Considering the importance of our natural environment

Transportation Technical Report

September 2024

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Transportation Technical Report

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ACRONYMS AND ABBREVIATIONS

Acronym/Abbreviation	Definition
AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	average daily traffic
APM	Analysis Procedures Manual
AVO	average vehicle occupancy
AWDT	average weekday daily traffic
BLTS	bicycle level of traffic stress
BRT	bus rapid transit
CBD	central business district
CD	collector-distributor
COP	City of Portland
COV	City of Vancouver
CRC	Columbia River Crossing
C-TRAN	Clark County Public Transit Benefit Area Authority
DOT	U.S. Department of Transportation
EB	eastbound
FEIS	Final Environmental Impact Statement
FHWA	Federal Highway Administration
FSCR	Flood Safe Columbia River
FTA	Federal Transit Administration
HOV	high-occupancy vehicle
IBR	Interstate Bridge Replacement
ICU	intersection capacity utilization

Acronym/Abbreviation	Definition
ITS	intelligent transportation systems
LOS	level of service
LPA	Locally Preferred Alternative
LRT	light-rail transit
LRV	light-rail vehicle
MAX	Metropolitan Area Express
Metro	Oregon Metro
NB	northbound
NEPA	National Environmental Policy Act
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
OHSU	Oregon Health & Science University
OTC	Oregon Transportation Commission
PBOT	Portland Bureau of Transportation
PDO	property damage only
PMLS	Portland Metro Levee System
PNCD	Preliminary Navigation Clearance Determination
ROD	record of decision
RTC	Southwest Washington Regional Transportation Council
RTP	Regional Transportation Plan
RWIS	Road-weather information system
SB	southbound
SEIS	Supplemental Environmental Impact Statement
SOV	single-occupancy vehicle

Acronym/Abbreviation	Definition
SPIS	Safety Priority Index System
SPUI	Single-point urban interchange
SR	state route
TAZ	transportation analysis zone
TDM	transportation demand management
TOD	transit-oriented development
TriMet	Tri-County Metropolitan Transportation District
TSM	transportation system management
TSP	transportation system plan
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
VAST	Vancouver Area Smart Trek
VHD	vehicle hours of delay
VHT	vehicle hours traveled
VMT	vehicle miles traveled
vph	vehicles per hour
WB	westbound
WSDOT	Washington State Department of Transportation
WSTC	Washington State Transportation Commission

1. SUMMARY

This technical report identifies, describes, and evaluates short-term and long-term effects related to transportation from the Interstate Bridge Replacement (IBR) Program. The IBR Program builds upon the Interstate 5 (I-5) Columbia River Crossing (CRC) project. The CRC project was a bridge, transit, and highway improvement project for I-5 between Washington and Oregon. It focused on addressing the congestion, mobility, and safety issues on I-5 between State Route (SR) 500 in Vancouver, Washington, and Columbia Boulevard in Portland, Oregon. The CRC Final Environmental Impact Statement (FEIS) and Record of Decision were completed in 2011.

The Interstate Bridge is a critical connection between Oregon and Washington, located on I-5 where it crosses the Columbia River. Replacing the existing structurally and operationally deficient bridge with a seismically resilient structure that meets the future transportation needs of the growing Portland and Vancouver metropolitan region is a high priority for Oregon and Washington. The closely spaced interchanges north and south of the bridge would also be reconfigured as part the proposed Modified Locally Preferred Alternative (Modified LPA), and this would have a direct impact to traffic operations at these interchanges.

The transportation system near the Interstate Bridge is complex, with a diverse array of elements including freeways, highways, local roads, transit, and active transportation networks. The transportation system serves commuters making recurring trips during the weekdays, trucks traveling to and from the ports on either side of the river, interstate truck through-trips, public transit routes, and traffic related to local businesses and residences, as well as active transportation users.

The purpose of this technical report is to satisfy applicable portions of the National Environmental Policy Act (NEPA) 42 United States Code (USC) 4321 “to promote efforts which will prevent or eliminate damage to the environment.” Information and potential environmental consequences described in this technical report is used to support the Draft Supplemental Environmental Impact Statement (SEIS) for the IBR Program pursuant to 42 USC 4332.

The objectives of this technical report are to:

- Define the methodology and assumptions used to analyze the transportation impacts for the IBR Program (Chapter 2).
- Describe existing transportation conditions (Chapter 3).
- Discuss and compare potential long-term, temporary, and indirect effects of the Modified LPA and the No-Build Alternative to transportation modes (Chapters 4, 5, and 6).
- Provide proposed avoidance and mitigation measures to help prevent, eliminate, or minimize environmental consequences from the Modified LPA (Chapter 7).

The IBR Program is a continuation of the previously suspended CRC project with the same purpose to replace the aging Interstate 5 (I-5) Bridge across the Columbia River with a modern, seismically resilient multimodal structure. The proposed infrastructure improvements are located along a 5-mile stretch of the I-5 corridor that extends from approximately Victory Boulevard in Portland to State Route (SR) 500 in Vancouver as shown in Figure 1-1.

The Modified LPA is a modification of the CRC LPA, which completed the NEPA process with a signed Record of Decision (ROD) in 2011 and two re-evaluations that were completed in 2012 and 2013. The CRC project was discontinued in 2014. This technical report is evaluating the effects of changes in project design since the CRC ROD and re-evaluations, as well as changes in regulations, policy, and physical conditions

Figure 1-1. IBR Program Location Overview

1.1 Components of the Modified LPA

The basic components of the Modified LPA include:

- A new pair of Columbia River bridges—one for northbound and one for southbound travel—built west of the existing bridge. The new bridges would each include three through lanes, safety shoulders, and one auxiliary lane (a ramp-to-ramp connection on the highway that improves interchange safety by providing drivers with more space and time to merge, diverge, and weave) in each direction. When all highway, transit, and active transportation would be moved to the new Columbia River bridges, the existing Interstate Bridge (both spans) would be removed.
  - Three bridge configurations are under consideration: (1) double-deck truss bridges with fixed spans, (2) single-level bridges with fixed spans, and (3) single-level bridges with movable spans over the primary navigation channel. The fixed-span configurations would provide up to 116 feet of vertical navigation clearance, and the movable-span configuration would provide 178 feet of vertical navigation clearance in the open position. The primary navigation channel would be relocated approximately 500 feet south (measured by channel centerline) of its existing location near the Vancouver shoreline.
  - A two auxiliary lane design option (two ramp-to-ramp lanes connecting interchanges) across the Columbia River is also being evaluated. The second auxiliary lane in each direction of I-5 would be added from approximately Interstate Avenue/Victory Boulevard to SR 500/39th Street.
- A 1.9-mile light-rail transit (LRT) extension of the current Metropolitan Area Express (MAX) Yellow Line from the Expo Center MAX Station in North Portland, where it currently ends, to a terminus near Evergreen Boulevard in Vancouver. Improvements would include new stations at Hayden Island, downtown Vancouver (Waterfront Station), and near Evergreen Boulevard (Evergreen Station), as well as revisions to the existing Expo Center MAX Station. Park and rides to serve LRT riders in Vancouver could be included near the Waterfront Station and Evergreen Station. The Tri-County Metropolitan Transportation District of Oregon (TriMet), which operates the MAX system, would also operate the Yellow Line extension.
  - Potential site options for park and rides include three sites near the Waterfront Station and two near the Evergreen Station (up to one park and ride could be built for each station location in Vancouver).
- Associated LRT improvements such as traction power substations, overhead catenary system, signal and communications support facilities, an overnight light-rail vehicle (LRV) facility at the Expo Center, 19 new LRVs, and an expanded maintenance facility at TriMet's Ruby Junction.
- Integration of local bus transit service, including bus rapid transit (BRT) and express bus routes, in addition to the proposed new LRT service.
- Wider shoulders on I-5 from Interstate Avenue/Victory Boulevard to SR 500/39th Street to accommodate express bus-on-shoulder service in each direction.
- Associated bus transit service improvements would include three additional bus bays for eight new electric double-decker buses at the Clark County Public Transit Benefit Area Authority

(C-TRAN) operations and maintenance facility (see Section 1.1.7, Transit Operating Characteristics, for more information about this service).

- Improvements to seven I-5 interchanges and I-5 mainline improvements between Interstate Avenue/ Victory Boulevard in Portland and SR 500/39th Street in Vancouver. Some adjacent local streets would be reconfigured to complement the new interchange designs, and improve local east-west connections.
  - An option that shifts the I-5 mainline up to 40 feet westward in downtown Vancouver between the SR 14 interchange and Mill Plain Boulevard interchange is being evaluated.
  - An option that eliminates the existing C Street ramps in downtown Vancouver is being evaluated.
- Six new adjacent bridges across North Portland Harbor: one on the east side of the existing I-5 North Portland Harbor bridge and five on the west side or overlapping with the existing bridge (which would be removed). The bridges would carry (from west to east) LRT tracks, southbound I-5 off-ramp to Marine Drive, southbound I-5 mainline, northbound I-5 mainline, northbound I-5 on-ramp from Marine Drive, and an arterial bridge for local traffic with a shared-use path for pedestrians and bicyclists.
- A variety of improvements for people who walk, bike, and roll throughout the study area, including a system of shared-use paths, bicycle lanes, sidewalks, enhanced wayfinding, and facility improvements to comply with the Americans with Disabilities Act (ADA). These are referred to in this document as *active transportation* improvements.
- Variable-rate tolling for motorists using the river crossing as a demand-management and financing tool.

The transportation improvements proposed for the Modified LPA and the design options are shown in Figure 1-2. The Modified LPA includes all of the components listed above. If there are differences in environmental effects or benefits between the design options, those are identified in the sections below.

Figure 1-2. Modified LPA Components

Section 1.1.1, Interstate 5 Mainline, describes the overall configuration of the I-5 mainline through the study area, and Sections 1.1.2, Portland Mainland and Hayden Island (Subarea A), through Section 1.1.5, Upper Vancouver (Subarea D), provide additional detail on four geographic subareas (A through D), which are shown on Figure 1-3. In each subarea, improvements to I-5, its interchanges, and the local roadways are described first, followed by transit and active transportation improvements. Design options are described under separate headings in the subareas in which they would be located.

Figure 1-3. Modified LPA – Geographic Subareas

Table 1-1 shows the different combinations of design options analyzed in this technical report. However, **any combination of design options is compatible**. In other words, any of the bridge configurations could be combined with one or two auxiliary lanes, with or without the C Street ramps, a centered or westward shift of I-5 in downtown Vancouver, and any of the park-and-ride location options. Figures in each section show both the anticipated limit of ground disturbance, which includes disturbance from temporary construction activities, and the location of permanent infrastructure elements.

Table 1-1. Modified LPA and Design Options

Design Options	Modified LPA	Modified LPA with Two Auxiliary Lanes	Modified LPA Without C Street Ramps	Modified LPA with I-5 Shifted West	Modified LPA with a Single-Level Fixed-Span Configuration	Modified LPA with a Single-Level Movable-Span Configuration
Bridge Configuration	**Double-deck fixed-span***	Double-deck fixed-span	Double-deck fixed-span	Double-deck fixed-span	**Single-level fixed-span***	**Single-level movable-span***
Auxiliary Lanes	**One***	**Two***	One	One	One	One
C Street Ramps	**With C Street ramps***	With C Street ramps	**Without C Street Ramps***	With C Street ramps	With C Street ramps	With C Street ramps
I-5 Alignment	**Centered***	Centered	Centered	**Shifted West***	Centered	Centered
Park-and-Ride Options	**Waterfront**:* 1. Columbia Way (below I-5); 2. Columbia Street/SR 14; 3. Columbia Street/Phil Arnold Way **Evergreen**:* 1. Library Square; 2. Columbia Credit Union					

Bold text with an asterisk (*) indicates which design option is different in each configuration.

1.1.1 Interstate 5 Mainline

Today, within the 5-mile corridor, I-5 has three 12-foot-wide through lanes in each direction, an approximately 6- to 11-foot-wide inside shoulder, and an approximately 10- to 12-foot-wide outside shoulder with the exception of the Interstate Bridge, which has approximately 2- to 3-foot-wide inside and outside shoulders. There are currently intermittent auxiliary lanes between the Victory Boulevard and Hayden Island interchanges in Oregon and between SR 14 and SR 500 in Washington.

The Modified LPA would include three 12-foot through lanes from Interstate Avenue/Victory Boulevard to SR 500/39th Street and a 12-foot auxiliary lane from the Marine Drive interchange to the Mill Plain Boulevard interchange in each direction. Many of the existing auxiliary lanes on I-5 between the SR 14 and Main Street interchanges in Vancouver would remain, although they would be reconfigured. The existing auxiliary lanes between the Victory Boulevard and Hayden Island interchanges would be replaced with changes to on- and off-ramps and interchange reconfigurations. The Modified LPA would also include wider shoulders (12-foot inside shoulders and 10- to 12-foot outside shoulders) to be consistent with Oregon Department of Transportation (ODOT) and WSDOT design standards. The wider inside shoulder would be used by express bus service to bypass mainline congestion, known as “bus on shoulder” (refer to Section 1.1.7, Transit Operating Characteristics). The shoulder would be available for express bus service when general-purpose speeds are below 35 miles per hour (mph).

Figure 1-4 shows a cross section of the collector-distributor (CD)[1] roadways, Figure 1-5 shows the location of the CD roadways, and Figure 1-6 shows the proposed auxiliary lane layout. The existing Interstate Bridge over the Columbia River does not have an auxiliary lane; the Modified LPA would add one auxiliary lane in each direction across the new Columbia River bridges.

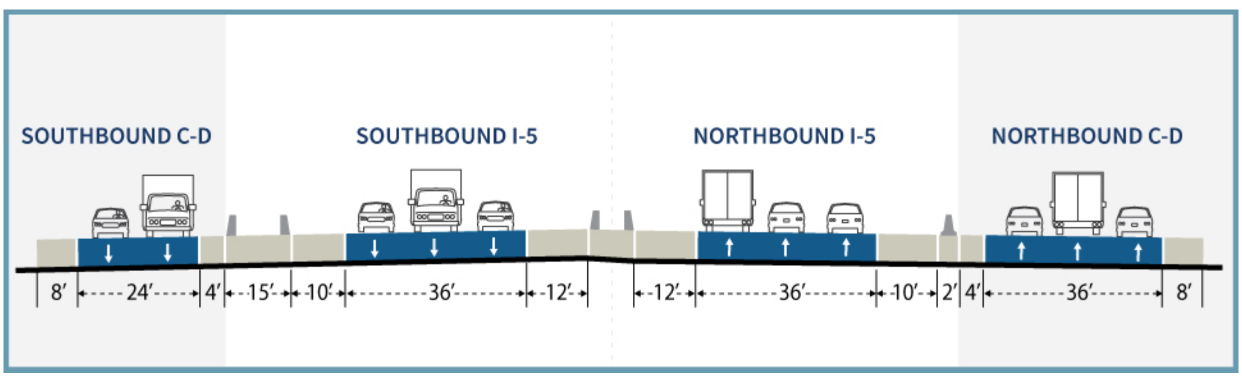
On I-5 northbound, the auxiliary lane that would begin at the on-ramp from Marine Drive would continue across the Columbia River bridge and end at the off-ramp to the CD roadway, north of SR 14 (see Figure 1-5). The on-ramp from SR 14 westbound would join the off-ramp to the CD roadway, forming the northbound CD roadway between SR 14 and Fourth Plain Boulevard. The CD roadway would provide access from I-5 northbound to the off-ramps at Mill Plain Boulevard and Fourth Plain Boulevard. The CD roadway would also provide access from SR 14 westbound to the off-ramps at Mill Plain Boulevard and Fourth Plain Boulevard, and to the on-ramp to I-5 northbound.

On I-5 northbound, the Modified LPA would also add one auxiliary lane beginning at the on-ramp from the CD roadway and ending at the on-ramp from 39th Street, connecting to an existing auxiliary lane from 39th Street to the off-ramp at Main Street. Another existing auxiliary lane would remain between the on-ramp from Mill Plain Boulevard to the off-ramp to SR 500.

On I-5 southbound, the off-ramp to the CD roadway would join the on-ramp from Mill Plain Boulevard to form a CD roadway. The CD roadway would provide access from I-5 southbound to the off-ramp to SR 14 eastbound and from Mill Plain Boulevard to the off-ramp to SR 14 eastbound and the on-ramp to I-5 southbound.

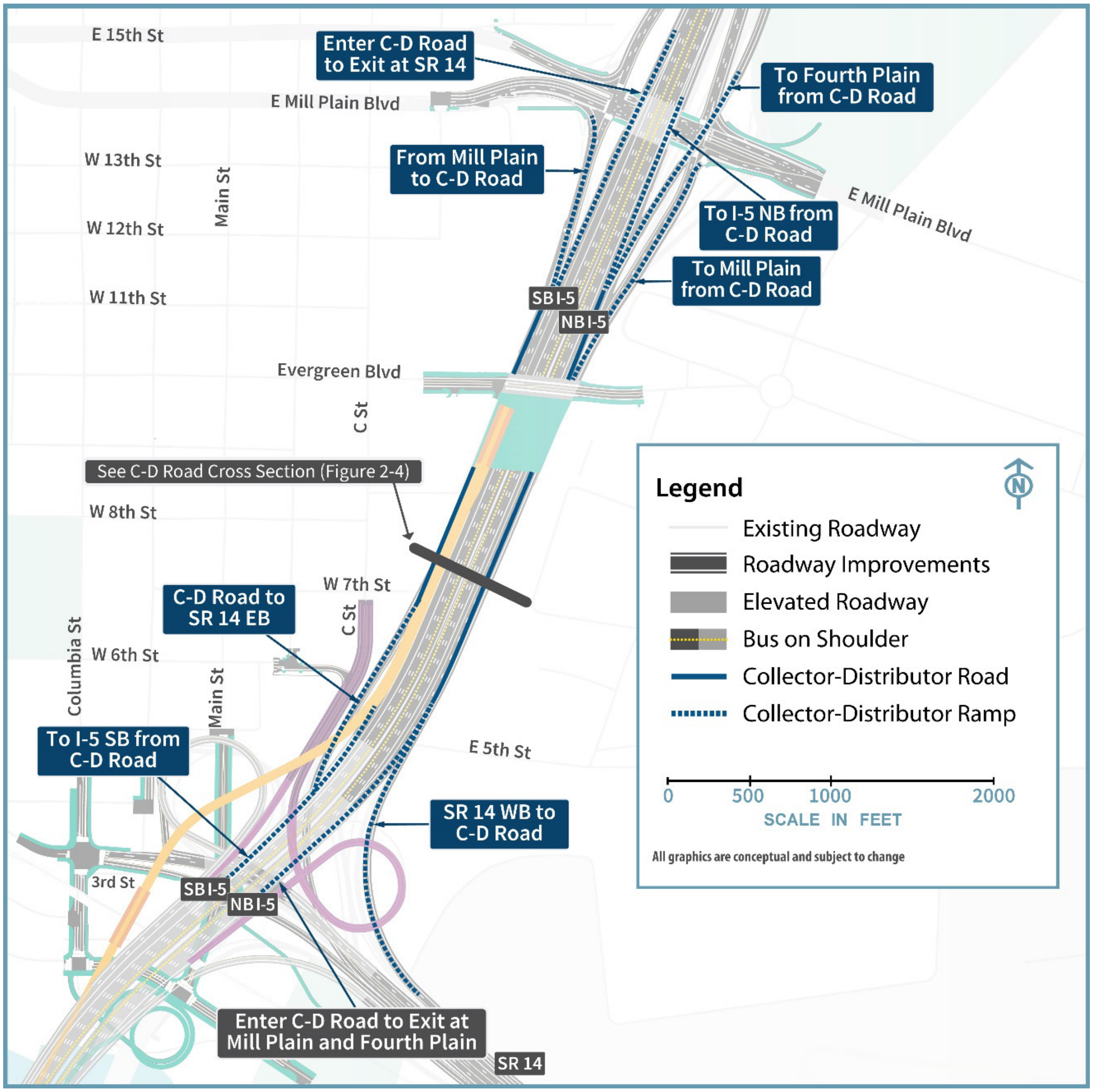
On I-5 southbound, an auxiliary lane would begin at the on-ramp from the CD roadway and would continue across the southbound Columbia River bridge and end at the off-ramp to Marine Drive. The combined on-ramp from SR 14 westbound and C Street would merge into this auxiliary lane.

Figure 1-4. Cross Section of the Collector-Distributor Roadways



[1] A collector-distributer roadway parallels and connects the main travel lanes of a highway and frontage roads or entrance ramps.

Figure 1-5. Collector-Distributor Roadways



CD = collector-distributor; EB = eastbound; NB = northbound; SB = southbound; WB = westbound

1.1.1.1 Two Auxiliary Lane Design Option

This design option would add a second 12-foot-wide auxiliary lane in each direction of I-5 with the intent to further optimize travel flow in the corridor. This second auxiliary lane is proposed from the Interstate Avenue/Victory Boulevard interchange to the SR 500/39th Street interchange.

On I-5 northbound, one auxiliary lane would begin at the combined on-ramp from Interstate Avenue and Victory Boulevard, and a second auxiliary lane would begin at the on-ramp from Marine Drive. Both auxiliary lanes would continue across the northbound Columbia River bridge, and the on-ramp from Hayden Island would merge into the second auxiliary lane on the northbound Columbia River bridge. At the off-ramp to the CD roadway, the second auxiliary lane would end but the first auxiliary lane would continue. A second auxiliary lane would begin again at the on-ramp from Mill Plain Boulevard. The second auxiliary lane would end at the off-ramp to SR 500, and the first auxiliary lane would connect to an existing auxiliary lane at 39th Street to the off-ramp at Main Street.

On I-5 southbound, two auxiliary lanes would begin at the on-ramp from SR 500. Between the on-ramp from Fourth Plain Boulevard and the off-ramp to Mill Plain Boulevard, one auxiliary lane would be added to the existing two auxiliary lanes. The second auxiliary lane would end at the off-ramp to the CD roadway, but the first auxiliary lane would continue. A second auxiliary lane would begin again at the southbound I-5 on-ramp from the CD roadway. Both auxiliary lanes would continue across the southbound Columbia River bridge, and the combined on-ramp from SR 14 westbound and C Street would merge into the second auxiliary lane on the southbound Columbia River bridge. The second auxiliary lane would end at the off-ramp to Marine Drive, and the first auxiliary lane would end at the combined off-ramp to Interstate Avenue and Victory Boulevard.

Figure 1-6 shows a comparison of the one auxiliary lane configuration and the two auxiliary lane configuration design option. Figure 1-7 shows a comparison of the footprints (i.e., the limit of permanent improvements) of the one auxiliary lane and two auxiliary lane configurations on a double-deck fixed-span bridge. For all Modified LPA bridge configurations (described in Section 1.1.3, Columbia River Bridges (Subarea B)), the footprints of the two auxiliary lane configurations differ only over the Columbia River and in downtown Vancouver. The rest of the corridor would have the same footprint. For all bridge configurations analyzed in this document, the two auxiliary lane option would add 16 feet (8 feet in each direction) in total roadway width compared to the one auxiliary lane option due to the increased shoulder widths for the one auxiliary lane option.[2] The traffic operations analysis incorporating both the one and two auxiliary lane design options applies equally to all bridge configurations in this technical report.

[2] Under the one auxiliary lane option, the width of each shoulder would be approximately 14 feet to accommodate maintenance of traffic during construction. Under the two auxiliary lane option, maintenance of traffic could be accommodated with 12-foot shoulders because the additional 12-foot auxiliary lane provides adequate roadway width. The total difference in roadway width in each direction between the one auxiliary lane option and the two auxiliary lane option would be 8 feet (12-foot auxiliary lane – 2 feet from the inside shoulder – 2 feet from the outside shoulder = 8 feet).

Figure 1-6. Comparison of Auxiliary Lane Configurations

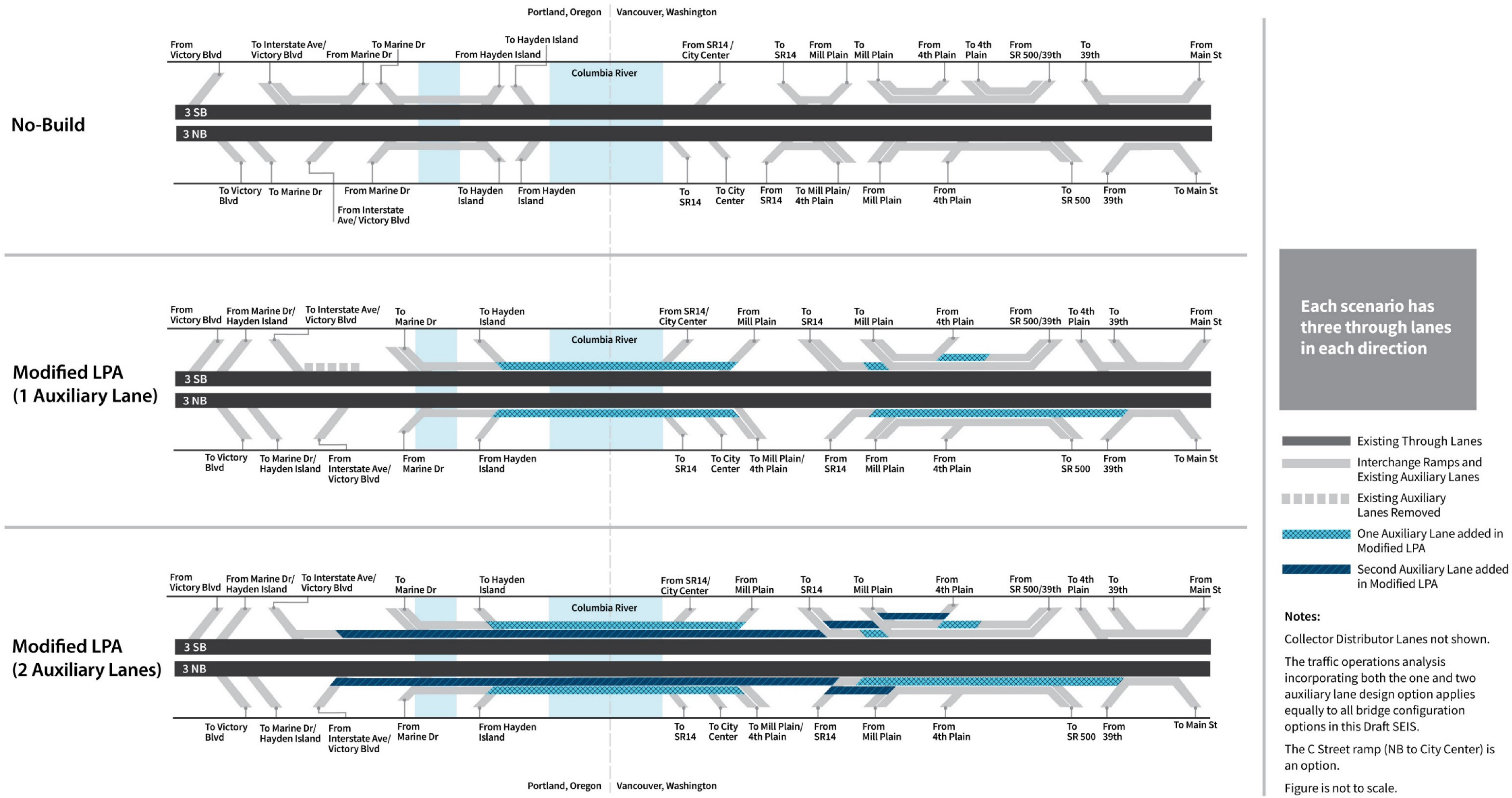
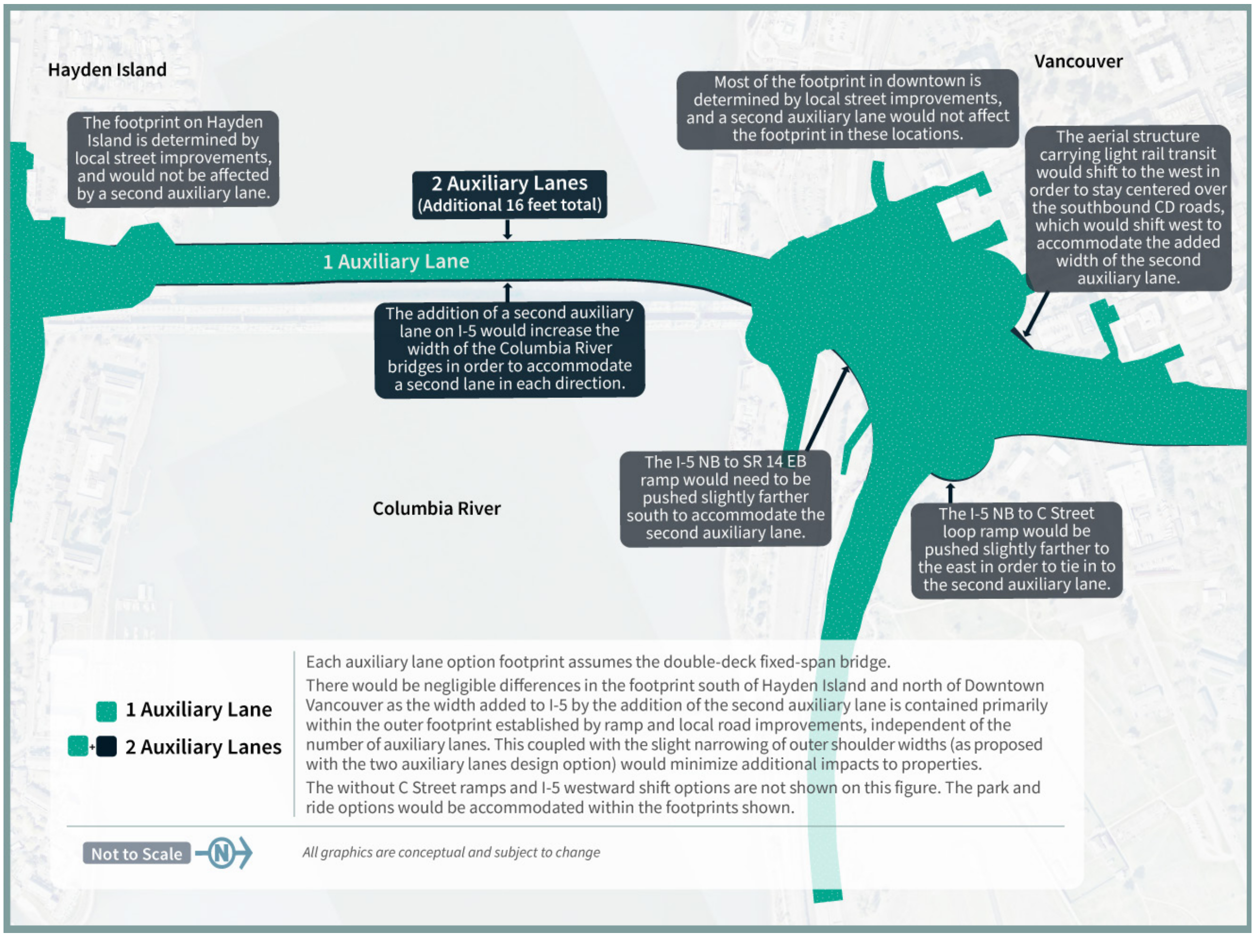


Figure 1-7. Auxiliary Lane Configuration Footprint Differences



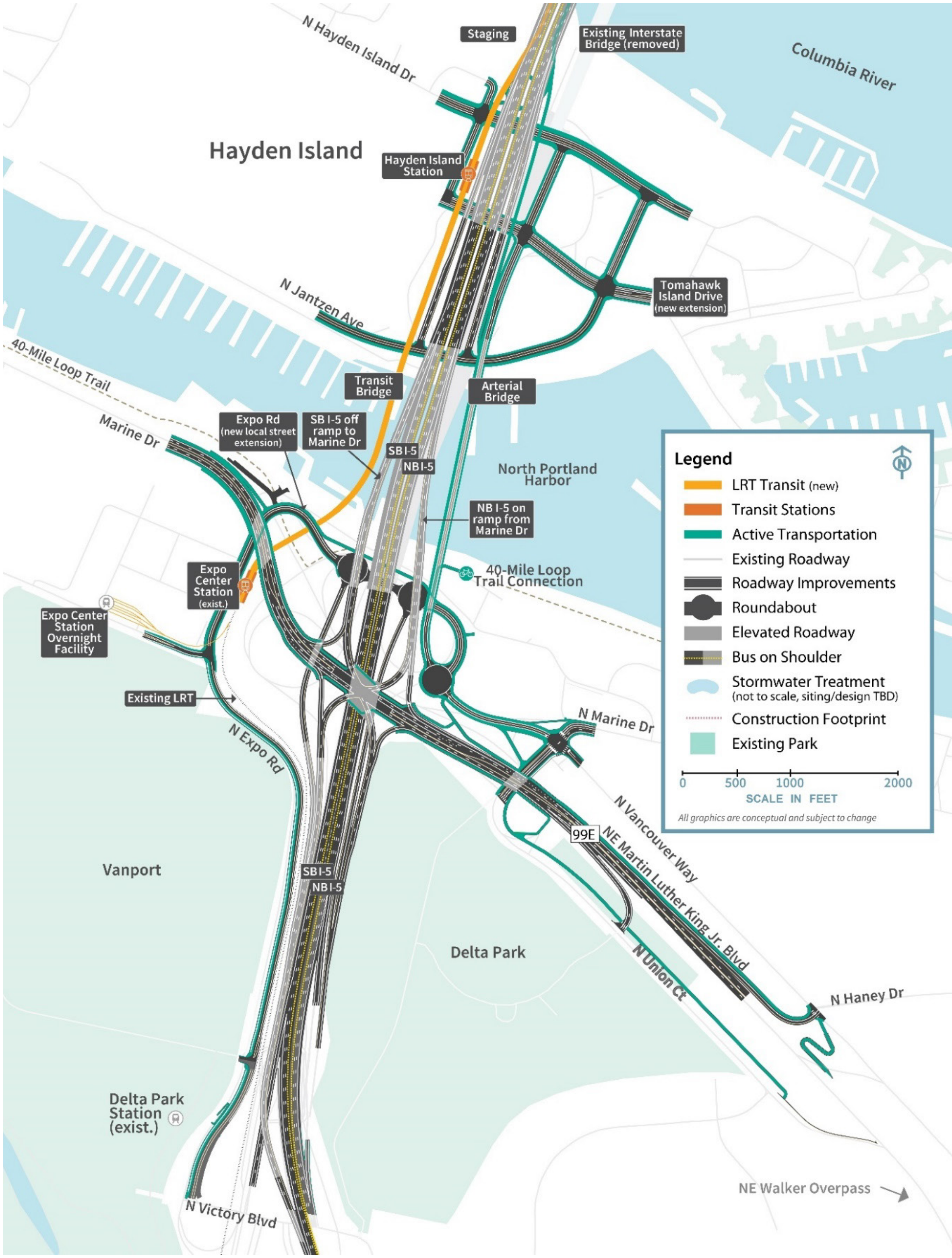
1.1.2 Portland Mainland and Hayden Island (Subarea A)

This section discusses the geographic Subarea A shown in Figure 1-3. See Figure 1-8 for highway and interchange improvements in Subarea A, including the North Portland Harbor bridge. Figure 1-8 illustrates the one auxiliary lane design option; please refer to Figure 1-6 and the accompanying description for how two auxiliary lanes would alter the Modified LPA's proposed design. Refer to Figure 1-3 for an overview of the geographic subareas.

Within Subarea A, the IBR Program has the potential to alter three federally authorized levee systems:

- The Oregon Slough segment of the Peninsula Drainage District Number 1 levee (PEN 1).
- The Oregon Slough segment of the Peninsula Drainage District Number 2 levee (PEN 2).
- The PEN1/PEN2 cross levee segment of the PEN 1 levee (Cross Levee).

Figure 1-8. Portland Mainland and Hayden Island (Subarea A)



LRT = light-rail transit; NB = northbound; SB = southbound; TBD = to be determined

The levee systems are shown on Figure 1-9, and intersections with Modified LPA components are described throughout Section 1.1.2, Portland Mainland and Hayden Island (Subarea A), where appropriate. Within Subarea A, the IBR Program study area intersects with PEN 1 to the west of I-5 and with PEN 2 to the east of I-5. PEN 1 and PEN 2 include a main levee along the south side of North Portland Harbor and are part of a combination of levees and floodwalls. PEN 1 and PEN 2 are separated by the Cross Levee that is intended to isolate the two districts if one of them fails. The Cross Levee is located along the I-5 mainline embankment, except in the Marine Drive interchange area where it is located on the west edge of the existing ramp from Marine Drive to southbound I-5.[3]

There are two concurrent efforts underway that are planning improvements to PEN1, PEN2, and the Cross Levee to reduce flood risk:

- The U.S. Army Corps of Engineers (USACE) Portland Metro Levee System (PMLS) project.
- The Flood Safe Columbia River (FSCR) program (also known as "Levee Ready Columbia").

The Urban Flood Safety and Water Quality District[4] is working with the USACE through the PMLS project, which includes improvements at PEN 1 and PEN 2 (e.g., raising these levees to elevation 38 feet North American Vertical Datum of 1988 [NAVD 88]).[5] Additionally, as part of the FSCR program, the Urban Flood Safety and Water Quality District is studying raising a low spot in the Cross Levee on the southwest side of the Marine Drive interchange.

The IBR Program is in close coordination with these concurrent efforts to ensure that the IBR Program's design efforts consider the timing and scope of the PMLS and the FSCR proposed modifications. The intersection of the IBR Program proposed actions to both the existing levee configuration and the anticipated future condition based on the proposed PMLS and FSCR projects are described below, where appropriate.

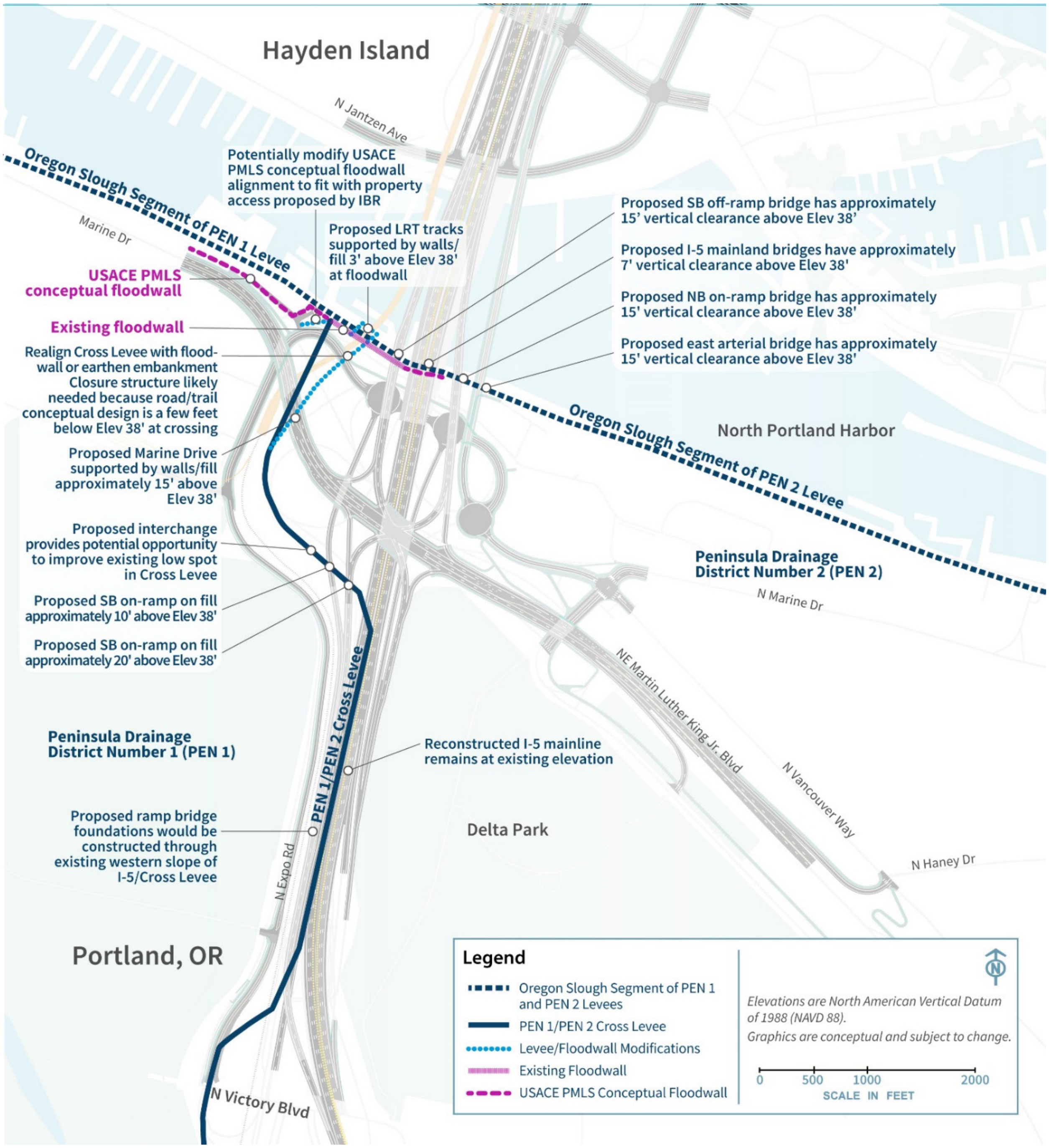
1.1.2.1 Highways, Interchanges, and Local Roadways

VICTORY BOULEVARD/INTERSTATE AVENUE INTERCHANGE AREA

The southern extent of the Modified LPA would improve two ramps at the Victory Boulevard/Interstate Avenue interchange (see Figure 1-8). The first ramp improvement would be the southbound I-5 off-ramp to Victory Boulevard/ Interstate Avenue; this off-ramp would be braided below (i.e., grade separated or pass below) the Marine Drive to the I-5 southbound on-ramp (see the Marine Drive Interchange Area section below). The other ramp improvement would lengthen the merge distance for northbound traffic entering I-5 from Victory Boulevard and from Interstate Avenue.

[3] The portion of the original Denver Avenue levee alignment within the Marine Drive interchange area is no longer considered part of the levee system by the Urban Flood Safety and Water Quality District .
[4] The Urban Flood Safety and Water Quality District includes PEN 1 and PEN 2, Urban Flood Safety and Water Quality District No. 1, and the Sandy Drainage Improvement Company.
[5] NAVD 88 is a vertical control datum (reference point) used by federal agencies for surveying.

Figure 1-9. Levee Systems in Subarea A



The existing I-5 mainline between Victory Boulevard/Interstate Avenue and Marine Drive is part of the Cross Levee (see Figure 1-9). The Modified LPA would require some pavement reconstruction of the mainline in this area; however, the improvements would mostly consist of pavement overlay and the profile and footprint would be similar to existing conditions.

MARINE DRIVE INTERCHANGE AREA

The next interchange north of the Victory Boulevard/Interstate Avenue interchange is at Marine Drive. All movements within this interchange would be reconfigured to reduce congestion for motorists entering and exiting I-5. The new configuration would be a single-point urban interchange. The new interchange would be centered over I-5 versus on the west side under existing conditions. See Figure 1-8 for the Marine Drive interchange's layout and construction footprint.

The Marine Drive to I-5 southbound on-ramp would be braided over I-5 southbound to the Victory Boulevard/Interstate Avenue off-ramp. Martin Luther King Jr. Boulevard would have a new more direct connection to I-5 northbound.

The new interchange configuration would change the westbound Marine Drive and westbound Vancouver Way connections to Martin Luther King Jr. Boulevard. An improved connection farther east of the interchange (near Haney Street) would provide access to westbound Martin Luther King Jr. Boulevard for these two streets. For eastbound travelers on Martin Luther King Jr. Boulevard exiting to Union Court, the existing loop connection would be replaced with a new connection farther east (near the access to the East Delta Park Owens Sports Complex).

Expo Road from Victory Boulevard to the Expo Center would be reconstructed with improved active transportation facilities. North of the Expo Center, Expo Road would be extended under Marine Drive and continue under I-5 to the east, connecting with Marine Drive and Vancouver Way through three new connected roundabouts. The westernmost roundabout would connect the new local street extension to I-5 southbound. The middle roundabout would connect the I-5 northbound off-ramp to the local street extension. The easternmost roundabout would connect the new local street extension to an arterial bridge crossing North Portland Harbor to Hayden Island. This roundabout would also connect the local street extension to Marine Drive and Vancouver Way.

To access Hayden Island using the arterial bridge from the east on Martin Luther King Jr. Boulevard, motorists would exit Martin Luther King Jr. Boulevard at the existing off-ramp to Vancouver Way just west of the Walker Street overpass. Then motorists would travel west on Vancouver Way, through the intersection with Marine Drive and straight through the roundabout to the arterial bridge.

From Hayden Island, motorists traveling south to Portland via Martin Luther King Jr. Boulevard would turn onto the arterial bridge southbound and travel straight through the roundabout onto Vancouver Way. At the intersection of Vancouver Way and Marine Drive, motorists would turn right onto Union Court and follow the existing road southeast to the existing on-ramp onto Martin Luther King Jr. Boulevard.

The conceptual floodwall alignment from the proposed USACE PMLS project is located on the north side of Marine Drive, near two industrial properties, with three proposed closure structures[6] for property access. The Modified LPA would realign Marine Drive to the south and provide access to the two industrial properties via the new local road extension from Expo Road. Therefore, the change in access for the two industrial properties could require small modifications to the floodwall alignment (a potential shift of 5 to 10 feet to the south) and closure structure locations.

Marine Drive and the two southbound on-ramps would travel over the Cross Levee approximately 10 to 20 feet above the proposed elevation of the improved levee, and they would be supported by fill and retaining walls near an existing low spot in the Cross Levee.

The I-5 southbound on-ramp from Marine Drive would continue on a new bridge structure. Although the bridge's foundation locations have not been determined yet, they would be constructed through the western slope of the Cross Levee (between the existing I-5 mainline and the existing light-rail).

NORTH PORTLAND HARBOR BRIDGES

To the north of the Marine Drive interchange is the Hayden Island interchange area, which is shown in Figure 1-8. I-5 crosses over the North Portland Harbor when traveling between these two interchanges. The Modified LPA proposes to replace the existing I-5 bridge spanning North Portland Harbor to improve seismic resiliency.

Six new parallel bridges would be built across the waterway under the Modified LPA: one on the east side of the existing I-5 North Portland Harbor bridge and five on the west side or overlapping the location of the existing bridge (which would be removed). From west to east, these bridges would carry:

- The LRT tracks.
- The southbound I-5 off-ramp to Marine Drive.
- The southbound I-5 mainline.
- The northbound I-5 mainline.
- The northbound I-5 on-ramp from Marine Drive.
- An arterial bridge between the Portland mainland and Hayden Island for local traffic; this bridge would also include a shared-use path for pedestrians and bicyclists.

Each of the six replacement North Portland Harbor bridges would be supported on foundations constructed of 10-foot-diameter drilled shafts. Concrete columns would rise from the drilled shafts and connect to the superstructures of the bridges. All new structures would have at least as much vertical navigation clearance over North Portland Harbor as the existing North Portland Harbor bridge.

Compared to the existing bridge, the two new I-5 mainline bridges would have a similar vertical clearance of approximately 7 feet above the proposed height of the improved levees (elevation 38 feet

[6] Levee closure structures are put in place at openings along the embankment/floodwall to provide flood protection during high water conditions.

NAVD 88). The two ramp bridges and the arterial bridge would have approximately 15 feet of vertical clearance above the proposed height of the levees. The foundation locations for the five roadway bridges have not been determined at this stage of design, but some foundations could be constructed through landward or riverward levee slopes.

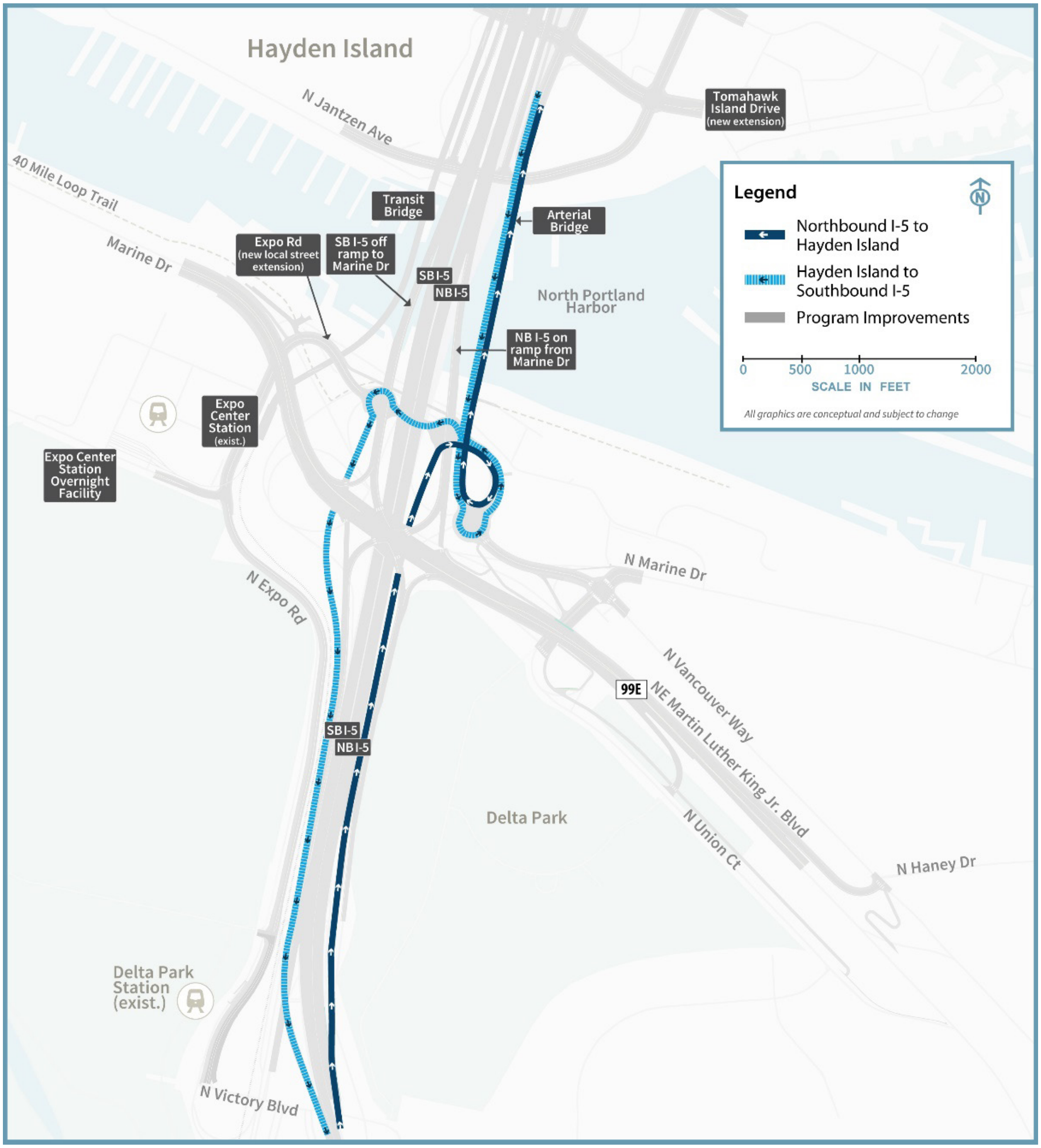
HAYDEN ISLAND INTERCHANGE AREA

All traffic movements for the Hayden Island interchange would be reconfigured. See Figure 1-8 for a layout and construction footprint of the Hayden Island interchange. A half-diamond interchange would be built on Hayden Island with a northbound I-5 on-ramp from Jantzen Drive and a southbound I-5 off-ramp to Jantzen Drive. This would lengthen the ramps and improve merging/diverging speeds compared to the existing substandard ramps that require acceleration and deceleration in a short distance. The I-5 mainline would be partially elevated and partially located on fill across the island.

There would not be a southbound I-5 on-ramp or northbound I-5 off-ramp on Hayden Island. Connections to Hayden Island for those movements would be via the local access (i.e., arterial) bridge connecting North Portland to Hayden Island (Figure 1-10). Vehicles traveling northbound on I-5 wanting to access Hayden Island would exit with traffic going to the Marine Drive interchange, cross under Martin Luther King Jr. Boulevard to the new roundabout at the Expo Road local street extension, travel east through this roundabout to the easternmost roundabout, and use the arterial bridge to cross North Portland Harbor. Vehicles on Hayden Island looking to enter I-5 southbound would use the arterial bridge to cross North Portland Harbor, cross under I-5 using the new Expo Road local street extension to the westernmost roundabout, cross under Marine Drive, merge with the Marine Drive southbound on-ramp, and merge with I-5 southbound south of Victory Boulevard.

Improvements to Jantzen Avenue may include additional left-turn and right-turn lanes at the interchange ramp terminals and active transportation facilities. Improvements to Hayden Island Drive would include new connections to the new arterial bridge over North Portland Harbor. The existing I-5 northbound and southbound access points from Hayden Island Drive would also be removed. A new extension of Tomahawk Island Drive would travel east-west through the middle of Hayden Island and under the I-5 interchange, thus improving connectivity across I-5 on the island.

Figure 1-10. Vehicle Circulation between Hayden Island and the Portland Mainland



NB = northbound; SB = southbound

1.1.2.2 Transit

A new light-rail alignment for northbound and southbound trains would be constructed within Subarea A (see Figure 1-8) to extend from the existing Expo Center MAX Station over North Portland Harbor to a new station at Hayden Island. An overnight LRV facility would be constructed on the southeast corner of the Expo Center property (see Figure 1-8) to provide storage for trains during hours when MAX is not in service. This facility is described in Section 1.1.6, Transit Support Facilities. The existing Expo Center MAX Station would be modified to remove the westernmost track and platform. Other platform modifications, including track realignment and regrading the station, are anticipated to transition to the extension alignment. This may require reconstruction of the operator break facility, signal/communication buildings, and traction power substations. Immediately north of the Expo Center MAX Station, the alignment would curve east toward I-5, pass beneath Marine Drive, cross the proposed Expo Road local street extension and the 40-Mile Loop Trail at grade, then rise over the existing levee onto a light-rail bridge to cross North Portland Harbor. On Hayden Island, proposed transit components include northbound and southbound LRT tracks over Hayden Island; the tracks would be elevated at approximately the height of the new I-5 mainline. An elevated LRT station would also be built on the island immediately west of I-5. The light-rail alignment would extend north on Hayden Island along the western edge of I-5 before transitioning onto the lower level of the new double-deck western bridge over the Columbia River (see Figure 1-8). For the single-level configurations, the light-rail alignment would extend to the outer edge of the western bridge over the Columbia River.

After crossing the new local road extension from Expo Road, the new light-rail track would cross over the main levee (see Figure 1-9). The light-rail profile is anticipated to be approximately 3 feet above the improved levees at the existing floodwall (and improved floodwall), and the tracks would be constructed on fill supported by retaining walls above the floodwall. North of the floodwall, the light-rail tracks would continue onto the new light-rail bridge over North Portland Harbor (as described above).

The Modified LPA's light-rail extension would be close to or would cross the north end of the Cross Levee. The IBR Program would realign the Cross Levee to the east of the light-rail alignment to avoid the need for a closure structure on the light-rail alignment. This realigned Cross Levee would cross the new local road extension. A closure structure may be required because the current proposed roadway is a few feet lower than the proposed elevation of the improved levee.

1.1.2.3 Active Transportation

In the Victory Boulevard interchange area (see Figure 1-8), active transportation facilities would be provided along Expo Road between Victory Boulevard and the Expo Center; this would provide a direct connection between the Victory Boulevard and Marine Drive interchange areas, as well as links to the Delta Park and Expo Center MAX Stations.

New shared-use path connections throughout the Marine Drive interchange area would provide access between the Bridgeton neighborhood (on the east side of I-5), Hayden Island, and the Expo Center MAX Station. There would also be connections to the existing portions of the 40-Mile Loop Trail, which runs north of Marine Drive under I-5 through the interchange area. The path would continue along the extension of Expo Road under the interchange to the intersection of Marine Drive and Vancouver Way, where it would connect under Martin Luther King Jr. Boulevard to Delta Park.

East of the Marine Drive interchange, new shared-use paths on Martin Luther King Jr. Boulevard and on the parallel street, Union Court, would connect travelers to Marine Drive and across the arterial bridge to Hayden Island. The shared-use facilities on Martin Luther King Jr. Boulevard would provide westbound and eastbound cyclists and pedestrians with off-street crossings of the interchange and would also provide connections to both the Expo Center MAX Station and the 40-Mile Loop Trail to the west.

The new arterial bridge over North Portland Harbor would include a shared-use path for pedestrians and bicyclists (see Figure 1-8). On Hayden Island, pedestrian and bicycle facilities would be provided on Jantzen Avenue, Hayden Island Drive, and Tomahawk Island Drive. The shared-use path on the arterial bridge would continue along the arterial bridge to the south side of Tomahawk Island Drive. A parallel, elevated path from the arterial bridge would continue adjacent to I-5 across Hayden Island and cross above Tomahawk Island Drive and Hayden Island Drive to connect to the lower level of the new double-deck eastern bridge or the outer edge of the new single-level eastern bridge over the Columbia River. A ramp down to the north side of Hayden Island Drive would be provided from the elevated path.

1.1.3 Columbia River Bridges (Subarea B)

This section discusses the geographic Subarea B shown in Figure 1-3. See Figure 1-11 for highway and interchange improvements in Subarea B. Refer to Figure 1-3 for an overview of the geographic subareas.

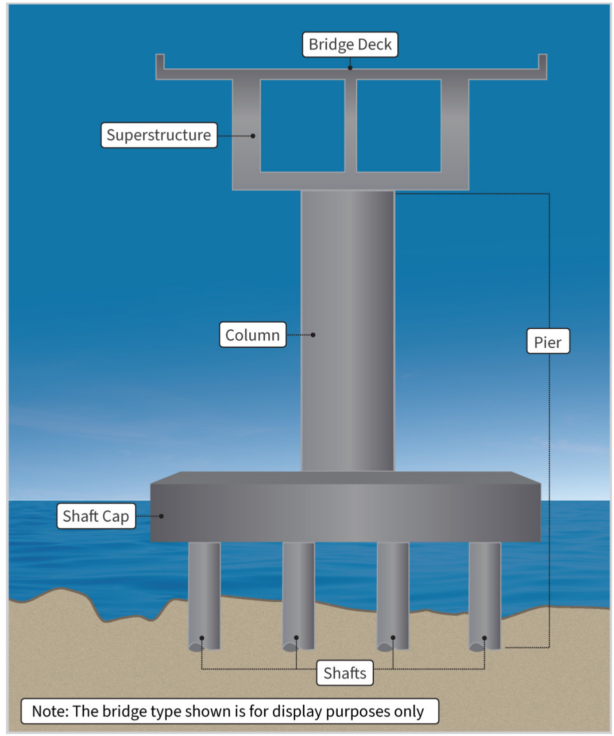
1.1.3.1 Highways, Interchanges, and Local Roadways

The two existing parallel I-5 bridges that cross the Columbia River would be replaced by two new parallel bridges, located west of the existing bridges (see Figure 1-11). The new eastern bridge would accommodate northbound highway traffic and a shared-use path. The new western bridge would carry southbound traffic and two-way light-rail tracks. Whereas the existing bridges each have three lanes with no shoulders, each of the two new bridges would be wide enough to accommodate three through lanes, one or two auxiliary lanes, and shoulders on both sides of the highway. Lanes and shoulders would be built to full design standards.

Figure 1-11. Columbia River Bridges (Subarea B)

As with the existing bridge (Figure 1-13), the new Columbia River bridges would provide three navigation channels: a primary navigation channel and two barge channels (see Figure 1-14). The current location of the primary navigation channel is near the Vancouver shoreline where the existing lift spans are located. Under the Modified LPA, the primary navigation channel would be shifted south approximately 500 feet (measured by channel centerlines), and the existing center barge channel would shift north and become the north barge channel. The new primary navigation channel would be 400 feet wide (this width includes a 300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side of the authorized channel) and the two barge channels would also each be 400 feet wide.

Figure 1-12. Bridge Foundation Concept



The existing Interstate Bridge has nine in-water pier sets,[7] whereas the new Columbia River bridges (any bridge configuration) would be built on six in-water pier sets, plus multiple piers on land (pier locations are shown on Figure 1-14). Each in-water pier set would be supported by a foundation of drilled shafts; each group of shafts would be tied together with a concrete shaft cap. Columns or pier walls would rise from the shaft caps and connect to the superstructures of the bridges (see Figure 1-12).

BRIDGE CONFIGURATIONS

Three bridge configurations are being considered: (1) double-deck fixed-span (with one bridge type), (2) a single-level fixed-span (with three potential bridge types), and (3) a single-level movable-span (with one bridge type). Both the double-deck and single-level fixed-span configurations would provide 116 feet of vertical navigation clearance at their respective highest spans; the same as the CRC LPA. The CRC LPA included a double-deck fixed-span bridge configuration. The single-level fixed-span configuration was developed and is being considered as part of the IBR Program in response to physical and contextual changes (i.e., design and operational considerations) since 2013 that necessitated examination of a refinement in the double-deck bridge configuration (e.g., ingress and egress of transit from the lower level of the double-deck fixed-span configuration on the north end of the southbound bridge).

[7] A pier set consists of the pier supporting the northbound bridge and the pier supporting the southbound bridge at a given location.

Figure 1-13. Existing Navigation Clearances of the Interstate Bridge

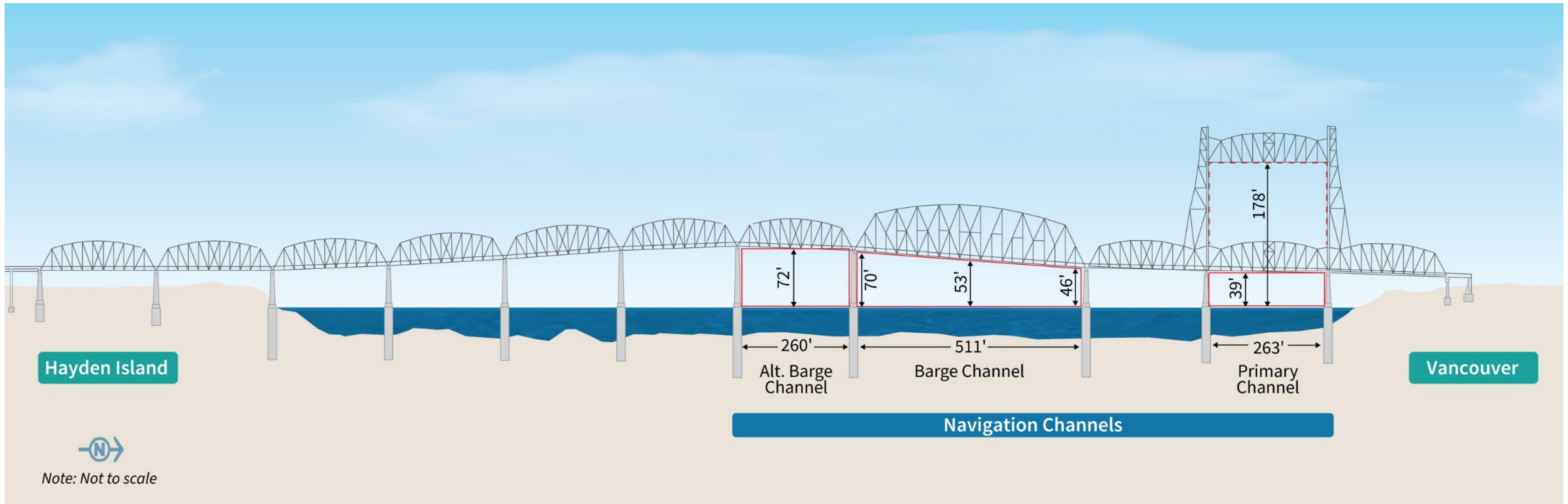
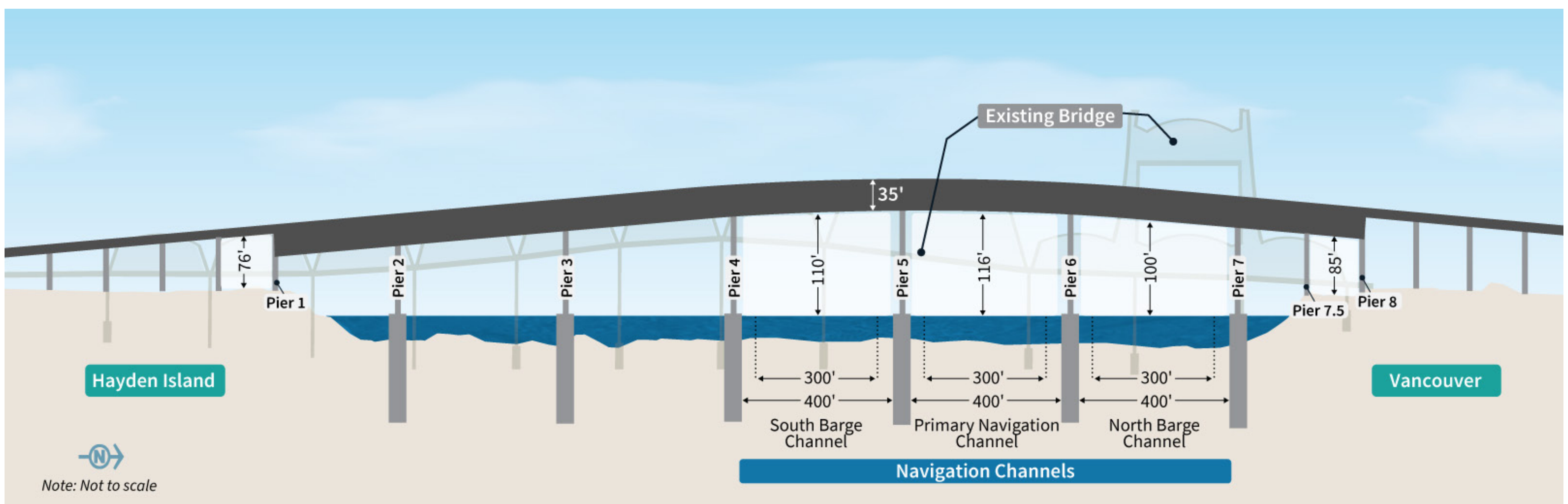


Figure 1-14. Profile and Navigation Clearances of the Proposed Modified LPA Columbia River Bridges with a Double-Deck Fixed-Span Configuration



Note: The location and widths of the proposed navigation channels would be same for all bridge configuration and bridge type options. The three navigation channels would each be 400 feet wide (this width includes a 300-foot congressionally or USACE-authorized channel (shown in dotted lines) plus a 50-foot channel maintenance buffer on each side of the authorized channel). The vertical navigation clearance would vary.

Consideration of the single-level movable-span configuration as part the IBR Program was necessitated by the U.S. Coast Guard's (USCG) review of the Program's navigation impacts on the Columbia River and issuance of a Preliminary Navigation Clearance Determination (PNCD) (USCG 2022). The USCG PNCD set the preliminary vertical navigation clearance recommended for the issuance of a bridge permit at 178 feet; this is the current vertical navigation clearance of the Interstate Bridge.

The IBR Program is carrying forward the three bridge configurations to address changed conditions, including changes in the USCG bridge permitting process, in order to ensure a permittable bridge configuration is within the range of options considered. The IBR Program continues to refine the details supporting navigation impacts and is coordinating closely with the USCG to determine how a fixed-span bridge may be permittable. Although the fixed-span configurations do not comply with the current USCG PNCD, they do meet the Purpose and Need and provide potential improvements to traffic (passenger vehicle and freight), transit, and active transportation operations.

Each of the bridge configurations assumes one auxiliary lane; two auxiliary lanes could be applied to any of the bridge configurations. All typical sections for the one auxiliary lane option would provide 14-foot shoulders to maintain traffic during construction of the Modified LPA and future maintenance.

Double-Deck Fixed-Span Configuration

The double-deck fixed-span configuration would be two side-by-side, double-deck, fixed-span steel truss bridges. Figure 1-15 is an example of this configuration (this image is subject to change and is shown as a representative concept; it does not depict the final design). The double-deck fixed-span configuration would provide 116 feet of vertical navigation clearance for river traffic using the primary navigation channel and 400 feet of horizontal navigation clearance at the primary navigation channel, as well as barge channels. This bridge height would not impede takeoffs and landings by aircraft using Pearson Field or Portland International Airport.

The eastern bridge would accommodate northbound highway traffic on the upper level and the shared-use path and utilities on the lower level. The western bridge would carry southbound traffic on the upper level and two-way light-rail tracks on the lower level. Each bridge deck would be 79 feet wide, with a total out-to-out width of 173 feet.[8]

[8] "Out-to-out width" is the measurement between the outside edges of the bridge across its width at the widest point.

Figure 1-15. Conceptual Drawing of a Double-Deck Fixed-Span Configuration

Note: Visualization is looking southwest from Vancouver.

Figure 1-16 is a cross section of the two parallel double-deck bridges. Like all bridge configurations, the double-deck fixed-span configuration would have six in-water pier sets. Each pier set would require 12 in-water drilled shafts, for a total of 72 in-water drilled shafts. Each individual shaft cap would be approximately 50 feet by 85 feet. This bridge configuration would have a 3.8% maximum grade on the Oregon side of the bridge and a 4% maximum grade on the Washington side.

Single-Level Fixed-Span Configuration

The single-level fixed-span configuration would have two side-by-side, single-level, fixed-span steel or concrete bridges. This report considers three single-level fixed-span bridge type options: a girder bridge, an extradosed bridge, and a finback bridge. The description in this section applies to all three bridge types (unless otherwise indicated). Conceptual examples of each of these options are shown on Figure 1-17. These images are subject to change and do not represent final design.

This configuration would provide 116 feet of vertical navigation clearance for river traffic using the primary navigation channel and 400 feet of horizontal navigation clearance at the primary navigation channel, as well as barge channels. This bridge height would not impede takeoffs and landings by aircraft using Pearson Field or Portland International Airport.

The eastern bridge would accommodate northbound highway traffic and the shared-use path; the bridge deck would be 104 feet wide. The western bridge would carry southbound traffic and two-way light-rail tracks; the bridge deck would be 113 feet wide. The I-5 highway, light-rail tracks, and the shared-use path would be on the same level across the two bridges, instead of being divided between two levels with the double-deck configuration. The total out-to-out width of the single-level fixed-span configuration (extradosed or finback options) would be 272 feet at its widest point, approximately 99 feet wider than the double-deck configuration. The total out-to-out width of the single-level fixed-span configuration (girder option) would be 232 feet at its widest point. Figure 1-18 shows a typical cross section of the single-level configuration. This cross section is a representative example of an extradosed or finback bridge as shown by the 10-foot-wide superstructure above the bridge deck; the girder bridge would not have the 10-foot-wide bridge columns shown on Figure 1-18.

Figure 1-16. Cross Section of the Double-Deck Fixed-Span Configuration

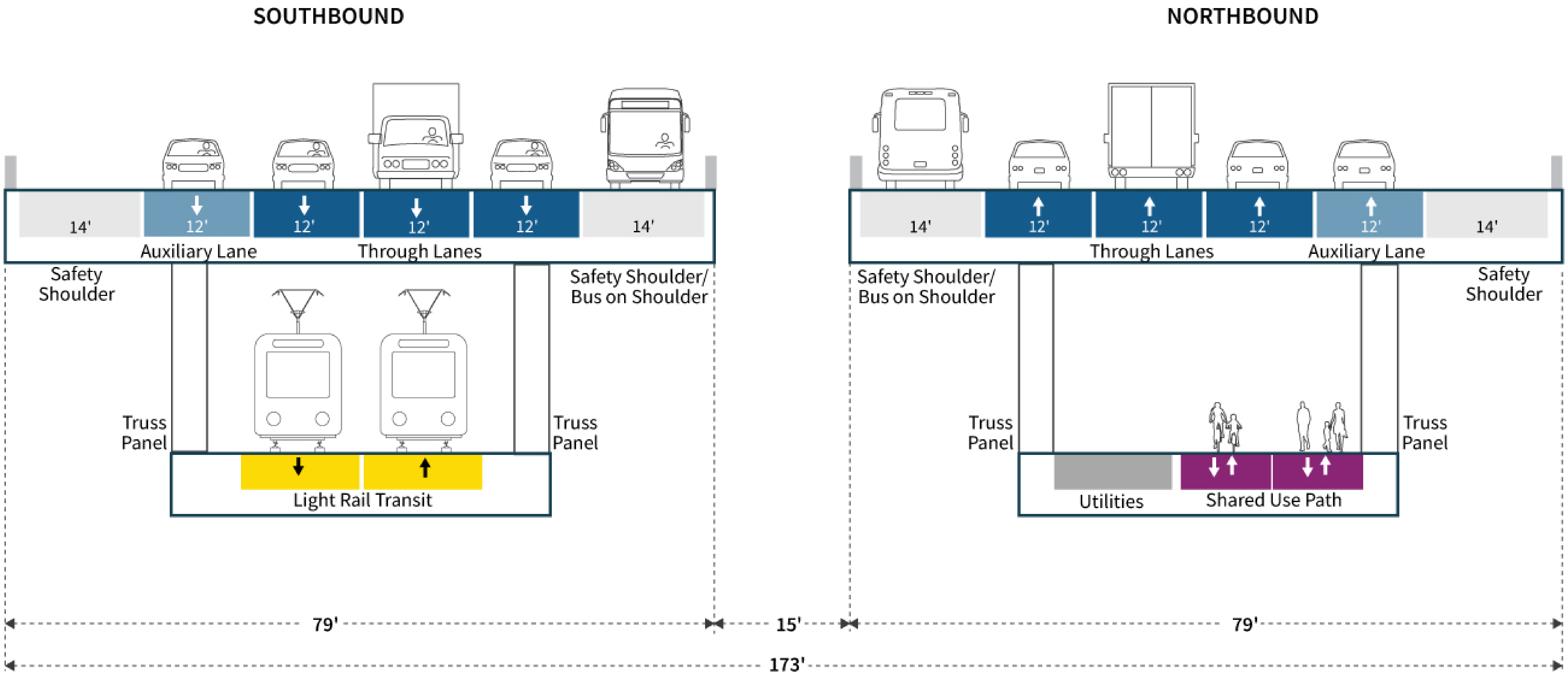
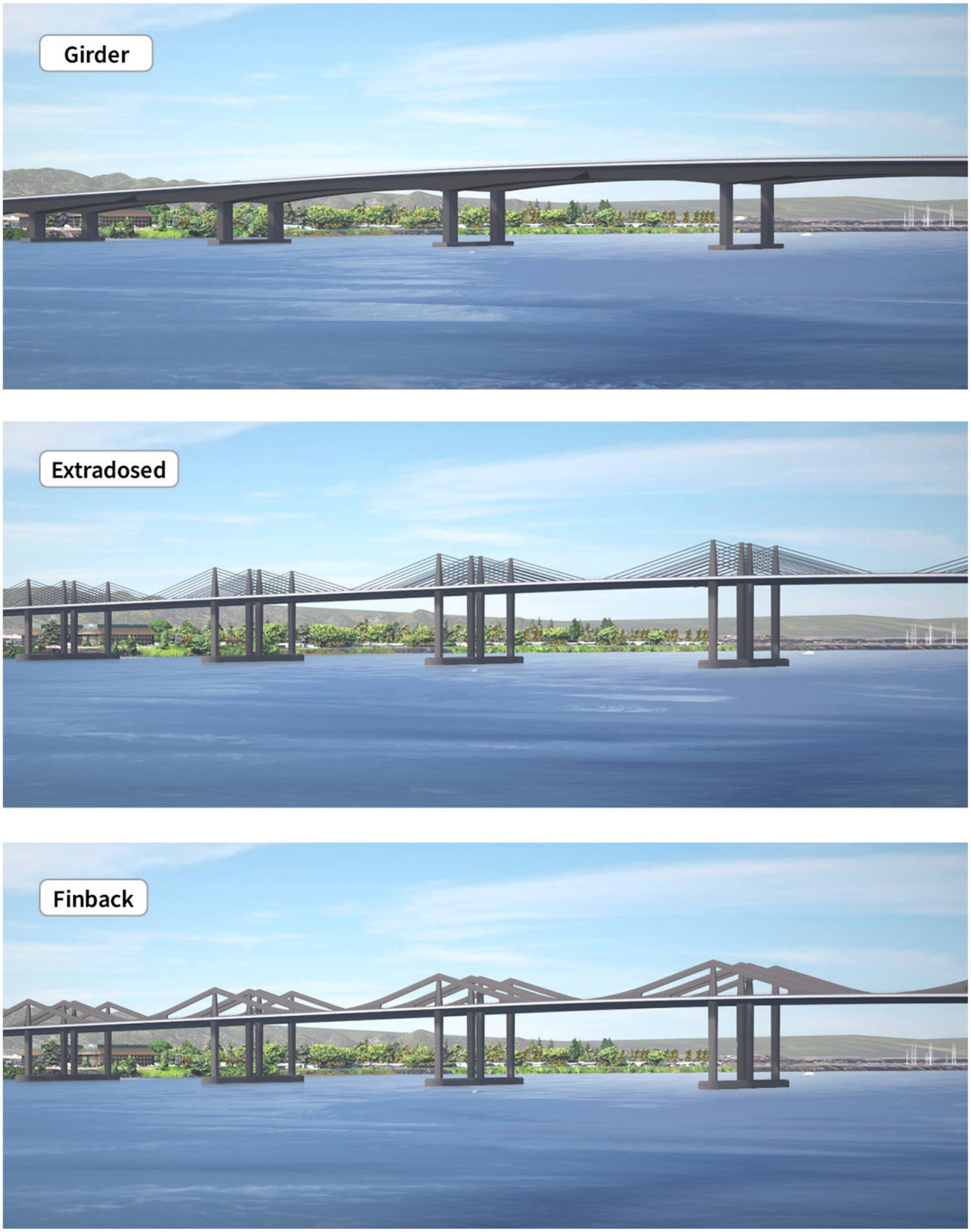
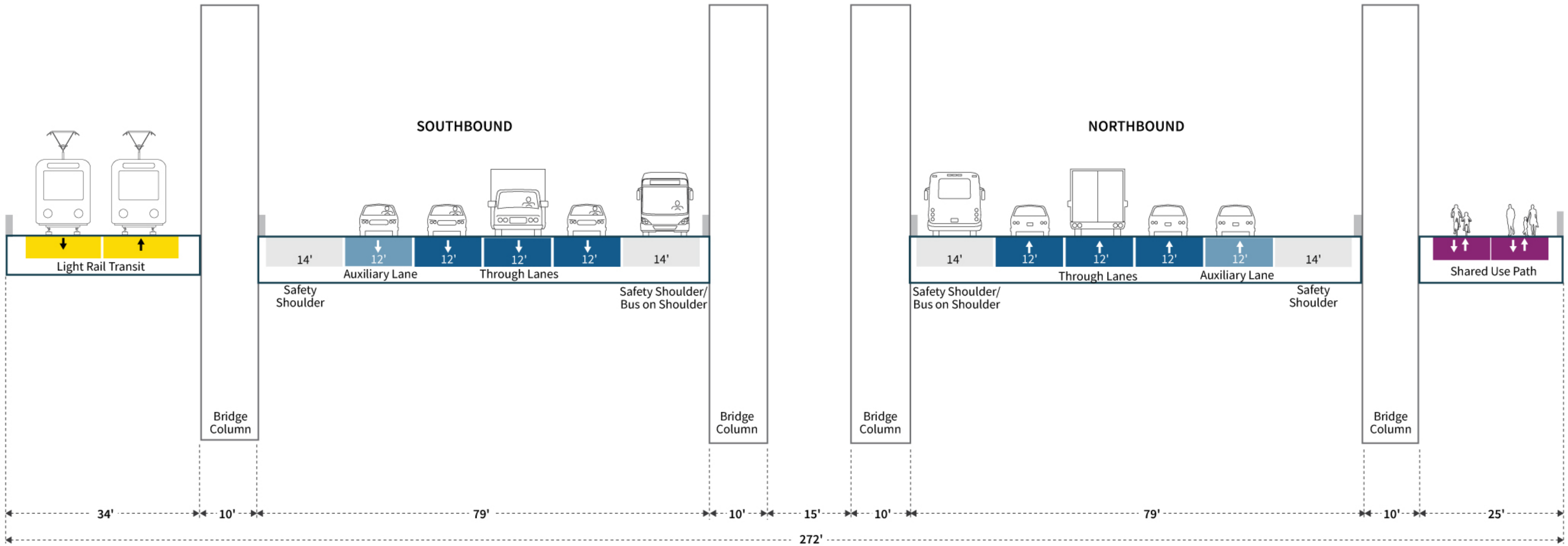


Figure 1-17. Conceptual Drawings of Single-Level Fixed-Span Bridge Types



Note: Visualizations are for illustrative purposes only. They do not reflect property impacts or represent final design. Visualization is looking southwest from Vancouver.

Figure 1-18. Cross Section of the Single-Level Fixed-Span Configuration (Extradosed or Finback Bridge Types)



Note: The cross section for a girder type bridge would be the same except that it would not have the four 10-foot bridge columns making the total out-to-out width 232 feet.

There would be six in-water pier sets with 16 in-water drilled shafts on each combined shaft cap, for a total of 96 in-water drilled shafts. The combined shaft caps for each pier set would be 50 feet by 230 feet.

This bridge configuration would have a 3% maximum grade on both the Oregon and Washington sides of the bridge.

Single-Level Movable-Span Configuration

The single-level movable-span configuration would have two side-by-side, single-level steel girder bridges with movable spans between Piers 5 and 6. For the purpose of this report, the IBR Program assessed a vertical-lift movable-span configuration with counterweights based on the analysis in the *River Crossing Bridge Clearance Assessment Report – Movable-Span Options,* included as part of Attachment C in Appendix D, Design Options Development, Screening, and Evaluation Technical Report. A conceptual example of a vertical lift-span bridge is shown in Figure 1-19. These images are subject to change and do not represent final design.

A movable span must be located on a straight and flat bridge section (i.e., without curvature and with minimal slope). To comply with these requirements, and for the bridge to maintain the highway, transit, and active transportation connections on Hayden Island and in Vancouver while minimizing property acquisitions and displacements, the movable span is proposed to be located 500 feet south of the existing lift span, between Piers 5 and 6. To accommodate this location of the movable span, the IBR Program is coordinating with USACE to obtain authorization to change the location of the primary navigation channel, which currently aligns with the Interstate Bridge lift spans near the Washington shoreline.

The single-level movable-span configuration would provide 92 feet of vertical navigation clearance over the proposed relocated primary navigation channel when the movable spans are in the closed position, with 99 feet of vertical navigation clearance available over the north barge channel. The 92-foot vertical clearance is based on achieving a straight, movable span and maintaining an acceptable grade for transit operations. In addition, it satisfies the requirement of a minimum of 72 feet of vertical navigation clearance (the existing Interstate Bridge's maximum clearance over the alternate (southernmost) barge channel when the existing lift span is in the closed position).

In the open position, the movable span would provide 178 feet of vertical navigation clearance over the proposed relocated primary navigation channel.

Similar to the fixed-span configurations, the movable span would provide 400 feet of horizontal navigation clearance for the primary navigation channel and for each of the two barge channels.

The vertical lift-span towers would be approximately 243 feet high; this is shorter than the existing lift-span towers, which are 247 feet high. This height of the vertical lift-span towers would not impede takeoffs and landings by aircraft using Portland International Airport. At Pearson Field, the Federal Aviation Administration issues obstacle departure procedures to avoid the existing Interstate Bridge lift towers; the single-level movable-span configuration would retain the same procedures.

Similar to the single-level fixed-span configuration, the eastern bridge would accommodate northbound highway traffic and the shared-use path, and the western bridge would carry southbound traffic and two-way light-rail tracks. The I-5 highway, light-rail tracks, and shared-use path would be on the same level across the bridges instead of on two levels as with the double-deck configuration. Cross sections of the single-level movable-span configuration are shown in Figure 1-20; the top cross section depicts the vertical lift spans (Piers 5 and 6), and the bottom cross section depicts the fixed spans (Piers 2, 3, 4, and 7). The movable and fixed cross sections are slightly different because the movable span requires lift towers, which are not required for the other fixed spans of the bridges.

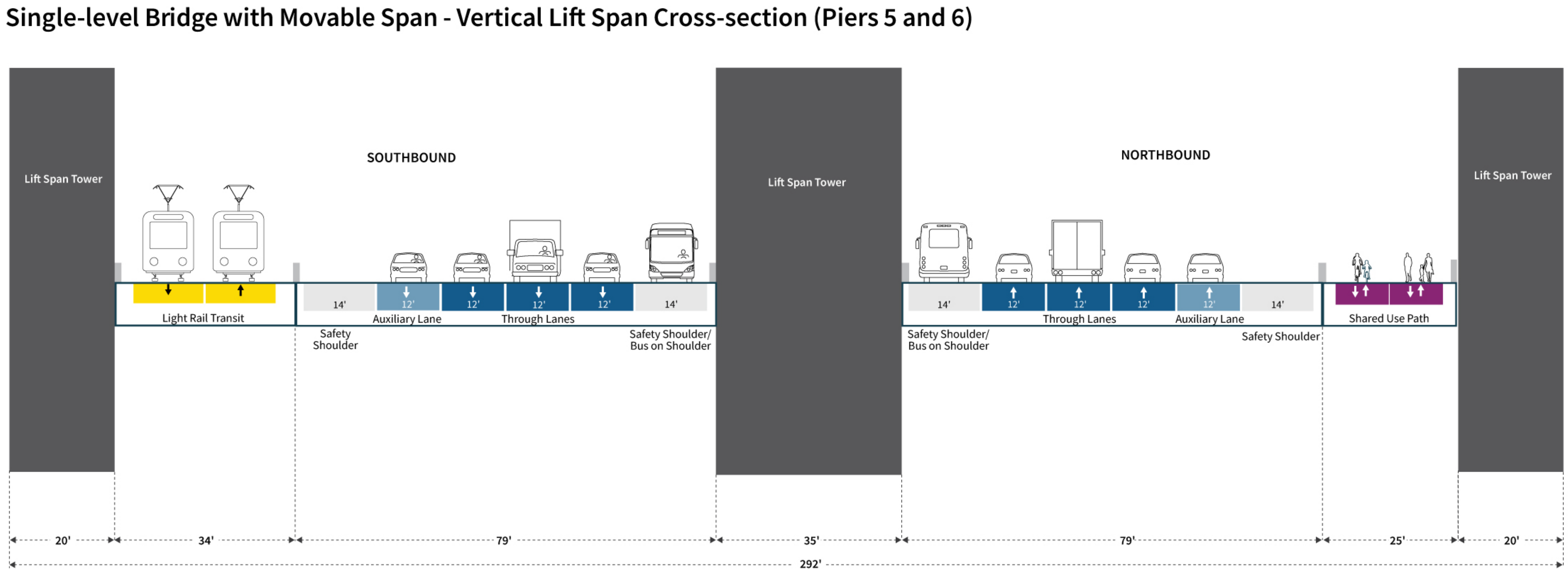
There would be six in-water pier sets and two piers on land per bridge. The vertical lift span would have 22 in-water drilled shafts each for Piers 5 and 6; the shaft caps for these piers would be 50 feet by 312 feet to accommodate the vertical lift spans. Piers 2, 3, 4, and 7 would have 16 in-water drilled shafts each; the shaft caps for these piers would be the same as for the fixed-span options (50 feet by 230 feet). The vertical lift-span configuration would have a total of 108 in-water drilled shafts.

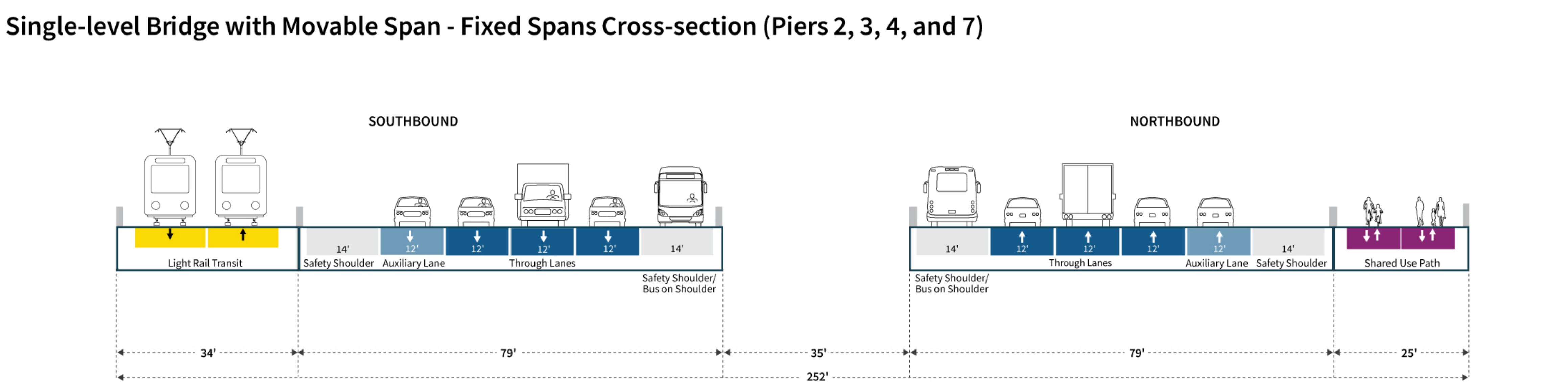
This single-level movable-span configuration would have a 3% maximum grade on the Oregon side of the bridge and a 1.5% maximum grade on the Washington side.

Figure 1-19. Conceptual Drawings of Single-Level Movable-Span Configurations in the Closed and Open Positions

Note: Visualizations are for illustrative purposes only. They do not reflect property impacts or represent final design. Visualization is looking southeast (upstream) from Vancouver.

Figure 1-20. Cross Section of the Single-Level Movable-Span Bridge Type





Summary of Bridge Configurations

This section summarizes and compares each of the bridge configurations. Table 1-2 lists the key considerations for each configuration. Figure 1-21 compares each configuration's footprint. The footprints of each configuration would differ in only three locations: over the Columbia River and at the bridge landings on Hayden Island and Vancouver. The rest of the I-5 corridor would have the same footprint. Over the Columbia River, the footprint of the double-deck fixed-span configuration would be 173 feet wide. Comparatively, the finback or extradosed bridge types of the single-level fixed-span configuration would be 272 feet wide (approximately 99 feet wider), and the single-level fixed-span configuration with a girder bridge type would be 232 feet wide (approximately 59 feet wider). The single-level movable-span configuration would be 252 feet wide (approximately 79 feet wider than the double-deck fixed-span configuration), except at Piers 5 and 6, where larger bridge foundations would require an additional 40 feet of width to support the movable span. The single-level configurations would have a wider footprint at the bridge landings on Hayden Island and Vancouver because transit and active transportation would be located adjacent to the highway, rather than below the highway in the double-deck option.

Figure 1-22 compares the basic profile of each configuration. The lower deck of the double-deck fixed-span and the single-level fixed-span configuration would have similar profiles. The single-level movable-span configuration would have a lower profile than the fixed-span configurations when the span is in the closed position.

Figure 1-21. Bridge Configuration Footprint Comparison

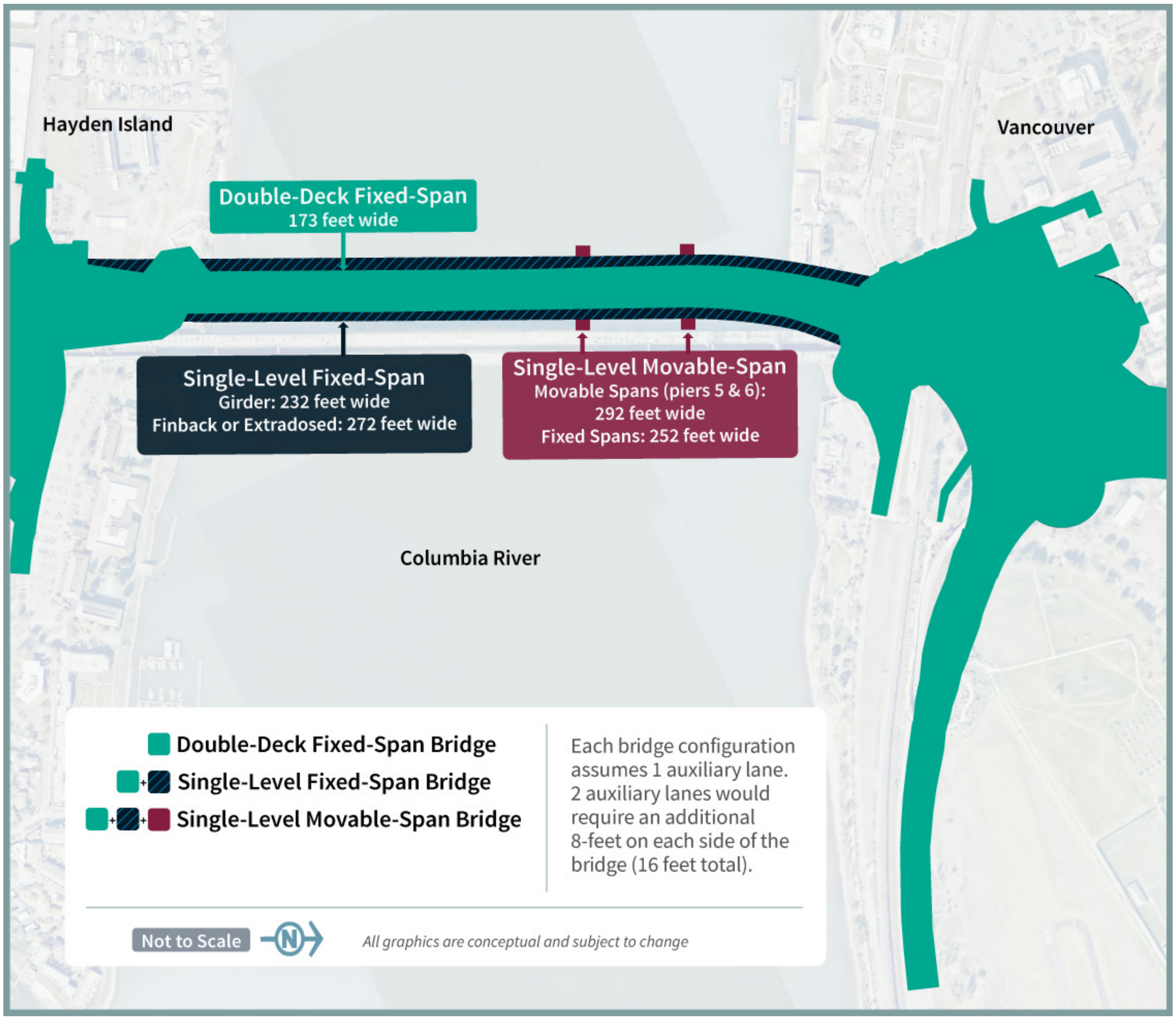
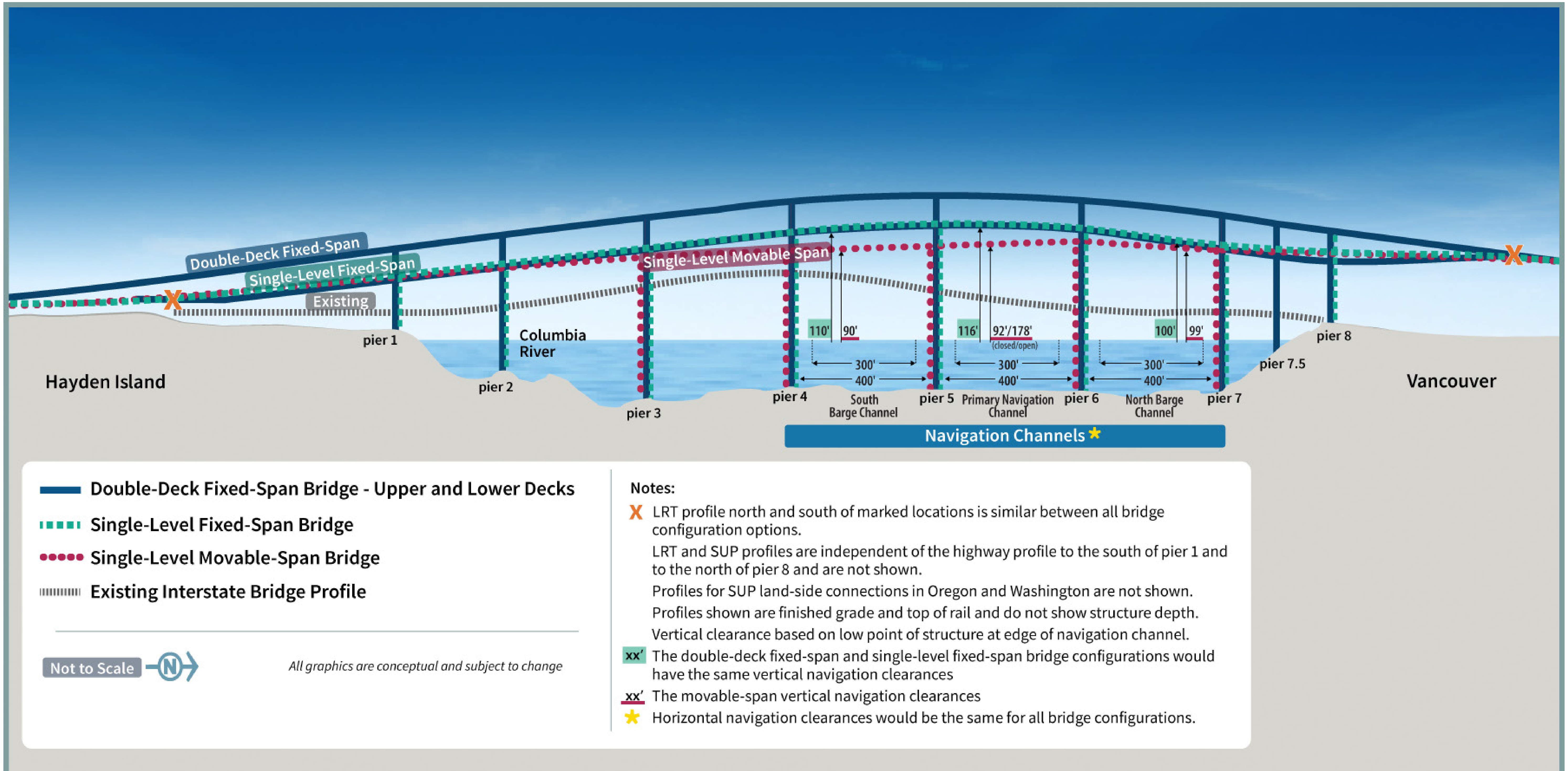


Figure 1-22. Bridge Configuration Profile Comparison



LRT = light-rail transit; SUP = shared-use path

Table 1-2. Summary of Bridge Configurations

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Bridge type	Steel through-truss spans.	Double-deck steel truss.	Single-level, concrete or steel girders, extradosed or finback.	Single-level, steel girders with vertical lift span.
Number of bridges	Two	Two	Two	Two
Movable-span type	Vertical lift span with counterweights.	N/A	N/A	Vertical lift span with counterweights.
Movable-span location	Adjacent to Vancouver shoreline.	N/A	N/A	Between Piers 5 and 6 (approximately 500 feet south of the existing lift span).
Lift opening restrictions	Weekday peak AM and PM highway travel periods. [b]	N/A	N/A	Additional restrictions to daytime bridge openings; requires future federal rulemaking process and authorization by USCG (beyond the assumed No-Build Alternative bridge restrictions for peak AM and PM highway travel periods).[b] Typical opening durations are assumed to be 9 to 18 minutes [c] for the purposes of impact analysis but would ultimately depend on various operational considerations related to vessel traffic and river and weather conditions. Additional time would also be required to stop traffic prior to opening and restart traffic after the bridge closes.
Out-to-out width [d]	138 feet total width.	173 feet total width.	Girder: 232 feet total width. Extradosed/Finback: 272 feet total width.	• 292 feet at the movable span. • 252 feet at the fixed spans.

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Deck widths	52 feet (SB) 52 feet (NB)	79 feet (SB) 79 feet (NB)	Girder: • 113 feet (SB) • 104 feet (NB) Extradosed/Finback: • 133 feet (SB) • 124 feet (NB)	113 feet SB fixed span. 104 feet NB fixed span.
Vertical navigation clearance	Primary navigation channel: • 39 feet when closed. • 178 feet when open. Barge channel: • 46 feet to 70 feet. Alternate barge channel: • 72 feet (maximum clearance without opening).	Primary navigation channel: • 116 feet maximum. North barge channel: • 100 feet maximum. South barge channel: • 110 feet maximum.	Primary navigation channel: • 116 feet maximum. North barge channel: • 100 feet maximum. South barge channel: • 110 feet maximum.	Primary navigation channel: • Closed position: 92 feet. • Open position: 178 feet. North barge channel: • 99 feet maximum. South barge channel: • 90 feet maximum.
Horizontal navigation clearance	263 feet for primary navigation channel. 511 feet for barge channel. 260 feet for alternate barge channel.	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).	400 feet for all navigation channels (300-foot congressionally or USACE-authorized channel plus a 50-foot channel maintenance buffer on each side).
Maximum elevation of bridge component (NAVD 88)[e]	247 feet at top of lift tower.	166 feet.	Girder: 137 feet. Extradosed/Finback: 179 feet at top of pylons.	243 feet at top of lift tower.

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Movable span length (from center of pier to center of pier)	278 feet.	N/A	N/A	450 feet.
Number of in-water pier sets	Nine	Six	Six	Six
Number of in-water drilled shafts	N/A	72	96	108
Shaft cap sizes	N/A	50 feet by 85 feet.	50 feet by 230 feet.	Piers 2, 3, 4, and 7: 50 feet by 230 feet. Piers 5 and 6: 50 feet by 312 feet (one combined footing at each location to house tower/equipment for the lift span).
Maximum grade	5%	4% on the Washington side. 3.8% on the Oregon side.	3% on the Washington side. 3% on the Oregon side.	1.5% on the Washington side. 3% on the Oregon side.
Light-rail transit location	N/A	Below highway on SB bridge.	West of highway on SB bridge.	West of highway on SB bridge.
Express bus	Shared roadway lanes.	Inside shoulder of NB and SB (upper) bridges.	Inside shoulder of NB and SB bridges.	Inside shoulder of NB and SB bridges.

	No-Build Alternative	Modified LPA with Double-Deck Fixed-Span Configuration	Modified LPA with Single-Level Fixed-Span Configuration [a]	Modified LPA with Single-Level Movable-Span Configuration
Shared-use path location	Sidewalk adjacent to roadway in both directions.	Below highway on NB bridge.	East of highway on NB bridge.	East of highway on NB bridge.

a When different bridge types are not mentioned, data applies to all bridge types under the specified bridge configuration.

b The No-Build Alternative assumes existing conditions that restrict bridge openings during weekday peak periods (Monday through Friday 6:30 a.m. to 9 a.m.; 2:30 p.m. to 6 p.m., excluding federal holidays). This analysis estimates the potential frequency for bridge openings for vessels requiring more than 99 feet of clearance.

c For the purposes of the transportation analysis (see the Transportation Technical Report), the movable-span opening time is assumed to be an average of 12 minutes.

d "Out-to-out width" is the measurement between the outside edges of the bridge across its width at the widest point.

e NAVD 88 (North American Vertical Datum of 1988) is a vertical control datum (reference point) used by federal agencies for surveying.

NB = northbound; SB = southbound; USCG = U.S. Coast Guard

1.1.4 Downtown Vancouver (Subarea C)

This section discusses the geographic Subarea C shown in Figure 1-3. See Figure 1-23 for all highway and interchange improvements in Subarea C. Refer to Figure 1-3 for an overview of the geographic subareas.

1.1.4.1 Highways, Interchanges, and Local Roadways

North of the Columbia River bridges in downtown Vancouver, improvements are proposed to the SR 14 interchange (Figure 1-23).

SR 14 INTERCHANGE

The new Columbia River bridges would touch down just north of the SR 14 interchange (Figure 1-23). The function of the SR 14 interchange would remain essentially the same as it is now, although the interchange would be elevated. Direct connections between I-5 and SR 14 would be rebuilt. Access to and from downtown Vancouver would be provided as it is today, but the connection points would be relocated. Downtown Vancouver I-5 access to and from the south would be at C Street as it is today, while downtown connections to and from SR 14 would be from Columbia Street at 3rd Street.

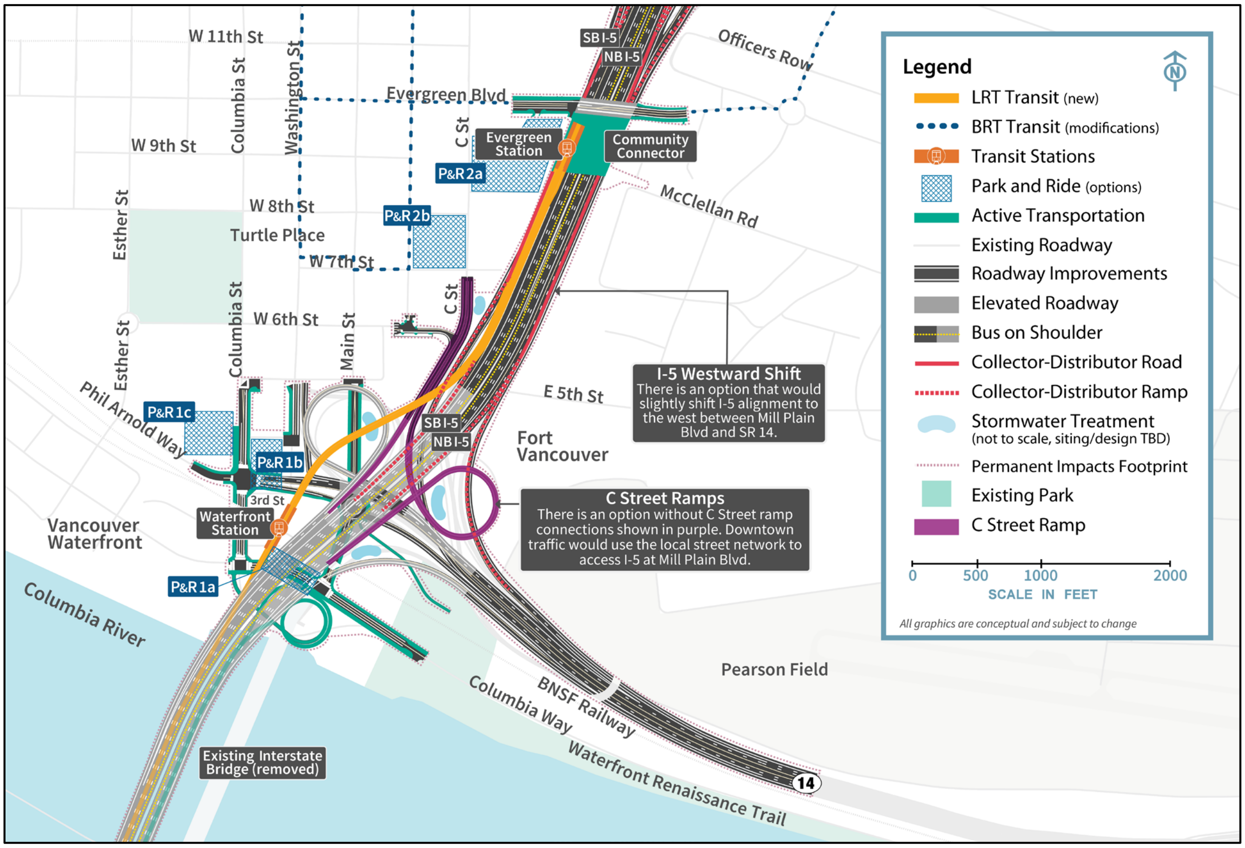
Main Street would be extended between 5th Street and Columbia Way. Vehicles traveling from downtown Vancouver to access SR 14 eastbound would use the new extension of Main Street to the roundabout underneath I-5. If coming from the west or south (waterfront) in downtown Vancouver, vehicles would use the Phil Arnold Way/3rd Street extension to the roundabout, then continue to SR 14 eastbound. The existing Columbia Way roadway under I-5 would be realigned to the north of its existing location and would intersect both the new Main Street extension and Columbia Street with T intersections.

In addition, the existing overcrossing of I-5 at Evergreen Boulevard would be reconstructed.

Design Option Without C Street Ramps

Under this design option, downtown Vancouver I-5 access to and from the south would be through the Mill Plain interchange rather than C Street. There would be no eastside loop ramp from I-5 northbound to C Street and no directional ramp on the west side of I-5 from C Street to I-5 southbound. The existing eastside loop ramp would be removed. This design option has been included because of changes in local planning that necessitate consideration of design options that reduce the footprint and associated direct and temporary environmental impacts in Vancouver.

Figure 1-23. Downtown Vancouver (Subarea C)



BRT = bus rapid transit; LRT = light-rail transit; NB = northbound; P&R = park and ride; SB = southbound

Design Option to Shift I-5 Westward

This design option would shift the I-5 mainline and ramps approximately 40 feet to the west between SR 14 and Mill Plain Boulevard. The westward I-5 alignment shift could also be paired with the design option without C Street ramps. The inclusion of this design option is due to changes in local planning, which necessitate consideration of design options that that shifts the footprint and associated direct and temporary environmental impacts in Vancouver.

1.1.4.2 Transit

LIGHT-RAIL ALIGNMENT AND STATIONS

Under the Modified LPA, the light-rail tracks would exit the highway bridge and be on their own bridge along the west side of the I-5 mainline after crossing the Columbia River (see Figure 1-23). The light-rail bridge would cross approximately 35 feet over the BNSF Railway tracks. An elevated light-rail station near the Vancouver waterfront (Waterfront Station) would be situated near the overcrossing of the BNSF tracks between Columbia Way and 3rd Street. Access to the elevated station would be primarily by elevator as the station is situated approximately 75 feet above existing ground level. A stairwell(s) would be provided for emergency egress. The number of elevators and stairwells provided would be based on the ultimate platform configuration, station location relative to the BNSF trackway, projected ridership, and fire and life safety requirements. Passenger drop-off facilities would be located at ground level and would be coordinated with the C-TRAN bus service at this location. The elevated light-rail tracks would continue north, cross over the westbound SR 14 on-ramp and the C Street/6th Street on-ramp to southbound I-5, and then straddle the southbound I-5 CD roadway. Transit components in the downtown Vancouver area are similar between the two SR 14 interchange area design options discussed above.

North of the Waterfront Station, the light-rail tracks would continue to the Evergreen Station, which would be the terminus of the light-rail extension (see Figure 1-23). The light-rail tracks from downtown Vancouver to the terminus would be entirely on an elevated structure supported by single columns, where feasible, or by columns on either side of the roadway where needed. The light-rail tracks would be a minimum of 27 feet above the I-5 roadway surface. The Evergreen Station would be located at the same elevation as Evergreen Boulevard, on the proposed Community Connector, and it would provide connections to C-TRAN's existing BRT system. Passenger drop-off facilities would be near the station and would be coordinated with the C-TRAN bus service at this location.

PARK AND RIDES

Up to two park and rides could be built in Vancouver along the light-rail alignment: one near the Waterfront Station and one near the Evergreen Station. Additional information regarding the park and rides can be found in the Transportation Technical Report.

> Park and rides can expand the catchment area of public transit systems, making transit more accessible to people who live farther away from fixed-route transit service, and attracting new riders who might not have considered using public transit otherwise.

Waterfront Station Park-and-Ride Options

There are three site options for the park and ride near the Waterfront Station (see Figure 1-23). Each would accommodate up to 570 parking spaces.

1. Columbia Way (below I-5). This park-and-ride site would be a multilevel aboveground structure located below the new Columbia River bridges, immediately north of a realigned Columbia Way.
2. Columbia Street/SR 14. This park-and-ride site would be a multilevel aboveground structure located along the east side of Columbia Street. It could span across (or over) the SR 14 westbound off-ramp to provide parking on the north and south sides of the off-ramp.
3. Columbia Street/Phil Arnold Way (Waterfront Gateway Site). This park-and-ride site would be located along the west side of Columbia Street immediately north of Phil Arnold Way. This park and ride would be developed in coordination with the City of Vancouver's Waterfront Gateway program and could be a joint-use parking facility not constructed exclusively for park-and-ride users.

Evergreen Station Park-and-Ride Options

There are two site options for the park and ride near the Evergreen Station (see Figure 1-23).

1. Library Square. This park-and-ride site would be located along the east side of C Street and south of Evergreen Boulevard. It would accommodate up to 700 parking spaces in a multilevel belowground structure according to a future agreement on City-owned property associated with Library Square. Current design concepts suggest the park and ride most likely would be a joint-use parking facility for park-and-ride users and patrons of other uses on the ground or upper levels as negotiated as part of future decisions.
2. Columbia Credit Union. This park-and-ride site is an existing multistory garage that is located below the Columbia Credit Union office tower along the west side of C Street between 7th Street and 8th Street. The existing parking structure currently serves the office tower above it and the Regal City Center across the street. This would be a joint-use parking facility, not for the exclusive use of park-and-ride users, that could serve as additional or overflow parking if the 700 required parking spaces cannot be accommodated elsewhere.

1.1.4.3 Active Transportation

Within the downtown Vancouver area, the shared-use path on the northbound (or eastern) bridge would exit the bridge at the SR 14 interchange, loop down on the east side of I-5 via a vertical spiral path, and then cross back below I-5 to the west side of I-5 to connect to the Waterfront Renaissance Trail on Columbia Street and into Columbia Way (see Figure 1-23). Access would be provided across state right of way beneath the new bridges to provide a connection between the recreational areas along the City's Columbia River waterfront east of the bridges and existing and future waterfront uses west of the bridges.

Active transportation components in the downtown Vancouver area would be similar without the C Street ramps and with the I-5 westward shift.

At Evergreen Boulevard, a Community Connector is proposed to be built over I-5 just south of Evergreen Boulevard and east of the Evergreen Station (see Figure 1-23). The structure is proposed to include off-street pathways for active transportation modes including pedestrians, bicyclists, and other micro-mobility modes, and public space and amenities to support the active transportation facilities. The primary intent of the Community Connector is to improve connections between downtown Vancouver on the west side of I-5 and the Vancouver National Historic Reserve on the east side.

1.1.5 Upper Vancouver (Subarea D)

This section discusses the geographic Subarea D shown in Figure 1-3. See Figure 1-24 for all highway and interchange improvements in Subarea D. Refer to Figure 1-3 for an overview of the geographic subareas.

1.1.5.1 Highways, Interchanges, and Local Roadways

Within the upper Vancouver area, the IBR Program proposes improvements to three interchanges—Mill Plain, Fourth Plain, and SR 500—as described below.

MILL PLAIN BOULEVARD INTERCHANGE

The Mill Plain Boulevard interchange is north of the SR 14 interchange (see Figure 1-24). This interchange would be reconstructed as a tight-diamond configuration but would otherwise remain similar in function to the existing interchange. The ramp terminal intersections would be sized to accommodate high, wide heavy freight vehicles that travel between the Port of Vancouver and I-5. The off-ramp from I-5 northbound to Mill Plain Boulevard would diverge from the CD road that would continue north, crossing over Mill Plain Boulevard, to provide access to Fourth Plain Boulevard via a CD roadway. The off-ramp to Fourth Plain Boulevard would be reconstructed and would cross over Mill Plain Boulevard east of I-5, similar to the way it functions today.

FOURTH PLAIN BOULEVARD INTERCHANGE

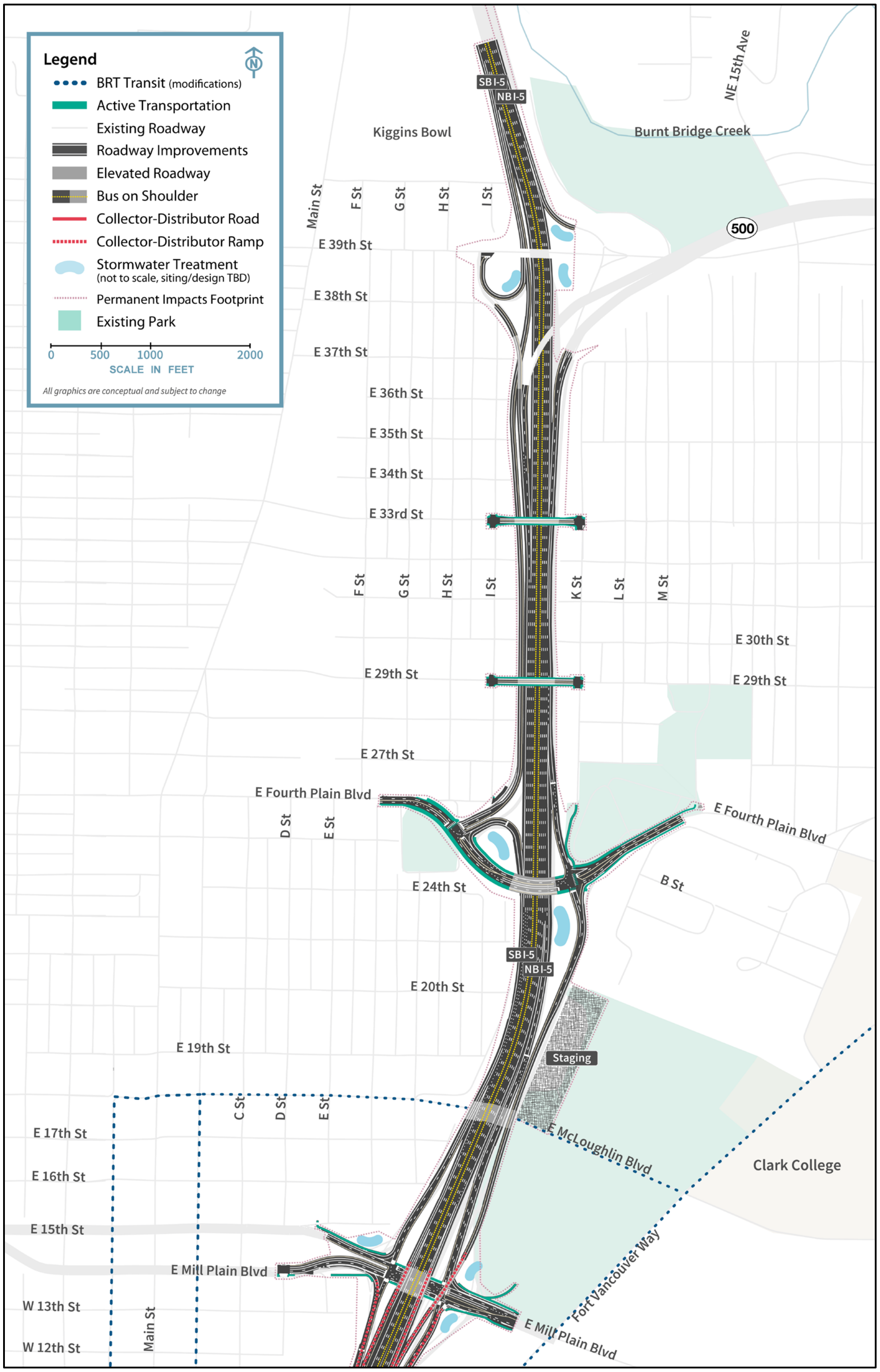
At the Fourth Plain Boulevard interchange (Figure 1-24), improvements would include reconstruction of the overpass of I-5 and the ramp terminal intersections. Northbound I-5 traffic exiting to Fourth Plain Boulevard would first exit to the northbound CD roadway which provides off-ramp access to Fourth Plain Boulevard and Mill Plain Boulevard. The westbound SR 14 to northbound I-5 on-ramp also joins the northbound CD roadway before continuing north past the Fourth Plain Boulevard and Mill Plain Boulevard off-ramps as an auxiliary lane. The southbound I-5 off-ramp to Fourth Plain Boulevard would be braided below the 39th Street on-ramp to southbound I-5. This change would eliminate the existing nonstandard weave between the SR 500 interchange and the off-ramp to Fourth Plain Boulevard. It would also eliminate the existing westbound SR 500 to Fourth Plain Boulevard off-ramp connection. The existing overcrossing of I-5 at 29th Street would be reconstructed to accommodate a widened I-5, provide adequate vertical clearance over I-5, and provide pedestrian and bicycle facilities.

SR 500 INTERCHANGE

The northern terminus of the I-5 improvements would be in the SR 500 interchange area (Figure 1-24). The improvements would primarily be to connect the Modified LPA to existing ramps. The off-ramp from I-5 southbound to 39th Street would be reconstructed to establish the beginning of the braided ramp to Fourth Plain Boulevard and restore the loop ramp to 39th Street. Ramps from existing I-5 northbound to SR 500 eastbound and from 39th Street to I-5 northbound would be partially reconstructed. The existing bridges for 39th Street over I-5 and SR 500 westbound to I-5 southbound would be retained. The 39th Street to I-5 southbound on-ramp would be reconstructed and braided over (i.e., grade separated or pass over) the new I-5 southbound off-ramp to Fourth Plain Boulevard.

The existing overcrossing of I-5 at 33rd Street would also be reconstructed to accommodate a widened I-5, provide adequate vertical clearance over I-5, and provide pedestrian and bicycle facilities.

Figure 1-24. Upper Vancouver (Subarea D)



BRT = bus rapid transit; TBD = to be determined

1.1.5.2 Transit

There would be no LRT facilities in upper Vancouver. Proposed operational changes to bus service, including I-5 bus-on-shoulder service, are described in Section 1.1.7, Transit Operating Characteristics.

1.1.5.3 Active Transportation

Several active transportation improvements would be made in Subarea D consistent with City of Vancouver plans and policies. At the Fourth Plain Boulevard interchange, there would be improvements to provide better bicycle and pedestrian mobility and accessibility; these include bicycle lanes, neighborhood connections, and a connection to the City of Vancouver's planned two-way cycle track on Fourth Plain Boulevard. The reconstructed overcrossings of I-5 at 29th Street and 33rd Street would provide pedestrian and bicycle facilities on those cross streets. No new active transportation facilities are proposed in the SR 500 interchange area. Active transportation improvements at the Mill Plain Boulevard interchange include buffered bicycle lanes and sidewalks, pavement markings, lighting, and signing.

1.1.6 Transit Support Facilities

1.1.6.1 Ruby Junction Maintenance Facility Expansion

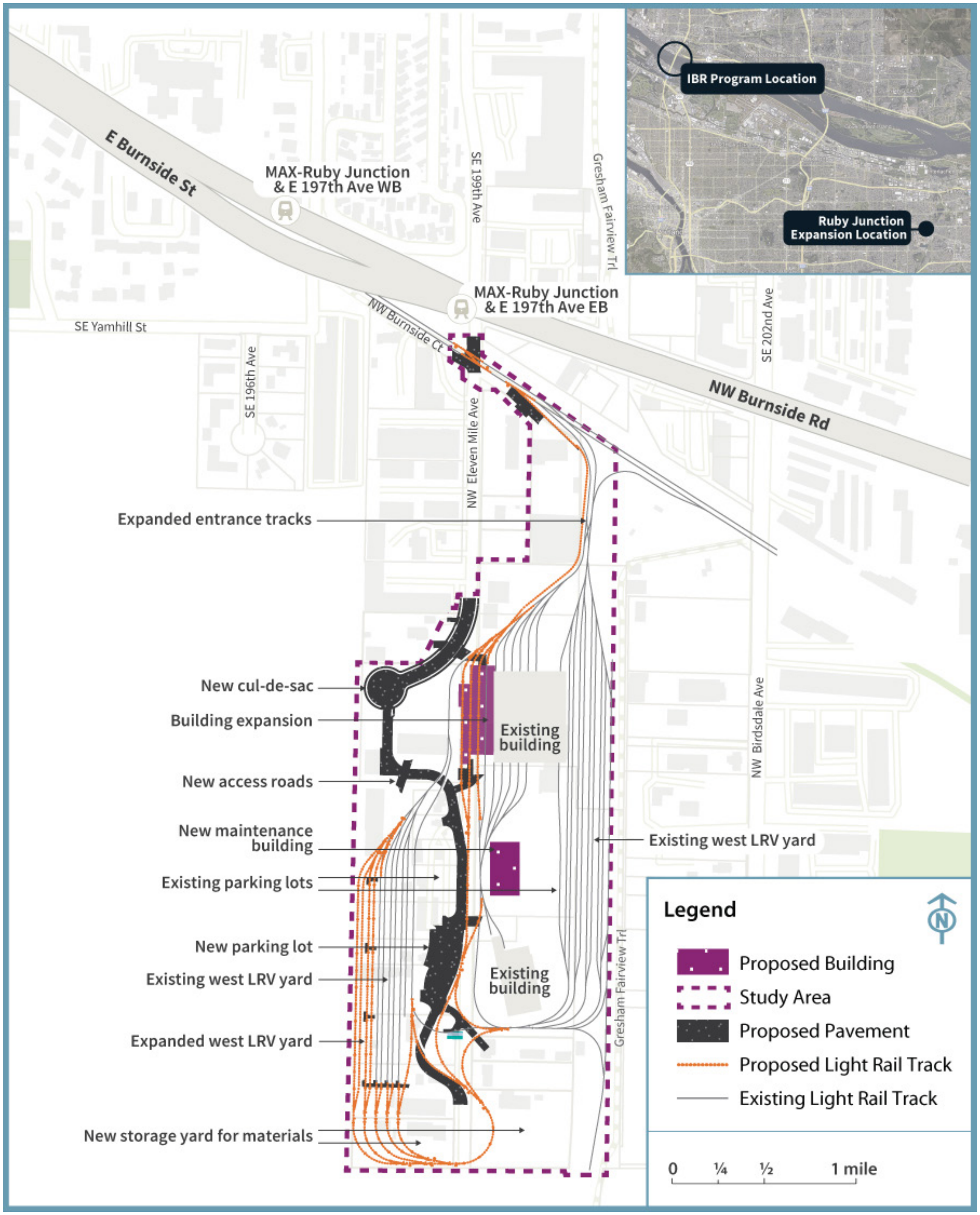
The TriMet Ruby Junction Maintenance Facility in Gresham, Oregon, would be expanded to accommodate the additional LRVs associated with the Modified LPA's LRT service (the Ruby Junction location relative to the study area is shown in Figure 1-25). Improvements would include additional storage for LRVs and maintenance materials and supplies, expanded LRV maintenance bays, expanded parking and employee support areas for additional personnel, and a third track at the northern entrance to Ruby Junction. Figure 1-25 shows the proposed footprint of the expansion.

The existing main building would be expanded west to provide additional maintenance bays. To make space for the building expansion, Eleven Mile Avenue would be vacated and would terminate in a new cul-de-sac west of the main building. New access roads would be constructed to maintain access to TriMet buildings south of the cul-de-sac.

The existing LRV storage yard, west of Eleven Mile Avenue, would be expanded to the west to accommodate additional storage tracks and a runaround track (a track constructed to bypass congestion in the maintenance yard). This expansion would require partial demolition of an existing TriMet building (just north of the LRV storage) and would require relocating the material storage yard to the properties just south of the south building.

All tracks in the west LRV storage yard would also be extended southward to connect to the proposed runaround track. The runaround track would connect to existing tracks near the existing south building. The connections to the runaround track would require partial demolition of an existing TriMet building plus full demolition of one existing building and partial demolition of another existing building on the private property west of the south end of Eleven Mile Avenue. The function of the existing TriMet building would either be transferred to existing modified buildings or to new replacement buildings on-site.

Figure 1-25. Ruby Junction Maintenance Facility Study Area



EB = eastbound; LRV = light-rail vehicle; WB = westbound

The existing parking lot west of Eleven Mile Avenue would be expanded toward the south to provide more parking for TriMet personnel.

A third track would be needed at the north entrance to Ruby Junction to accommodate increased train volumes without decreasing service. The additional track would also reduce operational impacts during construction and maintenance outages for the yard. Constructing the third track would require reconstruction of Burnside Court east of Eleven Mile Avenue. An additional crossover would also be needed on the mainline track where it crosses Eleven Mile Avenue; it would require reconstruction of the existing track crossings for vehicles, bicycles, and pedestrians.

1.1.6.2 Expo Center Overnight LRV Facility

An overnight facility for LRVs would be constructed on the southeast corner of the Expo Center property (as shown on Figure 1-8) to reduce deadheading between Ruby Junction and the northern terminus of the MAX Yellow Line extension. Deadheading occurs when LRVs travel without passengers to make the vehicles ready for service. The facility would provide a yard access track, storage tracks for approximately 10 LRVs, one building for light LRV maintenance, an operator break building, a parking lot for operators, and space for security personnel. This facility would necessitate relocation and reconstruction of the Expo Road entrance to the Expo Center (including the parking lot gates and booths). However, it would not affect existing Expo Center buildings.

The overnight facility would connect to the mainline tracks by crossing Expo Road just south of the existing Expo Center MAX Station. The connection tracks would require relocation of one or two existing LRT facilities, including a traction power substation building and potentially the existing communication building, which are both just south of the Expo Center MAX Station. Existing artwork at the station may require relocation.

1.1.6.3 Additional Bus Bays at the C-TRAN Operations and Maintenance Facility

Three bus bays would be added to the C-TRAN operations and maintenance facility. These new bus bays would provide maintenance capacity for the additional express bus service on I-5 (see Section 1.1.7, Transit Operating Characteristics). Modifications to the facility would accommodate new vehicles as well as maintenance equipment.

1.1.7 Transit Operating Characteristics

1.1.7.1 LRT Operations

Nineteen new LRVs would be purchased to operate the extension of the MAX Yellow Line. These vehicles would be similar to those currently used for the TriMet MAX system. With the Modified LPA, LRT service in the new and existing portions of the Yellow Line in 2045 would operate with 6.7-minute average headways (defined as gaps between arriving transit vehicles) during the 2-hour morning peak period. Midday and evening headways would be 15 minutes, and late-night headways would be 30 minutes. Service would operate between the hours of approximately 5 a.m. (first southbound train leaving Evergreen Station) and 1 a.m. (last northbound train arriving at the station), which is consistent with current service on the Yellow Line. LRVs would be deadheaded at Evergreen Station before beginning service each day. A third track at this northern terminus would accommodate layovers.

1.1.7.2 Express Bus Service and Bus on Shoulder

C-TRAN provides bus service that connects to LRT and augments travel between Washington and Oregon with express bus service to key employment centers in Oregon. Beginning in 2022, the main express route providing service in the IBR corridor, Route 105, had two service variations. One pattern provides service between Salmon Creek and downtown Portland with a single intermediate stop at the 99th Street Transit Center, and one provides service between Salmon Creek and downtown Portland with two intermediate stops: 99th Street Transit Center and downtown Vancouver. This route currently provides weekday service with 20-minute peak and 60-minute off-peak headways.

Once the Modified LPA is constructed, C-TRAN Route 105 would be revised to provide direct service from the Salmon Creek Park and Ride and 99th Street Transit Center to downtown Portland, operating at 5-minute peak headways with no service in the off-peak. The C-TRAN Route 105 intermediate stop service through downtown Vancouver would be replaced with C-TRAN Route 101, which would provide direct service from downtown Vancouver to downtown Portland at 10-minute peak and 30-minute off-peak headways.

Two other existing C-TRAN express bus service routes would remain unchanged after completion of the Modified LPA. C-TRAN Route 190 would continue to provide service from the Andresen Park and Ride in Vancouver to Marquam Hill in Portland. This route would continue to operate on SR 500 and I-5 within the study area. Route headways would be 10 minutes in the peak periods with no off-peak service. C-TRAN Route 164 would continue to provide service from the Fisher's Landing Transit Center to downtown Portland. This route would continue to operate within the study area only in the northbound direction during PM service to use the I-5 northbound high-occupancy vehicle (HOV) lane in Oregon before exiting to eastbound SR 14 in Washington. Route headways would be 10 minutes in the peak and 30 minutes in the off-peak.

C-TRAN express bus Routes 105 and 190 are currently permitted to use the existing southbound inside shoulder of I-5 from 99th Street to the Interstate Bridge in Vancouver. However, the existing shoulders are too narrow for bus-on-shoulder use in the rest of the I-5 corridor in the study area. The Modified LPA would include inside shoulders on I-5 that would be wide enough (14 feet on the Columbia River bridges and 11.5 to 12 feet elsewhere on I-5) to allow northbound and southbound buses to operate on the shoulder, except where I-5 would have to taper to match existing inside shoulder widths at the north and south ends of the corridor. Figure 1-8, Figure 1-16, Figure 1-23, and Figure 1-24 show the potential bus-on-shoulder use over the Columbia River bridges. Bus on shoulder could operate on any of the Modified LPA bridge configurations and bridge types. Additional approvals (including a continuing control agreement), in coordination with ODOT, may be needed for buses to operate on the shoulder on the Oregon portion of I-5.

After completion of the Modified LPA, two C-TRAN express bus routes operating on I-5 through the study area would be able to use bus-on-shoulder operations to bypass congestion in the general-purpose lanes. C-TRAN Route 105 would operate on the shoulder for the full length of the study area. C-TRAN Route 190 would operate on the shoulder for the full length of the corridor except for the distance required to merge into and out of the shoulder as the route exits from and to SR 500.

These two express bus routes (105 and 190) would have a combined frequency of every 3 minutes during the 2045 AM and PM peak periods. To support the increased frequency of express bus service, eight electric double-decker or articulated buses would be purchased.

If the C Street ramps were removed from the SR 14 interchange, C-TRAN Route 101 could also use bus-on-shoulder operations south of Mill Plain Boulevard; however, if the C Street ramps remained in place, Route 101 could still use bus-on-shoulder operations south of the SR 14 interchange but would need to begin merging over to the C Street exit earlier than if the C Street ramps were removed. Route 101 would operate at 10-minute peak and 30-minute off-peak headways. C-TRAN Route 164 would not be anticipated to use bus-on-shoulder operations because of the need to exit to SR 14 from northbound I-5.

1.1.7.3 Local Bus Route Changes

The TriMet Line 6 bus route would be changed to terminate at the Expo Center MAX Station, requiring passengers to transfer to the new LRT connection to access Hayden Island. TriMet Line 6 is anticipated to travel from Martin Luther King Jr. Boulevard through the newly configured area providing local connections to Marine Drive. It would continue west to the Expo Center MAX Station. Table 1-3 shows existing service and anticipated future changes to TriMet Line 6.

As part of the Modified LPA, several local C-TRAN bus routes would be changed to better complement the new light-rail extension. Most of these changes would reroute existing bus lines to provide a transfer opportunity near the new Evergreen Station. Table 1-3 shows existing service and anticipated future changes to C-TRAN bus routes. In addition to the changes noted in Table 1-3, other local bus route modifications would move service from Broadway to C Street. The changes shown may be somewhat different if the C Street ramps are removed.

Table 1-3. Proposed TriMet and C-TRAN Bus Route Changes

Bus Route	Existing Route	Changes with Modified LPA
TriMet Line 6	Connects Goose Hollow, Portland City Center, N/NE Portland, Jantzen Beach and Hayden Island. Within the study area, service currently runs between Delta Park MAX Station and Hayden Island via I-5.	Route would be revised to terminate at the Expo Center MAX Station. Route is anticipated to travel from Martin Luther King Jr. Boulevard through the newly configured Marine Drive area, then continue west to connect via facilities on the west side of I-5 with the Expo Center MAX Station.

Bus Route	Existing Route	Changes with Modified LPA
C-TRAN Fourth Plain and Mill Plain bus rapid transit (The Vine)	Runs between downtown Vancouver and the Vancouver Mall Transit Center via Fourth Plain Boulevard, with a second line along Mill Plain Boulevard. In the study area, service currently runs along Washington and Broadway Streets through downtown Vancouver.	Route would be revised to begin/end near the Evergreen Station in downtown Vancouver and provide service along Evergreen Boulevard to Fort Vancouver Way, where it would travel to or from Mill Plain Boulevard or Fourth Plain Boulevard depending on clockwise/counter-clockwise operations. The Fourth Plain Boulevard route would continue to serve existing Vine stations beyond Evergreen Boulevard.
C-TRAN #2 Lincoln	Connects the 99th Street Transit Center to downtown Vancouver via Lincoln and Kaufman Avenues. Within the study area, service currently runs along Washington and Broadway Streets between 7th and 15th Streets in downtown Vancouver.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #25 St. Johns	Connects the 99th Street Transit Center to downtown Vancouver via St. Johns Boulevard and Fort Vancouver Way. Within the study area, service currently runs along Evergreen Boulevard, Jefferson Street/Kaufman Avenue, 15th Street, and Franklin Street in downtown Vancouver.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #30 Burton	Connects the Fisher's Landing Transit Center with downtown Vancouver via 164th/162nd Avenues and 18th, 25th, 28th, and 39th Streets. Within the study area, service currently runs along McLoughlin Boulevard and on Washington and Broadway Streets between 8th and 15th Streets.	Route would be modified to begin/end near C Street and 9th Street in downtown Vancouver.
C-TRAN #60 Delta Park Regional	Connects the Delta Park MAX station in Portland with downtown Vancouver via I-5. Within the study area, service currently runs along I-5, Mill Plain Boulevard, and Broadway Street.	Route would be discontinued.

1.1.8 Tolling

Tolling cars and trucks that would use the new Columbia River bridges is proposed as a method to help fund the bridge construction and future maintenance, as well as to encourage alternative mode choices for trips across the Columbia River. Federal and state laws set the authority to toll the I-5 crossing. The IBR Program plans to toll the I-5 river bridge under the federal tolling authorization program codified in 23 U.S. Code Section 129 (Section 129). Section 129 allows public agencies to impose new tolls on federal-aid interstate highways for the reconstruction or replacement of toll-free bridges or tunnels. In 2023, the Washington State Legislature authorized tolling on the Interstate Bridge, with toll rates and policies to be set by the Washington State Transportation Commission (WSTC). In Oregon, the legislature authorized tolling giving the Oregon Transportation Commission the authority to toll I-5, including the ability to set the toll rates and policies. Subsequently, the Oregon Transportation Commission (OTC) is anticipated to review and approve the I-5 tollway project application that would designate the Interstate Bridge as a "tollway project" in 2024. At the beginning of 2024, the OTC and the WSTC entered into a bi-state tolling agreement to establish a cooperative process for setting toll rates and policies. This included the formation of the I-5 Bi-State Tolling Subcommittee consisting of two commissioners each from the OTC and WSTC and tasked with developing toll rate and policy recommendations for joint consideration and adoption by each state's commission. Additionally, the two states plan to enter into a separate agreement guiding the sharing and uses of toll revenues, including the order of uses (flow of funds) for bridge construction, debt service, and other required expenditures. WSDOT and ODOT also plan to enter into one or more agreements addressing implementation logistics, toll collection, and operations and maintenance for tolling the bi-state facility.

The Modified LPA includes a proposal to apply variable tolls on vehicles using the Columbia River bridges with the toll collected electronically in both directions. Tolls would vary by time of day with higher rates during peak travel periods and lower rates during off-peak periods. The IBR Program has evaluated multiple toll scenarios generally following two different variable toll schedules for the tolling assessment. For purposes of this NEPA analysis, the lower toll schedule was analyzed with tolls assumed to range between $1.50 and $3.15 (in 2026 dollars as representative of when tolling would begin) for passenger vehicles with a registered toll payment account. Medium and heavy trucks would be charged a higher toll than passenger vehicles and light trucks. Passenger vehicles and light trucks without a registered toll payment account would pay an additional $2.00 per trip to cover the cost of identifying the vehicle owner from the license plate and invoicing the toll by mail.

The analysis assumes that tolling would commence on the existing Interstate Bridge—referred to as pre-completion tolling—starting April 1, 2026. The actual date pre-completion tolling begins would depend on when construction would begin. The traffic and tolling operations on the new Columbia River bridges were assumed to commence by July 1, 2033. The actual date that traffic and tolling operations on the new bridges begin would depend on the actual construction completion date. During the construction period, the two commissions may consider toll-free travel overnight on the existing Interstate Bridge, as was analyzed in the Level 2 Toll Traffic and Revenue Study, for the hours between 11 p.m. and 5 a.m. This toll-free period could help avoid situations where users would be charged during lane or partial bridge closures where construction delays may apply. Once the new I-5 Columbia River bridges open, twenty-four-hour tolling would begin.

Tolls would be collected using an all-electronic toll collection system using transponder tag readers and license-plate cameras mounted to structures over the roadway. Toll collection booths would not be required. Instead, motorists could obtain a transponder tag and set up a payment account that would automatically bill the account holder associated with the transponder each time the vehicle crossed the bridge. Customers without transponders, including out-of-area vehicles, would be tolled by a license-plate recognition system that would bill the address of the owner registered to that vehicle's license-plate. The toll system would be designed to be nationally interoperable. Transponders for tolling systems elsewhere in the country could be used to collect tolls on I-5, and drivers with an account and transponder tag associated with the Interstate Bridge could use them to pay tolls in other states for which reciprocity agreements had been developed. There would be new signage, including gantries, to inform drivers of the bridge toll. These signs would be on local roads, I-5 on-ramps, and on I-5, including locations north and south of the bridges where drivers make route decisions (e.g., I-5/I-205 junction and I-5/I-84 junction).

1.1.9 Transportation System- and Demand-Management Measures

Many well-coordinated transportation demand-management and system-management programs are already in place in the Portland-Vancouver metropolitan region. In most cases, the impetus for the programs comes from state regulations: Oregon's Employee Commute Options rule and Washington's Commute Trip Reduction law (described in the sidebar).

The physical and operational elements of the Modified LPA provide the greatest transportation demand-management opportunities by promoting other modes to fulfill more of the travel needs in the corridor. These include:

- Major new light-rail line in exclusive right of way, as well as express bus routes and bus routes that connect to new light-rail stations.
- I-5 inside shoulders that accommodate express buses.
- Modern bicycle and pedestrian facilities that accommodate more bicyclists and pedestrians and improve connectivity, safety, and travel time.
- Park-and-ride facilities.
- A variable toll on the new Columbia River bridges.

In addition to these fundamental elements of the Modified LPA, facilities and equipment would be implemented that could help existing or expanded transportation system management measures

State Laws to Reduce Commute Trips

Oregon and Washington have both adopted regulations intended to reduce the number of people commuting in single-occupancy vehicles (SOVs). Oregon's Employee Commute Options Program, created under Oregon Administrative Rule 340-242-0010, requires employers with over 100 employees in the greater Portland area to provide commute options that encourage employees to reduce auto trips to the work site. Washington's 1991 Commute Trip Reduction (CTR) Law, updated as the 2006 CTR Efficiency Act (Revised Code of Washington §70.94.521) addresses traffic congestion, air pollution, and petroleum fuel consumption. The law requires counties and cities with the greatest traffic congestion and air pollution to implement plans to reduce SOV demand. An additional provision mandates "major employers" and "employers at major worksites" to implement programs to reduce SOV use.

maximize the capacity and efficiency of the system. These include:

- Replacement or expanded variable message signs in the study area. These signs alert drivers to incidents and events, allowing them to seek alternate routes or plan to limit travel during periods of congestion.
- Replacement or expanded traveler information systems with additional traffic monitoring equipment and cameras.
- Expanded incident response capabilities, which help traffic congestion to clear more quickly following accidents, spills, or other incidents.
- Queue jumps or bypass lanes for transit vehicles where multilane approaches are provided at ramp signals for on-ramps. Locations for these features will be determined during the detailed design phase.
- Active traffic management including strategies such as ramp metering, dynamic speed limits, and transit signal priority. These strategies are intended to manage congestion by controlling traffic flow or allowing transit vehicles to enter traffic before single-occupancy vehicles (SOVs).

1.2 Modified LPA Construction

The following information on the construction activities and sequence follows the information prepared for the CRC LPA. Construction durations have been updated for the Modified LPA. Because the main elements of the IBR Modified LPA are similar to those in the CRC LPA (i.e., multimodal river crossings and interchange improvements), this information provides a reasonable assumption of the construction activities that would be required.

The construction of bridges over the Columbia River sets the sequencing for other Program components. Accordingly, construction of the Columbia River bridges and immediately adjacent highway connections and improvement elements would be timed early to aid the construction of other components. Demolition of the existing Interstate Bridge would take place after the new Columbia River bridges were opened to traffic.

Electronic tolling infrastructure would be constructed and operational on the existing Interstate Bridge by the start of construction on the new Columbia River bridges. The toll rates and policies for tolling (including pre-completion tolling) would be determined after a more robust analysis and public process by the OTC and WSTC (refer to Section 1.1.8, Tolling).

1.2.1 Construction Components and Duration

Table 1-4 provides the estimated construction durations and additional information of Modified LPA components. The estimated durations are shown as ranges to reflect the potential for Program funding to be phased over time. In addition to funding, contractor schedules, regulatory restrictions on in-water work and river navigation considerations, permits and approvals, weather, materials, and equipment could all influence construction duration and overlap of construction of certain components. Certain work below the ordinary high-water mark of the Columbia River and North

Portland Harbor would be restricted to minimize impacts to species listed under the Endangered Species Act and their designated critical habitat.

Throughout construction, active transportation facilities and three lanes in each direction on I-5 (accommodating personal vehicles, freight, and buses) would remain open during peak hours, except for short intermittent restrictions and/or closures. Advanced coordination and public notice would be given for restrictions, intermittent closures, and detours for highway, local roadway, transit, and active transportation users (refer to the Transportation Technical Report, for additional information). At least one navigation channel would remain open throughout construction. Advanced coordination and notice would be given for restrictions or intermittent closures to navigation channels as required.

Table 1-4. Construction Activities and Estimated Duration

Component	Estimated Duration	Notes
Columbia River bridges	4 to 7 years	• Construction is likely to begin with the main river bridges. • General sequence would include initial preparation and installation of foundation piles, shaft caps, pier columns, superstructure, and deck.
North Portland Harbor bridges	4 to 10 years	• Construction duration for North Portland Harbor bridges is estimated to be similar to the duration for Hayden Island interchange construction. The existing North Portland Harbor bridge would be demolished in phases to accommodate traffic during construction of the new bridges.
Hayden Island interchange	4 to 10 years	• Interchange construction duration would not necessarily entail continuous active construction. Hayden Island work could be broken into several contracts, which could spread work over a longer duration.
Marine Drive interchange	4 to 6 years	• Construction would need to be coordinated with construction of the North Portland Harbor bridges.
SR 14 interchange	4 to 6 years	• Interchange would be partially constructed before any traffic could be transferred to the new Columbia River bridges.
Demolition of the existing Interstate Bridge	1.5 to 2 years	• Demolition of the existing Interstate Bridge could begin only after traffic is rerouted to the new Columbia River bridges.

Component	Estimated Duration	Notes
Three interchanges north of SR 14	3 to 4 years for all three	• Construction of these interchanges could be independent from each other and from construction of the Program components to the south. • More aggressive and costly staging could shorten this timeframe.
Light-rail	4 to 6 years	• The light-rail crossing would be built with the Columbia River bridges. Light-rail construction includes all of the infrastructure associated with light-rail transit (e.g., overhead catenary system, tracks, stations, park and rides).
Total construction timeline	9 to 15 years	• Funding, as well as contractor schedules, regulatory restrictions on in-water work and river navigation considerations, permits and approvals, weather, materials, and equipment, could all influence construction duration.

1.2.2 Potential Staging Sites and Casting Yards

Equipment and materials would be staged in the study area throughout construction generally within existing or newly purchased right of way, on land vacated by existing transportation facilities (e.g., I-5 on Hayden Island), or on nearby vacant parcels. However, at least one large site would be required for construction offices, to stage the larger equipment such as cranes, and to store materials such as rebar and aggregate. Criteria for suitable sites include large, open areas for heavy machinery and material storage, waterfront access for barges (either a slip or a dock capable of handling heavy equipment and material) to convey material to the construction zone, and roadway or rail access for landside transportation of materials by truck or train.

Two potential major staging sites have been identified (see Figure 1-8 and Figure 1-23). One site is located on Hayden Island on the west side of I-5. A large portion of this parcel would be required for new right of way for the Modified LPA. The second site is in Vancouver between I-5 and Clark College. Other staging sites may be identified during the design process or by the contractor. Following construction of the Modified LPA, the staging sites could be converted for other uses.

In addition to on-land sites, some staging activities for construction of the new Columbia River and North Portland Harbor bridges would take place on the river itself. Temporary work structures, barges, barge-mounted cranes, derricks, and other construction vessels and equipment would be present on the river during most or all of the bridges' construction period. The IBR Program is working with USACE and USCG to obtain necessary clearances for these activities.

A casting or staging yard could also be required for construction of the overwater bridges if a precast concrete segmental bridge design is used. A casting yard would require access to the river for barges, a slip or a dock capable of handling heavy equipment and material, a large area suitable for a concrete batch plant and associated heavy machinery and equipment, and access to a highway or railway for delivery of materials. As with the staging sites, casting or staging yard sites may be identified as the design progresses or by the contractor and would be evaluated via a NEPA re-evaluation or supplemental NEPA document for potential environmental impacts at that time.

1.3 No-Build Alternative

The No-Build Alternative illustrates how transportation and environmental conditions would likely change by the year 2045 if the Modified LPA is not built. This alternative makes the same assumptions as the Modified LPA regarding population and employment growth through 2045, and it assumes that the same transportation and land use projects in the region would occur as planned.

Regional transportation projects included in the No-Build Alternative are those in the financially constrained 2018 Regional Transportation Plan (2018 RTP) adopted in December 2018 by the Metro Council (Metro 2018) and in March 2019 (RTC 2019) by the Southwest Washington Regional Transportation Council (RTC) Board of Directors is referred to as the 2018 RTP in this report. The 2018 RTP has a planning horizon year of 2040 and includes projects from state and local plans necessary to meet transportation needs over this time period; financially constrained means these projects have identified funding sources. The Transportation Technical Report lists the projects included in the financially constrained 2018 RTP.

The implementation of regional and local land use plans is also assumed as part of the No-Build Alternative. For the IBR Program analysis, population and employment assumptions used in the 2018 RTP were updated to 2045 in a manner consistent with regional comprehensive and land use planning. In addition to accounting for added growth, adjustments were made within Portland to reallocate the households and employment based on the most current update to Portland's comprehensive plan, which was not complete in time for inclusion in the 2018 RTP.

Other projects assumed as part of the No-Build Alternative include major development and infrastructure projects that are in the permitting stage or partway through phased development. These projects are discussed as reasonably foreseeable future actions in the IBR Cumulative Effects Technical Report. They include the Vancouver Waterfront project, Terminal 1 development, the Renaissance Boardwalk, the Waterfront Gateway Project, improvements to the levee system, several restoration and habitat projects, and the Portland Expo Center.

In addition to population and employment growth and the implementation of local and regional plans and projects, the No-Build Alternative assumes that the existing Interstate Bridge would continue to operate as it does today. As the bridge ages, needs for repair and maintenance would potentially increase, and the bridge would continue to be at risk of mechanical failure or damage from a seismic event.

2. METHODOLOGY

The methodology and assumptions used to analyze the transportation impacts for the IBR Program Draft SEIS are discussed in detail in the Transportation Methods Report included in Appendix A. These methods build on those developed for the CRC project, which completed the NEPA process with a signed ROD in 2011. The methods report should be considered a living document that may be updated and amended to account for changes as the IBR Program proceeds. The following information is included in the IBR transportation methods:

- Introduction
- Relevant Plans, Policies, and Coordination
- Study Areas Definition
- Transportation Analysis Years and Study Periods
- Affected Environment Data Collection
- Travel Demand Forecasting
- Identification of Impacts (analysis tools, performance standards, evaluation measures)
    - Regional Transportation
    - Interstate 5
    - Freight Mobility and Access
    - Bridge Openings and Gate Closures
    - Arterials and Local Streets
    - Transit
    - Active Transportation
    - Safety
    - Transportation Demand Management and Transportation System Management
    - Tolling and Diversion
- References
- Attachments include the data collection program.

3. AFFECTED ENVIRONMENT

3.1 Introduction

This chapter discusses the existing conditions for the following elements of the transportation environment:

- Regional transportation, including major freeway and highway facilities, vehicle miles of travel, vehicle hours of travel, vehicle hours of delay, and mode share.
- Freeway operations including I-5 mainline and ramp volumes, bottlenecks, freeway level of service (LOS), volume-to-capacity (V/C) ratios, travel times, and speeds.
- Freight mobility and access.
- Bridge openings/gate closures, including yearly and hourly frequency as well as average event duration.
- Arterial and local streets, including corridor analysis, intersection operations, and impacts to local roadways caused by freeway congestion.
- Transit, including regional and local transit services, corridor and station ridership, and transit operations.
- Sufficiency and quality of active transportation (bicycle and pedestrian facilities) around stations, as well as circulation and connections to existing networks.
- Safety.
- Transportation demand management (TDM) and transportation system management (TSM).
- Tolling and diversion.

Comprehensive and quality data provide the foundation for robust transportation analysis to support the IBR Program. The IBR Program Area contains a diverse transportation system including freeways, highways, local roads, transit, active transportation systems, and programs for TDM and TSM. The baseline data collected for the IBR Program are similar in kind to the data collected during previous CRC planning efforts but have been updated and enhanced to support new technologies that have been developed since previous planning efforts occurred.

The COVID-19 pandemic that began in 2020 altered historical travel patterns and trends, traffic volumes, and transit ridership. Traffic volumes and transit ridership dropped below historic levels, and then began to increase as health emergency restrictions gradually eased over the following 3 years. As of March 2023, according to traffic count data from both WSDOT and ODOT (WSDOT 2022; ODOT 2021), traffic volumes were close to pre-pandemic levels for auto and freight traffic within the study area. Transit has been slower to recover, but according to both Clark County Public Transportation Benefit Area Authority (C-TRAN) and (Tri-County Metropolitan Transportation District of Oregon) TriMet, transit service levels and ridership continue to see increases as more time goes by since the start of the pandemic (C-TRAN n.d.; TriMet n.d.). In the immediate aftermath of the closures and travel restrictions that began in March 2020, traffic volumes and transit ridership dropped substantially below historical levels. Traffic volumes began to increase as restrictions gradually eased over the following 3 years. As of March 2023, according to traffic count data from both WSDOT and ODOT (WSDOT 2022; ODOT 2021), traffic volumes were close to pre-pandemic levels for auto and freight traffic within the IBR Program Area. Transit has been slower to recover, but according to both C-TRAN and TriMet performance data, transit use has continued to increase since the pandemic (C-TRAN n.d.; TriMet n.d.).

Transportation analyses generally incorporate the most recently available data. However, due to the influence of the COVID-19 pandemic on travel patterns between 2020 and 2023 as explained above, the most recently available data is not representative of standard conditions. Therefore, the IBR Program is following industry standards and using 2019 as the baseline year for the existing conditions instead since it most closely resembles standard conditions. Exceptions to this include:

- Outputs that rely on the Oregon Metro (Metro)/RTC regional travel demand model, which had not yet updated its base year model from 2015 to 2020.
- Safety data which summarizes 5-years of data from 2015–2019.
- Bridge lift/gate closure data that summarize 12 years of data (2012–2023) which is consistent with the data summarized for the Navigation Impact Report.

The Metro/RTC regional 2015 travel demand model outputs in this report are from the 2018 Regional Transportation Plan. The 2018 Regional Transportation Plan was jointly adopted by Metro in 2018 (2018 Regional Transportation Plan [Metro 2018]) and by RTC in 2019 (the 2019 Regional Transportation Plan for Clark County [RTC 2019]).

Recent counts in 2022 at the I-5 Interstate Bridge show similar volumes and patterns to the 2019 pre-COVID volumes (see Section 1.4 of the Transportation Methods Report included in Appendix A).

3.2 Regional Transportation

This section describes the existing regional transportation network, regional roadways, and regional travel measures and screenline performance from the regional travel demand model outputs.

3.2.1 Regional Roadways

The IBR Program Area, shown in Figure 3-1, includes several interstate and state highways that connect the Program Area to the region's major population and employment areas. Regional roadways within the IBR Program Area include I-5, SR 500, SR 14, and Martin Luther King Jr. Boulevard (OR 99E), all of which are limited-access corridors. In addition to the regional roadways, local roadways provide access to/from and within the IBR Program Area.

Figure 3-1. IBR Program Area

Table 3-1 summarizes characteristics of the regional roadways in the IBR Program Area including classification, number of travel lanes, speed limits, average daily traffic, and active transportation facilities.

Table 3-1. Existing Regional Roadways in the IBR Program Area

Regional Roadway	Roadway Classification	Number of Travel Lanes	Speed Limit (mph)	Average Weekday Daily Traffic [a]	Bicycle Facilities [b]	Pedestrian Facilities [b]
I-5	Interstate	4–9	50–60	60,000–146,500	Yes	Yes
SR 500	State Highway (Washington)	4–6	55	35,000–52,000	No	No
SR 14	State Highway (Washington)	4–6	60	58,000–73,000	No	No
MLK Jr. Blvd (OR 99E)	State Highway (Oregon)	4	30–55	16,200–18,400	Yes	No

Source: WSDOT Online Map Center "Historic Traffic Counts." ODOT Traffic Volume Tables for State Highways 2019

a A range of average weekday daily traffic volumes is shown, as the volumes differ along freeway segments in the Portland metropolitan region.

b Narrow shared-use paths exist on the Interstate Bridge over the Columbia River.

Blvd = Boulevard; MLK = Martin Luther King

I-5. Within the IBR Program Area, I-5 is classified as an Urban Interstate and a Highway of Statewide Significance by WSDOT and as an Interstate by ODOT. I-5 is the primary north-south limited-access corridor for regional, interstate, and international personal travel and commerce, including travel across the Columbia River. It has six travel lanes and a posted speed limit of 50 miles per hour (mph) across the bridge, 60 mph in Washington north of the bridge, and 55 mph in Oregon south of the bridge.

SR 500 is a state highway that provides an east-west connection between I-5 and I-205 and NE Fourth Plain Boulevard in north Vancouver. It has four to six travel lanes and a posted speed limit of 55 mph. WSDOT classifies it as an Other Freeway Expressway.

SR 14 is an east-west state highway that runs along Washington's southern border, following closely along the Columbia River. Classified by WSDOT as an Other Freeway Expressway and a Highway of Statewide Significance, it connects I-5 in the west to I-82 in central Washington. Within the IBR Program Area, the speed limit is 60 mph, and the roadway has four to six travel lanes.

Martin Luther King Jr. Boulevard (OR 99E) is classified as an Urban Principal Arterial by ODOT. It runs east of the I-5 interchange on Marine Drive through NE Lombard Street. Martin Luther King Jr. Boulevard has a posted speed limit of 55 mph for most of the segment but transitions to 30 mph near the intersection at NE Columbia Boulevard.

3.2.2 Regional Travel Measures

As described in the Transportation Methods Report (Appendix A), the two metropolitan planning organizations within the Program Area, Metro and RTC, maintain a single regional travel demand model. The Metro/RTC regional travel demand model is a macroscopic trip-based travel demand model that estimates person-trips for all modes and roadway network vehicle demand for each hour of a 24-hour average weekday. The version used for this analysis was developed for the 2018 RTP, adopted by Metro in 2018 and RTC in 2019, representing model years 2015 and 2040 with an update to 2045 that was developed for this and other major projects in the region.

Vehicle miles traveled (VMT), vehicle hours traveled (VHT), and vehicle hours of delay (VHD) are the measures typically used to summarize regional traffic performance and to evaluate the impacts of proposed changes to the transportation system. These measures are calculated based on output from the Metro/RTC regional travel demand model. As noted previously, 2015 is the current base year available from the Metro/RTC regional travel demand model and the year for which the Metro/RTC regional travel demand model is calibrated and validated. These regional measures are summarized in Table 3-2.

The existing VMT, VHT, and VHD are reported for two areas. The first larger area includes the entire Portland metropolitan region covered by the Metro/RTC regional travel demand model (see Figure 3-2). The second smaller traffic subarea, shown in Figure 3-3, is within the most densely developed areas of Portland and Vancouver. It covers the triangle bounded on the west by I-5 (between I-205 and I-84), on the east by I-205 (between I-5 and I-84), and on the south by I-84 (between I-5 and I-205). The traffic subarea allows for a more focused look at areas with the most potential impacts and benefits from the IBR Program as opposed to the impacts and benefits being minimized over the regional area. The VMT and VHT in the traffic subarea represent approximately 26% of the regional total, while VHD represents 52% of the regional total. The three congested freeway corridors within the traffic subarea contribute to a higher share of VHD compared to VMT and VHT.

Table 3-2. Regional Travel Measures – Existing 2015 Daily VMT, VHT, and VHD

Area	Vehicle Miles Traveled	Vehicle Hours Traveled	Vehicle Hours of Delay [a]
Portland Metropolitan Region	43,115,600	1,225,400	19,400
Traffic Subarea	11,277,600	326,900	10,100

Source: Metro/RTC regional travel demand model

a Delay is measured as time spent in congestion on network links that exceed 0.9 volume/capacity ratio.

Figure 3-2. Portland Metropolitan Model Region

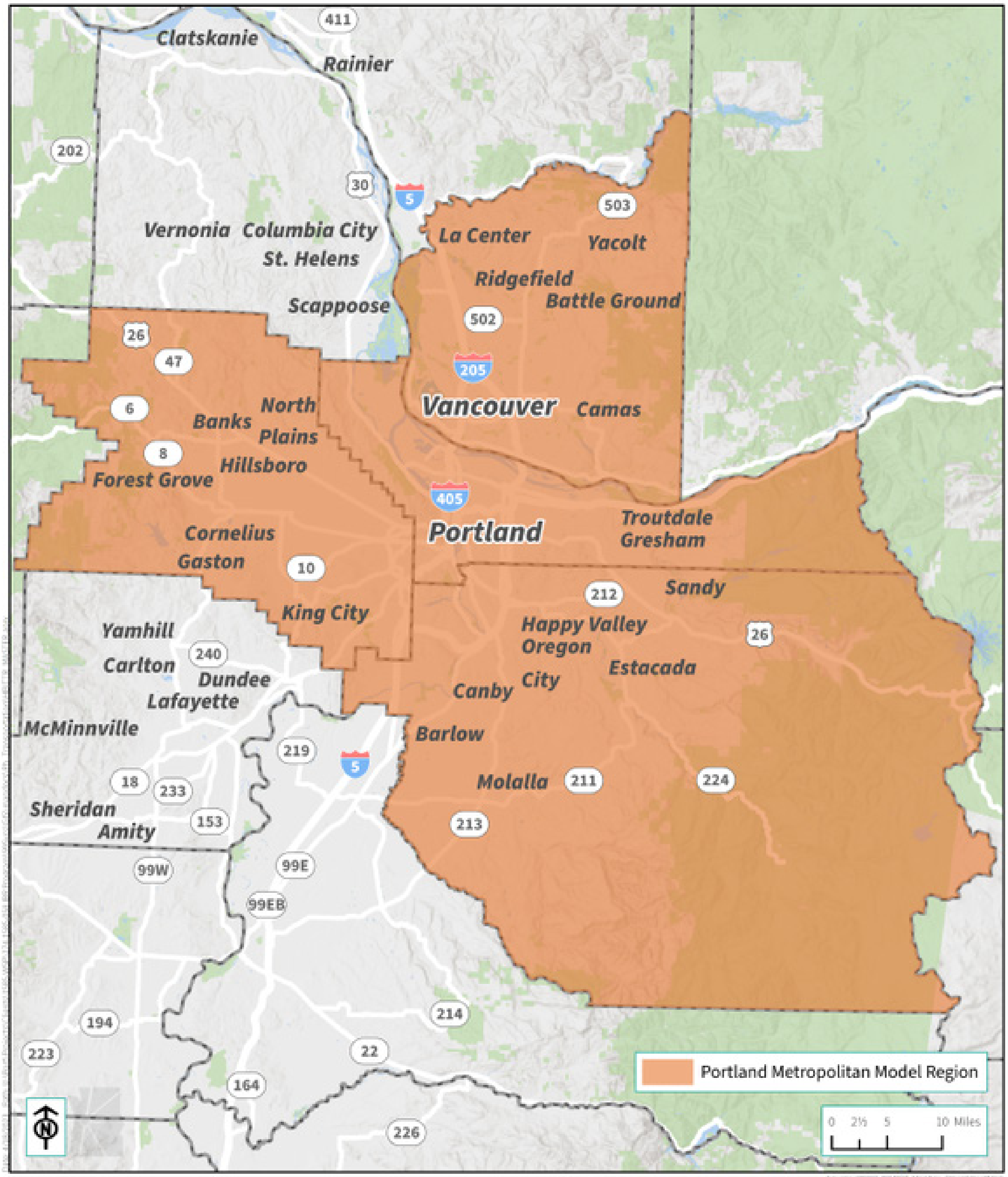
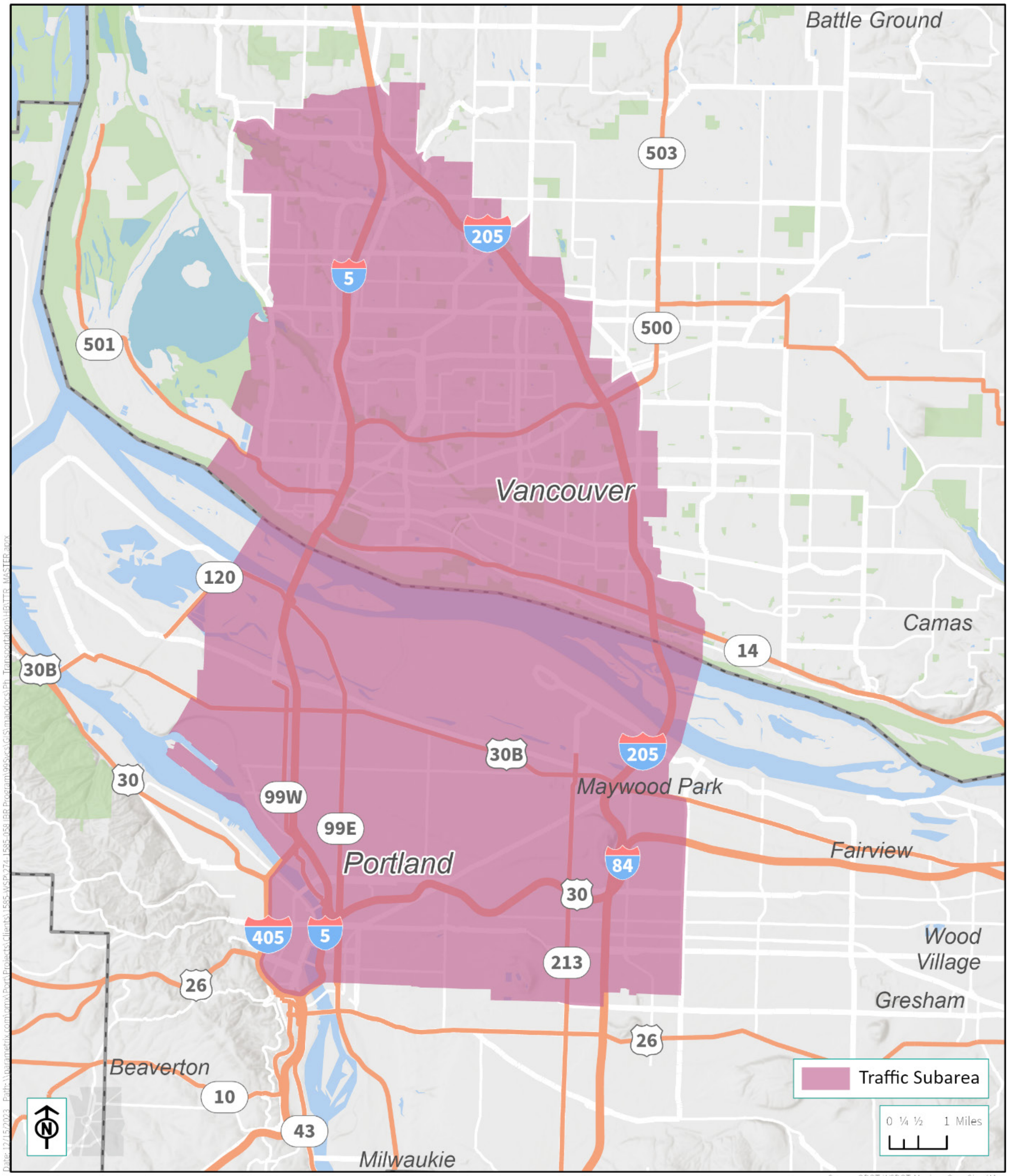


Figure 3-3. Traffic Subarea



3.2.3 Screenline Peak-Hour Traffic Volumes

Screenlines are imaginary lines drawn across major roadways to measure the total amount of traffic moving in each direction across multiple corridors. These screenlines are used to provide a snapshot of traffic conditions (such as volumes, roadway volume/capacity ratios, and vehicle mode share) along each corridor. Within the IBR Program Area, 13 screenlines were evaluated to assess regional north-south and east-west travel. These screenlines used 2015 data from the Metro/RTC regional travel demand model.

