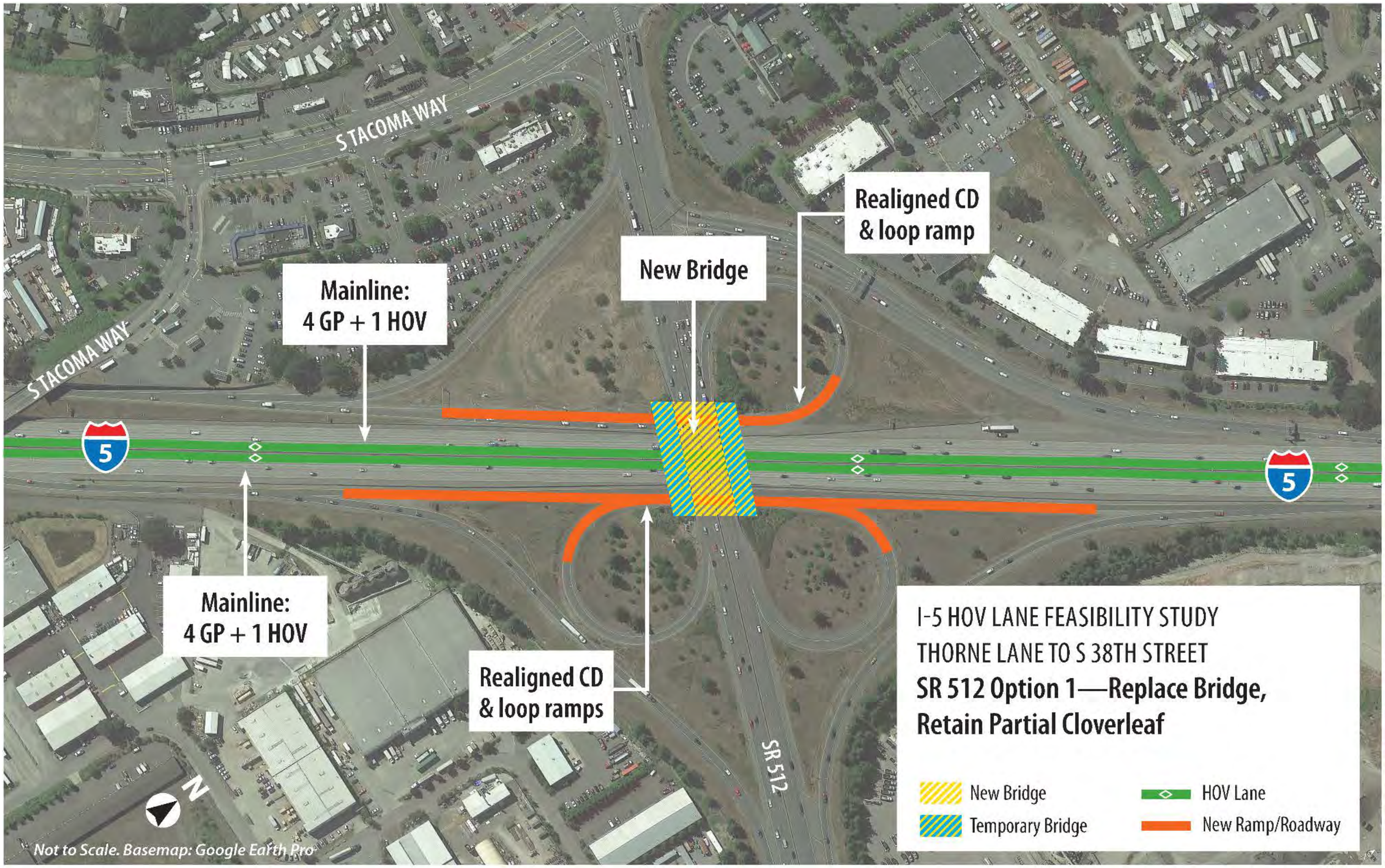


**Figure 7: SR 512 Practical Design Option 1 -- Replace Bridge, Retain Partial Cloverleaf**

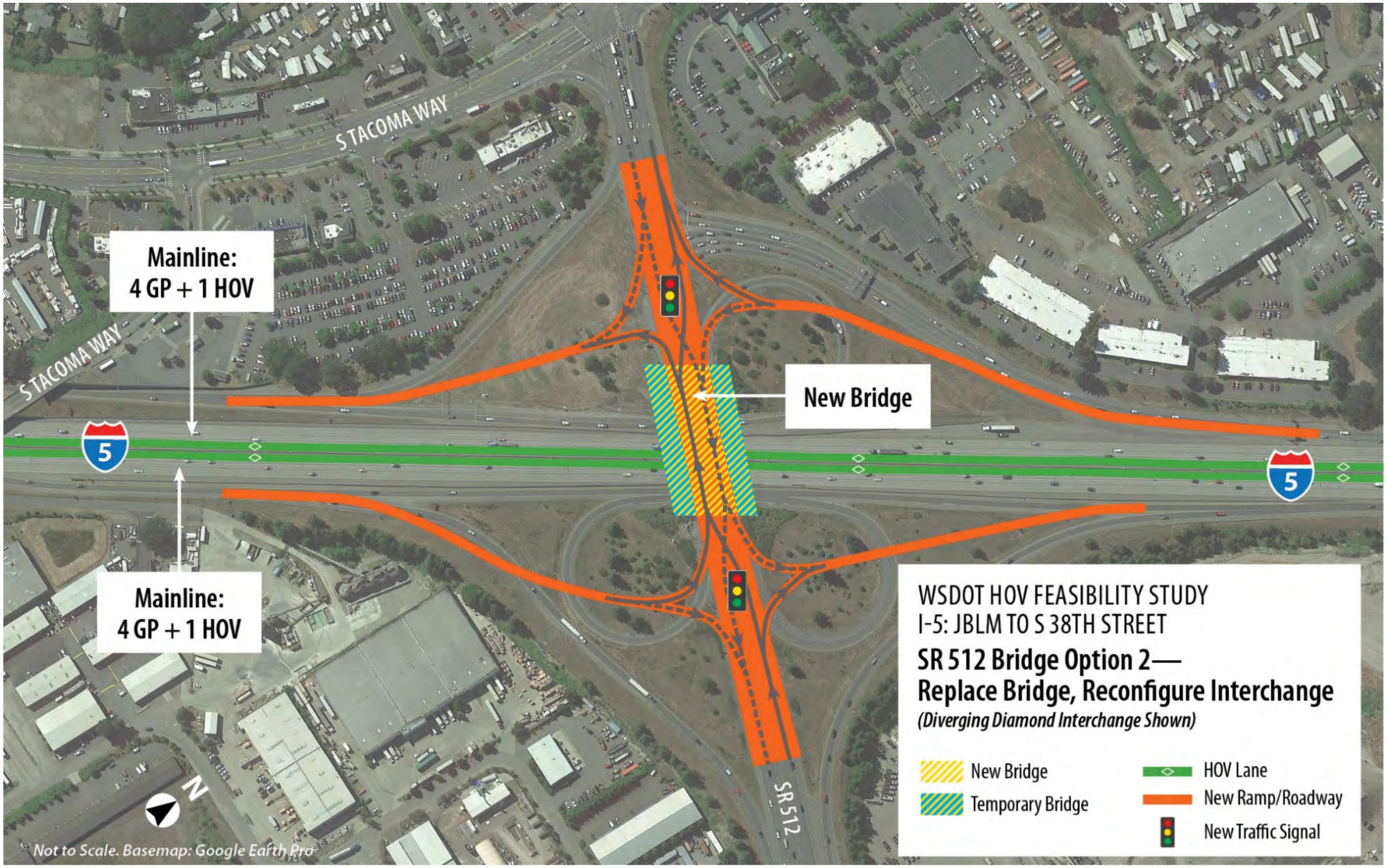


**Figure 8: SR 512 Option 2 -- Replace Bridge, Diverging Diamond Interchange**

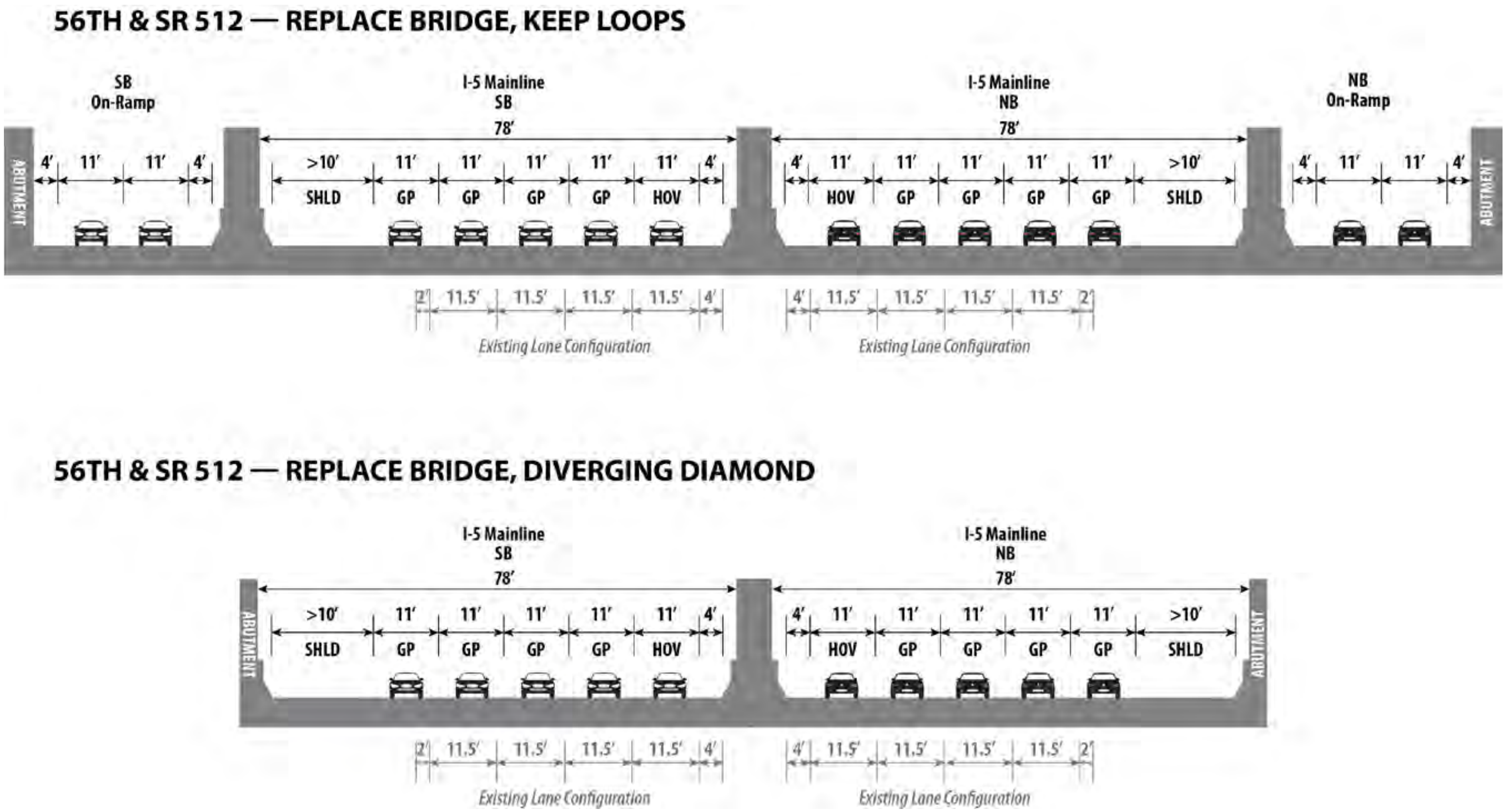


**Figure 9: I-5 Practical Design Cross Sections at SR 512 and S 56th Street Bridges**


**Figure 10: S 56th Street Practical Design Option 1 -- Replace Bridge, Retain Cloverleaf**

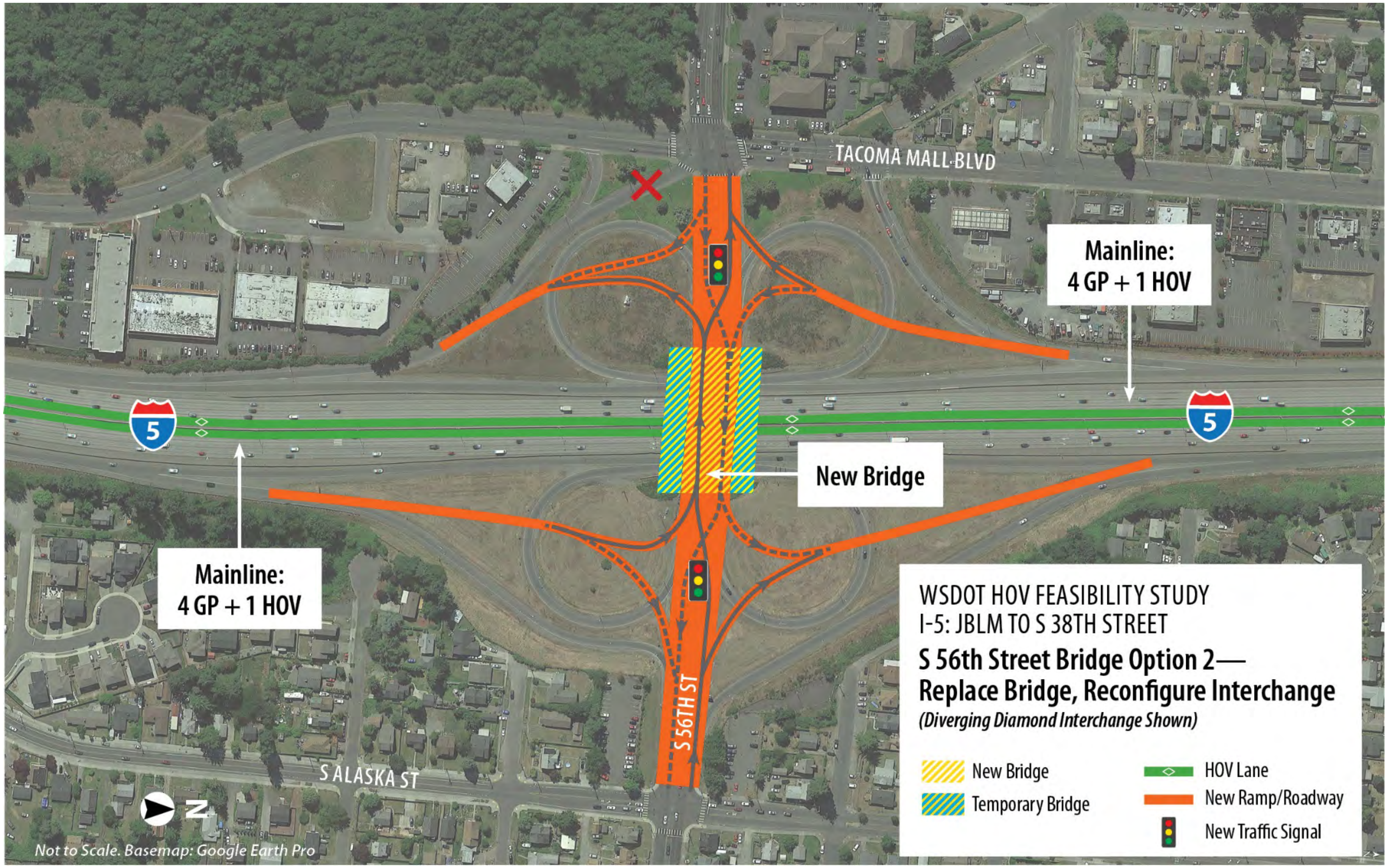


**Figure 11: S 56th Street Practical Design Option 2 – Replace Bridge, Implement Diverging Diamond Interchange**

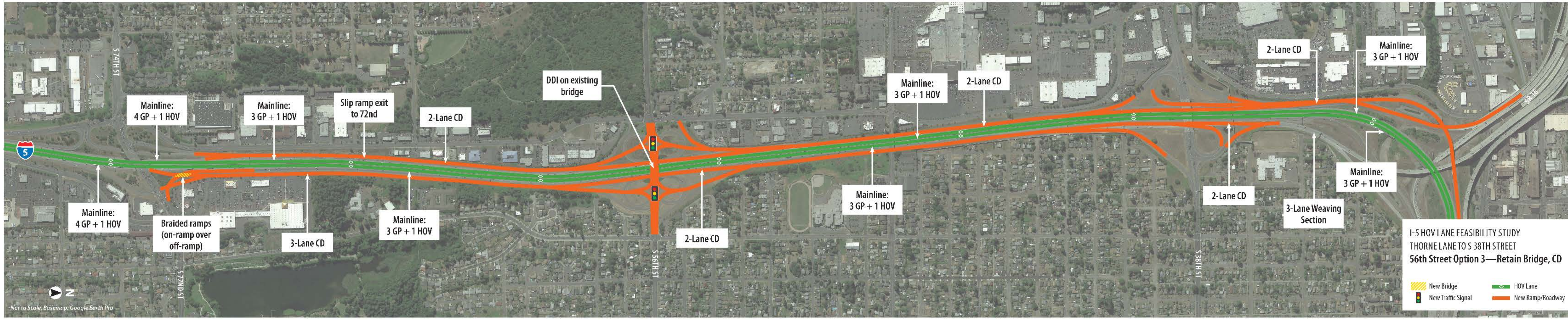


**Figure 12: S 56th Street Practical Design Option 3 – Retain Bridge, Implement CD Roadway**

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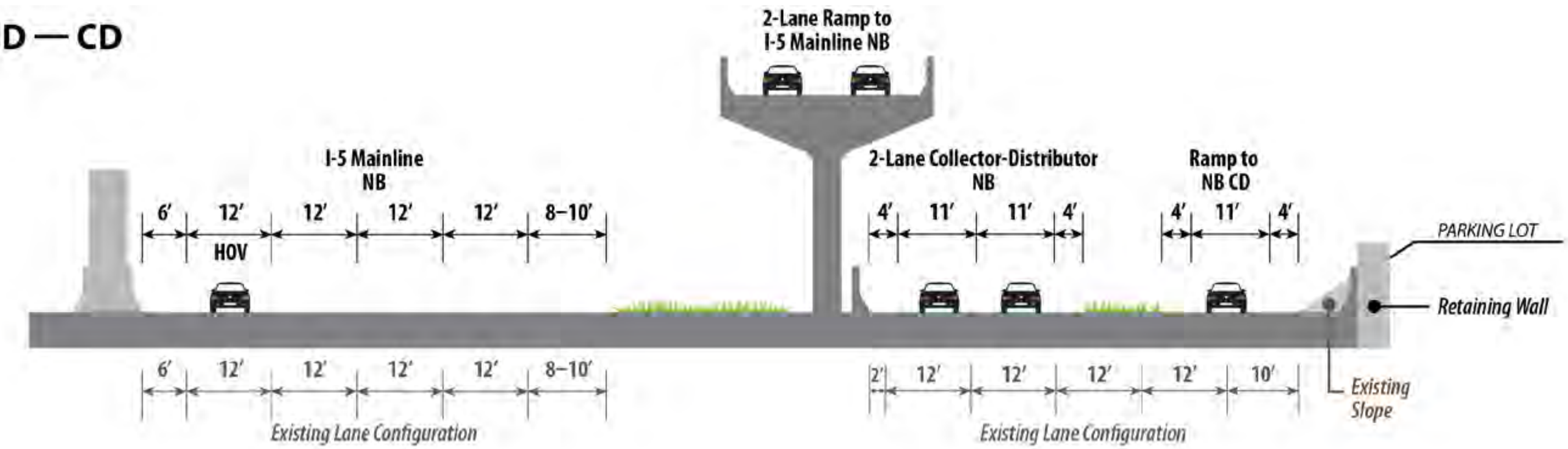
## 72ND — CD




