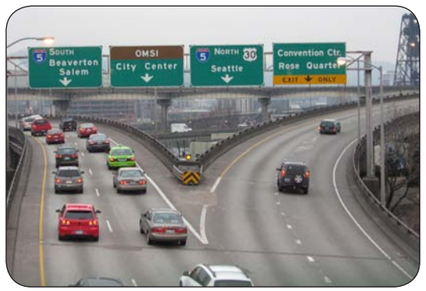
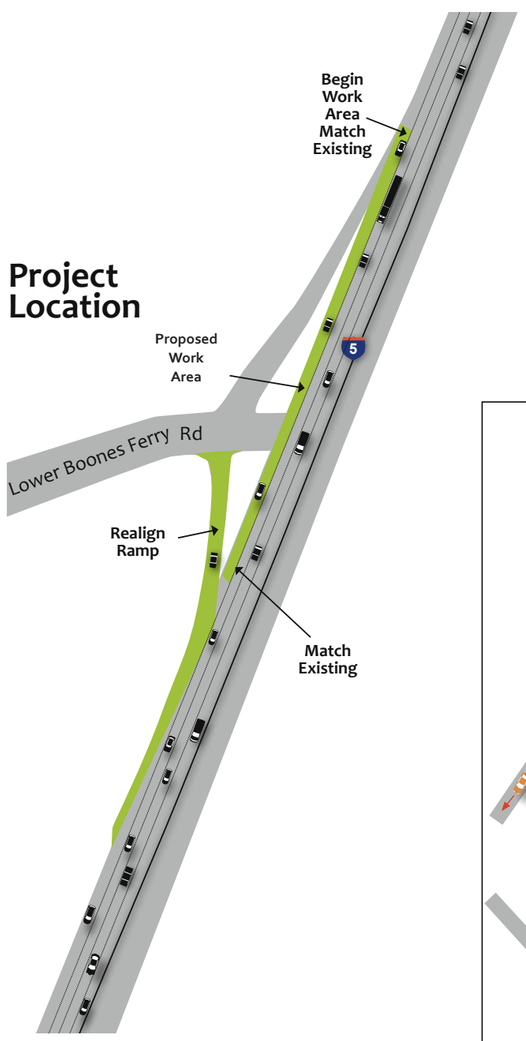
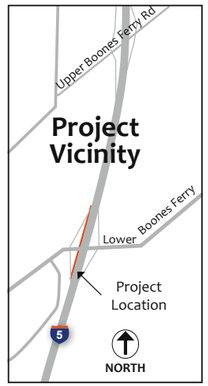
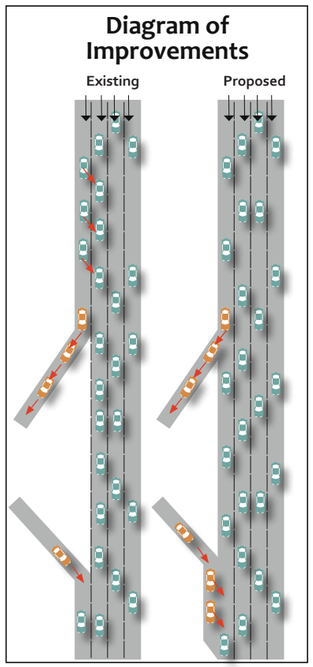
Project Atlas

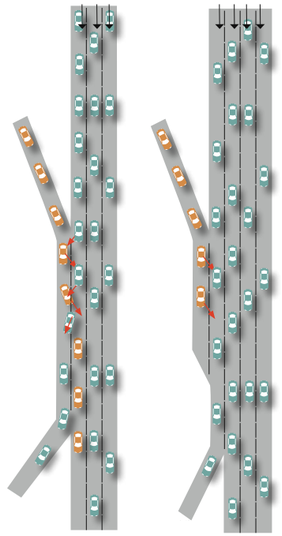
Corridor Bottleneck Operations Study - *ODOT Region 1*

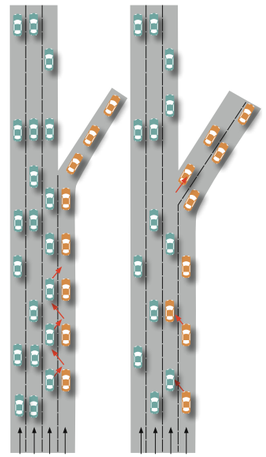












Project Atlas

Corridor Bottleneck Operations Study – ODOT Region 1

Oregon Department of Transportation, Region 1
123 NW Flanders
Portland, Oregon 97209

Consultant

David Evans and Associates, Inc.
2100 SW River Parkway
Portland, Oregon 97201

Acknowledgements

ODOT Region 1 Staff

Andrew Johnson – Major Projects Manager
Thomas Picco – CBOS Project Manager
Tim Wilson – CBOS Project Manager
Chi Mai – Senior Transportation Engineer
Simon Eng – Senior Traffic Engineer
Dennis Mitchell –Region Traffic Engineer
Katherine Carlos – Traffic Analyst
Canh Lam – Senior Preliminary Designer
Mark Johnson – Senior Preliminary Designer
Mark Barrett – Preliminary Designer
Lindsay Higa – Preliminary Designer
Sandra Koike - Planner

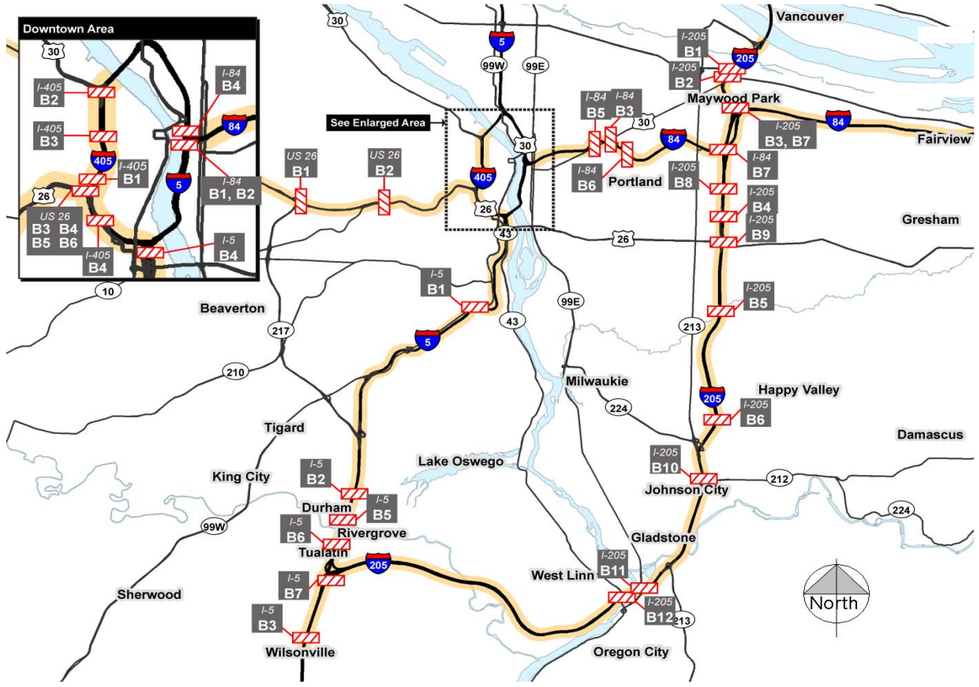
Consultant Staff (David Evans and Associates, Inc.)

Mike Baker – Principal, Lead Facilitator
Scott Harmon – Project Manager
Shelly Alexander – Traffic Engineer
Josh Anderson – Traffic Engineer
Ryan LeProwse – Traffic Engineer
Joshan Rohani – Traffic Engineer
Gavin Oien – Design Engineer
Aaron Shupien – Design Engineer
Angela Rogge – Traffic Analyst
Angie Jones – Graphic Specialist
Jordan Henderson – Intern

Final Working Draft

April 2013

Regional Recurring Bottleneck Location Summary



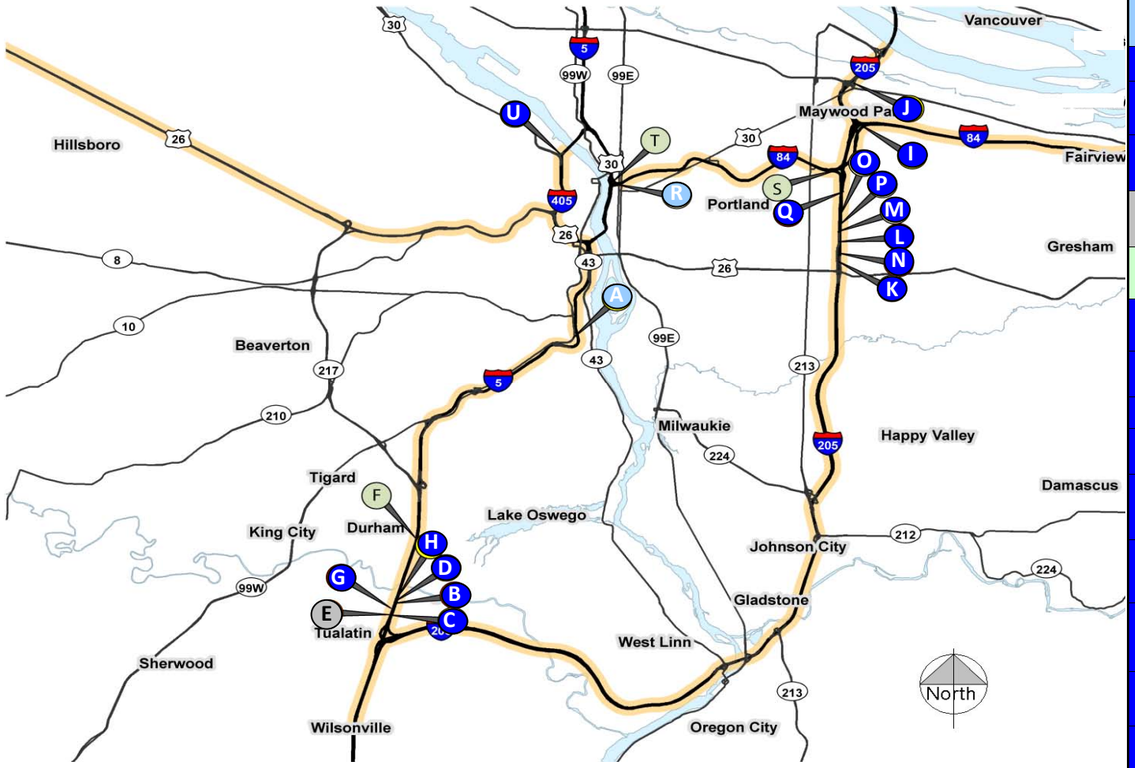
Recurring Bottleneck Location

Recurring Bottleneck ID	Recurring Bottleneck Locations	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail sheet on page #
		Decision Point	Physical Constraint			
I-5 Bottlenecks						
B1	I-5 NB: Terwilliger Boulevard Entrance Ramp (AM & PM)	X	X	20	4	Page | 3-5
B2	I-5 NB: Lower Boones Ferry Road Exit Ramp (AM)	X		30	1.25	Page | 3-5
B3 *	I-5 NB: Westbound Elligsen Road Entrance Ramp (PM)	X		*	*	Page | 3-5
B4	I-5 SB: Hood Avenue Exit Ramp (PM)	X		10	2.75	Page | 3-6
B5	I-5 SB: Carman Drive Lane Drop (PM)	X		10	2.25	Page | 3-6
B6	I-5 SB: Nyberg Street Exit Ramp (PM)	X		25	2.5	Page | 3-6
B7 **	I-5 SB: I-205 Entrance Ramp (PM)	X		**	**	Page | 3-6
I-205 Bottlenecks						
B1	I-205 NB: Sandy Boulevard/Columbia Boulevard Entrance Ramp (PM)	X		20	3	Page | 3-7
B2	I-205 NB: Columbia Boulevard/Hwy 30 Exit Ramp (PM)	X		35	Inconclusive	Page | 3-7
B3	I-205 NB: Westbound I-84 Entrance Ramp (PM)	X		5	5.25	Page | 3-7
B4	I-205 NB: Division Street Entrance Ramp and Hwy 26/Powell Blvd. Entrance	X		10	2.75	Page | 3-7
B5	I-205 NB: Foster Road Exit Ramp (AM & PM)	X		20	4	Page | 3-7
B6	I-205 NB: Sunnybrook Road Entrance Ramp (PM)	X		30	2.25	Page | 3-7
B7	I-205 SB: Westbound I-84 Exit Ramp (AM & PM)	X		5	4.25	Page | 3-8
B8	I-205 SB: Stark/Washington Street Entrance Ramp (PM)	X		10	3.25	Page | 3-8
B9	I-205 SB: Hwy 26/Division Street/Powell Boulevard Exit Ramp (PM)	X		25	3.25	Page | 3-8
B10	I-205 SB: 212/224 Entrance Ramp (PM)	X		35	1	Page | 3-8
B11	I-205 SB: 99E/McLoughlin Boulevard Exit Ramp (AM)	X		20	1.25	Page | 3-8
B12	I-205 SB: Hwy 43 Entrance Ramp (AM)	X		30	2	Page | 3-8
I-84 Bottlenecks						
B1	I-84 EB: I-5 SB Entrance Ramp (AM & PM)	X		10	12	Page | 3-9
B2	I-84 EB: I-5 SB/NB Merge (PM)		X	5	4	Page | 3-9
B3	I-84 EB: 39th Avenue Entrance Ramp (PM)	X		Inconclusive	Inconclusive	Page | 3-9
B4	I-84 WB: I-5 Diverge (AM & PM)	X		20	8+	Page | 3-10
B5	I-84 WB: 33rd Avenue Entrance Ramp (AM)	X		15	4	Page | 3-10
B6	I-84 WB: Glisan Entrance Ramp (AM)	X		Inconclusive	Inconclusive	Page | 3-10
B7	I-84 WB: I-205 SB to I-84 WB Ramp	X		Inconclusive	Inconclusive	Page | 3-10
I-405 Bottlenecks						
B1	I-405 NB: US 26/12th Ave (PM)	X		5	3	Page | 3-11
B2	I-405 SB: US 30 Entrance Ramp (PM)	X		5	3	Page | 3-12
B3	I-405 SB: Everett Street Entrance Ramp to US 26 Exit Ramp Weave (PM)	X		5	3	Page | 3-12
B4	I-405 SB: US 26 Entrance Ramp to Broadway Exit Ramp Weave (PM)	X		5	3	Page | 3-12
US 26 Bottlenecks						
B1	US 26 EB: Oregon 217 Entrance Ramp (AM)	X		10	3	Page | 3-13
B2	US 26 EB: Skyline/Scholls Ferry Entrance Ramp (AM & PM)	X		Inconclusive	Inconclusive	Page | 3-13
B3	US 26 EB: I-405 Positioning/Curves/Tunnel (AM & PM)	X	X	15	8	Page | 3-13
B4	US 26 EB: Ramp to I-405 SB (AM & PM)	X	X	5	8	Page | 3-13
B5	US 26 EB: Ramp to I-405 NB (AM & PM)	X	X	5	7	Page | 3-13
B6	US 26 WB: I-405 Ramps/US 26 merge (PM)	X	X	10	3	Page | 3-14

* Construction of NB Auxilary Lane in 2011

** Construction of SB Auxilary Lane in 2010

Potential Regional Projects Summary



Recommended Project Location

Map ID	Recurring Bottleneck ID	Potential Solution Identified	Potential Regional Projects	Est. Cost	See Project Sheet on page #
I-5 Potential Projects					
A	I-5: B1	Further Analysis	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	$30M - $40M	Page | 4-7
B	I-5: B2	Yes	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	$1M - $2M	Page | 4-8
C	I-5: B2	Yes	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	$11.5M - $13.5M	Page | 4-9
D	I-5: B2	Yes	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	$17M - $21M	Page | 4-10
E	I-5: B2	Project Phased	This Project is Phased into I-5 NB Projects B, C and D.	$18M - $22M	Page | 4-12
F	I-5: B5	Constructed August 2012	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	$1.25M	Page | 4-11
G	I-5: B6	Yes	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	$7.2M - $8.5M	Page | 4-13
H	I-5: B6	Yes	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	$10M -$18M	Page | 4-14
I-205 Potential Projects					
I	I-205: B3	Yes	I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane	$6.7M	Page | 4-19
J	I-205: B3	Yes	I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension	$6.5M	Page | 4-20
K	I-205: B4	Yes	I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.	6.5M - $7.5M	Page | 4-21
L	I-205: B4	Yes	I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension	$6.0M - $6.9M	Page | 4-22
M	I-205: B4	YES	I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension	$2.4M - $2.8M	Page | 4-23
N	I-205: B4	Yes	I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension	$2.2M - $2.5M	Page | 4-24
O	I-205: B4	Yes	I-205 NB: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington Street	$1.7M - $2.0M	Page | 4-25
P	I-205: B4	Yes	I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-lane Exit at Washington St.	$7.6M - $8.M	Page | 4-26
Q	I-205: B8/B9	Yes	I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane	$7.0M - $8.5M	Page | 4-27
I-84 Potential Projects					
R	I-84: B2	Further Analysis	I-84 EB: Grand Ave. Entrance Ramp Extension	$4.4M - $5.2M	Page | 4-33
S	I-84: B3	Construction 2013	I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane	$5.9M	Page | 4-34
T	I-84: B4	Construction 2013	I-84 WB: I-5 NB and I-5 SB Diverge Re-striping	$0.5M	Page | 4-35
I-405 Potential Projects					
U	I-405: B2	Yes	I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement	$0.5M - $1.0M	Page | 4-41

TABLE OF CONTENTS

CHAPTER 1: HOW TO USE THIS PROJECT ATLAS

1.1 How is This Atlas Organized 1-1

1.2 Where are the Bottlenecks and How Much do They Contribute to Congestion? 1-3

1.3 What and Where Are the Recommended Projects? 1-3

1.4 What Is the Best Way to Select a Recommended Project Based on Limited Funds Available? 1-6

CHAPTER 2: INTRODUCTION (PROJECT SYNOPSIS)

2.1 Study Area 2-3

2.2 Bottleneck Identification Methodology 2-3

CHAPTER 3: BOTTLENECKS AND SOLUTIONS

3.1 CBOS Purpose 3-3

3.2 Common Causes And General Locations Of Bottlenecks 3-3

3.3 What and Where Are the Bottlenecks? 3-3

3.4 Region Bottleneck Summary 3-4

3.5 Steps in Developing Solution 3-16

3.6 What Are Other Appropriate Solutions? 3-16

3.7 Fatal Flaw Screening 3-16

3.8 Refinement of Potential Solutions 3-16

3.9 Potential Regional Projects 3-17

3.10 Regional Project Modeling 3-23

3.11 What Do You Need to Know About the Recommended Projects? 3-24

CHAPTER 4: BOTTLENECKS AND PROJECT RECOMMENDATIONS BY CORRIDOR

4.1 I-5 Recurring Bottlenecks and Project Recommendations 4.3

Project A: *I-5 NB: Terwilliger Blvd. Entrance Ramp Extension* *4-7*

Project B: *I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration* *4-8*

Project C: *I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange* *4-9*

Project D: *I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange* *4-10*

Project E: *I-5 NB: Nyberg Rd. Interchange to Carman Dr. Interchange* *4-11*

Project F: *I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp* *4-12*

Project G: *I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance* *4-13*

Project H: *I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205* *4-14*

4.2 I-205 Recurring Bottlenecks and Project Recommendations 4-15

Project I: *I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp* *4-19*

Project J: *I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp* *4-20*

Project K: *I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp* *4-21*

Project L: *I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp* *4-22*

Project M: *I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp* *4-23*

Project N: *I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp* *4-24*

Project O: *I-205 NB: Phase 4 - Division Street to Stark St./Washington St. Exit Ramp* *4-25*

Project P: *I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp* *4-26*

Project: Q: *I-205 SB: I-84 EB Entrance Ramp to Stark St./Washington St. Exit Ramp* *4-27*

4.3 I-84 Recurring Bottlenecks and Project Recommendations 4-29

Project R: *I-84 EB: Grand Ave. Entrance Ramp Extension* *4-33*

Project S: *I-84 EB: Halsey St. Exit Ramp to I-205 NB Entrance Ramp* *4-34*

Project T: *I-84 WB: I-5 NB and I-5 SB Diverge Re-striping* *4-35*

4.4 I-405 Recurring Bottlenecks and Project Recommendations 4-39

Project U: *I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement* *4-41*

4.5 US 26 Recurring Bottlenecks and Project Recommendations 4-45

CHAPTER 5: APPENDICES (See Reference CD)

5.1 Appendix A: Technical Memoranda Reference CD

A.1 Technical Memoranda 1 & 2: Methodology and Assumptions (known and available data)

A.2 Technical Memoranda 3: Bottleneck Identification and Diagnosis

A.3 Technical Memoranda 4 & 5: Corridor Design Review

A.4 Technical Memoranda 6: Evaluation Framework for Investments to Improve Freeway Operations at Bottlenecks on I-5 & I-205

A.5 Technical Memoranda 7: Design Panel Results

A.6 Technical Memoranda 8: Feasibility Review

A.7 Technical Memoranda 9: Summary of Operations Results

5.2 Appendix B: Preliminary Design Schematics Reference CD

5.3 Appendix C: Initial Data Summary Reference CD

5.4 Appendix D: Regional Modeling Reference CD

5.5 Appendix E: Reserved for Additional Material

List of Tables

Chapter 3:

Table 3.1:	Potential Regional Projects Summary	3-18

List of Figures

Chapter 2:

Figure 2-1:	Study Area Corridors	2-3

Chapter 3:

Figure 3-1:	Common Locations for Localized Bottlenecks	3-4
Figure 3-2:	I-5 Northbound Bottlenecks	3-5
Figure 3-3:	I-5 Southbound Bottlenecks	3-6
Figure 3-4:	I-205 Northbound Bottlenecks	3-7
Figure 3-5:	I-205 Southbound Bottlenecks	3-8
Figure 3-6:	I-84 Eastbound Bottlenecks	3-9
Figure 3-7:	I-84 Westbound Bottlenecks	3-10
Figure 3-8:	I-405 Northbound Bottlenecks	3-11
Figure 3-9:	I-405 Southbound Bottlenecks	3-12
Figure 3-10:	US 26 Eastbound Bottlenecks	3-13
Figure 3-11:	US 26 Westbound Bottlenecks	3-14
Figure 3-12:	Regional Recurring Bottleneck Locations	3-15
Figure 3-13:	Potential Regional Projects	3-22

Chapter 4:

Figure 4-1:	I-5 Recurring Bottleneck Locations	4-6
Figure 4-2:	I-5 Recommended Projects	4-6
Figure 4-3:	I-205 Recurring Bottleneck Locations	4-18
Figure 4-4:	I-205 Recommended Projects	4-19
Figure 4-5:	I-84 Recurring Bottleneck Locations	4-32
Figure 4-6:	I-84 Recommended Projects	4-32
Figure 4-7:	I-405 Recurring Bottleneck Locations	4-40
Figure 4-8:	I-405 Recommended Projects	4-40
Figure 4-9:	US 26 Recurring Bottleneck Locations	4-46
Figure 4-10:	US 26 Recommended Projects	4-46

List of Exhibits

Chapter 1:

Exhibit 1-1:	How to Read the Bottleneck Operation Detail	1-4
Exhibit 1-2:	How to Read the Bottlenecks and Recommended Projects for each Corridor	1-5
Exhibit 1-3:	How to Read the Project Sheets	1-7

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CHAPTER 1:
HOW TO USE THIS PROJECT ATLAS

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Chapter 1: How to Use This Project Atlas

This Project Atlas provides a collection of maps, tables, and project sheets that can be used in a variety of different ways, depending on the user's needs. This combined document identifies bottleneck locations along five metro area corridors (I-5, I-205, I-84, I-405, and US 26) and correlates locations of congestion with recommended enhancement measures.

This chapter is to help the users understand and locate important information in this Project Atlas. The following sections provide a few examples of how this Project Atlas can be used, as well as detailed directions for how to read key figures throughout the document.

1.1 How is This Atlas Organized?

The **Table of Contents** on page iii of this Project Atlas provides a high-level overview of the document layout.

The Introduction, in **Chapter 2**, provides a project overview, defines the study area, and provides the methodology to identify the bottlenecks for the Atlas.

1.2 Where are the Bottlenecks and How Much do They Contribute to Congestion?

Chapter 3 deals with the identification and evaluation of bottlenecks and potential solutions. Bottlenecks are compared and evaluated in several different ways throughout the document.

How is Key Information Evaluated for Corridor Operations Bottlenecks?

The Corridor Bottleneck Operations analysis (I-5: **Figures 3-2 and 3-3**, I-205: **Figures 3-4 and 3-5**, I-84: **Figures 3-6 and 3-7**, I-405: **Figures 3-8 and 3-9**, and US26: **Figures 3-10 and 3-11**) provide a detailed bottleneck-specific perspective of identified bottlenecks along each metro area corridor.

These figures allow users to evaluate key information, including:

- Location
- Influence area
- Congestion duration and time periods
- Contributing factors
- Reported crashes
- Operations summary

Exhibit 1-1 provides a high-level overview of how to read the Bottleneck Operation Detail figures.

In these detailed figures, each bottleneck is labeled by its Bottleneck ID and classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. Each corridor has two figures, each of which is specific to one direction of travel.

Each bottleneck has an influence area that is illustrated by two dotted red lines, and within that influence area is a red-hatched activation range (the segment that contains the start of a new/confounding bottleneck). Historical crash data (5 years) from ODOT's Online Crash Database is shown along the length of the corridor to visually assess correlations between crash frequency and lane geometry on the facilities. Next to the corridor image, the important information for each bottleneck is summarized in a text box along with the data sources that were used to identify and validate the bottleneck.

How are Bottlenecks Compared Throughout the Region?

The Regional Bottleneck Summary Figure (**Figure 3-12**) provides a regional perspective of all identified bottlenecks along the five metro area corridors (I-5, I-205, I-84, I-405, and US 26). This figure allows users to understand the type of bottleneck, and evaluate the relative severity of congestion related to each bottleneck (duration and speed) throughout the region.

How are Potential Recommended Projects Evaluated Throughout the Region?

Table 3-1 provides a summary of the analysis and evaluation of the bottlenecks that were identified in the Regional Bottleneck Summary (**Figure 3-12**). From the analysis process, the bottlenecks are refined and identified as potential projects to address the bottlenecks. This table includes the potential project location, description, estimated cost of the project, and traffic analysis findings. The table has a recommended action for each potential project. The Potential Regional Projects (**Figure 3-13**) provide a corridor-specific perspective of identified bottlenecks along each metro area corridor (I-5, I-205, I-84, I-405, and US 26) and identifies potential solutions that have been in the analysis.

1.3 What and Where Are the Recommended Projects?

In **Chapter 4**, the individual recommended projects are presented by corridor and by individual project sheets. The chapter is organized by the five corridors; each corridor has a bottleneck identification figure and specific recommended projects figure. Recommended projects are compared and evaluated in several different ways throughout the document. The following sections identify the appropriate figures to use, based on the information desired.

How are Bottlenecks Compared for a Specific Corridor?

The corridor-specific Bottleneck Summary Figures (**Figure 4-1, Figure 4-3, Figure 4-5, Figure 4-7,** and **Figure 4-9**) provide a corridor-specific perspective of identified bottlenecks along each metro area corridor. These figures allow users to evaluate the relative severity of congestion related to each bottleneck (duration and speed) along a corridor.

How are Recommended Projects Compared for a Specific Corridor?

The corridor-specific Recommended Project Figures (**Figure 4-2, Figure 4-4, Figure 4-6, Figure 4-8,** and **Figure 4-10**) provide a corridor-specific perspective of recommended projects along each metro area corridor.

How to Read the Bottleneck and Recommended Projects Figures?

Exhibit 1-2 provides a high-level overview guide of how to read the bottlenecks and recommended projects for each corridor figures.

How is Key Information Evaluated for Each Recommended Project?

The project sheets (provided in **Chapter 4**) provide a detailed project-specific perspective of recommended projects along each metro area corridor.

Exhibit 1-1: How to Read the Bottleneck Detail Figures

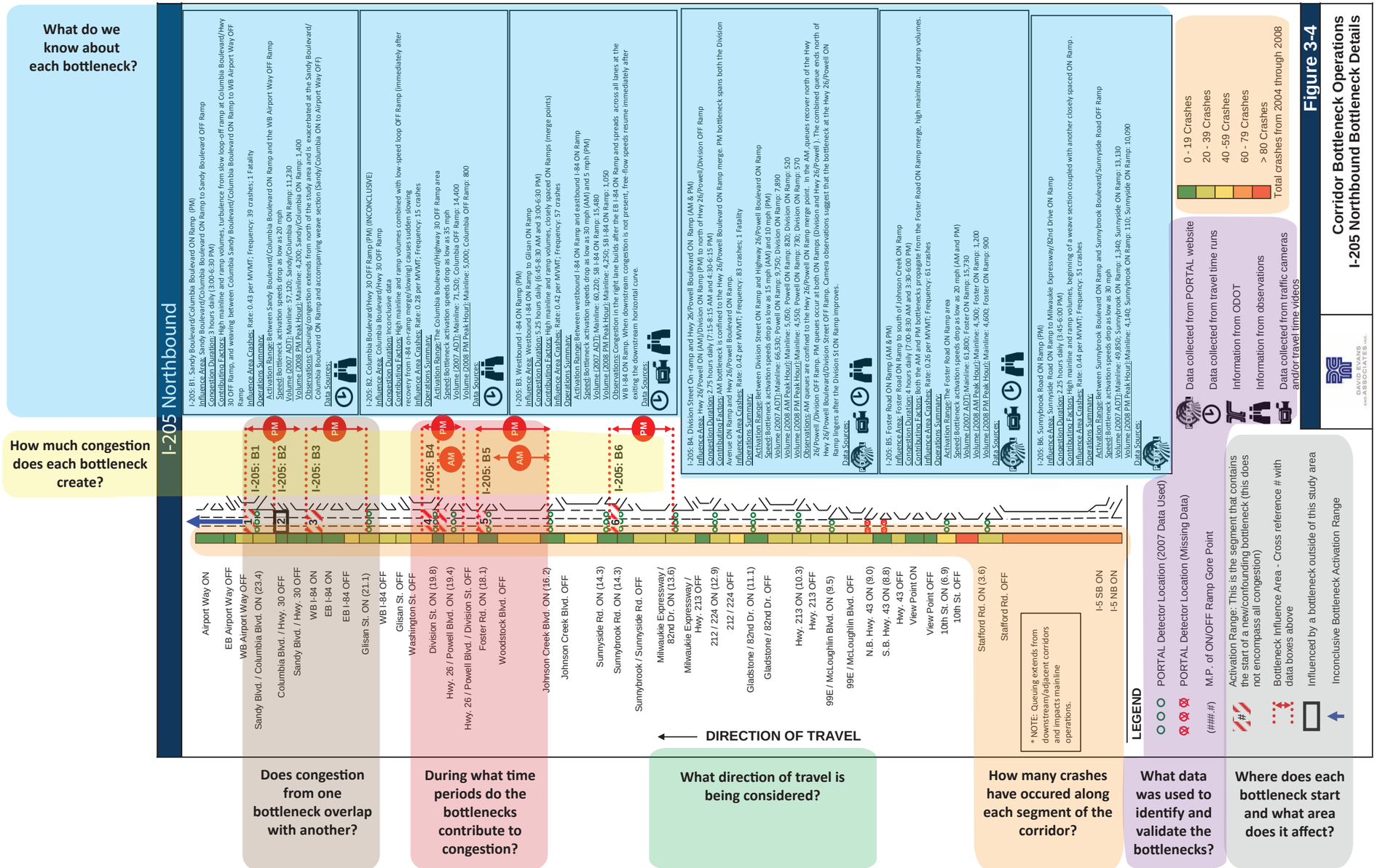
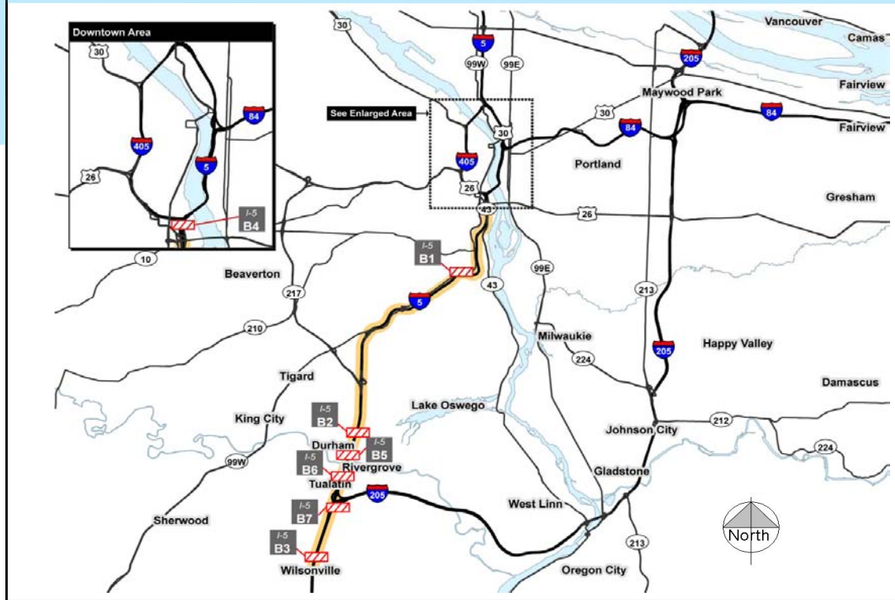


Exhibit 1-2: How to Compare Bottlenecks and Recommended Projects in the Region

Where are the existing bottlenecks?

Figure 4-1: I-5 Recurring Bottleneck Locations



Recurring Bottleneck Location

Where are the bottlenecks throughout the region, and how can they be located in the Atlas?

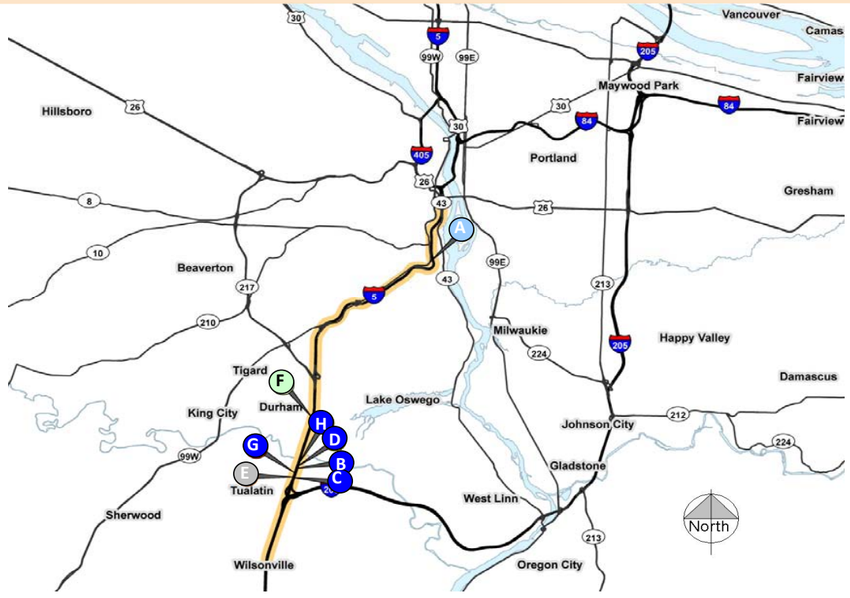
Bottleneck ID	Recurring Bottleneck Location	Cause: Decision Point	Cause: Physical Constraint	Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
I-5 Bottlenecks						
B1	I-5 NB: Terwilliger Boulevard Entrance Ramp (AM & PM)	X	X	20	4	Page | 3-5
B2	I-5 NB: Lower Boones Ferry Road Exit Ramp (AM)	X		30	1.25	Page | 3-5
B3	I-5 NB: Westbound Elligsen Road Entrance Ramp (PM)	X		30	Inconclusive	Page | 3-5
B4	I-5 SB: Hood Avenue Exit Ramp (PM)	X		10	2.75	Page | 3-6
B5	I-5 SB: Carman Drive Lane Drop (PM)	X		10	2.25	Page | 3-6
B6	I-5 SB: Nyberg Street Exit Ramp (PM)	X		25	2.5	Page | 3-6
B7	I-5 SB: I-205 Entrance Ramp (PM)	X		Inconclusive	Inconclusive	Page | 3-6

What are the common causes of recurring bottlenecks?

What is the congestion speed (MPH) in the bottleneck?

How long does the congestion last?

Figure 4-2: I-5 Recommended Projects



Recommended Project Location (indicates Potential Solution Recommendation)

Where are the recommended projects located?

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project sheet on page #
I-5 Recommended Projects to Move Forward					
B	I-5: B2	Yes	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	$1M - $2M	Page | 4-8
C	I-5: B2	Yes	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	$11.5M - $13.5M	Page | 4-9
D	I-5: B2	Yes	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	$17M - $21M	Page | 4-10
F	I-5: B5	Constructed August 2012	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	$1.25M	Page | 4-12
G	I-5: B6	Yes	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	$7.2M - $8.5M	Page | 4-13
H	I-5: B6	Yes	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	$10M -$18M	Page | 4-14
I-5 Recommended Projects for Additional Analysis and Evaluation					
A	I-5: B1	Further Analysis	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	$30M - $40M	Page | 4-7
Project Deleted					
E	I-5: B2	Delete Project	I-5 NB: Nyberg Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension w/ 2-lane Exit at Lower Boones Ferry Rd.	$18M - $22M	Page | 4-11

Where are the recommended projects throughout the region, and what is the project sheet page #?

What is the status of the potential solution?

What recurring bottleneck is addressed by the potential solution?

What are the costs of these projects?

How to Read the Recommended Project Sheets?

Each of the recommended projects has a summary sheet that presents the significant information in an organized and concise manner. **Exhibit 1-3** provides a high-level overview of how to read these project sheets.

Across the top of the project sheet is the name of each recommended project, along with the Bottleneck ID, Tracking ID, and Map ID. These different ID numbers are found throughout the Project Atlas within the tables and figures. The Bottleneck ID is the number assigned to each bottleneck; the number is referenced in all regional and corridor-specific bottleneck figures in the Project Atlas. The Tracking IDs correspond with the ODOT naming convention that was used throughout the development of the recommended projects. The Map ID is the letter that was assigned to each of the recommended projects within the summary graphics and tables in the Project Atlas.

The project sheets summarize existing operational s, including the duration of congestion and queue length, as well as average speed and the density d. This information is based upon existing observations and traffic analysis (Highway Capacity Software (HCS). The project sheets also explain the key points of existing conditions, proposed improvements and the operations/safety benefits of each recommended project.

An operations diagram in the middle of the sheet illustrates the existing and proposed improvements of the traffic movements. Generally, the diagram shows the proposed improvements operations/safety benefits by reducing the traffic conflicts that result in traffic queuing and congestion.

A concept design is displayed on the right half of the sheet and includes an overview map showing the location of the project in region. The concept illustrates the conceptual layout of the improvement.

Project impacts are unique and may include, but are not limited to: right-of-way acquisition, structural changes, safety concerns, environmental impacts, and duration of construction. These impacts are a result of the preliminary design and traffic evaluation process; they are provided to give an understanding of any constraints to the project and how feasible it is to construct. If the project could benefit from additional follow-up phases, the follow-up project is listed along with its benefit and estimated cost.

1.4 What Is the Best Way to Select a Recommended Project Based on Limited Funds Available?

This Project Atlas can serve as a menu of cost-effective, small-scale (primarily $1 million to $20 million range) projects to accomdate limited funding sources. As funds become available, the corridor-specific Recommended Project Figures (**Figure 4-2, Figure 4-4, Figure 4-6, Figure 4-8,** and **Figure 4-10**) can be evaluated together to assess the highest priority projects that can be completed within the available budget.

The project sheets in **Chapter 4** provide a project recommendation and project improvement with a recommended project concept. If the project analysis and evaluation were inconclusive, the project is recommended for further study.

Exhibit 1-3: How to Read the Recommended Project Sheets

How do I locate this project throughout the document?
These can be found throughout the Atlas within the tables and figures.
Map IDs: *Correspond with recommended projects.*
Bottleneck IDs: *Correspond with existing recurring bottlenecks.*
Tracking IDs: *Help link recommended projects with supporting documentation developed throughout the evaluation process.*

What is the conceptual layout of the project?

Map ID	F
Bottleneck ID	I-5: B5
Tracking ID	3
Direction	SB

I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane

Project Analysis/Evaluation

What is the status and estimated cost of this project?

Potential Solution	Cost Estimate
Constructed 2012	$1.25M

What are the existing operations at the bottleneck?
This information is based upon existing observations and traffic analysis (HCS and/or VISSIM).

Existing Operations*

Variable	Existing
Duration (hours)	2.25
Queue (miles)	< 1.8
Average Speed (mph)	< 10
Density (veh/mi/ln)	55

Key Points

Existing Conditions

What are the existing conditions and issues?
This information can be found on the bottleneck operation figures (Chapter 3).

Currently the Carman Dr. lane drop results in queues extending to approximately the Haines St. exit-ramp in all lanes. The cause of the queuing is a combination of the high volume of traffic from OR217 merging onto I-5 and the tendency of the majority of those drivers to merge quickly onto I-5, thus not fully utilizing the entire extent of the auxiliary lanes. An additional bottleneck exists downstream at the Nyberg St. exit-ramp; however, the section of roadway between the two bottlenecks is relatively unaffected (speed greater than 35 mph).

Proposed Improvements

What is the recommended project and what are the operations and safety benefits of the project?

This project would extend the current lane drop just south of the Carman Dr. exit ramp to the Lower Boones Ferry Rd. exit-ramp, where it would become a drop lane.

Operations/Safety Benefits

This is expected to minimize queuing on I-5 from the OR217 merge by 1 mile, and reduce the queuing on OR217 approaching I-5. This is expected to result in a decrease of 1 hour of congestion along I-5.

What are the operations improvements and the proposed traffic improvements? What are the high-level potential impacts that have been identified throughout the preliminary design and traffic evaluation process?

Potential Follow-Up Phases

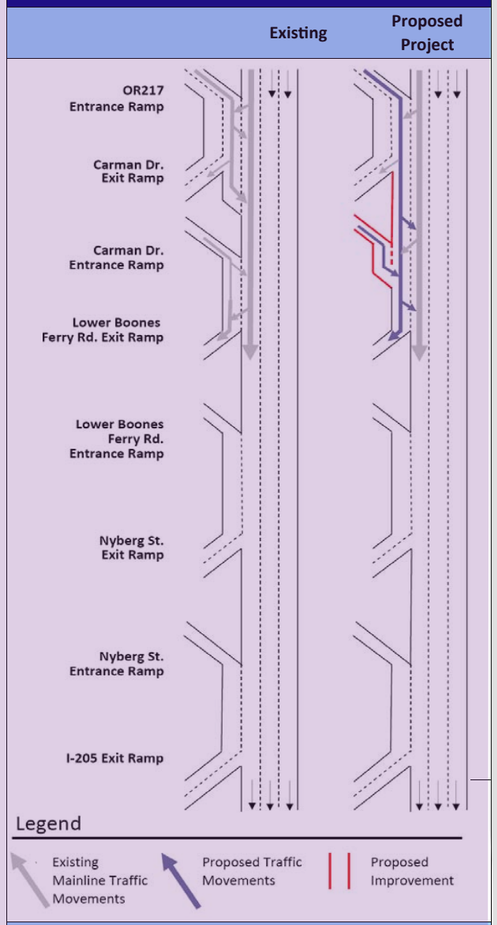
Could this project have additional benefits when combined with another recommended project?