Figure 3-4 and Figure 3-5 show the locations of screenlines, and Table 3-3 and Table 3-4 show the screenline results for the AM peak hour (7 a.m. to 8 a.m.) and PM peak hour (5 p.m. to 6 p.m.). For east-west screenlines that include northbound and southbound traffic, volumes are summarized separately for arterials and I-5 or I-205, along with a total for the entire screenline. The intent in providing individual facility volumes is to allow for a better understanding of whether traffic may divert or be drawn back to the freeway under different alternatives. Individual facility details for each of these screenlines are in Appendix B. All volumes summarized in tables and Appendix B are peak-hour volumes in vehicles per hour (vph).

Figure 3-4. Screenline Locations – Vancouver

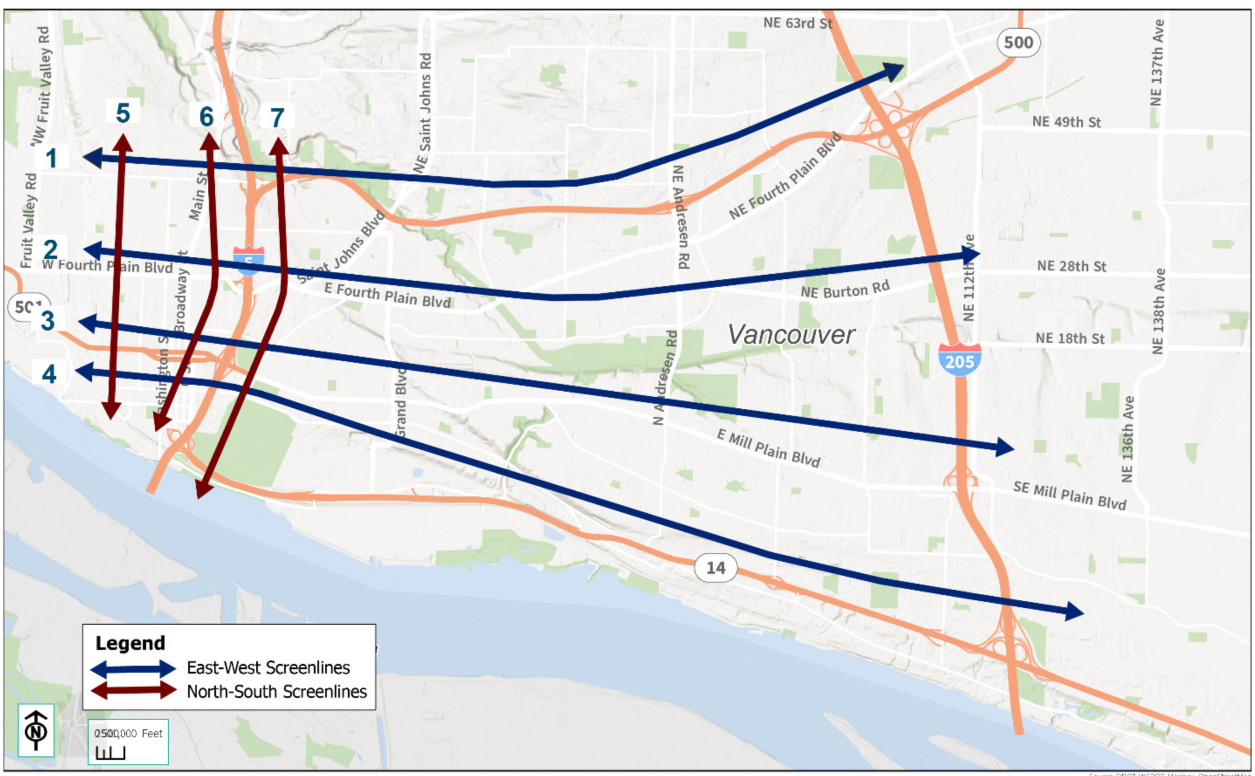


Figure 3-5. Screenline Locations – Portland

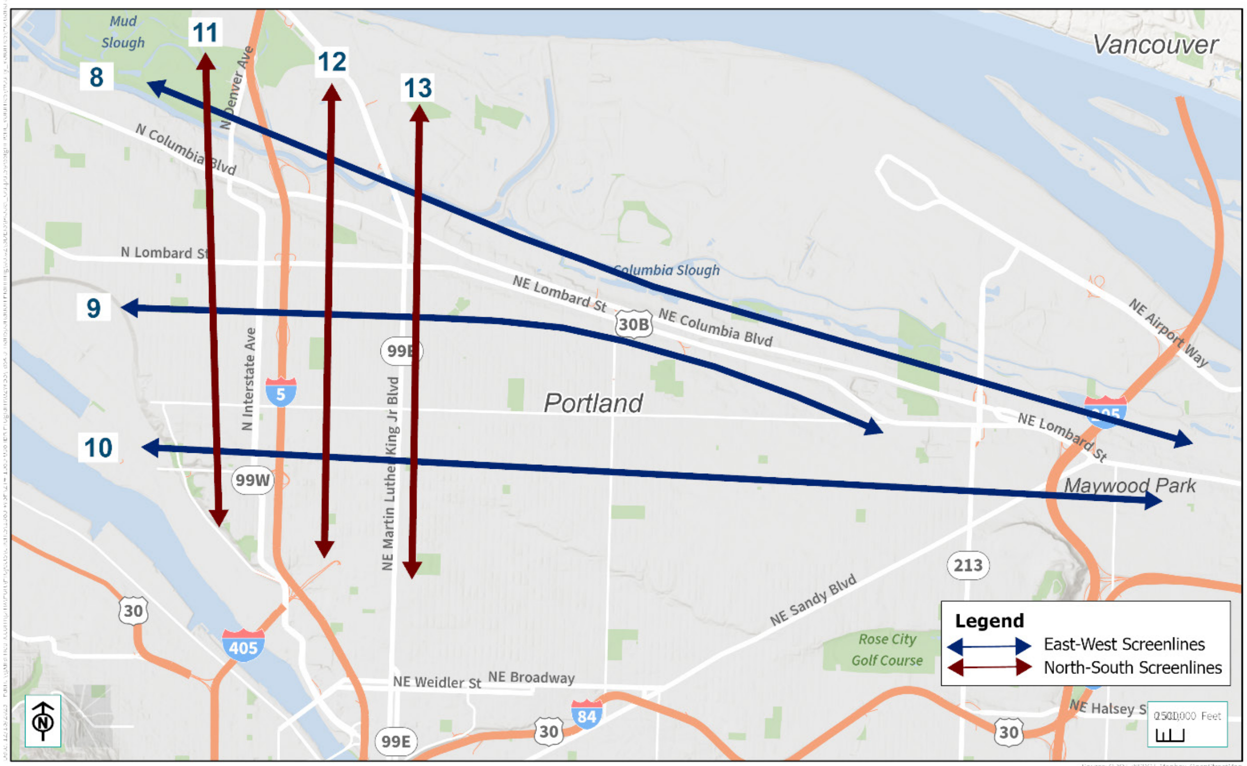


Table 3-3. 2015 Base Existing Vancouver Screenline Traffic Volumes – AM and PM Peak Hours

Screenline	Direction	Existing AM (vph)	Existing PM (vph)
East-West #1: North of 39th Street	Northbound Arterials	2,350	3,850
	Northbound I-5	2,300	4,550
	Northbound I-205	1,450	2,550
	Northbound Total	**6,100**	**10,950**
	Southbound Arterials	3,950	2,750
	Southbound I-5	5,050	3,250
	Southbound I-205	3,000	2,000
	Southbound Total	**12,000**	**7,900**

Screenline	Direction	Existing AM (vph)	Existing PM (vph)
East-West #2: North of Fourth Plain Boulevard	Northbound Arterials	2,550	4,500
	Northbound I-5	2,900	5,650
	Northbound I-205	2,450	4,450
	Northbound Total	**7,900**	**14,600**
	Southbound Arterials	4,900	3,250
	Southbound I-5	6,150	3,850
	Southbound I-205	4,600	2,750
	Southbound Total	**15,700**	**9,850**
East-West #3: North of 15th Street	Northbound Arterials	3,100	4,650
	Northbound I-5	2,550	5,150
	Northbound I-205	2,450	4,450
	Northbound Total	**8,100**	**14,200**
	Southbound Arterials	4,500	3,100
	Southbound I-5	6,050	3,800
	Southbound I-205	4,600	2,750
	Southbound Total	**15,150**	**9,650**
East-West #4: North of Evergreen Boulevard	Northbound Arterials	2,700	4,350
	Northbound I-5	2,250	4,200
	Northbound I-205	2,650	5,500
	Northbound Total	**7,550**	**14,050**
	Southbound Arterials	3,750	2,950
	Southbound I-5	5,250	3,050
	Southbound I-205	6,200	2,950
	Southbound Total	**15,200**	**8,950**
North-South #5: West of Franklin Street	Eastbound	800	1,100
	Westbound	1,200	850
North-South #6: West of I-5	Eastbound	1,450	2,000
	Westbound	1,750	1,700
North-South #7: East of I-5	Eastbound	4,300	5,750
	Westbound	5,400	4,400

Source: Metro/RTC regional travel demand model. vph = vehicles per hour.

Table 3-4. 2015 Base Existing Portland Screenline Traffic Volumes – AM and PM Peak Hours

Screenline	Direction	Existing AM (vph)	Existing PM (vph)
East-West #8: Columbia Slough	Northbound Arterials	4,000	3,000
	Northbound I-5	3,250	4,350
	Northbound I-205	3,200	5,250
	Northbound Total	**10,450**	**12,550**
	Southbound Arterials	2,400	3,450
	Southbound I-5	5,300	3,550
	Southbound I-205	6,200	3,850
	Southbound Total	**13,900**	**10,850**
East-West #9: North of Rosa Parks	Northbound Arterials	2,750	3,450
	Northbound I-5	4,300	5,150
	Northbound Total	**7,050**	**8,550**
	Southbound Arterials	3,200	2,800
	Southbound I-5	6,000	4,800
	Southbound Total	**9,200**	**7,600**
East-West #10: South of Alberta Street	Northbound Arterials	4,850	6,700
	Northbound I-5	4,750	5,800
	Northbound I-205	4,900	5,400
	Northbound Total	**14,450**	**17,850**
	Southbound Arterials	6,550	5,250
	Southbound I-5	6,750	5,100
	Southbound I-205	6,050	4,800
	Southbound Total	**19,350**	**15,150**
North-South #11: West of Interstate Avenue	Eastbound	2,850	3,600
	Westbound	3,750	2,750
North-South #12: East of I-5	Eastbound	2,800	3,000
	Westbound	3,050	3,000
North-South #13: East of Martin Luther King Jr. Boulevard	Eastbound	3,000	3,950
	Westbound	4,150	3,250

Source: Metro/RTC regional travel demand model. vph = vehicles per hour

3.3 Interstate 5

This section describes existing conditions in the I-5 corridor within the IBR Program Area, including trip origin-destination patterns, mainline and ramp volumes, and freeway operations.

3.3.1 Freeway Analysis Area

The IBR Program Area is the approximately 5-mile section of I-5 between the SR 500/39th Street interchange in Vancouver and the Interstate Avenue/Victory Boulevard interchange in Portland. It includes seven interchange areas: SR 500/39th Street, Fourth Plain Boulevard, Mill Plain Boulevard, City Center/SR 14, Hayden Island, Marine Drive, and Interstate Avenue/Victory Boulevard.

Traffic volumes and congestion within and outside of the IBR Program Area influence each other; these interactions were captured by analyzing a longer section of I-5. This *freeway analysis area* consists of a 17-mile length of I-5 between the I-205 interchange north of Vancouver and the Marquam Bridge in Portland. No proposed roadway improvements are anticipated outside of the IBR Program Area as part of the IBR Program. There are 21 interchanges within the freeway analysis area, including the 7 interchanges in the IBR Program Area. Figure 3-6 illustrates the freeway analysis area.

Because there are only two facilities, I-5 and I-205, that cross the Columbia River in the Portland metropolitan region, traffic volumes using the I-205 Glenn Jackson Bridge were documented to understand the interaction between the two corridors when roadway capacity, transit capacity, and tolling are added to I-5 as part of the IBR Program. A section summarizing the diversion impacts to other facilities and modes is summarized below. No freeway impact analysis was conducted for the I-205 corridor or the Glenn Jackson Bridge, as the IBR Program Area is focused on I-5 between SR 500 and Victory Boulevard.

3.3.2 Origin-Destination Patterns

An important aspect of traffic analysis is identifying the patterns of where drivers in the IBR Program Area are coming from, their origin, and where they are going, their destination. Understanding these “origin-destination patterns” is essential to evaluating traffic that uses the Interstate Bridge and the seven IBR Program Area interchanges, due to the limited number of Columbia River crossing locations within the Portland-Vancouver metropolitan area and I-5’s interface with key east-west highways and arterial roadways immediately north and south of the Columbia River.

During the CRC project, Interstate Bridge origin-destination flows were determined by collecting ramp-to-ramp origin-destination data in the IBR Program Area using a video license-plate survey. In the time since the CRC project, technological innovations in the realm of origin-destination data collection via GPS tracking and automatic vehicle identification (AVI) systems (e.g., anonymized cellular phone data and GPS data) have presented a new data source. The IBR Program collected new origin-destination pattern information using GPS and AVI systems using StreetLight Data in 2019. StreetLight Data is a company that specializes in providing transportation analytics. It collects and analyzes data related to traffic and transportation travel patterns with a set of proprietary data-processing algorithms that transform the data into contextualized, aggregated, and normalized travel patterns. It uses a variety of sources of information, including mobile phones, connected vehicles, and other location-based technologies, along with underlying census data to offer insights into traffic flows and travel patterns. The new origin-destination data collected included observed origin-destination patterns for all trips crossing the Columbia River using each of the two bridges as well as the ramp-to-ramp flows in the IBR Program Area. These data summaries were compared to the Metro/RTC regional travel demand data and the historical CRC origin-destination data.

Figure 3-6. I-5 Freeway Analysis Area

Figure 3-7 illustrates the spatial distribution of trips that originate in Oregon and use one of the two northbound bridges—either the I-5 Interstate Bridge or the I-205 Glenn Jackson Bridge—to cross the river. The circles reflect the overall magnitude of the river crossings with larger circles representing more trips. The different shading colors represent the shares of total northbound river crossings originating in each district that choose the I-5 Interstate Bridge to cross the river with the lightest color reflecting the smallest shares and the darkest color reflecting the largest shares. For example, of all the river-crossing trips originating in the southwest area of the Portland metropolitan region, colored in the darkest shade of blue, more than 80% of the trips chose the I-5 Interstate Bridge to cross the river, while less than 20% of those trips used the I-205 Glenn Jackson Bridge. In a similar fashion, 80% of the river-crossing trips originating in the east/southeast area of the Portland metropolitan region used the I-205 Glenn Jackson Bridge and less than 20% of the trips chose the I-5 Interstate Bridge to cross the river.

Figure 3-7. Total Northbound Columbia River Crossings with I-5 Bridge Shares

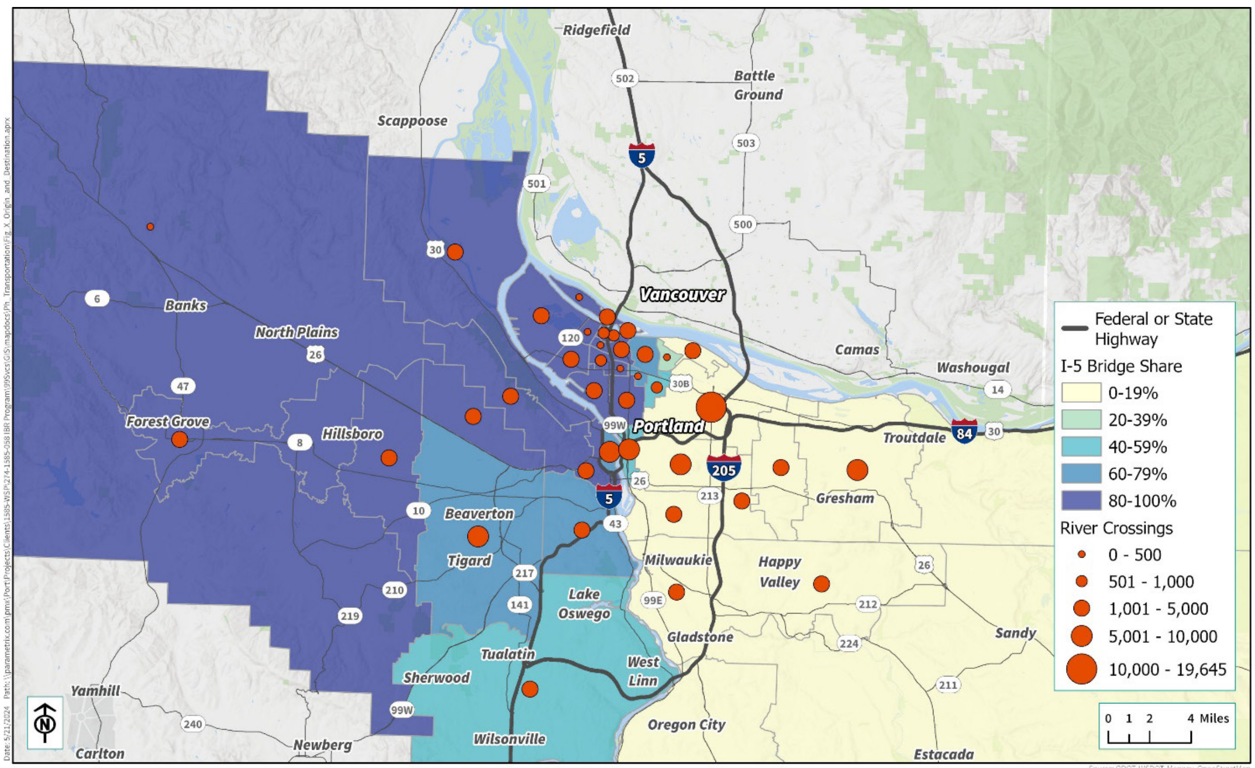
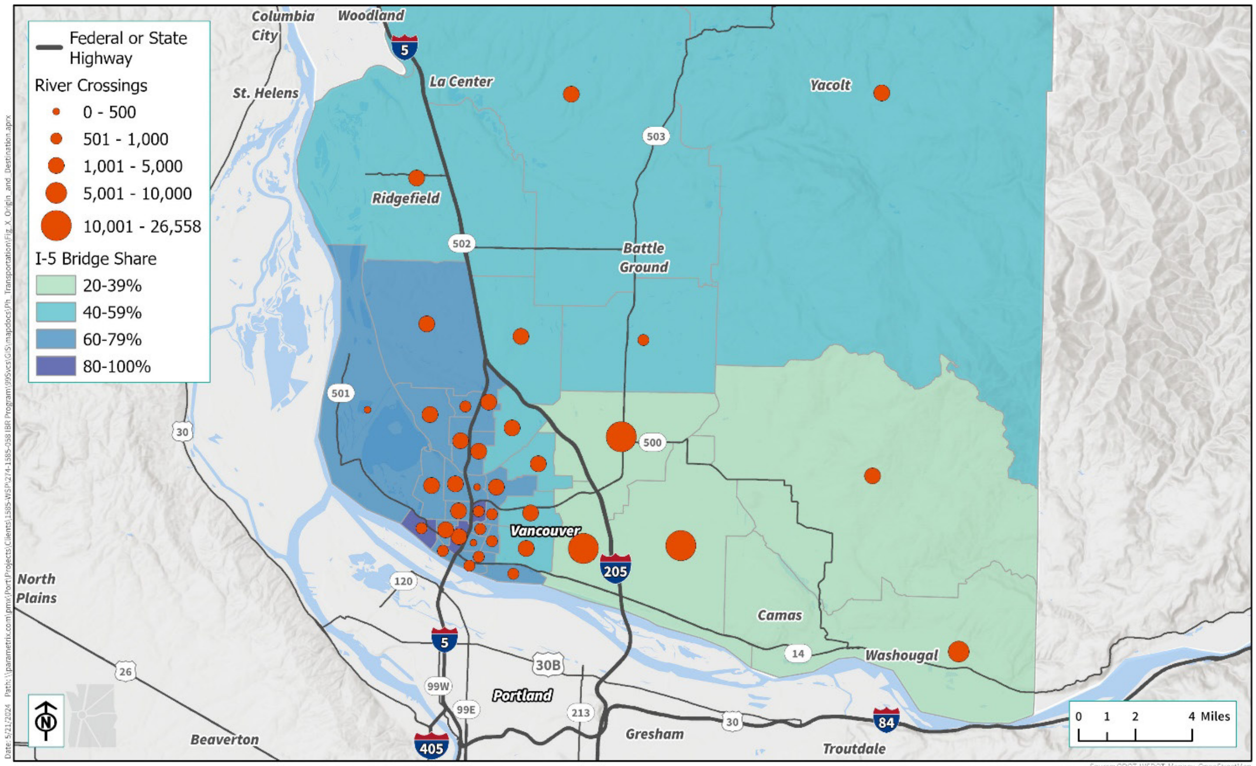


Figure 3-8 illustrates the spatial distribution of trips that originate in Washington and use one of the two southbound bridges—either the I-5 Interstate Bridge or the I-205 Glenn Jackson Bridge—to cross the river. Most districts near downtown Vancouver have more than 60% of southbound river crossings using the I-5 Interstate Bridge. As expected, a high percentage of trips in each district chose the nearest bridge to cross the river.

Several districts situated between the I-5 and I-205 corridors make a choice more evenly to select one of the two bridges, represented in the maps by districts that have 40% to 59% of total trip origins using I-5. It is important to note that the choice of bridge is highly dependent on where a trip originates and is destined.

Figure 3-8. Total Southbound Columbia River Crossings with I-5 Bridge Shares



In addition to regional origin-destination patterns, the IBR Program Area ramp origin-destination patterns were summarized. As shown in Figure 3-9, 14% of southbound AM peak-period traffic across the Interstate Bridge traveled on I-5 from north of SR 500 to south of Columbia Boulevard, and 86% of southbound AM peak-period traffic across the bridge entered and/or exited I-5 via a ramp in the IBR Program Area. As shown in Figure 3-10, 23% of northbound PM peak-period traffic across the Interstate Bridge traveled on I-5 from south of Columbia Boulevard to north of SR 500, and 77% of northbound peak-period traffic across the bridge entered and/or exited I-5 via a ramp within the IBR Program Area. Most of the traffic crossing the Interstate Bridge during the AM and PM peak periods is entering or exiting I-5 at one of the seven interchanges in the IBR Program Area.

Figure 3-9. Origin-Destination Patterns for Southbound AM Peak-Period Vehicle Trips within the IBR Program Area

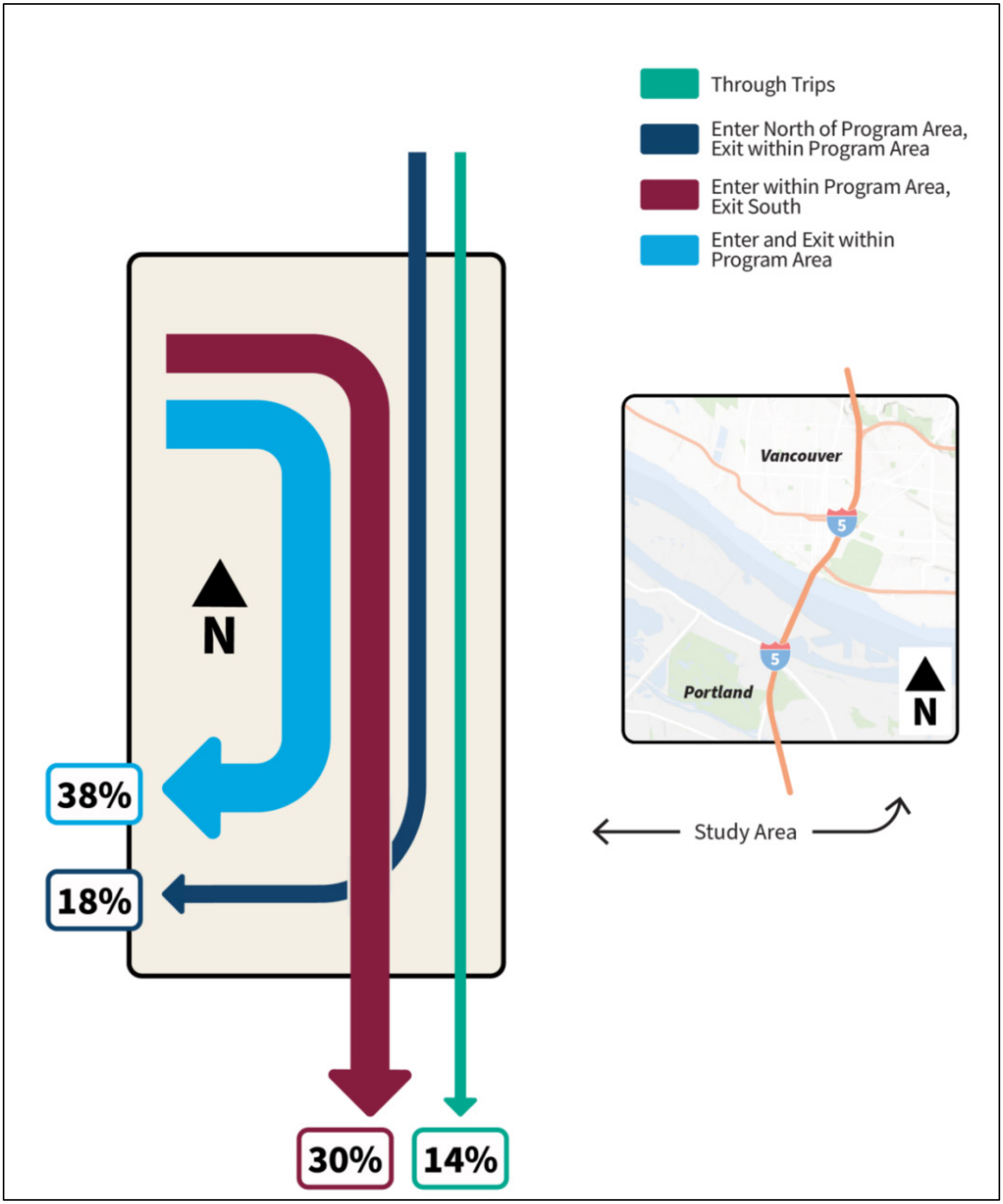
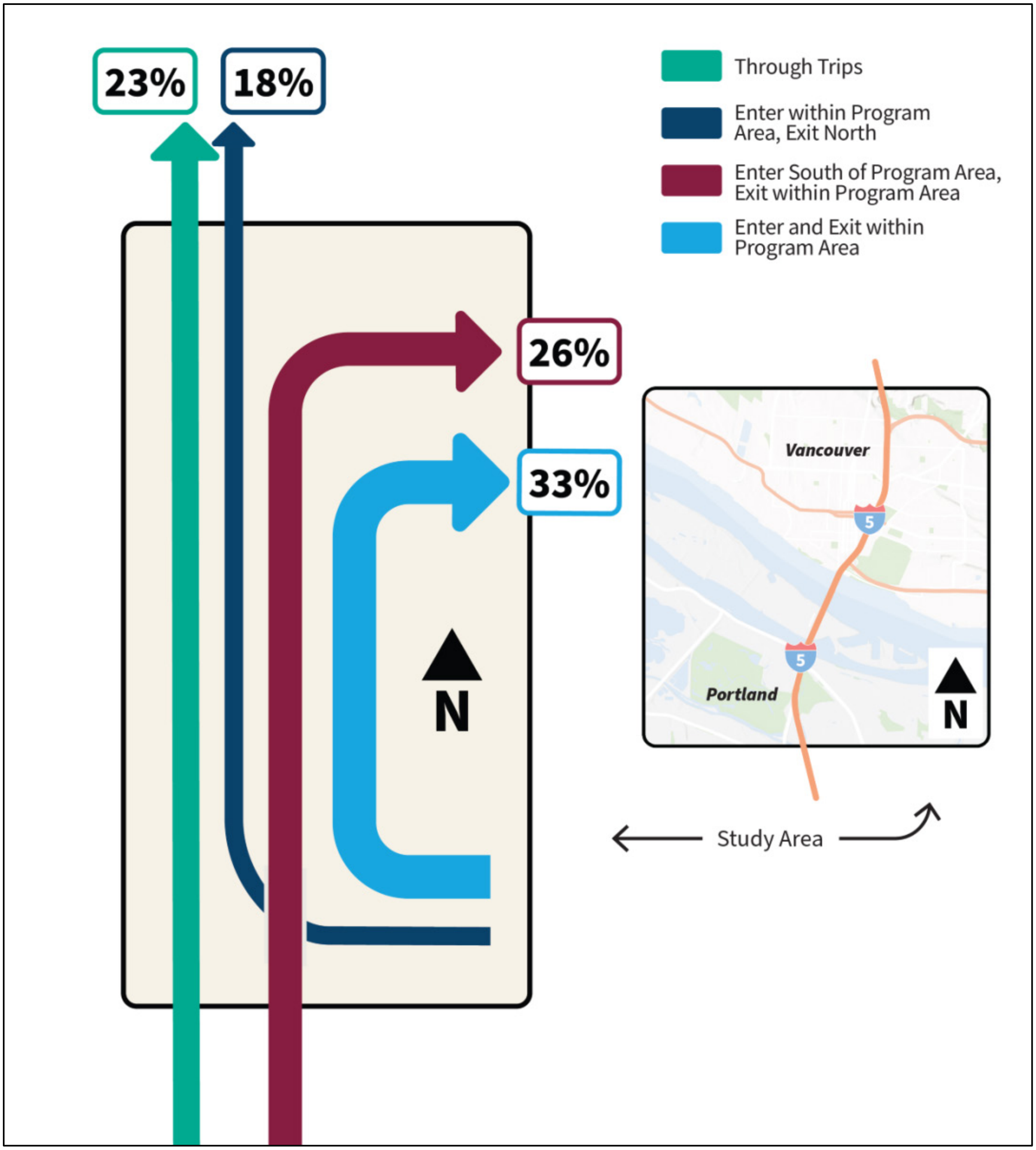


Figure 3-10. Origin-Destination Patterns for Northbound PM Peak-Period Vehicle Trips within the IBR Program Area



3.3.3 Mainline and Ramp Vehicle Volumes

This section describes the methodology used to collect vehicle counts on the I-5 mainline and ramps, evaluate the level of vehicle demand versus the actual volume of vehicles served, and calculate the final peak-period mainline and ramp volumes.

3.3.3.1 Average Weekday Daily Traffic Volumes

ODOT and WSDOT maintain permanent traffic counters throughout their freeway/highway systems that collect hourly traffic counts 365 days a year, 24 hours a day. Within the IBR freeway analysis area and the I-205 Glenn Jackson Bridge, ODOT and WSDOT maintain five permanent count locations. The five locations include I-5 south of the SR 500 interchange in Vancouver, the Interstate Bridge, I-5 near the Rosa Parks interchange in Portland, I-5 at the Marquam Bridge in Portland, and I-205 at the Glenn Jackson Bridge.

The IBR team collected hourly volume data for the entire year of data for 2019. The permanent traffic count data were then filtered to estimate average weekday daily traffic (AWDT) volumes in 2019. The filtering process excluded data that do not reflect typical weekday conditions, including:

- Mondays and Fridays (typically excluded from average weekday traffic counts because they often exhibit significantly different traffic patterns compared to other weekdays).
- Holidays and days before or after holidays with atypical traffic volumes.
- Days where incidents, crashes, weather, or other events caused atypical traffic volumes.

This filtering process produced a volume set that reflects average weekday travel patterns approaching the Interstate Bridge associated with commute traffic during the critical time periods and directions (southbound during the AM peak period and northbound during the PM peak period). Due to this filtering, the 2019 AWDT volumes used for the IBR analysis are different than the 2019 AWDT/AADT reported by ODOT and RTC.

AWDT volumes for the five permanent traffic count locations are summarized in Table 3-5.

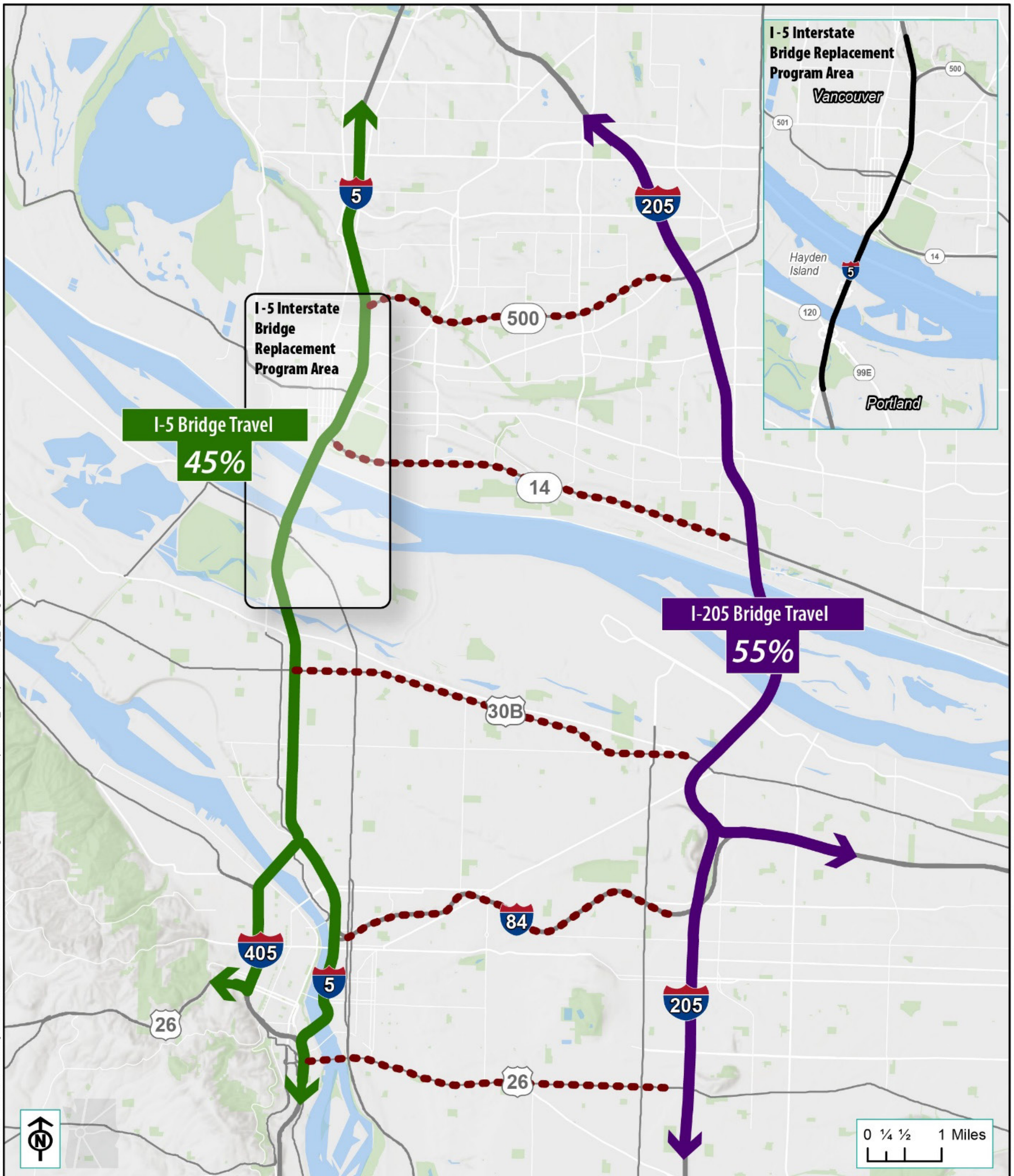
Table 3-5. AWDT Mainline Counts

ODOT/WSDOT ID	Data Collection Station Location	I-5 Milepost	2019 AWDT
P5S	I-5 at SR 500	1.98	152,100
26-004	I-5 Interstate Bridge	307.97	143,400
26-019	I-5 at Rosa Parks	304.66	134,700
26-026	I-5 Marquam Bridge	300.37	147,400
26-024	I-205 Glenn Jackson Bridge	307.97	169,600

Source: WSDOT and ODOT Traffic Counters, IBR Analysis

The current river crossing splits between the I-5 Interstate Bridge and I-205 Glenn Jackson Bridge are shown in Figure 3-11. As shown, the I-5 Interstate Bridge currently carries 45% of the daily river-crossing trips and the I-205 Glenn Jackson Bridge carries 55%.

Figure 3-11. Existing Columbia River Crossing Shares by Bridge

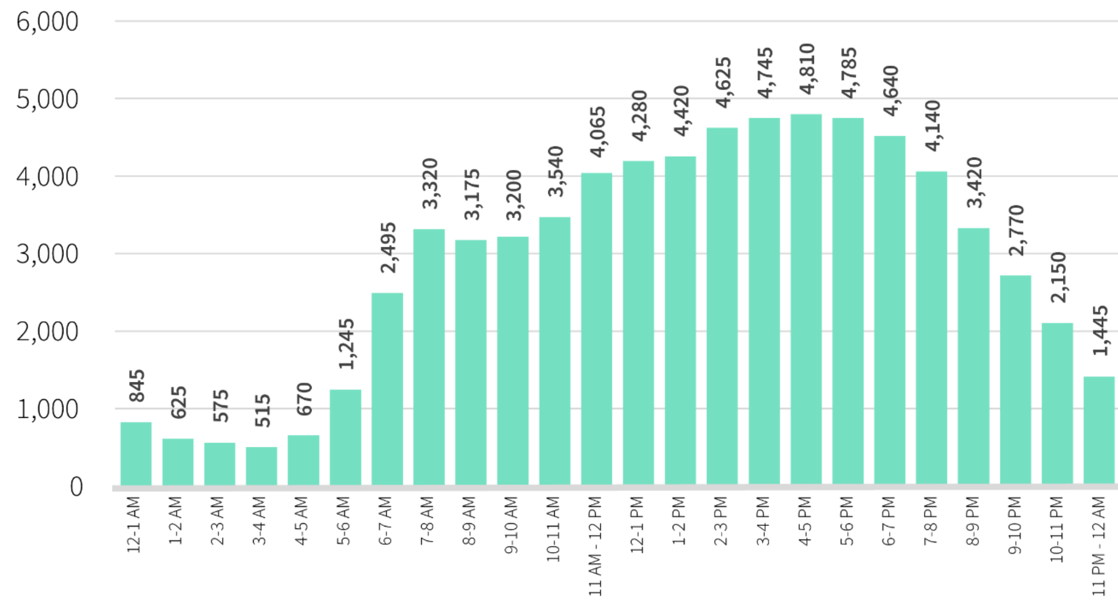


Date: 4/11/2024 Path: U:\Port\Projects\Clients\1585-WSP\274-1585-058 IBR Program\99Svcs\GIS\mapdocs\Ph_Transportation\Fig_X_Origin_and_Destination.aprx

Source: ODOT, WSDOT, Mapbox, OpenStreetMap

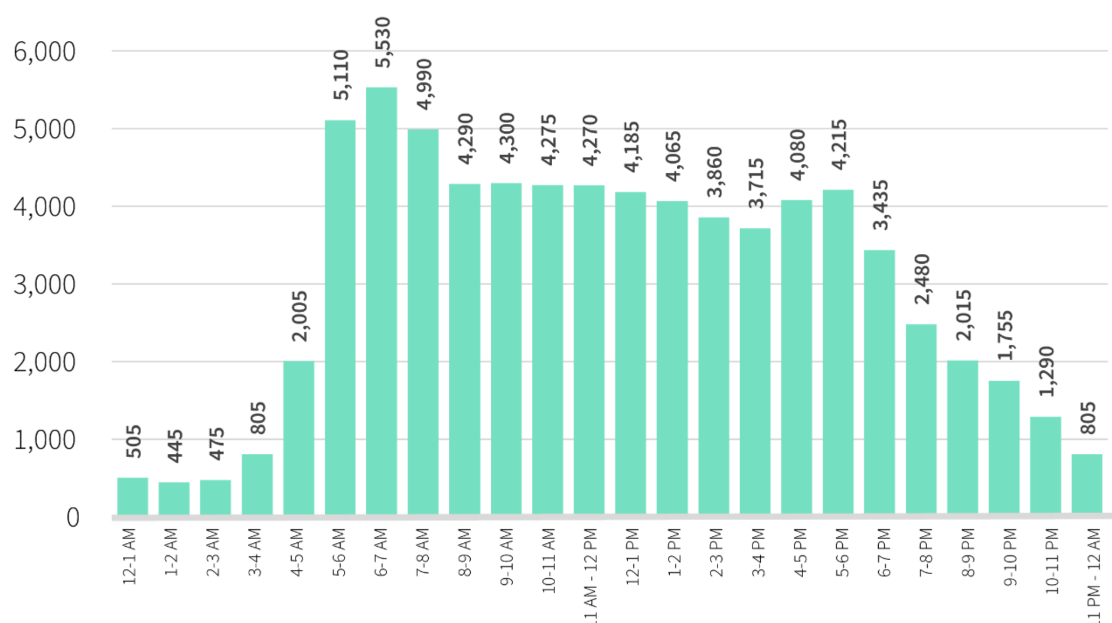
In addition to AWDT, the hourly profiles over the day and flows during the peak period are important to understand. The Interstate Bridge hourly volume profile for northbound and southbound are shown in Figure 3-12 and Figure 3-13, respectively. The 4-hour AM peak period is between 6 a.m. and 10 a.m., and the 4-hour PM peak period is between 3 p.m. and 7 p.m.

Figure 3-12. Interstate Bridge Hourly Profile – Northbound Weekday Service Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis

Figure 3-13. Interstate Bridge Hourly Profile – Southbound Weekday Service Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis

3.3.3.2 Ramp Counts

WSDOT and ODOT collect short-duration counts at freeway ramps. To supplement data from the permanent count locations, 2019 ramp counts were collected by WSDOT and ODOT within the freeway analysis area. The 2019 ramp counts were collected over different times of the year for different time periods, ranging from days to weeks. The ramp counts were summarized for average weekdays (Tuesdays through Thursdays), similar to the permanent traffic counts. WSDOT ramp counts contained adjustment factors that accounted for seasonal adjustments and axle correction factors.

3.3.3.3 Mainline and Ramp Volumes

This section describes the development of 2019 existing conditions peak-period mainline and ramp volumes that are used in the VISSIM traffic operations model. In the freeway analysis area, there are locations where the freeway is congested for multiple hours during the peak periods. In general, congestion occurs when the number of vehicles arriving at a particular location exceeds the number of vehicles that pass through the location. When congestion is present, it is critical to distinguish between *demand volume* (the number of vehicles arriving during a certain time period) and *service volume* (the number of vehicles getting through the congestion during the same time period). Traffic volumes collected in congested roadway segments or downstream of congested roadway segments reflect service volumes.

When traffic is flowing freely, the service volume is equal to the demand volume. When traffic is not flowing freely and the roadway is congested, the service volumes collected in the field reflect the capacity of the roadway, or the maximum number of vehicles that the roadway can accommodate in a certain location over a defined period of time. Congestion arises because the demand volume exceeds the capacity of the roadway, meaning that the number of vehicles arriving at a location is greater than the number of vehicles that can pass through that location. During congested periods of travel, demand volumes are equal to the service volumes plus the number of unserved vehicles. See Section 3.3.4 for discussion about congestion in the IBR Program Area.

The IBR team adjusted the traffic volumes collected in the field (service volumes) to account for roadway capacity and congestion when developing peak-period demand volumes. The traffic operations model throughputs were calibrated to the service volumes, but the traffic operations used demand volume inputs. Demand volumes and profiles were developed by adding volume to the service volume early in the peak period and subtracting volume from the service volume late in the peak period to account for the vehicles that arrive at a location without being able to get through the congestion. The amount of volume shifted to reflect unserved demand upstream of bottlenecks was estimated through the VISSIM calibration process.

The IBR team developed a consistent set of 4-hour peak-period demand volumes for the I-5 freeway analysis area using ODOT and WSDOT AWDT mainline and ramp counts. Due to different count periods, volume adjustments were required to individual ramp counts to match the more representative permanent traffic recorders along the freeway mainline. Final volume adjustments were included to represent demand volumes where congestion exists within the I-5 freeway analysis area.

Figure 3-14 and Figure 3-15 show the 4-hour northbound and southbound peak-period mainline and ramp demand volumes in the freeway analysis area, respectively. Mainline I-5 volumes at the north end, on the bridge, and at the south end of the IBR Program Area are in bold. Southbound mainline volumes reach their peak during the AM peak period, and northbound mainline volumes reach their peak during the PM peak period.

3.3.3.4 Daily Person Throughput

Person throughput is a concept developed to understand the number of people (as opposed to the number of vehicles) that a transportation facility can serve within a given time frame. The number of vehicles (passenger cars, freight trucks, and buses) crossing the Interstate Bridge was multiplied by average vehicle occupancy (AVO) assumptions to calculate total person throughput. AVO was based on recent observations completed on I-5 in the Program Area in 2019 and 2020 by ODOT. General-purpose traffic AVO is 1.28 people per vehicle, and freight AVO is 1.14 people per vehicle. In the southbound direction, daily person throughput across the Interstate Bridge is 93,400 people. For the northbound direction, the daily person throughput is 92,400 people. Consistent with historical traffic counts on the I-5 Interstate Bridge, the northbound and southbound traffic volumes are slightly different due to external through-trip patterns and different transit routing between the AM and PM peak periods.

3.3.4 Freeway Operations

Based on the traffic volume data described in Section 3.3.3, Mainline and Ramp Vehicle Volumes, 2019 freeway operations for I-5 within the freeway analysis area were evaluated using VISSIM microsimulation models. The 2019 VISSIM models were developed and calibrated to the observed traffic operations along northbound and southbound I-5 during the 6 to 10 a.m. and 3 to 7 p.m. peak periods. VISSIM model methodology and calibration is summarized in Appendix C. Outputs from the VISSIM model—throughput volume at the Interstate Bridge, travel times in the IBR Program Area, and speeds in the freeway analysis area—were the key data sources used to establish baseline conditions along the freeway network.

3.3.4.1 Bottlenecks and Speeds

Bottlenecks are locations on freeways that cause congestion. Congestion is an excess of vehicles on the roadway at a particular time, resulting in speeds that are slower than free-flow speeds. Congestion is divided into two categories: recurring and nonrecurring. Recurring congestion occurs when the traffic flow rate approaching a location exceeds the traffic flow rate departing the same location. This type of congestion occurs due to operational influences, which include decision points such as on- and off-ramps, merging/diverging segments, weaving segments, lane drops, and traffic signals; and design constraints such as curves, grades, underpasses, or narrow or nonexistent shoulders. Freeway segment types including merging/diverging and weaving are described in the Transportation Methods Report (Appendix A). Recurring congestion is routine to the point of being predictable in cause, location, time of day, and duration. Nonrecurring congestion is caused by traffic incidents, work zones, bad weather, and special events. Traffic crashes or incidents are summarized in Section 3.9, Safety, of this report. The VISSIM models used to evaluate traffic operations focused on the recurring congestion and the operational influences and design constraints that cause them.

Figure 3-14. 2019 Existing Conditions Northbound Peak Period Mainline and Ramp Volumes (vehicles per hour)

Location	AM Peak 6-7	AM Peak 7-8	AM Peak 8-9	AM Peak 9-10	PM Peak 3-4	PM Peak 4-5	PM Peak 5-6	PM Peak 6-7
I-5 Mainline	**1,715**	**2,380**	**2,300**	**2,670**	**4,570**	**5,370**	**5,315**	**4,265**
E 39th St On	*200*	*290*	*340*	*335*	*495*	*560*	*565*	*410*
SR 500 / E 39th St Off	*575*	*825*	*900*	*860*	*2,050*	*2,090*	*2,060*	*1,695*
E 4th Plain Blvd On	*245*	*350*	*440*	*415*	*750*	*855*	*730*	*465*
E Mill Plain Blvd On	*210*	*350*	*485*	*570*	*1,225*	*1,530*	*1,505*	*855*
E Mill Plain Blvd/E 4th Plain Blvd Off	*985*	*1,210*	*1,100*	*960*	*1,205*	*1,230*	*1,265*	*935*
SR 14 On	*905*	*1,175*	*1,030*	*930*	*1,370*	*1,555*	*1,520*	*1,020*
C St Off	*145*	*260*	*325*	*240*	*245*	*235*	*245*	*230*
SR 14 Off	*630*	*805*	*845*	*685*	*1,195*	*1,225*	*1,175*	*1,085*
I-5 Mainline ***Interstate Bridge***	**2,490**	**3,315**	**3,175**	**3,165**	**5,425**	**5,650**	**5,740**	**5,460**
Hayden Island On	*165*	*210*	*255*	*360*	*515*	*520*	*540*	*500*
Hayden Island Off	*400*	*470*	*495*	*620*	*455*	*410*	*375*	*320*
Marine Dr W On	*895*	*1,020*	*975*	*995*	*1,415*	*1,375*	*1,520*	*1,080*
N Victory Blvd/N Interstate Ave On	*475*	*605*	*635*	*665*	*1,075*	*1,135*	*1,095*	*1,035*
Marine Dr W Off	*575*	*555*	*555*	*645*	*130*	*140*	*150*	*260*
N Victory Blvd Off	*85*	*90*	*130*	*190*	*40*	*20*	*25*	*65*
I-5 Mainline	**2,015**	**2,595**	**2,490**	**2,600**	**3,045**	**3,190**	**3,135**	**3,490**

Direction of Travel

Figure 3-15. 2019 Existing Conditions Southbound Peak Period Mainline and Ramp Volumes (vehicles per hour)

Direction of Travel

AM Peak 6-7	AM Peak 7-8	AM Peak 8-9	AM Peak 9-10	Location	PM Peak 3-4	PM Peak 4-5	PM Peak 5-6	PM Peak 6-7
2,875	**3,010**	**3,865**	**3,635**	**I-5 Mainline**	**3,300**	**3,530**	**3,760**	**2,880**
580	*715*	*335*	*270*	*E 39th St Off*	*395*	*435*	*495*	*400*
2,110	*2,185*	*1,960*	*1,615*	*SR 500 / E 39th St On*	*1,265*	*1,365*	*1,375*	*1,190*
600	*865*	*715*	*570*	*E 4th Plain Blvd Off*	*650*	*700*	*740*	*480*
605	*660*	*460*	*420*	*E 4th Plain Blvd On*	*430*	*460*	*420*	*350*
365	*620*	*1,190*	*1,035*	*E Mill Plain Blvd Off*	*845*	*820*	*890*	*680*
1,335	*1,405*	*995*	*880*	*E Mill Plain Blvd On*	*905*	*1,005*	*970*	*565*
445	*580*	*910*	*885*	*SR 14 Off*	*1,275*	*1,485*	*1,430*	*915*
915	*870*	*920*	*1,010*	*SR 14 On*	*980*	*1,160*	*1,245*	*925*
5,850	**5,350**	**5,050**	**4,800**	**I-5 Mainline** *Interstate Bridge*	**3,715**	**4,080**	**4,215**	**3,435**
480	*590*	*650*	*590*	*Hayden Island Off*	*575*	*600*	*615*	*510*
570	*570*	*570*	*635*	*Hayden Island On*	*505*	*440*	*350*	*400*
1,680	*1,765*	*1,635*	*1,380*	*Marine Dr W Off*	*1,105*	*1,205*	*1,115*	*725*
355	*310*	*345*	*385*	*Marine Dr W On*	*240*	*185*	*145*	*170*
1,080	*1,085*	*840*	*670*	*N Victory Blvd/N Interstate Ave Off*	*480*	*395*	*335*	*280*
90	*100*	*90*	*110*	*N Victory Blvd On*	*405*	*320*	*225*	*220*
3,625	**2,890**	**2,930**	**3,290**	**I-5 Mainline**	**2,705**	**2,825**	**2,870**	**2,710**

ODOT and WSDOT define congestion as speeds below a certain threshold. ODOT has historically defined congestion as when travel speeds drop below 75% of the posted speed limit due to constrained conditions (for example, speeds slower than 45 mph in an area with a posted speed of 60 mph). In the CRC EIS analysis, congestion was defined as occurring when travel speeds were below 35 mph. ODOT has recently refined its measures of congestion into two levels, with congestion defined as speeds below 45 mph and severe congestion defined as speeds below 35 mph. Therefore, the IBR Program has defined congestion as speeds below 45 mph and summarized the hours of congestion at bottlenecks according to this definition.

I-5 was evaluated for traffic performance within the freeway analysis area based on modeled average vehicle speeds and empirical speed data. VISSIM model outputs were summarized in 15-minute increments for both the 4-hour AM and PM peaks to identify the location, duration and intensity of congestion. Midday travel speeds are based on empirical speed data. Travel speed "heat maps" were generated to show average vehicle speeds across set segments along the I-5 corridor between 5 a.m. and 9 p.m. Heat maps show speeds at different locations along the y-axis and how those speeds change across the time of day along the x-axis. On the heat maps, different colors represent different speeds, summarized by location. Dark red represents 0 to 15 mph, red 15 to 25 mph, orange 25 to 35 mph, yellow 35 to 45 mph, light green 45 to 55 mph, and dark green greater than 55 mph.

In the southbound direction, the Interstate Bridge bottleneck experiences 3 hours of congestion between 6 and 9 a.m. This congestion extends from the Interstate Bridge back to the SR 500/39th Street interchange. The congestion at the Interstate Bridge is caused by the bridge's limited capacity, limited sight distance, substandard shoulders, short merge and diverge locations north and south of the bridge, heavy on- and off-ramp flows north of the river, and heavy truck volumes. A second southbound bottleneck starts south of the IBR Program Area but affects traffic speeds from the start of the bottleneck near the I-5/I-405 split in North Portland and the Marine Drive interchange. This second bottleneck experiences 6.5 hours of congestion between 6:30 a.m. and 1 p.m. The congestion at the I-5/I-405 split in North Portland is caused primarily by capacity restrictions, as well as by heavy merging, diverging, and weaving flows at adjacent ramps. A third southbound bottleneck through the Rose Quarter, where I-5 is reduced from three to two travel lanes, experiences congestion for 12.5 hours from 7:15 a.m. to 7:45 p.m. The congestion at the Rose Quarter is caused primarily by capacity restrictions where I-5 is reduced from three to two travel lanes.

In the northbound direction, the Interstate Bridge bottleneck lasts for 8.75 hours between 11:15 a.m. and 8:00 p.m. The congestion extends south from the Interstate Bridge and influences traffic flows south of the IBR Program Area for 10 plus miles into downtown Portland. The northbound congestion occurs for similar reasons as the southbound Interstate Bridge congestion, including limited bridge capacity; limited sight distance; substandard shoulders; short merge and diverge locations north and south of the bridge; heavy merging, diverging, and weaving flows of traffic; and heavy freight flows.

Figure 3-16 and Figure 3-17 illustrate the average travel speeds from 5 a.m. to 9 p.m. across the freeway analysis area on I-5 southbound and northbound respectively.

Figure 3-16. 2019 Average Weekday Southbound Speeds (5 a.m. to 9 p.m.)

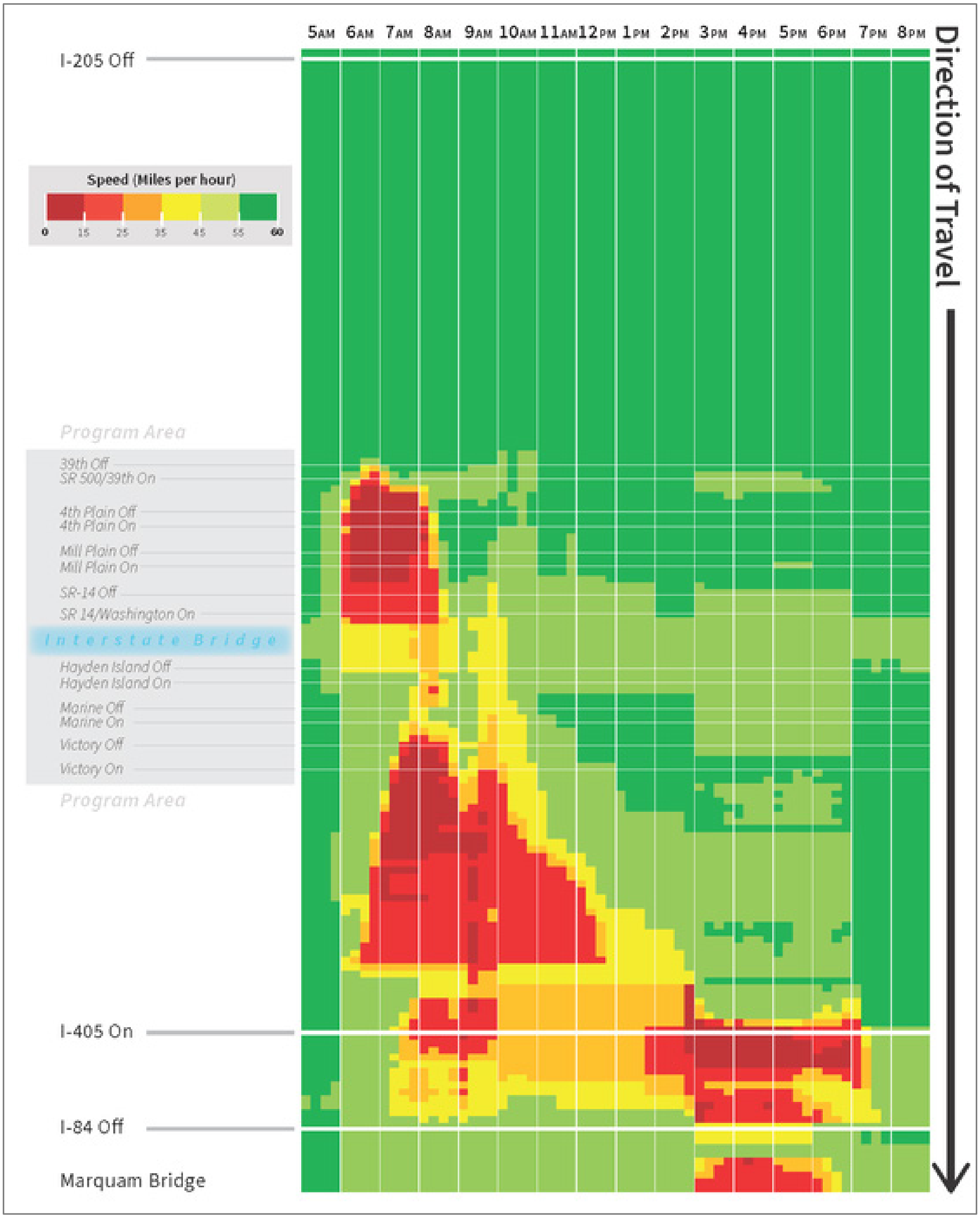
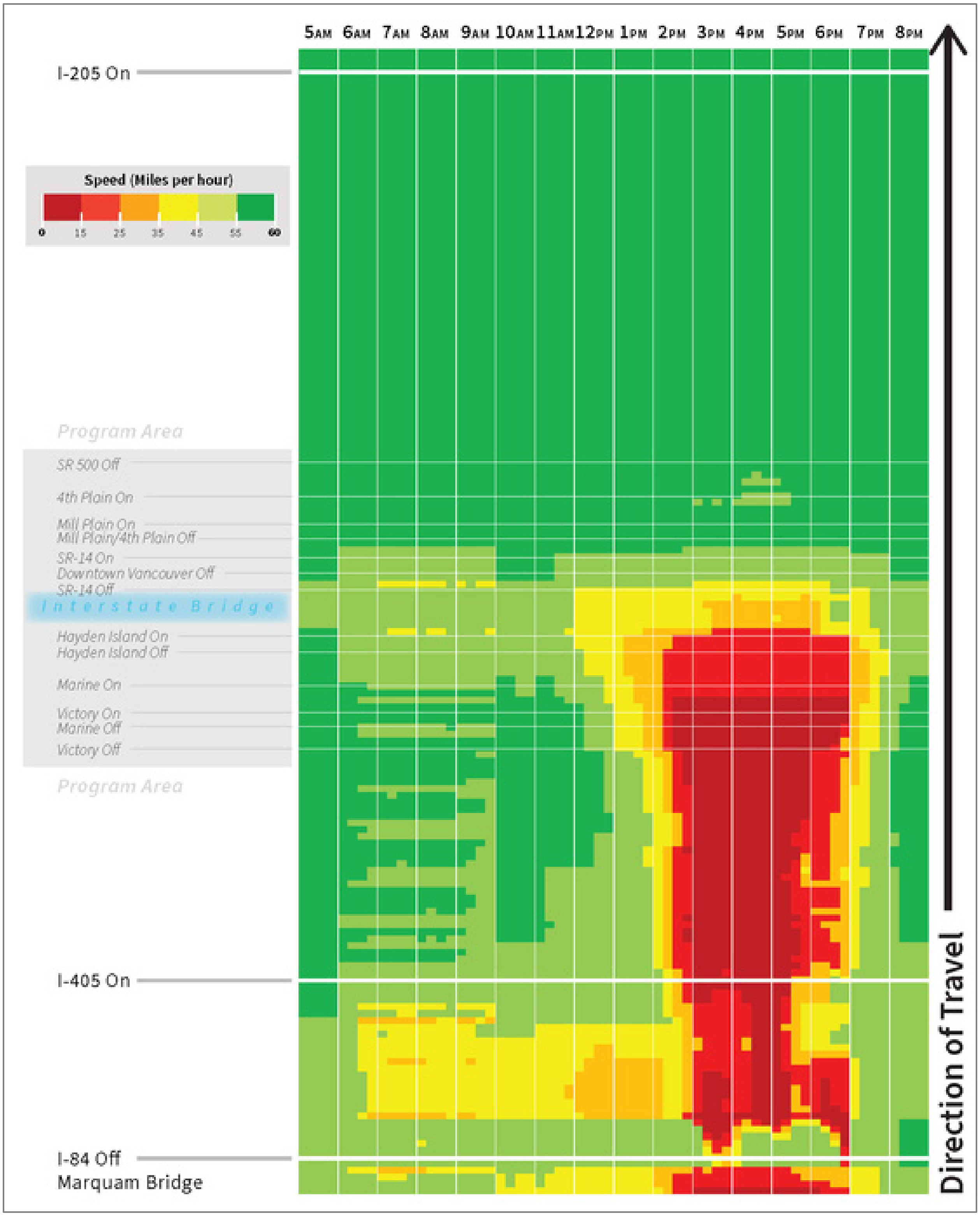


Figure 3-17. 2019 Average Weekday Northbound Speeds (5 a.m. to 9 p.m.)



Key information about existing bottlenecks—the location, time of day, duration, and geographic extent of the congestion are summarized in Table 3-6. The extents shown in Table 3-6 reflect the maximum extent of the congestion over the 16 hours. As shown in Figure 3-16 and Figure 3-17, once congestion starts at a bottleneck, it builds over time and dissipates as traffic demand volumes begin decreasing after peak periods.

Table 3-6. Weekday Bottleneck Locations when Speeds are Below 45 mph – 2019 Existing Conditions

Location	Time of Day	Duration (hours)	Maximum Extent (miles)
SB – Interstate Bridge	6–9 a.m.	3 hours	3 miles
SB – I-5/I-405 Split in North Portland	6:30 a.m.–1 p.m.	6.5 hours	3 miles
SB – Rose Quarter	7:15 a.m.–7:45 p.m.	12.5 hours	3 miles
NB – Interstate Bridge	11:15 a.m.–8:00 p.m.	8.75 hours	10+ miles

Source: IBR VISSIM Analysis.

NB = northbound; SB = southbound

3.3.4.2 Congestion Index

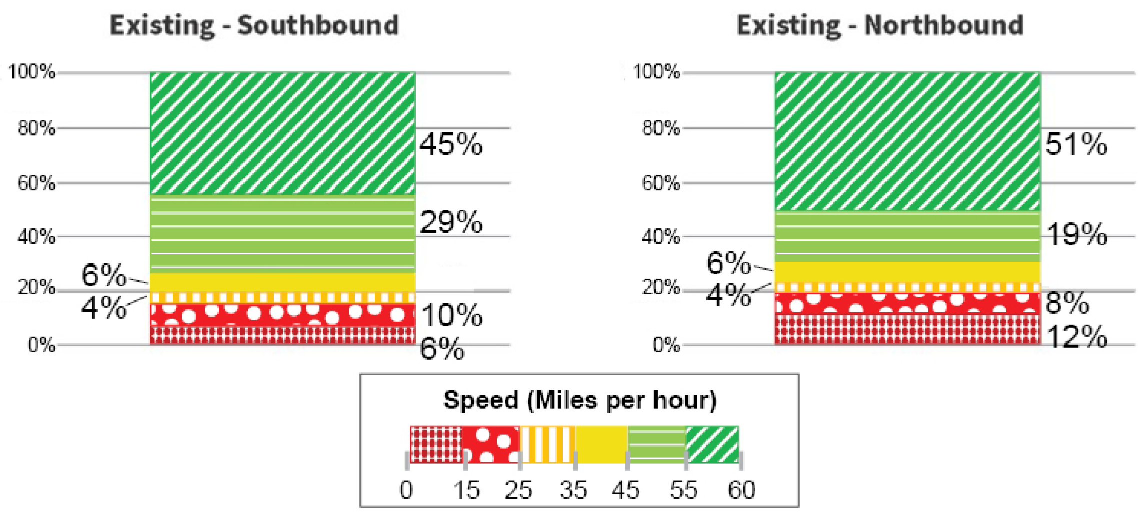
Congestion indices were developed to provide a simple, one-dimensional comparison of the level of congestion within the freeway analysis area during the modeled peak periods for each alternative. The congestion indices show the aggregated level of congestion on each direction of I-5 in the freeway analysis area during the 8 peak hours, (the 4-hour AM peak, 6 to 10 a.m., and the 4-hour PM peak period, 3 to 7 p.m.).

The heat maps in Section 3.3.4.1 are time-space diagrams. Each data point in the heat map represents an approximately 500-foot section of I-5 mainline and is color coded based on the average speed on that 500-foot section of I-5 over a 15-minute period. The data points are organized geographically and spatially, so they show the average speed at a given section of I-5 during a given time.

The congestion indices use this same data, but instead of organizing the data by location and time, the data are organized by speed bin. Thus, the congestion indices show what percentage of the data points on southbound I-5 (during the 4-hour AM and 4-hour PM peak periods) operation at a particular speed. The congestion indices answer the question of what percentage of the heat maps shown in Section 3.3.4.1 operate at a particular speed. By eliminating the spatial and temporal components of the heat maps, a quick comparison of the general level of congestion for each alternative is provided.

During the 4-hour AM and PM peak periods, 26% of the area in the I-5 southbound heat maps operates with speeds below 45 mph. During the 4-hour AM and PM peak periods, 30% of the area in the I-5 northbound heat maps operates with speeds below 45 mph. See Figure 3-18 for results.

Figure 3-18. Existing 2019 Peak-Period Congestion Index



3.3.4.3 Peak-Period Travel Times

The VISSIM traffic operations model was used to calculate AM and PM peak-period travel times across set segment corridors.

SOUTHBOUND TRAVEL TIMES

The longest travel time for southbound I-5 traffic occurs during the AM peak period. Total I-5 travel times during the modeled 4-hour AM peak period between I-205 and I-405 in North Portland range between 21 and 38 minutes. The average travel time during the peak 2 hours is 35 minutes, which exceeds the free-flow travel time by approximately 21 minutes.

Travel times during the modeled 4-hour PM peak period between I-205 and I-405 in North Portland range between 13 and 14 minutes. The average travel time during the peak 2 hours is 14 minutes, equivalent to the free-flow travel time.

Table 3-7 shows travel times on I-5 between I-205 and I-405 in North Portland in the AM and PM peak periods, respectively.

Table 3-7. I-5 Average Weekday Southbound Peak-Period Travel Times between I-205 and I-405 in North Portland – 2019 Existing Conditions

Metric	6 AM (mins)	7 AM (mins)	8 AM (mins)	9 AM (mins)	3 PM (mins)	4 PM (mins)	5 PM (mins)	6 PM (mins)
Hourly Average Travel Time	24	38	32	21	13	13	14	13
Peak 2-hour Average Travel Time	35	35	35	35	14	14	14	14

Source: IBR Analysis.

NORTHBOUND TRAVEL TIMES

I-5 travel times during the modeled 4-hour AM peak period between I-405 in North Portland and I-205 are 13 minutes, equivalent to the free-flow travel time, as there is no congestion.

The longest travel time for northbound I-5 traffic occurs during the PM peak period. Total I-5 travel times during the modeled 4-hour PM peak period between I-405 in North Portland and I-205 range between 19 and 40 minutes. The average travel time during the peak 2 hours is 35 minutes, which exceeds the free-flow travel time by approximately 22 minutes.

Table 3-8 shows the I-5 travel times between I-205 and I-405 in North Portland in the AM and PM peak periods, respectively.

Table 3-8. I-5 Average Weekday Northbound Peak-Period Travel Times between I-405 in North Portland and I-205 – 2019 Existing Conditions

Metric	6 AM (mins)	7 AM (mins)	8 AM (mins)	9 AM (mins)	3 PM (mins)	4 PM (mins)	5 PM (mins)	6 PM (mins)
Hourly Average Travel Time	13	13	13	13	36	40	31	19
Peak 2-hour Average Travel Time	13	13	13	13	35	35	35	35

Source: IBR Analysis.

3.3.4.4 Level of Service and Volume Capacity Ratios

As described in the Transportation Methods Report (see Appendix A), WSDOT uses LOS as its standard for freeway performance, while ODOT uses V/C ratios to set mobility standards and performance targets. WSDOT sets the LOS standard for I-5 in Washington at LOS D. ODOT's performance standard for I-5 in Oregon is a V/C ratio of 1.1 for the highest peak hour and 0.99 for all other hours. The Transportation Methods Report (Appendix A) provides more information on how these standards are defined and evaluated and describes the freeway segment types (basic, merge/diverge, and weave). The performance standard metrics in this section are only reported for the IBR Program Area because they are ultimately used to determine how a proposed roadway configuration aligns with the operational performance standards, and there are no proposed changes outside of the IBR Program Area.

As described in the Transportation Methods Report (Appendix A), VISSIM does not provide LOS or V/C as a direct output. VISSIM does provide density as a direct output, and while density in the VISSIM model (vehicles per mile per lane) is calculated differently compared to density calculations outlined in the FHWA Highway Capacity Manual (TRB 2016; passenger cars per mile per lane), the concept is the same in that both methods produce a result indicating how many units there are in a given distance. The density output from the VISSIM model was used to estimate the LOS for the different segments in the corridor in Washington.

While V/C ratios are not a direct output from the VISSIM model, the V/C ratios can be estimated based on the modeled density at each link in the VISSIM model. The capacity of the link is based on the Highway Capacity Manual thresholds of 45 passenger cars per mile per lane (pc/mi/ln) for basic freeway segments; 43 pc/mi/ln for weaving, merge, and diverge segments; and 40 pc/mi/ln for CD roadway segments. Depending on the density, links were assigned a range of V/C ratios from one of the following categories which allows operations performance to be compared with ODOT freeway standards (see Table 3-9).

Table 3-9. Roadway V/C Ratio and Densities by Segment Type

V/C Ratio	Basic Freeway Segment Density (veh/mi/ln)	Weave, Merge, Diverge Segment Density (veh/mi/ln)	CD Roadway Segment Density (veh/mi/ln)
< 0.25	< 11	< 11	< 10
0.25–0.50	11–23	11–22	10–20
0.50–0.75	23–34	22–32	20–30
0.75–0.80	34–36	32–34	30–32
0.80–0.90	36–41	34–39	32–36
0.90–1.0	41–45	39–43	36–40
1.0–1.1	45–50	43–47	40–44
> 1.1	> 50	> 47	> 44

veh/mi/ln = vehicles per mile per lane

On the Interstate Bridge, both the LOS and V/C ratio are reported to demonstrate how the Interstate Bridge performs compared against both states' performance measures.

The LOS and V/C ratios discussed in this section follow trends and results similar to those discussed in Sections 3.3.4.1 through 3.3.4.3 (Bottlenecks and Speeds, Congestion Index, and Peak-Period Travel Times). When bottlenecks are present and speeds and travel times are slow, the LOS and V/C ratios are poor, and when conditions are free-flow, LOS and V/C ratios meet mobility and performance standards.

In the southbound direction, I-5 in Washington does not meet WSDOT's mobility standard for three of the four AM peak hours due to the bottleneck at the bridge. Between 7 and 9 a.m., some sections at the southern end of the IBR Program Area do not meet ODOT's mobility standard due to congestion spilling back from the downstream bottleneck at the I-5/I-405 split in North Portland. All sections of southbound I-5 meet WSDOT and ODOT mobility standards during the PM peak period.

In the northbound direction, I-5 meets WSDOT and ODOT mobility standards during the AM peak period. However, during the PM peak period, all sections of I-5 in Oregon, including the Interstate Bridge, do not meet ODOT mobility standards due to the bottleneck at the Interstate Bridge, and the Interstate Bridge does not meet WSDOT mobility standards.

Table 3-10 and Table 3-11 summarize the I-5 IBR freeway analysis area segments performance for southbound and northbound traffic during both peak periods. Across the Interstate Bridge, both the

LOS and V/C ratio are reported to cover both states' performance measures. Locations that do not meet performance standards are highlighted in red.

Table 3-10. I-5 Highway Performance for Southbound AM and PM Peak – 2019 Existing Conditions

Location	Segment Type	AM LOS / V/C				PM LOS / V/C			
		6 AM	7 AM	8 AM	9 AM	3 PM	4 PM	5 PM	6 PM
Main St on-ramp to 39th St off-ramp	Weave	C	E [a]	B	B	B	B	B	B
39th St off-ramp to SR 500/39th St on-ramp	Basic	F [a]	F [a]	D	C	B	C	C	B
SR 500/39th St on-ramp to Fourth Plain off-ramp	Weave	F [a]	F [a]	E [a]	B	B	B	B	B
Fourth Plain off-ramp to Fourth Plain on-ramp	Basic	F [a]	F [a]	E [a]	B	B	B	B	B
Fourth Plain on-ramp to Mill Plain off-ramp	Weave	F [a]	F [a]	E [a]	B	B	B	B	B
Mill Plain off-ramp to Mill Plain on-ramp	Basic	F [a]	F [a]	F [a]	C	B	C	C	B
Mill Plain on-ramp to SR 14 off-ramp	Weave	F [a]	F [a]	F [a]	C	C	C	C	B
SR 14 off-ramp to SR 14/Washington St on-ramp	Basic	F [a]	F [a]	F [a]	C	C	C	C	B
SR 14/Washington St on-ramp merge	Merge	F [a]	F [a]	F [a]	C	B	C	C	B
Interstate Bridge	Basic	0.90-1.0 E [a]	0.90-1.0 E [a]	>1.1 F [a]	0.50-0.75 D	0.50-0.75 C	0.50-0.75 C	0.50-0.75 D	0.50-0.75 C
Hayden Island off-ramp to Hayden Island on-ramp	Basic	0.75-0.80	0.75-0.80	0.90-1.0	0.50-0.75	0.25-0.50	0.50-0.75	0.50-0.75	0.25-0.50
Hayden Island on-ramp to Marine Dr off-ramp	Weave	0.50-0.75	0.50-0.75	>1.1 [a]	0.50-0.75	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Marine Dr off-ramp to Marine Dr on-ramp	Basic	0.50-0.75	0.75-0.80	>1.1 [a]	0.50-0.75	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Marine Dr on-ramp to Interstate Ave off-ramp	Weave	0.50-0.75	1.0-1.1 [a]	>1.1 [a]	0.75-0.80	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Interstate Ave off-ramp to Victory on-ramp	Basic	0.50-0.75	>1.1 [a]	>1.1 [a]	>1.1 [a]	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50

Source: IBR Analysis

a Does not meet performance standard. Ave = Avenue; Dr = Drive; St = Street.

Table 3-11. I-5 Level of Service and V/C Ratio for Northbound AM and PM Peak – 2019 Existing Conditions

Location	Segment Type	6 AM (LOS/ V/C)	7 AM (LOS/ V/C)	8 AM (LOS/ V/C)	9 AM (LOS/ V/C)	3 PM (LOS/ V/C)	4 PM (LOS/ V/C)	5 PM (LOS/ V/C)	6 PM (LOS/ V/C)
Victory off-ramp to Marine Dr off-ramp	Diverge	<0.75	<0.75	<0.75	<0.75	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Marine Dr off-ramp to Int./Victory on-ramp	Basic	<0.25	0.25-0.50	0.25-0.50	<0.25	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Int./Victory on-ramp Merge	Merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Int./Victory on-ramp to Marine Dr on-ramp	Merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Marine Dr on-ramp to Hayden Island off-ramp	Weave	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Hayden Island off-ramp to Hayden Island on-ramp	Basic	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Hayden Island on-ramp merge	Merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	>1.1 [a]	>1.1 [a]	>1.1 [a]	>1.1 [a]
Interstate Bridge	Basic	0.25-0.50 B	0.50-0.75 C	0.50-0.75 C	0.25-0.50 C	1.0-1.1 F [a]	1.0-1.1 F [a]	1.0-1.1 F [a]	0.90-1.0 E [a]
SR 14 off-ramp to C St off-ramp	Diverge	B	B	B	B	C	C	C	C
C St off-ramp to SR 14 on-ramp	Basic	A	B	B	B	C	C	C	C
SR 14 on-ramp to Mill Plain/Fourth Plain off-ramp	Weave	B	B	B	B	C	C	C	C
Mill/Fourth Plain off-ramp to Mill Plain on-ramp	Basic	A	B	B	B	C	C	C	C
Mill Plain on-ramp merge	Merge	A	A	A	A	B	C	B	B
Mill Plain on-ramp to Fourth Plain on-ramp	Merge	A	B	B	B	C	C	C	B
Fourth Plain on-ramp merge	Weave	A	A	A	B	B	C	C	B
Fourth Plain on-ramp to SR 500/39th St off-ramp	Weave	A	B	B	B	C	D	C	B
SR 500/39th St off-ramp to 39th St on-ramp	Basic	A	B	A	B	C	C	C	B
39th St on-ramp to Main St off-ramp	Weave	A	A	A	B	B	C	B	B

Source: IBR Analysis

a Does not meet performance standard. Ave = Avenue; Dr = Drive; St = Street.

3.3.4.5 Impacts to Local Roads

As described in Section 3.3.1, Freeway Analysis Area, the VISSIM traffic operations model was used to analyze operations on I-5. In some cases, congestion on the I-5 mainline causes queuing at freeway on-ramps, which in turn can cause congestion and backups on the local cross streets at interchanges. The local streets are not included in the VISSIM model; however, the impact of freeway congestion on the local street network in the vicinity of the IBR Program Area can be estimated by measuring the number of unserved vehicles at the model input points (i.e., the on-ramps). The number of unserved vehicles is converted to a length (25 feet per unserved vehicle), which is used to estimate the maximum extents of the congestion on the local system that is caused by freeway congestion.

The study intersections that fall within the freeway congestion extents are expected to experience worse levels of service than what is reported in Section 3.6, Arterials and Local Streets. The estimated impact of freeway congestion on local roadways documented in this section illustrates how the overall system may operate, while the unconstrained operations analysis summarized in Section 3.6 shows how intersections operate in isolation and whether they require mitigation in the future impact analysis.

During the AM peak period, the Interstate Bridge is a major bottleneck for I-5 southbound traffic, and I-5 mainline congestion impacts adjacent southbound on-ramps throughout the IBR Program Area. As illustrated in Figure 3-19, congestion on I-5 southbound routinely spills back into downtown Vancouver at Washington Street, SR 14, Mill Plain Boulevard, Fourth Plain Boulevard, and SR 500.

During the PM peak period, the Interstate Bridge is the major northbound I-5 bottleneck, and I-5 mainline congestion impacts adjacent northbound on-ramps throughout the IBR Program Area. As illustrated in Figure 3-20, congestion on I-5 northbound spills back onto Marine Drive, Martin Luther King Jr. Boulevard, and the Victory Boulevard/Interstate Avenue interchange area.

3.4 Freight Mobility and Access

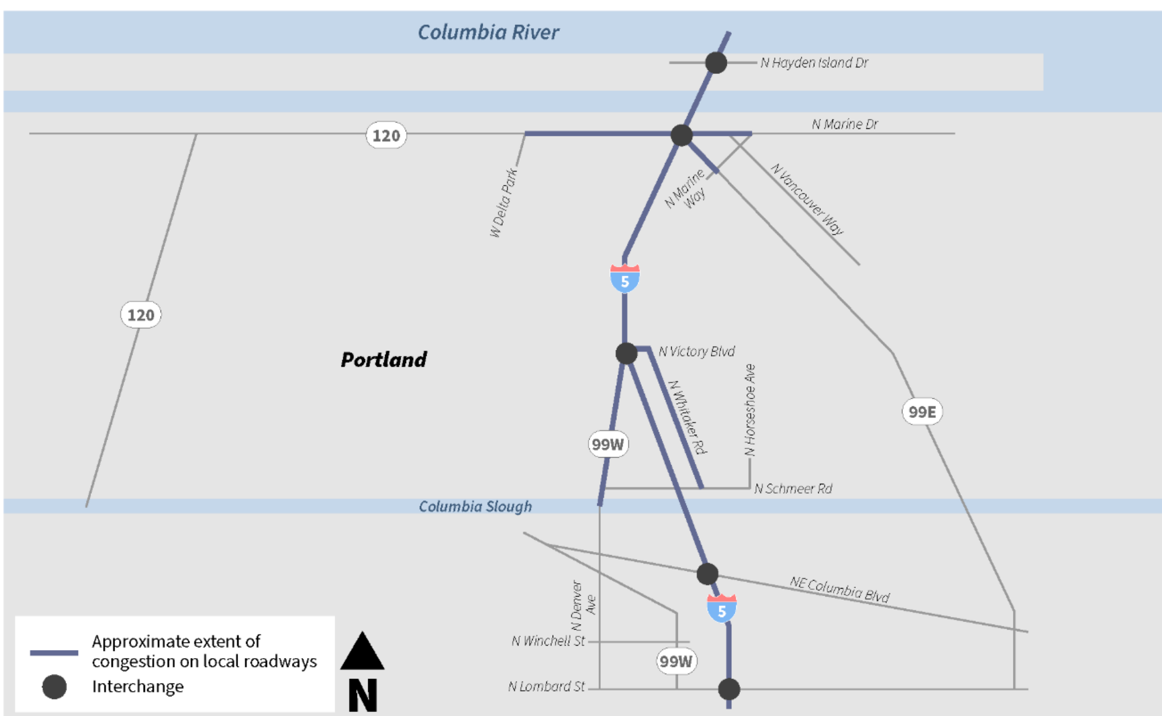
The I-5 crossing is critical to national and international freight flow. I-5 serves direct international land connections to Mexico and Canada. The Portland-Vancouver region is the fourth largest freight hub for domestic and international trade on the West Coast behind Los Angeles/Long Beach, Seattle/Tacoma, and San Francisco/Oakland. National, West Coast, and regional freight flows depend on the efficient functioning of I-5 within the IBR Program Area.

3.4.1 Freight Commodity Characteristics

I-5 is the primary truck route for local, regional, national, and international movement of goods through the Portland-Vancouver region. Trucks carry 55% of all freight in Clark County and 74% of all freight in Portland-Vancouver region. Approximately $133 million in commodity value was transported daily across the Interstate Bridge in 2019.

Figure 3-19. Existing 2019 Local Roadways Impacted by Freeway Bottlenecks – AM Peak Period

Figure 3-20. Existing 2019 Local Roadways Impacted by Freeway Bottlenecks – PM Peak Period



Truck trips are associated with certain industries. The five most freight-intensive industry sectors sensitive to transportation operations along Portland-Vancouver highways are petroleum products, minerals, food and beverages, wood products, and grain, accounting for more than half of the freight moved by truck in the Portland-Vancouver region. Manufacturing industries tend to produce and attract long-haul truck trips that originate over 250 miles from their destination. Manufacturers also attract and generate short-haul trips to and from ports and other local manufacturers. Wholesalers, which distribute goods throughout the region, attract long-haul and short-haul truck trips and generate the majority of local truck trips (less than 50 miles long). Retail establishments are the primary attraction for local distribution truck trips generated by the wholesale industries.

The global economy is supported through open trade policies, worldwide communication networks, and specialized supply chains. Higher-capacity freight is increasingly used to respond to the increased globalization of trade. From 2009 to 2019, United States e-commerce sales grew from 3.8% of all retail sales to 11.4%. The expansion of e-commerce and the existence of last-mile delivery have placed new demands on the goods movement infrastructure in the Portland-Vancouver region.

3.4.2 Program Area Freight Routes

WSDOT, ODOT, the City of Vancouver, and the City of Portland, as well as federal agencies, have designated freight routes and systems within the IBR Program Area. WSDOT designates state corridors by mode based on annual freight tonnage moved by trucks, rail, and waterway corridors. This classification system is called the Freight and Goods Transportation System. WSDOT's truck freight classifications, summarized in Table 3-12, range from T-1 corridors, which carry more than 10 million tons annually, to T-5 corridors, with more than 20,000 tons in 60 days.

Table 3-12. WSDOT Freight Goods Transportation Classification System

Freight Goods Transportation Classification	Annual Gross Tonnage
T-1	Over 10,000,000
T-2	4,000,000 to 10,000,000
T-3	300,000 to 4,000,000
T-4	100,000 to 300,000
T-5	Over 20,000 in 60 days

Source: Washington State Freight and Goods Transportation System 2021 Update.

ODOT has designated a State Highway Freight System through the Oregon Highway Plan to ensure that freight is able to move efficiently on the state's major trucking routes. The key criteria for freight route designation are freight volume, tonnage, connectivity, freight generating sites, and the implications of highway segment designations. While ODOT does not assign specific classifications, the State Highway Freight System identifies the designated freight routes in Oregon.

The City of Portland's designated truck routes are identified in the Portland Bureau of Transportation's Freight Master Plan. Freight street designations include Regional Truckway, Priority Truck Street, Major Truck Street, Freight District Street, Truck Access Street, and Local Truck Streets. These classifications match the designated land uses along city streets. The City of Vancouver and Clark County use WSDOT's Freight and Goods Transportation System classifications for city street designations.

Federal designations include the National Network and Intermodal Connectors. The National Network allows conventional combinations on the Interstate System, as well as on roadways that connect cities and densely developed portions of the states. Intermodal connectors were designated in cooperation with state departments of transportation and metropolitan planning organizations based on criteria developed by FHWA and the U.S. Department of Transportation.

Figure 3-21 shows designated freight routes from WSDOT, ODOT, and the City of Portland within the IBR Program Area as well as routes connecting to I-205, which also serves as a north-south freight corridor.

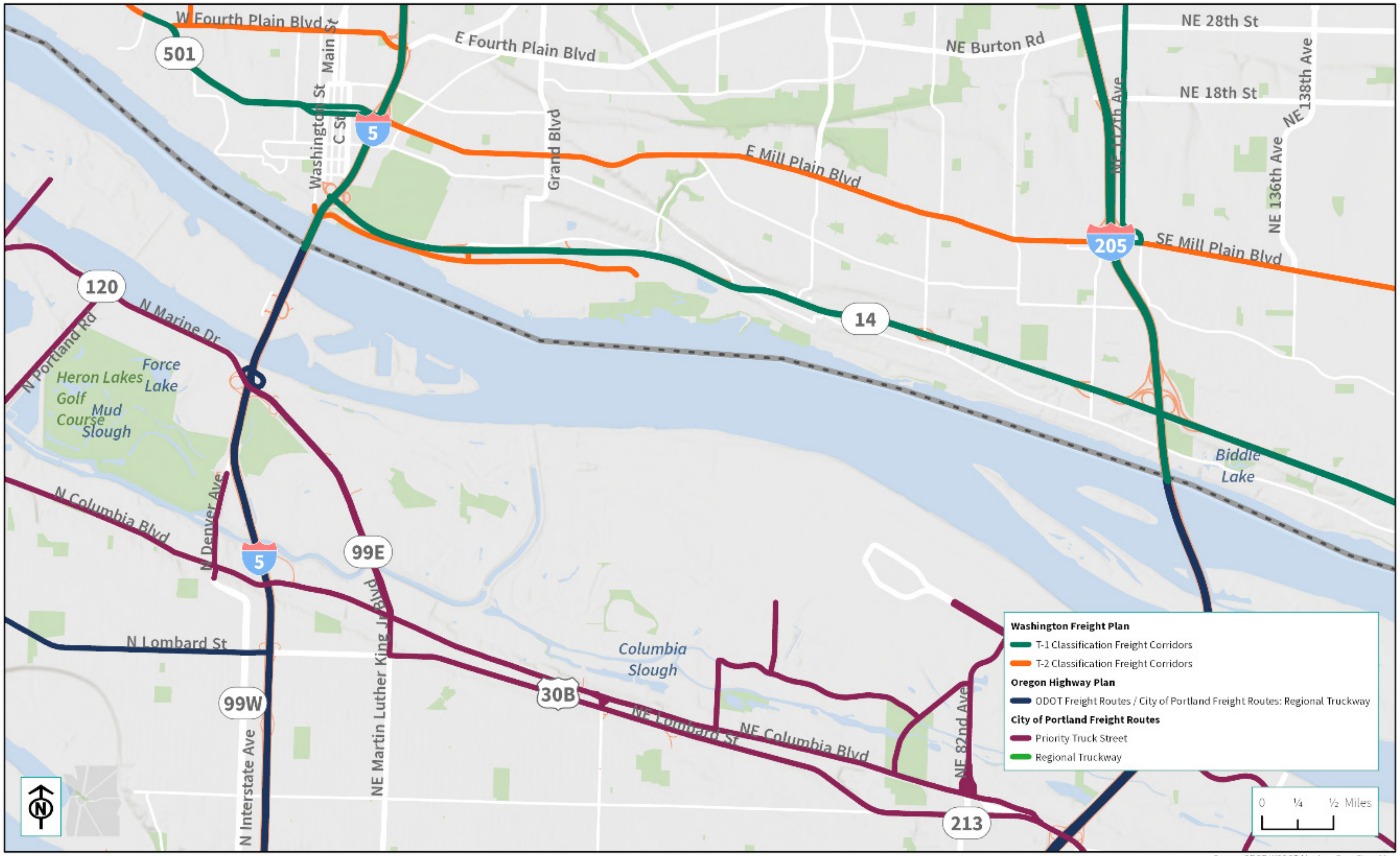
Figure 3-22 shows federal designations within the IBR Program Area as well as routes connecting to I-205.

3.4.3 Oversized Loads

Trucks regularly carry oversized loads through the IBR Program Area. Oversized loads are trucks carrying goods that cause them to be over-length, over-height, over-width, and/or overweight. Definitions of these terms for WSDOT and ODOT are as follows:

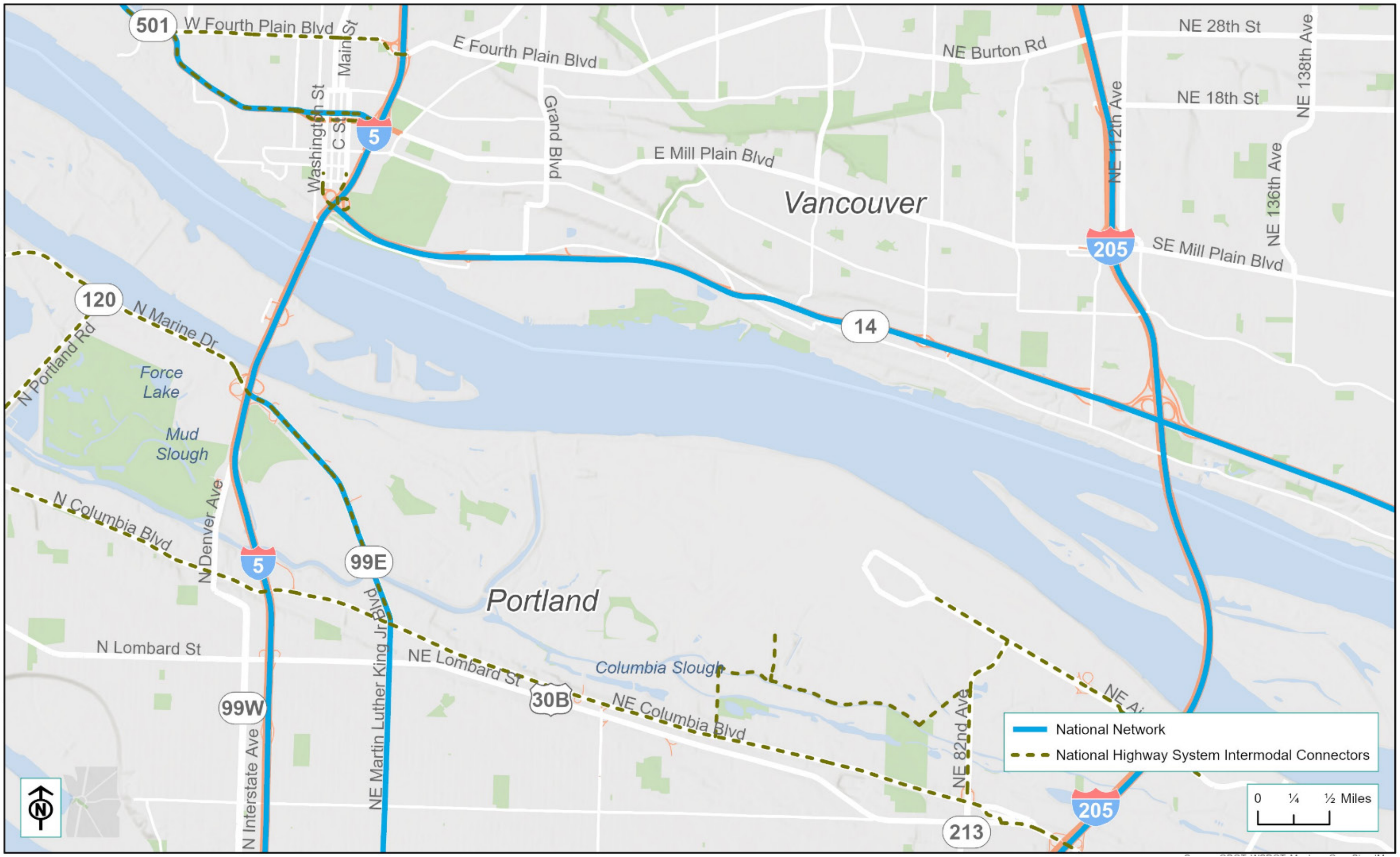
- Over-height – Vehicles and loads exceeding 14 feet in height are considered oversized/over-legal in both states.
- Over-width – For both WSDOT and ODOT, vehicles exceeding 8 feet, 6 inches wide are considered an oversized load.
- Over-length – WSDOT defines the length threshold for an oversized load as 40 feet for a single-unit truck and 75 feet overall for a truck and trailer. Additionally, WSDOT considers more than 4 feet of front overhang or 15 feet of rear overhang oversized. ODOT defines the length threshold for a single vehicle in a combination as 40 feet. Exceptions with combinations for this length threshold are tabulated in the ODOT Group Map 1, Transportation Permit Unit. Additionally, ODOT considers more than 4 feet of front overhang or 5 feet of rear extension to be oversized.
- Overweight – WSDOT's gross vehicle weight standards for a vehicle or a vehicle combination are determined by an overlapping set of three criteria: tire size, axle weight, and the weight table. ODOT maximum weight allowed is 80,000 pounds gross weight. Smaller maximums are determined for each vehicle or load combination based on the number of axles and their group axle weights.

Figure 3-21. Designated Freight Routes – WSDOT, ODOT, and City of Portland



Source: Portland Bureau of Transportation Freight Master Plan, WSDOT Freight Good and Classification System

Figure 3-22. Designated Freight Routes – Federal



Regulations on oversized limits in the City of Vancouver are defined in Chapter 9 of the Municipal Code. Vehicles and loads exceeding 14 feet in height or width are considered over-legal. Single-unit vehicles between 40 feet and 70 feet long must obtain an over-legal permit; single-unit vehicles over 70 feet long are not permitted. Combination-unit vehicles have a length threshold of between 75 feet and 100 feet. The City of Vancouver does not define thresholds for front overhang limits and limits the rear overhang to no more than 15 feet from the center of the last axle up to one-third the total length of the vehicle and load. The gross weight requirements are dependent on the size of the load and equal to the maximum allowed by WSDOT requirements.

The City of Portland defines vehicles and loads exceeding 14 feet in height and/or 8 feet, 6 inches in width as over-dimensional. The length thresholds are 50 feet for single-unit vehicles and 65 feet for combination-unit vehicles. The City of Portland does not define thresholds for front or rear overhang limits. Gross weights are limited to 80,000 pounds in Portland, equal to the maximum allowed by ODOT requirements.

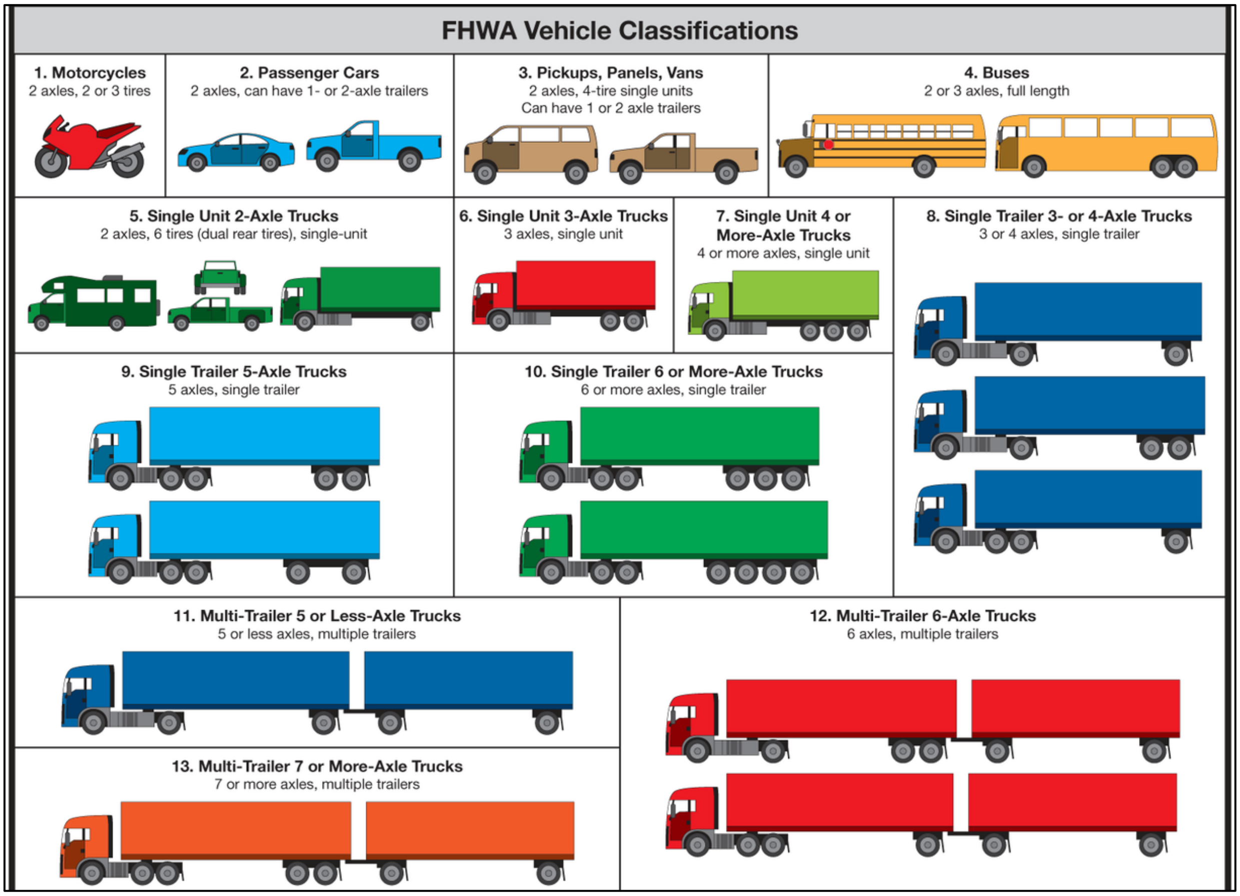
Within the IBR Program Area, there are important oversized load transport routes. The primary limiting factor for oversized load route choice is vertical clearance. Port of Vancouver shipments are received via the Columbia River and leave the Port of Vancouver on trucks that travel via Mill Plain Boulevard, I-5 southbound, and SR 14 eastbound. The Columbia Industrial Park generates oversized loads destined for the Port of Vancouver as well as locations north and south on I-5. These oversized loads travel westbound on SR 14 toward I-5, access I-5 northbound, and exit onto Mill Plain Boulevard. In Oregon, the oversized load activity occurs on I-5, exiting southbound at Marine Drive to access Martin Luther King Jr. Boulevard or northbound at the Columbia Corridor industrial area and the Port of Portland.

3.4.4 Freight Volumes and Travel Patterns

Approximately 14,000 heavy and medium trucks crossed the Interstate Bridge on an average weekday in 2019, accounting for approximately 10% of all bridge traffic. FHWA classifies vehicles into one of 13 categories depending on the size of the vehicle. See Figure 3-23 for the FHWA 13-classification system. Medium and heavy trucks include classes 4 and 6 through 13. Freight traffic does not peak during typical commute hours (6 to 9 a.m. and 3 to 6 p.m.). Instead, the highest freight volumes occur during the middle of the day as freight trucks try to avoid the most congested periods. Figure 3-24 and Figure 3-25 illustrate the 24-hour profile for freight volumes crossing the Interstate Bridge in the northbound and southbound direction, respectively.

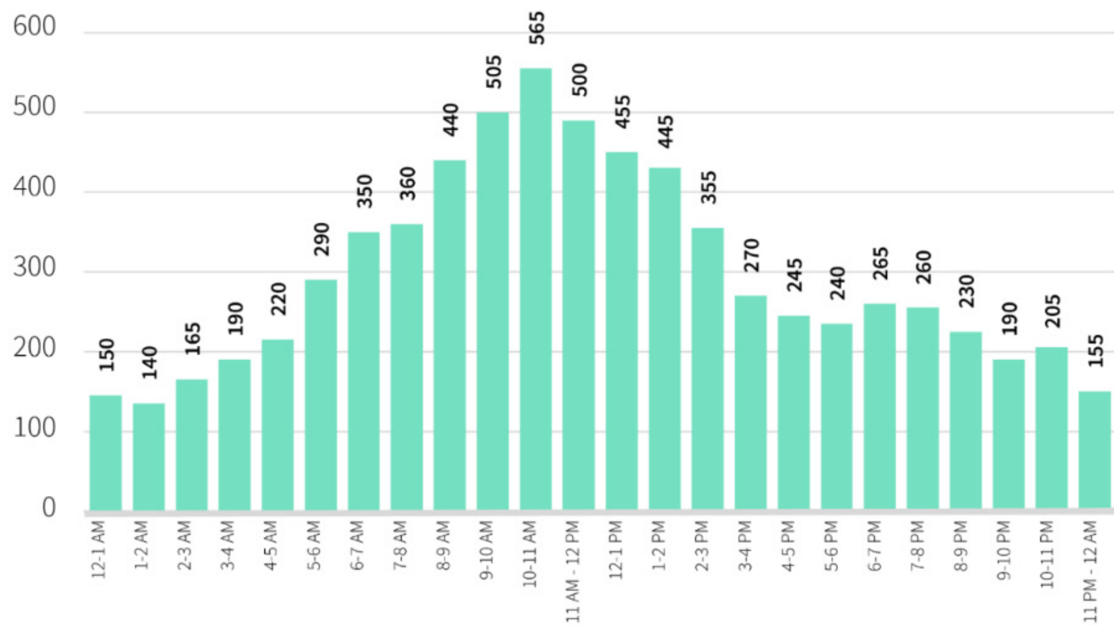
Substantial volumes of truck traffic pass through the IBR Program Area, and several interchanges experience more than 250 trucks per hour during periods of the highest truck activity, which sometimes includes the AM and PM peak periods. The Mill Plain Boulevard, City Center/SR 14, and Marine Drive interchanges all have large truck volumes, as they provide access to the Ports of Vancouver and Portland as well as industrial areas.

Figure 3-23. FHWA 13 Classification System



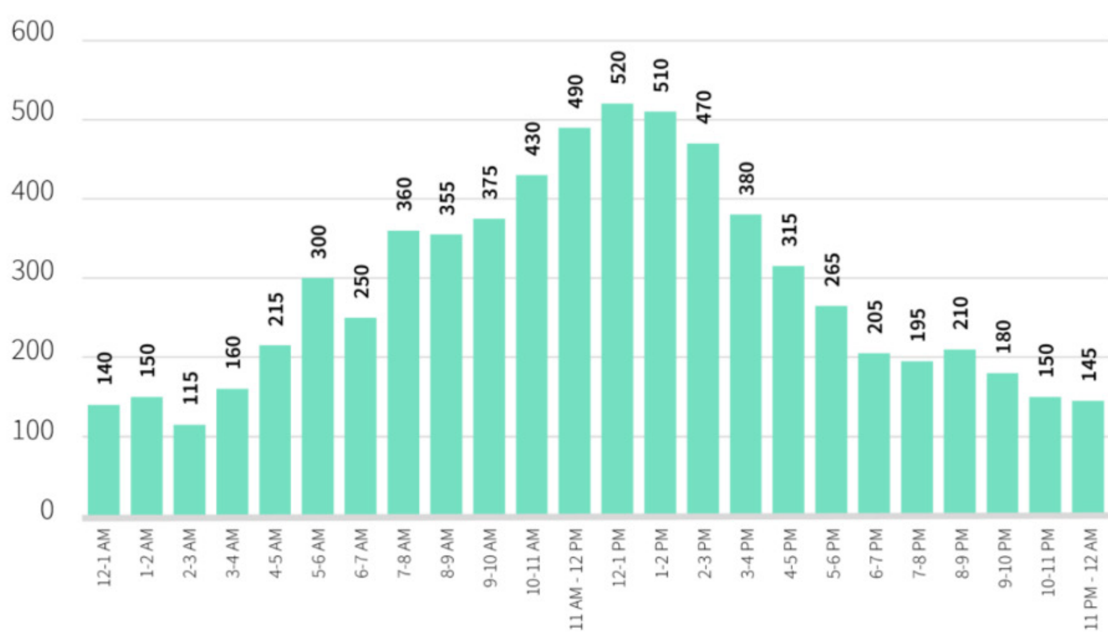
Source: Federal Highway Administration, Freight Classification System.

Figure 3-24. Interstate Bridge Hourly Profile – Northbound Weekday Freight Service Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis

Figure 3-25. Interstate Bridge Hourly Profile – Southbound Weekday Freight Service Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis

Truck origin-destination information was collected using similar methods as for general-purpose traffic (see Section 3.3.2, Origin-Destination Patterns). The data indicates that approximately 70% of the truck traffic using the Interstate Bridge has at least one trip ending in an area around the I-5 corridor. Figure 3-26 and Figure 3-27 show the magnitude of northbound and southbound truck origins and destinations, respectively, that use the Interstate Bridge on an average weekday. In both figures, darker shading indicates more origins or destinations in those areas, and lighter shading indicates fewer origins or destinations.

Forty-five percent of northbound truck trips crossing the Interstate Bridge originate in Delta Park, Rivergate, an industrial area in Tualatin/Lake Oswego/Wilsonville, an area just to the east of Rivergate in northeast Portland, Swan Island, and the Northwest Portland industrial area. Areas to the west of Portland, including greater Beaverton, Tigard, and Hillsboro, generate approximately 8% of total northbound truck trips crossing the bridge.

The highest share (16%) of southbound truck trips crossing the Interstate Bridge come from Ridgefield, an area between I-5 and I-205 north of SR 500 that includes the Vancouver Mall, the Columbia Way industrial area, and Orchards. Areas around downtown Vancouver, including the Port of Vancouver, comprise approximately 8% of the total southbound truck origins.

Of the total truck trips using the Interstate Bridge northbound, 30% originate south of Wilsonville. Most of the Interstate Bridge truck trips (77%) continue north of Clark County, with the remainder involving a destination in Clark County. Almost 60% of total truck trips using the Interstate Bridge southbound start north of Clark County. Most southbound Interstate Bridge truck trips have a destination within the Portland-Vancouver metropolitan region, with just over 20% of truck trips continuing south beyond Wilsonville.

Figure 3-26. Average Weekday Interstate Bridge Northbound Truck Origins and Destinations

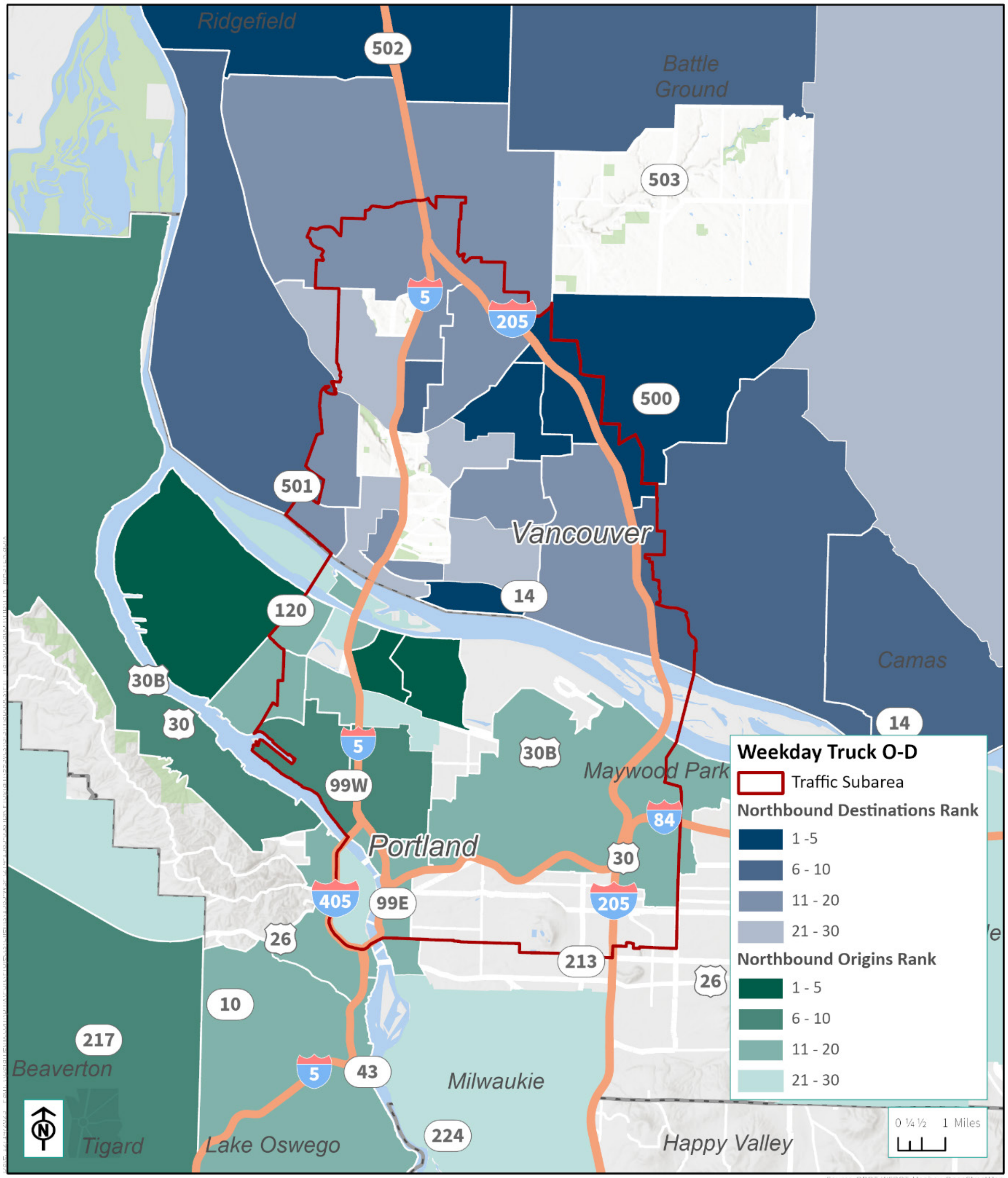
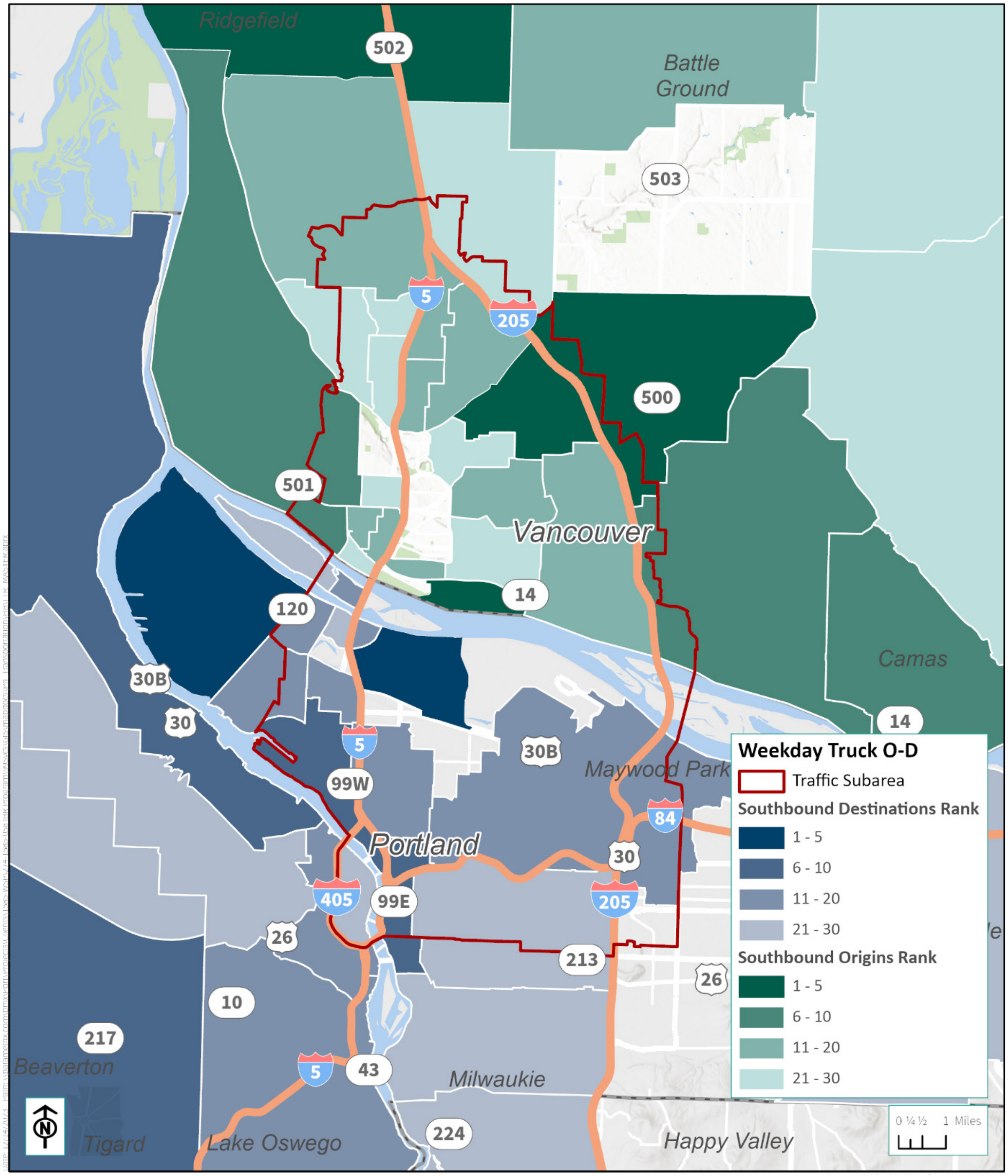


Figure 3-27. Average Weekday Interstate Bridge Southbound Truck Origins and Destinations



3.5 Bridge Openings and Gate Closures

Data on bridge openings and gate closures for the Interstate Bridge were obtained from ODOT and WSDOT for the 12-year period from January 1, 2012, to December 31, 2023. These data are consistent with the data summarized in the Navigation Impact Report. The data were analyzed for the number of bridge openings and gate closures per year by event type, average time that the bridge openings and gate closures began by event type, and the duration of the bridge openings and gate closures.

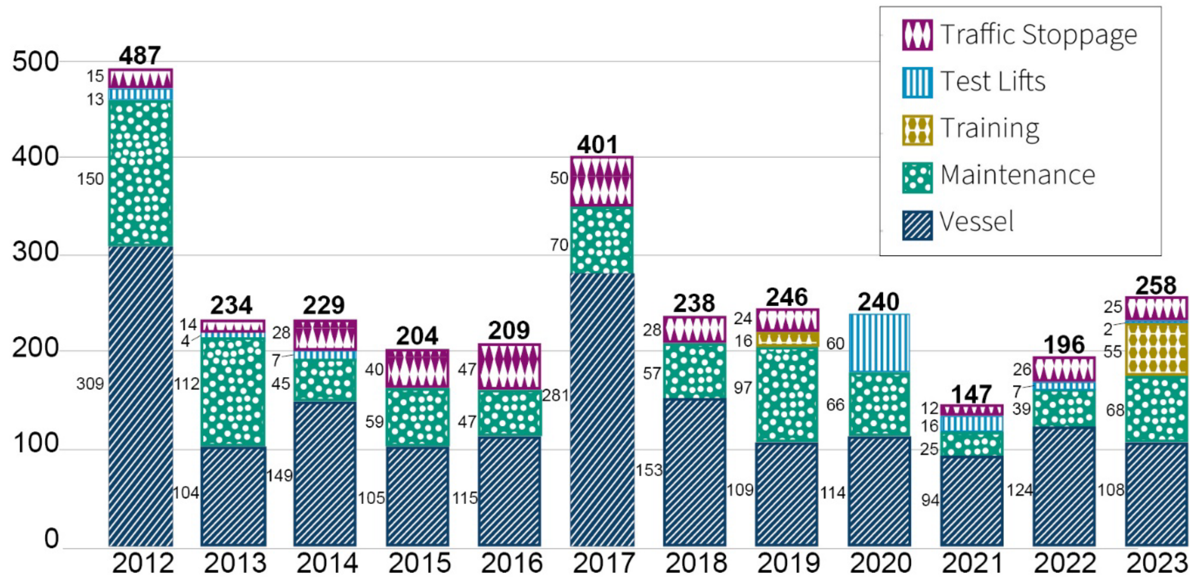
Bridge opening events are those in which the bridge is physically raised. Bridge spans are opened for the passage of commercial and non-commercial vessels. For these closures, auto and non-auto traffic is stopped in both northbound and southbound directions. A bridge opening is needed if a vessel's height above water exceeds the available clearance between the water level and the bridge in the lowered (or closed) position. The available clearance at any time will depend on the water level (higher river levels result in less clearance) but is typically approximately 89 feet. Based on the closed height of 89 feet, typical river traffic (tug and tows, river cruise ships, and recreational craft) would not require a bridge opening. Bridge openings are needed for some government vessels, including the Dredge Yaquina and USCG Juniper Class vessels; the tall ship Lady Washington; some floating construction equipment; larger ocean-going tugs and other vessels that may visit upstream shipyards; specialty shipments from area fabricators; and the tallest sailboats operating on the river.

Bridge spans are also opened to allow for maintenance. Individual northbound or southbound spans may be maintained at the same time or different times. Accordingly, auto and non-auto traffic may be stopped in either one or both directions during these maintenance bridge openings.

Gate closure events are those where traffic is stopped to allow for bridge-related activity without the bridge being raised. These gate closure events occur for several reasons, including bridge maintenance, traffic stoppages, test lifts, and training. Training and test lift openings are performed during the day and overnight periods. Depending on the reason for the event, traffic may be stopped in one or both directions.

For the 12-year period from January 1, 2012, to December 31, 2023, there were 3,089 bridge opening/gate closure events. On average, the bridge was opened/gate closed 257 times per year, with the range over the 12-year period fluctuating between 147 and 487 bridge openings/gate closures. The number of bridge openings/gate closures is affected by the number of river users and by river levels. Approximately 57% of the total bridge openings/gate closures were due to vessel crossings, 32% were due to maintenance, 3% were due to training lifts, 4% were due to test lifts, and 4% were due to traffic stoppages. Figure 3-28 displays bridge openings/gate closure events for each year, by reason, from 2012 to 2023.

Figure 3-28. Interstate Bridge Openings/Gate Closure Events by Year

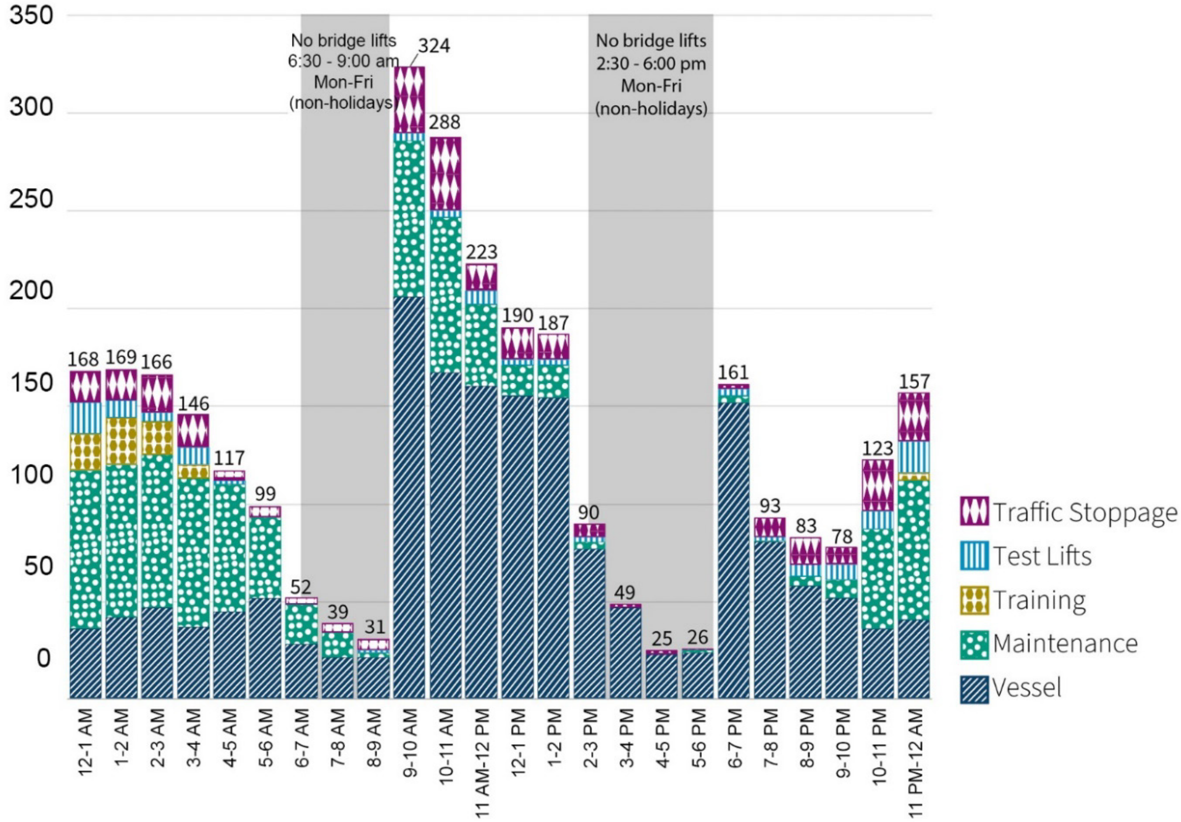


Source: ODOT, WSDOT

Figure 3-29 displays bridge openings/gate closures by individual hour over the 12-year period. Bridge openings are not allowed Monday through Friday between 6:30 to 9 a.m. and 2:30 to 6 p.m., except on holidays. A vessel operator will signal the bridge operator by sound, visual cues, telephone, or radio of the need for a bridge opening. The operator will acknowledge the request, communicate any details to the vessel operator, and then raise the bridge as requested. Federal rules prohibit the opening of a bridge if the vertical clearance provided by the bridge is sufficient to allow the vessel, after all lowerable nonstructural vessel appurtenances that are not essential to navigation have been lowered, to safely pass under the drawbridge in the closed position. Approximately 49% of all bridge opening/gate closure events occurred between 6 a.m. and 6 p.m., with 71% of these events due to vessels traveling along the Columbia River. Conversely, most non-traffic stoppage related maintenance events (67%) and all training events (100%) occur during the overnight period, between 6 p.m. and 6 a.m.

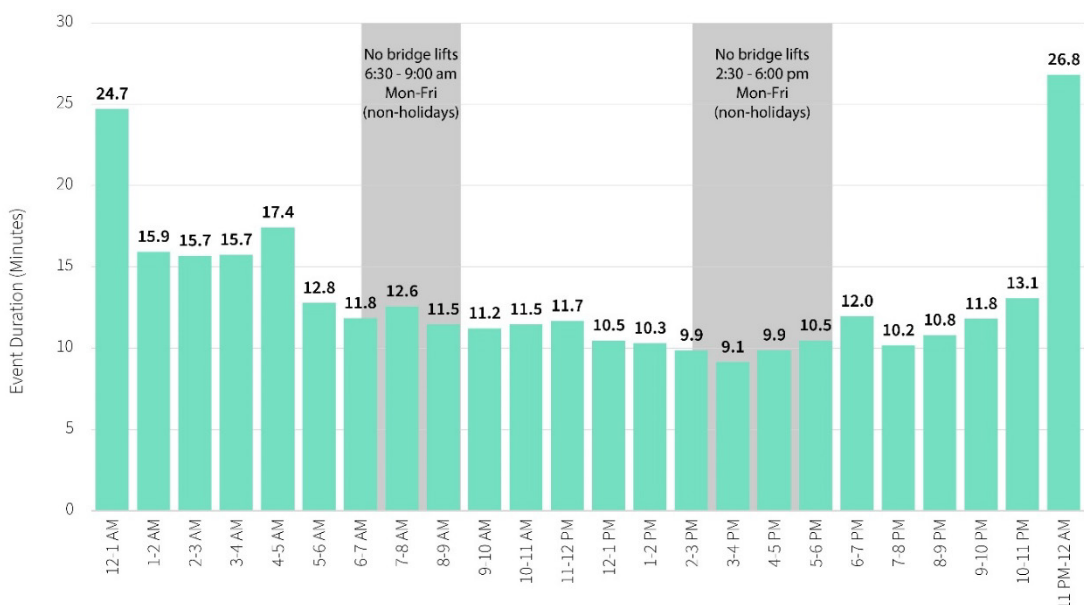
Figure 3-30 summarizes the average duration of bridge openings/gate closures by individual hour. The average bridge openings/gate closure duration was 13.2 minutes, with hourly averages ranging between 9.1 and 26.8 minutes. While bridge openings are not allowed during periods of high traffic volume, they are allowed just before and after these periods and thus may impact traffic conditions. The IBR team analyzed bridge opening data between 2015 to 2019 compared to congestion and determined that, depending upon the closure time, it takes between 5 and 110 minutes for traffic to recover from a bridge opening/gate closure in either direction. In certain circumstances, bridge openings/gate closures that occur just prior to midday combine with northbound congestion and last until the end of the PM peak period, resulting in a longer recovery period.

Figure 3-29. Interstate Bridge Opening/Gate Closure Events by Hour



Source: ODOT, WSDOT

Figure 3-30. Interstate Bridge Opening/Gate Closure Event Duration by Hour



Source: ODOT, WSDOT

3.6 Arterials and Local Streets

This section describes existing conditions for arterials and local streets, including the roadway network, peak-hour traffic volumes, and intersection operations.

3.6.1 Roadway Network

In addition to the regional roadways that connect population and employment centers, the IBR Program Area contains numerous local arterials and roadways that allow drivers to connect to the regional network. Information on roadways within the City of Vancouver and the City of Portland, including the number of travel lanes, speed limits, bicycle facilities, pedestrian facilities, and functional classification, is shown in Table 3-13 and Table 3-14.

Roadway information was collected in Vancouver for streets classified as minor arterial or a higher designation. Roadway information in Portland was collected for streets classified as Neighborhood Collectors or higher designations. A description of each jurisdiction's classifications is below.

- Principal Arterial (Vancouver). This is the basic element of the City of Vancouver's road system. It carries large volumes of traffic over long distances. Access is generally limited to intersections with other arterials and collectors. Signalized intersection spacing is regulated. Direct land access is minimal and managed. Spacing is typically 2 to 5 miles.
- Minor Arterial (Vancouver). This street collects and distributes traffic from principal arterials to streets of lower classifications and may allow traffic to access destinations directly. Minor arterials provide for movement within city subareas whose boundaries are largely defined by principal arterial roadways. Minor arterials serve through-traffic and provide direct access to large commercial, industrial, office, and multifamily development, but generally they do not provide access to single-family residential properties. Spacing is typically less than 2 miles.
- Regional Trafficways (Portland). Regional Trafficways are intended to serve regional traffic movement that has only one trip end in a City of Portland transportation district or to serve trips that bypass a district completely. Regional Trafficways should connect to other Regional Trafficways, Major City Traffic Streets, and District Collectors. A ramp that connects to a Regional Trafficway is classified as a Regional Trafficway from its point of connection up to its intersection with a lower-classified street.
- Major City Traffic Streets (Portland). Major City Traffic Streets are intended to serve as the principal routes for interdistrict traffic that has at least one trip end within a City of Portland transportation district. Major City Traffic Streets should serve as primary connections to Regional Trafficways and serve major activity centers in each district. Traffic with no trip ends within a City of Portland transportation district should be discouraged from using Major City Traffic Streets.
- Traffic Access Streets (Portland). Traffic Access Streets are intended to provide access to Central City destinations, distribute traffic within a Central City subdistrict, provide connections between Central City subdistricts, and distribute traffic from Regional Trafficways and Major City Traffic Streets for access within the district. Traffic Access Streets are not intended for through-traffic with no trip ends in the district.

- District Collectors (Portland). District Collectors are intended to serve as distributors of traffic from Major City Traffic Streets to streets of the same or lower classification or to serve trips that both start and end within a district.
- Neighborhood Collectors (Portland). Neighborhood Collectors are intended to serve as distributors of traffic from Major City Traffic Streets or District Collectors to Local Service Streets or to serve trips that both start and end within areas bounded by Major City Traffic Streets and District Collectors.

Table 3-13. Existing Local Roadway Facilities – City of Vancouver

Local Roadway	Arterial Classification	Number of Travel Lanes [a]	Speed Limit (mph)	Bicycle Lanes	Pedestrian Facilities [b]
Main Street	Principal Arterial Minor Arterial	2–5	20–30	No	Yes
Broadway Street	Principal Arterial Minor Arterial	2	25	No	Yes
E 39th Street	Minor Arterial	3	25	Yes	Partial
St. Johns Boulevard	Principal Arterial	2–5	30	Yes	Yes
Fourth Plain Boulevard	Principal Arterial	3–5	25	Yes	Partial
Fort Vancouver Way	Minor Arterial	2–4	25	Yes	Yes
E McLoughlin Boulevard	Principal Arterial	2–3	25	Yes	Yes
W McLoughlin Boulevard	Minor Arterial	2	25	Yes	Yes
Mill Plain Boulevard	Principal Arterial	3–7	35	Yes	Yes
Evergreen Boulevard	Minor Arterial	3	25	Yes	Yes
Washington Street	Principal Arterial	2–3	25	No	Yes
Columbia Street	Minor Arterial	2	25	Yes	Yes
C Street	Principal Arterial	2	25	Yes	Yes
8th Steet	Minor Arterial	2	25	Yes	Yes

Local Roadway	Arterial Classification	Number of Travel Lanes [a]	Speed Limit (mph)	Bicycle Lanes	Pedestrian Facilities [b]
6th Street	Minor Arterial	2	25	No	Yes
5th Street	Minor Arterial	1–2	25	No	Yes
Phil Arnold Way	Minor Arterial	2	25	No	Yes
Esther Street	Minor Arterial	2	25	Yes	Yes
SE Columbia Shores Boulevard	Principal Arterial	2	25	No	No

Source: City of Vancouver, WSDOT

Notes:

a Table includes only roads classified as minor arterials and above for City of Vancouver

b "Partial" indicates that a striped shoulder or sidewalk is provided on only one side of the roadway. Additional details on active transportation facilities are provided below in Section 3.8, Active Transportation.

Table 3-14. Existing Local Roadway Facilities – City of Portland

Local Roadway	Arterial Classification [a]	Number of Travel Lanes	Speed Limit (mph)	Bicycle Lanes	Pedestrian Facilities [b]
N Hayden Island Drive	District Collector	3	25	No	No
N Center Avenue	District Collector	2–4	20	No	Partial
N Jantzen Drive	District Collector	2	20	No	Partial
N Tomahawk Island Drive	Neighborhood Collector	2–3	25	Yes	Yes
N Marine Drive	Major City Traffic Street Neighborhood Collector	5	35–40	Yes	Partial
N Force Ave	Local Service Traffic Street	2	20	No	Yes
N Expo Road	Local Service Traffic Street	2	20–35	No	Partial
N Pier 99 Street	Local Service Traffic Street	2	20	No	No

Local Roadway	Arterial Classification [a]	Number of Travel Lanes	Speed Limit (mph)	Bicycle Lanes	Pedestrian Facilities [b]
N Vancouver Way	Neighborhood Collector	3	35	No	Yes
N Union Court	Neighborhood Collector	2–3	35	No	Partial
N Victory Boulevard	Neighborhood Collector	3	20	No	Yes
N Denver Avenue	District Collector	2	40–45	Yes	Partial
N Schmeer Road	Neighborhood Collector	2	35	No	Yes
N Vancouver Avenue	Neighborhood Collector	2–4	35	Yes	Yes
N Martin Luther King Jr. Boulevard	Regional Trafficway/Major City Traffic Street	4–5	55	Yes	No
Columbia Boulevard	Regional Trafficway/Major City Traffic Street	5	35	No	Partial

Source: City of Portland and ODOT

a Table includes only roads classified as neighborhood collector streets and above for City of Portland

b “Partial” indicates that a striped shoulder or sidewalk is provided on only one side of the roadway. Additional details on active transportation facilities are provided below in Section 3.8, Active Transportation.

3.6.2 Study Intersections

The intersection analysis study area includes 80 intersections: 58 in Vancouver and 22 in Portland. The study intersections were determined based on an initial list of intersections analyzed as part of the CRC project, followed by consultation with partner agency staff as part of the review of the IBR Transportation Methods Report and the Draft SEIS. The study intersections were identified based on the potential for them to be affected by IBR Program improvements, such as by a change in channelization or signal control, as well as those affected by changes in volume due to trips accessing the system.

The study intersections were categorized into four subareas based on their proximity to interchange areas and because different partner agencies have different performance standards. Subareas 1 through 3 are in Vancouver and Subarea 4 is in Portland. Table 3-15 describes each subarea.

Table 3-15. Intersection Subareas

Number	Subarea	Total Intersections	Intersection Number
1	SR 500/Main Street/39th Street/ Fourth Plain Boulevard	17	1–17
2	Mill Plain Boulevard	18	18–35
3	SR 14/City Center Interchange/ Columbia Way	23	36–58
4	Hayden Island/ Marine Drive/ Victory Boulevard/ Columbia Boulevard	22	59–80

Source: IBR Analysis

The study intersections are listed by subarea in Table 3-16 and shown in Figure 3-31 and Figure 3-32.

Table 3-16. Study Intersections

Subarea	Number	Intersection Location
Subarea 1 – SR 500, Main Street, 39th Street, and Fourth Plain Boulevard	1	Ross Street and Main Street (Highway 99)
	2	Hazel Dell and Main Street (West) and stop-controlled slip ramp
	3	39th Street and Main Street
	4	39th Street and H Street
	5	39th Street and I-5 southbound on-/off-ramps
	6	39th Street and I-5 northbound on-/off-ramps
	7	15th Avenue and SR 500 westbound off-ramp
	8	15th Avenue and SR 500 eastbound on-ramp/39th Street
	9	St. Johns Boulevard and SR 500 westbound on-/off-ramps
	10	St. Johns Boulevard and SR 500 eastbound on-/off-ramps
	11	Fourth Plain Boulevard and Main Street
	12	Fourth Plain Boulevard and Broadway Street
	13	Fourth Plain Boulevard and F Street
	14	Fourth Plain Boulevard and I-5 southbound on-/off-ramps
	15	Fourth Plain Boulevard and I-5 northbound on-/off-ramps

Subarea	Number	Intersection Location
	16	Fourth Plain Boulevard and St. Johns Boulevard
	17	Fourth Plain Boulevard and Fort Vancouver Way
Subarea 2 – Mill Plain Boulevard	18	McLoughlin Boulevard and Main Street
	19	McLoughlin Boulevard and Broadway Street
	20	McLoughlin Boulevard and F Street
	21	McLoughlin Boulevard and Fort Vancouver Way
	22	Mill Plain Boulevard and Franklin Street
	23	15th Street and Columbia Street
	24	15th Street and Washington Street
	25	15th Street and Main Street
	26	15th Street and Broadway Street
	27	15th Street and C Street
	28	Mill Plain Boulevard and Columbia Street
	29	Mill Plain Boulevard and Washington Street
	30	Mill Plain Boulevard and Main Street
	31	Mill Plain Boulevard and Broadway Street
	32	Mill Plain Boulevard and C Street
	33	Mill Plain Boulevard and I-5 southbound on-/off-ramps
	34	Mill Plain Boulevard and I-5 northbound on-/off-ramps
	35	Mill Plain Boulevard and Fort Vancouver Way

Subarea	Number	Intersection Location
Subarea 3 – SR 14, City Center Interchange, and Columbia Way	36	Evergreen Boulevard and Columbia Street
	37	Evergreen Boulevard and Washington Street
	38	Evergreen Boulevard and Main Street
	39	Evergreen Boulevard and Broadway Street
	40	Evergreen Boulevard and C Street
	41	Evergreen Boulevard and Fort Vancouver Way
	42	8th Street and Columbia Street
	43	8th Street and C Street
	44	7th Street and C Street
	45	6th Street and Grant Street
	46	6th Street and Esther Street
	47	6th Street and Columbia Street
	48	6th Street and Washington Street
	49	6th Street and Main Street
	50	6th Street and Broadway Street
	51	6th Street and C Street
	52	5th Street and Washington Street/I-5 southbound on-ramp
	53	Phil Arnold Way and Esther Street
	54	Phil Arnold Way and Columbia Street
	55	Columbia Way and Esther Street
	56	Columbia Way and Columbia Street
	57	Columbia House Boulevard and SR 14 eastbound/westbound on-/off-ramp
	58	Columbia Way and Columbia Shores Boulevard

Subarea	Number	Intersection Location
Subarea 4 – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard	59	Hayden Island Drive (south) and Center Avenue
	60	Hayden Island Drive (south) and Hayden Island Drive Connector to north
	61	Hayden Island Drive (north) and Hayden Island Drive Connector to south
	62	I-5 southbound Hayden Island off-ramp and Center Avenue/Tomahawk Island
	63	I-5 northbound Hayden Island off-ramp and Tomahawk Island Drive
	64	Tomahawk Island Drive and Jantzen Drive
	65	Center Avenue and Jantzen Avenue
	66	Marine Drive and OR 120 (N Portland Rd)
	67	Marine Dr and Force Ave
	68	Marine Drive/Martin Luther King Jr. Boulevard and I-5 northbound/southbound on-/off-ramps
	69	Marine Way and Vancouver Way (loop)
	70	Marine Drive and Anchor Way
	71	I-5 northbound off-ramp and Union Court/Marine Way
	72	Union Ct and Martin Luther King Jr. Blvd eastbound off-ramp
	73	Victory Boulevard and Expo Road
	74	Victory Boulevard and Interstate Avenue/Denver Avenue northbound off-ramp
	75	Victory Boulevard and I-5 southbound on-ramp
	76	Victory Boulevard and I-5 northbound off-ramp/Whitaker Road
	77	Interstate Avenue/Denver Avenue and Schmeer Road
	78	Columbia Boulevard and I-5 northbound/southbound on-/off-ramp
	79	Columbia Blvd and N Vancouver Ave
	80	Columbia Boulevard and Martin Luther King Jr. Boulevard

Source: IBR Analysis

Figure 3-31. Intersection Analysis Study Intersections – Vancouver

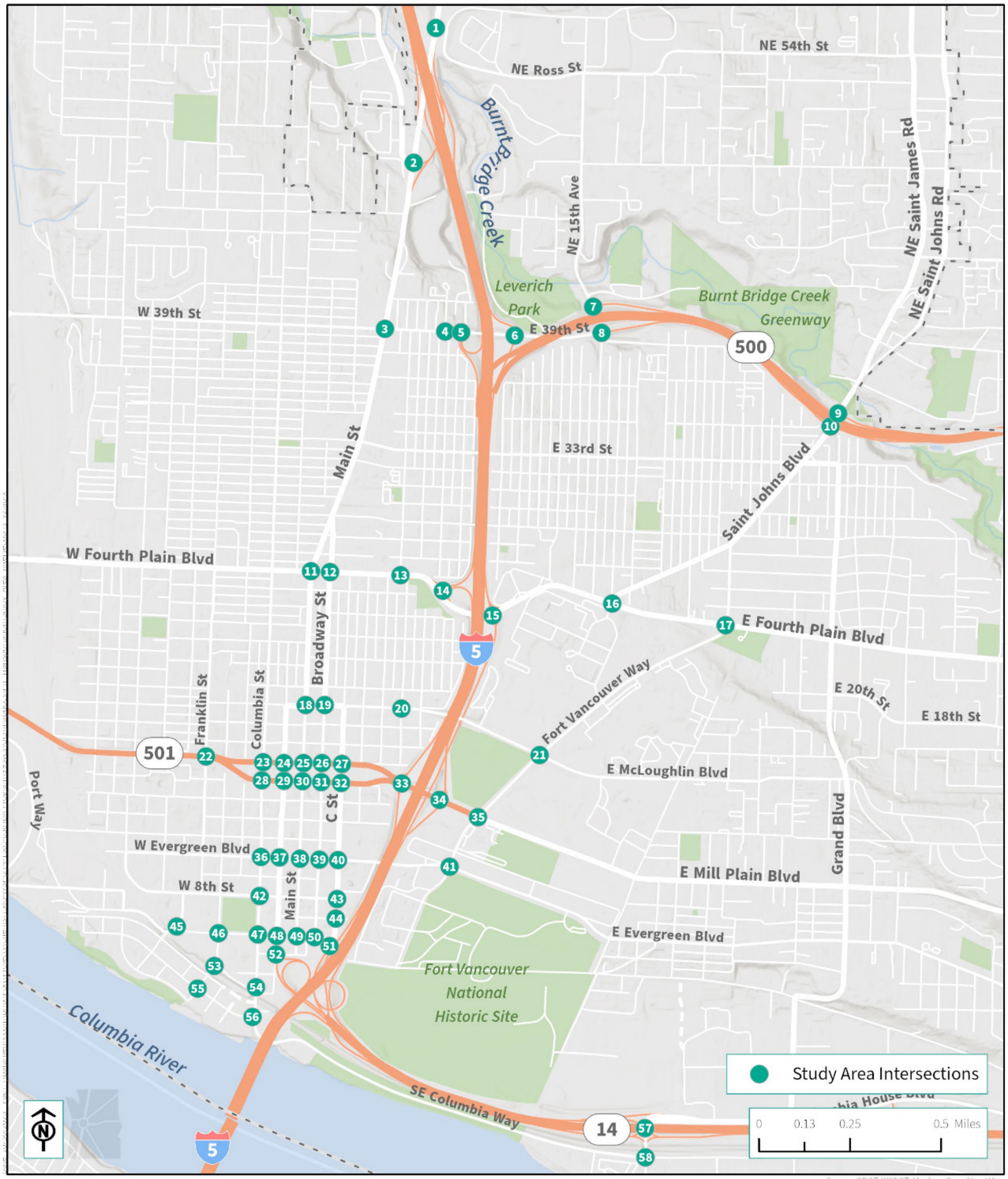
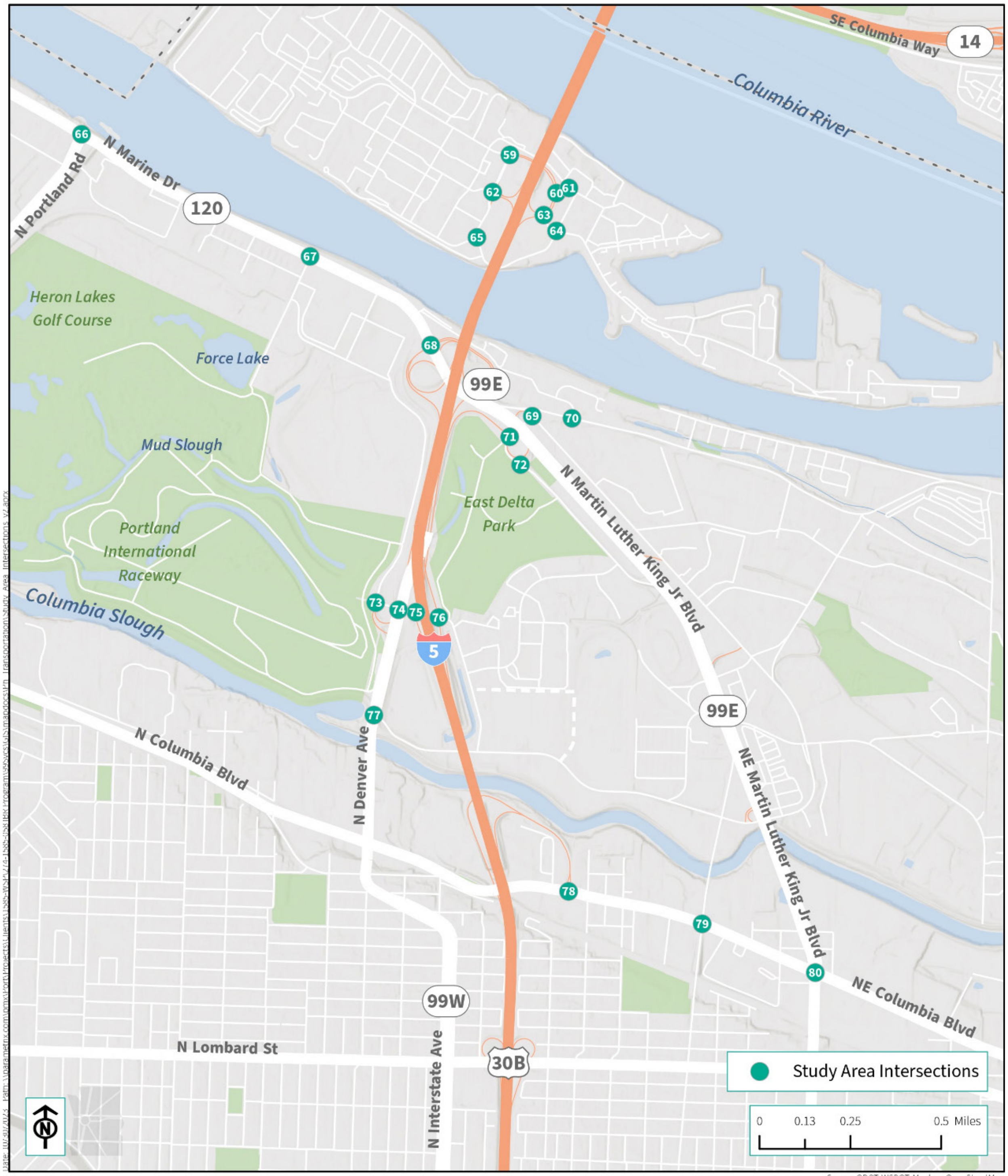


Figure 3-32. Intersection Analysis Study Intersections – Portland



3.6.3 Peak-Hour Intersection Volumes

Weekday intersection counts were not available at most of the study intersections from 2019 (pre-pandemic). All available intersection counts from 2019 were obtained from project partners. Therefore, weekday intersection turning movement counts were collected in July 2021 and September 2023. Many of the ramp terminal intersections that were counted in 2021 and 2023 also had data from 2019. Intersection counts were then balanced based on the ratio of the 2019 to 2021/2023 ramp terminal intersection counts to develop 2019 intersection turning movement volumes. The AM peak period was counted between 7 and 9 a.m., and the PM peak period between 4 and 6 p.m. The intersection turning movement counts included the total number of general-purpose vehicles, medium and large freight vehicles, pedestrians, and bicycles. A common peak hour was developed for each of the subareas during both peak periods. Due to the geographic spread of the study intersections, as well as the directional nature of the commute, the peak hour is different for different subareas. Final turning movement counts were balanced, including balancing study intersections with freeway ramp volumes to develop a congruent dataset. Peak-hour intersection traffic volumes are summarized in Appendix D.

3.6.4 Intersection Operations

An intersection operations analysis was prepared to document the existing conditions for each subarea. The subsections below summarize this analysis, which includes relevant performance standards, LOS, V/C, and delay for each study intersection. Intersections that currently do not meet the performance standards are noted in the discussion. For subareas within the City of Vancouver, the analysis also notes whether peak-hour speeds meet the City's standards for designated concurrency corridors, based on travel time data collected by RTC in the fall of 2019.

Information on intersection operations analysis tools, agency performance standards, concurrency corridors and standards, and evaluation measures is summarized in the Transportation Methods Report (Appendix A). Existing AM and PM peak-hour traffic operations analysis were developed using intersection counts, lane configurations, and traffic control. Existing signal timing plans were obtained from the City of Vancouver, WSDOT, the City of Portland, and ODOT to develop the existing conditions Synchro/SimTraffic models. The existing intersection operations analysis was completed for the peak hour. Peak-hour intersection operations are summarized in Appendix E.

The study intersections in this section were analyzed without considering the impacts of freeway congestion spilling back onto local roadways. Section 3.3.4.5, Impacts to Local Roads, documents the locations and extents of freeway congestion spilling back onto the local roadways. Intersections that would be impacted by freeway congestion may operate worse than shown in the following section. These intersections are identified in the tabulated operation results below.

During the existing condition, four intersections (#3, 5, 58, and 68) would not meet performance standards in the AM and/or PM peak hours.

3.6.4.1 Subarea 1: SR 500, Main Street, 39th Street, and Fourth Plain Boulevard

Subarea 1 consists of 17 study intersections and spans across SR 500, 39th Street, Main Street, and the Fourth Plain Boulevard corridor. Figure 3-33 illustrates the location of study intersection and identifies whether the intersection meets the relevant agency standards for the AM and PM peak hours.

The existing AM and PM peak-hour intersection operations in Subarea 1 are reported in Table 3-17 and Table 3-18, respectively. Details provided in the table include overall intersection LOS, delay, and V/C ratio. For two-way stop-controlled intersections, only the results for the worst stop-controlled approach are reported.

During the AM peak hour, all study intersections in Subarea 1 operate at or better than the intersection performance standards, except for the southbound I-5 ramp and 39th Street (Intersection 5). This is a two-way stop-controlled intersection that operates at LOS F, with an average delay greater than 300 seconds per vehicle and a V/C ratio of 1.25.

During the PM peak, all study intersections in Subarea 1 operate at or better than the intersection standards except for Main Street and 39th Street (Intersection 3) and the southbound I-5 ramp and 39th Street (Intersection 5). Intersection 3 is a signalized intersection that operates at LOS F, with an average delay of 106 seconds per vehicle and a V/C ratio of 0.53. Intersection 5 is a two-way stop-controlled intersection that operates at LOS F, with an average delay of 203 seconds per vehicle and a V/C ratio of 0.90.

Within Subarea 1, the City of Vancouver has established concurrency corridors along Fourth Plain Boulevard and St. Johns Boulevard/Fort Vancouver Way. The concurrency standard along Fourth Plain Boulevard between Mill Plain Boulevard and I-5 is 12 mph. The most recent data related to concurrency corridors, which are from fall 2019, measured the peak-hour speed along Fourth Plain Boulevard at 20 mph. The concurrency standard along St. Johns/Fort Vancouver Way between Fourth Plain and SR 500 is 12 mph; in fall 2019, RTC measured the peak-hour speed at 14 mph. Therefore, both corridors meet the concurrency standards.

Figure 3-33. Subarea 1 Existing Traffic Operations – SR 500, Main Street, 39th Street, and Fourth Plain Boulevard

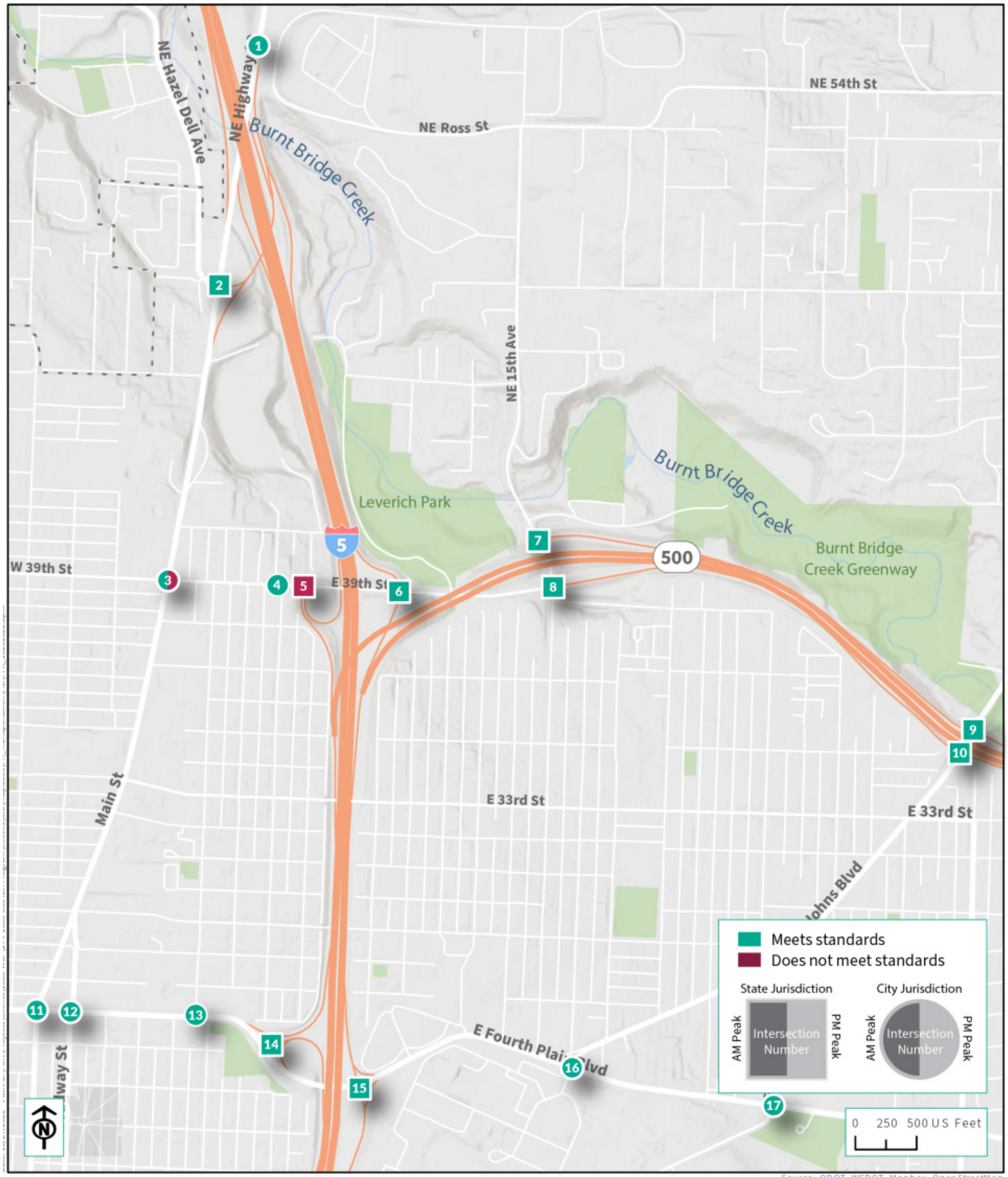


Table 3-17. Subarea 1 – AM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (seconds)	V/C	Meets Standard
1	Main St and Ross St	Signal	LOS E COV	A	3	0.27	Yes
2	Main St and Hazel Dell Ave	Signal	LOS D WSDOT	A	5	0.56	Yes
3	Main St and 39th St	Signal	LOS E COV	B	17	0.79	Yes
4	39th Street and H Street	Signal	LOS E COV	A	9	0.47	Yes
5 [b]	I-5 SB Ramp and 39th St [b]	TWSC [b]	LOS D WSDOT [b]	F [b]	> 300 [b]	1.25 [b]	No [b]
6	I-5 NB Ramp and 39th St [a]	Signal	LOS D WSDOT	B	15	0.77	Yes
7	15th Ave and SR 500 WB off-ramp	Signal	LOS E WSDOT	A	7	0.54	Yes
8	15th Ave and 39th St [a]	Signal	LOS E WSDOT	A	8	0.82	Yes
9	St. Johns Blvd and SR 500 WB Ramp	Signal	LOS E WSDOT	B	11	0.41	Yes
10	St. Johns Blvd and SR 500 EB Ramp	Signal	LOS E WSDOT	A	9	0.38	Yes
11	Fourth Plain Blvd and Main St	Signal	LOS E COV	D	43	1.13	Yes
12	Fourth Plain Blvd and Broadway St	Signal	LOS E COV	D	47	0.77	Yes
13	Fourth Plain Boulevard and F Street	Signal	LOS E COV	D	38	0.46	Yes
14	Fourth Plain Blvd and I-5 SB on-/off-ramps	Signal	LOS D WSDOT	B	19	0.85	Yes
15	Fourth Plain Blvd and I-5 NB on-/off-ramps [a]	Signal	LOS D WSDOT	B	13	0.75	Yes
16	Fourth Plain Blvd and St. Johns Blvd	Signal	LOS E COV	A	8	0.33	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (seconds)	V/C	Meets Standard
17	Fourth Plain Blvd and Fort Vancouver Way	Signal	LOS E COV	B	11	0.28	Yes

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 3.3.4.5 for more information.

b Cells highlighted in red identify intersections that operate below the relevant performance standard.

Ave = avenue; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; NB = northbound; St = Street; TWSC = two-way stop-control; V/C ratio = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation

Table 3-18. Subarea 1 – PM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
1	Main St and Ross St	Signal	LOS E COV	A	5	0.50	Yes
2	Main St and Hazel Dell Ave	Signal	LOS D WSDOT	A	7	0.46	Yes
3 [a]	Main St and 39th St [a]	Signal [a]	LOS E COV [a]	F [a]	106 [a]	0.53 [a]	No [a]
4	39th Street and H Street	Signal	LOS E COV	B	19	0.49	Yes
5 [a]	I-5 SB Ramp and 39th St [a]	TWSC [a]	LOS D WSDOT [a]	F [a]	203 [a]	0.90 [a]	No [a]
6	I-5 NB Ramp and 39th St	Signal	LOS D WSDOT	C	23	0.81	Yes
7	15th Ave and SR 500 WB off-ramp	Signal	LOS E WSDOT	A	8	0.52	Yes
8	15th Ave and 39th St	Signal	LOS E WSDOT	A	9	0.69	Yes
9	St. Johns Blvd and SR 500 WB Ramp	Signal	LOS E WSDOT	D	29	0.43	Yes
10	St. Johns Blvd and SR 500 EB Ramp	Signal	LOS E WSDOT	C	21	0.44	Yes
11	Fourth Plain Blvd and Main St	Signal	LOS E COV	C	24	0.71	Yes
12	Fourth Plain Blvd and Broadway St	Signal	LOS E COV	C	22	0.71	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
13	Fourth Plain Boulevard and F Street	Signal	LOS E COV	B	12	0.48	Yes
14	Fourth Plain Blvd and I-5 SB on-/off-ramps	Signal	LOS D WSDOT	B	11	0.74	Yes
15	Fourth Plain Blvd and I-5 NB on-/off-ramps	Signal	LOS D WSDOT	B	14	0.78	Yes
16	Fourth Plain Blvd and St. Johns Blvd	Signal	LOS E COV	B	12	0.47	Yes
17	Fourth Plain Blvd and Fort Vancouver Way	Signal	LOS E COV	B	19	0.36	Yes

Source: IBR Analysis

a Cells highlighted in red identify intersections that operate below the relevant performance standard.

Ave = avenue; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; NB = northbound; St = Street; TWSC = two-way stop-control; V/C ratio = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation

3.6.4.2 Subarea 2: Mill Plain Boulevard

Subarea 2 consists of 18 study intersections and covers McLoughlin Boulevard, 15th Street, and Mill Plain Boulevard. Figure 3-34 illustrates the locations of study intersections and whether each intersection meets the relevant agency standards for the AM and PM peak hours. The existing AM and PM peak-hour intersection operations in Subarea 2 are reported in Table 3-19 and Table 3-20, respectively. Details included in the tables include overall intersection LOS, delay, and V/C ratio. For two-way stop-controlled intersections, only the results for the worst stop-controlled approach are reported.

All study intersections in Subarea 2 operate at or better than the applicable standards during both the AM and PM peak hours.

Within this subarea, the City of Vancouver has established concurrency corridors along Mill Plain Boulevard and St Johns Boulevard/Fort Vancouver Way. The concurrency standard along Mill Plain Boulevard between Fourth Plain Boulevard and I-5 is 10 mph. The most recent data related to concurrency corridors, which are from 2019, measured the peak-hour speed along Fourth Plain Boulevard at 21 mph. The concurrency standard along St. Johns Boulevard/Fort Vancouver Way between Fourth Plain Boulevard and SR 500 is 12 mph. In 2019, RTC measured the peak-hour speed at 14 mph. Therefore, both corridors meet concurrency standards.

1 Figure 3-34. Subarea 2 Existing Traffic Operations – Mill Plain Boulevard

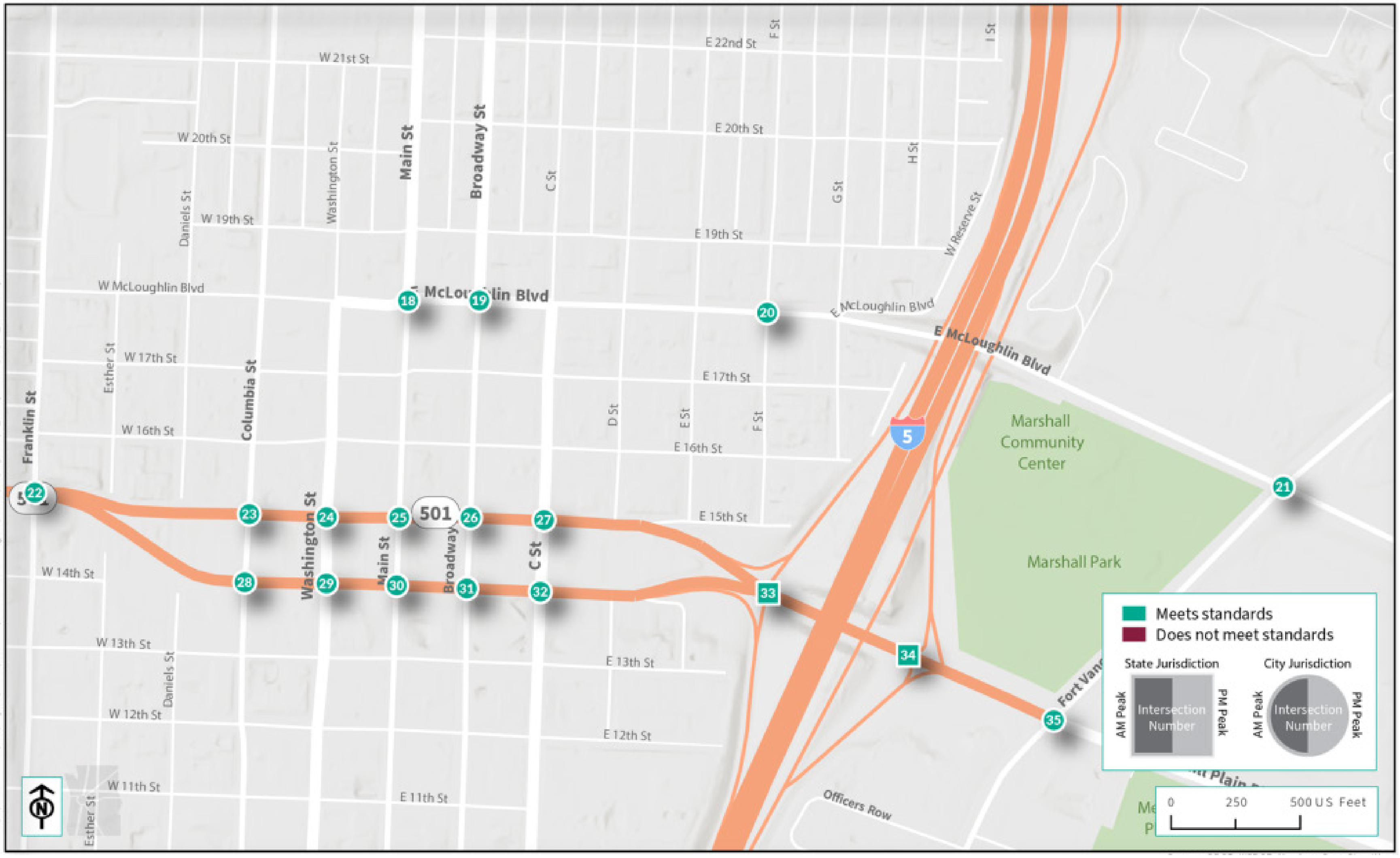


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Table 3-19. Subarea 2 – AM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
18	Main St and McLoughlin Blvd	Signal	LOS E COV	A	5	0.50	Yes
19	Broadway St and McLoughlin Blvd	Signal	LOS E COV	A	5	0.13	Yes
20	F St and McLoughlin Blvd	TWSC	LOS E COV	A	3	0.01	Yes
21	Fort Vancouver Way and McLoughlin Blvd	Signal	LOS E COV	B	11	0.14	Yes
22	Franklin St and Mill Plain Blvd	Signal	LOS E COV	B	15	0.44	Yes
23	Columbia St and 15th Street	Signal	LOS E COV	A	6	0.26	Yes
24	Washington St and 15th Street	Signal	LOS E COV	A	8	0.43	Yes
25	Main St and 15th Street	Signal	LOS E COV	A	6	0.43	Yes
26	Broadway St and 15th Street	Signal	LOS E COV	A	4	0.30	Yes
27	C St and 15th Street	Signal	LOS E COV	B	14	0.42	Yes
28	Columbia St and Mill Plain Blvd	Signal	LOS E COV	B	11	0.41	Yes
29	Washington St and Mill Plain Blvd	Signal	LOS E COV	A	8	0.38	Yes
30	Main St and Mill Plain Blvd	Signal	LOS E COV	A	4	0.40	Yes
31	Broadway St and Mill Plain Blvd	Signal	LOS E COV	A	6	0.31	Yes
32	C St and Mill Plain Blvd [a]	Signal	LOS E COV	A	5	0.38	Yes
33	I-5 SB Ramp and Mill Plain Blvd [a]	Signal	LOS D WSDOT	B	18	1.04	Yes
34	I-5 NB Ramp and Mill Plain Blvd[1]	Signal	LOS D WSDOT	C	24	0.71	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
35	Fort Vancouver Way and Mill Plain Blvd [a]	Signal	LOS E COV	C	21	0.43	Yes

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 3.3.4.5 for more information.