## 56TH — CD, RETAIN EXISTING BRIDGE

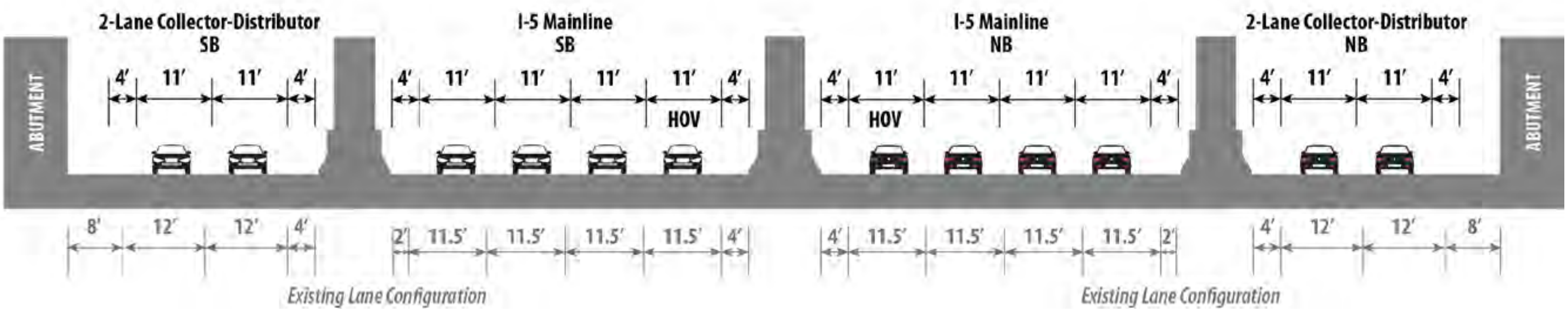



**Figure 13: I-5 Practical Design Cross Sections – Collector-Distributor at S 72nd Street & S 56th Street Bridges**

## 48TH — CD

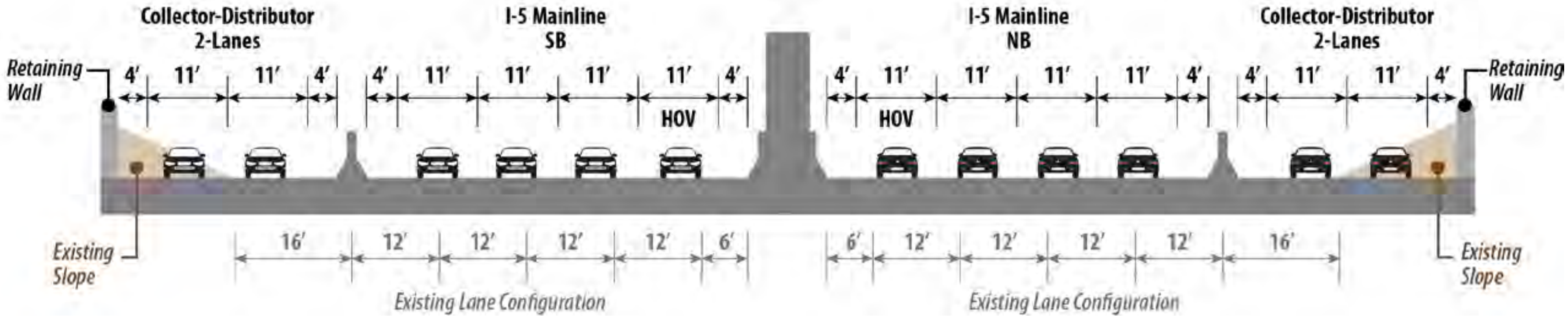



**Figure 14: I-5 Practical Design Cross Sections – Collector-Distributor at S 48th Street Bridge**

## Practical Design Option Screening and Evaluation Criteria

The following criteria were used to conduct a two stage evaluation of identified practical design options to address constrained areas of the corridor. The two stages included an initial screening of the options, and then a more detailed evaluation of the options that survived the initial screening. The criteria are described below.

### Mobility

Mobility was established as a measure to characterize, subjectively, operational conditions along the corridor. Two subcategories were used to define mobility: speed and the potential for congestion relief. For practical design options that included a collector-distributor (C-D) system, speed and congestion relief were evaluated separately for mainline and C-D operations.

### Safety

Safety is a measure of the potential increase or decrease in collisions on the main line in the corridor based on technical forecasting and professional judgment. For the screening and evaluation of the practical design options, safety for each option was assessed qualitatively based on a review of existing crashes in the corridor.

### Cost

Cost was established as an evaluation criteria to allow assessment of the alternatives' economic feasibility against its various other characteristics. Ratings for capital cost were performed qualitatively relative to the other alternatives at the SR 512 or S 56th Street interchange. Cost opinions were not generated for the proposed options in the initial screening, but were quantified for the second evaluation stage of practical design options.

### Constructability

Constructability encompassed two subcategories: construction complexity and maintenance of traffic. Construction complexity reflected the option's difficulty to construct due to impact on the main line I-5 traffic, confined construction space, or complex construction sequence. Maintenance of Traffic assessed an option's impact to traffic flow in and around the project area during construction.

### Other

The Other category contained two criteria that were also deemed significant characteristics of an option: compliance with design standards and forward compatibility.

Compliance with design standards is a subjective assessment of the extent of deviations the option may require based upon its perceived technical complexity and difficulty. The greater the likely deviations the less likely the design would be approved by WSDOT and FHWA.

Forward compatibility assesses the level to which an option is consistent with, or lays the groundwork for, an assumed desired future improvement. The full-standards design was assumed to be the desired ultimate configuration.

## Initial Screening of Practical Design Options

An initial screening was performed to select the most viable SR 512 and S 56th Street practical design solutions for discussion with WSDOT, FHWA and local agencies. As described above, five general categories of criteria were established to assess the design solutions at each interchange: mobility, safety, cost, constructability, and other. With the exception of cost, each general category was broken into one or more subcategories to permit fuller definition and assessment of each option. For the initial screening, each practical design option was evaluated against the criteria discussed based on a three-point scale and generally using the No-Build scenario as a basis for comparison.  A rating of 1 indicates conditions worse than No-Build, 2 is similar to No-Build, and 3 is better than No-build. The screening criteria are discussed below.

### Mobility

Mobility screening for the practical design options/elements included a high level investigation of the potential effects of a given design element on operational performance. For the congestion relief category, a rating of 1 implies congestion would be worse than No-Build, a rating of 2 suggesting similar levels of congestion as No-Build, and a rating of 3 indicting an improvement in corridor congestion. Similarly for speed, a rating of 1 would represent slower speeds compared to No-Build, a rating of 2 indicating similar average speeds as No-Build, and a rating of 3 representing higher speeds than No-Build. These same ratings would apply to both the mainline and C-D (where applicable). The options that add an HOV lane to the mainline (through bridge replacement) or create a dedicated C-D system to manage ramp movements north of 72nd Street, the ratings for congestion and speed were generally scored higher than options where bridge structures are retained and GP lanes are shifted outside the bridge piers.

### Safety

Initial safety screening of the design elements for a practical design option for I-5 included an assessment of the potential change in safety and operation in the corridor associated with each design element, i.e., whether safety would be worse than existing (rating = 1), would remain similar to existing (rating = 2) or would be better than existing (rating = 3) with the design treatment.  A concept to implement the HOV lane and retain the existing bridge at SR 512 by relocating one mainline lane to a C-D system was rejected based primarily on safety, with an expected decline in safety where one mainline lane would diverge with the C-D and rejoin beyond the interchange.  The practical design option to implement HOV lanes in the corridor must at least maintain safety comparable to the existing or No-Build condition and at best approach the safety expected with the full design buildout.

## Cost

Bridge replacement or construction resulted in a Cost rating of 1 to reflect high capital cost investment. Interchange configuration and ramp modifications resulted in a rating of 2. No practical design options were assessed a rating of 3 that would have indicated minimal capital cost outlay.

## Constructability

Constructability contains the subcategories of Construction Complexity and Maintenance of Traffic and were utilized only in this initial screening. This category was not assessed relative to the No-Build scenario as it would have resulted in only a "worse" rating being assigned for all build alternatives. Instead, this category was assessed as a relative comparison among the options at each interchange location.

A Construction Complexity rating of 3 represented existing bridges over I-5 were maintained with relatively minor construction modifications to the ramps. A rating of 2 indicated retention of the existing bridge coupled with significant interchange re-configuration (e.g. conversion to a diverging diamond interchange (DDI)) or replacement of the bridge over I-5 with minor modification to the ramp configurations. A rating of 1 reflected replacement of the bridge over I-5 along with major interchange re-configuration.

A maintenance of traffic rating of 3 indicated relatively minor traffic detour and no significant impacts to road network connectivity were anticipated. A rating of 2 was assessed where main line I-5 traffic was not directly impacted but moderate to significant traffic detours and temporary facilities for cross street and local road network were expected. An MOT rating of 1 was assessed for all options that required replacement of the bridge over I-5.

## Other

The Other category consisted of compliance with *Design Standards* and *Forward Compatibility*.

### *Design Standards*

The *Design Standards* subcategory assessed an option's compliance with WSDOT design standards. The lower the rating of a practical design option, the more technically "challenged" the option was assumed to be hence more design deviations were anticipated.

A Design Standards rating of 3 indicated very few or no design deviations were expected. Bridge replacement options that included interchange re-configuration received this score as it was assumed that such an option would meet full design standards. A rating of 2 was assigned to options that replaced the I-5 bridge but retained the existing interchange configuration. The existing loop ramp design was assumed to be compromised by the widening of the I-5 main line such that design deviations would be required. A rating of 2 was also assigned to the collector-distributor element of the S 56$^{th}$ Street practical design option. Due to the very conceptual level of design associated with this element, a moderate number of design deviations was assumed to be associated with the various braid, weave length, and on/off-ramp separation requirements. A

Design Standards rating of 1 was assigned to all of the options that retained the existing I-5 bridge. Retention of the I-5 bridge requires a main line GP through lane be routed to the space where the existing C-D ramp is located. The concept of mixing a main line through lane with lower speed interchange traffic was anticipated to contain numerous design standard infractions that would not receive WSDOT/FHWA approval.