Project Title:	Extend I-5 SB aux. lane from Lower Boones Ferry exit-ramp to Lower Boones Ferry entrance-ramp.
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B6	3a-1	G	$7.2M - $8.5M

*PM Peak Hour

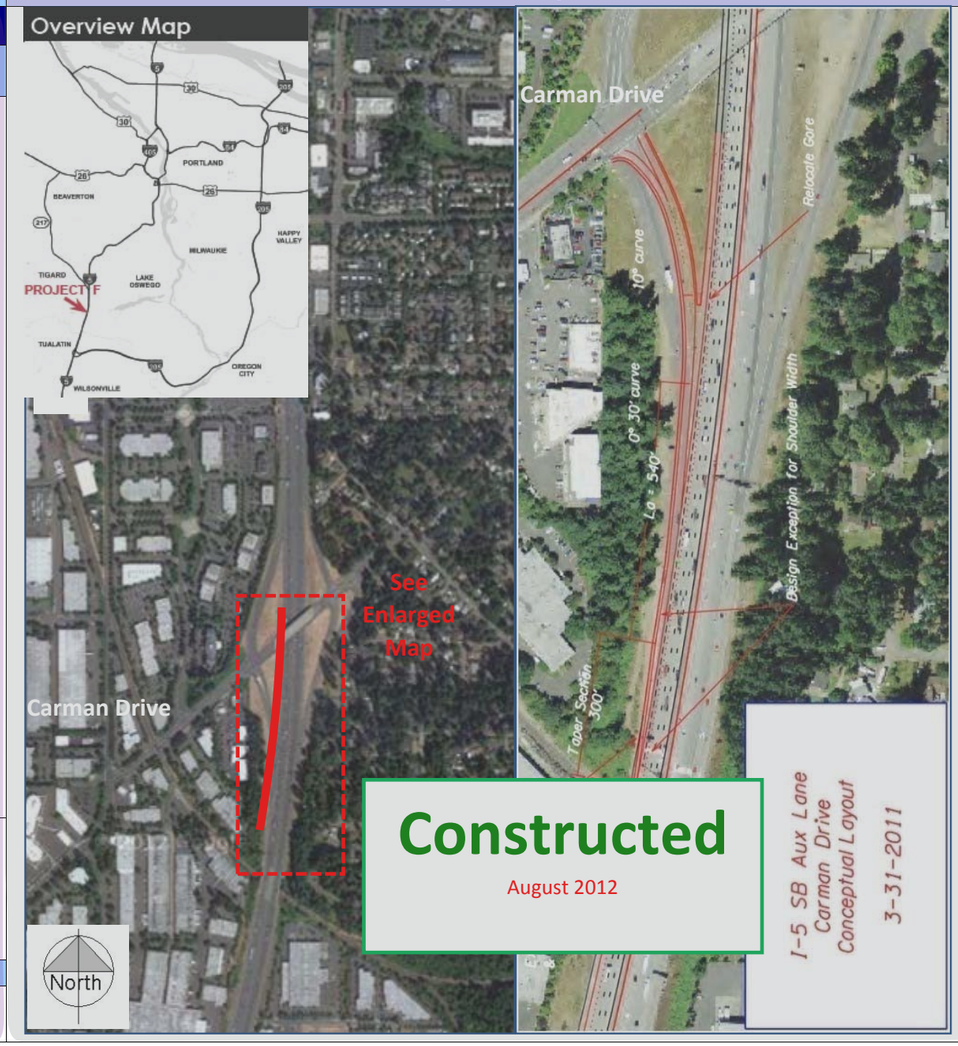
Operations Diagram



Impacts

ROW: Would occur within existing ROW
Structures: Widening possible under existing structure
Environment: No environmental impacts

Project Concept



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CHAPTER 2:
INTRODUCTION (PROJECT SYNOPSIS)

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Chapter 2: Introduction (Project Synopsis)

The Project Atlas identifies bottleneck locations along the five metro area corridors (I-5, I-205, I-84, I-405 and US 26) and correlate locations of congestion with recommended projects. This study is in response to Federal Highway Administration (FHWA) Localized Bottleneck Reduction (LBR) program. The LBR program focused on relieving recurring bottlenecks (as opposed to non-recurring bottleneck causes) and the operational influences that cause them. The primary purpose is to improve safety and operations at these bottlenecks. This new approach is to seek cost-effective and small-scale improvements to the existing system. The projects recommended are not capacity improvements.

The development of this Project Atlas consists of three steps:

- Corridor-level reconnaissance:

  This step consisted of corridor-level reconnaissance to provide the foundation for specific investigation to identify and validate bottleneck activity and causes.

- Bottleneck analysis, evaluation, screening, and selection of solutions:

  This step focused primarily on design and operations. Bottlenecks were analyzed and potential solutions were developed, evaluated, and screened by an expert multidisciplinary design panel.

- Refinement of solutions:

  The final step involved a more thorough operations and design evaluation of potential solutions deemed feasible by the screening panel. The detailed evaluation and refinement included traffic modeling to assess various performance measures, then assessment of project feasibility.

Projects were selected as providing the best value of benefits and cost (primarily $1 million to $20 million range). It should be noted, however, that traffic volumes on these highways are very high, particularly during the peak commute hours, and because these operational improvements do *not* add capacity, the benefits achieved will likely be moderate and incremental. Insofar as bottlenecks along these corridors often meter traffic flow, reducing the queuing and delay at a specific bottleneck may allow more traffic to pass through and move the bottleneck further downstream. Notwithstanding these occurrences, the proposed projects will alleviate congestion at identified bottlenecks, particularly on the peak commute shoulders, and enhance safety by improving the weaves and merges that occur at interchanges.

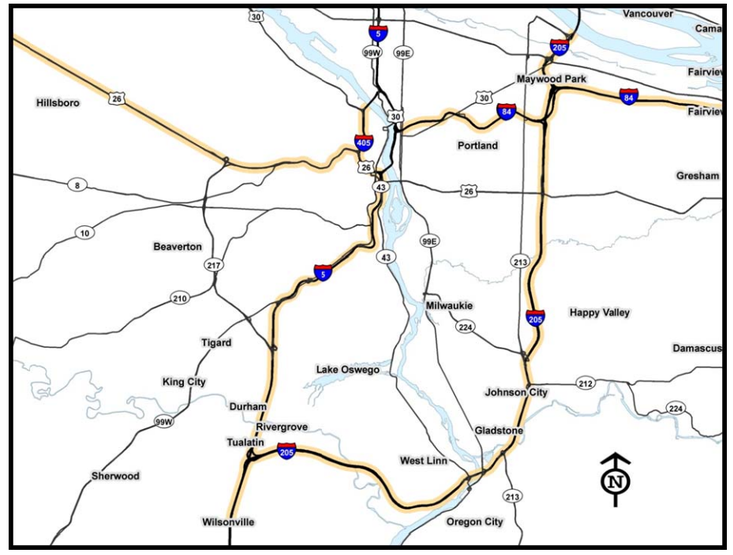
2.1 Study Area

The study area consists of five corridors in the Portland metropolitan area (see **Figure 2-1**): I-5, I-205, I-84, I-405, and US 26. The I-5 corridor is bounded on the north by the Marquam Bridge (approximately milepost 300) and on the south by the Boones Bridge (approximately milepost 283) in Wilsonville. The I-205 corridor is bounded on the north by Airport Way (approximately milepost 25) and on the south by the I-5 interchange in Tualatin (approximately milepost 0). The I-84 corridor is bounded on the west by I-5 and on the east by 257th Avenue. The I-405 corridor is bounded on the north and south by I-5. The US 26 corridor is bounded on the west by OR 47 and on the east by I-405. The study areas for each corridor includes the roadway mainline as well as the ramp merge/diverge locations. This project does not include evaluation of ramp terminals or other parallel roadway facilities.

2.2 Bottleneck Identification Methodology

The bottleneck identification analysis included in Phase 1 of this project is intended to provide spatial and temporal evaluation of freeway operations along each of the freeway corridors and to help correlate locations of congestion with potential mitigation measures. For this study, the term bottleneck was used to identify corridor operations that result in a speed of 35 miles per hour or less across all lanes. There were two tiers of analysis used to identify bottlenecks.

Figure 2-1: Study Area Corridors



The first tier of analysis included a corridor-level reconnaissance utilizing loop detector data from the Portland Oregon Regional Transportation Archive Listing (PORTAL), historical crash data (5 years) from ODOT's Online Crash Database, and a review of Oregon Highway Plan (OHP) mobility standards as they relate to the current operations of each facility. The PORTAL data is used to identify bottleneck locations for a typical weekday commute during the AM and PM peak periods.

The second tier of bottleneck analysis included validation of the PORTAL observations by means of existing documentation, or further investigation in the form of ODOT video camera footage, field travel time data, and traffic volume collection (to determine saturation flow rates). After validation, the bottleneck locations, activation and deactivation times, duration, and average queue lengths were verified and translated to graphics to combine and visually assess correlations between crash frequency and lane geometry on the facilities. More detailed methodology is identified in **Technical Memoranda 1 and 2**, a copy of which is included in **Appendix A**.

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CHAPTER 3:
BOTTLENECKS AND SOLUTIONS

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Chapter 3: Bottlenecks and Solutions

The main purpose of the CBOS project is to identify bottlenecks and develop potential project solutions to address the safety and operational problems. Chapter 3 provides a general overview of that process. The first step is to locate the bottlenecks and the second step is to develop solutions to address safety and operational issues.

3.1 CBOS Purpose

The purpose of the Corridor Bottleneck Operational Study (CBOS) is to identify bottlenecks and develop potential project solutions to address the safety and operational problems. CBOS is a new approach to identify and analyze safety-spot improvements. This approach is the trend for state and federal to seek operational and low-cost "fixes" at spot-specific locations to address safety issues.

FHWA Localized Bottleneck Reduction (LBR) Program

ODOT's CBOS is in response to Federal Highway Administration (FHWA) and SAFETEA-LU work with the Localized Bottleneck Reduction (LBR) Program. The LBR Program is targeted at point-specific locations (e.g., ramps, lane squeezes, weave areas, abrupt changes in highway alignments, etc) or small corridors of delay, as opposed to larger "mega-projects" or systemic congestion. Systemic congestion is often analogous to entire corridors or regional congestion; a situation that is far and above the focus of this program area. The LBR Program focuses on recurring bottlenecks; i.e., those that are operationally influenced by design or function, and impacted upon by excessive traffic demand.

Recurring Bottlenecks

CBOS is not a corridor-level analysis to develop a project to add capacity to the freeway system. Its purpose is to address site-specific recurring bottlenecks to reduce the conflicts (weaving, merging or drop lanes) and allow for a more stable flow of traffic at problematic interchanges. Every one of the bottlenecks identified in CBOS occurs at a freeway interchange as vehicles enter or leave the mainline. Therefore, improvements are designed to reduce the amount of conflicts with the mainline traffic. The addition of an auxiliary lane will allow for the weaving and merging occurring in a separate lane and not on the mainline. The result is a smoother flow of through traffic on the mainline. Recent ODOT safety analysis has indicated that by adding auxiliary lanes in weave/merge sections of freeways the crash rates will be reduced by nearly 30%.

Safety and Operational Improvements

The focus of the CBOS is on relieving recurring congestion chokepoints (as opposed to nonrecurring congestion cause) and the operational influences that cause them. Widening, lengthening or restriping these problem areas to unclog them can often be done with a lower cost, less intensive "footprint." These safety improvements will not provide long-term capacity relief to congestion problems, but they will improve safety at the time of their construction and, over time, the bottleneck location will continue to operate more safely.

Why ODOT Builds Auxiliary Lanes

Another expected benefit of freeway mainline improvements is that the frequency of crashes will be reduced. This is considered a key element of any proposed concept since the existing weaving distances are short and crash rates are high, and freeway collisions create significant costs to society in terms of safety, delay, and reliability.

To help quantify and compare the potential benefits of auxiliary lanes, ODOT prepared a before-and-after study of similar improvements in the Portland metropolitan area. ODOT investigated two urban sites in Region 1 where an auxiliary lane was built within the last 20 years. The data show the safety benefits of reducing the intensity of weaving activity on the freeway mainline. An auxiliary lane improvement by itself may reduce crashes about 30% to 70%, depending on how long the lane is and how many interchanges it connects.

Comparison of Annual Average Mainline Crashes Before and After Improvements

Improvement Type	Comparable Improvement	Before	After	Reduction
Short Auxiliary Section	I-205 Southbound at Sunnyside Road Interchange	12	8	32%
Long Auxiliary Section (Across multiple interchanges)	US 26 Eastbound, Cornell Road to OR 217	37	10	73%

Auxiliary lanes at interchanges help improve of the ramp area safety by separating slower traffic by allowing merging traffic to adjust to the proper speed before merging into traffic. The reduced interference decrease the possibly of conflicts that may congest the freeway.

3.2 Common Causes and General Locations of Bottlenecks

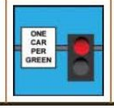
Previous traditional transportation solutions for freeway congestion bottlenecks were large-scale extensive, corridor-wide mega-projects. The recent economic downturn has resulted in a re-evaluation of developing congestion relief. Transportation agencies are now looking to understand and identify specific causes of freeway bottlenecks and develop the "best fit" solution to address congestion and safety concerns.

Recurring, localized bottlenecks occur any time the rate of approaching traffic is greater than the rate of departing traffic. The causal effect can usually be attributed to the existence of at least one of two factors:

- **Decision Points,** such as entrance and exit-ramps, merge areas, weave areas, and lane drops; or
- **Physical Constraints,** such as curves, underpasses, narrow structures, or absence of shoulders.

Figure 3-1 provides a summary of common locations for bottlenecks. The common causes for bottlenecks are illustrated in **Figure 3-12**. This figure indicates that the major causes are related to decision point characteristic.

Figure 3-1: Common Locations for Localized Bottlenecks

Location	Symbol	Description
Lane Drops		Bottlenecks can occur at lane drops, particularly midsegment where one or more traffic lanes ends or at a low-volume exit ramp. They might occur at jurisdictional boundaries, just outside the metropolitan area, or at the project limits of the last megaproject. Ideally, lane drops should be located at exit ramps where there is a sufficient volume of exiting traffic.
Weaving Areas		Bottlenecks can occur at weaving areas, where traffic must merge across one or more lanes to access entry or exit ramps or enter the freeway main lanes. Bottleneck conditions are exacerbated by complex or insufficient weaving design and distance.
Freeway On-Ramps		Bottlenecks can occur at freeway on-ramps, where traffic from local streets or frontage roads merges onto a freeway. Bottleneck conditions are worsened on freeway on-ramps without auxiliary lanes, short acceleration ramps, where there are multiple on-ramps in close proximity and when peak volumes are high or large platoons of vehicles enter at the same time.
Freeway Exit Ramps		Freeway exit ramps, which are diverging areas where traffic leaves a freeway, can cause localized congestion. Bottlenecks are exacerbated on freeway exit ramps that have a short ramp length, traffic signal deficiencies at the ramp terminal intersection, or other conditions (e.g., insufficient storage length) that may cause ramp queues to back up onto freeway main lanes. Bottlenecks could also occur when a freeway exit ramp shares an auxiliary lane with an upstream on-ramp, particularly when there are large volumes of entering and exiting traffic.
Freeway-to-Freeway Interchanges		Freeway-to-freeway interchanges, which are special cases on on-ramps where flow from one freeway is directed to another. These are typically the most severe form of physical bottlenecks because of the high traffic volumes involved.
Changes in Highway Alignment		Changes in highway alignment, which occur at sharp curves and hills and cause drivers to slow down either because of safety concerns or because their vehicles cannot maintain speed on upgrades. Another example of this type of bottleneck is in work zones where lanes may be shifted or narrowed during construction.
Tunnels/ Underpasses		Bottlenecks can occur at low-clearance structures, such as tunnels and underpasses. Drivers slow to use extra caution, or to use overload bypass routes. Even sufficiently tall clearances could cause bottlenecks if an optical illusion causes a structure to appear lower than it really is, causing drivers to slow down.
Narrow Lanes/Lack of Shoulders		Bottlenecks can be caused by either narrow lanes or narrow or a lack of roadway shoulders. This is particularly true in locations with high volumes of oversize vehicles and large trucks.
Traffic Control Devices		Bottlenecks can be caused by traffic control devices that are necessary to manage overall system operations. Traffic signals, freeway ramp meters, and tollbooths can all contribute to disruptions in traffic flow.

Source: Richard A. Margiotta, Federal Highway Administration; Recurring Traffic Bottlenecks: A Primer - Focus on Low Cost Operational Improvements (April 2012).

3.3 What and Where Are the Bottlenecks?

Based on the review of Bottleneck Operations Detail Figures including PORTAL data, ODOT cameras, and field travel time data, thirty-six (36) bottlenecks are identified along the I-5, I-205, I-84, I-405, and US 26 corridors. The study corridor bottlenecks are classified by direction, time of day (AM Peak or PM Peak), and location. A description of the contributing factors is also included.

This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures, while more detailed analyses and findings are presented in **Technical Memorandum 3**, which is included in **Appendix A**.

I-5 Corridor Bottleneck Operational Detail Findings

A total of seven (7) bottlenecks locations are identified within the I-5 study corridor; three bottlenecks are in the northbound direction and four in the southbound direction. These bottlenecks are illustrated in **Figure 3-2** and **Figure 3-3**. Bottleneck numbers B-3 and B-7 have been removed. B-3, a southbound auxiliary lane was built in 2011 and for B-7 a northbound auxiliary lane was built in 2010.

I-205 Corridor Bottleneck Operational Detail Findings

A total of twelve (12) bottleneck locations are identified within the I-205 study corridor; six bottlenecks are in the northbound direction and six in the southbound direction. These bottlenecks are illustrated in **Figure 3-4** and **Figure 3-5**.

I-84 Corridor Bottleneck Operational Detail Findings

A total of seven (7) bottleneck locations are identified within the I-84 study corridor; three bottlenecks are in the eastbound direction and four in the westbound direction. These bottlenecks are illustrated in **Figure 3-6** and **Figure 3-7**.

I-405 Corridor Bottleneck Operational Detail Findings

A total of four (4) bottleneck locations are identified within the I-405 study corridor; one bottleneck is in the northbound direction and three in the southbound direction. These bottlenecks are illustrated in **Figure 3-8** and **Figure 3-9**.

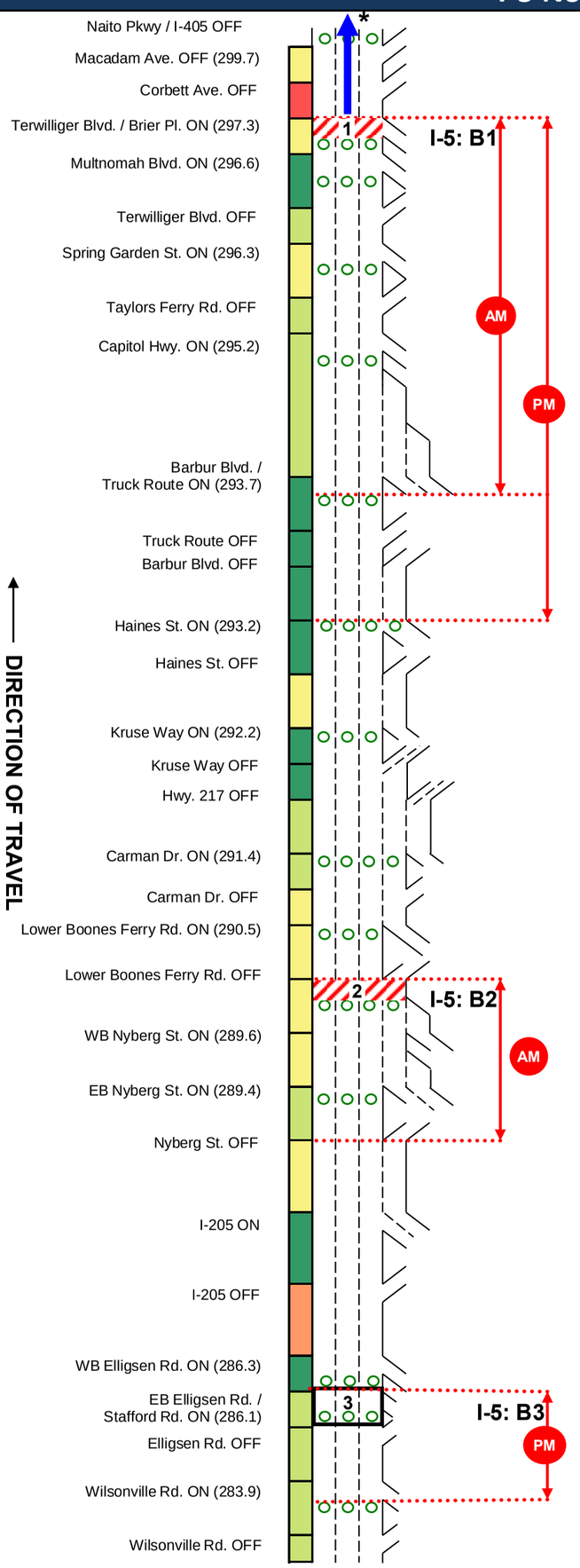
US 26 Corridor Bottleneck Operational Detail Findings

A total of six (6) bottleneck locations are identified within the US 26 study corridor; five in the eastbound direction and one in the westbound direction. These bottlenecks are illustrated in **Figures 3-10** and **Figure 3-11**.

3.4 Region Bottleneck Summary

Figure 3-12 illustrates the Regional Bottleneck Summary based on the analysis of the corridor bottleneck operational detail findings and the fatal flaw screening process.

I-5 Northbound



I-5: B1. Terwilliger Boulevard ON Ramp (AM & PM)
Influence Area: Terwilliger Boulevard ON Ramp to north of Barbur Boulevard ON ramp (AM)/north of Haines Street ON ramp (PM)
Congestion Duration: 4 hours daily (7:15-8:45 AM and 3:00-5:30 PM)
Contributing Factors: Short acceleration lane, horizontal curvature, grade, high mainline and ramp volumes
Influence Area Crashes: Rate: 0.50 per MVMT; Frequency: 223 crashes
Operations Summary:
Activation Area: Terwilliger Boulevard ON Ramp area
Speed: During the AM bottleneck activation speeds drop as low as 25 mph (AM) and 20 mph (PM).
Volume (2007 Average Daily Traffic (ADT)): Mainline: 65,800; Terwilliger ON Ramp: 8,290
Volume (2008 AM Peak Hour): Mainline: 5,800; Terwilliger ON Ramp: 650
Volume (2008 PM Peak Hour): Mainline: 4,750; Terwilliger ON Ramp: 450
Data Sources:

I-5: B2. Lower Boones Ferry Road OFF Ramp (AM)
Influence Area: Lower Boones Ferry Road OFF Ramp to Nyberg Street OFF Ramp
Congestion Duration: 7:15-8:30 AM
Contributing Factors: Two closely spaced ON Ramps merging into high through mainline volume
Influence Area Crashes: Rate: 0.94 per MVMT; Frequency: 119 crashes
Operations Summary:
Activation Area: Between the Lower Boones Ferry Road OFF Ramp and the Westbound Nyberg St. ON Ramp
Speed: Bottleneck activation speeds drop as low as 30 mph
Volume (2007 ADT): Mainline: 58,970; Nyberg St. ON (EB to NB) Ramp: 11,440; Nyberg St. ON (WB to NB) Ramp: 7,280; Lower Boones Ferry OFF Ramp: 12,450
Volume (2008 AM Peak Hour): Mainline: 5,000; Nyberg St. ON (EB to NB) Ramp: 1,150; Nyberg St. ON (WB to NB) Ramp: 1,050; Lower Boones Ferry OFF Ramp: 1,000
Observations: Queue starts between the Lower Boones Ferry Road OFF Ramp and the Westbound Nyberg St. ON ramp; however, the end of the queue is inconclusive. Observations suggest that the queue ends before the I-205 ON Ramp.
Data Sources:

I-5: B3. Westbound Elligsen Road ON Ramp (PM) **(Solution for B3 constructed in 2011)**
Influence Area: Westbound Elligsen Road ON Ramp to south of Elligsen Road OFF Ramp
Congestion Duration: PM
Contributing Factors: Two closely spaced ON Ramps merging into high through mainline volume
Influence Area Crashes: Rate: 0.22 per MVMT; Frequency: 59 crashes
Operations Summary:
Activation Area: Between the westbound Elligsen Road ON Ramp and the Elligsen Road OFF Ramp
Speed: Bottleneck activation speeds drop as low as 30 mph.
Volume (2007 ADT): Mainline: 58,030; Elligson ON (EB to NB) Ramp: 4,640; Elligson ON (WB to NB) Ramp: 6,890
Volume (2008 PM Peak Hour): Mainline: 4,300; Elligson ON (EB to NB) Ramp: 430; Elligson ON (WB to NB) Ramp: 350
Observations: The length of queue is inconclusive. PORTAL does not have data for this ramp location and the single day of travel time data does not reflect a reduction in speed to or below 35 mph. However, the single day of travel time data was collected during the month of March, not during the peak traffic month. Although the PORTAL data is limited and a single day of travel time data does not support this location as a bottleneck, based on numerous independent observations and general driver perception, the Stafford Rd. ON Ramp location is a questionable section of northbound I-5 when estimating travel time through the area.
Data Sources:

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

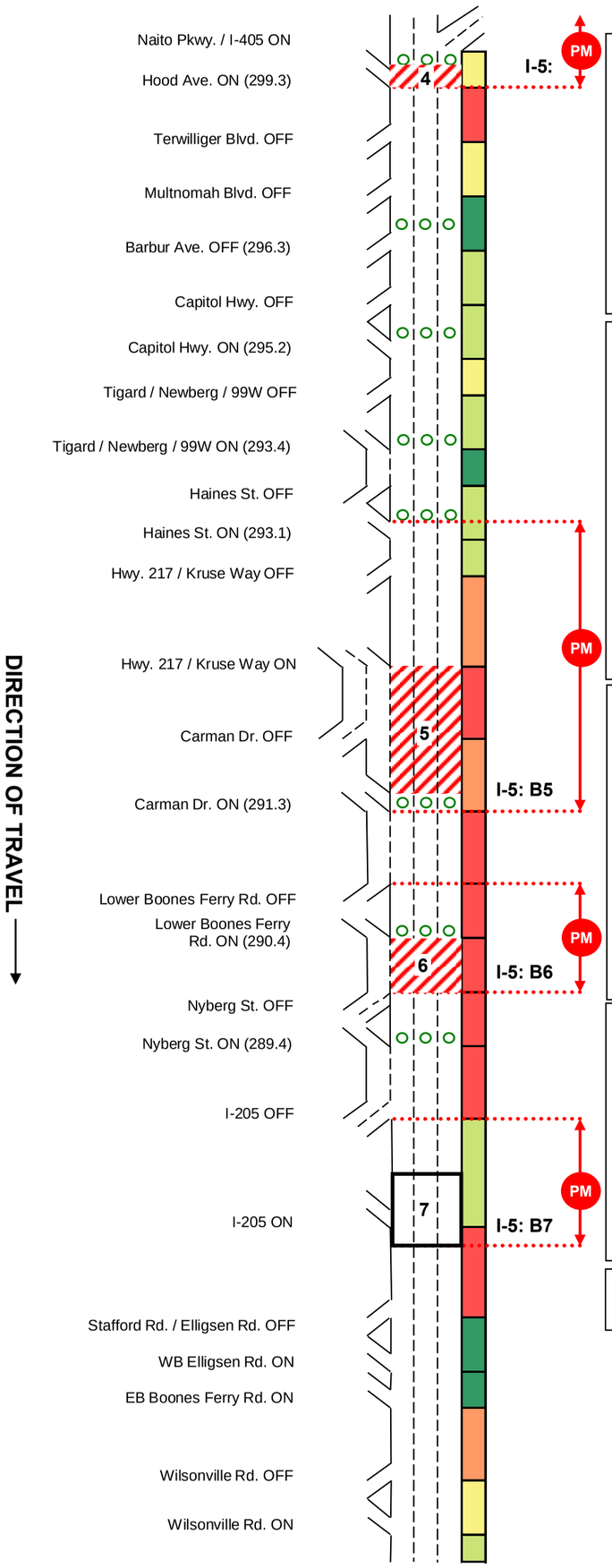
Total crashes from 2004 through 2008

Figure 3-2

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
I-5 Northbound Bottleneck Details

I-5 Southbound



I-5: B4. Hood Avenue ON Ramp (PM)
Influence Area: Hood Avenue ON Ramp to North of Study Area
Congestion Duration: 2.75 hours daily (3:30-6:15 PM)
Contributing Factors: Short acceleration lane, high mainline and ramp volumes (I-5/I-405 traffic merge)
Influence Area Crashes: Rate: 1.42 per MVMT; Frequency: 50 crashes; 1 Fatality
Operations Summary:
Activation Range: The Hood Avenue ON Ramp area
Speed: Bottleneck activation speeds drop as low as 10 mph
Volume (2007 ADT): Mainline: 62,040; Hood ON Ramp: 8,920
Volume (2008 PM Peak Hour): Mainline: 5,050; Hood ON Ramp: 850
Data Sources:

I-5: B5. Carman Drive Lane Drop (PM)
Influence Area: Carman Drive Lane Drop to south of Haines Street ON Ramp
Congestion Duration: 2.25 hours daily (3:30-5:45 PM)
Contributing Factors: Weave section between Hwy 217/Kruse Way ON Ramp and the Carman Drive OFF Ramp, lane drop between Carman Drive OFF Ramp and Carman Drive ON Ramp, driver behavior
Influence Area Crashes: Rate: 1.50 per MVMT; Frequency: 308 crashes
Operations Summary:
Activation Range: Between the Carman Drive lane drop and the Hwy 217/Kruse Way ON Ramp
Speed: Bottleneck activation speeds drop as low as 10 mph
Volume (2007 ADT): Mainline: 43,890; Hwy 217/Kruse ON Ramp: 34,030; Carman OFF Ramp: 8,120
Volume (2008 PM Peak Hour): Mainline: 3,770; Hwy 217/Kruse ON Ramp: 2,500; Carman OFF Ramp: 640
Data Sources:

I-5: B6. Nyberg Street OFF Ramp (PM)
Influence Area: Nyberg Street OFF Ramp to Lower Boones Ferry OFF Ramp
Congestion Duration: 2.5 hours daily (3:30-6:00 PM)
Contributing Factors: High Mainline and weaving volumes between Nyberg Street OFF Ramp and the Lower Boones Ferry Road ON Ramp
Influence Area Crashes: Rate: 2.45 per MVMT; Frequency: 307 crashes; 1 Fatality
Operations Summary:
Activation Range: Between Nyberg Street OFF Ramp and Lower Boones Ferry Road ON Ramp.
Speed: Bottleneck activation speeds drop as low as 25 mph.
Volume (2007 ADT): Mainline: 64,430; Lower Boones Ferry ON Ramp: 10,980; Nyberg OFF Ramp: 17,630
Volume (2008 PM Peak Hour): Mainline: 5,400; Lower Boones Ferry ON Ramp: 1,200; Nyberg OFF Ramp: 1,750
Data Sources:

I-5: B7. I-205 ON Ramp (PM) **(Solution for B7 constructed in 2010)**
Influence Area: I-205 ON Ramp to North of I-205 OFF Ramp
Congestion Duration: PM
Contributing Factors: Merge section for I-205 ON Ramp, high mainline and ramp volumes
Influence Area Crashes: Rate: 0.31 per MVMT; Frequency: 29 crashes
Operations Summary:
Activation Range: The I-205 ON Ramp area.
Speed: Inconclusive
Volume (2007 ADT): Mainline: 46,270; I-205 ON Ramp: 20,850
Volume (2008 PM Peak Hour): Mainline: 4,100; I-205 ON Ramp: 1,100
Data Sources:

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

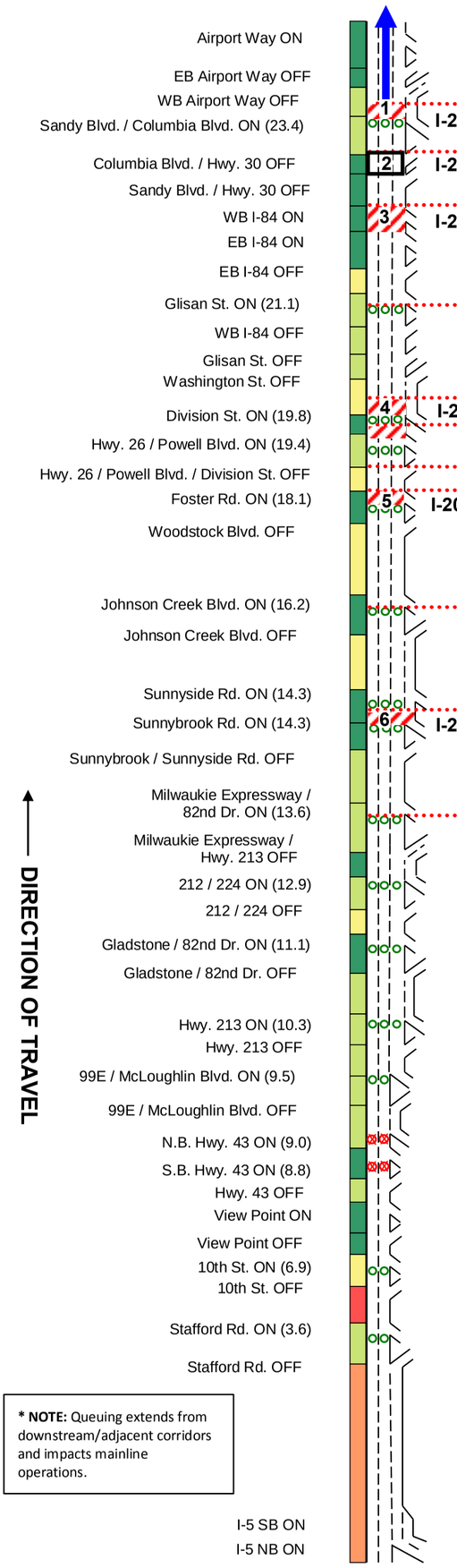
Total crashes from 2004 through 2008

Figure 3-3

Corridor Bottleneck Operations
I-5 Southbound Bottleneck Details

DAVID EVANS AND ASSOCIATES INC.

I-205 Northbound



I-205: B1. Sandy Boulevard/Columbia Boulevard ON Ramp (PM)
Influence Area: Sandy Boulevard/Columbia Boulevard ON Ramp to Sandy Boulevard OFF Ramp
Congestion Duration: 3 hours daily (3:00-6:30 PM)
Contributing Factors: High mainline and ramp volumes, turbulence from slow loop-off ramp at Columbia Boulevard/Hwy 30 OFF Ramp, and weaving between Columbia Sandy Boulevard/Columbia Boulevard ON Ramp to WB Airport Way OFF Ramp
Influence Area Crashes: Rate: 0.43 per MVMT; Frequency: 39 crashes; 1 Fatality
Operations Summary:
Activation Range: Between Sandy Boulevard/Columbia Boulevard ON Ramp and the WB Airport Way OFF Ramp
Speed: Bottleneck activation speeds drop as low as 20 mph
Volume (2007 ADT): Mainline: 57,120; Sandy/Columbia ON Ramp: 11,230
Volume (2008 PM Peak Hour): Mainline: 4,200; Sandy/Columbia ON Ramp: 1,400
Observations: Queuing/congestion extends from north of the study area and is exacerbated at the Sandy Boulevard/ Columbia Boulevard ON Ramp and accompanying weave section (Sandy/Columbia ON to Airport Way OFF)
Data Sources:

I-205: B2. Columbia Boulevard/Hwy 30 OFF Ramp (PM) (INCONCLUSIVE)
Influence Area: Columbia Boulevard/Hwy 30 OFF Ramp
Congestion Duration: Inconclusive data
Contributing Factors: High mainline and ramp volumes combined with low-speed loop OFF Ramp (immediately after recovery from I-84 on-ramp merge/slowing) causes sudden slowing
Influence Area Crashes: Rate: 0.28 per MVMT; Frequency: 15 crashes
Operations Summary:
Activation Range: The Columbia Boulevard/Highway 30 OFF Ramp area
Speed: Bottleneck activation speeds drop as low as 35 mph
Volume (2007 ADT): Mainline: 71,520; Columbia OFF Ramp: 14,400
Volume (2008 PM Peak Hour): Mainline: 5,000; Columbia OFF Ramp: 800
Data Sources:

I-205: B3. Westbound I-84 ON Ramp (PM)
Influence Area: Westbound I-84 ON Ramp to Glisan ON Ramp
Congestion Duration: 5.25 hours daily (6:45-8:30 AM and 3:00-6:30 PM)
Contributing Factors: High mainline and ramp volumes, closely spaced ON Ramps (merge points)
Influence Area Crashes: Rate: 0.42 per MVMT; Frequency: 57 crashes
Operations Summary:
Activation Range: Between westbound I-84 ON Ramp and eastbound I-84 ON Ramp
Speed: Bottleneck activation speeds drop as low as 30 mph (AM) and 5 mph (PM)
Volume (2007 ADT): Mainline: 60,220; SB I-84 ON Ramp: 15,480
Volume (2008 PM Peak Hour): Mainline: 4,250; SB I-84 ON Ramp: 1,050
Observations: Congestion in the right lane builds after the EB I-84 ON Ramp and spreads across all lanes at the WB I-84 ON Ramp. When downstream congestion is not present, free-flow speeds resume immediately after exiting the downstream horizontal curve.
Data Sources:

I-205: B4. Division Street On-ramp and Hwy 26/Powell Boulevard ON Ramp (AM & PM)
Influence Area: Hwy 26/Powell ON (AM)/Division ON Ramp (PM) to north of Hwy 26/Powell/Division OFF Ramp
Congestion Duration: 2.75 hours daily (7:15-8:15 AM and 4:30-6:15 PM)
Contributing Factors: AM bottleneck is confined to the Hwy 26/Powell Boulevard ON Ramp merge. PM bottleneck spans both the Division Avenue ON Ramp and Hwy 26/Powell Boulevard ON Ramp.
Influence Area Crashes: Rate: 0.42 per MVMT; Frequency: 83 crashes; 1 Fatality
Operations Summary:
Activation Range: Between Division Street ON Ramp and Highway 26/Powell Boulevard ON Ramp
Speed: Bottleneck activation speeds drop as low as 15 mph (AM) and 10 mph (PM)
Volume (2007 ADT): Mainline: 66,530; Powell ON Ramp: 9,750; Division ON Ramp: 7,890
Volume (2008 AM Peak Hour): Mainline: 5,050; Powell ON Ramp: 820; Division ON Ramp: 520
Volume (2008 PM Peak Hour): Mainline: 4,550; Powell ON Ramp: 730; Division ON Ramp: 570
Observations: AM queues are confined to the Hwy 26/Powell ON Ramp merge point. In the AM ,queues recover north of the Hwy 26/Powell /Division OFF Ramp. PM queues occur at both ON Ramps (Division and Hwy 26/Powell). The combined queue ends north of Hwy 26/Powell Boulevard/Division Street OFF Ramp. Camera observations suggest that the bottleneck at the Hwy 26/Powell ON Ramp lingers after the Division St ON Ramp improves.
Data Sources:

I-205: B5. Foster Road ON Ramp (AM & PM)
Influence Area: Foster Road ON Ramp to south of Johnson Creek ON Ramp
Congestion Duration: 4 hours daily (7:00-8:30 AM and 3:30-6:00 PM)
Contributing Factors: Both the AM and PM bottlenecks propagate from the Foster Road ON Ramp merge, high mainline and ramp volumes.
Influence Area Crashes: Rate: 0.26 per MVMT; Frequency: 61 crashes
Operations Summary:
Activation Range: The Foster Road ON Ramp area
Speed: Bottleneck activation speeds drop as low as 20 mph (AM and PM)
Volume (2007 ADT): Mainline: 61,800; Foster ON Ramp: 15,730
Volume (2008 AM Peak Hour): Mainline: 4,500; Foster ON Ramp: 1,200
Volume (2008 PM Peak Hour): Mainline: 4,600; Foster ON Ramp: 900
Data Sources:

I-205: B6. Sunnybrook Road ON Ramp (PM)
Influence Area: Sunnyside Road ON Ramp to Milwaukie Expressway/82nd Drive ON Ramp
Congestion Duration: 2.25 hours daily (3:45-6:00 PM)
Contributing Factors: High mainline and ramp volumes, beginning of a weave section coupled with another closely spaced ON Ramp .
Influence Area Crashes: Rate: 0.44 per MVMT; Frequency: 51 crashes
Operations Summary:
Activation Range: Between Sunnybrook Boulevard ON Ramp and Sunnybrook Boulevard/Sunnyside Road OFF Ramp
Speed: Bottleneck activation speeds drop as low as 30 mph
Volume (2007 ADT): Mainline: 49,850; Sunnybrook ON Ramp: 1,340; Sunnyside ON Ramp: 13,130
Volume (2008 PM Peak Hour): Mainline: 4,140; Sunnybrook ON Ramp: 110; Sunnyside ON Ramp: 10,090
Data Sources:

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

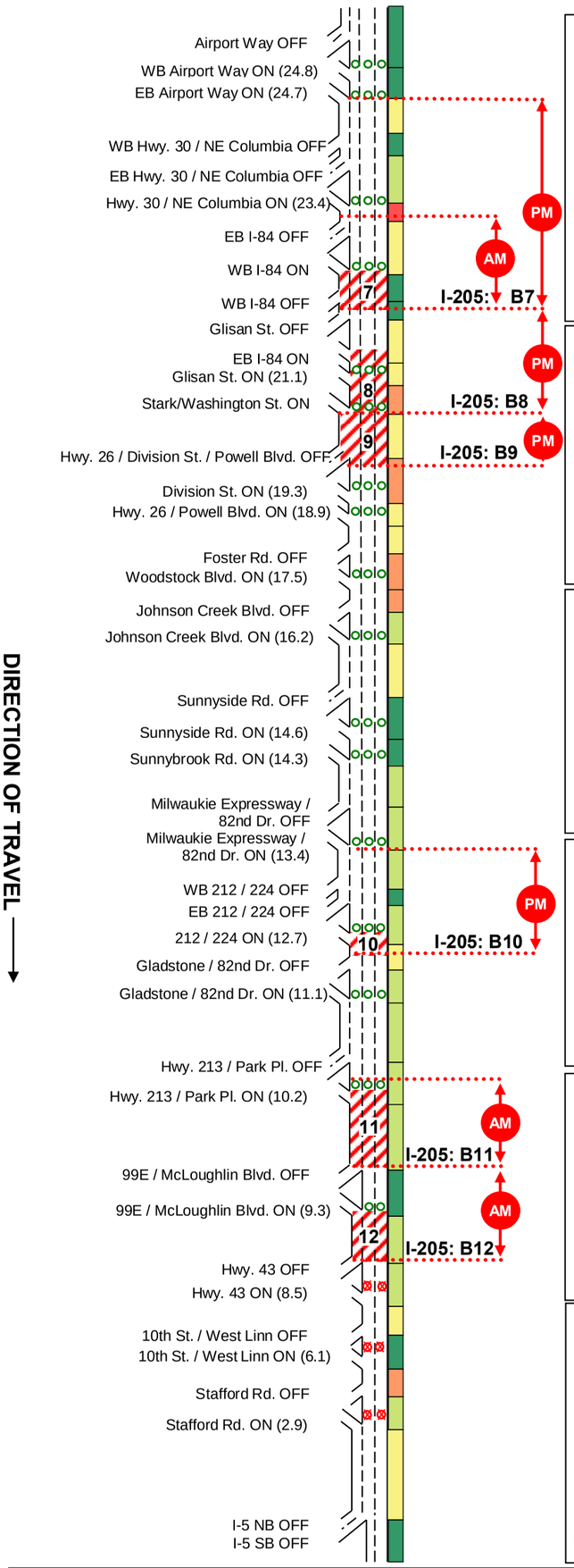
Total crashes from 2004 through 2008

Figure 3-4

Corridor Bottleneck Operations
I-205 Northbound Bottleneck Details

DAVID EVANS AND ASSOCIATES INC.