Ave = avenue; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; NB = northbound; St = Street; TWSC = two-way stop-control; V/C ratio = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation

Table 3-20. Subarea 2 – PM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
18	Main St and McLoughlin Blvd	Signal	LOS E COV	A	6	0.35	Yes
19	Broadway St and McLoughlin Blvd	Signal	LOS E COV	A	5	0.12	Yes
20	F St and McLoughlin Blvd	TWSC	LOS E COV	A	7	0.01	Yes
21	Fort Vancouver Way and McLoughlin Blvd	Signal	LOS E COV	A	9	0.12	Yes
22	Franklin St and Mill Plain Blvd	Signal	LOS E COV	C	26	0.37	Yes
23	Columbia St and 15th Street	Signal	LOS E COV	B	12	0.26	Yes
24	Washington St and 15th Street	Signal	LOS E COV	A	6	0.26	Yes
25	Main St and 15th Street	Signal	LOS E COV	A	10	0.37	Yes
26	Broadway St and 15th Street	Signal	LOS E COV	A	9	0.27	Yes
27	C St and 15th Street	Signal	LOS E COV	B	16	0.47	Yes
28	Columbia St and Mill Plain Blvd	Signal	LOS E COV	D	44	0.60	Yes
29	Washington St and Mill Plain Blvd	Signal	LOS E COV	C	28	0.35	Yes
30	Main St and Mill Plain Blvd	Signal	LOS E COV	C	29	0.57	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
31	Broadway St and Mill Plain Blvd	Signal	LOS E COV	C	35	0.58	Yes
32	C St and Mill Plain Blvd	Signal	LOS E COV	C	28	0.73	Yes
33	I-5 SB Ramp and Mill Plain Blvd	Signal	LOS D WSDOT	D	37	0.72	Yes
34	I-5 NB Ramp and Mill Plain Blvd	Signal	LOS D WSDOT	C	27	0.84	Yes
35	Fort Vancouver Way and Mill Plain Blvd	Signal	LOS E COV	C	24	0.46	Yes

Source: IBR Analysis

Ave = avenue; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; NB = northbound; St = Street; TWSC = two-way stop-control; V/C ratio = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation

3.6.4.3 Subarea 3: SR 14, City Center Interchange, and Columbia Way

Subarea 3 consists of 23 study intersections and includes the downtown Vancouver area as well as two groups of intersections on the east side of I-5 along Evergreen Boulevard and Columbia Way. Figure 3-35 illustrates the locations of study intersections and whether each intersection meets the relevant agency standards for the AM and PM peak hours.

The existing AM and PM peak-hour intersection operations in Subarea 3 are reported in Table 3-21 and Table 3-22, respectively. Details included in the table include overall intersection LOS, delay, and V/C ratio. For two-way stop-controlled intersections, only the results for the worst stop-controlled approach are reported.

All study intersections in Subarea 3 operate at or better than the intersection standards during the AM peak hour. During the PM peak hour, all study intersections in the subarea operate at or better than the intersection standards except for Columbia Shores Boulevard and Columbia Way (Intersection 58). This is a signalized intersection that operates at LOS F, with an average delay greater than 300 seconds per vehicle and a V/C ratio of 0.51.

The City of Vancouver has not established concurrency corridors within Subarea 3.

Figure 3-35. Subarea 3 Existing Traffic Operations – SR 14, City Center Interchange, and Columbia Way

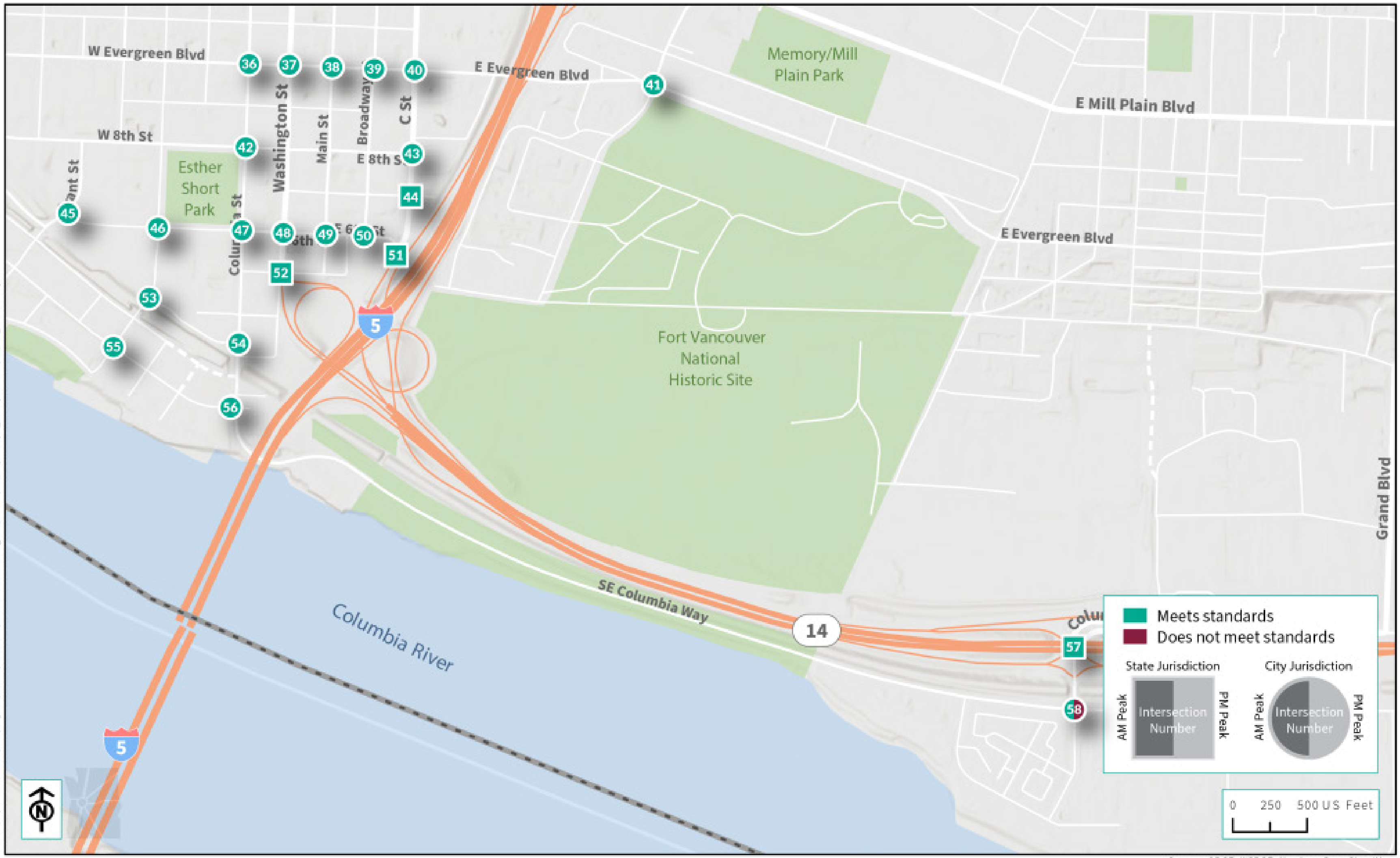


Table 3-21. Subarea 3 – AM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
36	Columbia St and Evergreen Blvd	Signal	LOS E COV	B	12	0.20	Yes
37	Washington St and Evergreen Blvd	Signal	LOS E COV	C	22	0.19	Yes
38	Main St and Evergreen Blvd	Signal	LOS E COV	A	8	0.16	Yes
39	Broadway St and Evergreen Blvd	Signal	LOS E COV	A	10	0.16	Yes
40	C St and Evergreen Blvd	Signal	LOS E COV	A	7	0.17	Yes
41	Fort Vancouver Way and Evergreen Blvd	RAB	LOS E COV	A	2	0.14	Yes
42	Columbia St and 8th St [a]	Signal	LOS E COV	A	6	0.11	Yes
43	C St and 8th St	Signal	LOS E COV	B	14	0.22	Yes
44	7th Street and C Street	TWSC	LOS D WSDOT	A	1	0.03	Yes
45	Grant St and 6th St	TWSC	LOS E COV	A	6	0.18	Yes
46	Esther St and 6th St	RAB	LOS E COV	A	5	0.16	Yes
47	Columbia St and 6th St [a]	Signal	LOS E COV	A	7	0.24	Yes
48	Washington St and 6th St [a]	Signal	LOS E COV	B	12	0.27	Yes
49	Main St and 6th St	AWSC	LOS E COV	A	6	0.41	Yes
50	Broadway St and 6th St	TWSC	LOS E COV	A	5	0.03	Yes
51	C St and 6th St	TWSC	LOS D WSDOT	A	2	0.00	Yes
52	Washington St and 5th St [a]	Signal	LOS D WSDOT	A	9	0.26	Yes
53	Esther St and Phil Arnold Way	TWSC	LOS E COV	A	4	0.02	Yes
54	Columbia St and Phil Arnold Way	TWSC	LOS E COV	A	4	0.04	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
55	Esther St and Columbia Way	Signal	LOS E COV	A	4	0.06	Yes
56	Columbia St and Columbia Way	Signal	LOS E COV	A	3	0.69	Yes
57	Columbia Shores Blvd and SR 14 EB off-ramp	Signal	LOS D WSDOT	C	20	0.59	Yes
58	Columbia Shores Blvd and Columbia Way	Signal	LOS E COV	B	18	0.85	Yes

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 3.3.4.5 for more information.

Ave = avenue; AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; RAB = roundabout; St = Street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation.

Table 3-22. Subarea 3 – PM Intersection Performance Results

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
36	Columbia St and Evergreen Blvd	Signal	LOS E COV	B	13	0.28	Yes
37	Washington St and Evergreen Blvd	Signal	LOS E COV	B	18	0.13	Yes
38	Main St and Evergreen Blvd	Signal	LOS E COV	B	11	0.17	Yes
39	Broadway St and Evergreen Blvd	Signal	LOS E COV	B	12	0.16	Yes
40	C St and Evergreen Blvd	Signal	LOS E COV	B	16	0.24	Yes
41	Fort Vancouver Way and Evergreen Blvd	RAB	LOS E COV	A	3	0.15	Yes
42	Columbia St and 8th St	Signal	LOS E COV	B	11	0.32	Yes
43	C St and 8th St	Signal	LOS E COV	B	16	0.23	Yes
44	7th Street and C Street	TWSC	LOS D WSDOT	A	8	0.03	Yes

Number	Intersection	Control Type	Standard	LOS	Delay (Seconds)	V/C	Meets Standard
45	Grant St and 6th St	TWSC	LOS E COV	B	10	0.28	Yes
46	Esther St and 6th St	RAB	LOS E COV	A	3	0.18	Yes
47	Columbia St and 6th St	Signal	LOS E COV	B	14	0.29	Yes
48	Washington St and 6th St	Signal	LOS E COV	B	14	0.24	Yes
49	Main St and 6th St	AWSC	LOS E COV	A	6	0.26	Yes
50	Broadway St and 6th St	TWSC	LOS E COV	A	4	0.03	Yes
51	C St and 6th St	TWSC	LOS D WSDOT	A	1	0.00	Yes
52	Washington St and 5th St	Signal	LOS D WSDOT	B	15	0.39	Yes
53	Esther St and Phil Arnold Way	TWSC	LOS E COV	A	5	0.04	Yes
54	Columbia St and Phil Arnold Way	TWSC	LOS E COV	A	6	0.03	Yes
55	Esther St and Columbia Way	Signal	LOS E COV	A	6	0.16	Yes
56	Columbia St and Columbia Way	Signal	LOS E COV	A	4	0.30	Yes
57	Columbia Shores Blvd and SR 14 EB off-ramp	Signal	LOS D WSDOT	D	40	0.68	Yes
58 [a]	Columbia Shores Blvd and Columbia Way [a]	Signal [a]	LOS E COV [a]	F [a]	> 300 [a]	0.51 [a]	No [a]

Source: IBR Analysis

a Cells highlighted in red identify intersections that operate below the relevant performance standard.

Ave = avenue; AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; RAB = roundabout; St = Street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound; WSDOT = Washington State Department of Transportation

3.6.4.4 Subarea 4: Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Subarea 4 consists of 22 study intersections and captures all study intersections within Portland. Figure 3-36 illustrates the locations of the study intersections and whether each meets the relevant agency standards for the AM and PM peak hours. The existing AM and PM peak-hour intersection operations in this subarea are reported in Table 3-23 and Table 3-24, respectively. Details provided in the table include overall intersection LOS, delay, and V/C ratio.

All study intersections in Subarea 4 operate at or better than the applicable intersection standards and targets during both the AM and PM peak hours except for Marine Drive/MLK Boulevard and the I-5 ramps (Intersection 68) during the AM peak hour. This is a signalized intersection that operates at LOS F during the AM peak hour. The intersection operates with an average delay of 140 seconds per vehicle and a V/C ratio of 1.04.

Figure 3-36. Subarea 4 Existing Traffic Operations – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Table 3-23. Subarea 4 – AM Intersection Performance Results

Number	Intersection	Control Type	Standard/ Target	LOS	Delay (Seconds)	V/C	Meets Standard
59	Hayden Island Dr (South) and Center Ave	Signal	V/C = 1.1 ODOT	A	8	0.42	Yes
60	Hayden Island Dr (South) and Hayden Island Dr Connector to North	Signal	V/C = 1.1 ODOT	A	5	0.28	Yes
61	Hayden Island Dr (North) and Hayden Island Dr Connector to South	Signal	LOS D COP	A	3	0.13	Yes
62	I-5 SB Hayden Island off-ramp and Center Ave/Tomahawk Island	Signal	V/C = 0.85 ODOT	A	9	0.45	Yes
63	I-5 NB Hayden Island off-ramp and Tomahawk Island Dr	TWSC	V/C = 0.85 ODOT	A	2	0.05	Yes
64	Tomahawk Island Dr and Jantzen Dr	TWSC	LOS D COP	A	8	0.12	Yes
65	Center Ave and Jantzen Ave	TWSC	LOS D COP	A	8	0.07	Yes
66	Marine Drive and OR 120 (N Portland Rd)	Signal	LOS D COP	B	18	0.73	Yes
67	Marine Dr and Force Ave	Signal	LOS D COP	A	7	0.65	Yes
68 [a]	Marine Dr/MLK Blvd and I-5 NB/SB on-/off-ramps [a]	Signal [a]	V/C = 0.85 ODOT [a]	F [a]	140 [a]	1.04 [a]	No [a]
69	Marine Dr and Vancouver Way (Loop)	AWSC	V/C = 0.99 ODOT	A	7	0.61	Yes
70	Marine Dr and Anchor Way	TWSC	LOS D COP	A	9	0.20	Yes
71	I-5 NB off-ramp and Union Ct/Marine Way	TWSC	V/C = 0.85 ODOT	B	11	0.28	Yes
72	Union Ct and MLK Blvd eastbound Off-Ramp	TWSC	V/C = 0.99 ODOT	A	3	0.04	Yes
73	Victory Blvd and Expo Rd	AWSC	V/C = 1.1 ODOT	B	10	0.18	Yes
74	Victory Blvd and Interstate Ave/Denver Ave NB off-ramp	TWSC	V/C = 0.85 ODOT	A	6	0.05	Yes
75	Victory Blvd and I-5 SB on-ramp	TWSC	V/C = 0.85 ODOT	A	3	0.10	Yes
76	Victory Blvd and I-5 NB off-ramp/Whitaker Rd	Signal	V/C = 0.85 ODOT	A	7	0.22	Yes

Number	Intersection	Control Type	Standard/ Target	LOS	Delay (Seconds)	V/C	Meets Standard
77	Interstate Ave/Denver Ave and Schmeer Rd	Signal	V/C = 0.85 ODOT	A	6	0.76	Yes
78	Columbia Blvd and I-5 NB/SB on-/off-ramp	Signal	V/C = 0.85 ODOT	B	15	0.57	Yes
79	Columbia Blvd and N Vancouver Ave	Signal	LOS D COP	B	15	0.46	Yes
80	Columbia Blvd and MLK Blvd	Signal	V/C = 0.99 ODOT	C	32	0.83	Yes

Source: IBR Analysis

a Cells highlighted in red identify intersections that operate below the relevant performance standard.

Ave = avenue; AWSC = all-way stop-control; Blvd = boulevard; COP = City of Portland; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; ODOT = Oregon Department of Transportation; RAB = roundabout; St = Street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound

Table 3-24. Subarea 4 – PM Intersection Performance Results

Number	Intersection	Control Type	Standard/ Target	LOS	Delay (Seconds)	V/C	Meets Standard
59	Hayden Island Dr (South) and Center Ave	Signal	V/C = 1.1 ODOT	A	8	0.50	Yes
60	Hayden Island Dr (South) and Hayden Island Dr Connector to North	Signal	V/C = 1.1 ODOT	A	8	0.55	Yes
61	Hayden Island Dr (North) and Hayden Island Dr Connector to South	Signal	LOS D COP	A	4	0.15	Yes
62	I-5 SB Hayden Island off-ramp and Center Ave/Tomahawk Island	Signal	V/C = 0.85 ODOT	A	10	0.43	Yes
63	I-5 NB Hayden Island off-ramp and Tomahawk Island Dr	TWSC	V/C = 0.85 ODOT	A	2	0.05	Yes
64	Tomahawk Island Dr and Jantzen Dr	TWSC	LOS D COP	A	9	0.27	Yes
65	Center Ave and Jantzen Ave	TWSC	LOS D COP	A	7	0.03	Yes
66	Marine Drive and OR 120 (N Portland Rd)	Signal	LOS D COP	C	27	0.85	Yes
67	Marine Dr and Force Ave	Signal	LOS D COP	B	11	0.57	Yes

Number	Intersection	Control Type	Standard/ Target	LOS	Delay (Seconds)	V/C	Meets Standard
68	Marine Dr/MLK Blvd and I-5 NB/SB on-/off-ramps [a]	Signal	V/C = 0.85 ODOT	D	47	0.80	Yes
69	Marine Dr and Vancouver Way (Loop)	AWSC	V/C = 0.99 ODOT	A	8	0.50	Yes
70	Marine Dr and Anchor Way	TWSC	LOS D COP	B	10	0.19	Yes
71	I-5 NB off-ramp and Union Ct/Marine Way	TWSC	V/C = 0.85 ODOT	B	16	0.16	Yes
72	Union Ct and MLK Blvd eastbound Off-Ramp	TWSC	V/C = 0.99 ODOT	A	7	0.10	Yes
73	Victory Blvd and Expo Rd	AWSC	V/C = 1.1 ODOT	A	8	0.52	Yes
74	Victory Blvd and Interstate Ave/Denver Ave NB off-ramp [a]	TWSC	V/C = 0.85 ODOT	B	10	0.27	Yes
75	Victory Blvd and I-5 SB on-ramp [a]	TWSC	V/C = 0.85 ODOT	A	5	0.47	Yes
76	Victory Blvd and I-5 NB off-ramp/Whitaker Rd [a]	Signal	V/C = 0.85 ODOT	B	13	0.50	Yes
77	Interstate Ave/Denver Ave and Schmeer Rd [a]	Signal	V/C = 0.85 ODOT	B	11	0.63	Yes
78	Columbia Blvd and I-5 NB/SB On-/off-ramp	Signal	V/C = 0.85 ODOT	B	10	0.46	Yes
79	Columbia Blvd and N Vancouver Ave	Signal	LOS D COP	C	23	0.65	Yes
80	Columbia Blvd and MLK Blvd	Signal	V/C = 0.99 ODOT	D	42	0.73	Yes

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 3.3.4.5 for more information.

Ave = avenue; AWSC = all-way stop-control; Blvd = boulevard; COP = City of Portland; delay = seconds of delay per vehicle; EB = eastbound; LOS = level of service; MLK = Martin Luther King Jr.; NB = northbound; ODOT = Oregon Department of Transportation; RAB = roundabout; SB = southbound; St = Street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; WB = westbound

3.7 Transit

This section summarizes the characteristics and performance of the existing 2019 public transportation system, both in the Portland-Vancouver metropolitan region and for routes and facilities in the IBR Program Area.

3.7.1 Transit Service

Transit service in the region and IBR Program Area is provided by TriMet and C-TRAN.

TriMet is the largest transit provider in the Portland metropolitan region, with a fleet of approximately 700 buses that serve 85 bus lines and seasonal shuttles. TriMet operates 216 miles of frequent service on 17 bus routes that provide 15-minute or better frequencies all day, 7 days a week. The 60-mile-long Metropolitan Area Express (MAX) light-rail system includes five lines and operates at 15-minute or better frequencies all day, 7 days a week. This includes the Yellow Line, also known as Interstate MAX, that runs northbound and southbound from downtown Portland (Portland State University) to the Expo Center. (South of downtown, the Yellow Line transitions to the Orange Line and continues south to Milwaukie.) The TriMet MAX system does not currently provide service across North Portland Harbor to Hayden Island or across the Columbia River into Clark County. TriMet operates one commuter rail line, the Westside Express Service, which operates during peak hours between Beaverton and Wilsonville. In addition to fixed-route service, TriMet operates more than 250 LIFT vehicles providing door-to-door service for people with special needs. TriMet also operates five operations and maintenance facilities, three for buses and two for rail. The TriMet service area also includes streetcar service managed by Portland Streetcar, Inc.

C-TRAN is the transit provider in the Clark County service area, with a fixed-route fleet of approximately 122 buses that serve 28 bus lines and The Vine BRT service. The Vine BRT service began operations in 2017 between downtown Vancouver and the Vancouver Mall Transit Center. In addition to local bus and BRT service, C-TRAN operates three regional routes that provide transit service crossing the Columbia River to connect with the TriMet rail system and Portland International Airport, as well as seven express routes that provide connections between regional park-and-ride locations, downtown Vancouver, and the downtown Portland area. In addition to fixed-route service, C-TRAN has a fleet of 64 demand-responsive vehicles and 40 vanpool vehicles. C-TRAN currently operates one bus operations and maintenance facility. Demand-responsive transit service are vehicles operated by a paid transit driver that can be requested by passengers and do not operate over a fixed route. Passengers must meet certain criteria, such as low income or physical disabilities, to qualify for Demand Response service.

3.7.1.1 Regional and Local Transit Service

Transit in the IBR Program Area is primarily fixed-route, fixed-schedule bus service operating in mixed traffic. There are 27 bus routes and one LRT line, including BRT, local, express, and regional service provided by C-TRAN and local bus and LRT provided by TriMet. Both C-TRAN and TriMet provide special access and shared mobility (i.e., paratransit, on-demand ridesharing, neighborhood shuttles, vanpools) services in the IBR Program Area. Other shuttle transit services that may operate outside of fixed-route service in the region (e.g., Multnomah County ACCESS shuttle in east Portland) are not included in the regional travel demand model that is being used to support transportation analysis for the Program, and therefore are not summarized below.

A number of routes connect the IBR Program Area communities to regional destinations, including downtown Vancouver, downtown Portland, the Lloyd District, and Portland International Airport.

C-TRAN

In the IBR Program Area, C-TRAN operates one BRT route, The Vine, which connects downtown Vancouver to the Vancouver Mall via Fourth Plain Boulevard. New Vine BRT service along Mill Plain Boulevard began service in late 2023 (note that this service is not reflected in existing conditions, which are based on 2019 conditions). The Vine provides service for 22 hours per day, with 10-minute headways (the frequency at which a vehicle passes by a point along the route) for most of the day and 15-minute headways during the early morning and evening. C-TRAN also provides local bus service with a variety of headways that connects multiple Vancouver and unincorporated Clark County neighborhoods.

C-TRAN operates seven express routes across the Columbia River via I-5 and I-205.C-TRAN routes that provide service on I-205 are being included because of the interaction these express routes have for commute trips between Vancouver and Portland, and because the routes that operate on I-205 southbound in the AM peak operate on I-5 northbound in the PM peak. All express routes, except Route 105, provide peak-only service. Most express routes connect park and rides or transit centers in Vancouver and unincorporated Clark County to Portland economic centers, including downtown Portland, the Lloyd District, and Oregon Health & Science University (OHSU). All peak-only express routes provide southbound service during the AM peak period and northbound service during the PM peak period. Route 105 provides all-day service between the Salmon Creek Park and Ride and the Portland Transit Mall. Five of the express routes cross the Columbia River in both directions via I-5. Two routes provide southbound service across the Columbia River via I-205 and northbound service across the Columbia River via I-5.

C-TRAN also operates three regional bus routes, two of which operate all day. Route 60 connects downtown Vancouver to the Delta Park/Vanport MAX Station with service to Hayden Island along the route, and Route 65 provides service between the Fisher's Landing Transit Center and Parkrose/Sumner Transit Center. Route 67 connects the Fisher's Landing Transit Center and Portland International Airport during two service periods: from 2:15 to 4:20 p.m. and from 9:30 p.m. to 12:15 a.m. Route 60 crosses the Columbia River via I-5, whereas Routes 65 and 67 cross the Columbia River via I-205 in both directions of travel.

TriMet

TriMet operates bus service in the IBR Program Area on eight routes that provide connections into the MAX Yellow Line at stations along Interstate Avenue. Two of these routes serve locations within the IBR Program Area directly. Route 6 provides all-day service between Hayden Island and downtown Portland, with 10- to 15-minute headways during the peak periods and 15-minute headways during off-peak periods. Route 11 provides peak-only service with 60-minute headways between Rivergate and St. Johns with service that connects riders to the Yellow Line at the Expo Center.

TriMet operates MAX light-rail service on the Yellow Line in the IBR Program Area, with stations at the Expo Center and Delta Park/Vanport. The Yellow Line connects the Expo Center, north and northeast Portland, the Portland city center, and Portland State University. Most southbound trains continue through Portland city center as MAX Orange Line trains to Milwaukie. The Yellow Line operates every 15 minutes between 5 a.m. and 1:30 a.m. on weekdays. Service is provided every 30 minutes on Saturdays and Sundays, with the same span of service as weekdays. Existing routes that provide service to the IBR Program Area or that cross the river, either on I-5 or I-205 and therefore would be impacted by the Program, including Yellow Line MAX service, are listed in Table 3-25 and shown in Figure 3-37. The Red and Blue Lines are also included in this list because of their connection with cross-river C-TRAN service and park-and-ride facilities that are served by cross-river C-TRAN service. Peak headways listed in the table below are for 2019. Where they are different between AM and PM peak periods, the times in the table reflect an average between AM and PM peak for both inbound and outbound directions of a route.

Table 3-25. 2019 Bus Transit Serving the IBR Program Area

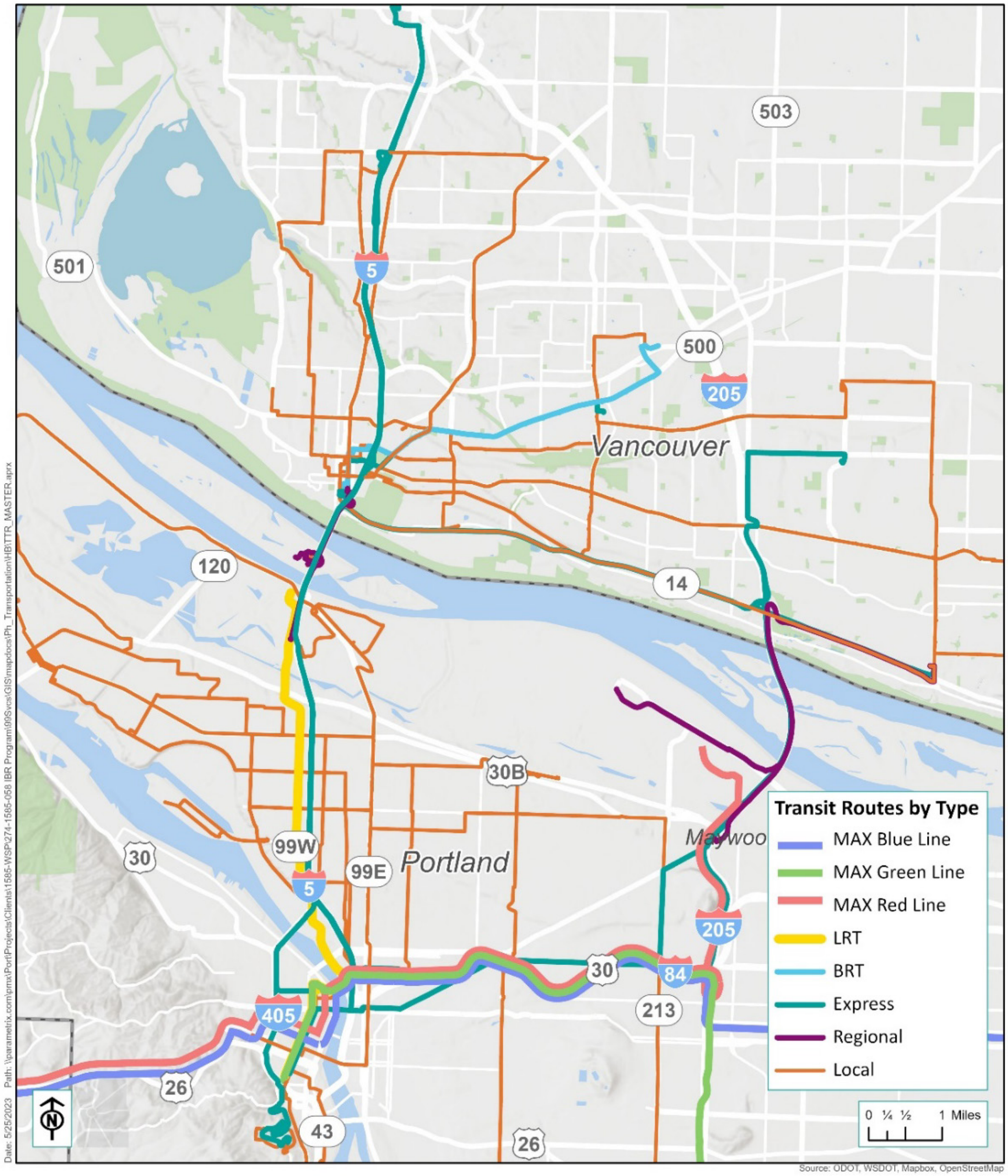
Route	Service Type	Peak Headway (minutes)	Off-Peak Headway (minutes)	Route Termini Locations
C-TRAN The Vine	Bus Rapid Transit	10	10	Downtown Vancouver (Turtle Place) to Vancouver Mall Transit Center
C-TRAN 2	Local	60	60	Downtown Vancouver to 99th Street Transit Center via Kauffman, Lincoln, and 9th Avenue
C-TRAN 6	Local	30	30	Fruit Valley to Columbia House Boulevard Park and Ride (WSDOT) via Fourth Plain Boulevard and Grand Avenue
C-TRAN 25	Local	30	30	Downtown Vancouver to 99th Street Transit Center via Fort Vancouver Way and St. Johns Boulevard
C-TRAN 30	Local	30	30	Downtown Vancouver to Fisher’s Landing Transit Center via McLoughlin Boulevard, 18th Street, 28th Street, 39th Street, and 162nd Avenue
C-TRAN 31	Local	30	30	99th Street Transit Center to downtown Vancouver via Hazel Dell Avenue and Main Street
C-TRAN 32	Local	30	30	Downtown Vancouver to Vancouver Mall Transit Center via Andresen Boulevard and Evergreen Boulevard
C-TRAN 37	Local	15	15	Downtown Vancouver to Fisher’s Landing Transit Center via Mill Plain Boulevard
C-TRAN 41	Local	35	N/A	Downtown Vancouver to Fisher’s Landing Transit Center via SR 14

Route	Service Type	Peak Headway (minutes)	Off-Peak Headway (minutes)	Route Termini Locations
C-TRAN 60	Regional	15	15	Downtown Vancouver to Hayden Island and Delta Park/Vanport MAX Station via I-5
C-TRAN 65	Regional	15	30	Fisher's Landing Transit Center to Parkrose Transit Center (Portland) via I-205
C-TRAN 67	Airport Regional	N/A	30	Fisher's Landing Transit Center to Portland International Airport via SR 14 and I-205
C-TRAN 71	Local	15	30	Downtown Vancouver to 99th Street Transit Center via Main Street/Highway 99
C-TRAN 105	Express	20	45	Salmon Creek Park and Ride, 99th Street Transit Center to Downtown Vancouver and Downtown Portland Transit Mall, via I-5
C-TRAN 134	Express	15	N/A	Salmon Creek Park and Ride, 99th Street Transit Center to Downtown Portland Transit Mall via I-5
C-TRAN 157	Express	30	N/A	99th Street Transit Center to Lloyd Center Mall in Portland via I-5
C-TRAN 164	Express	15	N/A	Fisher's Landing Transit Center to, Downtown Portland Transit Mall via I-205 (southbound) and I-5 (northbound)
C-TRAN 177	Express	45	N/A	Evergreen Park and Ride to Downtown Portland Transit Mall via I-205 southbound and I-5 northbound
C-TRAN 190	Express	30	N/A	Andresen Park and Ride to Marquam Hill in Portland via I-5
C-TRAN 199	Express	15	N/A	Salmon Creek Park and Ride, 99th Street Transit Center to Downtown Portland Transit Mall via I-5
TriMet 4	Local	12	15	Downtown Portland Transit Mall – St. Johns/North Portland

Route	Service Type	Peak Headway (minutes)	Off-Peak Headway (minutes)	Route Termini Locations
TriMet 6	Local	12	15	Downtown Portland Transit Mall to Delta Park and Hayden Island via Martin Luther King Jr. Boulevard
TriMet 8	Local	12	15	Marquam Hill (OHSU)/Downtown Portland Transit Mall to North Portland
TriMet 11	Local	60	N/A	Rivergate to St John’s in North Portland via Marine Drive and Columbia Boulevard
TriMet 35	Local	20	40	Southwest Portland to North Portland/St. Johns
TriMet 44	Local	20	30	Southwest Portland to North Portland/St. Johns
TriMet 72	Local	10	12	Clackamas Town Center to North Portland/Swan Island
TriMet 75	Local	15	15	Milwaukie Transit Center to North Portland/St. Johns
TriMet MAX Yellow Line	LRT	15	15	Downtown Portland Transit Mall to Expo Center via Interstate Avenue
TriMet MAX Red Line	LRT	15	15	Portland International Airport to Beaverton Transit Center
TriMet Blue Line	LRT	12	15	Gresham to Hillsboro

Source: C-TRAN, TriMet 2019 Schedules

Figure 3-37. Transit Serving the IBR Program Area



Other Transit Agencies

In addition to C-TRAN and TriMet, several rural transit agencies provide connections to and from the IBR Program Area. Skamania County Transit provides weekday service between communities in Skamania and Klickitat counties and Vancouver. Lower Columbia Community Action Program provides weekday connections between Longview, Kalama, Woodland, and Vancouver.

3.7.1.2 Intercity Transit Service

Amtrak provides long-distance intercity rail service, with stops in Vancouver and Portland. Amtrak operates two rail routes that pass through the IBR Program Area. The Amtrak Cascades route provides service between Vancouver, British Columbia and Eugene, Oregon, and the Coast Starlight route provides service between Seattle, Washington and Los Angeles, California. The Vancouver Amtrak station is located west of downtown Vancouver, near the boundary of the Esther Short and Fruit Valley neighborhoods. Portland's Amtrak station (Union Station) is in the Old Town neighborhood, just north of downtown Portland. Amtrak service crosses the Columbia River west of I-5 via a separate bridge. Amtrak provides three trips per day, both northbound and southbound, on the Cascades service. Two of the southbound Cascades trains continue south to Eugene and one ends in Portland. All of the northbound Cascades trains continue to Seattle. The Coast Starlight service operates one northbound and one southbound train per day.

Greyhound provides intercity bus service to destinations throughout the United States, Canada, and Mexico. Greyhound routes provide curbside service just south of Union Station. Trips depart daily, transporting passengers to destinations north, east, and south of Portland.

Flixbus provides intercity bus service along several routes, including routes between Portland and Eugene, Redmond, or Bellingham, Washington, with several intermediate stops. Flixbus service operates from Union Station.

3.7.2 Transit Centers and Park and Rides

Several transit centers and park-and-ride facilities are used for travel between Clark County and Portland. These are served by various combinations of local, express, and regional bus routes as well as MAX. Figure 3-38 displays the existing park and rides and transit centers in and near the IBR Program Area. The numbered symbols on the map correspond to the first column of Table 3-26 below the map. Six park and rides (Salmon Creek, 99th Street, Andresen, Evergreen, Fisher's Landing, and Columbia House) are in Vancouver, and four (Expo Center, Delta Park/Vanport, Parkrose, and Gateway) are in Portland. In addition, there are three transit centers (99th Street, Fisher's Landing and Vancouver Mall) in Vancouver and four (Lombard, Rose Quarter, Parkrose/Sumner, Gateway, and Hollywood) in Portland. Transit centers include different amenities depending on the location. These include things such as bicycle lockers/racks, public restrooms, security, and passenger service offices.

Table 3-26 includes a summary of amenities at each of these facilities. Surface parking lots are available at all IBR Program Area park and rides and transit centers except for those at the Vancouver Mall, Lombard, and Rose Quarter.

In addition to the park and rides listed, C-TRAN and TriMet partner with churches or unaffiliated parking lots in the area to provide additional parking. A total of approximately 1,500 park-and-ride spaces are currently provided in or near the IBR Program Area. TriMet conducted a license-plate survey at their park-and-ride lots in 2018. According to the survey, 76% of vehicles using the Delta Park/Vanport Park and Ride and 67% of vehicles using the Parkrose/Sumner Park and Ride were licensed in Washington state. These users from Washington are likely choosing to come just across the river to the nearest park and ride with access to LRT service to avoid congestion on I-5, I-205 and I-84, as well as parking charges in downtown Portland. Table 3-26 summarizes details for each of the transit centers and park-and-ride locations in the IBR Program Area, including type of facility, rider amenities, routes that provide service, number of park-and-ride stalls, and 2019 utilization.

Figure 3-38. Transit Centers and Park and Rides

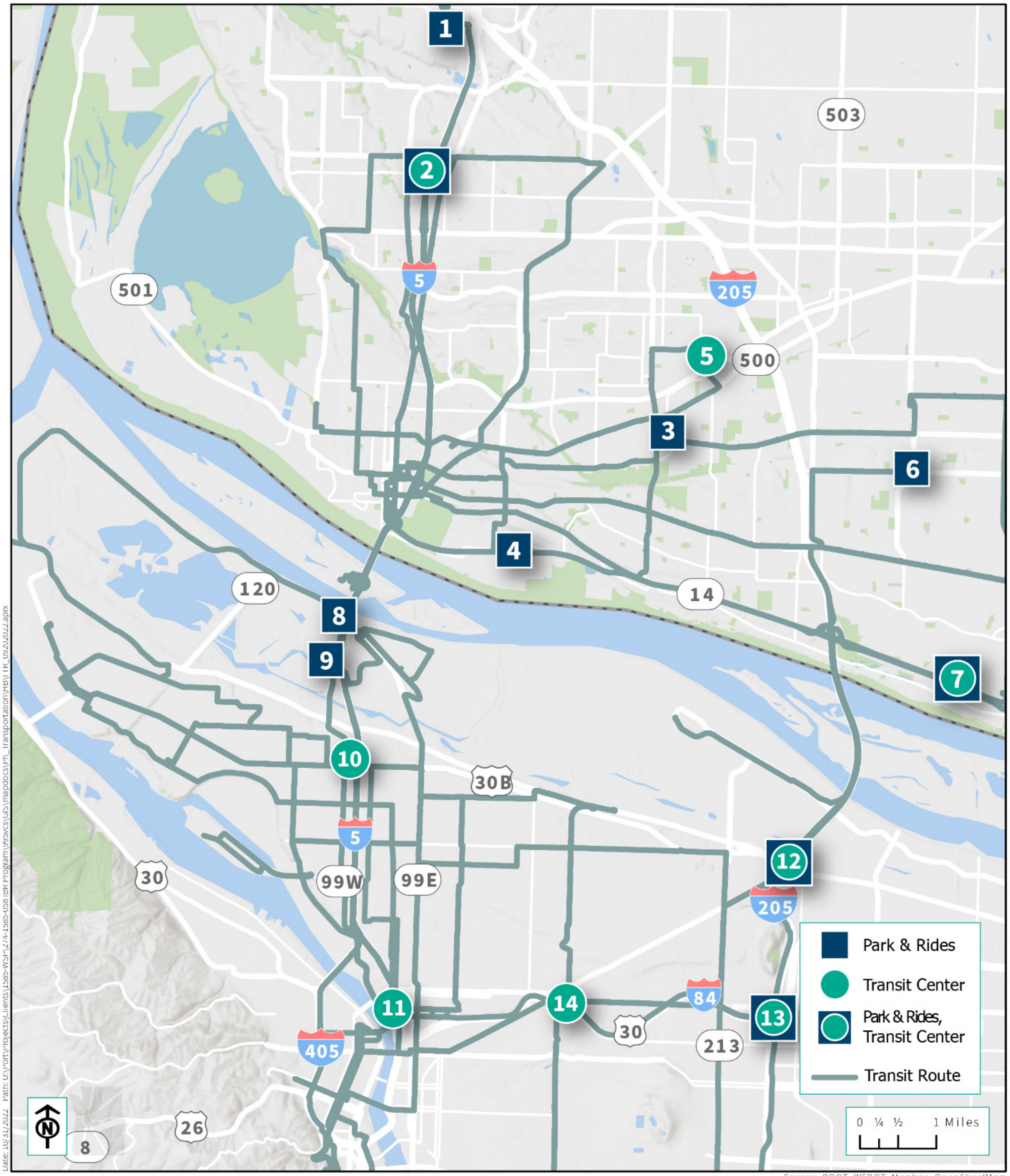


Table 3-26. IBR Program Area Transit Centers and Park and Rides

Map Identifier	Transit Facility	Type of Facility	Rider Amenities	Served by Routes	Park-and-Ride Stalls	2019 Utilization
1	Salmon Creek Park and Ride	Park and ride	Passenger shelters/bicycle parking	C-TRAN: 9, 105, 134	472	50.6%
2	99th Street Transit Center	Transit center/park and ride	Passenger shelters/ bicycle parking/ security	C-TRAN: 2, 9, 19, 25, 31, 71, 78, 105, 157, 199	609	55.1%
3	Andresen Park and Ride (Living Hope Church)	Park and ride	Passenger shelters	C-TRAN: 30, 32, 190	100	98.5%
4	Columbia House Park and Ride	Park and ride	None	C-TRAN: 6	34	80.7%
5	Vancouver Mall Transit Center	Transit center	Bicycle parking/ passenger service office	C-TRAN: The Vine, 7, 32, 47, 72, 74, 78, 80	N/A	N/A
6	Evergreen Park and Ride	Park and ride	Passenger shelters/bicycle parking	C-TRAN: 80, 177	267	15.2%
7	Fisher's Landing Park and Ride and Transit Center	Transit center/park and ride	Passenger shelters/ bicycle parking/ security/public rest room/ passenger service office/	C-TRAN: 30, 37, 41, 65, 67, 80, 92, 164	761	65.5%
8	Expo Center Park and Ride	Park and ride	Bicycle parking	TriMet: MAX Yellow Line, 11	100	48.0%
9	Delta Park/Vanport Park and Ride	Park and ride	Bicycle parking	C-TRAN: 60 TriMet: MAX Yellow Line, 6	300	68.3%
10	Lombard Transit Center	Transit center	Bicycle parking	TriMet: MAX Yellow Line, Bus Route 4, 75	N/A	N/A

Map Identifier	Transit Facility	Type of Facility	Rider Amenities	Served by Routes	Park-and-Ride Stalls	2019 Utilization
11	Rose Quarter Transit Center	Transit center	Bicycle parking	TriMet: MAX Yellow, Red, Blue, Green, Bus Routes 4, 8, 35, 44, 77, 85 C-TRAN: 157	N/A	N/A
12	Parkrose/Sumner Transit Center Park and Ride	Park and ride/transit center	Bicycle parking	C-TRAN: 65 TriMet: MAX Red, 12, 21,71,73	193	97%
13	Gateway/NE 99th Ave Transit Center Park and Ride	Park and ride/transit center	Bicycle parking	TriMet: MAX Red, Blue, Green, 15, 19, 22, 23, 24, 25, 87	690	100%
14	Hollywood Transit Center	Transit Center	Bicycle parking	TriMet: MAX Red, Blue, Green, 12, 75, 77	N/A	N/A

Source: TriMet, C-TRAN 2021

3.7.3 Regional Transit Ridership

Table 3-27 shows the existing 2019 transit unlinked trips (boardings) served by C-TRAN and TriMet in the IBR Program Area. The regional transit system serves over 332,500 daily boardings; the IBR Program Area makes up just under 24% of that regional total at approximately 79,100 daily boardings on a subset of routes in the corridor. C-TRAN's routes comprise approximately 15,500 of the total daily boardings, including those that serve downtown Vancouver and locations in Portland. TriMet's routes comprise approximately 63,600 daily boardings, including the Yellow Line LRT, as well as routes that serve LRT stations along the Yellow Line in north/northeast Portland. For both C-TRAN and TriMet, the routes in the IBR Program Area provide connections that allow riders to get to and from regional locations outside of the IBR Program Area.

Table 3-27. Existing 2019 Average Weekday Transit Ridership (Boardings)

Service	Regional System	IBR Program Area Routes [a]
TriMet – Local Bus	189,200	50,400
TriMet – Light-Rail	122,000	13,200
TriMet – WES	1,400	N/A
TriMet – Total	**312,600**	**63,600**
C-TRAN – Local Bus	10,400	7,100
C-TRAN – The Vine BRT	4,500	4,500
C-TRAN – Regional Bus	2,100	1,500
C-TRAN – Express Bus	2,900	2,400
C-TRAN – Total	**19,900**	**15,500**

Source: TriMet Spring 2019 Route Ridership Report, C-TRAN 2019 April Boarding Report

a Includes boardings for entire route, not just the portion within the IBR Program Area.

3.7.4 Cross-River Transit Service

Approximately 4,800 people travel across the Columbia River via bus each weekday. The existing weekday transit ridership for express and regional bus service across the I-5 and I-205 bridges is summarized in Table 3-28.

Table 3-28. Existing 2019 Weekday Transit Ridership (Boardings) by River Crossing

River Crossing	Service Type	Weekday Transit Ridership [a]	Routes
I-5	Express	1,700	C-TRAN 105, 134, 157, 164,[b] 177,[b] 190, 199
I-5	Regional	1,500	C-TRAN 60
I-205	Express	980	C-TRAN 164,[b] 177[b]
I-205	Regional	620	C-TRAN 65, 67

Source: C-TRAN 2019 April Weekday Ridership, IBR Program analysis

a Transit totals based on weekday boarding data from C-TRAN for April 2019. Routes that use both I-205 and I-5 have been separated out by boardings for inbound vs. outbound to estimate the portion of weekday trips that use each bridge.

b C-TRAN Routes 164 and 177 travel on I-205 in the southbound direction during the AM peak period and the northbound direction during the PM peak period.

3.7.5 Transit Travel Times

Transit travel time within the IBR Program Area varies by time of day. For all trips between Vancouver and Portland, congestion on I-5 impacts both transit travel time and the reliability of transit trips. Currently, only transit trips destined for downtown Portland have the possibility of a one-seat ride (i.e., a single ride with no transfers) on express buses that operate in mixed traffic on I-5. On some portions of I-5 in Vancouver and on I-205 near the river, C-TRAN buses operate on the shoulder when peak-period congestion warrants. Table 3-29 provides AM and PM peak transit travel times, including both in-vehicle time and total time (including walking, waiting, and transfer time) for locations in the IBR Program Area. Nearly all of these locations currently require a transfer to complete the trip exclusively on transit. Currently, total transit travel times range from 54% to 139% longer than in-vehicle times, with waiting and walking to and from transit making up a larger portion of the trip than time spent in the transit vehicle. The table includes footnotes for each movement indicating what routes were used to determine the travel times from 2019 C-TRAN and TriMet schedules.

Table 3-29. Average Weekday Transit Travel Times between Selected Corridor Locations

Metric	Origin/Destination	AM Peak Southbound (minutes)	PM Peak Northbound (minutes)
In-Vehicle Travel Time	Between Downtown Vancouver and Hayden Island [a]	20	22
	Between Downtown Vancouver and Lombard Transit Center [b]	18	23
	Between Downtown Vancouver and Rose Quarter [b]	30	36
	Between downtown Vancouver and Pioneer Square [c] (Portland central business district)	N/A	N/A
	• Express Bus (includes one stops between downtown Vancouver and Pioneer Square)	33.5	30.5
	• Regional bus transfer to LRT (includes C-TRAN Line 60 to Delta Park with transfer to Yellow Line)	40	46
Total Travel Time [d]	Between Downtown Vancouver and Hayden Island [a]	38	46
	Between Downtown Vancouver and Lombard Transit Center [b]	43	48

Metric	Origin/Destination	AM Peak Southbound (minutes)	PM Peak Northbound (minutes)
	Between Downtown Vancouver and Rose Quarter [b]	55	61
	Between downtown Vancouver and Pioneer Square [c] (Portland central business district)	N/A	N/A
	• Express Bus (includes one stops between downtown Vancouver and Pioneer Square)	59	51
	• Regional bus transfer to LRT (includes C-TRAN Line 60 to Delta Park with transfer to Yellow Line)	65	71

Source: TriMet, C-TRAN, IBR Analysis

a AM peak is Route 60 only, PM peak is Route 6 from Hayden Island to Delta Park and Route 60 to downtown Vancouver because Route 60 does not include a stop at Hayden Island in the PM peak. Riders may stay on Route 60 to travel into downtown Vancouver and then continue back to Hayden Island but this time is not included on the table.

b Route 60 between downtown Vancouver and Delta Park with transfer to Yellow Line LRT.

c Route 105 for Express Bus and Route 60 between downtown Vancouver and Delta Park with transfer to Yellow Line LRT for Regional Bus transfer to LRT.

d Total Transit travel times include 10 minutes of walk access (1/4 mile walk on either end of the trip at 3 mph average walk speed) in addition to initial and transfer (if applicable) wait time. Wait times are based on half the headway.

3.7.6 Transit Reliability

Current congestion on I-5 adversely impacts transit service reliability and travel speed. The existing scheduled time on express bus service between downtown Vancouver and downtown Portland is between 27% and 39% longer in the PM and AM peak periods, respectively, compared to the off-peak. For trips that use a local bus option to connect to the Yellow Line MAX, in-vehicle travel times during the AM peak are similar to off-peak travel times; however, in the PM peak the in-vehicle travel times are approximately 33% longer than in the off-peak for the regional bus portion of the trip that runs on I-5. For the full route (including both LRT and bus), the PM peak travel time is approximately 20% longer than the off-peak.

3.8 Active Transportation

This section describes the existing active transportation facilities in the IBR Program Area, including sidewalks, on-street bicycle facilities, and shared-use paths. It includes inventories of sidewalks and their conditions; marked crossing spacing; “soft barriers” (aspects of the transportation system that provide disincentives to walking); bikeways and bike facility conditions, including a bicycle level of traffic stress (BLTS) analysis; shared-use paths and their conditions, and pedestrian and bicycle travelshed analysis.

Sidewalks are defined as grade-separated facilities adjacent to a roadway that are intended for exclusive use by pedestrians, including people with personal mobility devices (such as wheelchairs or scooters) and other walking/rolling devices. In addition to the width and physical condition of sidewalks, other important considerations for the quality of the pedestrian network include the presence or absence of sidewalks on both sides of the street and the distance between street crossings that connect sidewalks on either side of the street (crossing spacing)

On-street bicycle facilities are bikeways in the right of way intended specifically for use by people biking or those using other small mobility devices that are capable of traveling at a speed faster than pedestrians.

Shared-use paths are shared walking, biking, and rolling facilities that are physically separated from motorized vehicle traffic. Shared-use paths can offer a user experience that is more comfortable than using bike lanes and sidewalks, provided that they are of sufficient width to accommodate a variety of different users traveling at speeds slower than vehicular traffic. Shared-use path users often benefit from visual and physical separation of people walking, biking, rolling, on the path itself as well, to provide a more comfortable environment for people moving at different speeds.

The active transportation network was evaluated within the IBR Program Area, as well as the travelsheds for walking, rolling, and biking. These travelsheds extend to over 3 miles beyond the IBR Program Area to account for local network conditions and the potential for active transportation modes to reach the Interstate Bridge from locations outside of the IBR Program Area.

3.8.1 Active Transportation Facilities on the Interstate Bridge

The existing bridges over the Columbia River between Vancouver and Hayden Island include substandard shared-use paths on the outside edge of each bridge. While the design of each path is different, neither meets the American Association of State Highway and Transportation Officials (AASHTO) standards for shared-use paths, which recommends a typical width of 10 feet and an 8-foot minimum in constrained environments. Neither do they meet local agency standards for shared-use paths. The clear widths of the paths on the existing bridges are less than 4 feet, and the mixing of pedestrians and bicycles in this constrained space can result in safety conflicts and an uncomfortable traveling environment for many users. For users to pass each other going the same direction or in the opposite direction, one user needs to step between the bridge stanchions to make way for the other. The outside railings do not include a rub bar to prevent bicycle handlebars from hitting the guardrail, and the ornamental grate of the guardrail itself presents the potential for cargo, panniers, and other items to get snagged, given the tight conditions. While the paths are physically separated from the highway, pedestrians and bicyclists are exposed to high levels of noise, exhaust, vibration, and debris. The grades on the bridges create high downhill speeds for people on bikes or similar devices and difficult uphill climbs for some pedestrians and bicyclists.

On October 19, 2022, a total of 300 pedestrians and bicyclists were counted crossing the Interstate Bridge in both the northbound and southbound directions on both bridges. During the 24-hour period over which the count was conducted, the temperature was a high of 75 degrees Fahrenheit and the air quality index was rated very poor due to a wildfire smoke event. Because of the poor air quality, the estimate of existing daily trips was adjusted based on research indicating that wildfire smoke events have a regressive impact to active trip behavior. This adjustment sets the daily number of active transportation trips to 410 bicyclists and pedestrian trips on average. While the count in October 2022 was conducted during a day with poor air quality, the factored count is in alignment with previous historical counts conducted on the Interstate Bridge. However, the number of active transportation trips across the bridge is likely to have a high degree of seasonal variation. In addition to reviewing the 24-hour counts, the project team reviewed permanent count data and attempted to develop supplemental reviews of other datasets to understand active traveler activity across the bridge. For further details on how this adjustment was made, see Appendix F.

3.8.2 Active Transportation Facilities in the City of Vancouver

3.8.2.1 Pedestrian Facilities

Existing walkways and pedestrian access on streets and shared-use paths in Vancouver are shown in Figure 3-39 and are listed in Table 3-30. The width and condition of sidewalks vary throughout the IBR Program Area; even where sidewalks exist, most do not meet current ADA standards or, where applicable, WSDOT and local standards.

In Vancouver, sidewalks are present on the west side of I-5 on most major corridors and in the downtown core. As shown in Figure 3-39, notable sidewalk gaps on key connecting streets include:

- On the east side of I-5: E Columbia Way, E 5th Street, E Fourth Plain Boulevard, E 33rd Street, E 39th Street.
- On the west side of I-5: Washington Street, E 5th Street, 8th Street, W Reserve Street, E Mill Plain Boulevard, E McLoughlin Boulevard, E 20th Street.

Figure 3-39. Existing Pedestrian Walkways in Vancouver

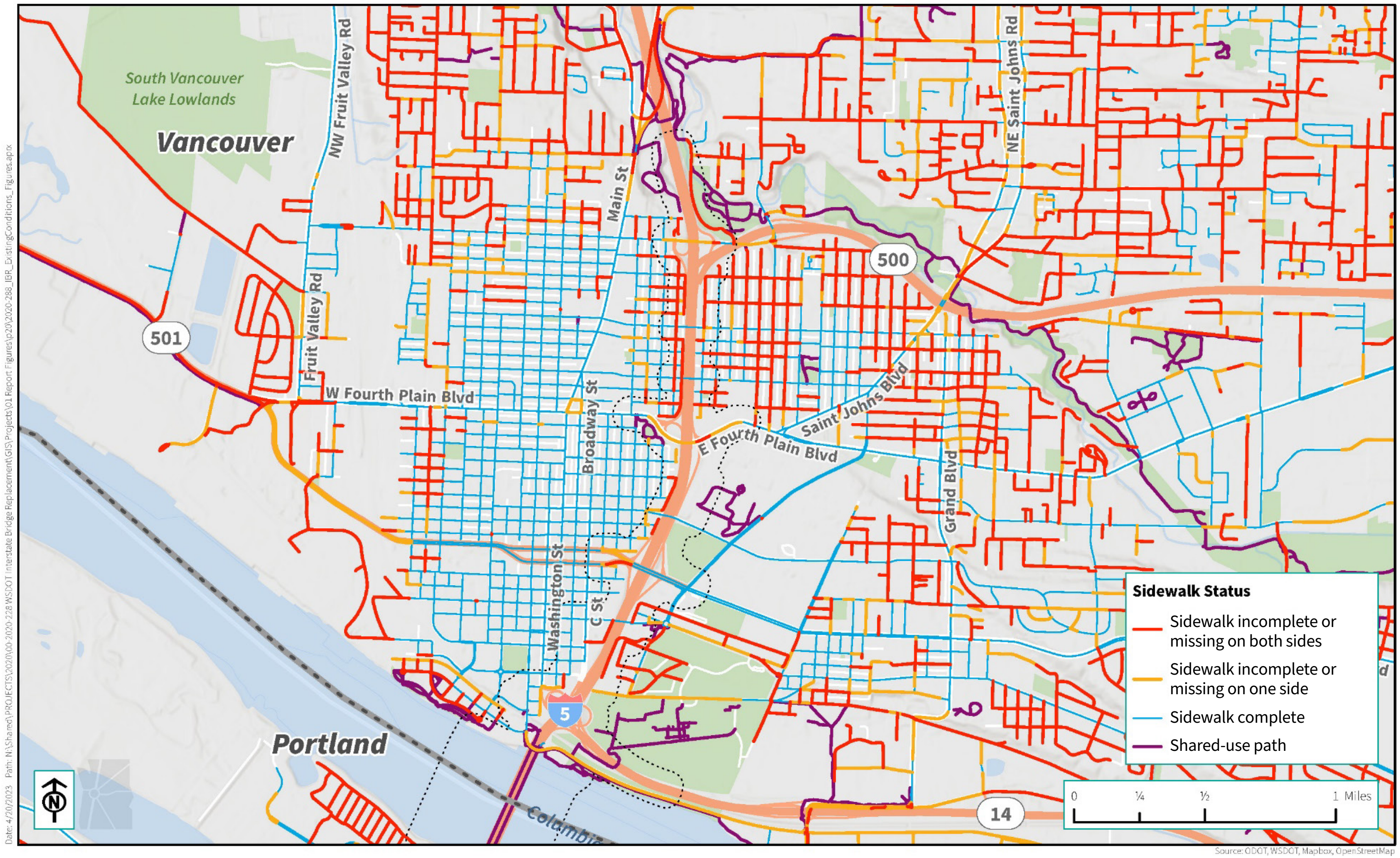


Table 3-30. Existing Pedestrian Facilities at I-5 Crossings

Crossing Location	Existing Facility
E Columbia Way	Shared-use path on one side of undercrossing
E Evergreen Boulevard	Curb-tight sidewalks, both sides of overcrossing
Mill Plain Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing
E McLoughlin Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing
E Fourth Plain Boulevard	Narrow curb-tight sidewalk, one side of overcrossing
E 29th Street	Narrow curb-tight sidewalks, both sides of undercrossing
E 33rd Street	Narrow curb-tight sidewalk, one side of overcrossing

Source: IBR Analysis

In addition to the presence of sidewalks along a roadway, the ability for people to cross the road is essential to creating a network that supports pedestrian movement. Figure 3-40 illustrates the distance between marked roadway crossings on streets classified as Collector and Arterial. Notable gaps—where crossings are more than 800 feet apart—exist on E Columbia Way, E Evergreen Boulevard, E 33rd Street, and E 39th Street.

Soft barriers in the pedestrian network are street segments or shared-use paths that are challenging for pedestrians to walk along or cross due to deficient facilities and high-speed and high-volume traffic corridors. Soft barriers that obstruct walking also include major intersections that pose a physical or perceived barrier to travel, and other poor walking/rolling conditions that may introduce an uncomfortable user experience.

I-5 is a major barrier to pedestrian travel between neighborhoods and destinations on the east and west sides of the highway. Pedestrian facilities are provided at some I-5 crossing locations, but not consistently, as shown in Table 3-30 and Figure 3-40. Soft barriers in Vancouver, including I-5, are displayed in Figure 3-41.

Figure 3-40. Existing Marked Crossing Spacing in Vancouver

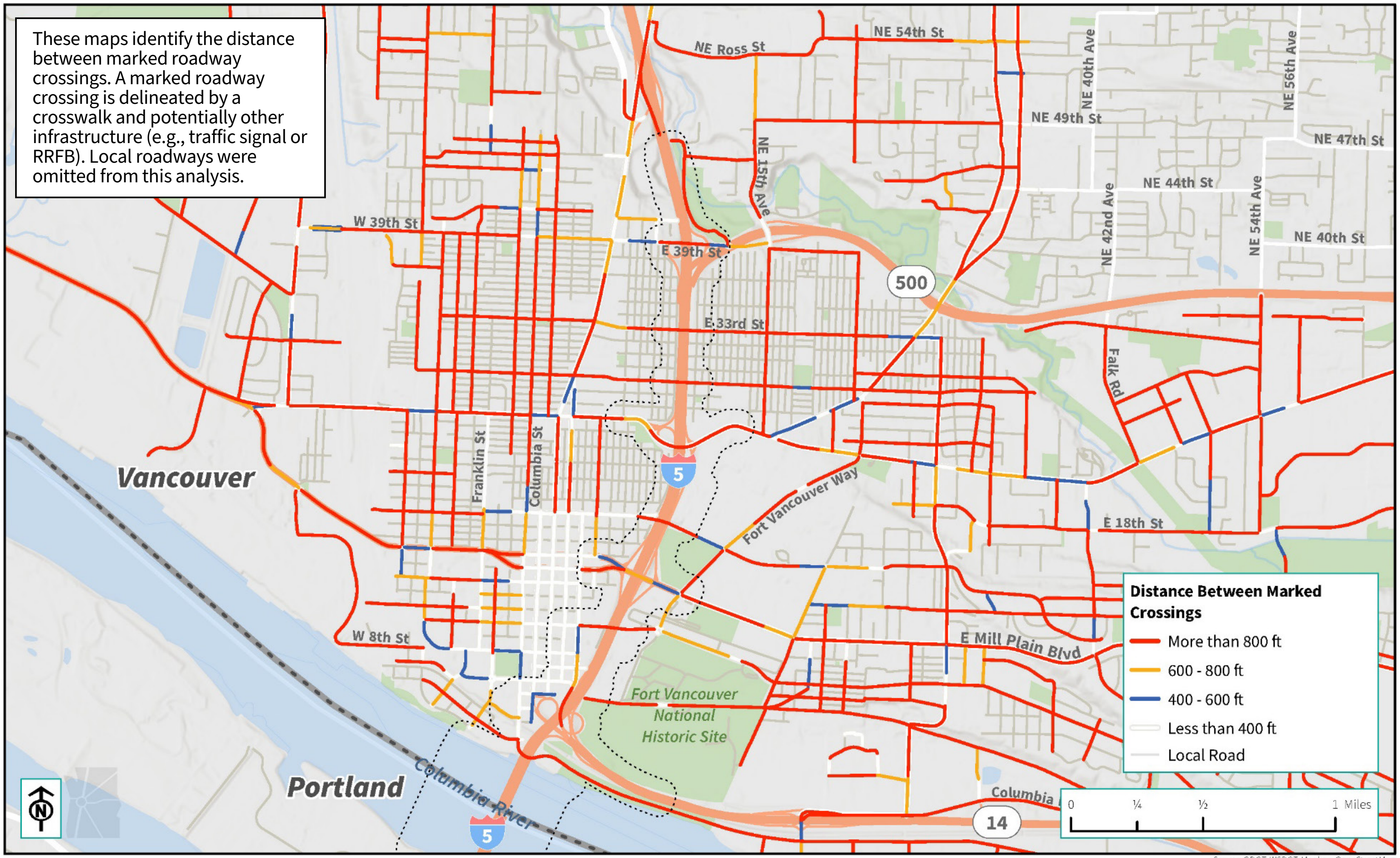
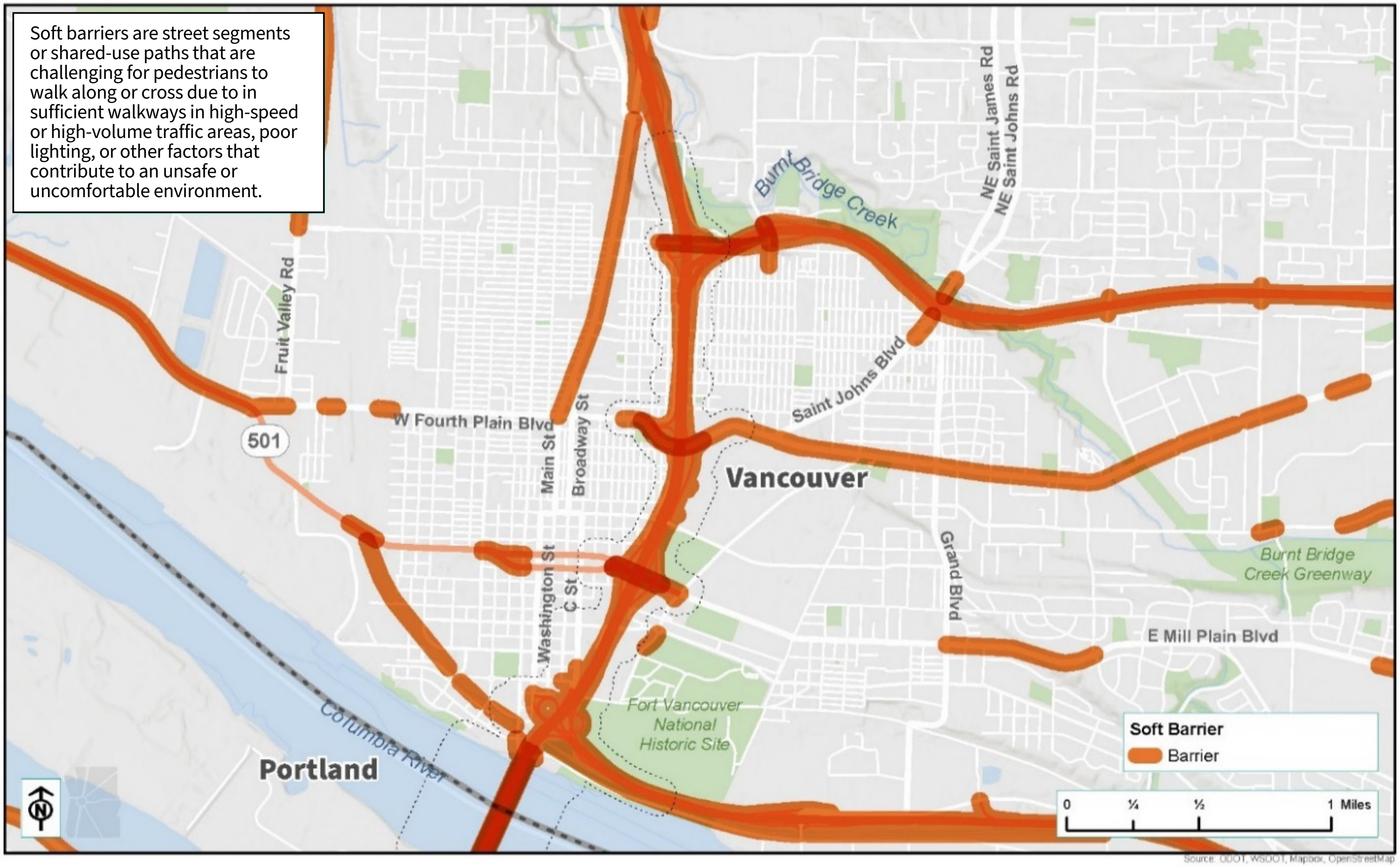


Figure 3-41. Existing Pedestrian Soft Barriers in Vancouver

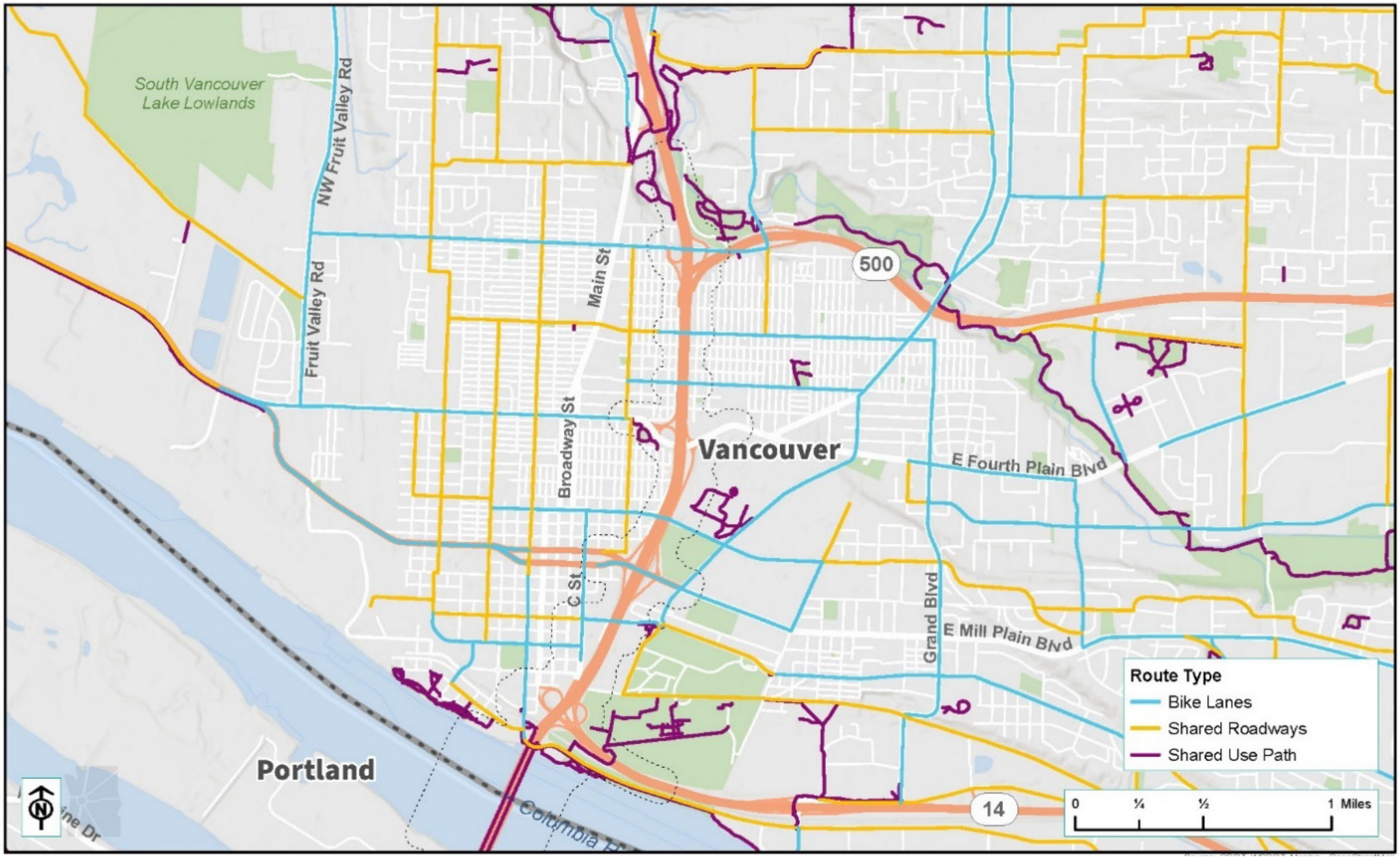


3.8.2.2 Bicycle Facilities

The existing bicycle facility network in Vancouver, as shown in Figure 3-42, comprises a mixture of shared roadways (designated bikeways in which people biking share the road space with cars and other vehicles), bike lanes, and off-street paved paths providing Interstate Bridge access within one mile of the IBR Program Area. Both dedicated bike facilities and shared-use paths exist on the east and west sides of I-5 in downtown Vancouver. Bike lanes connect the shared-use path on the Interstate Bridge with Waterfront Park to the west, and buffered bike lanes provide north-south connections along Columbia Street.[9] The northbound bridge connection point on the east side of I-5 requires out-of-direction travel and either crossing or traveling along Columbia Way, a higher-stress roadway. The nearest marked crossing to the existing path on the south side of the street is not ADA accessible.

[9] These facilities did not exist during 2019. They were completed in 2021 as part of the City of Vancouver's Westside Bike Mobility Project.

Figure 3-42. Existing Bicycle Facilities in Vancouver



In addition to the presence of bicycle facilities, the level of comfort a person feels on a street can influence whether they choose to ride a bike. A BLTS analysis, based on Mineta Transportation Institute Report 11-9, and as outlined in the ODOT Analysis Procedures Manual, helps to identify where "gaps" or deficiencies in a bike network exist and provides a measure of how likely different types of riders, based on ability and comfort level, are to use the facility. User comfort is determined by the speed and volume characteristics of vehicular traffic on street segments, as well as the conditions along the corridor and at intersections, such as the number of travel lanes and the presence and character of bike facilities. BLTS rankings range from 1 (very low stress; tolerable by all) to 4 (very high stress; tolerable to only a few). Data for this analysis were sourced from the City of Vancouver, WSDOT, and OpenStreetMap.

Figure 3-43 shows the BLTS rating of streets in Vancouver. It illustrates that most streets that cross I-5 will pose a barrier to most people biking, whether these streets currently have bike lanes or not. This is reflected in the BLTS scores of the I-5 crossings, and streets surrounding the I-5 interchanges with BLTS scores of 3 and 4, meaning only the most fearless adult bicycle rider would be comfortable riding in the bicycle facility provided on that street. Elsewhere in and around the IBR Program Area, many local streets are rated BLTS 1 or 2; of these, a majority are considered acceptable facilities for all ages and abilities (BLTS 1), with some considered a facility on which the average adult would be comfortable riding a bike (BLTS 2).

Table 3-31 summarizes the existing bicycle facilities and BLTS score for streets crossing I-5.

Figure 3-43. Existing Bicycle Facilities Level of Traffic Stress in Vancouver

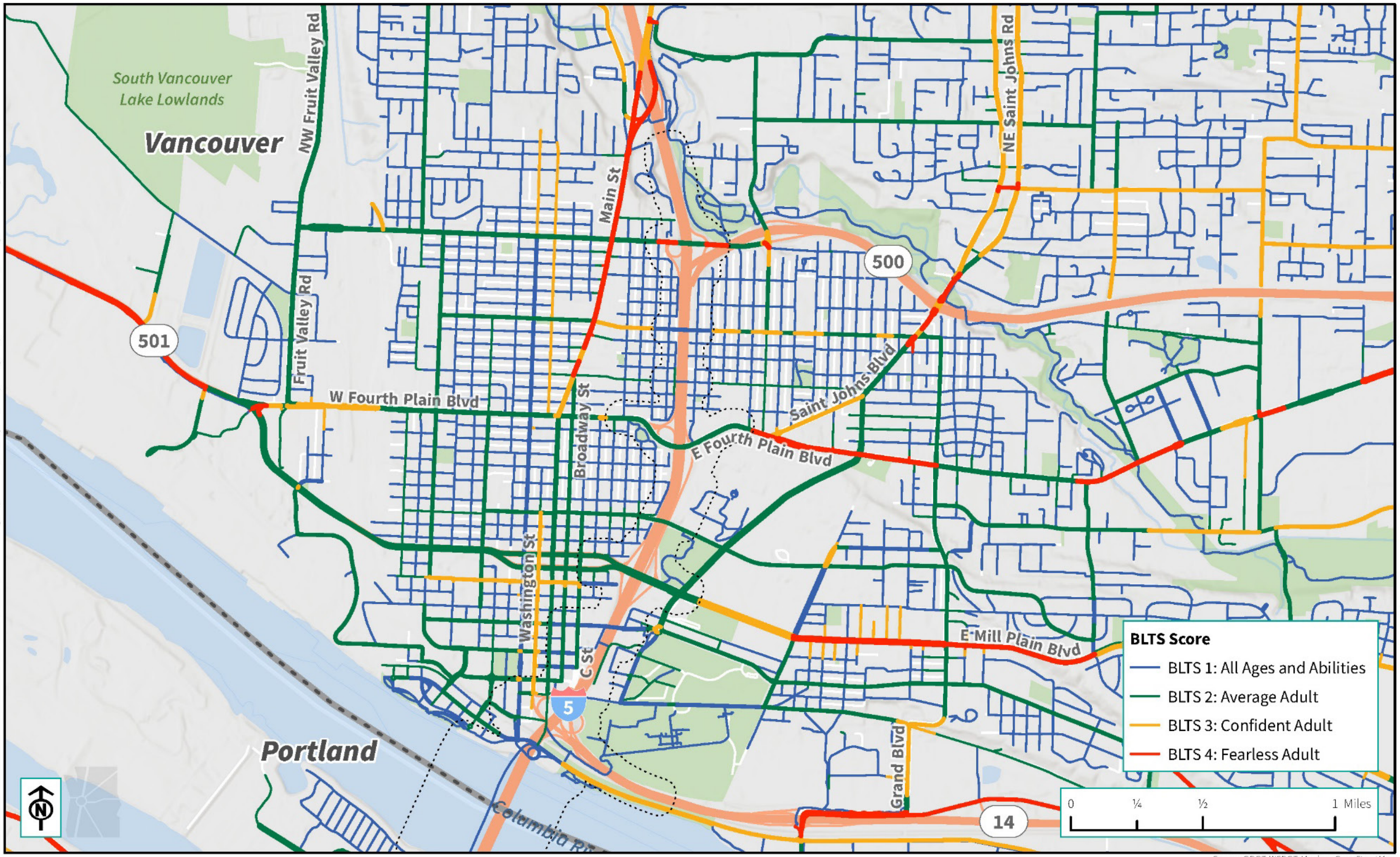


Table 3-31. Existing Bicycle Facilities at I-5 Crossings – Vancouver

Crossing Location	Existing Facility	BLTS Score
E Columbia Way	Shared-use path on one side of undercrossing, striped bike lane on the north side.	3
E Evergreen Boulevard	Striped bike lanes, both sides of overcrossing.	2
Mill Plain Boulevard	Striped bike lanes, both sides of undercrossing. [a]	4
E McLoughlin Boulevard	Striped bike lanes, both sides of undercrossing.	2
E Fourth Plain Boulevard	No bike facility. [b]	4
E 29th Street	No bike facility.	2
E 33rd Street	No bike facility.	3

Source: IBR Analysis

a At the time of this writing, improvements are being made to this stretch of Mill Plain Boulevard to include buffered and parking-protected bike lanes, wider sidewalks, and ADA curb ramps across the I-5 interchange, from Fort Vancouver Way to W 26th Avenue. These changes are not reflected in the existing BLTS scores here.

b At the time of this writing, the City of Vancouver is planning corridor-wide multimodal improvements across I-5 along Fourth Plain Boulevard. These changes are not reflected in the existing BLTS scores here.

3.8.2.3 Shared-Use Paths

In Vancouver, a shared-use path along the waterfront connects to the northern landing of the path on the Interstate Bridge. A shared-use path also connects to the Fort Vancouver National Historic Site to the north via the Vancouver Land Bridge, which crosses over SR 14. These shared-use path facilities are shown in Figure 3-39.

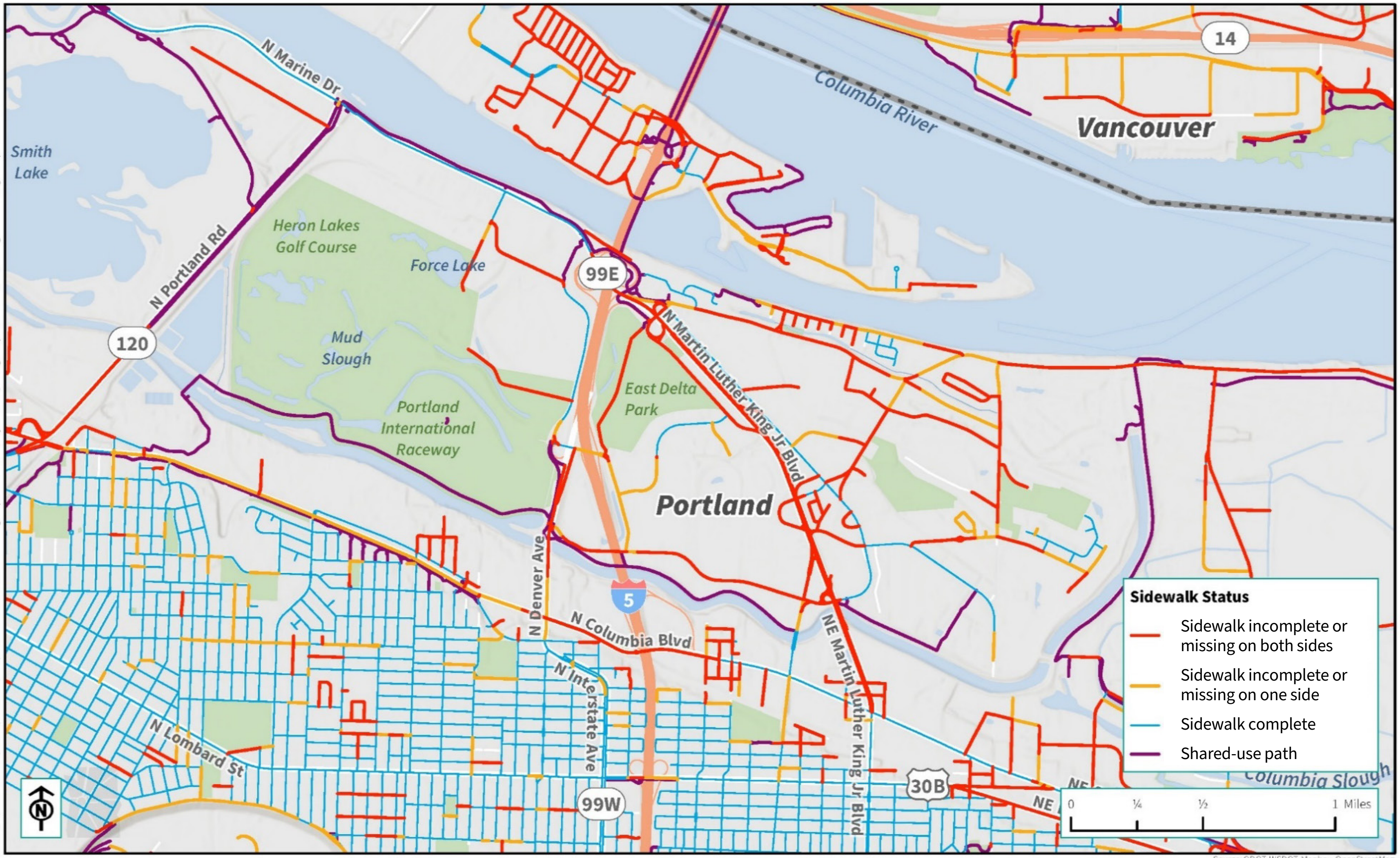
3.8.3 Active Transportation Facilities in the City of Portland

3.8.3.1 Pedestrian Facilities

Existing walkways and pedestrian access on streets and shared-use paths in the City of Portland are shown in Figure 3-44. While the width and condition of sidewalks vary throughout the IBR Program Area, most sidewalks are between 4 and 6 feet wide.

On Hayden Island, the pedestrian network is largely absent despite the grid-like nature of the street network. Land uses in the area south of North Portland Harbor (e.g., the Columbia Slough Watershed, Delta Park, the Expo Center, and industrial lands) have limited the overall roadway network development. As a result of large block spacing and historically lower standards, there are limited sidewalk connections in this area.

Figure 3-44. Existing Pedestrian Walkways in Portland



As shown in Figure 3-44, notable sidewalk gaps on key connecting streets include:

- On Hayden Island: N Hayden Island Drive, N Jantzen Street.
- North Portland: N Marine Drive, N Martin Luther King Jr. Boulevard, N Denver Avenue, N Interstate Avenue.

In addition to the presence of sidewalks along a roadway, the ability for people to cross the road is essential to creating a network that supports pedestrian movement. Marked crosswalks are provided at a few major intersections in Portland. Figure 3-45 illustrates the distance between marked roadway crossings on streets classified as Collector and Arterial. Notably, crossings do not meet the PedPDX (City of Portland n.d.) crossing spacing standards and are more than 800 feet apart on most streets in the Portland portion of the IBR Program Area. Figure 3-46 illustrates the soft barriers that obstruct walking in Portland. I-5, Marine Drive, and Martin Luther King Jr. Boulevard are all barriers to pedestrian travel between neighborhoods and destinations on the east and west sides of the highway. Pedestrian facilities are provided at some I-5 crossing locations, but not consistently, as shown in Table 3-32.

Figure 3-45. Existing Marked Crossing Spacing in Portland

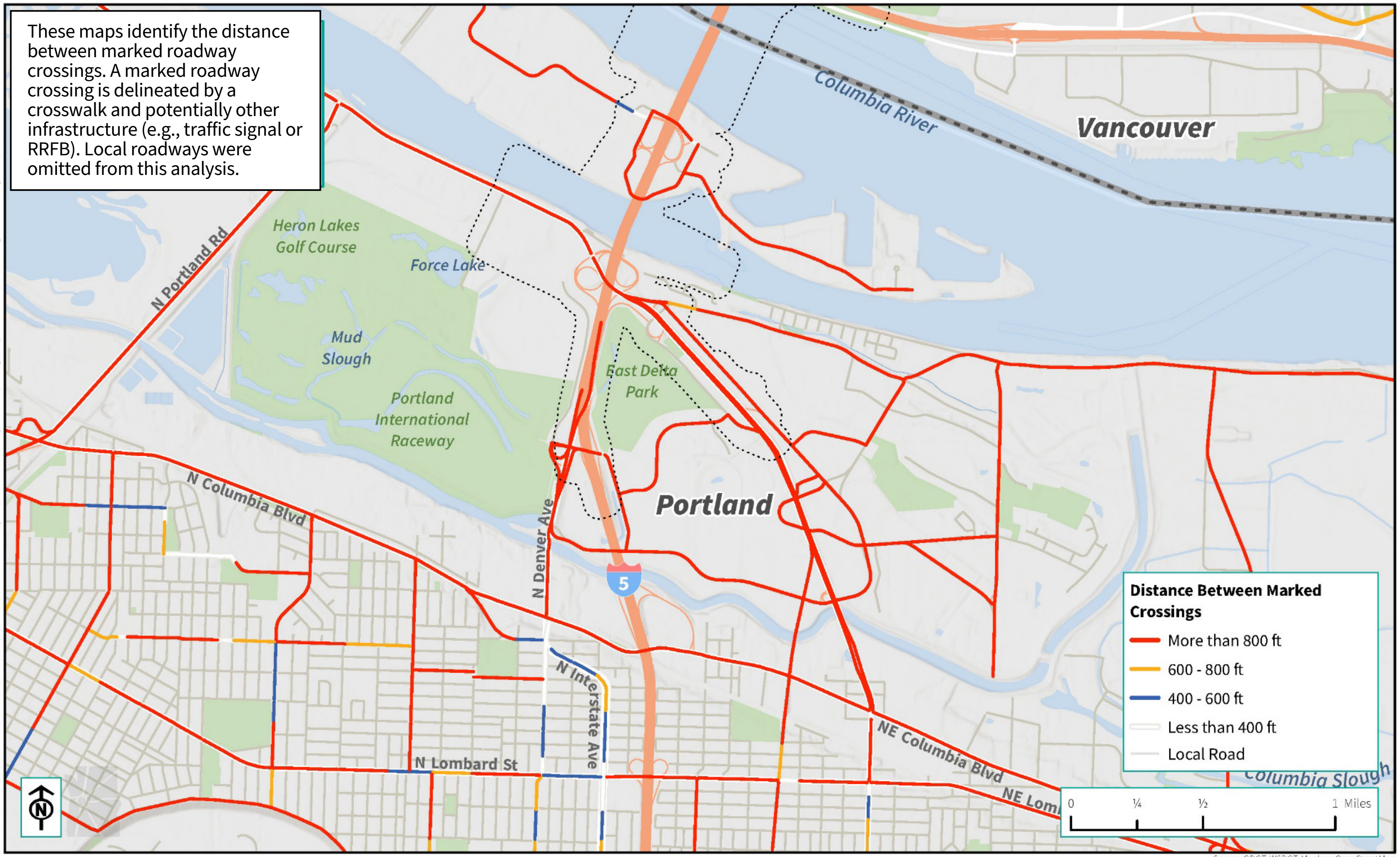


Figure 3-46. Existing Pedestrian Soft Barriers in Portland

Pedestrian circulation is also impacted by other features. Large block sizes create long distances between destinations, while multilane intersections result in delays and multiple conflict points at each crossing. Only a few major east-west roadways provide access between the IBR Program Area and residential areas within a 1-mile radius. Table 3-32 summarizes the condition of pedestrian facilities on all streets that provide connections across I-5.

Table 3-32. Existing Pedestrian Facilities at I-5 Crossings – Portland

Crossing Location	Existing Facility
N Victory Boulevard	Curb-tight sidewalks.
Marine Drive	No sidewalks on overcrossing.
I-5 northbound ramps, undercrossing of I-5 adjacent to N Pier 99th Street	Curb-tight sidewalk on south side.
N Pier 99 Street	No sidewalks.
N Janzen Street	Narrow sidewalk on south side of undercrossing.
N Hayden Island Drive	Narrow sidewalks on both sides of undercrossing.

Source: IBR Analysis

3.8.3.2 Bicycle Facilities

The existing bicycle facility network in the Portland portion of the IBR Program Area, shown in Figure 3-47, comprises a mixture of bike lanes and off-street shared-use paths. Part of the 40-Mile Loop Trail, which is planned to create a route around the Portland region, runs through the IBR Program Area on the south edge of the Columbia River but has a gap within the IBR Program Area.

Access to the shared-use path on the North Portland Harbor bridges is circuitous and non-continuous on both ends of the structure (in North Portland, and on Hayden Island). On Hayden Island, the path connecting the bridges with mainland Portland is narrow. The alignment of the path causes people on bikes to exit onto the sidewalk at Tomahawk Island Drive to reconnect for access to the Interstate Bridge. The route does not provide visual cues to orient the bike rider about how the path will lead them to either bridge connection. South of North Portland Harbor, a similarly circuitous shared-use path alignment connects the on-street bike network with the North Portland Harbor bridges. Bike lanes connect North and Northeast Portland with the North Portland Harbor bridges via N Denver Avenue, Martin Luther King Jr. Boulevard, and N Marine Drive. Table 3-33 highlights the deficiencies of the bicycle facilities on the roads that cross I-5.

Figure 3-47. Existing Bike Facilities in Portland

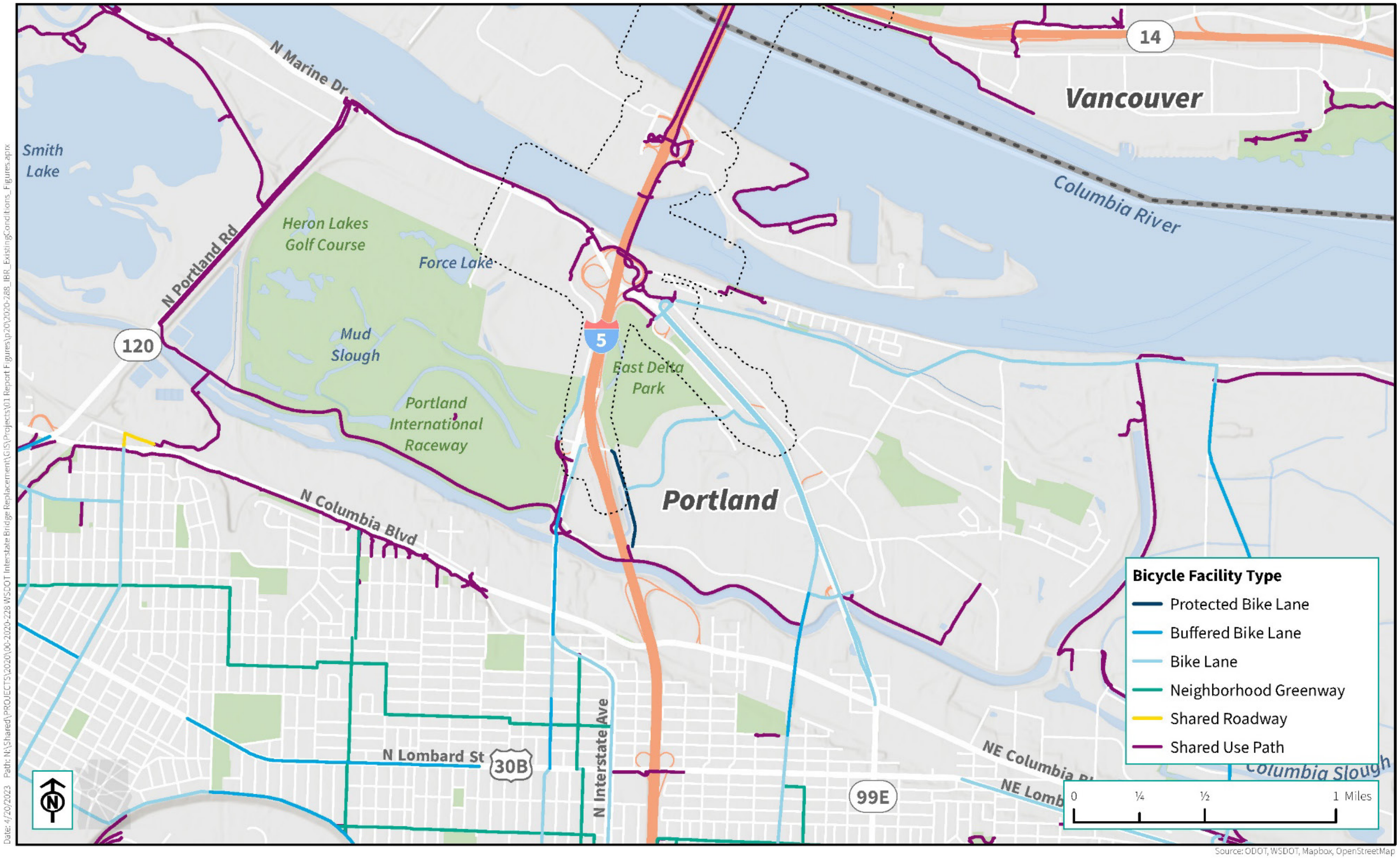


Table 3-33. Existing Bicycle Facilities at I-5 Crossings in Portland

Crossing Location	Existing Facility	BLTS Score
N Victory Boulevard	None	4
Marine Drive	None	4
I-5 northbound ramps, undercrossing of I-5 adjacent to N Pier 99th Street	Narrow shared-use path on north side	1
N Pier 99 Street	None	2
N Janzen Street	None	3
N Hayden Island Drive	None	3

Source: IBR Analysis

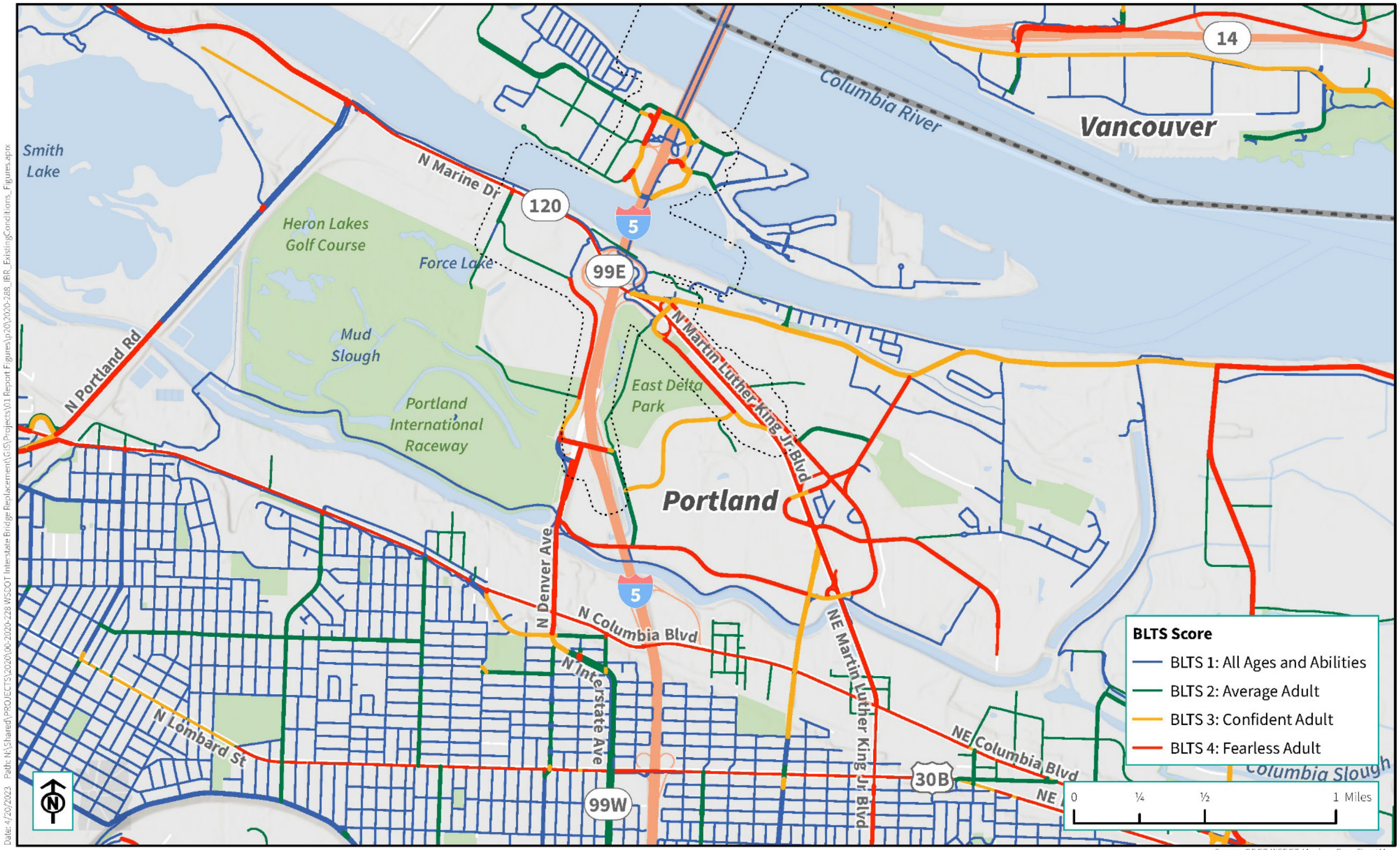
Figure 3-48 shows the BLTS rating of streets in Portland. It illustrates that even streets that include bike facilities are uncomfortable, and therefore a barrier, to most people. Within the IBR Program Area, many of the I-5 crossings, and streets surrounding the I-5 interchanges are rated as BLTS 4, meaning that only the most fearless adult bicycle rider would be comfortable riding in the bicycle facility provided on that street. Data for the BLTS analysis were sourced from the City of Portland, ODOT, and OpenStreetMap.

The City of Portland's Biketown bikeshare program operates a bikeshare fleet within Portland. The existing service area, which extends to the south edge of Columbia Boulevard, stops short of the IBR Program Area. Riders have been observed operating Biketown bikes as far north as Vancouver, but there are no current plans to extend Biketown further north or to Vancouver.

3.8.3.3 Shared-Use Paths

In Portland, an incomplete network of shared-use paths connects to and through the IBR Program Area. People access the shared-use path connection from North Portland to Hayden Island via the path that is parallel to N Marine Drive on the east side of I-5. The shared-use path on the I-5 North Portland Harbor bridges is on the east side of I-5. This shared-use path varies from roughly 10 feet to more than 20 feet wide. Sections that are less than 10 feet wide are considered nonstandard according to ODOT standards; this is considered a constrained width that does not account for separation of path users, passing widths, or ideal shy distances. The shared-use path is separated from highway traffic by a 1-foot-wide, 4-foot-tall barrier between the path and the adjacent northbound travel lane. While the path is physically separated from the highway, pedestrians and bicyclists are exposed to high noise levels, exhaust, debris, and vibration from interstate traffic just feet away. There are also existing shared-use paths south of the slough west of I-5, along N Expo Road and along N Marine Drive, and through and to the west of the interchange. While these shared-use paths are separated from vehicular traffic in between intersections, many do not meet the AASHTO minimum width of 10 feet.

Figure 3-48. Existing Bike Facilities Level of Traffic Stress in Portland



3.8.4 Active Transportation Access To and Across the Interstate Bridge (Travelshed Analysis)

This section describes active transportation on, to, and from the Interstate Bridge, including a 5-, 10-, 15-, and 20- minute pedestrian and bicycle travelshed analysis. These travelsheds are tied to the local walking, biking, and rolling networks, rather than general as-the-crow-flies buffers, to create a more accurate measure of how people would travel those distances using available facilities. Furthermore, these travelsheds can be stress-adjusted to account for the how the quality of the facilities (i.e., how stressful or comfortable the facilities are) affects travel times/distances. This analysis, based on peer-reviewed research, modifies the actual network distance that a person would travel using a “stress multiplier” to create a distance that reflects slower or out-of-direction travel.

The stress multiplier applies a factor for the perceived stress along the facility. Biking on a road with several lanes of fast vehicle traffic and no bicycle facility is far more stressful to the average person than biking on that same road in a separated bikeway. The increased stress levels make the trip feel longer than it is, increasing the perceived travel time or travel distance. Based on this premise, the change in network connectivity was assessed by mapping the area of Portland and Vancouver that is accessible in a given travel time from a fixed set of destinations. The stress multipliers were derived from the State Smart Transportation Initiative guide to measuring accessibility. The impedances were derived from Table 3 of the report but adjusted based on project goals, existing behavior change literature, and the IBR team’s experience on other projects.

The following distance multipliers were used to adjust network travel distances.

- BLTS 1 – 0.9
- BLTS 2 – 1.0
- BLTS 3 – 1.7
- BLTS 4 – 2.5

In Vancouver, pedestrian access points to the Interstate Bridge are provided on both the west and east sides of I-5. As shown in Figure 3-49, much of downtown Vancouver is within a 15-minute walk of the shared-use path on the west side of the bridge. On the east side of I-5, only the waterfront area and a portion of the Fort Vancouver Historical Site are within a 15-minute walk of the bridge. As illustrated in Figure 3-41, the soft barriers of I-5, the railroad corridor, and SR 14 obstruct access to the bridge. When these soft barriers are taken into account, pedestrian travelsheds become even smaller (see Figure 3-50), virtually eliminating pedestrian access to the bridge from the east side of I-5 in Vancouver.

In Portland, pedestrian access to the shared-use paths on the Interstate Bridge is limited. As shown in Figure 3-49, while most of the developed area of Hayden Island is within a 15-minute walk of the shared-use path on the bridge, most neighborhoods south of the Columbia River are not within a 15-minute walk of the bridge. As with Vancouver, consideration of soft barriers reduces these pedestrian travelsheds even further (see Figure 3-50). Most notable here are the impacts to the pedestrian travelsheds on the west side of I-5 on Hayden Island and the east side of I-5 in Vancouver.

Figure 3-49. Existing Pedestrian Access to the Interstate Bridge

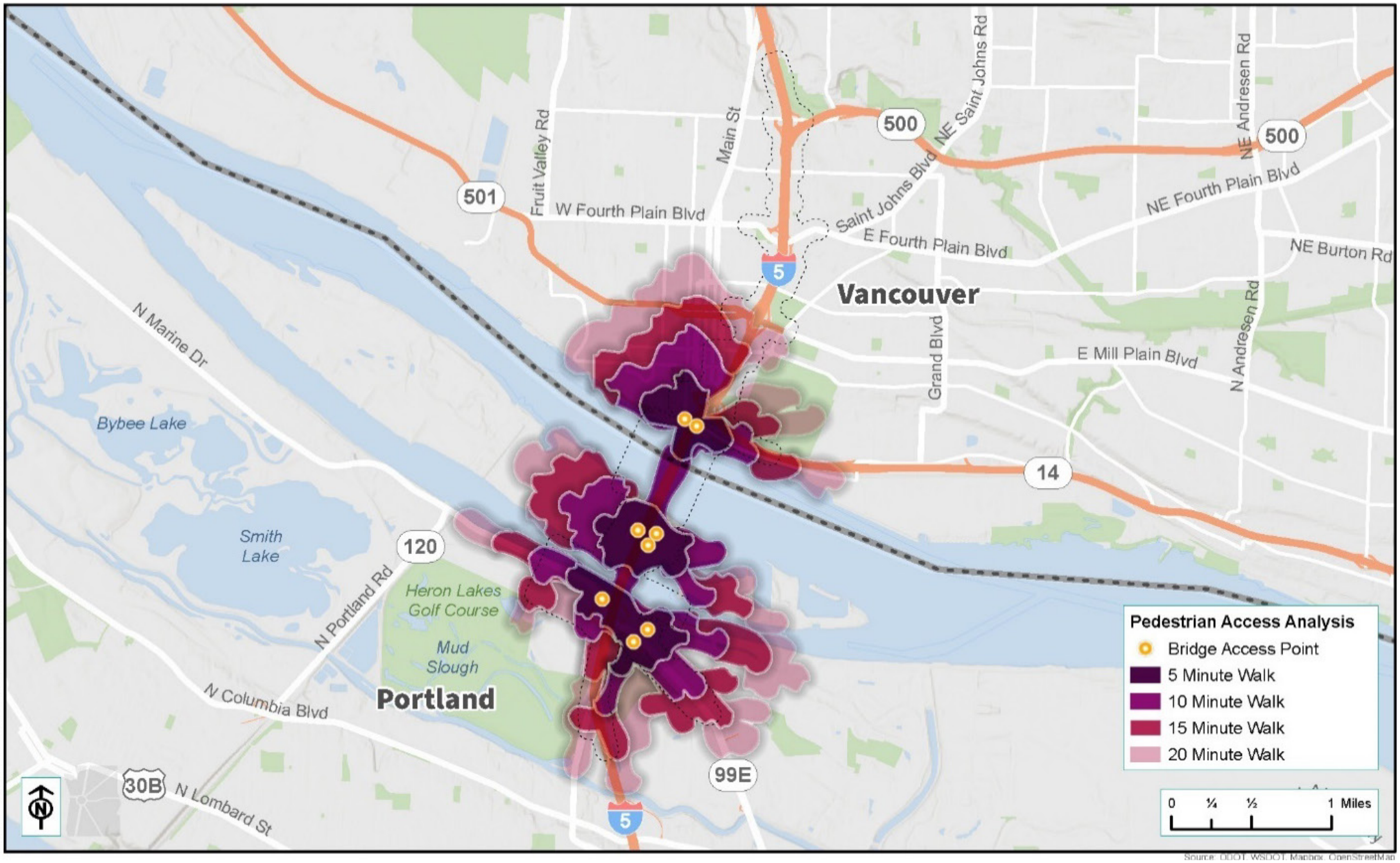


Figure 3-50. Existing Pedestrian Access to the Interstate Bridge (Considering Soft Barriers)

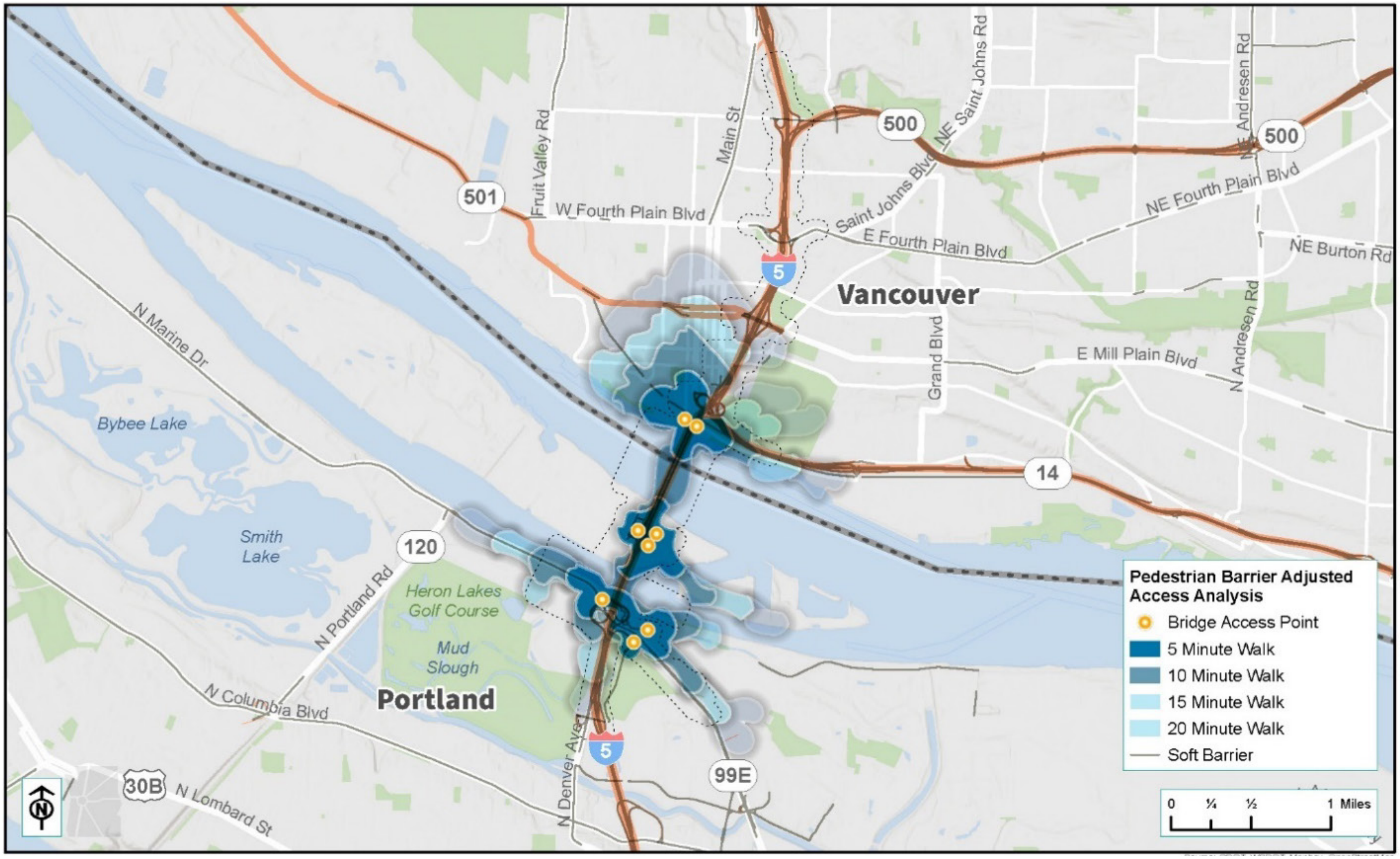


Figure 3-51 shows the bicycle travelsheds to and from the bridge access points, considering the bicycle facilities currently in place. This map illustrates how far a person can bike from the bridge access points at an average cycling speed of 10 miles an hour. The colored areas, shown in shades of blue, represent the 5-, 10-, 15-, and 20- minute travelsheds.

Figure 3-52 shows the stress-adjusted bike travelsheds, incorporating both the bicycle facilities and BLTS. This illustrates that the bike travelsheds for crossing the Interstate Bridge are significantly smaller when adjusted for levels of traffic stress. This is true particularly on the east side of I-5 in Vancouver and south of the Columbia River in Portland. Much of downtown Vancouver and Hayden Island are within a 5- to 10-minute bike ride of the Interstate Bridge, which indicates that there is substantial potential for increasing bicycle mode share.

Figure 3-51. Bicycle Access to the Interstate Bridge

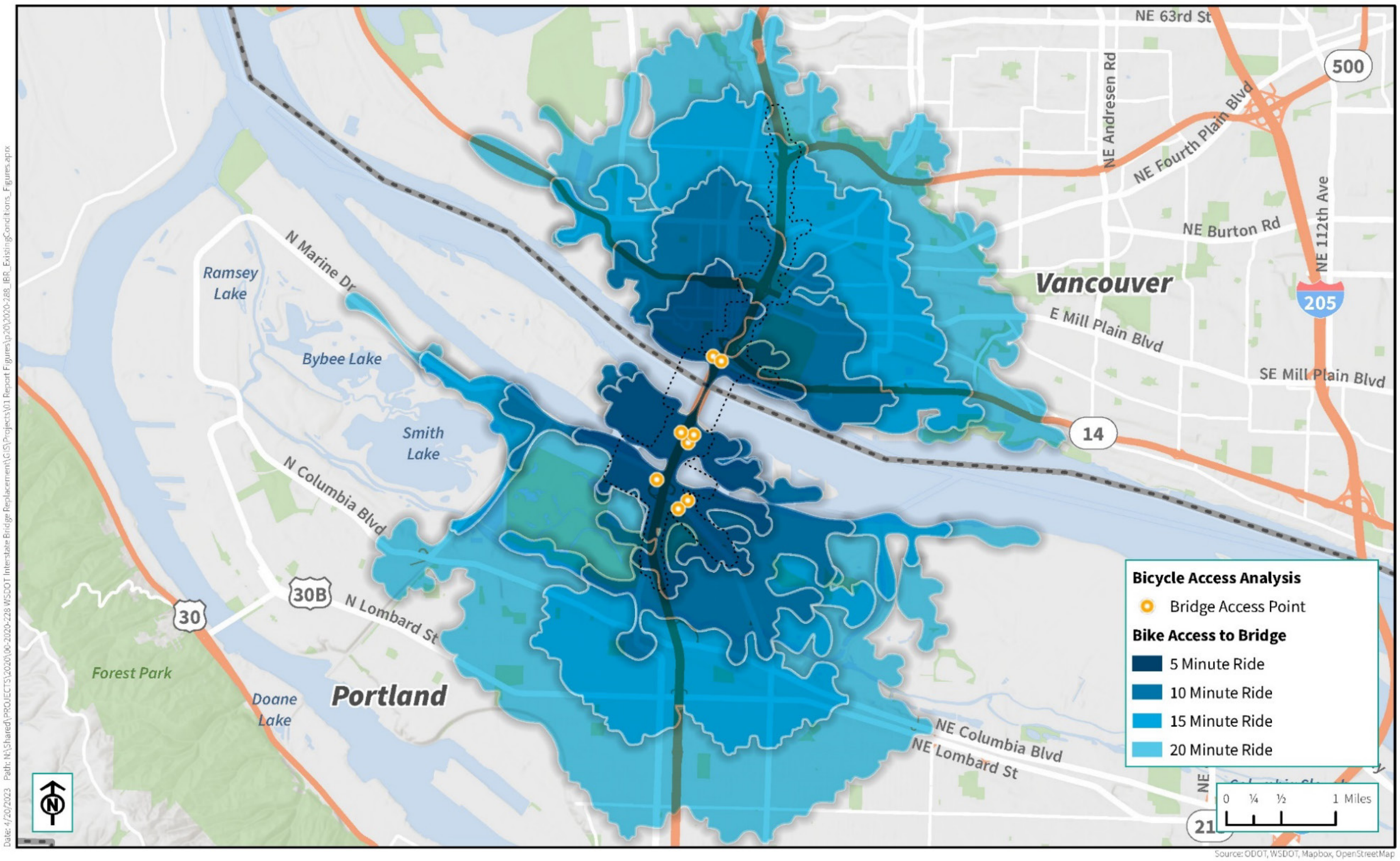
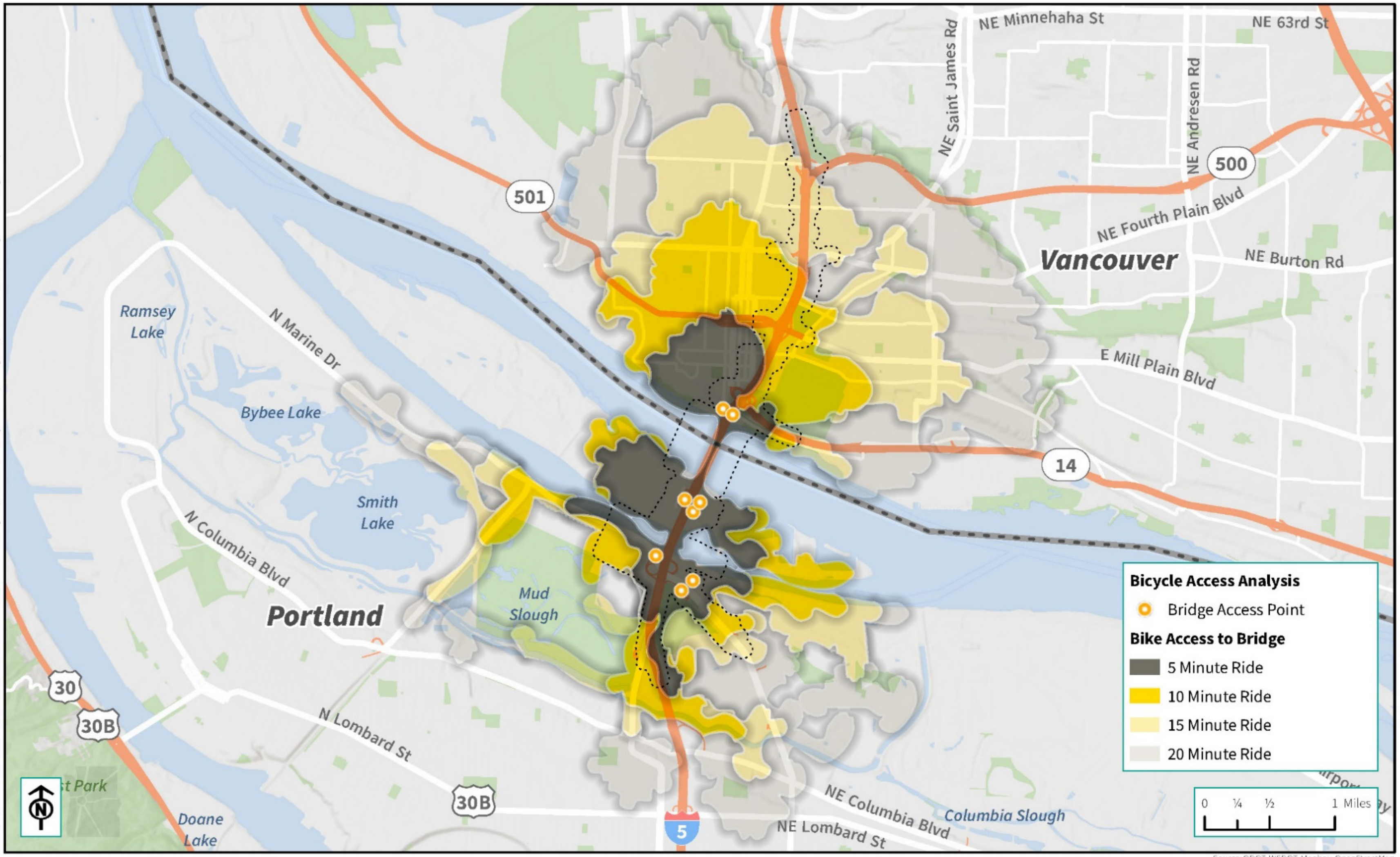


Figure 3-52. Bicycle Access to the Interstate Bridge (Stress-Adjusted)



3.9 Safety

This section discusses safety-related conditions in the IBR Program Area and includes a review of crash data records for roadways. Crash data records were collected from WSDOT and ODOT for the most recent 5-year period before the influence of the Covid-19 pandemic, from January 2015 to December 2019. Historical crash data were reviewed and summarized for an overall crash summary, as well as crash statistics along I-5, on the I-5 ramps, and within 250 feet of study intersections.

3.9.1 Overall Crash Summary

Within the IBR Program Area, there were 2,270 total crashes on the I-5 mainline, ramps and ramp terminal intersections, and study intersections for the 5-year period evaluated. Of these crashes, 1,250 occurred along the I-5 mainline, 326 along ramps, and 694 at study intersections, including ramp terminals. Table 3-34 displays IBR Program Area crashes summarized by year between 2015 and 2019. During this period, overall crashes ranged between approximately 400 and 515 crashes per year.

Table 3-34. IBR Program Area Crashes by Year (2015–2019)

Year	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
2015	103	274	57	44	**478**
2016	113	260	93	49	**515**
2017	96	249	73	42	**460**
2018	88	218	53	36	**395**
2019	90	249	50	33	**422**
Total	**490**	**1,250**	**326**	**204**	**2,270**

Source: WSDOT and ODOT Crash Database, IBR Analysis

Table 3-35 displays IBR Program Area crashes summarized by hour between 2015 and 2019. During this time period, higher crash frequencies generally align with the periods of higher congestion during the day—6 to 9 a.m. and 12 to 7 p.m. Crashes at study ramp terminal and local area intersections were most frequent during the afternoon, with 65 crashes occurring during the 2 p.m. hour. Interstate 5 mainline crashes were highest during the early afternoon, with 127 crashes during both the 1 p.m. and 2 p.m. hours. Ramp crashes were highest during the hours of 8 a.m. and 4 p.m., which had 21 crashes each. Overall, IBR Program Area crashes were highest during the 2 p.m. hour with 206 crashes.

Table 3-35. IBR Program Area Crashes by Hour (2015–2019)

Hour	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
0	8	18	9	3	**38**
1	10	10	10	2	**32**
2	3	19	17	1	**40**
3	3	15	6	1	**25**
4	4	10	8	3	**25**
5	6	37	12	4	**59**
6	15	85	13	12	**125**
7	20	94	12	6	**132**
8	24	59	21	8	**112**
9	18	42	16	10	**86**
10	21	38	12	15	**86**
11	29	51	10	13	**103**
12	31	80	19	10	**140**
13	26	127	14	17	**184**
14	42	127	14	23	**206**
15	35	82	20	11	**148**
16	33	84	21	23	**161**
17	41	73	19	17	**150**
18	29	59	15	15	**118**
19	16	38	12	10	**76**
20	17	26	12	11	**66**
21	15	19	10	6	**50**
22	9	28	11	3	**51**
23	10	29	13	5	**57**
Total	**465**	**1,250**	**326**	**229**	**2,270**

Source: WSDOT and ODOT Crash Database, IBR Analysis

3.9.1.1 Overall Crashes by Severity

ODOT and WSDOT define the following crash severity categories, from least severe to most severe: property damage only (no injuries), possible injury, minor injury, serious injury, and fatal. Crashes where severity was not determined are listed as having an unknown severity.

Table 3-36 displays IBR Program Area crashes summarized by severity. Overall, 856 crashes (38%) resulted in an injury, with 40 crashes (2%) resulting in a serious or fatal injury. Over 300 intersection crashes (44%) resulted in an injury, while just over 450 I-5 mainline crashes (36%) and almost 100 ramp crashes (30%) resulted in an injury.

Of the 40 crashes resulting in a fatal or serious injury, 7 crashes (18%) resulted in a fatal injury and 33 (82%) in a serious injury. Half of all fatal and serious injury crashes occurred at study ramp terminal or local intersections, while 15 crashes (38%) occurred along the I-5 mainline and 5 crashes (12%) occurred along I-5 ramps. People walking or biking were involved in 15% of fatal and serious injury crashes, while being involved in only 2% of all IBR Program Area crashes, regardless of severity. Rear-end crashes were the most common crash type among fatal and serious injury collisions (28%), followed by angle and turning collisions (15% each).

The seven fatal crashes occurred at the following locations within the IBR Program Area between 2015 and 2019:

- I-5 Mainline:
  - I-5 southbound between the Hayden Island on- and off-ramps (two crashes).
  - I-5 northbound between the Marine Drive off-ramp and Victory Boulevard on-ramp.
  - I-5 northbound between the C Street off-ramp and SR 14 on-ramp (involved a person walking).
  - I-5 northbound between the SR 500/E 39th Street off-ramp and E 39th Street on-ramp (involved a person walking).
- I-5 Ramps:
  - Marine Drive on-ramp to northbound I-5.
  - Westbound SR 14 on-ramp to northbound I-5.

Table 3-36. IBR Program Area Crashes by Severity

Severity	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
Fatal (K)	0	5	2	0	**7**
Serious Injury (A)	16	10	3	4	**33**
Minor Injury (B)	46	67	24	19	**156**
Possible Injury (C)	158	371	68	63	**660**
Property Damage Only (O)	238	793	218	140	**1,389**

Severity	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
Unknown	7	4	11	3	**25**
Total	**465**	**1,250**	**326**	**229**	**2,270**

Source: WSDOT and ODOT Crash Database, IBR Analysis

3.9.1.2 Overall Crashes by Type

ODOT and WSDOT define the following crash type categories: angle, animal, bicycle, fixed-object, head-on, off road, overturning, parking, pedestrian, rear-end, sideswipe, turning, and other.

Table 3-37 displays IBR Program Area crashes summarized by type. Overall, 1,102 of the 2,270 total crashes (49%) were rear-end, followed by 358 sideswipe crashes (16%), and 303 fixed-object crashes (13%). Rear-end crashes were the most prevalent crash type for both intersections and the I-5 mainline, comprising 32% and 65% of those crashes, respectively. This further supports the apparent link between congestion and a higher crash frequency, as a higher incidence of rear-end crashes is often associated with congestion. On ramps, however, fixed-object crashes were the most prevalent type of crash, comprising 55% of ramp crashes.

Table 3-37. IBR Program Area Crashes by Type

Type	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
Angle	150	1	1	26	**178**
Animal	0	1	3	0	**4**
Bicycle	13	0	0	4	**17**
Fixed-Object	21	92	179	11	**303**
Head-On	1	1	0	2	**4**
Off Road	0	0	3	0	**3**
Other	10	38	11	10	**69**
Overturning	3	6	16	0	**25**
Parking	1	4	2	2	**9**
Pedestrian	20	3	2	5	**30**
Rear-End	112	812	71	107	**1,102**
Sideswipe	21	285	38	14	**358**

Type	Local Intersection	Mainline	Ramp	Ramp Terminal	Total
Turning	113	7	0	48	**168**
Total	**465**	**1,250**	**326**	**229**	**2,270**

Source: WSDOT and ODOT Crash Database, IBR Analysis

3.9.2 Crashes in Vancouver

This section focuses on I-5 mainline, ramp terminal intersections, and study intersection crashes occurring in the Vancouver portion of the IBR Program Area between 2015 and 2019.

3.9.2.1 Freeway Mainline

TOTAL CRASHES

Figure 3-53 summarizes southbound I-5 mainline crashes in Vancouver by crash severity and crash type. A total of 522 crashes occurred in this segment of I-5 between 2015 and 2019. Most crashes (74%) resulted in property damage only. Five crashes resulted in serious injuries, 29 in minor injuries, and 98 in possible injuries. No crashes resulting in fatal injuries were reported. The highest concentrations of crashes occurred near the Mill Plain Boulevard interchange, the SR 14 interchange, and the southbound approach to the Interstate Bridge.

The most common type of crash on the southbound I-5 mainline in Vancouver was rear-end crashes, accounting for 61% of all crashes. A combination of sideswipe (25%) and fixed-object (8%) accounted for most of the remaining crashes on the mainline.

Figure 3-54 summarizes northbound I-5 mainline crashes in Vancouver by crash severity and crash type. A total of 171 crashes occurred in this segment of I-5 between 2015 and 2019. Most crashes (76%) resulted in property damage only. One crash resulted in fatal injuries, one in serious injuries, 7 in minor injuries, and 30 in possible injuries. The highest concentration of crashes occurred near the SR 14 interchange.

The most common type of crash on the northbound I-5 mainline in Vancouver was rear-end crashes, accounting for 37% of all crashes. A combination of sideswipe (33%) and fixed-object (22%) accounted for most of the remaining crashes on the mainline.

Figure 3-53. I-5 Mainline Southbound Crashes by Severity and Type (2015–2019) – Vancouver

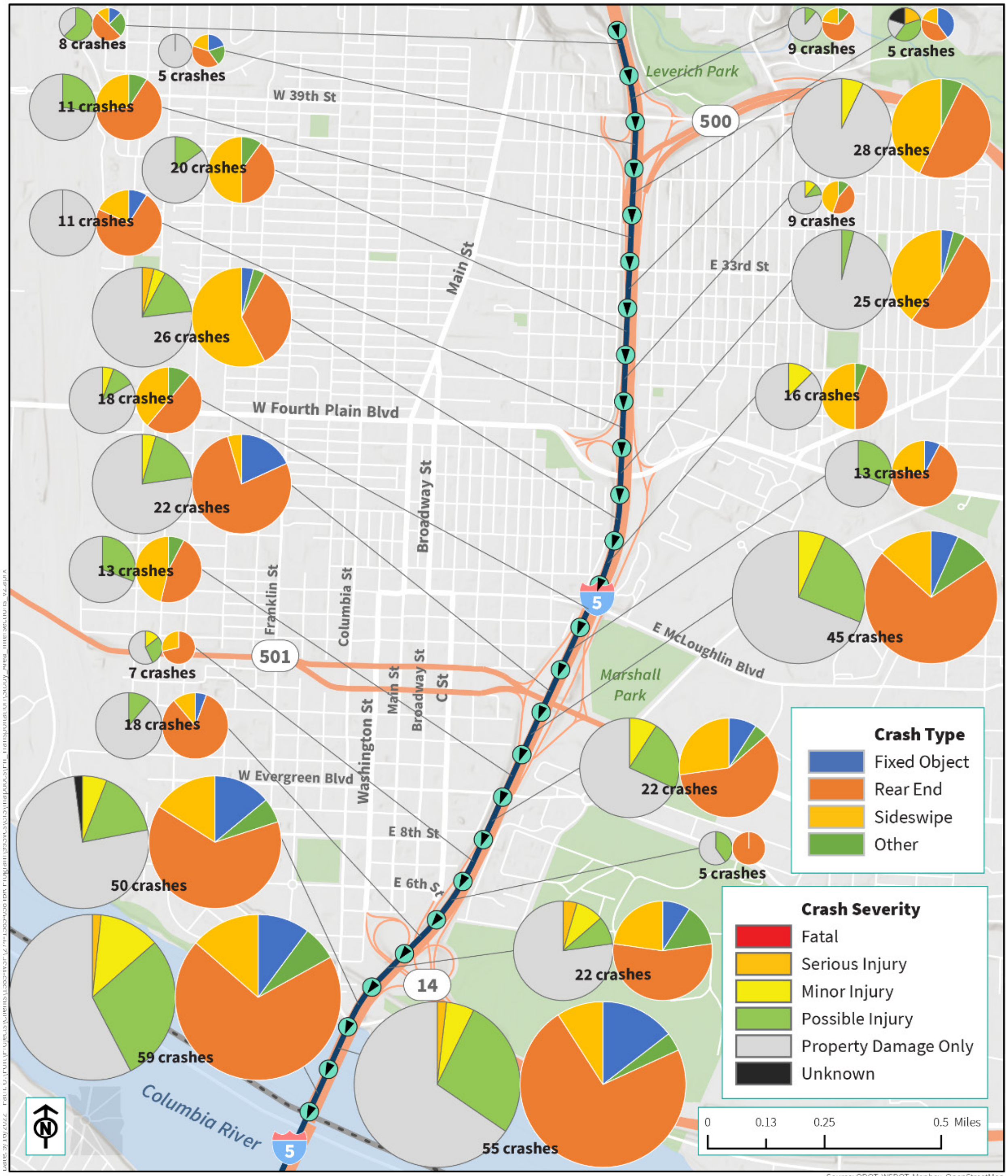
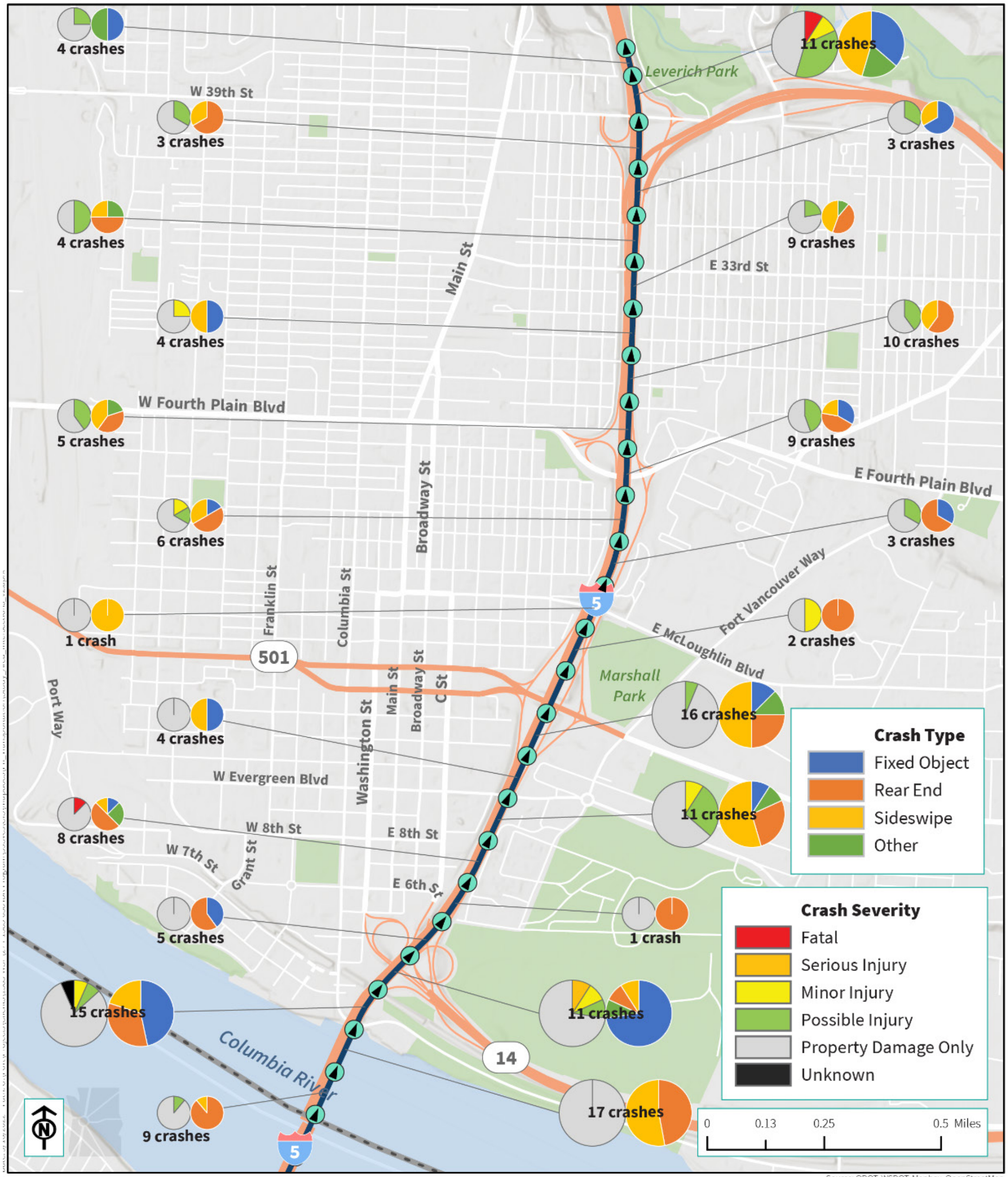


Figure 3-54. I-5 Mainline Northbound Crashes by Severity and Type (2015–2019) – Vancouver



Source: ODOT, WSDOT, Mapbox, OpenStreetMap

FATAL AND SERIOUS INJURY CRASHES

Two fatal and seven serious injury crashes occurred on I-5 mainline within Vancouver between 2015 and 2019. Table 3-38 summarizes the key driver and environmental contributing factors for each of these mainline fatal and serious injury crashes.

Table 3-38. IBR Program Area I-5 Mainline Fatal and Serious Injury Crash Contributing Factors (2015–2019) – Vancouver

Location	Year	Crash Type	During Peak Period	During Bridge Openings	Drive Contributing Factor(s)	Environmental Contributing Factor(s)
I-5 NB SR 14 Interchange (MP 0.67)	2016	Pedestrian (Fatal)	No	No	N/A	Dark – Lighted
I-5 NB SR 14 Interchange (MP 0.39)	2016	Rear-End	No	No	Alcohol, Speeding	Dark – Lighted
I-5 SB Columbia River Bridge (MP 0.11)	2017	Rear-End	No	Yes	Following too Close	N/A
I-5 NB Columbia River Bridge (MP 0.01)	2018	Rear-End	No	Yes	Alcohol	Dark – Not Lighted
I-5 SB SR 14 Interchange (0.42)	2018	Angle	No	No	Alcohol, Speeding	Wet Roadway, Dark – Lighted
I-5 SB 4th Plain to Mill Plain (MP 1.50)	2019	Fixed-Object	No	No	Alcohol	Wet Roadway, Dark – Lighted
I-5 SB SR 500/39th St Interchange (MP 2.20)	2019	Rear-End	Yes	No	Alcohol, Inattention	N/A
I-5 SB Columbia River Bridge (MP 0.23)	2019	Sideswipe	No	No	Alcohol	Dark – Lighted
I-5 NB SR 500/39th St Interchange (MP 2.37)	2019	Pedestrian (Fatal)	No	No	N/A	Dark – Lighted

Source: WSDOT and ODOT Crash Database

Note: All crashes are serious injury crashes unless otherwise noted.

MP = milepost; NB = northbound; SB = southbound; St = street

The two fatal crashes were both pedestrian crashes that occurred during dark and lighted conditions. Six of the seven serious injury crashes involved a driver under the influence of alcohol (86%). Of these six, two also involved speeding and one also involved inattention. Only one fatal or serious injury crash occurred during the peak periods and two occurred during bridge openings. Over 55% of fatal and serious injury crashes occurred between the hours of 10 p.m. and 12 a.m.

3.9.2.2 Freeway Ramps and Ramp Terminal Intersections

TOTAL CRASHES

Figure 3-55 summarizes the severity of I-5 interchange crashes along ramps and at ramp terminals within Vancouver. A total of 406 crashes occurred on these facilities between 2015 and 2019. Most crashes (70%) caused property damage only. One crash resulted in fatal injuries over the 5-year period, occurring along the ramp from westbound SR 14 to northbound I-5. There were six serious injury crashes along I-5 ramps and at ramp terminals in Vancouver, 22 crashes (5%) that resulted in minor injuries, and 78 (19%) that resulted in possible injuries.

Figure 3-56 summarizes crash types I-5 interchange ramps and at ramp terminals within Vancouver. Most crashes in the study segment (44%) were fixed-object, followed by rear-end crashes at 29%.

FATAL AND SERIOUS INJURY CRASHES

One fatal and six serious injury crashes occurred on I-5 ramps and at ramp terminal intersections within Vancouver between 2015 and 2019. Table 3-39 summarizes the key driver and environmental contributing factors for each of these ramp and ramp terminal fatal and serious injury crashes.

Table 3-39. IBR Program Area I-5 Ramp and Ramp Terminal Fatal and Serious Injury Crash Contributing Factors (2015–2019) – Vancouver

Location	Year	Crash Type	During Peak Period	During Bridge Openings	Drive Contributing Factor(s)	Environmental Contributing Factor(s)
I-5 NB to E 4th Plain Blvd	2016	Overturn	No	Yes	Speeding	Wet Roadway, Dark – Lighted
SR 14 WB to I-5 NB	2017	Fixed-Object (Fatal)	No	No	Alcohol, Speeding	Dark – Lighted
I-5 SB Off-Ramp & Mill Plain Blvd	2017	Rear-End	No	No	Following to Close	N/A
SR 500 WB to I-5 SB	2018	Rear-End	Yes	No	Speeding	N/A
I-5 SB to E 4th Plain Blvd	2018	Overturn	No	No	Alcohol	Raining/Wet Roadway, Dark – Lighted
I-5 NB Ramps & Mill Plain Blvd	2018	Turning	No	No	Alcohol	N/A
I-5 NB Off-Ramp & E 4th Plain Blvd	2018	Other	No	Yes	N/A	Wet Roadway

Source: WSDOT and ODOT Crash Database

Note: All crashes are serious injury crashes unless otherwise noted.

Blvd = boulevard; NB = northbound; SB = southbound

Figure 3-55. I-5 Ramp Crashes by Severity (2015–2019) – Vancouver

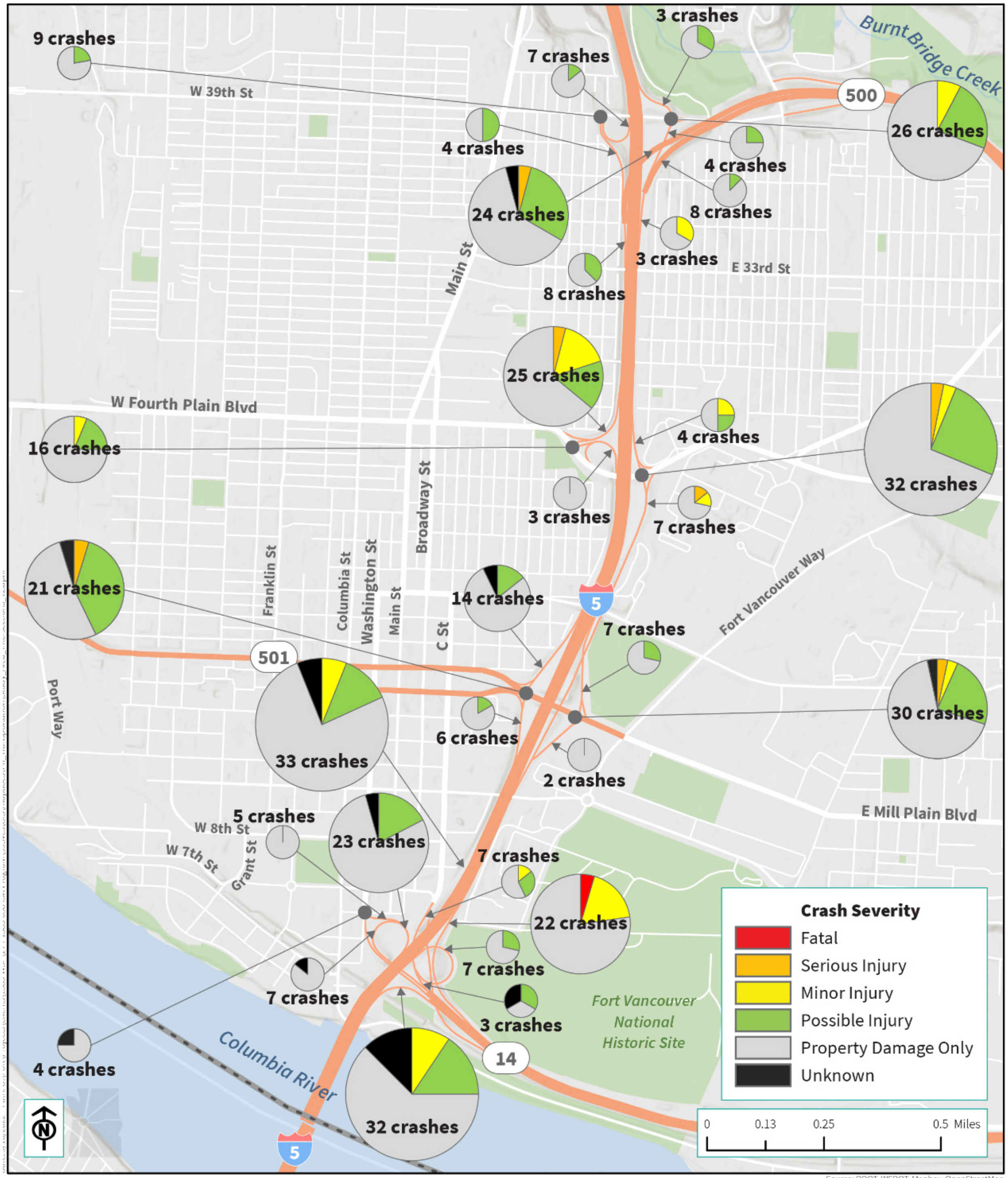
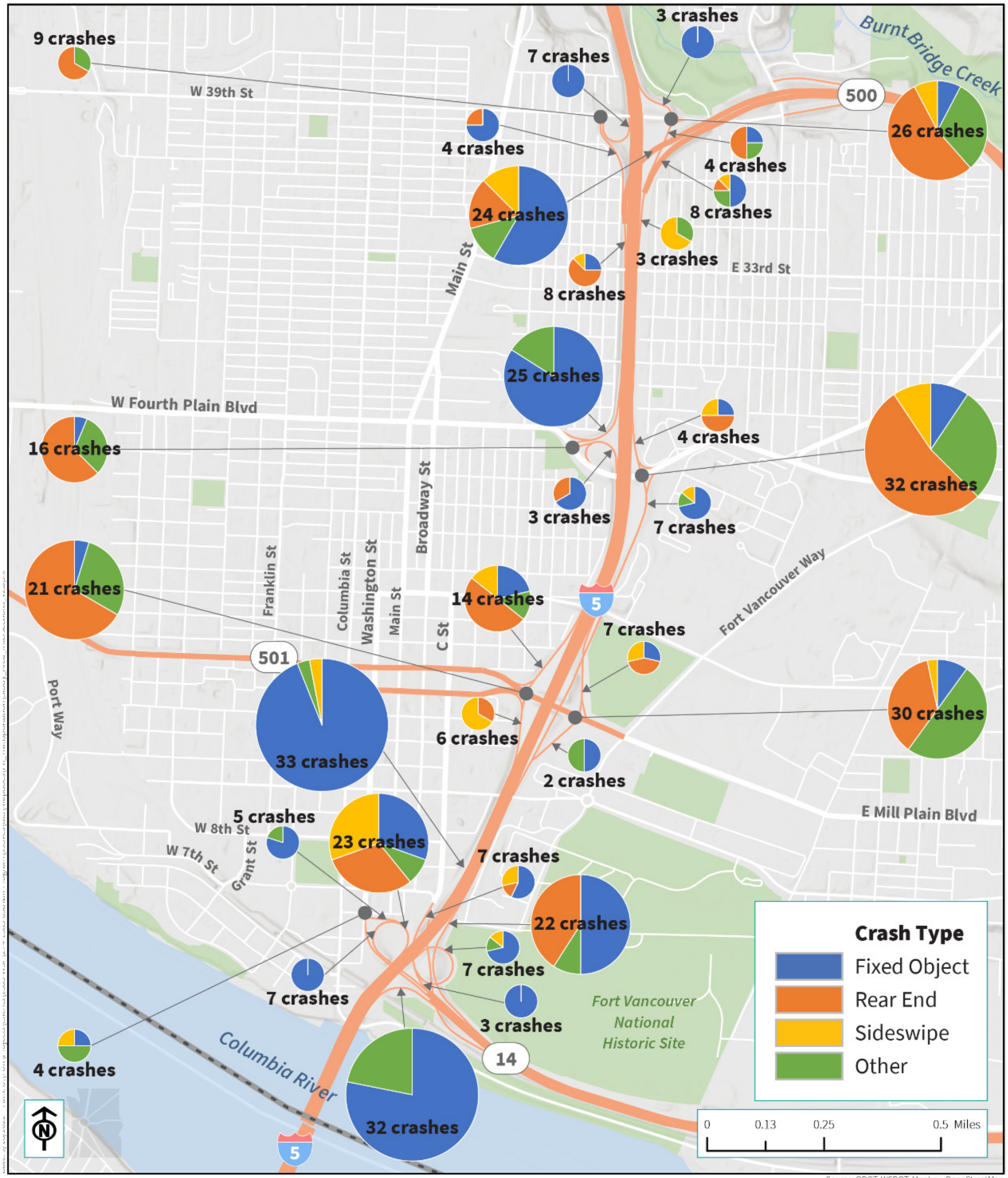


Figure 3-56. I-5 Ramp Crashes by Type (2015–2019) – Vancouver



Five fatal and serious injury ramp and ramp terminal crashes involved alcohol, speeding, or both. Three were during dark and lighted conditions. One crash occurred during a peak period, and two occurred during a bridge opening. Over 40% of fatal and serious injury ramp and ramp terminal crashes occurred between the hours of 8 p.m. and 4 a.m.

3.9.2.3 Local Intersections

A total of 355 crashes occurred at the local study intersections in Vancouver between 2015 and 2019. Most of these (55%) involved property damage only. Eleven crashes resulted in serious injuries over the 5-year period, while 39 crashes (11%) resulted in minor injuries and 101 (28%) in possible injuries. No crashes resulting in fatal injuries were reported. The most prevalent type of crash was angle crashes (40% of all crashes), followed by rear-end crashes at 21% and turning crashes at 15%. Appendix G summarizes the severity and type of all study intersection crashes by intersection.

A total of 35 crashes involving people walking and biking occurred at study intersections in Vancouver during the 5-year period. Four crashes (11%) resulted in serious injuries, while 17 crashes (49%) resulted in minor injuries, 13 (37%) in possible injuries, and 1 (3%) in no injury (property damage only). No crashes resulting in fatal injuries were reported. Crashes involving people walking and biking were most prevalent at the intersections of 6th Street and Washington Street (5 crashes), Fourth Plain Boulevard and Saint Johns Boulevard (3 crashes), Mill Plain Boulevard and Franklin Street (3 crashes), and Evergreen Boulevard and Washington Street (3 crashes). Appendix G summarizes the severity of study intersection crashes involving people walking and biking.

3.9.3 Crashes in Portland

This section focuses on I-5 mainline, ramp terminal intersections, and study intersection crashes occurring in the Portland portion of the IBR Program Area between 2015 and 2019.

3.9.3.1 Freeway Mainline

TOTAL CRASHES

Figure 3-57 summarizes southbound I-5 mainline crashes in Portland by crash severity and crash type. A total of 170 crashes occurred in this segment between 2015 and 2019. Most crashes (53%) resulted in property damage only. Two crashes resulted in fatal injuries, 14 in minor injuries, and 63 in possible injuries. No crashes resulting in serious injuries were reported. The highest concentration of crashes occurred on the Interstate Bridge and near the Hayden Island interchange.

The most common type of crash on the southbound I-5 mainline in Portland was rear-end crashes, accounting for 72% of all crashes. A combination of sideswipe (22%) and fixed-object (4%) accounted for most of the remaining crashes on the mainline.

Figure 3-58 summarizes northbound I-5 mainline crashes in Portland by crash severity and crash type. A total of 387 crashes occurred in this segment between 2015 and 2019. Property-damage-only crashes were the most common, accounting for 48% of all crashes. One crash resulted in fatal injuries, four in serious injuries, 17 in minor injuries, and 180 in possible injuries. The highest concentration of crashes occurred near the Hayden Island interchange and on the Interstate Bridge.

The most common type of crash on the northbound I-5 mainline in Portland was rear-end crashes, accounting for 79% of all crashes. Sideswipes (17%) accounted for most of the remaining crashes on the mainline.

Figure 3-57. I-5 Mainline Southbound Crashes by Severity and Type (2015–2019) – Portland

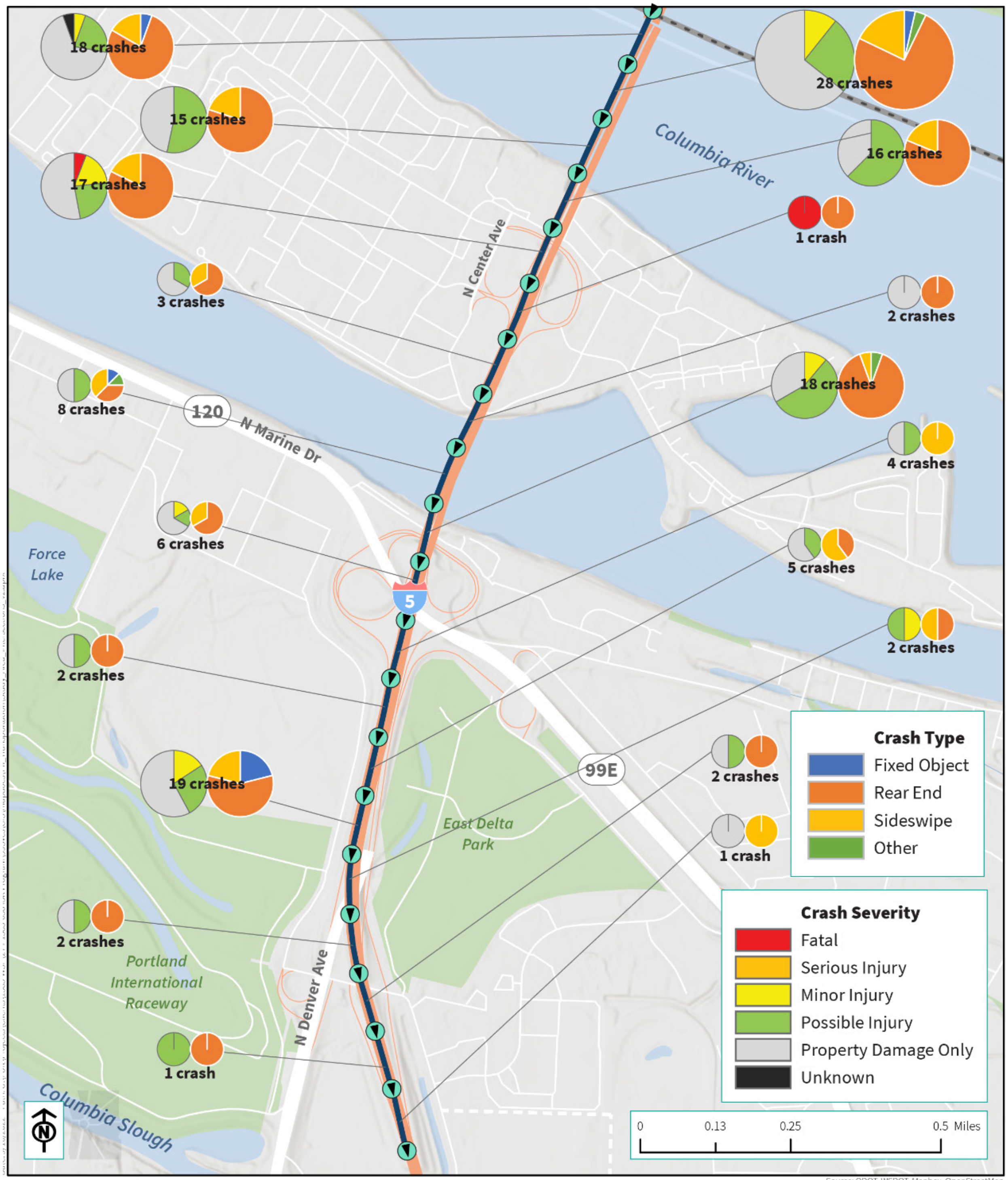
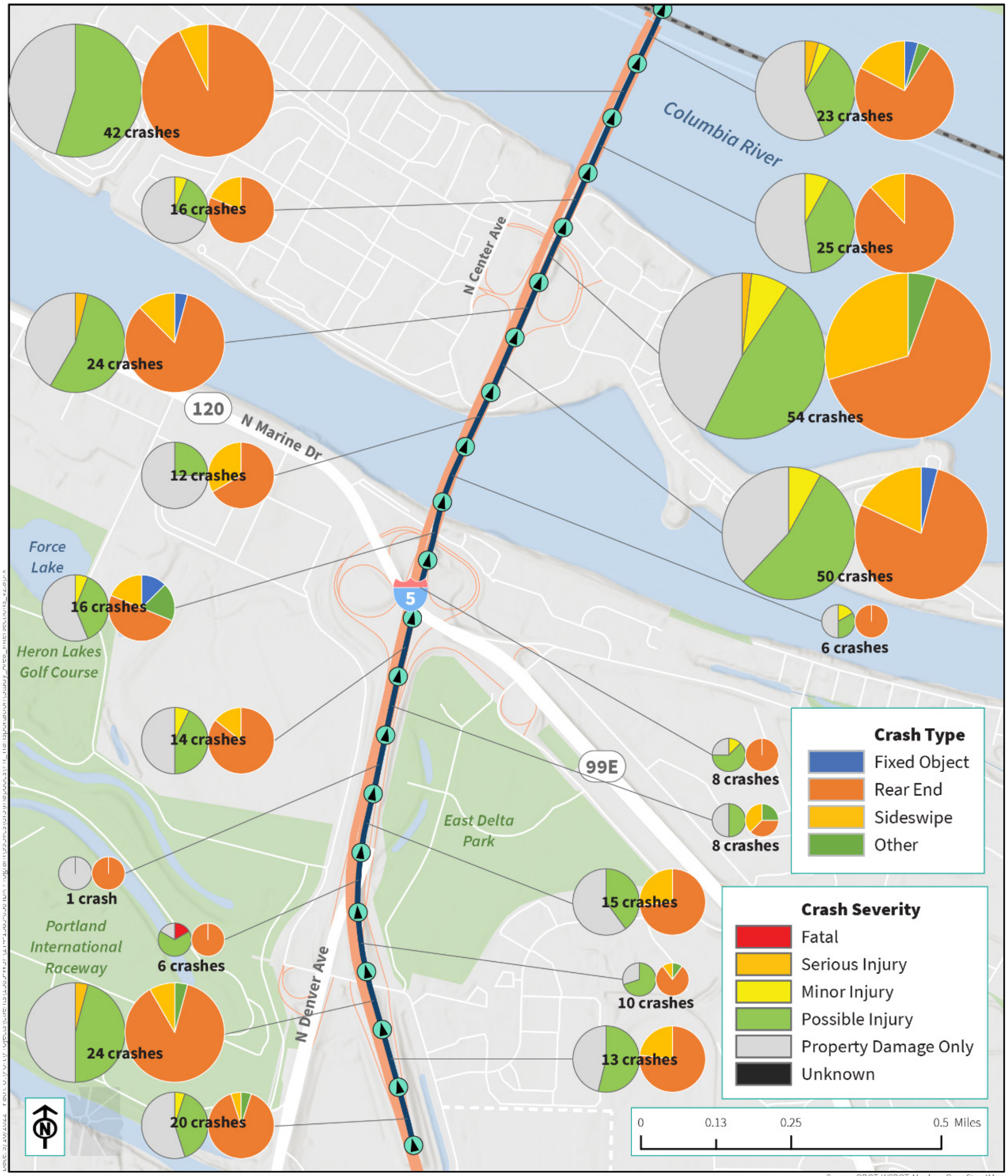


Figure 3-58. I-5 Mainline Northbound Crashes by Severity and Type (2015–2019) – Portland



FATAL AND SERIOUS INJURY CRASHES

Three fatal and three serious injury crashes occurred on the I-5 mainline within Portland between 2015 and 2019. Table 3-40 summarizes the key driver and environmental contributing factors for each of these mainline fatal and serious injury crashes.

Table 3-40. IBR Program Area I-5 Mainline Fatal and Serious Injury Crash Contributing Factors (2015–2019) – Portland

Location	Year	Crash Type	During Peak Period	During Bridge Openings	Drive Contributing Factor(s)	Environmental Contributing Factor(s)
I-5 NB SR 99W/Victory Blvd Interchange (MP 306.90)	2015	Rear-End (Fatal)	Yes	No	Speeding, Inattention	N/A
I-5 SB N Hayden Island Dr Interchange (MP 307.90)	2016	Rear-End (Fatal)	No	No	Inattention, Improper Movement	N/A
I-5 NB N Hayden Island Dr Interchange (MP 307.85)	2016	Sideswipe	Yes	No	Improper Movement	N/A
I-5 NB SR 99W/Victory Blvd Interchange (MP 306.68)	2017	Sideswipe	No	No	Improper Movement	N/A
I-5 NB Columbia River Bridge (MP 308.00)	2018	Sideswipe	Yes	No	Improper Movement	N/A
I-5 SB N Hayden Island Dr Interchange (307.98)	2018	Rear-End (Fatal)	No	No	Speeding	Dark – Lighted

Source: WSDOT and ODOT Crash Database

Note: All crashes are serious injury crashes unless otherwise noted.

Dr = drive; MP = milepost; NB = northbound; SB = southbound

The three fatal crashes were all rear-end crashes, two of which involved speeding. All three serious injury crashes were sideswipe crashes and involved improper movements (lane changes).

3.9.3.2 Freeway Ramps and Ramp Terminal Intersections

TOTAL CRASHES

Figure 3-59 summarizes the severity of I-5 interchange crashes along ramps and at ramp terminals within Portland. In total, there were 124 crashes on these facilities between 2015 and 2019. Of these crashes, 48% resulted in property damage only. One crash resulted in fatal injuries over the 5-year period, occurring along the ramp from N Marine Drive to northbound I-5. There was one serious injury crash, 17 crashes (14%) resulting in minor injuries, and 45 crashes (36%) that resulted in possible injuries.

Figure 3-60 summarizes crash types along I-5 ramps and at ramp terminals within Portland. The largest proportion of crashes (42%) were rear-end, followed by turning crashes at 21%.

Figure 3-59. I-5 Ramp Crashes by Severity (2015–2019) – Portland

Figure 3-60. I-5 Ramp Crashes by Type (2015–2019) – Portland

FATAL AND SERIOUS INJURY CRASHES

One fatal and one serious injury crash occurred on I-5 ramps and at ramp terminal intersections within Portland between 2015 and 2019. Table 3-41 summarizes the key driver and environmental contributing factors for each of these ramp and ramp terminal fatal and serious injury crashes.

Table 3-41. IBR Program Area I-5 Ramp and Ramp Terminal Fatal and Serious Injury Crash Contributing Factors (2015–2019) – Portland

Location	Year	Crash Type	During Peak Period	During Bridge Openings	Drive Contributing Factor(s)	Environmental Contributing Factor(s)
I-5 Northbound On-Ramp from N Marine Drive	2017	Fixed-Object (Fatal)	Yes	No	Speeding, Improper Movement, Disregard Traffic Control	Dark – Lighted
I-5 Ramps & N Marine Drive	2018	Turning	No	No	Disregard Traffic Control	Dark – Lighted

Source: WSDOT and ODOT Crash Database

Note: All crashes are serious injury crashes unless otherwise noted.

Both fatal and serious injury ramp/ramp terminal crashes involved disregard of the traffic control and occurred under dark and lighted conditions. One crash occurred during a peak period, and no crashes occurred during a bridge opening. Both crashes occurred after 6 p.m.

3.9.3.3 Local Intersections

A total of 135 crashes occurred at study intersections in Portland between 2015 and 2019. The most prevalent type of crashes (40%) involved property damage only. Five crashes resulted in serious injuries over the 5-year period, while 11 crashes (8%) resulted in minor injuries and 65 (48%) in possible injuries. No crashes resulting in fatal injuries were reported. Turning crashes, accounted for 49% of all crashes at the intersections, followed by rear-end crashes at 33%. Appendix G summarizes the severity and type of study intersection crashes in Portland from 2015 through 2019.

One crash involving people walking and biking occurred at study intersections during the 5-year period. The crash occurred at Columbia Boulevard and Martin Luther King Jr. Boulevard, involved a pedestrian, and resulted in a possible injury. No crashes resulting in fatal or serious injuries were reported. Appendix G summarizes the severity of study intersection crashes involving people walking and biking in Portland between 2015 and 2019.

3.9.4 Vehicular Crashes during Interstate Bridge Openings and Gate Closures

An analysis to determine the probability of crashes during bridge openings and gate closures was completed for the IBR Program. Bridge openings and gate closure data for the Interstate Bridge were analyzed for the number of times traffic was stopped by the signals for the gate closures, average time that closures began, day of closures, duration of closures, the reason for the closures, and the direction of traffic affected by the closure.

Using a 5-year crash database (for years 2015 through 2019), a comparison was made between crashes that were reported to have occurred within a 1-hour window of any logged gate closures on weekdays that began between 9 a.m. and 2:30 p.m. The analysis only considered crashes that involved vehicles approaching the bridge (i.e., northbound Oregon traffic or southbound Washington traffic), as gate closures directly impact only approaching traffic.

Based on the results of the analysis, crashes in both directions are approximately 2 times more likely when a gate closure occurs than when it does not.

3.10 Transportation Demand Management and Transportation System Management

This section highlights key programs for TDM and TSM in the Portland-Vancouver region.

TDM is defined as an action or set of actions intended to influence the intensity, timing, and spatial distribution of transportation demand for the purpose of reducing the impact of traffic or enhancing mobility options. TDM programs seek to reduce travel demand by shifting travelers to different modes, different times, and different routes through the following actions:

- Increasing the use of commute alternatives, essentially using modes other than SOVs.
- Spreading the timing of travel to less-congested periods.
- Reducing the need to travel.
- Shifting the routing of vehicles, including trucks and SOVs, to less-congested facilities or systems.

TSM is defined as the measures and actions used to increase the efficiency of transportation system operations, especially the street and highway network, including signals and signal systems. TSM measures are intended to increase efficiency of operation and to respond to changing traffic conditions. TSM measures help transportation agencies respond to scheduled and unscheduled disruptions and demands. These programs intend to maximize the available capacity of the existing transportation system.

A major distinction between TDM and TSM is the intended timeline. TDM aims to encourage long-term change in travel behavior, with the goal of reducing peak-period demand. TSM aims to observe real-time system operations in the short term and allow transportation agencies to operate at near-optimal capacity during as much of the day as possible.

Another key difference between TDM and TSM involves the participants. Once any needed facilities and equipment are in place, agencies, employers, transit operators and others can seek to affect travelers' behavior using TDM. In contrast, TSM is almost exclusively in the domain of transportation agencies' operations personnel. Some TSM measures, such as adjustments in signal timing, may go unnoticed by travelers, while others, including real-time traffic data and freeway speed harmonization, are outward-facing.

TDM and TSM are complementary and, for the most part, distinct, although certain facilities and equipment have dual use and help to implement both TDM and TSM.

3.10.1 TDM Programs and Measures

A variety of TDM programs and measures are currently in use in the IBR Program Area. These programs can be categorized according to four basic strategies:

- Programs to improve public awareness of transportation choices.
- Programs to improve access to or availability of alternative transportation choices.
- Incentives and disincentives that cause changes in transportation choices by individuals.
- Institutional and organization approaches to promote TDM.

3.10.1.1 Programs to Improve Public Awareness of Transportation Choices

Public awareness of TDM and alternatives to driving is being encouraged regionally by the Cities of Portland and Vancouver and Metro through two primary features:

- Broad public outreach via mainstream media (internet, newspaper, TV, radio, billboard, bus ads, etc.) and specialized advertising (events, etc.).
- Individualized marketing campaigns aimed at informing segments of the public of mode choices, availability, and potential incentives to use non-auto travel.

Specific public awareness resources available regionally include:

- SmartTrips New Movers, operated by the City of Portland Bureau of Transportation, is a comprehensive program focused on reducing drive-alone trips and increasing biking, walking, public transit use, carpooling and car sharing across the city. It incorporates an individualized marketing methodology, which delivers packets and personalized emails to residents who wish to learn more about all their transportation options. Key components feature biking and walking maps, digital and paper resources, and organized events that get people out in their neighborhoods or places of employment to discover how many trips they can easily, conveniently and safely make without using a car. Success is tracked by evaluating qualitative and quantitative results modeled after industry best practices.
- GetThereSWWashington.org and GetThereOregon.org websites. These websites, sponsored by the City of Vancouver and Metro, respectively, provide trip planning tools for travelers in the IBR Program Area. They provide information on different transportation alternatives, including finding carpool matches, joining or starting a vanpool, finding transit options, and locating bike share stations. The GetthereSWwashington.org website also provides resources

to employers subject to the requirements of the Washington State Commute Trip Reduction program.

- Destination Downtown. Destination Downtown is an effort led by the City of Vancouver, with support from C-TRAN and Vancouver's Downtown Association, to reduce drive-alone trips to downtown Vancouver. The program directs website visitors to the GetthereSWwashington.org website to learn more about trip planning options.