#### *Forward Compatibility*

For the initial screening, all practical design options that included rebuilding a bridge were given a rating of 3 (better forward compatibility than the No-Build) for this category because it was assumed that the bridges would be built to allow for full standards and/or allow for an additional mainline lane within acceptable practical design standards in the future.

The options that retained the existing structures over I-5 but reconfigured interchange ramps were given a rating of 1 (worse forward compatibility than No-Build) because it was determined that once this investment was made to somewhat improve conditions it was less likely that future investments would be made at these locations to improve them to full standards.

A rating of 2 was given to options that retained existing structures and simply restriped the roadway to fit another lane in (e.g., the BNSF Bridge location).

## Summary of Initial Screening of Practical Design Options

**Table 4** shows the results of the initial screening of practical design options. The objective was to identify and retain for further evaluation the options at each location that had the most merit—and to drop the remainder. The options that were dropped, and the reasons for dropping them, are described below.

### SR 512 Interchange

All options that retained the existing SR 512 Bridge over I-5 were dropped from further consideration. The primary reason for this was that they required reconfiguration of the existing cloverleaf C-D roadways to include a lane functioning as a mainline through lane. It was determined that this configuration would be counter intuitive to driver expectations and could result in less safe conditions and/or less capacity in that lane.

### S 56th Street Interchange

Similar to the SR 512 interchange location, all options that retained the existing S 56$^{th}$ Street Bridge over I-5 were dropped from further consideration for the same reasons as they were at SR 512 except for the C-D roadway option. The C-D roadway option does not necessitate use of the cloverleaf C-D system for one of the mainline lanes; hence, it was retained for further evaluation.

## Table 4  Initial Screening of Practical Design Options

| | Evaluation Criteria | | | | | | | | | | | I-5: JBLM to 38th Street HOV Feasibility Study - Initial Evaluation Summary Matrix for Practical Design Solutions - 12/13/2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mobility | | | | Safety | | Cost | Contructibility | | Other | | Notes | | | |
| Option | Congestion Relief - Mainline | Congestion Relief - CD | Speed - Mainline | Speed - CD | Potential for Crashes - Mainline | Potential for Crashes - Non-Mainline | Opinion of Cost | Construction Complexity | MOT | Design Standards | Forward Compatibility | Safety Annotations | Operational Annotations | Retain? | Score (% of Highest Possible) |
| **SOUTH SEGMENT** | | | | | | | | | | | | | | | |
| **BNSF Bridge** | | | | | | | | | | | | | | | |
| Squeeze lanes under existing BNSF Bridge | 3 | NA | 2 | NA | 2 | NA | 3 | 3 | 3 | 2 | 2 | Safety remains the same with restriping for HOV lane. Existing 15'0" NB and 14'11" SB center column vertical clearance constraint. This is not likely to be changed with restriping for add'l lane, however, the possibility of needing to replace the RR bridge remains. | | Yes | 83% |
| **S Tacoma Way Bridge** | | | | | | | | | | | | | | | |
| Rebuild S Tacoma Way Bridge | 3 | NA | 2 | NA | 3 | NA | 1 | 2 | 2 | 3 | 3 | Vertical clearance at outside lane/shoulder will require replacing this bridge. Existing bridge shows signs of strikes NB. Safety is improved with replaced bridge | | Yes | 79% |
| **SR 512** | | | | | | | | | | | | | | | |
| Replace Bridge/keep loops | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 3 | New bridge is benefit for safety on mainline. New bridge would resize the loops, reducing radii and probably reducing approach speeds for loop. Thus CD operation safety would decline. | Sufficient space to accommodate loop ramp shifting, trafffic flow would improve with HOV capacity | Yes | 70% |
| Retain Bridge/Replace NE loop (new signal on SR 512)/4th GP lane on CD | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 3 | 1 | 1 | Safety for mainline would remain the same. Safety for CD would be worse than existing with one through/GP lane separate from the mainline, even with barrier from CD. Decision point for 4th GP lane to diverge and rejoin the mainline is potentially a safety concern. Probably not able to quantify impacts. Additional signal on SR 512 with new ramps would reduce overall safety on SR 512. | Additional lane on CD for GP may create added friction and congestion at loop ramp interface points. | No | 58% |
| Retain Bridge/Replace SE loop/4th GP lane on CD | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 3 | 1 | 1 | Safety for mainline would remain the same. Safety for CD would be worse than existing with one through/GP lane separate from the mainline, even with barrier from CD. Decision point for 4th GP lane to diverge and rejoin the mainline is potentially a safety concern. Probably not able to quantify impacts .Replacing SE loop with new signal would potentially reduce safety on SR 512. | Additional lane on CD for GP may create added friction and congestion at loop ramp interface points. | No | 58% |
| Retain Bridge/convert to DDI/4th GP lane on CD | 2 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | Safety for mainline would remain the same. Safety for CD would be worse than existing with one through/GP lane separate from the mainline, even with barrier from CD. Decision point for 4th GP lane to diverge and rejoin the mainline is potentially a safety concern. Probably not able to quantify impacts. Replacing loops with DDI is likely to provide a safety improvement, but does not offset the split mainline lanes issue. | Additional lane on CD for GP may add friction but DDI configuration would offset impacts | No | 58% |
| Replace Bridge/convert to DDI | 3 | NA | 3 | NA | 3 | 3 | 1 | 2 | 1 | 3 | 3 | New bridge is benefit for safety on mainline and at new DDI configuration. | Retaining mainline cross section between bridge piers would avoid GP lane in CD and DDI would improve interchange efficiency and safety. | Yes | 67% |
| **NORTH SEGMENT** | | | | | | | | | | | | | | | |
| **56th Street** | | | | | | | | | | | | | | | |
| Replace Bridge/retain full cloverleaf | 3 | 1 | 3 | 1 | 3 | 1 | 1 | 2 | 1 | 2 | 3 | New bridge is benefit for safety on mainline. New bridge would resize the loops, reducing radii and probably reducing approach speeds for loop. Thus CD operation safety would decline. | Mainline operations would improve with added HOV capacity but tighter loop ramps may reduce ramp capacity and add friction at CD merge/weaving areas. | Yes | 64% |
| Replace Bridge/implement DDI | 3 | NA | 3 | NA | 3 | 3 | 1 | 1 | 1 | 3 | 3 | New bridge is benefit for safety on mainline and at new DDI configuration. | Mainline operations would improve with added HOV capacity and DDI configuration would improve merge and diverge operations compared to traditional cloverleaf. Possible operational impacts to 56th Street due to new signals between Tacoma Mall Blvd and Alaska Street. | Yes | 78% |
| Retain Bridge/convert to DDI/Add GP lane on CD | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 2 | 1 | 1 | Safety for mainline would remain the same. Safety for CD would be worse than existing with one through/GP lane separate from the mainline, even with barrier from CD. Decision point for 4th GP lane to diverge and rejoin the mainline is potentially a safety concern. Probably not able to quantify impacts. Replacing loops with DDI is likely to provide a safety improvement, but does not offset the split mainline lanes issue. | Mainline split with 3+1 and 1 GP on CD may reduce overall I-5 corridor efficiency. DDI would improve merge and diverge movements for CD but would be offset by GP lane in CD. Impacts to 56th may occur due to spacing of signals between Tacoma Mall Blvd and Alaska Street. | No | 55% |
| Retain Bridge/remove NE & SW loops/Add GP lane on CD/new signals on 56th | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 3 | 3 | 1 | 1 | Safety for mainline would remain the same. Safety for CD would be worse than existing with one through/GP lane separate from the mainline, even with barrier from CD. Decision point for 4th GP lane to diverge and rejoin the mainline is potentially a safety concern. Probably not able to quantify impacts. Replacing NE and SW loops with new signals on 56th may be a safety concern, given closely spaced urban intersections. | Mainline split with 3+1 and 1 GP on CD may reduce overall I-5 corridor efficiency. Removing NE and SW loop ramps would improve merging maneuvers for CD but would be offset by GP lane in CD. Impacts to 56th may occur due to spacing of signals between Tacoma Mall Blvd and Alaska. | No | 58% |
| **The following CD alternative assume one of the above "retain existing 56th St Bridge" options, i.e., retain w/DDI, or retain with partial cloverleaf** | | | | | | | | | | | | | | | |
| **Collector-Distributer NB: 72nd - SR 705** | | | | | | | | | | | | | | | |
| SR 16/56th/38th/SR 705 traffic exits to 2-3 lane CD north of 72nd. 72nd on-ramp braids with CD off-ramp. Convert inside mainline lane to HOV for 3+1 configuration. | 3 | 2 | 3 | 2 | 3 | 1 | 1 | 2 | 2 | 2 | 2 | CD system improves safety on mainline, with HOV and GP lane continuity and separation from the on/off friction with the interchanges. Safety on the CD is unknown at this time. Expect high volumes in segments of the CD. | Mainline operations would improve with only through and HOV trips accommodated. Modest lane changing required within mainline environment outside of HOV lane access at SR 16 interchange. CD operations would be similar to existing conditions due to two lane configuration and containment of 56th, 38th, and SR 16 ramp movements. Possible capacity issues on CD between 72nd Street and 56th Street interchanges for NB and near 38th Street interchange for SB. | Yes | 70% |
| **Collector-Distributer SB: SR 16 - 72nd** | | | | | | | | | | | | | | | |
| CD begins as 1-lane with 38th St off traffic, collecting SR 16 on- and 56th on- traffic before joining ML north of 72nd St off-ramp. 56th off- traffic weaves across the CD to exit. Inside mainline lane converted to HOV for 3+1 configuration through 56th Street Bridge. ML is 4+1 config south of where CD joins. | 3 | 2 | 3 | 2 | 3 | 1 | 2 | 2 | 2 | 2 | 2 | | | Yes | 73% |
| | Scale relative to No Build | 3 = Better | | 2 = Similar | | 1 = Worse | | | | | | | | | |

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## Further Evaluation of Practical Design Options

The practical design options that survived the initial screening to be evaluated further are described below.