I-205 Southbound



I-205: B7. Westbound I-84 OFF Ramp (AM & PM)
Influence Area: WB I-84 OFF Ramp to Hwy 30/Columbia ON Ramp (AM)/Eastbound Airport Way ON Ramp (PM)
Congestion Duration: 4.25 hours daily (8:00-9:00 AM and 3:00-6.15 PM)
Contributing Factors: The weave section between the WB I-84 ON Ramp, WB I-84 OFF Ramp and ON Ramp, as well as high mainline and ramp volumes
Influence Area Crashes: Rate: 0.75 per MVMT; Frequency: 247 crashes
Operations Summary:
- *Activation Range:* Between Glisan Street OFF Ramp and WB I-84 ON Ramp
- *Speed:* Bottleneck activation speeds drop as low as 5 mph (AM and PM)
- *Volume (2007 ADT):* Mainline: 74,470; WB I-84 ON Ramp: 15,140; WB I-84 OFF Ramp: 17,200; Glisan OFF Ramp: 10,640
- *Volume (2007 AM Peak Hour):* Mainline: 4,430; WB I-84 ON Ramp: 1,020; WB I-84 OFF Ramp: 1,100; Glisan OFF Ramp: 1,130
- *Volume (2008 PM Peak Hour):* Mainline: 4,540; WB I-84 ON Ramp: 750; WB I-84 OFF Ramp: 980; Glisan OFF Ramp: 920

Data Sources:

I-205: B8. Stark/Washington Street ON Ramp (PM)
Influence Area: Stark/Washington Street ON Ramp to Glisan Street OFF Ramp
Congestion Duration: 3.25 hours daily (3:00-6:15 PM)
Contributing Factors: Closely spaced ON Ramps, high mainline and ramp volumes
Influence Area Crashes: Rate: 1.12 per MVMT; Frequency: 157 crashes; 1 Fatality
Operations Summary:
- *Activation Range:* Between Stark/Washington Street ON Ramp and EB I-84 ON Ramp
- *Speed:* Bottleneck activation speeds drop as low as 10 mph
- *Volume (2007 ADT):* Mainline: 46,630; EB I-84 ON Ramp: 18,160; Glisan ON Ramp: 9,720; Stark/Washington ON Ramp: 11,040
- *Volume (2008 PM Peak Hour):* Mainline: 3,390; EB I-84 ON Ramp: 1,200; Glisan ON Ramp: 780; Stark/Washington ON Ramp: 950

Data Sources:

I-205: B9. Hwy 26/Division Street/Powell Boulevard OFF Ramp (PM)
Influence Area: Hwy 26/Division Street/Powell Boulevard OFF Ramp to Stark/Washington Street ON Ramp
Congestion Duration: 3.25 hours daily (3:00-6:15 PM)
Contributing Factors: Weave segment, high mainline and ramp volumes
Influence Area Crashes: Rate: 0.97 per MVMT; Frequency: 44 crashes
Operations Summary:
- *Activation Range:* Between Hwy 26/Division Street/Powell Boulevard OFF Ramp and Stark/Washington Street ON Ramp
- *Speed:* Bottleneck activation speeds drop as low as 25 mph
- *Volume (2007 ADT):* Mainline: 85,540; Division/Powell/US26 OFF Ramp: 22,230
- *Volume (2008 PM Peak Hour):* Mainline: 6,320; Division/Powell/US26 OFF Ramp: 1,350

Data Sources:

I-205: B10. 212/224 ON Ramp (PM)
Influence Area: 212/224 ON Ramp to Milwaukie Expressway/82nd Drive ON Ramp
Congestion Duration: 1 hour daily (4:45-5:45 PM)
Contributing Factors: High mainline and ramp volumes, and turbulence from upstream lane-drop
Influence Area Crashes: Rate: 0.47 per MVMT; Frequency: 114 crashes
Operations Summary:
- *Activation Range:* The 212/224 ON Ramp area
- *Speed:* Bottleneck activation speeds drop as low as 35 mph
- *Volume (2007 ADT):* Mainline: 58,120; 212/224 ON Ramp: 8,680
- *Volume (2008 PM Peak Hour):* Mainline: 4,580; 212/224 ON Ramp: 650

Data Sources:

I-205: B11. 99E/McLoughlin Boulevard OFF Ramp (AM)
Influence Area: 99E/McLoughlin Boulevard OFF Ramp to Hwy. 213/Park Place ON Ramp
Congestion Duration: 1.25 hours daily (7:15-8:30 AM)
Contributing Factors: Weave segment, lane drop and high mainline and ramp volumes
Influence Area Crashes: Rate: 0.47 per MVMT; Frequency: 20 crashes
Operations Summary:
- *Activation Range:* Between 99E/McLoughlin OFF Ramp and Hwy.213/Park Place ON Ramp
- *Speed:* Bottleneck activation speeds drop as low as 20 mph
- *Volume (2007 ADT):* Mainline: 44,150; Hwy. 213 ON Ramp: 10,930; 99E OFF Ramp 13,230
- *Volume (2008 AM Peak Hour):* Mainline: 3,380; Hwy. 213 ON Ramp: 730; 99E OFF Ramp 720

Data Sources:

I-205: B12. Hwy. 43 OFF Ramp (AM)
Influence Area: Hwy. 43 OFF Ramp to 99E/McLoughlin Boulevard OFF Ramp
Congestion Duration: 2 hours daily (6:30-8:30 AM)
Contributing Factors: Weave segment on bridge, and high mainline and ramp volumes.
Influence Area Crashes: Rate: 1.03 per MVMT; Frequency: 47 crashes
Operations Summary:
- *Activation Range:* Between the Hwy 43 OFF Ramp and 99E/McLoughlin ON Ramp
- *Speed:* Bottleneck activation speeds drop as low as 30 mph
- *Volume (2007 ADT):* Mainline: 41,850; Highway 99E ON Ramp: 7,160; Highway 43 OFF Ramp: 9,180
- *Volume (2008 AM Peak Hour):* Mainline: 3,390; Hwy. 99E ON Ramp: 680; Hwy. 43 OFF Ramp: 650
- *Observations:* Observations show Bottleneck #11 forming prior to Bottleneck #12, indicative of two independent bottlenecks.

Data Sources:

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

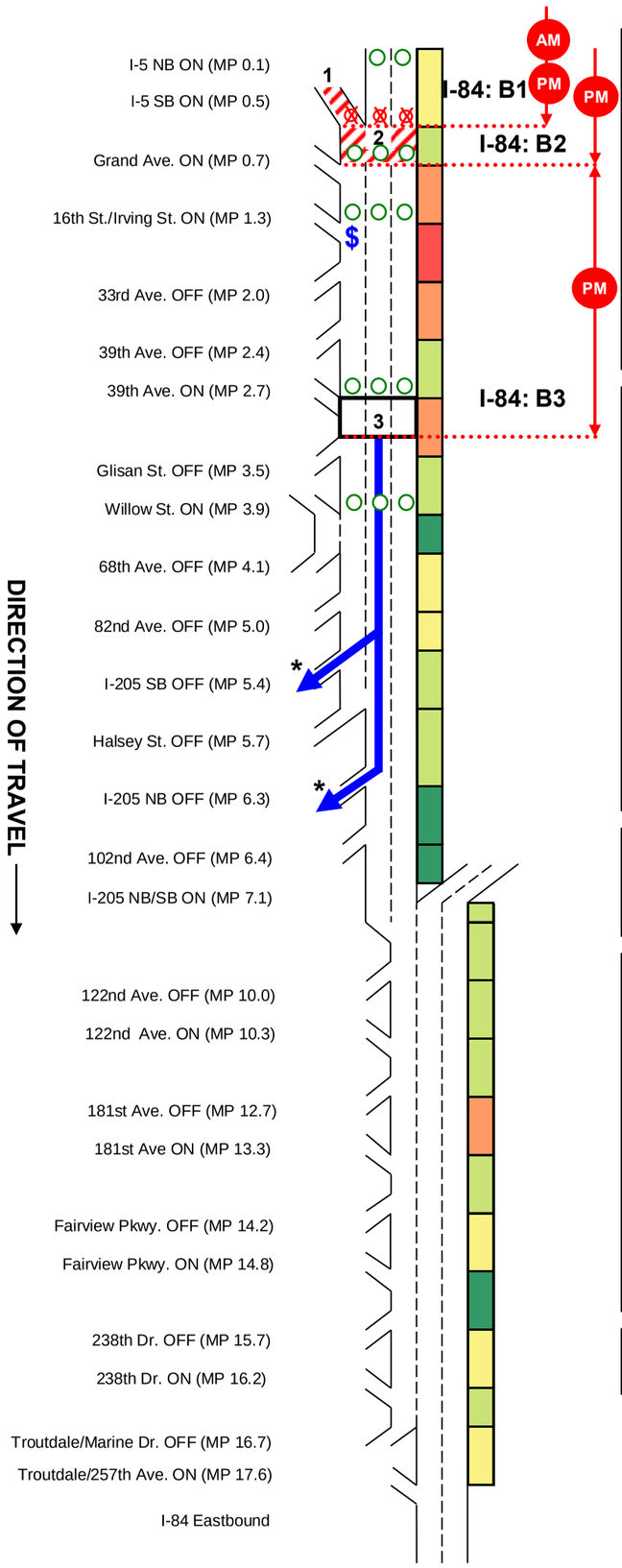
Total crashes from 2004 through 2008

Figure 3-5

Corridor Bottleneck Operations
I-205 Southbound Bottleneck Details

DAVID EVANS AND ASSOCIATES INC.

I-84 Eastbound



I-84: B1. I-5 SB ON Ramp (AM & PM)
Influence Area: I-84 EB mainline to I-5 SB mainline
Congestion Duration: 12 hours or more daily (7:00 AM to 7:00 PM)
Contributing Factors: High ramp demand.
Operations Summary:
Activation Range: Along the entire ramp
Speed: Ramp speeds drop as low as 10 mph and are only as high as 35 mph between 7:00 AM and 7:00 PM
Volume (2007 ADT): I-5 SB to I-84 EB Ramp: 21,550
Volume (2008 AM Peak Hour): I-5 SB to I-84 EB Ramp: 1,250
Volume (2008 PM Peak Hour): I-5 SB to I-84 EB Ramp: 1,300
Observations: Ramp advisory speed posted at 45 mph
Data Sources:

I-84: B2. I-5 SB/NB Merge (PM)
Influence Area: Grand Ave. ON Ramp to I-5 NB/SB mainlines
Congestion Duration: Approximately 4 hours daily (2:15-6:30 PM)
Contributing Factors: High facility-to-facility ramp volumes. Although there is an add lane for the ON ramp from I-5 SB, the activation area acts as a merge as vehicles reposition to avoid conflict with the next closely spaced ON ramps.
Influence Area Crashes: Rate: 1.21 per MVMT; Frequency: 88 crashes
Operations Summary:
Activation Range: Between Grand Avenue ON Ramp and I-5 SB/NB merge
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): Mainline: 67,580; I-5 SB ON Ramp: 21,550
Volume (2008 PM Peak Hour): Mainline: 2,700; I-5 SB ON Ramp: 1,300
Observations: Vehicles coming from the I-5 southbound ramp merge left very quickly once on I-84 mainline to avoid conflicting with the downstream Grand Avenue and Irving Street ON ramp vehicles.
Data Sources:

$ **NOTE:** Observations showed congestion emanating from the 16th/Irving ON Ramp area until the ramp meter turned on. Once the ramp meter was on, no further congestion was observed.

I-84: B3. 39th Avenue ON Ramp (PM) (INCONCLUSIVE)
Influence Area: 39th Ave. ON Ramp to I-5 NB/SB ON Ramp
Congestion Duration: Inconclusive data
Contributing Factors: High mainline and moderate ramp volumes. Spillback from downstream I-205 congestion (see I-205 graphics, Bottlenecks 3 and 8).
Influence Area Crashes: Rate: 0.87 per MVMT; Frequency: 347 crashes
Operations Summary:
Activation Range: 39th Ave ON Ramp merge area
Speed: Inconclusive data
Volume (2007 ADT): Mainline: 70,170; 39th ON Ramp: 10,780
Volume (2008 PM Peak Hour): Mainline: 4,730; 39th ON Ramp: 570
Data Sources:

* **NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

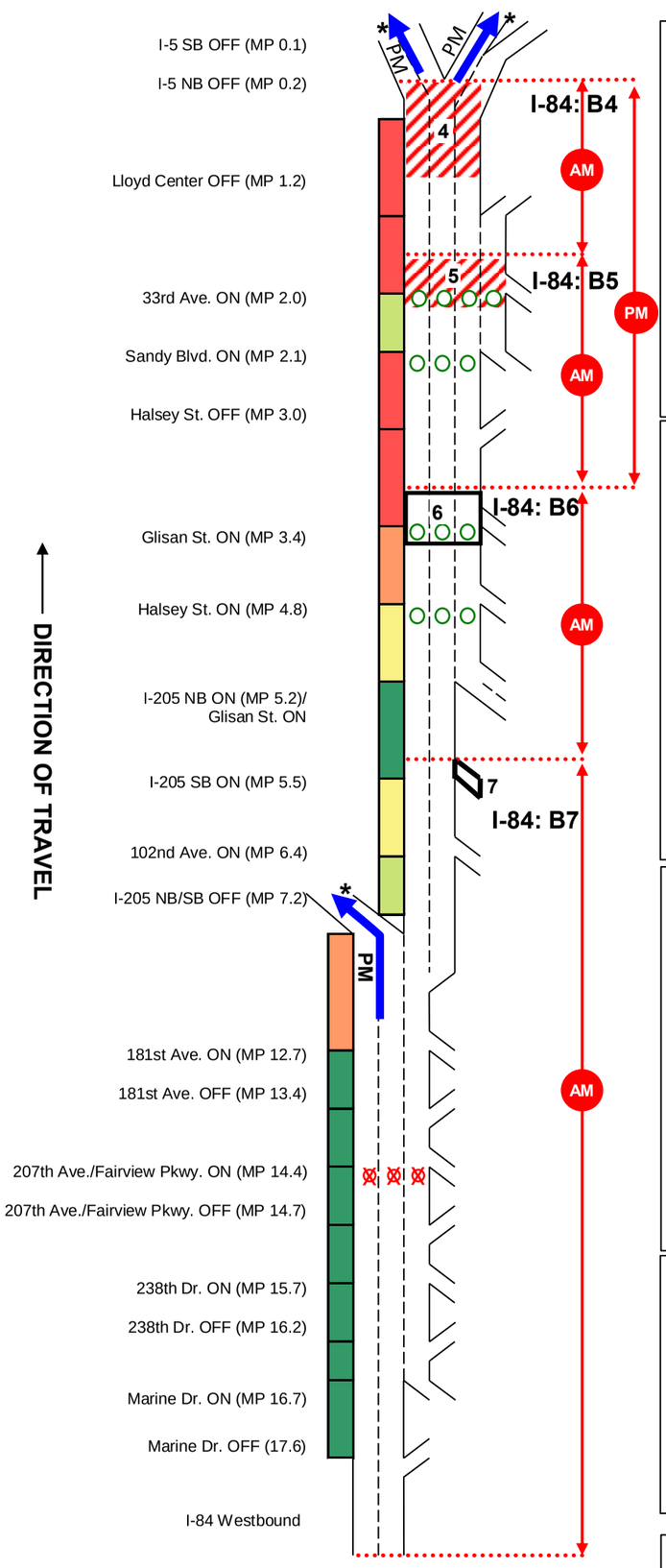
Total crashes from 2004 through 2008

Figure 3-6

Corridor Bottleneck Operations
I-84 Eastbound Bottleneck Details

DAVID EVANS AND ASSOCIATES INC.

I-84 Westbound



I-84: B4. I-5 Diverge (AM & PM)
***Influence Area*:** I-5 Mainline to 33rd Avenue ON Ramp (AM)/Glisan Street ON Ramp (PM)
***Congestion Duration*:** 8+ hours daily (6:00-10:30 AM; 3:00-7:00+ PM)
Contributing Factors: High mainline and ramp volumes, horizontal and vertical curvature, unclear advanced signage.
Influence Area Crashes: AM influence area rate: 0.71 per MVMT, Frequency: 99 crashes; PM influence area rate: 0.85 per MVMT, Frequency: 391 crashes
Operations Summary:
Activation Range: The I-84 diverge area
Speed: Bottleneck speeds drop as low as 20 mph
Volume (2007 ADT): Mainline: 75,660; to I-5 NB OFF Ramp: 21,960; to Rose Quarter OFF Ramp: 2,860; to I-5 SB OFF Ramp: 50,870
Volume (2008 AM Peak Hour): Mainline: 5,600; to I-5 NB OFF Ramp: 2,070; to Rose Quarter OFF Ramp: 230; to I-5 SB OFF Ramp: 3,300
Volume (2008 PM Peak Hour): Mainline: 4,600; to I-5 NB OFF Ramp: 1,400; to Rose Quarter OFF Ramp: 150; to I-5 SB OFF Ramp: 3,050
***Data Sources*:**

I-84: B5. 33rd Avenue ON Ramp (AM)
***Influence Area*:** 33rd Avenue ON Ramp to 58th Avenue/Glisan ON Ramp
***Congestion Duration*:** 4 hours daily (6:15-10:15 AM)
Contributing Factors: Heavy mainline, auxiliary lane, and moderate ramp volumes. Closely spaced ON Ramps, downstream lane drop/diverge, and advanced signage for above-mentioned bottleneck.
Influence Area Crashes: Rate: 0.91 per MVMT; Frequency: 292 crashes
Operations Summary:
Activation Range: The 33rd Avenue ON ramp area
Speed: Bottleneck speeds drop as low as 15 mph
Volume (2007 ADT): Mainline: 73,910; Sandy ON Ramp: 9,790; 33rd ON Ramp: 4,260; Lloyd Center OFF Ramp: 12,300
Volume (2008 AM Peak Hour): Mainline: 5,300; Sandy ON Ramp: 970; 33rd ON Ramp: 530; Lloyd Center OFF Ramp: 1,200
Observations: Advanced signage for mainline diverge is potentially misleading. Advanced signage for Lloyd Center exit only lane causes vehicles coming from Sandy ON Ramp and 33rd ON Ramp to merge left early and weave with mainline vehicles destined to Lloyd Center OFF Ramp.
***Data Sources*:**

I-84: B6. Glisan ON Ramp (AM) (INCONCLUSIVE)
***Influence Area*:** Glisan ON Ramp to I-205 SB ON Ramp
***Congestion Duration*:** Inconclusive data
Contributing Factors: High mainline volumes, limited sight distance for merge and downstream horizontal curve, vertical climb on ramp, and short ON Ramp acceleration lane.
Influence Area Crashes: Rate: 0.49 per MVMT; Frequency: 119 crashes
Operations Summary:
Activation range: The Glisan ON Ramp area
Speed: Inconclusive data
Volume (2007 ADT): Mainline: 76,510; Glisan ON Ramp: 7,050
Volume (2008 AM Peak Hour): Mainline: 5,450; Glisan ON Ramp: 450
Observations: During the review of the video data, it was noticed that any slight friction between merging traffic and mainline traffic (in this area) could cause all lanes to suddenly slow in the merge area. It is expected that with slightly more mainline volume this area could be an independently activated bottleneck.
***Data Sources*:**

I-84: B7. I-205 SB to I-84 WB Ramp (INCONCLUSIVE)
***Influence Area*:** I-205 SB mainline to I-84 WB mainline
***Congestion Duration*:** Inconclusive data
Contributing Factors: High ramp volume, horizontal curvature see I-205 graphic, bottleneck 7).
Operations Summary:
Activation Range: Along the entire ramp
Speed: Inconclusive data
Volume (2007 ADT): I-205 SB to I-84 WB Ramp: 17,210
Volume (2008 AM Peak Hour): I-205 SB to I-84 WB Ramp: 1,100
***Data Sources*:**

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

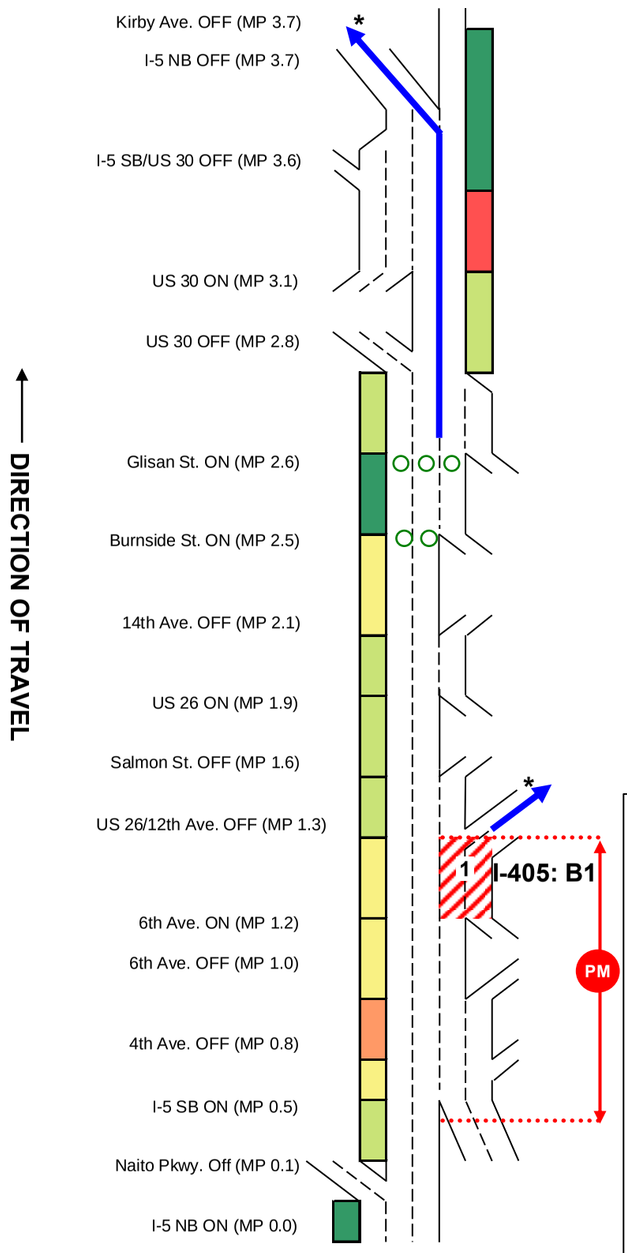
Total crashes from 2004 through 2008

Figure 3-7

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
I-84 Westbound Bottleneck Details

I-405 Northbound



I-405: B1. US 26/12th Ave. (PM)

***Influence Area*:** Between US 26/12th Ave. OFF and I-5 SB ON Ramp, in the auxiliary lanes

***Congestion Duration*:** Approximately 3 hours daily (3:45-6:30 PM)

Contributing Factors: High OFF Ramp volumes, weaving volumes, and closely spaced ramps. OFF Ramp merge to US 26 congestion (see US 26 graphic, Bottleneck 4).

Influence Area Crashes: Rate: 2.84 per MVMT; Frequency: 195 crashes

Operations Summary:

Activation Range: Weave area between 6th Avenue ON ramp and US 26/12th Avenue OFF Ramp

Speed: Bottleneck activation speeds drop as low as 5 mph

Volume (2007 ADT): Mainline: 37,720; 6th ON Ramp: 21,830; 12th/US 26 OFF Ramp: 34,980

Volume (2007 PM Peak Hour): Mainline: 3,940; 6th ON Ramp: 380; 12th/ US 26 OFF Ramp: 2,380

***Data Sources*:**

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

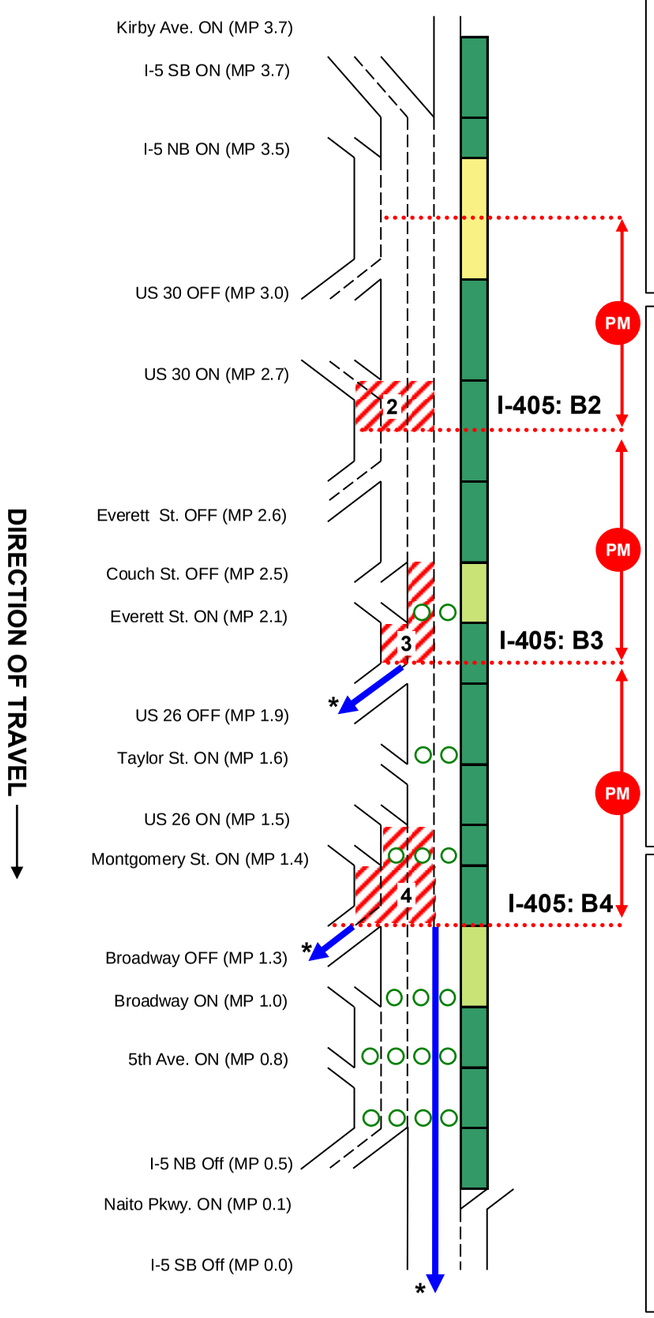
Total crashes from 2004 through 2008

Figure 3-8

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
I-405 Northbound Bottleneck Details

I-405 Southbound



I-405: B2. US 30 ON Ramp (PM)
***Influence Area*:** Between US 30 ON Ramp and north of US 30 OFF Ramp (on the Fremont Bridge)
***Congestion Duration*:** Approximately 3 hours daily (3:15-6:00 PM)
Contributing Factors: Poor lane utilization, high US 30 ON Ramp volume, and closely spaced ramps.
Influence Area Crashes: Rate: 0.33 per MVMT; Frequency: 16 crashes
Operations Summary:
Activation Range: US 30 ON Ramp area
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): Mainline: 37,170; US 30 ON Ramp: 18,070
Volume (2007 PM Peak Hour): Mainline: 2,700; US 30 ON Ramp: 1,400
Data Sources:

I-405: B3. Everett Street ON Ramp to US 26 OFF Ramp Weave (PM)
***Influence Area*:** Between US 26 OFF Ramp and US 30 ON Ramp
***Congestion Duration*:** 3 hours daily (3:15-6:15 PM)
Contributing Factors: Poor lane utilization while positioning for US 26 OFF Ramp. High ramp volumes (Everett Street ON Ramp and US 26 OFF Ramp), short weaving distance, and closely spaced ramps. Spillback from downstream US 26 congestion (see US 26 graphics, Bottleneck 4).
Influence Area Crashes: Rate: 0.68 per MVMT; Frequency: 48 crashes
Operations Summary:
Activation Range: US 26 OFF Ramp to Couch Street ON Ramp
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): Mainline: 38,400; Couch OFF Ramp: 10,030; Everett ON Ramp: 13,970; US 26 OFF Ramp: 27,030
Volume (2007 PM Peak Hour): Mainline: 3,730; Couch OFF Ramp: 610; Everett ON Ramp: 1,150; US 26 OFF Ramp: 2,600
Observations: Drivers from US 30 ON Ramp that desire to continue southbound on I-405 navigate two lane changes: 1. lane drop at Couch Street OFF Ramp, which requires a merge into a highly utilized lane occupied by vehicles destined to US 26 OFF Ramp, and 2. merge into an uncongested lane (left-most lane).
Data Sources:

I-405: B4. US 26 ON Ramp to Broadway OFF Ramp Weave (PM)
***Influence Area*:** Between Broadway Street OFF Ramp and US 26 OFF Ramp
***Congestion Duration*:** 3 hours daily (3:30-6:30 PM)
Contributing Factors: Poor lane utilization while positioning for the Broadway OFF Ramp. Broadway OFF Ramp queue (from local streets) backs onto I-405 mainline, and high volume weave area (US 26 to I-5 and I-405 to Broadway).
Influence Area Crashes: Rate: 0.73 per MVMT; Frequency: 53 crashes
Operations Summary:
Activation Range: Broadway OFF Ramp to US 26 ON Ramp
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): Mainline: 27,740; US 26 ON Ramp: 30,470; Montgomery ON Ramp: 7,500; Broadway OFF Ramp: 20,630
Volume (2007 PM Peak Hour): Mainline: 2,070; US 26 ON Ramp: 1,700; Montgomery ON Ramp: 800; Broadway OFF Ramp: 1,620
Observations: The queue associated with this box impacts operations on eastbound US 26.
Data Sources:

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

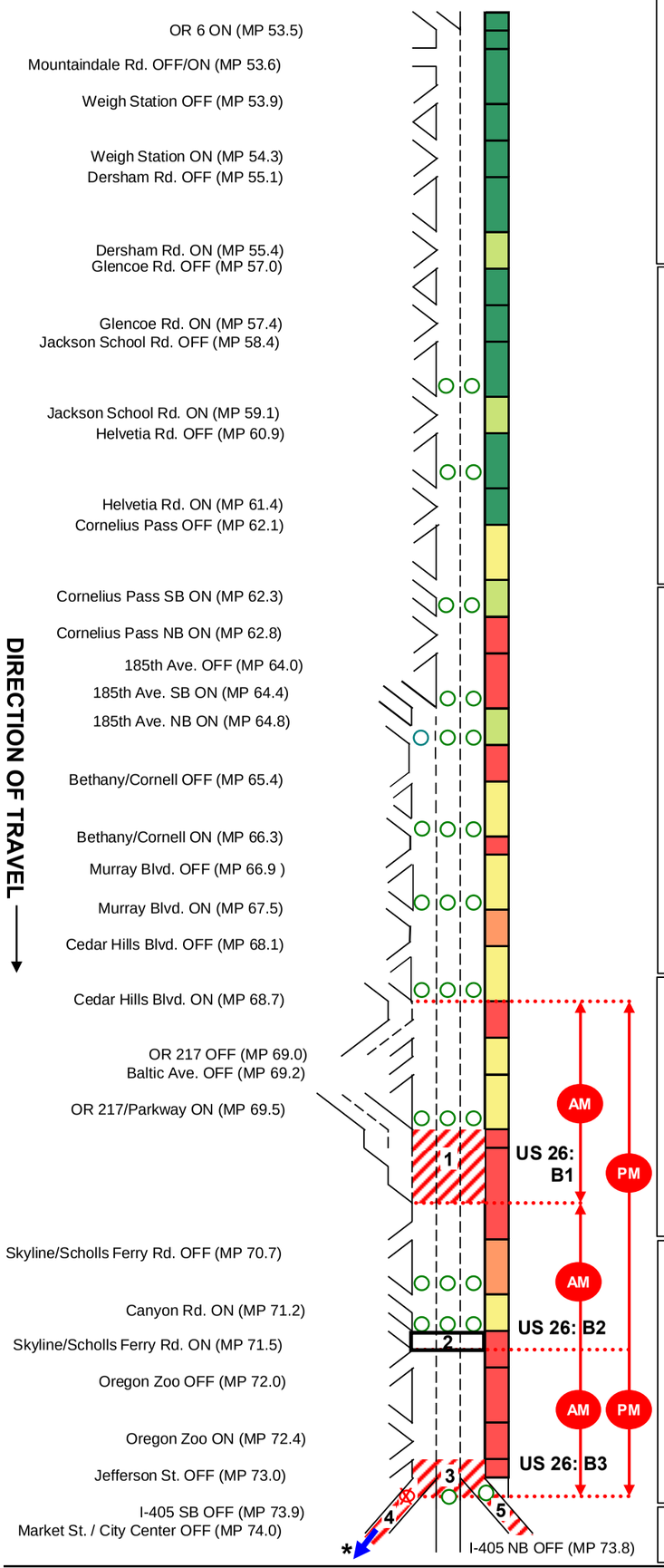
Total crashes from 2004 through 2008

Figure 3-9

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
I-405 Southbound Bottleneck Details

US 26 Eastbound



US 26: B1. OR 217 On Ramp (AM)
***Influence Area*:** Between OR 217 ON lane drop and Cedar Hills Blvd. ON Ramp
***Congestion Duration*:** 3 hours daily (7:00-10:00 AM)
Contributing Factors: High mainline and ramp volumes.
Influence Area Crashes: Rate: 1.23 per MVMT; Frequency: 189 crashes
Operations Summary:
Activation Range: Between OR 217 lane drop and OR 217 ON Ramp gore point
Speed: Bottleneck activation speeds drop as low as 10 mph (AM)
Volume (2007 ADT): Mainline: 40,830; OR 217 ON Ramp: 21,400
Volume (2008 AM Peak Hour): Mainline: 3,190; OR 217 ON Ramp: 1,300
Observations: Some mainline drivers use the long OR 217 ON Ramp acceleration lanes to bypass the mainline queue.
***Data Sources*:**

US 26: B2. Skyline/Scholls Ferry ON Ramp (AM & PM) (INCONCLUSIVE)
***Influence Area*:** Between Skyline ON Ramp and either OR 217 ON lane drop (AM) or Cedar Hills Blvd. ON Ramp (PM)
***Congestion Duration*:** Inconclusive data
Contributing Factors: High mainline and ramp volumes, closely spaced on-ramps (merge points)
Influence Area Crashes: AM influence area rate: 1.49 per MVMT, Frequency: 222 crashes; PM influence area rate: 1.34 per MVMT, Frequency: 411 crashes
Operations Summary:
Activation Range: Scholls Ferry ON Ramp merge area
Speed: Bottleneck speeds drop as low as 15 mph (AM and PM)
Volume (2007 ADT): Mainline: 67,360; Scholls Ferry ON Ramp: 7,100
Volume (2008 AM Peak Hour): Mainline: 4,810; Scholls Ferry ON Ramp: 820
Volume (2008 PM Peak Hour): Mainline: 4,640; Scholls Ferry ON Ramp: 480
***Data Sources*:**

US 26: B3. I-405 Positioning/Curves/Tunnel (AM & PM)
***Influence Area*:** I-405 Diverge to Skyline/Scholls Ferry ON
***Congestion Duration*:** 8 hours daily (6:45-10:15 AM; 3:00-7:30 PM)
Contributing Factors: High mainline volumes. High ramp volume (facility-to-facility connections). Mainline horizontal and vertical curvature approaching Vista Ridge tunnel. 45 mph approach signage. No lane changes from before tunnel to diverges. Sight distance issues.
Influence Area Crashes: Rate: 2.34 per MVMT; Frequency: 849 crashes
Operations Summary:
Activation Range: Between I-405 diverge ramps and Jefferson Street OFF Ramp
Speed: Bottleneck speeds drop as low as 15 mph
Volume (2007 ADT): Mainline: 71,260; I-405 NB OFF Ramp: 27,620; Market OFF Ramp: 13,170; I-405 SB OFF Ramp: 30,470
Volume (2008 AM Peak Hour): Mainline: 5,500; I-405 NB OFF Ramp: 2,100; Market OFF Ramp: 1,400; I-405 SB OFF Ramp: 2,000
Volume (2008 PM Peak Hour): Mainline: 4,800; I-405 NB OFF Ramp: 1,800; Market OFF Ramp: 1,300; I-405 SB OFF Ramp: 1,700
Observation: Center lane slows due to speed differentials with right and left lanes.
***Data Sources*:**

US 26: B4. Ramp to I-405 Southbound (AM & PM)
***Influence Area*:** I-405 mainline to US 26 mainline
***Congestion Duration*:** 8 hours daily (6:45-10:15 AM; 3:00-7:30 PM)
Contributing Factors: High ramp volume (facility to facility connection). Horizontal and vertical curvature. Sight distance issues.
Operations Summary:
Activation Range: Along the entire ramp
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): I-405 SB OFF Ramp: 30,470
Volume (2008 AM Peak Hour): I-405 SB OFF Ramp: 2,000
Volume (2008 PM Peak Hour): I-405 SB OFF Ramp: 1,700
***Data Sources*:**

US 26: B5. Ramp to I-405 Northbound (AM & PM)
***Influence Area*:** I-405 mainline to US 26 mainline
***Congestion Duration*:** 7 hours daily (7:00-10:00 AM; 3:00-7:00 PM)
Contributing Factors: High ramp volume (facility-to-facility connection). Horizontal and vertical curvature. Sight distance issues.
Operations Summary:
Activation Range: Along the entire ramp
Speed: Bottleneck speeds drop as low as 5 mph
Volume (2007 ADT): I-405 NB OFF Ramp: 27,620
Volume (2008 AM Peak Hour): I-405 NB OFF Ramp: 2,100
Volume (2008 PM Peak Hour): I-405 NB OFF Ramp: 1,800
***Data Sources*:**

*** NOTE:** Queuing extends from downstream/adjacent corridors and impacts mainline operations.

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

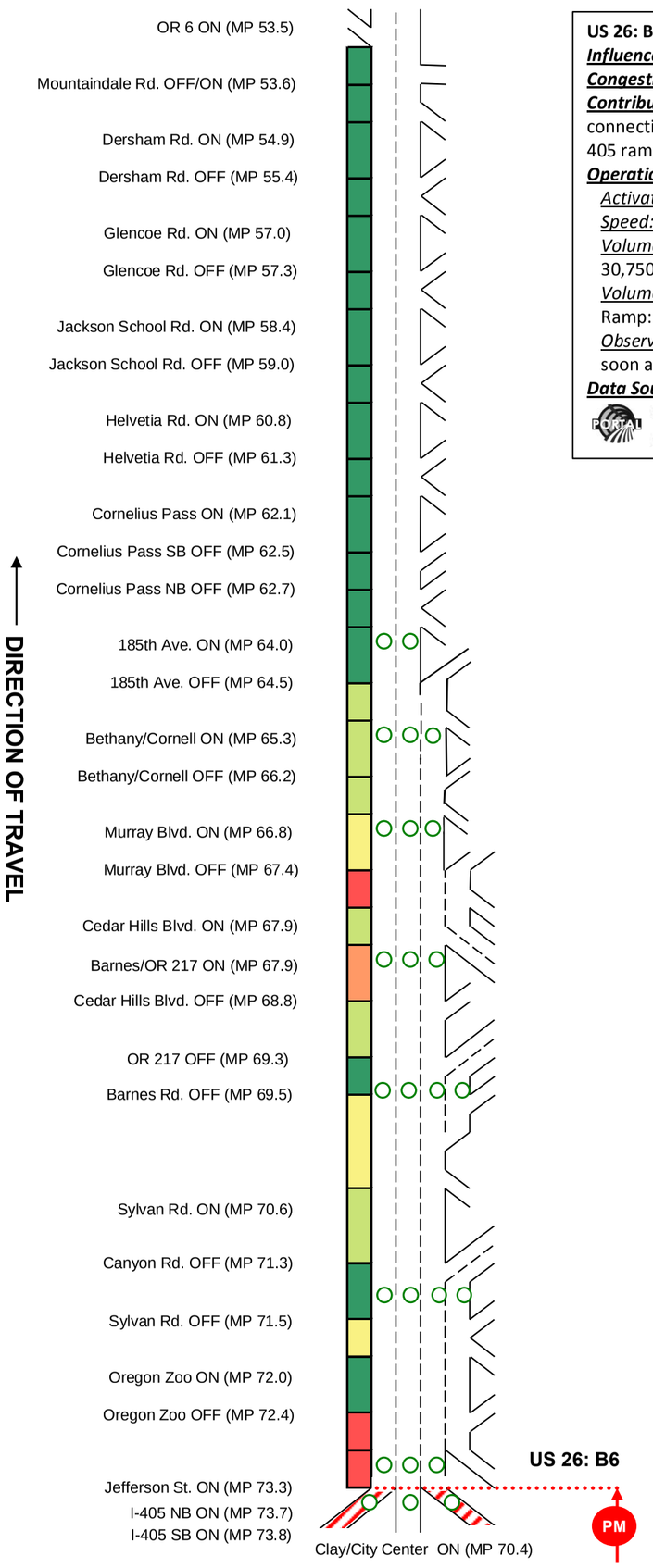
Total crashes from 2004 through 2008

Figure 3-10

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
US 26 Eastbound Bottleneck Details

US 26 Westbound



US 26: B6. I-405 Ramps/US 26 Merge (PM)
***Influence Area*:** Between US 26 merge and I-405 mainline along I-405 ramps
Congestion Duration: Approximately 3 hours daily (3:30-6:45 PM)
Contributing Factors: High ramp volume (including facility to facility connections). I-405 OFF ramp horizontal and vertical curvature. Lane drops on I-405 ramps. Positioning for climbing grade on US 26.
Operations Summary:
Activation Range: I-405 ramp merge areas
Speed: Bottleneck speeds drop as low as 10 mph
Volume (2007 ADT): Market ON Ramp: 12,370; ON from I-405 NB Ramp: 30,750; ON from I-405 SB Ramp: 27,030
Volume (2007 PM Peak Hour): Market ON Ramp: 1,300; ON from I-405 NB Ramp: 2,000; ON from I-405 SB Ramp: 2,600
Observation: Vehicles begin positioning for the downstream climbing grade as soon as the merge onto the US 26 mainline.
Data Sources:

LEGEND

- PORTAL Detector Location (2007 Data Used)
- PORTAL Detector Location (Missing Data)
- (###.#) M.P. of ON/OFF Ramp Gore Point
- Activation Range: This is the segment that contains the start of a new/confounding bottleneck (this does not encompass all congestion)
- Bottleneck Influence Area - Cross reference # with data boxes above
- Influenced by a bottleneck outside of this study area
- Inconclusive Bottleneck Activation Range

- Data collected from PORTAL website
- Data collected from travel time runs
- Information from ODOT
- Information from observations
- Data collected from traffic cameras and/or travel time videos

- 0 - 19 Crashes
- 20 - 39 Crashes
- 40 -59 Crashes
- 60 - 79 Crashes
- > 80 Crashes

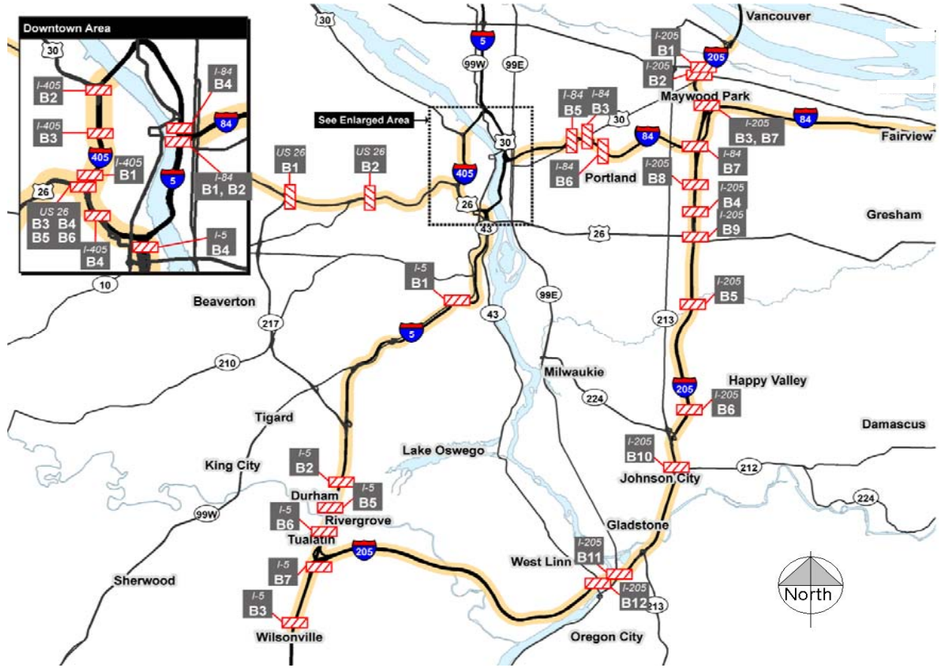
Total crashes from 2004 through 2008

Figure 3-11

DAVID EVANS AND ASSOCIATES INC.