3.10.1.2 Programs to Improve Access to or Availability of Alternative Transportation Choices

The following are TDM features employed regionally to support this strategy:

- Transit. C-TRAN and TriMet each operate regional bus-based fixed-route transit service as well as special access and shared mobility (i.e. paratransit, on-demand ridesharing, neighborhood shuttles, vanpools) services. Additionally, as described earlier in this chapter, TriMet operates regional fixed-route light-rail transit service, including service within the IBR Program Area along Interstate Avenue to Expo Center. C-TRAN operates express commuter buses to central Portland via I-5 on weekdays.
- Park-and-ride lots. C-TRAN and TriMet operate park-and-ride lots throughout the region. There are 10 lots providing 1,500 spaces that directly or indirectly serve commuters traveling within the I-5 travel markets.
- Shared mobility. The SmartTrips New Movers program and the GetthereSWWashington.org, and GetthereOregon.org websites can be used to help the public find potential shared mobility options including vanpool, rideshare, and carpool partners and well as bike share, car share, and park-and-ride lots based on individual information provided regarding people's travel needs.

3.10.1.3 Incentives and Disincentives that Encourage/Discourage Changes in Transportation Choices

Incentives and disincentives typically influence travel behavior, either positively or negatively, through modifications to the cost of travel and/or the time associated with travel. Actions that decrease either the cost or time required for travel are incentives, while those that increase cost or travel time are disincentives. Seeking to shift travel to non-SOV modes can involve incentives to increase their use and corresponding disincentives that make driving alone less attractive. Incentive programs in the IBR Program Area include:

- Promoting transit use through the coordinated fare program among TriMet, C-TRAN, and Portland Streetcar. This program minimizes the costs associated with transferring among transit providers. Additionally, with some limited exceptions, riders paying their fares with a Hop Fastpass incur maximum daily and monthly charges, depending on their fare category.
- Subsidized vanpool use in which vehicles are provided and some subsidies are provided for operating expenses.
- Prizes or cash for those who use alternative travel modes, such as those offered through the GetthereSWWashington.org and GetthereOregon.org websites.

- Variable-rate tolling.
- Park and rides that are available to transit users free of charge.
- An HOV lane on northbound I-5 in North Portland, which provides higher speeds for shared autos and thus reduces travel time.

The easy availability of free parking serves as a disincentive for some travelers to use transit, as it can encourage the use of SOVs. A common means to alter the tendency to drive alone involves managing the parking supply and charging fees for the available parking. Parking is free through much of the IBR Program Area; parking fees are generally charged in downtown Portland, downtown Vancouver, and the Lloyd District.

In response to or inspired by the Washington Commute Trip Reduction law and Oregon Employment Commuter Options rules, employers throughout the region offer incentives to influence their employees' travel choices. Under both the Washington law and Oregon rules, employers have considerable flexibility to tailor programs to their needs, their employees' needs, and the availability of alternative modes of travel. Typical employer-sponsored TDM features include:

- Flexible work schedules.
- Working from home (telecommuting).
- Subsidized/free transit passes.
- Ride matching and preferential parking for carpools and vanpools.
- Guaranteed ride home.
- Parking cash out (giving those who do not occupy a parking space the equivalent in cash to use to subsidize their mode of choice).
- Incentives to walk and bike.
- Secured bicycle parking.
- Changing rooms/showers for people who walk or bike to work.

Common features of the employer-based TDM programs are the use of incentives that seek to make non-SOV modes more competitive with the drive-alone mode for travel to and from the workplace.

3.10.1.4 Institutional and Organizational Approaches to Promote TDM

Features employed regionally to support TDM include:

- Employer-based TDM programs – Commute trip reduction laws in both Washington and Oregon have spurred actions on the part of employers to actively promote TDM. Employers of certain sizes are required to demonstrate efforts to achieve TDM results and track success.
- Transportation Management Associations (TMAs) – TMAs involve a group of employers that coordinate efforts to promote TDM through alternative mode use, parking management, traveler information, and more.
- Transit-oriented development (TOD) – Generally focused along higher-density transit corridors and transit station areas, TOD is a form of urban design that serves transit patrons through a variety of means such as orienting buildings close to sidewalks and transit stops.

TOD may also have different, lower parking requirements, reflecting the higher potential for transit ridership. TOD is generally driven by policies enumerated in specific development and design standards and reflected in zoning standards. TOD policies and standards are typically implemented by public agencies with land use authority.

3.10.1.5 Statewide Plans to Promote TDM

WASHINGTON

Expanding Travel Options: Faster, Smarter and More Affordable (WSDOT 2018), is Washington's plan to strengthen TDM decision-making and strategies throughout the state. It was developed by WSDOT and the Washington State Commute Trip Reduction Board. The plan outlines three main goals and their related outcomes:

- Goal 1: "Increase the use of high-efficiency transportation options for commutes."
  - ➢ Streamline program administration to shift resources to those that directly affect travel change.
  - ➢ Provide more flexibility to allow local changes to be made to priority travel markets in their communities.
  - ➢ Produce high-quality transportation behavior data to inform decision-making.
- Goal 2: "Expand the availability and use of transportation options."
  - ➢ Integrate TDM into state transportation projects and programs.
  - ➢ Expand funding to public and private sources.
  - ➢ Encourage and incentivize TDM at the local level by engaging with public, private, and non-profit organizations.
- Goal 3: "Increase policy makers' support for TDM."
  - ➢ Collaborate with policymakers to communicate about TDM values, successes, and opportunities.
  - ➢ Enlist and support those who can serve as ambassadors for TDM.

These three goals advance WSDOT's Practical Solutions approach, which focuses on identifying investments based on location and timing (WSDOT 2018). It also addresses the current TDM program through commute-trip reduction by using existing infrastructure and services. Additionally, the plan mentions significant factors that influence TDM: aging infrastructure and equipment, insufficient funding for highway construction projects, population and demographic shifts, affordable housing needs, evolving technology, and air quality.

While the plan does not describe how TDM affects specific urban areas such as Vancouver, the proposed outcomes and actions nested under the goals underscore the importance of working with local implementers and jurisdictions on TDM opportunities to meet community needs. Under Goal 1, this is conveyed through more flexibility for local implementers to make local changes.

OREGON

The *Oregon Transportation Options Plan* (ODOT 2015) is the state's policy guidance for TDM (referred to as "transportation options" in the document), and it is a topic plan nested under the broader *Oregon Transportation Plan* (ODOT 2023). While the *Oregon Transportation Plan* is a 25-year multimodal framework, the *Oregon Transportation Options Plan* focuses specifically on opportunities to expand transportation choice, funding for programs and investments, and information to better integrate transportation options into all levels of transportation planning. ODOT developed the plan while considering the effects of future trends on transportation options, trends such as the growing economy, funding challenges and limited space for new infrastructure, aging population, changing transportation preferences, growing public health concerns, updated state environmental goals, and emerging technology.

The plan includes 10 goals that help state, regional, and local programs consider how to implement transportation options programs.

1. Safety: Education and training for roadway designers, operators, and users of all modes.
2. Funding: Reliable, responsive, and equal consideration of funding among transportation options and levels (state, regional, and local).
3. Accessibility: Ease of use of transportation options, especially for accessing employment, services, education, social, and recreational needs.
4. Mobility and System Efficiency: Mobility and system efficiency through managing congestion, enhancing system reliability, and optimizing investment.
5. Economy: Support job creation, local businesses, and moving goods, and decrease household transportation costs.
6. Health and Environment: Reduction of transportation-related environmental impacts and improved health such as promoting physical activity.
7. Land Use and Transportation: Tools and strategies available for planners, developers, and decision makers to support land use and transportation integration.
8. Coordination: Collaboration with private and public partners in local, regional, and state processes and programs.
9. Equity: Diverse transportation needs that support user characteristics such as age, ability, income, and ethnicity.
10. Knowledge and Information: Easily accessible information about transportation options available in Oregon.

In Portland, there is a wide variety of partners who support transportation options. These include the Metro Regional Travel Options Program, TriMet Employer Outreach program, Portland SmartTrips program, City of Portland, and several management associations. These programs can range from events to education to infrastructure changes related to transportation options. The *Oregon Transportation Plan* also recognizes that transportation needs differ per local jurisdiction; transportation options popular in urban Oregon include transit, biking, and walking, which may not be viable in certain rural areas.

3.10.2 TSM Measures

As defined in the introduction, TSM measures and actions are used to increase the operational efficiency of the transportation system, especially the street and highway network including signals and signal systems. TSM measures help transportation agencies respond to scheduled and unscheduled disruptions and demands. TSM involves a certain amount of equipment, such as signals and communications equipment, and the technology to monitor traffic and adjust their operations on a real-time basis. It also involves systems and equipment used to respond to roadway incidents to minimize any unplanned loss of roadway capacity and traveler information systems that can help travelers adjust their planned route.

Common elements of TSM programs include:

- System monitoring and traveler information systems (e.g., web-based information systems, variable message signs).
- Facility management systems (e.g., active traffic management system, bus-on-shoulder operations, optimized signal systems, ramp meters, signal priority for special users, such as transit).
- Incident management systems (e.g., incident response and recovery teams).

3.10.2.1 System Monitoring and Traveler Information Systems

Several systems are used to monitor and optimize traffic operations in the IBR Program Area, as described below.

Vancouver Area Smart Trek (VAST). The VAST program is a coalition of state, regional and local agencies including the City of Vancouver, WSDOT, Clark County, C-TRAN, and the City of Camas. Managed by RTC, it includes regional collaboration on TSM and operations and on intelligent transportation systems (ITS). The program provides traveler information, freeway management, arterial management, coordinated incident management, and transit signal priority. VAST uses real-time information to integrate and manage conventional transportation system components such as roads, transit, ramp meters, traffic signals, and incident response for more efficient operations and performance.

Statewide Traveler Information. WSDOT's ITS system uses advanced technology and information to improve mobility and enhance traveler information and safety on the state's transportation system. It uses real-time information to integrate and manage conventional transportation system components and also serves as the state's road-weather information system (RWIS). In WSDOT's Southwest Region, the WSDOT website includes state and local construction information, bi-state and local cameras, and travel flow information.

TripCheck. ODOT's ITS system uses advanced technology and information to improve mobility and enhance traveler information and safety on the state's transportation system. It uses real-time information to integrate and manage conventional transportation system components and also serves as the state's RWIS.

Variable Message Signs. A variable message sign is a traffic control device on which a message can be changed to provide motorists with real-time information about traffic congestion, crashes, maintenance operations, adverse weather conditions, roadway conditions, organized events, or other highway features (e.g., drawbridges, travel times, and weigh stations). ODOT and WSDOT use variable message signs along I-5 to inform motorists of incidents and travel times.

Traffic Management Center/Transportation Management Operating Center. This is a nerve center that brings together an integrated system of monitoring technology (e.g., closed-circuit TV, pavement loop detectors, ramp meters, and variable message signs) to monitor transportation system performance, detect and respond to incidents in the system, and report real-time information to travelers to support choice making of routes, modes, and times to travel. ODOT Region 1 maintains a transportation management operating center in Portland and WSDOT Southwest Region operates a traffic management center in Vancouver. Each maintains 24-hour, 7-days-per-week operations that are integrated with information and technology employed by other agencies, such as TriMet through their on-board GPS systems and with Portland State University's ITS lab.

3.10.2.2 Facility Management System

A variety of actions are used to optimize the operations of the street and highway system. Examples are described below.

ACTIVE TRAFFIC MANAGEMENT SYSTEMS

Active Traffic Management Systems use overhead electronic signs to provide advance notice to drivers of changing traffic conditions. By providing real-time advance notice of traffic conditions ahead, drivers are alerted earlier and can respond sooner, reducing the need for last-second avoidance maneuvers or panic braking, both of which are primary factors that contribute to crashes. Electronic signs can be used in the following ways:

- Variable speed limits can be used, sometimes lane by lane, to address congestion or backups and encourage drivers to slow down early.
- Lane management symbols can be used to indicate a blocked lane or direct drivers to change lanes before they reach an incident site. They can also show the status of HOV lanes.
- Large signs can display messages warning of slowdowns, backups, or incidents ahead, including if the road is blocked in some way.

WSDOT implements active traffic management as part of its Active Traffic and Demand Management strategy. An Active Traffic and Demand Management system is in operation on I-5 southbound from NE 78th Street in Vancouver to the Interstate Bridge. This system was designed to address congestion, particularly during typical morning commutes, and provide advance warning of slow or stopped traffic associated with bridge openings.

ODOT employs active traffic management in Portland on OR 217 between SR 26 and I-5 and on other highways, including I-84.

RAMP METERS

Ramp meters are used on the on-ramps to freeways and other limited-access highways. Ramp meters are a specific type of traffic signal used to control the rate of vehicles entering traffic flow on a freeway. This strategy is designed to reduce crashes and decrease travel times. When traffic is heavy on both the mainline and the ramp, ramp metering can limit the amount of ramp traffic to the volume that can comfortably merge with traffic on the mainline. By adjusting the metering rate on the ramp, the combination of mainline and ramp volumes can be kept below the critical value at which a breakdown in traffic flow occurs. The benefits of metering can be achieved when traffic flows are neither too light (in which case metering is not needed) nor too high (in which case breakdown will happen anyway).

By metering the flow rate of traffic on the ramps, ramp meters increase travel times for traffic entering the highway, but keep travel speeds higher for longer-distance, mainline traffic. In their simplest application, ramp meters set minimum intervals between vehicles entering the highway from the ramp with a fixed-time signal. More sophisticated ramp metering adjusts the rate of entering vehicles in response to the actual, real-time flow on the highway and the number of vehicles waiting to enter on the on-ramp.

Since ramp meters are used only on highway entry ramps, they are most successful when deployed throughout the corridor system (over longer stretches of freeways). Ramp meters have a greater impact on the highway mainline and downstream interchanges than they have at the interchange at which they are installed. Ramp meters rely on sensors that are installed in the lanes of the highway to measure traffic volumes. The data used to program the ramp meters are also used to create real-time traveler information.

ODOT has installed ramp meters along each on-ramp to I-5 within the IBR Program Area, and WSDOT operated one ramp meter at the SR 14 on-ramp to southbound I-5 in 2019. Since 2019, WSDOT has added additional ramp meters on I-5 within the IBR Program Area. Ramp meters are typically used only during peak hours and meter traffic only in the peak direction; however, WSDOT and ODOT use demand-responsive meters and are starting to implement them in off-peak hours as demand increases and congestion stretches beyond the typical peak periods.

MANAGEMENT OF PREFERENTIAL LANES

Once a decision has been made to provide lanes for preferential or exclusive use, the operating agency can set parameters related to the hours of operation and the allowable users. Common operating parameters include restricting the lane usage to transit vehicles, vanpools and carpools with specific occupancy (both 2+ and 3+ occupant standards are used in different areas). In some areas, vehicles with a single occupant can also enter the lane by paying a toll. In other cases, carpools with three or more occupants are not charged a toll, those with two occupants pay a toll, and SOVs are prohibited.

In the Portland area, there is one example of a managed lane. ODOT has a northbound managed lane in operation for HOV users from 3 to 6 p.m. on I-5 from Going Street to Marine Drive. ODOT also uses a preferential on-ramp lane at the Victory Boulevard on-ramp to northbound I-5 for exclusive use by buses. This lane allows buses to bypass other vehicles waiting at the on-ramp meter and provides travel time savings and reliability for transit.

BUS-ON-SHOULDER OPERATIONS

Bus-on-shoulder operations allow buses to use the roadway shoulder as a travel lane. Shoulders can be available for use as bus lanes during specific days and times, providing an additional lane during periods of heavy congestion. The opportunity for bus-on-shoulder operations helps to improve bus speeds, reduce travel times, and contribute to more reliable service.

The use of existing shoulders for bus operations can serve as an alternative to highway widening, which can take longer to implement and require more physical space than may be available. However, shoulders must have the width, pavement depth, and other design elements necessary to accommodate buses, and the highway downstream must be able to handle the additional capacity. Signs and pavement markings are placed along the corridor noting that shoulder use is for authorized transit vehicles only. Signs also warn motorists when buses will be merging back into traffic at the end of the bus-on-shoulder corridor.

Priority for shoulder use is always given to emergency vehicles, incident management (e.g., fender benders or breakdowns) and maintenance activities. If another vehicle is in the shoulder because of an emergency, buses are required to merge back into the regular travel lanes.

Bus-on-shoulder operations are currently permitted on three roadways within and near the Greater Portland Metro Region:

- Southbound I-5 from 99th Street to the Interstate Bridge. The bus-on-shoulder lane allows C-TRAN buses to bypass congestion by traveling on the shoulder when speeds drop below 35 mph throughout this 5-mile stretch of highway. Signs along the freeway alert drivers to expect bus use on the inside shoulder during congestion.
- Westbound SR 14 from SE 164th Avenue to I-205. Bus-on-shoulder lanes are denoted using static signs.
- Northbound and southbound I-205 between SR 14 and the Airport Way exit ramp. Buses can use the shoulder only when traffic is moving slower than 35 mph. While using the shoulder, buses can travel up to 15 mph faster than traffic, with a maximum speed of 35 mph.

PREFERENTIAL TRAFFIC SIGNAL PRIORITY

ODOT, the City of Portland, and the City of Vancouver use traffic signal systems that allow emergency response vehicles to preempt traffic signals to give them preferential treatment at signalized intersections. At several intersections in Portland, buses are allowed to proceed straight on lanes that are designated as right-turn only lanes for other vehicles. At some of these intersections, the signal system is also programmed with an advanced green signal for buses only to allow them to jump ahead of other traffic in the adjacent lanes. Using this “queue jump” signal, the buses receive a green signal ahead of other traffic proceeding in the same direction, allowing them to pull ahead of the parallel through-traffic in the adjacent lane.

TRANSIT PRIORITY AT TRAFFIC SIGNALS

On some routes in Portland, TriMet buses interact with signals systems to help buses stay on schedule. The system allows minor changes in the signal timing to help buses running behind schedule to catch up. As of 2019, C-TRAN has included active transit signal priority on The Vine on the Fourth Plain alignment and on Mill Plain between I-5 and 164th Avenue. C-TRAN is committed to pursuing opportunities for transit signal priority in the future OR 99 corridor.

3.10.2.3 Incident Management System

The goals of the incident response program are preventing minor disruptions from becoming major ones, providing motorist assistance, and improving on-scene incident management. Prevention includes patrols to remove obstacles to the traveling public, such as roadway debris and abandoned vehicles. Motorist assistance is a short-term fix that removes a disabled or stalled vehicle from the flow of traffic, such as providing a gallon of gas, changing a tire, or pushing a vehicle out of a travel lane. Incident response vehicles can provide better on-scene incident management by coordinating with other responding agencies.

ODOT's incident response program consists of vehicles that regularly patrol major travel routes in the Portland area to keep them free from major obstructions, to provide emergency motorist assistance, and to improve on-scene incident management. Each incident response vehicle is equipped with automatic vehicle location that allows ODOT personnel to determine its proximity to any current incidents, a laptop computer, cellular and radio communication capabilities, and on-board variable message signs.

WSDOT also maintains two to three incident response vehicles in its Southwest Region that patrol I-5 and seek to clear highway incidents within 90 minutes of arrival on-site. By agreement, WSDOT manages incidents on the Interstate Bridge in the southbound direction and ODOT manages the northbound direction.

3.11 Tolling and Diversion

Tolling does not currently exist anywhere in the Portland metropolitan region, so no existing tolling data are available for summary.

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4. LONG-TERM EFFECTS

4.1 Introduction

The long-term effects described in this chapter are for the year 2045 and are a comparison of the No-Build Alternative and the Modified LPA[10] and design options. The Modified LPA and options are described in Chapter 1. This chapter discusses changes in regional transportation, freeway operations, freight mobility and access, bridge openings and gate closures, arterial and local street operations, transit operations, active transportation, safety, and TDM and TSM. For analysis elements where the Modified LPA or the design options would trigger mitigation, further discussion on potential mitigation is provided in Chapter 7.

Some of the Modified LPA design options would have differing impacts from those of the Modified LPA (described in the footnote below). Those differences are described in this chapter as appropriate.

4.2 Regional Transportation

Regional travel patterns, including regional travel measures and screenline performance measures, are discussed in detail in this section.

As described in Chapter 3, the Transportation Methods Report (Appendix A), and the Travel Demand Modeling Methods Report (Appendix H), Metro and RTC maintain a single travel demand model: the regional travel demand model. The model used for this work was originally developed for the 2018 RTP, adopted by Metro in 2018 and RTC in 2019, representing model years 2015 and 2040. The initial 2045 network and land use inputs were developed for another major project in the area, and further refined for this project. The 2045 model used the 2040 Financially Constrained network from the 2018 RTP. Land use inputs were extended from the 2040 forecast to 2045, through a process coordinated by the metropolitan planning organizations that considered comprehensive plans and other information supplied by their member jurisdictions. In addition to accounting for added growth, adjustments were made within the City of Portland to reallocate the households and employment based on the most current update to the City's comprehensive plan, which was not complete in time for inclusion in the 2018 RTP. The IBR Program's Land use assumptions for Hayden Island are consistent with the Hayden Island Plan rather than the 2035 City of Portland Comprehensive Plan. The reasons for this are that the 2035 City of Portland Comprehensive Plan does not yet include higher land use assumptions on Hayden Island partly because other areas of the city of Portland are growing faster and have been allocated additional growth. For the IBR analysis, the regional model includes adjustments to reflect the higher levels of growth proposed with the Hayden Island Plan (see the Land Use Technical Report Sections 3.4.2 and 4.4.4). The IBR Program consulted with Metro and the City of Portland and used the Hayden Island Plan land use to be conservative in travel forecasting, traffic analysis, and subsequent operational and design considerations in the I-5 corridor and on Hayden

[10] For purposes of the transportation analysis, the Modified LPA is defined as including one auxiliary lane in each direction, a double-deck bridge over the Columbia River, ramps at C Street, and a centered I-5 alignment in downtown Vancouver.

Island. Land use assumptions used are detailed in Section 3 of Appendix H, which includes a table showing households and employment for the region broken out by district.

In addition to the above listed changes, transit capacity constraints were added to the model to better represent feasible transit ridership relative to transit investments described in the 2018 RTP. The transit capacity constraints were added because the 2018 RTP model generated estimates of transit ridership across the system that could only be supported in practice with additional capital investment projects beyond those present in the 2018 RTP. While it is likely that those investments, which are already being identified, will be programmed and implemented by the 2045 design year, the decision was made for the IBR Project analysis to limit transit ridership to the carrying capacity of the system as described in the 2018 RTP. The transit capacity constraint is described in more detail in Appendix H, Section 3.8.

4.2.1 Major Improvement Projects to Regional Roadways

The background roadway network for the No-Build Alternative and the Modified LPA and options is the 2018 RTP Financially Constrained system adopted in December 2018 by the Metro Council and in March 2019 by the RTC Board of Directors. The 2018 RTP includes transportation projects from state and local plans that are needed to meet transportation needs over the next 25 years and that are financially constrained, meaning they have funding that is reasonably anticipated over the funding period to complete the projects.

Table 4-1 lists key future roadway improvement projects in the vicinity of the IBR Program Area, along with a description of the project. Key future freight projects, transit projects, and active transportation projects are summarized in their respective sections later in this chapter.

The only difference in the roadway network between the No-Build Alternative and the Modified LPA and options would be the IBR Program components, as described in Chapter 1.

Table 4-1. Major Planned Roadway Transportation Projects

Project	Description
Sunrise Project and Sunrise Jobs and Transportation Act Project	This project is a proposed 5-mile, east-west oriented, limited-access highway from I-205 to Rock Creek Junction in Clackamas County.
I-5 Rose Quarter Improvement Project	The purpose of the I-5 Rose Quarter Improvement Project is to improve safety and operations on I-5 between I-84 and I-405, the Broadway/Weidler interchanges, and adjacent surface streets in the vicinity of the interchange.
Ramp Meters	Ramp meters are planned to be added throughout the region, including on I-5 within the IBR Program Area.

Project	Description
OR 217 Project	OR 217 has over 10 interchanges in 7 miles which experience significant congestion and high crash rates. This project will build auxiliary lanes on OR 217 Southbound from Beaverton-Hillsdale Highway to Greenburg Road and on OR 217 northbound from OR 99W to Scholls Ferry Road. The project will also build a collector-distributor road between Allen Boulevard and Denney Road. Other improvements are included in this project as well.
I-205 South Corridor Widening and Seismic Improvement Project	This project will widen I-205 between OR 213 and Stafford Road and improve the I-205/Abernethy Bridge to ensure it remains functional after a catastrophic earthquake.

Source: Metro/RTC 2018 RTP Financially Constrained System

4.2.2 Regional Travel Measures

Table 4-2 shows the daily VMT, VHT, and VHD for the No-Build Alternative, Modified LPA, and the option with two auxiliary lanes for 2045. At the regional travel measures level, the Modified LPA without C Street ramps would be identical to the Modified LPA. With the Modified LPA and the option with two auxiliary lanes, regional VMT is anticipated to decrease by 1% or less in the Portland metropolitan area and the traffic subarea on an average weekday compared with the No-Build Alternative. Similarly, forecast VHT is anticipated to decrease by less than 1% for the Modified LPA and the option with two auxiliary lanes compared to the No-Build Alternative for the Portland metropolitan area but would decrease by about 3% in the traffic subarea. While the differences in VMT and VHT would be small, the differences between the Modified LPA and option with two auxiliary lanes compared to the No-Build Alternative for the VHD are forecast to be 11% in the Portland metropolitan area and between 30% and 32% in the traffic subarea, respectively. VMT is slightly higher for the Modified LPA with two auxiliary lanes than for the Modified LPA, while VHT and VHD are slightly lower.

At a regional level, the VMT and VHT changes are not as significant due to the sheer magnitude of the overall totals, but within the traffic subarea these changes represent a larger share of the total miles and hours. Total reductions for VHD are more substantial both regionally and within the traffic subarea, in part because, similar to existing conditions, congestion in the traffic subarea makes up a large share of total delay within the Portland-Vancouver metropolitan region. The Modified LPA, which includes highway improvements, transit improvements, active transportation improvements, and tolling, would contribute to a sizable reduction in overall vehicle trips through the IBR Program Area, which in turn would reduce congestion and delay on the order of approximately 11% and 30% compared to the No-Build Alternative for the region and traffic subarea, respectively. The Modified LPA with two auxiliary lanes, which includes similar components to the Modified LPA, shows regional and traffic subarea reductions of 11% and 32% compared to the No-Build Alternative. When comparing the Modified LPA with two auxiliary lanes to the Modified LPA, the differences for all values except subarea VHD are less than 1%, with VHD changing by 2%.

Table 4-2. 2045 Weekday Daily Vehicle Miles of Travel, Vehicle Hours of Travel, and Vehicle Hours of Delay

Alternative	VMT	VHT	VHD
No-Build Alternative			
Portland Metropolitan Region	59,042,000	1,803,600	65,500
Traffic Subarea	14,349,500	439,600	24,900
Modified LPA			
Portland Metropolitan Region	58,950,700	1,792,300	58,300
Traffic Subarea	14,270,500	428,000	17,400
Modified LPA with Two Auxiliary Lanes			
Portland Metropolitan Region	58,960,800	1,791,900	58,000
Traffic Subarea	14,279,300	427,400	17,000
Change between No-Build and Modified LPA			
Regional Difference	-91,300(<-1%)	-12,100 (<-1%)	-7,300 (-11%)
Subarea Difference	-79,000 (<-1%)	-11,600 (-3%)	-7,500 (-30%)
Change between No-Build and Modified LPA with Two Auxiliary Lanes			
Regional Difference	-83,300(<-1%)	-12,600 (-1%)	-7,600 (-11%)
Subarea Difference	-70,900 (<-1%)	-12,200 (-3%)	-7,900 (-32%)
Change between Modified LPA and Modified LPA with Two Auxiliary Lanes			
Regional Difference	10,100 (<1%)	-400 (<-1%)	-300 (<-1%)
Subarea Difference	8,800 (<1%)	-600 (<-1%)	-400 (-2%)

Source: Metro/RTC Regional Travel Demand Model

4.2.3 Screenline Peak-Hour Traffic Volume Performance

The AM and PM peak-hour screenline volumes for the 13 screenlines described in Section 3.2.3 were analyzed using the regional travel demand model to understand the relative differences in traffic volumes between the No-Build Alternative and the Modified LPA and options. Screenline volume totals in Vancouver and Portland are summarized in Table 4-3 and Table 4-4, respectively. The east-west screenlines summarize traffic volumes moving northbound and southbound. The north-south screenlines summarize traffic volumes moving eastbound and westbound. Detailed individual facility volumes can be found in Appendix B. For east-west screenlines that include I-5 or I-205, the arterials and freeway volumes are included separately along with a total for the entire screenline. For specific traffic differences at individual facilities or intersections it is more appropriate to use post-processed information, which is available in Section 4.6.

For the Vancouver east-west screenlines, the Modified LPA and options would result in increased volumes in the peak directions (southbound in the AM peak and northbound in the PM peak) for all screenlines compared to the No-Build Alternative (+4% to +11%). These increases are primarily from vehicles on I-5 rather than on surrounding arterial facilities, which for the most part would see decreases in volumes with the Modified LPA. These changes reflect the ability for more vehicles to be accommodated on I-5 during the peak period with the Modified LPA compared to the No-Build Alternative.

When compared to the No-Build Alternative, the Modified LPA and options would not result in large changes on I-205 (-3% to +12%). This is noted to point out that concerns about diversion impacts are not warranted based on the analysis.

The north-south screenlines in Vancouver would experience increases in both the AM and PM peak hours for most screenline movements with the Modified LPA and options. This is, in part, because of additional traffic using these facilities to access I-5 which shows up as higher volumes on I-5 for the north-south screenlines. Screenline #5, west of Franklin Street, would see minimal changes on most facilities, and Screenlines #6 and #7 would see a mix of increases and decreases resulting in a net increase, primarily from higher traffic volumes on Evergreen Boulevard and Mill Plain Boulevard. Also contributing to these increases specifically is SR-500 east of I-5 which has increases of just under 300 vehicles (approximately +20%) in the peak direction in both the AM and PM peak, and SR 14 east of I-5 which has increases of just under 200 vehicles (+7%) in the peak direction of the AM peak. SR 14 in the peak direction of the PM peak has less than 50 (+2%) vehicle difference.

For the Portland east-west screenlines capturing vehicles traveling north and south, like those in Vancouver, the Modified LPA and options would increase vehicle volumes in the peak directions (southbound in the AM peak and northbound in the PM peak) and decreases volumes in the off-peak directions compared to the No-Build Alternative. The increases are much more spread out in the Portland screenlines, with smaller changes on multiple facilities rather than larger changes on one or two facilities within a screenline. There would be increases on multiple facilities within the screenlines with the largest changes coming on Martin Luther King Jr. Boulevard in the peak direction. The east-west screenline with the largest changes is Screenline #8 which is closest to the Columbia River. This screenline is higher on arterials in the peak direction, likely due to access to and from Hayden Island from the south being routed through the North Portland Harbor arterial bridge rather than using I-5. Again, these changes are primarily peak direction increases spread out among most of the facilities that make up the screenline.

Also similar to the Vancouver screenlines, the Portland north-south screenlines would see modest changes in traffic in both directions in both the AM and PM peak periods. When compared to the No-Build Alternative, the Modified LPA and options would not have noteworthy changes on I-205 in the peak direction (-50 to +200 vehicles over the 1-hour peak). The volumes in the peak and off-peak would not differ among the design options.

Volume differences on the I-5 and I-205 Columbia River bridges are described in Section 4.3.

Table 4-3. 2045 Vancouver Screenline Traffic Volumes – AM and PM

Screenline	Direction	No-Build Volumes (AM peak)	Modified LPA and Options Volumes (AM peak)	Difference between Modified LPA – No-Build (AM peak)	No-Build Volumes (PM peak)	Modified LPA and Options Volumes (PM peak)	Difference between Modified LPA – No-Build (PM peak)
East-West #1: North of 39th Street	Northbound Arterials	2,600	2,550	-50	4,350	4,200	-150
	Northbound I-5	3,200	3,150	-50	4,700	5,700	1,000
	Northbound I-205	2,600	2,650	50	3,550	3,450	-100
	Northbound Total	**8,350**	**8,350**	**-**	**12,650**	**13,350**	**700**
	Southbound Arterials	4,550	4,300	-250	3,000	2,900	-100
	Southbound I-5	5,200	6,600	1,400	3,900	4,100	200
	Southbound I-205	4,200	4,150	-50	2,950	2,950	-
	Southbound Total	**13,950**	**15,100**	**1,150**	**9,850**	**9,950**	**100**
East-West #2: North of Fourth Plain Boulevard	Northbound Arterials	3,100	3,100	-	5,550	5,100	-450
	Northbound I-5	4,150	3,900	-250	6,000	7,500	1,500
	Northbound I-205	4,000	4,250	250	5,250	5,150	-100
	Northbound Total	**11,200**	**11,300**	**100**	**16,800**	**17,750**	**950**
	Southbound Arterials	5,950	5,500	-450	4,200	4,250	50
	Southbound I-5	6,500	7,800	1,300	4,950	4,500	-450
	Southbound I-205	5,400	5,300	-100	4,000	4,150	150
	Southbound Total	**17,850**	**18,600**	**750**	**13,100**	**12,900**	**-200**

Screenline	Direction	No-Build Volumes (AM peak)	Modified LPA and Options Volumes (AM peak)	Difference between Modified LPA – No-Build (AM peak)	No-Build Volumes (PM peak)	Modified LPA and Options Volumes (PM peak)	Difference between Modified LPA – No-Build (PM peak)
East-West #3: North of 15th Street	Northbound Arterials	3,750	3,750	-	4,550	4,300	-250
	Northbound I-5	3,750	3,550	-200	5,450	6,800	1,350
	Northbound I-205	4,000	4,250	250	5,250	5,150	-100
	Northbound Total	**11,500**	**11,550**	**50**	**15,250**	**16,300**	**1,050**
	Southbound Arterials	4,550	4,150	-400	3,700	3,600	-100
	Southbound I-5	6,250	8,500	2,250	4,850	4,850	-
	Southbound I-205	5,400	5,300	-100	4,000	4,150	150
	Southbound Total	**16,200**	**17,950**	**1,750**	**12,550**	**12,650**	**100**
East-West #4: North of Evergreen Boulevard	Northbound Arterials	3,750	3,800	50	5,200	5,250	50
	Northbound I-5	3,100	2,850	-250	4,200	5,200	1,000
	Northbound I-205	4,250	4,750	500	6,550	6,600	50
	Northbound Total	**11,100**	**11,350**	**250**	**15,900**	**17,050**	**1,150**
	Southbound Arterials	5,150	5,100	-50	4,150	4,000	-150
	Southbound I-5	5,000	6,800	1,800	3,650	3,600	-50
	Southbound I-205	6,550	6,700	150	4,350	4,750	400
	Southbound Total	**16,750**	**18,600**	**1,850**	**12,200**	**12,350**	**150**
North-South #5: West of Franklin Street	Eastbound	1,150	1,200	50	1,950	1,850	-100
	Westbound	2,100	2,000	-100	1,250	1,250	-
North-South #6: West of I-5	Eastbound	1,600	2,100	500	2,750	3,150	400
	Westbound	3,000	3,300	300	2,450	2,600	150

Screenline	Direction	No-Build Volumes (AM peak)	Modified LPA and Options Volumes (AM peak)	Difference between Modified LPA – No-Build (AM peak)	No-Build Volumes (PM peak)	Modified LPA and Options Volumes (PM peak)	Difference between Modified LPA – No-Build (PM peak)
North-South #7: East of I-5	Eastbound	5,650	5,700	50	6,900	7,450	550
	Westbound	6,550	7,400	850	5,950	5,550	-400

Source: Metro/RTC Regional Travel Demand Model

MLPA = Modified LPA

Note: Table volumes are from the regional travel demand model, which is not calibrated to individual facilities and does not reflect post-processing. The regional travel demand model assignments use an equilibrium process whereby the resulting volumes reflect a condition where no traveler can improve their travel time or cost by switching paths. Traffic loads onto the network via zone connectors that represent all traffic coming in and out of an area and does not reflect exact loading to and from the network via local connector facilities or driveways. Differences in assignments may simply be the result of the equilibrium process and how trips enter and exit the network. The assignments do not reflect real-world traffic conditions and should be used to gauge general changes between alternatives.

Table 4-4. 2045 Portland Screenline Traffic Volumes – AM and PM

Screenline	Direction	No-Build Volumes (AM Peak)	Modified LPA and Options Volumes (AM Peak)	Difference between Modified LPA – No-Build (AM Peak)	No-Build Volumes (PM Peak)	Modified LPA and Options Volumes (PM Peak)	Difference between Modified LPA – No-Build (PM Peak)
East-West #8: Columbia Slough	Northbound Arterials	5,750	5,750	-	3,750	4,350	600
	Northbound I-5	4,200	3,700	-500	4,350	4,250	-100
	Northbound I-205	4,950	5,450	500	6,500	6,600	100
	Northbound Total	**14,900**	**14,900**	**-**	**14,600**	**15,200**	**600**
	Southbound Arterials	2,900	3,550	650	5,300	5,200	-100
	Southbound I-5	5,100	5,250	150	4,400	3,950	-450
	Southbound I-205	6,350	6,500	150	5,450	6,000	550
	Southbound Total	**14,300**	**15,350**	**1,050**	**15,150**	**15,150**	**-**

Screenline	Direction	No-Build Volumes (AM Peak)	Modified LPA and Options Volumes (AM Peak)	Difference between Modified LPA – No-Build (AM Peak)	No-Build Volumes (PM Peak)	Modified LPA and Options Volumes (PM Peak)	Difference between Modified LPA – No-Build (PM Peak)
East-West #9: North of Rosa Parks	Northbound Arterials	4,350	4,200	-150	3,500	3,850	350
	Northbound I-5	4,950	4,700	-250	5,150	5,100	-50
	Northbound Total	**9,300**	**8,900**	**-400**	**8,700**	**8,950**	**250**
	Southbound Arterials	3,050	3,550	500	4,300	4,000	-300
	Southbound I-5	5,800	5,950	150	5,400	5,200	-200
	Southbound Total	**8,850**	**9,500**	**650**	**9,700**	**9,200**	**-500**
East-West #10: South of Alberta Street	Northbound Arterials	7,800	7,750	-50	7,550	7,850	300
	Northbound I-5	5,450	5,350	-100	5,800	5,900	100
	Northbound I-205	6,100	6,250	150	6,250	6,350	100
	Northbound Total	**19,350**	**19,350**	**-**	**19,600**	**20,100**	**500**
	Southbound Arterials	6,850	7,200	350	7,550	7,450	-100
	Southbound I-5	6,350	6,550	200	5,800	5,650	-150
	Southbound I-205	6,350	6,550	200	6,050	6,300	250
	Southbound Total	**19,600**	**20,300**	**700**	**19,350**	**19,400**	**50**
North-South #11: West of Interstate Avenue	Eastbound	3,200	3,300	100	3,800	3,950	150
	Westbound	4,000	4,200	200	3,200	3,250	50
North-South #12: East of I-5	Eastbound	3,100	3,400	300	3,250	3,350	100
	Westbound	3,150	3,300	150	3,300	3,450	150

Screenline	Direction	No-Build Volumes (AM Peak)	Modified LPA and Options Volumes (AM Peak)	Difference between Modified LPA – No-Build (AM Peak)	No-Build Volumes (PM Peak)	Modified LPA and Options Volumes (PM Peak)	Difference between Modified LPA – No-Build (PM Peak)
North-South #13: East of Martin Luther King Jr. Boulevard	Eastbound	3,750	4,150	400	4,400	4,350	-50
	Westbound	4,400	4,300	-100	4,000	4,250	250

Source: Metro/RTC Regional Travel Demand Model

Note: Table volumes are from the regional travel demand model, which is not calibrated to individual facilities and does not reflect post-processing. The regional travel demand model assignments use an equilibrium process whereby the resulting volumes reflect a condition where no traveler can improve their travel time or cost by switching paths. Traffic loads onto the network via zone connectors that represent all traffic coming in and out of an area and does not reflect exact loading to and from the network via local connector facilities or driveways. Differences in assignments may simply be the result of the equilibrium process and how trips enter and exit the network. The assignments do not reflect real-world traffic conditions and should be used to gauge general changes between alternatives.

4.3 Interstate 5

This section describes and compares the 2045 No-Build Alternative and the Modified LPA and options in the I-5 corridor within the IBR Program Area, including key changes to the roadway network, the process used to estimate 2045 forecast traffic volumes, and the resulting traffic operations on I-5.

4.3.1 Freeway Analysis Area

The IBR Program Area is the approximately 5-mile section of I-5 between the SR 500/39th Street interchange in Vancouver and the Interstate Avenue/Victory Boulevard interchange in Portland. Because traffic volumes and congestion within and outside of the IBR Program Area influence each other, these interactions were captured by analyzing a longer section of I-5. This section (referred to as the freeway analysis area) consists of a 17-mile length of I-5 between the I-205 interchange north of Vancouver and the Marquam Bridge in Portland.

4.3.2 Alternative Descriptions

The No-Build Alternative includes projects that are planned to occur with or without the IBR Program, as identified in the 2018 RTP Financially Constrained system and summarized above in Table 4-1. These include two projects that would impact traffic volume forecasts and operations on I-5 in the freeway analysis area:

1. The addition of ramp meters to I-5 ramps in Washington in the IBR Program Area.
2. The implementation of the I-5 Rose Quarter Improvement Project in Oregon, which would add an auxiliary lane to each direction of I-5 between the Broadway on-ramp and the Morrison Bridge off-ramp in the southbound direction and between the I-84 on-ramp and Broadway off-ramp in the northbound direction.

Four alternatives were evaluated for I-5 freeway operations:

1. No-Build Alternative.
2. Modified LPA.
3. Modified LPA without C Street ramps.
4. Modified LPA with two auxiliary lanes.

Descriptions of the Modified LPA and options are summarized in Chapter 1. The IBR Program improvements include modifications to interchange connections that are further described in Section 4.6.1, Roadway Network.

4.3.3 Mainline and Ramp Vehicle Volumes

As described in Appendix A, the 2045 forecast volumes were calculated using the Metro/RTC regional travel demand model and post-processing methods described in *NCHRP* [11] *765 Analytical Travel Forecasting Approaches for Project-Level Planning and Design*.

Year 2045 volumes were developed using the four-step Metro/RTC regional travel demand model and following industry standards on post-processing. Post-processing is the standard technique used to forecast future traffic volumes by adjusting for the differences between the observed base year traffic volumes and the traffic volumes simulated by the Metro/RTC regional travel demand model. Post-processing is not the substitution of judgment or guesses for the results of a transportation model. Rather, it is a comprehensive, systematic approach to account for the fact that the results of a regional travel demand model may be highly accurate on an aggregated regional basis (e.g., screenlines), but may not be accurate for individual roadways, ramps, or intersections within the modeled region. The post-processed volumes are ultimately used as inputs in the traffic operations models to identify the impacts to local roadways and to the I-5 freeway and ramps.

Year 2045 forecast volumes were developed for the No-Build Alternative and the Modified LPA and options. The only difference between the Modified LPA and the option without the C Street ramps is that the Modified LPA includes ramps that access downtown Vancouver via C Street. If there are no C Street ramps, vehicles from downtown Vancouver would need to access the freeway through the Mill Plain interchange. The main difference between the Modified LPA and the option with two auxiliary lanes is the number of auxiliary lanes across the Columbia River bridges. The year 2045 forecast volumes in the Modified LPA option with two auxiliary lanes, while not identical to the Modified LPA (with one auxiliary lane), are similar enough that the results do not change for many of the analyses completed. As such, these are noted to be the same in the context of only minor differences and therefore do not yield a change that is significant enough to include them separately in the documentation.

4.3.3.1 Average Weekday Daily Volume Forecasts

Average weekday daily volume forecasts across the Columbia River were estimated for the I-5 and I-205 bridges for 2045 using a two-step process:

1. The Metro/RTC regional travel demand model was used to calculate an annual growth rate for the total daily weekday traffic volume crossing the river, on both bridges combined. The annual growth rates between the 2015 and 2045 regional travel demand models are 1.07% per year for the No-Build Alternative and 0.93% per year for the Modified LPA and options. These trends follow historical growth patterns of approximately 1% per year for the total river crossing volumes. The annual growth rate percentages were applied to the existing year 2019 total daily traffic volume crossing the river on both bridges combined to develop the total 2045 total river crossing volume for the No-Build Alternative and the Modified LPA and options.

[11] National Cooperative Highway Research Program

2. Individual bridge weekday traffic volumes across the I-5 and I-205 bridges were forecast by proportionally allocating total river crossing volumes based off historical bridge volume data/splits and the Metro/RTC regional travel demand model volumes/splits for 2015 and 2045. The forecasts indicate that 45% of daily traffic would use the I-5 bridge and 55% would use the I-205 bridge in the No-Build Alternative, as well as in the Modified LPA and options. The bridge splits would be similar for the No-Build Alternative and the Modified LPA and options due to the improvement in I-5 operations, congestion on both freeway corridors, addition of variable-rate tolling on I-5, addition of high-capacity transit in the I-5 corridor, and addition of active transportation facilities in the I-5 corridor. Forecast No-Build Alternative and Modified LPA and options average daily weekday traffic volumes on the I-5 and I-205 bridges are summarized in Table 4-5.

Average weekday daily traffic volumes in the 2045 No-Build Alternative are forecast to increase 28% over 2019 conditions for total river crossings and 26% for the Interstate Bridge. Total daily vehicle volumes crossing the Columbia River would be reduced by approximately 3% with the Modified LPA and options compared to the No-Build Alternative, resulting in fewer crossings on both bridges. The reasons the Modified LPA and options would reduce vehicle trips includes more investment in high-capacity transit (LRT, express bus on shoulder, and new park-and-ride lots) throughout the Program Area, variable-rate tolls that are implemented on the new Columbia River bridges, and improved active transportation facilities. Transit, tolling, and active transportation impacts are discussed in their respective sections below.

Table 4-5. 2045 Forecast Average Weekday Daily Traffic Volumes

Location	Existing AWDT	2045 No-Build AWDT [a]	2045 Modified LPA and Options AWDT [b]
Total River Crossing	313,000	400,000 (+28%)	389,000 (-3%)
I-5 Bridge	143,400	180,000 (+26%)	175,000 (-3%)
I-205 Bridge	169,600	220,000 (+30%)	214,000 (-3%)

Source: ODOT/WSDOT, Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

a Percentages reflect change from existing 2019 conditions.

b Percentages reflect change from 2045 No-Build Alternative.

AWDT = average weekday daily traffic

4.3.3.2 Peak Period Demand Volume Forecasts

After developing the daily traffic forecasts crossing the I-5 and I-205 bridges, the 4-hour AM and 4-hour PM traffic volume forecasts for 2045 were estimated for the I-5 and I-205 bridges across the Columbia River. The Metro/RTC regional travel demand model distributes the daily volume over a 24-hour period, so different times of the day can have different growth rates in the Metro/RTC regional travel demand model.

Similar to the process described in Section 4.3.3.1, Average Weekday Daily Volume Forecasts, annual growth rates for the No-Build Alternative and the Modified LPA and options from the Metro/RTC regional travel demand model during the peak periods were applied to existing 2019 peak-period volumes crossing the I-5 and I-205 bridges.

Forecast No-Build and Modified LPA 4-hour AM and PM peak-period demand volumes by direction on the I-5 and I-205 bridges are summarized in Table 4-6. The Modified LPA without C Street ramps would have the same peak-period forecasts across the Columbia River as the Modified LPA.

Table 4-6. 2045 Forecast 4-hour AM and PM Peak-Period Volumes

Bridge	Direction of Travel	2019 Existing	2045 No-Build	2045 Modified LPA and Options
4-hour AM Peak-Period Volumes (6 to 10 a.m.)				
I-5 Interstate Bridge	Southbound	21,050	25,770	26,940
	Northbound	12,145	17,845	17,085
I-205 Glenn Jackson Bridge	Southbound	25,940	32,740	27,750
	Northbound	13,820	20,915	21,195
4-hour PM Peak-Period Volumes (3 to 7 p.m.)				
I-5 Interstate Bridge	Southbound	15,445	21,055	19,865
	Northbound	22,275	28,015	28,190
I-205 Glenn Jackson Bridge	Southbound	17,600	24,665	25,310
	Northbound	27,240	35,590	31,595

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024.

4.3.3.3 Mainline and Ramp Volume Forecasts

After developing the daily forecasts and the peak-period forecasts for the Columbia River bridges, hourly AM and PM forecasts for 2045 were estimated for I-5 ramp volumes for the No-Build Alternative, and the Modified LPA and options. The Metro/RTC regional travel demand model assigns volumes to individual ramps. However, to guard against the potential for the model to over or under assign volume at any given individual ramp, on- and off-ramps were aggregated geographically into four[12] groups and the total 4-hour peak-period volume growth at all on-ramps and the total 4-hour peak-period volume growth at all off-ramps was calculated for each group. The total 4-hour peak-period volume growth was distributed to individual ramps in each group based on the proportion of volume at individual ramps in the future-year model. The purpose of distributing the growth across ramps based on the future-year model volumes is to account for the effects of the future-year land use differences from existing land use. The total 4-hour peak-period volume at each ramp was then distributed across each of the four hours in the AM and PM peak periods to account for

[12] In the Existing and No-Build Alternative, the Hayden Island ramps comprised a fifth group, since the only access to and from the island is via the I-5 ramps. In the Modified LPA, the ramps to and from the south were aggregated with the ramps in North Portland because access to Hayden Island would be provided by the new arterial bridge.

peak spreading compared to the existing volumes. This technique is a standard practice that improves the accuracy of future volume forecasts.

NO-BUILD ALTERNATIVE

Figure 4-1 and Figure 4-2 show the forecast No-Build northbound and southbound peak period I-5 mainline and ramp hourly demand volumes in the freeway analysis area, respectively. Southbound during the AM peak period and northbound during the PM peak period, hourly demand volume crossing the Interstate Bridge would increase between 17% and 30% under the No-Build Alternative compared to existing conditions. Hourly demand volume crossing the Interstate Bridge in the reverse commute[13] period and direction would increase between 34% and 58% compared to existing conditions. Overall, the southbound mainline and ramp travel demand volumes would continue to be highest during the AM peak, and northbound mainline and ramp travel demand volumes would continue to be highest during the PM peak. However, in some locations near downtown Vancouver, such as Mill Plain Boulevard and the SR 14 ramps, there would be more balanced AM/PM peak volumes, with some slightly higher volumes in the reverse direction of the traditional commute. This likely reflects a predicted increase in mixed-use development in Vancouver's downtown and central areas, resulting in more people commuting to jobs in Vancouver, as well as the influence of continued congestion.

[13] The reverse commute refers to traveling in the opposite direction as typical commute traffic. In this case, the reverse commute refers to traveling northbound on I-5 during the AM peak period and traveling southbound on I-5 during the PM peak period.

Figure 4-1. 2045 Forecast Northbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – No-Build Alternative

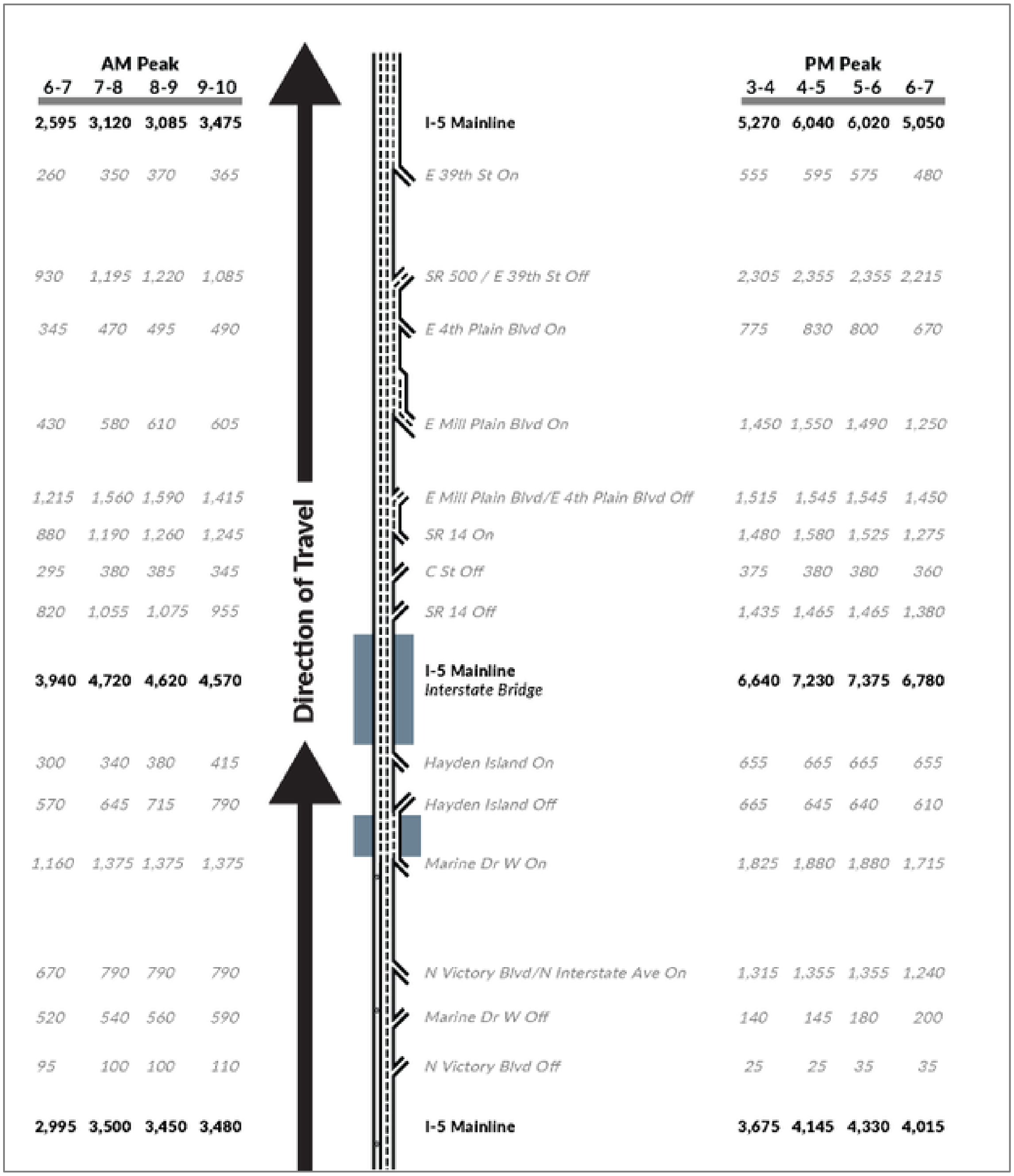


Figure 4-2. 2045 Forecast Southbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – No-Build Alternative

AM Peak 6-7	AM Peak 7-8	AM Peak 8-9	AM Peak 9-10	Location	PM Peak 3-4	PM Peak 4-5	PM Peak 5-6	PM Peak 6-7
3,235	**3,840**	**3,940**	**3,855**	**I-5 Mainline**	**4,160**	**4,325**	**4,550**	**3,505**
395	550	555	520	E 39th St Off	465	505	515	365
2,050	2,160	1,940	1,605	SR 500 / E 39th St On	1,610	1,740	1,740	1,355
595	835	840	790	E 4th Plain Blvd Off	720	775	790	560
860	865	815	685	E 4th Plain Blvd On	515	555	555	430
720	1,005	1,010	950	E Mill Plain Blvd Off	985	1,065	1,085	770
1,455	1,470	1,415	1,190	E Mill Plain Blvd On	1,090	1,180	1,180	915
580	810	815	765	SR 14 Off	1,365	1,475	1,500	1,070
1,530	1,450	1,520	1,630	SR 14 On	1,415	1,530	1,530	1,190
6,840	**6,585**	**6,410**	**5,940**	**I-5 Mainline** *Interstate Bridge*	**5,255**	**5,510**	**5,665**	**4,630**
545	665	675	655	Hayden Island Off	735	765	765	645
745	760	770	770	Hayden Island On	780	675	550	615
2,320	2,405	2,125	1,820	Marine Dr W Off	1,615	1,600	1,455	1,045
365	380	320	295	Marine Dr W On	210	180	150	165
1,390	1,380	1,140	1,000	N Victory Blvd/N Interstate Ave Off	680	675	615	440
95	95	80	75	N Victory Blvd On	340	290	245	270
3,790	**3,370**	**3,640**	**3,605**	**I-5 Mainline**	**3,555**	**3,615**	**3,775**	**3,550**

Direction of Travel

MODIFIED LPA

Figure 4-3 and Figure 4-4 show the forecast Modified LPA peak-period mainline and ramp demand volumes in the freeway analysis area on I-5 northbound and southbound, respectively. Similar to the 2045 No-Build Alternative, the southbound mainline and ramp volumes would be highest during the AM peak period and northbound mainline and ramp volumes would be highest during the PM peak period, although some locations would see higher mainline or ramp volumes in the reverse commute direction. Ramps that have the highest proportion of vehicle demand relative to other ramps in the No-Build Alternative would continue to have the highest proportion of vehicle demand relative to other ramps in the Modified LPA.

Hourly traffic volumes crossing the I-5 and I-205 Columbia River bridges in the peak period and peak direction (southbound during the AM peak period and northbound during the PM peak period) would be up to 10% higher in the Modified LPA and options compared to the No-Build Alternative. Hourly traffic volumes crossing the bridges in the reverse commute direction (northbound during the AM peak period and southbound during the PM peak period) would be between 4% and 6% lower in the Modified LPA and options compared to the No-Build Alternative. The reason that the number of vehicles crossing the bridges would increase during the peak period in the peak direction and decrease in the off-peak direction is the cost of variable-rate tolls and the congestion levels on both river crossings. In the No-Build Alternative, congestion in the peak period and peak direction would continue to limit the traffic volumes on the Interstate Bridge.

Under the Modified LPA, the regional travel demand model results reflect the additional person-moving capacity offered by the IBR Program for transit and the improvements in traffic operations from the addition of an auxiliary lane in each direction. Tolling is predicted to reduce the daily volume demand crossing the river on the I-5 corridor, but the forecasts still assume growth in commute trips during peak periods in the peak direction because these trips are less affected by tolls than during periods with more discretionary trips. The result would be an increase in vehicle volume demand during the peak periods in the peak direction even though daily volume demand crossing the river on the I-5 corridor is decreasing.

Figure 4-3. 2045 Forecast Northbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – Modified LPA

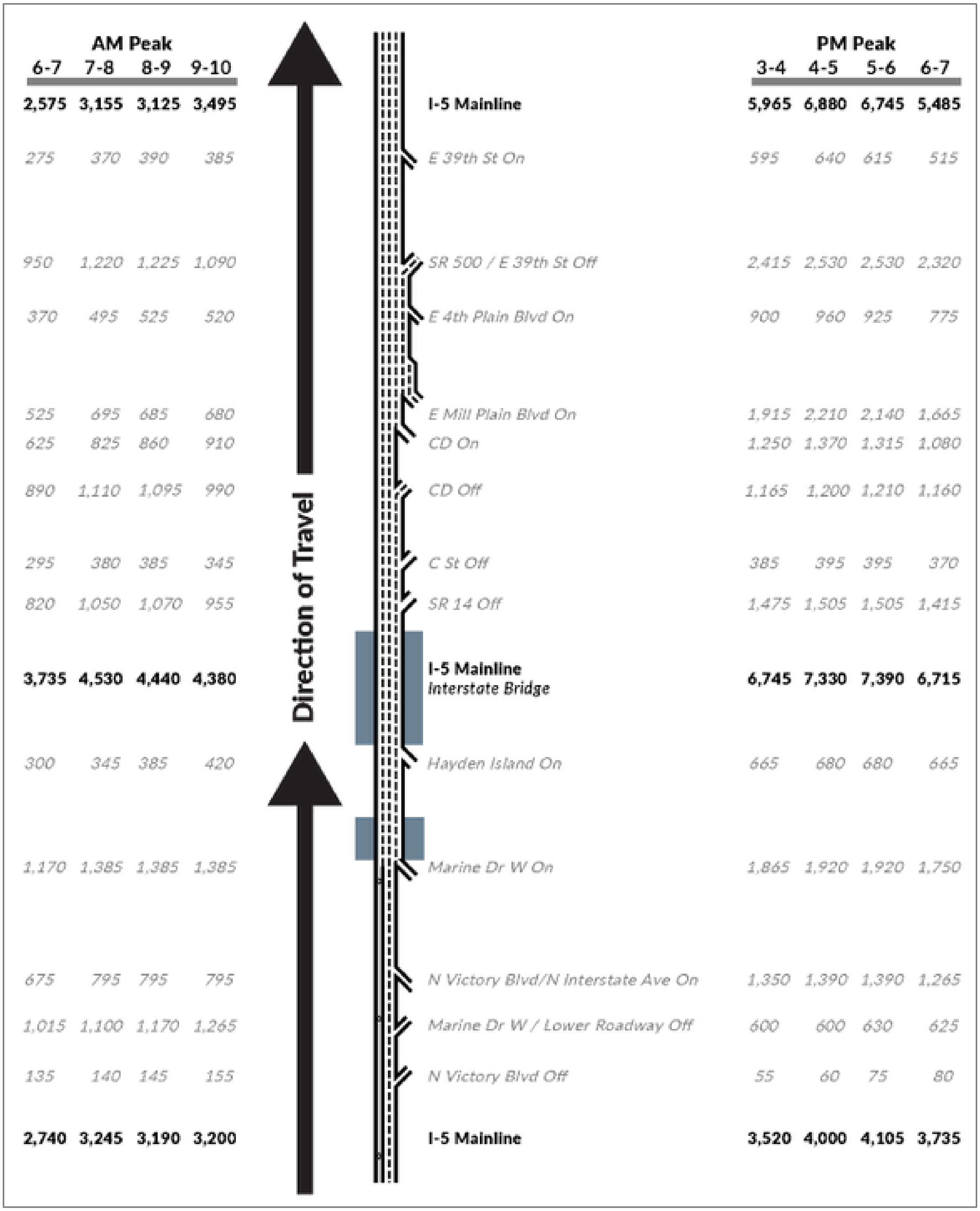
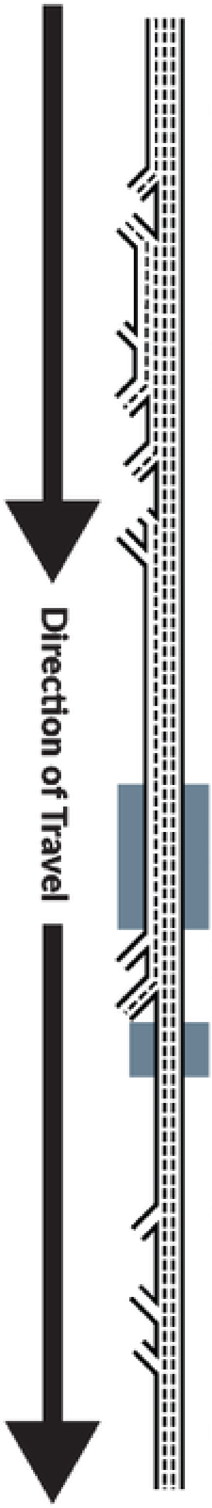


Figure 4-4. 2045 Forecast Southbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – Modified LPA

	AM Peak 6-7	AM Peak 7-8	AM Peak 8-9	AM Peak 9-10	PM Peak 3-4	PM Peak 4-5	PM Peak 5-6	PM Peak 6-7
I-5 Mainline	**4,375**	**4,850**	**4,930**	**4,765**	**4,140**	**4,305**	**4,540**	**3,500**
E 39th St / E 4th Plain Blvd Off	1,045	1,460	1,565	1,435	1,220	1,315	1,340	955
SR 500 / E 39th St On	2,180	2,280	2,065	1,780	1,605	1,745	1,745	1,350
E 4th Plain Blvd On	890	905	830	700	510	550	550	425
E Mill Plain Blvd Off	1,370	1,795	1,615	1,475	1,120	1,230	1,250	880
CD Off	585	805	870	810	1,140	1,220	1,250	900
CD On	1,365	1,315	1,185	1,005	765	820	825	675
SR 14 On	1,685	1,715	1,595	1,355	1,405	1,520	1,520	1,180
I-5 Mainline *Interstate Bridge*	**7,495**	**7,005**	**6,555**	**5,885**	**4,945**	**5,175**	**5,340**	**4,395**
Hayden Island Off	560	670	685	665	725	755	755	640
Marine Dr W Off	2,360	2,445	2,160	1,850	1,595	1,585	1,440	1,030
N Victory Blvd/N Interstate Ave Off	1,340	1,390	1,230	1,050	675	670	610	435
Marine Dr W / Lower Roadway On	935	950	895	885	785	690	575	630
N Victory Blvd On	100	105	90	80	355	320	290	300
I-5 Mainline	**4,270**	**3,555**	**3,465**	**3,285**	**3,090**	**3,175**	**3,400**	**3,220**



MODIFIED LPA WITHOUT C STREET RAMPS

The peak period ramp forecasts for the Modified LPA without C Street ramps are the same as for the Modified LPA, except that all volume forecast to use the C Street ramps was reassigned to the Mill Plain Boulevard ramps. Figure 4-5 and Figure 4-6 show the forecast northbound volumes for the Modified LPA and for the option without C Street ramps, respectively, and Figure 4-7 and Figure 4-8 show the forecast southbound volumes for the Modified LPA and the option without C Street ramps, respectively. Volumes are only shown between the Mill Plain interchange and the Columbia River bridges. All other ramp volumes in the corridor would be the same between the Modified LPA and the option without C Street ramps. The ramp demand volumes that change with the removal of the C Street ramps are highlighted in the figures.

The Modified LPA without C Street ramps would shift additional demand volume to the Mill Plain interchange compared to the Modified LPA, which is accessed through the CD roadway between the Mill Plain and SR 14 interchanges. In the northbound direction, approximately 300 to 400 vph would shift to the CD roadway and Mill Plain off-ramp during the AM peak period, and just under 400 vph would shift to the CD roadway and Mill Plain off-ramp during the PM peak period. In the southbound direction, approximately 350 to 450 vph would shift to the CD roadway and Mill Plain on-ramp during the AM peak period, and approximately 450 to 600 vph would shift to the CD roadway and Mill Plain on-ramp during the PM peak period. The removal of the C Street ramps would increase the volume on the CD roadways approximately 15% to 25% and would increase the demand volume at the Mill Plain interchange ramps between 30% and 50%.

MODIFIED LPA WITH TWO AUXILIARY LANES

The Modified LPA with two auxiliary lanes would have the same peak-period mainline and ramp volumes as the Modified LPA, which are summarized in Figure 4-3 and Figure 4-4 for northbound and southbound I-5, respectively.

Figure 4-5. 2045 Forecast Northbound Peak-Period Mainline and Ramp Volumes (vehicles per hour) – Modified LPA

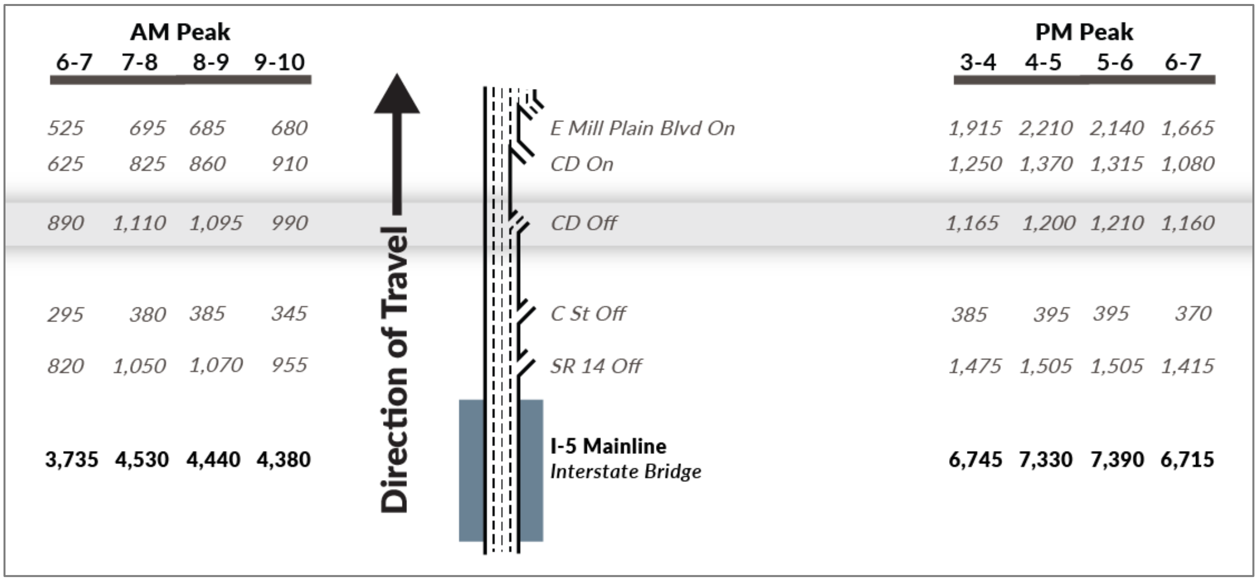


Figure 4-6. 2045 Forecast Northbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – Modified LPA Without C Street Ramps

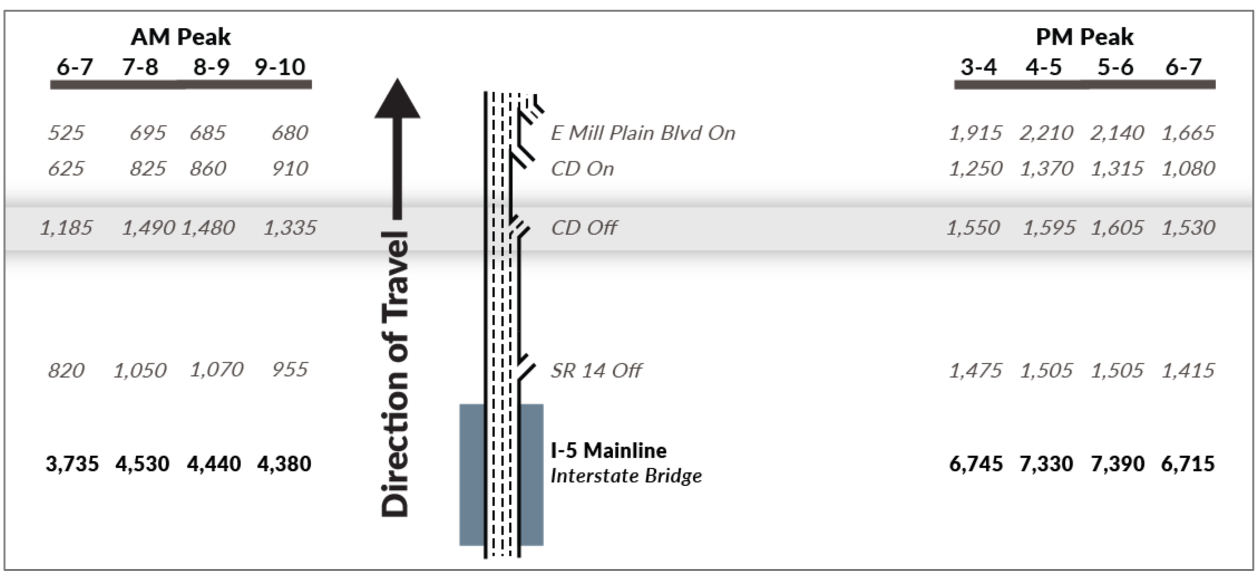


Figure 4-7. 2045 Forecast Southbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – Modified LPA

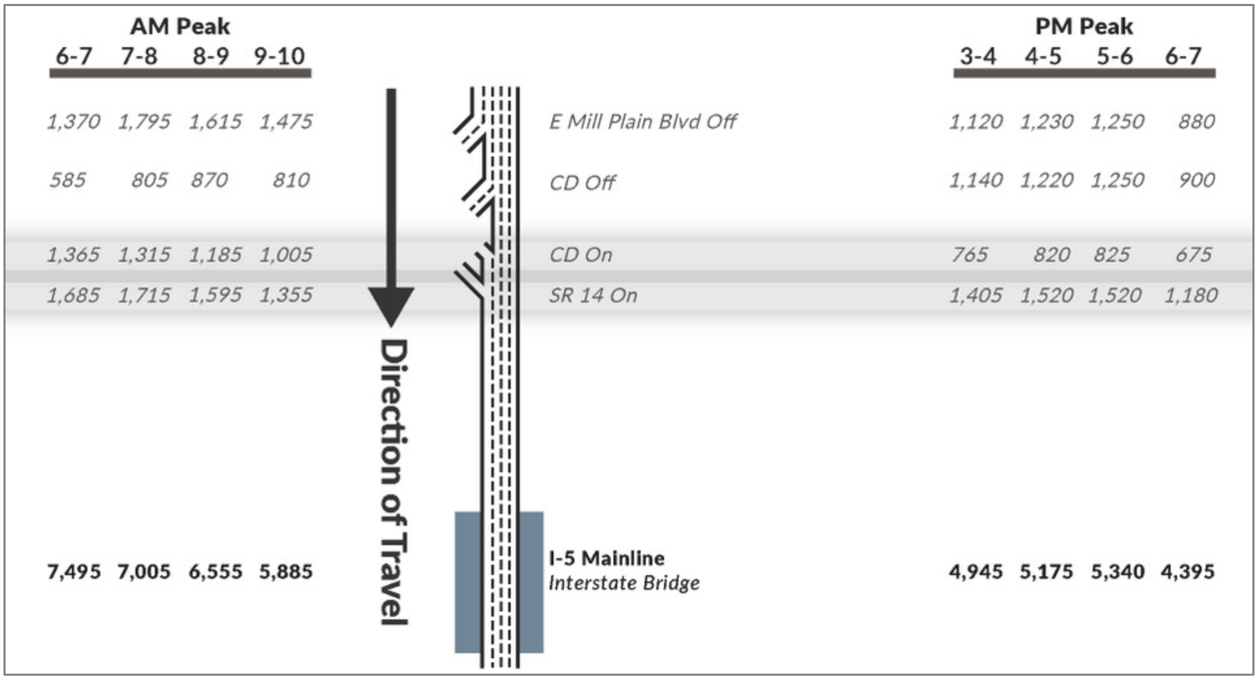
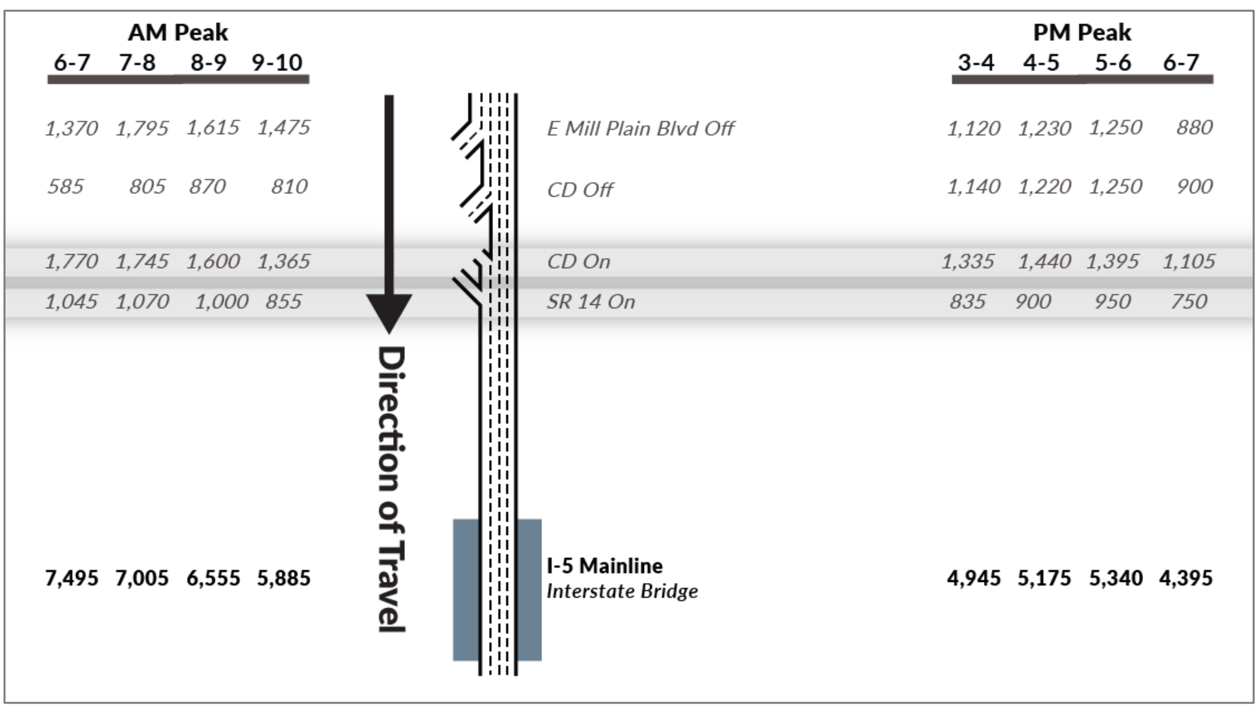


Figure 4-8. 2045 Forecast Southbound Peak-Period Mainline and Ramp Volumes (Vehicles per Hour) – Modified LPA Without C Street Ramps



4.3.3.4 Daily Person Throughput

Person throughput is a concept developed to understand the number of people (as opposed to the number of vehicles) that a transportation facility can serve within a given time frame. The number of vehicles (passenger cars and freight trucks) crossing the Interstate Bridge was multiplied by AVO assumptions to calculate total person throughput in vehicles. For all vehicle modes, the same AVO used to calculate existing year 2019 daily person throughput was applied to future-year vehicle volumes. The number of people crossing the bridge in transit (buses and light-rail) and in active transportation is included in the total number of people crossing the bridge to calculate future-year 2045 daily person throughput for the No-Build Alternative and the Modified LPA and options. Table 4-7 shows the daily person throughput across the I-5 Columbia River bridges by mode for 2019 Existing Conditions and the 2045 No-Build and Modified LPA Alternatives. The Modified LPA options would have the same person throughput as the Modified LPA.

Table 4-7. Daily Person Throughput on the I-5 Columbia River Bridges by Mode (Both Directions)

	2019 Existing Conditions	2045 No-Build Alternative	2045 Modified LPA and Options
Total Person Throughput	185,400	241,900	251,100
Passenger Cars	165,200	196,600	191,200
Freight Trucks	16,000	30,100	29,200
Transit (Bus and Light-Rail)	3,800	14,800	29,100
Active Transportation	400	400	1,600

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

Daily person throughput across the I-5 Interstate Bridge is forecast to increase by 30.5% with the 2045 No-Build Alternative compared to the 2019 Existing Conditions. The person throughput with the Modified LPA and options is forecast to increase an additional 3.8% compared to the No-Build Alternative. The increase in daily person throughput with the Modified LPA and options compared to the No-Build Alternative would be due to the increase in transit and active transportation and variable-rate tolling. The increase in the number of people crossing the Columbia River bridges in transit and active transportation modes is greater than the decrease in the number of people crossing the Columbia River bridges in vehicles.

4.3.4 Freeway Operations

Similar to the 2019 existing conditions analysis, the 2045 freeway operations for I-5 within the freeway analysis area were evaluated using VISSIM microsimulation models. Future-year 2045 forecast operations were analyzed during the 4-hour AM and PM peak periods only. While congestion outside of the 4-hour peaks is described by empirical data in the 2019 existing conditions, congestion occurring outside of the 4-hour AM and PM peak periods in the 2045 forecast operations analysis was estimated based on congestion levels at the beginning and end of the modeled 4-hour peak periods and the demand volume outside of the modeled 4-hour peak periods.

The freeway operations analysis includes peak period congestion estimates, peak period speeds, peak period travel times, LOS and V/C ratios, and peak period on-ramp service volumes.

4.3.4.1 Bottlenecks and Speeds

This section describes the results of the modeled 4-hour AM and PM peak period traffic analysis and the estimated speeds occurring outside of the modeled peak periods. Detailed information about bottlenecks and speeds with the No-Build Alternative, the Modified LPA (with and without C Street ramps), and the Modified LPA with two auxiliary lanes is provided in the sections below.

I-5 was evaluated for traffic performance within the freeway analysis area based on modeled average vehicle speeds during the 4-hour peak periods and estimated speeds during midday. Model outputs were summarized in 15-minute increments for both the 4-hour AM and PM peaks to identify the location, duration, and intensity of congestion. Midday travel speeds were estimated based on congestion levels at the beginning and ends of the modeled peak periods and the volume levels through the midday period. Travel speed “heat maps” were generated to show average vehicle speeds across set segments along the I-5 corridor between 5 a.m. and 9 p.m. Heat maps show speeds at different locations along the y-axis and how those speeds change across the time of day along the x-axis. On the heat maps, different colors represent different speeds, summarized by location. Dark red represents 0 to 15 mph, red 15 to 25 mph, orange 25 to 35 mph, yellow 35 to 45 mph, light green 45 to 55 mph, and dark green greater than 55 mph. The hours of congestion with speeds below 45 mph are summarized below at all bottlenecks.

NO-BUILD ALTERNATIVE

In the southbound direction, the Interstate Bridge would be congested during both 4-hour AM and PM peak periods under the No-Build Alternative. This congestion at the bridge is caused by the structure’s limited capacity, limited sight distance, substandard shoulders, short merge and diverge locations north and south of the bridge, high-volume on- and off-ramp flows north of the river, and high truck volumes. Based on congestion levels during the modeled 4-hour AM and PM peak periods and estimated demand volumes throughout the rest of the day, it is estimated that the 2045 Interstate Bridge southbound congestion would occur during the midday and into the PM peak period, with congestion lasting from 5 a.m. until 9 p.m. (16 hours). This is an increase of 13 hours from the 3 hours of southbound congestion that occurs under 2019 existing conditions. During the AM peak period and midday period, congestion from the Interstate Bridge would extend north from the bridge beyond the I-5/I-205 interchange north of Vancouver.

A second southbound bottleneck influencing the IBR Program Area exists south of the IBR Program Area near the I-5/I-405 split in North Portland. Under the No-Build Alternative, congestion from this bottleneck would back up northward across the Interstate Bridge and into the Interstate Bridge congestion during the AM peak period. This congestion from the I-5/I-405 split in North Portland would last for 8 hours, from 5 a.m. to 1 p.m. The congestion is caused primarily by capacity restrictions near the I-5/I-405 split in North Portland and heavy merging, diverging, and weaving flows at adjacent ramps. The third existing southbound I-5 bottleneck in the freeway analysis area, located near the Rose Quarter, would improve under the No-Build Alternative as a result of the I-5 Rose Quarter Improvement project (see Section 4.3.1, Freeway Analysis Area). This area would no longer have congestion during the AM peak period. Although it would still be a minor bottleneck during the PM peak period, congestion would not back up and interact with the bottlenecks farther north.

In the northbound direction under the No-Build Alternative, the Interstate Bridge bottleneck would remain the primary bottleneck and would be congested for most of the 4-hour AM peak period and all of the 4-hour PM peak period. The northbound congestion on the bridge is caused by similar factors as the southbound congestion including limited bridge capacity, limited sight distance, substandard shoulders, short merge and diverge locations north and south of the bridge high-volume merging, diverging, and weaving flows of traffic in the IBR Program Area, and high freight volumes. Based on congestion levels during the modeled 4-hour AM and PM peak periods and estimated demand volumes throughout the rest of the day, it is estimated that the 2045 Interstate Bridge northbound congestion would occur most of the day, with congestion lasting from 7 a.m. until 9 p.m. (14 hours). This is an increase of 5.25 hours over the 8.75 hours of congestion that exist in 2019. Congestion from the Interstate Bridge would extend south of the IBR Program Area beyond the Marquam Bridge and combine with other northbound I-5 bottlenecks near downtown Portland.

MODIFIED LPA

In the southbound direction, the bottleneck at the Columbia River bridges would improve under the Modified LPA compared to the No-Build Alternative, improving southbound traffic flow at the Columbia River bridges. During the PM peak period, no southbound congestion is forecast to occur in the Modified LPA representing substantially improved operating conditions compared with the No-Build Alternative. However, during the AM peak period, the downstream bottleneck near the I-5/I-405 split in North Portland would still exist, and the improved flow at the Columbia River bridges would increase the duration and extent of congestion at the downstream I-5/I-405 bottleneck in North Portland compared to the No-Build Alternative. Southbound congestion from the I-5/I-405 bottleneck in North Portland during the AM peak period would extend as far north as the CD system in Vancouver between Mill Plain Boulevard and SR 14. This would cause or contribute to congestion at the CD roadway that would impact traffic flows on I-5 southbound lasting for approximately 6 hours during the AM peak period north of the CD. While traffic congestion on southbound I-5 through North Portland is worse with the Modified LPA compared to the No-Build Alternative, the traffic volume demand forecasts are similar between the Modified LPA and the No-Build Alternative south of the IBR Program Area, and the Modified LPA would provide multimodal choices for users to avoid the downstream bottleneck near the I-5/I-405 split in North Portland via enhanced high-capacity transit, express bus options, and active transportation improvements connecting to the current active transportation system through North Portland.

In the northbound direction, the bottleneck at the Columbia River bridges would be reduced with the Modified LPA compared to the No-Build Alternative, improving northbound traffic flow at the bridges. However, the Columbia River bridges would still be a bottleneck for northbound traffic for 9 hours with congestion forecast to occur between the Columbia River bridges and the I-5/I-405 split in North Portland with the Modified LPA. No northbound congestion is forecast during the AM peak period at the Columbia River bridges with the Modified LPA representing improved operating conditions compared with the No-Build Alternative.

MODIFIED LPA WITHOUT C STREET RAMPS

Under the Modified LPA without C Street ramps, congestion would be the same as the Modified LPA except for the southbound congestion at the CD system in Vancouver. The congestion would still exist, but the removal of the C Street ramps would result in higher volumes at the Mill Plain on-ramp to southbound I-5, and thus higher demand volumes through the southbound CD system. The higher demand through the southbound CD would cause the congestion at the CD off-ramp to extend farther north (4.5 miles compared to 4 miles) than under the Modified LPA.

MODIFIED LPA WITH TWO AUXILIARY LANES

Under the Modified LPA with two auxiliary lanes, congestion patterns would be similar to the Modified LPA for the southbound direction, with congestion from the downstream bottleneck near the I-5/I-405 split in North Portland extending back to the new CD roadway in the IBR Program Area, and congestion from the CD roadway impacting traffic flows on I-5. However, the additional auxiliary lane would improve operations at the on- and off-ramps in the IBR Program Area, reducing the congestion spilling back from the CD roadway. With the Modified LPA with two auxiliary lanes, congestion from the CD roadway would last for 4 hours (compared to 6 hours with the Modified LPA) and would extend for only 1.5 miles (compared to 4 miles with the Modified LPA). Under the Modified LPA with two auxiliary lanes, congestion would be substantially reduced in the northbound direction compared to the Modified LPA. The northbound congestion would be reduced to 6 hours and extend back to less than 0.75 miles to Hayden Island compared to 9 hours of congestion that would spill back approximately 5 miles to the I-5/I-405 split in North Portland in the Modified LPA.

BOTTLENECKS AND SPEED SUMMARY

Figure 4-9 through Figure 4-16 illustrate the average travel speeds across the freeway analysis area in the No-Build Alternative, the Modified LPA with and without C Street ramps, and the Modified LPA with two auxiliary lanes.

Figure 4-9. Forecast 2045 Weekday Southbound Speeds (5 a.m. to 9 p.m.) – No-Build Alternative

Figure 4-10. Forecast 2045 Weekday Southbound Speeds (5 a.m. to 9 p.m.) – Modified LPA

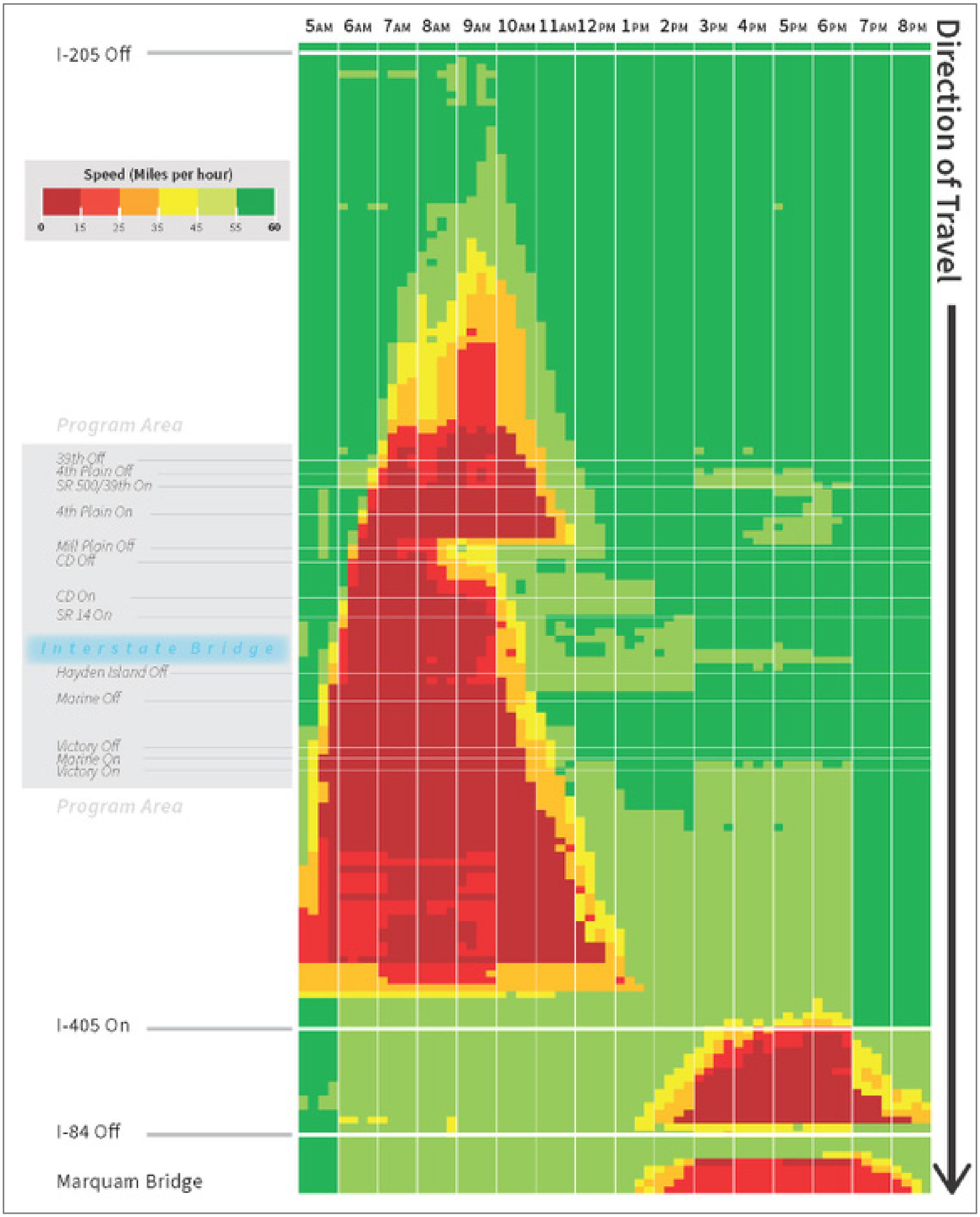


Figure 4-11. Forecast 2045 Weekday Southbound Speeds (5 a.m. to 9 p.m.) – Modified LPA Without C Street Ramps

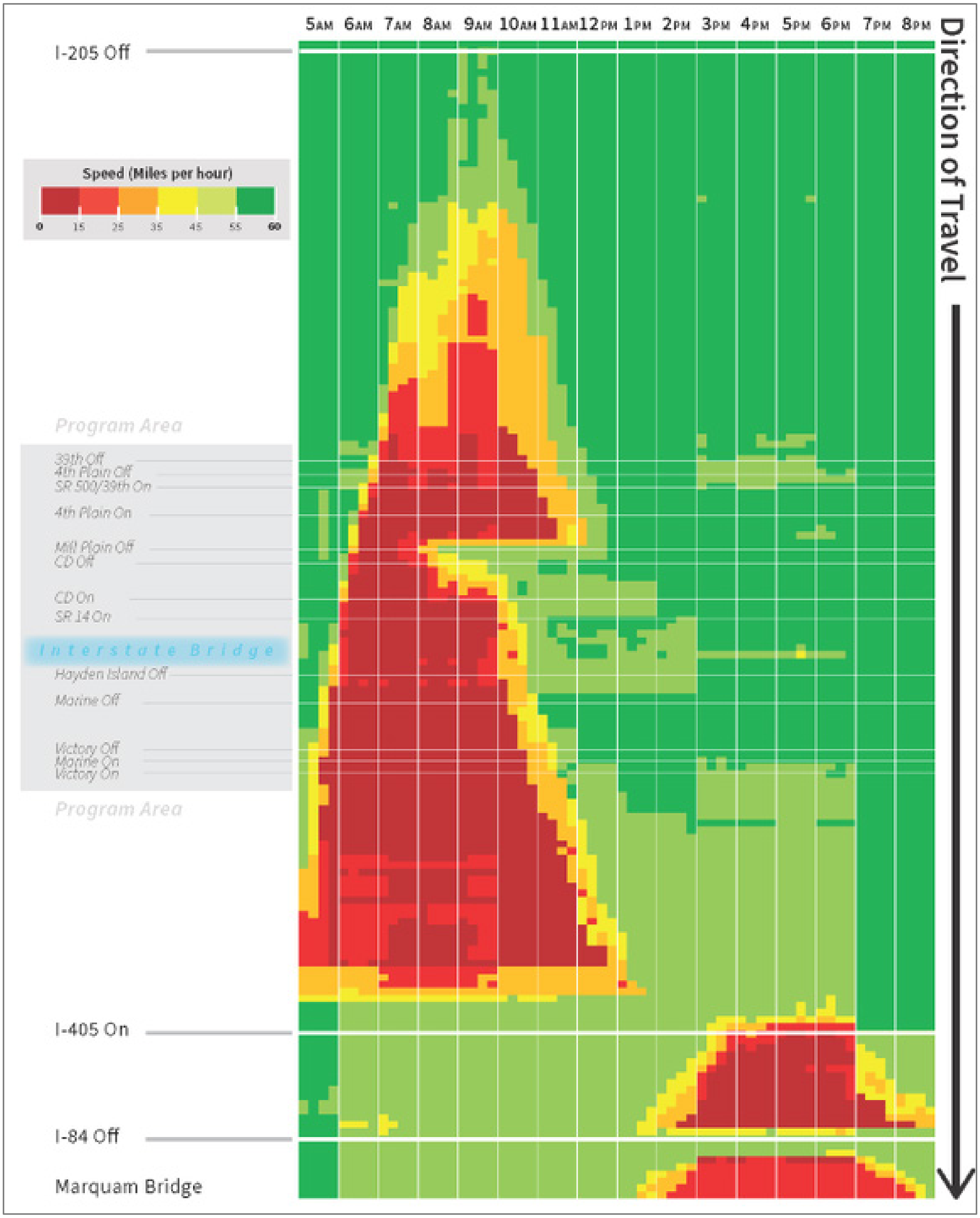


Figure 4-12. Forecast 2045 Weekday Southbound Speeds (5 a.m. to 9 p.m.) – Modified LPA with Two Auxiliary Lanes

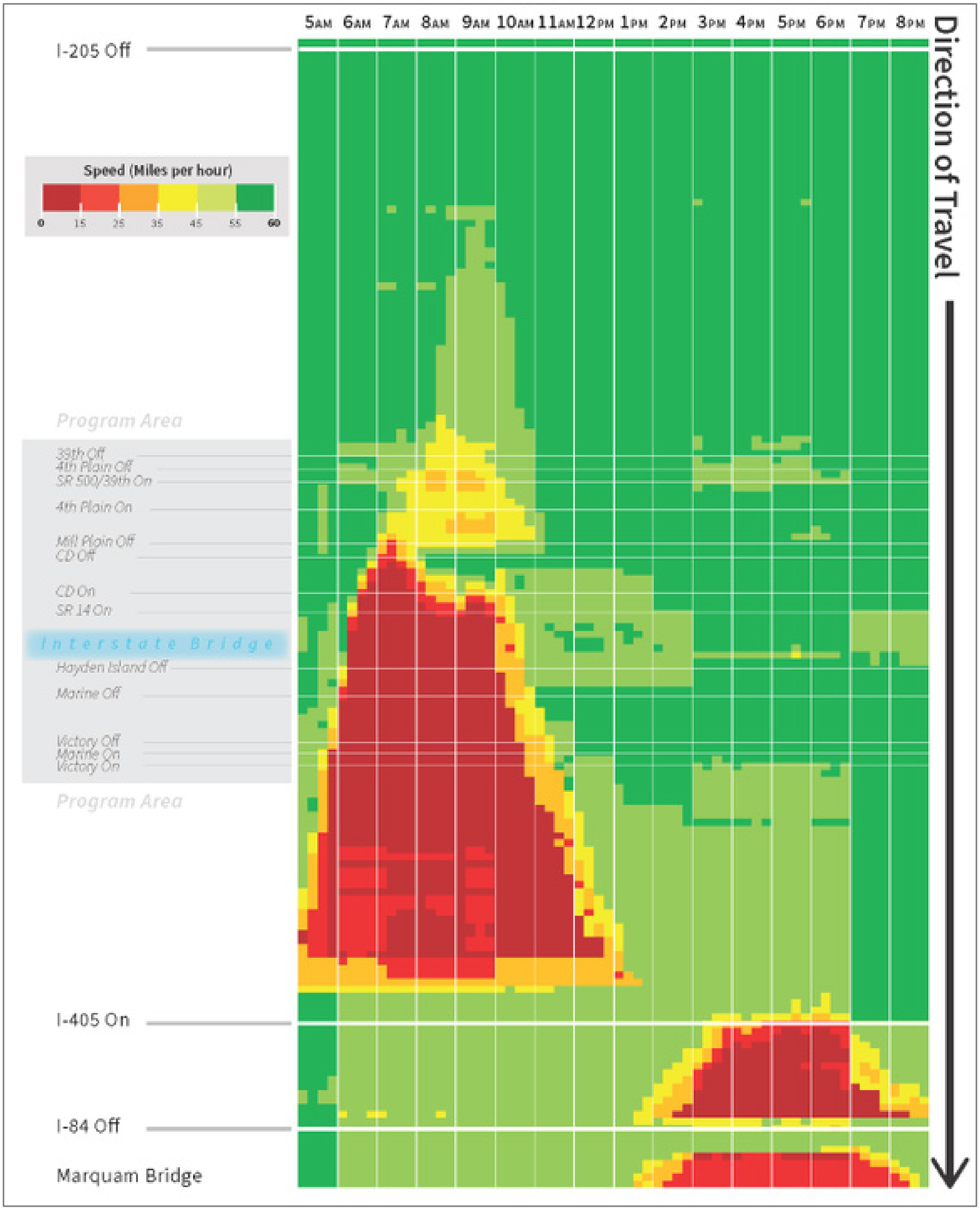


Figure 4-13. Forecast 2045 Weekday Northbound Speeds (5 a.m. to 9 p.m.) – No-Build Alternative

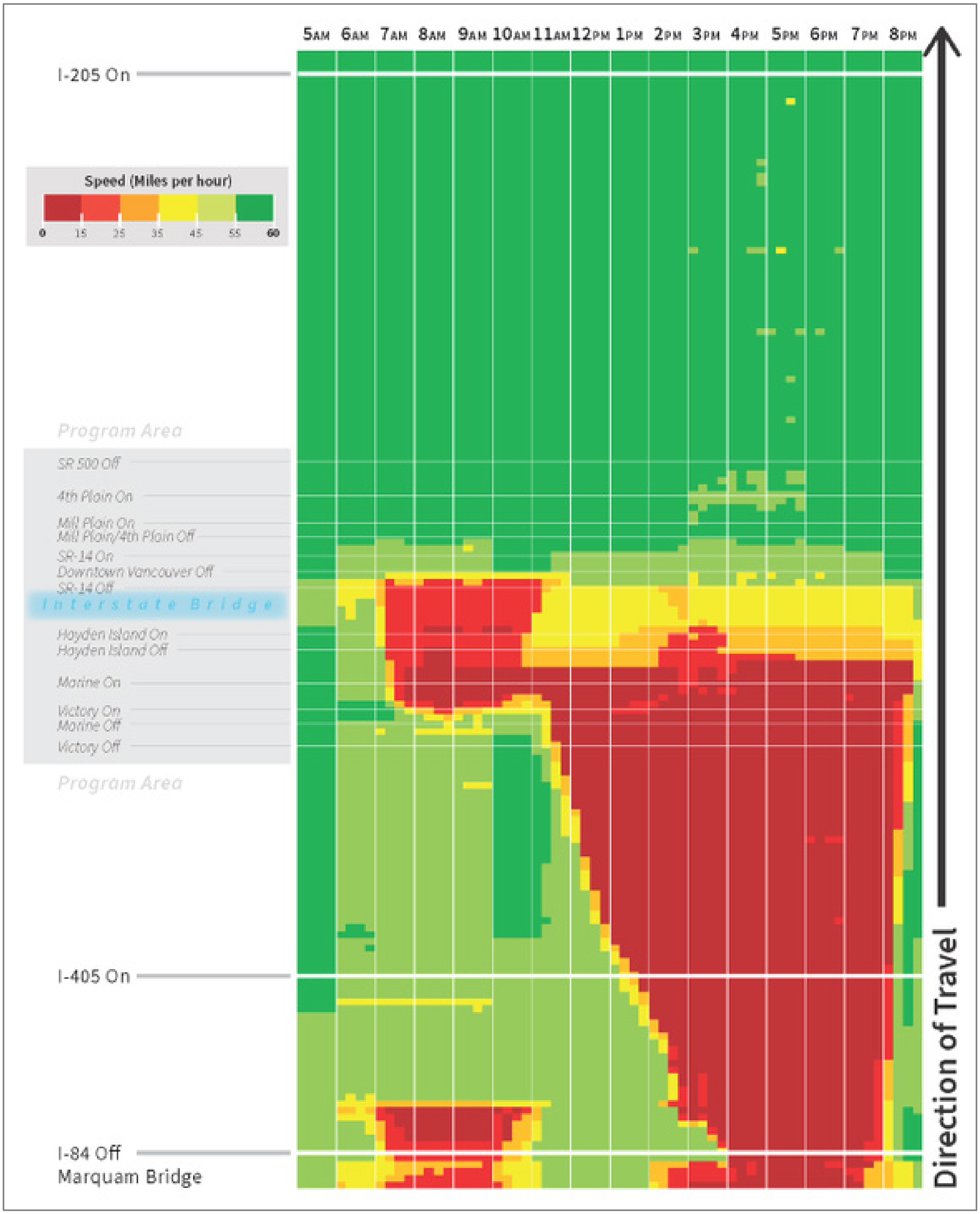


Figure 4-14. Forecast 2045 Weekday Northbound Speeds (5 a.m. to 9 p.m.) – Modified LPA

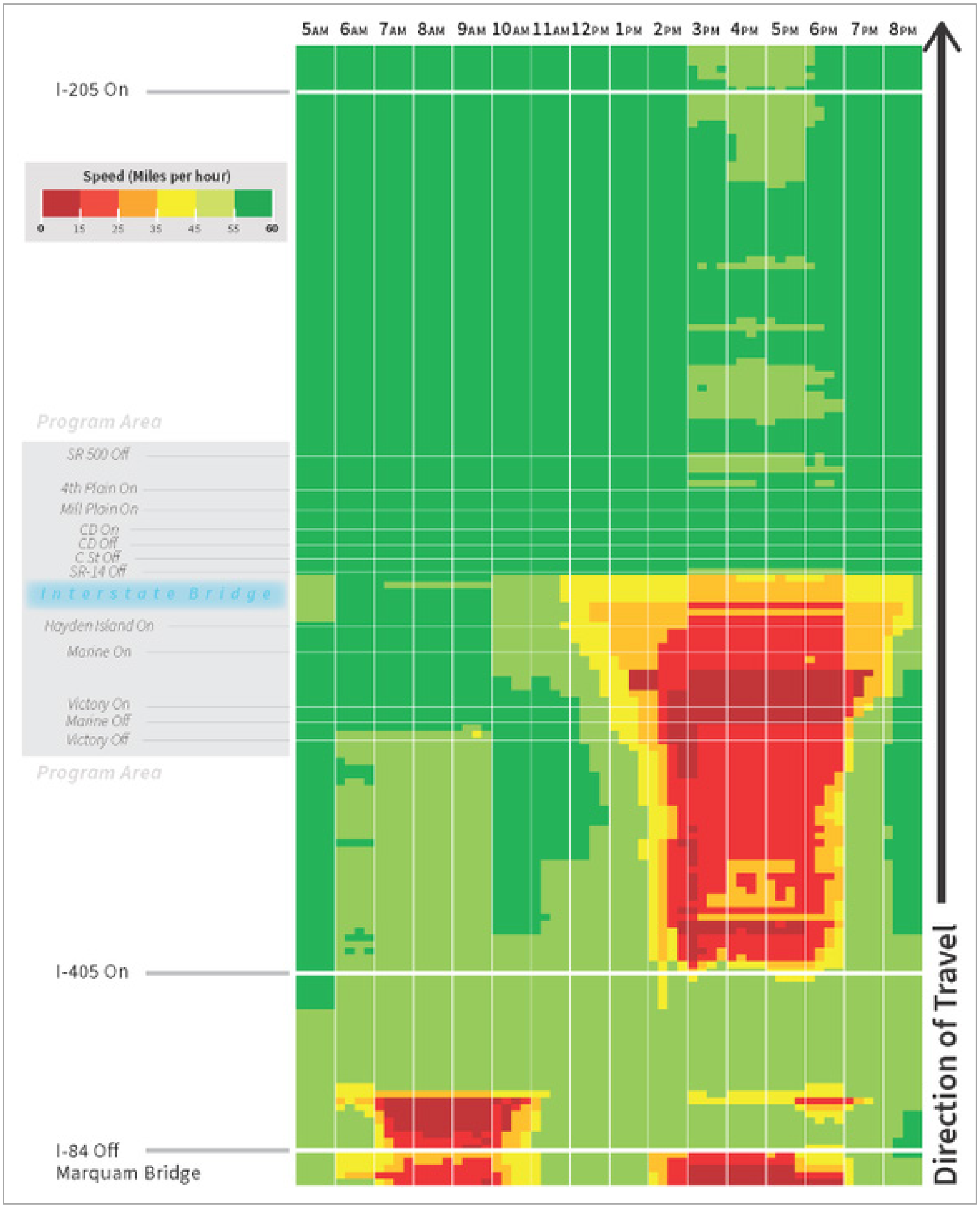


Figure 4-15. Forecast 2045 Weekday Northbound Speeds (5 a.m. to 9 p.m.) – Modified LPA Without C Street Ramps

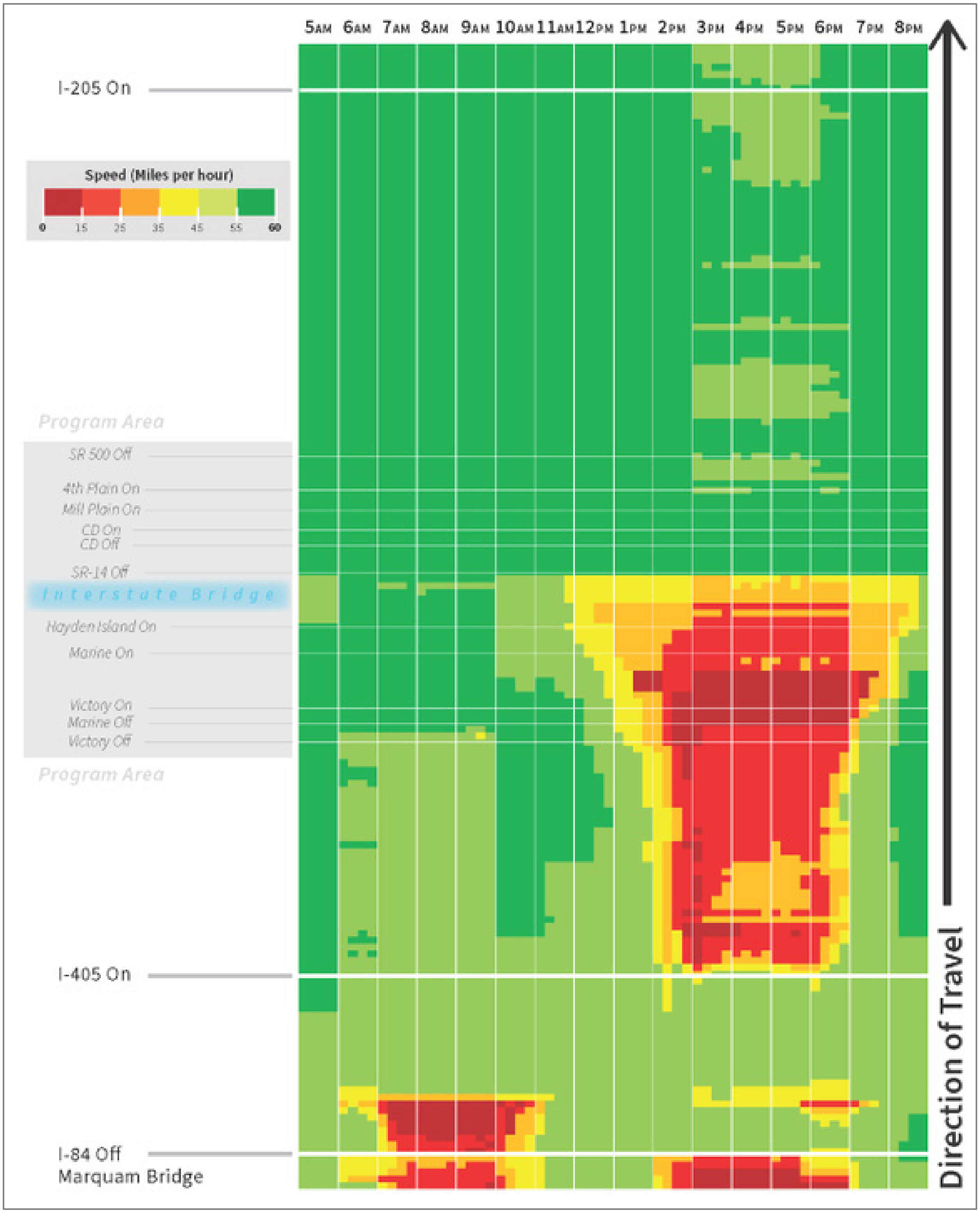
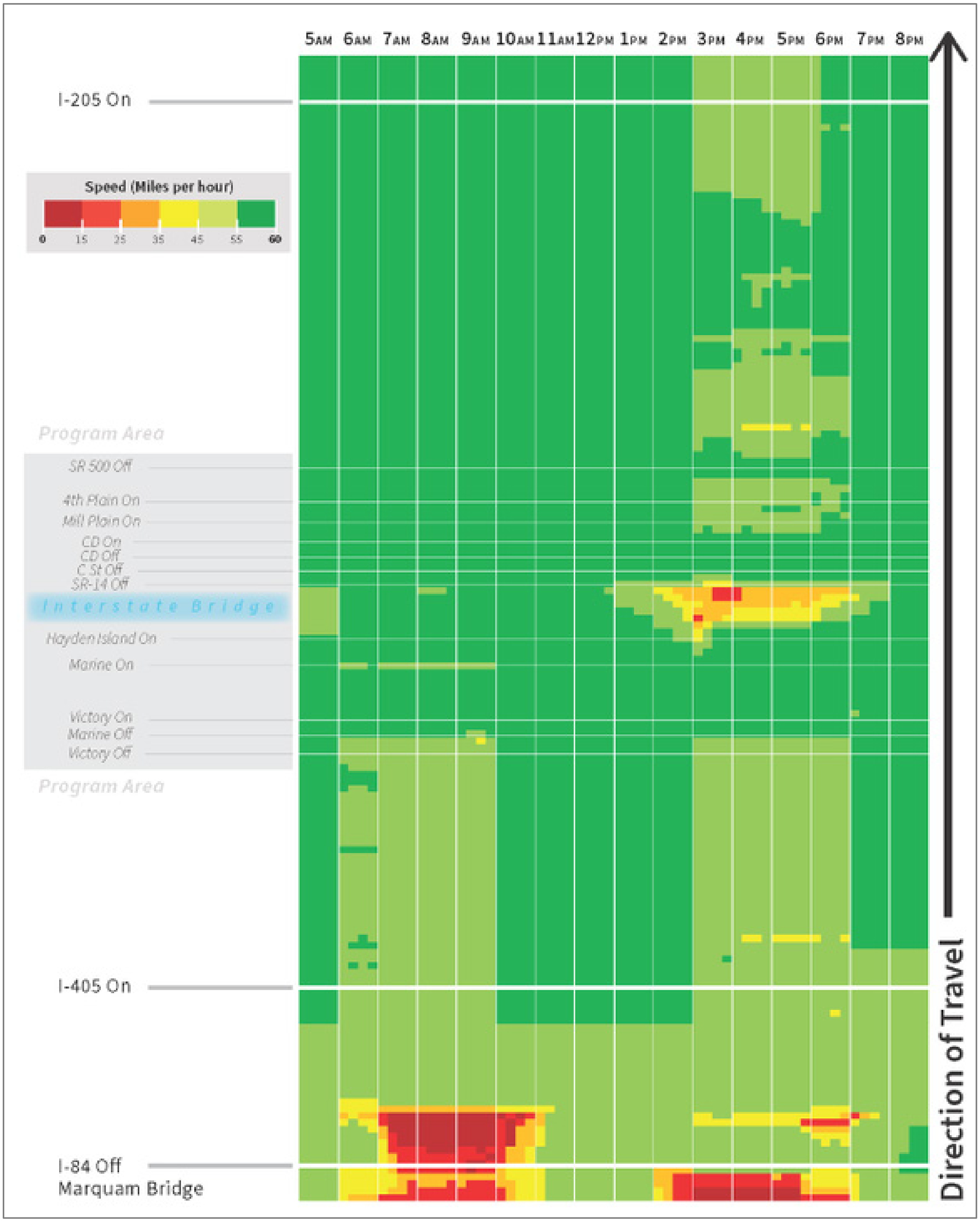


Figure 4-16. Forecast 2045 Weekday Northbound Speeds (5 a.m. to 9 p.m.) – Modified LPA with Two Auxiliary Lanes



Key information about forecast bottlenecks—including the location, time of day, duration, and extents of the congestion when speeds are below 45 mph—are summarized in Table 4-8 for the No-Build Alternative, the Modified LPA with and without C Street ramps, and the Modified LPA with two auxiliary lanes. The extents shown in Table 4-8 reflect the maximum extents of the congestion over the 16 hours. As shown in the heat map figures, once congestion starts at a bottleneck, it builds over time and then later dissipates as traffic demand volumes begin decreasing after peak periods.

Table 4-8. Future-Year 2045 Average Weekday Bottleneck Summary when Speeds are below 45 mph

	No-Build			Modified LPA			Modified LPA Without C Street Ramps			Modified LPA with Two Auxiliary Lanes		
	Time of Day	Duration (hours)	Extent (miles)	Time of Day	Duration (hours)	Extent (miles)	Time of Day	Duration (hours)	Extent (miles)	Time of Day	Duration (hours)	Extent (miles)
Southbound Mill Plain/SR 14 CD	N/A	N/A	N/A	6 AM – 12 PM	6	4	6 AM– 12 PM	6	4.5	7–11 AM	4	1.5
Southbound Interstate Bridge	5 AM– 9 PM	16	8+	6–10:45 AM	4.75	4.5	6–10:45 AM	4.75	4.5	6:15– 10:45 AM	4.5	1
Southbound I-5/I-405 Split in North Portland	5 AM– 1 PM	8	5	5 AM – 1:30 PM	8.5	6	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.
Southbound Rose Quarter	1:30– 9 PM	7.5	1	Same as No-Build.	Same as No-Build.	Same as No-Build.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.
Northbound Interstate Bridge	7 AM– 9 PM	14	10+	12 PM– 9 PM	9	5	Same as Modified LPA.	Same as Modified LPA.	Same as Modified LPA.	1:30–7:30 PM	6	0.75

Source: IBR Analysis

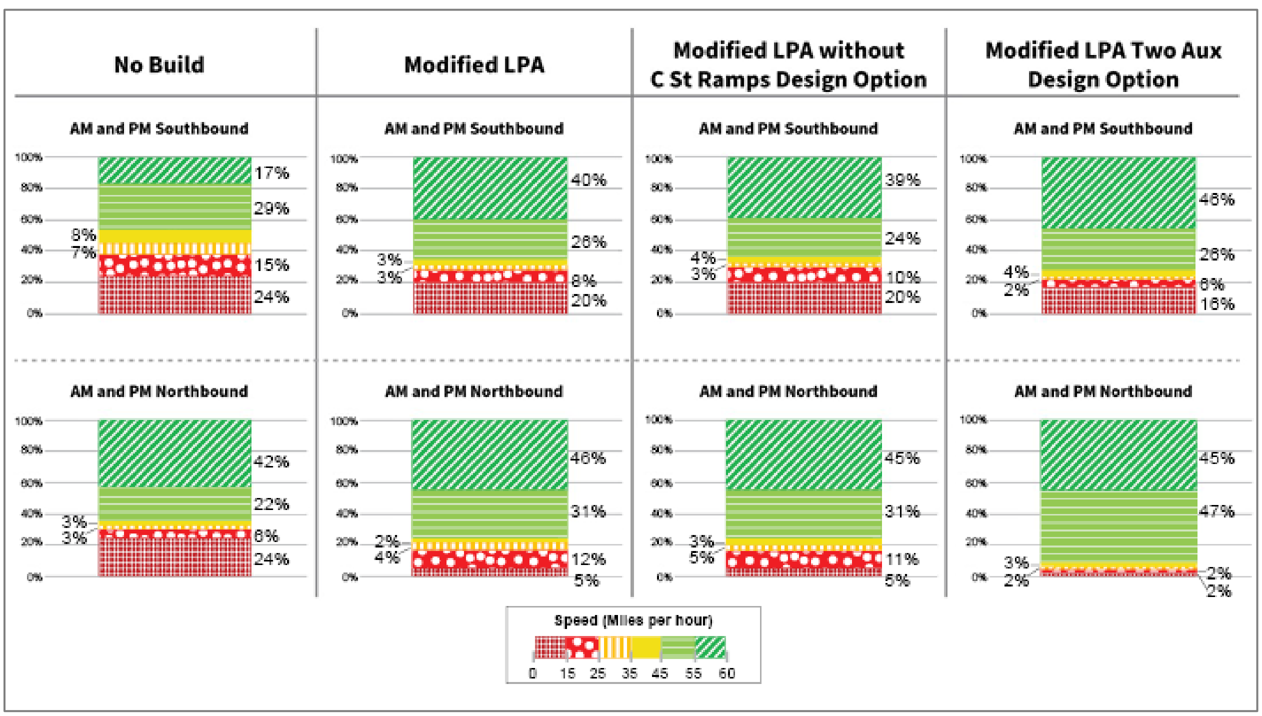
N/A = not applicable

4.3.4.2 Congestion Index

Congestion indices that provide an aggregated level of congestion in the freeway analysis area during the 8 peak hours including the 4-hour AM peak (6 to 10 a.m.) and the 4-hour PM peak period (3 to 8 p.m.) were developed. The intent of the congestion index is to provide a simple, one-dimensional comparison of the level of congestion within the freeway analysis area. While the heat maps above indicate when congestion occurs and what portions of I-5 are congested during various times, the congestion indices measure the proportion of time that any given section of I-5 in the freeway analysis area is operating at a particular speed. This allows for a simple comparison between alternatives.

In the No-Build Alternative, I-5 southbound operates with speeds below 45 mph 54% of the time, and I-5 northbound operates with speeds below 45 mph 36% of the time. Overall speed and congestion levels are improved compared to the No-Build Alternative with the Modified LPA, where I-5 southbound is operating with speeds below 45 mph approximately 34% of the time and I-5 northbound is operating with speeds below 45 mph approximately 23% of the time. The Modified LPA without C Street ramps operates with congestion levels similar to the Modified LPA, with southbound speeds below 45 mph 37% of the time and northbound speeds below 45 mph 24% of the time. The Modified LPA with two auxiliary lanes reduces congestion levels substantially on I-5 compared to the Modified LPA, with southbound operating at speeds below 45 mph 28% of the time and northbound operating at speeds below 45 mph 9% of the time. Figure 4-17 displays the congestion indices for the No-Build Alternative, the Modified LPA with and without C Street ramps, and the Modified LPA with two auxiliary lanes.

Figure 4-17. Forecast I-5 2045 Peak-Period Congestion Index



4.3.4.3 Peak-Period Travel Times

SOUTHBOUND TRAVEL TIMES

In 2045, the longest travel time for southbound I-5 traffic for the No-Build Alternative and the Modified LPA and options would be during the AM peak period. Under the No-Build Alternative, total I-5 travel times during the modeled 4-hour AM peak period between I-205 and I-405 in North Portland would range between 27 and 79 minutes. The average travel time between 7 and 9 a.m. would be 58 minutes, a 66% increase over existing travel times. The peak 2-hour average travel time would exceed the free-flow[14] travel time by approximately 45 minutes. With the Modified LPA with and without C Street ramps, travel times during the 4-hour AM peak period would range between 39 and 54 minutes. The average travel time between 7 and 9 a.m. would be 54 minutes, a 7% improvement compared to the No-Build Alternative. The peak 2-hour average travel time under the Modified LPA with and without C Street ramps would exceed the free-flow travel time by approximately 40 minutes. With the Modified LPA with two auxiliary lanes, southbound 4-hour AM peak-period travel times would range between 40 and 50 minutes. The average travel time between 7 and 9 a.m. would be 50 minutes, a 14% improvement compared to the No-Build Alternative and 7% improvement compared to the Modified LPA with and without C Street ramps. The peak 2-hour average travel time under the Modified LPA with two auxiliary lanes would exceed the free-flow travel time by approximately 36 minutes.

Total I-5 travel times during the modeled 4-hour PM peak period between I-205 and I-405 in North Portland under the No-Build Alternative would range between 21 and 32 minutes. The average travel time between 4 and 6 p.m. would be 29 minutes, a 111% increase over existing travel times. The peak 2-hour average travel time would exceed the free-flow travel time by approximately 15 minutes. With the Modified LPA, travel times throughout the modeled PM peak period would be the same as the free-flow travel time at 14 minutes. This represents a 52% improvement compared to the No-Build Alternative. During the PM peak period, the Modified LPA options would have the same travel time benefits to southbound I-5 as the Modified LPA.

The decrease in travel times under the Modified LPA and options is attributable to the IBR Program components, including the addition of the auxiliary lane, adding transit improvements (LRT and express bus), and variable-rate tolling. These components combine to reduce the impact of the bottleneck at the Columbia River bridges compared to the No-Build Alternative. There would still be bottlenecks on I-5 south of the IBR Program Area, however, which would dampen travel time improvements from the Modified LPA and options compared to the No-Build Alternative.

Table 4-9 and Table 4-10 show the 2045 forecast southbound I-5 travel times between I-205 and I-405 in North Portland in the AM and PM peak periods, respectively.

[14] Free-flow travel time refers to the amount of time it would take when traveling at the speed limit.

Table 4-9. 2045 Forecast Weekday Southbound AM Peak-Period Travel Times

Alternative/Design Option	Hour	Hourly Average Travel Time (mins)	Peak 2-hour Average Travel Time (mins)
No-Build Alternative	6 AM	27	58
	7 AM	46	58
	8 AM	70	58
	9 AM	79	58
Modified LPA	6 AM	39	54
	7 AM	54	54
	8 AM	53	54
	9 AM	51	54
Modified LPA Without C Street Ramps	6 AM	42	54
	7 AM	55	54
	8 AM	54	54
	9 AM	52	54
Modified LPA with Two Auxiliary Lanes	6 AM	40	50
	7 AM	50	50
	8 AM	50	50
	9 AM	47	50

Source: IBR Analysis.

Table 4-10. 2045 Forecast Weekday Southbound PM Peak-Period Travel Times

Alternative/Design Option	Hour	Hourly Average Travel Time (mins)	Peak 2-hour Average Travel Time (mins)
No-Build Alternative	3 PM	21	29
	4 PM	25	29
	5 PM	32	29
	6 PM	31	29
Modified LPA	3 PM	14	14
	4 PM	14	14
	5 PM	14	14
	6 PM	14	14

Alternative/Design Option	Hour	Hourly Average Travel Time (mins)	Peak 2-hour Average Travel Time (mins)
Modified LPA Without C Street Ramps	3 PM	14	14
	4 PM	14	14
	5 PM	14	14
	6 PM	14	14
Modified LPA with Two Auxiliary Lanes	3 PM	13	14
	4 PM	13	14
	5 PM	14	14
	6 PM	13	14

Source: IBR Analysis

NORTHBOUND TRAVEL TIMES

Total travel times during the modeled 4-hour AM peak period on I-5 between I-405 in North Portland and I-205 under the No-Build Alternative would range between 14 and 19 minutes. The average travel time between 7 and 9 a.m. would be 18 minutes, a 31% increase over existing travel times. The peak 2-hour average travel time would exceed the free-flow travel time by approximately 5 minutes. Under the Modified LPA, travel times would be the same as free-flow (13 minutes) throughout the modeled AM peak period. This is a 28% improvement compared to the No-Build Alternative. During the AM peak period, the Modified LPA options would have the same travel time benefits to northbound I-5 as the Modified LPA.

In 2045, the longest travel time for northbound I-5 traffic for the No-Build Alternative and the Modified LPA and options would be during the PM peak period. Under the No-Build Alternative, total travel times between I-405 in North Portland and I-205 during the modeled 4-hour PM peak period would range between 33 and 43 minutes. The average travel time between 4 and 6 p.m. would be 42 minutes, a 19% increase over existing travel times. The peak 2-hour average travel time would exceed the free-flow travel time by nearly 30 minutes. With the Modified LPA with and without C Street ramps, travel times during the 4-hour PM peak would range between 23 and 28 minutes. The average travel time between 4 and 6 p.m. would be 26 minutes, a 38% improvement compared to the No-Build Alternative. The peak 2-hour average travel time under the Modified LPA with and without C Street ramps would exceed the free-flow travel time by over 10 minutes.

With the Modified LPA with two auxiliary lanes, northbound 4-hour PM peak-period travel times would be nearly free-flow at 13 to 14 minutes. The average travel time between 4 and 6 p.m. would be 14 minutes, a 67% improvement compared to the No-Build Alternative and 46% improvement compared to the Modified LPA with and without C Street ramps. The peak 2-hour average travel time under the Modified LPA with two auxiliary lanes would be nearly free-flow at 14 minutes. The decrease in travel times under the Modified LPA and options is attributable to the IBR Program components including the addition of one or two auxiliary lanes, adding transit improvements (LRT and express bus), and variable-rate tolling. These components combine to reduce the impact of the northbound bottleneck at the Columbia River bridges during the PM peak period compared to the No-Build Alternative. However, with the Modified LPA with and without C Street ramps the bridge would remain a bottleneck, which would dampen travel time improvements compared to the Modified LPA with two auxiliary lanes, which would be almost free-flow conditions.

Table 4-11 and Table 4-12 show the 2045 forecast northbound I-5 travel times between I-405 in North Portland and I-205 in the AM and PM peak periods, respectively.

Table 4-11. 2045 Forecast Weekday Northbound AM Peak-Period Travel Times

Alternative/Design Option	Hour	Hourly Average Travel Time (mins)	Peak 2-hour Average Travel Time (mins)
No-Build Alternative	6 AM	14	18
	7 AM	16	18
	8 AM	19	18
	9 AM	18	18
Modified LPA	6 AM	13	13
	7 AM	13	13
	8 AM	13	13
	9 AM	13	13
Modified LPA Without C Street Ramps	6 AM	13	13
	7 AM	13	13
	8 AM	13	13
	9 AM	13	13
Modified LPA with Two Auxiliary Lanes	6 AM	13	13
	7 AM	13	13
	8 AM	13	13
	9 AM	13	13

Source: IBR Analysis

Table 4-12. 2045 Forecast Weekday Northbound PM Peak-Period Travel Times

Alternative/Design Option	Hour	Hourly Average Travel Time	Peak 2-hour Average Travel Time
No-Build Alternative	3 PM	42	42
	4 PM	43	42
	5 PM	41	42
	6 PM	33	42

Alternative/Design Option	Hour	Hourly Average Travel Time	Peak 2-hour Average Travel Time
Modified LPA	3 PM	28	26
	4 PM	26	26
	5 PM	26	26
	6 PM	23	26
Modified LPA Without C Street Ramps	3 PM	27	25
	4 PM	25	25
	5 PM	25	25
	6 PM	23	25
Modified LPA with Two Auxiliary Lanes	3 PM	14	14
	4 PM	14	14
	5 PM	14	14
	6 PM	13	14

Source: IBR Analysis

4.3.4.4 Level of Service and Volume-to-Capacity Ratios

WSDOT uses LOS for its freeway performance standard, and ODOT uses V/C ratios for mobility standards and performance targets. WSDOT sets the LOS standard for I-5 in Washington at LOS D. The ODOT performance standard depends on the implementation of project improvements. Segments of I-5 in Oregon that are reconstructed as part of an infrastructure improvement project have a V/C standard of 0.75. Segments of I-5 in Oregon that are not reconstructed as part of an infrastructure improvement project have a V/C ratio of 1.1 for the highest peak hour and 0.99 for all other hours. This means that in the IBR Program Area, the V/C standard for the No-Build Alternative is 1.1 for the peak hour and 0.99 for all other hours, and the V/C standards for the Modified LPA and options are 0.75. At the Interstate Bridge freeway segment, both LOS and V/C ratios are reported.

The VISSIM model was used to calculate the LOS for the different segments in the corridor in Washington. While V/C ratios are not a direct available output from the VISSIM model, they were estimated for the ODOT freeway segments based on the modeled density, which is an available output from VISSIM. Depending on the density, segments were assigned to a range of V/C ratios from one of the following categories:

- V/C < 0.25
- V/C 0.25–0.50
- V/C 0.50–0.75
- V/C 0.75–0.80
- V/C 0.80–0.90
- V/C 0.90–1.0

- V/C 1.0–1.1
- V/C > 1.1

The Modified LPA and options would change I-5 geometry, roadway configuration, and ramp connections such that there is not necessarily a one-to-one correspondence between freeway segments in the No-Build Alternative and freeway segments in the Modified LPA and options.

In general, the LOS and V/C ratios discussed in this section follow trends and show results similar to those already discussed in Sections 4.3.4.1 through 4.3.4.3 (Bottlenecks and Speeds, Congestion Index, and Peak-Period Travel Times). When bottlenecks are present and speeds and travel times are slow, the LOS and V/C ratios will be poor, and when conditions are free-flow, LOS and V/C ratios are likely to meet mobility and performance standards.

SOUTHBOUND LOS AND V/C RATIOS

I-5 Mainline

Across the Interstate Bridge, both the LOS and V/C ratio are reported to cover both states' performance measures.

The LOS and V/C ratios discussed in this section follow trends and results similar to those discussed in Sections 4.3.4.1 through 4.3.4.3 (Bottlenecks and Speeds, Congestion Index, and Peak-Period Travel Times). When bottlenecks are present and speeds and travel times are slow, the LOS and V/C ratios are poor, and when conditions are free-flow, LOS and V/C ratios meet mobility and performance standards.

In Washington, nearly all southbound I-5 freeway mainline segments are forecast to operate at LOS F during the AM peak period under the No-Build Alternative due to congestion from the Interstate Bridge bottleneck. Under the Modified LPA with and without C Street ramps, most southbound I-5 freeway mainline segments would continue to operate at LOS F during the AM peak period due to congestion from the downstream bottleneck at the I-5/I-405 interchange in North Portland. The Modified LPA with two auxiliary lanes would improve some mainline segments through Vancouver, but most of I-5 southbound would continue to operate at LOS F. The bottleneck at the CD roadway would create congestion and contribute to the poor LOS.

In Oregon, southbound I-5 freeway mainline segments south of the Interstate Bridge would operate with a V/C ratio better than 1.0 early during the AM peak period under the No-Build Alternative. However, later in the peak, the downstream bottleneck at the I-5/I-405 interchange in North Portland would cause congestion, and I-5 southbound would operate with V/C ratios worse than 1.1. Under the Modified LPA and options, I-5 southbound in Oregon would operate with V/C ratios worse than 1.1 for the entire AM peak period. This decline in operating conditions south of the bridges results from improving the flow of traffic across the bridges. While the demand volumes during the AM peak period are similar south of the IBR Program Area between the No-Build Alternative and the Modified LPA and options, the Modified LPA and options allow more traffic to reach the downstream bottleneck at the I-5/I-405 interchange in North Portland during the AM peak period.

During the PM peak period, most southbound I-5 freeway segments in Washington, including the Interstate Bridge, are forecast to operate at LOS E or F under the No-Build Alternative. All southbound I-5 freeway segments in Oregon, except for the Interstate Bridge, are forecast to operate with a V/C ratio of 0.75 or better under the No-Build Alternative. Under the Modified LPA and options, nearly all southbound I-5 segments would operate at LOS D or better in Washington and with a V/C ratio better than 0.75 in Oregon during the PM peak period. However, under the Modified LPA without C Street ramps, the segment approaching the CD roadway off-ramp would operate at LOS F at 5 p.m. This is due to congestion on the southbound CD system backing up onto the I-5 mainline.

Table 3-10 and Table 4-14 compare the forecast southbound LOS and V/C ratios across the freeway segments in the AM and PM peak periods, respectively. The performance standards are presented in four groups. The first, on the left, is for the No-Build Alternative. The second and third, in the middle, show the Modified LPA with and without C Street ramps, respectively. Generally, the Modified LPA with and without C Street ramps have the same LOS or V/C; two LOS or V/C values are shown only if the Modified LPA without C Street ramps differs from the Modified LPA. The fourth group of performance standards, on the right, shows the Modified LPA with two auxiliary lanes.

Locations without any highlighting indicate that the alternative would meet the performance standard. Locations highlighted in red indicate that the alternative would not meet the performance standard listed at the beginning of this section (Section 4.3.4.4).

Table 4-13. LOS and Volume-to-Capacity Ratio Categories – Southbound AM Peak I-5 Mainline

No-Build Alternative								Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
Segment Type	Location	AM LOS / V/C				Segment Type	Location	AM LOS / V/C				AM LOS / V/C				AM LOS / V/C			
		6 AM	7 AM	8 AM	9 AM			6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM
Weave	Main Street on-ramp to 39th Street off-ramp	C	F[a]	F[a]	F[a]	Weave	Main Street on-ramp to 39th St/Fourth Plain off-ramp	B	F[a]	F[a]	F[a]	C	F[a]	F[a]	F[a]	B	C	D	E[a]
Basic	39th Street off-ramp to SR 500/39th Street on-ramp	F[a]	F[a]	F[a]	F[a]	Basic	39th St/Fourth Plain off-ramp to SR 500/39th Street on-ramp	C	F[a]	F[a]	F[a]	D	F[a]	F[a]	F[a]	C	C	D	E[a]
Weave	SR 500/39th Street on-ramp to Fourth Plain off-ramp	F[a]	F[a]	F[a]	F[a]	Merge	SR 500/39th Street on-ramp	D	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	B	C	E[a]	F[a]
Basic	Fourth Plain off-ramp to Fourth Plain on-ramp	F[a]	F[a]	F[a]	F[a]	Basic	SR 500/39th Street on-ramp to Fourth Plain on-ramp	E[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	B	D	E[a]	F[a]
Weave	Fourth Plain on-ramp to Mill Plain off-ramp	F[a]	F[a]	F[a]	F[a]	Merge	Fourth Plain on-ramp merge	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	B	D	F[a]	F[a]
						Diverge	Mill Plain off-ramp diverge	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	B	D	F[a]	F[a]
Basic	Mill Plain off-ramp to Mill Plain on-ramp	F[a]	F[a]	F[a]	F[a]	Diverge	CD roadway off-ramp diverge	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	B	F[a]	F[a]	E[a]
Weave	Mill Plain on-ramp to SR 14 off-ramp	F[a]	F[a]	F[a]	F[a]	Basic	CD roadway off-ramp to CD roadway on-ramp	F[a]	F[a]	F[a]	E[a]	F[a]	F[a]	F[a]	E[a]	F[a]	F[a]	F[a]	E[a]
Basic	SR 14 off-ramp to SR 14/Washington Street on-ramp	F[a]	F[a]	F[a]	F[a]	Merge	CD roadway on-ramp	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]
Merge	SR 14/Washington Street on-ramp merge	F[a]	F[a]	F[a]	F[a]	Merge	SR 14/C Street on-ramp merge	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]	F[a]
Weave	Interstate Bridge	F[a] 1.0-1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	Weave	Interstate Bridge	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1	F[a] >1.1
Basic	Hayden Island off-ramp to Hayden Island on-ramp	0.90-1.0	1.0-1.1[a]	>1.1[a]	1.0-1.1[a]	Diverge	Hayden Island off-ramp to Marine Drive off-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]
Weave	Hayden Island on-ramp to Marine Drive off-ramp	0.90-1.0	1.0-1.1[a]	>1.1[a]	1.0-1.1[a]														
Basic	Marine Drive off-ramp to Marine Drive on-ramp	0.50.0.75	0.50.0.75	>1.1[a]	>1.1[a]	Basic	Marine Drive off-ramp to Victory off-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]
Weave	Marine Drive on-ramp to Victory off-ramp	0.50.0.75	0.25-0.50	>1.1[a]	>1.1[a]	Diverge	Victory off-ramp diverge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]
Basic	Victory off-ramp to Victory on-ramp	0.25-0.50	0.50-0.75	>1.1[a]	>1.1[a]	Basic	Victory off-ramp to Marine Drive on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]
						Merge	Marine Drive on-ramp merge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]

Source: IBR Analysis

a Red-highlighted cells do not meet performance standard.

Ave = Avenue; Dr = Drive; St = Street

Table 4-14. LOS and Volume-to-Capacity Ratio Categories – Southbound PM PeakI-5 Mainline

No-Build Alternative					
Segment Type	Location	PM LOS / V/C 3 PM	4 PM	5 PM	6 PM
Weave	Main Street on-ramp to 39th Street off-ramp	F[a]	F[a]	F[a]	F[a]
Basic	39th Street off-ramp to SR 500/39th Street on-ramp	F[a]	F[a]	F[a]	F[a]
Weave	SR 500/39th Street on-ramp to Fourth Plain off-ramp	F[a]	F[a]	F[a]	F[a]
Basic	Fourth Plain off-ramp to Fourth Plain on-ramp	F[a]	F[a]	F[a]	F[a]
Weave	Fourth Plain on-ramp to Mill Plain off-ramp	F[a]	F[a]	F[a]	F[a]
Basic	Mill Plain off-ramp to Mill Plain on-ramp	F[a]	F[a]	F[a]	F[a]
Weave	Mill Plain on-ramp to SR 14 off-ramp	F[a]	F[a]	F[a]	F[a]
Basic	SR 14 off-ramp to SR 14/Washington Street on-ramp	D	D	E[a]	E[a]
Merge	SR 14/Washington Street on-ramp merge	D	D	D	E[a]
Weave	Interstate Bridge	**E**[b] 0.90-1.0	**E**[b] 0.90-1.0	**E**[b] 0.90-1.0	**E**[b] 0.90-1.0
Basic	Hayden Island off-ramp to Hayden Island on-ramp	0.50-0.75	0.50-0.75	0.50-0.75	0.50-0.75
Weave	Hayden Island on-ramp to Marine Drive off-ramp	0.50-0.75	0.25-0.50	0.25-0.50	0.25-0.50
Basic	Marine Drive off-ramp to Marine Drive on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Weave	Marine Drive on-ramp to Victory off-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Basic	Victory off-ramp to Victory on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50

		Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
		PM LOS / V/C				PM LOS / V/C				PM LOS / V/C			
Segment Type	Location	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM	3PM	4PM	5PM	6PM
Weave	Main Street on-ramp to 39th St/Fourth Plain off-ramp	B	B	B	B	B	B	B	B	B	B	B	B
Basic	39th St/Fourth Plain off-ramp to SR 500/39th Street on-ramp	C	C	C	B	C	C	C	B	B	C	C	B
Merge	SR 500/39th Street on-ramp	B	B	C	B	B	B	C	C	B	B	B	B
Basic	SR 500/39th Street on-ramp to Fourth Plain on-ramp	B	B	C	C	B	B	C	C	B	B	B	B
Merge	Fourth Plain on-ramp merge	B	B	C	C	B	B	C	C	B	B	B	B
Diverge	Mill Plain off-ramp diverge	B	C	D	C	B	B	D	C	B	B	B	B
Diverge	CD roadway off-ramp diverge	B	C	D	C	B	C	F[a]	D	B	B	C	C
Basic	CD roadway off-ramp to CD roadway on-ramp	B	B	B	B	B	B	B	B	B	B	B	B
Merge	CD roadway on-ramp	B	B	B	B	B	B	B	B	B	B	B	A
Merge	SR 14/C Street on-ramp merge	B	B	B	B	B	B	B	B	B	B	B	B
Weave	Interstate Bridge	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C 0.50-0.75	C <0.25	C <0.25	C <0.25	B <0.25
Diverge	Hayden Island off-ramp to Marine Drive off-ramp	0.50-0.75	0.50-0.75	0.50-0.75	0.25-0.50	0.50-0.75	0.50-0.75	0.50-0.75	0.25-0.50	<0.25	<0.25	<0.25	<0.25
Basic	Marine Drive off-ramp to Victory off-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	<0.25	<0.25	<0.25
Diverge	Victory off-ramp diverge	0.25-0.50	0.25-0.50	0.50-0.75	0.25-0.50	0.25-0.50	0.25-0.50	0.50-0.75	0.25-0.50	<0.25	<0.25	<0.25	<0.25
Basic	Victory off-ramp to Marine Drive on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	<0.25	<0.25	<0.25
Merge	Marine Drive on-ramp merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	<0.25	<0.25	<0.25

Source: IBR Analysis

a Red-highlighted cells do not meet performance standard.

b Bold red text indicates peak periods where the Interstate Bridge is not meeting one agency standard but does meet the other agency standard.

Ave = Avenue; Dr = Drive; St = Street

Collector-Distributor Roadways

On the southbound CD system between the Mill Plain and SR 14 interchanges, the Modified LPA with and without C Street ramps generally operates at LOS F during the entire AM peak period, not meeting the WSDOT performance standard. With the Modified LPA with two auxiliary lanes, the CD system operates at LOS A during the 6 a.m. hour, but at LOS E or F for the remainder of the AM peak period. Congestion from the downstream bottleneck at the I-5/I-405 interchange spilling back into the CD system may contribute to or cause poor LOS on the CD system (Table 4-15).

During the PM peak, all segments under the Modified LPA would operate at LOS D or better with the exception of the SR 14 off-ramp diverge, which would operate at LOS E or F—below the WSDOT performance standard—during the 4 and 5 p.m. hours. Under the Modified LPA without C Street ramps, the additional demand volume at the Mill Plain on-ramp causes the CD system between the Mill Plain on-ramp and the SR 14 off-ramp to operate at LOS F during most of the 4-hour PM peak period. Under the Modified LPA with two auxiliary lanes, the CD system would operate similar to the Modified LPA (Table 4-16).

In Table 4-15 and Table 4-16, locations that do not meet the WSDOT mobility standard are highlighted in red.

Table 4-15. LOS – Southbound AM Peak Mill Plain to SR 14 CD

Segment Type	Location	Modified LPA – AM LOS				Modified LPA Without C Street Ramps – AM LOS				Modified LPA with Two Auxiliary Lanes – AM LOS			
		6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM
CD Roadway	Start of CD to Mill Plain on-ramp	B	F [a]	F [a]	F [a]	C	F [a]	F [a]	F [a]	A	D	F [a]	B
CD Roadway	Mill Plain on-ramp merge	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	A	F [a]	F [a]	E [a]
CD Roadway	SR 14 off-ramp diverge	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	A	F [a]	F [a]	F [a]
CD Roadway	SR 14 off-ramp to end of CD	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	F [a]	A	F [a]	F [a]	F [a]

Source: IBR Analysis

a Locations highlighted in red do not meet the WSDOT performance standard.

Table 4-16. LOS – Southbound PM Peak Mill Plain to SR 14 CD

Segment Type	Location	Modified LPA – PM LOS				Modified LPA Without C Street Ramps – PM LOS				Modified LPA with Two Auxiliary Lanes – PM LOS			
		3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM
CD Roadway	Start of CD to Mill Plain on-ramp	B	C	D	B	B	C	F [a]	E [a]	B	B	D	D
CD Roadway	Mill Plain on-ramp merge	B	C	D	C	D	F [a]	F [a]	F [a]	B	B	D	D
CD Roadway	SR 14 off-ramp diverge	B	E [a]	F [a]	C	F [a]	F [a]	F [a]	F [a]	C	C	F [a]	E [a]
CD Roadway	SR 14 off-ramp to end of CD	A	A	A	A	B	B	A	B	A	A	A	A

Source: IBR Analysis

a Locations highlighted in red do not meet the WSDOT performance standard.

NORTHBOUND LOS AND V/C RATIOS

I-5 Mainline

Under the No-Build Alternative, all northbound freeway segments between the Victory on-ramp merge and the Interstate Bridge are forecast to operate with a V/C ratio worse than 1.1 from 7 a.m. through the remainder of the AM peak period. The Interstate Bridge is forecast to operate with a V/C ratio of greater than 1.1 and at LOS F in Oregon and Washington, respectively. In Washington, all freeway segments would operate at LOS C or better during the AM peak period. Under the Modified LPA and options, all northbound freeway segments in Oregon would operate with a V/C ratio better than 0.75, and all northbound freeway segments in Washington would operate with LOS C or better during the AM peak period.

Under the No-Build Alternative, all northbound freeway segments in Oregon, except the Interstate Bridge, would operate with a V/C ratio worse than 1.1 throughout the PM peak period. In Washington, all segments would operate at LOS D or better (with the exception of the Interstate Bridge, which operates at LOS F). Under the Modified LPA with and without C Street ramps, northbound freeway segments in Oregon would continue to operate with a V/C worse than 1.1 during the PM peak period, not meeting the ODOT performance standard. In Washington, all northbound freeway segments (with the exception of the Interstate Bridge, which operates at LOS F), would perform at LOS D or better during the PM peak period, meeting the WSDOT performance standard. Under the Modified LPA with two auxiliary lanes, most Oregon segments would operate with a V/C ratio of 0.75 or better, with the exception of the Hayden Island on-ramp merge and the Columbia River bridges. In Washington, all northbound freeway segments would perform at LOS D or better during the PM peak period, except for the Columbia River bridges and at the 39th Street on-ramp merge area at the north end of the IBR Program Area.

Table 4-17 and Table 4-18 compare the forecast northbound LOS and V/C ratios across the freeway segments in the AM and PM peak periods, respectively.

The performance standards are presented in four groups in the tables. The first section, on the left, is the No-Build Alternative. The second and third sections show the Modified LPA with and without C Street ramps respectively. Generally, the Modified LPA with and without C Street ramps have the same LOS or V/C; two LOS or V/C values are shown only if the Modified LPA without C Street ramps differs from the Modified LPA. The fourth section of performance standards, on the right, shows the Modified LPA with Two Auxiliary Lanes.

Locations without any highlighting are where the alternative would meet the performance standard. Locations highlighted in red are where the alternative would not meet the performance standard listed at the beginning of this section (Section 4.3.4.4).

Table 4-17. LOS and Volume-to-Capacity Ratio Categories – Northbound AM Peak

No-Build Alternative								Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
Segment Type	Location	AM LOS / V/C				Segment Type	Location	AM LOS / V/C				AM LOS / V/C				AM LOS / V/C			
		6 AM	7 AM	8 AM	9 AM			6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM	6AM	7AM	8AM	9AM
Diverge	Marine Drive off-ramp diverge	0.50-0.75	0.50-0.75	0.50-0.75	0.50-0.75	Diverge	Marine Drive/Hayden Island off-ramp diverge	0.25-0.50	0.50-0.75	0.50-0.75	0.50-0.75	0.25-0.50	0.50-0.75	0.50-0.75	0.50-0.75	0.25-0.50	0.50-0.75	0.50-0.75	0.50-0.75
Basic	Marine Drive off-ramp to Victory on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	Basic	Marine Drive/Hayden Island off-ramp to Victory on-ramp	<0.25	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	0.25-0.50	0.25-0.50	0.25-0.50
Merge	Victory on-ramp merge	0.25-0.50	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Victory on-ramp merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Basic	Victory on-ramp to Marine Drive on-ramp	0.50-0.75	>1.1[a]	>1.1[a]	>1.1[a]	Basic	Victory on-ramp to Marine Drive on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	<0.25	0.25-0.50	0.25-0.50	0.25-0.50
Weave	Marine Drive on-ramp to Hayden Island off-ramp	0.50-0.75	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Marine Drive on-ramp	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Basic	Hayden Island off-ramp to Hayden Island on-ramp	0.50-0.75	>1.1[a]	>1.1[a]	>1.1[a]														
Merge	Hayden Island on-ramp merge	0.50-0.75	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Hayden Island on-ramp merge	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Weave	Interstate Bridge	0.50-0.75 D	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	Weave	Interstate Bridge	0.25-0.50 B	0.50-0.75 B	0.50-0.75 B	0.50-0.75 B	0.25-0.50 B	0.50-0.75 B	0.50-0.75 C	0.50-0.75 B	0.25-0.50 B	0.25-0.50 B	0.25-0.50 B	0.25-0.50 B
Diverge	C Street off-ramp diverge	C	C	C	C	Diverge	C Street off-ramp diverge*	B	B	B	B	B	B	B	B	A	B	B	B
Basic	C Street off-ramp to SR 14 on-ramp	C	C	C	C	Diverge	CD roadway off-ramp diverge	B	B	B	B	B	B	B	B	A	A	A	B
Weave	SR 14 on-ramp to Mill Plain/Fourth Plain off-ramp	B	C	C	C	Basic	CD roadway off-ramp to CD roadway on-ramp	A	A	A	B	A	A	A	B	A	A	A	A
Basic	Mill Plain/Fourth Plain off-ramp to Mill Plain on-ramp	B	B	B	B	Merge	CD roadway on-ramp	A	B	B	B	A	B	B	B	A	A	A	B
						Basic	CD roadway on-ramp to Mill Plain on-ramp	A	B	B	B	A	B	B	B	A	B	B	B
Merge	Mill Plain on-ramp merge	B	B	B	B	Merge	Mill Plain on-ramp merge	A	A	A	A	A	A	A	A	A	A	A	A
Basic	Mill Plain on-ramp to Fourth Plain on-ramp	B	B	B	B	Merge	Mill Plain on-ramp to Fourth Plain on-ramp	A	B	B	B	A	B	B	B	A	A	A	A
Merge	Fourth Plain on-ramp merge	B	B	B	B	Merge	Fourth Plain on-ramp merge	A	B	B	B	A	B	B	B	B	B	B	B
Diverge	SR 500/39th off-ramp diverge	B	B	B	B	Diverge	SR 500/39th off-ramp diverge	B	B	B	B	B	B	B	B	B	B	B	B
Basic	SR 500/39th off-ramp to 39th on-ramp	B	B	B	B	Basic	SR 500/39th off-ramp to 39th on-ramp	A	A	A	B	A	A	A	B	A	A	A	B

No-Build Alternative								Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
		AM LOS / V/C						AM LOS / V/C				AM LOS / V/C				AM LOS / V/C			
Segment Type	Location	6 AM	7 AM	8 AM	9 AM	Segment Type	Location	6 AM	7 AM	8 AM	9 AM	6 AM	7 AM	8 AM	9 AM	6AM	7AM	8AM	9AM
Weave	39th on-ramp to Main Street off-ramp	B	B	B	B	Merge	39th on-ramp merge	A	A	A	B	A	A	A	B	B	B	B	B
						Diverge	Main Street off-ramp diverge	B	B	B	B	B	B	B	B	B	B	B	B

Source: IBR Analysis

a Red-highlighted cells do not meet performance standard.

Ave = Avenue; Dr = Drive; St = Street

Table 4-18. LOS and Volume-to-Capacity Ratio Categories – Northbound PM Peak

No-Build Alternative								Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
		PM LOS / V/C						PM LOS / V/C				PM LOS / V/C				PM LOS / V/C			
Segment Type	Location	3 PM	4 PM	5 PM	6 PM	Segment Type	Location	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM
Diverge	Marine Drive off-ramp diverge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Diverge	Marine Drive/Hayden Island off-ramp diverge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.50-0.75	0.50-0.75	0.50-0.75	0.50-0.75
Basic	Marine Drive off-ramp to Victory on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Basic	Marine Drive/Hayden Island off-ramp to Victory on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Merge	Victory on-ramp merge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Victory on-ramp merge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.50-0.75	0.50-0.75	0.50-0.75	0.50-0.75
Basic	Victory on-ramp to Marine Drive on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Basic	Victory on-ramp to Marine Drive on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.25-0.50	0.25-0.50	0.25-0.50	0.25-0.50
Weave	Marine Drive on-ramp to Hayden Island off-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Marine Drive on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.50-0.75	0.50-0.75	0.50-0.75	0.50-0.75
Basic	Hayden Island off-ramp to Hayden Island on-ramp	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]														
Merge	Hayden Island on-ramp merge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	Merge	Hayden Island on-ramp merge	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	>1.1[a]	0.90-1.0[a]	0.85-0.90[a]	0.50-0.75
Weave	Interstate Bridge	0.90-1.0 F[b]	0.90-1.0 F[b]	0.90-1.0 F[b]	0.90-1.0 F[b]	Weave	Interstate Bridge	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 F[a]	>1.1 E[a]
Diverge	C Street off-ramp diverge	D	D	D	C	Diverge	C Street off-ramp diverge	C	C	C	C	C	C	C	C	C	C	C	C
Basic	C Street off-ramp to SR 14 on-ramp	C	C	C	C	Diverge	CD roadway off-ramp diverge	C	C	C	C	C	C	C	C	B	B	B	B
Weave	SR 14 on-ramp to Mill Plain/Fourth Plain off-ramp	C	C	C	C	Basic	CD roadway off-ramp to CD roadway on-ramp	C	C	C	C	C	C	C	C	B	B	B	B

No-Build Alternative								Modified LPA				Modified LPA Without C Street Ramps				Modified LPA with Two Auxiliary Lanes			
Segment Type	Location	PM LOS / V/C				Segment Type	Location	PM LOS / V/C				PM LOS / V/C				PM LOS / V/C			
		3 PM	4 PM	5 PM	6 PM			3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM
Basic	Mill Plain/Fourth Plain off-ramp to Mill Plain on-ramp	C	C	C	C	Merge	CD roadway on-ramp	C	C	C	C	C	C	C	C	B	B	B	B
						Basic	CD roadway on-ramp to Mill Plain on-ramp	C	C	C	C	C	C	C	C	C	C	C	C
Merge	Mill Plain on-ramp merge	C	C	C	C	Merge	Mill Plain on-ramp merge	B	B	B	B	B	B	B	B	B	C	C	B
Basic	Mill Plain on-ramp to Fourth Plain on-ramp	B	C	C	B	Merge	Mill Plain on-ramp to Fourth Plain on-ramp	C	C	C	C	C	C	C	C	B	C	C	B
Merge	Fourth Plain on-ramp merge	C	C	C	C	Merge	Fourth Plain on-ramp merge	C	C	C	C	C	C	C	C	B	C	C	B
Diverge	SR 500/39th off-ramp diverge	C	C	C	B	Diverge	SR 500/39th off-ramp diverge	C	C	D	C	C	C	D	C	C	D	D	C
Basic	SR 500/39th off-ramp to 39th on-ramp	C	D	D	C	Basic	SR 500/39th off-ramp to 39th on-ramp	C	C	C	C	C	C	C	C	C	C	D	C
Weave	39th on-ramp to Main Street off-ramp	C	D	D	C	Merge	39th on-ramp merge	B	C	C	B	B	C	C	B	C	E [a]	E [a]	C
						Diverge	Main Street off-ramp diverge	C	D	D	C	C	D	D	C				

Source: IBR Analysis

a Red-highlighted cells do not meet performance standard.

b Bold red text indicates peak periods where the Interstate Bridge is not meeting one agency standard but does meet the other agency standard.

Ave = Avenue; Dr = Drive; St = Street

Collector-Distributor Roadways

All segments of the northbound CD system would operate at LOS C or better, meeting the WSDOT performance standard, during the AM and PM peak periods under the Modified LPA and options.

Table 4-19 and Table 4-20 compare the forecast northbound LOS through the CD system in the AM and PM peak periods, respectively.

Table 4-19. LOS – Northbound AM Peak Mill Plain to SR 14 CD

Segment Type	Location	Modified LPA – AM LOS				Modified LPA Without C Street Ramps – AM LOS				Modified LPA with Two Auxiliary Lanes			
		6 AM	7 AM	6AM	7AM	8AM	9AM	8AM	9AM	6AM	7AM	8AM	9AM
CD Roadway	Start of CD to SR 14 on-ramp	A	A	A	B	B	B	A	A	A	A	A	A
CD Roadway	SR 14 on-ramp to Mill Plain off-ramp	A	B	B	B	B	B	B	B	A	B	B	B
CD Roadway	Mill Plain off-ramp to Fourth Plain off-ramp	B	B	B	B	B	B	B	B	B	B	B	B
CD Roadway	Fourth Plain off-ramp to end of CD	B	B	B	B	B	B	B	B	B	B	B	B

Source: IBR Analysis

Table 4-20. LOS – Northbound PM Peak Mill Plain to SR 14 CD

Segment Type	Location	Modified LPA – PM LOS				Modified LPA Without C Street Ramps – PM LOS				Modified LPA with Two Auxiliary Lanes			
		3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM	3 PM	4 PM	5 PM	6 PM
CD Roadway	Start of CD to SR 14 on-ramp	A	A	A	A	B	B	B	B	A	A	A	A
CD Roadway	SR 14 on-ramp to Mill Plain off-ramp	B	B	B	B	B	C	C	B	B	B	B	B
CD Roadway	Mill Plain off-ramp to Fourth Plain off-ramp	C	C	C	B	C	C	C	B	C	C	C	B
CD Roadway	Fourth Plain off-ramp to end of CD	C	C	C	B	C	C	C	B	C	C	C	B

Source: IBR Analysis

4.3.4.5 Impacts to Local Roads

As described previously, the VISSIM traffic operations model was used to analyze operations on I-5. In some cases, the congestion on the I-5 mainline causes queuing at freeway on-ramps, which in turn can cause congestion and backups on the local cross streets at interchanges. The local streets are not included in the VISSIM model; however, the impact of freeway congestion on the local street network in the vicinity of the IBR Program Area can be estimated by measuring the number of unserved vehicles at the model input points (i.e., the on-ramps). The number of unserved vehicles is converted to a length,[15] which is used to estimate the maximum extents of the congestion on the local system that is caused by freeway congestion.

The study intersections that fall within the freeway congestion extents are anticipated to experience worse LOS than what is reported in Section 4.6, Arterials and Local Streets. The estimated impact of freeway congestion on local roadways documented in this section illustrates how the overall system may operate, while the unconstrained operations analysis summarized in Section 4.6 shows the isolated intersection operations and if the intersection needs mitigation or not in the future impact analysis.

During the AM peak period, the Interstate Bridge is a major bottleneck for I-5 southbound traffic in the No-Build Alternative. I-5 mainline congestion impacts adjacent southbound on-ramps through the IBR Program Area. As illustrated in Figure 4-18, congestion on I-5 southbound spills back into downtown Vancouver at Washington Street, with congestion spilling back through downtown streets to Mill Plain Boulevard. SR 14 backs up to approximately Grand Boulevard. Mill Plain backs up east of I-5 to MacArthur Boulevard and west of I-5 as far as Lincoln Avenue. Fourth Plain Boulevard backs up east of I-5 to Stapleton and west of I-5 past Main Street. Congestion on SR 500 is estimated to extend as far as Andresen Road.

With the Modified LPA with and without C Street ramps, the bottleneck at the Columbia River bridges is reduced during the AM peak period compared to the No-Build Alternative, but congestion spilling back from the I-5/I-405 interchange in North Portland still impacts I-5 operations through Vancouver. Congestion spillback from I-5 onto local roadways would be similar to the No-Build Alternative on SR 14 and Mill Plain Boulevard. Congestion that spilled back from the Washington Street on-ramp in the No-Build Alternative would instead spill back from the C Street on-ramp with the Modified LPA, but would still spill back as far as Mill Plain. Congestion on Mill Plain west of I-5 would be worse under the Modified LPA without C Street ramps compared to the Modified LPA because traffic volume would shift from the removed C Street on-ramp to the Mill Plain corridor. Congestion levels on Fourth Plain and on SR 500 would be reduced compared to the No-Build Alternative because congestion on I-5 has been reduced.

[15] 25 feet per unserved vehicle.

Figure 4-18. Forecast 2045 Local Roadways Impacted by Freeway Bottlenecks – AM Peak Period

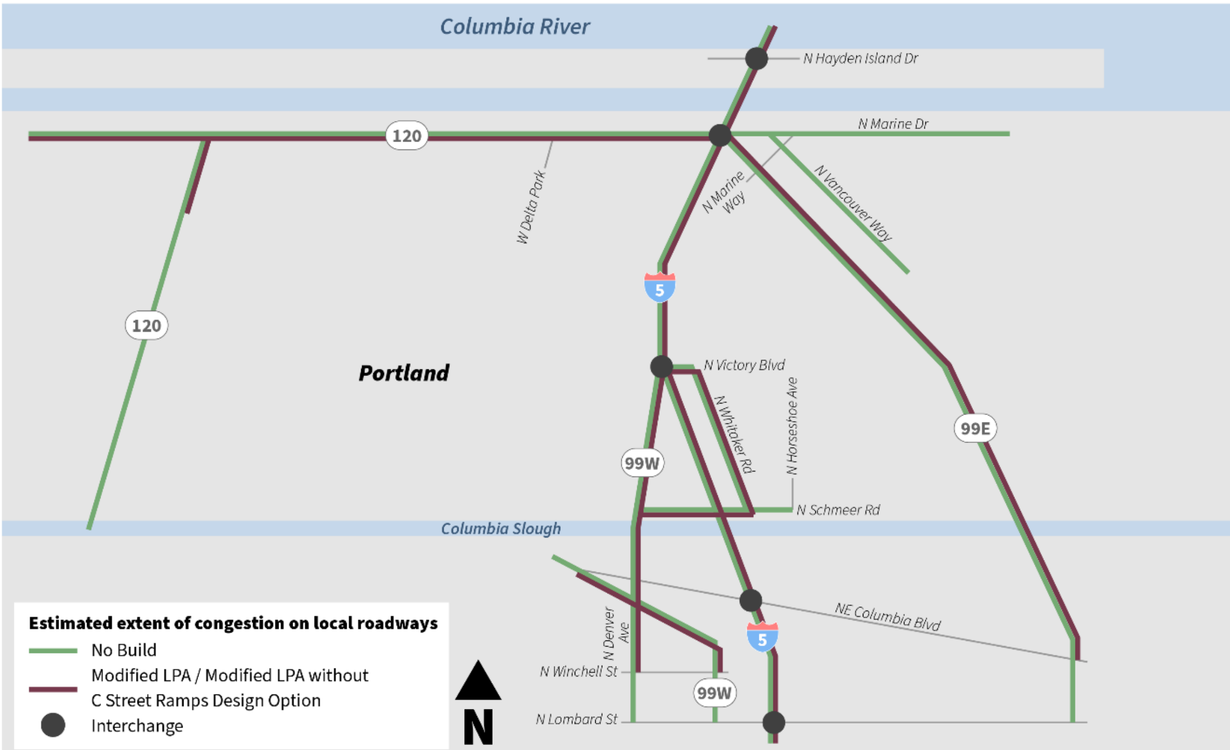
Under the Modified LPA with two auxiliary lanes, congestion levels on local streets during the AM peak period would be improved compared to the Modified LPA on SR 500, Fourth Plain, and Mill Plain due to the addition of the second auxiliary lane on I-5. Figure 4-18 shows the estimated maximum extents of congestion on local roadways in Vancouver during the AM peak period.

During the PM peak period, the Interstate Bridge is the major bottleneck for I-5 northbound traffic in the No-Build Alternative. I-5 mainline congestion impacts adjacent northbound on-ramps through the IBR Program Area. Congestion on I-5 northbound spills back onto Marine Drive and onto N Portland Road. Congestion spills back east of I-5 impacting Marine Drive, Vancouver Way, and Martin Luther King Jr. Boulevard. The Victory Boulevard/Interstate Avenue interchange area is also impacted with congestion spilling back as far as Lombard Street.

With the Modified LPA with and without C Street ramps, the bottleneck at the Columbia River bridges would be reduced during the PM peak period compared to the No-Build Alternative, and the extents of congestion on the local system are estimated to be less, but would generally still impact the same streets.

Under the Modified LPA with two auxiliary lanes, congestion on I-5 during the PM peak period is contained on the freeway and at the on-ramps, so no congestion is anticipated to extend onto the local roadway network. Figure 4-19 shows the estimated maximum extents of congestion on local roadways in Portland during the PM peak period.

Figure 4-19. Forecast 2045 Local Roadways Impacted by Freeway Bottlenecks – PM Peak Period



4.4 Freight Mobility and Access

This section describes the effects of the No-Build Alternative and the Modified LPA and options on freight mobility and access within the IBR Program Area.

Freight transportation in the Portland-Vancouver metropolitan region is forecast to increase in the coming years. In Washington, freight tonnage is forecast to increase by 45%, from 603 million to 872 million tons, between 2022 and 2050. Across all freight modes, truck transport is forecast to experience the largest absolute change, representing 61% of total increase in freight tonnage. Truck tonnage is forecast to increase by 55% during this time frame and forecast truck miles traveled on interstates are anticipated to increase by 67%. Increasing truck volumes are expected to exacerbate many challenges the state freight system currently faces, including those associated with traffic congestion and safety.

In Oregon, freight tonnage is forecast to increase by 62%, from 403 million tons to 651 million tons, between 2010 and 2035. Tonnage transported by trucks is forecast to increase by 73%, from 294 to 508 million tons, and will represent 78% of freight demand by mode. Similar to Washington, the state of Oregon expects that roadway congestion, transport reliability, and road access issues will be exacerbated by increases in truck traffic.

Trade volumes transported by all modes are forecast to double, between 2007 and 2040, in the Portland-Vancouver metropolitan region, with approximately 75% of that dependent on trucks to link producers and consumers, or to reach intermodal nodes for import and export. Data from the Metro/RTC regional travel demand model forecasts that by 2045, trucks will comprise almost 15% of total trips across the new I-5 Columbia River bridges which is an increase from the 10% of the daily volumes in 2019. This increase in the proportion of total trip is related to planned increases in activity at both ports (Portland and Vancouver) and the industrial areas.

Several projects are planned to improve freight mobility, access, and safety in the IBR Program Area. In Washington, an extension of the separated bike-pedestrian path is planned on Columbia Way that will connect the City's Waterfront Park with the Renaissance Trail through the Port of Vancouver Terminal 1 property. Additionally, a rail overpass at Gateway Avenue and the rail loop at the Port of Vancouver Terminal 5 would improve industrial access. Near the Port of Portland, planned improvements include grade-separated crossings to eliminate conflicts between rail and trucks, as well as roadway modifications to meet freight district street standards, and reduce congestion. These and other financially constrained freight mobility, access, and safety projects identified in the Metro 2018 RTP that would improve truck mobility in the IBR Program Area are summarized in Table 4-21.