### SR 512 Interchange

- Replace Bridge and maintain cloverleaf loops similar to existing
- Replace Bridge and convert to a diverging diamond interchange

### S 56th Street Interchange

- Replace bridge and maintain cloverleaf loops similar to existing
- Replace bridge and convert to a diverging diamond interchange
- Retain bridge and develop a northbound and southbound C-D roadway system between 72nd Street and SR 16.

### Mobility

Operationally, the mainline and interchange options selected for further consideration are generally expected to provide reasonable levels of mobility along I-5 and for traffic movements to/from the mainline. However, a detailed traffic analysis to ascertain the capacity of each interchange type and location and segment operations would be needed to guide and confirm the optimal design elements and overall corridor configuration. For example, while a DDI interchange configuration may be able to accommodate higher ramp volumes than a traditional loop ramp system, the specific application of a DDI may prove unnecessary depending on the results of the detailed operational analysis.

### Safety

The recommended representative practical design option for implementing HOV lanes in the corridor would include replacement of three bridges in the corridor – the SR 512 bridge over I-5, the S Tacoma Way/Union Avenue bridge over I-5 and the S 56th Street bridge over I-5. Each bridge replacement will require further study, specifically interchange justification report (IJR) documentation which would include a more detailed and in depth examination of safety for all bridge replacement options under consideration. Crash history at the interchange loops within the study area would indicate that with the bridge replacement, planners and designers should explore other interchange types, possibly diverging diamond or single point urban interchange options (depending upon traffic volumes and site constraints), with a goal to reduce predicted crashes at the interchange.

### Cost

Parametric opinions of cost were developed for the practical design options to allow a measure of comparison between the Lane Conversion, Practical Design and Full-Standard options. The opinion of cost, however, was not used to differentiate or select a particular practical design option.

Cost element unit prices developed for the practical design cost opinion utilized the 2010 WSDOT programmatic estimate for the "unfunded" Tacoma HOV project. The total programmatic estimate of $1.076B for the SR 512 to S 38th Street Interchange construction included anticipated ROW costs. To develop a parametric cost opinion, the unfunded Tacoma HOV project was broken into the following elements:

- SR 512 interchange (including Steele Street interchange)
- 96th Street overcrossing
- 72nd/74th Street interchange
- 84th Street interchange
- 56th Street interchange
- 48th Street undercrossing
- I-5 main line

A subjective, rudimentary budget allocation of these elements was performed to assign construction, preliminary engineering and right of way costs. See Opinion of Costs for cost allocation details. Factored cost opinions for various practical design option elements such as replacing bridges or modifying interchange configurations were established from the Tacoma HOV program elements. A summation of the costs for these elements determined the high end of the range of costs for the Practical Design solution. The low end of the range was assumed to be 20% less than the high end. Cost opinions and the range of costs for Lane Conversion and Full-Standard components south of SR 512 to the Thorne Lane interchange were also developed in this same manner. The cost opinions are expressed in year 2010 dollars.

### Forward Compatibility

This criterion assesses the level to which an alternative is consistent with, or lays the groundwork for, an assumed desired future improvement—which in most cases is assumed to be the full design standards alternative.

### Practical Design Options Evaluation Summary Results

The practical design options were discussed at the December 12, 2016 Evaluation Workshop with WSDOT and other agency staff. Analysis indicated that the C-D roadway was more expensive than the other options, and there were operational concerns about weaving operations on the C-D roadway for vehicles exiting the mainline and crossing the C-D to reach the S 56th Street exit. As a result, the decision was made to eliminate the C-D roadway option from consideration as part of the representative practical design alternative. Of the bridge replacement options that remained, those that assumed reconfiguration of the SR 512 and S 56th Street interchanges were selected as the representative solutions.

## Corridor HOV Lane Alternatives Evaluation

This study developed and analyzed three basic alternatives for providing an HOV lane on I-5 between Thorne Lane and S 38th Street, addressing configurations that would be in place 24 hours per day. The alternatives did not include "time of day" options. Other studies by WSDOT and PSRC are considering strategies for "time of day" operation (e.g., Hard Shoulder Running, peak period HOV restrictions, etc.), but these strategies are not included in this study. A summary description of each alternative follows.

## Lane Conversion

This alternative assumed a straight conversion of the inside general purpose travel lane to HOV-only use by applying pavement markings and signing. This would reduce the overall corridor capacity for general purpose traffic, likely causing increased congestion during the peak travel periods. It was acknowledged during the course of the study that other strategies could be combined with this option to mitigate its impacts to general purpose traffic and enhance its performance. Allowing shoulder use as a travel lane during the peak traffic periods to replace the general purpose capacity could mitigate the primary impacts. Additionally, active traffic management (ATM) strategies including variable speed limits and queue warning capabilities to address increased congested conditions could be considered. These mitigation strategies require construction of improvements and thus come at a cost. Because these additional treatments are also typically used as part of practical design solutions a decision was made to keep the Lane Conversion alternative as a straightforward conversion without added treatments, to illustrate one extreme of the possible HOV implementation techniques.

## Practical Design Alternative

The representative practical design alternative for the corridor is depicted in **Figure 15**. The basic corridor section of practical design assumes four-foot inside shoulders, 11-foot travel lanes and 10-foot outside shoulders as previously illustrated in **Figure 6**. At a number of physical constraints posed by bridges, further width reduction to two-foot inside and outside shoulders for short distances would be implemented. Even with these more reduced shoulder widths, three locations cannot accommodate the additional lanes within the mainline cross section: the S Tacoma Way (Union Avenue) Bridge, the SR 512 Bridge and the S 56$^{th}$ Street Bridge. At these three locations, the Practical Design Alternative assumes the following:

- S Tacoma Way Bridge: replace with new bridge to accommodate the added mainline width
- SR 512: replace the existing bridge and potentially reconfigure the interchange. While this study was not tasked to define interchange configurations, if the SR 512 Bridge were replaced, it would be an appropriate time to consider reconfiguring the interchange. This study assumed interchange reconfiguration as a Diverging Diamond Interchange (DDI) (see previous **Figure 8**). If work is advanced on the corridor, an Interchange Justification Report would be needed to evaluate and determine an appropriate interchange configuration.
- S 56th Street: replace the existing bridge and potentially reconfigure the interchange as a DDI. If work is advanced on the corridor, an Interchange Justification Report would be needed to evaluate and determine an appropriate interchange configuration. A DDI has been illustrated in **Figure 11**


**Figure 15: Practical Design Alternative Components**

### Full Design Standards

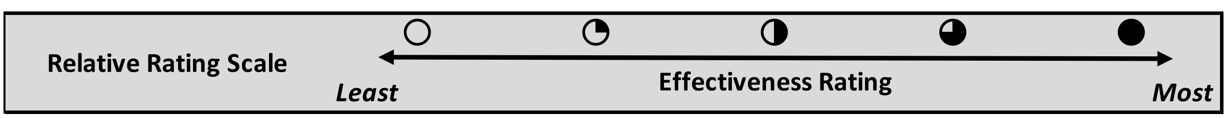
As its name implies, this alternative assumes the addition of an HOV lane through the study corridor with a design to full standards, including 12-foot travel lanes, 10-foot outside shoulders and ten-foot inside shoulders. It includes the recommendations from the Tacoma HOV Program for the corridor section between SR 512 and S 38th Street with every interchange and bridge being reconstructed, some with new interchange configurations. Between Thorne Lane and SR 512, all undercrossing structures were assumed to be replaced and the Clover Creek overcrossing widened to accommodate the wider main line. For the purposes of this study, the Bridgeport Way interchange was assumed to be modified to a diverging diamond interchange while the Gravelly Lake interchange was assumed to be modified but remain a tight diamond.

## Study Results

Once the representative alternatives were defined, they were compared with each other and with the No-Build alternative across multiple criteria in order to provide each alternative's merits and trade-offs. Note that it is not the intent of this study to make a recommendation as to which alternative would be most feasible for implementing HOV lanes in this corridor, but rather to show how the alternatives compare and what the primary trade-offs associated with each would likely be. The comparison criteria consisted of the following: mobility, safety, perceived stakeholder support and forward compatibility. In addition, "opinion of cost" estimates were developed for each alternative.

## Alternatives Evaluation

The results of the comparison of alternatives are shown in **Table 5**. Each alternative was given one of five different qualitative rankings for each criterion as indicated in the following rating scale.




A discussion of how the different alternatives were rated for each criterion follows.