Corridor Bottleneck Operations
US 26 Westbound Bottleneck Details

Figure 3-12: Regional Recurring Bottleneck Locations



Recurring Bottleneck Location

Recurring Bottleneck ID	Recurring Bottleneck Locations	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
I-5 Bottlenecks						
B1	I-5 NB: Terwilliger Boulevard Entrance Ramp (AM & PM)	X	X	20	4	Page | 3-5
B2	I-5 NB: Lower Boones Ferry Road Exit Ramp (AM)	X		30	1.25	Page | 3-5
B3 *	I-5 NB: Westbound Elligsen Road Entrance Ramp (PM)	X		*	*	Page | 3-5
B4	I-5 SB: Hood Avenue Exit Ramp (PM)	X		10	2.75	Page | 3-6
B5	I-5 SB: Carman Drive Lane Drop (PM)	X		10	2.25	Page | 3-6
B6	I-5 SB: Nyberg Street Exit Ramp (PM)	X		25	2.5	Page | 3-6
B7 **	I-5 SB: I-205 Entrance Ramp (PM)	X		**	**	Page | 3-6
I-205 Bottlenecks						
B1	I-205 NB: Sandy Boulevard/Columbia Boulevard Entrance Ramp (PM)	X		20	3	Page | 3-7
B2	I-205 NB: Columbia Boulevard/Hwy 30 Exit Ramp (PM)	X		35	Inconclusive	Page | 3-7
B3	I-205 NB: Westbound I-84 Entrance Ramp (PM)	X		5	5.25	Page | 3-7
B4	I-205 NB: Division Street Entrance Ramp and Hwy 26/Powell Blvd. Entrance Ramp (AM & PM)	X		10	2.75	Page | 3-7
B5	I-205 NB: Foster Road Exit Ramp (AM & PM)	X		20	4	Page | 3-7
B6	I-205 NB: Sunnybrook Road Entrance Ramp (PM)	X		30	2.25	Page | 3-7
B7	I-205 SB: Westbound I-84 Exit Ramp (AM & PM)	X		5	4.25	Page | 3-8
B8	I-205 SB: Stark/Washington Street Entrance Ramp (PM)	X		10	3.25	Page | 3-8
B9	I-205 SB: Hwy 26/Division Street/Powell Boulevard Exit Ramp (PM)	X		25	3.25	Page | 3-8
B10	I-205 SB: 212/224 Entrance Ramp (PM)	X		35	1	Page | 3-8
B11	I-205 SB: 99E/McLoughlin Boulevard Exit Ramp (AM)	X		20	1.25	Page | 3-8
B12	I-205 SB: Hwy 43 Entrance Ramp (AM)	X		30	2	Page | 3-8
I-84 Bottlenecks						
B1	I-84 EB: I-5 SB Entrance Ramp (AM & PM)	X		10	12	Page | 3-9
B2	I-84 EB: I-5 SB/NB Merge (PM)		X	5	4	Page | 3-9
B3	I-84 EB: 39th Avenue Entrance Ramp (PM)	X		Inconclusive	Inconclusive	Page | 3-9
B4	I-84 WB: I-5 Diverge (AM & PM)	X		20	8+	Page | 3-10
B5	I-84 WB: 33rd Avenue Entrance Ramp (AM)	X		15	4	Page | 3-10
B6	I-84 WB: Glisan Entrance Ramp (AM)	X		Inconclusive	Inconclusive	Page | 3-10
B7	I-84 WB: I-205 SB to I-84 WB Ramp	X		Inconclusive	Inconclusive	Page | 3-10
I-405 Bottlenecks						
B1	I-405 NB: US 26/12th Ave (PM)	X		5	3	Page | 3-11
B2	I-405 SB: US 30 Entrance Ramp (PM)	X		5	3	Page | 3-12
B3	I-405 SB: Everett Street Entrance Ramp to US 26 Exit Ramp Weave (PM)	X		5	3	Page | 3-12
B4	I-405 SB: US 26 Entrance Ramp to Broadway Exit Ramp Weave (PM)	X		5	3	Page | 3-12
US 26 Bottlenecks						
B1	US 26 EB: Oregon 217 Entrance Ramp (AM)	X		10	3	Page | 3-13
B2	US 26 EB: Skyline/Scholls Ferry Entrance Ramp (AM & PM)	X		Inconclusive	Inconclusive	Page | 3-13
B3	US 26 EB: I-405 Positioning/Curves/Tunnel (AM & PM)	X	X	15	8	Page | 3-13
B4	US 26 EB: Ramp to I-405 SB (AM & PM)	X	X	5	8	Page | 3-13
B5	US 26 EB: Ramp to I-405 NB (AM & PM)	X	X	5	7	Page | 3-13
B6	US 26 WB: I-405 Ramps/US 26 merge (PM)	X	X	10	3	Page | 3-14

*	Construction of NB Auxilary Lane in 2011
**	Construction of SB Auxilary Lane in 2010

3.5 Steps in Developing Solutions

In an effort to develop a comprehensive list of bottleneck solutions, a review of existing literature was conducted to identify previously proposed improvements. Several documents were critical in this effort:

- I-205 Reconnaissance Study
- I-5 Corridor Plan
- 2035 Regional Transportation Plan
- ODOT Concepts and Studies

The analysis team worked with the design team to review these documents and other documents, and to develop a preliminary list of planned improvements that had the potential to address identified bottleneck area deficiencies. There were a total of 89 possible improvements identified from this work.

More detailed analyses and findings are presented in **Technical Memoranda 4 and 5**, included in **Appendix A.**

3.6 What Are Other Appropriate Solutions?

The goal was to identify projects that could provide measurable benefit with keeping the current financial constraints in mind. To facilitate that goal, the following guidelines were used to guide the project development process:

- Design exceptions would be considered as long as there is a measurable safety or operational benefit
- Focus on relatively low-cost projects or projects that can be phased at a $1.0 million to $20 million range
- Minimal to no additional right-of-way (ROW) required
- Focus on projects with political readiness

Design Panel Alternatives

An expert multidisciplinary design panel, composed of select Consultant and Agency specialists, was convened to review and identify new possible design and operations solutions to mitigate known bottlenecks along the I-5, I-205, I-84, I-405, and US 26 study corridors. This panel provided high-level prioritization of projects, which were then advanced into the next phase of evaluation.

The complete list of identified projects is provided in **Technical Memorandum 7**, included in **Appendix A**.

Geometric Evaluation

The design team screened the preliminary list of possible improvements to identify those that were geometrically constructible. Though design standards and policy limitations were involved in this screening process, it was assumed that design exceptions may be required for some of the proposed improvements.

More detailed analyses and findings are presented in **Technical Memoranda 4 and 5**, included in **Appendix A.**

3.7 Fatal Flaw Screening

Fatal flaw screening involved assessing the feasibility of implementing potential design and operations solutions surfaced under initial development of options and culminating from the design panel as well as promising ideas (see **Technical Memoranda 4 and 5** in **Appendix A**). This feasibility review focused on obvious high-level fatal flaws such as, but not limited to: cost, right-of-way impacts, system integration, and political readiness, as outlined in **Technical Memorandum 6**, included in **Appendix A**.

The high-level fatal flaw feasibility review generally included the following:

1. High-level quantity estimation
2. High-level construction cost estimation
3. Examination of alternatives using screening criteria, accounting for the following characteristics:
    - Goals/objectives
    - Design principles/system needs
    - Geometric feasibility
    - Operational criteria
    - Impact/risk of impacts (right-of-way, environmental, traffic, etc.)
    - Constructability/staging
    - Cost

As a result of this process, not all bottlenecks (however severe they may be) have a recommended project.

What Projects Were Worth Further Evaluation?

The evaluation included analysis of traffic operations, safety, costs, constructability, and other user benefits to assess various performance measures, allowing for selection of potential solutions along the study corridors. This process identified a list of 18 potential solutions, and an evaluation matrix, to move forward into further traffic analysis and evaluation.

3.8 Refinement of Potential Solutions

The majority of the projects were identified for the I-5 and I-205 corridors. No projects were selected for advancement along the US 26 corridor. **Table 3-1** indicates the refinement of the bottleneck locations the development of a potential solution to address the bottleneck. The table provides a list of potential projects, including a project description, estimated cost, traffic analysis tool used for evaluation, and comments regarding relevant findings of the feasibility review by corridor. Overall, there are four recommended actions:

- Bottleneck solution is recommended to move forward to develop a project. The project solution is recommended to move forward if analysis indicates that solution provided an operational or safety benefit and the estimated cost fit the $1.0 million to $20.0 million range.
- Recommendation for the solution is for additional analysis to determine the project. The additional analysis is required to develop a potential solution that will provide operational or safety benefit and an estimated cost that fits in the $1.0 million to $20.0 million range.

- Recommendation is that the bottleneck solution should be dropped.
- The final recommendation is that the solution has been constructed or is planned/programmed for construction.

This list of recommended projects is in **Table 3-1**, while a more detailed summary of methodology is presented in **Technical Memorandum 8**, included in **Appendix A**.

I-5 Potential Solutions

A total of five (5) bottleneck locations are identified for analysis. From these locations a total of eight (8) potential solutions are identified. Five (5) potential solutions are recommended to move forward to be developed as projects. One (1) potential solution is recommended for further analysis to develop a potential project. One (1) bottleneck location has been constructed, and one (1) is recommended to be phased.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

I-205 Potential Solutions

A total of twelve (12) bottleneck locations are identified. From these locations a total of nine (9) potential solutions are identified. All nine (9) have potential solutions recommended to move forward to be developed as projects.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

I-84 Potential Solutions

A total of seven (7) bottleneck locations are identified for analysis. From these locations a total of three (3) potential solutions are identified. One (1) potential solution is recommended for further study. Two (2) bottleneck locations are scheduled to be constructed in 2013.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

I-405 Potential Solutions

A total of four (4) bottleneck locations are identified for analysis. From these locations a total of one (1) potential solution is identified.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

US 26 Potential Solutions

There are no recommended solutions identified for bottlenecks within the US 26 study corridor.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**

3.9 Potential Regional Projects

Potential Regional Projects **(Figure 3-12)** of this Atlas provides a list of potential projects by corridor. This figure summarizes the recommended projects from Table 3-1 and highlights the future action.

Table 3-1: Potential Regional Projects Summary

Map ID	Bottleneck ID	Tracking ID	Project	Description	Est. Cost	*Traffic Analysis Findings/Comments*	Potential Solutions Identified
I-5 Recommended Projects							
Northbound							
A	I-5: B1	1a	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	Extend Terwilliger Blvd. entrance ramp/acceleration lane around curve to address poor sight distance, reduce speed differential and improve merging.	$30M - $40M	The initial proposed project will extend the current acceleration lane at the Terwilliger entrance-ramp around the horizontal curve to allow drivers to navigate the curve and then merge into mainline traffic in a tangent section of the freeway. This would provide drivers additional time and proper sight line to pick up gaps for the merging maneuver. The proposed project has the potential to reduce the number of crashes in the area because drivers would not be attempting to merge while navigating a long horizontal curve in a steep grade. The proposed project may not result in significant congestion relief in the peak hours due to downstream bottlenecks, but there would be operational and safety benefits associated with the enhanced design for the Terwilliger Blvd entrance-ramp merge junction. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.	**Further Analysis**
B	I-5: B2	2a	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	Convert the existing I-5 NB exit ramp to Lower Boones Ferry Road from a one-lane exit to a two-lane exit ramp	$1M - $2M	This is Phase 1 of the potential solution project for this bottleneck. The mainline traffic south of Nyberg St. Interchange would have the ability to exit to Lower Boones Ferry Road without having to make a lane change, thereby reducing the turbulence near the exit gore area in the two outside lanes. The duration of queuing is expected to be reduced by 30 minutes.	**Yes**
C	I-5: B2	2b-1	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	Connect 2-lane entrance from Nyberg to existing NB auxiliary lane to Lower Bonnes Ferry. Extend auxiliary lane through Lower Bonnes Ferry interchange and connect to existing NB auxiliary lane. Construct merge lane for NB Lower Boones Ferry interchange entrance ramp.	$11.5M - $13.5M	Assuming Phase 1 (Map ID B) is built, this second phase of improvement is expected to provide further improvement of traffic operations and safety benefits in the project section. The length of queue is reduced and analysis of the peak periods does show some congestion relief. However, substantial operational benefits are expected in the adjacent hours to the peak periods.	**Yes**
D	I-5: B2	2b-2	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	Construct auxiliary lane from NB Lower Boones Ferry Road entrance ramp to connect with existing auxiliary lane between Carman Drive and OR 217. Construct merge lane for NB Carman Dr. entrance ramp.	$17M - $21M	This is Phase 3 of the potential solution project for this bottleneck. There is a very high demand for volumes exiting to OR217 N and this improvement will provide those motorists a longer distance to find adequate gaps for lane changes and to position themselves in the appropriate lane earlier. This project is expected to result in overall operations and safety improvement.	**Yes**
E	I-5: B2	2b-1 & 2b-2	This Project is Phased into I-5 NB Projects B, C and D.	Refer to I-5NB: Projects B,C and D	$18M - $22M	This project is broken into Phase 1, 2 and 3. Project cost exceeds CBOS criteria of $1 to $20 million range.	**Project Phased**
Southbound							
F	I-5: B5	3	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	This project would extend the current lane drop just south of the Carman Dr. Exit Ramp to the Lower Boones Ferry Rd. OFF Ramp, where it would become a drop lane.	$1.25M	This is Phase 1 of the potential solution project for this bottleneck. This is expected to minimize queuing on I-5 from the OR217 merge by 1 mile, and reduce the queuing on OR217 approaching I-5. This is expected to result in a decrease of 1 hour of congestion along I-5.	**Constructed August 2012**
G	I-5: B6	3a-1	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	The proposed project would extend the existing auxiliary lane from the Lower Boones Ferry Rd. exit-ramp to the Nyberg St. entrance-ramp.	$7.2M - $8.5M	This is Phase 2 of the potential solution project for this bottleneck. The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. This is expected to reduce congestion, improve lane balance and travel time reliability, and sustain stable traffic flow. Extension of the auxiliary lane is expected to result in a 30% reduction in mainline crashes.	**Yes**

Table 3-1: Potential Regional Projects Summary

Map ID	Bottleneck ID	Tracking ID	Project	Description	Est. Cost	*Traffic Analysis Findings/Comments*	Potential Solutions Identified
H	I-5: B6	3a-3	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	Extend I-5 SB auxiliary lane from Nyberg Rd exit ramp to I-205 exit ramp and maintain the SB auxiliary lane configuration from Nyberg Rd entrance ramp to I-205 exit ramp.	$10M -$18M	The additional auxiliary lanes are expected to reduce weaving behaviors and improve traffic operations. Of the volumes exiting to I-205, 36% are from OR217, 24% are from Carman and Lower Boones Ferry, and 30% are from Nyberg. With 90% of the traffic exiting at I-205 coming from the four entrance-ramps immediately north, this auxiliary lane would provide more direct connection without having to mix or interact with the rest of mainline traffic. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
I-205 Recommended Projects							
Northbound							
I	I-205: B3	2	I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane	Construct a short auxiliary lane by extending the acceleration lane from I-84 westbound merging traffic on I-205NB to the Sandy Boulevard off-ramp.	$6.7M	The proposed project will construct an auxiliary lane by extending the acceleration lane from the I-84 WB entrance-ramp to the Sandy Blvd. exit-ramp. The spacing between the I-84 WB entrance-ramp and Sandy Blvd. exit-ramp is approximately 2000'. With the addition of an auxiliary lane between these two ramps, the I-84 WB entrance-ramp traffic would not be required to merge into the I-205 mainline immediately as they currently do. This would allow vehicles on the I-84 WB entrance-ramp additional time to find gaps to access the I-205 mainline. As a result, this would help reduce the queuing and relieve congestion that the I-84 WB entrance-ramp currently propagates south to the I-84 EB entrance-ramp merge junction and would improve overall traffic safety in the project section.	**Yes**
J	I-205: B3	2a	I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension	Extend auxiliary lane from Sandy Blvd. exit ramp to Columbia Blvd. ramp in junction with the assumed auxiliary lane from I-84 WB entrance ramp to I-205 NB exit ramp to Sandy Blvd.	$6.5M	The proposed project will build upon Project Map ID I by creating an auxiliary lane from the I-84 WB entrance-ramp to the Columbia Blvd../Killingsworth St. (US30 Bypass) exit-ramp. This project would eliminate Bottleneck 3. In addition, it will improve traffic safety and operations for Freight movements as the Columbia Blvd and US30 Bypass are major Freight Routes serving the north Portland industrial areas.	**Yes**
K	I-205: B4	1	I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.	This project would eliminate Bottleneck 3, reducing queuing during off-peak period. Vehicles would arrive at the downstream bottleneck earlier in the peak period, increasing congestion at Bottleneck 1.	6.5M - $7.5M	The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes and completely reduced in the two leftmost lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
L	I-205: B4	1a	I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension	Add an auxiliary lane from Powell Blvd. entrance ramp to Division St. entrance ramp and tie to the existing auxiliary lane between Division St. entrance ramp and Washington St. exit ramp.	$6.0M - $6.9M	This project is the first phase of a phased approach to developing an auxiliary lane on I-205 NB. The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
M	I-205: B4	1b	I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension	Extend auxiliary lane fromWashington St. Exit Ramp to Glisan St. Exit Ramp.	$2.4M - $2.8M	The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements. The proposed improvement will enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**YES**

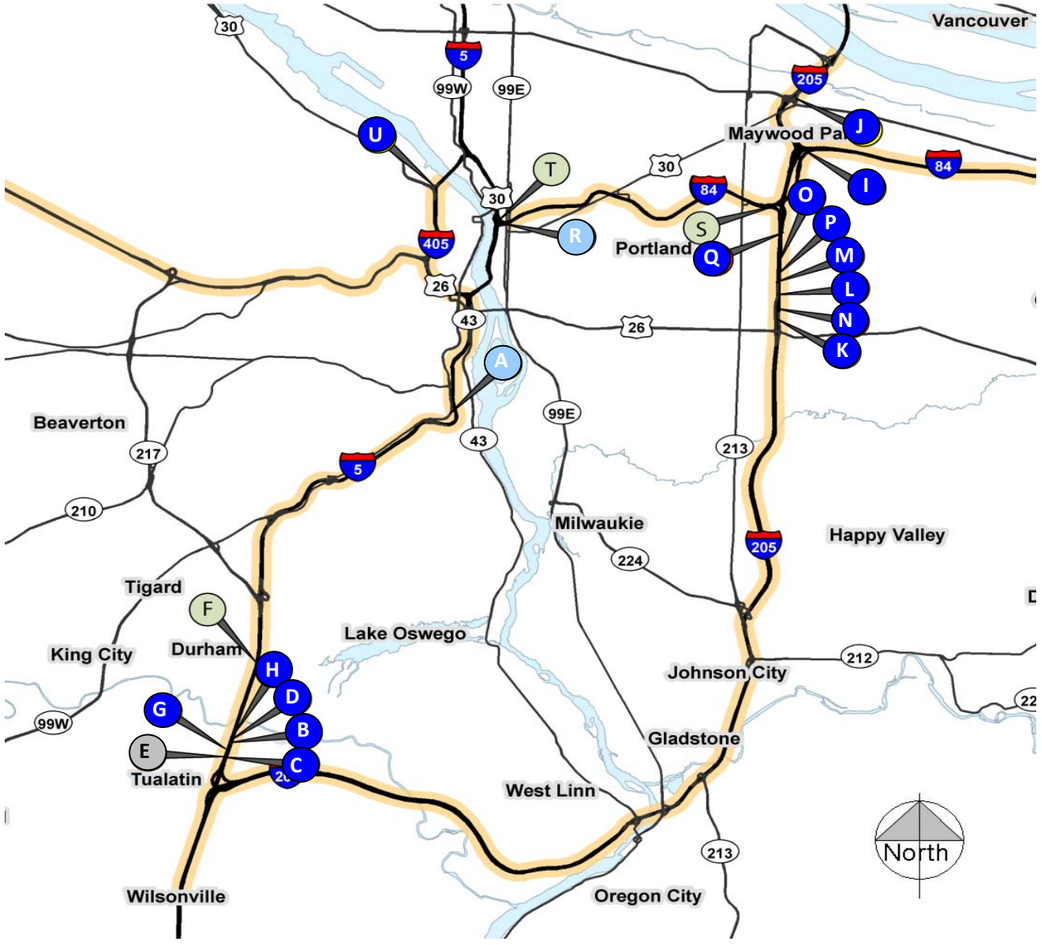
Table 3-1: Potential Regional Projects Summary

Map ID	Bottleneck ID	Tracking ID	Project	Description	Est. Cost	*Traffic Analysis Findings/Comments*	Potential Solutions Identified
N	I-205: B4	1c	I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension	Extend auxiliary lane from Glisan St. Exit Ramp ramp to I-84 WB exit ramp	$2.2M -$2.5M	Assuming that Projects Map ID L and M are built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project would extend the auxiliary lane from Glisan St. exit-ramp to I-84 WB exit-ramp.T he proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time/distance to find gaps and safely weave over lanes. Of the volumes exiting at I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
O	I-205: B4	1d	I-205 NB: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington Street	Extend the existing NB auxiliary lane from Stark St./Washington St. exit ramp to Glisan St. exit ramp.	$1.7M - $2.0M	Assuming Projects Map ID L, M, and N are built, this project would be the next and final low-cost phase. The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Of the volumes exiting to I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
P	I-205: B4	1e	I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-lane Exit at Washington St.	Extend auxiliary lane from Division St. exit ramp to I-84 WB exit ramp. Add an auxiliary lane from Division St. Entrance ramp ramp toWashington St. Exit Ramp. Convert the existing I-205 NB exit ramp to Washington St. from a one-lane exit to a two-lane exit ramp	$7.6M - $8.M	A follow-up phase to Project Map ID L, this project represents the ultimate improvement to address congestion relief for the area. Considering that funding may be a constraint, this project can be broken into three smaller projects: Project Map ID M, N and O. This project would extend the auxiliary lane from Washington St. exit-ramp to I-84 WB exit-ramp and build an additional auxiliary lane from Division entrance-ramp to Washington St. exit-ramp with two-lane exit. The proposed improvement will provide drivers additional time and distance to safely make the necessary weaving maneuvers. Congestion would be completely reduced in all lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**
Southbound							
Q	I-205: B8/B9	1	I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane	Add an auxiliary lane from I-84 EB entrance ramp to Washington St. entrance ramp and tie to the existing auxiliary lane between Washington St. and Division St.	$7.0M - $8.5M	Approximately 25% of traffic from I-84 EB Entrance-ramp is destined for Division/Powell and this project would provide direct connection to this exit. Congestion/queuing would be reduced in all lanes and completely reduced in the two leftmost lanes. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.	**Yes**

Table 3-1: Potential Regional Projects Summary

Map ID	Bottleneck ID	Tracking ID	Project	Description	Est. Cost	*Traffic Analysis Findings/Comments*	Potential Solutions Identified
I-84 Recommended Projects							
Eastbound							
R	I-84: B2	2a	I-84 EB: Grand Ave. Entrance Ramp Extension	Lengthen the EB entrance ramp to 12th Ave. U'xing structure	$4.4M - $5.2M	Initial analysis is inconclusive. Project needs further analysis to evaluate improvement to address safety/operational issues. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.	**Further Analysis**
S	I-84: B3	1	I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane	The project will construct a new exit-only lane by extending the current Halsey St. exit-only lane on I-84 eastbound to the I-205 northbound exit-ramp.	$5.9M	The new exit-only lane to I-205 northbound will improve safety by reducing traffic queuing and congestion on I-84 WB. It will also improve traffic flow for I-84 WB through traffic including freight movements destined to Troutdale or locations further east not only in the p.m. peak hours, but also throughout most of the day. This is because of the high hourly traffic volume exiting to I-205 northbound during the day.	**Construction 2013**
T	I-84: B4	4a	I-84 WB: I-5 NB and I-5 SB Diverge Re-striping	Re-stripe lane markings to provide two dedicated exit lanes to I-5 SB and one dedicated exit lane to I-5 NB. Add additional signage.	$0.5M	Over the past five years (2007-2011), there have been 237 collisions on I-84 westbound between the Convention Center/Rose Quarter exit ramp and 33rd Avenue. Of these, 31 occurred between the Grand Avenue overpass and the ramp for Convention Center/Rose Quarter.Of the 237 collisions that have occurred between the Convention Center/Rose Quarter ramp and 33rd Avenue, 95% have been rear end or sideswipe collisions resulting from traffic merging and weaving to get into the correct lanes and from the speed reductions and congestion that result from these actions. The restriping and signage upgrades will improve traffic flow and help reduce motorist confusion in this area and the collisions that result by providing clearly marked dedicated exit-only lanes.	**Construction 2013**
I-405 Recommended Projects							
Southbound							
U	I-405: B2	2a	I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement	Convert the EB-SB entrance ramp from a two-lane entrance to a one-lane entrance ramp	$0.5M - $1.0M	This project is expected to provide improved traffic operations and safety benefits by eliminating the inside lane merge. This will result in smoother traffic flow as vehicles entering from the entrance-ramp will stay in the auxiliary lane longer and wait for adequate gaps before making the lane change onto the mainline. A couple of similar type of projects that have been constructed in the Region over the past 6-8 years are: (1) Milwaukie Expressway (OR224, Hwy#171)/SE 82nd Ave. entrance-ramp merge junction on I-205 southbound, and (2) OR99W(SW Barbur Blvd) and the truck climbing lane entrance-ramp merge junction on I-5 northbound located approximately 1/2 mile north of the Haines Rd. interchange.)	**Yes**

Figure 3-13: Potential Regional Projects



Recommended Project Location (indicates Potential Solution Recommentation)

Map ID	Bottleneck ID	Potential Solution Identified	Potential Regional Projects	Est. Cost	See Project Sheet on page #
I-5 Bottlenecks					
A	I-5: B1	Further Analysis	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	$30M - $40M	Page | 4-7
B	I-5: B2	Yes	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	$1M - $2M	Page | 4-8
C	I-5: B2	Yes	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	$11.5M - $13.5M	Page | 4-9
D	I-5: B2	Yes	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	$17M - $21M	Page | 4-10
E	I-5: B2	Project Phased	This Project is Phased into I-5 NB Projects B, C and D.	$18M - $22M	Page | 4-12
F	I-5: B5	Constructed August 2012	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	$1.25M	Page | 4-11
G	I-5: B6	Yes	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	$7.2M - $8.5M	Page | 4-13
H	I-5: B6	Yes	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	$10M - $18M	Page | 4-14
I-205 Bottlenecks					
I	I-205: B3	Yes	I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane	$6.7M	Page | 4-19
J	I-205: B3	Yes	I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension	$6.5M	Page | 4-20
K	I-205: B4	Yes	I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.	6.5M - $7.5M	Page | 4-21
L	I-205: B4	Yes	I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension	$6.0M - $6.9M	Page | 4-22
M	I-205: B4	YES	I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension	$2.4M - $2.8M	Page | 4-23
N	I-205: B4	Yes	I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension	$2.2M - $2.5M	Page | 4-24
O	I-205: B4	Yes	I-205 NB: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington Street	$1.7M - $2.0M	Page | 4-25
P	I-205: B4	Yes	I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-lane Exit at Washington St.	$7.6M - $8.M	Page | 4-26
Q	I-205: B8/B9	Yes	I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane	$7.0M - $8.5M	Page | 4-27
I-84 Bottlenecks					
R	I-84: B2	Further Analysis	I-84 EB: Grand Ave. Entrance Ramp Extension	$4.4M - $5.2M	Page | 4-33
S	I-84: B3	Construction 2013	I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane	$5.9M	Page | 4-34
T	I-84: B4	Construction 2013	I-84 WB: I-5 NB and I-5 SB Diverge Re-striping	$0.5M	Page | 4-35
I-405 Bottlenecks					
U	I-405: B2	Yes	I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement	$0.5M - $1.0M	Page | 4-41

3.10 Regional Project Modeling

CBOS is a comprehensive effort to identify and evaluate recurring bottlenecks on the five major freeway corridors in the Portland Metro area. An important issue to examine and understand is the potential of these bottleneck improvements to create induced traffic. ODOT's primary goal of CBOS is to improve the safety and operations of the existing freeway by reducing the congestion at recurring bottlenecks without increasing the overall capacity of the freeway corridor.

FHWA states that "induced travel is often misused to imply that increases in highway capacity are directly responsible for increases in traffic. In fact, the relationship between increases in highway capacity and traffic is very complex, which encompasses various traffic behavior responses, residential and business location decisions, and changes in regional population and economic growth".[1]

Oregon land use planning laws requires local jurisdictions to establish and identify the amount and location of specific land uses based on population and employment projections of the region. In the Portland Metro area, METRO develops the population and employment targets based on its Metroscope model. These targets are incorporated into the Regional Transportation Plan (RTP) and transportation decisions are made based on those projections. These decisions are then reflected in the local Comprehensive Plans and Transportation System Plans.

The regional travel demand model is a four-step trip based travel behavior model that is consistent with the RTP and is utilized to project traffic volumes and travel times on the transportation network. The model offers an understanding of travel behavior and improvement project impacts. Travelers generally divert to alternative routes to avoid congestion and bottlenecks that will delay their trips. The travel demand model is sensitive to the capacity constraints and will reallocate trips based on capacity and travel time to reach the travelers destination. When the freeway is congested, the model will reroute trips to the local system. Vice versa, if a bottleneck is removed on the freeway, trips that would have taken the freeway will be rerouted back to the freeway.

The CBOS improvement projects were coded into the 2010 and 2035 AM and PM travel demand models and compared to No-Build conditions to determine the travel impacts and to answer the question of induced demand. The majority of the projects are auxiliary lane extensions with the purpose of improving safety through breaking up recurring bottlenecks and better facilitating freeway entering/exiting traffic.

The following projects were modeled:

I-5 Projects	Location	Type of Improvement
Project B	*I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration*	*2-Lane Exit at Lower Boones Ferry Road*
Project C	*I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange*	*Auxiliary Lane Extension*
Project D	*I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange*	*Auxiliary Lane Extension*
Project F	*I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp Auxiliary Lane*	*Auxiliary Lane*
Project G	*I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance*	*Auxiliary Lane*
Project H	*I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205*	*Auxiliary Lane Extension*

I-205 Projects		
Project I	*I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp*	*Auxiliary Lane*
Project J	*I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp*	*Auxiliary Lane Extension*
Project L	*I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp*	*Auxiliary Lane Extension*
Project P	*I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp*	*Auxiliary Lane Extension w/2-Lane Exit at Washington St.*
Project Q	*I-205 SB: I-84 EB Entrance Ramp to Stark St./Washington St. exit ramp*	*Auxiliary Lane*

I-84 Projects		
Project S	*I-84 EB: Halsey St. Exit Ramp to I-205 NB Entrance Ramp*	*Auxiliary Lane*
Project T	*I-84 WB: I-5 NB and I-5 SB Diverge*	*Re-striping*

For varying reasons, the following projects were not modeled:

I-5 Projects	Location	Type of Improvement
Project A	*I-5 NB: Terwilliger Blvd. Entrance Ramp*	*Recommended for further analysis*
Project E	I-5 NB: Nyberg Rd. Interchange to Carman Dr. Interchange	*Project phased into I-5ND projects B,C and D*

[1] Induced Travel: Frequently Asked Questions, FHWA's Planning web page: http://www.fhwa.dot.gov/planning/itfaq.cfm

I-205 Projects		
Projects M thru O	*I-205 NB*	*Projects are included in Project P*

I-84 Project		
Project R	*I-84 EB: Grand Ave. Entrance Ramp Extension*	*Recommended for further analysis*

I-405 Project		
Project U	*I-405 SB/US30 EB: Entrance ramp lane re-arrangement.*	*Re-striping*

The trip demand modeling results verified the assumption that the CBOS auxiliary lane improvements help the recurring bottlenecks. The Key Points are summarized below:

- For freeway sections where there are series of auxiliary lane improvements, the trip difference is more apparent, as consistent with the goal of relieving localized bottlenecks. There is generally 1-6% trip increases on the freeway section within the project area and extended to one interchange downstream.
    - Auxiliary lanes used between consecutive entrance and exit ramps allow traffic to speed up and slow down in designated lanes while reducing interference to the throughway.

  Auxiliary lanes improve the safety and freeway operations at interchanges, better facilitating vehicles existing and entering the freeway mainline.
- The auxiliary lane improvements generally benefit local roadways surrounding the area. Longer-distance trips are staying on the freeway a little longer by 1-2 interchanges, providing relief to the local facilities. This is seen in the trip differences on local roads, exit ramps and entrance ramps.
    - For I-5 S, more trips are now able to get to Tualatin-Sherwood Road and not using the local roadways as a cut-through route.
    - For I-5 N, more trips are now able to get to Upper Boones-Ferry Road/Carman and not getting off at Nyberg and using the local roadways as a cut-through route.
    - For I-205 N impacts, trips on I-84 W and I-84 E destined to the airport area are no longer exiting early to avoid the congestion at the connections to I-205.

  Generally, local roads parallel or adjacent to the freeway project area are seen to have a positive impact from trip changes.
- The modeling results indicated that that for the areas of the auxiliary lane improvements there was no significant increase in trips outside of the improvement area on I-5 or I-205.
    - The 2035 model indicated that on I-5 to the north and south of the auxiliary lanes area the net change in trips would be no greater than roughly 50 trips during the AM and PM peak hour. This is less than 0.1% of the total trips on I-5.
    - The 2035 model indicated that on I-205 to the north and south of the auxiliary lanes area the net change in trips would be no greater than 50 trips during the AM and PM peak hour. This is less than 0.01% of the total trips on I-205.

  For each freeway facility, latent travel demand is not seen on a corridor-wide basis. Nor is there any inclination for mode shift since this typically occurs where travel is improved for longer distance (corridor-wide travel time improvement).

The modeling results are consistent with the purpose of the CBOS improvement projects, which is to enhance traffic safety and operations at freeway entrance and exit ramp junctions which are experiencing safety and operational issues. By breaking up the recurring freeway bottlenecks, freeway traffic will experience improved operations and will also be using the exit and entrance ramps that are more direct to reach their destination and reducing the cut-through traffic on the local roadway network.

The ultimate goal is to improve safety and CBOS was developed in accordance with the guidelines established in the FHWA Localized Bottleneck Reduction (LBR) program. CBOS and the FHWA LBR program share the same common theme, that is, reducing potential crashes within weaving and merging areas has a positive safety impact and is highly cost effective.[2]

3.11 What Do You Need to Know About the Recommended Projects?

The project sheets in **Chapter 4** include a project description and schematic, along with summaries of traffic operations, safety, costs, constructability, and other user benefits. Also included on the project sheets is an assessment of impacts associated with each solution. Project sheets include aerial imagery, which provides a concept-level sketch of the identified solution. Also listed are the potential follow-up phases, where applicable.

[2] FHWA – "Recurring Traffic Bottlenecks: A Primer", Report No FHWA-HOP-12-012, pg. 16.

CHAPTER 4:
BOTTLENECKS AND PROJECT RECOMMENDATIONS BY CORRIDOR

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I-5 CBOS Recurring Bottlenecks and Project Recommendations

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Chapter 4: CBOS Recurring Bottlenecks and Project Recommendations

4.1 I-5 Recurring Bottlenecks and Project Recommendations

Based on review of PORTAL data, ODOT cameras, and field travel time data, a total of seven (7) bottlenecks are identified within the I-5 study corridor: three (3) bottlenecks are in the northbound direction and four (4) in the southbound direction. The bottlenecks are classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures **(Figure 3-2 and Figure 3-3)**, while more detailed analyses and findings are presented in **Technical Memorandum 3**, included in **Appendix A**.

Bottleneck and Recommended Project Summary Graphics

For an overview figure of the bottlenecks and recommended projects for the I-5 corridor, see **Figure 4-1** and **Figure 4-2**, respectively. See **Chapter 1** for guidelines on how to compare the bottleneck and recommended project summary graphics.

A total of five (5) bottleneck locations are identified for analysis. From these locations a total of eight (8) potential solutions are identified. Five (5) potential solutions are recommended to move forward to be developed as projects. One potential solution is recommended for further analysis to develop a potential project. One bottleneck location has been constructed, and one is recommended to be deleted.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

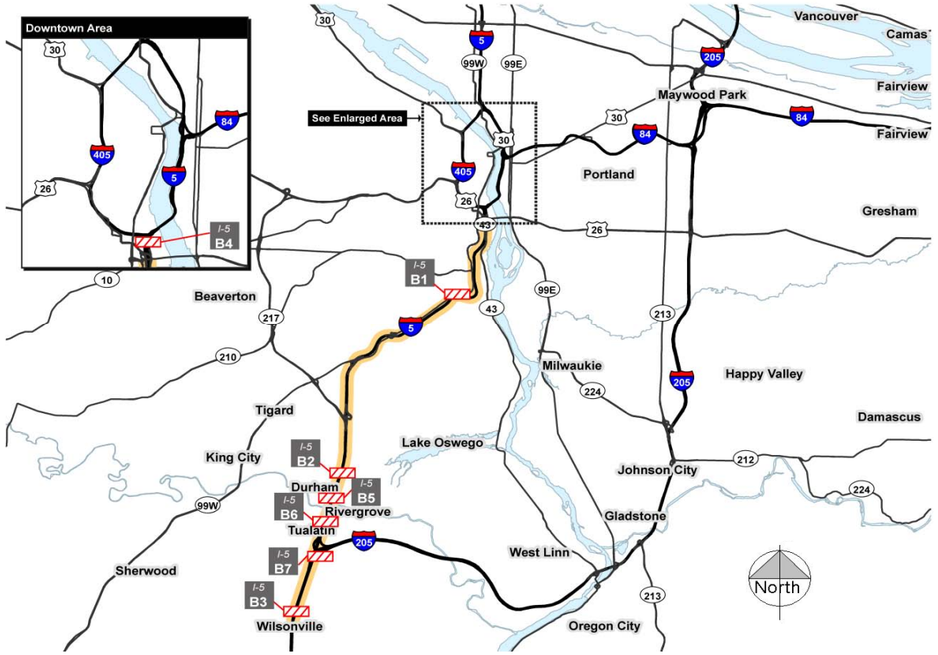
Project Sheets

Please see **pages 4-7** through **4-14** for project sheets unique to each recommended project for the I-5 corridor. There are eight project sheets for the I-5 corridor (Projects A – H). See **Chapter 1** for guidelines on how to read the project sheets.