Table 4-21. Freight Mobility, Access, and Safety Projects in the Financially Constrained RTP

Project	City/State	Agency	Start Location	End Location
Construct rail overcrossing on Marine Drive.	Portland, OR	Port of Portland	BNSF grade crossing on Marine Drive	BNSF grade crossing on Marine Drive
Construct second entrance from Marine Drive and internal rail overcrossing to Terminal 6.	Portland, OR	Port of Portland	N Bybee Lake Road	N Pacific Gateway
Provide access to the east end of Terminal 6 off the terminus of Suttle Road.	Portland, OR	Port of Portland	Terminus of N Suttle Road	Terminal 6
Improve Suttle Road to meet Freight District Street standards, separate rail and truck movements, provide pedestrian access to nearby bus line, and enable future Terminal 6 entrance Port project.	Portland, OR	City of Portland	N Portland Road	Terminal 6
Reconstruct Time Oil Road.	Portland, OR	Port of Portland	N Lombard Street	Rivergate Boulevard
Construct roadway improvements, including pedestrian and bicycle facilities.	Portland, OR	City of Portland	N Burgard Street and Columbia Boulevard	Burgard Viaduct
Replace the weight-restricted N Portland Road bridge over the Columbia Slough to enable the use of N Portland Road as an over-dimensional freight route and include a connection for the Columbia Slough Trail.	Portland, OR	City of Portland	N Portland Road at Columbia Slough	N Portland Road at Columbia Slough
Eliminate the at-grade crossing of Union Pacific and BNSF tracks at North Portland Junction.	Portland, OR	Port of Portland	Union Pacific Peninsula Junction	North Portland Junction

Project	City/State	Agency	Start Location	End Location
Lower the Columbia Boulevard undercrossing at the Union Pacific Railroad Bridge just west of I-5 to enable the use of Columbia Boulevard as an over-dimensional freight route.	Portland, OR	City of Portland	N Columbia Boulevard at railroad bridge near I-5	N Columbia Boulevard at railroad bridge near I-5
Provide street access from 33rd Avenue into SW Quad, a Portland International Airport property.	Portland, OR	Port of Portland	NE 33rd Avenue	SW Quad
Signalize intersection to improve freight operations.	Portland, OR	City of Portland	Marine Drive and NE 33rd Avenue	Marine Drive and NE 33rd Avenue

Source: Metro 2018 Regional Transportation Plan, RTC 2019 Regional Transportation Plan.

Freight mobility, access, and safety are anticipated to improve under the No-Build Alternative compared with existing conditions in response to the planned improvements included in the 2018 RTP. These projects would provide grade-separated crossings to eliminate conflicts between rail and trucks, create additional modal separation between trucks and active transportation users, improve roadways to meet freight district street standards, and reduce congestion. Trucks would still be subject to the same delays as general-purpose traffic on I-5 and arterial and local streets described in Section 4.3, Interstate 5, and Section 4.6, Arterials and Local Streets.

Under the Modified LPA and options, trucks crossing the new Columbia River bridges would be subject to tolls, but the I-5 freeway system in the IBR Program Area would be improved to meet current design standards. Although trucks would incur a cost associated with the tolls, truck value of time is more complex than auto value of time. Truck value of time depends on things like shipment terms, employment terms, distance, type of commodity being carried, as well as shipper and receiver characteristics. Truck value of time can vary greatly, depending on the type of goods the trucks carry. Federal guidance for truck value of time only includes driver compensation but recognizes that trucks' route choice also includes vehicle operating costs and other factors dependent on the type and value of the commodity being carried. Given the improved travel times combined with the proximity to both ports and industrial areas, trucks may be less likely than general-purpose traffic to divert from I-5 to I-205 to avoid tolls. Additionally, the proximity to the ports, forecast congestion on I-205, and the anticipated reliability improvements resulting from the Modified LPA and options are likely to make I-5 the more desirable river crossing, resulting in a shift of trucks from I-205 to I-5 compared to the No-Build condition.

The Modified LPA and options would provide improved access for oversized vehicles across the Columbia River bridges with lane and shoulder widths designed to current standards. The Modified LPA and options would maintain the ability to transport oversized loads along existing routes, and provide improved designs for trucks at critical port access point to I-5, such as the Mill Plain Boulevard interchange in Vancouver and the Marine Drive interchange in Portland. Trucks would still be subject to same delays as general-purpose traffic as described in Section 4.3, Interstate 5, and Section 4.6, Arterials and Local Streets.

The Modified LPA without C Street ramps would shift additional general-purpose traffic to the Mill Plain interchange, causing additional delay and congestion that could impact freight traffic traveling on the Mill Plain corridor compared to the Modified LPA. The Modified LPA with two auxiliary lanes would provide additional space on the I-5 mainline for trucks to get up to speed and merge and weave with through traffic on the I-5 mainline, reducing disruptions to flows on I-5 mainline compared to the Modified LPA.

4.5 Bridge Openings and Gate Closures

Under the No-Build Alternative, bridge openings and gate closures would occur at a frequency and for durations similar to existing conditions, assuming no major changes to the USCG Bridge Permit. Bridge openings avoid high traffic volume periods, and training and bridge maintenance activities would occur predominantly during the overnight period. However, as the durations of future congestion events increase compared to existing conditions, the recovery periods associated with bridge openings and gate closures would be similarly extended, exacerbating overall congestion within the IBR Program Area.

The Modified LPA and options, except the single-level movable-span configuration, would eliminate the bridge openings on the Columbia River bridges. Gate closures required for bridge openings and traffic stoppage events would no longer occur. Recovery times associated with bridge openings and gate closures would no longer contribute to the number and duration of congestion events.

The single-level movable-span configuration would require periodic bridge openings and gate closures that would interrupt traffic operations, but they would be up to 50% less frequent than the with No-Build Alternative because the vertical clearance for the alternative barge channel would be higher under this option than under the No-Build Alternative, thus allowing more vessels to pass without a bridge opening. There would also be additional timing restrictions on when the bridge would be opened. Based on existing marine vessels transiting the Interstate Bridge, the number of bridge openings would be reduced to approximately 60 per year for marine vessels, 12 per year for maintenance, and between 0 and 55 openings per year for training purposes; however, this number of bridge openings could vary over time as maritime activities evolve over the 100+ year service life of the bridge. The total number of resulting bridge openings would be less than with the No-Build Alternative, assuming USCG would approve further restrictions on when bridge openings would be allowed.

Similar to the No-Build Alternative, daytime bridge openings under the Modified LPA with a movable span could impact traffic congestion for an hour or more; nighttime bridge openings would have less impact to traffic congestion. Transit and active transportation trips would also be affected. For transit, the bridge openings would cause a system-level disruption in service, affecting operations for the Yellow Line to downtown and other lines serving downtown Portland. Bus and rail connections would also be disrupted, increasing overall travel times for riders. Depending on when the disruptions occur, it could take hours for the system to recover.

4.6 Arterials and Local Streets

This section describes traffic analysis for arterials and local streets under the No-Build Alternative and the Modified LPA and options, including roadway network, study intersections, peak-hour volumes, and intersection operations. The four subareas evaluated under the No-Build Alternative and Modified LPA and options are the same as those described in Chapter 3, Affected Environment, but intersections have been added, modified, or removed from each subarea, as applicable.

Appendix D contains peak-hour traffic volumes for the analysis. Refer to Appendix E for full operational results for existing, No-Build Alternative, Modified LPA and options, and park-and-ride facilities.

4.6.1 Roadway Network

In addition to the regional roadways that connect to regional population and employment centers, there are numerous local arterials and roadways that allow drivers to connect to the regional network. Major planned infrastructure projects that will affect the regional network were incorporated where applicable in the No-Build and the Modified LPA and options transportation networks.

All regional transportation projects noted in Section 4.2.1, Major Improvement Projects to Regional Roadways, were considered in the No-Build and the Modified LPA and options analyses. In addition to those major projects, planned municipal improvements were also included.

4.6.1.1 No-Build Alternative

- Geometry and signal changes at the Fourth Plain Boulevard and I-5 interchange as part of the Fourth Plain and Fort Vancouver Safety and Mobility Project.
- Geometry changes along Fourth Plain Boulevard at St. Johns Boulevard, Fort Vancouver Way, and along Fort Vancouver Way at McLoughlin Boulevard as part of the Fourth Plain and Fort Vancouver Safety and Mobility Project.
- Geometry changes along Mill Plain Boulevard at the Fort Vancouver Way intersection as part of the Fourth Plain and Fort Vancouver Safety and Mobility Project.

4.6.1.2 Modified LPA and Options

All changes listed under the No-Build Alternative plus:

- Updated geometry changes in the transportation network at the Fourth Plain Boulevard and I-5 interchange.
- Geometry changes in the transportation network at the Mill Plain Boulevard and I-5 interchange.
- Geometry changes in the roadway network at C Street and 6th Street providing access to I-5 southbound via downtown Vancouver.
- Three intersections (#52A, 4A, and 56A) added in the roadway network in downtown Vancouver.

- Changes to Hayden Island intersections related to the removal of the I-5 southbound on-ramp and I-5 northbound off-ramp. Includes addition of arterial bridge locally connecting Hayden Island to Marine Drive.
- Geometry changes in the transportation network at the Marine Drive and I-5 interchange. Includes three additional roundabouts to provide state facility access from Marine Drive.

4.6.1.3 Changes to Local Traffic Patterns in the Modified LPA and Options

Within Washington, the Modified LPA would change local traffic patterns compared to the No-Build Alternative, primarily in the Esther Short and Arnada neighborhoods in downtown Vancouver. These changes would be the result of modifications to the interchanges in this area. Effects would be similar across design options except for the option without the C Street ramps that would cause additional changes to traffic patterns by eliminating an access point to the downtown area.

The Modified LPA and options would affect local traffic patterns within the Hayden Island, Bridgeton, and North and Northeast Portland neighborhoods in the IBR Program Area. The changes to local traffic patterns would primarily result from the revised Hayden Island and Marine Drive interchanges and the proposed arterial bridge over North Portland Harbor.

All movements for the Hayden Island interchange would be reconfigured with the Modified LPA options. A half-diamond interchange would be built on Hayden Island with a northbound I-5 entrance ramp from Jantzen Drive and southbound I-5 exit ramp to Jantzen Drive. The southbound I-5 entrance ramp and northbound I-5 exit ramp would not be included on Hayden Island. Instead, ramps for those movements would be connected to the new local street that crosses under I-5 just north of Marine Drive. Vehicles traveling northbound on I-5 wanting to access Hayden Island would exit with traffic going to the Marine Drive interchange, cross under Marine Drive to the new local street, and use the arterial bridge to cross North Portland Harbor. Vehicles on Hayden Island looking to enter I-5 southbound would use the arterial bridge to cross North Portland Harbor, cross under I-5 using the new local street, cross under Marine Drive, merge with the Marine Drive southbound entrance ramp, and enter I-5 southbound at the Marine Drive interchange. A new local road, Tomahawk Island Drive, would travel east-west through the middle of Hayden Island and under the I-5 interchange, thus improving connectivity across I-5 on the island.

The Marine Drive interchange would be reconfigured to a single-point urban interchange. With this configuration, all four legs of the interchange would converge at a single point on Marine Drive over the I-5 mainline. The revised interchange configuration would change the westbound Marine Drive and westbound Vancouver Way connections to Martin Luther King Jr. Boulevard and to northbound I-5. These two streets would access westbound Martin Luther King Jr. Boulevard east of the existing access points. Martin Luther King Jr. Boulevard would have a new direct connection to I-5 northbound. The connections from Vancouver Way and Marine Drive would be served by improving the existing connection to Martin Luther King Jr. Boulevard east of the interchange. The improvements to this connection would allow traffic to turn right from Vancouver Way and accelerate onto Martin Luther King Jr. Boulevard. On the south side of Martin Luther King Jr. Boulevard, the existing loop connection would be replaced with a new connection east of the existing access point.

The arterial bridge over North Portland Harbor would be two-lanes and serve local traffic between the Oregon mainland via Vancouver Avenue and Hayden Island. This structure would also include a shared-use path for pedestrians and bicyclists. All of the new structures would have at least as much vertical clearance over North Portland Harbor as the existing North Portland Harbor bridge.

The proposed Hayden Island interchange configuration would create an alternative method to access northbound I-5 from Bridgeton and to travel from southbound I-5 to the Bridgeton neighborhood. There is potential for traffic from east of I-5 to use the Hayden Island northbound I-5 on-ramp instead of the Marine Drive northbound I-5 on-ramp during periods when northbound mainline I-5 is congested. Ramp meter rates could be set to discourage overuse of the Hayden Island northbound I-5 on-ramp. The proposed new roadway north of Marine Drive but below Marine Drive would provide direct access for Bridgeton traffic that is traveling to or from I-5 south of the interchange as well as access to Expo Road on the west of I-5.

4.6.2 Study Intersections

The No-Build Alternative analysis included the same 80 intersections that were analyzed as part of the existing conditions analysis. To analyze the traffic impacts for the Modified LPA and options roadway network, 11 intersections were added and 5 intersections were removed, resulting in 86 total study intersections.

Additionally, 5 intersections had their names changed due to new geometry. Intersection names typically changed when access to I-5, or other streets, was changed due to the proposed design.

New intersections considered in the future-year analysis were given ID numbers that matched the closest existing intersection along with a letter designation. This was done to help identify where new intersections were located. For example, the Modified LPA and options analysis considered a new intersection at Columbia Way and Main Street. This intersection was near the existing intersection #56 at Columbia Way and Columbia Street. Thus, the new intersection at Columbia Way and Main Street was given an ID number of #56A.

The study intersections were categorized into the four subareas based on their proximity to interchange areas and because different partner agencies have different performance standards. Table 4-22 summarizes the number of study intersections in each subarea.

Table 4-22. Intersection Subareas

#	Subarea	Total Intersections	Intersection #
1	SR 500, Main Street, 39th Street, and Fourth Plain Boulevard	17	#1–17
2	Mill Plain Boulevard	18	#18–35
3	SR 14, City Center Interchange, Columbia Way	23 (No-Build) 26 (Modified LPA)	#36–58
4	Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard	22 (No Build) 25 (Modified LPA)	#59–80

Source: IBR Analysis

The changes from the existing study intersections to the Modified LPA and options roadway network are listed by subarea in Table 4-23, and intersection locations are shown in Figure 4-20 and Figure 4-21.

Table 4-23. Intersection Changes with the Modified LPA and Options

ID	Intersection Change
Subarea 1 – SR 500, Main Street, 39th Street, and Fourth Plain Boulevard	
N/A	N/A
Subarea 2 – Mill Plain Boulevard	
N/A	N/A
Subarea 3 – SR 14, City Center Interchange, and Columbia Way	
51	Name changed to 6th Street and C Street/I-5 southbound on-ramp.
52	Name changed to 5th Street and Washington Street.
52A	Added 5th Street and Main Street.
54	Name changed to Phil Arnold Way and Columbia Street/SR 14 westbound off-ramp.
54A	Added Phil Arnold Way and Main St/SR 14 eastbound on-ramp.
56A	Added Columbia Way and Main Street.
Subarea 4 – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard	
60	Removed Hayden Island Drive (south) and Hayden Island Drive connector to North Hayden Island Drive.
60A	Added Hayden Island Drive (south) and arterial bridge access road.
61	Removed Hayden Island Drive (north) and Hayden Island Dr Connector to South Hayden Island Drive.
61A	Added Hayden Island Drive (South) and Jantzen Drive.
62	Name changed to Center Avenue and N Tomahawk Island Drive.
62A	Added Tomahawk Island Drive and arterial bridge access.
63	Removed I-5 northbound Hayden Island off-ramp and Tomahawk Island Drive.
65	Removed Center Avenue and Jantzen Avenue.

ID	Intersection Change
65A	Added I-5 southbound Hayden Island off-ramp and Tomahawk Island Drive.
65B	Added I-5 northbound Hayden Island on-ramp and Tomahawk Island Drive.
69	Name changed to Marine Drive and Vancouver Way.
69A	Added I-5 southbound Marine Drive on-ramp and N Pier 99 Street.
69B	Added I-5 northbound Marine Drive off-ramp and N Pier 99 Street.
69C	Added N Vancouver Way and N Pier 99 Street.
71	Removed I-5 northbound off-ramp and Union Court/Marine Way.

Source: IBR Analysis

Figure 4-20. Intersection Analysis Study Intersections for the City of Vancouver – Modified LPA and Options

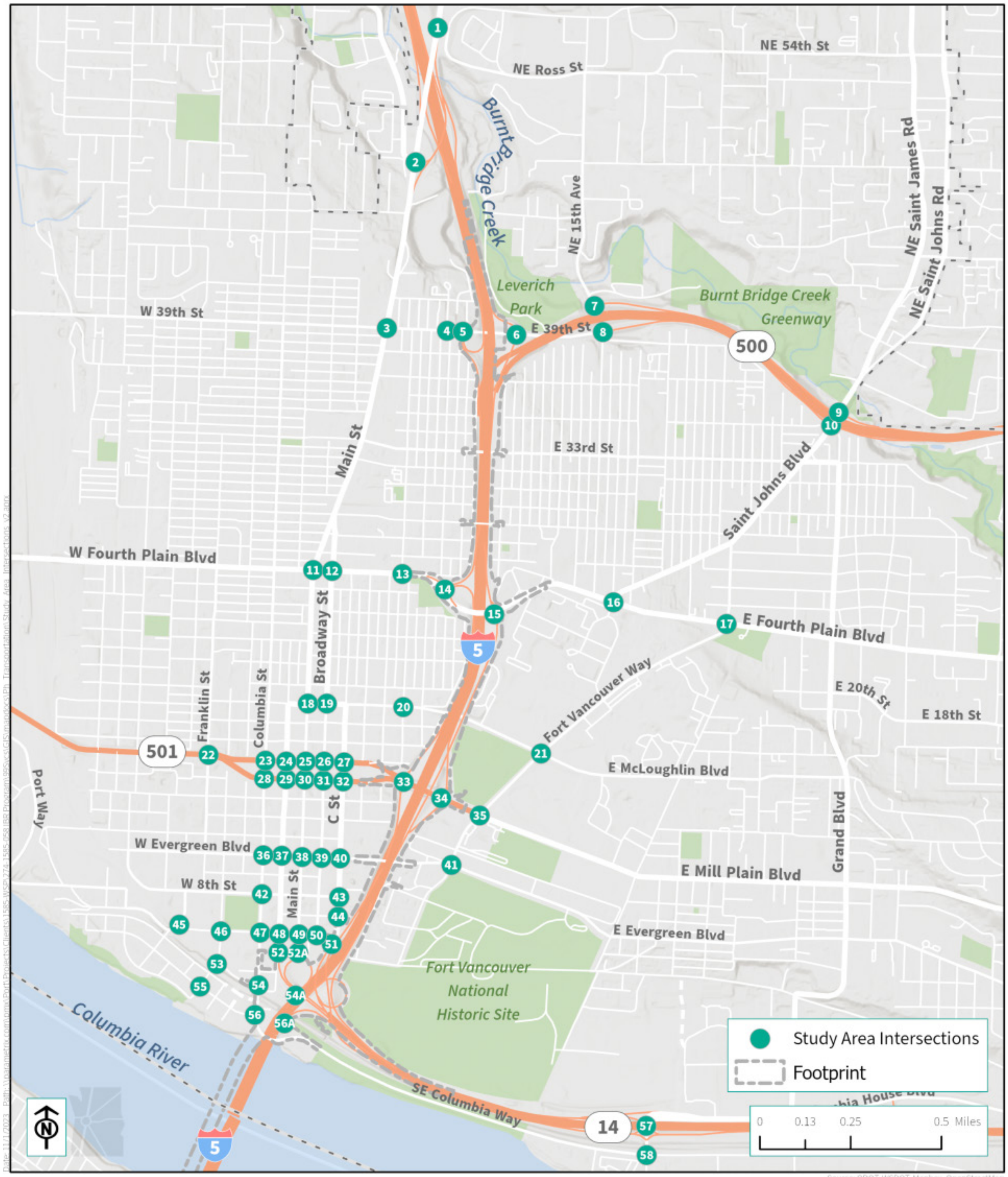
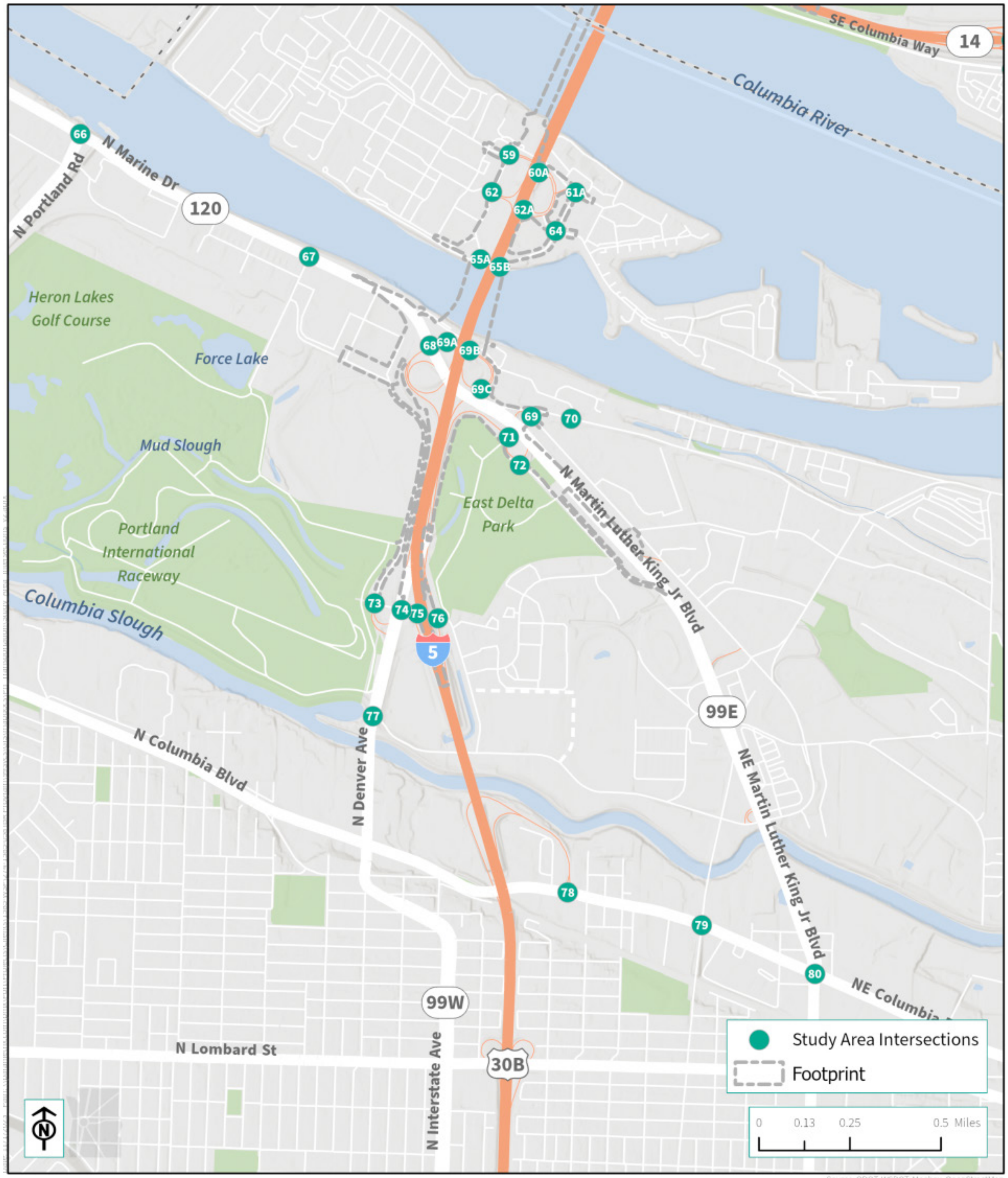


Figure 4-21. Intersection Analysis Study Intersections for the City of Portland – Modified LPA and Options



4.6.3 Peak-Hour Traffic Forecasts

This section describes the volume forecasting process for traffic demand in 2045 for the No-Build Alternative and the Modified LPA and options for the AM and PM peak hours. The Modified LPA and options include two park and rides: one at a waterfront location and one near an Evergreen Boulevard location. The Waterfront Park-and-Ride would include 570 parking spaces and the Evergreen Park-and-Ride would include 700 parking spaces. Peak-hour traffic volumes are summarized in Appendix D.

4.6.3.1 No-Build Alternative

In the No-Build Alternative, local roadway traffic volumes were developed using the following steps:

1. Summarize the year 2015 and 2045 No-Build Alternative Metro/RTC regional travel demand model volumes along key roadways.
2. Calculate the annual growth rate between 2015 and the 2045 No-Build Alternative Metro/RTC regional travel demand model.
3. Apply the annual growth rate to existing 2019 volumes to calculate 2045 volumes.
4. Balance volumes on the local system consistent with 2045 No-Build Alternative forecast freeway ramp volumes (see Section 4.3.3, Mainline and Ramp Vehicle Volumes).

The annual traffic growth rates (2019 to 2045) were calculated based on several key north-south and east-west screenlines within each intersection analysis area (Vancouver and Portland). Annual traffic growth rates for the No-Build Alternative are shown in Table 4-24.

Table 4-24. Traffic Volumes Annual Growth Rates for the No-Build Alternative

Screenline Location	Related Intersections	AM Peak-Period Annual Growth Rate	PM Peak-Period Annual Growth Rate
General Vancouver Area	1–15, 18–35, 41, 57–58	1.3%	1.2%
Downtown Vancouver	36–40, 42–44, 47–52	2.1%	1.7%
Vancouver Waterfront	45–46, 53–56	3.6%	3.2%
Fourth Plain Boulevard	16–17	0.3%	0.3%
Hayden Island	59–65	1.1%	1.4%
General Portland Area	66–80	1.1%	1.2%

Source: IBR Analysis

4.6.3.2 Modified LPA and Options

Local roadway traffic forecast volumes for the Modified LPA and options were developed using the same four steps outlined in Section 4.6.3.1, No-Build Alternative, and the additional steps listed below:

1. As described above, the Modified LPA and options would create new intersections or modified access at existing intersections. Where access was modified, trips were redistributed to

account for the modified network. For example, the existing southbound I-5 on-ramp from downtown Vancouver to I-5 is accessed from Washington Street under existing conditions, but with the Modified LPA and options, the access would be moved to C Street. Vehicle trips were therefore reassigned to reflect the changed I-5 access.

2. Vehicle trips to and from the park and rides were also added to the network. The total number of park-and-ride trips occurring in the peak hour was assumed to be 50% of the total parking spaces at a park-and-ride location (285 peak-hour trips at the Waterfront Park and Ride and 350 peak-hour trips at the Evergreen Park and Ride). This was determined through review of existing park-and-ride locations in the Portland-Vancouver system, as well as similar LRT park-and-ride stations in the Northwest. Actual mode of access will depend largely on future land use development patterns around stations, bus service, and activity associated with transportation network companies and autonomous vehicles. In the AM peak hour, these are inbound trips to the park and ride and in the PM peak hour these are outbound trips leaving the park and ride. The park-and-ride trips were assigned to the network based on the distribution of trips in the Metro/RTC regional travel demand model. These trips are in addition to the annual growth rates presented in Table 4-25.
3. Pickup/drop-off trips at the park and rides also needed to be added to the intersection volumes. These were assumed to occur at a rate of 15% of the total parking spaces during the peak hour at the park and ride lots (45 peak-hour trips at the Waterfront Park and Ride and 50 peak-hour trips at the Evergreen Park and Ride). These trips are both inbound and outbound during each peak hour. Similar to the park and ride trips, these were assigned to the network based on the distribution of trips in the Metro/RTC regional travel demand model. These trips are in addition to the annual growth rates presented in Table 4-25.
4. The Modified LPA and options include highway improvements, transit improvements, active transportation improvements, and tolling, which would in combination result in a reduction in peak-hour vehicle trips through the IBR Program Area compared to the No-Build Alternative. The annual traffic growth rates (2019 to 2045) were calculated based on several key north-south and east-west screenlines within each intersection analysis area (Vancouver and Portland). Annual traffic growth rates for the Modified LPA and options are as shown in Table 4-25.

Table 4-25. Traffic Volumes Annual Growth Rates for the Modified LPA and Options

Screenline Location	Related Intersections	AM Peak Period Annual Growth Rate	PM Peak Period Annual Growth Rate
General Vancouver Area	1–15, 18–35, 41, 57–58	1.1%	0.6%
Downtown Vancouver	36–40, 42–44, 47–52	1.6%	1.9%
Vancouver Waterfront	45–46, 53–56	3.1%	3.5%
Fourth Plain Boulevard	16–17	0.2%	0.2%
Hayden Island	59–65	0.5%	1.2%
General Portland Area	66–80	1.4%	1.1%

Source: IBR Analysis

4.6.4 Intersection Operations

The 2045 traffic operations analysis included 80 intersections in the AM and PM peak hours for the No-Build Alternative and 86 intersections for the Modified LPA and options. The local traffic operations analysis results for the Modified LPA with two auxiliary lanes are identical to the Modified LPA results in all four study subareas. Therefore, this report references only the local traffic operational results for the Modified LPA.

The No-Build Alternative and the Modified LPA and options traffic operations reflect 2045 traffic conditions based on traffic volume growth rates, planned projects, and future roadway conditions. Signal timing plans were optimized for the No-Build Alternative and the Modified LPA and options, including new proposed intersections.

Several site options were considered to analyze various placements for each of the two downtown Vancouver park and rides. The park-and-ride site alternatives were found not to significantly change intersection operation results.

Under the No-Build Alternative, nine intersections (#3, 5, 11, 57, 58, 66, 67, 68, and 79) would not meet performance standards in the AM and/or PM peak hours.

Under the Modified LPA, eight intersections (#3, 5, 11, 57, 58, 66, 68, and 79) would not meet performance standards in the AM and/or PM peak hours. All of the intersections that would not meet the performance standards for the Modified LPA also would not meet standards under the No-Build Alternative.

Under the Modified LPA without C Street ramps, 14 intersections (#3, 5, 11, 22, 24, 25, 28, 31, 34, 57, 58, 66, 68, and 79) would not meet performance standards in the AM and/or PM peak hours. All of the intersections that would not meet the performance standards for the Modified LPA without C Street ramps, but would meet standards in the Modified LPA, are in Subarea 2.

4.6.4.1 Subarea 1: SR 500, Main Street, 39th Street, and Fourth Plain Boulevard

Subarea 1 consists of 17 study intersections and spans across SR 500, 39th Street, Main Street, and the Fourth Plain Boulevard corridor. The traffic operation analysis for the Modified LPA options is identical to the Modified LPA in Subarea 1.

Figure 4-22 and Figure 4-23 illustrate the location of study intersections in Subarea 1 and whether the intersection would or would not meet the relevant agency standards for the AM and PM peak in the No-Build Alternative and the Modified LPA, respectively.

Table 4-26 and Table 4-27 show the intersection operations in Subarea 1 for both the No-Build Alternative and the Modified LPA, during the AM and PM peak respectively. Intersections that would fail to meet performance standards are shaded in red.

IMPACTS FOR THE NO-BUILD ALTERNATIVE

During the AM peak, all study intersections for the No-Build Alternative in Subarea 1 would operate at or better than the intersection performance standards except for two:

- 39th Street and I-5 southbound on-/off-ramps (Intersection #5).
- Fourth Plain Boulevard and Main Street (Intersection #11).

During the PM peak, all study intersections for the No-Build Alternative in Subarea 1 would operate at or better than the intersection performance standards except for two:

- 39th Street and Main Street (Intersection #3).
- 39th Street and I-5 southbound on-/off-ramps (Intersection #5).

IMPACTS FOR THE MODIFIED LPA

During the AM peak, all study intersections for the Modified LPA in Subarea 1 would operate at or better than the intersection performance standards except for two:

- 39th Street and I-5 southbound on-/off-ramps (Intersection #5).
- Fourth Plain Boulevard and Main Street (Intersection #11).

There were no intersections during the AM peak that would operate satisfactorily for the No-Build Alternative but would fail to meet the performance standards under the Modified LPA.

During the PM peak, all study intersections for the Modified LPA in Subarea 1 operate at or better than the intersection performance standards except for two:

- 39th Street and Main Street (Intersection #3).
- 39th Street and I-5 southbound on-/off-ramps (Intersection #5).

There were no intersections during the PM peak that would operate satisfactorily for the No-Build Alternative but would fail to meet the performance standards under the Modified LPA.

IMPACTS COMMON TO ALL POTENTIAL PARK AND RIDE SITES

All potential park-and-ride sites would have similar traffic operations as the Modified LPA for intersections in Subarea 1.

Figure 4-22. Subarea 1 – No-Build Traffic Operations – SR 500/Main Street/39th Street/Fourth Plain Boulevard

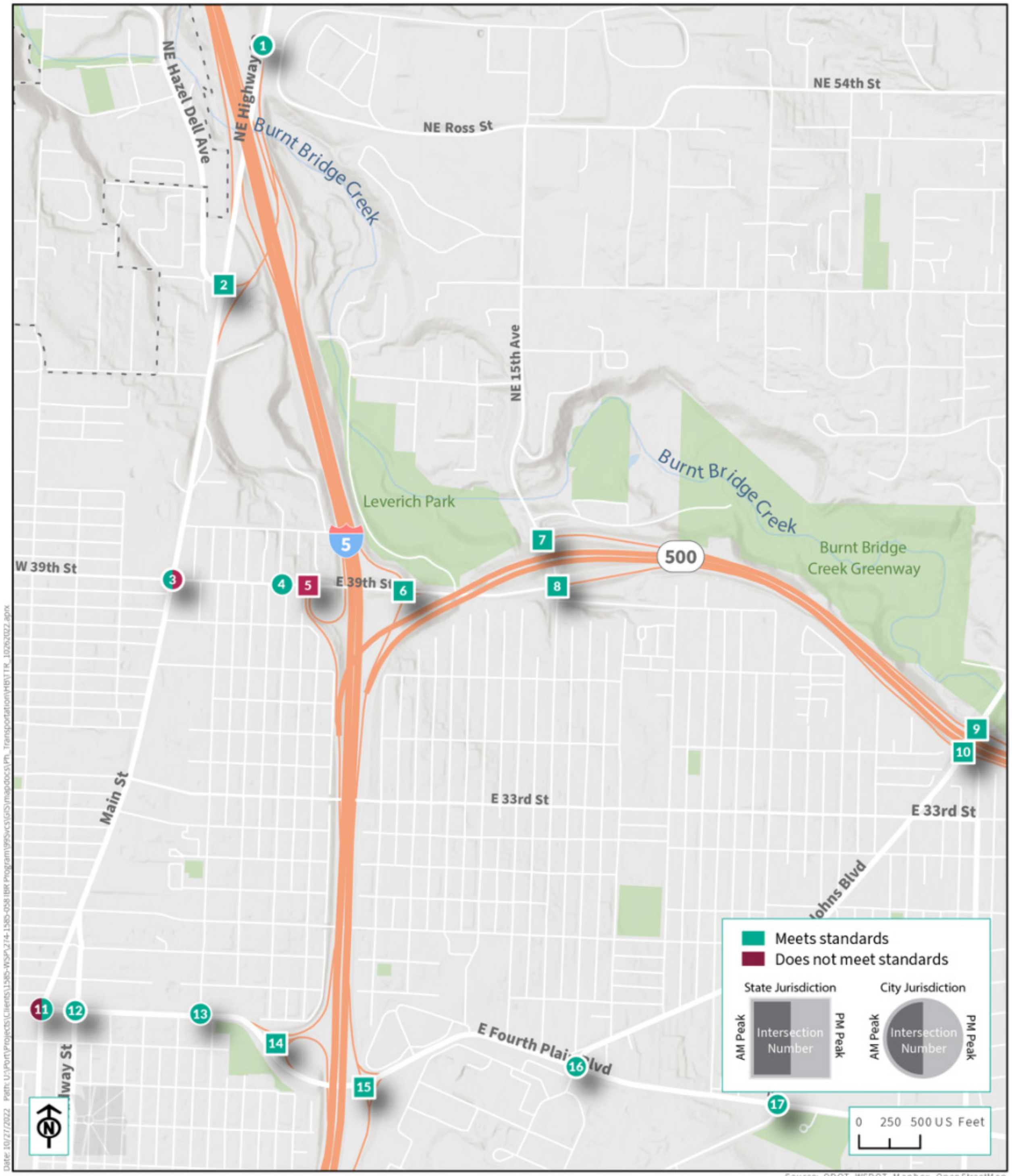


Figure 4-23. Subarea 1 – Modified LPA Traffic Operations – SR 500/Main Street/39th Street/Fourth Plain Boulevard

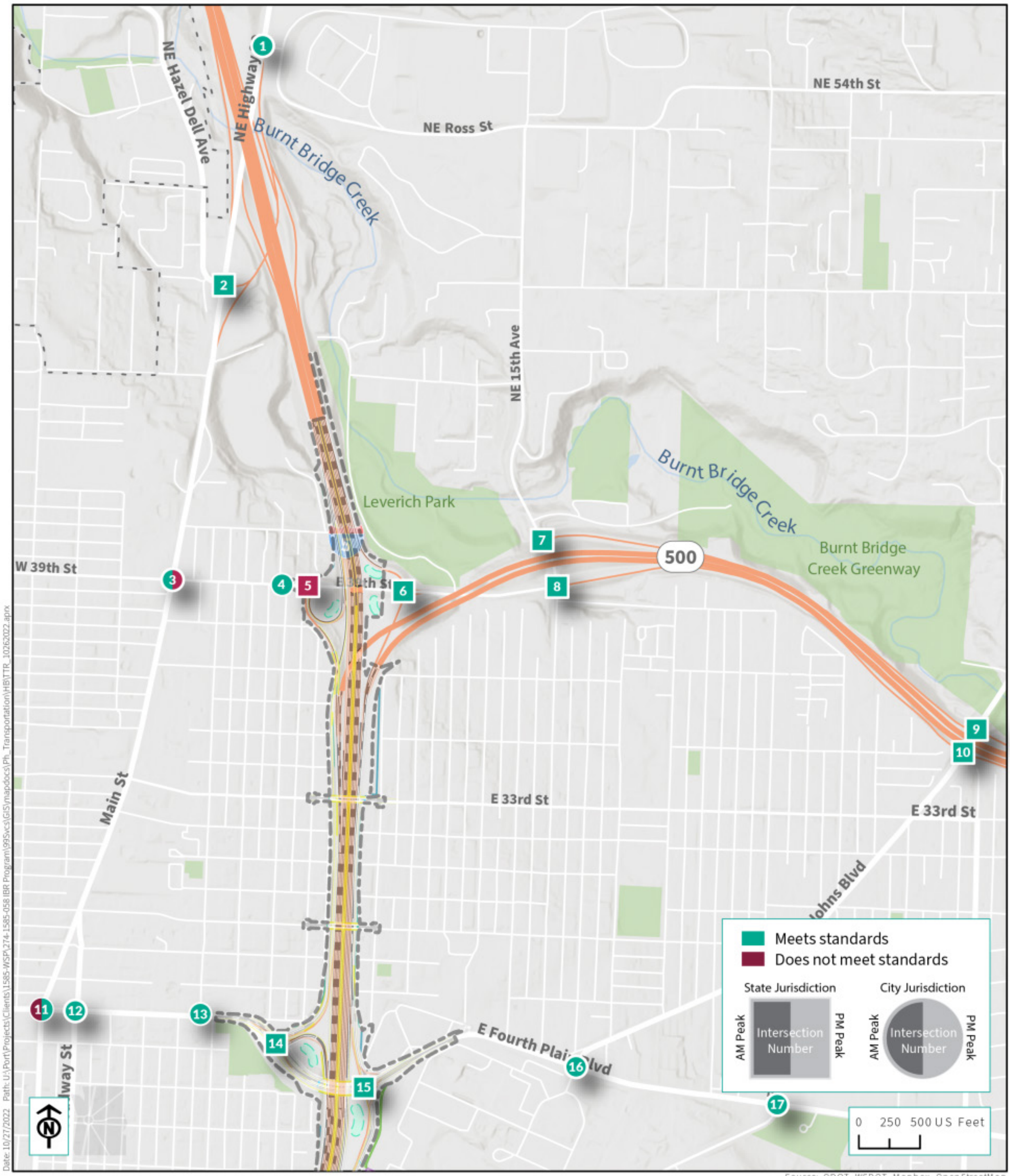


Table 4-26. 2045 AM Peak-Hour Traffic Operations – Subarea 1, SR 500/Main Street/39th Street

Number	Intersection	Control Type	No-Build Alternative					Modified LPA and Options				
			Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard
1	Main St and Ross St	Signal	LOS E COV	A	3	0.31	Y	LOS E COV	A	3	0.29	Y
2	Main St and Hazel Dell Ave	Signal	LOS D WSDOT	A	6	0.51	Y	LOS D WSDOT	A	5	0.43	Y
3	Main St and 39th St [a]	Signal	LOS E COV	C	26	0.86	Y	LOS E COV	C	21	0.74	Y
4	39th Street and H Street	Signal	LOS E COV	B	20	0.53	Y	LOS E COV	B	15	0.47	Y
5	I-5 SB Ramp and 39th St [a]	TWSC	LOS D WSDOT	F	> 300	1.12	N	LOS D WSDOT	F	> 300	1.02	N
6	I-5 NB Ramp and 39th St [a]	Signal	LOS D WSDOT	B	19	0.79	Y	LOS D WSDOT	B	19	0.76	Y
7	15th Ave and SR 500 WB off-ramp	Signal	LOS E WSDOT	A	9	0.57	Y	LOS E WSDOT	A	9	0.57	Y
8	15th Ave and 39th St [a]	Signal	LOS E WSDOT	A	9	0.80	Y	LOS E WSDOT	A	8	0.77	Y
9	St Johns Blvd and SR 500 WB Ramp [a]	Signal	LOS E WSDOT	B	16	0.46	Y	LOS E WSDOT	B	14	0.44	Y
10	St Johns Blvd and SR 500 EB Ramp [a]	Signal	LOS E WSDOT	B	11	0.42	Y	LOS E WSDOT	B	11	0.41	Y
11	Fourth Plain Blvd and Main St [a]	Signal	LOS E COV	F [b]	> 300 [b]	1.11 [b]	N [b]	LOS E COV [b]	F [b]	279 [b]	1.11 [b]	N [b]
12	Fourth Plain Blvd and Broadway St [a]	Signal	LOS E COV	C	31	0.72	Y	LOS E COV	C	33	0.74	Y
13	Fourth Plain Boulevard and F Street	Signal	LOS E COV	B	18	0.39	Y	LOS E COV	B	15	0.42	Y
14	Fourth Plain Blvd and I-5 SB on-/off-ramps [a]	Signal	LOS D WSDOT	B	13	0.77	Y	LOS D WSDOT	B	14	0.54	Y
15	Fourth Plain Blvd and I-5 NB on-/off-ramps [a]	Signal	LOS D WSDOT	B	15	0.83	Y	LOS D WSDOT	B	14	0.66	Y
16	Fourth Plain Blvd and St. Johns Blvd [a]	Signal	LOS E COV	B	12	0.71	Y	LOS E COV	B	13	0.75	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA and Options Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard
17	Fourth Plain Blvd and Fort Vancouver Way [a]	Signal	LOS E COV	B	20	0.77	Y	LOS E COV	B	19	0.77	Y

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 4.3.4.5 for more information.

b Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

Table 4-27. 2045 PM Peak-Hour Traffic Operations – Subarea 1, SR 500, Main Street, and 39th Street

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA and Options Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard
1	Main St and Ross St	Signal	LOS E COV	A	6	0.49	Y	LOS E COV	A	6	0.43	Y
2	Main St and Hazel Dell Ave	Signal	LOS D WSDOT	A	9	0.53	Y	LOS D WSDOT	A	8	0.47	Y
3	Main St and 39th St	Signal	LOS E COV	F [a]	185 [a]	0.64 [a]	N [a]	LOS E COV [a]	F [a]	152 [a]	0.59 [a]	N [a]
4	39th Street and H Street	Signal	LOS E COV	E	57	0.56	Y	LOS E COV	C	31	0.52	Y
5	I-5 SB Ramp and 39th St	TWSC	LOS D WSDOT	F [a]	> 300 [a]	1.04 [a]	N [a]	LOS D WSDOT [a]	F [a]	> 300 [a]	1.03 [a]	N [a]
6	I-5 NB Ramp and 39th St	Signal	LOS D WSDOT	D	35	0.86	Y	LOS D WSDOT	C	25	0.86	Y
7	15th Ave and SR 500 WB off-ramp	Signal	LOS E WSDOT	B	10	0.54	Y	LOS E WSDOT	A	9	0.53	Y
8	15th Ave and 39th St	Signal	LOS E WSDOT	A	8	0.72	Y	LOS E WSDOT	A	7	0.72	Y
9	St Johns Blvd and SR 500 WB Ramp	Signal	LOS E WSDOT	B	19	0.50	Y	LOS E WSDOT	B	17	0.46	Y
10	St Johns Blvd and SR 500 EB Ramp	Signal	LOS E WSDOT	C	23	0.54	Y	LOS E WSDOT	B	19	0.49	Y
11	Fourth Plain Blvd and Main St	Signal	LOS E COV	C	31	0.77	Y	LOS E COV	C	30	0.74	Y
12	Fourth Plain Blvd and Broadway St	Signal	LOS E COV	D	52	0.77	Y	LOS E COV	D	45	0.74	Y
13	Fourth Plain Boulevard and F Street	Signal	LOS E COV	D	36	0.53	Y	LOS E COV	C	25	0.55	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build Alternative LOS	No-Build Alternative Delay (sec/veh)	No-Build Alternative V/C	No-Build Alternative Meets Standard	Modified LPA and Options Standard (Agency)	Modified LPA and Options LOS	Modified LPA and Options Delay (sec/veh)	Modified LPA and Options V/C	Modified LPA and Options Meets Standard
14	Fourth Plain Blvd and I-5 SB on-/off-ramps	Signal	LOS D WSDOT	C	33	0.79	Y	LOS D WSDOT	C	26	0.53	Y
15	Fourth Plain Blvd and I-5 NB on-/off-ramps	Signal	LOS D WSDOT	D	37	0.84	Y	LOS D WSDOT	B	11	0.64	Y
16	Fourth Plain Blvd and St. Johns Blvd	Signal	LOS E COV	C	20	0.73	Y	LOS E COV	B	19	0.74	Y
17	Fourth Plain Blvd and Fort Vancouver Way	Signal	LOS E COV	C	25	0.57	Y	LOS E COV	C	26	0.60	Y

Source: IBR Analysis

a Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

4.6.4.2 Subarea 2: Mill Plain Boulevard

Subarea 2 consists of 18 study intersections and covers McLoughlin Boulevard, 15th Street, and Mill Plain Boulevard. The traffic operation analysis for the Modified LPA with two auxiliary lanes is identical to the Modified LPA in Subarea 2.

Figure 4-24 through Figure 4-26 illustrate the location of study intersections in Subarea 2 and whether the intersection meets or does not meet the relevant agency standards for the AM and PM peak in the No-Build and the Modified LPA with and without C Street ramps.

Table 4-28 and Table 4-29 show the intersection operations in Subarea 2 for the No-Build Alternative and the Modified LPA with and without C Street ramps during the AM and PM peaks, respectively. Intersections that would fail to meet performance standards are shaded in red.

IMPACTS FOR THE NO-BUILD ALTERNATIVE

During the AM and PM peaks, all study intersections for the No-Build Alternative in Subarea 2 would operate at or better than the intersection performance standards.

IMPACTS FOR THE MODIFIED LPA

During the AM and PM peak, all study intersections for the Modified LPA in Subarea 2 would operate at or better than the intersection performance standards.

IMPACTS FOR THE MODIFIED LPA WITHOUT C STREET RAMPS

This design option would remove access between I-5 and downtown Vancouver provided by the C Street ramps. Removal of the C Street ramps would result in substantial impacts to the Mill Plain Boulevard and I-5 interchange and to the Mill Plain Boulevard (eastbound) and 15th Street (westbound) couplet west of I-5. The number of redirected trips from downtown Vancouver that would otherwise have accessed I-5 through C Street would lead to much higher delays across several intersections, as well as queuing and blocking issues through the Mill Plain Boulevard and 15th Street couplet west of I-5 . During the AM peak, two intersections for this design option would fail the relevant intersection performance standards:

- Washington Street and 15th Street (Intersection #24).
- Main Street and 15th Street (Intersection #25).

In the AM peak, all of the intersections above would fail performance standards for this design option but would operate satisfactorily under the No-Build Alternative and Modified LPA.

During the PM peak, four study intersections for this design option would fail the relevant intersection performance standards:

- Franklin Street & Mill Plain Boulevard (Intersection #22).
- Columbia Street & Mill Plain Boulevard (Intersection #28).
- Mill Plain Boulevard and Broadway Street (Intersection #31).

- Mill Plain Boulevard and I-5 northbound on-/off-ramps (Intersection #34).

In the PM peak, all of the intersections above would fail relevant performance standards in this design option but would operate satisfactorily under the No-Build Alternative and Modified LPA.

The impact of removing the C Street ramps and adding volume through the Mill Plain Boulevard and 15th Street couplet and the Mill Plain and I-5 interchange is only partially captured in Table 4-28 and Table 4-29, and Figure 4-24 through Figure 4-26, which show the overall intersection delay.

One of the impacts not captured by the overall intersection delay is the queuing through the Mill Plain Boulevard and 15th Street couplet. In the Modified LPA (without the C Street ramps), there is additional volume at the northbound off-ramp left-turn movement compared to the Modified LPA. This additional volume conflicts with the critical eastbound left-turn volume to the I-5 northbound on-ramp and causes substantial queues to form on the northbound and eastbound approaches to the Mill Plain and northbound I-5 ramps intersection (Intersection #34). The eastbound queue spills back through the Mill Plain Boulevard and 15th Street couplet, past Franklin Street, and more than doubles the delay at intersections through the eastbound couplet (Mill Plain Boulevard) during the PM peak hour.

This same impact (additional volume and additional queuing compared to the Modified LPA) is also present during the AM peak hour, but the traffic patterns are slightly different compared to the PM peak hour, so the queuing patterns are also different. During the AM peak hour, there is more queuing through the eastbound couplet (Mill Plain Boulevard) with the Modified LPA without C Street Ramps compared to the Modified LPA, but to a lesser extent than the PM peak hour because the conflicting volume at the Mill Plain and I-5 northbound ramps intersection (Intersection #34) is lower.

Overall intersection delays are presented in Table 4-28 and Table 4-29, and Figure 4-24 through Figure 4-26. Detailed turn movements are shown in Appendix D, and detailed queue information is shown in Appendix E.

IMPACTS COMMON TO ALL POTENTIAL PARK-AND-RIDE SITES

All potential park-and-ride sites would have similar traffic operations as the Modified LPA for intersections in Subarea 2.

Figure 4-24. Subarea 2 – No-Build Traffic Operations – Mill Plain Boulevard

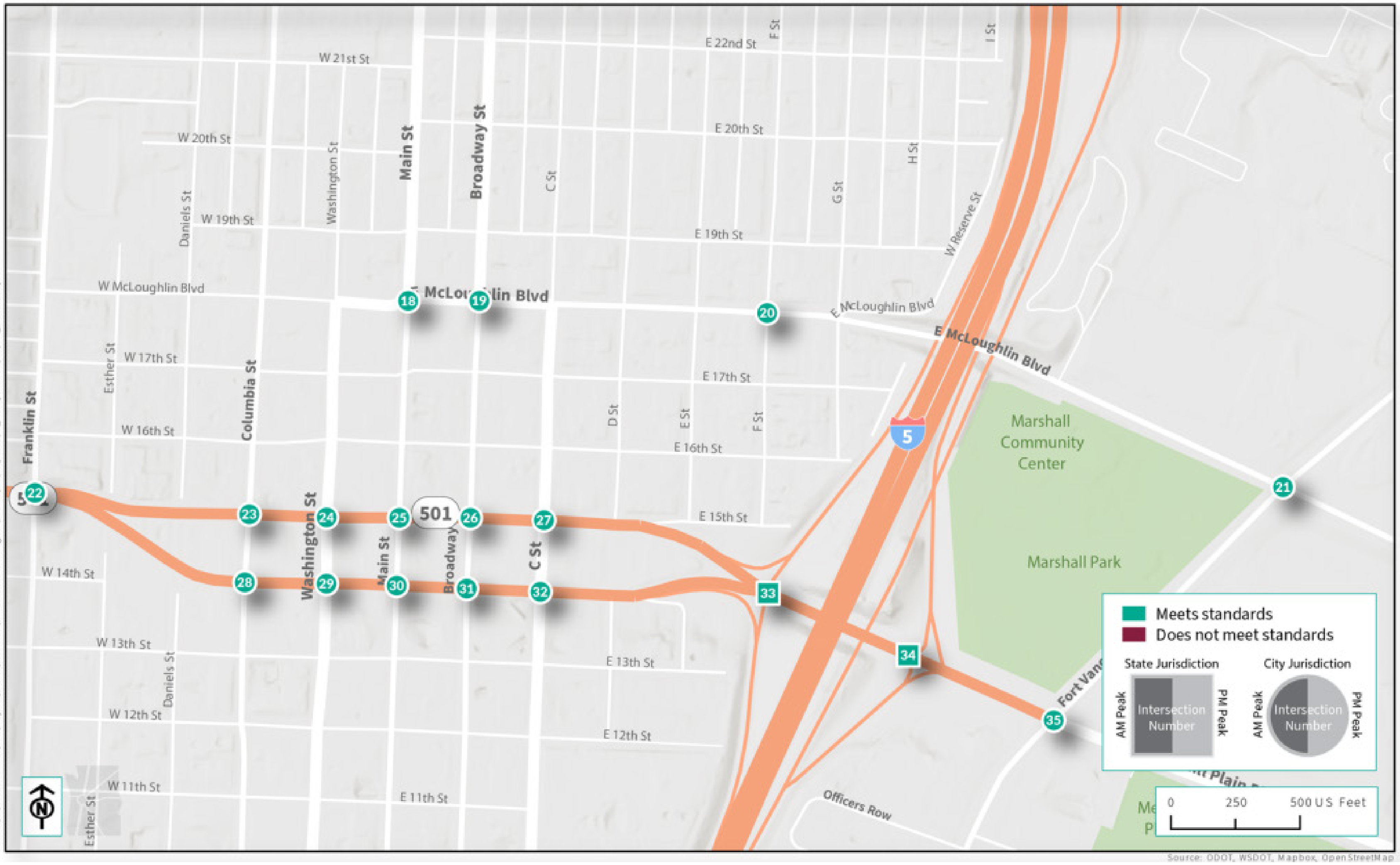


Figure 4-25. Subarea 2 – Modified LPA Traffic Operations – Mill Plain Boulevard

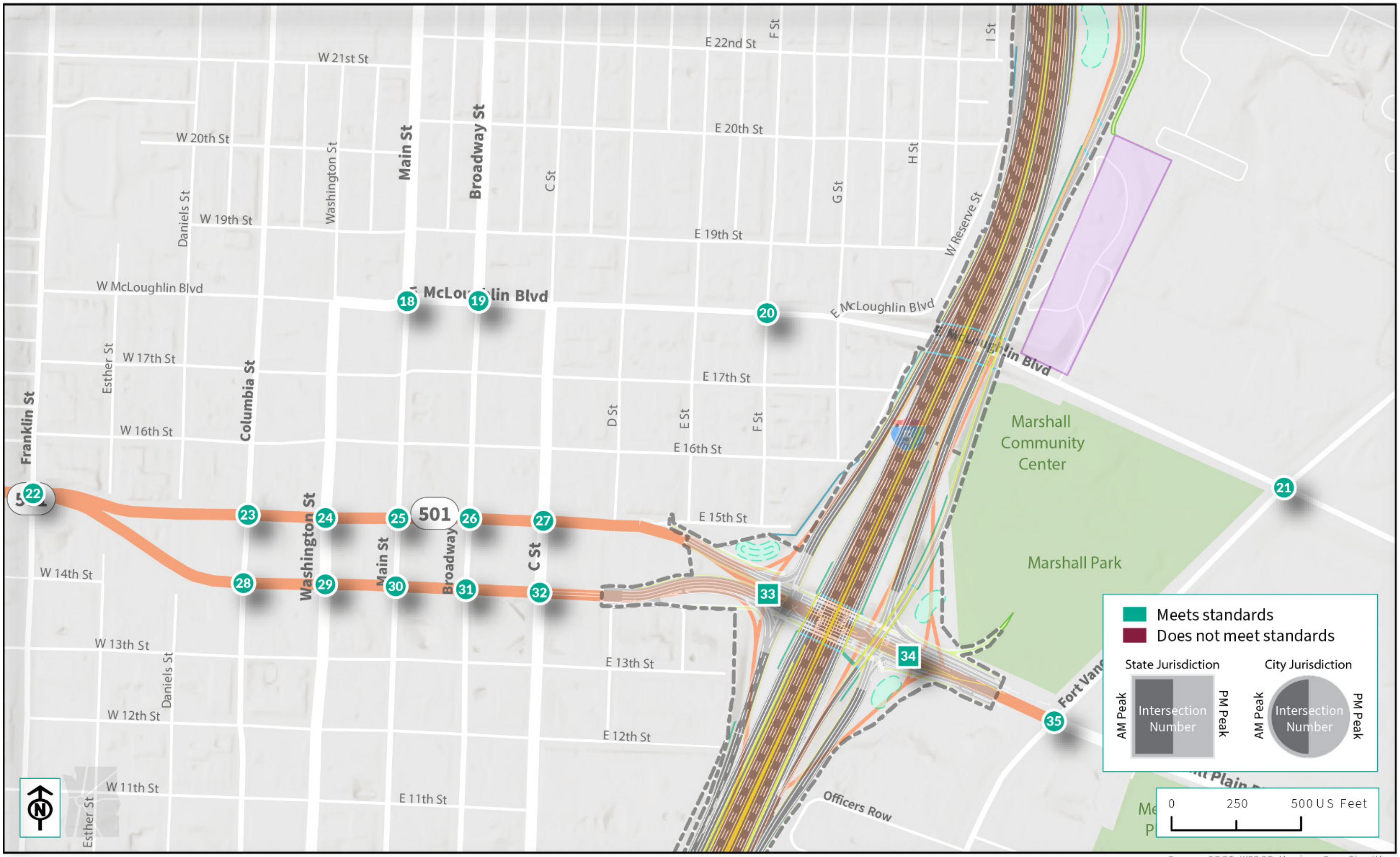


Figure 4-26. Subarea 2 – Modified LPA Without C Street Ramps Traffic Operations – Mill Plain Boulevard

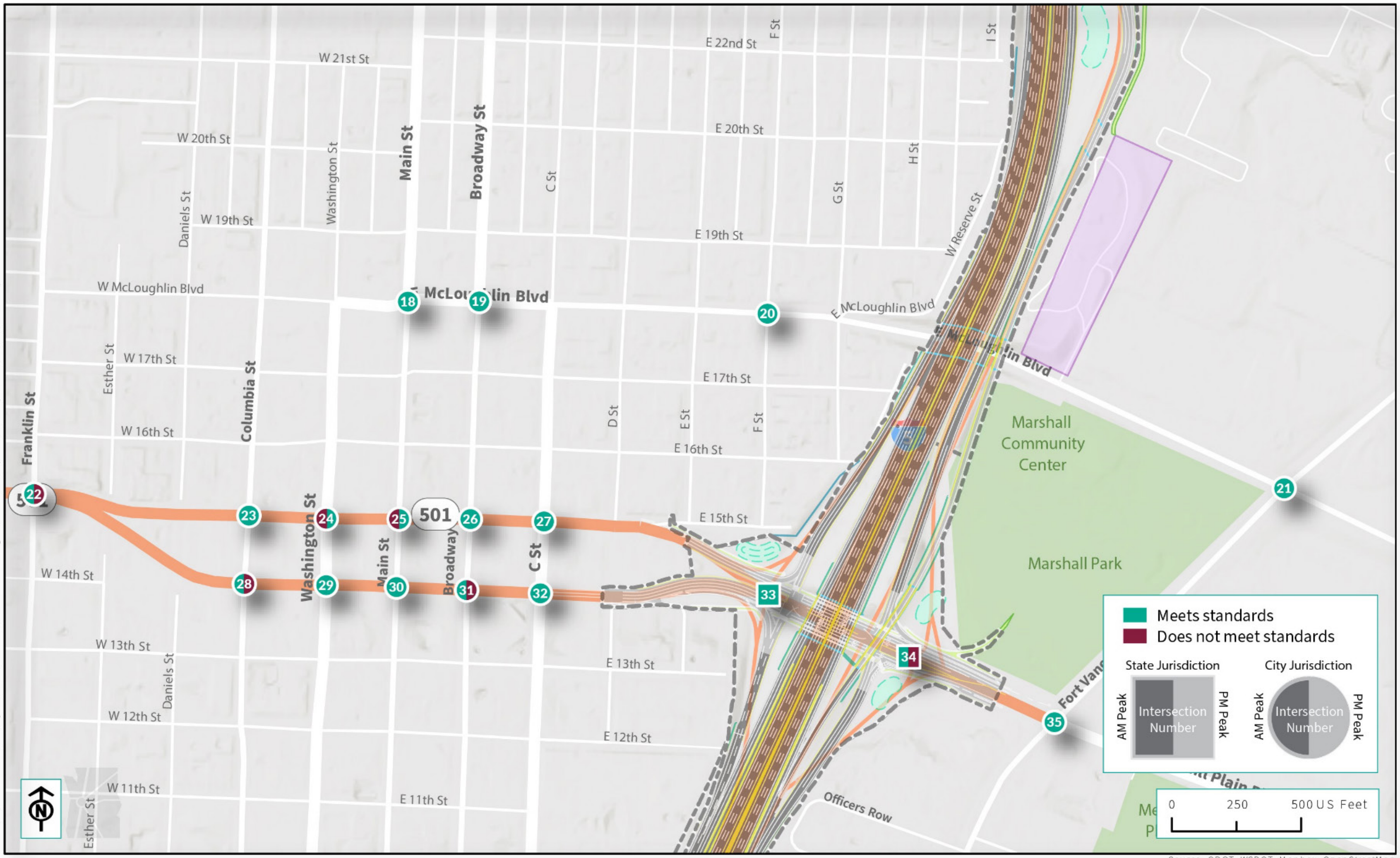


Table 4-28. 2045 AM Peak-Hour Traffic Operations – Subarea 2 Mill Plain Boulevard

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA, and Modified LPA with Two Auxiliary Lanes Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	Modified LPA Without C Street Ramps LOS	Delay (sec/veh)	V/C	Meets Standard
18	Main St and McLoughlin Blvd	Signal	LOS E COV	A	7	0.51	Y	LOS E COV	A	8	0.54	Y	A	8	0.38	Y
19	Broadway St and McLoughlin Blvd	Signal	LOS E COV	A	4	0.10	Y	LOS E COV	A	5	0.11	Y	A	5	0.14	Y
20	F St and McLoughlin Blvd	TWSC	LOS E COV	A	3	0.01	Y	LOS E COV	A	3	0.01	Y	A	3	0.01	Y
21	Fort Vancouver Way and McLoughlin Blvd	Signal	LOS E COV	B	12	0.21	Y	LOS E COV	B	11	0.23	Y	B	12	0.19	Y
22	Franklin St and Mill Plain Blvd [a]	Signal	LOS E COV	D	36	0.53	Y	LOS E COV	C	18	0.56	Y	B	18	0.49	Y
23	Columbia St and 15th Street [a]	Signal	LOS E COV	A	6	0.41	Y	LOS E COV	A	7	0.49	Y	B	15	0.37	Y
24	Washington St and 15th Street [a]	Signal	LOS E COV	A	8	0.59	Y	LOS E COV	B	16	0.65	Y	F [b]	95 [b]	0.37 [b]	N [b]
25	Main St and 15th Street [a]	Signal	LOS E COV	B	14	0.56	Y	LOS E COV	C	35	0.63	Y	F [b]	100 [b]	0.49 [b]	N [b]
26	Broadway St and 15th Street [a]	Signal	LOS E COV	A	6	0.38	Y	LOS E COV	B	11	0.47	Y	B	18	0.38	Y
27	C St and 15th Street [a]	Signal	LOS E COV	B	16	0.51	Y	LOS E COV	C	22	0.67	Y	E	64	0.64	Y
28	Columbia St and Mill Plain Blvd [a]	Signal	LOS E COV	B	11	0.40	Y	LOS E COV	A	9	0.41	Y	B	16	0.74	Y
29	Washington St and Mill Plain Blvd [a]	Signal	LOS E COV	A	8	0.38	Y	LOS E COV	A	9	0.34	Y	B	14	0.43	Y
30	Main St and Mill Plain Blvd [a]	Signal	LOS E COV	A	5	0.43	Y	LOS E COV	A	6	0.44	Y	B	14	0.83	Y
31	Broadway St and Mill Plain Blvd [a]	Signal	LOS E COV	A	7	0.33	Y	LOS E COV	A	7	0.33	Y	B	13	0.72	Y
32	C St and Mill Plain Blvd [a]	Signal	LOS E COV	A	6	0.38	Y	LOS E COV	A	7	0.53	Y	B	19	1.08	Y
33	I-5 SB Ramp and Mill Plain Blvd [a]	Signal	LOS D WSDOT	C	33	0.77	Y	LOS D WSDOT	C	23	1.03	Y	D	52	0.84	Y
34	I-5 NB Ramp and Mill Plain Blvd [a]	Signal	LOS D WSDOT	D	35	0.68	Y	LOS D WSDOT	B	19	0.57	Y	D	39	1.13	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build Alternative LOS	No-Build Alternative Delay (sec/veh)	No-Build Alternative V/C	No-Build Alternative Meets Standard	Modified LPA, and Modified LPA with Two Auxiliary Lanes Standard (Agency)	Modified LPA, and Modified LPA with Two Auxiliary Lanes LOS	Modified LPA, and Modified LPA with Two Auxiliary Lanes Delay (sec/veh)	Modified LPA, and Modified LPA with Two Auxiliary Lanes V/C	Modified LPA, and Modified LPA with Two Auxiliary Lanes Meets Standard	Modified LPA Without C Street Ramps LOS	Modified LPA Without C Street Ramps Delay (sec/veh)	Modified LPA Without C Street Ramps V/C	Modified LPA Without C Street Ramps Meets Standard
35	Fort Vancouver Way and Mill Plain Blvd [a]	Signal	LOS E COV	D	42	0.59	Y	LOS E COV	C	30	0.56	Y	C	35	0.63	Y

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 4.3.4.5 for more information.

b Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

Table 4-29. 2045 PM Peak-Hour Traffic Operations – Subarea 2 Mill Plain Boulevard

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build Alternative LOS	No-Build Alternative Delay (sec/veh)	No-Build Alternative V/C	No-Build Alternative Meets Standard	Modified LPA with One or Two Auxiliary Lanes Standard (Agency)	Modified LPA with One or Two Auxiliary Lanes LOS	Modified LPA with One or Two Auxiliary Lanes Delay (sec/veh)	Modified LPA with One or Two Auxiliary Lanes V/C	Modified LPA with One or Two Auxiliary Lanes Meets Standard	Modified LPA Without C Street Ramps LOS	Modified LPA Without C Street Ramps Delay (sec/veh)	Modified LPA Without C Street Ramps V/C	Modified LPA Without C Street Ramps Meets Standard
18	Main St and McLoughlin Blvd	Signal	LOS E COV	A	7	0.39	Y	LOS E COV	A	7	0.37	Y	A	7	0.37	Y
19	Broadway St and McLoughlin Blvd	Signal	LOS E COV	A	5	0.14	Y	LOS E COV	A	5	0.13	Y	A	5	0.13	Y
20	F St and McLoughlin Blvd	TWSC	LOS E COV	A	6	0.01	Y	LOS E COV	A	3	0.01	Y	A	3	0.01	Y
21	Fort Vancouver Way and McLoughlin Blvd	Signal	LOS E COV	B	12	0.24	Y	LOS E COV	B	12	0.25	Y	B	12	0.25	Y
22	Franklin St and Mill Plain Blvd [a]	Signal	LOS E COV	B	16	0.39	Y	LOS E COV	B	19	0.44	Y	F [b]	>300 [b]	0.53 [b]	N [b]
23	Columbia St and 15th Street [a]	Signal	LOS E COV	B	14	0.34	Y	LOS E COV	B	13	0.36	Y	B	10	0.42	Y
24	Washington St and 15th Street [a]	Signal	LOS E COV	A	7	0.31	Y	LOS E COV	A	9	0.33	Y	B	10	0.39	Y
25	Main St and 15th Street [a]	Signal	LOS E COV	B	11	0.45	Y	LOS E COV	B	10	0.46	Y	B	14	0.53	Y
26	Broadway St and 15th Street [a]	Signal	LOS E COV	A	10	0.35	Y	LOS E COV	A	5	0.37	Y	A	7	0.46	Y
27	C St and 15th Street [a]	Signal	LOS E COV	B	18	0.58	Y	LOS E COV	C	20	0.60	Y	C	25	0.69	Y
28	Columbia St and Mill Plain Blvd [a]	Signal	LOS E COV	B	13	0.57	Y	LOS E COV	C	38	0.63	Y	F [b]	>300 [b]	0.78 [b]	N [b]
29	Washington St and Mill Plain Blvd [a]	Signal	LOS E COV	A	8	0.34	Y	LOS E COV	C	21	0.36	Y	E	62	0.45	Y
30	Main St and Mill Plain Blvd [a]	Signal	LOS E COV	B	10	0.59	Y	LOS E COV	C	25	0.62	Y	D	54	0.84	Y

Number	Intersection	Control Type	No-Build Alternative: Standard (Agency)	No-Build Alternative: LOS	No-Build Alternative: Delay (sec/veh)	No-Build Alternative: V/C	No-Build Alternative: Meets Standard	Modified LPA with One or Two Auxiliary Lanes: Standard (Agency)	Modified LPA with One or Two Auxiliary Lanes: LOS	Modified LPA with One or Two Auxiliary Lanes: Delay (sec/veh)	Modified LPA with One or Two Auxiliary Lanes: V/C	Modified LPA with One or Two Auxiliary Lanes: Meets Standard	Modified LPA Without C Street Ramps: LOS	Modified LPA Without C Street Ramps: Delay (sec/veh)	Modified LPA Without C Street Ramps: V/C	Modified LPA Without C Street Ramps: Meets Standard
31	Broadway St and Mill Plain Blvd [a]	Signal	LOS E COV	A	10	0.52	Y	LOS E COV	C	25	0.57	Y	F [b]	93 [b]	0.70 [b]	N [b]
32	C St and Mill Plain Blvd [a]	Signal	LOS E COV	B	11	0.63	Y	LOS E COV	C	28	0.84	Y	D	42	1.02	Y
33	I-5 SB Ramp and Mill Plain Blvd [a]	Signal	LOS D WSDOT	B	17	0.74	Y	LOS D WSDOT	D	48	0.63	Y	D	53	0.77	Y
34	I-5 NB Ramp and Mill Plain Blvd [a]	Signal	LOS D WSDOT	C	29	0.75	Y	LOS D WSDOT	C	29	1.01	Y	F [b]	183 [b]	1.07 [b]	N [b]
35	Fort Vancouver Way and Mill Plain Blvd [a]	Signal	LOS E COV	C	26	0.50	Y	LOS E COV	D	41	0.64	Y	D	36	0.64	Y

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 4.3.4.5 for more information.

b Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

4.6.4.3 Subarea 3: SR 14, City Center Interchange, and Columbia Way

Subarea 3 consists of 26 study intersections and is defined by the downtown Vancouver area as well as two groups of intersections on the east side of I-5 along Evergreen Boulevard and Columbia Way. The traffic operation analysis for the Modified LPA with two auxiliary lanes is identical to the Modified LPA in Subarea 3.

Figure 4-27 through Figure 4-29 illustrate the location of study intersections in Subarea 3 and whether the intersection would or would not meet the relevant agency standards for the AM and PM peaks in the No-Build Alternative and the Modified LPA with and without C Street ramps.

Table 4-30 and Table 4-31 show the intersection operations in Subarea 3 for the No-Build Alternative and the Modified LPA with and without C Street ramps during the AM and PM peaks, respectively. Intersections that would fail to meet the performance standards are shaded in red.

IMPACTS FOR THE NO-BUILD ALTERNATIVE

During the AM peak, all study intersections for the No-Build Alternative in Subarea 3 would operate at or better than the intersection performance standards.

During the PM peak, all study intersections for the No-Build Alternative in Subarea 3 would operate at or better than the intersection performance standards except for two:

- Columbia House Boulevard and SR 14 eastbound/westbound on-/off-ramp (SPUI) (Intersection #57).
- Columbia Way and Columbia Shores Boulevard (Intersection #58).

IMPACTS FOR THE MODIFIED LPA

During the AM peak, all study intersections for the Modified LPA in Subarea 3 would operate at or better than the intersection performance standards.

During the PM peak, all study intersections for the Modified LPA in Subarea 3 would operate at or better than the intersection performance standards except for two:

- Columbia House Boulevard and SR 14 eastbound/westbound on-/off-ramp (SPUI) (Intersection #57).
- Columbia Way and Columbia Shores Boulevard (Intersection #58).

All intersections that would meet the performance standards under the No-Build Alternative during the PM peak would also meet the standards under the Modified LPA.

IMPACTS FOR THE MODIFIED LPA WITHOUT C STREET RAMPS

This design option would not provide access between I-5 and downtown Vancouver using the C Street ramps. Removal of the C Street ramps would result in a reduction of traffic volumes in the downtown core. The Modified LPA without C Street ramps would have similar traffic operations as the Modified LPA for intersections in Subarea 3.

IMPACTS COMMON TO ALL POTENTIAL PARK-AND-RIDE SITES

All potential park-and-ride sites would have similar traffic operations as the Modified LPA for intersections in Subarea 3.

Figure 4-27. Subarea 3 – No-Build Traffic Operations – SR 14, City Center Interchange, and Columbia Way

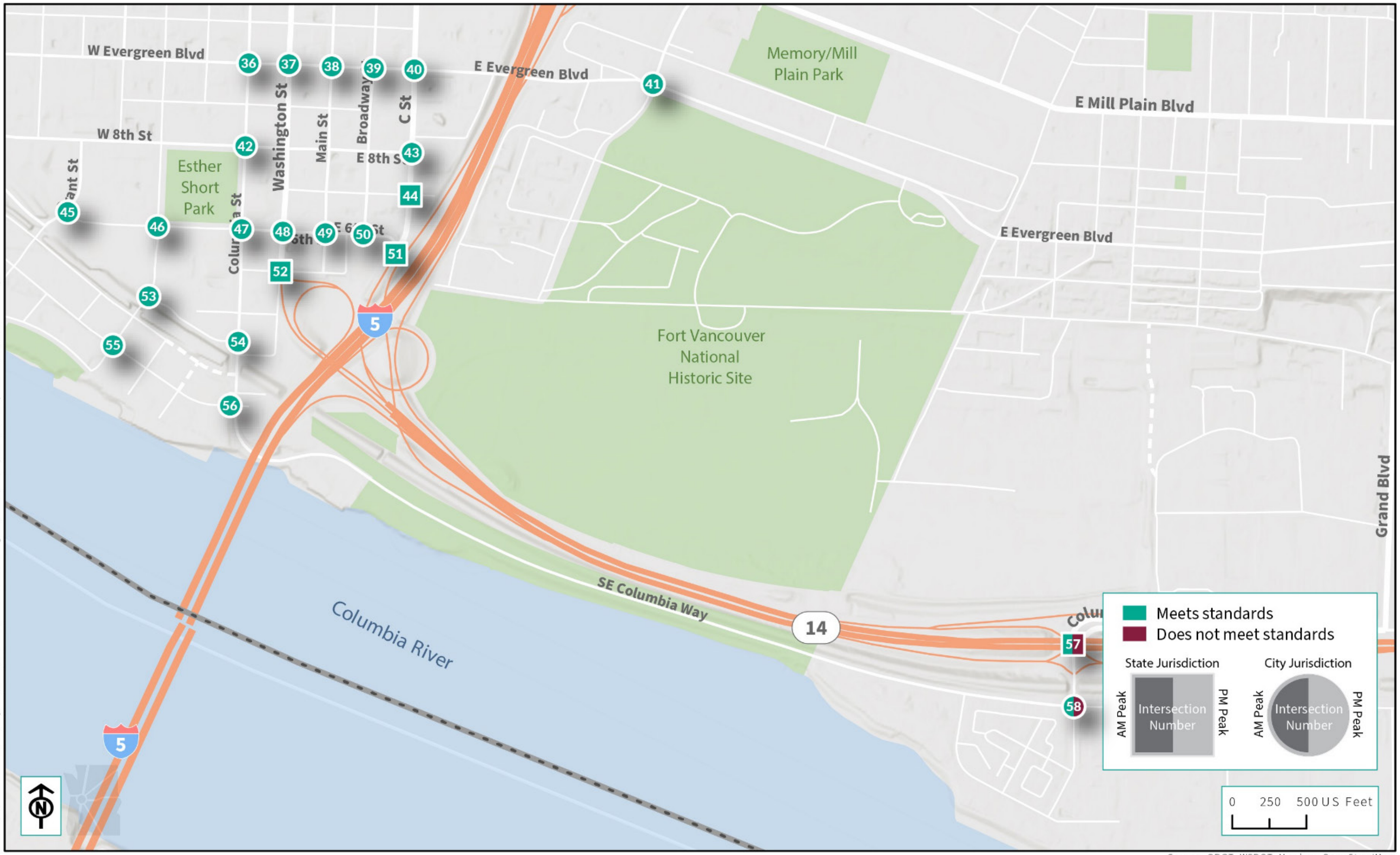


Figure 4-28. Subarea 3 – Modified LPA Traffic Operations – SR 14, City Center Interchange, and Columbia Way

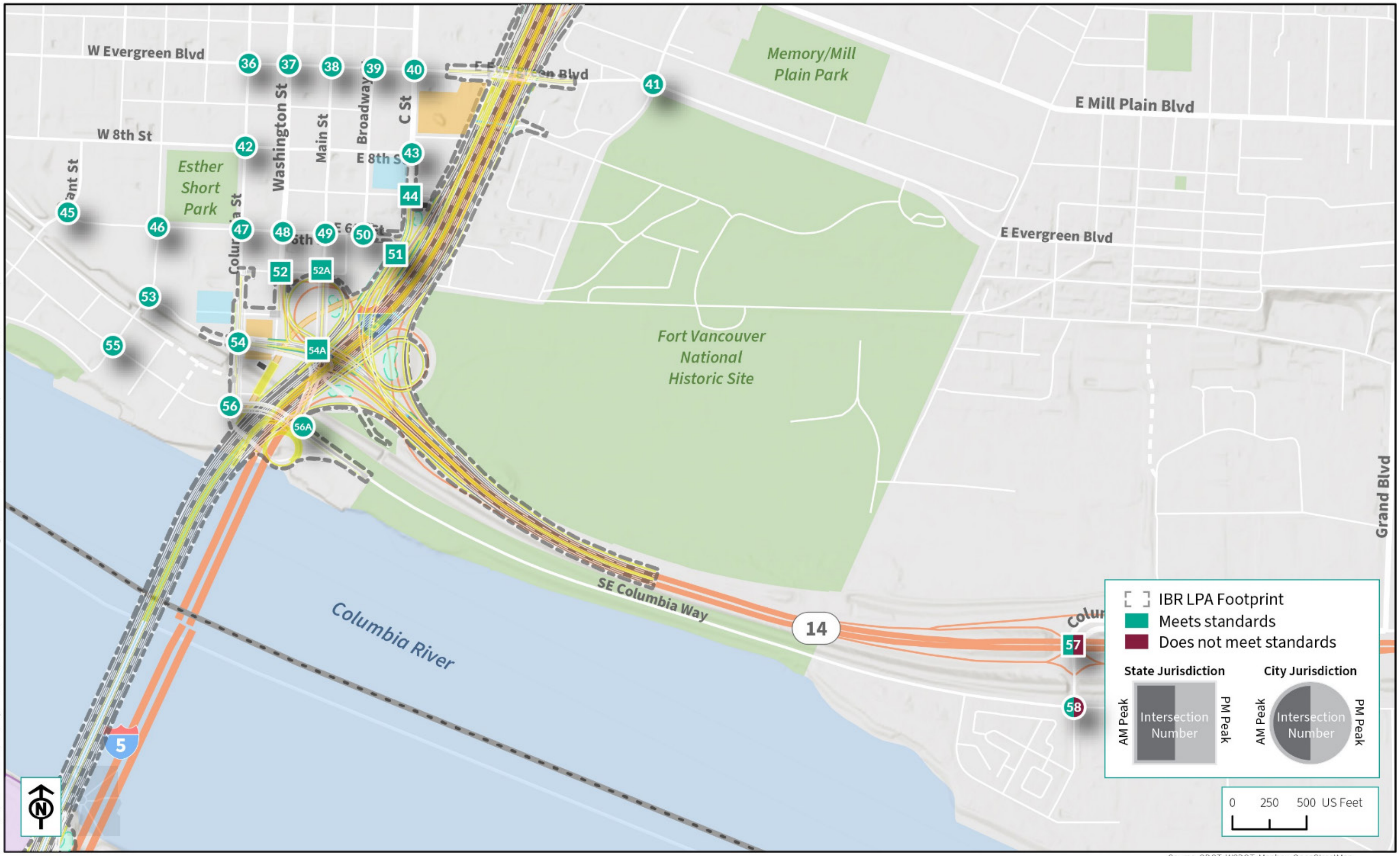


Figure 4-29. Subarea 3 – Modified LPA Without C Street Ramps Traffic Operations – SR 14, City Center Interchange, and Columbia Way

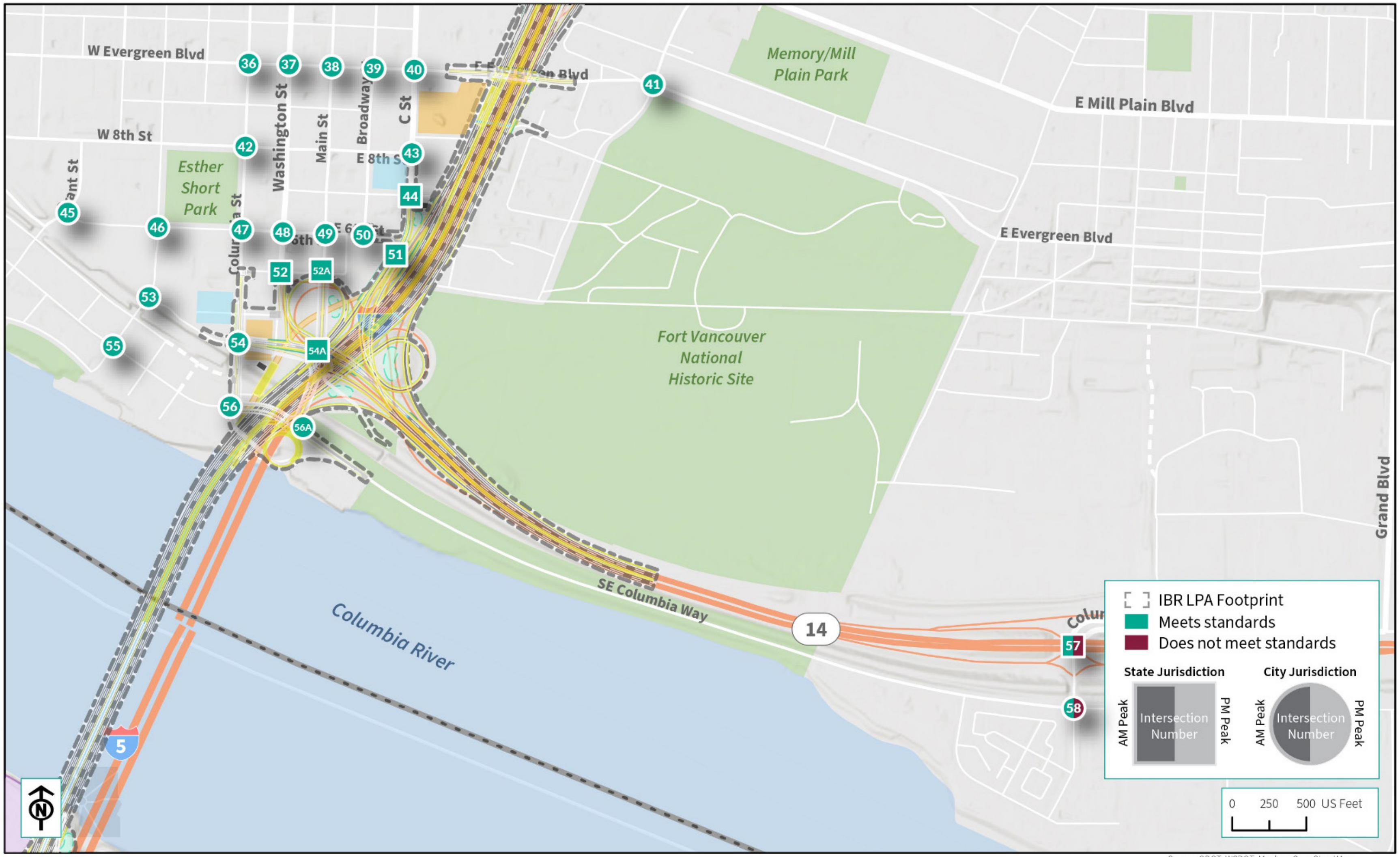


Table 4-30. 2045 AM Peak-Hour Traffic Operations – Subarea 3 SR 14, City Center Interchange, and Columbia Way

Number	Intersection	Control Type	No-Build Alternative					Modified LPA/Modified LPA with Two Auxiliary Lanes					Modified LPA Without C Street Ramps			
			Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	LOS	Delay (sec/veh)	V/C	Meets Standard
36	Columbia St and Evergreen Blvd	Signal	LOS E COV	B [a]	12 [a]	0.26*	Y [a]	LOS E COV	A	8	0.31	Y	A	9	0.38	Y
37	Washington St and Evergreen Blvd [a]	Signal	LOS E COV	C	23	0.26	Y	LOS E COV	C	23	0.25	Y	C	24	0.23	Y
38	Main St and Evergreen Blvd	Signal	LOS E COV	B	11	0.29	Y	LOS E COV	B	12	0.31	Y	B	16	0.27	Y
39	Broadway St and Evergreen Blvd	Signal	LOS E COV	B	11	0.21	Y	LOS E COV	B	16	0.22	Y	B	15	0.21	Y
40	C St and Evergreen Blvd	Signal	LOS E COV	A	9	0.20	Y	LOS E COV	C	32	0.36*	Y [a]	B	15	0.36	Y
41	Fort Vancouver Way and Evergreen Blvd	RAB	LOS E COV	A	2	0.14	Y	LOS E COV	A	2	0.21	Y	A	2	0.21	Y
42	Columbia St and 8th St	Signal	LOS E COV	A [a]	7 [a]	0.15*	Y [a]	LOS E COV	B	15	0.31	Y	B	18	0.35	Y
43	C St and 8th St	Signal	LOS E COV	B	16	0.23	Y	LOS E COV	A	7	0.34*	Y [a]	C	23	0.37	Y
44	7th St and C St	TWSC	LOS D WSDOT	A	1	0.06	Y	LOS D WSDOT	A	0	0.42	Y	A	0	0.15	Y
45	Grant St and 6th St	TWSC	LOS E COV	B	10	0.31	Y	LOS E COV	A	9	0.19	Y	B	11	0.28	Y
46	Esther St and 6th St	RAB	LOS E COV	A	5	0.16	Y	LOS E COV	A	6	0.14	Y	A	6	0.14	Y
47	Columbia St and 6th St	Signal	LOS E COV	A [a]	8 [a]	0.34*	Y [a]	LOS E COV	B	16	0.41	Y	B	18	0.39	Y
48	Washington St and 6th St [a]	Signal	LOS E COV	B	15	0.40	Y	LOS E COV	A	10	0.14	Y	A	9	0.08	Y
49	Main St and 6th St	AWSC	LOS E COV	A	7	0.26	Y	LOS E COV	A	5	0.18	Y	A	4	0.07	Y
50	Broadway St and 6th St	TWSC	LOS E COV	A	10	0.12	Y	LOS E COV	A	6	0.06	Y	A	3	0.02	Y
51	6th St and C St/I-5 SB on-ramp [b]	TWSC	LOS D WSDOT	A	4	0.00	Y	LOS D WSDOT	A [a]	2	0.29*	Y [a]	-	-	-	-
52	5th St and Washington St [b]	Signal	LOS D WSDOT	A [a]	8 [a]	0.41*	Y [a]	LOS D WSDOT	A	6	0.12	Y	A	6	0.13	Y
52A	5th St and Main St	Signal	LOS E COV	-	-	-	-	LOS E COV	A	4	0.06	Y	A	4	0.07	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA/Modified LPA with Two Auxiliary Lanes Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard	Modified LPA Without C Street Ramps LOS	Without C Street Ramps Delay (sec/veh)	Without C Street Ramps V/C	Without C Street Ramps Meets Standard
53	Esther St and Phil Arnold Way	TWSC	LOS E COV	A	5	0.03	Y	LOS E COV	A	7	0.30	Y	A	7	0.37	Y
54	Phil Arnold Way and Columbia Street/SR 14 WB Off-ramp [b]	TWSC	LOS E COV	A	6	0.05	Y	LOS E COV	B	11	0.72	Y	D	33	0.59	Y
54A	Phil Arnold Way and Main St/SR 14 EB on-ramp	RAB	LOS D WSDOT	-	-	-	-	LOS D WSDOT	A	3	0.13	Y	A	3	0.13	Y
55	Esther St and Columbia Way	Signal	LOS E COV	A	4	0.10	Y	LOS E COV	A	6	0.21	Y	A	6	0.27	Y
56	Columbia St and Columbia Way	Signal	LOS E COV	A	4	0.55	Y	LOS E COV	A	7	0.23	Y	A	7	0.37	Y
56A	Columbia Way and Main St	Signal	LOS E COV	-	-	-	-	LOS E COV	B	15	0.16	Y	B	14	0.18	Y
57	Columbia Shores Blvd and SR 14 EB off-ramp [a]	Signal	LOS D WSDOT	D	47	0.59	Y	LOS D WSDOT	C	33	0.57	Y	C	33	0.57	Y
58	Columbia Shores Blvd and Columbia Way [a]	Signal	LOS E COV	C	27	0.84	Y	LOS E COV	C	25	0.82	Y	C	26	1.11	Y

Source: IBR Analysis

Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 4.3.4.5 for more information.

b Intersection name is updated in the Modified LPA. No-Build intersection name remains consistent with existing.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

Table 4-31. 2045 PM Peak-Hour Traffic Operations – Subarea 3 SR 14, City Center Interchange, and Columbia Way

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA/Modified LPA with Two Auxiliary Lanes Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard	Modified LPA Without C Street Ramps LOS	Without C Street Ramps Delay (sec/veh)	Without C Street Ramps V/C	Without C Street Ramps Meets Standard
36	Columbia St and Evergreen Blvd	Signal	LOS E COV	B	16	0.33	Y	LOS E COV	C	22	0.41	Y	D	36	0.49	Y
37	Washington St and Evergreen Blvd	Signal	LOS E COV	C	21	0.18	Y	LOS E COV	C	21	0.19	Y	C	21	0.20	Y
38	Main St and Evergreen Blvd	Signal	LOS E COV	B	12	0.23	Y	LOS E COV	B	12	0.26	Y	B	14	0.26	Y
39	Broadway St and Evergreen Blvd	Signal	LOS E COV	B	13	0.22	Y	LOS E COV	B	11	0.26	Y	B	15	0.31	Y
40	C St and Evergreen Blvd	Signal	LOS E COV	B	18	0.28	Y	LOS E COV	D	46	0.46	Y	B	14	0.40	Y

Number	Intersection	Control Type	No-Build Alternative					Modified LPA/Modified LPA with Two Auxiliary Lanes					Modified LPA Without C Street Ramps			
			Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	LOS	Delay (sec/veh)	V/C	Meets Standard
41	Fort Vancouver Way and Evergreen Blvd	RAB	LOS E COV	A	7	0.15	Y	LOS E COV	A	2	0.21	Y	A	2	0.21	Y
42	Columbia St and 8th St	Signal	LOS E COV	B	11	0.31	Y	LOS E COV	B	10	0.41	Y	C	23	0.66	Y
43	C St and 8th St	Signal	LOS E COV	B	19	0.26	Y	LOS E COV	D	42	0.59	Y	A	10	0.27	Y
44	7th Street and C Street	TWSC	LOS D WSDOT	A	9	0.06	Y	LOS D WSDOT	C	26	0.69	Y	A	7	1.20	Y
45	Grant St and 6th St	TWSC	LOS E COV	C	30	0.46	Y	LOS E COV	C	23	0.29	Y	C	24	0.45	Y
46	Esther St and 6th St	RAB	LOS E COV	A	4	0.18	Y	LOS E COV	A	6	0.14	Y	A	6	0.14	Y
47	Columbia St and 6th St	Signal	LOS E COV	C	20	0.38	Y	LOS E COV	B	17	0.52	Y	C	20	0.58	Y
48	Washington St and 6th St	Signal	LOS E COV	B	20	0.35	Y	LOS E COV	B	11	0.33	Y	B	11	0.27	Y
49	Main St and 6th St	AWSC	LOS E COV	B	10	0.30	Y	LOS E COV	A	6	0.21	Y	A	6	0.79	Y
50	Broadway St and 6th St	TWSC	LOS E COV	A	6	0.05	Y	LOS E COV	A	9	0.13	Y	A	7	0.03	Y
51	6th Street and C Street/I-5 SB on-ramp [a]	TWSC	LOS D WSDOT	A	4	0.00	Y	LOS D WSDOT	A	3	0.30	Y	-	-	-	Y
52	5th Street and Washington Street [a]	Signal	LOS D WSDOT	B	15	0.44	Y	LOS D WSDOT	A	4	0.31	Y	A	4	0.34	Y
52A	5th St and Main St	Signal	N/A	-	-	-	-	LOS E COV	A	6	0.16	Y	A	6	0.18	Y
53	Esther St and Phil Arnold Way	TWSC	LOS E COV	A	6	0.05	Y	LOS E COV	A	8	0.20	Y	A	8	0.27	Y
54	Phil Arnold Way and Columbia Street/SR 14 WB Off-ramp [b]	TWSC	LOS E COV	A	7	0.11	Y	LOS E COV	A	10	0.50	Y	C	21	0.53	Y
54A	Phil Arnold Way and Main St/SR 14 EB on-ramp	RAB	N/A	-	-	-	-	LOS D WSDOT	A	3	0.13	Y	A	3	0.13	Y
55	Esther St and Columbia Way	Signal	LOS E COV	A	7	0.29	Y	LOS E COV	A	6	0.32	Y	A	6	0.35	Y
56	Columbia St and Columbia Way	Signal	LOS E COV	A	6	0.52	Y	LOS E COV	A	7	0.08	Y	A	8	0.10	Y
56A	Columbia Way and Main St	Signal	N/A	-	-	-	-	LOS E COV	A	8	0.15	Y	A	8	0.17	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build Alternative LOS	No-Build Alternative Delay (sec/veh)	No-Build Alternative V/C	No-Build Alternative Meets Standard	Modified LPA/Modified LPA with Two Auxiliary Lanes Standard (Agency)	Modified LPA/Modified LPA with Two Auxiliary Lanes LOS	Modified LPA/Modified LPA with Two Auxiliary Lanes Delay (sec/veh)	Modified LPA/Modified LPA with Two Auxiliary Lanes V/C	Modified LPA/Modified LPA with Two Auxiliary Lanes Meets Standard	Modified LPA Without C Street Ramps LOS	Modified LPA Without C Street Ramps Delay (sec/veh)	Modified LPA Without C Street Ramps V/C	Modified LPA Without C Street Ramps Meets Standard
57	Columbia Shores Blvd and SR 14 EB off-ramp	Signal	LOS D WSDOT	F [b]	127 [b]	0.78 [b]	N [b]	LOS D WSDOT [b]	E [b]	63 [b]	0.69 [b]	N [b]	E [b]	58 [b]	0.73 [b]	N [b]
58	Columbia Shores Blvd and Columbia Way	Signal	LOS E COV	F [b]	290 [b]	0.52 [b]	N [b]	LOS E COV [b]	F [b]	> 300 [b]	0.48 [b]	N [b]	F [b]	> 300 [b]	0.51 [b]	N [b]

Source: IBR Analysis

a Intersection name is updated in the Modified LPA. No-Build intersection name remains consistent with existing.

b Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COV = City of Vancouver; delay = seconds of delay per vehicle; LOS = level of service; NB = northbound; RAB = roundabout; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound; WSDOT = Washington State Department of Transportation

4.6.4.4 Subarea 4: Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Subarea 4 consists of 25 study intersections and captures all study intersections within the city of Portland. The traffic operation analysis for the Modified LPA options would be identical to the Modified LPA in Subarea 4.

Subarea 4 consists of 25 study intersections and captures all study intersections within the city of Portland. The traffic operation analysis for the Modified LPA options would be identical to the Modified LPA in Subarea 4.

Figure 4-30 and Figure 4-31 illustrate the location of study intersections in Subarea 4 and whether the intersection would or would not meet the relevant agency standards for the AM and PM peak for the No-Build Alternative and the Modified LPA, respectively.

Table 4-32 and Table 4-33 show the intersection operations in Subarea 4 for both the No-Build Alternative and the Modified LPA, during the AM and PM peak respectively. Intersections that would fail to meet performance standards are shaded in red.

IMPACTS FOR THE NO-BUILD ALTERNATIVE

During the AM peak, all study intersections for the No-Build Alternative in Subarea 4 would operate at or better than the intersection performance standards except one:

- Marine Drive/Martin Luther King Jr. Boulevard and I-5 northbound/southbound on-/off-ramps (Intersection #68).

During the PM peak, all study intersections for the No-Build Alternative in Subarea 4 would operate at or better than the intersection performance standards except four:

- Marine Drive and OR 120 (N Portland Road) (Intersection #66).
- Marine Drive and Force Avenue (Intersection #67).
- Marine Drive/Martin Luther King Jr. Boulevard and I-5 northbound/southbound on-/off-ramps (Intersection #68).
- Columbia Boulevard and N Vancouver Avenue (Intersection #79).

IMPACTS FOR THE MODIFIED LPA

During the AM peak, all study intersections for the Modified LPA in Subarea 4 would operate at or better than the intersection performance standards except one:

- Marine Drive/Martin Luther King Jr. Boulevard and I-5 northbound/southbound on-/off-ramps (Intersection #68).

During the PM peak, all study intersections for the Modified LPA in Subarea 3 would operate at or better than the intersection performance standards except three:

- Marine Drive and OR 120 (N Portland Road) (Intersection #66).

- Marine Drive/Martin Luther King Jr. Boulevard and I-5 northbound/southbound on-/off-ramps (Intersection #68).
- Columbia Boulevard and N Vancouver Avenue (Intersection #79).

Intersection #68 would fail to meet the AM and PM peak performance standards under the Modified LPA and would also not operate satisfactorily under the No-Build Alternative. The Modified LPA would introduce a SPUI for the Marine Drive intersection which would combine the previous Marine Drive and Union Court northbound off-ramps into a single off-ramp. A high increase in the number of trips for the southbound off-ramp would also contribute to higher delays.

IMPACTS COMMON TO ALL POTENTIAL PARK-AND-RIDE SITES

All potential park-and-ride sites would have similar traffic operations as the Modified LPA for intersections in Subarea 4.

Figure 4-30. Subarea 4 – No-Build Traffic Operations – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Figure 4-31. Subarea 4 – Modified LPA Traffic Operations – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

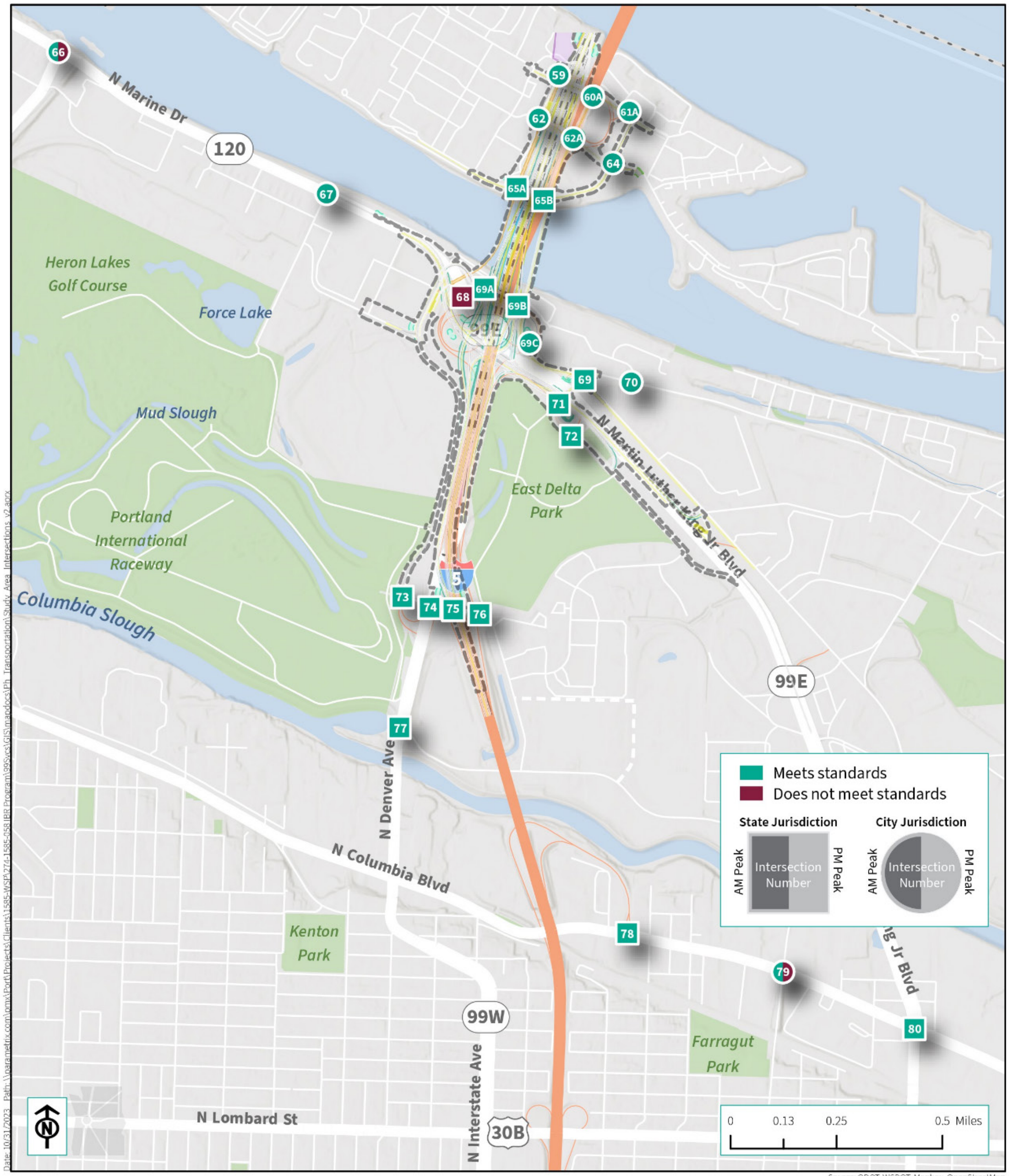


Table 4-32. 2045 AM Peak-Hour Traffic Operations – Subarea 4 Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA and Options Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard
59	Hayden Island Dr (South) and Center Ave	Signal	V/C = 1.1 ODOT	A	9	0.44	Y	V/C = 0.75 ODOT	A	6	0.44	Y
60	Hayden Island Dr (South) and Hayden Island Dr Connector to North	Signal	V/C = 1.1 ODOT	A	7	0.33	Y	V/C = 0.75 ODOT	-	-	-	-
60A	Hayden Island Dr (South) and Arterial Bridge Access Rd	AWSC	N/A	-	-	-	-	LOS D COP	A	9	0.59	Y
61	Hayden Island Dr (North) and Hayden Island Dr Connector to South	Signal	LOS D COP	A	4	0.16	Y	LOS D COP	-	-	-	-
61A	Hayden Island Dr (South) and Jantzen Dr	TWSC	N/A	-	-	-	-	LOS D COP	A	8	0.42	Y
62	Center Ave and N Tomahawk Island Dr [a]	Signal	V/C = 0.85 ODOT	B	10	0.51	Y	V/C = 0.75 ODOT	B	10	0.30	Y
62A	Tomahawk Island Dr and Arterial Bridge Access	Signal	N/A	-	-	-	-	LOS D COP	B	16	0.58	Y
63	I-5 NB Hayden Island off-ramp and Tomahawk Island Dr	TWSC	V/C = 0.85 ODOT	A	3	0.05	Y	V/C = 0.75 ODOT	-	-	-	-
64	Tomahawk Island Dr and Jantzen Dr	TWSC	LOS D COP	A	10	0.16	Y	LOS D COP	A	9	0.64	Y
65	Center Ave and Jantzen Ave	TWSC	LOS D COP	A	9	0.08	Y	LOS D COP	-	-	-	-
65A	I-5 SB Hayden Island off-ramp and Jantzen Dr	Signal	N/A	-	-	-	-	V/C = 0.75 ODOT	A	5	0.32	Y
65B	I-5 NB Hayden Island on-ramp and Jantzen Dr	Signal	N/A	-	-	-	-	V/C = 0.75 ODOT	A	2	0.50	Y
66	Marine Drive and OR 120 (N Portland Rd)	Signal	LOS D COP	C	28	0.89	Y	LOS D COP	D	43	0.90	Y
67	Marine Dr and Force Ave	Signal	LOS D COP	A	9	0.75	Y	LOS D COP	A	10	0.75	Y
68	Marine Dr/MLK Blvd and I-5 NB/SB on-/off-ramps	Signal	V/C = 0.85 ODOT [b]	F [b]	> 300 [b]	1.28 [b]	N [b]	V/C = 0.75 ODOT [b]	F [b]	291 [b]	1.07 [b]	N [b]
69	Marine Dr and Vancouver Way [a]	AWSC	V/C = 0.99 ODOT	A	9	0.50	Y	LOS D COP	B	10	0.44	Y
69A	I-5 SB Marine Drive on-ramp and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 ODOT	A	5	0.54	Y
69B	I-5 NB Marine Drive off-ramp and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 ODOT	A	4	0.51	Y

Number	Intersection	Control Type	No-Build Alternative: Standard (Agency)	No-Build Alternative: LOS	No-Build Alternative: Delay (sec/veh)	No-Build Alternative: V/C	No-Build Alternative: Meets Standard	Modified LPA and Options: Standard (Agency)	Modified LPA and Options: LOS	Modified LPA and Options: Delay (sec/veh)	Modified LPA and Options: V/C	Modified LPA and Options: Meets Standard
69C	N Vancouver Way and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 COP	A	8	0.51	Y
70	Marine Dr and Anchor Way	TWSC	LOS D COP	B	11	0.26	Y	LOS D COP	A	8	0.11	Y
71	I-5 NB off-ramp and Union Ct/Marine Way	TWSC	V/C = 0.85 ODOT	A	9	0.21	Y	V/C = 0.85 ODOT	-	-	-	-
72	Union Ct and Martin Luther King Jr. Blvd eastbound off-ramp	TWSC	V/C = 0.99 ODOT	A	3	0.05	Y	V/C = 0.99 ODOT	A	4	0.10	Y
73	Victory Blvd and Expo Rd	AWSC	V/C = 1.1 ODOT	B	12	0.78	Y	V/C = 1.1 ODOT	B	12	0.27	Y
74	Victory Blvd and Interstate Ave/Denver Ave NB off-ramp	TWSC	V/C = 0.85 ODOT	A	7	0.06	Y	V/C = 0.85 ODOT	A	7	0.07	Y
75	Victory Blvd and I-5 SB on-ramp	TWSC	V/C = 0.85 ODOT	A	4	0.31	Y	V/C = 0.85 ODOT	A	4	0.14	Y
76	Victory Blvd and I-5 NB off-ramp/Whitaker Rd	Signal	V/C = 0.85 ODOT	A	7	0.20	Y	V/C = 0.85 ODOT	A	7	0.22	Y
77	Interstate Ave/Denver Ave and Schmeer Rd	Signal	V/C = 1.1 ODOT	A	10	0.79	Y	V/C = 1.1 ODOT	A	10	0.79	Y
78	Columbia Blvd and I-5 NB/SB on-/off-ramp	Signal	V/C = 0.85 ODOT	B	17	0.60	Y	V/C = 0.85 ODOT	B	16	0.63	Y
79	Columbia Blvd and N Vancouver Ave	Signal	LOS D COP	B	19	0.53	Y	LOS D COP	C	20	0.56	Y
80	Columbia Blvd and MLK Blvd	Signal	V/C =0.99 ODOT	D	39	0.88	Y	V/C =0.99 ODOT	D	50	0.94	Y

Source: IBR Analysis

a Intersection name is updated in the Modified LPA. No-Build intersection name remains consistent with existing.

b Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COP = City of Portland; delay = seconds of delay per vehicle; LOS = level of service; MLK = Martin Luther King Jr.; NB = northbound; ODOT = Oregon Department of Transportation; RAB = roundabout; Rd = road; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound

Table 4-33. 2045 PM Peak-Hour Traffic Operations – Subarea 4 – Hayden Island, Marine Drive, Victory Boulevard, and Columbia Boulevard

Number	Intersection	Control Type	No-Build Alternative					Modified LPA and Options				
			Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard	Standard (Agency)	LOS	Delay (sec/veh)	V/C	Meets Standard
59	Hayden Island Dr (South) and Center Ave	Signal	V/C = 1.1 ODOT	A	10	0.54	Y	V/C = 0.75 ODOT	A	6	0.43	Y
60	Hayden Island Dr (South) and Hayden Island Dr Connector to North	Signal	V/C = 1.1ODOT	A	9	0.53	Y	V/C = 0.75 ODOT	-	-	-	-
60A	Hayden Island Dr (South) and Arterial Bridge Access Rd	AWSC	N/A	-	-	-	-	LOS D COP	A	8	0.51	Y
61	Hayden Island Dr (North) and Hayden Island Dr Connector to South	Signal	LOS D COP	A	5	0.21	Y	LOS D COP	-	-	-	-
61A	Hayden Island Dr (South) and Jantzen Dr	TWSC	N/A	-	-	-	-	LOS D COP	B	10	0.54	Y
62	Center Ave and N Tomahawk Island Dr [b]	Signal	V/C = 0.85 ODOT	B	12	0.53	Y	V/C = 0.75 ODOT	A	6	0.46	Y
62A	Tomahawk Island Dr and Arterial Bridge Access	Signal	N/A	-	-	-	-	LOS D COP	B	13	0.67	Y
63	I-5 NB Hayden Island off-ramp and Tomahawk Island Dr	TWSC	V/C = 0.85 ODOT	A	3	0.07	Y	V/C = 0.75 ODOT	-	-	-	-
64	Tomahawk Island Dr and Jantzen Dr	TWSC	LOS D COP	B	14	0.39	Y	LOS D COP	B	15	0.87	Y
65	Center Ave and Jantzen Ave	TWSC	LOS D COP	A	8	0.04	Y	LOS D COP	-	-	-	-
65A	I-5 SB Hayden Island off-ramp and Jantzen Dr	Signal	N/A	-	-	-	-	V/C = 0.75 ODOT	B	11	0.49	Y
65B	I-5 NB Hayden Island on-ramp and Jantzen Dr	Signal	N/A	-	-	-	-	V/C = 0.75 ODOT	A	3	0.67	Y
66	Marine Drive and OR 120 (N Portland Rd)	Signal	LOS D COP [c]	F [c]	138 [c]	0.99 [c]	N [c]	LOS D COP [c]	E [c]	73 [c]	0.97 [c]	N [c]
67	Marine Dr and Force Ave	Signal	LOS D COP [c]	F [c]	210 [c]	0.63 [c]	N [c]	LOS D COP	C	21	0.65	Y
68	Marine Dr/MLK Blvd and I-5 NB/SB on-/off-ramps [a]	Signal	V/C = 0.85 ODOT [c]	F [c]	141 [c]	0.92 [c]	N [c]	V/C = 0.75 ODOT [c]	F [c]	110 [c]	0.96 [c]	N [c]
69	Marine Dr and Vancouver Way [b]	AWSC	V/C = 0.99 ODOT	A	9	0.33	Y [a]	LOS D COP	B	12	0.75	Y
69A	I-5 SB Marine Drive on-ramp and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 ODOT	A	5	0.54	Y
69B	I-5 NB Marine Drive off-ramp and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 ODOT	A	4	0.51	Y

Number	Intersection	Control Type	No-Build Alternative Standard (Agency)	No-Build LOS	No-Build Delay (sec/veh)	No-Build V/C	No-Build Meets Standard	Modified LPA and Options Standard (Agency)	Modified LPA LOS	Modified LPA Delay (sec/veh)	Modified LPA V/C	Modified LPA Meets Standard
69C	N Vancouver Way and N Pier 99 St	RAB	N/A	-	-	-	-	V/C = 0.75 ODOT	A	8	0.51	Y
70	Marine Dr and Anchor Way	TWSC	LOS D COP	B [a]	11 [a]	0.26	Y [a]	LOS D COP	B	14	0.33	Y
71	I-5 NB off-ramp and Union Ct/Marine Way	TWSC	V/C = 0.85 ODOT	B	14	0.12	Y	V/C = 0.85 ODOT	-	-	-	-
72	Union Ct and Martin Luther King Jr. Blvd eastbound Off-Ramp	TWSC	V/C = 0.99 ODOT	A	8	0.15	Y	V/C = 0.99 ODOT	A	8	0.15	Y
73	Victory Blvd and Expo Rd	AWSC	V/C = 1.1 ODOT	A	9	0.63	Y	V/C = 1.1 ODOT	A	9	0.54	Y
74	Victory Blvd and Interstate Ave/Denver Ave NB off-ramp [a]	TWSC	V/C = 1.1 ODOT	B	14	0.33	Y	V/C = 1.1 ODOT	B	13	0.28	Y
75	Victory Blvd and I-5 SB on-ramp [a]	TWSC	V/C = 0.85 ODOT	A	6	0.56	Y	V/C = 0.85 ODOT	A	6	0.28	Y
76	Victory Blvd and I-5 NB off-ramp/Whitaker Rd [a]	Signal	V/C = 0.85 ODOT	B	13	0.49	Y	V/C = 0.85 ODOT	B	17	0.50	Y
77	Interstate Ave/Denver Ave and Schmeer Rd [a]	Signal	V/C = 0.85 ODOT	B	16	0.78	Y	V/C = 0.85 ODOT	B	17	0.78	Y
78	Columbia Blvd and I-5 NB/SB on-/off-ramp	Signal	V/C = 0.85 ODOT	B	12	0.60	Y	V/C = 0.85 ODOT	B	13	0.58	Y
79	Columbia Blvd and N Vancouver Ave	Signal	LOS D COP [c]	F [c]	92 [c]	0.85 [c]	N [c]	LOS D COP [c]	F [c]	124 [c]	0.83 [c]	N [c]
80	Columbia Blvd and MLK Blvd	Signal	V/C = 0.99 ODOT	E	64	0.91	Y	V/C = 0.99 ODOT	E	58	0.89	Y

Source: IBR Analysis

a This study intersection was analyzed without considering the impacts of freeway congestion spilling back into local roadways and may operate worse than shown above. Refer to Section 4.3.4.5 for more information.

b Intersection name is updated in the Modified LPA. No-Build intersection name remains consistent with existing.

c Cells highlighted in red identify intersections that would operate below the relevant LOS standard.

AWSC = all-way stop-control; Blvd = boulevard; COP = City of Portland; delay = seconds of delay per vehicle; LOS = level of service; MLK = Martin Luther King Jr.; NB = northbound; ODOT = Oregon Department of Transportation; RAB = roundabout; Rd = road; SB = southbound; sec = seconds; St = street; TWSC = two-way stop-control; V/C = volume-to-capacity ratio for worse movement in two-way stop-controlled intersections; veh = vehicle; WB = westbound

4.7 Transit

This section summarizes transit service in the No-Build Alternative and the Modified LPA and options along with transit routing, ridership, station area mode of access, and transit transfer rates.

4.7.1 Transit Service

The background transit network for the No-Build Alternative and the Modified LPA and options is the 2018 RTP Financially Constrained system adopted by the Metro Council in December 2018 and by the RTC Board of Directors in March 2019. The 2018 RTP includes transportation projects from state and local plans that are needed to meet transportation needs over the next 25 years and are financially constrained, meaning they have funding that is reasonably expected over the funding period to complete the projects. Specifically, the transit networks developed for the 2018 RTP include an approximately 60% increase in planned service on the Oregon side of the river and a 50% increase in planned service on the Washington side of the river. These increases include capital investments and increases in hours of service to all modes in the transit system.

The 2018 RTP model generated estimates of transit ridership across the system that could only be supported in practice with additional capital investment projects beyond those present in the 2018 RTP. While it is likely that those investments, which are already being identified, will be programmed and implemented by the 2045 design year, the decision was made for the IBR Project analysis to limit transit ridership to the carrying capacity of the system as described in the 2018 RTP.

4.7.1.1 Regional and Local Transit Service

Listed below in Table 4-34 are key future transit improvement projects in the regional transit system and projects that would influence the IBR Program Area for the No-Build Alternative and the Modified LPA and options.

Table 4-34. Major Planned Transit Projects between 2019 and 2045

Project	Description
Mill Plain Bus Rapid Transit [a]	New C-TRAN BRT route operating from Turtle Place in downtown Vancouver to Mill Plain Transit Center near 184th Avenue with the BRT route running along Mill Plain Boulevard.
Highway 99 Bus Rapid Transit	New C-TRAN BRT route operating from Turtle Place in downtown Vancouver including service to the waterfront that operates along Main Street and Highway 99 to the 99th Street Transit Center and the Salmon Creek Park and Ride.
Steel Bridge Improvements	Improvements to transit operations at the Steel Bridge to help TriMet maintain on-time performance for buses and trains in the system.
Division Street Transit Project [a]	New TriMet BRT from Downtown Portland Transit Mall to Gresham Transit Center along Division Street.

Project	Description
Southwest Corridor Project	12-mile MAX light-rail line servicing SW Portland, Tigard, Tualatin and surrounding communities. The proposed project also includes bicycle, pedestrian, and roadway projects to improve access to light-rail stations.
MAX Red Line Improvement Project [a]	Currently, the Red Line has two single-track sections near Gateway/99th Ave and Portland International Airport, which result in inbound and outbound trains having to wait for each other. This project will complete a 2-year design process for the MAX Red Line double tracking and other improvements to increase light-rail reliability on all five MAX lines and to improve carrying capacity to meet transit demand west of the Beaverton Transit Center.

Source: Metro 2018 Regional Transportation Plan, RTC 2019 Regional Transportation Plan

a Project is complete or in progress but was not in place in the 2019 existing network.

4.7.1.2 No-Build Alternative

The No-Build Alternative assumes the C-TRAN and TriMet anticipated regional transit networks for 2045, as informed by the 2018 RTP for both Metro (Metro 2018) and RTC (RTC 2019). These plans also incorporate the plans' underlying assumptions for population and employment growth in the area, where regional policies focus growth in areas served by transit. This includes the Vancouver central business district (CBD) and nearby areas, where land use plans anticipate more dense development and a greater array of alternatives to driving, as well as destinations in Portland along the MAX system and major bus routes.

The No-Build Alternative includes changes to service levels on the Yellow Line in North Portland and express bus service from Clark County to downtown Portland, compared to the 2018 RTP. First, the assumption that the Yellow Line would provide service into Vancouver was removed, and the line was assumed to operate as it does in existing conditions with a terminus at the Expo Center. Second, the frequency assumptions in the 2018 RTP included an increase over existing conditions from 15-minute peak frequency to 12-minute peak frequency. A review of the demand in the peak period, completed during previous planning, indicated that the 12-minute frequency would not provide enough service to accommodate the demand in North Portland. As a result, the peak-period frequency was adjusted to 10 minutes.

In addition to the Yellow Line changes, C-TRAN express buses went through a set of service changes in 2021 that revised how their routes operated. These routing changes were incorporated into the No-Build Alternative and are described below and in Table 4-35.

Changes in bus routing and frequency between existing 2019 service and the 2045 No-Build Alternative in the project vicinity include:

- Increased peak frequency on the Yellow Line between Milwaukie and the Expo Center.
- New C-TRAN BRT service on Mill Plain Boulevard, East Fourth Plain and 162nd Avenue and Highway 99.

- Removal of C-TRAN Express Route 134, Route 157, Route 177, Route 199. This service has been replaced by more frequent service on other express buses operating in the same corridors.
- More frequent service would be provided in the peak on C-TRAN Express Route 105 and Route 190 and in the peak and midday on Route 164, which does not currently include midday service.
- New C-TRAN Express Route 101 with all-day service between downtown Vancouver and downtown Portland.
- More frequent service would be provided on TriMet local bus Lines 4, 6, 8, 11, 35, 44, 72, and 75.
- More frequent service would be provided on C-TRAN local bus Route 2.
- More frequent service would be provided on C-TRAN regional bus Routes 60 and 65.
- New routing in and out of downtown Vancouver on C-TRAN local bus Route 32.
- Removal of C-TRAN local bus Routes 6, 31 and 37. Routes 31 and 37 have been replaced by BRT.

Table 4-35 includes a list of No-Build transit routes for both C-TRAN and TriMet for the year 2045.

Table 4-35. 2045 No-Build and Modified LPA and Options Conceptual Transit Routes and Headways

Route Number (Operator)	Route Description	2045 No-Build Alternative Headways[a] (minutes) Peak Period	2045 No-Build Headways[a] (minutes) Midday	2045 Modified LPA and Options Headways[a] (minutes) Peak Period	2045 Modified LPA Options Headways[a] (minutes) Midday
Yellow Line (TriMet)	Milwaukie to Expo Center	10	15	N/A	N/A
Yellow Line (TriMet)	Milwaukie to Evergreen	N/A	N/A	6.7	15
4 Fessenden (TriMet)	Downtown Portland – St. Johns	10	10	10	10
6 Martin Luther King Jr. (TriMet)	Downtown Portland – Hayden Island	10	10	N/A	N/A
6 Martin Luther King Jr. (TriMet)	Downtown Portland – Expo Center	N/A	N/A	10	10
08 Jackson Park (TriMet)	Portland central business district – North Portland	10	10	10	10
11 Rivergate (TriMet)	Parkrose – St. Johns	20	30	20	30
35 Macadam/ Greeley (TriMet)	Oregon City – University of Portland	10	15	10	15
44 Capitol Hwy/ Mocks Crest (TriMet)	Portland Community College Sylvania – St. Johns (via Portland central business district)	10	12	10	12
72 Killingsworth (TriMet)	Clackamas Town Center – Swan Island	10	10	10	10
75 St. Johns (TriMet)	Milwaukie Transit Center to St. Johns	10	10	10	10
Vine Loop BRT (C-TRAN)	Clockwise and counter-clockwise loop from downtown Vancouver – via McLoughlin – Fourth Plain – Mill Plain to Mill Plain Transit Center	10	10	N/A	N/A

Route Number (Operator)	Route Description	2045 No-Build Alternative Headways[a] (minutes) Peak Period	2045 No-Build Headways[a] (minutes) Midday	2045 Modified LPA and Options Headways[a] (minutes) Peak Period	2045 Modified LPA Options Headways[a] (minutes) Midday
Vine Loop BRT (C-TRAN)	Clockwise and counter-clockwise loop from downtown Vancouver via Evergreen – Fort Vancouver – Fourth Plain – Mill Plain to Mill Plain Transit Center	N/A	N/A	10	10
Hwy 99 Vine BRT (C-TRAN)	Downtown Vancouver to Salmon Creek Park and Ride via Main Street and Hwy 99	10	10	10	10
Route 101 (C-TRAN)	Express bus from downtown Vancouver to downtown Portland via I-5	15	30	10	30
Route 105 (C-TRAN)	Express bus from Salmon Creek Park and Ride and 99th Street Park and Ride to downtown Portland via I-5	10	0	5	0
Route 164 (C-TRAN)	Express bus from Fisher's Landing Park and Ride to downtown Portland via I-205 (SB) and I-5 (NB)	10	30	10	30
Route 190 (C-TRAN)	Express bus from Andresen Park and Ride to downtown Portland via I-5	10	0	10	0
Route 60 (C-TRAN)	Regional bus from downtown Vancouver to Delta Park (with northbound service to Hayden Island)	10	10	N/A	N/A
Route 65 (C-TRAN)	Regional bus from Fisher's Landing Park and Ride to Parkrose Transit Center	20	20	20	20
Route 67 (C-TRAN)	Regional bus from Fisher's Landing Park and Ride to Portland International Airport	0	30	0	30

Route Number (Operator)	Route Description	2045 No-Build Alternative Headways [a] (minutes) Peak Period	2045 No-Build Headways [a] (minutes) Midday	2045 Modified LPA and Options Headways [a] (minutes) Peak Period	2045 Modified LPA Options Headways [a] (minutes) Midday
Route 2 (C-TRAN) [b]	Local bus from 99th Street Transit Center to downtown Vancouver	45	45	45	45
Route 3 (C-TRAN)	Local bus circulator 30th – Grand Boulevard – Columbia Way – downtown Vancouver	45	45	45	45
Route 25 (C-TRAN) [b]	99th Street Transit Center to downtown Vancouver	30	30	30	30
Route 30 (C-TRAN) [b]	Local bus from Fisher's Landing Transit Center to downtown Vancouver	30	30	30	30
Route 32 (C-TRAN) [c]	Local bus from Vancouver Mall to downtown Vancouver	30	30	30	30
Route 41 (C-TRAN)	Camas/Washougal to downtown Vancouver	120	0	120	0

Source: Metro, RTC, C-TRAN, TriMet, IBR Analysis 2024

Route numbers are subject to change with final service decisions by transit agencies.

The starting point for route information was the 2018 RTP; transit agencies then made modifications for SEIS networks.

a Headways are the frequency at which a vehicle passes by a point along the route.

b C-TRAN routes were rerouted in the Modified LPA and options to provide service to Evergreen Station with a stop at C Street and 9th Street.

c The Modified LPA and options would provide connection to Evergreen Station with a stop at C Street and 9th Street.

BRT = bus rapid transit; Hwy = highway; NB = northbound; SB = southbound

4.7.1.3 Modified LPA and Modified LPA Design Options

Both C-TRAN and TriMet have identified conceptual transit bus service plans that could be integrated in the Modified LPA and options. The underlying transit network assumptions would fundamentally be the same for the Modified LPA and options. The Modified LPA without C Street ramps would have small routing changes to access downtown Vancouver when the C Street ramps are not included, as transit would enter and exit downtown Vancouver through the Mill Plain Boulevard interchange. The information provided by these agencies represents a potential condition that could meet the foreseeable transit needs of the IBR Program Area. It should be noted that actual changes to regional and local bus routes would require agency approval prior to implementation. Table 4-35 provides a list of transit service in the IBR Program Area in 2045 with the Modified LPA and options.

The Modified LPA and options would include the extension of the Yellow Line LRT north from the current terminus at the Expo Center to a terminus location near Evergreen Boulevard along I-5 in Vancouver. The Yellow Line extension would include new light-rail stations at Hayden Island, the downtown Vancouver Waterfront, and Evergreen Boulevard. As noted above in the No-Build Alternative description, the Yellow Line LRT starting point for analysis was 10 minutes in the peak and 15 minutes in the off-peak. Initial modeling results with the extension of the Yellow Line to Evergreen under the Modified LPA indicated that additional service would be needed to accommodate the peak-period demand on the line with this extension into Vancouver. Thus, the Yellow Line LRT would operate at average 6.7-minute frequencies during the peak and 15-minute frequencies during the off-peak between downtown Portland and the Evergreen Station in Vancouver for the Modified LPA and options. Yellow Line service to Vancouver would operate 20 hours per day (5 a.m. to 1 a.m.) 7 days a week.

In addition to the LRT extension, C-TRAN express bus service would be included as part of the Modified LPA and options with Routes 101, 105 and 190 all using bus-on-shoulder for the portions of their routes that run on I-5 through the IBR Program Area. Routes 101 and 105 would also include peak period frequency increases to 10 minutes and 5 minutes respectively.

In Portland, TriMet Route 6 would be modified with the extension of the Yellow Line LRT to Vancouver in the Modified LPA and options. Once LRT is extended north to Hayden Island, Route 6 would be truncated to end at the Expo Center LRT station. No other TriMet bus routes in Portland would be adjusted as part of the Modified LPA and options.

In Vancouver, several routes would be adjusted as part of the Modified LPA and options. These routes would be rerouted to terminate in downtown Vancouver along C Street near 9th Street to provide transfer opportunities to and from the Modified LPA and options transit services at Evergreen Station. The Vine BRT routing would be changed, which would be rerouted in and out of downtown Vancouver to serve the Evergreen Station via Evergreen Boulevard and Fort Vancouver Way rather than via McLoughlin Boulevard. Highway 99 Vine service would be modified to include an additional station at the Waterfront MAX station. Route 60 would be eliminated. C-TRAN local bus routes with modifications in routing to serve the new Evergreen Station are denoted with Note 1 in Table 4-35.

Design of transit elements of the Modified LPA and options would incorporate Crime Prevention Through Environmental Design principles to implement best practices for lighting, CCTV, fare zone enforcement and other design standards adopted for both TriMet and C-TRAN. A fire, life, and safety committee will be assembled to review designs. Compliance will be documented through a safety and security certification process for final design and construction phases.

On-time performance is a measure that transit agencies use to understand how well a route is performing related to arrival times at timepoints published in timetables. With increased frequencies on the Yellow Line as part of the Modified LPA and options, impacts to operations in TriMet's rail system will be evaluated as additional design refinement and operations details are developed. Any impacts that are identified will be documented as the analysis is completed.

One design option under consideration is a single-level fixed-span configuration. Under this configuration, on-time performance would be similar except that LRT service would be subject to interruption by bridge openings and gate closures unless openings were restricted only to overnight hours. In addition, LRT speeds over the bridge would be reduced to 20 mph or less due to movable joints on the rails, but design speeds would be similar (55 mph).

4.7.1.4 Amount of Service

The amount of service provided in the transit system can be measured by VHT in revenue service, daily VMT in revenue service, and daily place-miles of service. Table 4-36 below provides average weekday totals for all three of these measures for the model base year (2015) as well as for the 2045 No-Build Alternative and Modified LPA and options. The base year is included to provide a point of comparison of service levels under the No-Build Alternative and Modified LPA which reflect background transit changes that are part of the 2018 RTP. Daily VHT and VMT are measured as time and distance, respectively, for transit vehicles in service on an average weekday. As shown in Table 4-36, transit miles and hours in the No-Build Alternative increase over 50% as compared to existing conditions and place-miles increase just under 50%. This increase reflects the changes in the transit system planned in the 2018 RTP that are not part of the IBR Program. VMT would increase in 2045 with the Modified LPA and options as compared to the No-Build Alternative primarily due to the extension of LRT and to more frequent express buses operating in bus-on-shoulder mode in the IBR Program Area. Also, under the Modified LPA, VHT would decrease on local bus and increase on LRT and express bus by a similar number of hours resulting in approximately the same total VHT compared to the No-Build Alternative.

Place-miles reflect the carrying capacity of the vehicles in service (seated and standing) for each bus or train and are calculated by multiplying the vehicle capacity by the VMT. Place-miles can highlight differences in total available capacity between alternatives as shown in Table 4-36 below. The Modified LPA and options have more place-miles than the No-Build Alternative, in part because of the extension of LRT across the Columbia River and in part because additional express bus service between Vancouver and Portland would be provided under the Modified LPA and options. Reductions in place-miles on local bus and BRT routes would be due to the removal of C-TRAN Route 60 as well as rerouting primarily TriMet Line 6 and Vine BRT.

Table 4-36. 2045 Average Weekday Corridor[a] Transit Service Characteristics

Metric	Measure	Existing (2015)	2045 No-Build Alternative	2045 Modified LPA and Options
Transit VMT	Local Bus	9,250	13,500	11,900
	Express Bus	5,450	3,900	7,650

Metric	Measure	Existing (2015)	2045 No-Build Alternative	2045 Modified LPA and Options
	LRT [b]	800	850	1,300
	BRT	0	5,300	5,250
	Total	**15,500**	**23,550**	**26,050**
	% Change [c]	**N/A**	**51.0%**	**9.5%**
Transit VHT	Local Bus	650	850	750
	Express Bus	200	150	250
	LRT [b]	50	70	75
	BRT	0	300	300
	Total	**850**	**1,400**	**1,400**
	% Change [c]	**N/A**	**58.8%**	**0%**
Place-Miles [d]	Local Bus	602,100	879,100	773,200
	Express Bus	545,300	388,900	763,300
	LRT [b]	225,400	247,300	380,300
	BRT	0	530,200	524,500
	Total	**1,372,800**	**2,045,500**	**2,441,300**
	% Change [c]	**N/A**	**49.0%**	**19.3%**

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

a Excludes Portland central business district.

b For LRT, transit VMT and VHT are measured in train miles rather than in car miles.

c For the No-Build Alternative, the percentage change is the change compared to existing; for the Modified LPA the percentage change is compared to the No-Build Alternative.

d Place-miles = transit vehicle capacity (seated and standing) multiplied by VMT. Bus capacity = 55, BRT and express bus capacity = 100, LRT capacity = 288 (LRT consists of two-car trains; each car can carry 144 people).

VMT = Vehicle Miles Traveled; VHT = Vehicle Hours Traveled; BRT = Bus Rapid Transit; LRT = light-rail transit; N/A = Not Applicable

4.7.2 Transit Capital Facilities

Several existing transit centers and park-and-ride facilities are used for bi-state travel between Clark County and Oregon in the No-Build Alternative and the Modified LPA and options. These are served by various combinations of local, express, and regional bus routes, and BRT and LRT.

All but one of the transit centers and park-and-ride facilities that are in place in existing conditions are part of the 2045 No-Build and the Modified LPA and options. The one park-and-ride lot that is no longer assumed in 2045 is the Evergreen Park and Ride which is located near NE 18th Street and NE 136th Avenue in Clark County. The bus route that provided service to this park-and-ride lot was eliminated and is no longer in service as part of the 2045 assumptions, so the lot has been removed. These park-and-ride facilities would be in place in both the 2045 No-Build Alternative and Modified LPA, with some modifications to the routes that provide service to them. There will be one new transit center in place in the 2045 No-Build and the Modified LPA and options that is not part of the

Program—the Mill Plain Transit Center—which will be the terminus for The Vine Loop. In addition, there would be new capital facilities in the form of LRT and BRT stations and park-and-ride lots associated with the Modified LPA. The Modified LPA and options include an additional 1,270 park-and-ride spaces at two new lots compared to the No-Build Alternative. Table 4-37 provides details on transit capital facilities for the No-Build Alternative and the Modified LPA and options, including information on the facility type, amenities, routes that serve them, and park-and-ride stalls (if applicable). There would be no difference in transit capital facilities between the Modified LPA and options.

Table 4-37. Transit Capital Facilities

Alternative	Transit Facility	Type of Facility	Rider Amenities	Served by Routes	Park-and-Ride Stalls
2045 No-Build Alternative	Salmon Creek Park and Ride	Park and ride	Passenger shelters/bicycle parking	C-TRAN: Highway 99 BRT, 9, 105	472
	99th Street Transit Center	Transit center/park and ride	Passenger shelters/ bicycle parking/ security	C-TRAN: Highway 99 BRT, 2, 9, 19, 25, 31, 78, 105	609
	Andresen Park and Ride (Living Hope Church)	Park and ride	Passenger shelters	C-TRAN: 30, 32, 190	100
	Columbia House Park and Ride	Park and ride	None	C-TRAN: 3	34
	Vancouver Mall Transit Center	Transit center	Bicycle parking/ passenger service office	C-TRAN: The Vine, 7, 32, 47, 72, 78, 80	N/A
	Fisher's Landing Park and Ride and Transit Center	Transit center/park and ride	Passenger shelters/ bicycle parking/ security/public rest room/ passenger service office	C-TRAN: 30, 41, 65, 67, 80, 92, 164	761
	Mill Plain Transit Center	Transit Center	Passenger shelters/ bicycle parking/ security	C-TRAN: The Vine	N/A
	Expo Center Park and Ride	Park and ride	Bicycle parking	TriMet: MAX Yellow Line, 11	100
	Delta Park/Vanport Park and Ride	Park and ride	Bicycle parking	C-TRAN: 60 TriMet: MAX Yellow Line, 6	300
	Lombard Transit Center	Transit center	Bicycle parking	TriMet: MAX Yellow Line; 4, 75	N/A

Alternative	Transit Facility	Type of Facility	Rider Amenities	Served by Routes	Park-and-Ride Stalls
	Rose Quarter Transit Center	Transit center	Bicycle parking	TriMet: MAX Yellow, Red, Blue, Green; 4, 8, 35, 44, 77, 85 C-TRAN: 101, 105	N/A
	Parkrose/Sumner Transit Center Park and Ride	Park and ride/transit center	Bicycle parking	C-TRAN: 65 TriMet: MAX Red, 12,21,71,73	193
	Gateway/NE 99th Ave Transit Center Park and Ride	Park and ride/transit center	Bicycle parking	TriMet: MAX Red, Blue, Green, 15, 19, 22, 23, 24, 25, 87	690
2045 Modified LPA and Options [a]	Expo Center Park and Ride [b]	park and ride	bicycle parking	TriMet: MAX Yellow Line, 6, 11	100
	Delta Park/Vanport Park and Ride [b]	Park and ride	Bicycle parking	TriMet: MAX Yellow Line	300
	Hayden Island Station	LRT station	Passenger shelters, bicycle parking, security	TriMet: MAX Yellow Line	N/A
	Waterfront Station/Park and Ride	LRT station/BRT station/ park and ride	Park and ride, passenger shelters, bicycle parking, security	TriMet: MAX Yellow Line C-TRAN: 3, 32, Hwy 99 BRT	570
	Evergreen/I-5 Station/Park and Ride [c]	LRT station/ park and ride	Park and ride, passenger shelters, bicycle parking, security, passenger service office	TriMet: MAX Yellow Line C-TRAN: 2, 3, 25, 30, 32, 41, 47, 101, Vine Loop	700
	Evergreen Vine Station [d]	BRT stations	Passenger shelters	Vine Loop	N/A

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2022, C-TRAN, TriMet

a Modified LPA list includes new and changed facilities from No-Build Alternative.

b Capital facility with a change in the Modified LPA and options. Details around specific changes at existing stations under the Modified LPA and options are still under consideration at the time of this report development.

c Passengers on other routes operating in downtown Vancouver would also be able to walk from locations along Broadway Street and Washington Street to access the Evergreen Station.

d New eastbound and westbound Vine stations would be built in proximity to the Evergreen/I-5 LRT station.

4.7.3 Regional Transit Ridership

The Metro/RTC regional travel demand model was used to produce estimates of ridership for 2045 for the No-Build Alternative and the Modified LPA and options. This section evaluates several measurements for ridership: total systemwide ridership, total corridor ridership, work and non-work transit trips and mode shares, express bus ridership, and overall ridership attributed to capital improvements which are part of the Modified LPA and options along with station-level boardings and mode of access. It is important to note that increases in transit ridership between the base year and future year are influenced by policies in the 2018 RTP, such as parking policies and fare subsidy policies, that have an impact on transit mode choice. The introduction of tolling on the I-5 Columbia River bridges also contributes to increases in transit ridership.

4.7.3.1 Travel Demand and Mode Choice

The Metro/RTC regional travel demand model provides information on overall travel that occurs within the region for all trip purposes and modes (auto, transit, walk, bike). This information is reported as person-trips at the highest level in the model and is measured as trips between Transportation Analysis Zones (TAZ).

Table 4-38 shows the 2045 daily person-trips and transit trips for the No-Build Alternative and the Modified LPA and options, including project, corridor, and systemwide totals. Total daily person-trips are the same between the two alternatives. Trips are shown in Table 4-38 in two categories, those that begin or end at work and all other trips. Corridor trips do not include intra-Portland central city trips. Table 4-38 also documents the anticipated daily ridership and change in the number of new transit riders between the No-Build Alternative and the Modified LPA and options. Differences between the Modified LPA and options for metrics presented below fall within rounding so only one set of numbers is presented below that reflects both.

Under the Modified LPA and options, there would be approximately 12,500 new transit riders overall in the per average weekday. These new riders would be in part due to a shift to transit because of variable-rate tolling on the new Columbia River bridges, as well as the extension of LRT between Expo Center and Evergreen, new park-and-ride lots, and improvements to the speed and frequency on express bus service crossing the river. With the Modified LPA and options, the number of daily transit boardings in the TriMet and C-TRAN service area is anticipated to increase by 2.9%.

Table 4-38. 2045 Weekday Daily Systemwide and Corridor Transit Trips

Measure	No-Build Alternative	Modified LPA and Options
Regional Person-Trips (all modes)	11,905,000	Same as No-Build
Work Trips (all modes)	2,165,500	Same as No-Build
Non-Work Trips (all modes)	9,739,500	Same as No-Build
Total Regional Linked Transit Trips [a]	626,300	638,800
Regional Transit Mode Share	5.26%	5.37%
Regional New Linked Transit Trips [a]	N/A	12,500
Percentage Change from No-Build	N/A	+2.0%

Measure	No-Build Alternative	Modified LPA and Options
Total Regional Daily Unlinked Transit Boardings [b]	991,900	1,021,100
Percentage Change from No-Build	N/A	2.9%
Total Daily Regional Unlinked Light-Rail Boardings [b]	335,600	362,200
Percentage Change from No-Build	N/A	7.9%
Total Corridor Person-Trips (all modes)	3,249,500	3,250,200
Total Corridor Work Trips (all modes)	743,400	743,300
Total Corridor Non-Work Trips (all modes)	2,506,100	2,506,900
Total corridor Linked transit trips [a]	351,300	363,300
Corridor New Linked Transit Trips [a]	N/A	11,700
Percentage Change from No-Build	N/A	3.3%

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

a Transit trips count each passenger only once between the origin and destination of their trip. Transit trips include all trips on any transit mode.

b Boardings count each time a passenger boards a transit vehicle; passengers who transfer between transit lines in a single "linked" trip count as multiple transit boardings.

4.7.3.2 Transit Trip Productions and Attractions

Figure 4-32 and Figure 4-33 show where the 12,500 new linked transit trips would occur by showing the difference in transit trip productions (where trips originate) or attractions (where trips end) for the Modified LPA and options compared to the No-Build Alternative at a TAZ level. The map indicates which areas would benefit from the project with density dots to indicate the overall magnitude of trips associated with each TAZ. TAZs that show increases in productions throughout Clark County track with increases in project ridership related to both the LRT extension and the express bus improvements under the Modified LPA and options. Increases in North Portland along the Yellow Line also track with improved frequencies under the Modified LPA and options. Some of these increases are related to frequency improvements under the Modified LPA and options, but some are trips that would shift to transit for travel to Clark County—primarily the Vancouver CBD—where, in addition to a toll for crossing the river, there are parking charges at the destination. While these parking charges exist in the No-Build Alternative as well, the addition of better transit service on both LRT and express bus, supported with the direct connection between light-rail and the C-TRAN Vine BRT, along with added costs for drivers in the form of tolls, would increase transit trips to these destinations. TAZs that show increases in attractions fall primarily along the Yellow Line, including both downtown Portland and downtown Vancouver, where parking charges at the destination zone would make transit more attractive.

In the case of both productions and attractions, the maps show red zones where transit trips are lower in the Modified LPA and options as compared to the No-Build Alternative. In terms of the production side, there is one zone that has 30 fewer productions. In terms of the attraction side, there are seven zones that have more than 20 fewer attractions. The largest reduction is a loss of 46 attractions and the average of all seven zones is 30 fewer attractions. All of the zones with reductions compared to the No-Build Alternative are the result of routing changes to the Route 2, Route 25 and the Fourth and Mill

Plain BRTs under the Modified LPA which change access to some zones in the downtown Vancouver CBD.

Figure 4-32. Transit Trip Productions

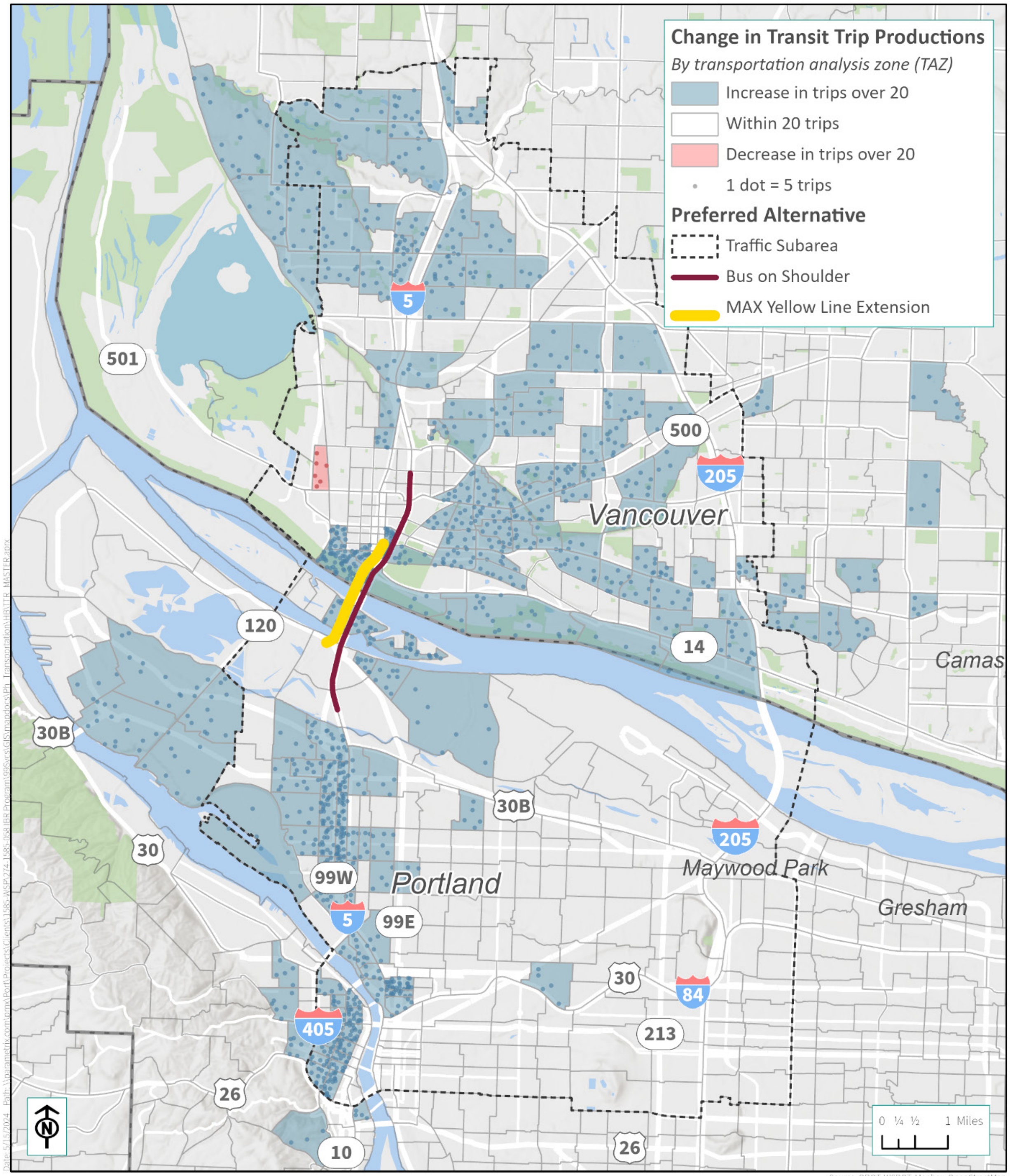
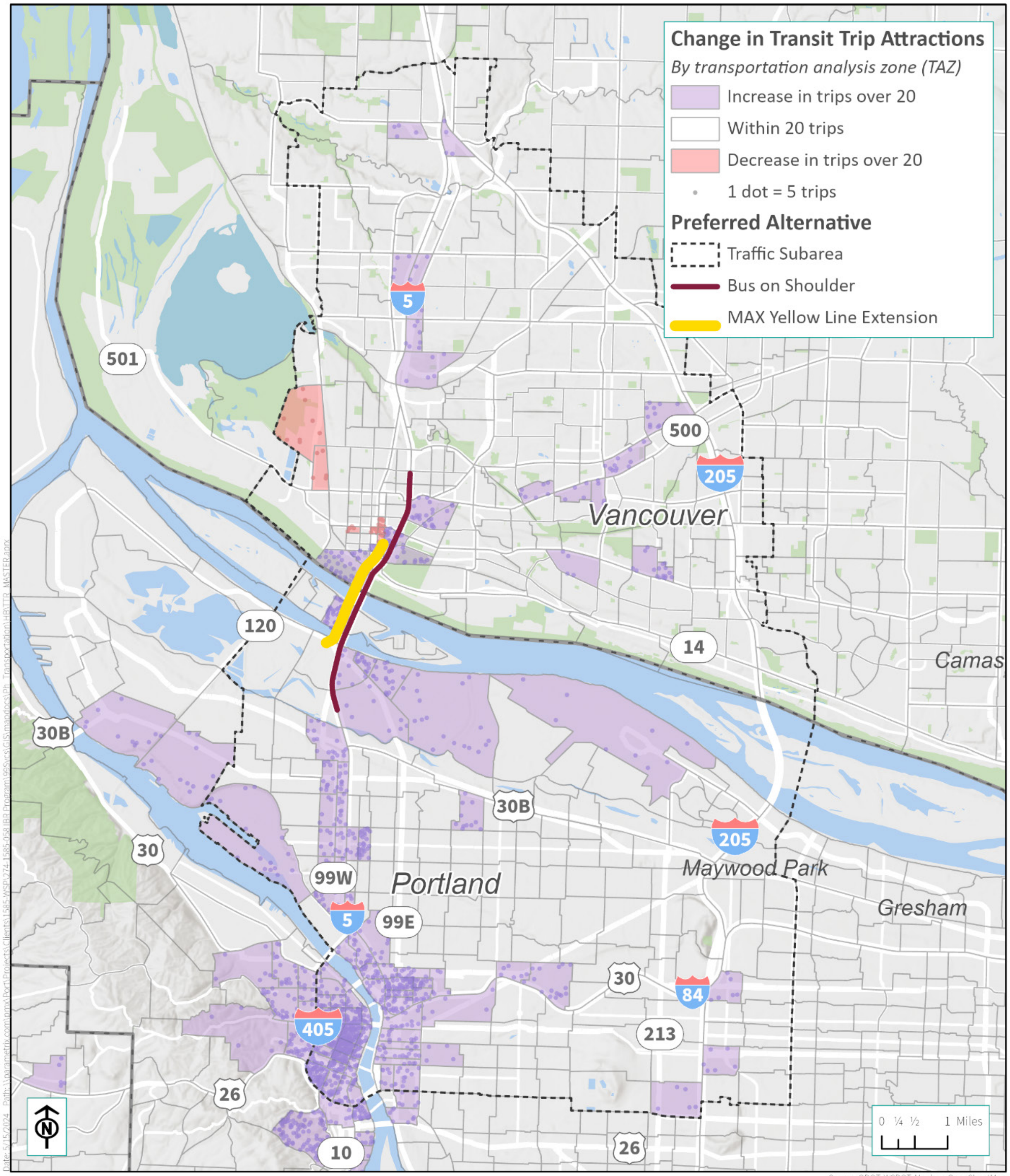


Figure 4-33. Transit Trip Attractions



4.7.3.3 LRT Station Mode of Access/Egress

Light-rail stations are typically accessed by automobile (including park-and-ride trips and passenger drop-off/pickup), transit (local, regional, and express bus, BRT, LRT) or by active transportation modes including walking, biking, and rolling. The Metro/RTC regional travel demand model provides an estimate of the various modes of access at each station; however, it does not explicitly forecast drop-off/pickup trips that could be made by private vehicle, transportation network company, or by taxi. It also does not explicitly forecast bike access trips to stations. Table 4-39 summarizes individual station use and modes of access and egress to the new LRT stations with the Modified LPA and options as output from the Metro/RTC regional travel demand model. Actual mode of access would depend largely on future land use development patterns around stations, bus service, and activity associated with transportation network companies and autonomous vehicles.

Table 4-39. 2045 Modified LPA and Options LRT Station Usage (Boardings and Alightings) by Mode of Access and Egress

Station Location	Station Boardings/Alightings	% of Total Boardings/Alightings	% Walking [a]	% Transfer	% Park and Ride [b]
Hayden Island	3,300	15%	100%	N/A	N/A
Waterfront	5,200	24%	25%	60%	15%
Evergreen/I-5	13,100	61%	16%	75%	10%

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

a Bike access is assumed to be approximately 3% of walk access trips based on TriMet 2018 On-Board Survey data.

b Park-and-ride numbers do not include numbers for drop-off (private vehicle, taxi, transportation network company) or C-TRAN microtransit trips on The Current. Drop-off is estimated to be approximately 22% of total drive access trips to MAX stations based on TriMet 2018 On-Board Survey data.

The mode of access in the Metro/RTC regional travel demand model does not explicitly assume numbers for bike access or drop-off (private vehicle, taxi, transportation network company) or C-TRAN microtransit trips on The Current and are not reflected in Table 4-39. TriMet on-board survey data from 2018 were used to develop estimates for drop-off trips and bicycle trips. Drop-off trips to TriMet MAX stations with park and rides and drop-off facilities is approximately 22% of total drive access trips at the lots. The analysis of traffic impacts around transit stations which considered these modes of access can be found in Section 4.6, Arterials and Local Streets. Bicycle access to MAX stations is estimated to be approximately 3% of walk access trips.

EVERGREEN STATION

The most frequently used station on the Modified LPA and options LRT extension would be Evergreen Station, accounting for 61% of total boardings and alightings at the three proposed stations. Modifications to the background transit network to provide connections adjacent to the light-rail station for several local bus routes, express bus Route 101 and the Vine BRT would result in approximately 75% of total station activity being related to transfers to or from light-rail via BRT or local bus at this location. A 700-space park-and-ride lot at this station is projected to be fully utilized accounting for 10% of total station activity. In addition, drop-off/pickup not estimated explicitly in the model is anticipated to increase the overall share of driving access as part of the total station activity. The remainder of the trips would access by nonmotorized modes.

WATERFRONT STATION

The Waterfront Station would be the second most-utilized station of the three stations with 24% of total station activity on the Modified LPA and options LRT extension. With three bus routes (Highway 99 Vine and two local routes) that would have integrated stop locations at the station, transfers at this location would also be very high at 60% of total activity. A 570-space park-and-ride lot at or near the station is projected to be fully utilized accounting for 15% of total activity. In addition, drop-off/pickup not explicitly stated in the model is anticipated to increase the overall share of driving access as part of the total station activity. Because of the station's proximity to activities and land uses at the waterfront, area nonmotorized access would be just over a quarter of the total station activity.

HAYDEN ISLAND STATION

The Hayden Island Station would have the lowest assumed station activity among the three new stations on the Modified LPA and options LRT extension. Current background transit assumptions do not include bus connections at this station, but these would be possible through adjacent on-street areas should this assumption change in the future. This station would not include a formal park and ride, so any auto access would be from drop-off/pickup activity, which as noted, is not explicitly reflected in the model. The remainder of the access to this station would be from nonmotorized modes.

EXPO STATION

The Expo Station is the existing terminus of the Yellow Line in North Portland. While it is not a new station, it would be the starting point for the extension of the Yellow Line across the Columbia River into Vancouver. Access to this station will change with the extension of the line with adjacent local roads and active transportation facility improvements. Total daily boardings at this station are forecast in the Metro/RTC regional travel demand model to be 1,400 on an average weekday. Access to this station is primarily transfer related at 83% with both the TriMet Route 6 and Route 11 providing connections. In addition, the park and ride would contribute approximately 13% and walk access would contribute 5% of total station activity.

4.7.4 Cross-River Transit Service

Similar to existing conditions, cross-river transit in the No-Build Alternative would consist of C-TRAN regional service and express bus service. The regional service connects downtown Vancouver to the Yellow Line LRT at Delta Park and connects the Fisher's Landing Transit Center to either Portland International Airport or Parkrose Transit Center where passengers have access to the Red Line LRT. The express bus service crossing the river, as noted above, has been consolidated in the No-Build Alternative to include service on one of four routes that connect park-and-ride locations in Clark County downtown Vancouver with downtown Portland and Marquam Hill/OHSU. These express buses operate at 10- or 15-minute frequencies in the peak periods. Two express buses—Route 101 from downtown Vancouver to downtown Portland and Route 164 from Fisher's Landing Transit Center to downtown Portland—provide off-peak service at 30-minute frequencies. In the No-Build Alternative, there would be more demand than these routes can accommodate in the peak period. Route 105 would be able to operate on the inside shoulder between 99th Street and the Columbia River when freeway speeds degrade below 25 mph in this segment. The bus would only be able to operate up to a maximum speed of 25 mph.

In the Modified LPA and options, one of the regional routes (Route 60) which provides service between downtown Vancouver, Delta Park, and Hayden Island would be removed once the LRT is extended to provide this connection. As under the No-Build Alternative, four express buses would remain in operation in the Modified LPA and options, providing complementary service to the LRT extension. Because of the high demand for cross-river transit service, frequencies on Routes 101 and 105 would be adjusted in the Modified LPA and options to provide more service in the peak periods only. All routes and frequencies for the No-Build Alternative and the Modified LPA and options are shown in Table 4-40. In addition to more frequent service on Routes 101 and 105, three of the express bus routes would operate on the shoulder on the new Columbia River bridges when freeway speeds degrade below 35 mph between SR 500 and the southern end of the IBR Program Area near Victory Boulevard. The buses would be able to operate up to a maximum speed of 35 mph when they use the shoulders for operations.

In 2045, approximately 17,200 riders in the No-Build Alternative and 30,800 riders in the Modified LPA and options would cross the Columbia River using transit. Table 4-40 below provides details on these average weekday river crossings by bridge and transit mode.

Table 4-40. 2045 Weekday Transit Ridership by River Crossing

Alternative	River Crossing	Service Type	Weekday Transit Ridership[a]	Routes
2045 No-Build Alternative	I-5	Express	13,100	C-TRAN 101, 105, 164,[b] 190
	I-5	Regional	1,600	C-TRAN 60
	Total I-5 Transit	N/A	14,800	N/A
	I-205	Express	1,400	C-TRAN 164 [b]
	I-205	Regional	1,000	C-TRAN 65, 67
	Total I-205 Transit	N/A	2,400	N/A
2045 Modified LPA and Options	I-5	Express	11,100	C-TRAN 101, 105, 164,[b] 190
	I-5	Light-Rail	17,900	Yellow Line
	Total I-5 Transit	N/A	29,100	N/A
	I-205	Express	1,200	C-TRAN 164,[b] 177 [b]
	I-205	Regional	600	C-TRAN 65, 67
	Total I-205 Transit	N/A	1,800	N/A

Source: Metro/RTC Regional Travel Demand Model, C-TRAN, TriMet, IBR Analysis 2024

a Routes that use both I-205 and I-5 have been separated out by boardings for inbound vs. outbound to estimate the portion of weekday trips that use each bridge.

b C-TRAN Route 164 travels on I-205 in the southbound direction during the AM peak period and the northbound direction during the PM peak period.

4.7.5 Travel Time

Transit travel times for both the AM and PM peak periods were calculated to show differences between the No-Build Alternative and the Modified LPA and options as defined above in Section 4.7.1, Transit Service, and Section 4.7.2, Transit Capital Facilities. The travel time estimates were developed using regional travel demand modeling, freeway operations modeling, and engineering designs as detailed below and are presented for both in-vehicle and total travel time. Total travel time includes in-vehicle travel time, wait time (initial and transfer where applicable), and walk access/egress time. Bus travel times were developed using the Metro/RTC regional travel demand model along with more detailed data from the freeway operations modeling completed in VISSIM. Light-rail travel times were derived using engineering designs developed for the Modified LPA and options. The travel times take into account operational speed limits based on the engineering designs of each segment of the LRT extension. Travel times for these 2045 alternatives are not always directly comparable to existing travel times included in Chapter 3 of this report because of routing and other service changes that are included in the 2045 alternatives. Notes in the first column (Origin/Destination) and under Table 4-41 provide details to clarify the assumptions being used for the calculation of the travel times.

The travel time summary below in Table 4-41 includes travel time information for trips between downtown Vancouver and four locations in Portland, including Hayden Island, Lombard Transit Center, Rose Quarter and downtown Portland. The latter three locations in Portland provide access to connections for travel to other regional locations via transfer to and from the TriMet system. Travel times for the Modified LPA and options are provided for both express bus and LRT where they both provide service.

LRT times in the PM peak are higher than express bus for these locations, but it should be noted that express bus operates without intermediate stops where the LRT includes stops throughout the IBR Program Area and North Portland providing connections to locations that express bus does not serve. The additional LRT stops add dwell time (approximately 20 seconds per station), so there is a trade-off between access and travel time.

In the AM peak, southbound express bus times in the Modified LPA and options for trips between Vancouver and the Rose Quarter or downtown Portland are longer than times in the No-Build Alternative. As described in Section 4.3.4, Freeway Operations, while the southbound bottleneck at the Columbia River bridges would be reduced under the Modified LPA and options compared to the No-Build Alternative, the improved southbound flow at the Columbia River bridges would increase the extent and duration of the downstream bottleneck approaching the I-5/I-405 split in North Portland, with congestion spilling back into the IBR Program Area for most of the AM peak period. For southbound AM peak movements between Vancouver and the Rose Quarter or downtown Portland, the LRT times are not impacted by I-5 freeway congestion and provide a faster trip than in the No-Build Alternative. In combination, express bus and LRT complement each other to connect North Portland, downtown Portland, and Clark County.

Differences in travel times between the Modified LPA and options show up in the express bus travel times primarily in the PM peak period in the northbound direction where the Modified LPA with two auxiliary lanes results in faster travel times (12 minutes) than the Modified LPA which assumes one auxiliary lane. The LRT travel times between the Modified LPA and options do not change.

Table 4-41. 2045 Average Weekday AM and PM Peak Transit Travel Time for Selected Corridor Locations

Origin/Destination	2045 No-Build Alternative		Modified LPA [a]		Modified LPA with Two Auxiliary Lanes	
	AM Peak Southbound	PM Peak Northbound	AM Peak Southbound	PM Peak Northbound	AM Peak Southbound	PM Peak Northbound
In-Vehicle Travel Time (in minutes)						
Between downtown Vancouver and Hayden Island	21 [b]	6	3 [c]	3 [c]	3 [c]	3 [c]
Between downtown Vancouver and Lombard Transit Center	23 [d]	21 [d]	12 [c]	12 [c]	12 [c]	12 [c]
Between downtown Vancouver and Rose Quarter	-	-	-	-	-	-
• Express Bus [e] (no stops between downtown Vancouver and Rose Quarter)	26	45	37	23	37	11
• LRT (includes 13 stations between downtown Vancouver and Rose Quarter)	-	-	24	24	24	24
• Regional bus transfer to LRT (includes C-TRAN Line 60 to Delta Park with transfer to Yellow Line)	35	33	-	-	--	
Between downtown Vancouver and Pioneer Square (Portland central business district)	-	-	-	-	-	-
• Express Bus [e] (includes two stops between downtown Vancouver and Pioneer Square)	33	52	44	30	44	18
• LRT (includes 16 stops between downtown Vancouver and Pioneer Square)	-	-	33	33	33	33
Total Travel Time [f]						
Between downtown Vancouver and Hayden Island	36 [b]	21	17 [c]	17 [c]	17 [c]	17 [c]
Between downtown Vancouver and Lombard Transit Center	43 [d]	41 [d]	25 [c]	25 [c]	25 [c]	25 [c]
Between downtown Vancouver and Rose Quarter	-	-	-	-	-	-

Origin/Destination	2045 No-Build Alternative		Modified LPA [a]		Modified LPA with Two Auxiliary Lanes	
	AM Peak Southbound	PM Peak Northbound	AM Peak Southbound	PM Peak Northbound	AM Peak Southbound	PM Peak Northbound
• Express Bus [f] (no stops between downtown Vancouver and Rose Quarter)	43	62	52	38	52	26
• LRT (includes 13 stations between downtown Vancouver and Rose Quarter)	-	-	37	37	37	37
Between downtown Vancouver and Pioneer Square (Portland central business district)	-	-	-	-	-	-
• Express Bus [f] (includes two stops between downtown Vancouver and Pioneer Square)	48	67	59	45	59	33
• LRT (includes 16 stops between downtown Vancouver and Pioneer Square)	-	-	47	47	47	47

Sources: Metro/RTC Regional Travel Demand Model, C-TRAN, TriMet, IBR Analysis 2024, IBR VISSIM Microsimulation

a The Modified LPA without C Street ramps would require express bus transit to be rerouted to access downtown Vancouver via Mill Plain Boulevard. This would add more travel time for express bus transit trips in and out of downtown Vancouver on express bus because of added distance and congestion on the mainline.

b Route 60 does not stop at Hayden Island southbound so a trip from Vancouver to Hayden Island travels south to Delta Park and then back north to stop on Hayden Island.

c Travel time is on Yellow Line LRT.

d Route 60 between downtown Vancouver and Delta Park with transfer to Yellow Line LRT.

e Route includes Route 101 between downtown Vancouver and Rose Quarter or Pioneer Square.

f Total transit travel times include 10 minutes of walk access (1/4 mile walk on either end of the trip at 3 mph average walk speed) in addition to initial and transfer (if applicable) wait time. Wait times are based on half the headway.

4.7.6 Transit Reliability

Light-rail lines in the TriMet system use reserved or exclusive right of way and exhibit higher percentages of on-time arrival than do buses operating in mixed traffic. C-TRAN also operates express bus-on-shoulder operations on a few segments of freeway in Clark County where shoulders are able to accommodate these operations, providing more reliability during times of heavy congestion. C-TRAN would operate bus service on the shoulder in the No-Build Alternative and the Modified LPA and options, but operations would differ in terms of how fast vehicles could travel in the IBR Program Area (25 mph in the No-Build vs 35 mph in the Modified LPA and options) and the distance for which buses could operates on the shoulder because of the enhanced shoulders that are part of the Modified LPA and options. In the No-Build Alternative, buses would be able to operate between 99th Street and the Interstate Bridge (north end before the river), and in the Modified LPA and options buses would be able to operate between 99th Street and the end of the IBR Program Area at Victory Boulevard in North Portland.

Table 4-42 summarizes three measures of transit reliability in the I-5 corridor: (1) miles of exclusive or reserved right of way, (2) the number of passenger miles that would occur in the right of way, and (3) the percentage of passenger miles that would occur in the right of way. The extension of the Yellow Line from the Expo Center north to the new terminus at the Evergreen/I-5 station would be completely in its own guideway, and new shoulders proposed as part of the Modified LPA would provide bus-on-shoulder operations that are reserved for express buses. These both contribute to the increase in average weekday passenger miles in the Modified LPA as compared to the No-Build Alternative. Differences between the Modified LPA and options for measures of reliability only exist in passenger miles which have a 0.002% difference on an average weekday.

Table 4-42. 2045 Measures of Transit Reliability in the I-5 Corridor

Right-of-Way Measure	2045 No-Build Alternative	2045 Modified LPA and Options
Miles of Exclusive/Reserved ROW	20.07	26.88
Average Weekday Passenger Miles	69,500	213,000
Percent of Total Corridor Passenger Miles	12%	31%

Source: Metro/RTC Regional Travel Demand Model, IBR Analysis 2024

4.7.6.1 On-Time Performance

On-time performance is an additional measure of reliability, particularly for multiline rail systems such as MAX. As part of ongoing regional system planning, TriMet previously conducted analysis using the Rail Traffic Controller model, which showed that on-time performance of the regional light-rail system would remain in an acceptable range under TriMet's performance policy when up to 56 trains per hour travel through the system where all lines converge at the Rose Quarter.

Key assumptions in the No-Build Alternative and Modified LPA that would affect on-time performance are defined below:

- To meet demand in the peak periods when ridership is highest under the No-Build Alternative, the Yellow Line is assumed to operate at 10-minute frequencies. When combined with other LRT lines operating through the Rose Quarter (Blue, Red, and Green Lines), this results in 52 to 54 trains per hour (fewer than the 56 trains per hour threshold target at the Rose Quarter that has been identified as acceptable for on-time performance by TriMet).
- To meet demand in the peak periods when ridership is highest under the Modified LPA—with extension of the Yellow Line across the Columbia River to a terminus near Evergreen Boulevard in Vancouver—6.7-minute frequencies are assumed. When combined with other LRT lines operating through the Rose Quarter (Blue, Red, Green Lines) this results in 58 to 60 trains per hour, which is 2 to 4 trains per hour over the target threshold at the Rose Quarter that was identified as acceptable for on-time performance by TriMet's conducted Rail Traffic Controller model analysis). Because 6.7 minute headways under the Modified LPA would result in 2 to 4 more trains per hour over the threshold target, this would likely result in lower on-time performance.