### Mobility

The overall mobility criterion considers the alternative's effect on the level of congestion in the corridor, and the associated speed and reliability for both general purpose and HOV traffic. The evaluation of mobility for the final evaluation of alternatives remained at a conceptual level in order to provide "generalized" comparisons (as opposed to detailed technical analysis) of the congestion relief potential and operational performance for each alternative. For this level of evaluation, mobility for mainline operations was largely assessed by comparing estimated hourly volumes on the mainline with potential mainline and C-D capacity (estimated at approximately 2,000 vehicles per hour per lane). Consideration of narrowed lane widths and shoulders and their combined effect on vehicle speeds was taken into

**Table 5: Summary Comparison of HOV Lane Alternatives**

| Alternative | Evaluation Criteria | | | | Combined Rating | Opinion of Cost ($M) | Performance Rating Comparison (Relative to Full Standards) | Summary |
|---|---|---|---|---|---|---|---|---|
| | Mobility | Safety | Perceived Stakeholder Support | Forward Compatibility | | | | |
| **No Build** | ◔ | ◑ | ◔ | ○ | ◔ | 0 | 44% | Traffic conditions through this segment of I-5 will continue to worsen, particularly with the improvements to I-5 on segments both north and south of this segment. Provides no improvement to HOV mobility. |
| **Lane Conversion**[1] | ◔ | ◔ | ○ | ○ | ○ | $4–$5 | 33% | Provides HOV mobility, but scores lower than No Build due to low scores on all criteria, including the lowest on mobility, stakeholder support, and forward compatibility. |
| **Practical Design**[2] | ◕ | ◕ | ◕ | ◕ | ◕ | $250–$310 | 89% | Provides HOV mobility. High ratings across all criteria. Ratings of 89% of full design standards benefits at 16–20% of the cost. |
| **Full Design Standards**[3] | ● | ● | ◕ | ● | ● | $1,250–$1,560 | 100% | Provides HOV mobility. Scores the highest of all alternatives, but very high cost. |

**NOTES:**

1. Assumes basic lane conversion, without additional mitigating treatments.
2. The representative practical design alternative assumes a four-foot inside shoulder, eleven-foot lanes and a ten-foot outside shoulder through the majority of the corridor. At constrained locations, i.e., overcrossings or undercrossings, the inside and outside shoulder widths may be further reduced, but to never less than two-feet. The following 3 bridges over I-5 would need to be rebuilt: S Tacoma Way/Union Avenue Bridge; SR 512 Bridge (including an interchange reconfiguration, represented in this study as a Diverging Diamond Interchange (DDI)); and the 56th Street Bridge (including reconfiguration of the interchange, represented in this study as a DDI).
3. Assumes full compliance with the WSDOT Design Manual standards, including the improvements identified by Tacoma HOV program from SR 512 interchange to the 38th Street interchange. It also includes bridge replacement at the South Tacoma Way, BNRR, 47th Ave SW, Bridgeport Way, McChord Drive, and Gravelly Lake undercrossings, widening of the Clover Creek overcrossing bridge, modifications to the Bridgeport Way and Gravelly Lake interchanges, and main line I-5 widening—all to full standards.

**Relative Rating Scale**

○ ◔ ◑ ◕ ●

*Least* ← *Effectiveness Rating* → *Most* account for the practical design options to contrast the potential operational benefits of the added HOV lanes to the full design standard alternative where the additional HOV lanes are accommodated *without* reductions in lane and shoulder widths. An assessment of interchange operations was not conducted for each configuration type since it was assumed that a detailed traffic analysis of interchange operations would be conducted in the future to confirm and guide the follow-on design process.

The corridor currently experiences peak period congestion on a regular basis, and travel can frequently be unreliable through this segment. The No-Build Alternative would not address these issues, and travel conditions would be expected to worsen as traffic through the corridor grows. Additionally, without the addition of an HOV lane, HOV traffic would experience the same levels of congestion as general purpose traffic. Based on this, the No-Build Alternative was given a relatively low ranking of "◔" for mobility.

The Lane Conversion Alternative would reduce the general purpose capacity of the corridor from four to three lanes, which would result in better conditions for HOV traffic, but would likely create more congestion for general traffic. For this reason, and despite the benefits for HOV traffic, the Lane Conversion Alternative is considered to be worse than the No-Build Alternative for mobility and was given a ranking of "○".

The Practical Design Alternative would add an HOV lane through the study corridor and hence increase the overall capacity of the corridor. This would provide benefits for both general purpose as well as HOV traffic. This is estimated to be a significant benefit over No-Build conditions, and hence this alternative is given a ranking of "◕" for mobility.

The Full Design Standards Alternative would provide the same added capacity for both general purpose and HOV traffic as the Practical Design Alternative, but with full design standards. Because of this, it would likely result in a slightly higher quality of travel and level of comfort for the traveling public. Additionally, this alternative assumes significant reconfiguration of multiple interchanges through the corridor which would improve traffic flow to and from I-5. Because of this, the Full Design Standards Alternative is given a ranking of "●" for mobility.

## Safety

A more detailed evaluation of the expected safety impacts associated with implementing HOV lanes in the I-5 corridor was conducted using the AASHTO Interactive Highway Safety Design Model (IHSDM), an element of the Highway Safety Manual. The IHSDM is a "suite of software analysis tools for evaluating safety and operational effects of geometric design decisions on highways. It checks existing or proposed highway designs against relevant design policy values and provides estimates of a design's expected safety and operational performance."(Highway Safety Manual, introduction) For the purpose of this analysis, a simplistic model was developed for the 8.8 mile I-5 corridor (MP 123.26 – 132.14) mainline lanes for four segments, considering daily volumes and cross-section characteristics (number of lanes, lane widths, shoulder widths, barrier offset) for the following alternatives: a No-Build condition, a Lane Conversion condition, a Practical Design option, and the full design standards condition for implementing the HOV lanes between Thorne Lane interchange and the S 38th Street interchange. While simplistic, the crash prediction results for these models offer a tool for comparing the expected safety with the geometric characteristics of the range of options to implement the HOV lanes in the corridor -- an indication of the safety variation we could expect among the options and design features (predicted number of crashes that could be expected with each configuration). For comparison among the various options to implement the HOV lane through the study area, a measure of predicted crashes per general purpose lane per year is provided. These results are shown in **Table 6**.

**Table 6 HOV Implementation Configurations for Predicted Crash Modeling**

| Condition or Configuration | Number of GP Lanes and width | Shoulders | Range of Volumes (GP daily volume) | Crashes/GP Lane/Year (IHSDM Crash Prediction Model) |
|---|---|---|---|---|
| Existing or No-Build | 4 lanes at 12’ | 6’ inside, 10’ outside shoulders | 110,700 to 197,000 vpd | 126 crashes/GP lane/year |
| Lane Conversion | 5 lanes at 11’, one is HOV lane | 6’ inside, 10’ outside shoulders | 88,560 to 157,600 vpd (GP volumes only, 20% in HOV lane) | 132 crashes/GP lane/year |
| Practical Design – Replace 3 Bridges at S Tacoma Way, SR 512 and S 56th Street | 5 lanes at 11’, one is HOV lane | 4’ inside, 8’ outside shoulders except four locations with 2’ shoulders: 47th Street Bridge, McChord Dr Bridge, Bridgeport Way I/C, BNSF RR bridge | 88,560 to 157,600 vpd (GP volumes only, 20% in HOV lane) | 95 crashes/GP lane/year |
| Full Design or Buildout | 5 lanes at 12’, one is HOV lane | 8’ inside shoulder, 10’ outside shoulder | 88,560 to 157,600 vpd (GP volumes only, 20% in HOV lane) | 90 crashes/GP lane/year |

Congestion on I-5 is expected to continue with continued high incidence of congestion-related crashes – rear end and sideswipe crashes. However, for comparison purposes, the No-Build alternative was given a ranking of “◑” for safety, and the other alternatives are subsequently compared to No-Build.

The Lane Conversion Alternative is given a ranking of “◔” because with increased congestion and more traffic per general purpose lane than the No-Build, safety is expected to worsen in the corridor

The Practical Design Alternative is expected to improve safety in the corridor by adding one travel lane thereby reducing congestion and reducing the predicted crashes per general purpose lane. The interchange improvements at SR 512 and S 56th Street also are expected to improve safety, resulting in an overall ranking of "◕" for safety.

The Full Design Standards Alternative is expected to improve safety in the corridor by adding one travel lane and full shoulder widths thereby reducing congestion and reducing the predicted crashes per general purpose lane in comparison with the No-Build alternative. Additionally, the associated interchange improvements included in this alternative are also expected to improve safety. This alternative is given a safety ranking of "●".

## Perceived Stakeholder Support

The level of perceived stakeholder support was assessed based on feedback from local agency staff during study team workshops, as well as experience with the public from implementation of HOV lane projects elsewhere in the state and country.

The No-Build Alternative would not address the current and anticipated future traffic issues in the corridor and because of this was given a moderately low ranking of "◔".

Lane conversion experience from other areas around the country shows the potential for a major public backlash resulting from converting a general purpose traffic lane to HOV only use. This is particularly true when it occurs within an already congested corridor, such as I-5 in South Tacoma, resulting in a noticeable increase in congestion in the general purpose lanes. Because of this, the Lane Conversion Alternative is considered to be worse than the No-Build Alternative for this criterion and was given a ranking of "○".

The Practical Design Alternative adds an HOV lane through the study corridor and increases the overall capacity of the corridor. Because this provides benefits for both general purpose and HOV traffic, it is considered a significant improvement and is given a ranking of "◕".

The Full Design Standards Alternative provides the same added capacity for both general purpose and HOV traffic as the Practical Design Alternative does at higher design standards. It also provides significant improvements to multiple interchanges through the corridor which would improve traffic flow to and from I-5. The cumulative benefits are likely higher than any other alternative; however, because of its extremely high cost, this alternative is less likely to be funded and built. Because of this, the Full Design Standards Alternative is given a ranking of "◕" for perceived stakeholder support.

## Forward Compatibility

This criterion assesses the level to which an alternative is consistent with, or lays the groundwork for, an assumed desired future improvement—which in most cases is assumed to be the full design standards alternative. The No-Build Alternative was given a low ranking of "○" for forward compatibility because it does nothing to lay the groundwork for this future improvement.

The Lane Conversion Alternative was given a similarly low ranking of "○" because it also does not provide any foundation for the ultimate future improvement.

The Practical Design Alternative adds many elements of the full design standards alternative, most notably an HOV lane through the corridor. However, it does not reconfigure some corridor interchanges, and in the case of the SR 512 interchange could include a configuration that may need replacing if the ultimate plan from the Tacoma HOV Program were to be implemented. However, if the proposed practical design improvement at SR 512 proves to be functional, then the ultimate improvement may not be desirable due to its extremely high cost. For this reason, the Practical Design Alternative is given a relatively high ranking of "◕" for forward compatibility.

The Full Design Standards Alternative is given a ranking of "●" for forward compatibility because it reflects an ultimate build-out alternative for the corridor.

## Opinion of Costs

WSDOT's un-escalated October 1, 2010 "Unfunded" estimate of $1.076 billion for the Tacoma/Pierce County HOV Program was utilized for the full-design build alternative opinion of cost for the I-5 corridor from SR 512 to S 38th St. The estimate breakdown is shown in **Table 7** below.