I-5 Corridor Recommended Projects

Map ID	Bottleneck ID	Project Description	Est. Cost	Traffic Analysis Findings/Comments
Northbound				
A	I-5: B1	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	$30M - $40M	The proposed project may not result in significant congestion relief in the peak hours due to downstream bottlenecks, but there would be operational and safety benefits associated with the enhanced design for the Terwilliger Blvd entrance-ramp merge junction. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.
B	I-5: B1	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	$1M - $2M	This is Phase 1 of the potential solution project for this bottleneck. The mainline traffic south of Nyberg St. Interchange would have the ability to exit to Lower Boones Ferry Road without having to make a lane change, thereby reducing the turbulence near the exit gore area in the two outside lanes. The duration of queuing is expected to be reduced by 30 minutes.
Northbound				
C	I-5: B1	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	$11.5M - $13.5M	Assuming Phase 1 (Map ID B) is built, this second phase of improvement is expected to provide further improvement of traffic operations and safety benefits in the project section. The length of queue is reduced and analysis of the peak periods does show some congestion relief. However, substantial operational benefits are expected in the adjacent hours to the peak periods.
D	I-5: B1	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	$17M - $21M	This is Phase 3 of the potential solution project for this bottleneck. There is a very high demand for volumes exiting to OR217 N and this improvement will provide those motorists a longer distance to find adequate gaps for lane changes and to position them in the appropriate lane earlier. This project is expected to result in overall operations and safety improvement.
E	I-5: B1	Refer to I-5NB: Projects B,C and D	$18M - $22M	This Project is Phased into I-5 NB Projects B, C and D. Project cost exceeds CBOS criteria of $1 to $20 million range.
Southbound				
F	I-5: B1	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	$1.25M	This is Phase 1 of the potential solution project for this bottleneck. It is expected to minimize queuing on I-5 from the Hwy 217 merge by 1 mile, and reduce the queuing on Hwy 217 approaching I-5. This is expected to result in a decrease of 1 hour of congestion along I-5.
G	I-5: B6	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	$7.2M - $8.5M	This is Phase 2 of the potential solution project for this bottleneck. The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. This is expected to reduce congestion, improve lane balance and travel time reliability, and sustain stable traffic flow. Extension of the auxiliary lane is expected to result in a 30% reduction in mainline crashes.
H	I-5: B6	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	$10M - $18M	The additional auxiliary lanes are expected to reduce weaving behaviors and improve traffic operations. Of the volumes exiting to I-205, 36% are from OR217, 24% are from Carman and Lower Boones Ferry, and 30% are from Nyberg. With 90% of the traffic exiting at I-205 coming from the four entrance-ramps immediately north, this auxiliary lane would provide more direct connection without having to mix or interact with the rest of mainline traffic. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

Figure 4-1: I-5 Recurring Bottleneck Locations



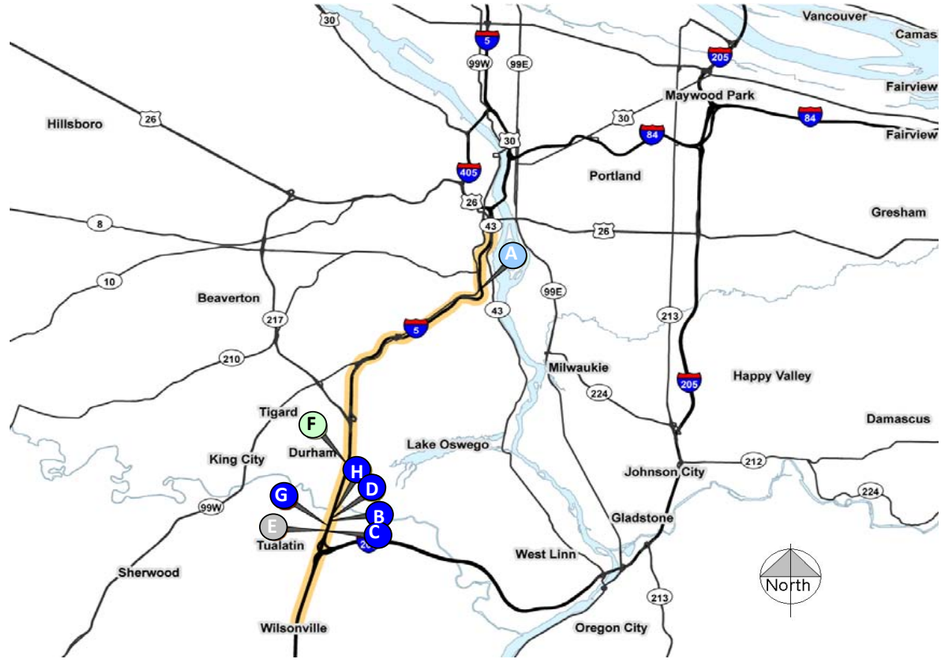
Recurring Bottleneck Location

Bottleneck ID	Recurring Bottleneck Location	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
I-5 Bottlenecks						
B1	I-5 NB: Terwilliger Boulevard Entrance Ramp (AM & PM)	X	X	20	4	Page | 3-5
B2	I-5 NB: Lower Boones Ferry Road Exit Ramp (AM)	X		30	1.25	Page | 3-5
B3 *	I-5 NB: Westbound Elligsen Road Entrance Ramp (PM)	X		*	*	Page | 3-5
B4	I-5 SB: Hood Avenue Exit Ramp (PM)	X		10	2.75	Page | 3-6
B5	I-5 SB: Carman Drive Lane Drop (PM)	X		10	2.25	Page | 3-6
B6	I-5 SB: Nyberg Street Exit Ramp (PM)	X		25	2.5	Page | 3-6
B7 **	I-5 SB: I-205 Entrance Ramp (PM)	X		**	**	Page | 3-6

* Construction of NB Auxilary Lane in 2011

** Construction of SB Auxilary Lane in 2010

Figure 4-2: I-5 Recommended Projects



Recommended Project Location (indicates Potential Solution Recommentation)

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project sheet on page #
I-5 Recommended Projects to Move Forward					
B	I-5: B2	Yes	I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration	$1M - $2M	Page | 4-8
C	I-5: B2	Yes	I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension	$11.5M - $13.5M	Page | 4-9
D	I-5: B2	Yes	I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension	$17M - $21M	Page | 4-10
F	I-5: B5	Constructed August 2012	I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane	$1.25M	Page | 4-12
G	I-5: B6	Yes	I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane	$7.2M - $8.5M	Page | 4-13
H	I-5: B6	Yes	I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension	$10M -$18M	Page | 4-14
I-5 Recommended Projects for Additional Analysis and Evaluation					
A	I-5: B1	Further Analysis	I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.	$30M - $40M	Page | 4-7
Project Phased					
E	I-5: B2	Project Phased	This Project is Phased into I-5 NB Projects B, C and D.	$18M - $22M	Page | 4-11

I-5 NB: Terwilliger Blvd. Entrance Ramp Extension.

Map ID	A
Bottleneck ID	I-5: B1
Tracking ID	1a
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Further Analysis	$30M - $40M

Existing Operations*

Variable	Existing
Duration (hours)	1.5
Queue (miles)	3.6 - 4.1
Average Speed (mph)	21 - 30
Density (veh/mi/ln)	55

Key Points

Existing Conditions

Currently the Terwilliger Blvd. entrance-ramp merges into the I-5 mainline at the beginning of a long, sweeping horizontal curve, restricting back-view sight distance to pick up adequate gaps for merging maneuver. Compounding this is the steep grade, high volumes of trucks, mainline and on-ramp traffic. The downtown Portland queue extends back to just north of the Barbur Blvd entrance-ramp. Simulation model testing has shown that when ignoring the downstream bottleneck, the resulting Terwilliger Blvd entrance-ramp queue spills back to the Taylors Ferry exit-ramp. The duration of this queue is approximately 1.5 hours (7:15-8:45AM) on weekdays. The project section is a top 10% SPIS site.

Proposed Improvements

Conclusion: Project needs further analysis/evaluation to develop improvement to address safety/operational issues.

Operations/Safety Benefits

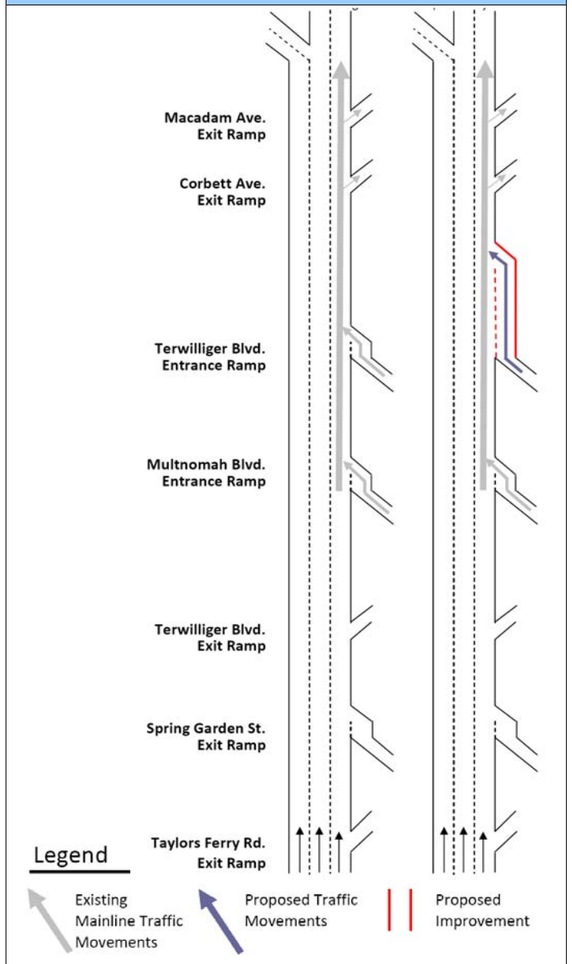
The initial proposed project will extend the current acceleration lane at the Terwilliger entrance-ramp around the horizontal curve to allow drivers to navigate the curve and then merge into mainline traffic in a tangent section of the freeway. This would provide drivers additional time and proper sight line to pick up gaps for the merging maneuver. The proposed project has the potential to reduce the number of crashes in the area because drivers would not be attempting to merge while navigating a long horizontal curve in a steep grade. The proposed project may not result in significant congestion relief in the peak hours due to downstream bottlenecks, but there would be operational and safety benefits associated with the enhanced design for the Terwilliger Blvd entrance-ramp merge junction. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.

Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.
Notes:	

*AM Peak Hour

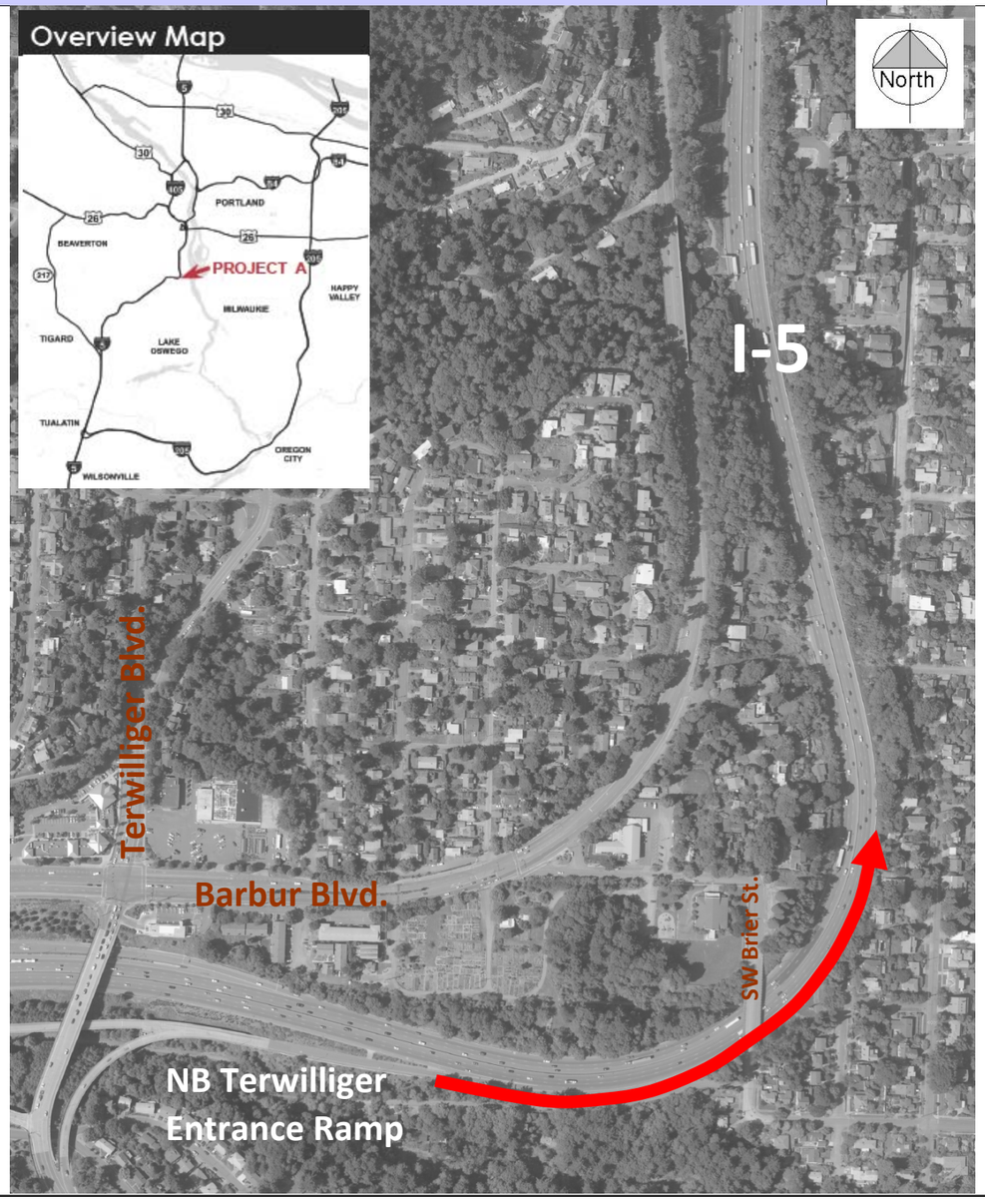
Operations Diagram



Impacts

ROW: May require ROW
Structures: Potential retaining walls/bridge replacement
Environment: To be determined

Project Concept



Map ID	B
Bottleneck ID	I-5: B2
Tracking ID	2a
Direction	NB

I-5 NB: Phase 1 - Lower Boones Ferry Road Exit Ramp Reconfiguration

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$1M - $2M

Existing Operations*

Variable	Existing
Duration (hours)	1.25
Queue (miles)	0.9 - 1.0
Average Speed (mph)	11 - 20
Density (veh/mi/ln)	86

Key Points

Existing Conditions

Currently the queuing starts between the Lower Boones Ferry Rd. exit-ramp and the WB Nyberg St. entrance-ramp; however, the end of the queue is inconclusive. Original observations suggest the queue ends before the I-205 entrance-ramp, yet subsequent observations indicate the queue extends back through the ramp from I-205 SB to I-5 NB. The queuing is caused by the high volumes of entering traffic from the two Nyberg St. entrance-ramps, high volumes of exiting traffic to Lower Boones Ferry Rd., and the associated weaving maneuvers between Nyberg St. entrance-ramps and Lower Boones Ferry Rd. exit-ramp. The project section is a top 10% SPIS site.

Proposed Improvements

The proposed project will convert the current exit-ramp to Lower Boones Ferry Rd. from one lane to two lanes where the right-most lane is an exit only lane and the adjacent lane is a choice lane (stay on I-5 or exit).

Operations/Safety Benefits

The mainline traffic south of Nyberg St. Interchange would have the ability to exit to Lower Boones Ferry Road without having to make a lane change, thereby reducing the turbulence near the exit gore area in the two outside lanes. The duration of queuing is expected to be reduced by 30 minutes.

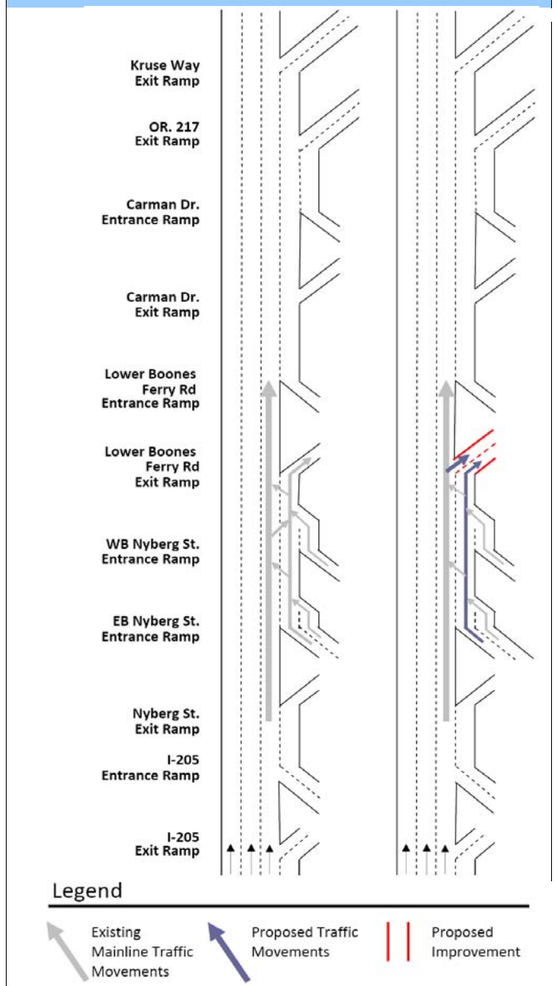
Potential Follow-Up Phases

Project Title:	I-5NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchnage - Auxiliary Lane Extension.

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B2	2b-1	C	$11.5M - $13.5M

*AM Peak Hour

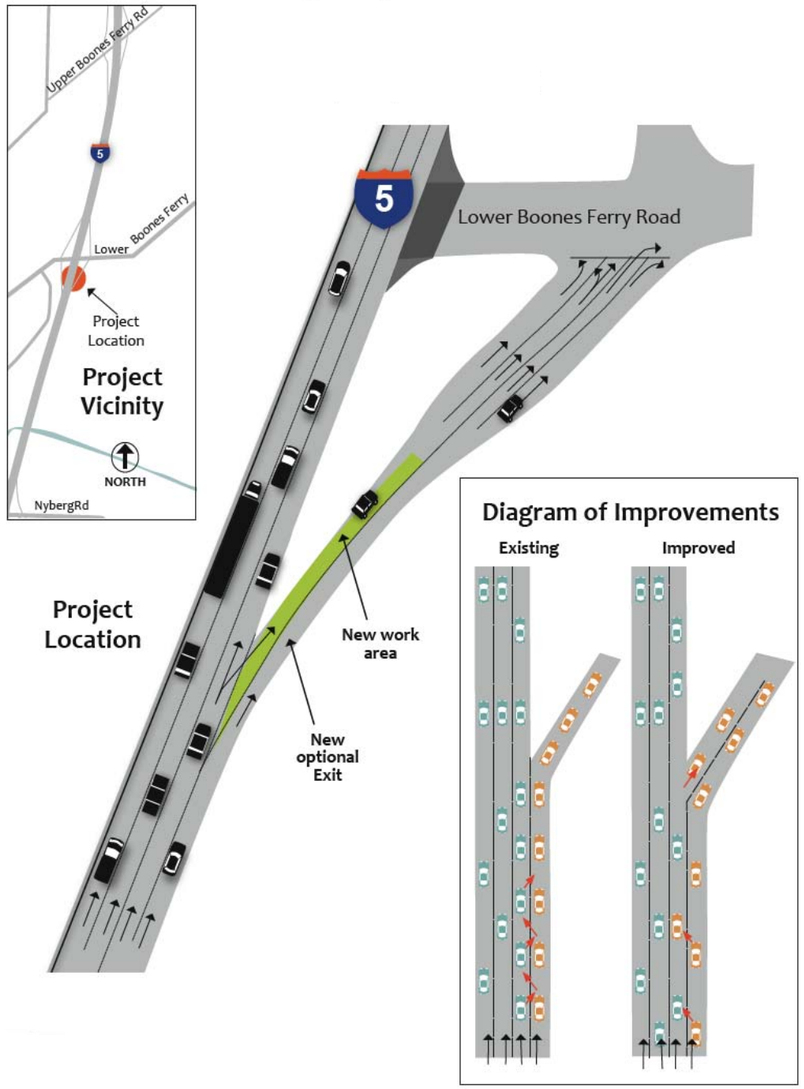
Operations Diagram



Impacts

ROW: Not anticipated
Structures: Not anticipated
Environment: To be determined

Project Concept



I-5 NB: Phase 2 - Nyberg Rd. Interchange to Lower Boones Ferry Rd. Interchange - Auxiliary Lane Extension

Map ID	C
Bottleneck ID	I-5: B2
Tracking ID	2b-1
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$11.5M - $13.5M

Existing Operations*

Variable	Existing
Duration (hours)	1.25
Queue (miles)	0.9 - 1.0
Average Speed (mph)	11 - 20
Density (veh/mi/ln)	86

Key Points

Existing Conditions

Currently the queuing starts between the Lower Boones Ferry Rd. exit-ramp and the WB Nyberg St. entrance-ramp; however, the end of the queue is inconclusive. Original observations suggest the queue ends before the I-205 entrance-ramp, yet subsequent observations indicate the queue extends back through the ramp from I-205 SB to I-5 NB. The queuing is caused by the high volumes of entering traffic from the two Nyberg St. entrance-ramps, high volumes of exiting traffic at Lower Boones Ferry Rd., and the associated weaving maneuvers between Nyberg St. entrance-ramps and Lower Boones Ferry Rd. exit-ramp. The project section is a top 10% SPIS site.

Proposed Improvements

The proposed project will extend the existing outside lane to Lower Boones Ferry Rd. entrance-ramp and add an auxiliary lane between EB Nyberg St. entrance-ramp and the Lower Boones Ferry Rd. exit-ramp.

Operations/Safety Benefits

Assuming Phase 1 (Map ID B) is built, this second phase of improvement is expected to provide further improvement of traffic operations and safety benefits in the project section. The length of queue is reduced and analysis of the peak periods does show some congestion relief. However, substantial operational benefits are expected in the adjacent hours to the peak periods.

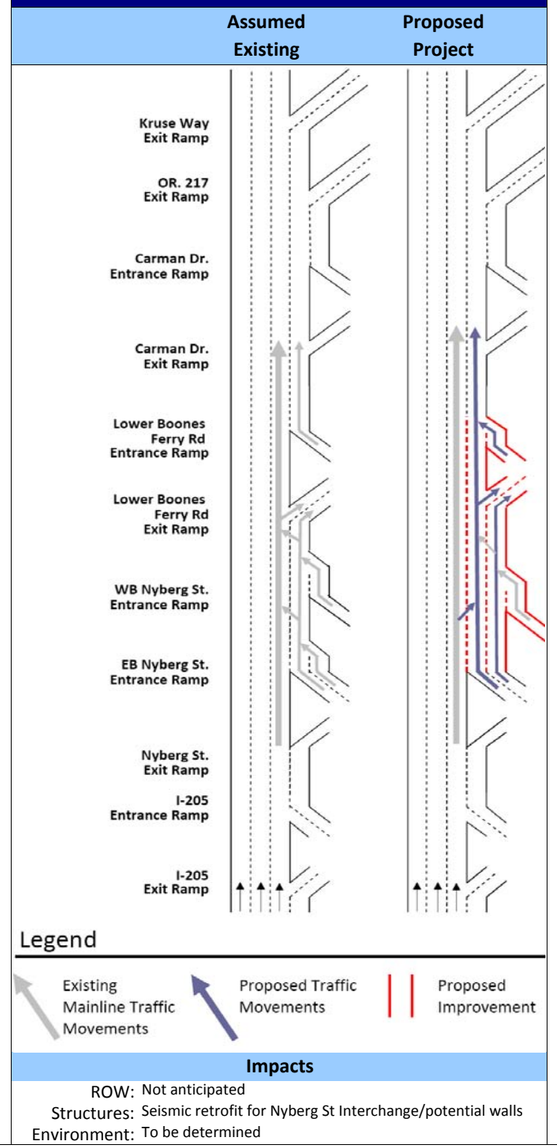
Potential Follow-Up Phases

Project Title:	Phase 3: Lower Boones Ferry Rd Interchange to Carman Dr. Interchange
Notes:	See combined project benefits on Map ID D.

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B2	2b-2	D	$17M - $21M

*AM Peak Hour

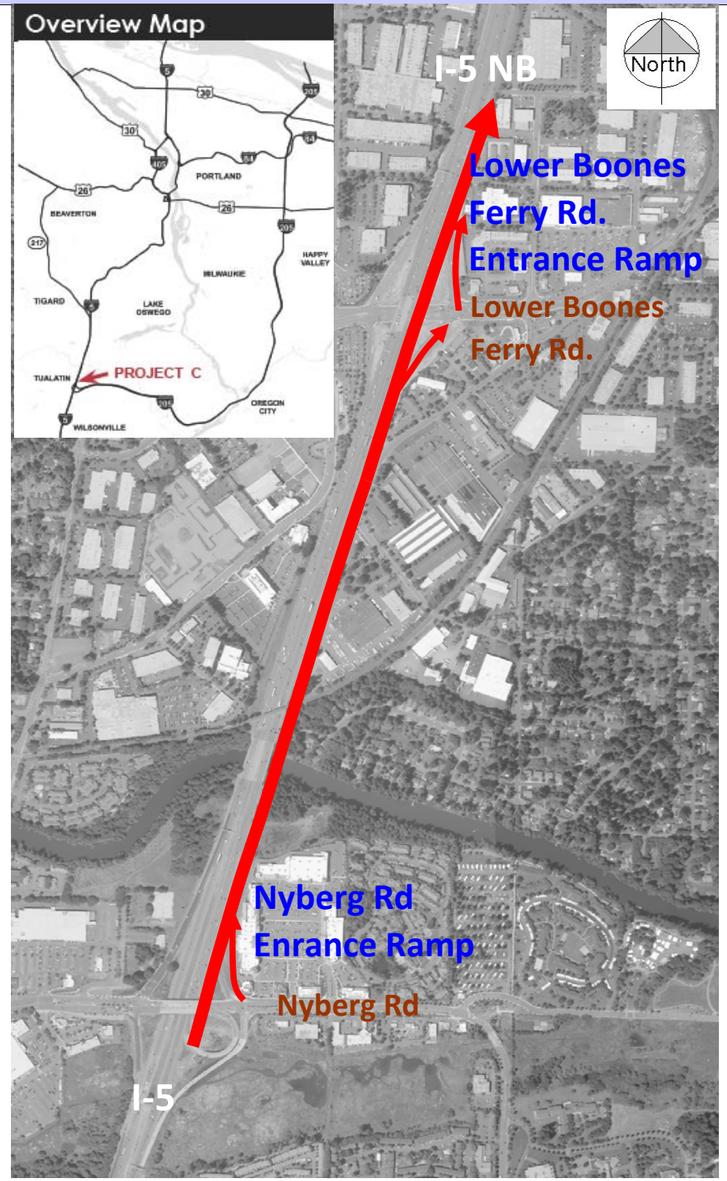
Operations Diagram



Impacts

ROW: Not anticipated
Structures: Seismic retrofit for Nyberg St Interchange/potential walls
Environment: To be determined

Project Concept



Map ID	D
Bottleneck ID	I-5: B2
Tracking ID	2b-2
Direction	NB

I-5 NB: Phase 3 - Lower Boones Ferry Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$17M - $21M

Existing Operations*

Variable	Existing
Duration (hours)	1.25
Queue (miles)	0.9 - 1.0
Average Speed (mph)	11 - 20
Density (veh/mi/ln)	86

Key Points

Existing Conditions

Currently the queuing starts between the Lower Boones Ferry Rd. exit-ramp and the WB Nyberg St. entrance-ramp; however, the end of the queue is inconclusive. Original observations suggest the queue ends before the I-205 entrance-ramp, yet subsequent observations indicate the queue extends back through the ramp from I-205 SB to I-5 NB. The queuing is caused by the high volumes of entering traffic from the two Nyberg St. entrance-ramps, high volumes of exiting traffic at Lower Boones Ferry Rd., and the associated weaving maneuvers between Nyberg St. entrance-ramps and Lower Boones Ferry Rd. exit-ramp. The project section is a top 10% SPIS site.

Proposed Improvements

The proposed project will extend the auxiliary lane from Lower Boones Ferry Rd. entrance-ramp to Carman Dr entrance-ramp.

Operations/Safety Benefits

There is a very high demand for volumes exiting to OR217 N and this improvement will provide those motorists a longer distance to find adequate gaps for lane changes and to position themselves in the appropriate lane earlier. This project is expected to result in overall operations and safety improvement.

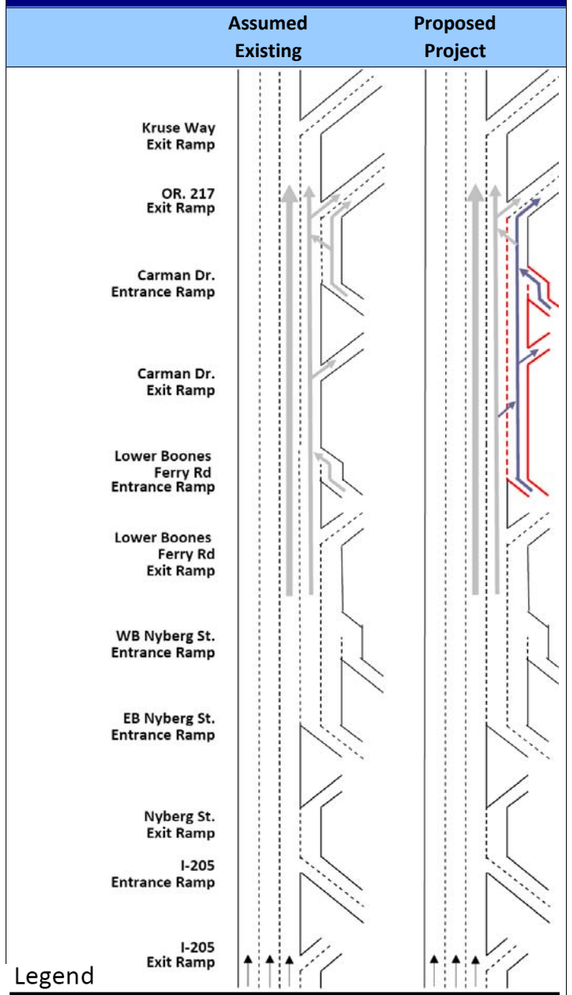
Potential Follow-Up Phases

Extend the auxiliary lane connecting the I-205 entrance-ramp and the Nyberg EB entrance-ramp. The I-205 entrance-ramp would be two lanes with the left lane being an add lane, connecting through to the north. The right lane would be an auxiliary lane, exiting at Nyberg exit-ramp. It is estimated that 30% of the traffic from the I-205 entrance-ramp exits at OR217. In addition to the improved operations, this will have safety improvement by eliminating the I-205 entrance-ramp inside merge. (Additional analysis required.)

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B2	--	--	--

*AM Peak Hour

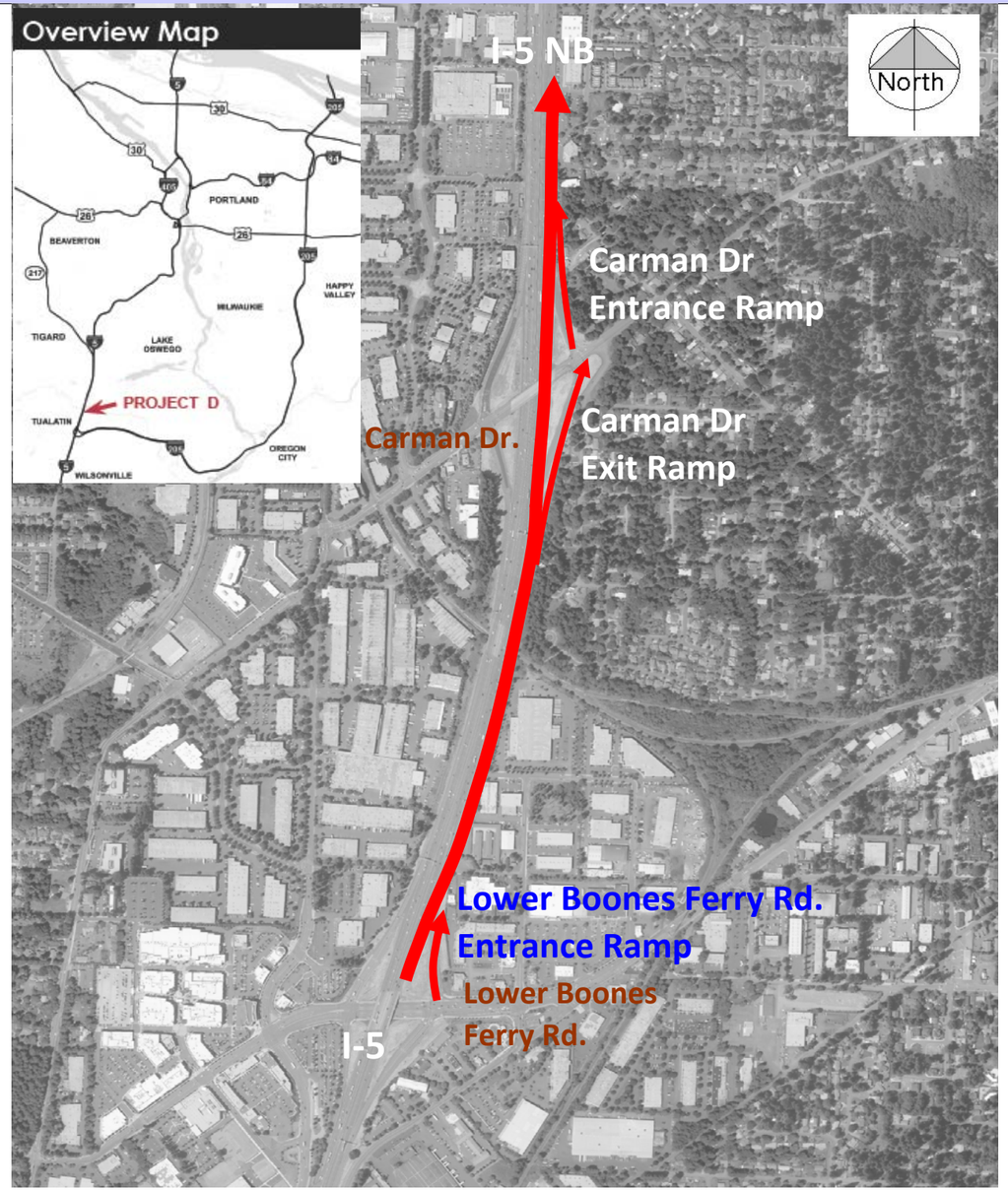
Operations Diagram



Impacts

ROW: None anticipated
Structures: Seismic retrofit for Lower Boones Interchange
Environment: To be determined

Project Concept



This Project is Phased into I-5 NB Projects B, C and D.

Map ID	E
Bottleneck ID	I-5: B2
Tracking ID	2b-1 & 2b-2
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Project Phased	$18M - $22M

Existing Operations*

Variable	Existing
Duration (hours)	1.25
Queue (miles)	0.9 - 1.0
Average Speed (mph)	11 - 20
Density (veh/mi/ln)	86

Key Points

Existing Conditions

Currently the queuing starts between the Lower Boones Ferry OFF Ramp and the WB Nyberg St. ON Ramp; however, the end of the queue is inconclusive. Original observations suggest the queue ends before the I-205 ON Ramp, yet subsequent observations indicate the queue extends back through the ramp from I-205 SB to I-5 NB. The queuing is caused by high volumes of entering traffic from the Nyberg St. ON Ramp, high volumes of exiting traffic at Lower Boones Ferry and the associated weaving maneuvers between Nyberg St. and Lower Boones Ferry.

Proposed Improvements

This project is broken into Phase 1, 2 and 3. Project cost exceeds CBOS criteria of $1 to $20 million range. I-5 NB: Nyberg Rd. Interchange to Carman Dr. Interchange - Auxiliary Lane Extension w/ 2-lane Exit at Lower Boones Ferry Rd.

Potential Follow-Up Phases

Project Title:	
Notes:	N/A

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
-	-	-	-

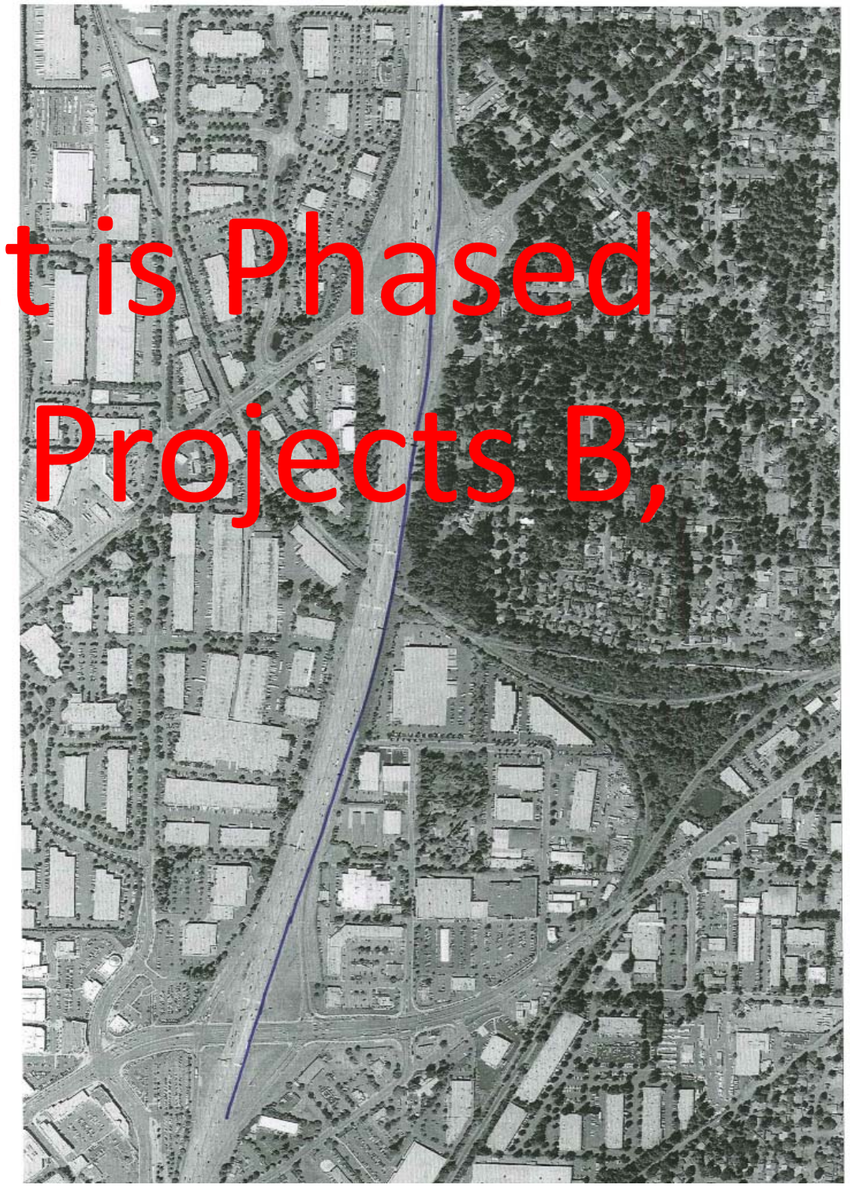
*AM Peak Hour

Operations Diagram

	Assumed Existing	Proposed Project

This Project is Phased into I-5 NB Projects B, C and D.

Project Concept



Map ID	F
Bottleneck ID	I-5: B5
Tracking ID	3
Direction	SB

I-5 SB: Phase 1 - Carman Dr Entrance Ramp to Lower Boones Ferry Exit Ramp - Auxiliary Lane

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Constructed 2012	$1.25M

Existing Operations*

Variable	Existing
Duration (hours)	2.25
Queue (miles)	< 1.8
Average Speed (mph)	< 10
Density (veh/mi/ln)	55

Key Points

Existing Conditions

Currently the Carman Dr. lane drop results in queues extending to approximately the Haines St. exit-ramp in all lanes. The cause of the queuing is a combination of the high volume of traffic from OR217 merging onto I-5 and the tendency of the majority of those drivers to merge quickly onto I-5, thus not fully utilizing the entire extent of the auxiliary lanes. An additional bottleneck exists downstream at the Nyberg St. exit-ramp; however, the section of roadway between the two bottlenecks is relatively unaffected (speed greater than 35 mph).

Proposed Improvements

This project would extend the current lane drop just south of the Carman Dr. exit ramp to the Lower Boones Ferry Rd. exit-ramp, where it would become a drop lane.

Operations/Safety Benefits

This is expected to minimize queuing on I-5 from the OR217 merge by 1 mile, and reduce the queuing on OR217 approaching I-5. This is expected to result in a decrease of 1 hour of congestion along I-5.