4.7.7 Operations and Maintenance Facilities

C-TRAN has an operations and maintenance facility at an existing site at NE 65th Avenue. To meet the needs for additional vehicles in the Modified LPA and options, three more bus bays with electric chargers would be needed beyond those required for the No-Build Alternative. The annual operating and maintenance cost of these additional bays is included in the Operating and Revenue Expense section below.

TriMet is considering two options for operations and maintenance facilities under the Modified LPA and options. One option is an expansion of the existing facility at Ruby Junction in Gresham. A second alternative site in the vicinity of the Expo Center is also being considered for an overnight yard. Operating and maintenance costs associated with both are included in the Operating and Revenue Expense section below. See the project description for more details on the proposed operations and maintenance facilities.

4.7.8 Operating Revenue and Expense

This section provides details on annual revenue hours, operations and maintenance costs, and costs per boarding for both TriMet and C-TRAN for the No-Build Alternative and the Modified LPA and options. Calculation of these costs includes an assumption about the total number of vehicles and maintenance facilities that would be required as part of the alternatives.

Table 4-43 provides details on the differences in operating and revenue expenses for C-TRAN. Cost differences are directly related to service changes between the No-Build Alternative and the Modified LPA and options. As detailed Table 4-35, under the Modified LPA and options, C-TRAN regional Route 60 is removed, The Vine BRT and several local routes are rerouted to provide direct service to Evergreen Station, and additional express bus service is provided between Vancouver and downtown Portland. The increase in both hours and miles for express bus service results in additional vehicles being required. This is the main contributor to increases in the operating and maintenance costs on the C-TRAN side. In addition, as noted above, C-TRAN facilities would need to be expanded to accommodate the additional vehicles that would be needed to provide express bus service. This would also result in added operating and maintenance costs that are captured in the overall annual cost difference below.

Table 4-43. C-TRAN Operating and Maintenance Costs

Service Type	Metric	2045 No-Build Alternative	2045 Modified LPA and Options
Bus Rapid Transit	Peak-Hour Vehicles Required	25	25
Bus Rapid Transit	Peak-Hour Vehicles Required with 20% Spare	30	30
Express Bus	Peak-Hour Vehicles Required	25	31
Express Bus	Peak-Hour Vehicles Required with 20% Spare	30	38
Systemwide	Annual Hours	-	-10,000
Systemwide	Annual Miles	-	+170,400
Systemwide	Annual Operation and Maintenance Cost Delta in millions of 2019$	-	$940,500

Source: Metro/RTC Regional Travel Demand Model, C-TRAN, TriMet, IBR Analysis 2024

Table 4-44 provides details on differences in operating and revenue expenses for TriMet. Cost differences are directly related to LRT service changes between the No-Build Alternative and the Modified LPA and options. TriMet estimates the need for an additional 19 LRT vehicles when accounting for spares with the Modified LPA and options. The Modified LPA and options would cost an additional $10 million annually to operate compared to the No-Build Alternative if Ruby Junction is the operations and maintenance facility for all vehicles. This number would go down to $9.73 million if a new overnight yard is constructed near the Expo Center. This is due to the reduced miles and hours that trains would need to go in and out of service if an overnight yard was located closer to where the trains would operate. For the rest of the TriMet system, costs between the No-Build and the Modified LPA and options would stay relatively the same with the only adjustment in transit being a slight reduction from the truncation of the Line 6 at Expo Center rather than Hayden Island.

Table 4-44. TriMet Light-Rail Transit Operating and Maintenance Costs

Metric	2045 No-Build Alternative	2045 Modified LPA and Options	2045 Modified LPA and Options Delta vs. 2045 No-Build Alternative
Peak-Hour Vehicles Required	42	58	16
Peak-Hour Vehicles Required with 20% Spare	50	68	19
Annual Hours	104,700	140,700	36,000
Annual Train Miles [a]	1,110,100	1,493,900	383,800
Annual Car Miles [a]	2,220,200	2,987,800	767,700
Annual O&M Cost Delta in millions of 2019$ (only Ruby)	-	$10 million	$10 million
Annual O&M Deadhead Savings with Overnight Yard in millions of 2019$	-	$1.1 million	$1.1 million
Annual Overhead Cost for Overnight Yard in millions of 2019$	-	$0.86 million	$0.86 million
Total Annual O&M Cost Delta in Millions of 2019$		$9.73 million	$9.73 million

Source: Metro/RTC Regional Travel Demand Model, C-TRAN, TriMet, IBR Analysis 2024

a Trains are made up of two vehicles so train miles reflect a two-car set where car miles reflect miles for each car in the set (double the number of train miles).

4.8 Active Transportation

This section describes conditions for active transportation under the No-Build Alternative and the Modified LPA for active transportation.

4.8.1 No-Build Alternative

4.8.1.1 Active Transportation Facilities on the Interstate Bridge

Conditions for active transportation on the Interstate Bridge and in connecting areas would continue to worsen under the No-Build Alternative. Although marginal improvements are planned to the local active transportation system, the substandard and stressful facilities on the Interstate Bridge inhibit large increases in use. As the region experiences increased population growth and development intensifies, more pressure would be placed on deficient existing active transportation facilities, including the shared-use path for walking, rolling, and riding between the two cities. An increase in the volume of people traveling on the narrow and constrained paths would result in increased conflict between users sharing space along the paths, which are not wide enough for two-way travel or for people to pass each other. This deterioration in user experience would limit the potential for active transportation trips over the bridge and further reinforce the bridge as a barrier to active travel.

Therefore, to be conservative, the No-Build evaluation assumes average daily bridge trips to be the same as the existing 2019 conditions (410 daily trips).

4.8.1.2 Active Transportation Facilities in the City of Vancouver

The transportation systems in Vancouver will face increasing pressures as the regional population continues to grow. The Vancouver waterfront and downtown are planned to continue developing with higher-density mixed uses. The importance of active transportation modes will only increase as residents, workers, and visitors look for efficient, convenient, and affordable ways to get around that do not involve sitting in traffic or searching and paying for parking.

The No-Build Alternative would include the active transportation improvements listed within the regional long-range financially constrained project lists for the Vancouver area in the RTC RTP. As shown in Table 4-45, there are two RTP projects within the IBR Program Area.

Table 4-45. RTC Financially Constrained RTP Active Transportation Projects

Project ID #	Project Name	Changes to Pedestrian Facilities	Changes to Bicycle Facilities
1058	Reconstruction of Main Street including sidewalks and crossing improvements	Sidewalk improvements on both sides of street	None
1263	Multimodal improvements to Mill Plain Boulevard west of I-5	ADA curb ramps, sidewalk and crossing improvements	None

Source: Metro/RTC Financially Constrained RTP 2018

PEDESTRIAN AND BICYCLE FACILITIES

These two RTP projects propose modest improvements for walking, rolling, and riding within the IBR Program Area. They would result in a positive, yet marginal, improvement between existing conditions and No-Build conditions.

The reconstruction of Main Street will improve sidewalk conditions (on both sides of the street) from 5th Street to 16th Street. While outside the IBR Program Area, this project intends to improve general pedestrian access and connectivity in the immediate area (C Street and Washington Street, which border Main Street, are both within the IBR Program Area).

While the Mill Plain Boulevard project in the RTP, Project 1263, is a vehicular capacity project, it would include curb ramps, crossings, and construction of some sidewalks up to the interchange ramps. The higher-stress nature of the Mill Plain interchange minimizes the impact of these pedestrian improvements, and the project would not expand the pedestrian travelshed.

However, WSDOT is constructing buffered and parking-protected bike lanes, wider sidewalks, and ADA curb ramps along this stretch of Mill Plain Boulevard. The separated bike lanes constructed in 2022 will not continue through the I-5 interchange (they are reduced to buffered bike lanes); therefore Mill Plain Boulevard will not be a facility that is considered adequate for all ages and abilities. Less-confident and inexperienced users would choose adjacent lower-stress crossings of I-5, Columbia Way, Evergreen Boulevard, or McLoughlin Boulevard).

Table 4-46 summarizes the existing and No-Build BLTS for the I-5 crossing locations. BLTS rankings range from 1 (very low stress; tolerable by all) to 4 (very high stress; tolerable to only a few).

Table 4-46. Vancouver Pedestrian and Bike Facilities at I-5 Crossings, No-Build Alternative

Crossing Location	Existing Facility: Pedestrian	No-Build Facility: Pedestrian	Existing Facility: Bicycle	Existing BLTS	No-Build BLTS
E Columbia Way	Shared-use path on one side of undercrossing	No change	Shared-use path on one side of undercrossing, striped bike lane on the north side	1	1
E Evergreen Boulevard	Curb-tight sidewalks, both sides of overcrossing	No change	Striped bike lanes, both sides of overcrossing	2	2
Mill Plain Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing	Unknown	Striped bike lanes, both sides of undercrossing [a]	4	4
E McLoughlin Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing	No change	Striped bike lanes, both sides of undercrossing	2	2
E Fourth Plain Boulevard	Narrow curb-tight sidewalk, one side of overcrossing	No change	No bike facility [b]	4	4
E 29th Street	Narrow curb-tight sidewalks, both sides of undercrossing	No change	No bike facility	2	2
E 33rd Street	Narrow curb-tight sidewalk, one side of overcrossing	No change	No bike facility	3	3

Source: Alta 2022

BLTS = bicycle level of traffic stress

a At the time of this writing, improvements are being made to this stretch of Mill Plain Boulevard to include buffered and parking-protected bike lanes, wider sidewalks, and ADA curb ramps across the I-5 interchange, from Fort Vancouver Way to W 26th Ave. These changes are not reflected in the existing or No-Build BLTS scores here.

b At the time of this writing, the City of Vancouver is planning corridor-wide multimodal improvements across I-5 along Fourth Plain Boulevard. These changes are not reflected in the existing or No-Build BLTS scores here.

4.8.1.3 Active Transportation Facilities in the City of Portland

As with Vancouver, the transportation systems in Portland will face increasing pressures as the regional population continues to grow. Hayden Island and the Expo Center are planned for higher-density, mixed-use development. The importance of active transportation modes will increase as residents, workers, and visitors look for efficient, convenient, and affordable ways to get around the IBR Program Area.

The No-Build Alternative would include the active transportation improvements listed within the Metro RTP. The only active transportation project in the Metro RTP within the IBR Program Area, the shared-use path along Hayden Island Drive, is summarized in Table 4-47.

Table 4-47. Metro Financially Constrained Projects in the IBR Program Area

Project ID #	Project Name	Changes to Pedestrian Facilities	Changes to Bicycle Facilities
11632	Shared-use path along Hayden Island Drive and crossing improvements.	Sidewalks and/or shared-use path on N Hayden Island Drive.	Project could potentially be a shared-use path for pedestrians and bicyclists that would physically separate them from vehicular traffic, creating a low-stress east-west connection along N Hayden Island Drive.

Source: Metro/RTC Financially Constrained RTP, 2018

PEDESTRIAN AND BICYCLE FACILITIES

This shared-use path project along Hayden Island Drive (Project #11632) would improve conditions for walking, rolling, and riding within the IBR Program Area, roughly from Jantzen Beach Avenue on the east side of I-5 all the way to the BNSF Railway Bridge on the west side of the island. The shared-use path on N Hayden Island Drive would create an enhanced active transportation corridor for east-west connectivity on Hayden Island. It would reduce the barrier I-5 poses to active travel. As shown in Table 4-48**,** the BLTS score of Hayden Island Drive would improve from BLTS 2 to BLTS 1. BLTS rankings range from 1 (very low stress; tolerable by all) to 4 (very high stress; tolerable to only a few).

Table 4-48. Portland Pedestrian and Bike Facilities at I-5 Crossings, No-Build Alternative

Crossing Location	Existing Facility: Pedestrian	No-Build Facility: Pedestrian	Existing Facility Bike	Existing BLTS	No-Build BLTS
N Victory Boulevard	Curb-tight sidewalk on north side	No change	None	4	4
Marine Drive	None	No change	None	4	4
I-5 on-ramp, undercrossing of I-5	Curb-tight sidewalk on south side	No change	Narrow shared-use path on one side	1	1
N Pier 99 Street	None	No change	None	2	2
N Jantzen Street	Narrow sidewalk on south side of undercrossing	No change	None	3	3
N Hayden Island Drive	Narrow sidewalks on both sides of undercrossing	Improved, lower-stress physically separated shared-use path	None	3	1

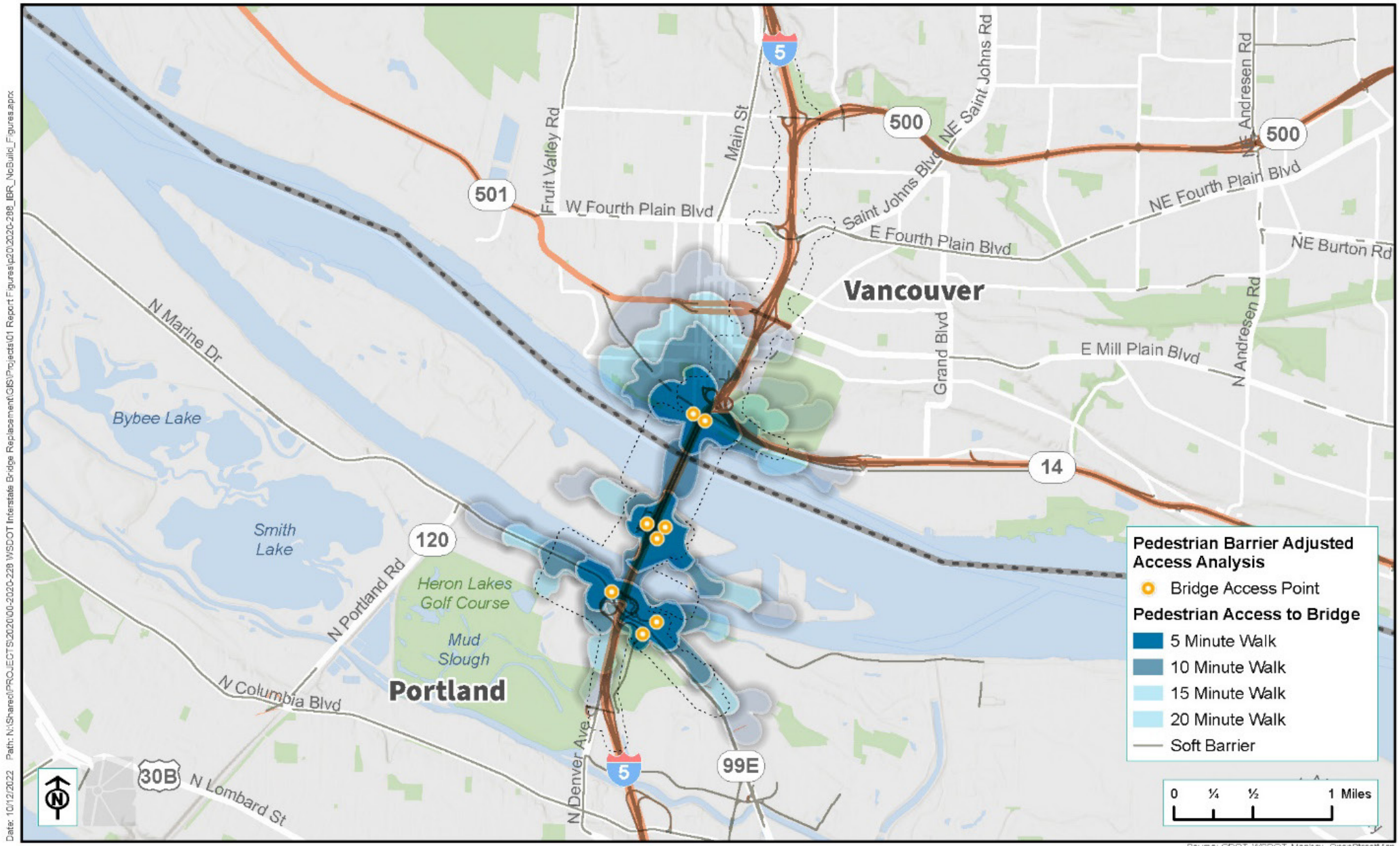
Source: Alta 2022. BLTS = bicycle level of traffic stress.

Active Transportation Access to and across the Interstate Bridge (Travelshed Analysis)

In Vancouver, the Interstate Bridge bike and pedestrian travelsheds (adjusted for BLTS and barriers) would remain the same under the No-Build Alternative as in the existing conditions. In Portland, the Interstate Bridge bike and pedestrian travelsheds would improve slightly on Hayden Island due to improvements along the existing narrow sidewalks. These Hayden Island improvements would extend the walksheds further west of I-5. If the planned project is constructed as a shared-use path, there would not be a noteworthy change to the size or shape of the bike travelshed for people traveling to and from the Interstate Bridge.

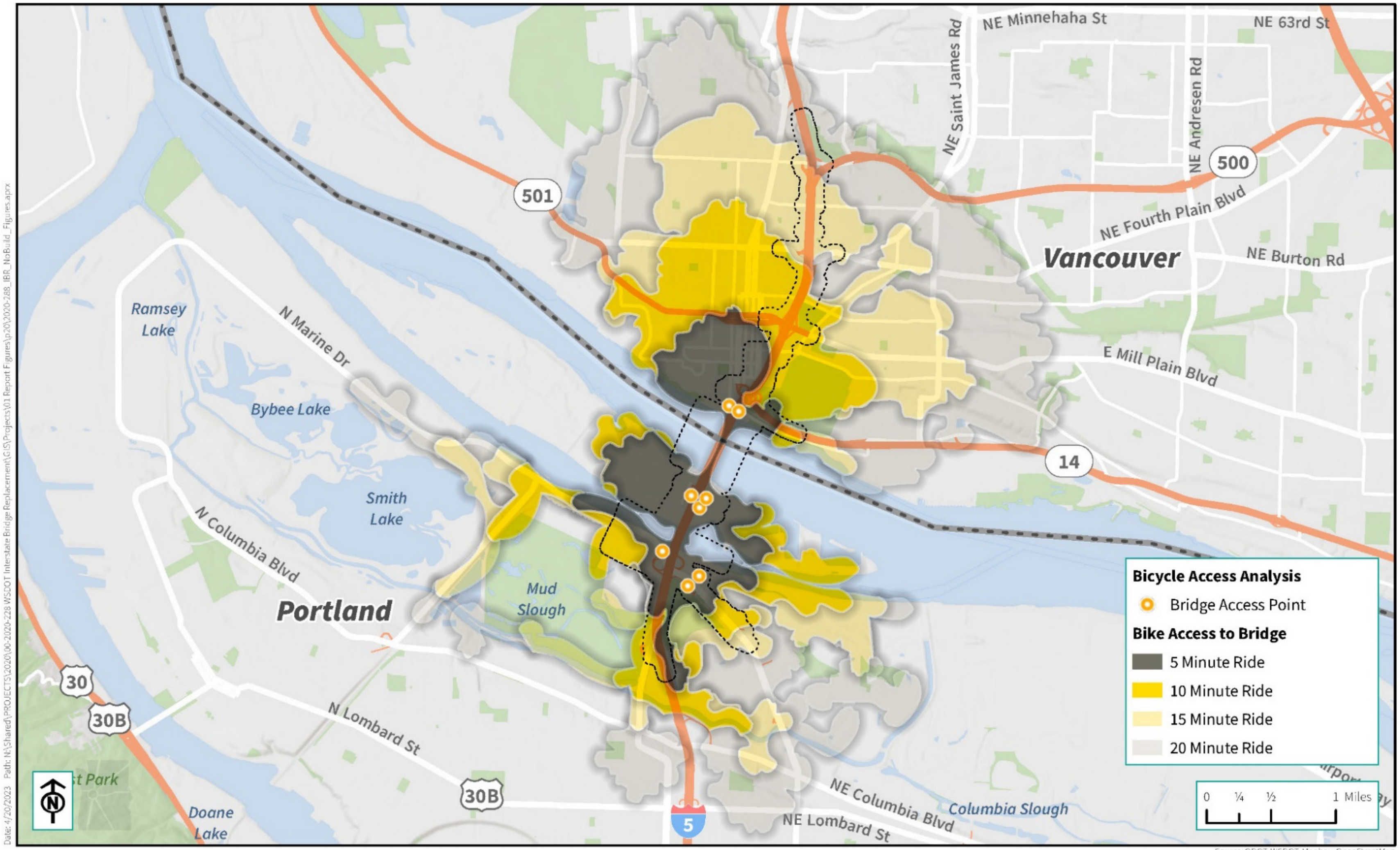
Figure 4-34 illustrates the pedestrian travelshed under the No-Build Alternative. Figure 4-35 illustrates the bicycle access shed (adjusted for BLTS) under the No-Build Alternative.

Figure 4-34. No-Build Alternative – Pedestrian Access to the Interstate Bridge



Source: Alta 2022.

Figure 4-35. No-Build Alternative – Bike Access to the Interstate Bridge (Stress-Adjusted)



Source: Alta 2022.

4.8.2 Modified LPA

This section describes the active transportation improvements proposed under the Modified LPA and the resulting effect on the active transportation network. The active transportation impacts would be the same for the Modified LPA with or without C Street ramps and the Modified LPA with two auxiliary lanes, so the results are summarized once in this section.

4.8.2.1 Active Transportation Facilities on the Columbia River Bridge

The Modified LPA includes bicycle and pedestrian improvements for all ages and abilities on the new Columbia River bridge, as well as facilities to access these bridge connections. The Modified LPA proposes a shared-use path on the lower deck of the I-5 northbound bridge. The shared-use path would be approximately 25 feet wide in total for a two-way path and would be designed to meet ADA standards. It would also include other features to optimize user experience, safety, comfort, and directness. To prevent conflicts between path users traveling at varying speeds, the shared-use path would provide separate space for people walking and biking. The design elements of the path would help buffer it from vehicle traffic, noise, exposure to street debris, and stormwater to provide a well-lit, attractive, and comfortable environment for all users. On each end of the bridge, the shared-use path would include improvements to existing and proposed network facilities and would also provide new connections that do not exist today.

The shared-use path across the Columbia River would be significantly higher in elevation than the existing bridge and path due to waterway clearance requirements. At its highest point, the Modified LPA bridge over the Columbia River is at an elevation of 163 feet (compared to an elevation of 90 feet for the existing bridge). This means the path transition from the I-5 northbound bridge down to Columbia Way in Vancouver would require extensive ramp lengths to span the vertical distance at a grade that meets or exceeds ADA requirements. The helix ramp shown in the Modified LPA accomplishes this transition but introduces considerable additional path length to overcome the difference in elevation and vertical circulation needs. Co-locating the shared-use path with the proposed Waterfront Station to provide additional elevator access down to Columbia Street/Columbia Way is a potential design solution that is being considered.

The single-level fixed-span configuration would not see any change to the width of the proposed shared-use path. At its highest point, the single-level fixed-span configuration over the Columbia River is at an elevation of 135 feet. The bridge height over the water would not be as high as the Modified LPA, but would still be higher than the No-Build Alternative, thus all users must climb over a longer distance to get over the peak. The maximum grade on the Washington side of the bridge is 1.5% and 3% on the Oregon side. Users would experience the same level of security as with the No-Build Alternative and would continue to be exposed to the elements similar to the No-Build Alternative.

The single-level movable-span configuration would not see any change to the width of the proposed shared-use path. At its highest point, the single-level movable-span configuration over the Columbia River is at an elevation of 120 feet. The bridge height over the water would not be as high as the Modified LPA or the single-level fixed-span configuration, but would still be higher than the No-Build Alternative, thus all users must climb over a longer distance to get over the peak. The maximum grade on the Washington side of the bridge is 4% and 1% on the Oregon side. Similar to the single-level fixed-span configuration, users would experience the same level of security as with the No-Build Alternative and would continue to be exposed to the elements similar to the No-Build Alternative.

4.8.2.2 Active Transportation Trip Forecast Estimates

The IBR team estimated bicycle and pedestrian trips across the Columbia River with the Modified LPA. The team used two methods, including Short Trip Conversion (Method 1) and Percent Ridership Inflation (Method 2), to develop a range of forecasts representing conservative, moderate, and optimistic estimates for future active transportation trips on the new bridge. These two methods were applied to develop a range of estimates (conservative, moderate, and optimistic) across methods. Detailed methodology and estimates can be found in Appendix F. The range of active transportation estimates is in response to the improvement of river crossing conditions, connection facilities, and traveler characteristics.

METHOD 1: SHORT TRIP CONVERSION

The Short Trip Conversion Method converts short distance auto trips to active transportation trips based on improved facilities and travel time. For the purposes of this analysis, a threshold of trip distances less than 3 miles was used to identify convertible trips to yield a conservative estimate for analysis. The AWDT across the Interstate Bridge in 2019 is estimated at 143,400 trips, but only 1.6% of those trips are less than 3 miles.[16] This translates to an estimate of roughly 2,300 trips per day that would potentially be available for mode shift. Three scenarios were developed by applying different mode shift factors to estimate how many of these 2,300 short trips could be converted to pedestrian and bicycle trips. The estimates of active transportation users and the number of mode-shifted trips from the Short Trip Conversion Method analysis is presented in Table 4-49

Table 4-49. Estimated Active Transportation Trips for the Modified LPA Using the Short Trip Conversion Method

	Method 1: Short Trip Conversation	Scenario 1: Conservative	Scenario 2: Moderate	Scenario 3: Optimistic
a	Existing Daily Pedestrian and Bicycle Trips [a]	410	410	410
b	Short Car and Motorcycle Daily Trips (<3 miles)	2,300	2,300	2,300
c	*Mode Shift Factor* [b]	15%	30%	40%
d	Mode Substitution Trips (b x c)	350	690	920
e	Existing and Mode Substituted Trips (a + d)	760	1,100	1,330
f	*Generated Trips Factor* [c]	10%	15%	20%
g	Generated Trips (e x f)	80	170	270
h	**TOTAL TRIPS (a + d + g)**	840	1,270	1,600

Source: Active Transportation Bridge Trips (Appendix F)

a Daily pedestrian and bicycle trips on the existing bridge path were counted during the fall of 2022.

b For context related to mode shift factors, please see Appendix F.

c For context related to Generated Trip Factors, please see Appendix F.

16 Based on StreetLight Data.

METHOD 2: PERCENT RIDERSHIP INFLATION

The Percent Ridership Inflation Method is based on literature-derived percentage increases in active transportation users on similar trail or bridge facility projects. Existing literature provides evidence from resources such as before and after intercept surveys that document percentage increases in total ridership. These same resources also provide data that supports the stratification of this increase into rates of mode, route, and activity shift.

Estimates of active travelers and the number of mode-shifted trips for the Modified LPA using the Percent Ridership Inflation Method are summarized in Table 4-50.

Table 4-50. Estimated Active Transportation Trips for the Modified LPA Using the Percent Ridership Inflation Method

	Method 2: Percent Ridership Inflation	Scenario 1: Conservative	Scenario 2: Moderate	Scenario 3: Optimistic
a	Existing Daily Pedestrian and Bicycle Trips [a]	410	410	410
b	*Percent Inflation Factor*	80%	120%	160%
c	New Pedestrian and Bicycle Trips (a x b)	330	490	660
d	*Mode Shift Substitution Percentage* [b]	20%	30%	70%
e	Mode-Shifted Trips (c x d)	70	150	460
f	*Generated Trip Percentage* [b]	15%	20%	25%
g	Generated Trips (c x f)	50	100	170
h	*Route Diversion Percentage* [b]	0%	0%	0%
i	Route Diversion Trips (a x h)	0	0	0
j	Other New Trips (c – (e + g + i))	210	240	30
k	**TOTAL TRIPS (a + c)**	**740**	**900**	**1,070**

Source: Active Transportation Bridge Trips (Appendix F)

a Daily pedestrian and bicycle trips on the existing bridge path were counted during the fall of 2022.

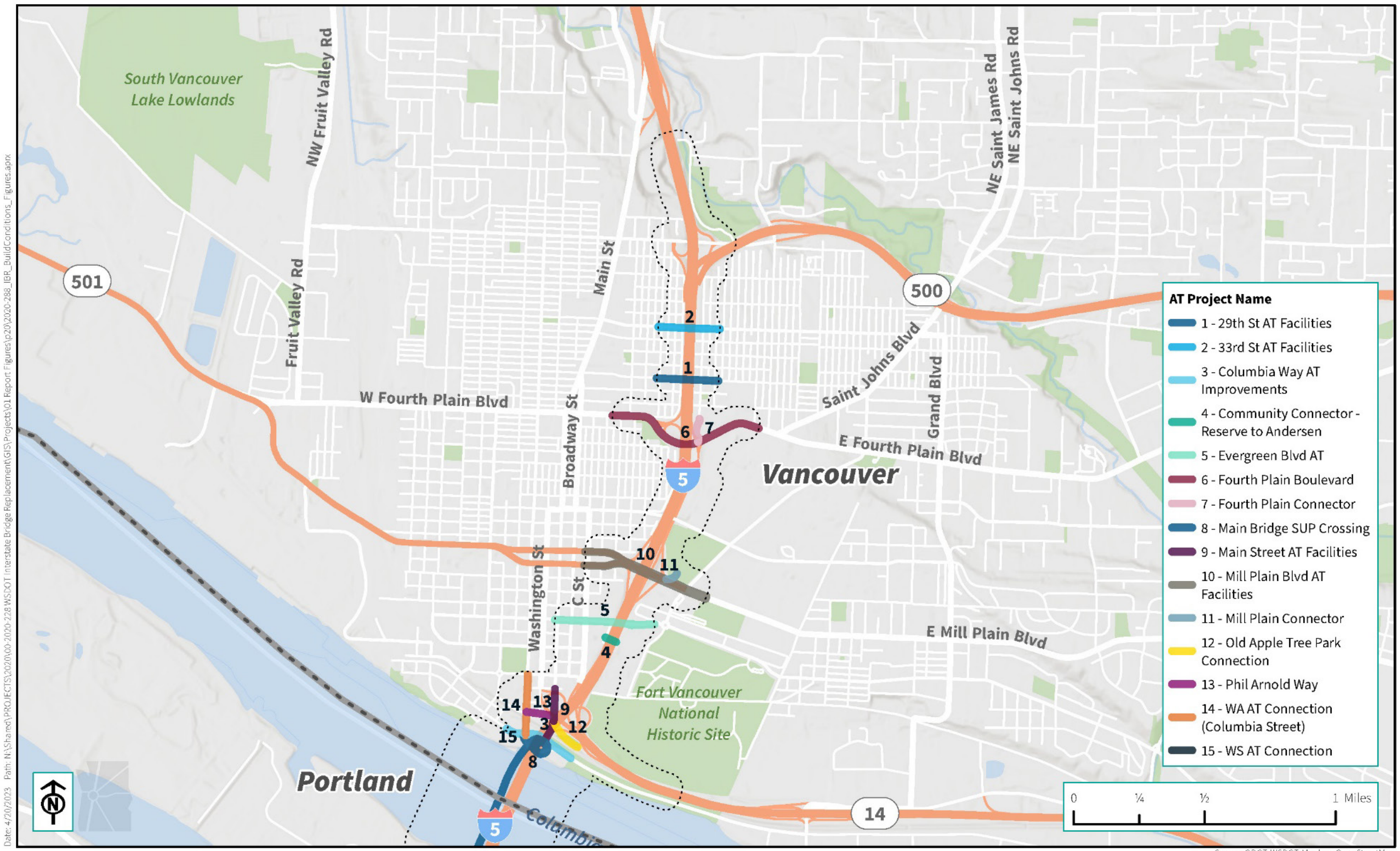
b For context related to Mode Shift, Generated Trip, and Route Diversion Percentages, please see Appendix F.

Based on the two evaluation methods used, future active transportation trips across the bridge are estimated to range between 740 and 1,600 trips per day.

4.8.2.3 Active Transportation Facilities in the City of Vancouver

The Modified LPA would include substantial bicycle and pedestrian improvements in Vancouver, as shown in Figure 4-36. These include new facilities to access the shared-use pathway across the Columbia River, street improvements around the rebuilt street segments and interchanges, and new facilities for people walking, biking, and rolling to and around the new transit stations. All improvements constructed by the IBR Program would be designed to meet appropriate jurisdictional guidelines and would meet or exceed ADA accessibility standards. The proposed improvements, which would comply with local design guidance, are described below.

Figure 4-36. Modified LPA Proposed Active Transportation Projects in Vancouver



Source: Alta 2022.

In Vancouver, the shared-use path off the Columbia River bridge would provide access to downtown Vancouver via a helix ramp to the intersection of Southeast Columbia Way and Columbia Street. The shared-use path would provide connections to regional pedestrian and bikeway facilities including the Waterfront Renaissance Trail on the north bank of the Columbia River, which provides vehicle-separated access to the Confluence Land Bridge, Vancouver National Historic Reserve, and points farther east. Two new shared-use paths would connect people from the east side of I-5 to the west: a new shared-use path along the south side of the Phil Arnold Way extension between Columbia Street and Main Street, and a new shared-use path connection between the new Phil Arnold Way extension and Old Apple Tree Park.

The Modified LPA would reconstruct I-5 interchanges and crossings throughout the IBR Program Area. Where roadways are replaced, active transportation facilities would meet applicable standards, at a minimum.

Specific active transportation improvements to streets crossing I-5 that are included in the Modified LPA are described below and shown on Figure 4-36.

- The existing I-5 overpass for Evergreen Boulevard would be rebuilt and would include new pedestrian and bicycle facilities to connect to existing routes. In addition, a new Community Connector structure to the south of the overpass would include landscaping, pathways, and other public space. It would provide an exclusive pedestrian and bicycle connection between downtown Vancouver and the Vancouver National Historic Reserve, and would also serve as the terminus for the proposed light-rail line (Evergreen Station).
- The Mill Plain interchange would be rebuilt and would include several improvements for bicyclists and pedestrians. These include bicycle facilities and sidewalks through the interchange area, and a new connection to the path network in Marshall Park.
- The Fourth Plain interchange would be rebuilt and would include several improvements for bicyclists and pedestrians, including bicycle facilities and sidewalks or a shared-use path. North of Fourth Plain Boulevard, a pathway connection to K Street would provide biking and walking access to and from Rose Village and other adjacent neighborhoods.

New I-5 overpasses would be built at 29th Street and 33rd Street. Each overpass would include upgraded walking, rolling, and biking facilities.

PEDESTRIAN FACILITIES

The Modified LPA would upgrade pedestrian facilities by filling gaps in the sidewalk and shared-use path network, widening and buffering sidewalks where they are replaced, and designing crossings and intersections for pedestrian safety. The Modified LPA includes changes that would enhance pedestrian safety and comfort where roadways and shared-use paths are constructed, including:

- Sidewalks on both sides of the street, and/or shared-use paths.
- Shortened, perpendicular crosswalks at intersections.
- Wayfinding signage.
- Separation of pedestrians from faster-moving vehicles, either physically or temporally.
- Signalization and lighting designed for pedestrian safety.

- Clear delineation and signing, short perpendicular crossings at the ramp terminals, and ramp orientations that would encourage high pedestrian visibility.

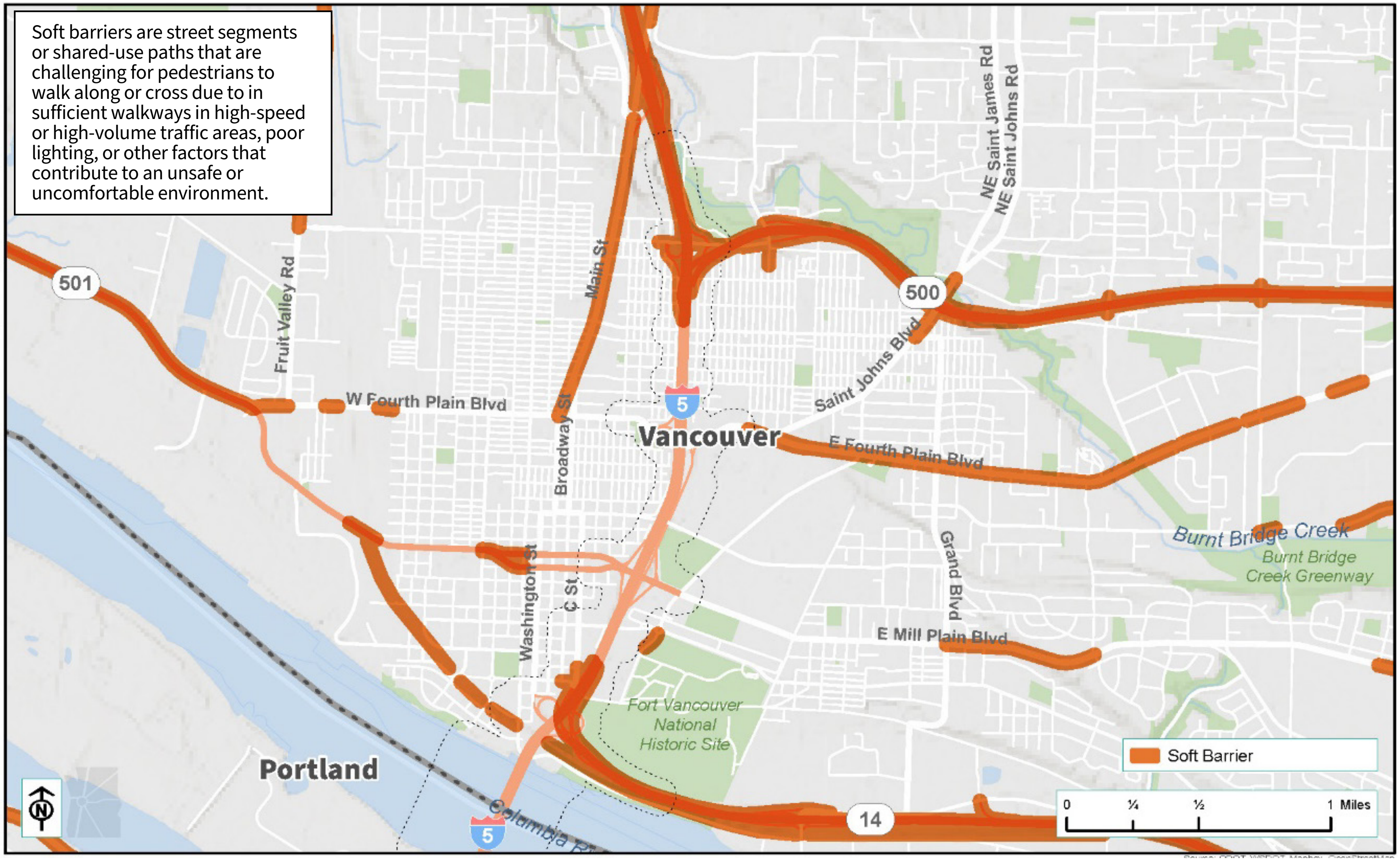
I-5 and associated interchanges are barriers to pedestrian travel in the IBR Program Area. The Modified LPA includes changes that would add pedestrian access for people crossing from one side of I-5 to the other. Table 4-51 outlines the changes included in the Modified LPA to improve pedestrian access across I-5.

Table 4-51. Modified LPA Pedestrian Facilities at I-5 Crossings in Vancouver

Crossing Location	Existing Facility	Proposed Facility
E Columbia Way	Shared-use path on one side of undercrossing	Upgrades to the shared-use path on one side of undercrossing, to coincide with Columbia Way realignment.
Phil Arnold Way	N/A – Does not currently exist	New shared-use path along south side of Phil Arnold Way extension between Columbia Street and Main Street.
Old Apple Tree Park Path Connection	N/A – Does not currently exist	New shared-use path connection between new Phil Arnold Way extension and Old Apple Tree Park. Connects to the Confluence Land Bridge.
Community Connector	N/A – Does not currently exist	A new structure, up to approximately 250 feet wide, would provide a pedestrian and bicycle connection between Reserve Street and Anderson Street.
E Evergreen Boulevard	Curb-tight sidewalks, both sides of overcrossing	Wider sidewalks, buffered from traffic by bike lanes, on both sides of overcrossing.
Mill Plain Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing	Wider sidewalks, buffered from travel lanes by buffered bike lanes, both sides of undercrossing.
E McLoughlin Boulevard	Narrow curb-tight sidewalks, both sides of undercrossing	No change to existing.
E Fourth Plain Boulevard	Narrow curb-tight sidewalk, one side of overcrossing	Wider sidewalks buffered from travel lanes by separated bike lanes on both sides of street, or shared-use path on south side of street.
E 29th Street	Narrow curb-tight sidewalks, both sides of overcrossing	Wider sidewalks on both sides.
E 33rd Street	Narrow curb-tight sidewalk, one side of overcrossing	Wider sidewalks on both sides.

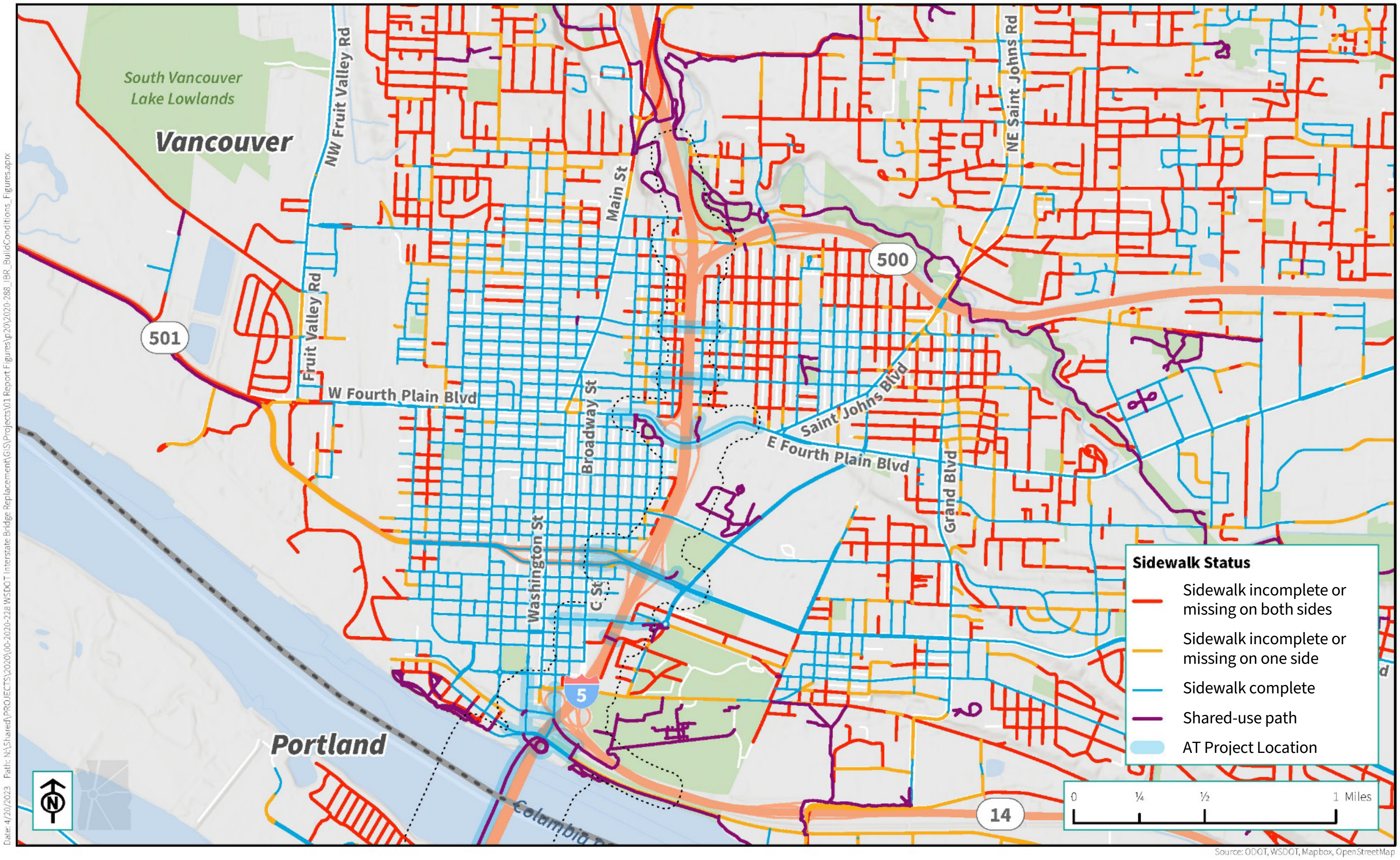
These changes would reduce many of the soft barriers to pedestrian travel, as shown in Figure 4-37, and therefore would improve the connectivity of the pedestrian network in Vancouver within the IBR Program Area, as shown in Figure 4-38. In Vancouver, I-5 poses the largest barrier to east-west pedestrian travel. The longest stretch of this barrier is approximately two-thirds of a mile, between Evergreen Boulevard and Columbia Way, where there is no existing way for a pedestrian to cross I-5 between these two streets. The proposed Community Connector and the proposed shared-use path between the Phil Arnold Way extension and Old Apple Tree Park have the potential to reduce this barrier by roughly 900 feet.

Figure 4-37. Modified LPA Pedestrian Soft Barriers in Vancouver



Source: Alta 2022

Figure 4-38. Modified LPA Pedestrian Network in Vancouver



Source: Alta 2022

BICYCLE FACILITIES

The Modified LPA would upgrade bicycle facilities by filling gaps in the bikeway and shared-use path network, widening and protecting existing bikeways where they are replaced, designing crossings and intersections for bicycle safety, and in many cases creating more attractive, comfortable, and direct bike network connections within the IBR Program Area and to local bike networks. The Modified LPA includes changes that would enhance bicycle safety and comfort where roadways and shared-use paths are constructed. The specific bicycle facility type (buffered, protected, or shared-use path) to be provided on local streets is not yet defined, but the Modified LPA assumes the provision of bicycle facilities on local streets that would result in a low-stress cycling environment. Bicycle facilities in the Modified LPA include:

- Buffered or protected bike lanes.
- Shared-use paths.
- Improved crossing enhancements for bikes, including pavement markings, signage, signal detection.
- Wayfinding signage.
- Clear delineation and signing, short perpendicular crossings at the ramp terminals, ramp orientations that would encourage high bicycle visibility.

I-5 and associated interchanges are barriers to bicycle travel in the IBR Program Area. The Modified LPA includes changes that would add bicycle access and provide bicycle facilities to meet the needs of a broader population with lower-stress bicycle facilities. Table 4-52 outlines the changes included in the Modified LPA in Vancouver to improve bicycle access across I-5. These changes would both expand network connectivity in the IBR Program Area and improve the BLTS of the network, with major improvements to existing facilities, some new proposed connections, and upgrading of all higher-stress facilities to lower-stress standing, as shown in Figure 4-39. Overall, the Modified LPA would result in multiple benefits for bicyclists. Many crossings of I-5 would improve by one or two BLTS levels, a new connection would be created at Andersen Street, and the connections at the waterfront would be clarified and streamlined to make bridge access less stressful and geometrically simpler.

Table 4-52. Modified LPA Vancouver Bicycle Facilities at I-5 Crossings

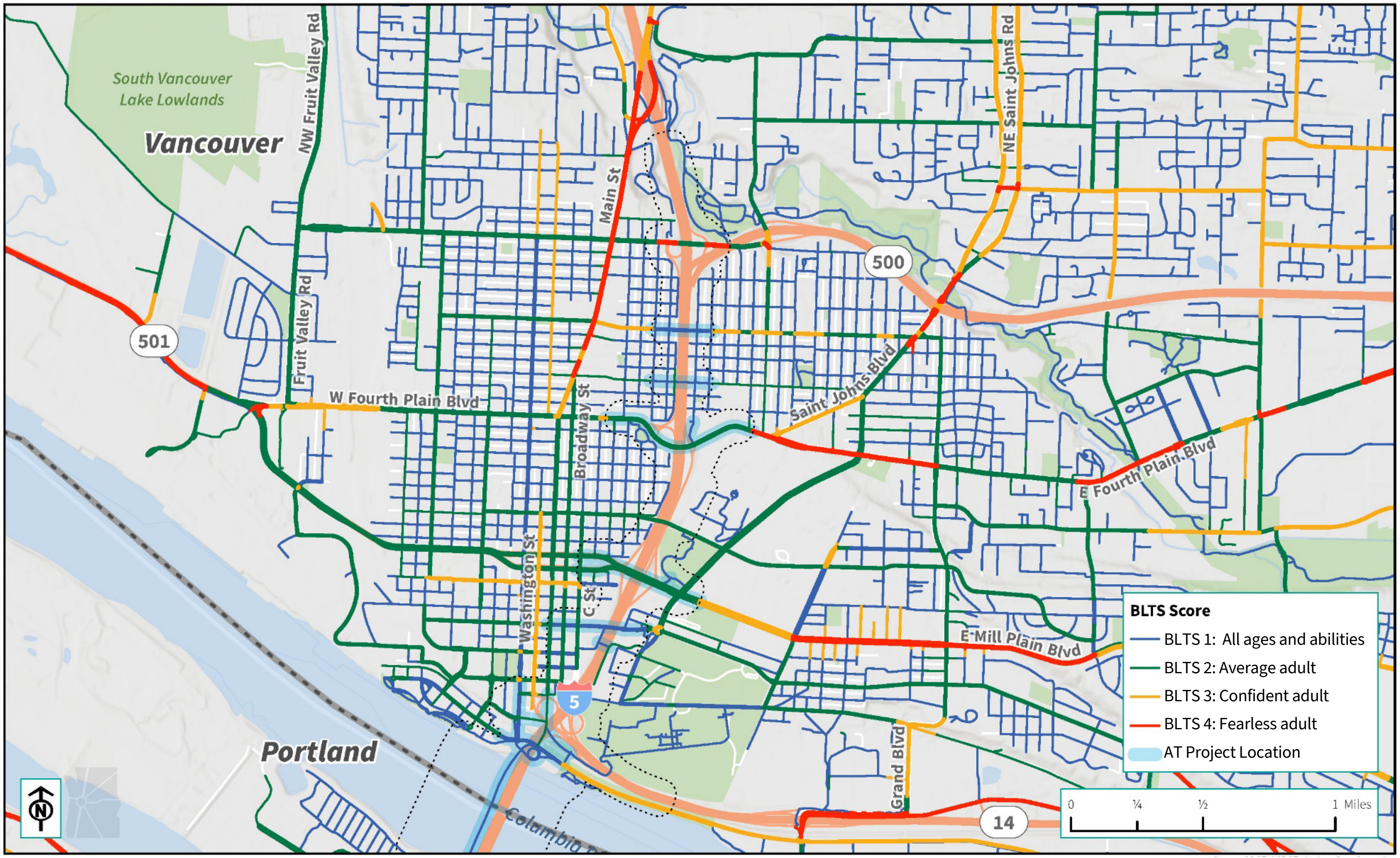
Crossing Location	Existing Facility	Modified LPA Facility	No-Build Facility BLTS Score	Modified LPA Facility BLTS Score
E Columbia Way (Waterfront Renaissance Trail)	Shared-use path on one side of undercrossing, striped bike lane on the north side.	Upgrades to the shared-use path on one side of undercrossing, to coincide with Columbia Way realignment.	1	1
Phil Arnold Way (extension)	N/A – Does not currently exist.	New shared-use path along south side of Phil Arnold Way extension between Columbia Street and Main Street.	N/A	2

Crossing Location	Existing Facility	Modified LPA Facility	No-Build Facility BLTS Score	Modified LPA Facility BLTS Score
Old Apple Tree Park Path Connection	N/A – Does not currently exist.	New shared-use path connection between new Phil Arnold Way extension and Old Apple Tree Park. Connects to the Vancouver Land Bridge.	N/A	1
Community Connector	N/A – Does not currently exist.	A new structure, up to approximately 250 feet wide, would provide a pedestrian and bicycle connection between 8th/Reserve Street to Anderson Street.	N/A	1
E Evergreen Boulevard	Striped bike lanes, both sides of overcrossing.	Buffered / protected bike lanes, on both sides of overcrossing.	2	1
Mill Plain Boulevard	Striped bike lanes, both sides of undercrossing.	Buffered bike lanes, both sides of undercrossing.	4	2
E McLoughlin Boulevard	Striped bike lanes, both sides of undercrossing.	No change to existing.	2	2
E Fourth Plain Boulevard	No bike facility.	East and west bound buffered bicycle lanes.	4	2
E 29th Street	No bike facility.	Buffered bike lanes, on both sides of overcrossing.	2	1
E 33rd Street	No bike facility.	Buffered/ protected bike lanes, on both sides of overcrossing.	3	1

Source: Alta 2022

BLTS = bicycle level of traffic stress; N/A = not applicable

Figure 4-39. Modified LPA BLTS – Vancouver



Source: Alta 2022.

Bikeway improvements included in the Modified LPA address many of the high-stress BLTS scores on the No-Build bike network by creating low-stress connections that would be physically separated from vehicle traffic. These facilities would increase the total number of low-stress network connections and replace the challenging No-Build interchange facilities with bikeways that are simplified, more direct, and provide easier user navigation.

The BLTS scores of nearly all affected streets in Vancouver would improve to a low-stress standing with the Modified LPA bike network improvements. This would have a major overall effect on the quality of local network connections across and around the I-5 corridor and access to the Columbia River bridge. SR 14 and the I-5 interchange would continue to be a barrier, but connectivity would improve in the Modified LPA with the proposed Community Connector and Old Apple Tree Park shared-use paths. McLoughlin Boulevard is one of the few streets shown within the IBR Program Area where no active transportation improvements are proposed as a part of the Modified LPA. This would have little impact to the quality of the bike network in this area, however, because McLoughlin Boulevard is already a low-stress route.

4.8.2.4 Active Transportation Facilities in the City of Portland

The Modified LPA includes substantial improvements for the walking, rolling, and biking networks in Portland, as shown in Figure 4-40. These include new shared-use paths, street improvements on the rebuilt street segments and interchanges, and new facilities for people walking, biking, and rolling to and around the new light-rail stations. All improvements constructed by the IBR Program would be designed to meet appropriate jurisdictional guidelines and would meet or exceed ADA accessibility standards. Where conditions warrant and where practical, major city bikeways should have separated facilities for bicycles and pedestrians. Proposed improvements, which would comply with local design guidance, are described below.

To improve east-west connections on Hayden Island, sidewalks or shared-use paths would be constructed along Jantzen Drive, Hayden Island Drive, and Tomahawk Island Drive. Marked crosswalks would be provided at all intersections and roundabouts. The walkways along Jantzen Drive, Hayden Island Drive, and the new Tomahawk Island Drive extension under I-5 would also feature a buffer from travel lanes with buffered or protected bike lanes or may take the form of grade-separated shared-use path.

The shared-use path on the new arterial bridge spanning the North Portland Harbor between Hayden Island and mainland Oregon would feature a fully separated shared-use path along the west side of the arterial structure. It would provide a direct ramp down to Hayden Island at the proposed Tomahawk Island Drive, as well as a continuous elevated path connecting onto the new Columbia River bridge.

In North Portland, the Modified LPA would provide active transportation access to the arterial bridge via a network of shared-use paths. The circuitous path network that winds through the interchange today would be replaced entirely with new simplified path connections offering more direct, clearer navigation for path users. West of I-5, the shared-use path would travel west to an at-grade crossing of the light-rail tracks and connect to the existing Marine Drive Trail (part of the 40-Mile Loop) along North Portland Harbor. This path would also provide an important connection under Marine Drive to the Expo Center light-rail station.

Figure 4-40. Modified LPA Proposed Active Transportation Projects in Portland

Source: Alta 2022

The proposed configuration of the Marine Drive interchange would be entirely grade separated with I-5, with a local road network and shared-use paths below. Parallel active transportation facilities would provide people walking, biking, and rolling with multiple options to travel from one side of I-5 to the other, and to access the shared-use path on the North Portland Harbor bridge. These improvements would upgrade existing facilities, create new ones, and connect to existing local walking and biking networks. While the reconstructed Marine Drive would provide bicycle and pedestrian facilities through the interchange, the main east-west crossing for people walking and biking would be along a new local street and path network below I-5 at ground level. These new facilities would connect to the existing bicycle and pedestrian networks.

Accessing the bridge shared-use path from NE Portland neighborhoods would be accomplished by the proposed improved walking, biking, and rolling facilities on Expo Road, Union Court, and Martin Luther King Jr. Boulevard within the IBR Program Area. These proposed active transportation facilities would need to be connected to future improvements on or along those locally and state-controlled streets outside of the IBR Program Area.

PEDESTRIAN FACILITIES

The Modified LPA would upgrade pedestrian facilities by filling gaps in the sidewalk and shared-use path network, widening and buffering sidewalks where they are replaced, and designing crossings and intersections for pedestrian safety. The Modified LPA includes changes that would enhance pedestrian safety and comfort where roadways and shared-use paths are constructed, including:

- Sidewalks on both sides of the street, and/or shared-use paths.
- Shortened, perpendicular crosswalks at intersections.
- Wayfinding signage.
- Separation of pedestrians from faster-moving vehicles, either physically or temporally.
- Signalization and lighting designed for pedestrian safety and comfort.
- Clear delineation and signing, short perpendicular crossings at the ramp terminals, and ramp orientations that would encourage high pedestrian visibility.

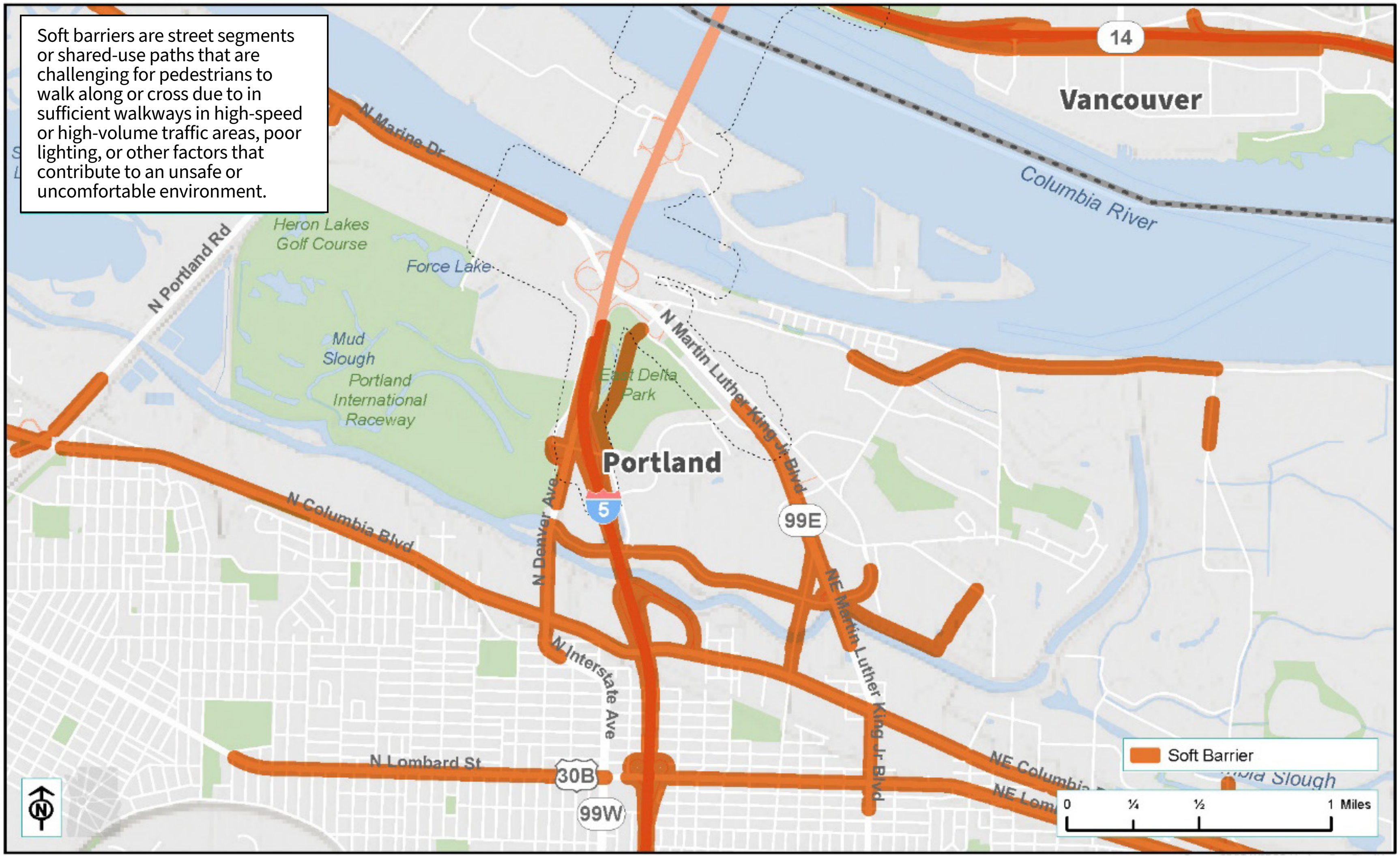
I-5 and associated interchanges are barriers to pedestrian travel in the IBR Program Area. The Modified LPA includes changes that would add pedestrian access for people crossing from one side of I-5 to the other. Table 4-53 outlines the changes included in the Modified LPA in Portland to improve pedestrian access across I-5, from east to west. These changes would remove some of the soft barriers to pedestrian travel, as shown in Figure 4-41, and would therefore improve the connectivity of the pedestrian network in Portland within the IBR Program Area, as shown in Figure 4-42. Pedestrian improvements in the Modified LPA would improve dramatically over the No-Build condition. The relatively poor conditions for walking and rolling today would be improved with proposed pedestrian walkways and paths, particularly in the Marine Drive and Hayden Island interchange areas.

Table 4-53. Modified LPA Pedestrian Facilities at I-5 Crossings in Portland

Crossing Location	Existing Facility	Proposed Facility
N Hayden Island Drive	Narrow sidewalks on both sides of undercrossing	Shared-use path on north side of Hayden Island Drive.
Tomahawk Island Drive	N/A – Does not currently exist	Shared-use path or sidewalks on both sides of the street.
N Janzen Drive	Narrow sidewalk on south side of undercrossing	New shared-use path on south side of Jantzen Drive.
N Pier 99 Street	No sidewalks	Shared-use path on north side of realigned Pier 99 Street connecting Expo Road and Vancouver Way. This becomes the primary east-west crossing of I-5 in N Portland.
I-5 on-ramp, undercrossing of I-5	Curb-tight sidewalk on south side	N/A. This facility and crossing is removed in proposed interchange configuration.
Marine Drive	No sidewalks on overcrossing	Wider sidewalks across single-point urban interchange on both sides of street, buffered from travel lanes by protected bike lanes. This becomes a secondary east-west connection across I-5 in N Portland. The existing at-grade pedestrian crossing of Marine Drive at the I-5 interchange loop ramps would be replaced with a pedestrian path undercrossing along Expo Road to provide a more direct, lower stress connection between Expo Station and the 40-Mile Loop Trail (see Pier 99 Street).
N Victory Boulevard	Curb-tight sidewalks	No change.

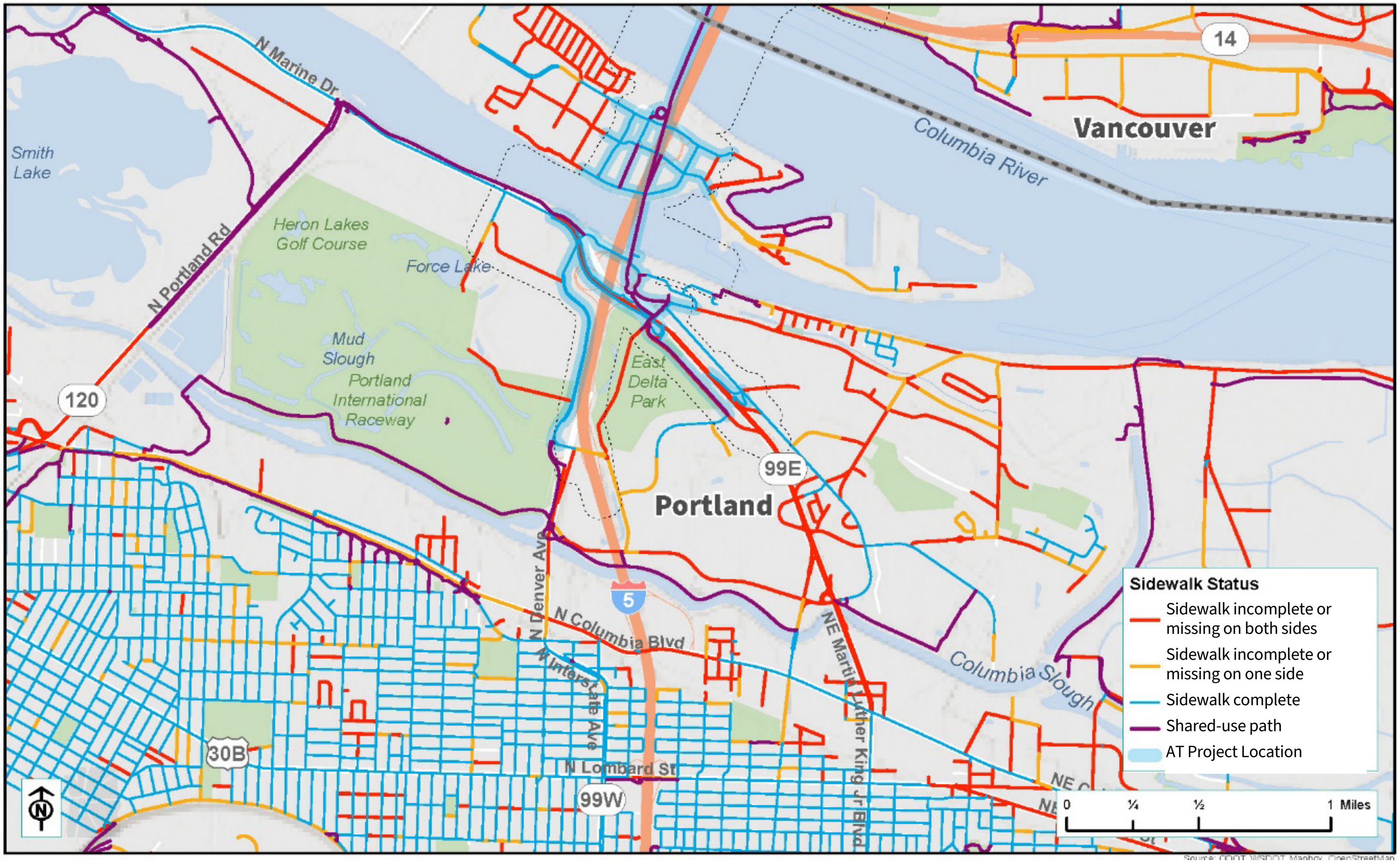
Source: Alta 2022

Figure 4-41. Modified LPA Pedestrian Soft Barriers in Portland



Source: Alta 2022.

Figure 4-42. Modified LPA Pedestrian Network in Portland



Source: Alta 2022

BICYCLE FACILITIES

The Modified LPA would upgrade bicycle facilities by filling gaps in the bikeway and shared-use path network, widening and protecting bike lanes where they are replaced, and designing crossings and intersections for bicycle safety. The Modified LPA includes changes that would enhance bicycle safety and comfort where roadways and shared-use paths are constructed. The specific bicycle facility type (buffered, protected, or shared-use path) to be provided on local streets is not yet defined, but the Modified LPA assumes provision of bicycle facilities on local streets that would result in a low-stress cycling environment. The bicycle facilities included in the Modified LPA in Portland include:

- Buffered or protected bike lanes.
- Shared-use paths.
- Improved crossing enhancements for bikes, including pavement markings, signage, signal detection.
- Wayfinding signage.
- Clear delineation and signing, short perpendicular crossings at the ramp terminals, and ramp orientations that would encourage high bicycle visibility.

I-5 and associated interchanges are barriers to bicycle travel in the IBR Program Area. The Modified LPA includes changes that would add bicycle access and provide bicycle facilities to meet the needs of a broader population. Table 4-54 outlines the changes included in the Modified LPA in Portland to improve bicycle access across I-5. These changes would both expand network connectivity in the IBR Program Area and improve the BLTS of the network, as shown in Figure 4-43.

On Hayden Island, additional bike infrastructure and new pathways would be added, including access to the new Hayden Island light-rail station. Access to the shared-use path crossing the Columbia River would be streamlined via the new Tomahawk Island Drive bicycle facilities. Reconstruction of the Marine Drive interchange would result in much-simplified access to the I-5 overcrossing. All facilities would be either a BLTS 1 or 2 under the Modified LPA.

Table 4-54. Modified LPA Bicycle Facilities at I-5 Crossings in Portland

Crossing Location	Existing Facility	LPA Facility	No-Build Facility BLTS Score	LPA Facility BLTS Score
N Victory Boulevard	None	No change.	4	4
Marine Drive	None	Protected bike lanes through the proposed single-point urban interchange. This becomes a secondary east-west connection across I-5 in N Portland.	4	2
NB I-5 on-ramp, undercrossing of I-5	Narrow shared-use path on one side	N/A. This facility and crossing is removed in proposed interchange configuration but replaced with new N Pier 99 Street shared-use path.	1	N/A

Crossing Location	Existing Facility	LPA Facility	No-Build Facility BLTS Score	LPA Facility BLTS Score
N Pier 99 Street	None	Shared-use path on north side of realigned Pier 99 Street connecting Expo Road and Vancouver Way. This becomes the primary east-west crossing of I-5 in N Portland.	2	1
N Janzen Street	None	New shared-use path on south side of Jantzen Drive.	3	1
Tomahawk Island Drive	N/A. Does not currently exist	Shared-use path or protected bike lanes.	N/A	2
N Hayden Island Drive	Narrow striped bike lanes	Buffered/protected bike lanes or shared-use path.	1	1

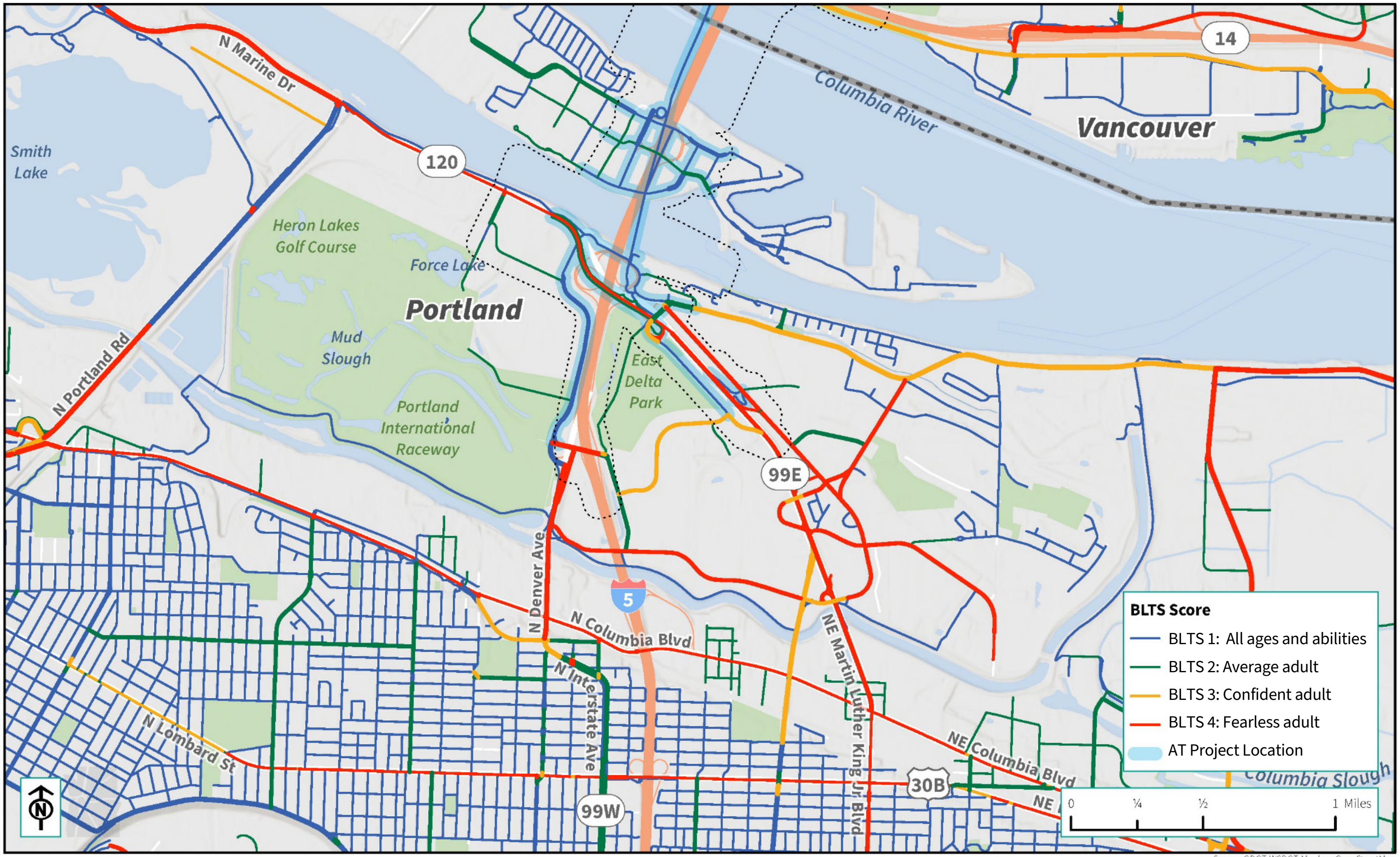
Source: Alta 2022

BLTS = bicycle level of traffic stress

Bikeway improvements included in the Modified LPA address many of the high-stress BLTS scores on the No-Build bike network, by creating low-stress connections that are physically separated from vehicle traffic. These facilities increase the total number of low-stress network connections and replace the challenging No-Build interchange facilities with bikeways that are greatly simplified, more direct routing, and easier user navigation.

The BLTS scores of nearly all affected streets would improve to a low-stress standing with the Modified LPA's proposed bike network improvements. This would have a major overall effect on the quality of local network connections across and around the I-5 corridor and access to the new Columbia River bridge.

Figure 4-43. Proposed Bike Facilities Level of Traffic Stress in Portland



Source: Alta 2022

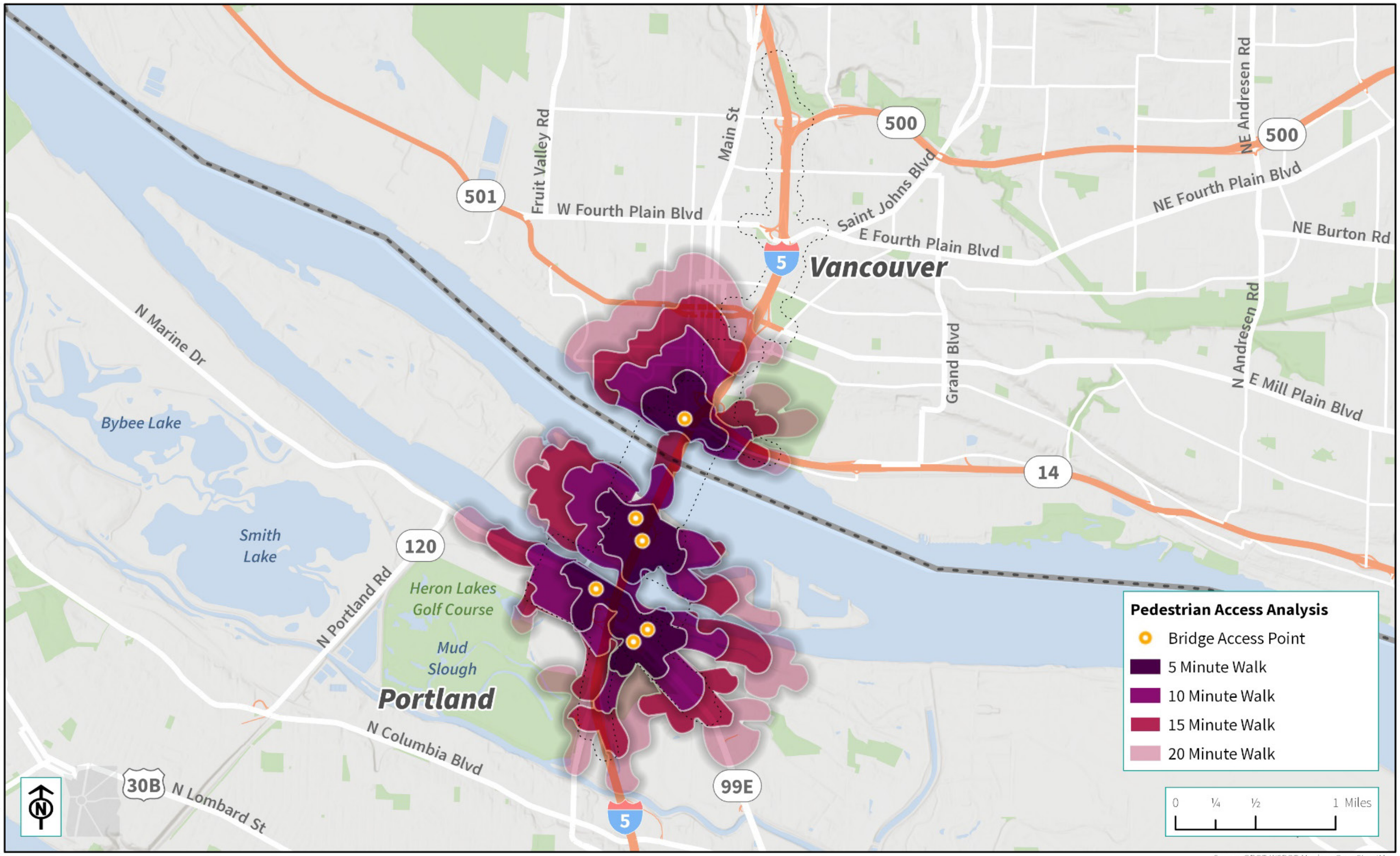
Active Transportation Access to and across the Columbia River Bridge (Travelshed Analysis)

Together, the active transportation facilities included in the Modified LPA in Vancouver, in Portland, and on the new Columbia River bridge would expand access by active transportation. Under the Modified LPA, all bicycle and pedestrian travelsheds would grow to varying degrees, except for the SR 14 corridor in Vancouver. Figure 4-44 and Figure 4-45 illustrate the pedestrian travelsheds under the Modified LPA without and with consideration, respectively, of the soft pedestrian barriers present within the IBR Program Area.

Figure 4-46 and Figure 4-47 illustrate the bike travelsheds under the Modified LPA without and with consideration, respectively, of the BLTS conditions present within the IBR Program Area.

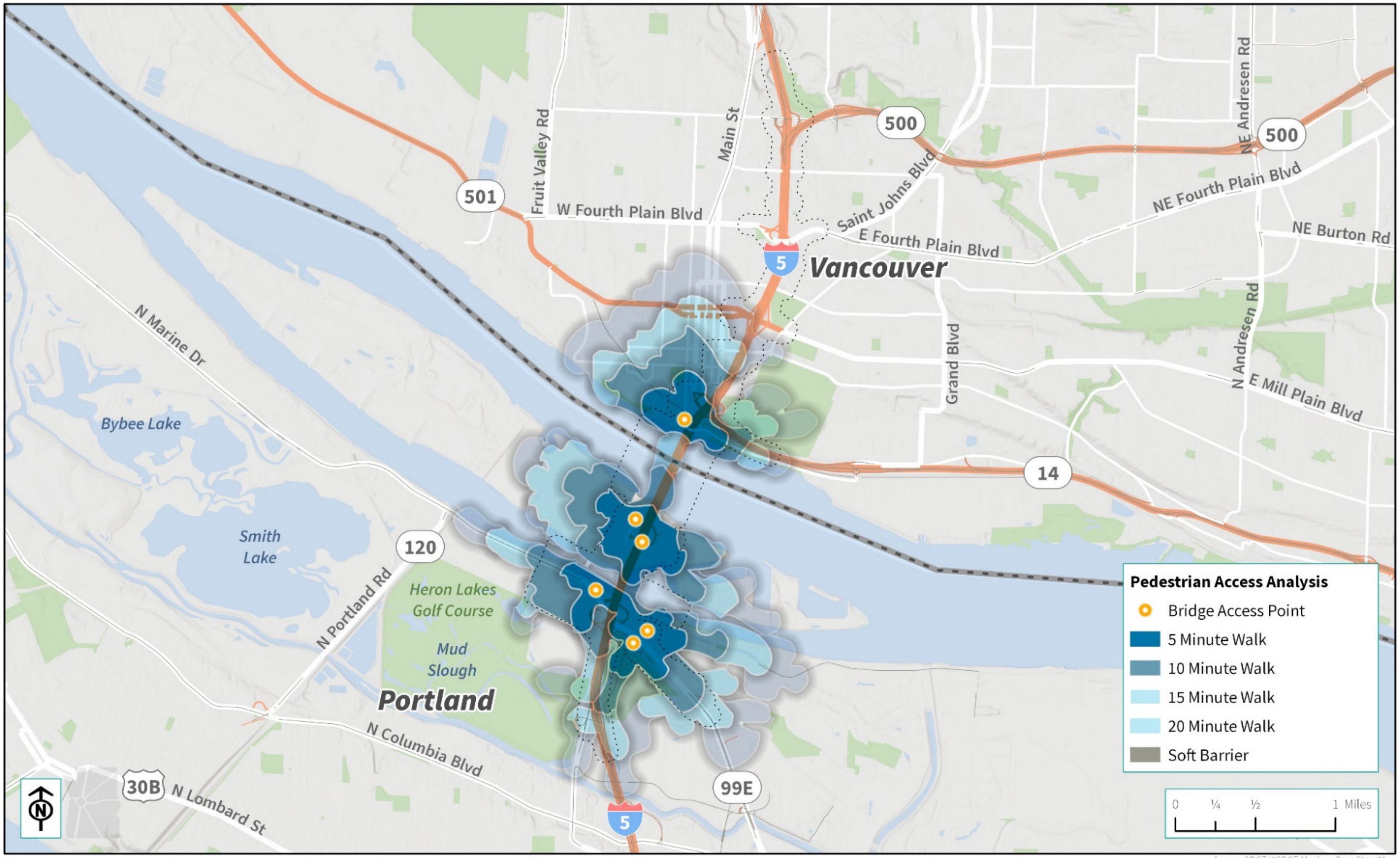
The bicycle travelshed would increase significantly in both Portland and Vancouver, especially the 5-minute travelshed. Under the Modified LPA, the bicycle travelsheds would grow to varying degrees, except the SR 14 corridor in Vancouver. In Portland, the connectivity improvements are more evident east of I-5. The BLTS-adjusted bicycle travelshed access would be improved in both Portland and Vancouver.

Figure 4-44. Modified LPA Pedestrian Access to the Columbia River Bridges



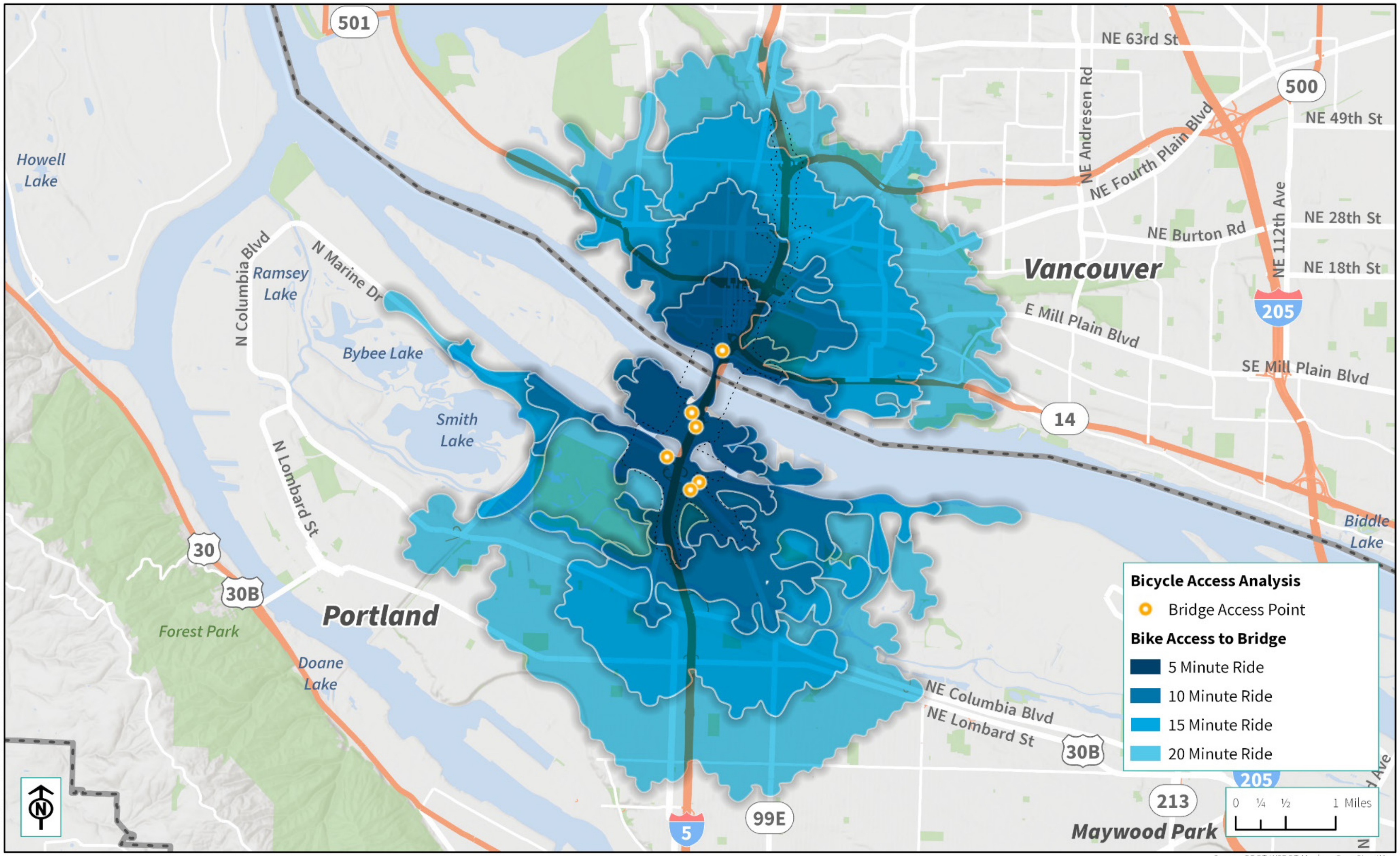
Source: Alta 2022

Figure 4-45. Modified LPA Pedestrian Access to the Columbia River Bridges (Considering Barriers)



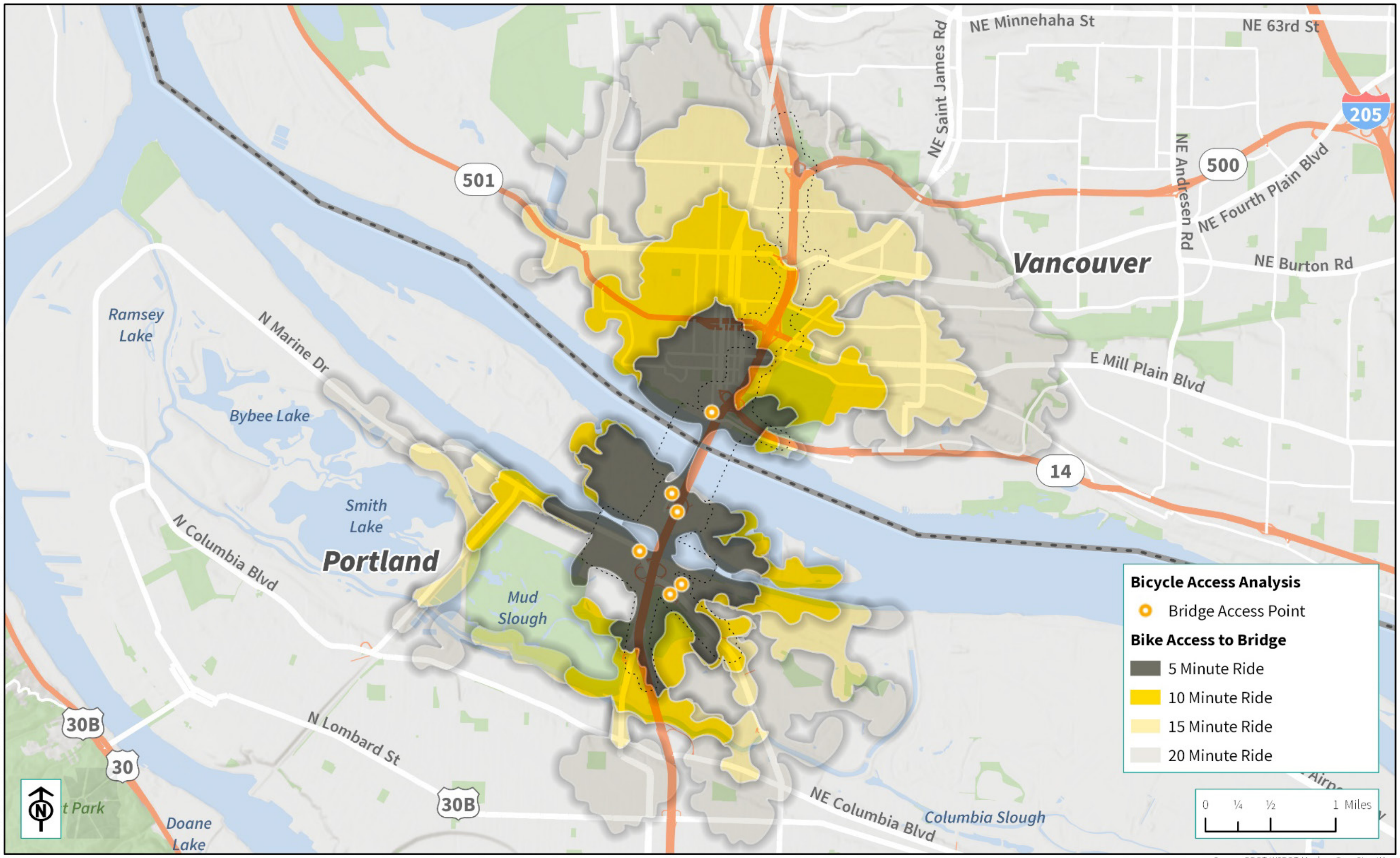
Source: Alta 2022

Figure 4-46. Proposed Bike Access to the Columbia River Bridges



Source: Alta 2022

Figure 4-47. Proposed Bike Access to the Columbia River Bridges (Stress-Adjusted)



Source: Alta 2022.

4.9 Safety

This section summarizes the predicted safety conditions for the No-Build Alternative, as well as for the Modified LPA and options compared to the No-Build Alternative.

The Enhanced Interchange Safety Analysis Tool (ISATe) was used to calculate the predicted crash frequencies of all I-5 mainline segments, CD roadways, ramps, and ramp terminal intersections within the IBR Program Area for each alternative, as applicable. ISATe is based on the *Highway Safety Manual* (AASHTO 2010) predictive methodology for freeway facilities. This analysis included an assessment of the following attributes:

- Number of lanes.
- Length of facility.
- Horizontal alignment (i.e., horizontal curves).
- Lane width.
- Median/inside and roadside/outside shoulder widths.
- Median/inside and roadside/outside barrier.
- Weaving segments.
- Collector-distributor facilities.
- Average daily traffic.
- Ramp types, access locations, and volumes.
- Ramp terminal intersection control, configuration, and volumes.

Some ISATe input elements were excluded due to the availability of data given the current level of design or because no change was anticipated between alternatives. The excluded elements are not listed above. Detailed ISATe worksheets are included in Appendix I, as well as a figure illustrating the segmentation of the roadway segments for the No-Build Alternative and Modified LPA.

4.9.1 No-Build Alternative

Crash patterns along the I-5 mainline, along ramps, and at ramp terminals within the IBR Program Area for the No-Build Alternative are anticipated to be similar to existing conditions, but crash frequencies are predicted to increase due to increased traffic volumes and increased hours where I-5 is operating at capacity. Crash types, severities, and locations would be anticipated to be similar to those described in Section 3.9, Safety.

A predictive analysis, based on the *Highway Safety Manual* (AASHTO 2010), was used to estimate the assumed safety impact on the I-5 mainline, ramps, and ramp terminal intersections from the increase in background volume between the 2019 existing conditions and the 2045 No-Build conditions. The geometric configuration was held fixed between the two conditions; only the volumes were changed to represent the future condition.

ISATe was used to calculate the predicted crash frequency for all of the included facilities (i.e., mainline, ramps, and ramp terminal intersections) for each condition. The percentage difference between the predicted crash frequencies of each condition represents the change in crashes due to all of the volume changes that are forecast to occur between 2019 and 2045.

The changes in volume (typically increases) along the facilities within the IBR Program Area are predicted to increase total crashes by up to 28% by 2045 under the No-Build Alternative compared to 2019 Existing Conditions. Volumes on the Interstate Bridge are forecast to increase by 26% by 2045.

4.9.2 Modified LPA

4.9.2.1 Freeway Facilities

The Modified LPA proposes significant changes to the configuration of the network within the IBR Program Area including, but not limited to, new or removed ramps, reconfigured interchanges, and access point changes. Due to these types of changes, a direct comparison between specific facilities is challenging and misleading. A higher-level look at the freeway network as a whole provides a better understanding of the safety implications of the proposed alternative and the significant changes to many facilities within the IBR Program Area. Therefore, the entire analyzed freeway network was assessed collectively to better illustrate the overall changes in safety associated with the Modified LPA. This freeway network-wide analysis was also conducted for the No-Build Alternative to provide a direct comparison between the alternatives.

ISATe was used to calculate the predicted crash frequency for the I-5 mainline, CD roadways, ramps, and ramp terminal intersections for the 2045 Modified LPA based on the corresponding geometric and volumetric data. The results of this analysis can be compared directly to the No-Build Alternative analysis results to determine the change in predicted crash frequency between these alternatives.

Given all of the geometric and volumetric changes, the Modified LPA is predicted to experience 13% fewer total crashes overall than the No-Build Alternative. This reduction in crashes would largely be due to the volume decrease on the I-5 mainline with the Modified LPA. Some of the interchange reconfigurations would also decrease the number of ramps and/or the lane mileage of those ramps, which would further contribute to fewer predicted crashes.

Additionally, the Modified LPA would eliminate the movable span from the Columbia River bridges, the openings of which are correlated with an increased likelihood of crashes (see Section 3.9.4). The safety implications of the movable span cannot be quantified within the predictive analysis, as no predictive models or crash modification factors exist to quantitatively assess this type of roadway feature.

However, because the movable span is shown to correlate with a negative impact on safety performance (i.e., increased likelihood of crashes with bridge openings, as discussed in Section 3.9.4), the predicted number of crashes within the IBR Program Area is likely underestimated in the No-Build Alternative predictive analysis, as the No-Build Alternative maintains the movable span. Therefore, removing the movable span under the Modified LPA would likely result in a larger reduction in crashes (above 13%) by improving the congestion that results from those openings, and it would contribute to improved safety performance within the IBR Program Area.

4.9.2.2 Local Facilities

The safety effects of volume changes at local study intersections (non-ramp terminals) were assessed to identify intersections where crashes were predicted to change by one or more crashes per year. Overall, the change in crashes of all of the local study intersections was negligible, with no total change in crashes across the network.

Only one intersection, Evergreen Boulevard and C Street, was predicted to increase by one or more crashes per year (one crash per year). This change is the result of a volume increase along C Street (with corresponding decreases in other locations) with the Modified LPA, which reconfigures the I-5 access in this vicinity. Even with this small increase, the increase in fatal and serious injury crashes at this intersection would be predicted to be negligible (e.g., less than 1% of 1 crash per year). Therefore, the safety performance of the local study intersections is likely to be similar between the No-Build and Modified LPA conditions.

Changes to the active transportation facilities as part of the Modified LPA may also have an impact on safety conditions for users. In general, safety conditions for active transportation users are likely to improve with the Modified LPA over the No-Build conditions. This is primarily due to the Modified LPA adding a wide shared-use path across the bridge that also fully separates active transportation users from vehicle traffic via the double-deck configuration. Users would no longer need to travel across the bridge on a narrow sidewalk adjacent to the travel lanes with a narrow barrier and minimal shoulders as a buffer.

Other pedestrian and bicycle improvements included with the Modified LPA on the local system would also likely improve safety for active transportation users. Detailed descriptions of these specific improvements and locations are included in Sections 4.8.2.3 and 4.8.2.4. Generally, this includes reconstructing or building new interchanges and crossings, upgrading existing active transportation facilities, filling gaps in the pedestrian and bicycle networks, and designing crossings and intersections to promote pedestrian and bicycle safety.

New or rebuilt pedestrian and bicycle facilities would be wider and sometimes include a barrier and/or buffer, all providing more separation and less exposure (i.e., improving safety) to vehicle traffic for active transportation users. Filling in gaps in the network and providing new connections would improve pedestrian and bicycle safety throughout Vancouver and Portland by providing enhanced, more continuous connections to key destinations, such as transit stations, that reduce exposure with vehicle traffic. Specifically at intersections, shortened and perpendicular crossings, new or improved traffic control, and new or enhanced lighting would also contribute to promoting safety for active transportation users by increasing visibility.

4.9.3 Modified LPA Design Options

4.9.3.1 Modified LPA without C Street Ramps

The Modified LPA without C Street ramps would remove access between I-5 and C Street, removing two ramps and a ramp terminal intersection. The vehicles that would have previously used the C Street ramps would instead use the Mill Plain Boulevard interchange. While more traffic traveling through the Mill Plain Boulevard interchange could increase the likelihood of crashes at the Mill Plain Boulevard interchange ramps and intersections, the removal of the C Street northbound off-ramp and southbound on-ramp are would reduce the number of crashes at the C Street interchange ramps and intersections due to the removal of the interchange.

Local study intersection safety performance would still be predicted to be similar between the No-Build Alternative and the Modified LPA without C Street ramps. The active transportation facilities and related safety conditions are expected to be similar with the Modified LPA without the C Street ramps as with the Modified LPA, and thus are expected to have similar safety benefits for active transportation users.

4.9.3.2 Modified LPA with Two Auxiliary Lanes

The Modified LPA with two auxiliary lanes would add additional lanes to the I-5 mainline through most of the IBR Program Area. ISATe was used to calculate the predicted crash frequency for the IBR Program Area for the Modified LPA with two auxiliary lanes. Based on the predictive models, more lanes are generally associated with a slight reduction in crashes; therefore, the Modified LPA with two auxiliary lanes is predicted to reduce crashes over the Modified LPA (one auxiliary lane) by up to 4% and by up to 17% over the No-Build Alternative. Similar to the Modified LPA, the Modified LPA with two auxiliary lanes would also not include a movable span.

The local study intersection safety performance would be expected to be the same as with the Modified LPA. The active transportation facilities and related safety conditions are expected to be the same for the Modified LPA with one or two auxiliary lanes, and thus are expected to have similar safety benefits for active transportation users.

4.9.3.3 Bridge Configurations

SINGLE-LEVEL CONFIGURATIONS

The single-level bridge options would modify the configuration of the Columbia River bridges' travel ways to be on a single level instead of a stacked two-level configuration. Because this option is a reconfiguration of the roadway and the cross-sectional geometry of each direction of I-5 mainline remains the same, the single-level configurations would likely have a similar safety performance to the Modified LPA.

The local study intersection safety performance would be expected to be the same as with the Modified LPA. A wide shared-use path would also be included as part of the single-level configurations. This is also likely to improve safety for active transportation users similar to the Modified LPA. While the shared-use path would still remain on the same level as the travel lanes, unlike the Modified LPA, it would be separated by a much wider shoulder, a barrier, and an additional separation due to the bridge supports. This would greatly minimize the potential exposure with vehicle traffic. The other active transportation facilities and safety conditions are expected to be the same with the single-level configurations as with the Modified LPA.

MOVABLE SPAN

The movable-span configuration would maintain the existing movable-span operations, but otherwise would similar geometry and volumes as the Modified LPA. While the impacts of the movable span cannot be quantified within the predictive analysis, the movable span is associated with a higher likelihood of crashes. It is therefore likely that the movable-span configuration would perform slightly worse (i.e., experience more crashes) than the Modified LPA, which does not have a movable span, but better (i.e., experience fewer crashes) than the No-Build Alternative due to the volume decreases that would occur on the network as with the Modified LPA. As with the Modified LPA, the volume decreases would result from the added CD system between SR 14 and Mill Plain Boulevard, as well as from greater investment in high-capacity transit facilities that would result in mode shifts.

The local study intersection safety performance would be expected to be the same as with the Modified LPA. The active transportation facilities and related safety conditions are expected to be similar for the movable-span configuration as the Modified LPA and thus are expected to have similar safety benefits for active transportation users.

4.10 Transportation Demand Management and Transportation System Management

This section describes the effects of the No-Build Alternative and the Modified LPA and options on TDM and TSM within the IBR Program Area.

Under the No-Build Alternative, existing TDM programs would continue to be implemented. The existing TDM programs could be modified in response to state-mandated programs, such as Oregon's Employee Commute Options rule and Washington's Commute Trip Reduction law, or implementation of locally funded programs designed to support a shift away from single-occupancy vehicle use. Similarly, existing established TSM programs including system monitoring and traveler information systems, facility management systems, and incident management systems would be maintained and advancements in technologies and infrastructure programs identified in the 2018 RTP.

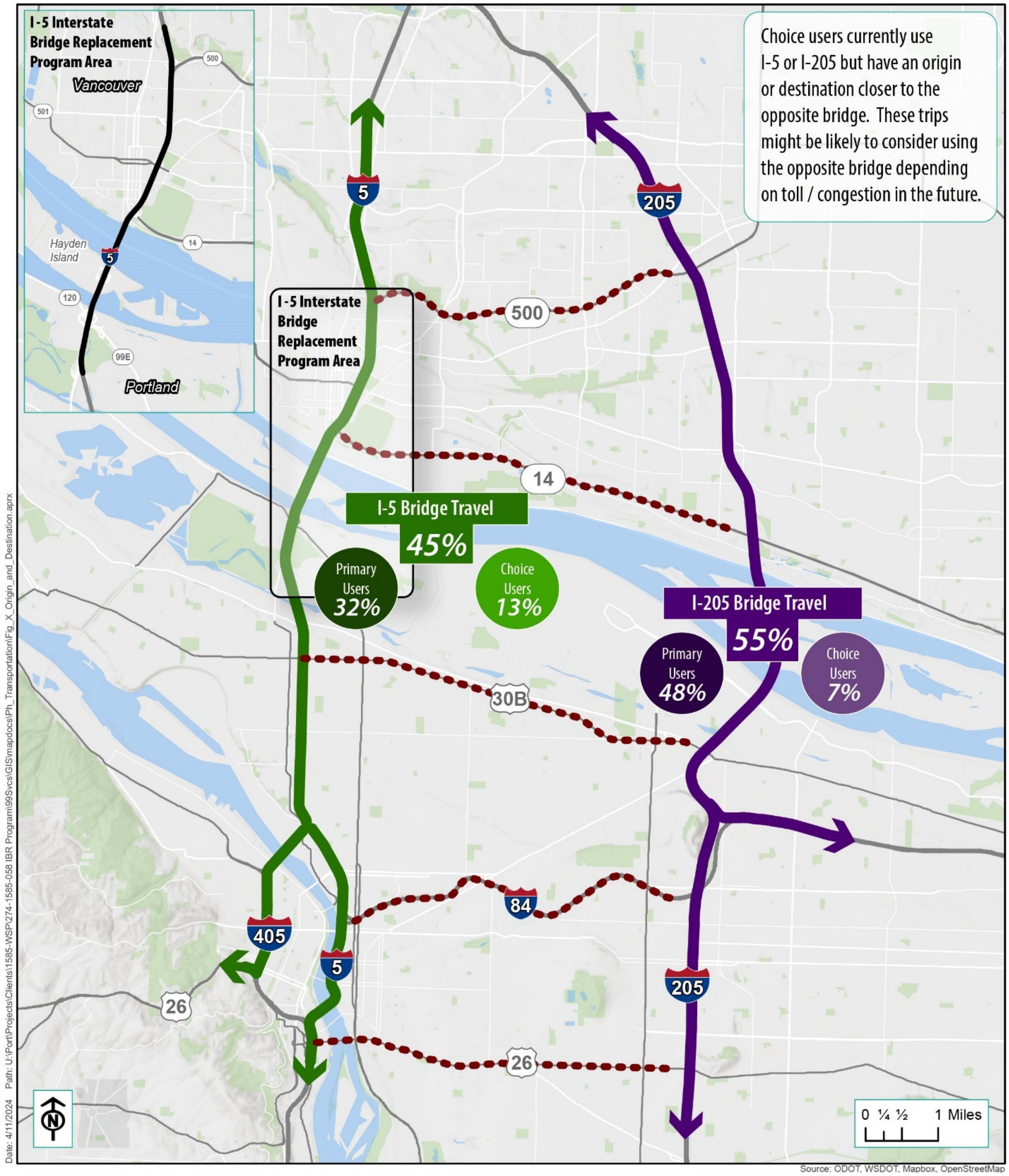
The Modified LPA and options would develop physical infrastructure and provide operations that support non-single-occupancy vehicle modes for travel needs in the project corridor. These include:

- Expanded and improved transit service via the extension of the MAX Yellow Line with three new stations in the IBR Program Area, park-and-ride facilities at two of the new light-rail stations, express bus and feeder routes, and I-5 median shoulders that accommodate bus-on-shoulder operations.
- New and improved bicycle and pedestrian facilities that accommodate more bicyclists and pedestrians and improve connectivity, safety, and travel time.
- Variable-rate tolling on the Columbia River bridge.
- The Modified LPA would also include facilities and equipment that could support or expand TSM programs, including:
    - Replacement or expansion of traveler information systems.
    - Active traffic management system expansion.
    - Expanded use of ramp meters.
    - Queue jumps or bypass lanes for transit vehicles at freeway ramp meters or bus-on-shoulder operations.
    - Preferential traffic signal priority.
    - Incident management.

4.11 Tolling and Diversion

This section summarizes tolling and diversion for the Modified LPA compared to the No-Build Alternative with details around how travel behavior changes because of project elements associated with the Modified LPA. Both tolling and diversion are related to the two options people have for travel across the Columbia River: the I-5 Interstate Bridge and the I-205 Glenn Jackson Bridge. The I-205 Glenn Jackson Bridge—which is about 6 miles east of Interstate Bridge—is the only other crossing over the Columbia River within the Portland-Vancouver metropolitan area. I-205 provides important connectivity for the region—particularly eastside suburban areas—but provides a less direct link between the downtown hubs in Portland and Vancouver as well as both ports. Figure 4-48 shows existing travel patterns for trips that cross the Columbia River on both the I-5 Interstate Bridge and the I-205 Glenn Jackson Bridge. The figure shows that there is a primary market and a choice market. The primary market reflects people who, based on their origins and destinations, have a primary bridge they use to make their trip. The choice market reflects people who have an origin or destination that would allow them to consider a shift to the opposite bridge depending on accessibility, availability of mode to complete the trip, or traffic conditions (including tolls and congestion) at the time the trip is being made. This tolling and diversion section describes these trip types in more detail.

Figure 4-48. Columbia River Crossing Trip Shares for Primary and Choice Users



4.11.1 Tolling

As part of the Modified LPA, all motor vehicle users on I-5 crossing the Columbia River would pay a toll. This tolling would help fund the IBR Program and be a mechanism for managing congestion in the Program Area. Tolls would be collected using an electronic toll collection system whereby motorists would either obtain a transponder that would automatically bill the user when they cross the toll collection point, or motorists without a transponder would be charged the toll using a license-plate recognition system that would send a bill to the registered owner of the vehicle. Tolls would be higher for vehicles without transponders to account for the processing cost of the bill.

The Modified LPA assumes that time-of-day variable-rate tolling on a set schedule would be in place for vehicles using the I-5 Columbia River bridges. This means that tolls would vary by time of day with higher rates during peak travel periods and lower rates at other times of day based on a set schedule. Medium and heavy trucks would be charged a higher toll than passenger vehicles. The impact analysis for the Modified LPA is based on toll rates that, for passenger cars with transponders, would range from $1.45 (in 2023 dollars) at its lowest during the off-peak to $2.95 at its highest (in 2023 dollars) during the peak travel times. The toll rate structure used for the Modified LPA is shown in Table 4-55. While final toll rates would be set by the WSTC and the OTC and may be different than what was assumed for the Modified LPA, the rates used in this technical analysis are a reasonable approximation of values that would allow for the revenue generation and congestion management needed for the IBR Program.

Table 4-55. I-5 Columbia River Bridges Toll Rate Structure Assumed in Regional Travel Demand Modeling

Time Period	Toll Rates (2023$)	Toll Rates (2045$)
12 a.m. – 4 a.m.	$1.45	$2.25
4 a.m. – 5 a.m.	$1.95	$3.10
5 a.m. – 6 a.m.	$2.45	$3.90
6 a.m. – 9 a.m.	$2.95	$4.75
9 a.m. – 10 a.m.	$2.45	$3.90
10 a.m. – 2 p.m.	$1.95	$3.10
2 p.m. – 3 p.m.	$2.45	$3.90
3 p.m. – 7 p.m.	$2.95	$4.75
7 p.m. – 8 p.m.	$2.45	$3.90

Time Period	Toll Rates (2023$)	Toll Rates (2045$)
8 p.m. – 11 p.m.	$1.95	$3.10
11 p.m. – 12 a.m.	$1.45	$2.25

These are example tolling rates developed for planning purposes. Actual toll rates will depend on additional financial analysis and be set by the Washington and Oregon Transportation Commissions with approval by the state legislatures.

Assumes medium trucks pay 2x and heavy trucks pay 4x the auto toll rate.

Administrative fees would be added to process payments not involving a transponder meaning those vehicles would see actual rates higher than what is reflected in the table.

Tolls are assumed to escalate at 2.15% per year to match expected inflation.

Tolling on a highway often leads to diversion where drivers opt for alternative routes or transportation modes to avoid paying tolls. These diversion effects can result in several outcomes including reduced traffic congestion on tolled routes, increased traffic on parallel roads, potential shifts to transit or active transportation modes, as well as changing where, or if, a trip is even made.

Table 4-56 below shows the changes in both average weekday vehicle trips and transit trips crossing the Columbia River for the Modified LPA and options as compared to the No-Build Alternative to help illustrate some of these impacts. Total daily vehicle volumes crossing the Columbia River would be reduced by approximately 3% with the Modified LPA and options compared to the No-Build Alternative, resulting in fewer vehicle crossings on both bridges. Along with tolling, high-capacity transit investments (even with the assumed transit capacity constraints applied to the model) in the Modified LPA would contribute to a higher number of transit trips crossing the Columbia River resulting in an increase of 73% compared to the No-Build Alternative.

While overall vehicle throughput would be reduced under the Modified LPA and options as compared to the No-Build Alternative, as previously discussed in Section 4.3 vehicle throughput does not provide an overall picture of the total number of people that a transportation facility can serve. The calculation of total person throughput includes assumptions of the average number of people in each vehicle (occupancy). Total auto, truck, and transit person-trips are included in Table 4-56. Person throughput across the river would increase on the I-5 bridge and decrease on I-205 under the Modified LPA, but overall totals on an average weekday for crossings on both bridges would be approximately the same.

Table 4-56. 2045 Forecast Average Weekday Daily Traffic and Transit Volumes and Total Person-Trips for Vehicles and Transit Only

Location	2045 No-Build AWDT	2045 No-Build Transit Trips	2045 No-Build Total Person-Trips	2045 Modified LPA and Options AWDT [a]	2045 Modified LPA and Options Transit Trips [a]	2045 Modified LPA and Options Total Person-Trips [a]
Total River Crossing	400,000	17,200	523,200	389,000 (-3%)	30,800 (+79%)	522,600 (-.1%)
I-5 Bridge	180,000	14,800	241,500	175,000 (-3%)	29,100 (+96%)	249,400 (+3%)
I-205 Bridge	220,000	2,400	281,600	214,000 (-3%)	1,800 (-25%)	273,100 (-3%)

Source: ODOT/WSDOT, Metro/RTC Regional Travel Demand Model, IBR Analysis

a Percentages reflect change from 2045 No-Build Alternative.

AWDT = average weekday daily traffic

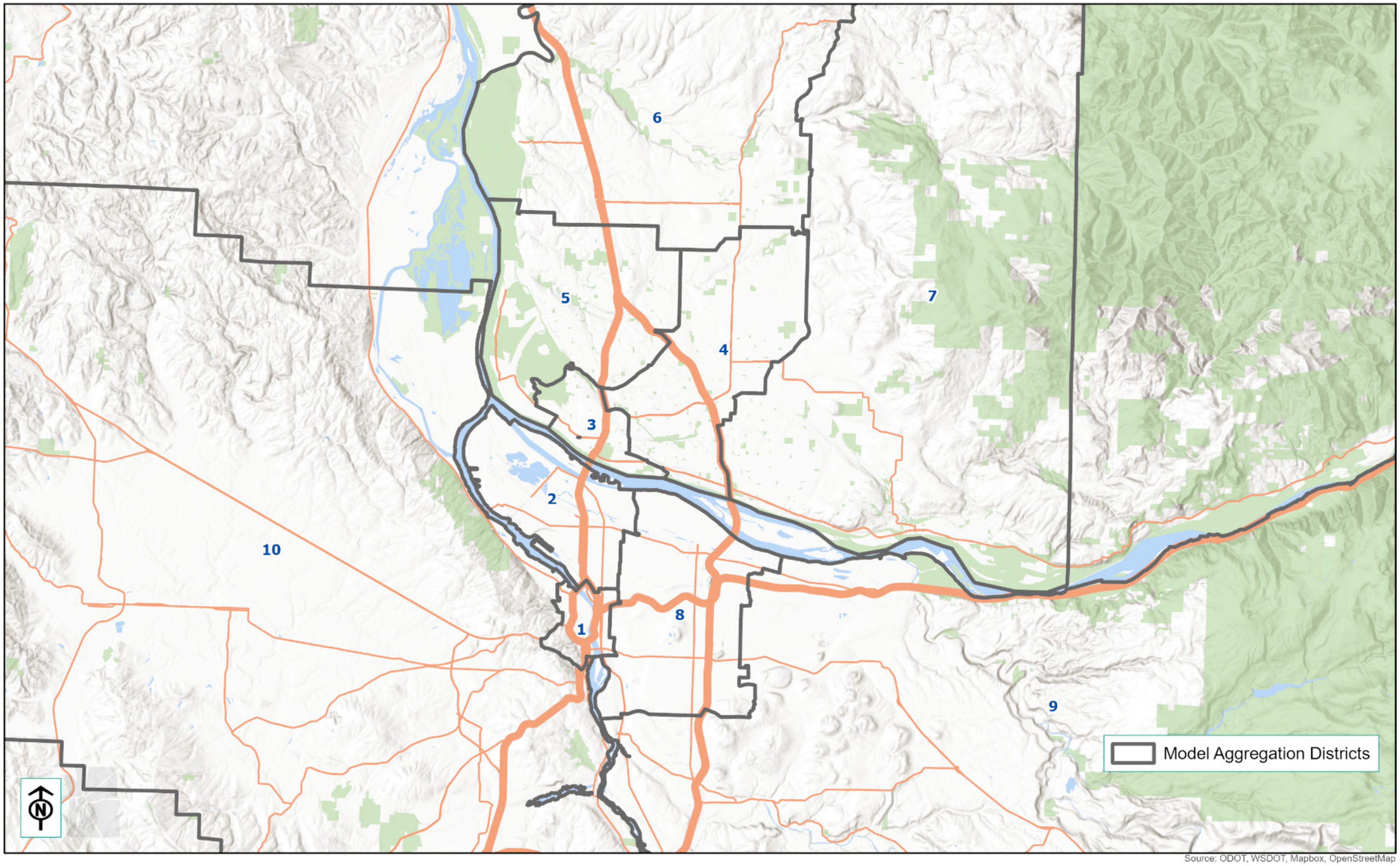
Sensitivity testing was completed in advance of Draft SEIS analysis to test different toll rates and analyze the impacts these toll rates would have on overall vehicle diversion, destination choice (where or if a trip is made), and mode choice (i.e., shifting to transit or active transportation modes). Five different model runs were completed (the No-Build Alternative, three Build model runs including tolling, and a Build model run without tolling). The Build model run with no toll was included to understand how much of an impact the toll on its own would have if other background assumptions (highway and transit improvements) were the same. The Build model runs with different toll assumptions included a base toll rate and two with higher toll rates than the base.

The results of these tolling sensitivity testing scenarios are provided in Appendix H.

4.11.2 Diversion

In the context of travel demand modeling, diversion typically is thought of as the rerouting of traffic flows in response to changes in the transportation network. Diversion can take many forms including alternative route, alternative mode, different destination, changing time of trip or changing frequency of trip making. Travel demand models are used to simulate and predict the movement of trips within a transportation network including where trips will go (destination choice), how they will travel (mode choice) and finally what paths they will take (route choice). This section provides a summary of how the Modified LPA with highway, transit, active transportation, and tolling elements would impact each of these different types of diversion as compared to the No-Build Alternative. Diversion results below are described using the 10 districts shown in Figure 4-49.

Figure 4-49. Ten-District System



4.11.2.1 Destination Choice

Destination choice reflects travel between production areas and attraction areas, and at this point are not separated out by travel mode.

With the Modified LPA, there is an increase in trips that are generated in Clark County that have an attraction (e.g., destination) in Oregon of approximately 7,150 daily person-trips. This reflects the increased accessibility and travel time improvement that is seen for trips crossing the Columbia River in the Modified LPA. These accessibility and travel time improvements outweigh the cost of the toll on the I-5 Columbia River bridges and result in additional trips that cross the river between Clark County and Oregon. What this means is that trips that were being made entirely within Clark County under the No-Build Alternative are now crossing the Columbia River into Oregon in the Modified LPA. The largest changes in trips are between Salmon Creek (District 5) and the Portland Central City area (District 3). The corresponding decrease in trips from Salmon Creek were previously destined to other districts along I-5 (Vancouver CBD and Surrounding Area District 3, East Vancouver District 4 and Salmon Creek District 5). All districts in Clark County show increases in trips to the Portland Central City (District 1) and to N/NE Portland (District 2) as well.

With the Modified LPA, there is a decrease of approximately 500 daily person-trips generated in Oregon and attracted to Clark County. There are also small increases in trips between the outer areas of Portland (NE/Multnomah County District 8, East Multnomah County/Clackamas County District 9, and the Westside District 10) to Clark County.

4.11.2.2 Mode Choice

After the travel demand model determines where trips will travel between production areas and attraction areas, the trips are then separated out by travel mode. Travel modes reflected in comparisons below include auto person-trips, transit person-trips and walk/bike (active transportation) person-trips.

Table 4-57 provides an overall look at differences in systemwide mode shares between the No-Build Alternative and Modified LPA. Overall mode share to auto and walk/bike trips decrease between the No-Build and Modified LPA and transit shares increase. This is the result of the inclusion of a toll for auto trips across the I-5 Columbia River bridges along with transit improvements included as part of the IBR Program. Transit improvements include the extension of the Yellow Line light-rail north from the Expo Center in Portland to a terminus at Evergreen Blvd in Vancouver which includes the addition of three new stations at Hayden Island, Vancouver Waterfront, and Evergreen Boulevard, as well as improved frequency and operations of express bus operating in bus on shoulder across the new I-5 Columbia River bridges.

Table 4-57. Mode Share Comparison No-Build Alternative and Modified LPA

Mode	2045 No-Build Alternative	Mode Share Percentage	2045 Modified LPA	Mode Share Percentage	2045 Modified LPA – 2045 No-Build	Change 2045 Modified LPA – 2045 No-Build Alternative
Auto Person-Trips	9,981,900	83.85%	9,971,000	83.76%	-10,900	-0.11%
Transit	623,500	5.24%	636,200	5.34%	12,700	+2.04%
Walk/Bike	1,299,700	10.92%	1,297,550	10.90%	-2,150	-0.17%

Unlike total person-trips which reflected increases in trips generated in Clark County attracted to Oregon, auto person-trips for the same movements decrease for just over half of the district-to-district movements between the No-Build Alternative and the Modified LPA. The district-to-district movement with the largest decrease in auto person-trips is East Vancouver (District 4) to Portland Central City (District 1).

Transit mode shares increase between the No-Build and Modified LPA for all districts with trips between Clark County and Oregon (both directions). Highlights of district movements that show transit mode share increases are the following:

- Trips between the Vancouver CBD and Surrounding Area (District 3) and the Portland Central City area (District 1).
- Trips between East Vancouver (District 4) and the Portland Central City area (District 1).
- Trips between Salmon Creek (District 5) and the Portland Central City area (District 1).
- Trips between all Oregon districts and the Vancouver CBD and Surrounding Area (District 3).

4.11.2.3 Assignment/Route Choice

Auto and transit assignments are the final step in the travel demand modeling process where trips by auto or transit are assigned to the transportation network for each alternative under consideration. Differences discussed below include shifts in auto or transit trips on the I-5 Columbia River Bridges and the I-205 Glenn Jackson Bridge between the No-Build Alternative and the Modified LPA. As shown in Table 4-57, overall auto person-trips decrease and transit person-trips increase between the No-Build and the Modified LPA. Auto person-trips are converted to vehicles for assignment to account for the fact that some auto person-trips are passengers in a vehicle.

Between the No-Build and Modified LPA, overall auto vehicle trips crossing the Columbia River on both bridges is reduced by approximately 3%. Highlights of these changes include the following:

- The majority of auto reductions are SOVs.
- District movements with the largest changes include the following:
  - Auto trips between the Portland Central City (District 1) and the Vancouver CBD and Surrounding Area (District 3).

- ➢ Auto trips between the Portland Central City (District 1) and East Vancouver (District 4).
- ➢ Auto trips between the Portland Central City (District 1) and Salmon Creek (District 5).

- Except for very small gains between the Vancouver CBD and Surrounding Area (District 3) and NE/Multnomah County (District 8) and East Multnomah/Clackamas County (District 9), all district movements between Clark County and Oregon see auto reductions between the No-Build and Modified LPA.

4.11.3 Key Tolling and Diversion Findings

Key findings related to tolling and diversion indicate the following:

- Reduced auto volumes on I-5, and overall across the Columbia River.
- Reductions on I-5 were the result of diversion to the I-205 Glenn Jackson Bridge as well as increased transit use.
- Changes in destination choice (trips not crossing the river at all).
- Increased transit trips across the river.
- The higher the I-5 Interstate Bridge toll rate, the larger the reduction in cross-river auto trips and the higher the increase in cross-river transit trips.
- Slight reductions in active transportation in the Modified LPA as compared to the No-Build. Alternative.

5. TEMPORARY EFFECTS

This chapter provides an overview of potential construction impacts for transportation modes and facilities affected by the construction of the Modified LPA. The Modified LPA options would be similar to the Modified LPA, so only the Modified LPA is summarized in this chapter.

5.1 Modified LPA

As described in Chapter 1, construction of the Modified LPA is anticipated to last 9 to 15 years and would impact all modes of transportation within the IBR Program Area as well as adjacent corridors. Temporary effects on all modes of transportation would result from construction-related activities and would occur throughout the IBR Program Area to varying degrees.

The construction of bridges over the Columbia River is the most substantial element of the Program, and this element sets the sequencing for other Program components. Accordingly, construction of the main river crossing and immediately adjacent highway connections and improvement elements would be timed early in the Program to aid the construction of other Program elements. Demolition of the existing Interstate Bridge would take place after the new Columbia River bridges were opened to traffic.

Table 5-1 provides the expected durations of Modified LPA construction components and additional information on each element. These estimates are preliminary and are subject to change as design and planning progress. The estimated durations are shown as ranges to reflect the potential for Program funding to be phased over time.

Table 5-1. Construction Activities and Estimated Duration

Element	Estimated Duration	Notes
Columbia River bridges	4 to 7 years	• Construction is likely to begin with the main river bridges. • General sequence would include initial preparation and installation of foundation piles, shaft caps, pier columns, superstructure, and deck.
North Portland Harbor bridges	4 to 10 years	• Construction duration for North Portland Harbor bridges is expected to be similar to the duration for Hayden Island Interchange construction.
Hayden Island interchange	4 to 10 years	• Interchange construction duration would not necessarily entail continuous active construction. Hayden Island work could be broken into several contracts, which could spread work over a longer duration.

Element	Estimated Duration	Notes
Marine Drive interchange	4 to 6 years	• Construction would need to be coordinated with construction of the North Portland Harbor bridges.
SR 14 interchange	4 to 6 years	• Interchange would be partially constructed before any traffic could be transferred to the new Columbia River bridges.
Demolition of the existing Interstate Bridge	1.5 to 2 years	• Demolition of the existing Interstate Bridge could begin only after traffic is rerouted to the new Columbia River bridges.
Three interchanges north of SR 14	3 to 4 years for all three	• Construction of these interchanges could be independent from each other and from construction of the Program components to the south. • More aggressive and costly staging could shorten this timeframe.
Light-rail	4 to 6 years	• The light-rail crossing would be built with the Columbia River bridges.
Total construction timeline	9 to 15 years	• Funding, as well as contractor schedules, regulatory restrictions on in-water work and river navigation considerations, permits and approvals, weather, materials, and equipment, could all influence construction duration.

There are several factors that affect how Program improvements would be built, including site-specific conditions, in-water work construction periods, permit requirements, and market conditions at the time of construction. Many impacts described in this chapter are discussed qualitatively because it is not known exactly how the Modified LPA would be constructed, and construction planning would likely be adjusted during preliminary and final design as additional information on-site conditions is obtained. The IBR Program will coordinate with partners and permitting agencies regarding the necessary permits required for construction. Specific mitigation measures and timing for their implementation would be determined through these permitting processes.

A Maintenance of Traffic Plan that addresses all modes of transportation would be prepared during subsequent IBR design and construction phases for agency approval. The Maintenance of Traffic Plan would include detailed design drawings that establish all physical and operating characteristics for staging, access, lane or shoulder closures and transitions, hauling, traffic management (including general-purpose traffic, transit, bicycle, and pedestrian traffic), detours, lane modifications, and other construction zones or activities. The plan would incorporate guidance in FHWA's Manual on Uniform

Traffic Control Devices, ODOT and WSDOT's Transportation Management Plan strategies from each agency's respective Design Manual, and the guidance and requirements of local partners.

5.2 Regional Transportation

In addition to I-5, several regional roadway facilities including I-205, SR 500, SR 14, I-405, and I-84 would be impacted by IBR construction. The Modified LPA could require nighttime closure of regional roadways, interchanges, and local roads during construction. Approval would be needed from WSDOT, ODOT and local jurisdictions for traffic control plans for the Modified LPA.

5.3 Interstate 5

The I-5 mainline and interchanges within the IBR Program Area would be impacted by IBR construction. To reduce impacts that could disrupt peak-period and daytime transportation travel on I-5, construction of the IBR Modified LPA could occur during the nighttime hours and on weekends following Department of Transportation ordinances. Similar to impacts to regional transportation facilities, approval would be needed from WSDOT, ODOT and local jurisdictions for traffic control plans for the Modified LPA on I-5 at IBR Program Area interchanges.

5.4 Freight Mobility and Access

Impacts of the Modified LPA on freight truck movements would be similar to the impacts to general traffic. It is anticipated that freight would continue to travel on designated freight corridors during construction. If freight corridors are temporarily closed, detour routes would be determined in partnership with local jurisdictions and signed for freight traffic.

Temporary access closures or access modifications for businesses could also occur, affecting freight (such as deliveries). If driveway closures are required, access to these properties would be maintained to the extent possible. With driveway closures, detours for freight would cause similar impacts compared to what is described for general-purpose traffic impacts.

Marine Drive serves as the primary truck traffic access corridor between I-5 and the Port of Portland container terminals. Mill Plain Boulevard and Fourth Plain Boulevard serve as the primary truck traffic access corridors between I-5 and the Port of Vancouver container terminals. Closures on these roads could result in temporary delays to freight traffic resulting from detours.

During construction across active rail lines, there could be temporary closures that result in delays to freight train traffic. Coordination plans with the rail operators would be required.

5.5 Bridge Openings and Gate Closures

All highway and active transportation users would be affected during construction by ongoing bridge openings and gate closures of the existing Interstate Bridge, similar to existing conditions. This would include bridge openings for maintenance activities (until traffic is shifted onto the new Columbia River bridges) but it could also include additional openings to accommodate construction equipment. These bridge openings and gate closures would impact all modes of transportation similarly to existing conditions. To reduce impacts that could disrupt peak-period and daytime travel on I-5 within and adjacent to the IBR Program Area, bridge openings and gate closures could be limited to occurring only during the nighttime hours and on weekends. Approval would be needed from WSDOT, ODOT, USCG, the Ports, and other jurisdictions to implement this plan.

5.6 Arterials and Local Streets

Construction of the Modified LPA would require local road closures, lane closures, traffic detours, and property access modifications and closures to maintain traffic flow. The construction staging plan would limit roadway closures to the greatest extent practical. Detour routes would be developed when closures are required. If driveway closures are required, access to these properties would be maintained to the extent practical. If access to a business could not be maintained during construction, the specific construction activity would be conducted during non-business hours where feasible.

Construction truck traffic would use approved truck routes and, where necessary, local roadways to access the construction areas. This could result in increased congestion, queues, and delays for local traffic and access. Delivery of large items would occur via truck routes. There would be limited direct access to construction areas via the I-5 mainline, although trucks may use I-5 to access construction areas. During construction there may be some short-term closures (night/weekend) to on- and off-ramps to accommodate construction activities. As the design and construction plans are advanced, there could be a need for direct access between I-5 and construction areas. If direct access is required, the IBR Program would coordinate with WSDOT, ODOT, and FHWA.

Construction staging areas will continue to be identified as part of the Program's construction planning.

5.7 Transit Operations

Construction of the Modified LPA could involve lane closures, bus stop relocations, light-rail station closures, partial or full temporary closures of park-and-ride facilities, schedule adjustments, and sidewalk and bicycle lane impacts that could affect transit operations and/or access to transit within the IBR Program Area.

Buses on the existing routes could experience delays from increased congestion due to potential roadway or interchange closures. Buses that travel through downtown Vancouver may encounter temporary closures and reroutes as LRT guideway is installed and I-5 is reconstructed.

The existing TriMet MAX Yellow Line could be adversely affected during construction. The current Yellow Line travels along Denver/Expo Road and has two stations in the south end of the IBR Program Area. Construction along Expo Road and as part of the Marine Drive interchange may require temporary relocation or closure of the Yellow Line's station near Delta Park and its terminus station near the Expo Center. These temporary relocations, closures, or schedule adjustments could take place intermittently for up to 4 years.

5.8 Active Transportation Access

Construction of the Modified LPA could temporarily close sidewalks, bicycle facilities, or shared-use paths or reduce facility widths within construction areas. Active transportation travel could be affected within the IBR Program Area, including in the Expo Center and Delta Park light-rail station area, during station and guideway construction. Limited opportunities are available for active transportation crossings of I-5, and existing crossings would therefore be maintained to the extent practical. Active transportation facilities would be temporarily rerouted during intermittent and temporary closures.

5.9 Safety

Many of the construction modifications to facilities, routes, and services would involve temporary conditions where safety would be an increased concern. Maintaining safety for travelers and construction workers is one of the primary elements of construction plans, including for traffic control. Traffic diversion caused by construction would lead to higher traffic volumes on detour streets. The higher traffic volumes could lead to a potential increase in collision frequency. In locations where there is no physical change to the roadway, the types of crashes would remain similar to existing conditions.

5.10 Transportation Demand Management and Transportation System Management

During construction of the Modified LPA, the impacts to TDM and TSM systems could be impacted during construction.

5.11 Tolling and Diversion

During construction of the Modified LPA, pre-completion tolling would commence on the existing Interstate Bridge. During the pre-completion period while the new bridges are under construction, the existing Interstate Bridge is assumed to operate toll-free between 11 p.m. and 5 a.m. Diversion could occur during construction as people try to avoid pre-completion tolling or congestion from construction impacts. Depending on the origin and destination of the trip, this could increase travel times, modify the time of day a trip is made, or potentially change the route or mode that is chosen.

6. INDIRECT IMPACTS

This chapter discusses the indirect transportation impacts that could result from the Modified LPA. The Modified LPA options are assumed to be similar to the Modified LPA, so only the Modified LPA is summarized in this chapter.

6.1 Regional Transportation

The No-Build Alternative would not provide the multimodal improvements assumed in adopted regional transportation and land use plans, which seek to manage growth through coordinated land use and transportation actions. The trips generated by higher-density TOD may have higher levels of automobile use in the absence of the IBR investments. Future developments in the blocks surrounding stations could also be lower density than assumed. This would result in similar to higher levels of congestion for the No-Build Alternative, compared to the findings reported in long-term effects in Chapter 4.

This increase in automobile trips for the No-Build Alternative near station areas is consistent with findings in studies by the National Institute for Transportation and Communities, which estimate that TOD can reduce automobile trips from 10% to as much as 65%, compared to a development of comparable density with limited multimodal options. This varies also based on the size of the development and the overall transportation and urban characteristics of a given station area.

The Modified LPA would improve freeway facilities and safety on I-5, enhance transit solutions (light-rail service and increased express bus service), and improve active transportation facilities. This would improve regional transportation between Vancouver and Portland. Because regional and local land use planning anticipates implementation of the IBR Program, such changes are expected to be consistent with the adopted land use plans and policies and the transit-oriented developments already incorporated within the transportation analysis and its forecasts, and no additional indirect effects are anticipated.

Sections 3.4.2 and 4.4.4 of the Land Use Technical Report have additional discussions of the relationship between land use plans and future growth patterns anticipated that already assume the implementation of the Modified LPA. The Land Use Technical Report Section 6.1 on indirect effects addresses the potential for induced growth as well. It concludes that regional and local land use and transportation plans already anticipate the IBR Program's planned transportation improvements and the facilities that serve them. Oregon and Washington both incorporate comprehensive growth management planning at the state and local levels. The Modified LPA is designed to support the level and character of growth that is already anticipated in these growth planning efforts, and therefore there would be a low potential for additional indirect effects or induced demand at the regional level and at the localized and modal levels discussed below.

6.2 Interstate 5

Completion of the Modified LPA would eliminate the need for bridge openings, contribute to more efficient movement through the corridor, and improve safety. These Program elements would help to reduce travel time delay, provide greater travel time reliability, and contribute to a safer travel environment for drivers crossing the Columbia River bridges. Improved operations on I-5 could contribute to reduced societal costs associated with fewer crashes and increased economic benefits resulting from more efficient and reliable freight deliveries to local businesses and residences.

6.3 Freight Mobility and Access

The construction of new Columbia River bridges would eliminate the need for bridge openings. The inclusion of auxiliary lanes would help optimize the existing three through lanes and allow for more efficient movement through the corridor by improving safety and helping to relieve congestion with better traffic flow. These Program elements would help to reduce current impediments to freight mobility and provide greater travel time reliability for trucks crossing the bridges. Improved freight mobility across the Columbia River bridges could contribute to more efficient, reliable, and predictable operations at local, regional, and national ports. It could also lead to more reliable freight deliveries to local businesses and residences.

Development densities in LRT station areas, as discussed in Section 6.1, Regional Transportation, are already incorporated within the Modified LPA and options, consistent with local and regional land use plans. No additional indirect effects are predicted for the Modified LPA.

6.4 Arterials and Local Streets

Indirect effects under the No-Build Alternative would be likely to involve shifts in the characteristics of future transportation conditions because the population, employment and land use patterns under anticipated local land use plans would be less likely to be achieved over time. While land use densities may be lower at the local intersection level, the trips generated by future developments would likely be more car-oriented because critical transit and nonmotorized improvements would not be present. See Appendix H of this report and the Land Use Technical Report for additional discussion.

Potential development in the IBR Program Area, such as around the new transit stations, is already incorporated within the Modified LPA and options, consistent with local and regional land use plans.

6.5 Transit Operations

In addition to the planned changes to local and commuter bus service assumed for the IBR Program, C-TRAN and TriMet could make additional changes in response to the project. These could include redeploying and/or reinvesting in bus service that would be replaced by the extension of Yellow Line light-rail service into the IBR Program Area. Such changes are dependent on transit funding and could result in a net benefit for transit riders.

As described above, the extension of light-rail service could facilitate transit-oriented development in areas around the IBR Program stations, but such development is consistent with local and regional land use plans and already incorporated within the direct impacts analysis. The population and employment projections used to forecast transit ridership in the Metro/RTC regional travel demand model were the 2018 RTP land use targets, which were developed in part to reflect the planned development of light-rail and transit improvements for this project as one of the major investments identified in the 2018 RTP. The regional travel demand model already anticipates planned land use changes in the IBR Program Area, including for transit-oriented development in the vicinity of future IBR Program light-rail stations. Compared to the No-Build Alternative, the mode of access to reach transit may shift to a greater percentage of active transportation or transit transfers.

6.6 Active Transportation

Increased transit ridership would support increased active transportation trips to station areas, but increased activity is already considered in the direct effects analysis. Travelers making these trips, as well as additional active transportation trips across the bridges, might need to travel along streets that lack ADA accessibility or along regional trail networks that have other gaps, but increased usage of these facilities could encourage improvements by local jurisdictions.

6.7 Safety

The safety benefits resulting from roadways designed to current standards, expanded use of ramp metering, expanded active transportation management systems, and additional transit options via bus-on-shoulder operations could contribute to lower societal costs associated with crashes. The safety benefits resulting from expanded TSM solutions (e.g., active transportation, ramp metering) and TDM features (e.g., light-rail extension into Vancouver and additional transit options via bus-on-shoulder operations) could contribute to lower societal costs associated with crashes.

6.8 Transportation Demand Management and Transportation System Management

The mode shifts resulting from the IBR Program transit and active transportation infrastructure could increase participation in local TDM programs. Institutions and organizations that administer these programs may require additional resources to respond to this increased demand.

6.9 Tolling and Diversion

Implementation of the Modified LPA, including variable-rate tolling of the new Columbia River bridges, would result in changes to traffic volumes and to alternative travel modes. Variable-rate tolling and improvements made through both the highway and transit components of the IBR Program would result in reduced congestion on I-5 through the Program Area. This variable-rate tolling would include lower toll rates during times of day that are less congested, which would help minimize potential traffic diversion to the I-205 Glenn Jackson Bridge and arterial facilities in and around I-5 during these time periods.

7. POTENTIAL MITIGATION

This chapter identifies whether mitigation could be required to address impacts of the Modified LPA or options and describes potential mitigation measures for the transportation elements analyzed in this report. It also describes potential measures that the IBR Program could take but that require agreement by other parties. For instance, the IBR Program has identified potential freeway and intersection improvements to mitigate project-related impacts, but does not have the sole authority to make those improvements when the facilities are owned and managed by others. Other agencies may also have alternative plans or projects to address future conditions with or without the IBR Program. In these cases, the IBR Program would coordinate with these other agencies to further define and implement improvements to mitigate the impacts of the IBR Program. As possible mitigations are identified and considered, the IBR Program will determine whether additional environmental analysis is necessary

7.1 Mitigation for Long-Term Effects

7.1.1 Key Findings

Key observations and findings by transportation element include the following:

- Regional Transportation – No mitigation would be required.
- Freeway Operations – Mitigation would be required to meet ODOT and WSDOT mobility standards.
- Freight Mobility and Access – No specific freight mitigation would be required.
- Bridge Openings and Gate Closures – Mitigation could be required for the Modified LPA single-level movable-span configuration.
- Arterials and Local Streets – Mitigation would be required to meet City of Portland, City of Vancouver, WSDOT and ODOT mobility standards.
- Transit – Mitigation could be needed to respond to regional transit system reliability impacts at the Rose Quarter.
- Active Transportation – No mitigation would be required.
- Safety – No mitigation would be required.
- TDM and TSM – No additional TDM and TSM mitigation would be required.
- Tolling – No additional mitigation would be required.

7.1.2 Regional Transportation

No long-term transportation impacts were identified for regional transportation facilities as a result of the IBR Program; therefore, no mitigation would be needed for these elements.

7.1.3 Freeway Operations

Traffic impacts were determined for I-5 mainline and ramp segments in the freeway analysis area by comparing freeway and ramp operations for the No-Build Alternative and the Modified LPA and options against agency performance standards for the 2045 design year.

WSDOT maintains a performance standard of LOS D for the No-Build Alternative and the Modified LPA and options. Mitigation could be required for the IBR Program Area freeway and ramp segments in Washington when operations do not meet agency performance standards of LOS D or if they do not meet the agency performance standards under the No-Build Alternative and the Modified LPA or options and operations were degraded by more than 10% compared to the No-Build Alternative.

The ODOT performance standard for the 2045 design year Modified LPA and options is a 0.75 V/C ratio compared to a 1.1 and 0.99 V/C ratio (highest hour and second highest hour respectively) for the 2045 No-Build Alternative. Therefore, freeway and ramp mitigation could be required when the Modified LPA or options did not meet the ODOT 0.75 V/C ratio performance standard in Oregon.

- With the Modified LPA with and without C Street ramps, I-5 northbound approaching the Columbia River bridges would not meet ODOT's mobility standard in the IBR Program Area during the PM peak period due to over-capacity conditions at the Columbia River bridges. Congestion from the bottleneck at the bridges would back up to the I-5/I-405 interchange in North Portland and last for approximately 9 hours.
- With the Modified LPA with two auxiliary lanes, I-5 northbound approaching the Columbia River bridges would not meet the ODOT mobility standard during the PM peak period due to over-capacity conditions at the Columbia River bridges. Congestion from the bottleneck at the bridges would back up 0.75 miles to Hayden Island and last for approximately 6 hours.
- With the Modified LPA and options, I-5 southbound through the IBR Program Area would not meet WSDOT's or ODOT's mobility standards during the AM peak period due to congestion spilling back from the I-5/I-405 bottleneck in North Portland. Congestion from the I-5/I-405 bottleneck in North Portland would extend 6 miles north to the CD roadway in Vancouver and last for approximately 8.5 hours.
- With the Modified LPA and options, the southbound CD roadway between the Mill Plain and SR 14 interchanges would not meet the WSDOT mobility standard during the AM or PM peak periods. The congestion from the CD roadway would reach I-5, but the extent to which this would vary depends on the design option. Congestion in the Modified LPA would extend 4 miles and last approximately 6 hours. Congestion with the two auxiliary lane design option would extend 1.5 miles and last approximately 4 hours.

Potential mitigation to meet ODOT's and/or WSDOT's performance standards on I-5 could include the following.

7.1.3.1 Modified LPA

Provide an additional auxiliary lane northbound and southbound within the IBR Program limits, and/or the program and partners could implement more intensive demand reduction and system management strategies, beyond what the IBR Program already includes (variable-rate tolling, improved transit and active transportation systems, and enhanced TDM and TSM systems).

7.1.3.2 Modified LPA and Design Options

ODOT will continue to work with partners to study the downstream bottleneck at the I-5/I-405 split in North Portland. This downstream bottleneck is a separate project that ODOT is looking into understanding causes and potential solutions.

The southbound CD roadway would be impacted by congestion spilling back from I-5 during the AM peak period, but even during the PM peak period when no downstream congestion is present, the CD roadway does not meet WSDOT's mobility standards. Potential mitigation measures could include braiding the Mill Plain on-ramp and SR 14 off-ramp and possibly providing a slip lane to continue providing access for trips traveling from the Mill Plain interchange to SR 14.

Final mitigation measures will be determined and agreed upon with the appropriate agency and partners as needed. The Final SEIS and ROD will include all mitigation commitments that have been finalized by the time of publication; however, some mitigation measures may not be finalized until later in the project design process.

7.1.4 Freight Mobility and Access

The Modified LPA and options would not require freight mitigation beyond the mitigation identified for freeway operations in Section 7.1.3, Freeway Operations, and local intersections in Section 7.1.6, Arterials and Local Streets.

7.1.5 Bridge Openings and Gate Closures

With one exception, the Modified LPA and options would eliminate bridge openings and gate closures. The single-level movable-span configuration would require periodic bridge openings and gate closures.

Measures to minimize disruptions to I-5 operations, transit service, and active transportation associated with bridge openings and gate closures under the Modified LPA with a single-level movable-span configuration could include:

- Establish new bridge opening and gate closure timing limitations, which could include scheduled days and/or times that avoid peak periods for passenger vehicles and trucks, in coordination with the USCG.
- Incorporate bridge opening and gate closure limitations into transit service schedules.
- Disseminate information concerning bridge openings and gate closures to the public, businesses, travel organizations, freight industry, and mariners.

7.1.6 Arterials and Local Streets

Traffic impacts were determined for arterials and local streets by comparing the overall intersection operations (LOS or V/C ratios) for the No-Build Alternative and the Modified LPA and options against the agency performance standards for the 2045 design year. Details on the various agency performance standards and are described in detail in Appendix A, Transportation Methods and Assumptions.

Mitigation could be required for study intersections that meet agency performance standards under the No-Build Alternative but operate below agency performance standards under the Modified LPA or options. Mitigation could also be required for the Modified LPA or options if the intersection operations that did not meet agency standards under the No-Build Alternative were degraded by more than 10% under the Modified LPA or options.

Final mitigation measures will be determined and agreed upon with the appropriate agency and partners as needed. The IBR Program (ODOT/WSDOT) could contribute a proportionate share toward identified mitigation to improve intersection performance as agreed to with the local jurisdiction. The Final SEIS and ROD will include all mitigation commitments that have been finalized by the time of publication; however, some mitigation measures may not be finalized until later in the project design process.

7.1.6.1 Modified LPA and Modified LPA with Two Auxiliary Lanes

No intersections in the Modified LPA or Two Auxiliary Lane design option would require mitigation improvements because intersection operations are not worsened compared to the No-Build Alternative. Traffic impacts for the Modified LPA with two auxiliary lanes and park-and-ride options are expected to be similar to the Modified LPA for all subareas. As part of final design, a traffic analysis would be conducted to confirm the analysis and identify any mitigation measures, if necessary. Final mitigation will be determined and agreed upon by the IBR Program and the affected agency.

7.1.6.2 Modified LPA Without C Street Ramps

Six intersections in the Modified LPA without C Street ramps could require potential mitigation improvements and are summarized below. The impacts are caused by the additional traffic volumes accessing the Mill Plain Boulevard/15th Street east-west couplet due to the elimination of I-5 access via the C Street ramps.

- Intersection #22: Mill Plain Boulevard and Franklin Street.
- Intersection #24: 15th Street and Washington Street.
- Intersection #25: 15th Street and Main Street.
- Intersection #28: Mill Plain Boulevard and Columbia Street.
- Intersection #31: Mill Plain Boulevard and Broadway Street.
- Intersection #34: Mill Plain Boulevard and I-5 northbound on-/off-ramps.

Mitigation of this congestion could include retaining the C Street ramps or adding additional lanes or turn-pockets at study intersections. As part of final design, additional traffic analysis would be conducted to confirm the SEIS analysis and refine mitigation and design measures as needed. Final mitigation will be determined and agreed upon by the IBR Program and the affected agency.

7.1.7 Transit

In the course of considering mitigation, an updated on-time performance analysis in the Rose Quarter may be completed. Final mitigation measures will be determined and agreed upon with the appropriate agency and partners as needed. The IBR Program could contribute a proportionate share toward identified mitigation to improve on-time performance at the Rose Quarter. The Final SEIS and ROD will include all mitigation commitments that have been finalized by the time of publication; however, some mitigation measures may not be finalized until later in the project design process.

Otherwise, the analysis indicates that the Modified LPA and options would not result in permanent adverse impacts to transit, and therefore would not require mitigation.

7.1.8 Active Transportation

The Modified LPA and options would not result in any permanent adverse impacts on existing active transportation facilities in the IBR Program Area; therefore, no mitigation would be required.

7.1.9 Safety

The Modified LPA and options would have no permanent impact to transportation safety that would require mitigation.

7.1.10 Transportation Demand Management and Transportation System Management

Mitigation for TDM and TSM would not be required because the IBR Program would reduce the reliance on SOVs in the IBR Program Area and the Portland-Vancouver metropolitan region, and the improved freeway operations and TSM measures would be coordinated with project partners.

7.1.11 Tolling and Diversion

Analysis indicates that the Modified LPA and options with tolling included would not result in permanent adverse impacts to other modes or cause diversion to other facilities that would require mitigation. If toll rates set by the Washington State and Oregon Transportation Commissions are different than what has been evaluated, impacts to other facilities or modes have the potential to increase.

7.2 Mitigation for Temporary Effects

Construction activities would comply with ODOT and WSDOT requirements for maintenance of traffic. More specific measures related to maintenance of traffic are discussed below.

7.2.1 Regional Travel

Detailed construction plans and maintenance of traffic plans would be developed to address all affected facilities and their modes of transportation. Such plans would be prepared during subsequent design and construction phases for agency approvals. The plans would describe staging, access, facility, lane or shoulder closures and transitions, hauling, traffic management (including general-purpose traffic, transit, bicycle, and pedestrian traffic), detours, lane modifications, incident management, traffic control, closure details, coordination and communications plans, and other construction zones or activities. Plans would be developed to meet applicable agency standards. The Program would coordinate with agencies with jurisdiction for review and applicable approvals.

7.2.2 Freight Mobility and Access

Freight mobility and access would be an element of the Program construction plans identified above. To minimize potential freight impacts, the IBR Program would coordinate with all facility owners, including railroads, as well as freight operators and affected businesses throughout the construction period to notify them of facility or access closures. Construction information would be provided to the Port of Vancouver, Port of Portland, and local jurisdictions. Similar information would be provided to WSDOT and ODOT for use in the states' freight notification systems. The IBR Program would provide information in formats required by WSDOT and ODOT.

To minimize impacts to freight rail operations, the Program would coordinate with the railroad owners and rail operators and would obtain all applicable required permits. Critical work that would result in rail line shutdowns would be performed only at night and on weekends. Construction would be limited to the times approved and coordinated with freight rail operations.

7.2.3 Bridge Openings

During IBR construction, the IBR Program would work with WSDOT, ODOT, USCG, the Ports, and other jurisdictions to minimize bridge openings and gate closures to overnight periods to lessen the impact to all transportation modes. A construction plan would be developed that identifies available resources that could be used to inform the public of upcoming bridge openings and gate closures.

7.2.4 Arterials and Local Streets

All avoidance and minimization measures associated with constructing the Modified LPA would comply with local regulations governing construction traffic control and construction truck routing. The IBR Program would finalize detailed construction plans in close coordination with local jurisdictions, WSDOT, and ODOT during the final design and permitting phases of the Program.

7.2.5 Transit Operations

Transit service and facility modifications would be coordinated with TriMet and C-TRAN to minimize temporary impacts and disruptions to bus and light-rail facilities and service during construction. Detailed construction plans and coordination/communication plans would be developed. This would include support for public information and communication throughout the construction period, including for periods where alternative routes, facilities, or services would be needed to maintain service.

7.2.6 Active Transportation

Construction plans would include specific mitigation for impacts to active transportation facilities and users, such as protected facilities through construction areas, signage, lighting, communications, safety and maintenance, in coordination with local jurisdictions.

7.2.7 Safety

In addition to the commitments to develop construction plans as identified above, the IBR Program would work with WSDOT and ODOT on implementing the latest safety technology during construction.

7.2.8 Transportation Demand Management

The IBR Program would work with WSDOT, ODOT, and partner agencies on implementing additional TDM and TSM treatments during construction. Potential strategies could include:

- Expanded transit service.
- Vanpool and carpool programs.
- Telecommuting options.
- Compressed work week and flexible work schedules.
- Active transportation improvements and enhancements.

7.2.9 Tolling and Diversion

The IBR Program would work with WSDOT, ODOT, and partner agencies on a pre-completion tolling and any diversion impacts during construction.

Diversion impacts during construction will be evaluated, and potential mitigation will be discussed with partner agencies to offset any impacts.

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Appendix A. Transportation Methods Report

Interstate BRIDGE Replacement Program

A **modern** connection for a growing **community**

Transportation Methods Report

September 2024

Transportation Methods Report

CONTENTS

FIGURES

TABLES

ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

APM	Analysis Procedures Manual
BRT	Bus rapid transit
C-TRAN	Clark County Public Transit Benefit Area Authority
CRC	Columbia River Crossing
EIS	Environmental Impact Statement
FHWA	Federal Highway Administration
FTA	Federal Transit Administration
GP	General purpose
HCM	Highway Capacity Manual
HDM	Highway Design Manual
HSM	Highway Safety Manual
IBR	Interstate Bridge Replacement
LOS	level of service
LPA	locally preferred alternative
Metro	Oregon Metro
MPO	Metropolitan Planning Organization
NEPA	National Environmental Policy Act
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
ROD	Record of Decision
RTC	Southwest Washington Regional Transportation Council
RTP	Regional Transportation Plan
T&R	Tolling and Revenue
TriMet	Tri-County Metropolitan Transportation District
VHD	Vehicle hours of delay
VHT	Vehicle hours traveled
VMT	Vehicle miles traveled
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

This report describes the methods and assumptions that were used to conduct the transportation analysis for the Interstate Bridge Replacement (IBR) Program. The IBR Program builds upon the Interstate 5 (I-5) Columbia River Crossing (CRC) project that was analyzed from 2005 to 2014. The CRC project was a bridge, transit, and highway improvement project for I-5 in Washington and Oregon. It focused on addressing the congestion, mobility, and safety issues on I-5 between State Route (SR) 500 in Vancouver, Washington, and Columbia Boulevard in Portland, Oregon.

The Interstate Bridge is a critical connection between Oregon and Washington, located on I-5 where it crosses the Columbia River. Replacing the existing structurally and operationally deficient bridge with a seismically resilient structure that meets the future transportation needs of the growing Portland and Vancouver metropolitan region is a high priority for Oregon and Washington. The closely spaced interchanges north and south of the bridge were be considered in this analysis because the proposed Modified Locally Preferred Alternative (Modified LPA) developed as part of an earlier screening process would have a direct impact on the design and traffic operations at nearby interchanges.

The transportation system in the vicinity of the Interstate Bridge is complex, with a diverse array of transportation elements, including freeways, highways, local roads, transit, and active transportation networks. The transportation system serves commuters making recurring trips during the weekdays, trucks traveling to and from the ports on either side of the river, public transit routes, traffic related to local businesses and residences, and active transportation users.

This report describes the IBR Program Area, multiple modal study areas used for impact analysis, analysis years, time periods analyzed, data used in analysis, volume development for existing and future scenarios, tools used, agency performance standards, analysis completed for each of the various elements of the transportation network, and the metrics used to identify operational impacts resulting from the IBR Program. This report describes the transportation analysis for all modes of transportation including regional, highway, freight, arterial/local streets, transit, and active transportation.

The analysis is designed to comply with the National Environmental Policy Act (NEPA) and relevant federal, state, and local laws. These methods build on those developed for the CRC project, which completed the NEPA process with a signed Record of Decision (ROD) in 2011.

1.1 Background

In the Portland-Vancouver metropolitan region, the I-5 Interstate Bridge and I-205 Glenn Jackson Bridge are the only two routes across the Columbia River, making them critical connections for people to access jobs and services, interstate commerce, and freight movement. I-5 is the primary spine running north and south through the region, and it is an international link from Canada to Mexico, carrying freight and passenger vehicles to many major cities on the West Coast. The I-5 Interstate Bridge consists of two bridges that were constructed in 1917 (northbound) and 1958 (southbound). Each bridge has a vertical lift section. The I-5 Interstate Bridge has narrow lanes, lacks functional shoulders, and has substandard sight distances, all of which contribute to safety issues. There are no dedicated/exclusive transit facilities across the Interstate Bridge, and the substandard paths on the bridges are uncomfortable for pedestrians and bicyclists. The lack of dedicated transit facilities and substandard paths on the Interstate Bridge limit modal choice.

The I-5 corridor north and south of the Interstate Bridge is characterized by narrow lanes, limited sight distance, and bridge lifts that stop traffic on I-5, as well as short merging, diverging, and weaving roadway segments resulting from closely spaced interchanges. Due to the lack of functional shoulders on the bridge and the narrow shoulders through portions of I-5 in the vicinity of the bridge, even minor incidents or crashes can cause congestion. I-5 has three continuous lanes in each direction with auxiliary lanes between some of the closely spaced interchanges. The posted speed in Washington, north of the Interstate Bridge, is 60 miles per hour (mph). The posted speed on the bridge and immediately north and south of the bridge is 50 mph. The posted speed in Oregon, south of the Interstate Bridge, is 55 mph.

There are limited facilities to support bistate public transit connectivity and reliability, which act as barriers to accessing jobs, health care, education, and other essential service for transit-dependent individuals. There are shared-use paths on each bridge, but the 3.5- to-4-foot width is narrower than the current standards, makes passing other users difficult, and is not compliant with the Americans with Disabilities Act. The paths are also directly adjacent to traffic lanes, increasing bicycle and pedestrian exposure to vehicular traffic, noise, and emissions. The deficient pedestrian and bicycle facilities on the Interstate Bridge, lack of direct connectivity to facilities on either side of the river, and the complex, substandard, and difficult wayfinding all constrain nonmotorized access.

1.2 IBR Program Area

The IBR Program Area is the approximately 5-mile section of I-5 between the SR 500/39th Street interchange in Vancouver and the Interstate Avenue/Victory Boulevard interchange in Portland. It includes seven interchange areas: SR 500/39th Street, Fourth Plain Boulevard, Mill Plain Boulevard, City Center/SR 14, Hayden Island, Marine Drive, and Interstate Avenue/Victory Boulevard. See Figure 1 for the IBR Program Area.

1.3 Accounting for the COVID-19 Pandemic

The COVID-19 pandemic that began in 2020 altered historical travel patterns and trends, traffic volumes, and transit ridership. Traffic volumes and transit ridership dropped below historic levels, and then began to increase as health emergency restrictions gradually eased over the following 3 years. As of March 2023, according to traffic count data from both WSDOT and ODOT (WSDOT 2022a; ODOT 2021), traffic volumes were close to pre-pandemic levels for auto and freight traffic within the study area. Transit has been slower to recover, but according to both Clark County Public Transportation Benefit Area Authority (C-TRAN) and (Tri-County Metropolitan Transportation District of Oregon) TriMet, transit service levels and ridership continue to see increases as more time goes by since the start of the pandemic (C-TRAN n.d.; TriMet n.d.).

Transportation analyses generally incorporate the most recently available data. Due to the influence of the COVID-19 pandemic on travel patterns between 2020 and 2023, the IBR Program is following industry standards and using 2019 as the baseline year for the existing conditions section of this report. The exception to using 2019 data is outputs from the Oregon Metro (Metro)/Southwest Washington Regional Transportation Council (RTC) regional travel demand model which are from 2015, as Metro and RTC have not yet updated their base year model from 2015 to 2020.

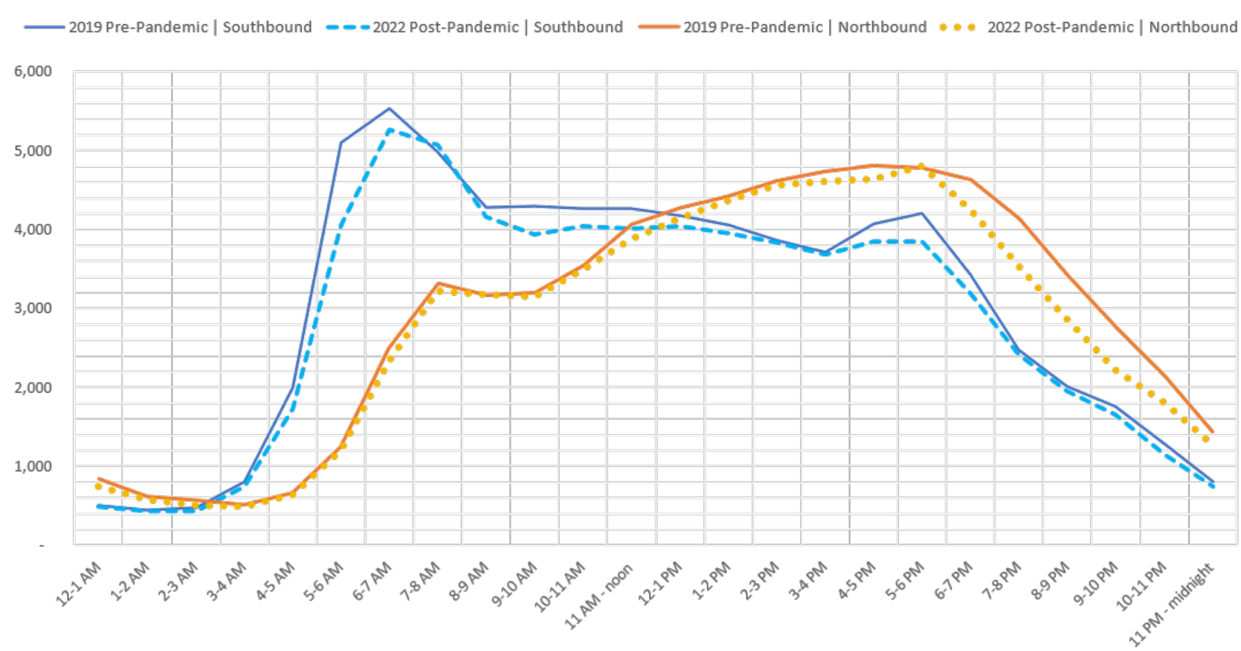
Figure 1. IBR Program Area

1.4 Volume Recovery since start of COVID-19 Pandemic

Figure 2 shows the 24-hour volume profiles for northbound and southbound traffic on the I-5 Interstate Bridge in 2019 and 2022. The lines in blue (2019 shown in solid blue, and 2022 shown in hatched blue) show the southbound daily volume profile. The lines in orange (2019 shown in solid orange, and 2022 shown in hatched orange) show the northbound daily volume profile. In addition to showing northbound and southbound hourly traffic volume profiles this graphic shows that volumes on I-5 in the program area have recovered to nearly 95% of pre-pandemic levels by 2022. This is true for both peak periods in the IBR program area.

In addition to showing hourly volume profiles, Figure 2 also shows the AM and PM peak period duration of congestion with flattened or camel hump peak volumes during the AM and PM peak periods at the I-5 Interstate Bridge. Southbound volumes on the I-5 Interstate Bridge peak during the AM peak period (6-8 AM) then come down and hold steady in the middle of the day before showing a small peak again in the afternoon peak period (4-6 PM). The northbound volume profiles rise to a small morning peak then holds steady midmorning before rising to the PM peak and holding constant for multiple hours during the afternoon (3-7 PM). Traffic flows on the I-5 Interstate Bridge are congested southbound for 3 hours from 6-9 AM and northbound from 11 AM to 8 PM. These patterns are consistent pre-covid in 2019 and in recent counts in 2022.

Figure 2. Twenty-Four-Hour Volume Profiles for Northbound and Southbound Traffic on the I-5 Interstate Bridge in 2019 and 2022



1.5 Overview of Updates Compared to the CRC Methods and Assumptions

The approach to the transportation analysis for the IBR Program remains the same as the approach to the CRC project. While a formal transit analysis methodology was not prepared as part of the CRC project's Environmental Impact Statement (EIS), several elements of the transit system were analyzed and summarized in the CRC transit technical report and Final EIS. This IBR transportation methods and assumptions report addresses all modes of transportation, including traffic, transit, freight, and nonmotorized transportation. The analysis years have been updated, models have been updated, some of the software tools have changed, and the analysis metrics have been updated to account for changes to agency performance standards.

2. RELEVANT PLANS, POLICIES, AND COORDINATION

2.1 Guiding Regulations, Plans, and/or Policies

The transportation analysis was guided by the following laws and regulations:

- National Environmental Policy Act (NEPA)
- State Environmental Policy Act (SEPA)
- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), Public Law 109-59
- Code of Federal Regulations (CFR) 23 Part 450
- CFR 23 Part 111 (Agreements relating to use of and access to rights-of-way-Interstate System)
- CFR 23 Part 134 (Metropolitan Transportation Planning)
- CFR 23 Part 135 (Statewide and Nonmetropolitan Transportation Planning)
- CFR 23 Part 710 (Right-of-Way Regulations for Federal Assisted Transportation Programs)
- Washington State Growth Management Act (Revised Code of Washington [RCW] 36.70A.070)
- Comprehensive Land Use Planning Act (Oregon Revised Statute [ORS] 197)

In addition to the laws and regulations identified above, analysis of the local transportation impacts was guided by the policy direction established in the numerous plans or policy documents adopted by jurisdictions within the project corridor. These include, but are not limited to:

- Washington Transportation Plan – 2040 and Beyond (Washington State Transportation Commission 2018)
- Washington State Department of Transportation (WSDOT) 2019–2022 Statewide Transportation Improvement Program (WSDOT 2019)
- VISSIM Protocol (WSDOT)
- Synchro and SimTraffic Protocols (WSDOT)
- SIDRA Policy Settings (WSDOT)
- Oregon Transportation Plan (Oregon Department of Transportation [ODOT] 2023e)
- ODOT Analysis Procedures Manual (ODOT 2023a)
- Comprehensive and Transportation Plans for the City of Vancouver and Portland, as well as Multnomah County
- 2018 Regional Transportation Plan (Metro 2018)
- Regional Transportation Plan for Clark County (RTC 2019)

2.2 Agency Coordination

The transportation planning and analysis process involved local jurisdictions, state agencies, federal agencies, transit agencies, metropolitan planning organizations (MPOs), and other interested parties.

2.2.1 Lead Agency

The Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) are the NEPA co-leads for development of the IBR Supplemental Environmental Impact Statement in accordance with NEPA regulations.

2.2.2 Cooperating and Partner Agencies

For development of this Transportation Technical Report, the IBR Program met with and/or provided opportunity for coordination with staff planners and engineers from the cooperating and participating agencies for this project:

- FHWA
- FTA
- WSDOT
- ODOT
- City of Vancouver
- City of Portland
- Oregon Metro
- Southwest Washington Regional Transportation Council
- Clark County Public Transportation Benefit Area (C-TRAN)
- Tri-County Metropolitan Transportation District (TriMet)
- Port of Vancouver USA
- Port of Portland
- Cowlitz Indian Tribe
- Confederated Tribes of Grand Ronde
- Confederated Tribes of Siletz Indians
- Colville Tribe
- Spokane Tribe of Indians
- Confederated Tribes of Warm Springs
- Confederated Tribes of the Umatilla Indian Reservation
- Nez Perce Tribe
- Confederated Tribes and Bands Yakama Nation
- Nisqually Indian Tribe
- Chinook Indian Nation

3. STUDY AREAS DEFINITION

The IBR Program analyzed transportation impacts over multiple study areas (inclusive of the IBR Program Area shown in Figure 1) to determine the IBR Program's impact on regional transportation, I-5 freeway operations, freight mobility and access, local intersection operations, transit, active transportation modes, and safety.

3.1 Regional Transportation

Regional transportation was analyzed for two areas. The first, larger area includes the entire Portland metropolitan region covered by the Metro/RTC regional travel demand model (see Figure 3). The second smaller traffic subarea, shown in Figure 4, is within the most densely developed areas of Portland and Vancouver, covering the triangle around I-5 from I-205 to I-84 on the west, I-205 from I-5 to I-84 on the east, and I-84 from I-5 to I-205 on the south. The traffic subarea allows for a more focused look at areas with the most potential impacts and benefits from the IBR Program that may be minimized when looking at the entire four-county region.