**Table 7 Tacoma/Pierce County HOV Program "Unfunded" Cost Estimate**

| Oct 1, 2010 | SR 512 I/C | SR 512 I/C to SR 16 I/C | Notes |
|---|---|---|---|
| PE | $48 million | $48 million | Includes $8 million for Project Definition & Env. Documentation |
| Construction | $400 million | $400 million | |
| ROW | $100 million | $80 million | |
| Total | $548 million | $528 million | |

To be consistent, this estimate was used as the basis for the development of cost elements in the build alternatives' cost opinions. Since the above information was all that was available, subjective cost distribution factors were developed to allocate the construction cost among the various interchange and main line improvements. PE cost is calculated at 12% of the construction cost and ROW costs were allocated to the interchanges deemed to require ROW acquisition. The Tacoma HOV cost estimates were assumed to constitute the high end of the cost range. A low end was established by taking 80% of the high end cost.

A cost comparison with the *I-5 – JBLM Vicinity – Congestion Relief Study* and the *I-5 – Marvin Road/SR 510 Interchange* planning level cost estimates was performed to confirm that the cost allocations were in the "ball park" with other corridor estimates. See **Table 8** for the cost allocations of the Tacoma HOV program full-design cost opinion and comparison with the above mentioned projects.

Element costs were generated from the Tacoma HOV program cost allocations for application in the development of cost opinions for the Practical Design alternative and for the full-standard design elements not covered by the Tacoma HOV program. These cost elements were then further revised to better reflect the proposed alternative's modifications. See **Table 9** for derived cost elements.

Cost opinions for the build alternatives are shown in **Table 10**. The cost opinions developed for the Practical Design alternative include the cost elements found at the top of the table and a combination of the modifications proposed for the SR 512 and S 56th Street interchanges. The Active Traffic Management System cost shown is provided for information only and not included in the cost opinion as it was considered to be a mitigation measure and not a fundamental component of the alternative. The high end of the cost opinion range was obtained by summing the high end costs of the corridor's practical design improvements with the reconstruction of bridges and reconfiguration of the SR 512 and S 56th Street interchanges as Diverging Diamonds (PDO #1). The low end of the Practical Design alternative was established as 80% of the high end costs.

The cost opinion for the Full-Standards alternative includes the Tacoma HOV "unfunded" program cost plus the cost of the elements indicated.

The opinion of cost for the lane conversion alternative, $4-$5 million (M), reflects the simple concept of restriping an existing GP lane for HOV traffic and providing additional fixed signing associated with HOV restrictions. Additional congestion and traffic safety mitigation elements such as Active Traffic Management Systems (ATMS) were not included here but may be worth considering if this alternative is selected to advance for further study.

The opinion of cost for the practical design alternative of $250M to $310M reflects the practical design options that include reconstruction of the I-5 bridges at SR 512 and S 56th Street as well as at South Tacoma Way (Union Avenue). The cost also includes reconfiguration of the SR 512 and S 56th Street interchanges, reconstruction of the inside main line shoulders, pavement widening to provide an HOV lane and 10-foot outside shoulders, restriping, and HOV restriction signing.

The full standard alternative opinion of cost includes the Tacoma HOV unfunded programmatic cost and the proportional capital cost of rebuilding the undercrossing structures between Thorne Lane and SR 512. The $1.25 billion (B) to $1.56B range of costs also includes interchange revisions at Gravelly Lake Drive and Bridgeport Way and reconstruction of the main line pavement to account for an additional lane and full-design shoulder and lane widths.

## Table 8 - Tacoma HOV Cost Allocation & Comparison

| Project | Cost Date | Distr. Factor | Construction | PE | ROW | Total Low (80% of High) | Total High | Notes |
|---|---|---|---|---|---|---|---|---|
| Cost Opinion Basis | | | | | | | | |
| **Tacoma HOV** | | | | | | | | |
| S 84th St I/C to S 38th St I/C | 2010 | 5.65 | $400,000,000 | $48,000,000 | $80,000,000 | $422,000,000 | $528,000,000 | |
| 84th St I/C | | 0.50 | $35,400,000 | $4,200,000 | $0 | $32,000,000 | $40,000,000 | 1/2 interchange |
| 72nd/74th St I/C | | 1.00 | $70,800,000 | $8,500,000 | $32,000,000 | $89,000,000 | $111,000,000 | |
| 56th St I/C | | 1.40 | $99,100,000 | $11,900,000 | $48,000,000 | $127,000,000 | $159,000,000 | SPUI proposed |
| 48th St underxing bridge | | 0.25 | $17,700,000 | $2,100,000 | $0 | $16,000,000 | $20,000,000 | Undercrossing only |
| Main line I-5 | | 2.50 | $177,000,000 | $21,200,000 | $0 | $158,000,000 | $198,000,000 | MP 128.0 - MP 132.0 (4 lanes each direction x 4 miles) |
| | | | | | | | | |
| SR 512 I/C | 2010 | 5.00 | $400,000,000 | $48,000,000 | $100,000,000 | $438,000,000 | $548,000,000 | |
| 96th St overxing bridge | | 0.10 | $8,000,000 | $1,000,000 | $0 | $7,000,000 | $9,000,000 | Overcrossing only |
| Cost Comparison Check | | | | | | | | |
| **JBLM** | | | | | | | | |
| Thorne I/C | Dec 2014 | | $65,352,937 | $10,480,281 | $0 | | $75,833,218 | Per WSDOT, JBLM costs have been minimized. Did not use to |
| Berkeley I/C | Dec 2014 | | $63,786,400 | $10,229,064 | $0 | | $74,015,464 | establish capital cost opinion. |
| DuPont-Steilacoom I/C | Dec 2014 | | $86,221,857 | $13,826,912 | $0 | | $100,048,769 | |
| 7th & 8th Lanes | Dec 2014 | | $40,894,411 | $6,558,005 | $0 | | $47,452,416 | |
| | | | | | | | | |
| **Marvin Road I/C (SPUI)** | Sep 2016 | | $63,000,000 | $9,000,000 | $0 | $72,000,000 | $90,000,000 | Per WSDOT, original SPUI cost est. = $90M |

## Table 9 - Cost Elements

| Element | Construction | PE | ROW | Total Low (80% of High) | Total High | Notes |
|---|---|---|---|---|---|---|
| Replace Bridge only | $20,000,000 | $3,000,000 | $0 | $16,000,000 | $20,000,000 | From 48th St underxing bridge |
| | | | | | | |
| Replace Bridge-DDI | $89,000,000 | $13,000,000 | $0 | $82,000,000 | $102,000,000 | 90% of 56th St I/C SPUI. No ROW costs. |
| Replace Bridge-retain clover | $42,000,000 | $6,000,000 | $0 | $38,000,000 | $48,000,000 | 120% of 84th St I/C |
| Clover leaf partial mod | $19,000,000 | $3,000,000 | $0 | $18,000,000 | $22,000,000 | 45% of Replace Bridge-retain clover. |
| 2-3 lane CD (72nd - 38th, both directions) | $113,000,000 | $17,000,000 | $20,000,000 | $120,000,000 | $150,000,000 | CD assumed to be 4x 56th St CD (29% of 56th St I/C cost). Assumed |
| | | | | | | ROW = 1/4 of Tacoma HOV |
| Restriping (per lane-mile) | $48,000 | $7,000 | $0 | $44,000 | $55,000 | JBLM 7th & 8th lanes (4 lanes x 4 miles) + 10% for traffic control |
| Active Traffic Management System (per directional mile) | $2,290,000 | $340,000 | $0 | $2,100,000 | $2,600,000 | Example cost: I-90 Peak Use Shoulder Lane (1 direction) |
| | | | | | | |

## Table 10 Alternatives Opinion of Cost

| Alternative | Construction | PE | ROW | Total Low (80% of High) | Total High | Notes |
|---|---|---|---|---|---|---|
| **Practical Design** | | | | | | |
| S Tacoma Way underxing bridge | $35,400,000 | $4,200,000 | $0 | $32,000,000 | $40,000,000 | Used Tacoma HOV 84th St I/C |
| Restriping | $4,200,000 | $600,000 | $0 | $3,800,000 | $4,800,000 | 5 lanes each direction x 8.75 miles |
| Widening ML between constraints | $53,000,000 | $8,000,000 | $0 | $49,000,000 | $61,000,000 | MP 123.25 - MP 128.0 (Thorne Lane to SR 512) (1 lane each direction x 4.75 miles) |
| Active Traffic Management | $40,100,000 | $6,000,000 | $0 | $37,000,000 | $46,000,000 | Each direction x 8.75 miles - FOR INFO ONLY. Not included in cost est. |
| | | | | | | |
| Subtotal | $132,700,000 | $18,800,000 | $0 | $84,800,000 | $105,800,000 | |
| | | | | | | |
| 56th St & SR 512 I/C Practical Design Permutations | | | | | | |
| PDO #1 (Rebuild bridge @ SR 512 w/ DDI/Rebuild bridge @ 56th w/ DDI) | | | | $249,000,000 | **$310,000,000** | incl. S Tacoma Way bridge+Restriping+mainline widening |
| ~~PDO #2 (Rebuild bridge 512 w/ DDI/ CD w/ 56th DDI)~~ | | | | ~~$305,000,000~~ | ~~$380,000,000~~ | incl. S Tacoma Way bridge+Restriping+mainline widening |
| PDO #3 (Rebuild bridge @ SR 512 w/ DDI /Rebuild bridge @ 56th w/ clover) | | | | $205,000,000 | $256,000,000 | incl. S Tacoma Way bridge+Restriping+mainline widening |
| | | | | | | |
| PDO #4 (Rebuild bridge @ SR 512 w/ partial clover/Rebuild bridge @ 56th w/ DDI) | | | | $205,000,000 | $256,000,000 | incl. S Tacoma Way bridge+Restriping+mainline widening |
| ~~PDO #5 (Rebuild bridge @ SR 512 w/ partial clover / CD w/ 56th DDI)~~ | | | | ~~$261,000,000~~ | ~~$326,000,000~~ | incl. S Tacoma Way bridge+Restriping+mainline widening |
| PDO #6 (Rebuild bridge @ SR 512 w/ partial clover / Rebuild bridge @ 56th w/ clover) | | | | **$161,000,000** | $202,000,000 | incl. S Tacoma Way bridge+Restriping+mainline widening |
| | | | | | | |
| **Lane Conversion** | | | | **$4,000,000** | **$5,000,000** | Restriping & HOV signing |
| | | | | | | |
| **Full Standards** | | | | | | |
| Tacoma HOV - SR 512 to 38th St I/C | | | | $861,000,000 | $1,076,000,000 | Tacoma HOV |
| S Tacoma Way underxing bridge | | | | $16,000,000 | $20,000,000 | Replace Bridge Only element |
| BNRR Bridge | | | | $22,000,000 | $27,000,000 | Assumed 35% higher than Replace Bridge Only element |
| 47th Ave SW underxing bridge | | | | $16,000,000 | $20,000,000 | Replace Bridge Only element |
| Bridgeport I/C | | | | $82,000,000 | $102,000,000 | Replace Bridge-DDI element |
| Clover Creek overxing bridge | | | | $7,000,000 | $9,000,000 | Used 96th St Overxing cost allocation |
| McChord Drive underxing bridge | | | | $16,000,000 | $20,000,000 | Replace Bridge Only element |
| Gravelly Lake I/C (retain tight diamond) | | | | $38,000,000 | $48,000,000 | Used Replace Bridge-retain clover element |
| Main line I-5 | | | | $188,000,000 | $235,000,000 | Percentage (4.75 mi/4 mi) of Tacoma HOV Main line I-5 |
| | | | | | | |
| | | | | **$1,246,000,000** | **$1,557,000,000** | |