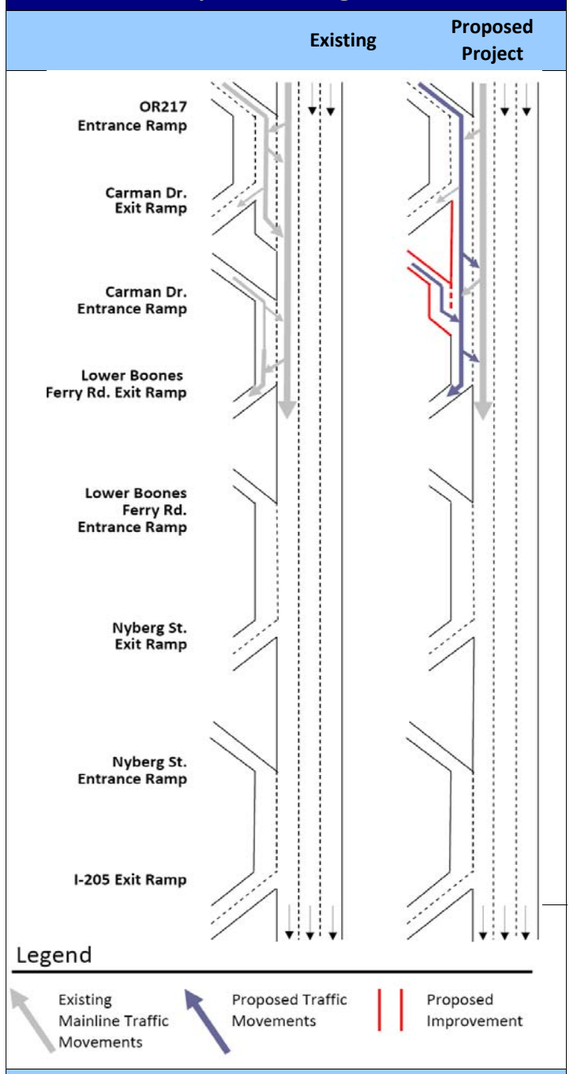
Potential Follow-Up Phases

Project Title:	Extend I-5 SB aux. lane from Lower Boones Ferry exit-ramp to Lower Boones Ferry entrance-ramp.
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B6	3a-1	G	$7.2M - $8.5M

*PM Peak Hour

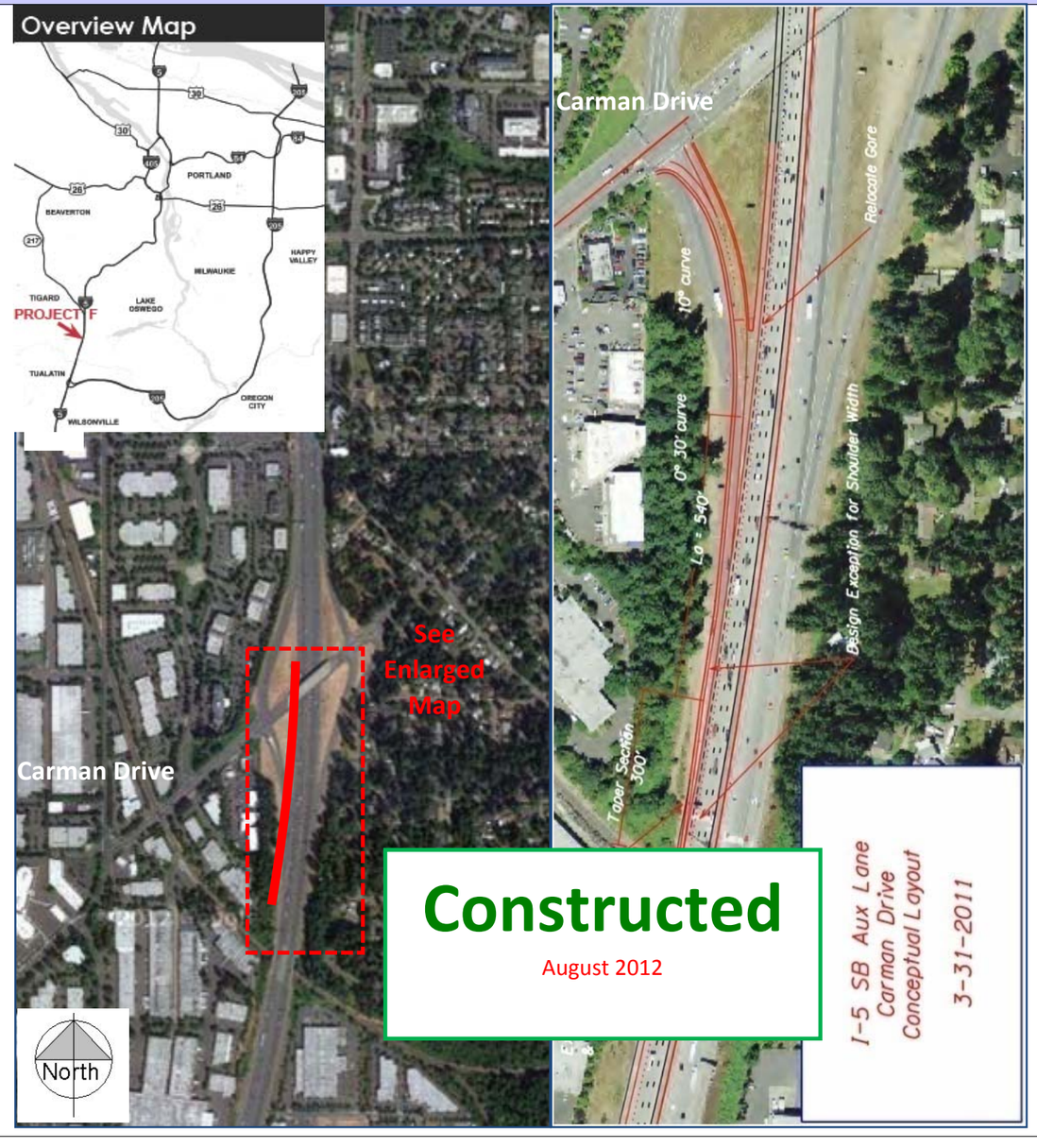
Operations Diagram



Impacts

ROW: Would occur within existing ROW
Structures: Widening possible under existing structure
Environment: No environmental impacts

Project Concept



I-5 SB: Phase 2 - Lower Boones Ferry Rd. Exit to Lower Boones Ferry Rd. Entrance Auxiliary Lane

Map ID	G
Bottleneck ID	I-5: B6
Tracking ID	3a-1
Direction	SB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$7.2M - $8.5M

Existing Operations*

Variable	Existing
Duration (hours)	2.5
Queue (miles)	0.6 - 1.0
Average Speed (mph)	≥ 30
Density (veh/mi/ln)	ODOT to Provide

Key Points

Existing Conditions

Currently the Nyberg St. exit-ramp results in a bottleneck with an influence area spanning from the Nyberg St. entrance-ramp to the Lower Boones Ferry Rd. exit-ramp. The cause of the bottleneck is attributed to a combination of high mainline volumes and weaving behaviors between the Lower Boones Ferry Rd. entrance-ramp and the Nyberg St. exit-ramp. During the periods of the worst congestion, speeds throughout the bottleneck drop as low as 25 mph but the average speed throughout normal congestion remains greater than 30 mph. The project section is a top 10% SPIS site.

Proposed Improvements

The proposed project would extend the existing auxiliary lane from the Lower Boones Ferry Rd. exit-ramp and the Lower Boones Ferry Rd. entrance-ramp. Reconstruct the Lower Boones Ferry Rd. entrance-ramp.

Operations/Safety Benefits

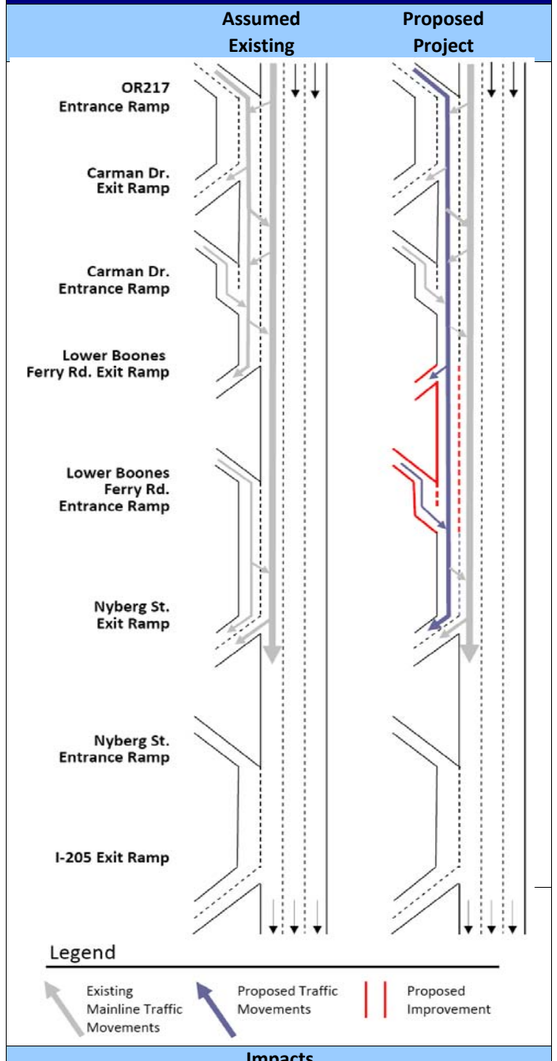
The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. This is expected to reduce congestion, improve lane balance and travel time reliability, and sustain stable traffic flow. Extension of the auxiliary lane is expected to result in a 30% reduction in mainline crashes.

Potential Follow-Up Phases

Project Title:	Extend the existing auxiliary lane from the Nyberg St. exit-ramp to the Nyberg Rd. entrance-ramp (Project ID H).
Notes:	This would result in improved traffic operations from Hwy 217 to I-205.

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-5: B6	3a-3	H	$10M - $18M

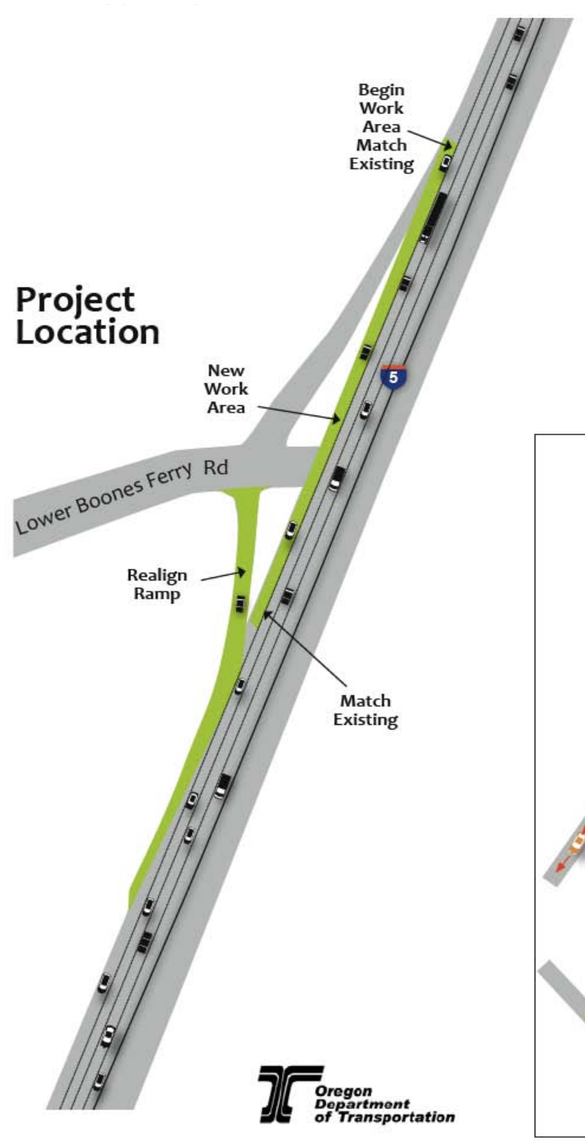
Operations Diagram

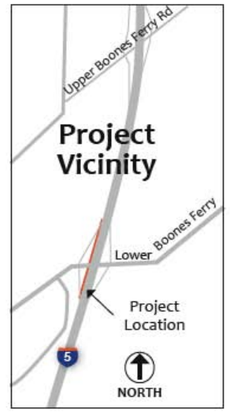


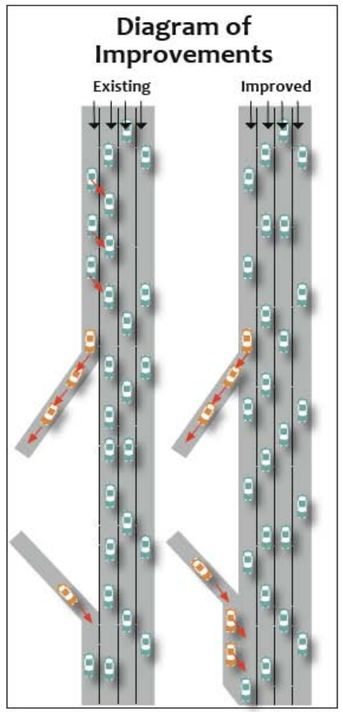
Impacts

ROW: None anticipated
Structures: none anticipated
Environment: To be determined

Project Concept







Oregon Department of Transportation

*PM Peak Hour

Map ID	H
Bottleneck ID	I-5: B6
Tracking ID	3a-3
Direction	SB

I-5 SB: Phase 3 - Lower Boones Ferry Rd. to I-205 Auxiliary Lane Extension

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$10M -$18M

Existing Operations*

Variable	Existing
Duration (hours)	2.5
Queue (miles)	0.6 - 1.0
Average Speed (mph)	≥ 30
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently the Nyberg St. exit-ramp results in a bottleneck with an influence area spanning from the Nyberg St. entrance-ramp to the Lower Boones Ferry exit-ramp. The cause of the bottleneck is attributed to a combination of high mainline volumes and weaving behaviors between the Nyberg St. exit-ramp and the Lower Boones Ferry Rd. entrance-ramp. During the periods of the worst congestion, speeds throughout the bottleneck drop as low as 25 mph but the average speed throughout normal congestion remains greater than 30 mph. The project section is a top 10% SPIS site.

Proposed Improvements

Assuming Map ID G is built, this project would extend the main auxiliary lane from Lower Boones Ferry Rd. to I-205. Two additional auxiliary lanes would be built/rebuilt: (1) from Lower Boones Ferry entrance-ramp to Nyberg exit-ramp, and (2) from Nyberg entrance-ramp to I-205 exit-ramp.

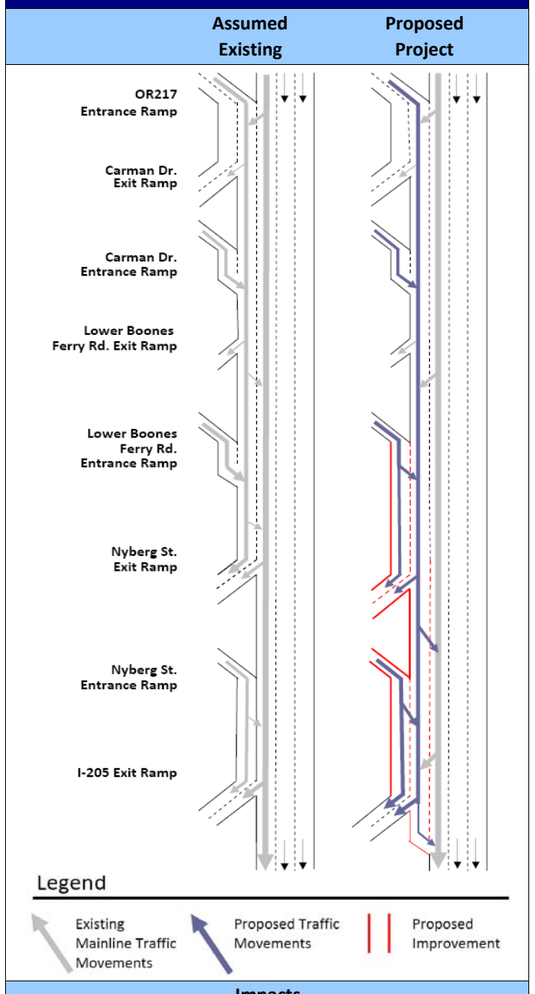
Operations/Safety Benefits

The additional auxiliary lanes are expected to reduce weaving behaviors and improve traffic operations. Of the volumes exiting to I-205, 36% are from OR217, 24% are from Carman and Lower Boones Ferry, and 30% are from Nyberg. With 90% of the traffic exiting at I-205 coming from the four entrance-ramps immediately north, this auxiliary lane would provide more direct connection without having to mix or interact with the rest of mainline traffic. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.

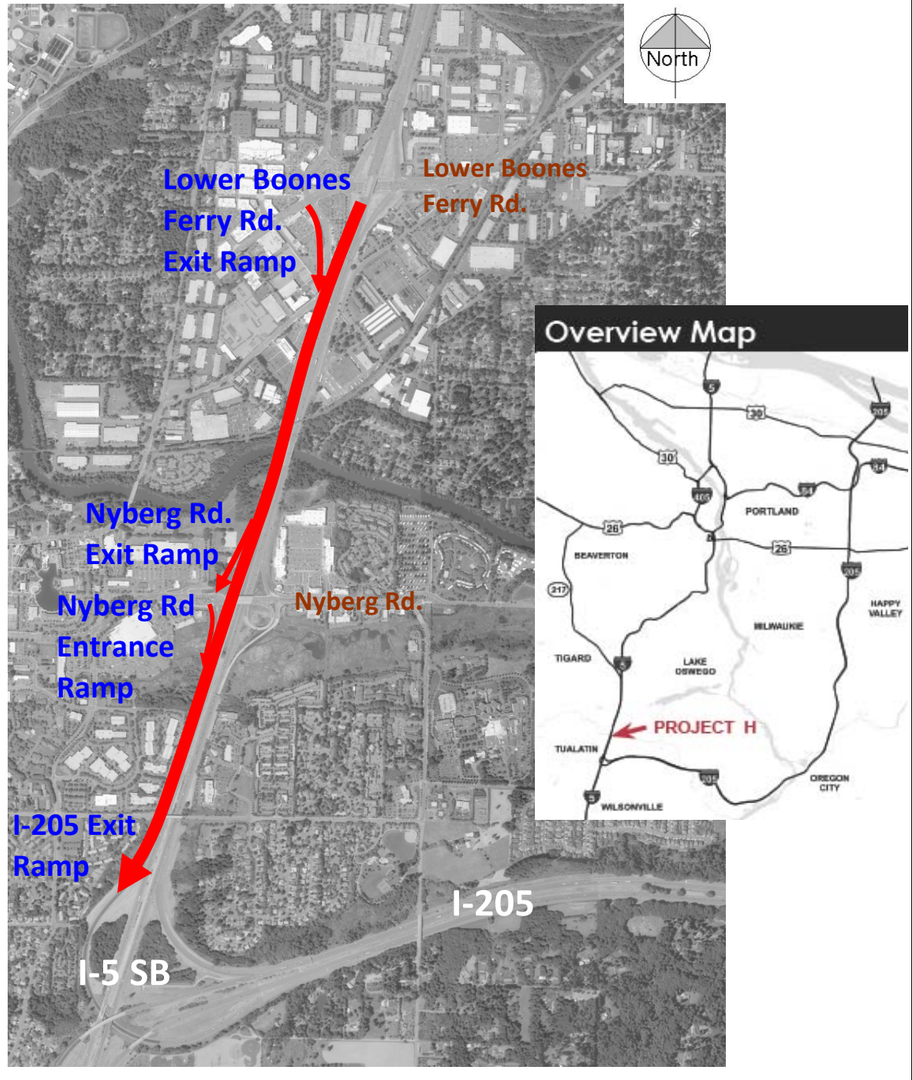
Operations Diagram



Impacts

ROW: Anticipated
Structures: Seismic retrofit
Environment: To be determined

Project Concept



*PM Peak Hour

I-205 CBOS Recurring Bottlenecks and Project Recommendations

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Chapter 4: CBOS Recurring Bottlenecks and Project Recommendations

4.2 I-205 Recurring Bottlenecks and Project Recommendations

Based on review of PORTAL data, ODOT cameras, and field travel time data, a total of twelve (12) bottleneck locations are identified within the I-205 study corridor: six (6) bottlenecks are in the northbound direction and six (6) in the southbound direction. The bottlenecks are classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures **(Figure 3-4** and **Figure 3-5),** while more detailed analyses and findings are presented in **Technical Memorandum 3**, included in **Appendix A**.

Bottleneck and Recommended Project Summary Graphics

For an overview figure of the bottlenecks and recommended projects for the I-205 corridor, see **Figure 4-3** and **Figure 4-4**, respectively. See **Chapter 1** for guidelines on how to compare the bottleneck and recommended project summary graphics.

A total of twelve (12) bottleneck locations are identified. From these locations, a total of nine (9) potential solutions are identified. All nine (9) potential solutions are recommended to move forward to be developed as projects.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A**.

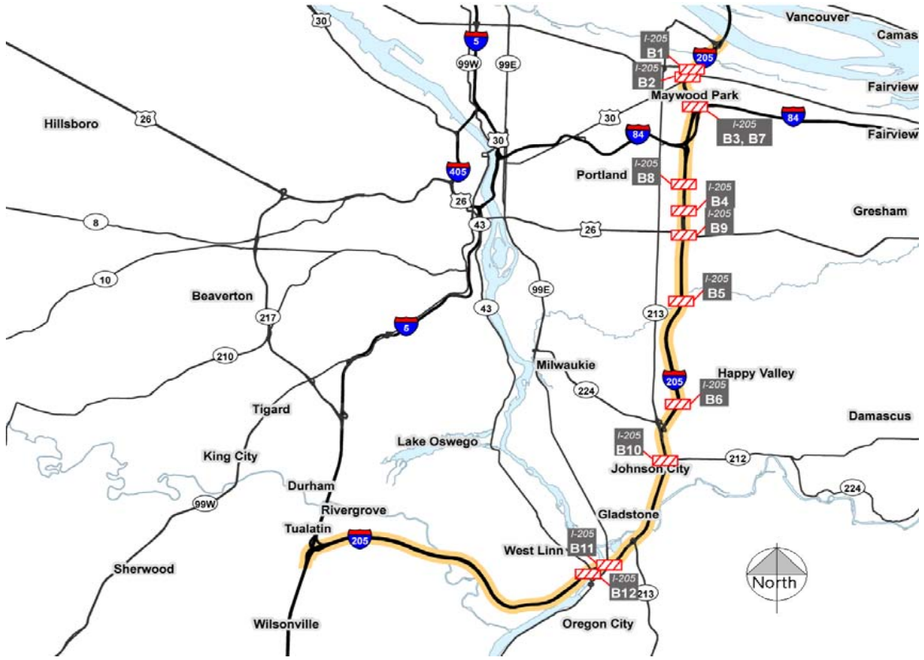
Project Sheets

Please see **pages 4-19** through **4-27** for project sheets unique to each recommended project for the I-205 corridor. There are nine (9) project sheets for the I-205 corridor (Project I - Q). See **Chapter 1** for guidelines on how to read the project sheets.

I-205 Corridor Recommended Projects

Map ID	Bottleneck ID	Project Description	Est. Cost	Traffic Analysis Findings/Comments
Northbound				
I	I-205: B3	I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane	$6.7M	The proposed project will construct an auxiliary lane by extending the acceleration lane from the I-84 WB entrance-ramp to the Sandy Blvd. exit-ramp. The spacing between the I-84 WB entrance-ramp and Sandy Blvd. exit-ramp is approximately 2000'. With the addition of an auxiliary lane between these two ramps, the I-84 WB-entrance ramp traffic would not be required to merge into the I-205 mainline immediately as they currently do. This would allow vehicles on the I-84 WB entrance-ramp additional time to find gaps to access the I-205 mainline. As a result, this would help reduce the queuing and relieve congestion that the I-84 WB entrance-ramp propagates to the I-84 EB entrance-ramp merge junction and would improve overall traffic safety in the project section.
J	I-205: B3	I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension	$6.5M	The proposed project will build upon Project Map ID I by creating an auxiliary lane from the I-84 WB entrance-ramp to the Columbia Blvd./Killingsworth St. (US30 Bypass) exit-ramp. This project would eliminate Bottleneck 3. In addition, it will improve traffic safety and operations for Freight movements as the Columbia Blvd and US30 Bypass are major Freight Routes serving the north Portland industrial areas.
K	I-205: B4	I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension w/ 2-Lane Exit at Washington St.	6.5M - $7.5M	The proposed improvement will provide motorists additional time/distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes and completely reduced in the two leftmost lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.
L	I-205: B4	I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension	$6.0M - $6.9M	This project is the first phase of a phased approach to developing an auxiliary lane on I-205 NB. The phasing of the auxiliary lane will allow for an increment development of 4 cost-effective projects. Each phase providing operational and safety benefits.
M	I-205: B4	I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension	$2.4M - $2.8M	Assuming that Project Map ID L is built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project will extend the existing auxiliary lane on I-205 NB in the project section from Washington St. exit-ramp to Glisan St. exit-ramp. The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time/distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.
N	I-205: B4	I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension	$2.2M - $2.5M	Assuming that Projects Map ID L and M are built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project would extend the auxiliary lane from Glisan St. exit-ramp to I-84 WB exit-ramp.T he proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time/distance to find gaps and safely weave over lanes. Of the volumes exiting at I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.
O	I-205: B4	I-205 NB: Phase 4 - Division Street to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-Lane Exit at Washington Street	$1.7M - $2.0M	Assuming Projects Map ID L, M, and N are built, this project would be the next and final low-cost phase. The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Of the volumes exiting to I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.
P	I-205: B4	I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-Lane Exit at Washington St.	$7.6M - $8.0M	A follow-up phase to Project Map ID L, this project represents the ultimate improvement to address congestion relief for the area. Considering that funding may be a constraint, this project can be broken into three smaller projects: Project Map ID M, N and O. This project would extend the auxiliary lane from Washington St. exit-ramp to I-84 WB exit-ramp and build an additional auxiliary lane from Division entrance-ramp to Washington St. exit-ramp with two-lane exit. The proposed improvement will provide drivers additional time and distance to safely make the necessary weaving maneuvers. Congestion would be completely reduced in all lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.
Southbound				
Q	I-205: B8/B9	I-205 SB: I-84 EB Entrance Ramp to Stark St./Washington St. exit ramp - Auxiliary Lane	$7.0M - $8.5M	Approximately 25% of traffic from I-84 EB Entrance-ramp is destined for Division/Powell and this project would provide direct connection to this exit. Congestion/queuing would be reduced in all lanes and completely reduced in the two leftmost lanes. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

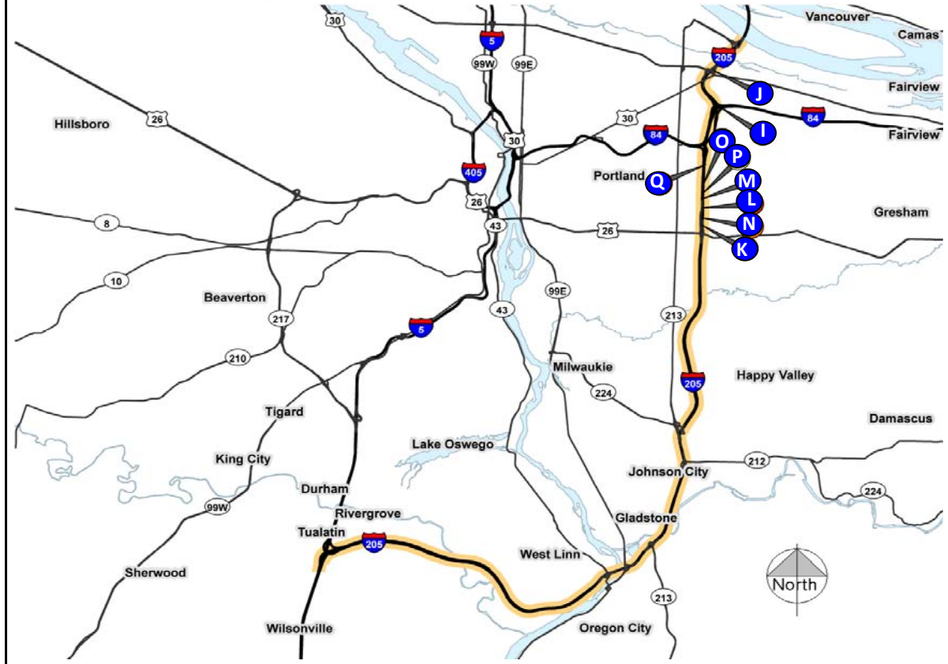
Figure 4-3: I-205 Recurring Bottleneck Locations



Recurring Bottleneck Location

Bottleneck ID	Recurring Bottleneck Location	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
I-205 Bottlenecks						
B1	I-205 NB: Sandy Boulevard/Columbia Boulevard Entrance Ramp (PM)	X		20	3	Page | 3-7
B2	I-205 NB: Columbia Boulevard/Hwy 30 Exit Ramp (PM)	X		35	Inconclusive	Page | 3-7
B3	I-205 NB: Westbound I-84 Entrance Ramp (PM)	X		5	5.25	Page | 3-7
B4	I-205 NB: Division Street Entrance Ramp and Hwy 26/Powell Blvd. Entrance Ramp (AM & PM)	X		10	2.75	Page | 3-7
B5	I-205 NB: Foster Road Exit Ramp (AM & PM)	X		20	4	Page | 3-7
B6	I-205 NB: Sunnybrook Road Entrance Ramp (PM)	X		30	2.25	Page | 3-7
B7	I-205 SB: Westbound I-84 Exit Ramp (AM & PM)	X		5	4.25	Page | 3-8
B8	I-205 SB: Stark/Washington Street Entrance Ramp (PM)	X		10	3.25	Page | 3-8
B9	I-205 SB: Hwy 26/Division Street/Powell Boulevard Exit Ramp (PM)	X		25	3.25	Page | 3-8
B10	I-205 SB: 212/224 Entrance Ramp (PM)	X		35	1	Page | 3-8
B11	I-205 SB: 99E/McLoughlin Boulevard Exit Ramp (AM)	X		20	1.25	Page | 3-8
B12	I-205 SB: Hwy 43 Entrance Ramp (AM)	X		30	2	Page | 3-8

Figure 4-4: I-205 Recommended Projects



Recommended Project Location (indicates Potential Solution Recommentation)

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project Sheet on page #
I-205 Recommended Projects to Move Forward					
I	I-205: B3	Yes	I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane	$6.7M	Page | 4-19
J	I-205: B3	Yes	I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension	$6.5M	Page | 4-20
K	I-205: B4	**Yes**	I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.	6.5M - $7.5M	Page | 4-21
L	I-205: B4	Yes	I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension	$6.0M - $6.9M	Page | 4-22
M	I-205: B4	**Yes**	I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension	$2.4M - $2.8M	Page | 4-23
N	I-205: B4	Yes	I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension	$2.2M -$2.5M	Page | 4-24
O	I-205: B4	Yes	I-205 NB: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington Street	$1.7M - $2.0M	Page | 4-25
P	I-205: B4	Yes	I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-lane Exit at Washington St.	$7.6M - $8.M	Page | 4-26
Q	I-205: B8/B9	Yes	I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane	$7.0M - $8.5M	Page | 4-27

I-205 NB: Phase 1 - I-84 WB Entrance Ramp to Sandy Blvd. Exit Ramp - Auxiliary Lane

Map ID	I
Bottleneck ID	I-205: B3
Tracking ID	2
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$6.7M

Existing Operations*

Variable	Existing
Duration (hours)	3.5
Queue (miles)	< 1.4
Average Speed (mph)	≥ 5
Density (veh/mi/ln)	104

Key Points

Existing Conditions

Currently, there is recurring congestion between the I-84 EB and WB entrance-ramps in the p.m. peak hours. The congestion is attributed to:
- There are very high traffic volumes on both I-84 EB and WB entrance-ramps.
- There is a short spacing (~1000') between the two Interstate Freeway to Freeway entrance-ramp merge junctions.
- The I-84 EB entrance-ramp merges into the I-205 mainline in a horizontal curve alignment, limiting the ability of motorists to pick up gaps for merging maneuver.
- The Columbia Blvd./Killingsworth St. (US30 Bypass) exit-ramp carries high volume and cause congestion at the diverge junction, which propagates upstream to the I-84 WB entrance-ramp junction.

The high volume entrance-ramp from I-84 WB creates significant turbulence at the merge junction, which propagates upstream to the I-84 EB entrance ramp merge junction. This results in frequent queue spillback on the I-84 EB entrance-ramp beyond the tunnel under the I-84 mainline west of NE 102nd Ave., which has caused numerous rear-end crashes over the years. The project section is a top 10% SPIS site.

Proposed Improvements

The project will construct an auxiliary lane by extending the acceleration lane from the I-84 WB entrance-ramp to the Sandy Blvd. exit-ramp.

Operations/Safety Benefits

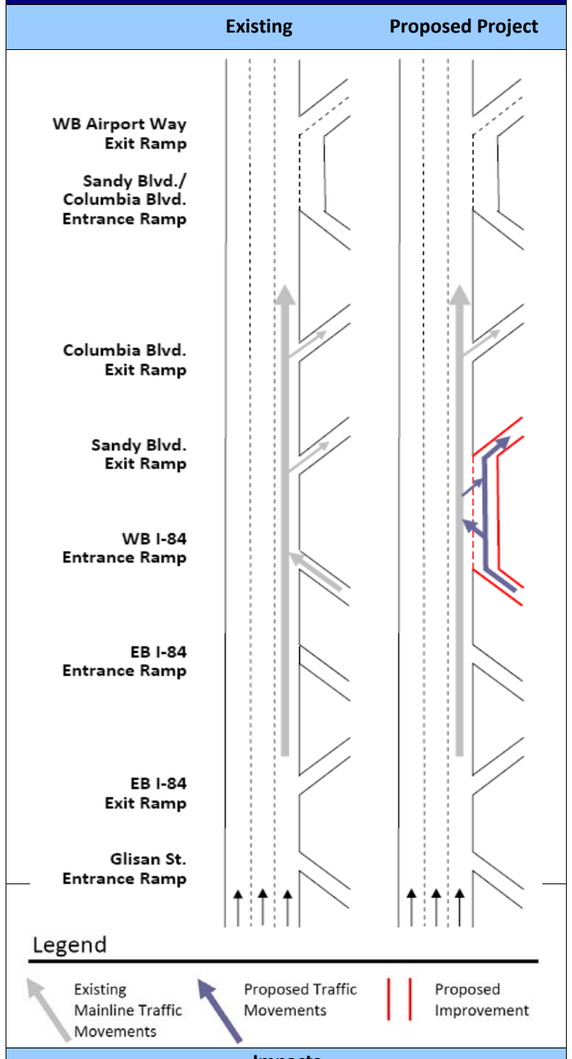
The spacing between the I-84 WB entrance-ramp and Sandy Blvd. exit-ramp is approximately 2000'. With the addition of an auxiliary lane between these two ramps, the I-84 WB entrance-ramp traffic would not be required to merge into the I-205 mainline immediately as they currently do. This would allow vehicles on the I-84 WB entrance-ramp additional time to find gaps to access the I-205 mainline. As a result, this would help reduce the queuing and relieve congestion that the I-84 WB entrance-ramp currently propagates south to the I-84 EB entrance-ramp merge junction and would improve overall traffic safety in the project section.

Potential Follow-Up Phases

Auxiliary Lane Extension: Sandy Blvd. to Columbia Blvd./Killingsworth St. (US30 Bypass) exit-ramp (Project Map ID J)

*PM Peak Hour

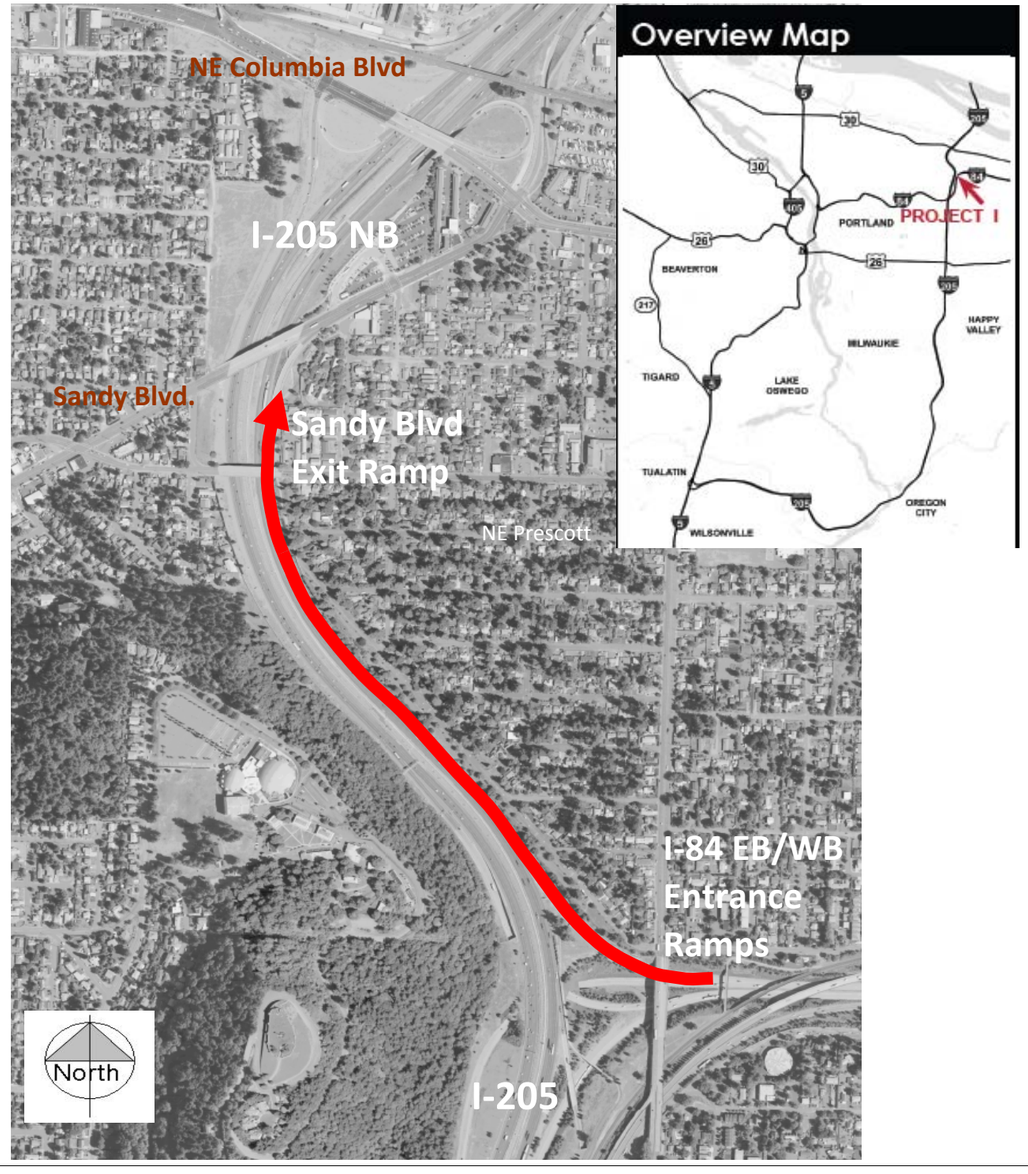
Operations Diagram



Impacts

ROW: Anticipated
Structures: Potential need for sound walls
Environment: To be determined

Project Concept



Map ID	J
Bottleneck ID	I-205: B3
Tracking ID	2a
Direction	NB

I-205 NB: Phase 2 - Sandy Blvd. Exit Ramp to Columbia Blvd. Exit Ramp - Auxiliary Lane Extension

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$6.5M

Existing Operations*

Variable	Existing
Duration (hours)	3.5
Queue (miles)	< 1.4
Average Speed (mph)	≥ 5
Density (veh/mi/ln)	104

Key Points

Existing Conditions

Currently, there is recurring congestion between the I-84 EB and WB entrance-ramps in the p.m. peak hours. The congestion is attributed to:
- There are very high traffic volumes on both I-84 EB and WB entrance-ramps.
- There is a short spacing (~1000') between the two Interstate Freeway to Freeway entrance-ramp merge junctions.
- The I-84 EB entrance-ramp merges into the I-205 mainline in a horizontal curve alignment, limiting the ability of motorists to pick up gaps for merging maneuver.
- The Columbia Blvd./Killingsworth St. (US30 Bypass) exit-ramp carries high volume and cause congestion at the diverge junction, which propagates upstream to the I-84 WB entrance-ramp junction.

The high volume entrance-ramp from I-84 WB creates significant turbulence at the merge junction, which propagates upstream to the I-84 EB entrance ramp merge junction. This results in frequent queue spillback on the I-84 EB entrance-ramp beyond the tunnel under the I-84 mainline west of NE 102nd Ave., which has caused numerous rear-end crashes over the years. The project section is a

Proposed Improvements

The goal of this project is to improve traffic safety and operations at the I-84 EB and WB merge junctions. The proposed project will build upon Project Map ID I by creating an auxiliary lane from the I-84 WB entrance-ramp to the Columbia Blvd./Killingsworth St. (US30 Bypass) exit-ramp.

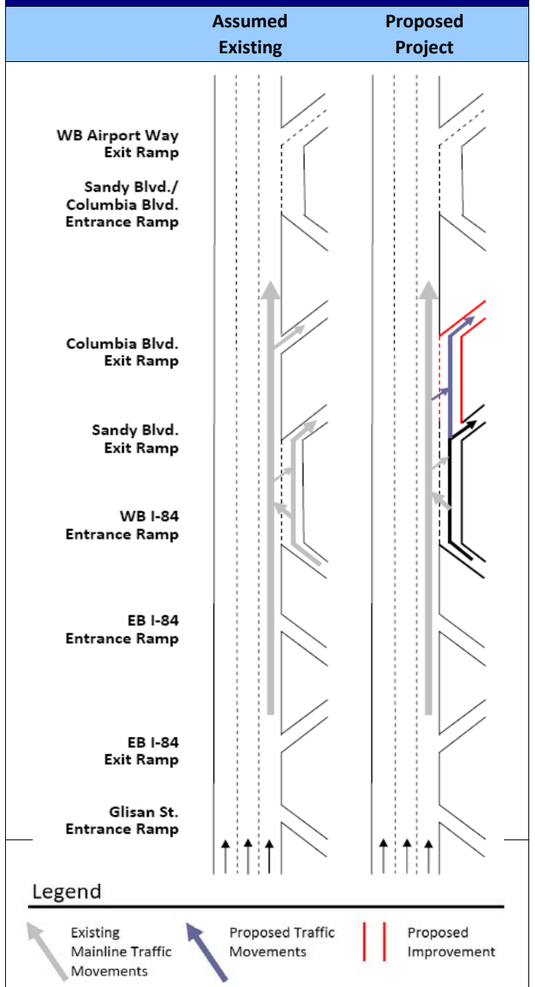
Operations/Safety Benefits

This project would eliminate Bottleneck 3. In addition, it will improve traffic safety and operations for Freight movements as the Columbia Blvd and US30 Bypass are major Freight Routes serving the north Portland industrial areas.

Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.
Notes:	

Operations Diagram



Impacts

ROW:	Anticipated (minimal)
Structures:	Potential retaining walls
Environment:	To be determined

Project Concept

*PM Peak Hour

I-205 NB: Powell Blvd. Entrance Ramp to Division St. Entrance Ramp - Auxiliary Lane Extension and 2-Lane Exit at Washington St.

Map ID	K
Bottleneck ID	I-205: B4
Tracking ID	1
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	6.5M - $7.5M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

This project will extend the existing acceleration lane from the Powell Blvd. entrance-ramp to match with the existing auxiliary lane between the Division St. entrance-ramp and Stark/Washington St. exit-ramp, and provide a two-lane exit at Stark/Washington. The proposed auxiliary lane would provide an extended distance for traffic to merge onto mainline, thereby reducing congestion at the US26/Powell Blvd entrance-ramp merge junction. The two-lane exit at Stark/Washington St. will reduce weaving conflicts in this segment.