3.2 Interstate 5

Traffic volumes and congestion within and outside of the IBR Program Area influence each other, and these interactions were captured by analyzing a longer section of I-5. The *freeway analysis area* consists of a 17-mile section of I-5 (including the IBR Program Area) between the I-205 interchange north of Vancouver and the Marquam Bridge in Portland. No proposed roadway improvements are anticipated outside of the IBR Program Area as part of the IBR Program. There are 21 interchange areas in the freeway analysis area (including the 7 interchanges in the IBR Program Area). See Figure 5 for the freeway analysis area which includes 9 interchanges in Washington and 12 interchanges in Oregon:

- Washington I-5 interchanges
  - I-205/NE 139th Street
  - NE 134th Street
  - NE 99th Street
  - NE 78th Street
  - Main Street
  - SR 500/E 39th Street (IBR Program Area)
  - E Fourth Plain Boulevard (IBR Program Area)
  - Mill Plain Boulevard (IBR Program Area)
  - SR 14/City Center (IBR Program Area)
- Oregon I-5 interchanges
  - Hayden Island (IBR Program Area)
  - Marine Drive/NE Martin Luther King Jr. Boulevard (IBR Program Area)
  - N Interstate Avenue/N Victory Boulevard (IBR Program Area)
  - N Columbia Boulevard

- N Lombard Street
- N Rosa Parks Way
- N Alberta Street
- N Going Street
- I-405 (Fremont Bridge)/N Greeley Avenue
- Broadway/Weidler Street/NE Wheeler Avenue
- I-84
- SE Morrison Bridge

3.3 Freight Mobility and Access

Freight impacts used the Freeway Analysis Area as defined in Section 3.2.

3.4 Arterials and Local Streets

Intersections that were anticipated to be affected by the IBR Program, such as by a change in channelization or signal control, as well as those affected by changes in volume due to trips accessing the system were included in the analysis. The intersection analysis study area includes 80 intersections: 58 in Vancouver and 22 in Portland. The study intersections were determined based on reviewing the intersections analyzed as part of the CRC project, reviewing intersections potentially impacted by IBR Modified LPA design options, and through consultation with partner agency staff. The study area intersections are shown in Figure 6 and Figure 7.

Figure 3. Portland Metropolitan Model Region

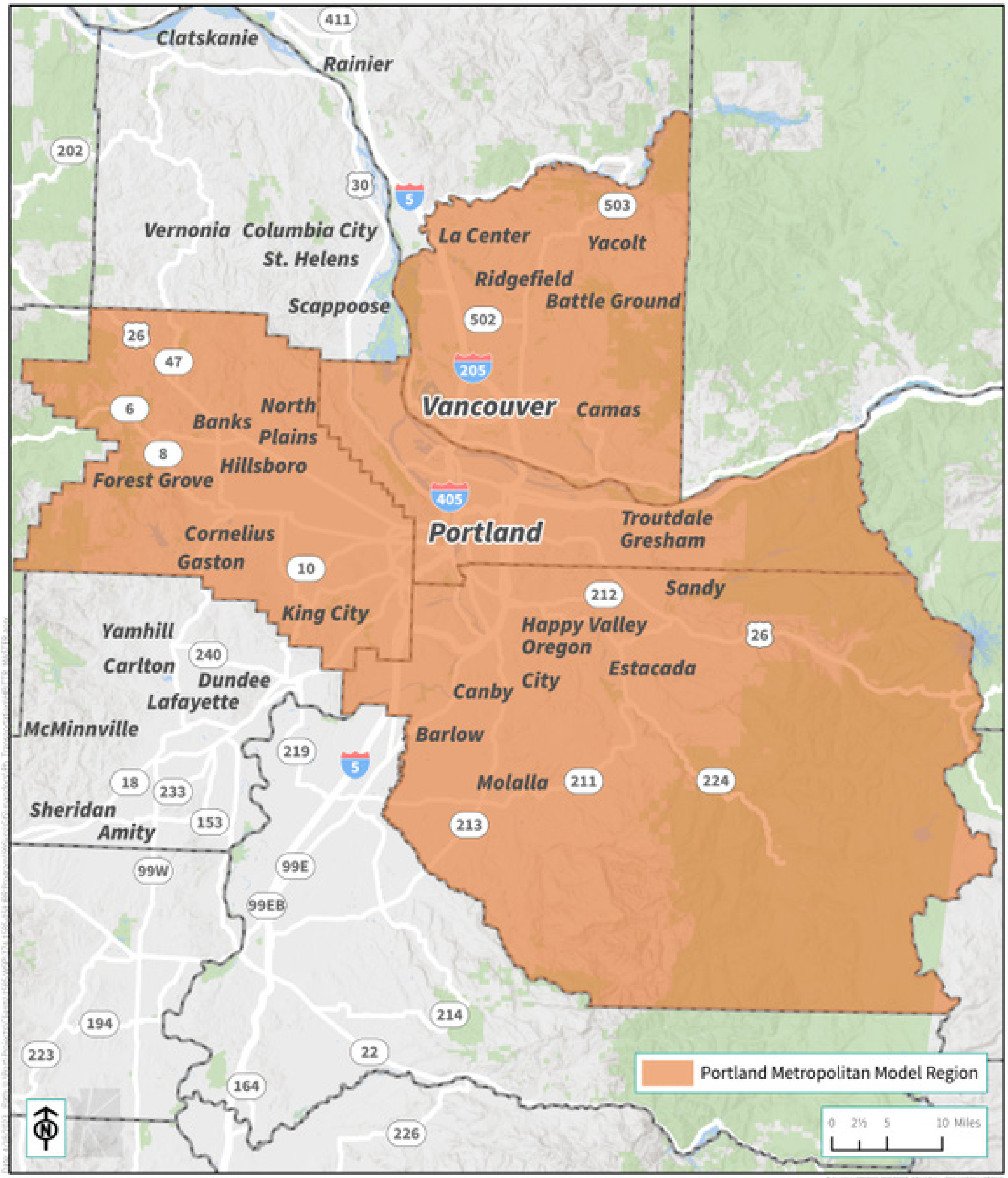


Figure 4. Traffic Subarea

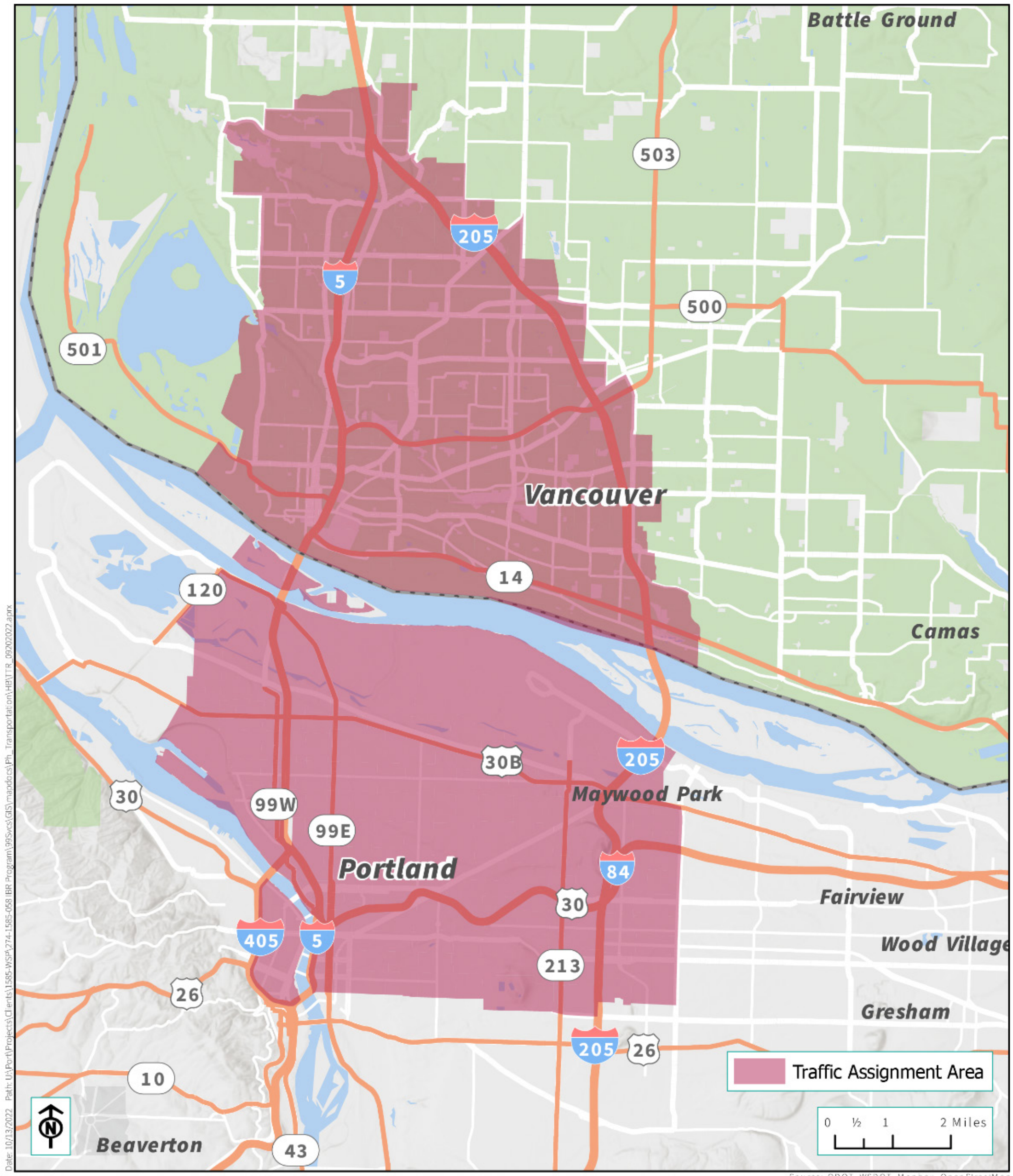


Figure 5. Freeway Analysis Study Area

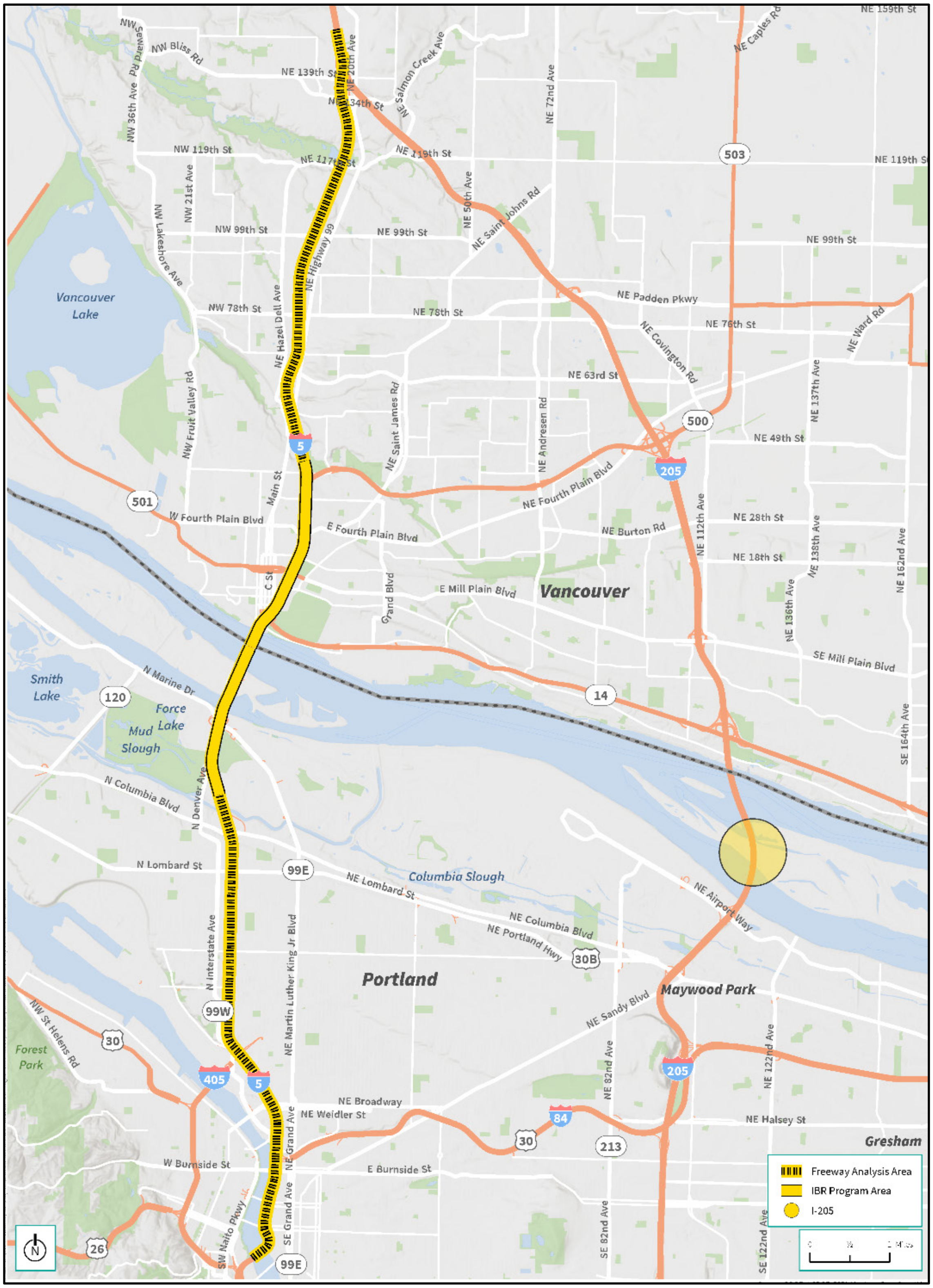


Figure 6. Intersection Analysis Study Area – Vancouver

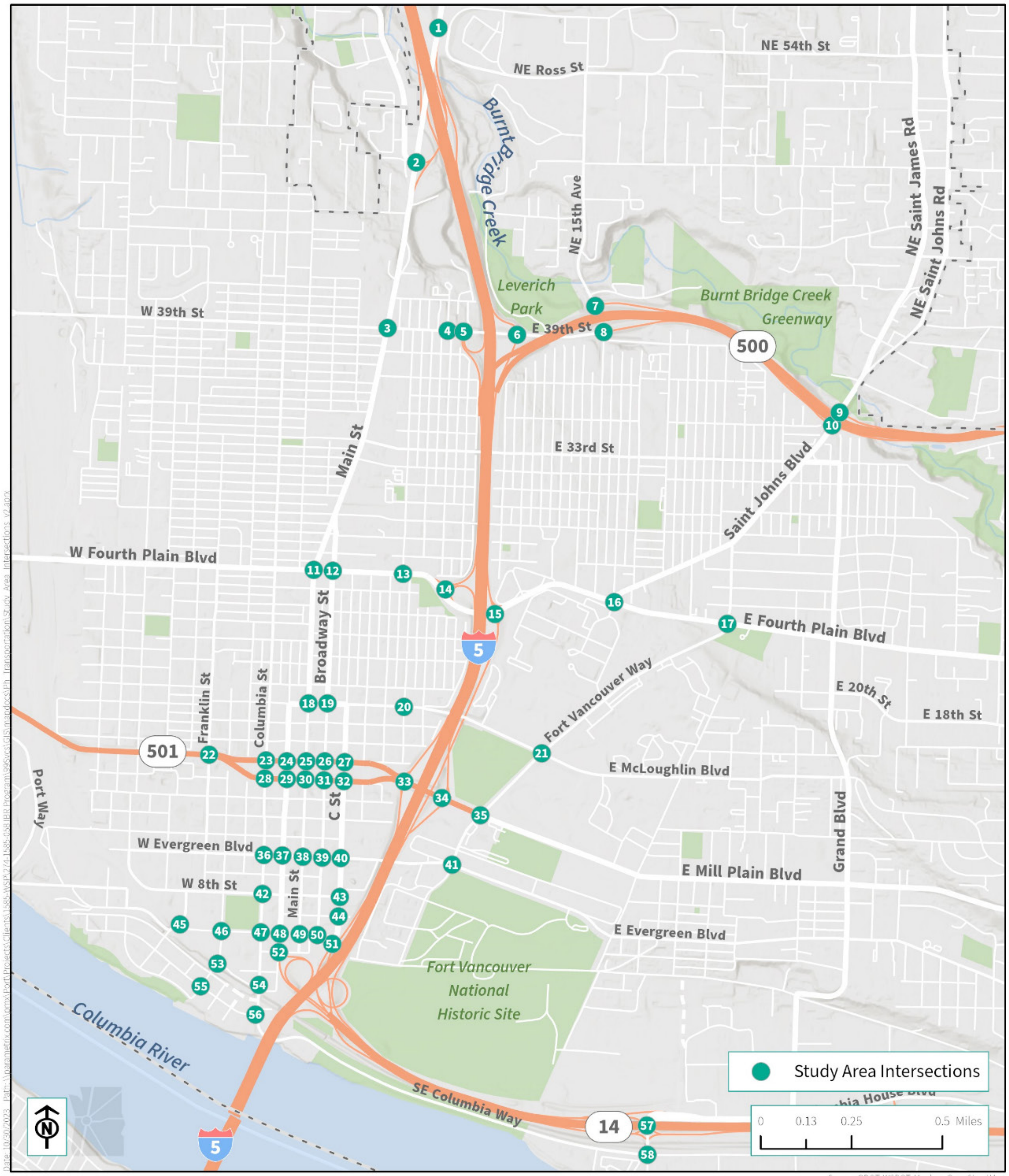
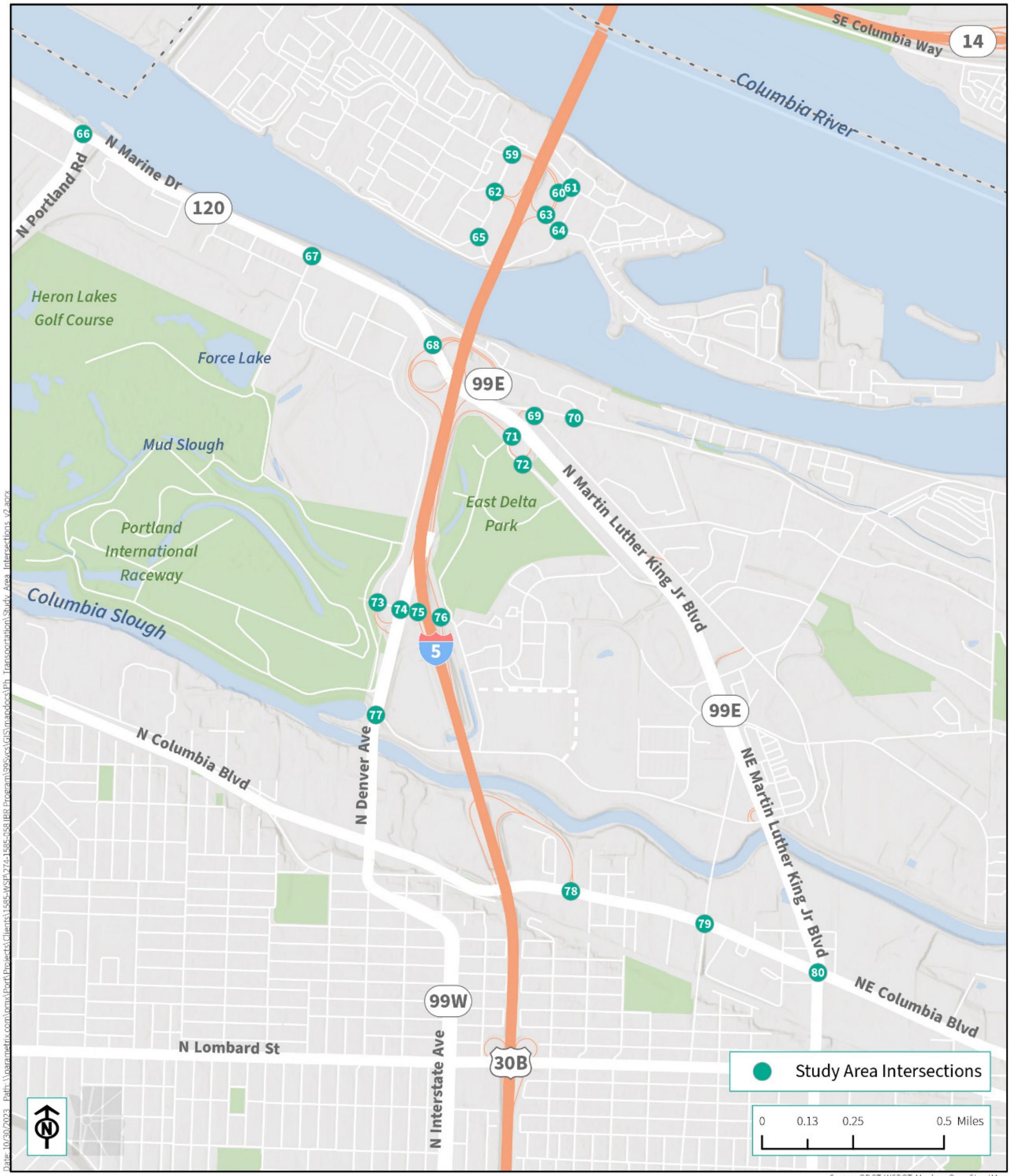


Figure 7. Intersection Analysis Study Area – Portland



3.5 Transit

The transit network anticipated to be affected by the IBR Program includes light-rail, express bus, bus rapid transit, and regional and local service operated by both TriMet and C-TRAN. The area these services operate in is the same as the traffic subarea shown in Figure 4 above. All cross-river transit lines as well as those that operate in north/northeast Portland and downtown Vancouver are included in this subarea and were evaluated for impacts.

3.6 Active Transportation

The active transportation network was evaluated within the IBR Program Area, as well as the travelsheds for walking, rolling, and biking. These travelsheds extend to over 3 miles beyond the IBR Program Area to account for local network conditions and the potential for active transportation modes to reach the Interstate Bridge from locations outside of the Program Area.

3.7 Safety

Historical crash data were reviewed and summarized for the IBR Program Area as well as within 250 feet of study intersections.

3.8 Tolling Analysis

To develop an understanding of the possible effects of tolling in conjunction with potential improvements to the I-5 Columbia River bridges, highway, and transit networks; average weekday traffic volumes using the I-5 Columbia River and I-205 Glenn Jackson Bridges were analyzed to understand diversion impacts for the Interstate Bridge and I-205 Glenn Jackson Bridge (see Figure 4). However, no traffic operations analysis was conducted for I-205 and the Glenn Jackson Bridge.

4. TRANSPORTATION ANALYSIS YEARS AND STUDY PERIODS

4.1 Existing Year Analysis

Transportation analyses generally incorporate the most recently available data. Due to the influence of the COVID-19 pandemic on travel patterns between 2020 and 2023, the IBR Program is following industry standards and trends observed over a long period of time rather than basing the analysis on short-term phenomena. Therefore, the IBR Program is using 2019 as the baseline year for most of the data presented in the existing conditions section of this report. The exception is outputs from the Metro/RTC regional travel demand model. Metro and RTC have not yet updated their base year model from 2015 to 2020. As a result, the regional travel demand model that supports the transportation analysis and metrics was calibrated to a base year of 2015. All Metro/RTC regional travel demand model outputs in this section summarize data that is from the Metro 2018 Regional Transportation Plan (Metro 2018) and 2019 RTC Regional Transportation Plan for Clark County (RTC 2019).

Recent counts in 2022 at the I-5 Interstate Bridge show similar volumes and patterns to the 2019 pre-covid volumes (see Section 1.4).

4.2 Future Year Analysis

The regional travel demand model that supports the transportation analysis and metrics for the future design year represents 2045 conditions.

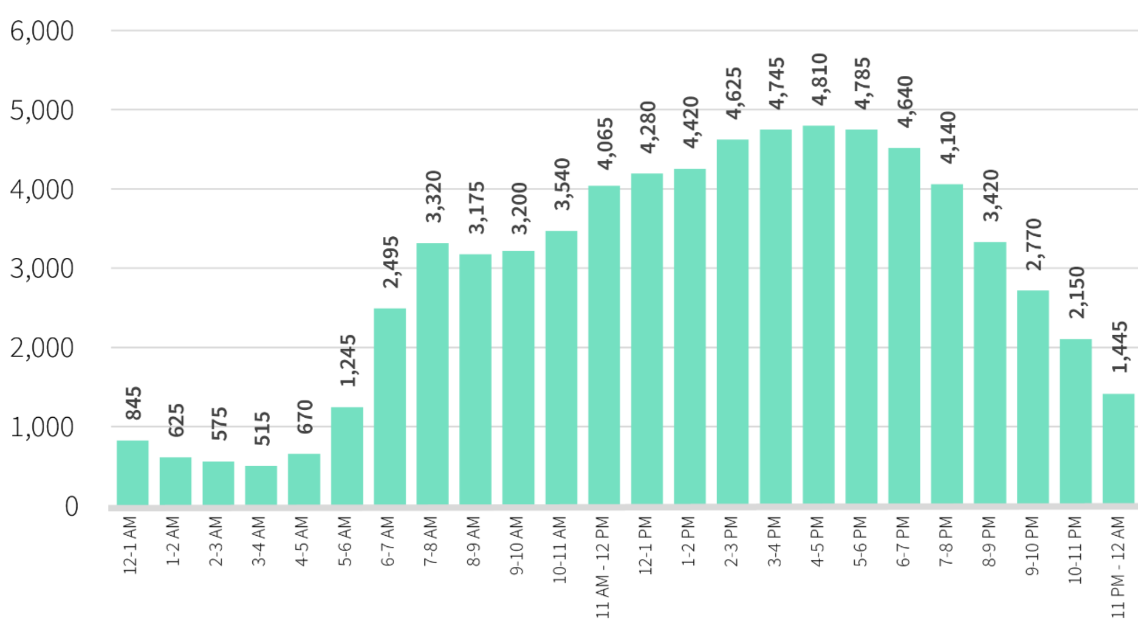
4.3 Analysis Periods

In existing year 2019, weekday travel patterns in the IBR Program Area follow typical commuter patterns with volumes peaking in the morning and afternoon peak periods. Travel in the IBR Program Area has a directional peak component, with heavy volumes and congestion in the southbound direction during the morning commute when many people travel from home to work, and heavy volumes and congestion in the northbound direction during the evening commute when many people travel from work to home. Average weekday 24-hour counts at the I-5 Interstate Bridge were collected to understand 24-hour profiles and peaking conditions. The I-5 Interstate Bridge hourly volume profiles for northbound and southbound are shown in Figure 8 and Figure 9, respectively. Based on the 24-hour profiles, the I-5 freeway operation analysis represents the weekday morning peak period from 6 to 10 a.m. and the evening peak period from 3 to 7 p.m.

While the study intersections also peak during the AM and PM peak periods, the durations of the intersection peaks are less than durations of the freeway peaks, so the data collection included only the peak 2-hour AM and PM periods.

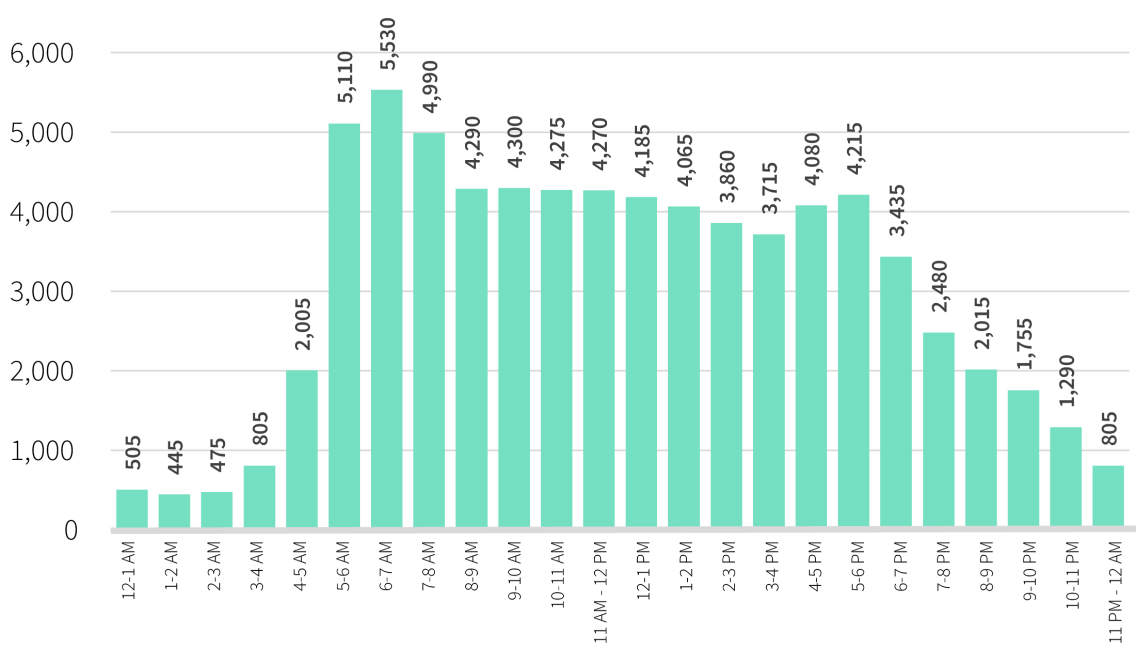
The geographic spread of the intersections being analyzed means that intersection volumes in different parts of the study area may peak at different times during the peak 2-hour AM and PM periods. Intersections were grouped based on proximity and *system peaks* were identified for each group. The intersection analysis was conducted for a single weekday AM peak hour and PM peak hour.

Figure 8. Interstate Bridge Hourly Profile – Northbound Average Weekday Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis.

Figure 9. Interstate Bridge Hourly Profile – Southbound Average Weekday Volumes (2019)



Source: WSDOT and ODOT Traffic Counters, IBR Analysis.

5. AFFECTED ENVIRONMENT DATA COLLECTION

A variety of data was assembled to analyze the transportation-related effects of the IBR Program. The range of data collected was similar to the range of data that was collected for the CRC project. The data collected to support the IBR Program were compared to data previously collected for the CRC project to understand how the transportation system has changed over the past 10 to 15 years. These comparisons provided insight as to how proposed improvements would operate with the revised travel patterns.

The detailed data collection plan (included in Attachment A) was developed to ensure that quality and comprehensive transportation data were collected. Due to the influence of the COVID-19 pandemic on travel patterns between 2020 and 2023, the IBR Program is following industry standards using 2019 as the baseline year for most of the data presented in the existing conditions section of this report. The exception is outputs from the Metro/RTC regional travel demand model. Metro and RTC have not yet updated their base year model from 2015 to 2020. As a result, all Metro/RTC regional travel demand model outputs in this section summarize 2015 data that is from the Metro 2018 Regional Transportation Plan (Metro 2018) and 2019 RTC Regional Transportation Plan for Clark County (RTC 2019).

The IBR Program team documented existing conditions for each element of the transportation system evaluated in the Transportation Technical Report. Existing conditions information is both quantitative and qualitative and is documented both graphically and in a tabular format as appropriate. Specific information about existing conditions information includes the following:

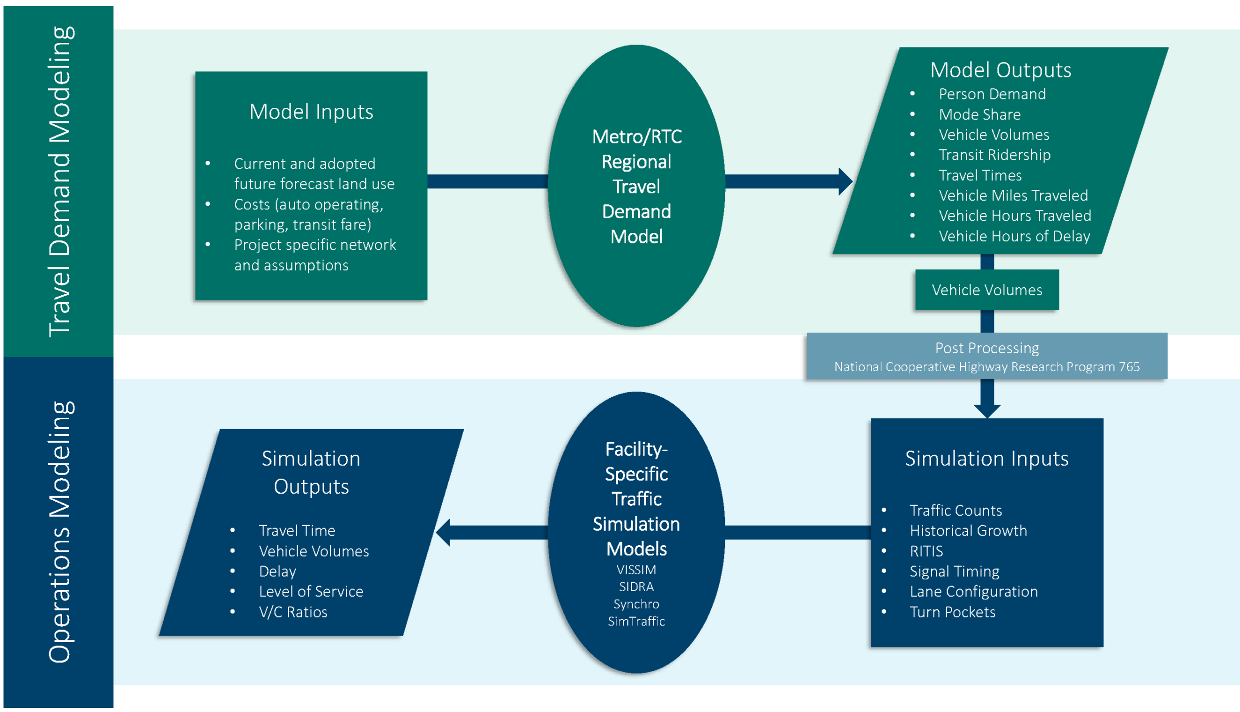
- Roadway characteristics: functional use, lane geometry, traffic signal timings and phasing patterns, ramp meters, speed limits, etc., for facilities analyzed within the Program Area.
- Regional travel measures including vehicle miles traveled (VMT), vehicle hours traveled (VHT), and vehicle hours of delay (VHD).
- Screenline summary information.
- Traffic counts: daily and hourly freeway and ramp volumes for all modes (general purpose [GP], freight, transit, and high-occupancy vehicle [HOV]), ramp-to-ramp origin-destination data, and AM and PM peak hour intersections counts, including heavy vehicle percentages and nonmotorized volumes at identified Program Area intersections.
- Speeds and Travel Times: hourly freeway speeds
- Freight: freight routes and over-dimension routes, freight data statistics, and freight volumes were collected.
- Bridge lift and maintenance data from 2012 through 2023.
- Transit: existing and future transit service levels, travel times, facilities (e.g., park and ride), routing, and ridership information in the study area from C-TRAN and TriMet.
- Pedestrian and bicycle volumes on the Interstate Bridge and at study intersections. Existing and planned pedestrian and bicycle facilities in the Program Area were inventoried. This inventory included identification of any barriers to pedestrian or bicycle travel.
- Crash data between 2015 and 2019 within the Program Area, including the local street networks of Vancouver and Portland.
- Travel Demand Management and Transportation System Management programs.

6. TRAVEL DEMAND FORECASTING

6.1 Travel Demand Model and Post-Processing

This section describes the travel demand modeling and post-processing that were used to conduct the 2045 Horizon Year transportation forecasts. Figure 10 shows the connections between different models.

Figure 10. Regional Model and Operational Model Flow Chart



The two MPOs within the study area—Metro and RTC—maintain a single regional travel demand model: the regional travel demand model. The MPOs prioritize consistency in all modeling efforts in the region and for this and all other travel demand modeling efforts in the region, Metro codes and runs the model, providing resulting outputs to partner agencies and consultants for their use in analysis on projects. The regional travel demand model is a macroscopic trip-based travel demand model that estimates person-trips for all modes and roadway network vehicle demand for each hour of a 24-hour average weekday. The model was developed using household survey information for the region, along with other underlying travel data, including population, employment, and costs (e.g., parking, transit, auto operating costs) that was coordinated between the MPOs for use in the model. This coordinated regional travel model maintained by Metro with support from RTC was the basis for forecasting efforts for the IBR Program.

The model used for this work was originally developed for the 2018 Regional Transportation Plan (2018 RTP), jointly developed and adopted by Metro in 2018 and RTC in 2019, representing model years 2015 and 2040. The initial 2045 network and land use inputs were developed for another major project in the area, and further refined for this project. The 2045 model used the 2040 Financially Constrained network from the 2018 RTP. Land use inputs were extended from the 2040 forecast to

2045, through a process coordinated by the MPOs that considered comprehensive plans and other information supplied by their member jurisdictions. In addition, transit capacity constraints were added to the model to better represent feasible transit ridership relative to transit investments described in the 2018 RTP.

The transit capacity constraints were added because the 2018 RTP model generated estimates of transit ridership across the system that could only be supported in practice with additional capital investment projects beyond those present in the 2018 RTP. While it is likely that those investments, which are already being identified, will be programmed and implemented by the 2045 design year, the decision was made for the IBR Project analysis to limit transit ridership to the carrying capacity of the system as described in the 2018 RTP. Details for the development of the 2045 No-Build Alternative and Modified LPA Alternative are provided below.

Base year and future year forecasts for traffic volumes and transit ridership are described below.

The regional travel demand model uses a four-step process:

1. **Trip generation** determines the location, magnitude, and purpose of trip-making based on land use and socioeconomic input data.
2. **Destination choice** identifies origin and destination travel patterns by calculating trip costs and travel times as well as accounting for available modes at the destination zone.
3. In **mode choice**, trips are sorted into the various vehicle, transit, walk, and bike modes.
4. Through **trip assignment**, routing paths for vehicle and transit trips are determined for individual hours throughout the day.

The regional travel demand model includes calculations to estimate the impact of tolling in the region. These toll calculations are present in destination choice, mode choice, and trip assignment and are documented in the Travel Demand Modeling Methods Report (Appendix H to the Transportation Technical Report) along with additional details on model estimation, calibration, and validation.

Based on 2045 demand forecasts from the regional travel demand model, horizon year 2045 volumes for the IBR Program were developed following industry standard post-processing steps. Post-processing is a standard technique used to forecast future traffic volumes by adjusting for the differences in traffic volumes between the observed base year traffic volumes and the traffic volumes simulated by the regional travel demand model. Industry-standard post-processing procedures are outlined in the National Cooperative Highway Research Program Report 765 – Analytical Travel Forecasting Approaches for Project-Level Planning and Design published by the National Academy of Science's Transportation Research Board.

The general post-processing approach applied to the IBR Program is as follows:

- Calculate the growth rate between the existing base year 2015 travel demand model and the horizon year 2045 travel demand model (30 years of growth) for I-5 mainline segments, I-5 ramps within the freeway analysis area, and for local roadways in the intersection analysis area.

- The 30 years of growth was then factored to 26 years as that is the difference between the 2019 existing counts and future horizon year of 2045.
- The factored 26-year growth was then added to the existing 2019 count data to estimate 2045 weekday volumes.

6.2 Future Year 2045 No-Build Alternative

The 2045 No-Build Alternative includes adopted land use growth and highway, transit, and active transportation projects from the state, regional, and surrounding local agencies' transportation plans. Additional details on land use, highway networks, and transit networks that are part of the 2045 No-Build Alternative are included in the Travel Demand Modeling Methods Report and its attachments (Appendix H to the Transportation Technical Report). All projects in the network are assumed to be built and in place before the 2045 Horizon Year. The list of background projects provides valuable insight into how the transportation system within and surrounding the IBR Program Area would change from existing conditions. These projects may directly affect transportation conditions, such as altering travel patterns, affecting roadway operations and safety, and influencing nonmotorized access and connections. The sources for developing the background project list include:

- Oregon Metro's Regional Transportation Plan – 2018 (Metro 2018)
- Regional Transportation Council's Metropolitan Transportation Plan – 2019 (RTC 2019)

The horizon year conditions include state, regional, and local agency projects that are reasonably foreseeable, in an officially adopted plan, and have either completed environmental review or are funded or permitted.

The 2045 No-Build Alternative includes all the projects in place for the region, minus the highway and transit components of the IBR Program. In addition to the physical network elements, it is assumed that tolling would not be in place on the Interstate Bridge in the No-Build Alternative.

6.3 Future Year 2045 Modified LPA Alternative

The regional travel demand model was run for the horizon year 2045 for the Modified LPA. The Modified LPA improvements to the IBR Program Area include additional auxiliary lanes, high-capacity transit extension from the Expo Center in Portland to downtown Vancouver, active transportation improvements, and variable-rate tolling. Costs of operating an auto used in the model considered relevant tolls and driving fees. Additional details around each of these items are documented in the Travel Demand Modeling Methods Report and its attachments (Appendix H to the Transportation Technical Report).

7. IDENTIFICATION OF IMPACTS

7.1 Introduction

This chapter describes the tools, processes, and criteria that were used to identify impacts caused by the implementation of the IBR Program compared to the future No-Build Alternative across multiple modal categories. Some of the criteria align with the performance standards of the partner agencies, but other metrics were added or modified to better evaluate whether the IBR Program is meeting the project purpose and need.

The analysis and measures in this section are presented by the specific modal category that are documented in the Transportation Technical Report. Table 1 below summarizes the modal categories, transportation tools used if applicable, and transportation analysis evaluation measures which are both quantitative and qualitative. More details on the evaluation measures are provided in the sections below.

Table 1. Transportation Evaluation Measures by Modal Category

Modal Category	Transportation Tool (if applicable)	Evaluation Measure
Regional Transportation	Regional Travel Demand Model (EMME software platform)	Vehicle demand, person demand, total average weekday vehicle miles traveled, average weekday vehicle hours travelled, average weekday vehicle hours of delay, screenline volumes in vehicle demand.
Interstate 5	VISSIM	Density, V/C ratios, hours of congestion, speeds, travel times, demand volumes, person throughput.
Freight Mobility and Access	Regional Travel Demand Model (EMME software platform), VISSIM, Synchro	Freight volumes, travel patterns, travel times, speed, and throughput.
Bridge Lifts and Gate Closures	N/A	Qualitative description of bridge lifts and gate closures and their impact on traffic operations.
Arterials and Local Streets	Synchro, SimTraffic, SIDRA	Synchro – V/C ratios (used for all intersections, HCM 2000 for signalized intersections, HCM 6th Edition for unsignalized intersections) SimTraffic – Delay, level of service, queue lengths (all non-roundabouts) SIDRA – Delay, level of service, V/C ratios, queue lengths (all roundabouts)
Transit	Regional Travel Demand Model (EMME software platform), VISSIM, qualitative analysis	Ridership forecasts, transit travel times, transit operating characteristics, transit capital facilities, operating revenue and expenses, travel demand and mode choice, transit service characteristics, travel times, reliability, ridership, safety and security, trip generation at transit stations.
Active Transportation	N/A	Pedestrian access and circulation, identification of active transportation facilities, physical and perceived barriers, bridge travel times for people walking and biking, Bicycle Level of Traffic Stress.
Safety	ISATe	Percentage difference of predicted crash frequency outputs.

Modal Category	Transportation Tool (if applicable)	Evaluation Measure
Tolling	Regional Travel Demand Model Volumes/Post-processed	Quantitative diversion summary of Interstate Bridge and I-205 Glenn Jackson Bridge volumes.
Travel Demand Management and Transportation System Management	N/A	Qualitative discussion on key programs for travel demand management and transportation system management.

Source: IBR Analysis

7.2 Regional Transportation

7.2.1 Analysis Tools

7.2.1.1 Regional Travel Demand Model

The starting point for regional transportation analysis was the regional travel demand model, calibrated and validated to the year 2015, which is the basis for both the 2018 Metro and the 2019 RTC adopted regional transportation plans. The regional travel demand model was adjusted to represent 2045 conditions for the IBR project as described in Appendix H. This model was used to develop vehicle volume and transit forecasts that result from a future year transportation network and other associated inputs such as land use and costs (parking, auto operating, tolling) with and without the proposed IBR Program. Highway and transit assignments were run in the EMME software platform, and transportation performance measures were developed. The EMME software platform assigns regional vehicle demands developed in the regional travel demand model to a transportation network using an equilibrium assignment. The vehicle assignment results in roadway link volumes that optimize paths so that no traveler can achieve additional travel time savings by changing routes. The software itself is used to edit highway networks, assign trips, develop travel times, analyze data, display and plot results, and import and export data.

7.2.2 Evaluation Measures

The regional travel demand model developed for the IBR Program provided VMT, VHT, VHD for the two regional study areas shown in Figure 3 and Figure 4.

The following measures, and the extents where they were evaluated, are summarized below:

- Vehicle demand (screenline totals and differences in the Program Area to understand diversion). This measure uses total vehicle demand on links as output from assignments completed in the regional travel demand model. Vehicle demand includes single-occupancy vehicles (SOV), HOV, medium trucks, and heavy trucks.
- Person demand (screenline at river crossing). This measure converts vehicles to person-trips by adding together SOV vehicles, medium trucks, and heavy trucks along with total HOV person-trips that are calculated from the regional travel demand model (total HOV vehicles divided by total HOV drivers + passengers).

- Total average weekday VMT on the regional highway system (regional extents). This measure uses total vehicle demand on links as output from assignments completed in the regional travel demand model. Vehicle demand includes SOV, HOV, medium trucks, and heavy trucks. Vehicle demand on each link is multiplied by the length of the link to arrive at VMT. This calculation is completed for each individual hour of the 24-hour day and added together to get a daily total. For regional calculations, all links in the region are used in the calculations. For subarea calculations, a flag is included on links that fall into the subarea and the VMT is summarized for only that subset of links.
- Total average weekday VHT on the regional highway system (regional extents). This measure uses total vehicle demand on links as output from assignments completed in the regional travel demand model. Vehicle demand includes SOV, HOV, medium trucks, and heavy trucks. Vehicle demand on each link is multiplied by the travel time on the link to arrive at VHT. This calculation is completed for each individual hour of the 24-hour day and added together to get a daily total. For regional calculations, all links in the region are used in the calculations. For subarea calculations, a flag is included on links that fall into the subarea and the VMT is summarized for only that subset of links.
- Total average weekday VHD on the regional highway system (regional extents). This measure uses total vehicle demand and travel times on links as output from assignments completed in the regional travel demand model. Vehicle demand includes SOV, HOV, medium trucks, and heavy trucks. The starting point for this measure is a calculation of the volume to capacity (V/C) ratio which measures how congested a link in the network is given the number of vehicles that are assigned to it and its assumed capacity for carrying those vehicles. The V/C ratio is calculated for all links in the regional travel demand model for each individual hour of a 24-hour average weekday using regional travel demand model output assignments. The travel times for the final assignments are compared to travel times on links in the network that result if a link is over a V/C ratio of 0.90. The resulting time difference is the vehicle hours of delay. This calculation is completed for each individual hour of the 24-hour day and added together to get a daily total. For regional calculations, all links in the region are used in the calculations. For subarea calculations, a flag is included on links that fall into the subarea and the VHD is summarized for only that subset of links.

In addition to regional outputs, screenline data were summarized. Screenlines are imaginary lines drawn across one or more roadways to compare aggregate changes in traffic conditions. Screenline data were summarized for the traffic subarea shown above in Figure 4. Information was generated for the AM and PM peak hour at each screenline shown in Figure 11 for Vancouver and Figure 12 for Portland. Other outputs were aggregated at a regional level.

The regional travel demand model was also used to develop transit ridership estimates. These evaluation measures are described in section 7.7.

Figure 11. Vancouver Screenlines

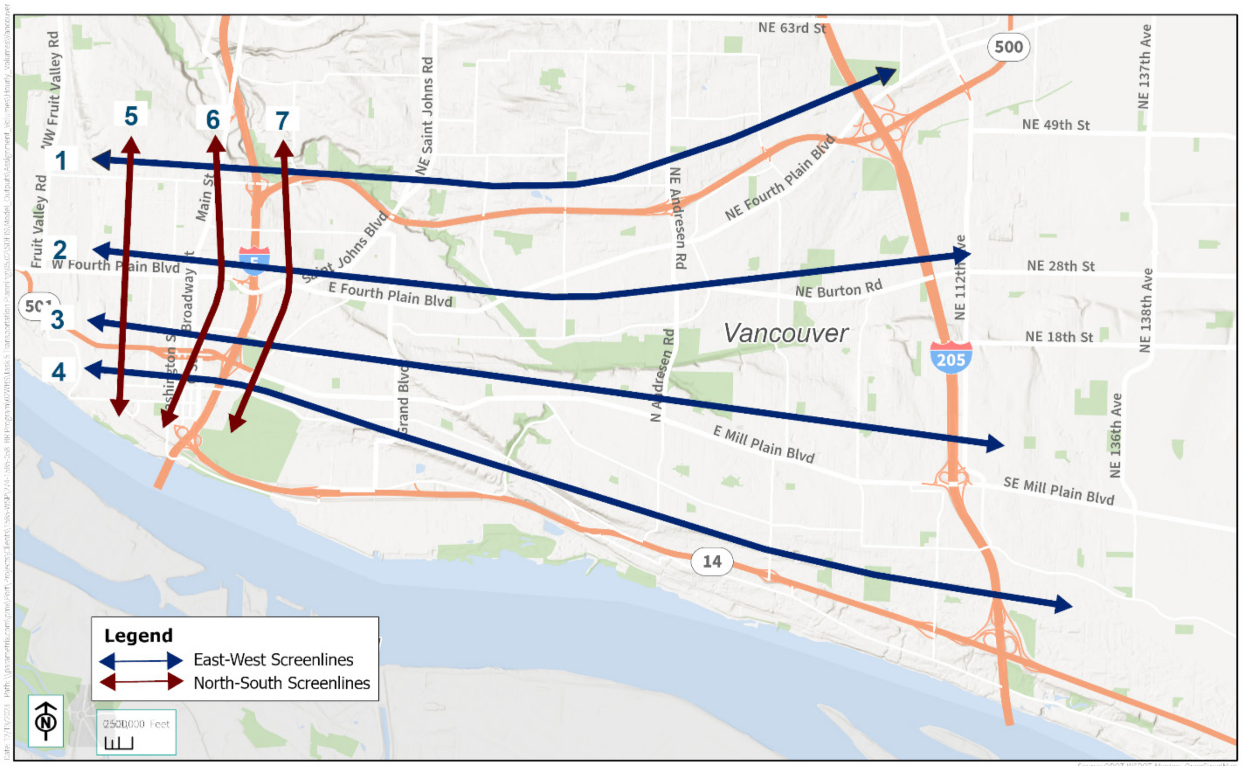
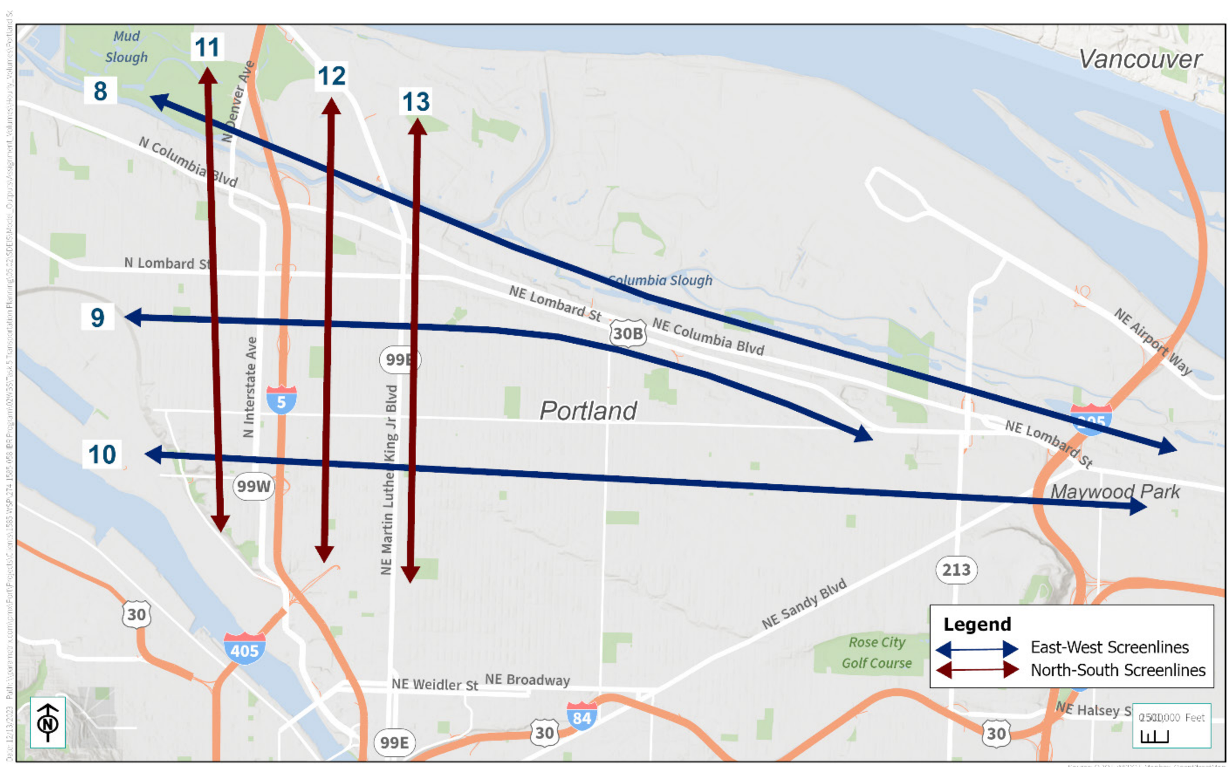


Figure 12. Portland Screenlines



7.3 Interstate 5

7.3.1 Analysis Tools

Freeway performance analysis was completed using VISSIM, a microscopic simulation software for modeling and analyzing multimodal transportation systems. VISSIM models individual vehicles on the transportation network. Each vehicle interacts with the vehicles around it and with network elements (such as signals and stop signs) as it travels through the network. The freeway analysis includes basic mainline sections and merge, diverge, and weaving areas in the freeway analysis area.

- Basic Freeway Segments. A basic freeway segment is outside the influence area of any merge, diverge, or weaving areas of the freeway.
- Merge Freeway Segments. Segments in which two or more traffic streams combine to form a single traffic stream.
- Diverge Freeway Segments. Segments in which a single traffic stream divides to form two or more separate traffic streams.
- Weaving Freeway Segments. Segments in which two or more traffic streams cross paths along a length of freeway. Typically formed with a diverge segment closely follows a merge segment.

The freeway analysis area includes basic freeway segment, merge, diverge, and weaving freeway segments. Ramp meters at on-ramps were included in the VISSIM model, including planned future on-ramp ramp meter installations. At off-ramps, the signalized approach at the end of the off-ramp was included in the VISSIM model. The network coding within the VISSIM software was built based on existing aerial imagery for the existing and future No-Build conditions and the plan sheets for the Modified LPA.

The freeway analysis included GP traffic, HOV traffic, transit, and freight operations. Metrics such as travel time, speeds, density, and volumes were collected for each individual mode of travel, and differences between passenger car and freight travel patterns were accounted for. Transit routes and schedules provided by C-TRAN and TriMet were coded in the model.

The VISSIM model development and analysis was based on the guidelines outlined in the WSDOT VISSIM Protocol and the ODOT Analysis Procedures Manual (APM). The analysis included the 4-hour AM and 4-hour PM peak periods with an additional 1-hour seeding period prior to the 4-hour analysis period. The VISSIM model was calibrated to reflect existing year 2019 travel times, speeds, and throughput volume across the Interstate Bridge, as documented in Transportation Technical Report Appendix C, VISSIM Confidence and Calibration Report.

7.3.2 Agency Performance Standards

Highway segment performance standards differ by agency within the study area. WSDOT and ODOT have performance thresholds which are applied to sections of I-5 based on jurisdiction. The individual agency thresholds are summarized below.

7.3.2.1 WSDOT Performance Standards

WSDOT sets level of service (LOS) standards for Highways of Statewide Significance under WSDOT jurisdiction. The performance standard for I-5 north of the Columbia River is LOS D.

7.3.2.2 ODOT Performance Standards

ODOT references the Oregon Highway Plan (OHP; ODOT 2023d) for highway mobility standards on state highway sections. These highway mobility standards are applied to existing conditions and future No-Build conditions. Future build conditions performance targets are documented in the ODOT *Highway Design Manual* (HDM; ODOT 2023b). Highway mobility standards and performance targets were developed as a method to gauge reasonable and consistent standards for traffic flow along state highways. Mobility standards and performance targets are set with V/C ratios.

I-5 is a state highway under ODOT's jurisdiction within the Portland UGB. I-5 south of the Columbia River between the Interstate Bridge and the Marquam Bridge has a performance standard of a V/C ratio of 1.1 for the first hour and 0.99 for the second hour. These performance standards apply to existing and No-Build conditions.

The HDM states the performance target for the build condition as 0.75 as the V/C performance target.

7.3.3 Evaluation Measures

Output from the VISSIM model for general purpose traffic, freight traffic, and transit was the key data source for determining the impacts the Modified LPA would have on the freeway network. The following measures were used to assess freeway performance:

- **Density.** Number of vehicles per lane-mile of vehicles traveling through a given freeway segment. This measure used output from the VISSIM model was recorded at all I-5 mainline segments and collector-distributor (CD) roadway segments in the IBR Program Area. The density output from the VISSIM model is not calculated the same way that that density is calculated using the HCM procedures, but the density output from the VISSIM model can be used to compare operational performance across alternatives.
- **V/C ratios.** The ratio of the throughput volume at a given roadway segment to the capacity of the roadway segment was estimated[1] for freeway segments and CD roadways in the

[1] The Highway Capacity Manual (HCM) outlines a process for estimating the capacity of a freeway segment. The process begins by assuming an ideal capacity of 2,400 passenger cars per hour per lane (pc/h/ln), and then applies factors based on free-flow speed, freight mix as well as geometric elements including lane and shoulder widths, percentage of commuter drivers (understanding of the area), and interchange spacing. The application of these factors decreases the ideal capacity below 2,400 pc/h/ln. Applying the HCM process to roadways in the IBR Program Area results in estimated capacities between 2,100–2,200 pc/h/ln, approximately 10 to 15 percent less than the ideal capacity.

However, the highest throughput across the Interstate Bridge (the primary bottleneck in the study area) as well as the ramp terminals just north and south of the Interstate Bridge ranges between 1,550 and 1,850 pc/h/ln. This indicates that the capacity of the Interstate Bridge is near 1,550 to 1,850 pc/h/ln, The HCM capacity estimates of 2,100 to 2,200 pc/h/ln are 20 to 30 percent higher than the capacity of the Interstate Bridge, indicating that the HCM model is not an appropriate analysis tool in this case. The HCM process is not accounting for factors that would further reduce the ideal capacity. Some possible contributing factors not accounted for by the HCM process include the influence of limited sight distance across and approaching the Interstate Bridge, closely spaced interchanges, short merge, diverge, and weaving distances.

IBR Program Area. This measure used output from the VISSIM model. V/C ratios are not a direct output from the VISSIM model, so the V/C ratios were estimated based on the modeled density at each link in the VISSIM model. The capacity of the link was based on the HCM thresholds of 45 pc/mi/ln for basic freeway segments, 43 pc/mi/ln for weaving, merge and diverge segments, and 40 pc/mi/ln for CD roadway segments. Depending on the density, links were assigned a range of V/C ratios from one of the following categories which allowed operations performance to be compared with ODOT freeway standards (see Table 2).

Table 2. Roadway V/C Ratio and Densities by Segment Type

V/C Ratio	Basic Freeway Segment Density (veh/mi/ln)	Weave, Merge, Diverge Segment Density (veh/mi/ln)	CD Roadway Segment Density (veh/mi/ln)
< 0.25	< 11	< 11	< 10
0.25–0.50	11–23	11–22	10–20
0.50–0.75	23–34	22–32	20–30
0.75–0.80	34–36	32–34	30–32
0.80–0.90	36–41	34–39	32–36
0.90–1.0	41–45	39–43	36–40
1.0–1.1	45–50	43–47	40–44
> 1.1	> 50	> 47	> 44

veh/mi/ln = vehicles per mile per lane

- **Hours of congestion.** The duration bottleneck locations operate at speeds less than 45 mph. This measure used speed output from the VISSIM model to estimate the length of time that freeway speeds at a given bottleneck are below 45 mph during the 4-hour peak periods. Outside of the 4-hour peak periods, demand volume was used to estimate the length of time a given bottleneck identified in the VISSIM model would remain over capacity beyond the 4-hour peak period.
- **Speeds.** The average speed of vehicles on a segment of freeway or CD roadway during a specified time. Speeds on each freeway segment are reported in 15-minute time intervals throughout the modeled 4-hour peak periods for the 17-mile freeway analysis area. This measure used output from the VISSIM model to develop heat maps for comparing the impact of bottlenecks between alternatives.
- **Congestion Index.** An aggregated measure indicating the level of congestion in the freeway analysis area during the 8 peak hours, including the 4-hour AM peak and the 4-hour PM peak. This measure used speed output from the VISSIM model and created a simple, one-dimensional summary of the level of congestion in each alternative for comparison across alternatives.
- **Travel times.** The time it takes to travel through various segments of the corridor during a specified time period. This measure used output from the VISSIM model for freeway segments in the freeway analysis area over 1-hour time intervals during the modeled 4-hour peak periods. The travel time in the freeway analysis area is reported for each hour of the 4-hour AM

and PM peak periods and the average travel time is reported during the peak 2 hours. (The peak 2 hours occur within the modeled 4-hour peak periods).

- **Vehicle Demand volume.** The number of vehicles crossing the Columbia River bridges (passenger cars, freight trucks, buses). This measure used the post-processed volume forecasts developed using existing count data for the existing year 2019, and the growth from the regional travel demand model
- **Person volume.** The number of people crossing the Columbia River bridges daily in all modes (GP, HOV, transit). This measure was calculated by applying average vehicle occupancy counts to vehicle forecasts described above. See the data collection plan (Attachment A to this report) for recent average vehicle occupancy counts.

As noted above, multiple modes were directly modeled in VISSIM, including GP traffic, HOV, bus, and freight traffic.

7.4 Freight Mobility and Access

Freight impacts were qualitatively and quantitatively assessed. The qualitative assessment focused on truck movement and truck routing impacts. This assessment of truck-related issues focused on designated major truck routes and truck service areas, as well as on access to these facilities and areas.

Quantitative freight traffic impacts were based on the VISSIM model output, which included freight-specific travel times, speeds, and throughput. Freight growth came from the regional travel demand model which included a truck model component used to develop trip tables for assignment to the regional network.

7.4.1 Evaluation Measures

The following measures were used to evaluate freight impacts. Measures for assessing these elements were both quantitative and qualitative, and results are displayed both graphically and in a tabular format as appropriate.

- **Freight Tonnage (Quantitative).** Amount of tonnage transported via various freight modes in Washington and Oregon. Data taken from the *Washington State Freight System Plan* (2022b) and the *Oregon Freight Plan* (2023c).
- **Truck Freight Tonnage (Quantitative).** Percentage of all modal freight tonnage transported via truck.
- **Truck Volumes (Quantitative).** Truck volume growth from existing to future conditions across Washington, Oregon, and specifically across the Interstate Bridge crossing. Discussion of truck volume peaking in comparison to GP traffic patterns.
- **Truck Travel Patterns/Truck Miles (Qualitative).** Truck movement, truck routing, and origin-destination information across the Vancouver-Portland metropolitan area as summarized. This information was obtained from Program partners.
- **Freight Mobility, Access, and Safety (Qualitative).** Qualitative discussion of projects from the 2018 RTP that are financially constrained in the Program Area related to freight mobility, access, and safety.

- **Truck Delay (Quantitative).** Discussion of truck delay subject to the same delays as GP traffic on I-5 and arterial and local streets.
- **Truck Impacts from Tolls (Qualitative).** Discussion of truck value of time in consideration with interstate tolls in the area.
- **Oversized Vehicle/Load Crossings (Qualitative).** Identification of important oversized load transport routes and their potential impacts from the Modified LPA Design.

7.5 Bridge Lifts and Gate Closures

Impacts associated with bridge lifts and gate closures were quantified, and future impacts were quantified for impacts for different alternatives.

7.6 Arterials and Local Streets

7.6.1 Analysis Tools

The operations analysis for the study intersections used the software programs Synchro (version 11) for signalized and unsignalized intersections and SIDRA (version 9) for roundabout-controlled intersections. Synchro was used to summarize overall intersection V/C ratios, while SimTraffic outputs included average intersection delay and LOS. Roundabouts were evaluated consistent with the WSDOT SIDRA Policy and Settings.

7.6.1.1 Synchro/SimTraffic

Synchro is a macroscopic analysis and optimization program that is used to analyze intersections on the local network and optimize future year signal timing plans. Synchro applies the methodologies outlined in the *Highway Capacity Manual* (HCM; National Academies of Sciences, Engineering, and Medicine 2022) to calculate metrics related to intersection operations such as delay and LOS, V/C ratios, and queues.

SimTraffic is a companion software to Synchro that applies microsimulation modeling techniques to the network defined in the Synchro model. Similar to VISSIM, SimTraffic models individual vehicle interactions through time on the transportation network, and captures the dynamic interaction of closely spaced intersections, congestion and queue spillback when calculating intersection delay, LOS, queues, travel times, and speeds. This is in contrast to Synchro, which uses static input and output metrics, which do not fully account for congestion and spillback between intersections.

Synchro's percentile delay method was used to calculate V/C ratios at intersection approaches and movements and to inform lane configuration needs for the Modified LPA. Synchro's macroscopic analysis methods do not always fully account for the operational impacts from closely spaced intersections, which can influence delays and queues. To address this limitation, SimTraffic was used to estimate intersection delay, LOS, queue lengths, and speeds along corridors.

The Synchro and SimTraffic models used to analyze traffic operations for the IBR Program were developed based on the guidelines outlined in WSDOT's Synchro and SimTraffic Protocols and ODOT's APM.

Default model parameters were used in the models where field information was unavailable and WSDOT and ODOT protocols do not provide specific direction.

7.6.1.2 SIDRA

SIDRA is a macroscopic analysis tool, like Synchro, which was used to analyze roundabout intersection alternatives. SIDRA uses static lane-by-lane and vehicle path models to provide estimates of capacity. Due to the macroscopic nature of SIDRA, it has some of the same limitations as Synchro related to the interactions between closely spaced intersections, but similar to Synchro it includes a network function that accounts for some upstream/downstream metering effects. Because of the differences in recommended methodology, roundabouts analyzed are consistent with either WSDOT's SIDRA Policy Settings or ODOT's APM, depending on which state the proposed roundabout is located in.

7.6.2 Agency Performance Standards

Intersection or corridor performance standards differ by agency within the Program Area. WSDOT and ODOT have intersection performance thresholds that are applied to freeway ramp terminal intersections and state highway intersections. Outside of the state highway facilities, the Cities of Vancouver and Portland have performance thresholds for roadway corridors or individual intersections, respectively. The individual agency thresholds are summarized below.

7.6.2.1 WSDOT Standards

For intersections under WSDOT control, WSDOT sets performance standards based on LOS. The LOS standards for I-5 and SR 14 ramp terminal intersections are LOS D, and for SR 500 ramp terminal intersections is LOS E. Other state highway intersections in the study area (e.g., SR 501 Mill Plain Boulevard) are under City of Vancouver Performance thresholds so see the City of Vancouver performance standards section for appropriate standards.

7.6.2.2 Vancouver Performance Standards

The City of Vancouver defines LOS standards for intersections as LOS E or better for both signalized and unsignalized intersections. The City of Vancouver also defines standards for concurrency corridors based on average peak hour speed for designated corridors within Vancouver. The City of Vancouver defines concurrency corridors as corridors designated by ordinance to be fully constructed.

The standards for the concurrency corridors are set by Vancouver City Council consistent with HCM guidance. On corridors that the Vancouver City Council have not designated as having reached ultimate capacity, Vancouver's transportation concurrency is evaluated according to the average peak hour speed on a corridor. When a corridor has been built following complete urban standards, the Vancouver City Council may designate that the corridor has reached ultimate capacity. The impact review then focuses on safety, access management and circulation, and transportation demand management instead.

Where a corridor has been built to full urban standard with sidewalks, bike lanes, travel lanes appropriate to its designation, intersection capacity consistent with the roadway cross section, and state of the art traffic control, the Vancouver City Council may determine that the corridor has reached ultimate peak capacity. Once a corridor is designated as having been constructed to ultimate capacity, the focus turns to safety, access management, and circulation and transportation demand management versus increasing capacity.

Vancouver's designated concurrency corridors and relevant travel speeds located within or adjacent to the study area are summarized in Table 3. The Southwest Washington Regional Transportation Council (RTC) conducts travel time runs along the concurrency corridors to support the City concurrency corridor work. Travel time data is collected on an annual basis; however, it takes 2 years to acquire complete coverage for each concurrency corridor.

Table 3. City of Vancouver Concurrency Corridor Thresholds

Facility	LOS Standard: Average Peak Hour Speeds (mph)
Mill Plain Boulevard • Fourth Plain Boulevard to I-5 • I-5 to Andresen Road	 10 12
Fourth Plain Boulevard • Port of Vancouver to I-5 • I-5 to Andresen	 12 10
Ft Vancouver Way /St. Johns Boulevard • Fourth Plain Boulevard to SR 500	 12
St. Johns Boulevard. / St. James Boulevard • SR 500 to NE 63rd Street	 12
Other Principal and Minor Arterials	12

Source: City of Vancouver Comprehensive Plan 2018.

7.6.2.3 ODOT Standards

For all study intersections under ODOT control, ODOT sets performance standards along ODOT facilities for two consecutive hours. The IBR local intersection operations analysis was completed for the peak hour however, so the 1st hour is the performance standard. ODOT has two sets of performance standards: the Oregon Highway Plan sets performance thresholds for both the existing and 2045 No-Build conditions and the HDM sets performance thresholds for the 2045 Modified LPA condition.

In the existing and No-Build conditions, the OHP performance standard for I-5 ramp terminal intersections is a V/C ratio of 0.85 given that there is no adopted Interchange Area Management Plan present, per Action 1F.1, bullet point six. In addition to the ramp terminals, ODOT has jurisdiction over Martin Luther King Jr. Boulevard between the I-5 Marine Drive ramp terminal, Columbia Boulevard, and other principal arterial routes in the study area. The OHP V/C ratio performance standard for intersections along this roadway is 0.99. See Table 4 for V/C ratio standards for relevant facilities in and near the study area for the existing conditions and 2045 No-Build conditions.

Table 4. Volume-to-Capacity Ratio Targets within Portland Metropolitan Region

Location	Target	
	1st Hour	2nd Hour
Central City, Regional Centers, Town Centers, Main Streets, Station Communities	1.1	0.99
Corridors, Industrial Areas, Intermodal Facilities, Employment Areas, Inner Neighborhoods, Outer Neighborhoods	0.99	0.99
I-5 North (from Marquam Bridge to Interstate Bridge)[1]	1.1	0.99
Other Principal Arterial Routes I-205, I-84 (east of I-205), I-5 (Marquam Bridge to Wilsonville), OR 217, US 26 (west of Sylvan), US 30, OR 8 (Murray Boulevard to Brookwood Avenue), OR 224, OR 47, 242nd /US 26 in Gresham, OR 99W	0.99	0.99

Source: ODOT Oregon Highway Plan.

1 I-5 North volume to capacity ratio targets via this table in the Oregon Highway Plan refers to the freeway mainline. Action 1F.1 designates a volume to capacity ratio target for freeway ramp terminals at an interchange of 0.85.

In the Modified LPA condition, the HDM sets a V/C ratio performance standard of 0.75 that applies to any reconstructed study intersections. I-5 is categorized as an Interstate Highway and Statewide Expressway for the entire length of the Program Area and is both located inside of an urban growth boundary as well as within an area with an MPO. For ramp terminals in the Modified LPA with highway phasing that remains unchanged from the No-Build condition, previous performance standards apply. See Table 5 for the V/C ratio standards for relevant facilities in and near the study area for the 2045 Modified LPA condition.

Table 5. 20-Year Design-Mobility Standards (V/C Ratio)

Highway Category	STAs	MPO	Non-MPO outside of STAs where non-freeway speed limit <45 mph	Non-MPO where non-freeway speed limit > = 45 mph	Unincorporated Communities	Rural Lands
	Inside Urban Growth Boundary				Outside Urban Growth Boundary	
Interstate Highways and Statewide (NHS) Expressways	N/A	0.75	0.70	0.65	0.60	0.60
Statewide (NHS) Freight Routes	0.85	0.75	0.70	0.70	0.60	0.60
Statewide (NHS) Non-Freight Routes and Regional or District Expressways	0.90	0.80	0.75	0.70	0.60	0.60
Regional Highways	0.95	0.85	0.75	0.75	0.70	0.65
District/Local Interest Roads	0.95	0.85	0.80	0.75	0.75	0.70

Source: ODOT Highway Design Manual, Table 1200-1 (ODOT 2023b).
MPO = metropolitan planning organization; STA = special transportation areas

7.6.2.4 Portland Performance Standards

The City of Portland defines LOS targets as LOS D or better for all signalized and unsignalized intersections under their jurisdiction. These are performance targets not standards.

7.6.3 Evaluation Measures

Traffic impacts were determined for arterial intersections by comparing the 2045 Modified LPA to the 2045 No-Build Alternative. Outputs from the Synchro, SimTraffic, and SIDRA models were the evaluation measures used to determine impacts of the IBR Program at study intersections. Outputs are displayed both graphically and in a tabular format as appropriate.

- Intersection Level of Service and Delay: Intersection LOS is defined in terms of average intersection delay on a scale ranging from A to F, depending on the delay conditions at the intersection. LOS A represents the best conditions with minimal delay, and LOS F represents the worst conditions with severe congestion. The LOS at an unsignalized intersection is also defined in terms of delay, but only for the worst operating movement, which is typically on the minor street or stopped approaches. See Table 6 for thresholds for signalized and unsignalized intersections.
- Volume to Capacity Ratio: A V/C ratio is a common method of measuring traffic congestion and is defined as a measurement of the operating capacity of the roadway where the number of vehicles passing through the segment is divided by the number of vehicles that could theoretically pass through that segment when at capacity. The V/C ratio is measured on a decimal scale with 0.0 representing excessive capacity and anything greater than

1.0 representing congestion because volume has exceeded roadway capacity. A V/C ratio can be calculated for either the intersection as a whole or by approach.

- Queue Lengths: Vehicle queue estimation is used to determine locations where queue spillback may be a problem, especially in congested areas. The 95th percentile queue is the 95th percentile of the reported maximum queue over the simulated period and is compared with allowable storage length along study arterials.

Table 6. Level of Service Thresholds for Signalized and Unsignalized Intersections

LOS	Average Control Delay (seconds per vehicle [sec/veh]) Signalized/Washington Roundabout Intersections[1]	Average Control Delay (sec/veh) Unsignalized/Oregon Roundabout Intersections[1]	Traffic Flow Characteristics
A	< 10	< 10	Virtually free flow; completely unimpeded.
B	> 10 and < 20	> 10 and < 15	Stable flow with slight delays; less freedom to maneuver.
C	> 20 and < 35	> 15 and < 25	Stable flow with delays; less freedom to maneuver.
D	> 35 and < 55	> 25 and < 35	High density but stable flow.
E	> 55 and < 80	> 35 and < 50	Operating conditions at or near capacity; unstable flow.
F	> 80	> 50	Forced flow; breakdown conditions.

Source: Transportation Research Board Highway Capacity Manual 2010

Notes: (1) The LOS criteria are based on control delay, which includes initial deceleration delay, final deceleration delay, stopped delay, and queue move-up time.

Unsignalized intersections, not including roundabouts, used HCM 6th Edition to report V/C ratios. Signalized intersections used HCM 2000 to report V/C ratios.

The measures of effectiveness for roundabouts in order of importance are V/C ratios, percentage stopped, queues, and LOS. If V/C is equal to or more than 0.9, microsimulation may be used to closely examine the volumes at the roundabout intersections. As shown in Table 7, LOS F is assigned to individual lanes in roundabouts regardless of the control delay if the V/C ratio exceeds 1.0. For overall intersection and approaches at roundabouts, LOS is measured solely against the control delay thresholds.

Table 7. LOS Thresholds for Roundabouts

Control Delay at WA Roundabouts	Control Delay at OR Roundabouts	LOS by Volume to Capacity Ratio[1] V/C < 1.0	LOS by Volume to Capacity Ratio[1] V/C > 1.0
≤ 10	≤ 10	A	F
> 10 and ≤ 20	> 10 and ≤ 15	B	F
> 20 and ≤ 35	> 15 and ≤ 25	C	F
> 35 and ≤ 55	> 25 and ≤ 35	D	F
> 55 and ≤ 80	> 35 and ≤ 50	E	F
> 80	> 50	F	F

Source: Transportation Research Board Highway Capacity Manual 2010.

1 For approaches and overall intersection assessment, LOS is defined solely by control delay.

For study intersections, mitigation is identified for locations that meet the LOS or V/C performance standards/targets in the No-Build Alternative but exceed the LOS or V/C performance standards/targets in the Modified LPA. In addition, if both the No-Build Alternative and Modified LPA exceed the LOS or V/C performance standards/targets, the Modified LPA would be mitigated if the intersection increases delay or V/C ratio by 10 percent more than the No-Build Alternative.

7.7 Transit

The regional travel demand model was used to produce transit ridership forecasts and calculate transit travel times for Base Year (2015) as well as all 2045 Horizon Year conditions (for the No-Build Alternative and the Modified LPA). The regional travel demand model uses a series of scripts in the R programming language that are interfaced with the software platform EMME (version 4). The software was used for all travel time calculations and final assignments of transit trip tables that are an output of the demand model.

The IBR Program team coordinated with Metro, RTC, and transit agencies to develop a 2045 No-Build Alternative by updating the horizon year networks to remove the highway and transit elements of the Modified LPA. The remainder of the region maintained assumptions as developed for the 2018 RTP. As the region has implemented projects since the completion of the 2018 RTP, it has identified areas of the regional transit system, beyond the IBR corridor, where additional transit service levels and capital investments may be needed. This may result in new transit projects or refined transit projects being identified in future RTP updates or amendments and their transportation investment plans. While ongoing work is being completed to identify regional funding and projects that would allow for the confirmation of additional service, the IBR program used a technique to capacity constrain transit ridership for the Draft EIS analysis alternatives at the direction of the Federal Transit Administration.

7.7.1 Evaluation Measures

The following measures were used to evaluate transit performance. Measures for assessing these elements, discussed in the following sections, are both quantitative and qualitative, and results are displayed both graphically and in a tabular format as appropriate.

- **Transit Operating Characteristics.** The number of vehicles by mode, and maintenance facilities required to operate the transit networks assumed for the Modified LPA were calculated. This measure used output from the regional travel demand model in the form of vehicle demand along with assumed capacities for different service types (light rail, bus, bus rapid transit) to arrive at the number of transit vehicles needed to operate service being assumed under different alternatives along with analysis from both TriMet and C-TRAN regarding span of service.
- **Transit Capital Facilities.** Transit centers and park and rides used to support bistate transit trips were identified and described, including required new facilities.
- **Operating Revenue and Expenses.** Annual revenue hours, operations and maintenance costs, and costs per boarding were calculated for each project alternative. This measure used output from the regional travel demand model in the form of vehicle demand along with assumed capacities for different service types (light rail, bus, bus rapid transit) to arrive at the number of transit vehicles needed to operate service being assumed under different alternatives along with analysis from both TriMet and C-TRAN regarding span of service and costs to operate them.
- **Travel Demand and Mode Choice.** Travel demand, measured in person-trips (a trip made by one person from a point of origin to a destination), and mode choice was determined through analysis of overall average weekday travel between Oregon and Washington as calculated in the regional travel demand model. Demand and mode choice forecasts included total average weekday trips as well as commute and non-commute trips.
- **Transit Service Characteristics.** The amount of service was measured and forecast using the regional travel demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks in the EMME software platform. Calculations using these assignment results included the following:
  - Average weekday VHT in revenue service: cumulative time that transit vehicles are in revenue service.
  - Average weekday VMT in revenue service: distance traveled by transit vehicles, regardless of their size.
  - Average weekday place-miles of service: total carrying capacity, seating, and standing of each bus/bus rapid transit (BRT) or light rail vehicle, calculated by multiplying the vehicle capacity of each bus/BRT or light rail vehicle by the daily VMT.
- **Travel times.** Transit travel times, both in-vehicle and total travel time, were calculated. Representative beginning and ending termini for trips were identified to reflect the travel demand markets and allow for consistent comparison between the No-Build Alternative and the Modified LPA. Total travel time included in-vehicle, wait, and walk-access times. Average

weekday travel times were calculated over the peak 4-hour period. Travel times used both the regional travel demand model final transit assignments as well as the VISSIM operational model for selected origins and destinations in the Program Area.

- **Reliability.** Transit reliability was assessed using three metrics from the regional travel demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks in the EMME software platform. Calculations using these assignment results include the following:
  1. Total average weekday transit passenger miles.
  2. Average weekday transit passenger miles on fixed guideway.
  3. Percentage of total corridor passenger miles on fixed guideway.
- **Ridership.** Ridership was forecast across several metrics from the regional travel demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks in the EMME software platform. Calculations using these assignment results include the following:
  1. Average weekday and PM 1-hour peak direction, peak load point, project ridership by individual line and across the total transit system.
  2. Average weekday transit person-trips (originating rides).
  3. Average weekday transit trips crossing the I-5 and I-205 Columbia River bridges by transit mode.
  4. Average weekday transit trip productions (where trips are produced as well as the delta compared to the No-Build Alternative).
  5. Average weekday work and nonwork transit trips and mode share.
  6. Station usage (boardings and alightings) by mode of access and egress.
  7. Project rider distribution (the number of project riders on connecting transit lines).
- **Safety and security.** Safety features of transit stations are qualitatively described for each project alternative.
- **Trip generation at transit stations.** Trip generation at transit stations was developed for various modes of travel using metrics from the regional travel demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks in the EMME software platform. Calculations using these assignment results include the following:
  1. Park and rides and other public parking facilities.
  2. Auto trips: drop-off/pick-up and transportation network company trips, such as Uber and Lyft.

3. Transit vehicle trips: number of buses serving a station.
4. Walk/bike trips: bus transfers and walk/bike access trips.
5. Trip generation estimates were based on several sources. Trip generation at park and rides assumed the parking supply is fully utilized and were based on the maximum capacity of the parking facility. Information on bus service for each station was developed in coordination with C-TRAN and TriMet service planners as part of the planning-level transit service integration plan. This plan includes changes in local transit circulation to and from the station area, which was incorporated into the overall trip generation.
6. The vehicle and nonmotorized (pedestrian and bicycle) trips associated with station ridership forecasts at each planned station were used for evaluating the station area effects. Trips were assigned to the nonmotorized and vehicular networks around the station locations based on existing and anticipated future circulation patterns.

7.8 Active Transportation

The potential of the IBR Program to alter operations of active transportation facilities in the Program Area was both quantitatively and qualitatively assessed and considered the following:

- **Active transportation facilities (Quantitative)**. Summarize active transportation facilities and circulation within the Program Area and the surrounding travelsheds for walking, biking, and rolling.
- **Barriers (Qualitative)**. Physical and perceived barriers that inhibit pedestrian and bicycle traffic movements.
- **Bicycle level of traffic stress (Quantitative)**. The bicycle level of traffic stress was summarized for the IBR Program Area.
- **Interstate Bridge access (Qualitative)**. Document access and travel times for people walking, biking, and rolling to and from the Interstate Bridge.
- **Active Transportation Trip Forecasts (Quantitative)**. Active transportation forecasts crossing the river were estimated using two methods.

7.9 Safety

The crash data for the study area, the city of Vancouver, and the city of Portland were collected from WSDOT and ODOT for a 5-year period beginning January 1, 2015, and ending December 31, 2019. The analysis provides an overview of safety performance in the study area.

7.9.1 Evaluation Measures

7.9.1.1 Existing Safety Analysis

The existing conditions safety analysis included a summary of crash data from mainline I-5, the connecting ramps, ramp terminal intersections, as well as at any additional study area intersections. For the mainline, ramp, and ramp terminal facilities, the crash data were analyzed to understand trends in crash type/severity, time of day, frequency, and mode. Fatal and serious injury crashes for these facilities were considered in more detail to identify trends in contributing factors. Additionally, mainline crashes reported during or within a given period of bridge lifts and regularly scheduled maintenance work were analyzed to estimate crash consequences when all lanes of traffic are closed.

7.9.1.2 Future Safety Analysis

FREEWAY FACILITIES

The future freeway facility safety conditions were assessed using the Enhanced Interchange Safety Analysis Tool (ISATe), which is based on the Highway Safety Manual (HSM) predictive methodology. Due to the level of design expected during this effort, some inputs were not used for this analysis. Therefore, the change in the safety performance between alternatives was not assessed by reporting actual predicted crash frequency outputs from ISATe. Instead, the percentage difference between alternatives was reported, and possibly applied to the historical crash data, in order to estimate the magnitude of the change in safety performance due to the geometric and volumetric differences.

There are also limitations within the HSM predictive method that restrict capturing the safety implications of certain conditions, including HOV and other managed lanes, truck safety, congestion, movable-span operations, etc. Congestion and the movable span are particularly applicable to this project and are likely playing a key role in the safety performance of the area; however, these effects are not quantifiable. The HSM predictive methodologies are unable to assess these conditions, and there are no other tools available to address the safety impacts of these conditions. Additionally, the analysis is only able to capture the effects of the inputs that are included in the analysis and methodology. Therefore, there are likely other contributing factors that may be influencing safety performance. All of these conditions may impact safety but cannot be quantified, and therefore they are not factored into the results.

Additionally, a calibration factor of 1.0 is assumed for the predictive safety analysis. Because Washington data were used in development of the HSM models, WSDOT assumed a calibration factor of 1.0 (the default value). In Oregon, calibration factors for freeway facilities are not available, but 1.0 is assumed as a default and to be consistent with WSDOT. However, since calibration factors would be applied to all alternatives, the relative percentage difference between alternatives (i.e., the reported result) would not be affected by a non-default calibration factor regardless.

The future safety analysis included 2045 No-Build, 2045 Modified LPA, and Modified LPA Design Options. All Modified LPA Design Options were compared with the No-Build Alternative and the Modified LPA. The Modified LPA and design options would likely change the freeway and ramp configurations and access, number of, or length of ramps, which makes a direct comparison by facility misleading. Therefore, the entire analyzed network within the study area was assessed collectively to better illustrate the overall changes due to the proposed designs of the entire network.

This safety analysis included the I-5 mainline, I-5 ramps and collector-distributor facilities, and ramp terminal intersections, within the study area. The safety analysis included an assessment of the following attributes:

- Number of lanes
- Length of segment
- Horizontal alignment (i.e., horizontal curves)
- Lane width

- Median/inside and roadside/outside shoulder widths
- Median/inside and roadside/outside barrier
- Ramp types, access location, and volumes
- Weaving sections
- Collector-distributor facilities
- ADT
- Ramp terminal type, traffic control, and configuration

Some assumptions were made for certain facilities as well in order to be able to provide an estimate of safety performance or to model the locations more accurately. Table 8 summarizes these assumptions, including a description of the incompatibility and how it was ultimately analyzed.

Table 8. HSM Site Type Assumptions

Location	Scenario	Description of Incompatibility	Analyzed As
Ramp Terminals I-5/SR 99E Ramp Terminal	No-Build Configuration	Intersection configuration does not represent any HSM ramp terminal site types. While ramps make up 2 approaches, the configuration is more closely represented by a signalized arterial intersection.	Signalized Arterial Intersection (4SG, HSM CH. 12)
Ramp Terminals I-5/SR 99E Ramp Terminal	Modified LPA 1 Aux and 2 Aux	Intersection (SPUI) does not represent any current HSM ramp terminal site types. NCHRP 17-68 developed an SPF and spreadsheet tool that can analyze SPUIs. This tool was used to analyze this configuration.	SPUI (NCHRP 17-68)
Ramp Terminals I-5/Marine Drive Ramp Terminals	Modified LPA 1 Aux and 2 Aux	The NB and SB I-5 ramp connections to Marine Drive will be roundabouts, which are not included in the current HSM. While NCHRP 17-70 has produced SPF models for roundabouts, the level of design at this stage is limited and not all inputs are known. A CMF for converting a signal to a roundabout at an interchange was applied to estimate the safety performance.	D3ex with applied CMF for interchange roundabouts (CMF ID: 11166)
Ramps C-D System between SR 14 and Mill Plain Blvd	Modified LPA 1 Aux and 2 Aux	NB and SB ramp sections includes three to four lanes on this CD system. The HSM only allows for analyzing a 2-lane ramp (2 through lanes). However, because the 3rd and/or 4th lanes are less than 1,600ft (0.3 miles), these are not included as through lanes according to the HSM methodology. No analysis adjustments or assumptions needed.	Two-lane ramp section

Location	Scenario	Description of Incompatibility	Analyzed As
Mainline Segments All odd-numbered lane mainline segments	All	The HSM only includes SPFs for 4-, 6-, 8-, and 10-lane freeway segments. Odd-numbered lane segments are estimated by averaging the two adjacent even-numbered SPFs (e.g., the SPF for 7 lanes would be an average of the SPF for 6 lanes and 8 lanes). This is consistent with the HSM methodology and what is automatically applied within ISATe. No additional analysis adjustments or assumptions needed.	Varied

LOCAL INTERSECTIONS

Volume changes are the key changes expected at the local study intersections due to the project. The safety effects at local, non-ramp terminal study intersections were assessed based on these volume changes between the No-Build and the Modified LPA conditions. The applicable HSM safety performance functions (SPFs) were used to assess the impact on predicted crashes based on the daily volumes forecast at each intersection. No geometric features were factored into this analysis apart from traffic control type (which dictates the applicable SPF). Intersections that were predicted to experience more than 1 additional crash per year were identified.

7.10 Transportation Demand Management and Transportation System Management

Key programs for travel demand management and transportation system management were summarized including current regional and local plans and policies. TDM is defined as an action or set of actions intended to influence the intensity, timing, and spatial distribution of transportation demand for the purpose of reducing the impact of traffic or enhancing mobility options. TSM is defined as the measures and actions used to increase the efficiency of transportation system operations, especially the street and highway network, including signals and signal systems.

7.11 Tolling

Tolling sensitivity testing has been summarized to understand the impact of higher and lower toll rates as well as no tolls on vehicle crossing demand and transit passenger demand over the Columbia River bridges. This sensitivity testing is included as Attachment F to Appendix H. In addition, toll effects were also considered in the trip diversion analysis that is reported in Appendix J.

7.11.1 Evaluation Measures

The following measures were developed to evaluate tolling impacts.

- **Person-Trips:** Daily person-trips from the regional travel demand model were analyzed at a district level after the mode choice step of the model to evaluate destination choice changes. Trips were summarized by work and non-work travel purposes to gain insight into whether there is a difference between discretionary and non-discretionary travel with tolling.

- **Mode Choice:** Daily person-trips from the regional travel demand model were analyzed at a district level after the mode choice step of the model to evaluate shifts in travel mode. Trips were summarized in total.
- **Vehicle Volumes:** Vehicle volumes on both the I-5 and I-205 bridge were developed in the regional travel demand model for each hour of an average weekday. Volumes will be post-processed using industry-standard post-processing steps as described in Section 6.1.
- **Transit Volumes**: Transit ridership was developed from the regional travel demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks for each scenario being analyzed in the EMME software platform. These assignments and resulting outputs were used to summarize total average weekday transit ridership crossing the Columbia River on I-5 and I-205 to understand shifts to transit with tolling.
- **Production/attraction and origin/destination shifts:** Changes in productions and attractions for destination choice and mode choice as well as origins and destinations for route choice (assignments) were analyzed and are summarized in a diversion report in Appendix J to the Transportation Technical Report.

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Attachment A. Data Collection Program

DATA COLLECTION PROGRAM

1. INTRODUCTION

Comprehensive and quality traffic data provides the foundation for robust transportation analysis to support the Interstate Bridge Replacement (IBR) Program. The IBR Program contains a diverse transportation system, including freeways, highways, local roads, transit, and active transportation systems. Traffic in the transportation system is composed of commuters, non-commute auto trips, trucks, transit users, and non-motorized users.

This data collection program describes the data necessary to support the transportation analysis for the IBR Program and the intended use of the data. It was developed with specific attention given to the widespread restrictions in place between 2020 and 2023 in response to the COVID-19 pandemic and the resulting effects on the transportation system. Strategies for collecting traffic data while accounting for the effects of the COVID-19 pandemic are discussed below.

1.1 Historical Columbia River Crossing Project Data

The data to be collected for the IBR Program is similar in kind and nearly identical in extents to the data collected for the Columbia River Crossing (CRC) Project in 2005-2009. Data collected to support the CRC Project was reviewed and compared to data collected to support the IBR Program to help describe how the transportation system has changed over the past 15 years and how those changes may affect proposed improvements. New data collection technologies and sources that were not available during the data collection program for CRC will not have corresponding historical data for comparison.

1.2 COVID-19 Considerations

The COVID-19 pandemic that began in 2020 altered historical travel patterns and trends, traffic volumes, and transit ridership. Traffic volumes and transit ridership dropped below historic levels, and then began to increase as health emergency restrictions gradually eased over the following 3 years. As of March 2023, according to traffic count data from both WSDOT and ODOT (WSDOT 2022; ODOT 2021), traffic volumes were close to pre-pandemic levels for auto and freight traffic within the study area. Transit has been slower to recover, but according to both Clark County Public Transportation Benefit Area Authority (C-TRAN) and Tri-County Metropolitan Transportation District of Oregon (TriMet), transit service levels and ridership continue to see increases as more time goes by since the start of the pandemic (C-TRAN n.d.; TriMet n.d.).

Transportation analyses generally incorporate the most recently available data. However, due to the influence of the COVID-19 pandemic on travel patterns between 2020 and 2023 as explained above, the most recently available data is not representative of standard conditions. Therefore, the IBR Program is following industry standards and using 2019 as the baseline year for the existing conditions instead since it most closely resembles standard conditions. Exceptions to this include outputs that rely on the Oregon Metro/Southwest Washington Regional Transportation Council (RTC) regional travel demand model, which has not yet updated its base year model from 2015 to 2020, safety data which summarizes 5 years of data from 2015 through 2019, and bridge lift/gate closure data which summarizes 12 years of data (2012 through 2023) which is consistent with the data summarized for the Navigation Determination Report.

2. DATA SOURCES

2.1 Freeway Mainline and Ramp Volumes

WSDOT and ODOT both maintain permanent data collection stations along the major freeways in the Portland Metro Region. These permanent data collection stations collect data 24 hours a day, 7 days a week, 365 days a year. Along I-5 and I-205 near the IBR Program Area, ODOT and WSDOT maintain five permanent count locations. The five locations include I-5 south of the SR 500 interchange in Vancouver, the Interstate Bridge, I-5 near the Rosa Parks interchange in Portland, I-5 at the Marquam Bridge in Portland, and I-205 at the Glenn Jackson Bridge. The IBR team collected hourly volume data for the entire year of data for 2019.

WSDOT and ODOT also perform short duration counts at freeway ramps, and the most recent of these (2019 or earlier) were collected from WSDOT and ODOT and used to supplement the data collected from the freeway and ramp data collection stations.

2.2 Turn Movement Counts

Two-hour AM peak and PM peak turn movement counts were collected at all study intersections. Recent 2019 data will be requested from WSDOT and ODOT as well from local partners. New data were collected in 2021 to 2023 to supplement any missing data, and the 2021 to 2023 data were factored to 2019 based on data from count locations that had data from 2019.

2.3 Vehicle Classification

Some of the WSDOT and ODOT data collection stations and short duration counts provide vehicle classification data to distinguish between passenger cars, light trucks, medium trucks, and heavy trucks. The tube counts classified vehicles into one of 13 bins per FHWA classifications, while the turn movement counts provided the percentage of heavy vehicles. The vehicle classification data were used to determine the percent of large trucks on the roadway and track the impacts associated with freight traffic.

2.4 Transit

The study area includes transit services operated by two different transit agencies (C-TRAN and TriMet). Data collected from both C-TRAN and TriMet used as part of the IBR Program include the following:

- Existing transit route information in the study area
- Service levels and route connectivity throughout the study area
- System ridership
- Route ridership
- Stop ridership
- Park and ride locations and utilization
- Travel patterns
- Travel times
- TriMet Equity Index
- On time performance

2.5 Active Transportation

Pedestrian and bicycle volume data were collected at all study intersections as well on the Interstate Bridge.

2.6 I-5 Bridge Origin-Destination Flows

During the CRC project, origin-destination flows were determined by collecting ramp to ramp origin-destination data in the IBR Program Area using a video license plate survey. In the time since the CRC Project, technological innovations in the realm of origin-destination data collection via Big Data (anonymized cellular phone data, and GPS data) have presented a new source of collection origin-destination data. The IBR Program collected StreetLight Data to verify 2019 origin-destination patterns in the Program Area and compared those with historical origin-destination patterns collected during the CRC project.

StreetLight Data is a company that specializes in providing transportation analytics by collecting and analyzing data related to traffic and transportation travel patterns with a set of proprietary data processing algorithms that transform the data into contextualized, aggregated, and normalized travel patterns. It uses a variety of sources of information, including mobile phones, connected vehicles and other location-based technologies along with underlying census data to offer insights into traffic flows and travel patterns.

2.7 Freeway Speed

Interstate 5 freeway speed information was collected from WSDOT and ODOT sources. Some of the WSDOT mainline data collection stations provide speed data and ODOT has access to the Regional Integrated Transportation Information System, which uses INRIX data.

2.8 Ramp Meters

Documentation on ramp meter rates in the Portland metropolitan region was requested from ODOT and WSDOT. WSDOT and ODOT use dynamic metering, so rates vary based on traffic, but the prevailing ramp meter rates were summarized.

2.9 Signal Timing

Signal timing plans were requested from the appropriate jurisdiction at all study intersections. At intersections where videos were used to collect turn movement counts, the videos were reviewed to confirm peak hour signal timing plans.

2.10 Occupancy

In 2019, the northbound I-5 Interstate Bridge over the Columbia River was closed to vehicle traffic so the south tower trunnion could be replaced. As part of that project, occupancy data (the number of people in a vehicle) was collected before, during, and after the closure. The IBR Program requested this data from ODOT.

2.11 Crashes

Crash Data in the IBR Program Area, the City of Vancouver, and the City of Portland was collected from WSDOT and ODOT for the period from January 1, 2015 to December 31, 2019.

2.12 Bridge Lifts

Bridge lift data for the Interstate Bridge for the period from January 1, 2012 to December 31, 2023, were collected from ODOT.

3. DATA COLLECTION PLAN SUMMARY

Table A-1 summarizes the data types, sources, and study areas that were used for the analysis.

Table A-1 Data Collection Plan Summary

Category	Source	Year	Study Area
Freeway Mainline and Ramp Volumes	WSDOT and ODOT permanent count station and short duration counts. New Tube Counts.	Historical: 2018–2019 New: 2021	IBR Program Area, Freeway Analysis Area, and the I-205 Glenn Jackson Bridge
Turn Movement Counts	New turn movement counts.	New: 2021–2023	Intersection Analysis Area
Vehicle Classification	WSDOT and ODOT permanent count station and short duration counts. WSDOT, ODOT, Vancouver, and Portland turn movement counts. New Tube Counts. New turn movement counts.	Historical: 2015–2019 New: 2021–2023	IBR Program Area, Freeway Analysis Area, and Intersection Analysis Area
Transit	C-TRAN, TriMet	2019	Regional
Active Transportation	WSDOT, ODOT, PBOT, Vancouver and Metro counts. New video counts	Historical: 2018–2020 New: 2021–2023	Interstate Bridge, Intersection Analysis Area
I-5 Bridge Origin-Destination Flows	StreetLight Data	Historical: 2019	Regional
Freeway Speed	WSDOT, ODOT	Historical: 2019	IBR Program Area and Freeway Analysis Area
Ramp Meters	WSDOT, ODOT	2019–2020	IBR Program Area and Freeway Analysis Area
Signal Timing	WSDOT, ODOT, Vancouver, Portland	2021	Intersection Analysis Area
Occupancy	ODOT Trunnion Replacement Project	2019	Interstate Bridge
Crashes	WSDOT, ODOT	2015–2019	IBR Program Area
Bridge Lifts	ODOT	2012–2023	Interstate Bridge

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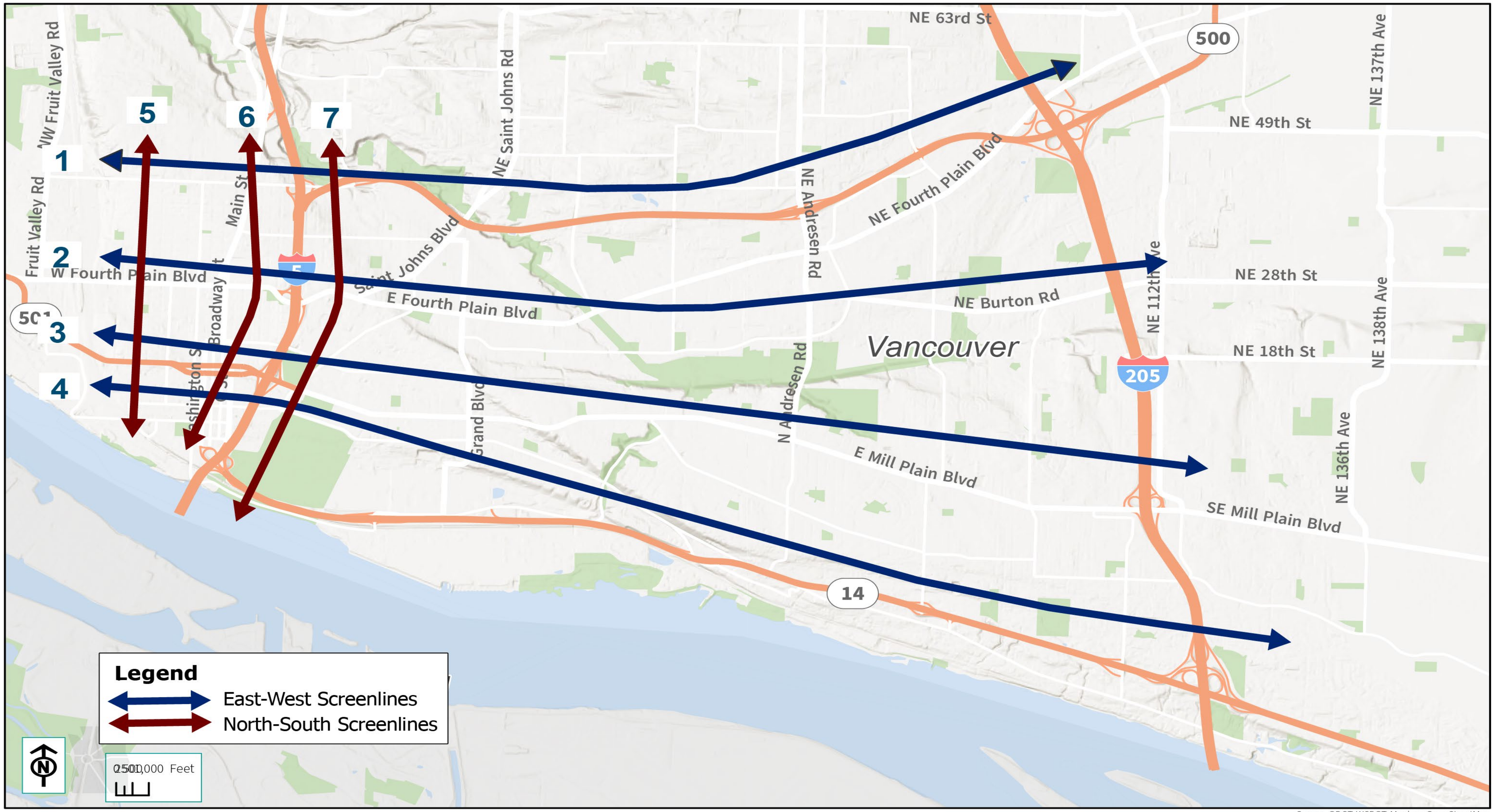
Appendix B. Screenline Volumes

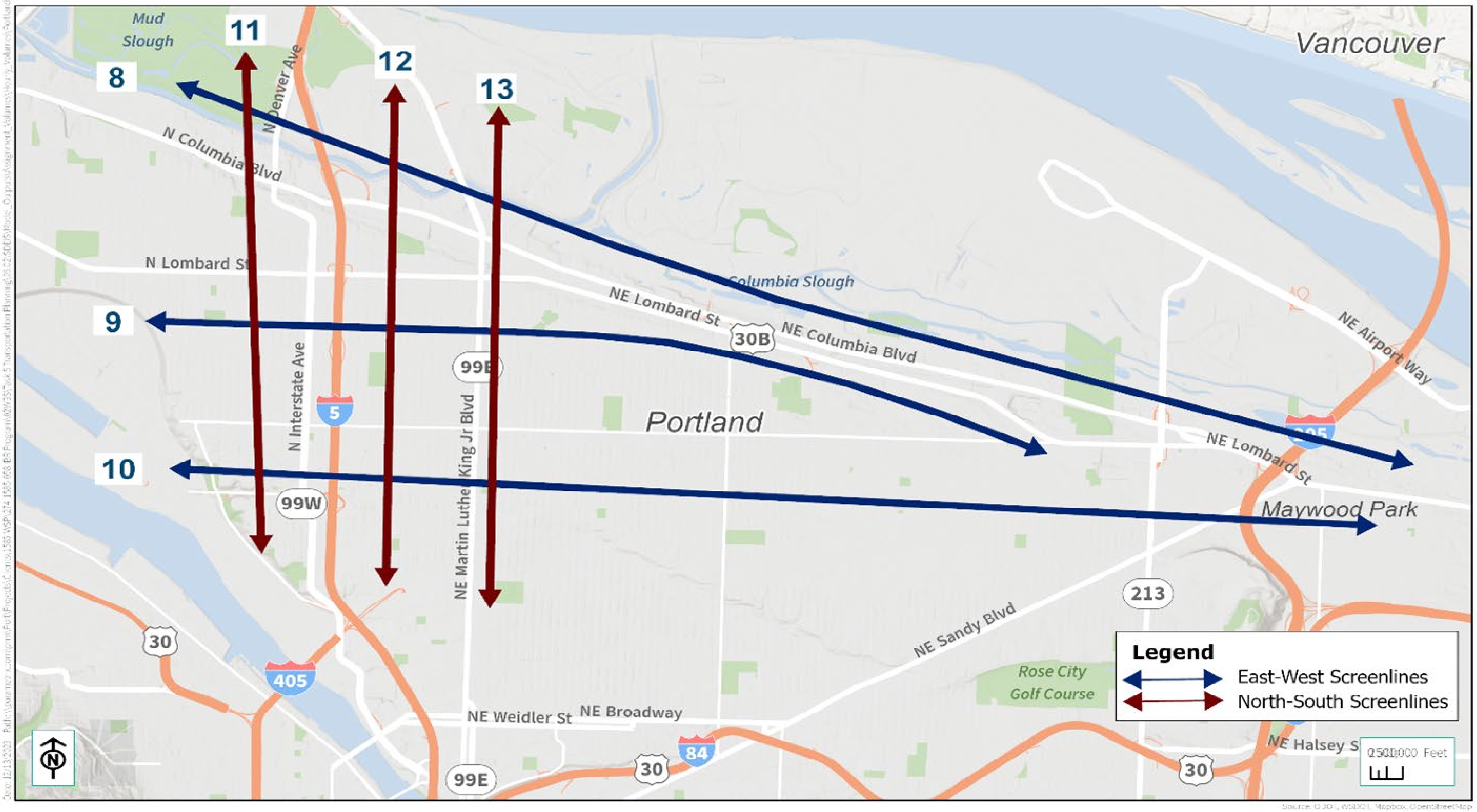
This appendix contains screenline volumes for the individual facilities that make up the larger screenlines. These aggregated screenlines are referenced in sections 3.3.2 and 4.3.2 of the Transportation Technical Report (TTR). Screenline figures (Figure 3-4 and 3-5 in the TTR) are provided below to show where each screenline is located in both Vancouver and Portland.

It is important to keep in mind that the volumes presented in these tables are from a regional travel demand model that is not calibrated to individual facilities and does not reflect post-processing. The regional travel demand model assignments use an equilibrium process whereby the resulting volumes reflect a condition where no traveler can improve their travel time or cost by switching paths. Traffic loads onto the network via zone connectors that represent all traffic coming in and out of an area and does not reflect exact loading to and from the network via local connector facilities or driveways. Differences in assignments may simply be the result of the equilibrium process and how trips enter and exit the network. The assignments do not reflect real-world traffic conditions and should be used to gauge general changes between alternatives. For more specific traffic differences at individual facilities or intersections it is more appropriate to utilize post-processed information that is available in Section 4.6 of the TTR.

Screenline Locations – Vancouver



Screenline Locations – Portland



	Volumes															
	Vancouver															
Location	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
Screenline 5 - East of Kauffman Ave																
W 39th St east of Kauffman Ave	111	152	176	115	159	267	255	149	158	283	255	173	159	286	255	174
W 33rd St east of Kauffman Ave	15	18	18	16	15	172	46	16	16	69	35	19	16	66	33	19
W 4th Plain Blvd east of Kauffman Ave	309	504	427	363	342	667	627	385	419	654	619	404	418	653	618	397
W McLoughlin Blvd east of Kauffman Ave	4	2	3	4	4	2	4	3	5	2	4	3	5	2	4	3
W Mill Plain Blvd east of Kauffman Ave	262	304	267	194	436	751	704	490	430	775	724	482	439	777	725	482
W 13th St east of Kauffman Ave	25	7	12	24	67	15	22	32	38	11	20	30	46	11	20	30
W Evergreen Blvd east of Jefferson St	11	3	4	10	26	14	16	33	25	18	15	34	25	18	15	34
W 8th St east of Jefferson St	60	195	207	110	120	190	257	135	123	173	162	108	114	175	163	106
Total	**797**	**1185**	**1114**	**835**	**1169**	**2079**	**1929**	**1242**	**1214**	**1986**	**1834**	**1253**	**1221**	**1988**	**1833**	**1245**
Screenline 6 - West of I5																
W 39th St west of I5	151	199	240	157	172	341	333	199	280	356	345	366	282	365	344	363
W 33rd St west of I5	35	60	64	36	40	51	80	44	41	65	80	54	41	63	81	54
W 29th St west of I5	18	53	53	26	24	52	62	31	22	65	66	31	22	65	66	31
W 4th Plain Blvd west of I5	277	441	451	592	344	778	554	641	584	807	631	595	682	805	626	592
W McLoughlin Blvd west of I5	109	53	114	85	118	56	122	93	125	63	116	90	126	64	116	90
W Mill Plain Blvd/E 15th St west of I5	704	780	878	638	717	1509	1357	1207	867	1669	1652	1213	872	1671	1646	1217
W Evergreen Blvd west of I5	130	163	211	163	172	224	267	222	160	251	247	262	159	235	250	262
Total	**1426**	**1750**	**2010**	**1696**	**1588**	**3011**	**2774**	**2435**	**2080**	**3276**	**3136**	**2612**	**2185**	**3269**	**3129**	**2609**
Screenline 7 - East of I5																
W 39th St east of I5	410	331	458	374	535	405	493	447	446	427	513	418	444	429	511	417
SR 500	591	1204	1126	687	888	1532	1376	1072	714	1828	1672	829	724	1889	1737	835
W 33rd St east of I5	29	50	47	33	35	40	63	41	36	55	64	52	35	53	64	52
W 29th St east of I5	21	24	29	24	27	17	35	28	23	30	39	27	24	30	39	27
W 4th Plain Blvd east of I5	783	646	783	746	734	639	681	701	863	657	753	724	887	655	752	726
W McLoughlin Blvd east of I5	119	67	129	94	131	66	137	103	138	72	127	100	138	74	127	100
W Mill Plain Blvd east of I5	849	779	936	812	1103	984	1157	1207	1311	1044	1189	1216	1292	1083	1199	1222
W Evergreen Blvd east of I5	111	171	216	152	231	284	328	280	233	521	441	318	232	505	443	318
SR14 east of I5	1401	2127	2020	1495	1990	2587	2628	2066	1955	2776	2668	1849	1941	2829	2681	1828
Total	**4313**	**5400**	**5742**	**4417**	**5674**	**6554**	**6899**	**5945**	**5719**	**7410**	**7467**	**5532**	**5716**	**7547**	**7554**	**5525**
	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB
Screenline 1 - North of 39th St																
Columbia St north of E 39th St	40	136	107	61	57	215	129	69	37	153	136	56	36	155	136	56
Main St north of E 39th St	216	844	686	276	296	1105	943	382	303	891	714	334	304	902	718	333
H St north of E 39th St	32	25	32	37	44	32	39	50	44	33	40	49	44	34	40	49
I-5 north of E 39th St	2285	5042	4565	3236	3181	5203	4723	3886	3132	6605	5713	4082	3129	6685	5736	4094
NE 15th Ave north of E 39th St	169	98	137	80	176	85	140	89	183	75	146	89	182	77	146	88
NE St Johns Blvd north of WA-500	190	779	464	331	247	760	556	410	236	753	563	373	237	761	564	374

Location	Volumes															
	Vancouver															
	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
NE 42nd Ave north of WA-500	132	288	299	160	68	184	149	100	70	167	138	104	70	168	138	103
NE 54th Ave north of WA-500	120	30	47	93	110	242	255	125	108	252	266	121	108	253	266	122
NE Andresen Rd north of WA-500	564	1133	1001	834	578	1041	1004	848	573	1062	1020	828	573	1069	1026	824
NE Thurston Way north of WA-500	907	638	1061	807	1009	895	1155	946	1006	915	1174	933	1007	914	1171	935
I-205 north of WA-500	1459	2977	2574	1986	2577	4187	3555	2955	2668	4170	3436	2969	2672	4161	3444	2970
Total w/ I-5 and I-205	**6115**	**11988**	**10972**	**7902**	**8344**	**13948**	**12648**	**9862**	**8359**	**15076**	**13345**	**9937**	**8361**	**15176**	**13385**	**9949**
Total w/o I-5 and I-205	**2371**	**3970**	**3833**	**2680**	**2586**	**4558**	**4370**	**3020**	**2559**	**4301**	**4197**	**2886**	**2560**	**4331**	**4206**	**2885**
Screenline 2 - North of 4th Plain Blvd																
Kauffman Ave north of 4th Plain Blvd	46	211	182	67	51	234	109	65	31	127	100	65	30	128	100	67
Columbia St north of 4th Plain Blvd	31	220	172	50	45	331	168	63	63	203	112	62	59	207	116	61
Main St north of 4th Plain Blvd	65	632	424	74	97	659	586	142	95	571	408	99	96	576	410	99
Broadway St north of 4th Plain Blvd	76	82	115	76	44	135	185	61	44	112	105	51	44	133	105	51
I-5 north of 4th Plain Blvd	2908	6156	5633	3852	4126	6488	5980	4925	3923	7795	7514	4513	3937	7920	7603	4535
P St north of 4th Plain Blvd	44	146	130	71	41	165	120	57	32	144	77	66	31	148	78	66
St Johns Blvd north of 4th Plain Blvd	28	99	117	47	17	105	94	44	15	190	84	85	16	191	84	85
Ft. Vancouver Way north of 4th Plain Blvd	95	586	338	287	96	702	420	399	100	705	423	378	100	700	424	378
Grand Blvd north of 4th Plain Blvd	64	153	118	77	110	189	239	126	95	131	215	124	96	136	215	124
Norris Rd north of 4th Plain Blvd	74	147	143	92	96	161	157	113	94	162	158	111	94	162	158	111
Falk Rd north of 4th Plain Blvd	96	208	193	162	202	339	373	333	229	342	365	335	228	342	365	335
Caples Dr north of 4th Plain Blvd	4	0	6	0	5	35	39	0	5	33	9	7	5	35	13	6
General Anderson Ave north of 4th Plain Blvd	150	88	176	195	224	138	219	262	206	138	218	262	206	138	218	262
Stapleton Rd south of 4th Plain Blvd	94	141	176	123	117	163	202	138	122	160	184	149	122	160	185	150
NE 65th Ave north of NE Campus Dr	60	159	174	115	120	185	201	192	119	169	212	189	119	169	212	189
NE Andressen Rd north of Burton Rd	535	740	746	618	589	856	835	665	568	780	815	700	569	781	813	702
NE 18th St north of Burton Rd	46	32	49	84	60	48	60	97	60	26	60	97	60	26	60	97
NE 86th Ave north of Burton Rd	217	306	329	266	265	314	358	316	266	318	352	320	266	317	353	321
NE 98th Ave north of Burton Rd	29	108	77	42	29	97	74	42	29	101	75	42	29	102	75	42
NE 103rd Ave north of Burton Rd	34	68	76	38	36	80	79	41	37	80	81	41	37	80	81	41
I-205 north of Burton Rd	2449	4618	4451	2747	3985	5395	5241	3985	4262	5290	5142	4149	4263	5276	5107	4149
NE 105th Ave north of Burton Rd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE 112th Ave north of Burton Rd	768	791	784	776	866	1037	1043	1025	890	1018	1035	1060	891	1015	1030	1058
Total w/ I-5 and I-205	**7912**	**15694**	**14608**	**9859**	**11223**	**17855**	**16783**	**13091**	**11285**	**18594**	**17743**	**12905**	**11298**	**18742**	**17805**	**12928**
Total w/o I-5 and I-205	**2555**	**4920**	**4524**	**3260**	**3112**	**5972**	**5563**	**4181**	**3099**	**5510**	**5087**	**4243**	**3098**	**5546**	**5096**	**4244**
Screenline 3 - North of Mill Plain Blvd																
Kauffman Ave north of Mill Plain Blvd	32	136	83	39	44	155	104	50	44	79	84	49	44	81	84	49
Franklin St north of Mill Plain Blvd	12	103	40	30	27	175	55	32	34	114	60	32	33	87	60	32
Columbia St north of W 15th St	21	47	66	21	24	79	74	32	23	96	70	26	23	68	70	26
Washington St north of W 15th St	-	261	-	41	-	460	-	60	-	291	-	33	-	292	-	32

Location	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	Volumes – Vancouver															
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
Main St north of Mill Plain Blvd	133	445	394	181	157	441	468	264	157	382	320	223	157	382	321	223
Broadway St north of Mill Plain Blvd	0	60	1	36	1	126	5	38	1	63	1	41	1	52	1	41
C St north of Mill Plain Blvd	101	0	164	0	134	0	202	0	144	0	158	0	142	0	158	0
I-5 north of Mill Plain Blvd	2575	6045	5141	3824	3736	6233	5429	4829	3549	8515	6822	4870	3570	8771	6922	4896
Ft Vancouver Way north of Mill Plain Blvd	336	187	364	164	434	176	411	335	416	185	401	309	416	189	404	311
E Reserve St north of Mill Plain Blvd	156	31	164	128	305	67	188	161	312	85	189	157	310	91	189	156
Grand Blvd north of Mill Plain Blvd	139	325	314	146	192	336	410	181	172	292	377	178	174	275	376	178
Brandt Rd north of Mill Plain Blvd	256	329	334	294	351	352	360	327	353	333	347	331	353	337	348	331
Ogden Ave north of Mill Plain Blvd	11	35	22	19	11	33	20	19	11	34	29	19	11	35	29	19
N Devine Rd north of Mill Plain Blvd	226	180	278	238	271	245	346	309	286	253	326	318	280	253	329	319
NE Andresen Rd north of Mill Plain Blvd	377	635	558	454	492	825	656	550	490	719	640	547	500	728	638	546
N Garrison Rd north of Mill Plain Blvd	98	106	87	104	115	113	100	146	114	117	101	138	114	119	101	136
NE 87th Ave north of Mill Plain Blvd	265	149	201	270	411	132	211	338	387	138	208	339	385	139	208	341
NE 90th Ave north of Mill Plain Blvd	118	0	0	104	162	0	0	134	168	0	0	131	166	0	0	130
NE 92nd Ave north of Mill Plain Blvd	259	147	190	236	303	147	211	255	312	150	217	259	314	152	217	258
NE 97th Ave north of Mill Plain Blvd	48	237	109	71	38	58	81	33	44	152	78	33	50	151	78	33
NE 104th Ave north of Mill Plain Blvd	42	445	108	153	53	125	112	63	53	131	115	64	53	129	115	64
I-205 north of Mill Plain Blvd	2449	4618	4451	2747	3985	5395	5241	3985	4262	5290	5142	4149	4263	5276	5107	4149
NE 112th Ave north of Mill Plain Blvd	446	651	1152	347	232	526	557	383	219	531	596	386	218	532	593	384
Total w/ I-5 and I-205	**8100**	**15170**	**14220**	**9650**	**11477**	**16199**	**15241**	**12526**	**11549**	**17950**	**16282**	**12630**	**11575**	**18138**	**16349**	**12653**
Total w/o I-5 and I-205	**3075**	**4507**	**4627**	**3079**	**3756**	**4571**	**4572**	**3712**	**3737**	**4145**	**4318**	**3611**	**3742**	**4091**	**4320**	**3609**
Screenline 4 - North of Evergreen Blvd																
Jefferson St north of W Evergreen Blvd	96	43	77	99	122	180	205	177	166	188	193	173	165	189	192	174
Franklin St north of W Evergreen Blvd	1	1	1	1	2	1	2	3	2	1	2	3	2	1	2	3
Columbia St north of W Evergreen Blvd	408	252	422	264	531	454	589	370	632	351	570	404	610	324	569	404
Washington St north of W Evergreen Blvd	-	374	-	284	-	956	-	655	-	703	-	533	-	655	-	533
Main St north of W Evergreen Blvd	81	8	158	57	55	23	201	42	98	4	312	7	89	4	305	7
Broadway St north of W Evergreen Blvd	0	92	0	65	0	107	0	65	0	125	0	94	0	120	0	93
C St north of W Evergreen Blvd	207	10	227	22	184	9	264	14	121	21	205	37	121	21	204	37
I-5 north of W Evergreen Blvd	2239	5252	4207	3046	3088	4997	4196	3663	2842	6794	5187	3592	2865	7112	5292	3616
Ft Vancouver Way north of W Evergreen Blvd	79	199	217	159	248	373	422	323	218	567	486	326	253	583	489	326
E Reserve St north of W Evergreen Blvd	152	179	269	156	150	223	285	201	192	223	304	206	191	220	306	206
Grand Blvd north of W Evergreen Blvd	343	440	608	329	533	449	641	347	521	367	586	348	518	367	592	353
Ft Vancouver Way north of W Evergreen Blvd	79	199	217	159	248	373	422	323	218	567	486	326	253	583	489	326
E Reserve St north of W Evergreen Blvd	152	179	269	156	150	223	285	201	192	223	304	206	191	220	306	206
Grand Blvd north of W Evergreen Blvd	343	440	608	329	533	449	641	347	521	367	586	348	518	367	592	353
N Blandford Dr north of W Evergreen Blvd	19	301	38	147	49	357	93	145	34	315	63	131	34	316	63	130
S Andresen Rd north of W Evergreen Blvd	75	59	226	39	220	83	271	44	230	78	286	43	222	79	286	43

Location	Volumes															
	Vancouver															
	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
S Lieser Rd north of W Evergreen Blvd	375	409	549	307	403	433	412	447	367	474	416	431	372	466	418	435
SE Ellsworth Rd north of W Evergreen Blvd	270	582	444	391	327	480	443	460	273	520	440	394	274	527	447	396
I-205 north of W Evergreen Blvd	2638	6205	5519	2931	4268	6557	6551	4369	4738	6707	6602	4763	4737	6701	6569	4763
Total w/ I-5 and I-205	**7554**	**15223**	**14059**	**8939**	**11111**	**16727**	**15922**	**12194**	**11364**	**18595**	**17029**	**12363**	**11416**	**18854**	**17120**	**12403**
Total w/o I-5 and I-205	**2677**	**3766**	**4332**	**2962**	**3755**	**5174**	**5176**	**4163**	**3784**	**5094**	**5241**	**4008**	**3814**	**5041**	**5259**	**4025**

	Volumes															
	Portland															
Location	**2015**				**2045 NB**				**2045 LPA 1 Aux**				**2045 LPA 2 Aux**			
	AM Peak		**PM Peak**		**AM Peak**		**PM Peak**		**AM Peak**		**PM Peak**		**AM Peak**		**PM Peak**	
	EB	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**	**EB**	**WB**
Screenline 11 - West of 99W																
N Columbia Blvd west of I-5	1331	1016	1193	1205	1438	1187	1349	1331	1429	1228	1367	1334	1424	1246	1364	1316
Argyle West of I-5	56	46	60	60	46	22	54	68	44	47	69	72	43	49	69	72
N Terry St west of Interstate	24	18	18	24	34	29	33	41	29	32	37	34	29	28	33	34
N Lombard St west of Interstate	449	288	377	414	689	578	621	604	739	596	702	613	715	615	728	606
N Buffalo St west of Interstate	73	41	54	77	84	69	88	113	87	69	85	136	86	69	89	133
N Dekum St west of Interstate	31	23	26	33	57	30	38	53	60	36	35	51	60	37	34	52
N Rosa Parks Way west of Interstate	388	358	342	443	317	255	294	408	329	282	263	401	333	285	264	389
N Ainsworth St west of Interstate	103	10	11	51	105	48	35	79	137	36	25	83	165	25	26	84
N Killingsworth St west of Interstate	10	2	0	3	0	7	0	0	4	7	0	0	4	6	0	0
N Willamette Blvd west of Interstate	83	48	61	99	99	55	72	101	97	55	71	100	97	54	71	100
N Alberta St west of Interstate	57	7	37	26	47	10	48	36	48	10	47	41	50	10	47	63
N Going St west of Interstate	230	1914	1398	322	281	1724	1189	377	278	1800	1269	391	268	1802	1264	389
Total	**2836**	**3772**	**3577**	**2756**	**3196**	**4013**	**3821**	**3211**	**3280**	**4198**	**3969**	**3256**	**3274**	**4226**	**3989**	**3238**
Screenline 12 - East of I5																
N Columbia Blvd east of I5	1032	657	728	1012	1096	790	862	1227	1330	847	912	1296	1331	754	894	1308
N Lombard St east of I5	1051	901	1088	1078	1428	1043	1273	1255	1416	1099	1279	1335	1411	1107	1280	1334
N Rosa Parks Way east of I5	448	465	541	489	263	298	387	332	306	292	407	297	303	286	391	288
N Ainsworth St east of I5	48	107	74	55	91	128	122	93	102	131	126	96	100	129	121	98
N Killingsworth St east of I5	75	363	212	122	57	207	142	68	56	225	145	110	56	213	144	108
N Alberta St east of I5	44	317	134	137	61	360	193	205	74	375	220	213	74	375	220	216
N Skidmore St east of I5	80	255	224	98	116	335	261	122	106	340	246	121	110	340	246	122
Total	**2777**	**3064**	**3001**	**2991**	**3113**	**3162**	**3241**	**3303**	**3391**	**3309**	**3335**	**3468**	**3386**	**3203**	**3297**	**3473**
Screenline 13 - East of 99E																
N Columbia Blvd east of 99E/MLK	983	1064	1075	1039	1255	1197	1240	1210	1462	1162	1210	1303	1495	1153	1203	1309
N Lombard St east of 99E/MLK	1285	1461	1410	1244	1458	1491	1446	1552	1467	1466	1439	1585	1464	1455	1440	1586
NE Dekum St east of 99E/MLK	113	169	182	123	196	219	288	223	276	211	281	264	283	202	276	265
N Ainsworth St east of 99E/MLK	127	322	286	181	262	356	357	277	293	357	365	298	298	358	364	297
N Killingsworth St east of 99E/MLK	96	246	205	134	274	479	462	358	290	447	442	367	289	434	435	366
N Alberta St east of 99E/MLK	214	430	381	269	116	222	199	126	109	220	191	129	109	214	184	128
NE Presscott St east of 99E/MLK	198	458	424	267	203	436	410	236	248	419	418	290	257	411	414	289
Total	**3017**	**4150**	**3964**	**3257**	**3763**	**4399**	**4402**	**3981**	**4145**	**4281**	**4346**	**4235**	**4195**	**4227**	**4317**	**4240**
	NB	**SB**	**NB**	**SB**	**NB**	**SB**	**NB**	**SB**	**NB**	**SB**	**NB**	**SB**	**NB**	**SB**	**NB**	**SB**
Screenline 8 - North of Columbia Blvd																
Denver Ave north of Columbia Blvd	516	570	815	554	682	668	850	726	568	685	930	539	576	758	1017	545
I-5 north of columbia Blvd HOV	1263	-	928	-	1687	-	957	-	1475	-	967	-	1488	-	985	-
I-5 north of Columbia Blvd GP	1974	5320	3400	3570	2502	5079	3377	4396	2212	5274	3264	3968	2233	5525	3326	3996
N Vancouver Ave north of Columbia Blvd	339	205	274	304	541	296	441	539	570	435	468	549	569	435	460	554

Location	Volumes															
	Portland															
	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
99E north of Columbia Blvd	908	661	756	936	1393	711	855	1361	1280	1115	1224	1335	1312	1183	1244	1341
NE 21st Ave north of Columbia Blvd	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
NE 33rd Dr north of Columbia Blvd	*520*	*74*	*172*	*310*	*1001*	*215*	*355*	*705*	*998*	*248*	*474*	*735*	*986*	*248*	*478*	*734*
NE 47th Ave north of Columbia Blvd	*485*	*500*	*394*	*512*	*625*	*528*	*482*	*696*	*762*	*530*	*483*	*738*	*747*	*498*	*482*	*738*
NE Alderwood Rd north of Columbia Blvd	*300*	*82*	*154*	*226*	*216*	*52*	*90*	*169*	*164*	*61*	*86*	*153*	*165*	*61*	*84*	*154*
NE 80th Ave north of Columbia Blvd	*154*	*37*	*67*	*153*	*170*	*43*	*78*	*225*	*166*	*45*	*76*	*226*	*166*	*45*	*76*	*226*
NE 82nd Ave north of Columbia Blvd	*626*	*158*	*235*	*242*	*820*	*267*	*417*	*568*	*902*	*291*	*416*	*591*	*909*	*286*	*417*	*592*
NE 92nd Dr north of Columbia Blvd	*0*	*0*	*1*	*0*	*23*	*3*	*8*	*10*	*23*	*3*	*7*	*12*	*23*	*3*	*7*	*12*
I-205 north of Columbia Blvd	*3198*	*6206*	*5240*	*3838*	*4962*	*6338*	*6490*	*5464*	*5436*	*6521*	*6621*	*5978*	*5430*	*6491*	*6568*	*5977*
NE 105th Ave north of Columbia Blvd	*166*	*95*	*120*	*221*	*301*	*116*	*177*	*286*	*340*	*126*	*190*	*321*	*339*	*123*	*190*	*320*
Total w/ I-5 and I-205	**10448**	**13907**	**12555**	**10868**	**14923**	**14317**	**14577**	**15144**	**14895**	**15333**	**15205**	**15144**	**14943**	**15654**	**15336**	**15188**
Total w/o I-5 and I-205	**4013**	**2381**	**2987**	**3460**	**5772**	**2899**	**3753**	**5285**	**5773**	**3538**	**4353**	**5198**	**5792**	**3638**	**4456**	**5216**
Screenline 9 - North of N Rosa ParksWay & South of N Lombard St																
N Greeley Ave north of N Rosa ParksWay	137	297	391	132	279	382	447	284	283	416	482	216	280	435	499	217
N Delaware Ave north of N Rosa ParksWay	11	25	25	22	3	30	36	20	7	30	33	20	7	30	32	21
N Denver Ave north of N Rosa ParksWay	4	24	33	0	11	4	31	2	10	18	39	0	10	27	38	0
99W north of N Rosa ParksWay	242	567	632	198	557	524	584	338	543	532	610	302	537	552	610	304
I-5 north of N Rosa ParksWay HOV	1573	-	1350	-	1794	-	1424	-	1701	-	1471	-	1720	-	1475	-
I-5 north of N Rosa ParksWay GP	2751	5993	3782	4815	3161	5796	3741	5410	2993	5935	3638	5202	3012	6045	3691	5219
N Albina Ave north of N Rosa ParksWay	37	268	244	124	149	266	204	363	105	303	253	302	91	304	265	305
N Vancouver Ave north of N Rosa ParksWay	100	162	108	121	120	142	115	181	112	240	131	153	112	252	128	151
99E north of N Rosa ParksWay	697	1032	992	694	1147	883	971	1162	1131	1084	1135	1119	1123	1107	1143	1117
NE 15th Ave south of NE Dekum St	73	50	56	78	188	76	85	172	149	80	86	160	150	79	86	160
NE 27th Ave south of NE Dekum St	131	74	93	130	229	70	114	204	227	96	132	202	224	103	131	204
NE 33rd Ave south of NE Dekum St	329	219	273	378	542	237	341	529	542	266	382	509	542	273	389	509
NE 42nd Ave south of N Lombard St	464	263	360	445	480	218	321	416	481	239	310	403	483	250	315	406
NE 60th Ave south of N Lombard St	182	52	60	151	247	81	109	215	236	87	115	205	238	91	116	205
NE Cully Blvd south of N Lombard St	148	26	54	125	211	34	89	157	220	34	89	139	221	36	89	140
NE Killingsworth St south of N Lombard St	178	138	115	206	193	127	64	244	176	129	69	265	173	124	68	265
Total w/ I-5	**7057**	**9188**	**8567**	**7619**	**9311**	**8869**	**8676**	**9697**	**8915**	**9488**	**8974**	**9197**	**8921**	**9708**	**9076**	**9222**
Total w/o I-5	**2733**	**3195**	**3435**	**2803**	**4355**	**3073**	**3511**	**4286**	**4221**	**3553**	**3865**	**3995**	**4189**	**3663**	**3909**	**4003**
Screenline 10 - North of N Skidmore St/ NE Prescott St																
N Greeley Ave north of N Skidmore St	317	1039	926	530	618	978	923	697	606	1021	959	671	604	1040	965	675
99W north of N Skidmore St	285	770	885	256	409	755	870	439	378	769	881	356	382	774	885	358
I5 north of N Skidmore St (HOV)	1651	-	1393	-	1924	-	1489	-	1860	-	1543	-	1866	-	1552	-
I5 north of N Skidmore St	2693	5573	3578	4574	2979	5286	3491	5093	2907	5407	3521	4954	2909	5467	3540	4958
I-5 ramps	382	1178	824	521	569	1066	828	683	594	1154	837	683	593	1169	842	684
N Albina Ave north of N Skidmore St	142	318	341	218	198	259	319	235	168	257	342	225	170	281	349	226

Location	Volumes															
	Portland															
	2015				2045 NB				2045 LPA 1 Aux				2045 LPA 2 Aux			
	AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak		AM Peak		PM Peak	
	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB
N Vancouver Ave north of N Skidmore St	-	465	-	321	-	489	-	485	-	527	-	463	-	540	-	467
N Williams Ave north of N Skidmore St	440	-	675	-	693	-	701	-	618	-	745	-	617	-	753	-
99E north of N Skidmore St	460	927	821	660	948	983	890	1110	894	1114	939	1034	894	1140	950	1038
NE 7th Ave north of NE Prescott St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NE 15th Ave north of NE Prescott St	162	243	288	171	286	236	293	253	269	269	325	232	266	278	331	231
NE 27th Ave north of NE Prescott St	101	119	140	107	161	195	232	195	156	216	248	180	157	226	252	182
NE 33rd Ave north of NE Prescott St	248	233	248	260	414	296	347	374	398	327	374	368	397	337	377	368
NE 42nd Ave north of NE Prescott St	462	370	439	468	453	339	395	456	444	368	403	436	445	380	408	436
NE 60th Ave north of NE Prescott St	208	114	114	181	277	150	171	244	267	158	175	237	268	162	180	237
NE Cully Blvd north of NE Prescott St	227	150	132	235	353	199	181	354	344	218	179	356	343	223	183	356
NE 72nd Ave north of NE Prescott St	65	24	32	44	97	56	85	94	92	69	99	94	87	69	99	94
NE 82nd Ave north of NE Prescott St	991	478	518	694	1311	565	709	1086	1315	587	716	1135	1325	583	718	1136
NE 89th Ave north of NE Prescott St	42	7	0	23	52	8	14	22	52	8	14	44	54	8	14	41
NE Sandy Blvd north of NE Prescott St	319	1074	858	535	749	1047	979	804	881	1028	1004	947	880	1005	988	948
I-205 north of NE Prescott St	3870	6050	5009	4811	5341	6367	5945	6030	5593	6527	6023	6304	5598	6529	5985	6306
I-205 ramp	1034	-	376	-	740	-	325	-	647	-	324	-	647	-	337	-
NE 96th Ave north of NE Prescott St	0	3	0	6	0	1	0	0	0	1	0	0	0	1	0	0
NE 102nd Ave north of NE Prescott St	310	222	252	505	719	306	418	645	790	263	435	624	793	280	425	628
NE 105th Ave north of NE Prescott St	48	4	15	49	53	5	8	50	52	5	8	50	52	5	8	50
Total w/ I-5 and I-205	**14459**	**19359**	**17863**	**15168**	**19344**	**19588**	**19612**	**19347**	**19326**	**20295**	**20093**	**19395**	**19347**	**20497**	**20142**	**19416**
Total w/o I-5 and I-205	**4829**	**6558**	**6683**	**5261**	**7791**	**6868**	**7535**	**7542**	**7725**	**7207**	**7845**	**7453**	**7733**	**7333**	**7886**	**7468**

VISSIM Model Confidence and Calibration Report

September 2024

Oregon

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VISSIM Model Confidence and Calibration Report

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

FHWA	Federal Highway Administration
IBR	Interstate Bridge Replacement
LPA	Locally Preferred Alternative
lrt	light-rail transit
ODOT	Oregon Department of Transportation
RITIS	Regional Integrated Transportation Information System
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

This technical report documents the methods used to calibrate the VISSIM traffic operations models for the Interstate Bridge Replacement Program (IBR Program) and summarizes the confidence and calibration results. This report demonstrates that the VISSIM models used for the IBR Program analysis satisfy the requirements outlined in FHWA's Guidelines for Applying Traffic Microsimulation Modeling Software.[1] This report provides a brief overview of existing traffic operations in the IBR Program area, describes the VISSIM model extents, the analysis year, the time periods analyzed, the data used to develop and calibrate the VISSIM models, and the model outputs as they relate to the confidence and calibration metrics outlined in the FHWA, protocols.

Interstate 5 (I-5) provides a critical connection between Oregon and Washington that supports local jobs and families and is a vital trade route for regional, national, and international economies. It also serves as a vital community connection in the Portland-Vancouver region, with the Interstate Bridge comprising one of only two crossings of the Columbia River, serving the metropolitan area that spans both states. In the study area, the current Interstate Bridge across the Columbia River consists of two dual lift bridges, which opened to traffic in 1917 and 1958.

Replacing the existing structurally and operationally deficient bridges with seismically resilient structures that meet the future transportation needs of the growing Portland and Vancouver metropolitan region is a high priority for Oregon and Washington. The closely spaced interchanges north and south of the bridge would also be reconfigured as part of the proposed Modified Locally Preferred Alternative (LPA).

Transportation challenges within the study area include seismic vulnerability; closely spaced interchanges; impaired freight movement; limited public transportation options, connectivity, and travel time reliability; substandard bicycle and pedestrian facilities; high crash rates; bridge lift delays; substandard travel lane widths and lack of shoulders; growing travel demand and congestion; and impact to aquatic habitat from stormwater runoff. The IBR Program would replace the aging Interstate Bridge across the Columbia River with seismically resilient, multimodal structures; expand light-rail transit (LRT) into Vancouver; enhance zero emission express bus service and associated transit improvements; expand active transportation facilities for walking, biking, and rolling; and implement other improvements along 5 miles of I-5, including improvements to seven interchanges.

[1] The Washington State Department of Transportation and the Oregon State Department of Transportation also provide protocol for developing and calibration VISSIM models. These protocols are based on FHWA's guidelines. While the FHWA guidelines were used to demonstrate calibration and confidence, the WSDOT and ODOT procedures are included in Attachment A for informational purposes only.

2. IBR VISSIM MODEL OVERVIEW

This section introduces and provides a high-level overview of traffic operations in the IBR Program study area. The overarching characteristics of the VISSIM model are also discussed, including the extents of the VISSIM model, the analysis year, and the analysis time periods. More detailed information about the VISSIM base model development is presented in Section 3, VISSIM Model Development.

2.1 IBR Program Area

The IBR Program area is the approximately 5-mile section of I-5 between the SR 500/39th Street interchange in Vancouver and the Interstate Avenue/Victory Boulevard interchange in Portland (see Figure 1). It includes seven interchange areas: SR 500/39th Street, Fourth Plain Boulevard, Mill Plain Boulevard, City Center/SR 14, Hayden Island, Marine Drive, and Interstate Avenue/Victory Boulevard. The transportation system near the Interstate Bridge is complex, with a diverse array of elements including freeways, highways, local roads, transit, and active transportation networks.

Within the IBR Program study area, I-5 is classified as an Urban Interstate and a Highway of Statewide Significance by WSDOT and as an Interstate by ODOT. I-5 is the primary north-south limited-access corridor for regional, interstate, and international personal travel and commerce, including travel across the Columbia River. It has six travel lanes and a posted speed limit of 50 miles per hour (mph) across the bridge, 60 mph in Washington north of the bridge, and 55 mph in Oregon south of the bridge. The I-5 corridor near the Interstate Bridge experiences multiple recurring bottlenecks with congestion effects overlapping between bottlenecks throughout the day.

2.2 VISSIM Model Extents, Analysis Year, and Analysis Time Periods

A VISSIM microsimulation model was selected as the preferred analysis tool because it allows the IBR Program to capture the impacts to I-5 of proposed changes within the study area and account for the interaction between the overlapping bottlenecks on the I-5 corridor in the vicinity of the study area over multiple hours during the morning and evening commute periods. VISSIM is a stochastic traffic simulation that uses driver behavior models. Individual vehicles are modeled with assigned characteristics and parameters selected from a coded distribution. Based on the assigned parameters and characteristics, each vehicle interacts with the coded network elements (such as signals and stop signs), as well as other vehicles. VISSIM allows for the analysis of time-dynamic congestion patterns and captures the interaction between geographically separate bottlenecks with overlapping congestion patterns.

An existing year transportation analysis is typically completed for the current year based on data collected at the time the study is conducted or on recent historical data (within the past 3 years). The COVID-19 pandemic and the widespread restrictions put in place by both Oregon and Washington in 2020 and 2021 altered historical travel patterns and trends, traffic volumes, and transit ridership. In the immediate aftermath of the closures and travel restrictions that began in March 2020, traffic volumes and transit ridership dropped substantially below historical levels. Traffic volumes began to increase as restrictions gradually eased over the following 3 years. The IBR Program is following industry standards by using long-term travel forecasts to analyze future conditions. These forecasts are based on historical trends observed over a long period of time rather than short-term phenomena such as the COVID-19 pandemic or the rise in gas prices in mid-2022. Therefore, the IBR Program is using 2019 as the baseline year for model calibration.

The VISSIM models for the IBR Program include a longer section of I-5 than the 5-mile IBR Program area shown in Figure 1. The VISSIM models for the IBR Program extend from the I-205 interchange in Vancouver to the Marquam Bridge in Portland, approximately 17 miles as shown in Figure 2. The VISSIM models for the IBR Program include a longer section of I-5 to account for the congestion impacts that extend beyond the 5-mile study area, and to account for bottlenecks outside the IBR Program study area that cause congestion to spill back into the study area.

The VISSIM models include mainline sections; on- and off-ramps; and merge, diverge, and weaving areas in the 17-mile freeway analysis area. Ramp meters at on-ramps are included in the VISSIM models. At off-ramps, the signalized or stop-controlled approach at the end of the off-ramp is included in the VISSIM models.

Travel patterns in the study area follow typical commuter patterns, meaning that the roadway reaches and often exceeds capacity during weekday mornings, when many people travel from home to work, and during weekday evenings, when many people travel from work to home. Travel in the study area also has a directional peak component, with heavy volumes and congestion in the southbound direction during the morning commute, and heavy volumes and congestion in the northbound direction during the evening commute. The study period for the VISSIM models represents the weekday morning peak period from 6 to 10 a.m. and the evening peak period from 3 to 7 p.m.

Two VISSIM models were developed for the IBR Program: one for the 4-hour AM peak period and one for the 4-hour PM peak period. These two VISSIM models include both directions of travel on I-5 (northbound and southbound). Baseline VISSIM models were developed representing existing year 2019 traffic conditions. The existing 2019 models serve as the basis for modeling the future year No-Build Alternative and Modified LPA.

Figure 1. IBR Program Area

Figure 2. Freeway Analysis Area

3. VISSIM MODEL DEVELOPMENT

This section discusses the details of the VISSIM model development process, including data collection, base model development, and error checking.

3.1 Data Collection

The VISSIM model development required geometric, traffic control, and traffic flow data at the I-5 mainline and ramps along the 17-mile freeway analysis area shown in Figure 2. The geometric and traffic control data provide information about the network to be coded in the VISSIM model. The traffic flow data include traffic volume counts, which inform the input volumes used in the model and which are compared against model output volumes to verify the calibration and confidence of the model (discussed in Section 4). Traffic flow data also include speed and travel time data, which are also used to verify the calibration and confidence of the model. Details about key data used to develop the model are provided below.

3.1.1 Geometric Data

Scaled aerial photographs covering all 17 miles of the VISSIM model extents were collected. Geometric data collected included the location of on-ramps and off-ramps, the number of lanes, lane additions, lane drops, auxiliary lanes, highway curvature, weaving sections, and ramp meter locations.

3.1.2 Traffic Control Data

Traffic signal timing plans for the signalized ramp intersections, along with ramp meter rates and operating times, were obtained from ODOT and WSDOT. The existing signal timing plans were used to code the red and green times at the signal heads at the end of each off-ramp, and the ramp meter operating times and rates were used to code the ramp meters in the model.

Posted speed limits were also collected via map street views and field visits. The posted speed in Washington, north of the Interstate Bridge, is 60 mph. The posted speed on the bridge and immediately north and south of the bridge is 50 mph. The posted speed in Oregon, south of the Interstate Bridge, is 55 mph.

3.1.3 Traffic Flow Data

3.1.3.1 Volume Data

Traffic volume data were collected at I-5 mainline and ramp locations in the freeway analysis area. Both WSDOT and ODOT maintain permanent data collection stations along the major freeways in the Portland and Vancouver metropolitan area. These permanent data collection stations collect data 24 hours a day, 7 days a week, 365 days a year. Within the IBR freeway analysis area, ODOT and WSDOT maintain four permanent count locations. The four locations include I-5 south of the SR 500 interchange in Vancouver, the Interstate Bridge, I-5 near the Rosa Parks interchange in Portland, I-5 at the Marquam Bridge in Portland.

The IBR team collected hourly volume data for the entire year for 2019. The permanent traffic count data were then filtered to estimate average weekday daily traffic volumes in 2019. The filtering process excluded data that did not reflect typical weekday conditions, including:

- Mondays and Fridays (typically excluded from average weekday traffic counts because they often exhibit significantly different traffic patterns compared to other weekdays).
- Holidays and days before or after holidays with atypical traffic volumes.
- Days where incidents, crashes, weather, or other events caused atypical traffic volumes.

This filtering process produced mainline volumes at four locations that reflect average weekday travel patterns approaching the Interstate Bridge associated with commute traffic during the critical time periods and directions (southbound during the AM peak period and northbound during the PM peak period).

WSDOT and ODOT also perform short-duration counts at ramps, and the most recent of these (2019 or earlier) within the freeway analysis area were used to supplement the data collected at the permanent count locations on the I-5 mainline. The ramp counts available were collected over different times of the year for different time periods, ranging from days to weeks. The ramp counts were summarized for average weekdays (Tuesdays through Thursdays), similar to the permanent traffic counts. WSDOT ramp counts contained adjustment factors that accounted for seasonal adjustments and axle correction factors. New 3-day tube counts were also collected at all ramps in the IBR Program area.

The granularity of data available varies by location; all mainline locations and some ramp locations are only available on an hourly basis, but 15-minute flow data are available at some ramps, and these locations were used to develop 15-minute volume flows at all volume inputs in the VISSIM model.

3.1.3.2 Speed and Travel Time Data

Similar to volume data, INRIX speed and travel time data were collected for the freeway analysis area for Tuesday through Thursday for 2019 using the Regional Integrated Transportation Information System (RITIS). The speed and travel time data are ultimately compared to the VISSIM model output to ensure congestion patterns and bottleneck locations in the VISSIM model reflect congestion patterns and bottleneck locations identified with the INRIX data (see Section 4.1.2, Calibration Results).

In the IBR freeway analysis area, there are locations where the freeway is congested for multiple hours during the peak periods. Multiple bottlenecks exist in the freeway analysis area and overlap at different time periods. Figure 3 and Figure 4 illustrate the peak hour travel speeds on major highways in the Portland and Vancouver Metropolitan Region, providing a snapshot of peak period congestion patterns. Figure 3 shows travel speeds into Portland (southbound and westbound) during the AM peak hour, and Figure 4 shows travel speeds leaving Portland (northbound and eastbound) during the PM peak hour.

Figure 3. Observed 2019 Average Travel Speed – Southbound/Westbound – AM Peak Hour

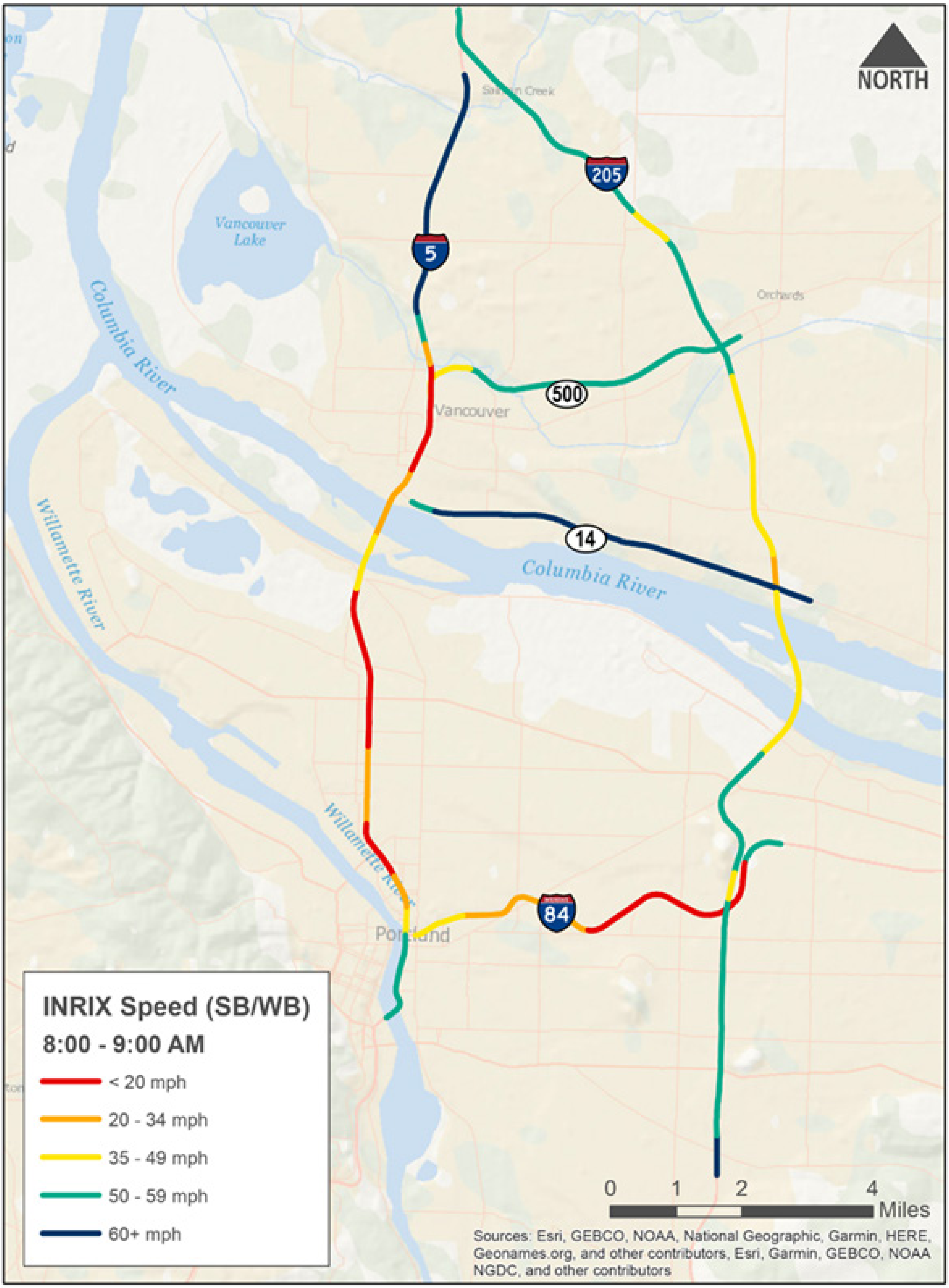
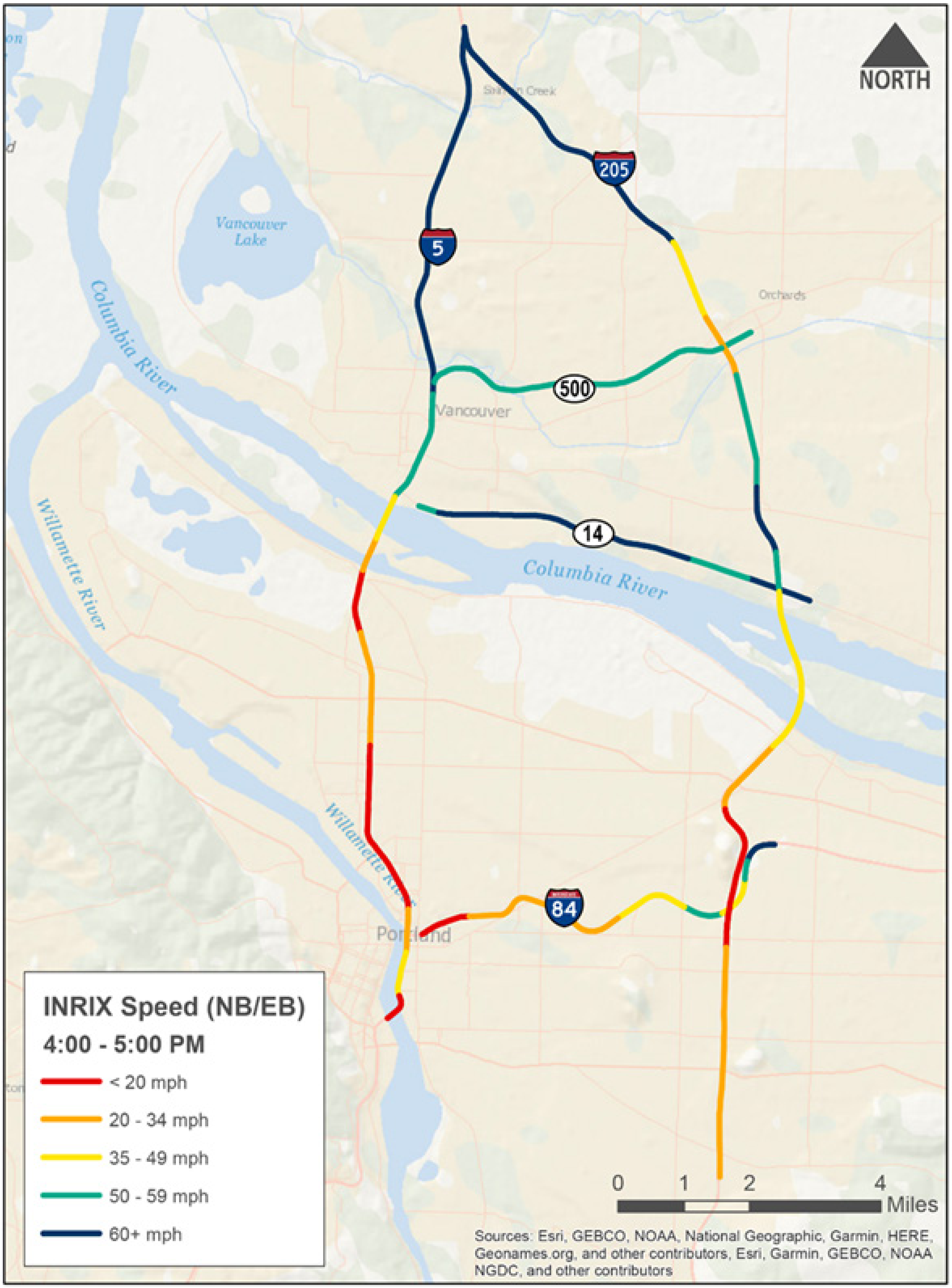


Figure 4. Observed 2019 Average Travel Speed – Northbound/Eastbound – PM Peak Hour



The Interstate Bridge is a bottleneck on the I-5 corridor causing congestion that lasts for multiple hours during the weekday commute periods. ODOT and WSDOT define congestion as speeds below a certain threshold. ODOT has historically defined congestion as when travel speeds drop below 75% of the posted speed limits due to constrained conditions (for example, speeds slower than 45 mph in an area with a posted speed of 60 mph). In the CRC EIS analysis, congestion was defined as occurring when travel speeds were below 35 mph. ODOT is finalizing a white paper in the fall/winter of 2023 to document the definition of congestion and severe congestion. Based on early findings, which are subject to revision before the white paper is finalized, ODOT defines congestion as highway speeds below 45 mph and severe congestion defined as speeds below 35 mph. ODOT is coordinating this updated congestion definition with WSDOT. Therefore, the IBR Program has defined congestion as speeds below 45 mph.

In the southbound direction, the Interstate Bridge bottleneck experiences 3 hours of congestion between 6 and 9 a.m. This congestion extends from the Interstate Bridge back to the SR 500/39th Street interchange. The congestion at the Interstate Bridge is caused by the bridge's limited capacity, limited sight distance, substandard shoulders, short merge and diverge locations north and south of the bridge, heavy on- and off-ramp flows north of the river, and heavy truck volumes. A second southbound bottleneck starts south of the study area but affects traffic speeds from the start of the bottleneck near the I-5/I-405 split in North Portland and the Marine Drive interchange. This second bottleneck experiences 6.5 hours of congestion between 6:30 a.m. and 1 p.m. The congestion at the I-5/I-405 split in North Portland is caused primarily by capacity restrictions, as well as by heavy merging, diverging, and weaving flows at adjacent ramps. A third southbound bottleneck through the Rose Quarter experiences congestion for 12.5 hours from 7:15 a.m. to 7:45 p.m. The congestion at the Rose Quarter is caused primarily by capacity restrictions where I-5 is reduced from three to two travel lanes.

In the northbound direction, the Interstate Bridge bottleneck lasts for 8.75 hours between 11:15 a.m. and 8 p.m. The congestion extends south from the Interstate Bridge and influences traffic flows south of the study area for 10 plus miles into downtown Portland. The northbound congestion occurs for similar reasons as the southbound Interstate Bridge congestion, including limited bridge capacity; limited sight distance; substandard shoulders; short merge and diverge locations north and south of the bridge; heavy merging, diverging, and weaving flows of traffic; and heavy freight flows.

The location, time of day, duration, and geographic extent of the congestion are summarized in Table 1. The extents shown in Table 1 reflect the maximum extent of the congestion over the 16 hours.

Table 1. Weekday Bottleneck Locations when Speeds are Below 45 mph – 2019 Existing Conditions

Location	Time of Day	Duration	Maximum Extent
Southbound			
Interstate Bridge	6–9 a.m.	3 hours	3 miles
I-5/I-405 Split in North Portland	6:30 a.m.–1 p.m.	6.5 hours	3 miles
Rose Quarter	7:15 a.m.–7:45 p.m.	12.5 hours	3 miles
Northbound			
Interstate Bridge	11:15 a.m.–8 p.m.	8.75 hours	10+ miles

Source: IBR VISSIM Analysis.

3.2 Base Model Development

The model was developed in VISSIM version 23. The existing VISSIM model was developed by overlaying network elements on the aerial images, and then updated as necessary where the aerial imagery was inconsistent with the roadway configuration in 2019. Additional details including posted speed limits, reduced speed areas, grades, ramp meter rates, and signals at off-ramp terminals were incorporated into the VISSIM network.

The network was coded with the speed profiles, ramp reduced-speed zones, signals and stop signs at ramp terminals, and vehicle compositions at each mainline, entrance and exit ramp per the existing volume sets. Peak-specific parameters, including signal timings at ramp terminals, truck percentages, and a high-occupancy vehicle lane in the northbound direction for 3 hours during the PM peak period, were included in each model. Truck percentages along I-5 were based on data provided by WSDOT and ODOT and counts collected at on- and off-ramps. Grades were incorporated along the I-5 corridor and at ramps where grades were higher than 3%. Ramp meters were coded at on-ramps.

From the collected turning movement counts at the ramp terminals and mainline permanent and automatic traffic recorders, 15-minute interval demand volumes were developed for the study area for the entire 4-hour period. This volume set was converted to origin-destination static routes in 15-minute interval demand increments. Origin-destination routes assign each vehicle a terminus location upon entering a model. Usage of origin-destination routes simulates typical driving behaviors and reduces unnecessary and last-minute lane changes within the model since the static routes were long from end to end and span the entire network with origin routes having destination pairs at every ramp.

Initial adjustments were made to the off-ramp lane change distance parameters prior to calibration to achieve reasonable positioning behavior upstream of off-ramps. At locations where congestion occurs upstream of an off-ramp, lane change distances were set to be relatively short, allowing vehicles to use the inside lanes to bypass congestion then begin changing lanes shortly upstream of the off-ramp.

At locations where mainline freeway lanes drop or merge, lane change distances were set to be relatively long, keeping vehicles making through-trips in the inside lanes.

Each base model has a seeding period of 1 hour and an analysis interval of 4 hours for a total model run time of 5 hours. Model outputs were summarized for 4 hours for the AM peak model and 4 hours for the PM peak model.

3.3 Error Checking

The input data, parameters, and base model output were reviewed to ensure reasonableness.

The review involved checking the basic network connectivity and coded geometry. Errors or inconsistencies were corrected. Additionally, static network displays were used to validate lane configurations, lane use, lane alignment, and lane drops, while ensuring the consistency of link attributes, such as free-flow speed.

Vehicle inputs were checked against collected volumes to ensure correct input volumes at network entrances. Vehicle behavior at off-ramp terminal traffic signals and on-ramp meters was reviewed, and issues with phasing, signal settings, or vehicle behavior were addressed.

Animation was used to visually check the model's performance. Initial runs with reduced demand volumes were conducted to check for smooth vehicle travel without slowdowns. Subsequently, traffic demands were increased, ultimately to match the existing demand volume set, and animation was used to visually confirm that operations, speed, and congestion patterns were consistent with model output data. Modeled traffic patterns and congestion at interchange ramp terminals were adjusted to ensure modeled vehicle behavior reflected field conditions. Coding issues identified through the animation were corrected.

The review of input data and parameters, along with the examination of animation, contributed to the overall accuracy and reliability of the model.

4. MODEL CALIBRATION AND CONFIDENCE

This section describes the calibration of the base model to match existing conditions, and the confidence that the model output reflects the true average of the model output.

Calibration refers to how closely the model output matches field conditions. Based on the data collected in the field, FHWA provides procedures to calculate acceptable ranges for the model output. The base model, described in Section 3, was adjusted so that the model output fell within the ranges identified by FHWA. The findings related to FHWA are presented within this section, while the results for WSDOT and ODOT are provided in Attachment A.

Confidence refers to the certainty that the model output reflects the true average of the model. The VISSIM model was run multiple times and produced results that varied from run to run. A confidence level of 90% was selected. From that confidence level, the minimum number of times the model needed be run was determined.

4.1 Calibration

This section documents the VISSIM model calibration process results and shows that the VISSIM model was sufficiently calibrated for vehicle throughput at the Interstate Bridge, travel times, and spot speeds per the criteria outlined in FHWA's guidelines. Vehicle throughputs from the VISSIM model met FHWA's guidelines for the 4-hour modeled peak period, detailed below. VISSIM model AM and PM peak period travel times also met the criteria outlined in the FHWA's guideline, and "heat maps" that show the peak period speeds in the freeway analysis area demonstrate that typical congestion patterns seen in the RITIS data are replicated in the VISSIM model.

4.1.1 Calibration Parameters

The calibration process involves adjusting model parameters to get the model to replicate field conditions. An iterative process of making model adjustments and comparing the VISSIM model outputs to the field collected data was conducted to meet the calibration criteria targets.

Default driver behaviors were initially set on all links. Driver behaviors were refined through an iterative process to match the model outputs to the field throughputs and RITIS data speeds and travel times. The primary parameters that were adjusted to achieve calibration were two driving behavior parameters: the standstill distance between vehicles (CC0), and the headway factor (CC1). The lane-change positioning distances at off-ramps set during the base model development were also iteratively adjusted.

4.1.2 Calibration Results

This section documents the calibration targets and the results of the calibration process for throughput volume, travel times, and spot speeds per FHWA's guidelines.

4.1.2.1 Vehicle Throughput

A comparative analysis of vehicle throughput results between the field and the model was conducted at the Interstate Bridge, which is the primary bottleneck location during the 4-hour modelled peak periods. The GEH statistical parameter was chosen as the metric for this comparison. FHWA's Guideline for Applying Traffic Microsimulation Modelling Software (Publication No. FHWA-HRT-04-040) does not specify particular criteria for GEH targets. WSDOT and ODOT do provide targets: a GEH value below 3.0 for WSDOT and a GEH value below 5.0 for ODOT. The more stringent standard of 3.0 was used for this analysis. The GEH statistic is computed as follows:

$$GEH = \sqrt{\frac{2(E - V)^2}{(E + V)}}$$

Where:

E = Model estimated volume

V = Field Count

Table 2 and Table 3 indicate the field counts, and model estimated volumes as well as the calculated GEH statistic values for AM and PM models respectively:

Table 2. Vehicle Throughput Calibration Results – IBR Bridge – AM Peak

Parameter	6:00 AM to 7:00 AM	7:00 AM to 8:00 AM	8:00 AM to 9:00 AM	9:00 AM to 10:00 AM
SB Direction				
Field Count Data (Veh)	5530	4990	4290	4280
VISSIM Service Volume (Veh)	5322	5198	4213	4088
GEH Statistic	**2.8**	**2.9**	**1.2**	**3.0**
NB Direction				
Field Count Data (Veh)	2495	3320	3175	3200
VISSIM Service Volume (Veh)	2426	3287	3236	3127
GEH Statistic	**1.4**	**0.6**	**1.1**	**1.3**

Source: IBR VISSIM Analysis.

Table 3. Vehicle Throughput Calibration Results – IBR Bridge – PM Peak

Parameter	3:00 PM to 4:00 PM	4:00 PM to 5:00 PM	5:00 PM to 6:00 PM	6:00 PM to 7:00 PM
SB Direction				
Field Count Data (Veh)	3735	4135	4230	3475
VISSIM Service Volume (Veh)	3715	4080	4256	3494
GEH Statistic	**0.3**	**0.9**	**0.4**	**0.3**
NB Direction				
Field Count Data (Veh)	4745	4810	4785	4640
VISSIM Service Volume (Veh)	4766	4778	4729	4543
GEH Statistic	**0.3**	**0.5**	**0.8**	**1.4**

Source: IBR VISSIM Analysis.

The data presented in the tables above demonstrate that the GEH statistic for VISSIM service volume at the Interstate Bridge falls within the acceptable range during both the AM and PM peak periods.

4.1.2.2 Travel Time

The process of travel time calibration fine-tunes both the global and link-specific parameters within the simulation model to accurately replicate local field measurements of travel time. The calibration aims to identify a set of model parameters that allow model travel times to closely match the observed field travel time data. The travel time calibration procedure is structured as follows:

1. Gather field measurements of travel time segments within the study area.
2. Generate model-based estimates of the same travel time segments within the study area.
3. Specify a confidence level to determine the confidence interval for the field travel time data.
4. Compute the confidence interval based on the chosen confidence level.
5. Estimate the variation envelope to encapsulate the range of field travel times.
6. Evaluate whether the model's average travel time falls within the variation envelope of the observed field travel times.

Selection of Study Area for Travel Time Calibration

The following segments were selected for travel time calibration due to their consistent congestion during peak conditions, and their proximity to the primary bottleneck location at the Interstate Bridge:

1. Northbound I-5: From north of the Lombard WB off-ramp to just south of the Hayden Island off-ramp.
2. Southbound I-5: From north of the Main St. off-ramp to north of the SR-14 on-ramp.