## Combined Rating

A simple "combined rating" was calculated by taking the average of the rankings across all four criteria, as a way to assess the overall performance of each alternative. The Full Design Standards Alternative received the highest combined rating of "●" and the Practical Design Alternative received a moderately high rating of "◕". The No-Build received a moderately low rating of "◔", and the Lane Conversion Alternative received the lowest rating at "○".

## Performance Rating Percentage Comparison

Another way to assess the overall performance of the alternatives is to compare the cumulative rating score for each alternative to the rating of the Full Design Standards Alternative in terms of "percentage of benefits". The Full Design Standards Alternative received rating scores of "4" for Mobility, "5" for Safety, "4" for Perceived Stakeholder Support, and "5" for Forward Compatibility for a cumulative rating score of 18. The Full Design Standards Alternative, when compared to itself, by definition receives a score of 18 out of 18 or 100%. The Practical Design Alternative's cumulative rating score of 16 is estimated at 89% (16 out of 18) of the Full Design Standards Alternative benefits, while the No-Build is estimated at 44% (8 out of 18) and the Lane Conversion Alternative at 33% (6 out of 18).

## Summary Conclusions

This high level assessment of three representative build alternatives for implementing a 24-hour HOV lane through the I-5 corridor between Thorne Lane and S 38th Street has revealed the following findings:

No-Build Alternative: Both general purpose and HOV traffic in this segment of I-5 currently experience congestion and unreliable travel times. The currently programmed improvements north and south of this segment may relieve congestion resulting from the reduction from four to three lanes at Thorne Lane, and northbound congestion stemming from the heavy SR 16 and I-705 merges. However, these same improvements will also accommodate more northbound traffic into the corridor from the south, and more southbound traffic into the corridor from the north due to the resulting increase in capacity from those improvements. With the overall growth in traffic expected in Pierce County, including that associated with JBLM, traffic and related safety conditions through this section of I-5 are expected to worsen. The No-Build Alternative provides no relief to address these conditions, nor improvement to HOV mobility.

Lane Conversion Alternative: While this alternative provides improved HOV mobility, it would impact general purpose mobility and safety. When compared to all alternatives, including No-Build, lane conversion scores the lowest with an estimated 33 percent of the benefits associated with the Full Design Standards Alternative, including scoring the lowest on mobility, perceived stakeholder support, and forward compatibility. Some strategies to alleviate the impacts of this alternative were identified and discussed during this study, but were beyond the scope of this study to pursue further. If a lane conversion option were to warrant further consideration, then complementary active traffic management treatments (such as variable speed limits, queue warning, and hard shoulder running during the peak periods) and enhanced incident management programs should also be considered.

Practical Design Alternative: This alternative scored high or moderately high for all of the criteria. It is expected to provide improved mobility for both HOV and general purpose traffic and improved safety as compared to the No-Build. It is also expected to be well supported by stakeholders and is relatively forward compatible with what might be the ultimate configuration for the corridor. In all, it is anticipated to provide up to 89 percent of the benefits associated with the Full Design Standards Alternative at 16 to 25 percent of the cost. If this alternative is selected for further development however, a field survey at each bridge location is needed to confirm available widths. Results of this survey could ultimately produce different results, including the possible need to replace more bridges than indicated here.

Full Design Standards Alternative: This alternative scores the highest of all the alternatives. It provides improved HOV and general purpose mobility and improved safety. It scores high on forward compatibility because it is likely to be the ultimate build-out configuration for the corridor. However, it is also four to six times more costly than the Practical Design Alternative, which may make it cost-prohibitive.

# Appendix A: List of Agency Stakeholder Meeting Attendees

## Project Team Meeting #1
## Baseline Conditions & Evaluation Measures

*October 13, 2016 (1:00 pm – 3:00 pm)*

WSDOT Olympic Region Board room (Tumwater)

### Attending:

| Name | Phone | Email | Organization |
|---|---|---|---|
| Bill Elliott | 360-357-2735 | elliotb@wsdot.wa.gov | WSDOT |
| John Wynands | 360-357-2658 | wynandj@wsdot.wa.gov | WSDOT |
| Steve Kim | 360-357-2670 | kims@wsdot.wa.gov | WSDOT |
| Joseph Perez | 360-357-2683 | perezj@wsdot.wa.gov | WSDOT |
| Chris Wellander | 206-382-5296 | wellanderc@pbworld.com | WSP\|PB |
| Tony Lo | 206-382-5241 | loan@pbworld.com | WSP\|PB |
| Keith Nakano | 206-382-5202 | nakano@pbworld.com | WSP\|PB |
| Katherine Casseday | 206-450-8758 | katherine@cassedaytraffic.com | Casseday Consulting |
| Scott Zeller | 360-705-7253 | zellers@wsdot.wa.gov | WSDOT |
| Don Peterson | 360-534-9323 | DON.PETERSEN@FHWA.DOT.GOV | FHWA |
| Dennis Bloom | 360-705-5832 | dbloom@intercitytransit.com | Intercity Transit |
| Eric Phillips | 360-705-5885 | ephillips@intercitytransit.com | Intercity Transit |
| Scott Gowan | 360-705-3257 | Gowans@wsdot.wa.gov | WSDOT |
| Weston Ott | 253-983-7725 | wott@cityoflakewood.us | Lakewood |
| Dean Moberg | 360-534-9344 | Dean.Moberg@fhwa.dot.gov | FHWA |
| Josh Diekmann | 253-591-5756 | jdiekmann@cityoftacoma.org | Tacoma |
| Mazedur Hossain | 253-591-5523 | mhossain@cityoftoacoma.org | Tacoma |
| Veena Tabbutt | 360-741-2550 | tabbuttv@trpc.org | Thurston Regional Planning Council |

# Project Team Meeting #2
# Alternatives Definition Workshop

*October 28, 2016 (9:00 am – 12:00 noon)*

WSDOT Olympic Region Board room (Tumwater)

**Attending:**

| Name | Phone | Email | Organization |
|---|---|---|---|
| Bill Elliott | 360-357-2735 | elliotb@wsdot.wa.gov | WSDOT |
| Steve Kim | 360-357-2670 | kims@wsdot.wa.gov | WSDOT |
| Joseph Perez | 360-357-2683 | perezj@wsdot.wa.gov | WSDOT |
| Chris Wellander | 206-382-5296 | wellanderc@pbworld.com | WSP\|PB |
| Keith Nakano | 206-382-5202 | nakano@pbworld.com | WSP\|PB |
| Katherine Casseday | 206-450-8758 | katherine@cassedaytraffic.com | Casseday Consulting |
| Dennis Bloom | 360-705-5832 | dbloom@intercitytransit.com | Intercity Transit |
| Weston Ott | 253-983-7725 | wott@cityoflakewood.us | Lakewood |
| Dean Moberg | 360-534-9344 | Dean.Moberg@dot.gov | FHWA |
| Eric Chipps | 206-398-5020 | eric.chipps@soundtransit.org | Sound Transit |

# Project Team Meeting #3
# Alternatives Evaluation Workshop

*December 12, 2016 (9:00 am – 12:00 pm)*

WSDOT Olympic Region Board room (Tumwater)

**Attending:**

| Name | Phone | Email | Organization |
|---|---|---|---|
| Bill Elliott | 360-357-2735 | elliotb@wsdot.wa.gov | WSDOT |
| Steve Kim | 360-357-2670 | kims@wsdot.wa.gov | WSDOT |
| Joseph Perez | 360-357-2683 | perezj@wsdot.wa.gov | WSDOT |
| Chris Wellander | 206-382-5296 | wellanderc@pbworld.com | WSP\|PB |
| Tony Lo | 206-382-5241 | loan@pbworld.com | WSP\|PB |
| Keith Nakano | 206-382-5202 | nakano@pbworld.com | WSP\|PB |
| Katherine Casseday | 206-450-8758 | katherine@cassedaytraffic.com | Casseday Consulting |
| Dennis Bloom | 360-705-5832 | dbloom@intercitytransit.com | Intercity Transit |
| Scott Gowan | 360-705-3257 | Gowans@wsdot.wa.gov | WSDOT |
| Dean Moberg | 360-534-9344 | Dean.Moberg@fhwa.dot.gov | FHWA |