Operations/Safety Benefits

The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes and completely reduced in the two leftmost lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

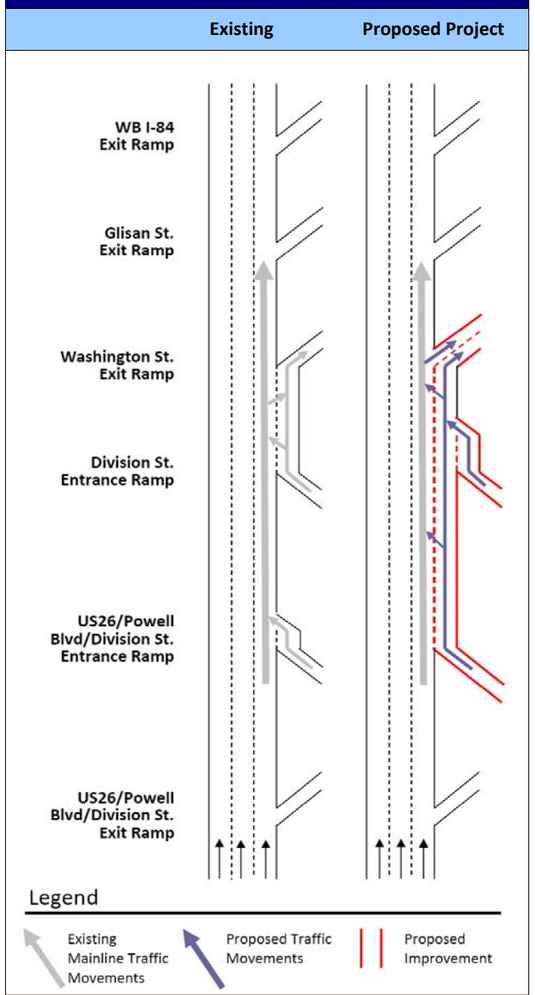
Potential Follow-Up Phases

Project Title:	Auxiliary Lane Addition: Washington St. - I-84 WB (Project Map ID P)
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-205: B4	1e	P	$7.6M - $8.0M

*PM Peak Hour

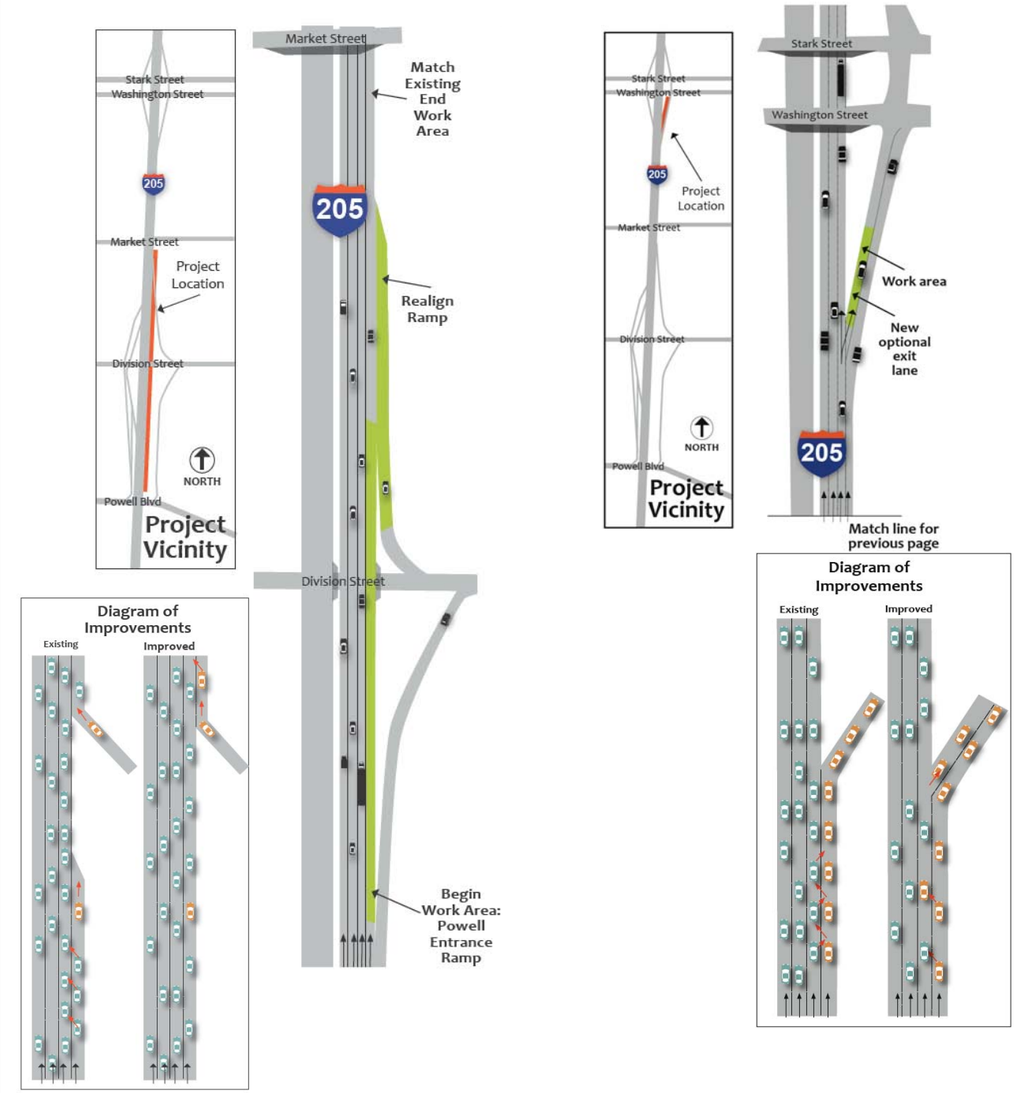
Operations Diagram



Impacts

ROW: None anticipated
Structures: Modification
Environment: To be determined

Project Concept



Map ID	L
Bottleneck ID	I-205: B4
Tracking ID	1a
Direction	NB

I-205 NB: Phase 1 - Powell Blvd Entrance Lane to Washington St. Exit Ramp - Auxiliary Lane Extension

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$6.0M - $6.9M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

This project would extend the existing acceleration lane from the Powell Blvd. entrance-ramp to match with the existing auxiliary lane between the Division St. entrance-ramp and Stark/Washington St. exit-ramp. Auxiliary lane would provide an extended distance for traffic to merge onto mainline.

Operations/Safety Benefits

The proposed improvement will provide motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

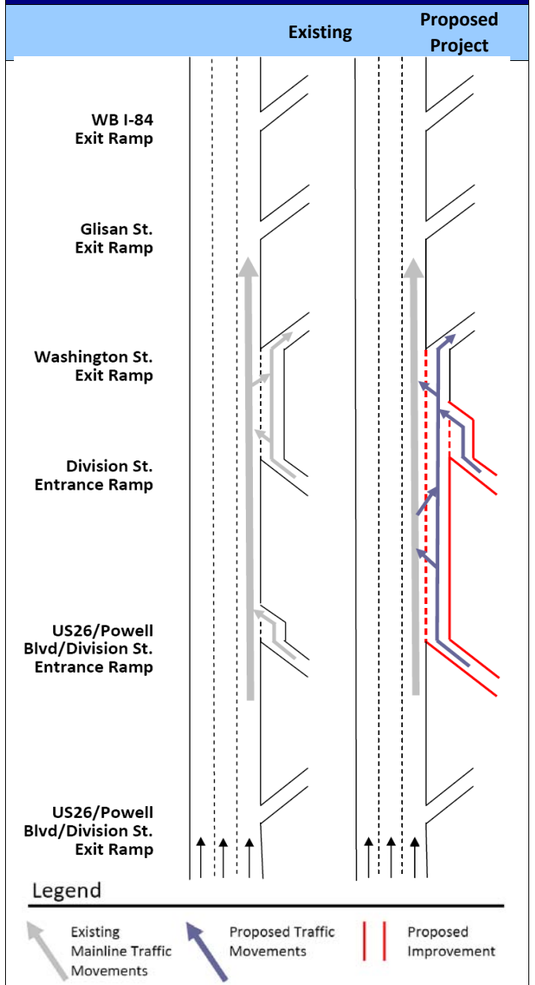
Potential Follow-Up Phases

Project Title:	Auxiliary Lane Addition: Powell Blvd. to I-84 exit-ramp
Notes:	Follow-up projects: three low-cost incremental projects (Map ID M, N & O) or one higher-cost project (Map ID P)

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-205: B4	1b	M	$2.4M - $2.8M

*PM Peak Hour

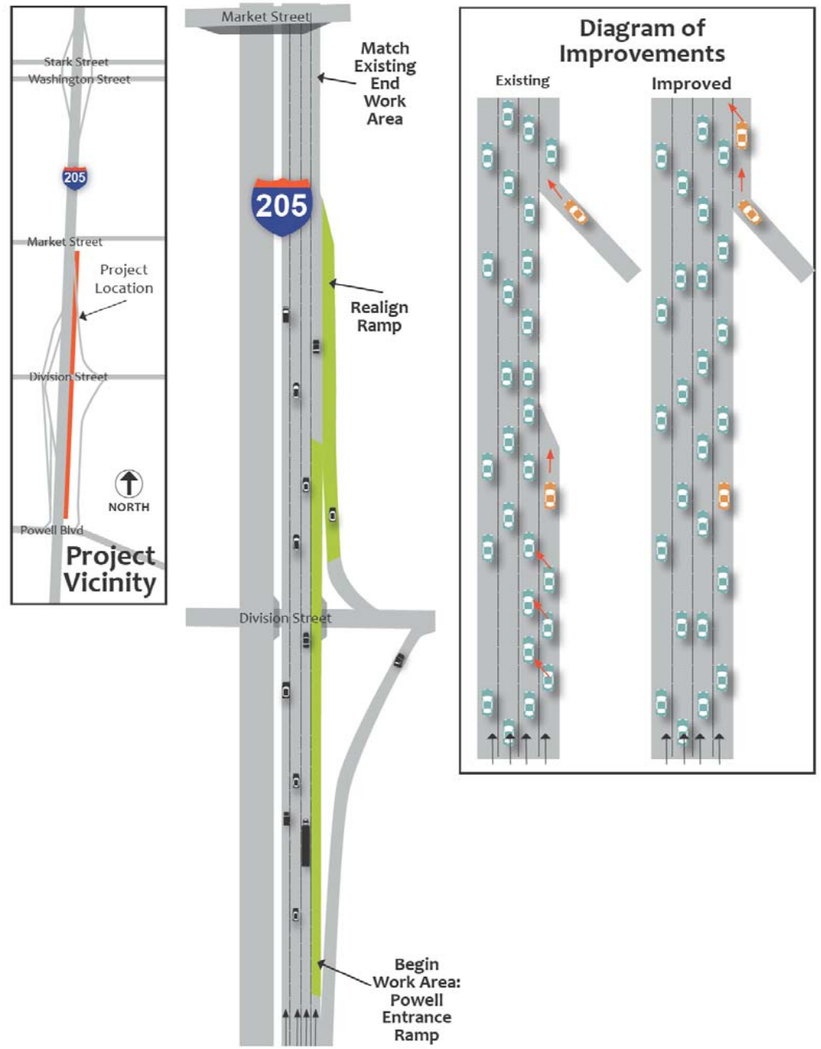
Operations Diagram



Impacts

ROW: None anticipated
Structures: Modification
Environment: To be determined

Project Concept



I-205 NB: Phase 2 - Washington St. Exit Ramp to Glisan St. Exit Ramp - Auxiliary Lane Extension

Map ID	M
Bottleneck ID	I-205: B4
Tracking ID	1b
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
YES	$2.4M - $2.8M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

Assuming that Project Map ID L is built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project will extend the existing auxiliary lane on I-205 NB in the project section from the Washington St. exit-ramp to the Glisan St. exit-ramp.

Operations/Safety Benefits

The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Congestion/queuing would be reduced in most lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

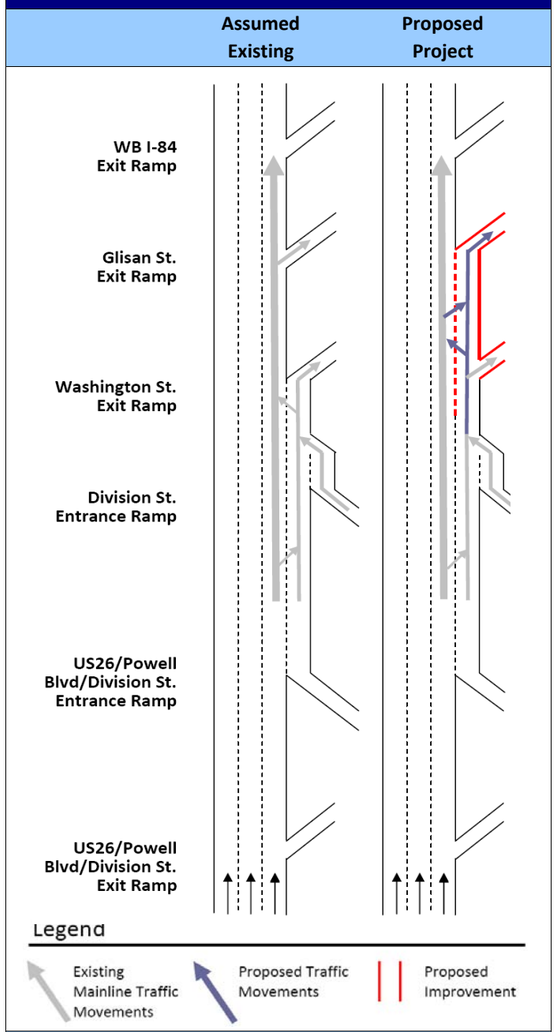
Potential Follow-Up Phases

Project Title:	Extend auxiliary lane from Glisan St. exit-ramp to I-84 WB exit-ramp (Project Map ID N)
Notes:	Follow-up projects: low-cost incremental projects (Map ID N & O)

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-205: B4	1c	N	$2.2M - $2.5M

*PM Peak Hour

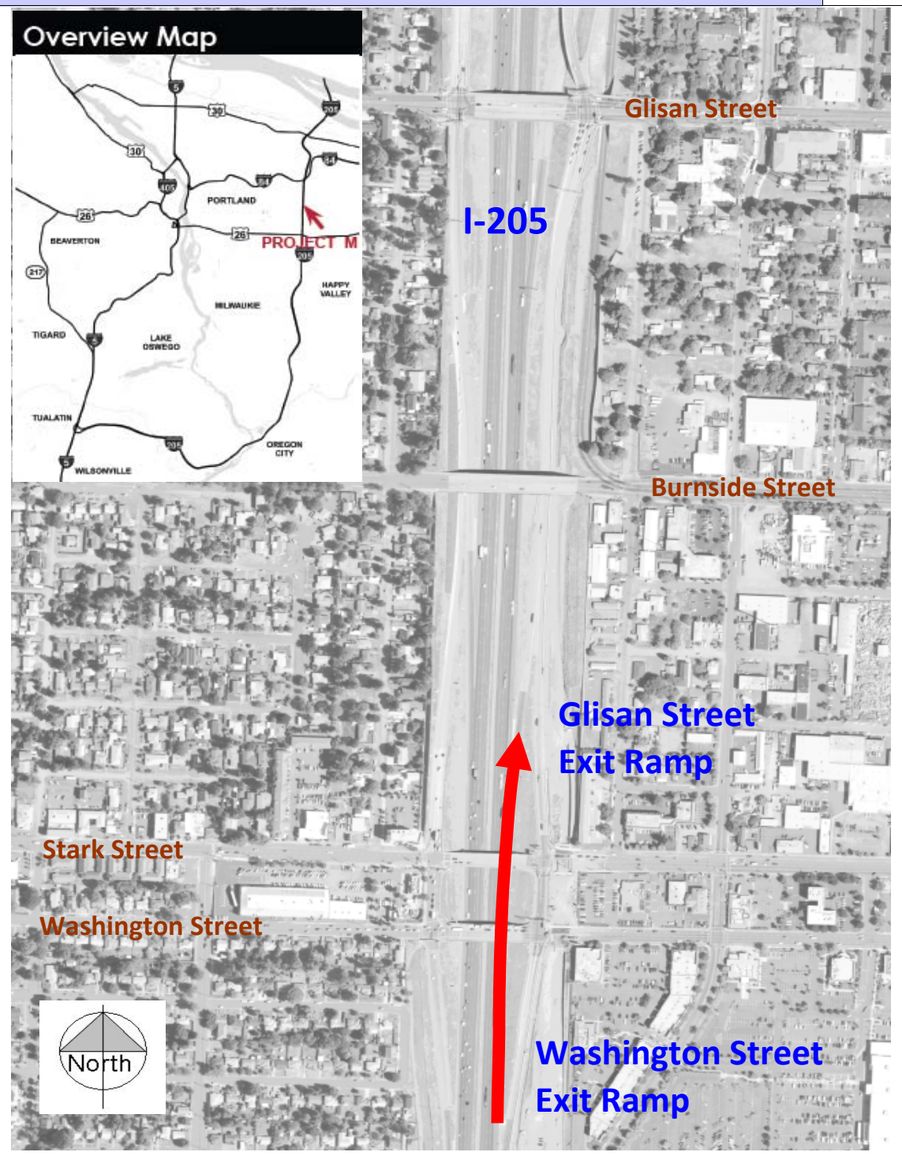
Operations Diagram



Impacts

ROW: None anticipated
Structures: None anticipated
Environment: To be determined

Project Concept



Map ID	N
Bottleneck ID	I-205: B4
Tracking ID	1c
Direction	NB

I-205 NB: Phase 3 - Glisan St. Exit to I-84 WB Exit Ramp - Auxiliary Lane Extension

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$2.2M -$2.5M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

Assuming that Projects Map ID L and M are built, this would be the next low-cost incremental improvement for congestion relief in the area. The proposed project would extend the auxiliary lane from Glisan St. exit-ramp to I-84 WB exit-ramp.

Operations/Safety Benefits

The proposed improvement will further enhance the operational benefits of the auxiliary lane by providing motorists additional time and distance to find gaps and safely weave over lanes. Of the volumes exiting to I-84 WB, 37% are from Powell and Division. This extended auxiliary lane would provide more direct connection without having to mix with mainline traffic. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

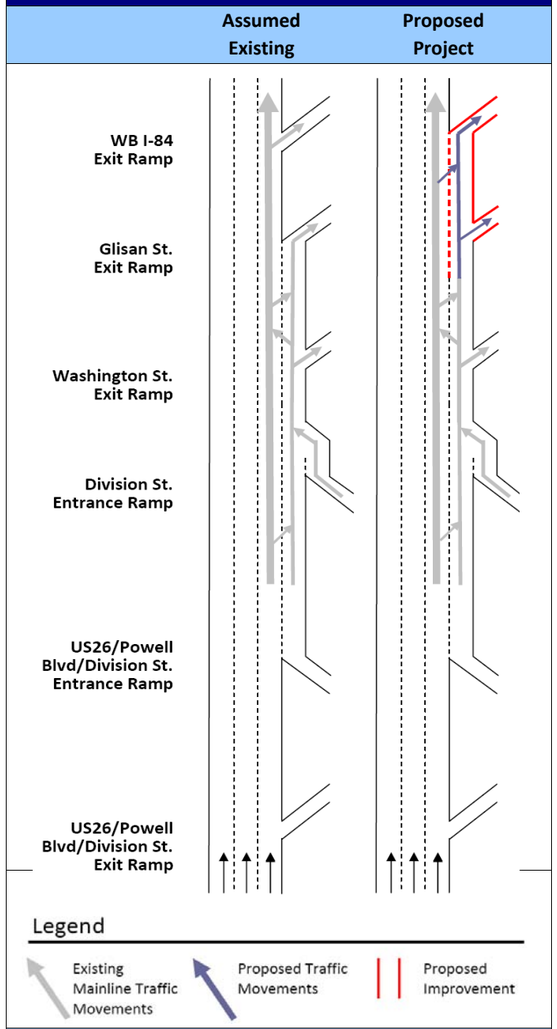
Potential Follow-Up Phases

Project Title:	Auxiliary Lane between Division St entrance-ramp and Washington St exit-ramp
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-205 - B4	1-d	O	$1.7M - $2.0M

*PM Peak Hour

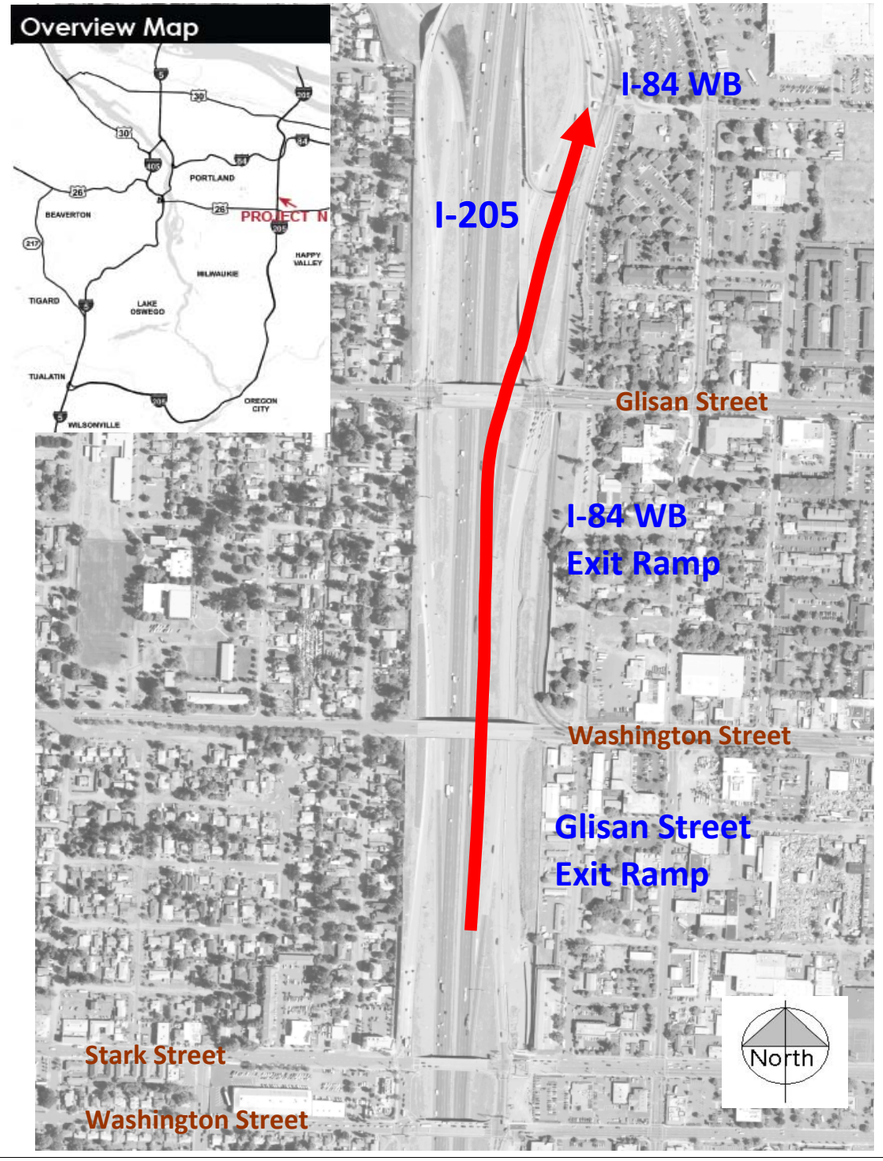
Operations Diagram



Impacts

ROW: None anticipated
Structures: None anticipated
Environment: To be determined

Project Concept



I-205 NB: Phase 4 - Division Street Entrance Ramp to Stark St./Washington St. Exit Ramp - Auxiliary Lane Extension w/ 2-lane Exit at Washington Street

Map ID	O
Bottleneck ID	I-205: B4
Tracking ID	1d
Direction	NB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$1.7M - $2.0M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

Assuming Projects Map ID L, M, and N are built, this project would be the next and final low-cost phase. The project will build an auxiliary lane between the Division St. entrance-ramp and the Washington St. exit-ramp. This project will also provide a two-lane exit-ramp at Stark/Washington.

Operations/Safety Benefits

This additional auxiliary lane will provide entrance-ramp traffic from the Division St. additional time and distance to find gaps and safely weave over lanes. Congestion would be completely reduced in all lanes.

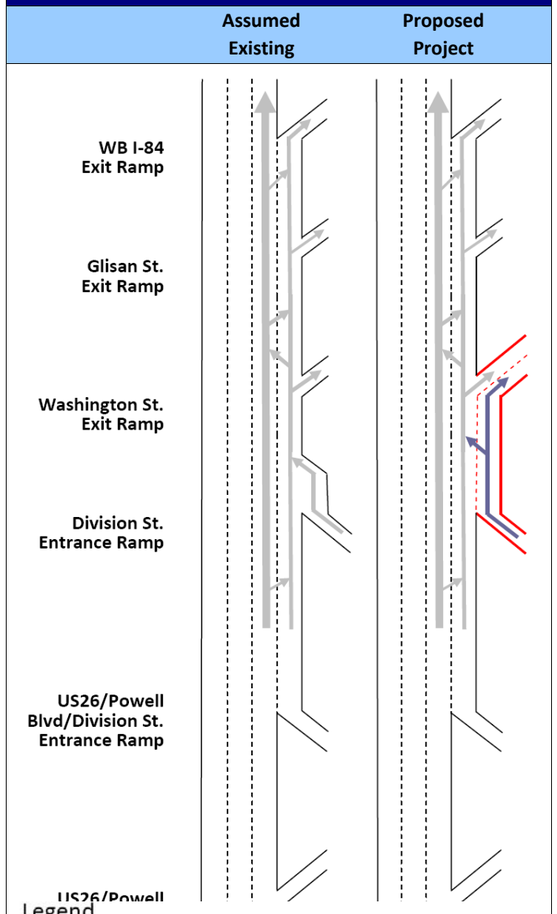
Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
---	---	---	---

*PM Peak Hour

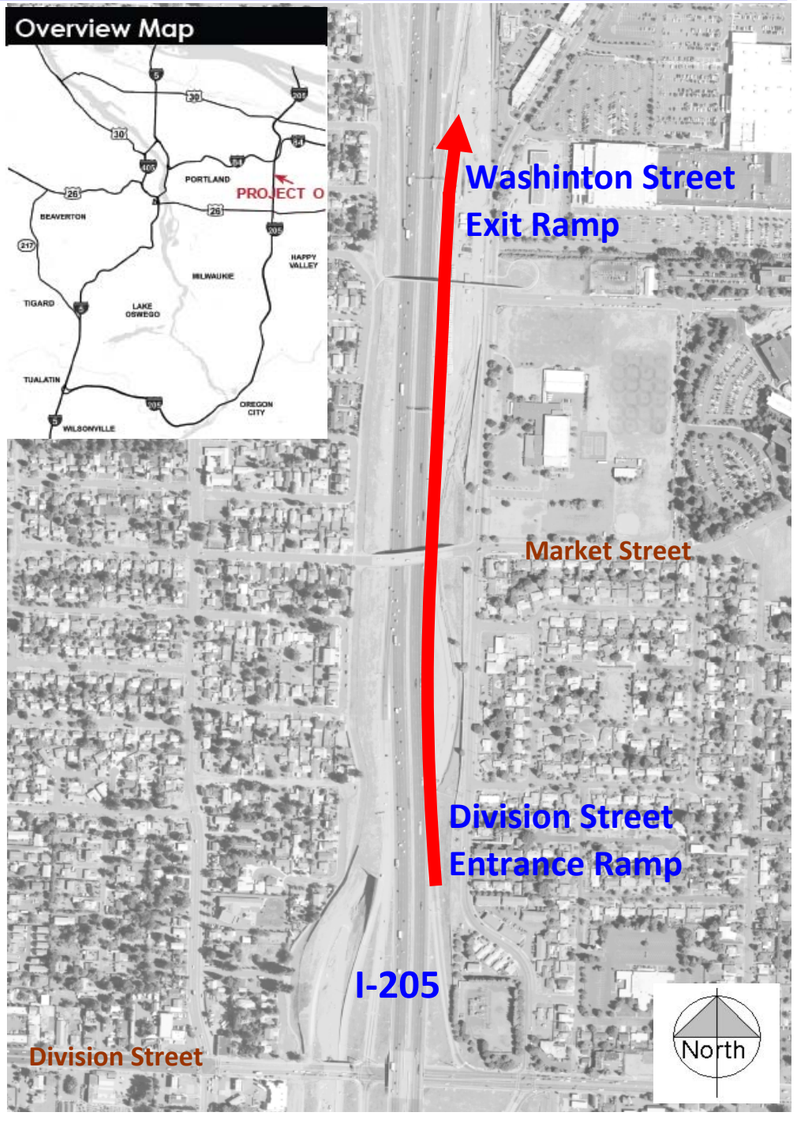
Operations Diagram



Impacts

ROW: None anticipated
Structures: None anticipated
Environment: To be determined

Project Concept



Map ID	P
Bottleneck ID	I-205: B4
Tracking ID	1e
Direction	NB

I-205 NB: Division St. entrance ramp to I-84 WB Exit Ramp - Auxiliary Lane Extension w/2-lane Exit at Washington St.

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$7.6M - $8.M

Existing Operations*

Variable	Existing
Duration (hours)	1.75
Queue (miles)	0.4 - 1.0
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the Division St. entrance-ramp and Powell Blvd. exit-ramp bottleneck is confined to the US26/Powell Blvd. entrance-ramp merge during the AM peak, and spans both the Division St. and Powell Blvd. entrance-ramps during the PM peak. The combined queue ends north of the US26/Powell/Division exit-ramp. Camera observations suggest that the bottleneck at the US26/Powell Blvd. entrance-ramp lingers after the Division St. entrance-ramp bottleneck improves. Speeds in the area drop as low as 15 mph in the AM and 10 mph in the PM. The project section is a top 10% SPIS site.

Proposed Improvements

As a follow-up phase to Project Map ID L, this project represents the ultimate improvement to address re-occuring bottleneck relief for the area. Considering that funding may be a constraint, this project can be broken into three smaller projects: Project Map ID M, N and O. This project would extend the auxiliary lane from the Washington St. exit-ramp to the I-84 WB exit-ramp and build an additional auxiliary lane from the Division St. entrance-ramp to the Washington St. exit-ramp with a two-lane exit.

Operations/Safety Benefits

The proposed improvement will provide drivers additional time and distance to safely execute the necessary weaving maneuvers. Congestion would be completely reduced in all lanes. It is anticipated that this would result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

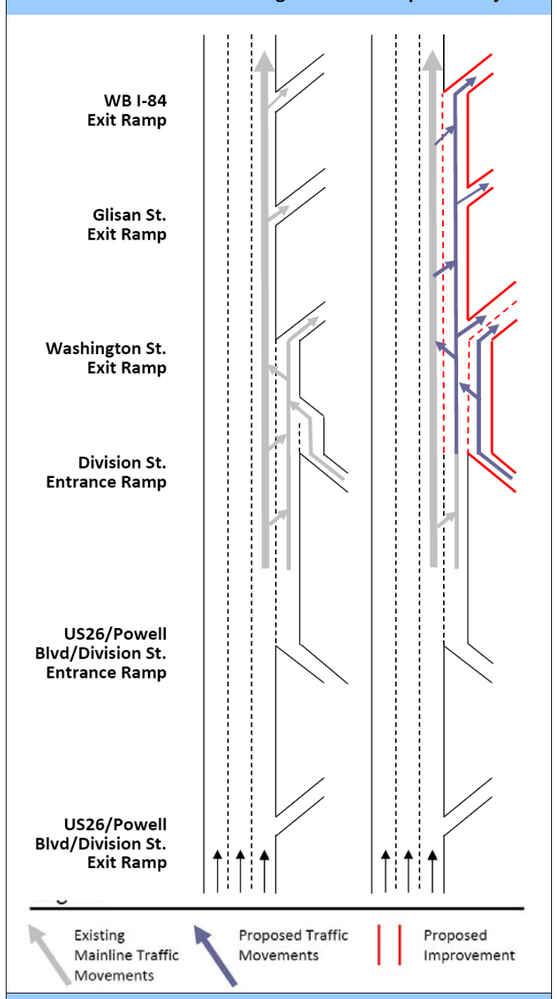
Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
---	---	---	---

*PM Peak Hour

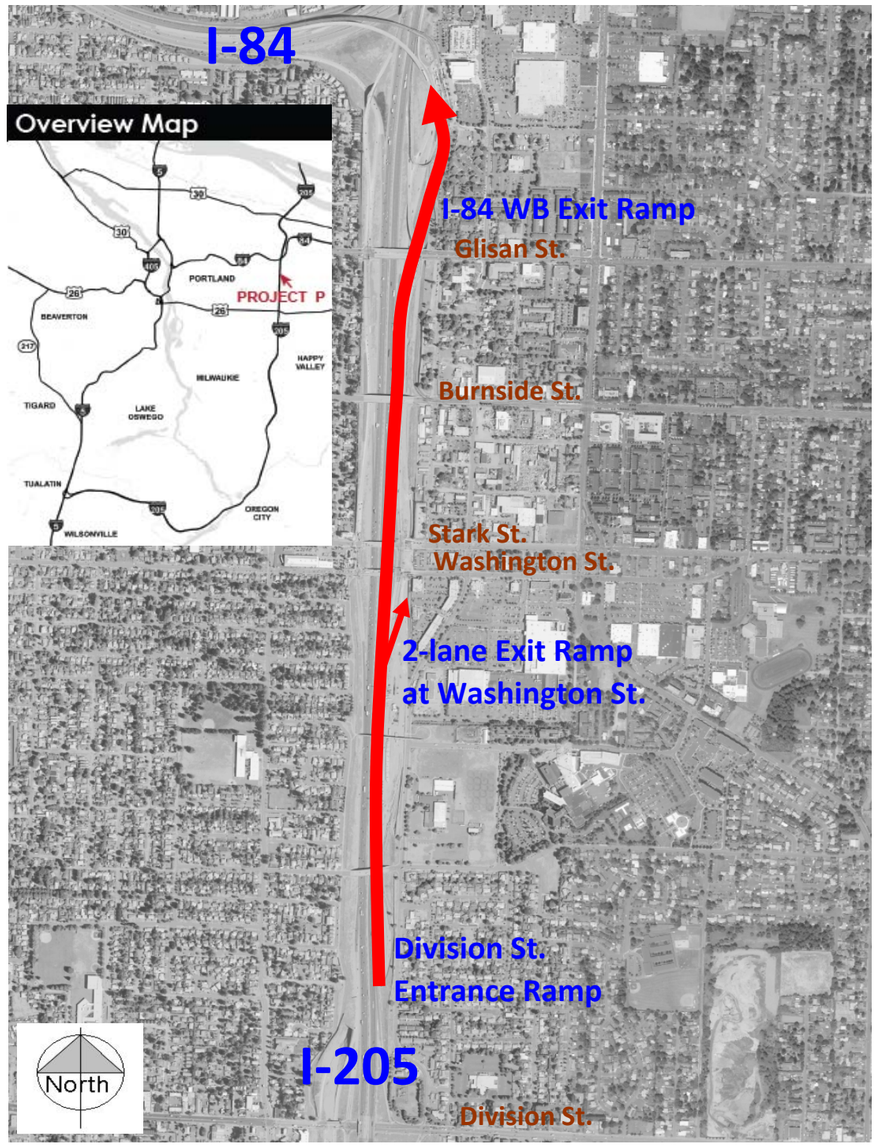
Operations Diagram



Impacts

ROW: None anticipated
Structures: None anticipated
Environment: To be determined

Project Concept



I-205 SB: I-84 EB Entrance ramp to Stark St./Washington St. exit Ramp - Auxiliary Lane

Map ID	Q
Bottleneck ID	I-205: B8/B9
Tracking ID	1
Direction	SB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$7.0M - $8.5M

Existing Operations*

Variable	Existing
Duration (hours)	3.25
Queue (miles)	1.2 - 1.5
Average Speed (mph)	≥ 10
Density (veh/mi/ln)	-

Key Points

Existing Conditions

The existing bottlenecks on I-205 SB between the I-84 entrance-ramp and the US26/Powell Blvd exit-ramp are attributed to the high mainline and ramp volumes in the area as well as closely spaced ramps, and weaving maneuvers between US26/Powell and Stark St./Washington St. Bottleneck speeds drop as low as 10 mph through Bottleneck 8 and 25 mph through Bottleneck 9. The project section is a top 10% SPIS site.

Proposed Improvements

The proposed project will extend an auxiliary lane from the I-84 EB Entrance-ramp to the Stark/Washington St. entrance-ramp to match with the existing auxiliary lane from Stark/Washington to Division/Powell.

Operations/Safety Benefits

Approximately 25% of traffic from the I-84 EB entrance-ramp is destined for Division/Powell and this project would provide a direct connection to this exit. Congestion/queuing would be reduced in all lanes and completely reduced in the two leftmost lanes. This auxiliary lane is anticipated to result in a 30% reduction in mainline crashes, based on comparable auxiliary lane improvements.

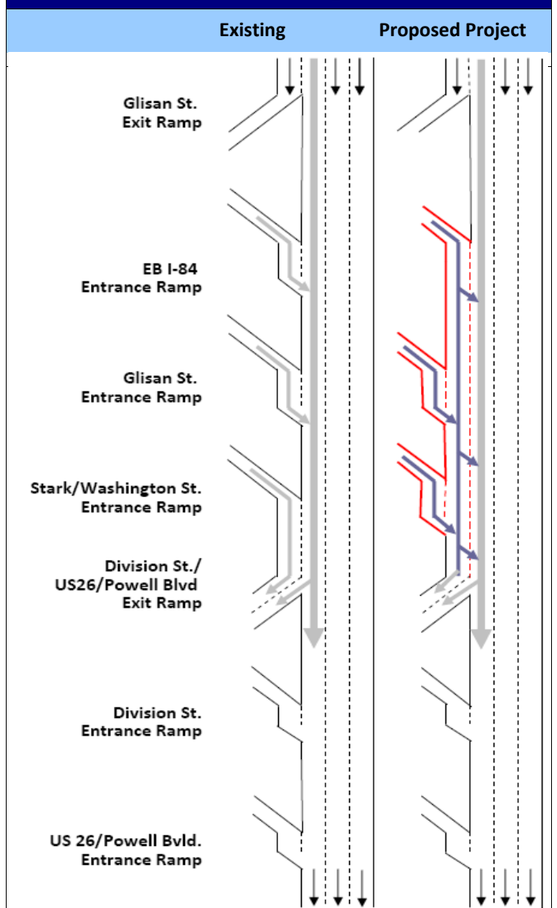
Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
---	---	---	---

*PM Peak Hour

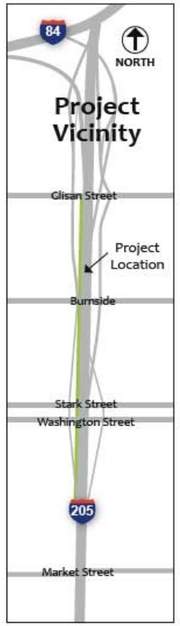
Operations Diagram

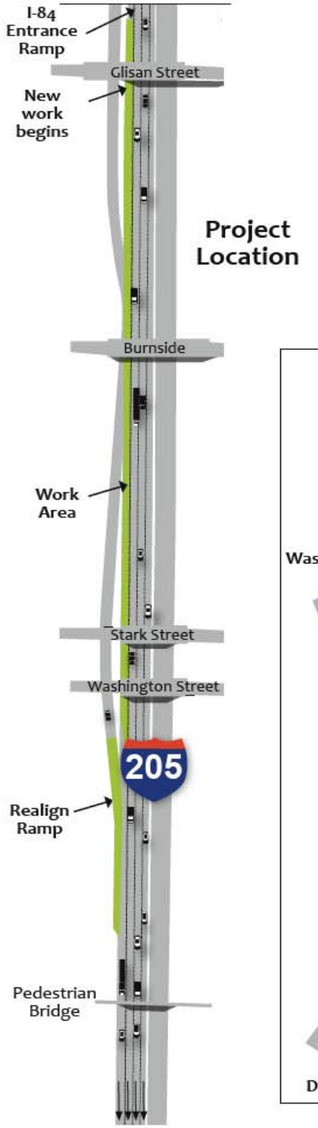


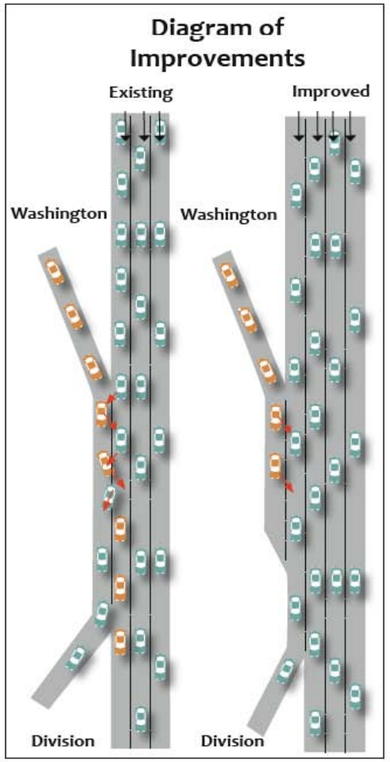
Impacts

ROW: None anticipated
Structures: Potential walls
Environment: To be determined

Project Concept







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I- 84 CBOS Recurring Bottlenecks and Project Recommendations

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Chapter 4: CBOS Recurring Bottlenecks and Project Recommendations

4.3 I-84 Recurring Bottlenecks and Project Recommendations

I-84 Recurring Bottlenecks

Based on review of PORTAL data, ODOT cameras, and field travel time data, a total of seven (7) bottleneck locations are identified within the I-84 study corridor: three (3) bottlenecks are in the eastbound direction and four (4) in the westbound direction. The bottlenecks are classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures **(Figure 3-6** and **Figure 3-7)** contained in this chapter, while more detailed analyses and findings are presented in **Technical Memorandum 3**, included in **Appendix A**.

Bottleneck and Recommended Project Summary Graphics

For an overview figure of the bottlenecks and recommended projects for the I-84 corridor, see **Figure 4-5** and **Figure 4-6**, respectively. See **Chapter 1** for guidelines on how to compare the bottleneck and recommended project summary graphics.

A total of seven (7) bottleneck locations are identified for analysis. From these locations, a total of three (3) potential solutions are identified. Two (2) bottleneck locations are scheduled for construction in 2013. One (1) potential solution is recommended for further analysis.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A.**

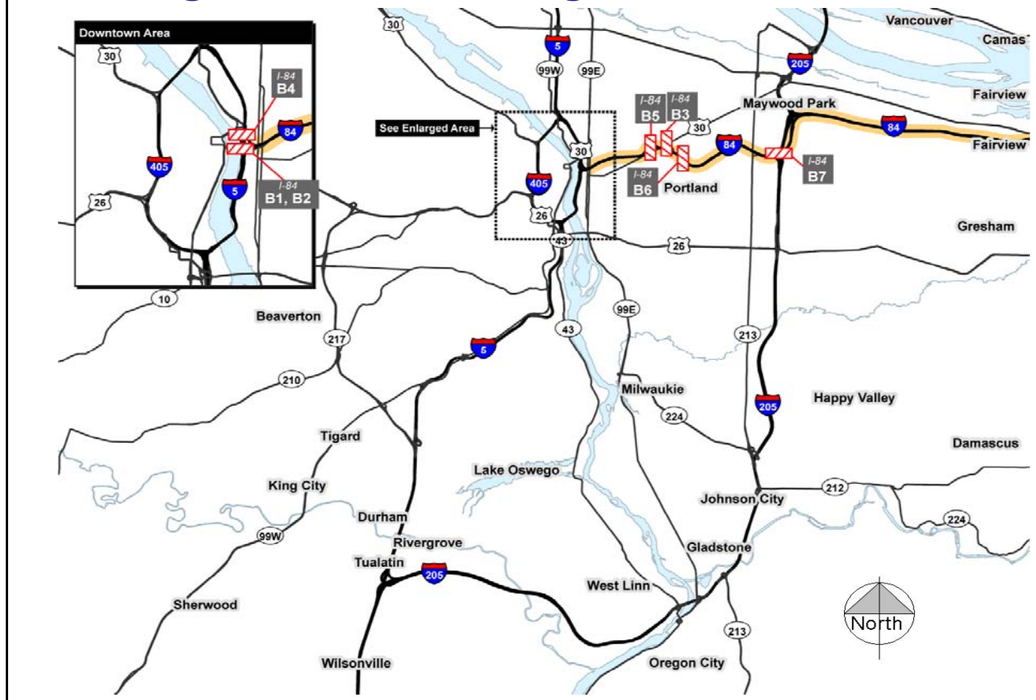
Project Sheets

Please see **pages 4-33** through **4-35** for project sheets unique to each recommended project for the I-84 corridor. There are three (3) project sheets for the I-84 corridor (Projects R - T). See **Chapter 1** for guidelines on how to read the project sheets.

I-84 Corridor Recommended Projects

Map ID	Bottleneck ID	Project Description	Est. Cost	Traffic Analysis Findings/Comments
Eastbound				
R	I-84: B2	I-84 EB: Grand Ave. Entrance Ramp Extension	$4.4M - $5.2M	Initial analysis is inconclusive. Project needs further analysis to evaluate improvement to address safety/operational issues. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.
S	I-84: B3	I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane	$5.9M	Construction 2013. The new exit-only lane to I-205 northbound will improve safety by reducing traffic queuing and congestion on I-84 WB. It will also improve traffic flow for I-84 WB through traffic including freight movements destined to Troutdale or locations further east not only in the p.m. peak hours, but also throughout most of the day. This is because of the high hourly traffic volume exiting to I-205 northbound during the day.
Westbound				
T	I-84: B4	I-84 WB: I-5 NB and I-5 SB Diverge Re-striping	$0.5M	Construction 2013.This project is expected to provide improved traffic operations and safety benefits by eliminating the inside lane merge. This will result in smoother traffic flow as vehicles entering from the entrance-ramp will stay in the auxiliary lane longer and wait for adequate gaps before making the lane change onto the mainline. A couple of similar type of projects that have been constructed in the Region over the past 6-8 years are: (1) Milwaukie Expressway (OR224, Hwy#171)/SE 82nd Ave. entrance-ramp merge junction on I-205 southbound, and (2) OR99W(SW Barbur Blvd) and the truck climbing lane entrance-ramp merge junction on I-5 northbound located approximately 1/2 mile north of the Haines Rd. interchange.)

Figure 4-5: I-84 Recurring Bottleneck Locations



Recurring Bottleneck Location

Bottleneck ID	Recurring Bottleneck Location	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
I-84 Bottlenecks						
B1	I-84 EB: I-5 SB Entrance Ramp (AM & PM)	X		10	12	Page | 3-9
B2	I-84 EB: I-5 SB/NB Merge (PM)		X	5	4	Page | 3-9
B3	I-84 EB: 39th Avenue Entrance Ramp (PM)	X		Inconclusive	Inconclusive	Page | 3-9
B4	I-84 WB: I-5 Diverge (AM & PM)	X		20	8+	Page | 3-10
B5	I-84 WB: 33rd Avenue Entrance Ramp (AM)	X		15	4	Page | 3-10
B6	I-84 WB: Glisan Entrance Ramp (AM)	X		Inconclusive	Inconclusive	Page | 3-10
B7	I-84 WB: I-205 SB to I-84 WB Ramp	X		Inconclusive	Inconclusive	Page | 3-10

Figure 4-6: I-84 Recommended Projects

Recommended Project Location (indicates Potential Solution Recommentation)

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project Sheet on page #
I-84 Recommended Projects to Move Forward					
S	I-84: B3	**Construction 2013**	I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane	$5.9M	Page | 4-34
T	I-84: B4	**Construction 2013**	I-84 WB: I-5 NB and I-5 SB Diverge Re-striping	$0.5M	Page | 4-35
I-5 Recommended Projects for Additional Analysis and Evaluation					
R	I-84: B2	**Further Analysis**	I-84 EB: Grand Ave. Entrance Ramp Extension	$4.4M - $5.2M	Page | 4-33

I-84 EB: Grand Ave. Entrance Ramp Extension

Map ID	R
Bottleneck ID	I-84: B2
Tracking ID	2a
Direction	EB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Further Analysis	$4.4M-$5.2M

Existing Operations*

Variable	Existing
Duration (hours)	4.25
Queue (miles)	> 0.6
Average Speed (mph)	≥ 5
Density (veh/mi/ln)	-

Key Points

Existing Conditions

Currently, the convergence of the I-5 SB and I-5 NB ramp connections on I-84 EB creates a major bottleneck due to the high Interstate Freeway to Freeway volumes and the presence of the Grand Ave. entrance-ramp located only approximately 650' downstream. Although there is an add lane for the entrance-ramp from I-5 SB, the activation area acts as a merge segment for vehicles repositioning to avoid conflicts with the merging traffic from the entrance-ramps ahead. Observations show that vehicles coming from the I-5 SB ramp merge left on the I-84 EB mainline quickly to avoid merging conflicts with the downstream high-volume Grand Ave. and 16th Ave. entrance-ramps. This create significant congestion in the project area in the p.m. peak hours.

Proposed Improvements

This project will extend the Grand Ave. entrance-ramp acceleration lane to the 12th Ave. overcrossing, and install appropriate pavement markers to delineate the I-5 SB and NB traffic on I-84 EB mainline from the Grand Ave entrance-ramp traffic in an effort to provide longer separation between the I-5 SB/NB convergence point and the Grand Ave. entrance-ramp. This would allow motorists entering from the Grand Ave. additional time and distance to blend into the mainline rather than merging at the current location that is very close to the I-5 SB/NB convergence area.

Operations/Safety Benefits

Initial analysis is inconclusive. Project needs further analysis to evaluate improvement to address safety/operational issues. Further analysis needed could include HSM and before/after crash analysis for similar acceleration lane extension projects.

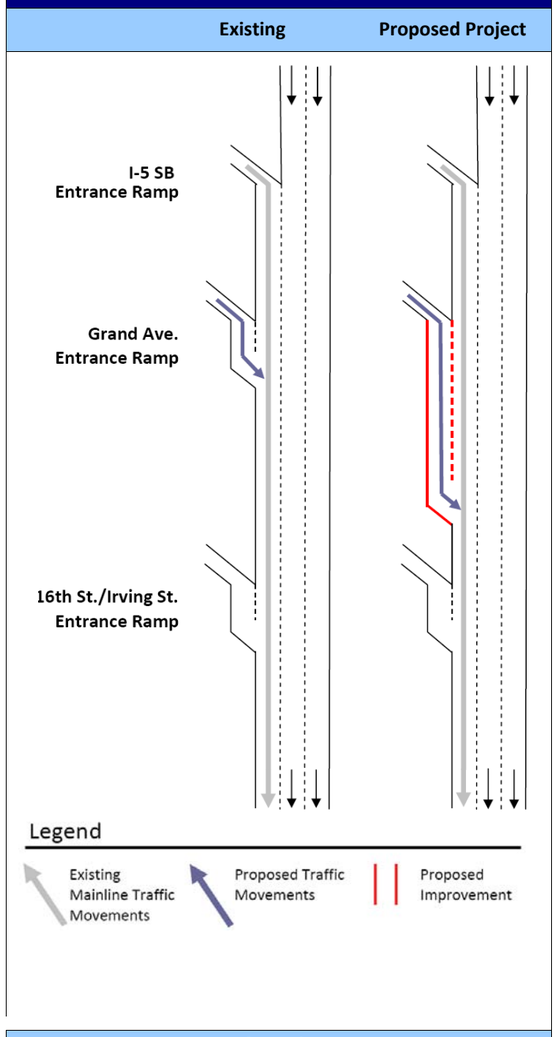
Potential Follow-Up Phases

Project Title:	Extend acceleration lane from Grand Ave. entrance-ramp to 33rd Ave. exit-ramp. (Further analysis required.)

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
---	---	---	---

*PM Peak Hour

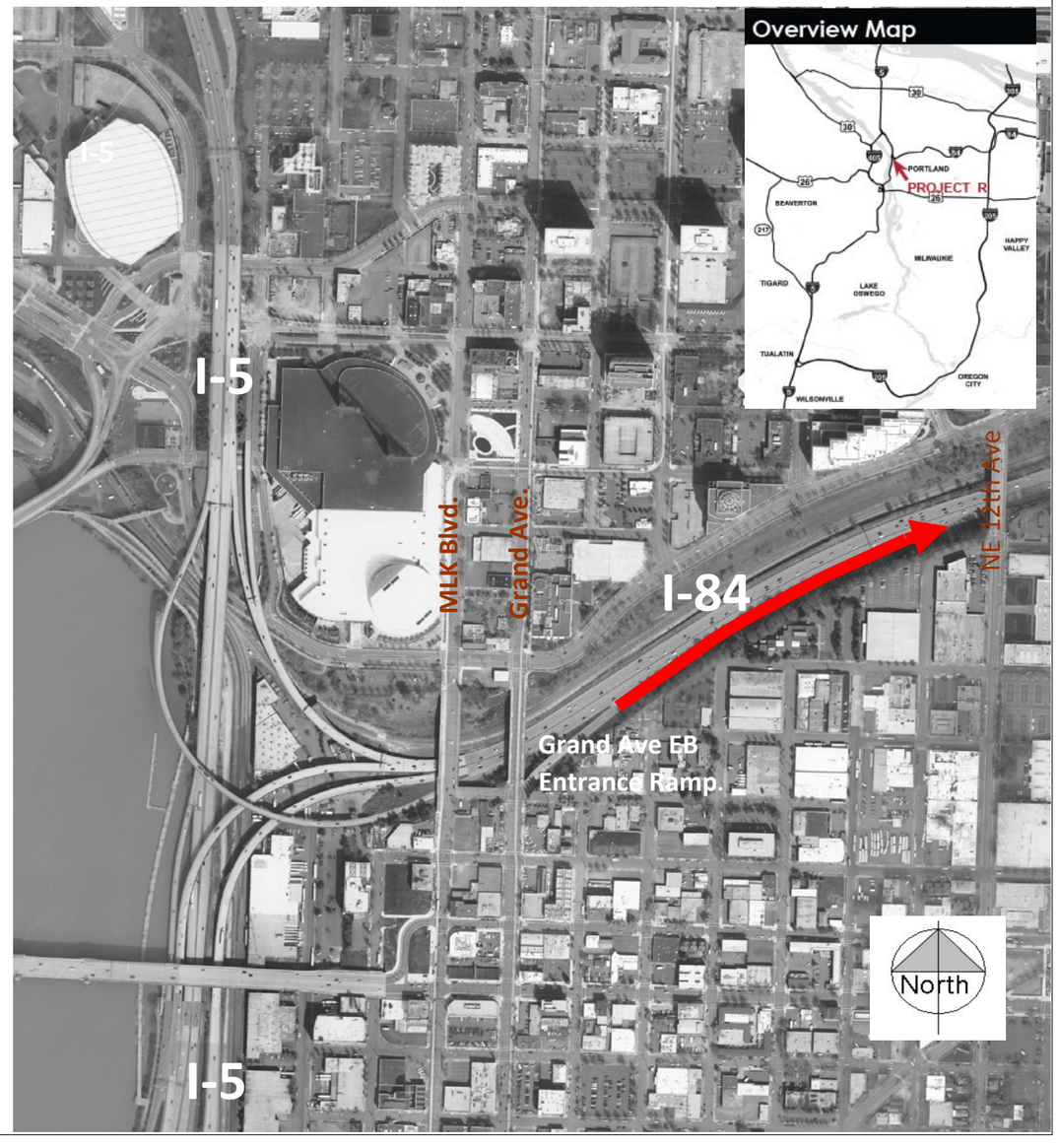
Operations Diagram



Impacts

ROW: None anticipated
Structures: Retaining walls
Environment: To be determined

Project Concept



Map ID	S
Bottleneck ID	I-84: B3
Tracking ID	1
Direction	EB

I-84 EB: Halsey St.Exit Ramp to I-205 NB Entrance Ramp - Auxiliary Lane

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Construction 2013	$5.9M

Existing Operations*

Variable	Existing
Duration (hours)	3.5
Queue (miles)	Inconclusive
Average Speed (mph)	Inconclusive
Density (veh/mi/ln)	36

Key Points

Existing Conditions

The I-205 northbound exit-ramp diverge junction causes congestion and vehicle queues propagating to the I-84 eastbound outer travel lane west of the Halsey St. exit-ramp. Due to the high volume and slower moving vehicles exiting to I-205 northbound (Exit 8) and the upstream lane reduction at Halsey Street, there is a tendency for some of the through traffic in the center lane to make a lane change to the left within the Halsey Street exit and I-205 northbound exit segment, creating turbulence in the project area. This creates a hazard for mainline traffic attempting to drive through the project area with unexpected congestion.

Proposed Improvements

The project will construct a new exit-only lane by extending the current Halsey St. exit-only lane on I-84 eastbound to the I-205 northbound exit-ramp.

Operations/Safety Benefits

The new exit-only lane to I-205 northbound will improve safety by reducing traffic queuing and congestion on I-84 EB. It will also improve traffic flow for I-84 EB through traffic including freight movements destined to Troutdale or locations further east not only in the p.m. peak hours, but also throughout most of the day. This is because of the high hourly traffic volume exiting to I-205 northbound during the day.

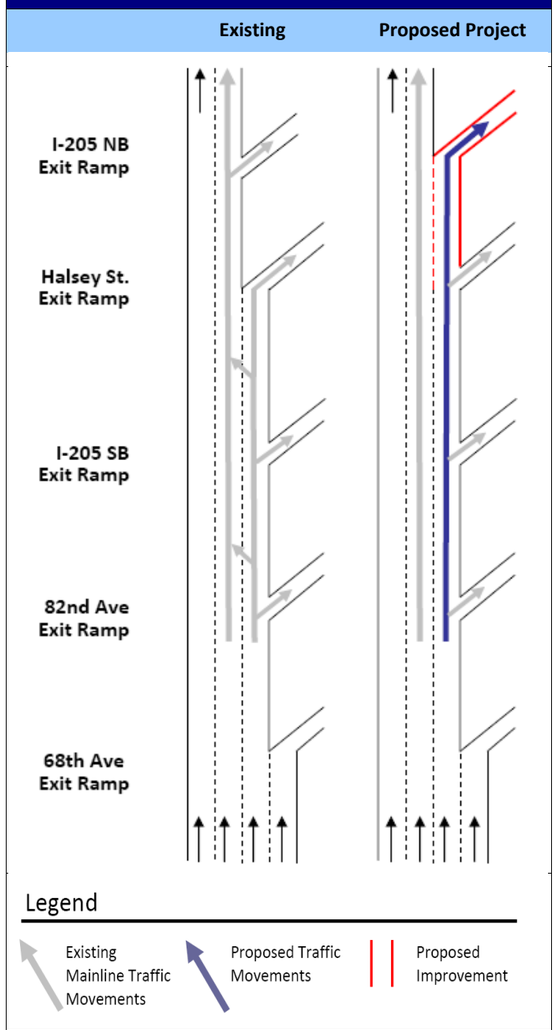
Potential Follow-Up Phases

Project Title:	Project Map ID I & J
Notes:	

Bottleneck ID	*Tracking ID*	*Map ID*	*Cost*
I-205 - B3	2 & 2a	I & J	---

*PM Peak Hour

Operations Diagram

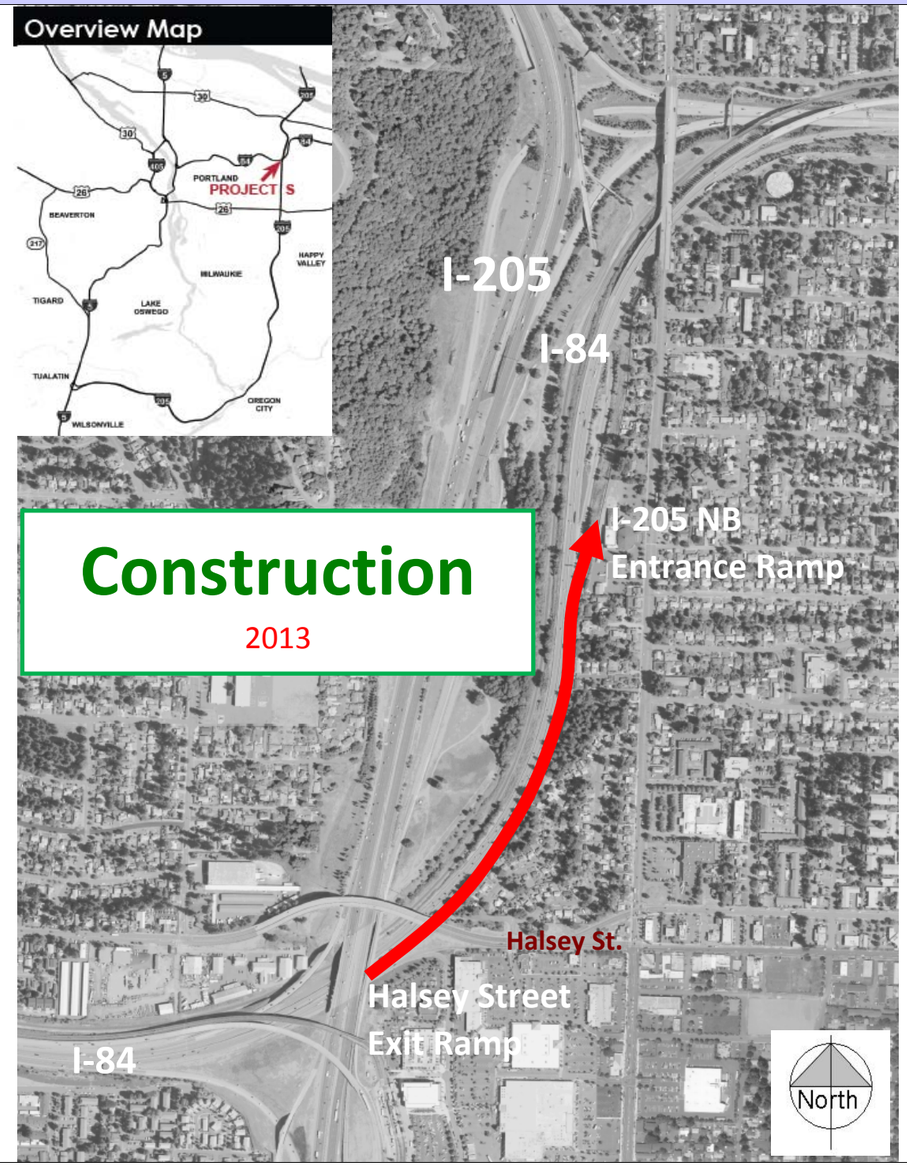


Impacts

ROW:
Structures:
Environment:

Construction 2013

Project Concept



I-84 WB: I-5 NB and I-5 SB Diverge Re-striping

Map ID	T
Bottleneck ID	I-84: B4
Tracking ID	4a
Direction	WB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Final Plans	$0.5M

Existing Conditions*

Variable	Existing
Duration (hours)	4
Queue (miles)	< 1.9
Average Speed (mph)	≥ 20
Density (veh/mi/ln)	-

Key Points

Existing Conditions

The WB I-84 diverge creates a bottleneck that spans back to the 33rd Avenue entrance-ramp in the AM peak period and to the Glisan Street entrance-ramp during the PM peak period. On westbound I-84, there is one dedicated lane for I-5 southbound on the inside, one dedicated lane for I-5 northbound and the Convention Center/Rose Quarter on the outside, and one lane in the middle that can be used to access either I-5 northbound or I-5 southbound in this area. An examination of traffic volumes at the I-84 westbound at I-5 diverge junction shows that during peak travel times, twice as many vehicles travel from I-84 westbound to I-5 southbound than to I-5 northbound and the Convention Center/Rose Quarter exit. High mainline and ramp volumes, existing lane use designation, horizontal and vertical curvature, as well as unclear advanced signage are main contributing factors to the existing bottleneck.

Proposed Improvements

Re-stripe lane markings to provide two dedicated exit lanes to SB I-5 and one dedicated exit lane to NB I-5. Upgrade existing signage.

Operations/Safety Benefits

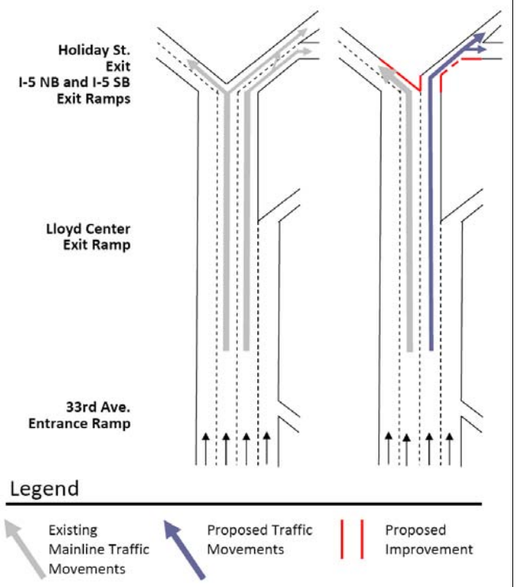
Over the past five years (2007-2011), there have been 237 collisions on I-84 westbound between the Convention Center/Rose Quarter exit ramp and 33rd Avenue. Of these, 31 occurred between the Grand Avenue overpass and the ramp for Convention Center/Rose Quarter.Of the 237 collisions that have occurred between the Convention Center/Rose Quarter ramp and 33rd Avenue, 95% have been rear end or sideswipe collisions resulting from traffic merging and weaving to get into the correct lanes and from the speed reductions and congestion that result from these actions. The restriping and signage upgrades will improve traffic flow and help reduce motorist confusion in this area and the collisions that result by providing clearly marked dedicated exit-only lanes.

Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.

Operations Diagram

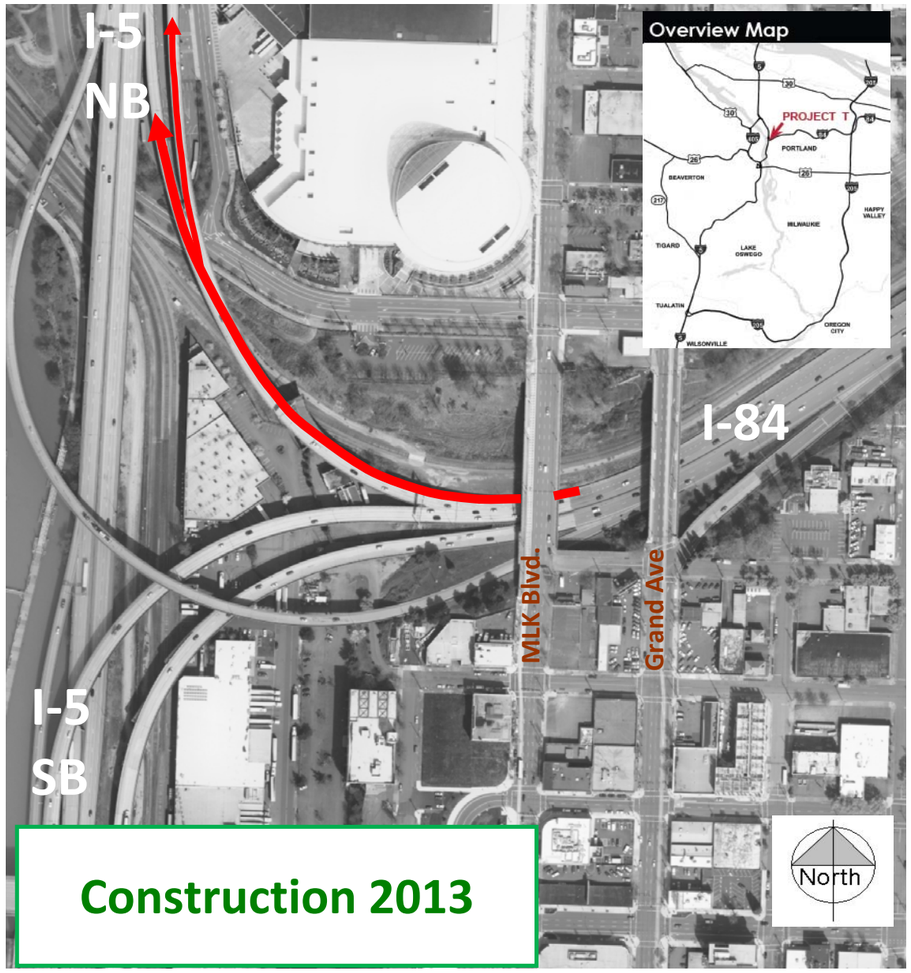
Existing **Proposed Project**



Impacts

ROW:
Structures:
Environment:
Construction 2013

Project Concept



*PM Peak Hour

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I- 405 CBOS Recurring Bottlenecks and Project Recommendations

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Chapter 4: CBOS Recurring Bottlenecks and Project Recommendations

4.4 I-405 Recurring Bottlenecks and Project Recommendations

I-405 Recurring Bottlenecks

Based on review of PORTAL data, ODOT cameras, and field travel time data, a total of four (4) bottleneck locations are identified within the I-405 study corridor: one (1) bottleneck is in the northbound direction and three (3) in the southbound direction. The bottlenecks are classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures (**Figure 3-8** and **Figure 3-9**), while more detailed analyses and findings are presented in **Technical Memorandum 3**, included in **Appendix A**.

Bottleneck and Recommended Project Summary Graphics

For an overview figure of the bottlenecks and recommended projects for the I-405 corridor, see **Figure 4-7** and **Figure 4-8**, respectively. See **Chapter 1** for guidelines on how to compare the bottleneck and recommended project summary graphics.

A total of four (4) bottleneck locations are identified for analysis. From these locations, only one (1) potential solution is identified.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A.**

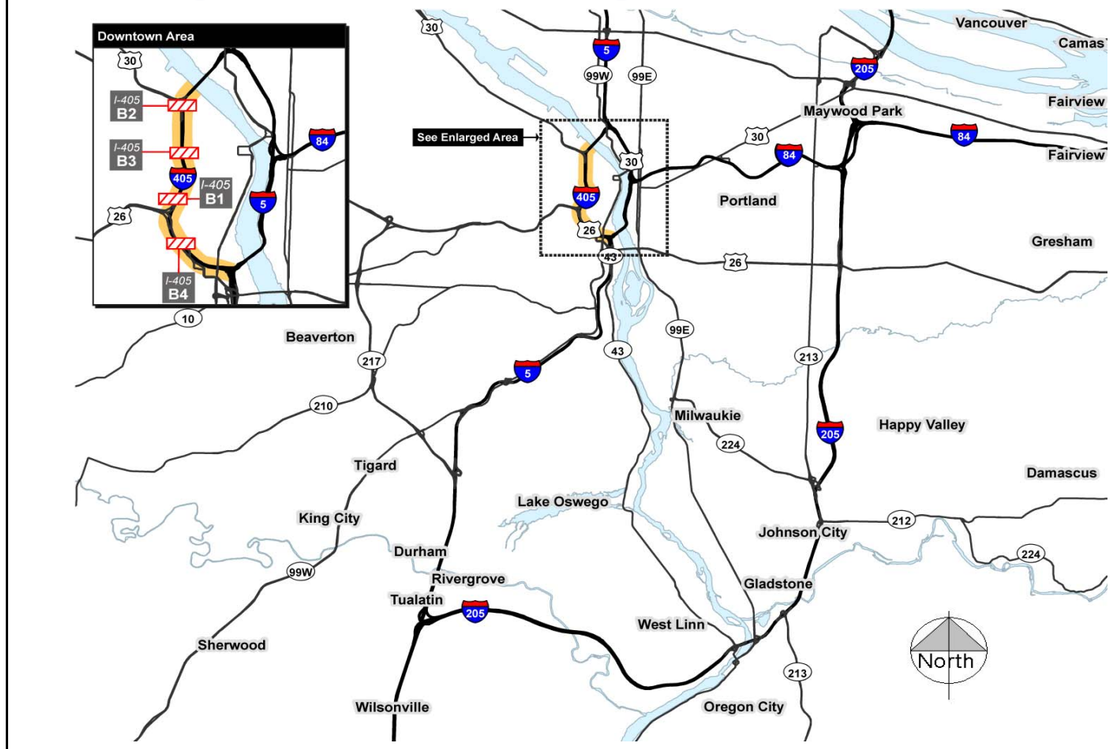
Project Sheets

Please see **page 4-41** for the project sheet unique to the recommended project for the I-405 corridor. See **Chapter 1** for guidelines on how to read the project sheets.

I-405 Corridor Recommended Projects

Map ID	Bottleneck ID	Project Description	Est. Cost	Traffic Analysis Findings/Comments
Southbound				
U	I-405: B2	I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement	$0.5M - $1.0M	This project is expected to provide improved traffic operations and safety benefits by eliminating the inside lane merge. This will result in smoother traffic flow as vehicles entering from the entrance-ramp will stay in the auxiliary lane longer and wait for adequate gaps before making the lane change onto the mainline. A couple of similar type of projects that have been constructed in the Region over the past 6-8 years are: (1) Milwaukie Expressway (OR224, Hwy#171)/SE 82nd Ave. entrance-ramp merge junction on I-205 southbound, and (2) OR99W(SW Barbur Blvd) and the truck climbing lane entrance-ramp merge junction on I-5 northbound located approximately 1/2 mile north of the Haines Rd. interchange.)

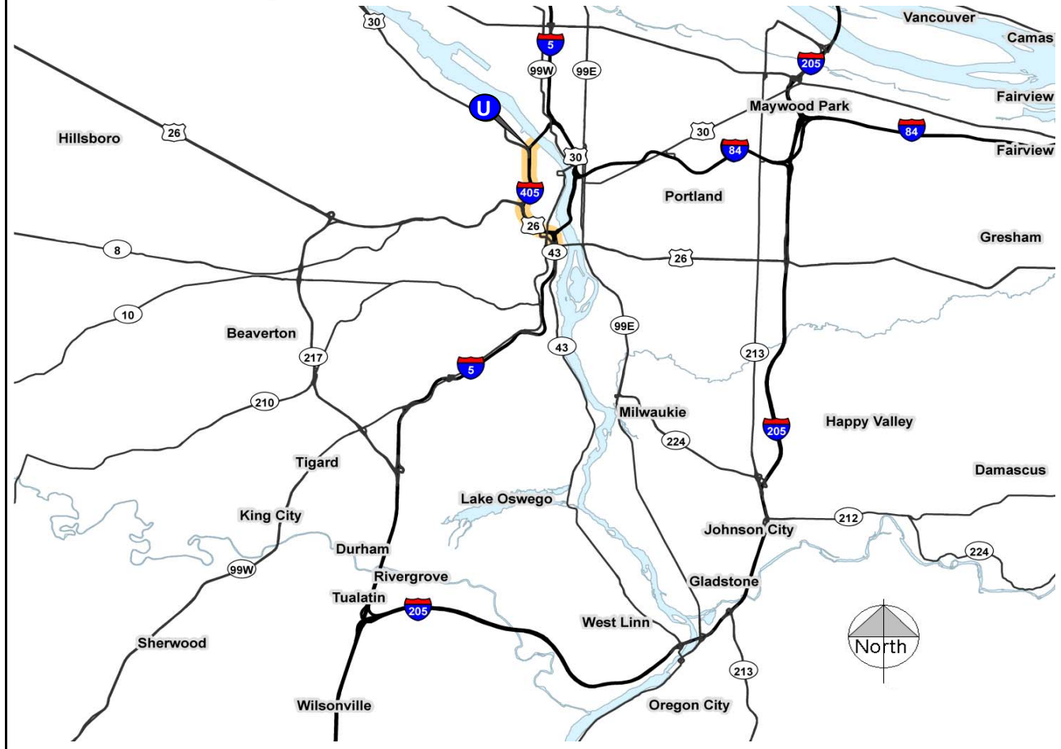
Figure 4-7: I-405 Recurring Bottleneck Locations



Recurring Bottleneck Location

Bottleneck ID	Recurring Bottleneck Location	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
I-405 Bottlenecks						
B1	I-405 NB: US 26/12th Ave (PM)	**X**		5	3	Page | 3-11
B2	I-405 SB: US 30 Entrance Ramp (PM)	**X**		5	3	Page | 3-12
B3	I-405 SB: Everett Street Entrance Ramp to US 26 Exit Ramp Weave (PM)	**X**		5	3	Page | 3-12
B4	I-405 SB: US 26 Entrance Ramp to Broadway Exit Ramp Weave (PM)	**X**		5	3	Page | 3-12

Figure 4-8: I-405 Recommended Projects



Recommended Project Location (indicates Potential Solution Recommentation)

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project Sheet on page #
I-405 Recommended Projects to Move Forward					
U	I-405: B2	**Yes**	I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement	$0.5M - $1.0M	Page | 4-41

I-405 SB/US30 EB: Entrance Ramp Lane Re-arrangement

Map ID	U
Bottleneck ID	I-405: B2
Tracking ID	2a
Direction	SB

Project Analysis/Evaluation

Potential Solution	Cost Estimate
Yes	$0.5M - $1.0M

Existing Operations*

Variable	Existing
Duration (hours)	2.75
Queue (miles)	0.6
Average Speed (mph)	≥ 5
Density (veh/mi/ln)	-

Key Points

Existing Conditions

The bottleneck at the US30 entrance-ramp is attributed to the inside lane taper merge from the US30 entrance-ramp and closely spaced ramps. The 2-lane entrance-ramp converges with I-405 South with the left (inside) lane merging onto I-405 under a taper entrance configuration and the right lane becoming an auxiliary lane to the Everett St. exit-ramp. Unlike a typical merge junction where there is a parallel acceleration lane provided to allow motorists to safely execute the merging maneuver, the existing taper convergence of the left lane from the US30 entrance-ramp force motorists to merge onto mainline traffic rather abruptly, limiting the ability of motorists to pick up gaps. Compounding this is the Everett St. exit-ramp located only 900 feet downstream. All these factors have contributed to very sluggish traffic flow and has resulted in numerous crashes over the years. The bottleneck influence area spans from the US30 entrance-ramp to north of the US30 exit-ramp on the Fremont Bridge. Speeds through the bottleneck are as low as 5 mph. The project section is a top 5% SPIS site.

Proposed Improvements

The proposed project will re-stripe the US30 entrance-ramp from an existing two-lane ramp with the left lane converging with I-405 mainline traffic within a tapered section to a single lane ramp operating as an auxiliary lane, thereby eliminating the taper merging maneuvers. The Everett St. exit-ramp will remain as a 2-lane exit-ramp.

Operations/Safety Benefits

This project is expected to provide improved traffic operations and safety benefits by eliminating the inside lane merge. This will result in smoother traffic flow as vehicles entering from the entrance-ramp will stay in the auxiliary lane longer and wait for adequate gaps before making the lane change onto the mainline. A couple of similar type of projects that have been constructed in the Region over the past 6-8 years are: (1) Milwaukie Expressway (OR224, Hwy#171)/SE 82nd Ave. entrance-ramp merge junction on I-205 southbound, and (2) OR99W(SW Barbur Blvd) and the truck climbing lane entrance-ramp merge junction on I-5 northbound located approximately 1/2 mile north of the Haines Rd. interchange.)

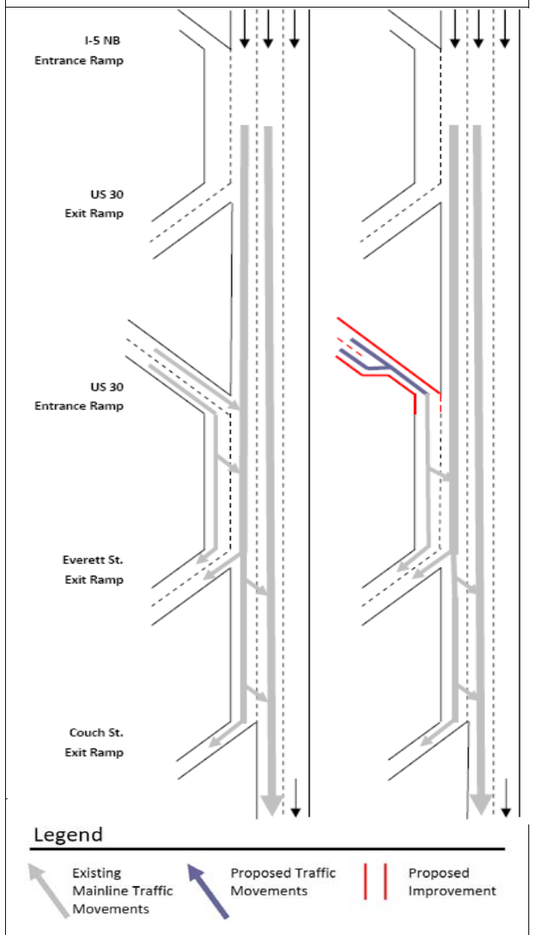
Potential Follow-Up Phases

Project Title:	No follow-up phases identified at this time.

*AM Peak Hour

Operations Diagram

Existing **Proposed Project**



Impacts

ROW:	None anticipated
Structures:	None anticipated
Environment:	None anticipated

Project Concept

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US 26 CBOS Recurring Bottlenecks and Project Recommendations

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Chapter 4: CBOS Recurring Bottlenecks and Project Recommendations

4.5 US 26 Recurring Bottlenecks and Project Recommendations

Based on review of PORTAL data, ODOT cameras, and field travel time data, a total of six (6) bottleneck locations are identified within the US 26 study corridor: five (5) in the eastbound direction and one (1) in the westbound direction. The bottlenecks are classified by direction (northbound or southbound), time of day (AM Peak or PM Peak), and location, along with a description of the contributing factors. This information, as well as the frequency of crashes (identified by milepost) and PORTAL loop locations, is summarized graphically in the Bottleneck Operations Detail Figures **(Figure 3-10** and **Figure 3-11)**, while more detailed analyses and findings are presented in **Technical Memorandum 3**, included in **Appendix A**.

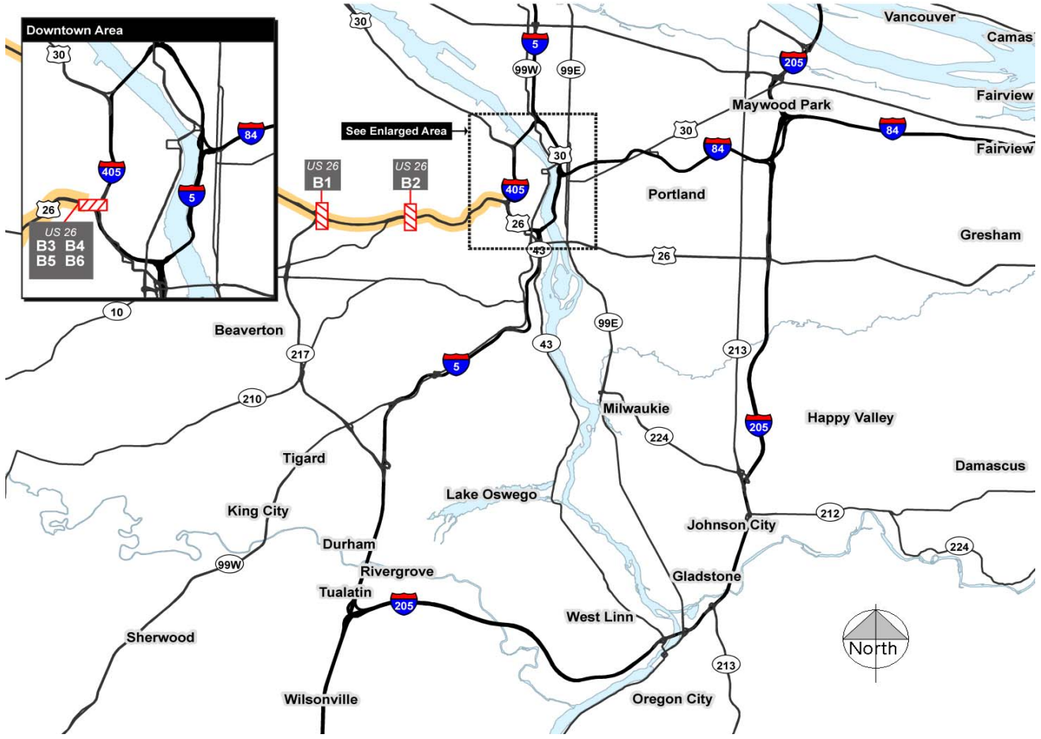
Bottleneck and Recommended Project Summary Graphics

For an overview figure of the bottlenecks and recommended projects for the US 26 corridor, see **Figure 4-9** and **Figure 4-10**, respectively. See **Chapter 1** for guidelines on how to compare the bottleneck and recommended project summary graphics.

There are no recommended solutions identified for bottlenecks within the US 26 study corridor.

More detailed findings are presented in **Technical Memorandum 8**, included in **Appendix A.**

Figure 4-9: US 26 Recurring Bottleneck Locations



Recurring Bottleneck Location

Bottleneck ID	Recurring Bottleneck Location	Cause		Congestion Speed (MPH)	Congestion Duration (Hours)	See Bottleneck Detail Sheet on page #
		Decision Point	Physical Constraint			
US 26 Bottlenecks						
B1	US 26 EB: Oregon 217 Entrance Ramp (AM)	**X**		10	3	Page | 3-13
B2	US 26 EB: Skyline/Scholls Ferry Entrance Ramp (AM & PM)	**X**		Inconclusive	Inconclusive	Page | 3-13
B3	US 26 EB: I-405 Positioning/Curves/Tunnel (AM & PM)	**X**	**X**	15	8	Page | 3-13
B4	US 26 EB: Ramp to I-405 SB (AM & PM)	**X**	**X**	5	8	Page | 3-13
B5	US 26 EB: Ramp to I-405 NB (AM & PM)	**X**	**X**	5	7	Page | 3-13
B6	US 26 WB: I-405 Ramps/US 26 merge (PM)	**X**	**X**	10	3	Page | 3-14

Figure 4-10: US 26 Recommended Projects

There are no recommended projects selected for the US 26 study corridor.

Map ID	Bottleneck ID	Potential Solution Identified	Recommended Projects	Est. Cost	See Project Sheet on page #
US 26 Recommended Projects					
There are no recommended projects selected for the US 26 study corridor.					

US 26 Project Sheets

There are no recommended projects selected for the US 26 study corridor.

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CHAPTER 5:

APPENDICES (SEE REFERENCE CD)

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Chapter 5: Appendices (See Reference CD)

5.1 Appendix A: Technical Memoranda

- A.1 Technical Memoranda 1 & 2: Methodology and Assumptions (known and available data)
- A.2 Technical Memoranda 3: Bottleneck Identification and Diagnosis
- A.3 Technical Memoranda 4 & 5: Corridor Design Review
- A.4 Technical Memoranda 6: Evaluation Framework for Investments to Improve Freeway Operations at Bottlenecks on I-5 & I-205
- A.5 Technical Memoranda 7: Design Panel Results
- A.6 Technical Memoranda 8: Feasibility Review
- A.7 Technical Memoranda 9: Summary of Operations Results

5.2 Appendix B: Preliminary Design Schematics

- B.1 I-5 Bottleneck Preliminary Design Schematics
- B.2 I-205 Bottleneck Preliminary Design Schematics
- B.3 I-84 Bottleneck Preliminary Design Schematics
- B.4 I-405 Bottleneck Preliminary Design Schematics
- B.5 US 26 Bottleneck Preliminary Design Schematics

5.3 Appendix C: Initial Data Summary

5.4 Appendix D: Regional Modeling

5.5 Appendix E: Reserved for Additional Material

CD of Atlas and Appendices

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