Field and Model Measurements of Travel Time

The calculation of field travel time relied on field data from RITIS to compute average travel times and travel time standard deviations for subsequent standard error calculations, leveraging a dataset encompassing 144 weekdays. The VISSIM model underwent 15 iterations to derive model average field travel times and travel time standard deviations. A comprehensive evaluation of the adequacy of the number of iterations is presented later Section 4.2. The outcomes of the travel time calibration are presented in Table 4.

Table 4. Field and Model Measurements of Travel Time – Study Area selected for Travel Time Calibration

Parameter	AM	PM
Number of Observations (days)	144	144
Field Average Travel Time (min)	8.97	10.39
Field Travel Time Standard Deviation (min)	5.69	2.87
Model Average Travel Time (min)	10.16	10.92
Model Travel Time Standard Deviation (min)	1.19	0.31

Source: RITIS and IBR VISSIM Analysis.

Calculate Confidence Interval for Field Average Travel Time

Appendix B of FHWA's Guideline for Applying Traffic Microsimulation Modelling Software (Publication No. FHWA-HRT-04-040) provides details on calculating confidence interval for true mean. To compute the confidence interval, a confidence level of 90% was established. Confidence interval is calculated using the following formula:

$$CI_{1-\alpha\%} = 2 * t_{\left(1-\frac{\alpha}{2}\right),N-1} \frac{s}{\sqrt{N}}$$

Where:

$CI_{1-\alpha\%}$ = Confidence Interval for the true mean, where α equals the probability of the true mean not lying within the confidence interval

$t_{\left(1-\frac{\alpha}{2}\right),N-1}$ = Student's t-statistic for two-sided error of summing to α with N-1 degrees of freedom, N equals the number of observations (i.e., 144 days)

s = Standard Deviation about the mean for selected MOE (i.e., field travel times)

Applying the confidence interval formula, the confidence interval for the true field average travel times was calculated, and the results are tabulated in Table 5 below.

Table 5. Confidence Interval for Field Average Travel Time – Study Area selected for Travel Time Calibration

Parameter	AM	PM
Number of Observations (days)	144	144
Confidence Interval for Field Average Travel Time (min)	1.57	0.79
Field Average Travel Time Upper Limit (min)	10.54	11.18
Model Average Travel Time (min) Within Variation Envelope?	10.16 Yes	10.92 Yes
Field Average Travel Time Lower Limit (min)	7.40	9.60

Source: RITIS and IBR VISSIM Analysis.

The VISSIM model average travel time falls within the variation envelope, indicating the VISSIM model is calibrated to travel times approaching the Interstate Bridge during the peak periods.

4.1.2.3 Spot Speeds (Congestion Diagrams)

Congestion diagrams were generated from the model output to visually confirm that the bottleneck locations in the model aligned with bottleneck locations in the field. The VISSIM congestion diagrams were compared to RITIS speed data congestion diagrams. The congestion diagram comparisons presented below illustrate that the congestion patterns in the VISSIM model are a close match to the congestion patterns in the RITIS data. Figure 5 through Figure 8 show the congestion diagrams for each peak and direction.

Figure 5. RITIS Data and VISSIM Output Speed Map Comparison – Southbound I-5 AM Peak Period

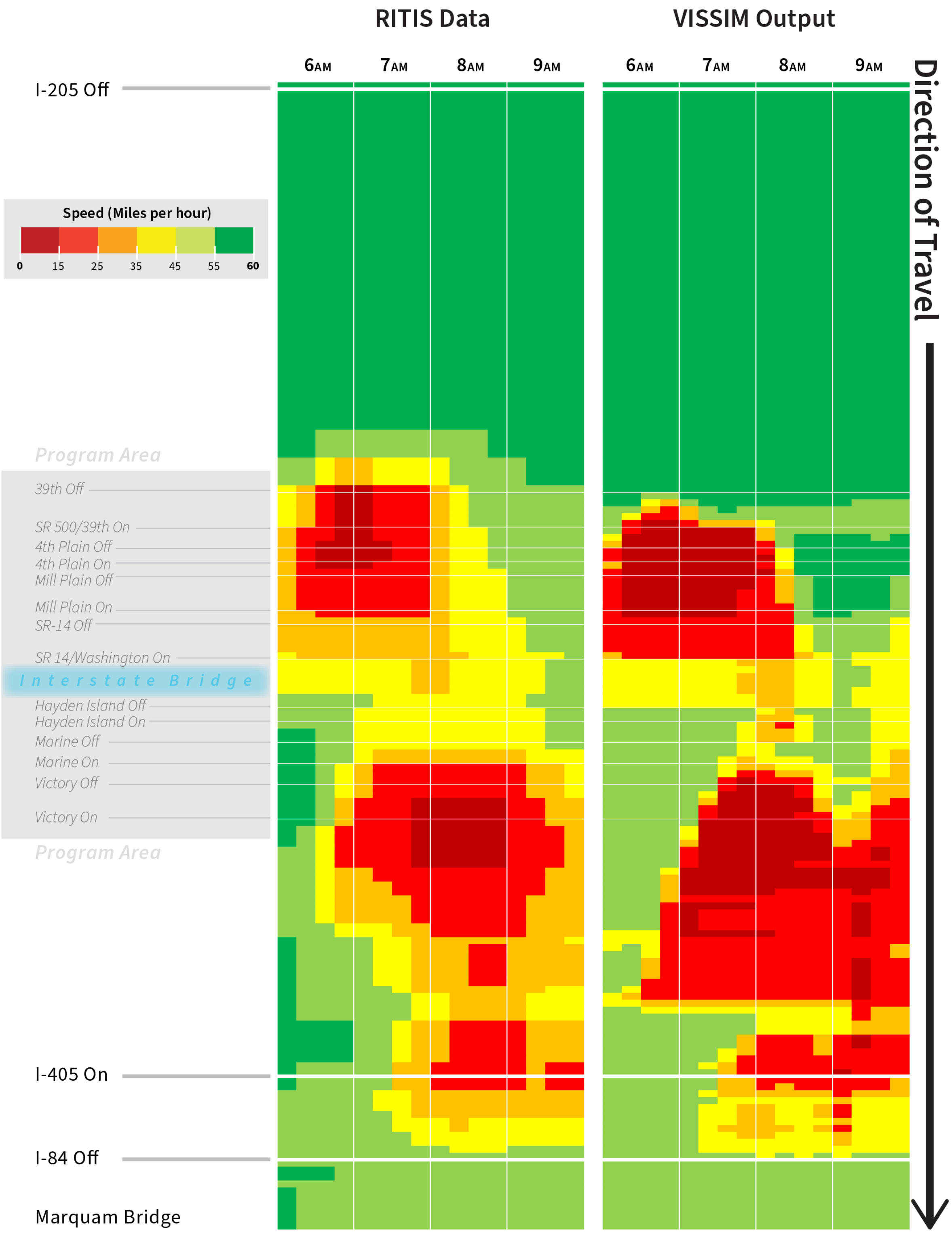


Figure 6. RITIS Data and VISSIM Output Speed Map Comparison – Northbound I-5 AM Peak Period

Figure 7. RITIS Data and VISSIM Output Speed Map Comparison – Southbound I-5 PM Peak Period

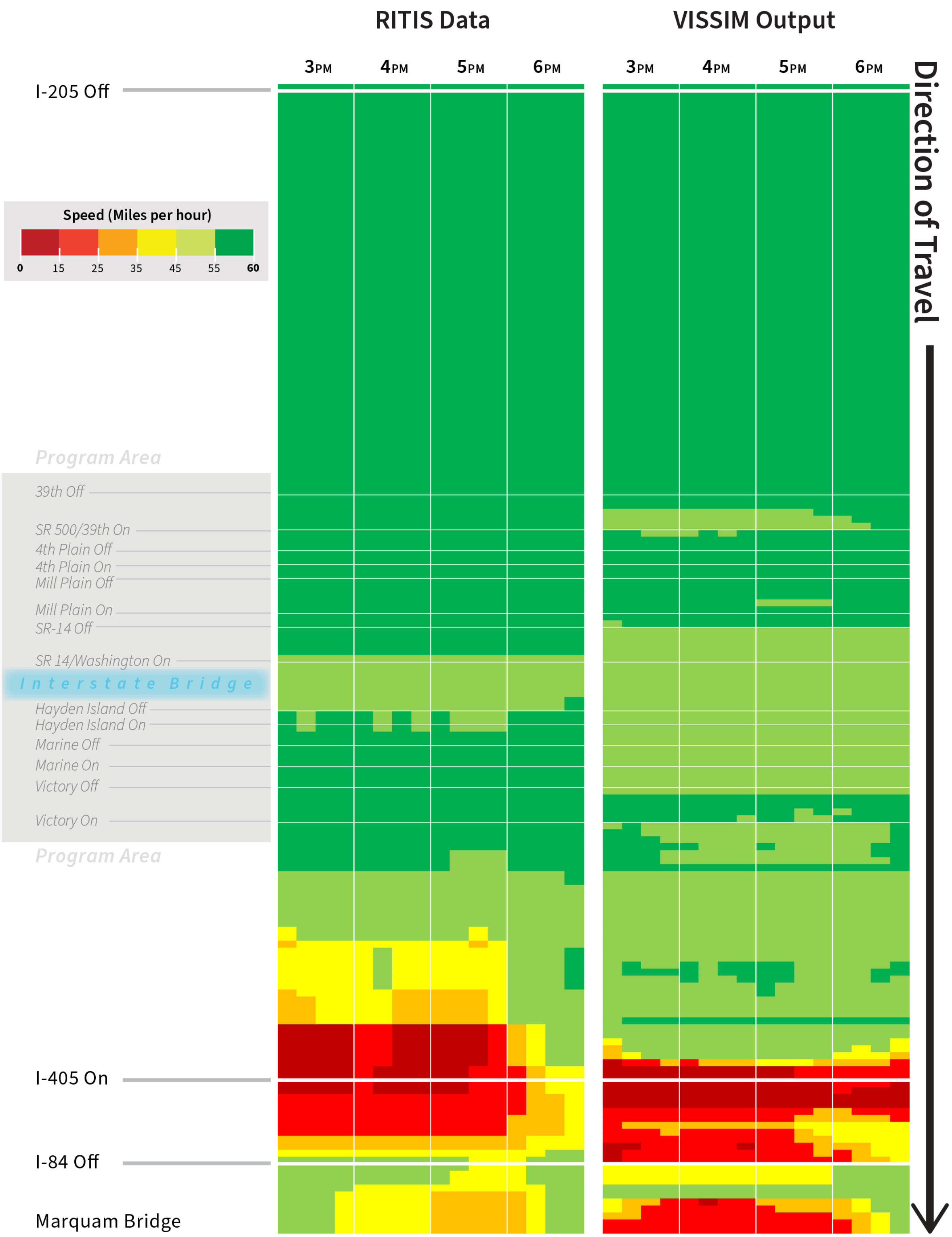
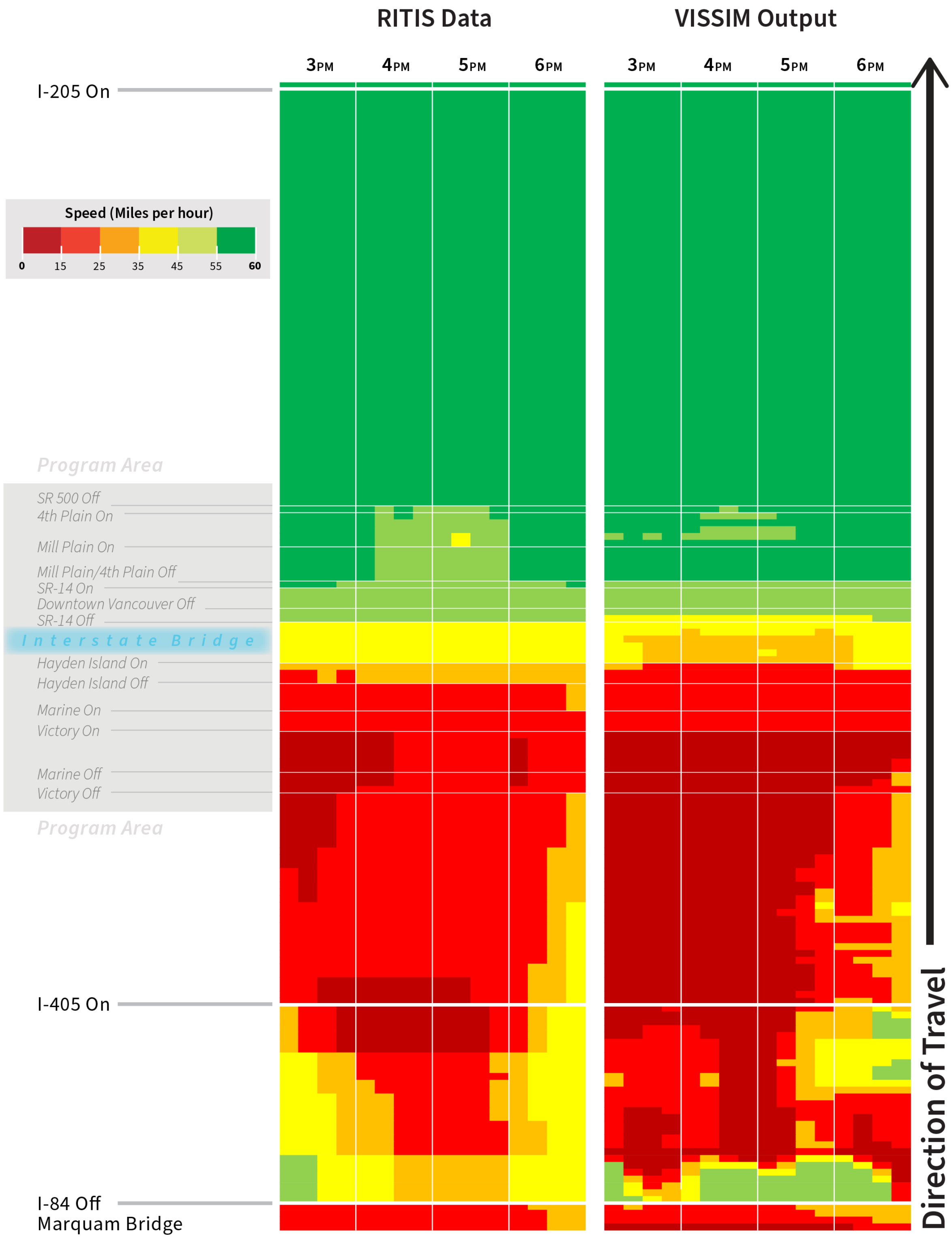


Figure 8. RITIS Data and VISSIM Output Speed Map Comparison – Northbound I-5 PM Peak Period



4.2 Confidence

VISSIM model results for the IBR Program are based on the average of 15 model runs. This section demonstrates that the 15 VISSIM model runs used for the IBR Program satisfies the desired 90% confidence level for assessing the statistical validity of the models when comparing the impacts of the alternatives.

4.2.1 Initial Sample Size

To determine the level of confidence in the reported results, an initial sampling of the model outputs was required. Initial model results were based on a sample of 15 simulation runs, which is higher than the WSDOT minimum recommendation of 11 runs and the ODOT minimum recommendation of 10 simulation runs. Both WSDOT and ODOT recommend a minimum number of runs to reduce the impact that an atypical run will have on the sample average. The random seed numbers used for this analysis were 101 through 115.

4.2.2 Confidence Level

The confidence level is the probability that the true mean lies within the target confidence interval. Following discussions with FHWA, a confidence level of 90% was selected for this project.

4.2.3 Confidence Interval

The confidence interval is the range of values within which the true mean value may lie. To have confidence that the true mean will lie within the calibration targets (see Section 3, VISSIM Model Development) the allowable variation between the model and real-world observations were used.

4.2.4 Required Number of Simulation Runs

FHWA uses the following equation to determine the minimal number of repetitions:

$$N = \left(2 * t_{\left(1-\frac{\alpha}{2}\right),N-1} * \frac{s}{R}\right)^2$$

R = Confidence Interval for the true mean

s = Standard Deviation of the model results

All the other terms were described in the previous section.

The objective of this effort is to assess the adequacy of the number of simulation runs used to generate the average outcome that fell within the variation envelope. The confidence interval represents the level of belief (confidence level) in which the true mean of the model resides.

The standard deviation of the initial sample must be evaluated by the equation above to determine if a sufficient number of runs has been conducted to provide the target confidence that the reported average travel times are within an acceptable range of the true model average travel times. The acceptable range is referred to as the *confidence interval*. A range of values is needed as a target because the true average is unknown. The calculation of the confidence interval for the true mean in the preceding section was based on travel time as the performance measure. Using the formula provided and considering the standard deviation of travel time derived from the initial 15 model runs during the four-hour peak period, it was determined that six runs were required for the AM peak hour, while the PM peak period necessitated only two runs (See Table 6).

Table 6. Required Number of Simulation Model Runs

Parameter	AM	PM
Number of Observations (days)	144	144
Confidence Interval for Field Average Travel Time (min)	1.57	0.79
Model Average Travel Time (min)	10.16	10.92
Model Average Travel Time Standard Deviation (min)	1.19	0.31
N	**6**	**2**

Source: IBR VISSIM Analysis.

The average travel times for the VISSIM model were generated based on 15 model runs, which is greater than the number of runs required. Additional runs are unnecessary and are unlikely to produce contrasting model outputs.

5. CONCLUSION

This report documents the scope and extents of the VISSIM model used for the IBR Program, provides details about the base model development, demonstrates that the model is sufficiently calibrated to existing data, and demonstrates that the number of simulation runs (15) is sufficient to meet a desired 90% confidence level.

The VISSIM model was calibrated for vehicle throughput at the Interstate Bridge, travel times approaching the Interstate Bridge during the peak periods, and speeds.

- The VISSIM model service volume falls within the acceptable range during both the AM and PM peak periods.
- The VISSIM model satisfied all the travel time calibration targets,
- The VISSIM model congestion diagrams were a close match to the field congestion diagrams.
- The 15 simulation runs of the VISSIM model were sufficient to meet the 90% confidence interval of the true model average.

Based on the calibration targets and visual inspections of the field in comparison with the VISSIM model, the base model is adequately calibrated for the purposes of the IBR Program. This calibrated base model will be used as the basis for other VISSIM models developed for this study.

6. REFERENCES

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Attachment A. WSDOT and ODOT Calibration Procedure

CALIBRATION RESULTS

This attachment documents the VISSIM model calibration targets and the results of calibration process for throughput volume and travel times per WSDOT's and ODOT'S VISSIM protocols. The result shows that the VISSIM model was sufficiently calibrated for vehicle throughput and travel times per the guidelines outlined in WSDOT's and ODOT's VISSIM protocols. Vehicle throughputs from the VISSIM model met WSDOT and ODOT standards for the 4-hour modeled peak period with minor exceptions, detailed below. VISSIM model AM and PM peak hour travel times met the standards outlined in the protocols.

Vehicle Throughput

WSDOT and ODOT vehicle throughput calibration targets use the GEH statistic to compare model volume throughput with field data throughput. The VISSIM model output is first presented in comparison to WSDOT's calibration targets, and then again in comparison to ODOT's targets.

WSDOT GEH Targets

WSDOT's GEH targets are outlined in Table A-1.

Table A-1. WSDOT Criteria for Vehicle Throughput

Criterion	Acceptable Target
GEH < 3.0	All state facility segments within the calibration area
Sum of all segment flows within the calibration area	Within 5%

Source: WSDOT Protocol for VISSIM Simulation. Table 5.

In addition to the targets outlined in Table A-1, the WSDOT Protocol for VISSIM Simulation also states that meeting the GEH threshold of 3.0 for all locations may be difficult, that it may be acceptable for some locations to fall short of the 3.0 threshold, and that a threshold of 5.0 may be acceptable for certain projects.

The IBR VISSIM model met the 3.0 threshold at 83% to 97% of locations depending on the peak and direction (see Table A-2). Notably, within the IBR study area, which aligns with our primary focus, the VISSIM Model met this threshold, at 88% to 99% of the locations (see Table A-3).

For the 5.0 threshold, the IBR VISSIM model met the criterion at all locations for all peaks and directions, with the exception of the northbound PM for which only 95% of the locations met the 5.0 threshold. Notably, when considering only IBR study area every location met the 5.0 threshold. All the locations not meeting the 5.0 threshold during the PM peak period were on- and off-ramps to I-5 northbound well south of the IBR Program study area through the Rose Quarter; the GEH values ranged from 5.1 to 7.3.

Northbound I-5 through the Rose Quarter is highly congested during the PM peak period due to congestion spilling back from the bottleneck at the Interstate Bridge. This section of freeway also contains short spacing between ramps and weave sections, which contributed to variations in the model flows at individual ramps compared to field data. However, the sum of all segment flows in the model was well within the 5% goal, with total model flows only varying from field data by 1%. Given the close match in the overall model flows to field data (and the close match in model travel times and speeds to field travel times and speeds presented in Sections 4.1.2.2 and 4.1.2.3), 5% of ramps not meeting the 5.0 GEH threshold does not detract from the ability of the model to function as an accurate predictor of transportation system performance in alternatives analysis.

Table A-2 summarizes the WSDOT volume throughput calibration results.

Table A-2. Vehicle Throughput Calibration Results – WSDOT Criteria

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 3.0 for all model segments.	92% Does not meet goal.	91% Does not meet goal.	97% Does not meet goal.	83% Does not meet goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	95% Does not meet goal.
Sum of model segment flow within 5% of field segment flows.	1% Meets goal.	1% Meets goal.	-1% Meets goal.	0% Meets goal.

Source: IBR Analysis.

Table A-3 provides a summary of the WSDOT Volume throughput calibration results conducted within the IBR study area.

Table A-3. Vehicle Throughput Calibration Results – WSDOT Criteria – IBR Study Area

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 3.0 for all model segments.	88% Does not meet goal.	91% Does not meet goal.	99% Does not meet goal.	91% Does not meet goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
Sum of model segment flow within 5% of field segment flows.	1% Meets goal.	-1% Meets goal.	-1% Meets goal.	0% Meets goal.

Source: IBR Analysis.

Table A-4 provides a summary of the WSDOT Volume throughput calibration results conducted outside the IBR study area.

Table A-4. Vehicle Throughput Calibration Results – WSDOT Criteria – Outside IBR Study Area

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 3.0 for all model segments.	95% Does not meet goal.	92% Does not meet goal.	96% Does not meet goal.	79% Does not meet goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	93% Does not meet goal.
Sum of model segment flow within 5% of field segment flows.	0% Meets goal.	2% Meets goal.	0% Meets goal.	-1% Meets goal.

Source: IBR Analysis.

ODOT GEH Targets

ODOT’s GEH targets are outlined in Table A-5.

Table A-5. ODOT Criteria for Vehicle Throughput

Criterion	Acceptable Target
GEH < 5.0	At least 85% of freeway links within the calibration area.
GEH < 5.0	All entry and exit locations within the calibration area.
GEH < 5.0	All entrance and exit ramps within the calibration area.
Individual flows within ±400 vehicles per hour for flows exceeding 2,700 vehicles per hour.	At least 85% of applicable mainline links.
Sum of all segment flows within the calibration area.	Within 5%.

Source: ODOT Protocol for VISSIM Simulation.

The IBR VISSIM model met the 5.0 threshold at 100% of freeway links for each direction and peak, satisfying the 85% threshold. The IBR VISSIM model met the 5.0 threshold at all entry and exit locations, and all entrance and exit ramps, with the exception of the northbound PM for which only 95% of the locations met the 5.0 threshold (see Table A-6). All the locations not meeting the 5.0 threshold during the PM peak period were on- and off-ramps to I-5 northbound well south of the IBR Program study area through the Rose Quarter, and the GEH values ranged from 5.1 to 7.3. Considering only IBR study area every location met the 5.0 threshold (see Table A-7).

Northbound I-5 through the Rose Quarter is highly congested during the PM peak period due to congestion spilling back from the bottleneck at the Interstate Bridge. This section of freeway also contains short spacing between ramps and weave sections, which contributed to variations in the model flows at individual ramps compared to field data. However, the sum of all segment flows in the model was well within the 5% goal with total model flows only varying from field data by 1%. Given the close match in the overall model flows to field data (and the close match in model travel times and speeds to field travel times and speeds presented in Sections 4.1.2.2 and 4.1.2.3), 5% of ramps not meeting the 5.0 GEH threshold does not detract from the ability of the model to function as an accurate predictor of transportation system performance in alternatives analysis.

Table A-6 summarizes the ODOT volume throughput calibration results.

Table A-6. Vehicle Throughput Calibration Results – ODOT Criteria

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 5.0 for 85% of freeway segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
GEH less than 5.0 for ell entry and exit locations.	100% Meets goal.	100% Meets goal.	100% Meets goal.	95% Does not meet goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	95% Does not meet goal.
Flows over 2,700 vph within 400 vph for 85% of segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
Sum of model segment flow within 5% of field segment flows.	1% Meets goal.	1% Meets goal.	-1% Meets goal.	0% Meets goal.

Source: IBR Analysis.

Table A-7 provides a summary of the ODOT Volume throughput calibration results conducted within the IBR study area.

Table A-7. Vehicle Throughput Calibration Results – ODOT Criteria – IBR Study Area

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 5.0 for 85% of freeway segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
GEH less than 5.0 for ell entry and exit locations.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
Flows over 2,700 vph within 400 vph for 85% of segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
Sum of model segment flow within 5% of field segment flows.	1% Meets goal.	-1% Meets goal.	-1% Meets goal.	0% Meets goal.

Source: IBR Analysis.

Table A-8 provides a summary of the ODOT Volume throughput calibration results conducted outside the IBR study area.

Table A-8. Vehicle Throughput Calibration Results – ODOT Criteria – Outside IBR Study Area

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
GEH less than 5.0 for 85% of freeway segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
GEH less than 5.0 for ell entry and exit locations.	100% Meets goal.	100% Meets goal.	100% Meets goal.	92% Does not meet goal.
GEH less than 5.0 for all model segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	93% Does not meet goal.

Criterion	AM Peak Period		PM Peak Period	
	Southbound I-5	Northbound I-5	Southbound I-5	Northbound I-5
Flows over 2,700 vph within 400 vph for 85% of segments.	100% Meets goal.	100% Meets goal.	100% Meets goal.	100% Meets goal.
Sum of model segment flow within 5% of field segment flows.	0% Meets goal.	2% Meets goal.	0% Meets goal.	-1% Meets goal.

Source: IBR Analysis.

Travel Time

The protocols for VISSIM simulation also include travel time calibration criteria which are based on the difference between the peak hour model travel time and the peak hour field observed travel time.

WSDOT's protocol requires that peak hour model travel times should be met for all segments and time intervals. The amount of allowable travel time variation is calculated using the free-flowing facility type equation from Table A-9 for each time interval.

Table A-9. WSDOT's Travel Time Calibration Criteria

Facility Type	Equation
Free-Flowing	$\Delta = \frac{1}{\frac{1}{t} - \frac{4.4}{L}} - t$
Interupted Flow	$\Delta = \frac{1}{\frac{1}{t} - \frac{0.1 * 5280\,S}{3600\,L}} - t$

Δ = Allowable Travel Time Variation (+/- seconds)
t = Real World Travel Time (seconds)
L = Length (feet)
S = Free Flow Speed (mph); Posted Speed may be used for FFS if unknown

Source: WSDOT Protocol for VISSIM Simulation

ODOT's Protocol requires that the model travel times be met for the highest peak demand for all segments.

- For routes with observed travel times less than 7 minutes, the acceptable model travel time is within ±1 minute.
- For routes with observed travel times greater than 7 minutes, the acceptable model travel with is within ±15%.

Travel time outputs from the models for the AM and PM peak hours were compared to the RITIS travel times collected in 2019. The model travel time outputs meet both WSDOT's and ODOT's calibration targets. The average field travel time, allowable calibration range, and average model travel time for the AM and PM peaks are presented in Table A-10 and Table A-11, respectively.

Table A-10. Travel Time Calibration Summary – AM Peak Hour

I-5 Southbound Travel Times (min)									
2019 Existing AM					**WSDOT Calibration Criteria**			**ODOT Calibration Criteria**	
Description	**Distance** mi	**Free Flow Speed** mph	**Average Field Travel Time** min	**Model Travel Time** min	**Lower delta**	**Upper delta**	**Calibrated?**	**Goal** % or minute	**Calibrated?**
I-205 to 99th	3.0	60	2.8	2.9	2.7	2.9	yes	0.1	yes
99th to SR 14	4.8	55	14.7	13.6	11.9	17.5	yes	-8%	yes
SR 14 to I-405	5.2	55	13.6	14.1	11.6	15.7	yes	3%	yes
I-405 to Marquam	2.0	50	3.9	3.7	3.5	4.3	yes	-0.2	yes

I-5 Northbound Travel Times (min)									
2019 Existing AM					**WSDOT Calibration Criteria**			**ODOT Calibration Criteria**	
Description	**Distance** mi	**Free Flow Speed** mph	**Average Field Travel Time** min	**Model Travel Time** min	**Lower delta**	**Upper delta**	**Calibrated?**	**Goal** % or minute	**Calibrated?**
99th to I-205	2.8	60	2.7	2.7	2.6	2.9	yes	0.0	yes
SR 14 to 99th	4.8	60	4.7	4.8	4.5	5.0	yes	0.1	yes
I-405 to SR 14	5.2	55	5.4	5.7	5.1	5.7	yes	0.3	yes
Morrison to I-405	2.1	50	3.8	3.5	3.4	4.2	yes	-0.3	yes

Source: IBR Analysis.

Table A-11. Travel Time Calibration Summary – PM Peak Hour

I-5 Southbound Travel Times (min)									
2019 Existing PM					**WSDOT Calibration Criteria**			**ODOT Calibration Criteria**	
Description	**Distance** mi	**Free Flow Speed** mph	**Average Field Travel Time** min	**Model Travel Time** min	**Lower delta**	**Upper delta**	**Calibrated?**	**Goal** % or minute	**Calibrated?**
I-205 to 99th	3.0	60	2.8	**2.9**	2.6	2.9	yes	0.1	yes
99th to SR 14	4.8	55	4.8	**5.0**	4.5	5.0	yes	0.2	yes
SR 14 to I-405	5.2	55	7.5	**8.1**	7.0	8.1	yes	7%	yes
I-405 to Marquam	2.0	50	9.2	**9.7**	6.5	11.9	yes	5%	yes

I-5 Northbound Travel Times (min)									
2019 Existing PM					**WSDOT Calibration Criteria**			**ODOT Calibration Criteria**	
Description	**Distance** mi	**Free Flow Speed** mph	**Average Field Travel Time** min	**Model Travel Time** min	**Lower delta**	**Upper delta**	**Calibrated?**	**Goal** % or minute	**Calibrated?**
99th to I-205	2.8	60	2.7	**2.8**	2.6	2.9	yes	0.1	yes
SR 14 to 99th	4.8	60	5.2	**5.0**	4.9	5.5	yes	-0.1	yes
I-405 to SR 14	5.2	55	18.4	**20.3**	14.5	22.4	yes	10%	yes
Morrison to I-405	2.1	50	12.5	**11.5**	7.0	18.1	yes	-8%	yes

Source: IBR Analysis.

Appendix D. Local Peak-Hour Traffic Volumes

Existing Volumes

Existing AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		420	50	30	445					25		40
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	35			65	930	10		15	85			
3	39th Street & Main Street	15	90	35	95	730	65	60	345	10	55	310	25
4	H Street & E 39th Street	5	5	40	25	5	5	5	465	5	40	380	60
5	39th Street & I-5 SB On-/Off-Ramps	25		690					315	215	105	455	
6	39th Street & I-5 NB On-/Off-Ramps	135		30				40	965			425	250
7	15th Ave & SR 500 WB Off-Ramp		50			85					505		30
8	15th Ave & SR 500 EB On-Ramp/39th Street	110	10	75	25	25	540	40	845	60			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	35	245			390	215				280		115
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		200	165	205	465		80		40			
11	4th Plain Blvd & Main Street	10	35	35	15	505	45	20	295	55	50	755	15
12	4th Plain Blvd & Broadway Street	5	15	15	20	10			335	10	40	815	35
13	W Fourth Plain Blvd & F Street				105		20	5	365			870	50
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				355			260	210			410	400
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	305		215				185	380			505	165
16	4th Plain Blvd & Saint Johns Blvd	20	5	10		85	115	25	200	185	45	380	5
17	4th Plain Blvd & Fort Vancouver Way	5	30	15	25	120	15	10	170	40	40	365	35
18	McLoughlin Blvd & Main Street		40	10	15	400	20	5	20	10	5	35	15
19	McLoughlin Blvd & Broadway Street		10	10	15	45	15		45		5	40	15
20	McLoughlin Blvd & F Street			5					60			55	
21	McLoughlin Blvd & Fort Vancouver Way	25	60	25	25	120	30	20	15	25	30	25	15
22	Mill Plain Blvd & Franklin Street	5	5	90	75	75	5	5	465	20	170	285	20
23	Mill Plain Blvd WB & Columbia Street	10	15			50	5				90	460	15
24	Mill Plain Blvd WB & Washington Street					250	5				280	560	25
25	Mill Plain Blvd WB & Main Street	10	35			140	120				40	735	65
26	Mill Plain Blvd WB & Broadway Street	5	20			30	10				55	825	5
27	Mill Plain Blvd WB & C Street	10	20			105	25				60	875	90
28	Mill Plain Blvd EB & Columbia Street		20	140	35	105		5	620	5			
29	Mill Plain Blvd EB & Washington Street				30	500			790	5			
30	Mill Plain Blvd EB & Main Street		40	30	100	80		5	805	10			
31	Mill Plain Blvd EB & Broadway Street		15	30	30	55		10	920	5			
32	Mill Plain Blvd EB & C Street		25	155	95	70		5	930	5			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				155		465		275	905	500	560	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	430		255				185	245			630	165
35	Mill Plain Blvd & Fort Vancouver Way	95	10	5	15	55	105	80	340	80	25	595	20
36	Evergreen Blvd & Columbia Street	5	85	10	5	90	30	10	20	5	30	125	20
37	Evergreen Blvd & Washington Street				10	225	25		20	15	20	150	
38	Evergreen Blvd & Main Street	10	30		5	55	10	5	25		5	150	5
39	Evergreen Blvd & Broadway Street	5	30	5		20	5		20	10	5	150	10
40	Evergreen Blvd & C Street	85	100	15	10	30	10		25		10	70	5
41	Evergreen Blvd & Fort Vancouver Way	10	55	5	20	55	85	35	15	5	5	30	20
42	8th Street & Columbia Street	10	75			95	30	20		35			
43	8th Street & C Street	75	195				40	5					
44	7th Street & C Street	20	250					20					
45	6th Street & Grant Street		35	60	5	60					120		15
46	6th Street & Esther Street	5		10	10	5	5		55	10	50	125	25
47	6th Street & Columbia Street	5	15		20	100	10	5	45	25	90	185	65
48	6th Street & Washington Street				5	185	35		10	55	130	305	
49	6th Street & Main Street	5	5		5	10	10	5	10		20	420	30
50	6th Street & Broadway Street						10	15				460	20

Existing Volumes

Existing AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
51	6th Street & C Street	480	270										
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				345	25		5	80	50			
53	Phil Arnold Way & Esther Street		10		20	45					5		5
54	Phil Arnold Way & Columbia Street	5	50			70	5	10		10			
55	Columbia Way & Esther Street		5	10	15	15	20		10			15	5
56	Columbia Way & Columbia Street	5	30		5	60	15	25		10			
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	110	45	55	65	315	115	160		325			
58	Columbia Way & Columbia Shores Blvd		55	5	540	55	45	25	20		5	10	130
59	Hayden Island Dr (South) & Center Ave	125	60	90		25			75	125	85	175	15
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North		260	40	35	130					80		15
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	35	20			5	60	15		60			
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island		60	275	175	50	10	5	120	15	200	180	210
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr		270	200		210							30
64	Tomahawk Island Dr & Jantzen Dr	10	20	35	10	35		20	70	110	85	20	35
65	Center Ave & Jantzen Ave	5	310			245	20	25					
66	N Portland Rd & W Marine Dr	25		460					210	5	645	645	
67	N Force Ave & W Marine Dr	20		15					660	10	95	1270	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	705		1060	10		355	405	140	130	180	305	615
69	Marine Dr & Vancouver Way (Loop)	25	255	190	15	75	345	20		20	25	95	15
70	Marine Dr and Anchor Way				15		100	40	250			335	15
71	I-5 NB Off-Ramp & Union Ct/Marine Way		295			120		175		15			
72	NE MLK & N Union Ct				30		255		135			40	
73	Victory Blvd & Expo Rd		55	125		5					15		90
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	35		40					125			70	
75	Victory Blvd & I-5 SB On-Ramp								140	25	75	70	
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	25		65				60	80			120	295
77	Interstate Ave/Denver Ave & Schmeer Rd		300	45	120	805					30		25
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp				255		235	220	445			365	255
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	15	70	35	70	150	145	85	665	30	30	540	105
80	Columbia Blvd & MLK Blvd	160	290	50	260	455	35	40	665	150	75	555	265

Notes:

[1]SBL to I-5 southbound on-ramp = 245 vph, SBL to SR 14 eastbound on-ramp = 100 vph (Intersection #52)

[2]EBR to SR 14 eastbound on-ramp = 45 vph, EBR to Washington St = 5 vph (Intersection #52)

Existing Volumes

Existing PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		890	55	70	645					40		105
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	145			70	435	40		25	135			
3	39th Street & Main Street	65	290	80	85	245	100	105	365	35	45	300	65
4	H Street & E 39th Street	5	5	55	50	10	10	5	520	5	65	395	65
5	39th Street & I-5 SB On-/Off-Ramps	25		470					370	255	40	500	
6	39th Street & I-5 NB On-/Off-Ramps	325	5	80				50	790			215	510
7	15th Ave & SR 500 WB Off-Ramp		85			80					570		55
8	15th Ave & SR 500 EB On-Ramp/39th Street	55	10	50	45	50	555	75	640	100			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	55	610			450	170				285		195
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		390	265	275	460		275	5	60			
11	4th Plain Blvd & Main Street	40	175	85	35	160	35	45	335	40	100	675	15
12	4th Plain Blvd & Broadway Street	15	70	70	10	20	5		440	15	70	770	40
13	W Fourth Plain Blvd & F Street				205		25	15	505			855	85
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				280			200	510			480	220
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	305	5	385				360	430			395	365
16	4th Plain Blvd & Saint Johns Blvd	95	50	30	5	15	80	105	650	20	15	525	15
17	4th Plain Blvd & Fort Vancouver Way	20	100	70	60	70	25	40	495	50	45	480	80
18	McLoughlin Blvd & Main Street	15	210	15	15	155	25	25	35	20	10	35	30
19	McLoughlin Blvd & Broadway Street		40	15	20	50	10	10	45	10	5	65	55
20	McLoughlin Blvd & F Street		5	5	5		5	5	105	5		75	
21	McLoughlin Blvd & Fort Vancouver Way	60	85	40	25	80	35	10	35	60	30	35	15
22	Mill Plain Blvd & Franklin Street	25	30	165	50	20		10	500	10	100	260	70
23	Mill Plain Blvd WB & Columbia Street	25	80			75	5				115	400	40
24	Mill Plain Blvd WB & Washington Street					65	5				175	550	30
25	Mill Plain Blvd WB & Main Street	25	140			190	35				75	695	155
26	Mill Plain Blvd WB & Broadway Street	5	45			65	20				40	900	15
27	Mill Plain Blvd WB & C Street	15	55			250	45				100	920	95
28	Mill Plain Blvd EB & Columbia Street		100	355	30	160		5	700	10			
29	Mill Plain Blvd EB & Washington Street				60	180			1065	20			
30	Mill Plain Blvd EB & Main Street		130	150	95	170		35	1085	5			
31	Mill Plain Blvd EB & Broadway Street		40	175	55	50		10	1315	5			
32	Mill Plain Blvd EB & C Street		65	250	200	150		5	1545	5			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				235		655		1275	720	250	460	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	300		270				1090	420			410	415
35	Mill Plain Blvd & Fort Vancouver Way	165	55	20	35	40	95	130	500	60	30	565	20
36	Evergreen Blvd & Columbia Street	5	250	25	10	150	20	50	95	10	40	55	30
37	Evergreen Blvd & Washington Street				20	165	35		80	50	40	90	
38	Evergreen Blvd & Main Street	5	105	10	20	75	35	25	70	5	5	90	35
39	Evergreen Blvd & Broadway Street	5	80	15	10	20	15	15	80	5	5	110	20
40	Evergreen Blvd & C Street	45	180	35	15	25	20	35	70		5	70	30
41	Evergreen Blvd & Fort Vancouver Way	5	85	15	35	15	60	105	65	15	5	40	50
42	8th Street & Columbia Street	10	200	20	5	200	30	60	65	35	10	25	10
43	8th Street & C Street	30	185				30	75					
44	7th Street & C Street	25	190					25					
45	6th Street & Grant Street		130	155	25	95					130		20
46	6th Street & Esther Street	10	15	50	35	15	5	5	170	5	60	135	40
47	6th Street & Columbia Street	10	95	20	30	155	60	50	165	40	70	165	85
48	6th Street & Washington Street				20	315	60		45	170	65	260	
49	6th Street & Main Street	15	15		5	10	50	40	25		10	260	40
50	6th Street & Broadway Street						20	30				290	20

Existing Volumes

Existing PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
51	6th Street & C Street	310	215										
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				515	35		10	110	150			
53	Phil Arnold Way & Esther Street		60	10	5	75					10		15
54	Phil Arnold Way & Columbia Street	5	110			105	20	15					
55	Columbia Way & Esther Street	15	30	15	10	25	50	35	50	5	15	55	5
56	Columbia Way & Columbia Street	15	70			45	60	45		30			
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	260	80	110	180	195	345	255		205			
58	Columbia Way & Columbia Shores Blvd	5	125		120	200	80	65	10	15	15	5	260
59	Hayden Island Dr (South) & Center Ave	85	60	150		30	5		275	95	60	145	10
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North		195	40	80	345					195		20
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	60	20			15	155	35		85			
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island		85	135	135	40	10	20	80	20	245	180	190
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr		200	175		540							35
64	Tomahawk Island Dr & Jantzen Dr	5	90	100	25	25	5	20	80	75	105	25	50
65	Center Ave & Jantzen Ave	10	210			295	10	10					
66	N Portland Rd & W Marine Dr	10		805					465	15	480	200	
67	N Force Ave & W Marine Dr	15		90					1230	40	25	665	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	440	5	670	20		60	835	370	115	30	190	680
69	Marine Dr & Vancouver Way (Loop)	30	380	140	45	175	55	55	10	40	70	40	40
70	Marine Dr and Anchor Way				30		75	110	365			200	20
71	I-5 NB Off-Ramp & Union Ct/Marine Way		490			285		60		10			
72	NE MLK & N Union Ct				55		370		295			120	
73	Victory Blvd & Expo Rd		130	40	245	25					45		275
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	110		170					285			210	
75	Victory Blvd & I-5 SB On-Ramp								410	45	180	210	
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	15		10				250	160			375	595
77	Interstate Ave/Denver Ave & Schmeer Rd		440	120	25	210					130		90
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp				75		35	80	705			715	170
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	40	210	35	105	150	175	130	685	45	25	735	110
80	Columbia Blvd & MLK Blvd	205	435	70	265	455	35	90	680	185	120	705	225

Notes:

[1]SBL to I-5 southbound on-ramp = 195 vph, SBL to SR 14 eastbound on-ramp = 320 vph

[2]EBR to SR 14 eastbound on-ramp = 140 vph, EBR to Washington St = 10 vph

No-Build Volumes

No-Build AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		425	50	40	610					40		55
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	45			60	905	10		20	115			
3	39th Street & Main Street	20	120	45	95	730	65	80	490	15	80	325	40
4	H Street & E 39th Street	5	5	50	35	5	5	5	620	5	55	435	80
5	39th Street & I-5 SB On-/Off-Ramps	20		530					485	220	195	550	
6	39th Street & I-5 NB On-/Off-Ramps	230		50				50	965			515	300
7	15th Ave & SR 500 WB Off-Ramp		55			95					650		40
8	15th Ave & SR 500 EB On-Ramp/39th Street	110	15	100	35	35	675	40	845	60			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	45	325			520	285				375		155
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		265	220	275	620		105		55			
11	4th Plain Blvd & Main Street	15	45	45	20	670	60	25	355	75	50	745	15
12	4th Plain Blvd & Broadway Street	5	20	20	25	15			405	15	40	805	35
13	W Fourth Plain Blvd & F Street				105		25	5	445			855	50
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				345			265	285			415	600
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	275		195				250	380			740	220
16	4th Plain Blvd & Saint Johns Blvd	25	5	10		90	200	35	280	260	50	735	5
17	4th Plain Blvd & Fort Vancouver Way	20	30	15	25	130	35	15	225	50	45	735	40
18	McLoughlin Blvd & Main Street		55	15	20	535	25	5	25	15	5	45	20
19	McLoughlin Blvd & Broadway Street		15	15	15	45	15		60		5	55	20
20	McLoughlin Blvd & F Street			5					80			75	
21	McLoughlin Blvd & Fort Vancouver Way	40	85	40	30	120	35	25	20	35	30	35	20
22	Mill Plain Blvd & Franklin Street	5	5	90	75	100	5	5	465	25	295	495	50
23	Mill Plain Blvd WB & Columbia Street	15	20			60	5				140	820	45
24	Mill Plain Blvd WB & Washington Street					310	5				300	1000	40
25	Mill Plain Blvd WB & Main Street	15	45			190	150				65	1175	105
26	Mill Plain Blvd WB & Broadway Street	5	20			30	10				90	1330	10
27	Mill Plain Blvd WB & C Street	15	25			130	35				95	1380	140
28	Mill Plain Blvd EB & Columbia Street		30	140	45	155		5	620	5			
29	Mill Plain Blvd EB & Washington Street				40	570			790	15			
30	Mill Plain Blvd EB & Main Street		55	35	120	135		5	810	15			
31	Mill Plain Blvd EB & Broadway Street		15	30	30	90		10	945	10			
32	Mill Plain Blvd EB & C Street		35	165	100	125		5	990	10			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				250		755		425	830	640	860	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	680	5	405				305	370			820	275
35	Mill Plain Blvd & Fort Vancouver Way	95	15	5	30	70	85	125	525	125	35	915	25
36	Evergreen Blvd & Columbia Street	10	130	15	10	125	50	15	30	10	50	205	35
37	Evergreen Blvd & Washington Street				20	380	45		30	25	30	245	
38	Evergreen Blvd & Main Street	15	45		10	195	15	10	40		10	245	10
39	Evergreen Blvd & Broadway Street	10	45	10		40	15		35	15	10	240	15
40	Evergreen Blvd & C Street	130	155	25	20	65	20		45		15	115	10
41	Evergreen Blvd & Fort Vancouver Way	15	55	5	25	80	125	40	20	5	5	40	20
42	8th Street & Columbia Street	15	115			140	45	30		50			
43	8th Street & C Street	125	300				80	10					
44	7th Street & C Street	30	385					40					
45	6th Street & Grant Street		95	100	10	160					200		25
46	6th Street & Esther Street	15		15	15	15	15		85	25	80	195	40
47	6th Street & Columbia Street	10	25		35	140	15	10	65	40	140	290	95
48	6th Street & Washington Street				10	425	55		15	85	235	470	
49	6th Street & Main Street	10	10		10	15	15	10	15		30	680	45
50	6th Street & Broadway Street						50	25				705	30

No-Build Volumes

No-Build AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
51	6th Street & C Street	735	415										
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				705	40		10	100	80			
53	Phil Arnold Way & Esther Street		20		30	90					15		10
54	Phil Arnold Way & Columbia Street	10	120			175	15	15		15			
55	Columbia Way & Esther Street		10	25	30	30	45		25			35	10
56	Columbia Way & Columbia Street	15	75		10	150	30	55		25			
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	145	60	75	85	420	155	215		430			
58	Columbia Way & Columbia Shores Blvd		75	5	715	75	60	35	25		5	15	170
59	Hayden Island Dr (South) & Center Ave	125	60	130		30			125	170	115	240	20
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North		355	55	45	210					130		20
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	75	30			30	75	35		65			
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island		75	365	235	65	15	5	160	20	225	205	235
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr		370	275		340							40
64	Tomahawk Island Dr & Jantzen Dr	15	25	45	15	45		25	95	155	110	25	45
65	Center Ave & Jantzen Ave	5	410			285	25	30					
66	N Portland Rd & W Marine Dr	30		600					275	5	825	820	
67	N Force Ave & W Marine Dr	25		25					860	15	120	1620	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	960		1445	15		390	545	180	160	220	390	830
69	Marine Dr & Vancouver Way (Loop)	25	270	205	20	100	440	25		25	30	120	20
70	Marine Dr and Anchor Way				20		130	45	270			430	20
71	I-5 NB Off-Ramp & Union Ct/Marine Way		375			155		125		10			
72	NE MLK & N Union Ct				40		325		165			50	
73	Victory Blvd & Expo Rd		95	215		5					20		110
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	45		50					215			85	
75	Victory Blvd & I-5 SB On-Ramp								240	25	75	85	
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	25		75				60	180			135	305
77	Interstate Ave/Denver Ave & Schmeer Rd		480	55	135	960					40		40
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp				250		230	235	570			465	270
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	20	90	55	110	190	155	95	825	35	50	660	145
80	Columbia Blvd & MLK Blvd	205	375	65	335	585	45	50	855	195	95	715	340

Notes:

[1]SBL to I-5 southbound on-ramp = 520 vph, SBL to SR 14 eastbound on-ramp = 185 vph

[2]EBR to SR 14 eastbound on-ramp = 70 vph, EBR to Washington St = 10 vph

No-Build Volumes

No-Build PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		885	55	90	840					50		135
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	190			95	610	55		35	175			
3	39th Street & Main Street	85	380	95	110	345	140	135	435	45	50	335	75
4	H Street & E 39th Street	5	5	65	60	15	15	5	625	10	85	440	85
5	39th Street & I-5 SB On-/Off-Ramps	30		485					465	285	45	580	
6	39th Street & I-5 NB On-/Off-Ramps	355		90				50	900			270	525
7	15th Ave & SR 500 WB Off-Ramp		100			90					640		70
8	15th Ave & SR 500 EB On-Ramp/39th Street	60	15	65	60	65	605	85	730	115			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	70	800			585	220				370		255
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		510	345	360	595		360		80			
11	4th Plain Blvd & Main Street	50	230	100	40	210	45	60	395	50	160	625	25
12	4th Plain Blvd & Broadway Street	20	90	80	15	25			515	20	115	790	65
13	W Fourth Plain Blvd & F Street				265		35	20	590			935	90
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				300			265	590			535	290
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	305	5	390				395	495			520	405
16	4th Plain Blvd & Saint Johns Blvd	105	55	35	5	15	85	115	705	25	15	570	15
17	4th Plain Blvd & Fort Vancouver Way	20	110	75	65	75	25	45	535	55	50	520	85
18	McLoughlin Blvd & Main Street	15	275	25	20	175	30	35	55	25	15	45	40
19	McLoughlin Blvd & Broadway Street		60	20	20	50	10	10	80	10	5	90	70
20	McLoughlin Blvd & F Street		5	5	5		5	5	135	5		100	
21	McLoughlin Blvd & Fort Vancouver Way	90	130	60	30	80	40	15	45	80	40	45	20
22	Mill Plain Blvd & Franklin Street	35	40	180	55	25		15	540	15	130	350	90
23	Mill Plain Blvd WB & Columbia Street	35	105			100	5				150	530	55
24	Mill Plain Blvd WB & Washington Street					85	5				230	730	40
25	Mill Plain Blvd WB & Main Street	35	180			230	40				100	925	205
26	Mill Plain Blvd WB & Broadway Street	5	50			75	20				55	1205	20
27	Mill Plain Blvd WB & C Street	20	70			325	60				130	1200	125
28	Mill Plain Blvd EB & Columbia Street		135	390	40	210		5	755	15			
29	Mill Plain Blvd EB & Washington Street				80	235			1160	25			
30	Mill Plain Blvd EB & Main Street		170	215	120	210		45	1190	5			
31	Mill Plain Blvd EB & Broadway Street		40	195	60	70		15	1505	5			
32	Mill Plain Blvd EB & C Street		85	275	220	235		5	1750	5			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				285		800		1370	875	305	655	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	445		400				1130	525			515	360
35	Mill Plain Blvd & Fort Vancouver Way	165	80	35	50	55	95	175	670	80	40	615	25
36	Evergreen Blvd & Columbia Street	5	365	35	15	170	30	75	130	10	60	75	45
37	Evergreen Blvd & Washington Street				35	240	50		105	75	70	130	
38	Evergreen Blvd & Main Street	5	150	15	30	105	45	35	100	5	5	150	55
39	Evergreen Blvd & Broadway Street	5	115	30	20	35	20	15	125	5	5	185	35
40	Evergreen Blvd & C Street	65	260	50	30	50	45	35	140		5	115	45
41	Evergreen Blvd & Fort Vancouver Way	5	105	20	55	25	95	115	85	20	5	50	60
42	8th Street & Columbia Street	15	265	20	5	240	45	85	65	35	10	25	15
43	8th Street & C Street	45	265				55	110					
44	7th Street & C Street	45	265					45					
45	6th Street & Grant Street		250	265	40	185					185		30
46	6th Street & Esther Street	20	15	85	60	35	10	5	290	10	80	185	55
47	6th Street & Columbia Street	15	125	20	35	180	70	65	310	60	100	235	110
48	6th Street & Washington Street				30	495	85		85	280	110	360	
49	6th Street & Main Street	20	20		5	15	75	80	35		15	375	60
50	6th Street & Broadway Street						30	40				420	30

No-Build Volumes

No-Build PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
51	6th Street & C Street	450	310										
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				835	50		15	205	220			
53	Phil Arnold Way & Esther Street		95	40	10	115					10		25
54	Phil Arnold Way & Columbia Street	10	335			150	25	50					
55	Columbia Way & Esther Street	15	90	35	20	40	65	35	135	5	20	75	10
56	Columbia Way & Columbia Street	45	210			90	60	135		55			
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	340	105	145	235	255	450	330		265			
58	Columbia Way & Columbia Shores Blvd	5	165		155	260	105	85	15	15	20	5	340
59	Hayden Island Dr (South) & Center Ave	75	70	230		40	5		345	145	95	235	20
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North		325	70	110	465					200		25
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	65	25			20	160	105		75			
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island		115	210	210	55	15	25	125	25	305	225	235
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr		340	300		665							55
64	Tomahawk Island Dr & Jantzen Dr	5	120	135	35	35	5	30	140	130	145	45	70
65	Center Ave & Jantzen Ave	15	310			370	15	15					
66	N Portland Rd & W Marine Dr	15		985					570	20	680	280	
67	N Force Ave & W Marine Dr	20		105					1505	50	40	940	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	575	5	880	25		155	1010	480	120	30	250	865
69	Marine Dr & Vancouver Way (Loop)	40	465	170	60	230	70	70	10	50	90	50	50
70	Marine Dr and Anchor Way				40		100	135	450			260	25
71	I-5 NB Off-Ramp & Union Ct/Marine Way		640			370		35		10			
72	NE MLK & N Union Ct				70		480		380			160	
73	Victory Blvd & Expo Rd		160	50	320	35					60		360
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	145		220					370			275	
75	Victory Blvd & I-5 SB On-Ramp								540	50	195	275	
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	20		15				255	285			450	595
77	Interstate Ave/Denver Ave & Schmeer Rd		720	155	40	460					170		150
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp				75		35	80	1090			1050	170
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	50	275	50	160	195	200	150	1045	50	40	1045	155
80	Columbia Blvd & MLK Blvd	270	570	90	350	595	45	120	890	245	155	925	295

Notes:

[1] SBL to I-5 southbound on-ramp = 370 vph, SBL to SR 14 eastbound on-ramp = 465 vph

[2] EBR to SR 14 eastbound on-ramp = 205 vph, EBR to Washington St = 15 vph

Modified LPA Volumes

MLPA AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		415	50	40	570					30		50
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	45			50	705	10		20	110			
3	39th Street & Main Street	20	115	40	65	535	50	75	440	15	65	305	35
4	H Street & E 39th Street	5	5	50	35	5	5	5	535	5	55	395	80
5	39th Street & I-5 SB On-/Off-Ramps	20		545					405	215	195	510	
6	39th Street & I-5 NB On-/Off-Ramps	230		55				50	900			475	320
7	15th Ave & SR 500 WB Off-Ramp		55			90					655		40
8	15th Ave & SR 500 EB On-Ramp/39th Street	80	15	95	30	30	685	40	820	55			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	45	315			500	275				360		150
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		255	210	265	595		105		50			
11	4th Plain Blvd & Main Street	15	45	40	20	650	60	25	360	70	50	770	15
12	4th Plain Blvd & Broadway Street	5	20	20	25	15			405	15	40	830	35
13	W Fourth Plain Blvd & F Street				130		25	5	445			880	60
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				365		530	280	295			410	625
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	275	5	190				260	400			760	235
16	4th Plain Blvd & Saint Johns Blvd	25	5	10		90	180	35	280	260	45	735	5
17	4th Plain Blvd & Fort Vancouver Way	15	30	15	25	125	35	15	225	50	45	735	40
18	McLoughlin Blvd & Main Street		50	15	20	615	25	5	25	15	5	45	20
19	McLoughlin Blvd & Broadway Street		15	15	15	50	20		60		5	50	20
20	McLoughlin Blvd & F Street			5					80			75	
21	McLoughlin Blvd & Fort Vancouver Way	45	105	45	25	125	35	25	20	35	30	30	20
22	Mill Plain Blvd & Franklin Street	5	5	95	80	95	5	5	505	25	380	630	70
23	Mill Plain Blvd WB & Columbia Street	15	20			60	5				215	1060	25
24	Mill Plain Blvd WB & Washington Street					280	5				300	1295	45
25	Mill Plain Blvd WB & Main Street	15	45			190	150				120	1475	125
26	Mill Plain Blvd WB & Broadway Street	5	20			55	10				130	1705	10
27	Mill Plain Blvd WB & C Street	15	25			175	30				325	1800	175
28	Mill Plain Blvd EB & Columbia Street		30	165	55	220		5	640	35			
29	Mill Plain Blvd EB & Washington Street				50	530			855	5			
30	Mill Plain Blvd EB & Main Street		55	35	120	190		5	885	15			
31	Mill Plain Blvd EB & Broadway Street		15	35	35	150		10	1025	5			
32	Mill Plain Blvd EB & C Street		35	205	105	395		5	1085	5			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				375		1420		510	885	695	880	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	685		410				385	500			890	305
35	Mill Plain Blvd & Fort Vancouver Way	100	15	5	20	60	110	145	620	145	30	985	35
36	Evergreen Blvd & Columbia Street	5	135	15	5	215	50	15	20	35	45	200	35
37	Evergreen Blvd & Washington Street				20	365	50		20	20	35	230	
38	Evergreen Blvd & Main Street	15	40		5	240	15	5	35		5	235	5
39	Evergreen Blvd & Broadway Street	5	40	5		100	10		25	15	5	230	15
40	Evergreen Blvd & C Street	120	170	20	15	440	15		30		65	115	5
41	Evergreen Blvd & Fort Vancouver Way	15	60	5	25	85	125	40	20	5	5	45	20
42	8th Street & Columbia Street	60	425		50	165	40	30		30			5
43	8th Street & C Street	110	305			450	55	5		200			
44	7th Street & C Street	20	360			270	380	55		100			
45	6th Street & Grant Street		100	125	10	170					120		15
46	6th Street & Esther Street	15	15	10	25	15	15		105	30	45	105	20
47	6th Street & Columbia Street	115	470		20	160	15		115	25	20	40	15
48	6th Street & Washington Street				35	135	50		105	30	10	25	
49	6th Street & Main Street	5	10		50	15	15	5	135			15	
50	6th Street & Broadway Street				30		15	20	165				
51	6th Street & C Street/I-5 SB On-Ramp		380			370				195			

Modified LPA Volumes

MLPA AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				140		35		10	195	5	10	
52A	5th Street & Main St	5	5	5	5	10		5	5	140	5	5	5
53	Phil Arnold Way & Esther Street		25	30	30	60					215		15
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	15	135		80	55	5	30		30	100	210	520
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp		15	5	140	15			80				
55	Columbia Way & Esther Street		25	30	85	80	110	10	30			45	20
56	Columbia Way & Columbia Street				150		35	70	75			30	80
56A	Columbia Way & Main St				5		10	5	220			100	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	140	60	70	85	405	150	205		415			
58	Columbia Way & Columbia Shores Blvd		70	5	690	70	60	30	25		5	15	170
59	Hayden Island Dr (South) & Center Ave	10	5	90	10	30	5	5	80	135	145	305	25
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	335		50					30	150	150	140	
61A	Hayden Island Dr (South) & Jantzen Dr	265		55					10	75	70	25	
62	Center Ave & N Tomahawk Island Dr				260		50	55	15			10	50
62A	Tomahawk Island Dr & Arterial Bridge Access	40	275	300	10	280	10	75	80	120	180	10	35
64	Tomahawk Island Dr & Jantzen Dr	35	85	140	10	40	95	195	190	5	85	95	40
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr				445		225		40			10	
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr							225	260			10	120
66	N Portland Rd & W Marine Dr	30		605					280	5	840	835	
67	N Force Ave & W Marine Dr	25		30					870	15	130	1650	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	395		205	1470		975	550	190	160	220	410	835
69	Marine Dr & Vancouver Way	50	345	255	20	100	200	85	25	25	35	30	20
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St								125	10	560	175	
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10		490					125			725	
69C	N Vancouver Way & N Pier 99 St				125		490	570	10			125	155
70	Marine Dr and Anchor Way				20		50	50	400			270	20
72	NE MLK & N Union Ct				60		475		160			175	
73	Victory Blvd & Expo Rd		95	215		5					20		120

Modified LPA Volumes

MLPA PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		730	40	80	750					45		120
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	170			85	525	45		30	155			
3	39th Street & Main Street	75	340	90	100	295	120	120	410	40	50	335	70
4	H Street & E 39th Street	5	5	65	60	10	10	5	590	5	75	440	80
5	39th Street & I-5 SB On-/Off-Ramps	25		505					435	280	45	570	
6	39th Street & I-5 NB On-/Off-Ramps	365		90				55	885			250	560
7	15th Ave & SR 500 WB Off-Ramp		90			90					635		65
8	15th Ave & SR 500 EB On-Ramp/39th Street	60	10	60	50	60	615	80	725	110			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	65	710			525	200				330		225
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		455	310	320	535		320		70			
11	4th Plain Blvd & Main Street	45	205	110	45	185	40	50	400	45	160	615	25
12	4th Plain Blvd & Broadway Street	15	80	90	10	25			540	15	115	785	65
13	W Fourth Plain Blvd & F Street				265		30	15	625			935	90
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				305		505	260	630			520	290
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	315	5	400				455	480			495	465
16	4th Plain Blvd & Saint Johns Blvd	110	50	30		15	95	100	705	20	15	605	15
17	4th Plain Blvd & Fort Vancouver Way	20	105	75	65	75	30	35	550	45	45	555	85
18	McLoughlin Blvd & Main Street		245	15	15	170	30	30	40	25	10	40	35
19	McLoughlin Blvd & Broadway Street		50	15	20	55	10	10	50	10	5	75	65
20	McLoughlin Blvd & F Street			5					120			85	
21	McLoughlin Blvd & Fort Vancouver Way	90	140	65	30	125	40	10	40	70	35	40	15
22	Mill Plain Blvd & Franklin Street	30	35	195	60	25		10	600	10	135	385	95
23	Mill Plain Blvd WB & Columbia Street	45	95			85	5				155	565	55
24	Mill Plain Blvd WB & Washington Street					75	5				240	770	40
25	Mill Plain Blvd WB & Main Street	45	170			210	40				105	965	215
26	Mill Plain Blvd WB & Broadway Street	5	65			70	25				55	1255	20
27	Mill Plain Blvd WB & C Street	15	65			290	50				145	1265	135
28	Mill Plain Blvd EB & Columbia Street		135	410	40	200		5	840	10			
29	Mill Plain Blvd EB & Washington Street				80	235			1265	25			
30	Mill Plain Blvd EB & Main Street		175	230	110	205		40	1300	5			
31	Mill Plain Blvd EB & Broadway Street		60	205	70	55		10	1625	5			
32	Mill Plain Blvd EB & C Street		75	510	245	190		5	1890	5			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				350		900		1775	870	300	645	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	455		410				1530	595			490	610
35	Mill Plain Blvd & Fort Vancouver Way	235	70	25	40	40	150	190	730	85	65	715	35
36	Evergreen Blvd & Columbia Street	35	440	35	15	240	30	75	135	15	65	85	50
37	Evergreen Blvd & Washington Street				30	265	55		110	75	65	145	
38	Evergreen Blvd & Main Street	5	215		30	115	50	35	105		5	155	55
39	Evergreen Blvd & Broadway Street	5	160	20		25	20		130	5	5	190	35
40	Evergreen Blvd & C Street	75	525	60	20	245	30		150		35	125	45
41	Evergreen Blvd & Fort Vancouver Way	5	135	15	50	20	120	130	85	15	5	80	65
42	8th Street & Columbia Street	25	575			60	45	90		10			30
43	8th Street & C Street	125	400			235	45	260		130			
44	7th Street & C Street	50	345			325	40	45		40			
45	6th Street & Grant Street		305	195	30	225					110		20
46	6th Street & Esther Street	25	100	60	40	35	10		215	10	40	95	30
47	6th Street & Columbia Street	55	555		40	15	15		300	15	40	95	45
48	6th Street & Washington Street				70	315	90		145	195	20	90	
49	6th Street & Main Street	10	5		20	15	75	60	155			25	5
50	6th Street & Broadway Street				75		30	45	130				
51	6th Street & C Street/I-5 SB On-Ramp		395			365				205			

Modified LPA Volumes

MLPA PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				480		50		10			10	
52A	5th Street & Main St	5	5	5	5	10		5	5	480	5	5	5
53	Phil Arnold Way & Esther Street		150	30	5	80					100		35
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	10	245		175	55	5	35			50	120	215
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp		15	5	480	15			175				
55	Columbia Way & Esther Street	10	150	35	25	55	100	25	120	10	5	80	5
56	Columbia Way & Columbia Street				45		60	75	105			30	180
56A	Columbia Way & Main St				5		10	5	145			200	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	305	95	130	210	225	400	295		240			
58	Columbia Way & Columbia Shores Blvd		145		135	235	95	75	10		15	5	310
59	Hayden Island Dr (South) & Center Ave	20	10	50	10	50	5	5	115	140	120	285	20
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	290		65					90	85	85	135	
61A	Hayden Island Dr (South) & Jantzen Dr	195		205					20	135	135	25	
62	Center Ave & N Tomahawk Island Dr				195		115	35	75			45	45
62A	Tomahawk Island Dr & Arterial Bridge Access	40	220	350	10	150	10	90	90	90	150	40	45
64	Tomahawk Island Dr & Jantzen Dr	35	135	105	35	135	100	200	200	50	190	100	65
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr				270		485		380			70	
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr							375	275			70	305
66	N Portland Rd & W Marine Dr	15		1005					605	20	620	260	
67	N Force Ave & W Marine Dr	20		115					1560	50	35	860	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	75		120	870		570	1040	480	155	40	250	880
69	Marine Dr & Vancouver Way	50	495	180	60	230	230	85	25	25	90	60	50
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St								125	10	370	175	
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10		425					125			535	
69C	N Vancouver Way & N Pier 99 St				125		425	380	10			185	155
70	Marine Dr and Anchor Way				40		105	130	500			415	25
72	NE MLK & N Union Ct				75		530		345			195	
73	Victory Blvd & Expo Rd		160	50	280	35					60		360

Modified LPA Volumes

LPA 1 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		415	50	40	570					30		50
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	45			50	705	10		20	110			
3	39th Street & Main Street	20	115	40	65	535	50	75	440	15	65	305	35
4	H Street & E 39th Street	5	5	50	35	5	5	5	535	5	55	395	80
5	39th Street & I-5 SB On-/Off-Ramps	20		545					405	215	195	510	
6	39th Street & I-5 NB On-/Off-Ramps	230		55				50	900			475	320
7	15th Ave & SR 500 WB Off-Ramp		55			90					655		40
8	15th Ave & SR 500 EB On-Ramp/39th Street	80	15	95	30	30	685	40	820	55			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	45	315			500	275				360		150
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		255	210	265	595		105		50			
11	4th Plain Blvd & Main Street	15	45	40	20	650	60	25	360	70	50	770	15
12	4th Plain Blvd & Broadway Street	5	20	20	25	15			405	15	40	830	35
13	W Fourth Plain Blvd & F Street				130		25	5	445			880	60
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				365		530	280	295			410	625
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	275	5	190				260	400			760	235
16	4th Plain Blvd & Saint Johns Blvd	25	5	10		90	180	35	280	260	45	735	5
17	4th Plain Blvd & Fort Vancouver Way	15	30	15	25	125	35	15	225	50	45	735	40
18	McLoughlin Blvd & Main Street		50	15	20	615	25	5	25	15	5	45	20
19	McLoughlin Blvd & Broadway Street		15	15	15	50	20		60		5	50	20
20	McLoughlin Blvd & F Street			5					80			75	
21	McLoughlin Blvd & Fort Vancouver Way	45	105	45	25	135	35	25	20	35	40	30	20
22	Mill Plain Blvd & Franklin Street	5	5	170	80	100	5	5	505	25	380	630	70
23	Mill Plain Blvd WB & Columbia Street	15	20			60	5				315	1060	45
24	Mill Plain Blvd WB & Washington Street					280	5				315	1415	45
25	Mill Plain Blvd WB & Main Street	15	45			190	150				155	1610	125
26	Mill Plain Blvd WB & Broadway Street	5	20			55	10				240	1875	10
27	Mill Plain Blvd WB & C Street	15	25			175	35				430	2075	160
28	Mill Plain Blvd EB & Columbia Street		30	265	55	320		5	735	15			
29	Mill Plain Blvd EB & Washington Street				50	545			1040	15			
30	Mill Plain Blvd EB & Main Street		55	190	120	225		5	1070	15			
31	Mill Plain Blvd EB & Broadway Street		15	175	35	260		10	1360	10			
32	Mill Plain Blvd EB & C Street		35	270	105	500		5	1555	10			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				375		1420		510	1420	725	1245	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	1050		425				385	500			920	305
35	Mill Plain Blvd & Fort Vancouver Way	130	15	5	30	70	110	145	620	160	35	985	35
36	Evergreen Blvd & Columbia Street	5	135	15	5	215	50	15	20	35	45	200	35
37	Evergreen Blvd & Washington Street				20	365	50		20	20	35	230	
38	Evergreen Blvd & Main Street	15	40		5	240	15	5	35		5	235	5
39	Evergreen Blvd & Broadway Street	5	40	5		100	10		25	15	5	230	15
40	Evergreen Blvd & C Street	120	170	20	15	440	15		30		65	115	5
41	Evergreen Blvd & Fort Vancouver Way	15	60	5	25	85	125	40	20	5	5	45	20
42	8th Street & Columbia Street	60	425		50	165	40	30		30			5
43	8th Street & C Street	110	305			450	55	5		200			
44	7th Street & C Street	20	360			270	380	55		100			
45	6th Street & Grant Street		100	125	10	170					120		15
46	6th Street & Esther Street	15	15	10	25	15	15		105	30	45	105	20
47	6th Street & Columbia Street	115	470		20	160	15		115	25	20	40	15
48	6th Street & Washington Street				35	135	50		105	30	10	25	
49	6th Street & Main Street	5	10		50	15	15	5	135			15	
50	6th Street & Broadway Street				30		15	20	165				
51	6th Street & C Street/I-5 SB On-Ramp		380			370				195			

Modified LPA Volumes

LPA 1 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				140		35		10	195	5	10	
52A	5th Street & Main St	5	5	5	5	10		5	5	140	5	5	5
53	Phil Arnold Way & Esther Street		25	30	30	60					215		15
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	15	135		80	55	5	30		30	100	210	520
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp		15	5	140	15			80				
55	Columbia Way & Esther Street		25	30	85	80	110	10	30			45	20
56	Columbia Way & Columbia Street				150		35	70	75			30	80
56A	Columbia Way & Main St				5		10	5	220			100	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	140	60	70	85	405	150	205		415			
58	Columbia Way & Columbia Shores Blvd		70	5	690	70	60	30	25		5	15	170
59	Hayden Island Dr (South) & Center Ave	10	5	90	10	30	5	5	80	135	145	305	25
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	335		50					30	150	150	140	
61A	Hayden Island Dr (South) & Jantzen Dr	265		55					10	75	70	25	
62	Center Ave & N Tomahawk Island Dr				260		50	55	15			10	50
62A	Tomahawk Island Dr & Arterial Bridge Access	40	275	300	10	280	10	75	80	120	180	10	35
64	Tomahawk Island Dr & Jantzen Dr	35	85	140	10	40	95	195	190	5	85	95	40
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr				445		225		40			10	
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr							225	260			10	120
66	N Portland Rd & W Marine Dr	30		605					280	5	840	835	
67	N Force Ave & W Marine Dr	25		30					870	15	130	1650	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	395		205	1470		975	550	190	160	220	410	835
69	Marine Dr & Vancouver Way	50	345	255	20	100	200	85	25	25	35	30	20
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St								125	10	560	175	
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10		490					125			725	
69C	N Vancouver Way & N Pier 99 St				125		490	570	10			125	155
70	Marine Dr and Anchor Way				20		50	50	400			270	20
72	NE MLK & N Union Ct				60		475		160			175	
73	Victory Blvd & Expo Rd		95	215		5					20		120

Modified LPA Volumes

LPA 1 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)		730	40	80	750					45		120
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	170			85	525	45		30	155			
3	39th Street & Main Street	75	340	90	100	295	120	120	410	40	50	335	70
4	H Street & E 39th Street	5	5	65	60	10	10	5	590	5	75	440	80
5	39th Street & I-5 SB On-/Off-Ramps	25		505					435	280	45	570	
6	39th Street & I-5 NB On-/Off-Ramps	365		90				55	885			250	560
7	15th Ave & SR 500 WB Off-Ramp		90			90					635		65
8	15th Ave & SR 500 EB On-Ramp/39th Street	60	10	60	50	60	615	80	725	110			
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	65	710			525	200				330		225
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps		455	310	320	535		320		70			
11	4th Plain Blvd & Main Street	45	205	110	45	185	40	50	400	45	160	615	25
12	4th Plain Blvd & Broadway Street	15	80	90	10	25			540	15	115	785	65
13	W Fourth Plain Blvd & F Street				265		30	15	625			935	90
14	4th Plain Blvd & I-5 SB On-/Off-Ramps				305		505	260	630			520	290
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	315	5	400				455	480			495	465
16	4th Plain Blvd & Saint Johns Blvd	110	50	30		15	95	100	705	20	15	605	15
17	4th Plain Blvd & Fort Vancouver Way	20	105	75	65	75	30	35	550	45	45	555	85
18	McLoughlin Blvd & Main Street		245	15	15	170	30	30	40	25	10	40	35
19	McLoughlin Blvd & Broadway Street		50	15	20	55	10	10	50	10	5	75	65
20	McLoughlin Blvd & F Street			5					120			85	
21	McLoughlin Blvd & Fort Vancouver Way	90	145	70	30	125	40	10	40	85	45	40	15
22	Mill Plain Blvd & Franklin Street	35	40	320	60	25		15	680	15	185	485	95
23	Mill Plain Blvd WB & Columbia Street	45	95			100	5				180	715	60
24	Mill Plain Blvd WB & Washington Street					85	5				315	950	45
25	Mill Plain Blvd WB & Main Street	45	185			230	40				140	1225	215
26	Mill Plain Blvd WB & Broadway Street	5	70			85	25				140	1550	25
27	Mill Plain Blvd WB & C Street	20	70			335	60				170	1635	135
28	Mill Plain Blvd EB & Columbia Street		135	515	40	240		5	1040	15			
29	Mill Plain Blvd EB & Washington Street				80	320			1570	25			
30	Mill Plain Blvd EB & Main Street		185	400	120	250		45	1600	5			
31	Mill Plain Blvd EB & Broadway Street		60	230	70	155		15	2100	5			
32	Mill Plain Blvd EB & C Street		85	585	245	260		5	2385	10			
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps				350		900		1775	1440	300	1040	
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	850		410				1530	595			490	610
35	Mill Plain Blvd & Fort Vancouver Way	235	80	35	50	55	150	190	730	85	65	715	35
36	Evergreen Blvd & Columbia Street	35	440	35	15	240	30	75	135	15	65	85	50
37	Evergreen Blvd & Washington Street				30	265	55		110	75	65	145	
38	Evergreen Blvd & Main Street	5	215		30	115	50	35	105		5	155	55
39	Evergreen Blvd & Broadway Street	5	160	20		25	20		130	5	5	190	35
40	Evergreen Blvd & C Street	75	525	60	20	245	30		150		35	125	45
41	Evergreen Blvd & Fort Vancouver Way	5	135	15	50	20	120	130	85	15	5	80	65
42	8th Street & Columbia Street	25	575			60	45	90		10			30
43	8th Street & C Street	125	400			235	45	260		130			
44	7th Street & C Street	50	345			325	40	45		40			
45	6th Street & Grant Street		305	195	30	225					110		20
46	6th Street & Esther Street	25	100	60	40	35	10		215	10	40	95	30
47	6th Street & Columbia Street	55	555		40	15	15		300	15	40	95	45
48	6th Street & Washington Street				70	315	90		145	195	20	90	
49	6th Street & Main Street	10	5		20	15	75	60	155			25	5
50	6th Street & Broadway Street				75		30	45	130				
51	6th Street & C Street/I-5 SB On-Ramp		395			365				205			

Modified LPA Volumes

LPA 1 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]				480		50		10			10	
52A	5th Street & Main St	5	5	5	5	10		5	5	480	5	5	5
53	Phil Arnold Way & Esther Street		150	30	5	80					100		35
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	10	245		175	55	5	35			50	120	215
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp		15	5	480	15			175				
55	Columbia Way & Esther Street	10	150	35	25	55	100	25	120	10	5	80	5
56	Columbia Way & Columbia Street				45		60	75	105			30	180
56A	Columbia Way & Main St				5		10	5	145			200	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	305	95	130	210	225	400	295		240			
58	Columbia Way & Columbia Shores Blvd		145		135	235	95	75	10		15	5	310
59	Hayden Island Dr (South) & Center Ave	20	10	50	10	50	5	5	115	140	120	285	20
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	290		65					90	85	85	135	
61A	Hayden Island Dr (South) & Jantzen Dr	195		205					20	135	135	25	
62	Center Ave & N Tomahawk Island Dr				195		115	35	75			45	45
62A	Tomahawk Island Dr & Arterial Bridge Access	40	220	350	10	150	10	90	90	90	150	40	45
64	Tomahawk Island Dr & Jantzen Dr	35	135	105	35	135	100	200	200	50	190	100	65
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr				270		485		380			70	
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr							375	275			70	305
66	N Portland Rd & W Marine Dr	15		1005					605	20	620	260	
67	N Force Ave & W Marine Dr	20		115					1560	50	35	860	
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	75		120	870		570	1040	480	155	40	250	880
69	Marine Dr & Vancouver Way	50	495	180	60	230	230	85	25	25	90	60	50
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St								125	10	370	175	
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10		425					125			535	
69C	N Vancouver Way & N Pier 99 St				125		425	380	10			185	155
70	Marine Dr and Anchor Way				40		105	130	500			415	25
72	NE MLK & N Union Ct				75		530		345			195	
73	Victory Blvd & Expo Rd		160	50	280	35					60		360

Modified LPA Volumes

LPA 2 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)	-	415	50	40	570	-	-	-	-	30	-	50
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	45	-	-	50	705	10	-	20	110	-	-	-
3	39th Street & Main Street	20	115	40	65	535	50	75	410	15	80	305	35
4	H Street & E 39th Street												
5	39th Street & I-5 SB On-/Off-Ramps	20	-	545	-	-	-	-	405	225	195	510	-
6	39th Street & I-5 NB On-/Off-Ramps	230	-	55	-	-	-	50	900	-	-	475	320
7	15th Ave & SR 500 WB Off-Ramp	-	55	-	-	90	-	-	-	-	655	-	40
8	15th Ave & SR 500 EB On-Ramp/39th Street	80	15	95	30	30	685	40	820	55	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	45	315	-	-	500	275	-	-	-	360	-	150
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	-	255	210	265	595	-	105	-	50	-	-	-
11	4th Plain Blvd & Main Street	15	45	40	20	650	60	25	360	70	40	310	15
12	4th Plain Blvd & Broadway Street	5	20	20	25	15	-	-	405	15	30	360	30
13	W Fourth Plain Blvd & F Street												
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	365	-	530	280	295	-	-	410	625
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	275	5	190	-	-	-	260	400	-	-	760	235
16	4th Plain Blvd & Saint Johns Blvd	30	5	10	-	90	150	15	125	115	45	490	5
17	4th Plain Blvd & Fort Vancouver Way	5	30	15	25	125	20	5	110	25	40	470	35
18	McLoughlin Blvd & Main Street	-	50	15	20	615	25	5	25	15	5	45	20
19	McLoughlin Blvd & Broadway Street	-	15	15	15	50	20	-	60	-	5	50	20
20	McLoughlin Blvd & F Street	-	-	5	-	-	-	-	75	-	-	70	-
21	McLoughlin Blvd & Fort Vancouver Way	45	105	45	25	110	35	25	20	30	25	30	20
22	Mill Plain Blvd & Franklin Street	5	5	95	80	95	5	5	510	25	310	515	35
23	Mill Plain Blvd WB & Columbia Street	15	20	-	-	60	5	-	-	-	165	840	25
24	Mill Plain Blvd WB & Washington Street	-	-	-	-	35	5	-	-	-	630	1025	45
25	Mill Plain Blvd WB & Main Street	15	45	-	-	410	175	-	-	-	85	1510	125
26	Mill Plain Blvd WB & Broadway Street	5	20	-	-	55	10	-	-	-	130	1705	10
27	Mill Plain Blvd WB & C Street	15	25	-	-	175	30	-	-	-	325	1800	175
28	Mill Plain Blvd EB & Columbia Street	-	30	150	55	170	-	5	645	35	-	-	-
29	Mill Plain Blvd EB & Washington Street	-	-	-	50	615	-	-	845	5	-	-	-
30	Mill Plain Blvd EB & Main Street	-	55	45	120	375	-	5	875	15	-	-	-
31	Mill Plain Blvd EB & Broadway Street	-	15	35	35	150	-	10	1025	5	-	-	-
32	Mill Plain Blvd EB & C Street	-	35	205	105	345	-	5	1085	5	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	375	-	1420	-	510	885	670	880	-
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	685	-	410	-	-	-	385	500	-	-	865	305
35	Mill Plain Blvd & Fort Vancouver Way	100	15	5	20	60	85	145	620	145	30	985	35
36	Evergreen Blvd & Columbia Street	5	120	15	20	155	50	15	35	20	45	205	35
37	Evergreen Blvd & Washington Street	-	-	-	20	450	50	-	50	20	35	235	-
38	Evergreen Blvd & Main Street	15	55	-	5	205	15	5	65	-	5	240	5
39	Evergreen Blvd & Broadway Street	5	40	5	40	65	10	-	55	15	5	235	15
40	Evergreen Blvd & C Street	125	170	20	15	390	15	-	30	70	65	115	5
41	Evergreen Blvd & Fort Vancouver Way	15	60	5	25	80	125	40	20	5	5	45	20
42	8th Street & Columbia Street	65	460	-	25	115	40	30	-	30	-	-	-
43	8th Street & C Street	105	275	-	-	235	55	5	-	130	-	-	-
44	7th Street & C Street												
45	6th Street & Grant Street	-	130	125	10	225	-	-	-	-	120	-	15
46	6th Street & Esther Street	15	-	10	25	15	15	-	105	30	45	105	30
47	6th Street & Columbia Street	130	510	-	20	110	15	-	115	25	20	40	15
48	6th Street & Washington Street	-	-	-	35	220	50	-	105	30	15	25	-
49	6th Street & Main Street	5	25	-	50	20	20	5	135	-	-	15	-
50	6th Street & Broadway Street	-	-	-	25	-	15	20	165	-	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	-	380	-	-	365	-	-	-	195	-	-	-

Modified LPA Volumes

LPA 2 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]	15	-	20	140	90	35	-	10	325	10	5	-
52A	5th Street & Main St	5	5	5	5	10	5	20	5	145	5	5	5
53	Phil Arnold Way & Esther Street	-	35	50	30	75	-	-	-	-	215	-	20
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	20	190	-	80	55	5	40	-	40	100	210	470
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	-	15	5	145	15	-	-	80	-	-	-	-
55	Columbia Way & Esther Street	-	45	40	85	85	120	25	45	-	-	50	15
56	Columbia Way & Columbia Street	-	-	-	160	-	35	95	75	-	-	30	115
56A	Columbia Way & Main St	-	-	-	5	-	10	5	230	-	-	135	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	140	60	70	85	405	150	205	-	415	-	-	-
58	Columbia Way & Columbia Shores Blvd	-	70	5	690	70	60	30	25	-	5	15	170
59	Hayden Island Dr (South) & Center Ave	10	5	90	10	30	5	5	80	135	145	305	25
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	335	-	50	-	-	-	-	30	150	150	140	-
61A	Hayden Island Dr (South) & Jantzen Dr	265	-	55	-	-	-	-	10	75	70	25	-
62	Center Ave & N Tomahawk Island Dr	-	-	-	260	-	50	55	15	-	-	10	50
62A	Tomahawk Island Dr & Arterial Bridge Access	40	275	300	10	280	10	75	80	120	180	10	35
64	Tomahawk Island Dr & Jantzen Dr	35	85	140	10	40	95	195	190	5	95	95	40
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	-	-	-	445	-	225	-	55	-	-	10	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	-	-	-	-	-	-	240	260	-	-	10	130
66	N Portland Rd & W Marine Dr												
67	N Force Ave & W Marine Dr												
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	395	-	205	1470	-	975	550	190	160	220	410	835
69	Marine Dr & Vancouver Way	10	345	255	20	100	95	10	-	10	35	30	20
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	-	-	-	-	-	-	-	10	10	560	30	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10	-	490	-	-	-	-	10	-	-	580	-
69C	N Vancouver Way & N Pier 99 St	-	-	-	10	-	490	570	10	-	-	125	10
70	Marine Dr and Anchor Way	-	-	-	20	-	50	50	325	-	-	165	20
72	NE MLK & N Union Ct												
73	Victory Blvd & Expo Rd	-	95	215	-	5	-	-	-	-	20	-	120

Modified LPA Volumes

LPA 2 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)	-	915	55	80	750	-	-	-	-	45	-	120
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	170	-	-	85	525	45	-	30	155	-	-	-
3	39th Street & Main Street	75	340	90	100	295	120	120	410	40	50	335	70
4	H Street & E 39th Street												
5	39th Street & I-5 SB On-/Off-Ramps	25	-	505	-	-	-	-	425	280	45	570	-
6	39th Street & I-5 NB On-/Off-Ramps	365	-	90	-	-	-	55	875	-	-	250	560
7	15th Ave & SR 500 WB Off-Ramp	-	90	-	-	90	-	-	-	-	635	-	65
8	15th Ave & SR 500 EB On-Ramp/39th Street	60	10	60	50	60	615	80	715	110	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	65	710	-	-	525	200	-	-	-	330	-	225
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	-	455	310	320	535	-	320	-	70	-	-	-
11	4th Plain Blvd & Main Street	45	205	110	45	185	40	50	425	45	105	400	15
12	4th Plain Blvd & Broadway Street	15	80	90	10	25	-	-	565	15	70	505	40
13	W Fourth Plain Blvd & F Street												
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	305	-	505	260	630	-	-	520	290
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	315	5	400	-	-	-	455	480	-	-	495	470
16	4th Plain Blvd & Saint Johns Blvd	110	50	30	-	15	95	100	620	20	15	605	15
17	4th Plain Blvd & Fort Vancouver Way	20	105	75	65	75	30	35	470	45	45	555	85
18	McLoughlin Blvd & Main Street	-	245	15	15	170	30	30	40	25	10	40	35
19	McLoughlin Blvd & Broadway Street	-	50	15	20	55	10	10	50	10	5	75	65
20	McLoughlin Blvd & F Street	-	-	5	-	-	-	-	120	-	-	85	-
21	McLoughlin Blvd & Fort Vancouver Way	90	130	60	30	90	40	10	40	70	35	40	15
22	Mill Plain Blvd & Franklin Street	30	35	195	60	25	-	10	600	10	135	385	95
23	Mill Plain Blvd WB & Columbia Street	60	95	-	-	85	5	-	-	-	155	550	55
24	Mill Plain Blvd WB & Washington Street	-	-	-	-	75	5	-	-	-	240	755	40
25	Mill Plain Blvd WB & Main Street	30	170	-	-	210	40	-	-	-	105	965	215
26	Mill Plain Blvd WB & Broadway Street	5	65	-	-	70	25	-	-	-	55	1255	20
27	Mill Plain Blvd WB & C Street	15	65	-	-	290	50	-	-	-	135	1265	130
28	Mill Plain Blvd EB & Columbia Street	-	150	430	40	200	-	5	840	10	-	-	-
29	Mill Plain Blvd EB & Washington Street	-	-	-	80	235	-	-	1285	25	-	-	-
30	Mill Plain Blvd EB & Main Street	-	160	280	110	205	-	40	1320	5	-	-	-
31	Mill Plain Blvd EB & Broadway Street	-	60	215	70	55	-	10	1695	5	-	-	-
32	Mill Plain Blvd EB & C Street	-	75	530	245	180	-	5	1970	5	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	320	-	885	-	1875	870	300	645	-
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	455	-	410	-	-	-	1630	565	-	-	490	510
35	Mill Plain Blvd & Fort Vancouver Way	200	70	25	40	40	115	175	715	85	65	685	35
36	Evergreen Blvd & Columbia Street	20	390	35	15	240	30	75	135	15	65	100	65
37	Evergreen Blvd & Washington Street	-	-	-	30	265	55	-	110	75	65	175	-
38	Evergreen Blvd & Main Street	5	250	-	30	115	50	35	105	-	5	185	55
39	Evergreen Blvd & Broadway Street	5	120	20	-	25	20	-	130	5	5	220	55
40	Evergreen Blvd & C Street	125	545	60	20	245	30	-	150	-	35	125	45
41	Evergreen Blvd & Fort Vancouver Way	5	100	15	50	20	120	130	85	15	5	80	65
42	8th Street & Columbia Street	30	675	-	-	60	45	90	-	10	-	-	-
43	8th Street & C Street	55	340	-	-	235	45	110	-	130	-	-	-
44	7th Street & C Street												
45	6th Street & Grant Street	-	450	195	30	330	-	-	-	-	130	-	20
46	6th Street & Esther Street	35	155	60	45	50	15	-	210	15	45	100	30
47	6th Street & Columbia Street	65	660	-	40	15	15	-	300	15	40	95	45
48	6th Street & Washington Street	-	-	-	70	315	90	-	145	195	25	90	-
49	6th Street & Main Street	10	100	-	20	15	75	60	155	-	-	30	5
50	6th Street & Broadway Street	-	-	-	75	-	35	45	130	-	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	-	395	-	-	365	-	-	-	205	-	-	-

Modified LPA Volumes

LPA 2 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]	130	-	95	480	-	55	-	10	-	5	10	-
52A	5th Street & Main St	5	5	5	5	10	-	100	5	480	5	10	5
53	Phil Arnold Way & Esther Street	-	200	50	5	105	-	-	-	-	90	-	50
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	15	380	-	110	55	5	55	-	-	50	120	215
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	-	15	10	480	15	-	-	110	-	-	-	-
55	Columbia Way & Esther Street	10	220	50	25	55	115	25	175	10	5	80	5
56	Columbia Way & Columbia Street	-	-	-	45	-	60	125	125	-	-	30	270
56A	Columbia Way & Main St	-	-	-	5	-	10	5	165	-	-	290	20
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	305	95	130	210	225	400	295	-	240	-	-	-
58	Columbia Way & Columbia Shores Blvd	-	145	-	135	235	95	75	10	-	15	5	310
59	Hayden Island Dr (South) & Center Ave	5	10	50	10	50	5	5	115	140	120	285	20
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	290	-	65	-	-	-	-	90	85	85	135	-
61A	Hayden Island Dr (South) & Jantzen Dr	195	-	190	-	-	-	-	20	135	135	25	-
62	Center Ave & N Tomahawk Island Dr	-	-	-	195	-	115	35	75	-	-	30	30
62A	Tomahawk Island Dr & Arterial Bridge Access	40	220	350	10	150	10	90	90	90	150	10	45
64	Tomahawk Island Dr & Jantzen Dr	5	120	135	35	135	100	200	200	50	190	100	65
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	-	-	-	455	-	290	-	180	-	-	70	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	-	-	-	-	-	-	375	260	-	-	70	305
66	N Portland Rd & W Marine Dr												
67	N Force Ave & W Marine Dr												
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	75	-	120	870	-	570	1035	480	155	40	250	840
69	Marine Dr & Vancouver Way	50	495	180	60	230	85	10	-	10	90	60	50
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	-	-	-	-	-	-	-	10	10	370	30	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10	-	425	-	-	-	-	10	-	-	390	-
69C	N Vancouver Way & N Pier 99 St	-	-	-	10	-	425	380	10	-	-	185	10
70	Marine Dr and Anchor Way	-	-	-	40	-	105	130	425	-	-	270	25
72	NE MLK & N Union Ct												
73	Victory Blvd & Expo Rd	-	160	50	280	35	-	-	-	-	60	-	360

Modified LPA Volumes

LPA 3 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)	-	415	50	40	570	-	-	-	-	30	-	50
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	45	-	-	50	705	10	-	20	110	-	-	-
3	39th Street & Main Street	20	115	40	65	535	50	75	410	15	80	305	35
4	H Street & E 39th Street												
5	39th Street & I-5 SB On-/Off-Ramps	20	-	545	-	-	-	-	405	225	195	510	-
6	39th Street & I-5 NB On-/Off-Ramps	230	-	55	-	-	-	50	900	-	-	475	320
7	15th Ave & SR 500 WB Off-Ramp	-	55	-	-	90	-	-	-	-	655	-	40
8	15th Ave & SR 500 EB On-Ramp/39th Street	80	15	95	30	30	685	40	820	55	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	45	315	-	-	500	275	-	-	-	360	-	150
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	-	255	210	265	595	-	105	-	50	-	-	-
11	4th Plain Blvd & Main Street	15	45	40	20	650	60	25	360	70	40	310	15
12	4th Plain Blvd & Broadway Street	5	20	20	25	15	-	-	405	15	30	360	30
13	W Fourth Plain Blvd & F Street												
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	365	-	530	280	295	-	-	410	625
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	275	5	190	-	-	-	260	400	-	-	760	235
16	4th Plain Blvd & Saint Johns Blvd	30	5	10	-	90	150	15	125	115	45	490	5
17	4th Plain Blvd & Fort Vancouver Way	5	30	15	25	125	20	5	110	25	40	470	35
18	McLoughlin Blvd & Main Street	-	50	15	20	615	25	5	25	15	5	45	20
19	McLoughlin Blvd & Broadway Street	-	15	15	15	50	20	-	60	-	5	50	20
20	McLoughlin Blvd & F Street	-	-	5	-	-	-	-	75	-	-	70	-
21	McLoughlin Blvd & Fort Vancouver Way	45	105	45	25	110	35	25	20	30	25	30	20
22	Mill Plain Blvd & Franklin Street	5	5	95	80	95	5	5	505	25	310	515	35
23	Mill Plain Blvd WB & Columbia Street	15	20	-	-	60	5	-	-	-	215	840	25
24	Mill Plain Blvd WB & Washington Street	-	-	-	-	35	5	-	-	-	545	1075	45
25	Mill Plain Blvd WB & Main Street	15	45	-	-	410	175	-	-	-	120	1475	125
26	Mill Plain Blvd WB & Broadway Street	5	20	-	-	55	10	-	-	-	130	1705	10
27	Mill Plain Blvd WB & C Street	15	25	-	-	125	30	-	-	-	325	1800	175
28	Mill Plain Blvd EB & Columbia Street	-	30	165	55	220	-	5	640	35	-	-	-
29	Mill Plain Blvd EB & Washington Street	-	-	-	50	530	-	-	855	5	-	-	-
30	Mill Plain Blvd EB & Main Street	-	55	35	120	410	-	5	885	15	-	-	-
31	Mill Plain Blvd EB & Broadway Street	-	15	35	35	150	-	10	1025	5	-	-	-
32	Mill Plain Blvd EB & C Street	-	35	205	105	345	-	5	1085	5	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	375	-	1420	-	510	885	670	880	-
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	685	-	410	-	-	-	385	500	-	-	865	305
35	Mill Plain Blvd & Fort Vancouver Way	100	15	5	20	60	85	145	620	145	30	985	35
36	Evergreen Blvd & Columbia Street	5	140	15	5	215	50	15	20	35	45	200	35
37	Evergreen Blvd & Washington Street	-	-	-	20	365	50	-	20	20	35	230	-
38	Evergreen Blvd & Main Street	15	40	-	5	240	15	5	35	-	5	235	5
39	Evergreen Blvd & Broadway Street	5	40	5	-	105	10	-	25	15	5	230	15
40	Evergreen Blvd & C Street	120	170	20	15	390	15	-	30	-	65	115	5
41	Evergreen Blvd & Fort Vancouver Way	15	60	5	25	85	125	40	20	5	5	45	20
42	8th Street & Columbia Street	65	475	-	50	165	40	30	-	30	-	-	5
43	8th Street & C Street	110	305	-	-	450	55	5	-	195	-	-	-
44	7th Street & C Street												
45	6th Street & Grant Street	-	120	125	10	225	-	-	-	-	135	-	15
46	6th Street & Esther Street	15	15	10	25	15	15	-	105	30	45	105	20
47	6th Street & Columbia Street	115	470	-	20	160	15	-	115	25	65	40	15
48	6th Street & Washington Street	-	-	-	30	135	50	-	105	35	10	70	-
49	6th Street & Main Street	5	10	-	50	15	60	5	135	-	-	15	-
50	6th Street & Broadway Street	-	-	-	25	-	15	20	165	-	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	-	380	-	-	365	-	-	-	195	-	-	-

Modified LPA Volumes

LPA 3 AM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]	-	-	-	140	-	35	-	10	195	5	5	-
52A	5th Street & Main St	5	5	5	5	10	-	5	5	140	5	5	5
53	Phil Arnold Way & Esther Street	-	35	50	30	75	-	-	-	-	215	-	20
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	20	205	-	65	180	5	40	-	40	200	210	370
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	-	15	20	140	15	-	-	65	-	-	-	-
55	Columbia Way & Esther Street	-	45	40	85	85	120	25	45	-	-	50	15
56	Columbia Way & Columbia Street	-	-	-	385	-	35	95	75	-	-	30	130
56A	Columbia Way & Main St	-	-	-	5	-	10	20	230	-	-	135	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	140	60	70	85	405	150	205	-	415	-	-	-
58	Columbia Way & Columbia Shores Blvd	-	70	5	690	70	60	30	25	-	5	15	170
59	Hayden Island Dr (South) & Center Ave	10	5	90	10	30	5	5	80	135	145	305	25
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	335	-	50	-	-	-	-	30	150	150	140	-
61A	Hayden Island Dr (South) & Jantzen Dr	265	-	55	-	-	-	-	10	75	70	25	-
62	Center Ave & N Tomahawk Island Dr	-	-	-	260	-	50	55	15	-	-	10	50
62A	Tomahawk Island Dr & Arterial Bridge Access	40	275	300	10	280	10	75	80	120	180	10	35
64	Tomahawk Island Dr & Jantzen Dr	35	85	140	10	40	95	195	190	5	95	95	40
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	-	-	-	445	-	225	-	55	-	-	10	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	-	-	-	-	-	-	240	260	-	-	10	130
66	N Portland Rd & W Marine Dr												
67	N Force Ave & W Marine Dr												
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	395	-	205	1470	-	975	550	190	160	220	410	835
69	Marine Dr & Vancouver Way	10	345	255	20	100	95	10	-	10	35	30	20
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	-	-	-	-	-	-	-	10	10	560	30	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10	-	490	-	-	-	-	10	-	-	580	-
69C	N Vancouver Way & N Pier 99 St	-	-	-	10	-	490	570	10	-	-	125	10
70	Marine Dr and Anchor Way	-	-	-	20	-	50	50	325	-	-	165	20
72	NE MLK & N Union Ct												
73	Victory Blvd & Expo Rd	-	95	215	-	5	-	-	-	-	20	-	120

Modified LPA Volumes

LPA 3 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
1	Ross Street & Main Street (Hwy 99)	-	915	55	80	750	-	-	-	-	45	-	120
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	170	-	-	85	525	45	-	30	155	-	-	-
3	39th Street & Main Street	75	340	90	100	295	120	120	410	40	50	335	70
4	H Street & E 39th Street												
5	39th Street & I-5 SB On-/Off-Ramps	25	-	505	-	-	-	-	425	280	45	570	-
6	39th Street & I-5 NB On-/Off-Ramps	365	-	90	-	-	-	55	875	-	-	250	560
7	15th Ave & SR 500 WB Off-Ramp	-	90	-	-	90	-	-	-	-	635	-	65
8	15th Ave & SR 500 EB On-Ramp/39th Street	60	10	60	50	60	615	80	715	110	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	65	710	-	-	525	200	-	-	-	330	-	225
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	-	455	310	320	535	-	320	-	70	-	-	-
11	4th Plain Blvd & Main Street	45	205	110	45	185	40	50	425	45	105	400	15
12	4th Plain Blvd & Broadway Street	15	80	90	10	25	-	-	565	15	70	505	40
13	W Fourth Plain Blvd & F Street												
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	305	-	505	260	630	-	-	520	290
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	315	5	400	-	-	-	455	480	-	-	495	470
16	4th Plain Blvd & Saint Johns Blvd	110	50	30	-	15	95	100	620	20	15	605	15
17	4th Plain Blvd & Fort Vancouver Way	20	105	75	65	75	30	35	470	45	45	555	85
18	McLoughlin Blvd & Main Street	-	245	15	15	170	30	30	40	25	10	40	35
19	McLoughlin Blvd & Broadway Street	-	50	15	20	55	10	10	50	10	5	75	65
20	McLoughlin Blvd & F Street	-	-	5	-	-	-	-	120	-	-	85	-
21	McLoughlin Blvd & Fort Vancouver Way	90	130	60	30	90	40	10	40	70	35	40	15
22	Mill Plain Blvd & Franklin Street	30	35	195	60	25	-	10	600	10	135	385	95
23	Mill Plain Blvd WB & Columbia Street	45	95	-	-	85	5	-	-	-	155	565	55
24	Mill Plain Blvd WB & Washington Street	-	-	-	-	75	5	-	-	-	240	770	40
25	Mill Plain Blvd WB & Main Street	45	170	-	-	210	40	-	-	-	105	965	215
26	Mill Plain Blvd WB & Broadway Street	5	65	-	-	70	25	-	-	-	55	1255	20
27	Mill Plain Blvd WB & C Street	15	65	-	-	290	50	-	-	-	135	1265	130
28	Mill Plain Blvd EB & Columbia Street	-	135	480	40	200	-	5	840	10	-	-	-
29	Mill Plain Blvd EB & Washington Street	-	-	-	80	235	-	-	1335	25	-	-	-
30	Mill Plain Blvd EB & Main Street	-	175	230	110	205	-	40	1370	5	-	-	-
31	Mill Plain Blvd EB & Broadway Street	-	60	235	70	55	-	10	1695	5	-	-	-
32	Mill Plain Blvd EB & C Street	-	75	510	245	180	-	5	1990	5	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	-	-	-	320	-	885	-	1875	870	300	645	-
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	455	-	410	-	-	-	1630	565	-	-	490	510
35	Mill Plain Blvd & Fort Vancouver Way	200	70	25	40	40	115	175	715	85	65	685	35
36	Evergreen Blvd & Columbia Street	35	440	35	15	240	30	75	135	15	65	85	50
37	Evergreen Blvd & Washington Street	-	-	-	30	265	55	-	110	75	65	145	-
38	Evergreen Blvd & Main Street	5	215	-	30	115	50	35	105	-	5	155	55
39	Evergreen Blvd & Broadway Street	5	160	20	-	25	20	-	130	5	5	190	35
40	Evergreen Blvd & C Street	75	525	60	20	245	30	-	150	-	35	125	45
41	Evergreen Blvd & Fort Vancouver Way	5	100	15	50	20	120	130	85	15	5	80	65
42	8th Street & Columbia Street	30	710	-	-	60	45	90	-	10	-	-	30
43	8th Street & C Street	125	550	-	-	235	45	110	-	130	-	-	-
44	7th Street & C Street												
45	6th Street & Grant Street	-	450	195	30	330	-	-	-	-	130	-	20
46	6th Street & Esther Street	35	155	60	45	50	15	-	210	15	45	100	30
47	6th Street & Columbia Street	65	695	60	40	15	15	-	300	15	40	95	45
48	6th Street & Washington Street	-	-	-	70	315	90	-	205	195	20	90	-
49	6th Street & Main Street	10	5	-	20	15	75	120	155	-	-	25	5
50	6th Street & Broadway Street	-	-	-	75	-	30	45	130	-	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	-	395	-	-	365	-	-	-	205	-	-	-

Modified LPA Volumes

LPA 3 PM Volumes

ID	Intersection	NBL	NBT	NBR	SBL	SBT	SBR	EBL	EBT	EBR	WBL	WBT	WBR
52	5th Street & Washington Street/I-5 SB On-Ramp [1,2]	-	-	-	480	-	50	-	10	-	-	10	-
52A	5th Street & Main St	5	5	5	5	10	-	5	5	480	5	5	5
53	Phil Arnold Way & Esther Street	-	200	45	5	105	-	-	-	-	90	-	50
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	15	505	-	10	55	5	50	-	-	50	120	215
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	-	15	105	480	15	-	-	10	-	-	-	-
55	Columbia Way & Esther Street	10	215	50	25	55	115	25	175	10	5	80	5
56	Columbia Way & Columbia Street	-	-	-	45	-	60	125	125	-	-	30	395
56A	Columbia Way & Main St	-	-	-	5	-	10	105	165	-	-	290	15
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	305	95	130	210	225	400	295	-	240	-	-	-
58	Columbia Way & Columbia Shores Blvd	-	145	-	135	235	95	75	10	-	15	5	310
59	Hayden Island Dr (South) & Center Ave	5	10	50	10	50	5	5	115	140	120	285	20
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	290	-	65	-	-	-	-	90	85	85	135	-
61A	Hayden Island Dr (South) & Jantzen Dr	195	-	190	-	-	-	-	20	135	135	25	-
62	Center Ave & N Tomahawk Island Dr	-	-	-	195	-	115	35	75	-	-	30	30
62A	Tomahawk Island Dr & Arterial Bridge Access	40	220	350	10	150	10	90	90	90	150	10	45
64	Tomahawk Island Dr & Jantzen Dr	5	120	135	35	135	100	200	200	50	190	100	65
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	-	-	-	455	-	290	-	180	-	-	70	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	-	-	-	-	-	-	375	260	-	-	70	305
66	N Portland Rd & W Marine Dr												
67	N Force Ave & W Marine Dr												
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	75	-	120	870	-	570	1035	480	155	40	250	840
69	Marine Dr & Vancouver Way	50	495	180	60	230	85	10	-	10	90	60	50
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	-	-	-	-	-	-	-	10	10	370	30	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	10	-	425	-	-	-	-	10	-	-	390	-
69C	N Vancouver Way & N Pier 99 St	-	-	-	10	-	425	380	10	-	-	185	10
70	Marine Dr and Anchor Way	-	-	-	40	-	105	130	425	-	-	270	25
72	NE MLK & N Union Ct												
73	Victory Blvd & Expo Rd	-	160	50	280	35	-	-	-	-	60	-	360

Appendix E. Local Operation Results

Performance Results

AM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	Overall	3	A	0.27	LOS E	Y	-	-	-	Overall	3	A	0.31	LOS E	Y	-	-	-
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	Overall	5	A	0.56	LOS D	Y	-	-	-	Overall	6	A	0.51	LOS D	Y	-	-	-
3	39th Street & Main Street	Overall	18	B	0.79	LOS E	Y	EBL/WBL/SBL	70/75/75	110/110/115	Overall	25	C	0.86	LOS E	Y	EBL/WBL/SBL	70/75/75	150/140/120
4	H Street & E 39th Street	Overall	8	A	0.47	LOS E	Y	-	-	-	Overall	17	B	0.53	LOS E	Y	WBTR	95	115
5	39th Street & I-5 SB On-/Off-Ramps	NBL	368	F	1.25	LOS D	N	EBTR/NBLR	100/1565	135/1945	NBL	833	F	1.12	LOS D	N	EBTR/NBLR	95/1595	155/1875
6	39th Street & I-5 NB On-/Off-Ramps	Overall	15	B	0.77	LOS D	Y	-	-	-	Overall	19	B	0.79	LOS D	Y	WBTR	315	350
7	15th Ave & SR 500 WB Off-Ramp	Overall	7	A	0.54	LOS E	Y	-	-	-	Overall	9	A	0.57	LOS E	Y	-	-	-
8	15th Ave & SR 500 EB On-Ramp/39th Street	Overall	8	A	0.82	LOS E	Y	-	-	-	Overall	9	A	0.80	LOS E	Y	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	Overall	11	B	0.40	LOS E	Y	-	-	-	Overall	14	B	0.46	LOS E	Y	-	-	-
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	Overall	9	A	0.38	LOS E	Y	-	-	-	Overall	11	B	0.42	LOS E	Y	SBL	145	175
11	4th Plain Blvd & Main Street	Overall	43	D	1.13	LOS E	Y	WBL/WBTR/ SBL/SBTR	130/195/50/ 780	145/230/80/8 10	Overall	312	F	1.11	LOS E	N	WBL/WBTR/ NBR/SBL/ SBTR	130/195/70/ 50	140/240/75/8 5/860
12	4th Plain Blvd & Broadway Street	Overall	47	D	0.77	LOS E	Y	WBL/WBTR	125/850	175/1285	Overall	32	C	0.72	LOS E	Y	WBL/WBTR	125/850	175/1175
13	W Fourth Plain Blvd & F Street	Overall	38	D	0.46	LOS E	Y	WBT/WBTR	360/360	455/470	Overall	14	B	0.39	LOS E	Y	WBT/WBTR	360/360	375/365
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	Overall	19	B	0.85	LOS D	Y	EBL/SBL	170/100	200/130	Overall	13	B	0.77	LOS D	Y	EBL/SBL	170/100	195/130
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	Overall	13	B	0.75	LOS D	Y	-	-	-	Overall	15	B	0.83	LOS D	Y	-	-	-
16	4th Plain Blvd & Saint Johns Blvd	Overall	8	A	0.33	LOS E	Y	EBR	75	85	Overall	13	B	0.71	LOS E	Y	EBR	75	100
17	4th Plain Blvd & Fort Vancouver Way	Overall	11	B	0.28	LOS E	Y	-	-	-	Overall	23	C	0.77	LOS E	Y	-	-	-
18	McLoughlin Blvd & Main Street	Overall	5	A	0.50	LOS E	Y	-	-	-	Overall	7	A	0.51	LOS E	Y	-	-	-
19	McLoughlin Blvd & Broadway Street	Overall	5	A	0.13	LOS E	Y	-	-	-	Overall	5	A	0.10	LOS E	Y	-	-	-
20	McLoughlin Blvd & F Street	NBR	3	A	0.01	LOS E	Y	-	-	-	NBR	3	A	0.01	LOS E	Y	-	-	-
21	McLoughlin Blvd & Fort Vancouver Way	Overall	11	B	0.14	LOS E	Y	-	-	-	Overall	11	B	0.21	LOS E	Y	-	-	-
22	Mill Plain Blvd & Franklin Street	Overall	15	B	0.44	LOS E	Y	SBL	50	85	Overall	39	D	0.53	LOS E	Y	WBL/SBL	370/50	395/80
23	Mill Plain Blvd WB & Columbia Street	Overall	6	A	0.26	LOS E	Y	-	-	-	Overall	6	A	0.41	LOS E	Y	-	-	-
24	Mill Plain Blvd WB & Washington Street	Overall	8	A	0.43	LOS E	Y	-	-	-	Overall	8	A	0.59	LOS E	Y	SBTR	270	280
25	Mill Plain Blvd WB & Main Street	Overall	6	A	0.43	LOS E	Y	-	-	-	Overall	14	B	0.56	LOS E	Y	WBT/WBTR	190/190	205/215
26	Mill Plain Blvd WB & Broadway Street	Overall	4	A	0.30	LOS E	Y	-	-	-	Overall	6	A	0.38	LOS E	Y	-	-	-
27	Mill Plain Blvd WB & C Street	Overall	14	B	0.42	LOS E	Y	-	-	-	Overall	15	B	0.51	LOS E	Y	-	-	-
28	Mill Plain Blvd EB & Columbia Street	Overall	11	B	0.41	LOS E	Y	-	-	-	Overall	11	B	0.40	LOS E	Y	-	-	-
29	Mill Plain Blvd EB & Washington Street	Overall	8	A	0.38	LOS E	Y	-	-	-	Overall	8	A	0.38	LOS E	Y	-	-	-
30	Mill Plain Blvd EB & Main Street	Overall	4	A	0.40	LOS E	Y	-	-	-	Overall	5	A	0.43	LOS E	Y	-	-	-
31	Mill Plain Blvd EB & Broadway Street	Overall	6	A	0.31	LOS E	Y	-	-	-	Overall	7	A	0.33	LOS E	Y	SBL	50	55
32	Mill Plain Blvd EB & C Street	Overall	5	A	0.38	LOS E	Y	-	-	-	Overall	6	A	0.38	LOS E	Y	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	18	B	1.04	LOS D	Y	EBR/WBL/ WBT	250/200/540	255/370/555	Overall	25	C	0.77	LOS D	Y	EBT/EBR/ WBL	385/250/200	525/370/270
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	24	C	0.71	LOS D	Y	WBT/NBLT	475/300	480/350	Overall	36	D	0.68	LOS D	Y	WBT	465	580
35	Mill Plain Blvd & Fort Vancouver Way	Overall	21	C	0.43	LOS E	Y	NBL	75	135	Overall	28	C	0.59	LOS E	Y	WBL/NBL	125/75	205/160

Performance Results

AM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
36	Evergreen Blvd & Columbia Street	Overall	12	B	0.20	LOS E	Y	-	-	-	Overall	12	B	0.26	LOS E	Y	-	-	-
37	Evergreen Blvd & Washington Street	Overall	22	C	0.19	LOS E	Y	-	-	-	Overall	23	C	0.26	LOS E	Y	SBLT	245	285
38	Evergreen Blvd & Main Street	Overall	8	A	0.16	LOS E	Y	-	-	-	Overall	11	B	0.29	LOS E	Y	-	-	-
39	Evergreen Blvd & Broadway Street	Overall	10	A	0.16	LOS E	Y	-	-	-	Overall	11	B	0.21	LOS E	Y	-	-	-
40	Evergreen Blvd & C Street	Overall	7	A	0.17	LOS E	Y	-	-	-	Overall	9	A	0.20	LOS E	Y	NBL	70	90
41	Evergreen Blvd & Fort Vancouver Way	Overall	2	A	0.14	LOS E	Y	-	-	-	Overall	2	A	0.14	LOS E	Y	-	-	-
42	8th Street & Columbia Street	Overall	6	A	0.11	LOS E	Y	-	-	-	Overall	7	A	0.15	LOS E	Y	-	-	-
43	8th Street & C Street	Overall	14	B	0.22	LOS E	Y	-	-	-	Overall	16	B	0.23	LOS E	Y	-	-	-
44	7th Street & C Street	EBL	1	A	0.03	LOS E	Y	-	-	-	EBL	1	A	0.06	LOS E	Y	-	-	-
45	6th Street & Grant Street	WBL	6	A	0.18	LOS E	Y	-	-	-	WBL	10	B	0.31	LOS E	Y	WBL	100	110
46	6th Street & Esther Street	Overall	5	A	0.16	LOS E	Y	-	-	-	Overall	5	A	0.16	LOS E	Y	-	-	-
47	6th Street & Columbia Street	Overall	7	A	0.24	LOS E	Y	-	-	-	Overall	8	A	0.34	LOS E	Y	-	-	-
48	6th Street & Washington Street	Overall	12	B	0.27	LOS E	Y	-	-	-	Overall	15	B	0.40	LOS E	Y	WBLT	200	205
49	6th Street & Main Street	Overall	6	A	0.41	LOS E	Y	-	-	-	Overall	7	A	0.26	LOS E	Y	-	-	-
50	6th Street & Broadway Street	EBL	5	A	0.03	LOS E	Y	-	-	-	EBL	10	A	0.12	LOS E	Y	-	-	-
51	6th Street & C Street	Overall	2	A	0.00	LOS D	Y	-	-	-	Overall	4	A	0.00	LOS D	Y	-	-	-
52	5th Street & Washington Street/I-5 SB On-Ramp	Overall	9	A	0.26	LOS D	Y	-	-	-	Overall	8	A	0.41	LOS D	Y	-	-	-
53	Phil Arnold Way & Esther Street	WBL	4	A	0.02	LOS E	Y	-	-	-	WBL	5	A	0.03	LOS E	Y	-	-	-
54	Phil Arnold Way & Columbia Street	EBL	4	A	0.04	LOS E	Y	-	-	-	EBL	6	A	0.05	LOS E	Y	-	-	-
55	Columbia Way & Esther Street	Overall	4	A	0.06	LOS E	Y	-	-	-	Overall	4	A	0.10	LOS E	Y	-	-	-
56	Columbia Way & Columbia Street	Overall	3	A	0.68	LOS E	Y	-	-	-	Overall	4	A	0.55	LOS E	Y	-	-	-
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	Overall	20	C	0.59	LOS D	Y	EBR/NBL	115/50	135/125	Overall	47	D	0.59	LOS D	N	EBR/NBL/ SBL	115/50/375	235/165/430
58	Columbia Way & Columbia Shores Blvd	Overall	18	B	0.85	LOS E	Y	SB	245	355	Overall	27	C	0.84	LOS E	Y	EBL/WBR/ SBLTR	50/100/245	70/130/465
59	Hayden Island Dr (South) & Center Ave	Overall	8	A	0.42	V/C = 1.1	Y	-	-	-	Overall	9	A	0.44	V/C = 1.1	Y	-	-	-
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North	Overall	5	A	0.28	V/C = 1.1	Y	-	-	-	Overall	7	A	0.33	V/C = 0.85	Y	WBLR	85	90
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	Overall	3	A	0.13	LOS D	Y	-	-	-	Overall	4	A	0.16	LOS D	Y	-	-	-
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island	Overall	9	A	0.45	V/C = 0.85	Y	-	-	-	Overall	10	B	0.51	V/C = 0.85	Y	-	-	-
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr	NBR	2	A	0.05	V/C = 0.85	Y	-	-	-	NBR	3	A	0.05	V/C = 0.85	Y	-	-	-
64	Tomahawk Island Dr & Jantzen Dr	NBT	9	A	0.12	LOS D	Y	-	-	-	NBL	10	A	0.16	LOS D	Y	-	-	-
65	Center Ave & Jantzen Ave	EBL	8	A	0.07	LOS D	Y	-	-	-	EBL	9	A	0.08	LOS D	Y	-	-	-
66	N Portland Rd & W Marine Dr	Overall	18	B	0.73	LOS D	Y	WBL	300	365	Overall	28	C	0.89	LOS D	Y	WBL	300	355
67	N Force Ave & W Marine Dr	Overall	7	A	0.65	LOS D	Y	-	-	-	Overall	9	A	0.75	LOS D	Y	-	-	-
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	Overall	140	F	1.04	V/C = 0.85	N	WBL/NBL/ SBR	155/175/90	275/285/270	Overall	471	F	1.28	V/C = 0.85	N	EBL/WBL/ NBL/SBR	500/155/175/ 90	905/305/ 305/290
69	Marine Dr & Vancouver Way (Loop)	Overall	7	A	0.61	V/C = 0.99	Y	NBT/NBR	55/55	75/90	Overall	9	A	0.50	V/C = 0.99	Y	WBL/NBR	75/55	80/90
70	Marine Dr and Anchor Way	SBL	9	A	0.20	LOS D	Y	-	-	-	SBL	11	B	0.26	LOS D	Y	-	-	-
71	I-5 NB Off-Ramp & Union Ct/Marine Way	EBL	11	B	0.27	V/C = 0.85	Y	-	-	-	EBL	9	A	0.21	V/C = 0.85	Y	-	-	-
72	NE MLK & N Union Ct	SBL	3	A	0.04	V/C = 0.99	Y	-	-	-	SBL	3	A	0.05	V/C = 0.99	Y	-	-	-

Performance Results

AM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
73	Victory Blvd & Expo Rd	Overall	10	B	0.18	V/C = 1.1	Y	-	-	-	Overall	12	B	0.78	V/C = 0.85	Y	-	-	-
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	NBL	6	A	0.05	V/C = 0.85	Y	-	-	-	NBL	7	A	0.06	V/C = 1.1	Y	-	-	-
75	Victory Blvd & I-5 SB On-Ramp	WBL	3	A	0.10	V/C = 0.85	Y	-	-	-	WBL	4	A	0.31	V/C = 0.85	Y	-	-	-
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	Overall	7	A	0.22	V/C = 0.85	Y	WBTR	100	105	Overall	7	A	0.20	V/C = 0.85	Y	-	-	-
77	Interstate Ave/Denver Ave & Schmeer Rd	Overall	6	A	0.76	V/C = 0.85	Y	-	-	-	Overall	10	A	0.79	V/C = 0.85	Y	-	-	-
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp	Overall	15	B	0.57	V/C = 0.85	Y	WBR	95	160	Overall	17	B	0.60	V/C = 0.85	Y	EBL/WBR	225/95	255/190
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	Overall	16	B	0.47	LOS D	Y	-	-	-	Overall	19	B	0.53	LOS D	Y	SBL	125	150
80	Columbia Blvd & MLK Blvd	Overall	32	C	0.83	V/C = 0.99	Y	WBL/WBR/ NBL/SBL	140/125/70/ 200	180/190/ 140/300	Overall	39	D	0.88	V/C = 0.99	N	EBL/EBR/ WBL/WBR/ NBL/SBL/ SBT	140/300/140/ 125/150/200/ 525	190/340/ 220/250/ 220/390/570

Performance Results

PM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	Overall	5	A	0.50	LOS E	Y	SBL	10	70	Overall	6	A	0.49	LOS E	Y	-	-	-
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	Overall	7	A	0.47	LOS D	Y	-	-	-	Overall	9	A	0.53	LOS D	Y	-	-	-
3	39th Street & Main Street	Overall	105	F	0.53	LOS E	N	EBL/WBL/ WBTR/NBL/ SBL	70/75/785/ 75/75	175/165/960/ 100/105	Overall	185	F	0.64	LOS E	N	EBL/EBTR/ WBL/WBTR/ NBL/SBL	70/1425/75/ 785/75/75	175/1700/ 160/965/ 115/130
4	H Street & E 39th Street	Overall	19	B	0.49	LOS E	Y	WBL/WBTR	50/100	75/140	Overall	57	E	0.56	LOS E	Y	WBL/WBTR/ NBLTR	50/100/250	90/145/265
5	39th Street & I-5 SB On-/Off-Ramps	NBL	203	F	0.90	LOS D	N	EBTR	100	130	NBL	1392	F	1.04	LOS D	N	EBTR/WBL/W BT/NBLR	100/115/705/ 1575	145/180/ 870/1990
6	39th Street & I-5 NB On-/Off-Ramps	Overall	23	C	0.81	LOS D	Y	WBTR	315	320	Overall	35	D	0.86	LOS D	Y	WBTR	315	385
7	15th Ave & SR 500 WB Off-Ramp	Overall	8	A	0.52	LOS E	Y	-	-	-	Overall	11	B	0.54	LOS E	Y	-	-	-
8	15th Ave & SR 500 EB On-Ramp/39th Street	Overall	8	A	0.69	LOS E	Y	-	-	-	Overall	8	A	0.72	LOS E	Y	-	-	-
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	Overall	29	C	0.42	LOS E	Y	SBT	190	305	Overall	19	B	0.50	LOS E	Y	SBT	190	195
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	Overall	20	C	0.44	LOS E	Y	SBL	145	180	Overall	23	C	0.54	LOS E	Y	EBL/SBL	190/145	265/180
11	4th Plain Blvd & Main Street	Overall	24	C	0.71	LOS E	Y	WBL/WBTR/ NBL/NBR/SBL	130/195/70/ 70/50	170/260/ 100/115/80	Overall	31	C	0.77	LOS E	Y	WBL/WBTR/ NBL/NBR/ SBL	130/195/70/ 70/50	200/265/ 130/170/105
12	4th Plain Blvd & Broadway Street	Overall	22	C	0.71	LOS E	Y	WBL/WBTR	125/610	190/700	Overall	52	D	0.77	LOS E	Y	WBL/WBTR	125/850	250/1220
13	W Fourth Plain Blvd & F Street	Overall	12	B	0.48	LOS E	Y	EBT	240	250	Overall	36	D	0.53	LOS E	Y	EBT/WBT/ WBTR	240/360/360	250/465/485
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	Overall	11	B	0.74	LOS D	Y	SBL	100	130	Overall	33	C	0.79	LOS D	Y	EBL/EBT/ WBT/SBL	170/170/810/ 100	185/175/ 830/135
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	Overall	14	B	0.78	LOS D	Y	-	-	-	Overall	37	D	0.84	LOS D	Y	EBL	230	270
16	4th Plain Blvd & Saint Johns Blvd	Overall	12	B	0.47	LOS E	Y	-	-	-	Overall	20	C	0.73	LOS E	Y	EBL	115	140
17	4th Plain Blvd & Fort Vancouver Way	Overall	19	B	0.36	LOS E	Y	NBR/SBL	75/75	80/85	Overall	25	C	0.57	LOS E	Y	EBL/SBL	75/75	100/95
18	McLoughlin Blvd & Main Street	Overall	6	A	0.35	LOS E	Y	-	-	-	Overall	7	A	0.39	LOS E	Y	-	-	-
19	McLoughlin Blvd & Broadway Street	Overall	5	A	0.12	LOS E	Y	-	-	-	Overall	5	A	0.14	LOS E	Y	-	-	-
20	McLoughlin Blvd & F Street	NBT	7	A	0.01	LOS E	Y	-	-	-	NBR	6	A	0.01	LOS E	Y	-	-	-
21	McLoughlin Blvd & Fort Vancouver Way	Overall	9	A	0.12	LOS E	Y	-	-	-	Overall	12	B	0.24	LOS E	Y	NBL	80	90
22	Mill Plain Blvd & Franklin Street	Overall	26	C	0.37	LOS E	Y	NBL/SBL	50/50	60/70	Overall	16	B	0.39	LOS E	Y	NBL/SBL	50/50	70/80
23	Mill Plain Blvd WB & Columbia Street	Overall	12	B	0.26	LOS E	Y	-	-	-	Overall	14	B	0.34	LOS E	Y	-	-	-
24	Mill Plain Blvd WB & Washington Street	Overall	6	A	0.26	LOS E	Y	-	-	-	Overall	7	A	0.31	LOS E	Y	-	-	-
25	Mill Plain Blvd WB & Main Street	Overall	10	A	0.37	LOS E	Y	-	-	-	Overall	11	B	0.45	LOS E	Y	-	-	-
26	Mill Plain Blvd WB & Broadway Street	Overall	9	A	0.27	LOS E	Y	-	-	-	Overall	10	A	0.35	LOS E	Y	-	-	-
27	Mill Plain Blvd WB & C Street	Overall	16	B	0.47	LOS E	Y	SBTR	235	240	Overall	18	B	0.58	LOS E	Y	SBTR	235	285
28	Mill Plain Blvd EB & Columbia Street	Overall	44	D	0.60	LOS E	Y	EBLT/EBTR/ NBTR	390/390/235	395/395/275	Overall	13	B	0.57	LOS E	Y	NBTR	235	265
29	Mill Plain Blvd EB & Washington Street	Overall	28	C	0.35	LOS E	Y	EBT/EBTR	230/230	275/270	Overall	8	A	0.34	LOS E	Y	-	-	-
30	Mill Plain Blvd EB & Main Street	Overall	29	C	0.57	LOS E	Y	EBLT/EBT/ EBTR	205/205/205	260/265/260	Overall	10	B	0.59	LOS E	Y	NBTR	215	230
31	Mill Plain Blvd EB & Broadway Street	Overall	35	C	0.58	LOS E	Y	EBLT/EBT/ EBTR/NBTR/ SBL	205/205/205/ 240/50	270/285/ 270/280/95	Overall	10	A	0.52	LOS E	Y	SBL	50	60

Performance Results

PM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
32	Mill Plain Blvd EB & C Street	Overall	28	C	0.73	LOS E	Y	EBLT/EBT/ EBTR	215/215/215	300/315/300	Overall	11	B	0.63	LOS E	Y	-	-	-
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	37	D	0.72	LOS D	Y	EBT/WBL	395/200	490/250	Overall	17	B	0.74	LOS D	Y	-	-	-
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	27	C	0.84	LOS D	Y	EBL/NBLT	210/300	265/435	Overall	29	C	0.75	LOS D	Y	EBL/EBL	210/545	380/550
35	Mill Plain Blvd & Fort Vancouver Way	Overall	24	C	0.47	LOS E	Y	NBL	75	160	Overall	26	C	0.50	LOS E	Y	NBL	75	180
36	Evergreen Blvd & Columbia Street	Overall	13	B	0.28	LOS E	Y	EBL	50	65	Overall	16	B	0.33	LOS E	Y	EBL	50	80
37	Evergreen Blvd & Washington Street	Overall	18	B	0.13	LOS E	Y	-	-	-	Overall	21	C	0.18	LOS E	Y	-	-	-
38	Evergreen Blvd & Main Street	Overall	11	B	0.17	LOS E	Y	-	-	-	Overall	12	B	0.23	LOS E	Y	EBL	55	65
39	Evergreen Blvd & Broadway Street	Overall	12	B	0.16	LOS E	Y	-	-	-	Overall	13	B	0.22	LOS E	Y	-	-	-
40	Evergreen Blvd & C Street	Overall	16	B	0.24	LOS E	Y	NBL	70	80	Overall	18	B	0.28	LOS E	Y	NBL	70	115
41	Evergreen Blvd & Fort Vancouver Way	Overall	3	A	0.15	LOS E	Y	-	-	-	Overall	7	A	0.15	LOS E	Y	-	-	-
42	8th Street & Columbia Street	Overall	11	B	0.32	LOS E	Y	-	-	-	Overall	11	B	0.31	LOS E	Y	-	-	-
43	8th Street & C Street	Overall	17	B	0.23	LOS E	Y	-	-	-	Overall	19	B	0.26	LOS E	Y	-	-	-
44	7th Street & C Street	EBL	8	A	0.03	LOS D	Y	-	-	-	EBL	9	A	0.06	LOS D	Y	-	-	-
45	6th Street & Grant Street	WBL	10	B	0.28	LOS E	Y	-	-	-	WBL	30	C	0.46	LOS E	Y	WBL	100	140
46	6th Street & Esther Street	Overall	3	A	0.18	LOS E	Y	-	-	-	Overall	4	A	0.18	LOS E	Y	-	-	-
47	6th Street & Columbia Street	Overall	14	B	0.29	LOS E	Y	-	-	-	Overall	20	C	0.38	LOS E	Y	EBL	100	140
48	6th Street & Washington Street	Overall	14	B	0.24	LOS E	Y	-	-	-	Overall	20	B	0.35	LOS E	Y	WBLT/WBT	200/200	225/205
49	6th Street & Main Street	Overall	6	A	0.26	LOS E	Y	-	-	-	Overall	10	B	0.30	LOS E	Y	-	-	-
50	6th Street & Broadway Street	EBL	4	A	0.03	LOS E	Y	-	-	-	EBL	6	A	0.05	LOS E	Y	-	-	-
51	6th Street & C Street	Overall	1	A	0.00	LOS D	Y	-	-	-	Overall	4	A	0.00	LOS D	Y	-	-	-
52	5th Street & Washington Street/I-5 SB On-Ramp	Overall	15	B	0.39	LOS D	Y	-	-	-	Overall	15	B	0.44	LOS D	Y	EBR	175	180
53	Phil Arnold Way & Esther Street	WBL	5	A	0.04	LOS E	Y	-	-	-	WBR	6	A	0.05	LOS E	Y	-	-	-
54	Phil Arnold Way & Columbia Street	EBL	6	A	0.03	LOS E	Y	-	-	-	EBL	7	A	0.11	LOS E	Y	-	-	-
55	Columbia Way & Esther Street	Overall	6	A	0.16	LOS E	Y	-	-	-	Overall	7	A	0.29	LOS E	Y	-	-	-
56	Columbia Way & Columbia Street	Overall	4	A	0.30	LOS E	Y	-	-	-	Overall	7	A	0.52	LOS E	Y	-	-	-
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	Overall	40	D	0.68	LOS D	Y	NBL/NBT/ NBR	50/245/125	155/265/145	Overall	127	F	0.78	LOS D	N	EBR/NBL/ NBT/NBR/ SBL	115/50/245/ 125/375	230/150/265/ 150/745
58	Columbia Way & Columbia Shores Blvd	Overall	392	F	0.51	LOS E	N	EBL/WBT/ WBR/NBLTR/ SBLTR	50/935/100/ 345/245	175/1230/ 170/450/285	Overall	317	F	0.52	LOS E	N	EBL/EBTR/ WBT/WBR/ NBLTR/ SBLTR	50/620/945/ 100/345/245	185/795/ 1230/155/ 435/410
59	Hayden Island Dr (South) & Center Ave	Overall	8	A	0.50	V/C = 1.1	Y	-	-	-	Overall	10	A	0.54	V/C = 1.1	Y	-	-	-
60	Hayden Island Dr (South) & Hayden Island Dr Connector to North	Overall	8	A	0.55	V/C = 1.1	Y	WBLR	85	105	Overall	9	A	0.53	V/C = 0.85	Y	WBLR	85	110
61	Hayden Island Dr (North) & Hayden Island Dr Connector to South	Overall	4	A	0.15	LOS D	Y	-	-	-	Overall	5	A	0.21	LOS D	Y	-	-	-
62	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island	Overall	10	A	0.43	V/C = 0.85	Y	-	-	-	Overall	12	B	0.53	V/C = 0.85	Y	-	-	-
63	I-5 NB Hayden Island Off-Ramp & Tomahawk Island Dr	NBR	2	A	0.05	V/C = 0.85	Y	-	-	-	NBR	3	A	0.07	V/C = 0.85	Y	-	-	-
64	Tomahawk Island Dr & Jantzen Dr	NBT	9	A	0.26	LOS D	Y	-	-	-	NBL	14	B	0.39	LOS D	Y	-	-	-
65	Center Ave & Jantzen Ave	EBL	7	A	0.03	LOS D	Y	-	-	-	EBL	8	A	0.04	LOS D	Y	-	-	-

Performance Results

PM Peak Hour		2019 Existing Conditions									2045 No-Build								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
66	N Portland Rd & W Marine Dr	Overall	27	C	0.85	LOS D	Y	EBT/WBL	200/300	240/355	Overall	138	F	0.99	LOS D	N	EBT/WBL	200/300	255/335
67	N Force Ave & W Marine Dr	Overall	11	B	0.57	LOS D	Y	-	-	-	Overall	210	F	0.63	LOS D	Y	EBT/EBTR	3680/3680	4440/4450
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	Overall	47	D	0.80	V/C = 0.85	N	EBL	500	785	Overall	141	F	0.92	V/C = 0.85	N	EBL/EBL/ EBT/EBR/ NBL/SBR	500/2145/ 2145/275/ 175/90	805/2520/ 2575/410/ 265/155
69	Marine Dr & Vancouver Way (Loop)	Overall	8	A	0.50	V/C = 0.99	Y	NBT/NBR	55/55	85/75	Overall	9	A	0.33	V/C = 0.99	Y	WBL/NBR	75/55	80/90
70	Marine Dr and Anchor Way	SBL	10	B	0.19	LOS D	Y	-	-	-	SBL	11	B	0.26	LOS D	Y	-	-	-
71	I-5 NB Off-Ramp & Union Ct/Marine Way	EBL	16	B	0.16	V/C = 0.85	Y	-	-	-	EBL	14	B	0.12	V/C = 0.85	Y	-	-	-
72	NE MLK & N Union Ct	SBL	7	A	0.10	V/C = 0.99	Y	-	-	-	SBL	8	A	0.15	V/C = 0.99	Y	-	-	-
73	Victory Blvd & Expo Rd	Overall	8	A	0.52	V/C = 1.1	Y	SBL	65	75	Overall	9	A	0.63	V/C = 0.85	Y	SBL	65	90
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	NBL	10	B	0.27	V/C = 0.85	Y	-	-	-	NBL	14	B	0.33	V/C = 1.1	Y	-	-	-
75	Victory Blvd & I-5 SB On-Ramp	WBL	5	A	0.47	V/C = 0.85	Y	-	-	-	WBL	6	A	0.56	V/C = 0.85	Y	-	-	-
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	Overall	13	B	0.50	V/C = 0.85	Y	WBTR	100	195	Overall	13	B	0.49	V/C = 0.85	Y	WBTR	150	240
77	Interstate Ave/Denver Ave & Schmeer Rd	Overall	11	B	0.63	V/C = 0.85	Y	-	-	-	Overall	16	B	0.78	V/C = 0.85	Y	-	-	-
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp	Overall	10	B	0.46	V/C = 0.85	Y	WBR	95	140	Overall	12	B	0.60	V/C = 0.85	Y	WBR	95	195
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	Overall	23	C	0.65	LOS D	Y	-	-	-	Overall	92	F	0.85	LOS D	N	EBL/SBL/ SBT/SBR	200/125/ 1510/425	215/170/ 1975/625
80	Columbia Blvd & MLK Blvd	Overall	42	D	0.73	V/C = 0.99	Y	EBL/WBL/ WBR/NBL/ SBL	140/140/125/ 70/200	210/220/ 220/135/295	Overall	64	E	0.91	V/C = 0.99	N	EBL/EBR/WBL /WBT/WBT/ WBR/NBL/SB L/SBT	140/300/140/ 710/710/125/ 150/200/525	280/410/295/ 735/730/305/ 225/390/540

Performance Results

AM Peak Hour		2045 Modified LPA[1]									2045 Modified LPA Design Option[2]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	Overall	3	A	0.29	LOS D	Y	-	-	-	[redacted]								
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	Overall	5	A	0.43	LOS D	Y	-	-	-									
3	39th Street & Main Street	Overall	21	C	0.74	LOS E	Y	EBL/WBL/SBL	70/75/75	140/120/100									
4	H Street & E 39th Street	Overall	15	B	0.47	LOS E	Y	WBT	100	110									
5	39th Street & I-5 SB On-/Off-Ramps	NBL	551	F	1.02	LOS D	N	EBTR/NBLR	100/1575	160/1985									
6	39th Street & I-5 NB On-/Off-Ramps	Overall	19	B	0.76	LOS D	Y	WBTR	315	335									
7	15th Ave & SR 500 WB Off-Ramp	Overall	9	A	0.57	LOS E	Y	-	-	-									
8	15th Ave & SR 500 EB On-Ramp/39th Street	Overall	8	A	0.77	LOS E	Y	-	-	-									
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	Overall	14	B	0.44	LOS E	Y	-	-	-									
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	Overall	11	B	0.41	LOS E	Y	SBL	145	170									
11	4th Plain Blvd & Main Street	Overall	279	F	1.11	LOS E	N	WBL/WBTR/SBL/SBTR	130/195/50/525	140/235/100/640									
12	4th Plain Blvd & Broadway Street	Overall	33	C	0.74	LOS E	Y	WBL/WBT	125/850	175/1200									
13	W Fourth Plain Blvd & F Street	Overall	15	B	0.42	LOS E	Y	EBT/WBT/WBR	240/245/245	255/355/310									
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	Overall	14	B	0.54	LOS D	Y	EBL	175	205									
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	Overall	14	B	0.66	LOS D	Y	-	-	-									
16	4th Plain Blvd & Saint Johns Blvd	Overall	14	B	0.75	LOS E	Y	EBR/WBL	75/100	110/110									
17	4th Plain Blvd & Fort Vancouver Way	Overall	19	B	0.77	LOS E	Y	-	-	-									
18	McLoughlin Blvd & Main Street	Overall	8	A	0.54	LOS E	Y	-	-	-									
19	McLoughlin Blvd & Broadway Street	Overall	5	A	0.11	LOS E	Y	-	-	-									
20	McLoughlin Blvd & F Street	NBR	3	A	0.01	LOS E	Y	-	-	-									
21	McLoughlin Blvd & Fort Vancouver Way	Overall	11	B	0.23	LOS E	Y	-	-	-									
22	Mill Plain Blvd & Franklin Street	Overall	18	C	0.56	LOS E	Y	WBL	370	385	Overall	18	B	0.49	LOS E	Y	SBL	50	95
23	Mill Plain Blvd WB & Columbia Street	Overall	7	A	0.49	LOS E	Y	-	-	-	Overall	15	B	0.37	LOS E	Y	WBLT/WBTR	225/225	290/250
24	Mill Plain Blvd WB & Washington Street	Overall	16	B	0.65	LOS E	Y	WBL/WBT	200/200	250/260	Overall	95	F	0.37	LOS E	Y	WBL/WBT/WBTR/SBTR	200/200/200/330	260/265/280/330
25	Mill Plain Blvd WB & Main Street	Overall	35	C	0.63	LOS E	Y	WBL/WBT/WBR/SBT	190/190/190/255	200/205/195/325	Overall	100	F	0.49	LOS E	Y	WBLT/WBT/WBTR/SBTR	190/190/190/255	260/270/270/285
26	Mill Plain Blvd WB & Broadway Street	Overall	11	B	0.47	LOS E	Y	-	-	-	Overall	18	B	0.38	LOS E	Y	WBLT/WBT/WBTR	220/220/220	290/300/295
27	Mill Plain Blvd WB & C Street	Overall	22	C	0.67	LOS E	Y	-	-	-	Overall	64	E	0.64	LOS E	N	WBLT/WBT/WBTR/SBTR	800/800/800/235	970/1085/1070/265
28	Mill Plain Blvd EB & Columbia Street	Overall	9	A	0.41	LOS E	Y	-	-	-	Overall	16	B	0.74	LOS E	N	SBLT	170	210
29	Mill Plain Blvd EB & Washington Street	Overall	9	A	0.34	LOS E	Y	-	-	-	Overall	14	B	0.43	LOS E	Y	SBLT	180	185

Performance Results

AM Peak Hour		2045 Modified LPA[1]									2045 Modified LPA Design Option[2]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
30	Mill Plain Blvd EB & Main Street	Overall	6	A	0.44	LOS E	Y	-	-	-	Overall	14	B	0.83	LOS E	Y	SBLT	190	225
31	Mill Plain Blvd EB & Broadway Street	Overall	7	A	0.33	LOS E	Y	-	-	-	Overall	13	B	0.72	LOS E	Y	SBL/SBT	50/200	90/230
32	Mill Plain Blvd EB & C Street	Overall	7	A	0.53	LOS E	Y	SBT	195	210	Overall	19	B	1.08	LOS E	Y	EBLT/EBT/ EBTR/SBT	215/215/215/ 195	250/265/290/ 235
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	23	C	1.03	LOS D	Y	-	-	-	Overall	52	D	0.84	LOS D	N	SBL/SBL/ SBR/SBR	350/1610/ 1610/275	525/1745/ 1755/355
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	19	B	0.57	LOS D	Y	-	-	-	Overall	39	D	1.13	LOS D	Y	WBT/WBT	300/300	320/350
35	Mill Plain Blvd & Fort Vancouver Way	Overall	30	C	0.56	LOS E	Y	WBL/NBL	125/75	180/115	Overall	35	C	0.63	LOS E	Y	WBL/NBL	125/75	225/170
36	Evergreen Blvd & Columbia Street	Overall	8	A	0.31	LOS E	Y	-	-	-	Overall	9	A	0.38	LOS E	Y	-	-	-
37	Evergreen Blvd & Washington Street	Overall	23	C	0.25	LOS E	Y	SBLT	245	280	Overall	24	C	0.23	LOS E	Y	SBLT	245	280
38	Evergreen Blvd & Main Street	Overall	12	B	0.31	LOS E	Y	-	-	-	Overall	16	B	0.27	LOS E	Y	-	-	-
39	Evergreen Blvd & Broadway Street	Overall	16	B	0.22	LOS E	Y	-	-	-	Overall	15	B	0.20	LOS E	Y	-	-	-
40	Evergreen Blvd & C Street	Overall	32	C	0.36	LOS E	Y	WBL/NBL /SBT	50/70/240	70/140/280	Overall	15	B	0.36	LOS E	Y	-	-	-
41	Evergreen Blvd & Fort Vancouver Way	Overall	2	A	0.21	LOS E	Y	-	-	-	Overall	2	A	0.21	LOS E	Y	-	-	-
42	8th Street & Columbia Street	Overall	15	B	0.31	LOS E	Y	NBL	65	155	Overall	18	B	0.35	LOS E	Y	NBL	65	155
43	8th Street & C Street	Overall	7	A	0.34	LOS E	Y	NBL	65	155	Overall	23	C	0.37	LOS E	Y	-	-	-
44	7th Street & C Street	EBL	0	A	0.42	LOS D	Y	-	-	-	EBL	0	A	0.15	LOS D	Y	-	-	-
45	6th Street & Grant Street	WBL	9	A	0.19	LOS E	Y	-	-	-	WBL	11	B	0.28	LOS E	Y	-	-	-
46	6th Street & Esther Street	Overall	6	A	0.14	LOS E	Y	-	-	-	Overall	6	A	0.14	LOS E	Y	-	-	-
47	6th Street & Columbia Street	Overall	16	B	0.41	LOS E	Y	NBL/NBTR	55/200	130/245	Overall	18	B	0.39	LOS E	Y	NBL/NBTR/ SBL	55/200/60	135/245/65
48	6th Street & Washington Street	Overall	10	A	0.14	LOS E	Y	-	-	-	Overall	9	A	0.08	LOS E	Y	-	-	-
49	6th Street & Main Street	Overall	5	A	0.18	LOS E	Y	-	-	-	Overall	4	A	0.07	LOS E	Y	-	-	-
50	6th Street & Broadway Street	SBL	6	A	0.06	LOS E	Y	-	-	-	SBR	3	A	0.02	LOS E	Y	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	NBT	2	A	0.29	LOS D	Y	-	-	-	EB	-	-	-	LOS D	-	-	-	-
52	5th Street & Washington Street	Overall	6	A	0.12	LOS D	Y	-	-	-	[redacted]								
52A	5th Street & Main St	Overall	4	A	0.06	LOS E	Y	-	-	-									
53	Phil Arnold Way & Esther Street	WBL	7	A	0.30	LOS E	Y	-	-	-									
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	EBL	11	B	0.72	LOS E	Y	-	-	-	WBL	33	D	0.59	LOS E	Y	SBL	100	105
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	Overall	3	A	0.13	LOS D	Y	-	-	-	Overall	3	A	0.13	LOS D	Y	-	-	-
55	Columbia Way & Esther Street	Overall	6	A	0.21	LOS E	Y	SBL	55	70	[redacted]								
56	Columbia Way & Columbia Street	Overall	7	A	0.23	LOS E	Y	-	-	-									
56A	Columbia Way & Main St	Overall	15	B	0.16	LOS E	Y	-	-	-									
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	Overall	33	C	0.57	LOS D	N	EBR/NBL	115/50	235/150									

Performance Results

AM Peak Hour		2045 Modified LPA[1]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
58	Columbia Way & Columbia Shores Blvd	Overall	25	C	0.82	LOS D	Y	EBL/WBR /SBT	50/100/245	55/115/460
59	Hayden Island Dr (South) & Center Ave	Overall	6	A	0.44	LOS D	Y	-	-	-
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	Overall	9	A	0.59	LOS D	Y	-	-	-
61A	Hayden Island Dr (South) & Jantzen Dr	NBL	8	A	0.42	LOS D	Y	-	-	-
62	Center Ave & N Tomahawk Island Dr	Overall	11	B	0.30	LOS D	Y	-	-	-
62A	Tomahawk Island Dr & Arterial Bridge Access	Overall	16	B	0.58	LOS D	Y	-	-	-
64	Tomahawk Island Dr & Jantzen Dr	Overall	9	A	0.64	LOS D	Y	-	-	-
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	Overall	5	A	0.32	V/C = 0.75	Y	-	-	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	Overall	2	A	0.50	V/C = 0.75	Y	-	-	-
66	N Portland Rd & W Marine Dr	Overall	43	D	0.90	LOS D	Y	WBL	300	350
67	N Force Ave & W Marine Dr	Overall	10	A	0.75	LOS D	Y	-	-	-
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	Overall	291	F	1.07	V/C = 0.75	N	EBL/EBT	650/1100	820/1575
69	Marine Dr & Vancouver Way	Overall	10	B	0.44	V/C = 0.80	Y	-	-	-
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	Overall	5	A	0.54	V/C = 0.75	Y	-	-	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	Overall	4	A	0.51	V/C = 0.75	Y	-	-	-
69C	N Vancouver Way & N Pier 99 St	Overall	8	A	0.51	V/C = 0.75	Y	-	-	-
70	Marine Dr and Anchor Way	SBL	8	A	0.11	LOS D	Y	-	-	-
72	NE MLK & N Union Ct	SBL	7	A	0.10	V/C = 0.99	Y	-	-	-
73	Victory Blvd & Expo Rd	Overall	12	B	0.27	V/C = 0.75	Y	-	-	-
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	NBL	7	A	0.07	V/C = 0.75	Y	-	-	-
75	Victory Blvd & I-5 SB On-Ramp	WBL	4	A	0.14	V/C = 0.75	Y	-	-	-
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	Overall	7	A	0.22	V/C = 0.75	Y	WBTR	100	120
77	Interstate Ave/Denver Ave & Schmeer Rd	Overall	10	A	0.79	V/C = 0.75	Y	-	-	-
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp	Overall	16	B	0.63	V/C = 0.75	Y	WBR	95	205
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	Signalized	20	C	0.56	LOS D	Y	SBL	125	165
80	Columbia Blvd & MLK Blvd	Overall	50	D	0.94	V/C = 0.75	N	EBL/EBR /WBL/WBR /NBL/SBL /SBT	140/300/140/ 125/150/200/ 525	220/410/255/ 285/225/395/ 620

2045 Modified LPA Design Option[2]								
Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
[redacted]								

[1]The Modified LPA Alternative includes 2 P&R locations. The Evergreen Site 2 which is bounded by Broadway Street, C Street, E 8th Street, and E 7th Street and the Waterfront Site 3 which is located west of Columbia Street at the intersection of W 4th Street.

[2]The Modified LPA Design Option includes the same P&R locations as the Modified LPA Alternative.

Performance Results

PM Peak Hour		2045 Modified LPA[1]									2045 Modified LPA Design Option[2]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	Overall	6	A	0.43	LOS D	Y	-	-	-	[redacted]								
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	Overall	8	A	0.47	LOS D	Y	-	-	-									
3	39th Street & Main Street	Overall	152	F	0.59	LOS E	N	EBL/EBTR/WBL/WBTR/NBL/SBL	70/1425/75/785/75/75	175/1825/160/955/110/115									
4	H Street & E 39th Street	Overall	31	C	0.52	LOS E	Y	WBL/WBTR/NBL/NBR/SBL	50/100	85/145									
5	39th Street & I-5 SB On-/Off-Ramps	NBL	716	F	1.03	LOS D	N	EBT/WBL/NBT	100/115/1590	140/160/2065									
6	39th Street & I-5 NB On-/Off-Ramps	Overall	25	C	0.86	LOS D	Y	WBT	315	365									
7	15th Ave & SR 500 WB Off-Ramp	Overall	9	A	0.53	LOS E	Y	-	-	-									
8	15th Ave & SR 500 EB On-Ramp/39th Street	Overall	7	A	0.72	LOS E	Y	-	-	-									
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	Overall	17	B	0.46	LOS E	Y	-	-	-									
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	Overall	19	B	0.49	LOS E	Y	SBL	145	180									
11	4th Plain Blvd & Main Street	Overall	30	C	0.74	LOS E	Y	WBL/WBTR/NBL/NBR/SBL	130/195/70/70/50	205/285/115/180/105									
12	4th Plain Blvd & Broadway Street	Overall	45	D	0.74	LOS E	Y	WBL/WBT	125/850	250/1320									
13	W Fourth Plain Blvd & F Street	Overall	25	C	0.55	LOS E	Y	EBT/WBT	240/540	280/690									
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	Overall	26	C	0.53	LOS D	Y	EBL/SBR	175/250	230/300									
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	Overall	11	B	0.64	LOS D	Y	-	-	-									
16	4th Plain Blvd & Saint Johns Blvd	Overall	19	B	0.74	LOS E	Y	EBL	115	140									
17	4th Plain Blvd & Fort Vancouver Way	Overall	26	C	0.60	LOS E	Y	EBL/SBL	75/75	100/105									
18	McLoughlin Blvd & Main Street	Overall	7	A	0.37	LOS E	Y	-	-	-									
19	McLoughlin Blvd & Broadway Street	Overall	5	A	0.13	LOS E	Y	-	-	-									
20	McLoughlin Blvd & F Street	NBR	3	A	0.01	LOS E	Y	-	-	-									
21	McLoughlin Blvd & Fort Vancouver Way	Overall	12	B	0.25	LOS E	Y	NBL	80	90									
22	Mill Plain Blvd & Franklin Street	Overall	19	B	0.44	LOS E	Y	NBL/SBL	50/50	75/80	Overall	558	F	0.53	LOS E	Y	EBL/EBT/EBTR/NBL/NBTR/SBL	160/1520/1520/50/485/50	205/2065/2055/125/585/90
23	Mill Plain Blvd WB & Columbia Street	Overall	13	B	0.36	LOS E	Y	-	-	-	Overall	10	B	0.42	LOS E	Y	-	-	-
24	Mill Plain Blvd WB & Washington Street	Overall	9	A	0.33	LOS E	Y	-	-	-	Overall	10	B	0.39	LOS E	Y	-	-	-
25	Mill Plain Blvd WB & Main Street	Overall	10	B	0.46	LOS E	Y	-	-	-	Overall	14	B	0.53	LOS E	Y	-	-	-
26	Mill Plain Blvd WB & Broadway Street	Overall	5	A	0.37	LOS E	Y	-	-	-	Overall	7	A	0.46	LOS E	Y	-	-	-
27	Mill Plain Blvd WB & C Street	Overall	20	C	0.60	LOS E	Y	SBT	235	265	Overall	25	C	0.69	LOS E	Y	SBTR	235	265
28	Mill Plain Blvd EB & Columbia Street	Overall	38	C	0.63	LOS E	Y	EBLT/EBTR/NBTR/SBLT	390/390/235/170	430/420/285/130	Overall	303	F	0.78	LOS E	Y	EBLT/EBTR/NBTR	390/390/235	475/470/250
29	Mill Plain Blvd EB & Washington Street	Overall	21	C	0.36	LOS E	Y	EBT/EBTR	230/230	250/250	Overall	62	E	0.45	LOS E	Y	EBT/EBT/EBTR	230/230/230	260/270/260
30	Mill Plain Blvd EB & Main Street	Overall	25	C	0.62	LOS E	Y	EBLT/EBT/EBTR/NBTR	205/205/205/215	250/250/240/245	Overall	54	D	0.84	LOS E	Y	EBLT/EBT/EBTR/NBTR/SBLT	205/205/205/215/190	230/240/225/275/225

Performance Results

PM Peak Hour		2045 Modified LPA[1]									2045 Modified LPA Design Option[2]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
31	Mill Plain Blvd EB & Broadway Street	Overall	25	C	0.57	LOS E	Y	EBLT/EBT /EBTR/ NBTR/SBL	205/205/205/ 240/50	265/280 /270/295 /75	Overall	93	F	0.70	LOS E	N	EBLT/EBT/ EBTR/NBTR/ SBL	205/205/205/ 240/50	240/245/235/ 320/90
32	Mill Plain Blvd EB & C Street	Overall	28	C	0.84	LOS E	Y	EBLT/EBT /EBTR/NBR	215/215/215/ 280	295/275 /325/325	Overall	42	D	1.02	LOS E	N	EBLT/EBT/ EBTR/NBT/ NBR	215/215/215/ 280/280	280/260/295/ 360/360
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	48	D	0.63	LOS D	Y	EBT	790	1015	Overall	53	D	0.77	LOS D	Y	EBT/EBT/EBT /EBT	790/790/790/ 790	940/945/ 1000/1025
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	29	C	1.01	LOS D	Y	EBL	360	405	Overall	183	F	1.07	LOS D	N	EBL/EBL/ NBL/NBLT/ NBR	360/360/ 1160/1160/ 700	385/390/ 1360/1370/ 940
35	Mill Plain Blvd & Fort Vancouver Way	Overall	41	D	0.64	LOS E	Y	NBL	75	230	Overall	36	D	0.64	LOS E	Y	NBL	75	225
36	Evergreen Blvd & Columbia Street	Overall	22	C	0.41	LOS E	Y	EBL	50	75	Overall	36	D	0.49	LOS E	Y	EBL/SBLTR	50/225	70/260
37	Evergreen Blvd & Washington Street	Overall	21	C	0.19	LOS E	Y	WBL/SBL	60/245	65/250	Overall	21	C	0.20	LOS E	Y	SBLT	245	260
38	Evergreen Blvd & Main Street	Overall	12	B	0.26	LOS E	Y	EBL	55	65	Overall	14	B	0.26	LOS E	Y	EBL	55	60
39	Evergreen Blvd & Broadway Street	Overall	12	B	0.26	LOS E	Y	-	-	-	Overall	15	B	0.31	LOS E	Y	NBLT/NBR	240/75	255/100
40	Evergreen Blvd & C Street	Overall	46	D	0.46	LOS E	Y	WBL/NBL/NBT R/SBL	50/70/485 /65	60/150/585 /90	Overall	14	B	0.40	LOS E	Y	-	-	-
41	Evergreen Blvd & Fort Vancouver Way	Overall	2	A	0.21	LOS E	Y	-	-	-	Overall	2	A	0.21	LOS E	Y	-	-	-
42	8th Street & Columbia Street	Overall	10	B	0.41	LOS E	Y	-	-	-	Overall	23	C	0.66	LOS E	Y	NBL	65.00	85
43	8th Street & C Street	Overall	42	D	0.59	LOS E	N	NBL/NBT	75/220	135/270	Overall	10	A	0.27	LOS E	Y	-	-	-
44	7th Street & C Street	EBL	26	C	0.69	LOS D	N	-	-	-	EBL	7	A	1.20		Y	-	-	-
45	6th Street & Grant Street	WBL	23	C	0.29	LOS E	Y	-	-	-	WBL	24	C	0.45	LOS E	Y	WBL	100	105
46	6th Street & Esther Street	Overall	6	A	0.14	LOS E	Y	-	-	-	Overall	6	A	0.14	LOS E	Y	-	-	-
47	6th Street & Columbia Street	Overall	17	B	0.52	LOS E	Y	NBL/NBTR/SBL	55/200/60	95/240/65	Overall	20	C	0.58	LOS E	Y	NBL/NBTR/ SBL	55/200/60	100/220/85
48	6th Street & Washington Street	Overall	11	B	0.33	LOS E	Y	-	-	-	Overall	11	B	0.27	LOS E	Y	-	-	-
49	6th Street & Main Street	Overall	6	A	0.21	LOS E	Y	EBL	50	65	Overall	6	A	0.79	LOS E	Y	EBL	50	65
50	6th Street & Broadway Street	SBL	9	A	0.13	LOS E	Y	-	-	-	SBR	7	A	0.03	LOS E	Y	-	-	-
51	6th Street & C Street/I-5 SB On-Ramp	EBR	3	A	0.30	LOS D	Y	-	-	-	EB	-	-	-	LOS D	-	-	-	-
52	5th Street & Washington Street	Overall	4	A	0.31	LOS D	Y	-	-	-	[redacted]								
52A	5th Street & Main St	Overall	6	A	0.16	LOS E	Y	-	-	-									
53	Phil Arnold Way & Esther Street	WBL	8	A	0.20	LOS E	Y	-	-	-									
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	EBL	10	A	0.50	LOS E	Y	SBL	100.00	115.00	WBL	21	C	0.53	LOS E	Y	SBL	100	125
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	Overall	3	A	0.13	LOS D	Y	-	-	-	Overall	3	A	0.13	LOS D	Y	-	-	-
55	Columbia Way & Esther Street	Overall	6	A	0.32	LOS E	Y	-	-	-	[redacted]								
56	Columbia Way & Columbia Street	Overall	7	A	0.08	LOS E	Y	-	-	-									
56A	Columbia Way & Main St	Overall	8	A	0.15	LOS E	Y	-	-	-									
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	Overall	63	E	0.69	LOS D	N	EBR/NBL /NBT/NBR	115/50/245/1 25	145/155/280/ 145									

Performance Results

PM Peak Hour		2045 Modified LPA[1]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
58	Columbia Way & Columbia Shores Blvd	Overall	290	F	0.48	LOS D	N	EBL/WBT /WBR/NBT/SBT	50/925/100/345/245	180/1180/ 170/465 /355
59	Hayden Island Dr (South) & Center Ave	Overall	6	A	0.43	LOS D	Y	-	-	-
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd	Overall	8	A	0.51	LOS D	Y	-	-	-
61A	Hayden Island Dr (South) & Jantzen Dr	NBL	10	B	0.54	LOS D	Y	-	-	-
62	Center Ave & N Tomahawk Island Dr	Overall	6	A	0.46	LOS D	Y	-	-	-
62A	Tomahawk Island Dr & Arterial Bridge Access	Overall	13	B	0.67	LOS D	Y	-	-	-
64	Tomahawk Island Dr & Jantzen Dr	EBL	15	B	0.87	LOS D	Y	-	-	-
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr	Overall	11	B	0.49	V/C = 0.75	Y	-	-	-
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr	Overall	3	A	0.67	V/C = 0.75	Y	-	-	-
66	N Portland Rd & W Marine Dr	Overall	73	E	0.97	LOS D	N	WBL	300	360
67	N Force Ave & W Marine Dr	Overall	21	C	0.65	LOS D	Y	-	-	-
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	Overall	110	F	0.96	V/C = 0.75	N	EBL/EBT /WBR	650/1090 /1050	820/1515 /1100
69	Marine Dr & Vancouver Way	Overall	12	B	0.75	V/C = 0.80	Y	-	-	-
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St	Overall	5	A	0.54	V/C = 0.75	Y	-	-	-
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St	Overall	4	A	0.51	V/C = 0.75	Y	-	-	-
69C	N Vancouver Way & N Pier 99 St	Overall	8	A	0.51	V/C = 0.75	Y	-	-	-
70	Marine Dr and Anchor Way	SBL	14	B	0.33	LOS D	Y	-	-	-
72	NE MLK & N Union Ct	SBL	8	A	0.15	V/C = 0.99	Y	-	-	-
73	Victory Blvd & Expo Rd	Overall	9	A	0.54	V/C = 0.75	Y	SBL	65	80
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp	NBL	13	B	0.28	V/C = 0.75	Y	-	-	-
75	Victory Blvd & I-5 SB On-Ramp	WBL	6	A	0.28	V/C = 0.75	Y	-	-	-
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	Overall	17	B	0.50	V/C = 0.75	Y	WBT	100	200
77	Interstate Ave/Denver Ave & Schmeer Rd	Overall	17	B	0.78	V/C = 0.75	Y	-	-	-
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp	Overall	13	B	0.58	V/C = 0.75	Y	WBR	95	195
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd	Signalized	124	F	0.83	LOS D	N	EBL/SBL /SBT/SBR	200/125 /1510/425	225/160 /2020/630
80	Columbia Blvd & MLK Blvd	Overall	58	E	0.89	V/C = 0.75	N	EBL/EBR /WBL/WBR/NBL/SBL	140/300/140/ 125/150 /200	275/385 /295/305 /230/370

2045 Modified LPA Design Option[2]								
Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
[redacted]								

[1]The Modified LPA Alternative includes 2 P&R locations. The Evergreen Site 2 which is bounded by Broadway Street, C Street, E 8th Street, and E 7th Street and the Waterfront Site 3 which is located west of Columbia Street at the intersection of W 4th Street.

[2]The Modified LPA Design Option includes the same P&R locations as the Modified LPA Alternative.

Performance Results

AM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	[redacted]									[redacted]								
2	Hazel Dell & Main Street (West) & stop controlled slip ramp	[redacted]									[redacted]								
3	39th Street & Main Street	[redacted]									[redacted]								
4	H Street & E 39th Street	[redacted]									[redacted]								
5	39th Street & I-5 SB On-/Off-Ramps	[redacted]									[redacted]								
6	39th Street & I-5 NB On-/Off-Ramps	[redacted]									[redacted]								
7	15th Ave & SR 500 WB Off-Ramp	[redacted]									[redacted]								
8	15th Ave & SR 500 EB On-Ramp/39th Street	[redacted]									[redacted]								
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	[redacted]									[redacted]								
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	[redacted]									[redacted]								
11	4th Plain Blvd & Main Street	[redacted]									[redacted]								
12	4th Plain Blvd & Broadway Street	[redacted]									[redacted]								
13	W Fourth Plain Blvd & F Street	[redacted]									[redacted]								
14	4th Plain Blvd & I-5 SB On-/Off-Ramps	[redacted]									[redacted]								
15	4th Plain Blvd & I-5 NB On-/Off-Ramps	[redacted]									[redacted]								
16	4th Plain Blvd & Saint Johns Blvd	[redacted]									[redacted]								
17	4th Plain Blvd & Fort Vancouver Way	[redacted]									[redacted]								
18	McLoughlin Blvd & Main Street	Overall	8	A	0.59	LOS E	Y	-	-	-	Overall	8	A	0.59	LOS E	Y	-	-	-
19	McLoughlin Blvd & Broadway Street	Overall	5	A	0.32	LOS E	Y	-	-	-	Overall	4	A	0.32	LOS E	Y	-	-	-
20	McLoughlin Blvd & F Street	NBR	3	A	0.01	LOS E	Y	-	-	-	NBR	3	A	0.01	LOS E	Y	-	-	-
21	McLoughlin Blvd & Fort Vancouver Way	Overall	11	B	0.40	LOS E	Y	-	-	-	Overall	11	B	0.40	LOS E	Y	-	-	-
22	Mill Plain Blvd & Franklin Street	Overall	34	C	0.59	LOS E	Y	WBL/SBL	370/50	400/85	Overall	41	D	0.59	LOS E	Y	WBL/SBL	370/50	420/90
23	Mill Plain Blvd WB & Columbia Street	Overall	6	A	0.46	LOS E	Y	-	-	-	Overall	6	A	0.47	LOS E	Y	-	-	-
24	Mill Plain Blvd WB & Washington Street	Overall	4	A	0.59	LOS E	Y	-	-	-	Overall	4	A	0.55	LOS E	Y	-	-	-
25	Mill Plain Blvd WB & Main Street	Overall	25	C	0.77	LOS E	Y	WBLT/WBT/WBTR/SBTR	190/190/190/255	245/245/235/320	Overall	27	C	0.77	LOS E	Y	WBLT/WBT/WBTR/SBTR	190/190/190/255	240/250/245/320
26	Mill Plain Blvd WB & Broadway Street	Overall	16	B	0.90	LOS E	Y	WBLT/WBT/WBTR	220/220/220	295/310/260	Overall	18	B	0.90	LOS E	Y	WBLT/WBT/WBTR	220/220/220	285/305/275
27	Mill Plain Blvd WB & C Street	Overall	76	E	0.73	LOS E	Y	WBLT/WBT/WBTR	395/395/395	525/515/490	Overall	90	F	0.73	LOS E	N	WBLT/WBT/WBTR	395/395/395	515/510/495
28	Mill Plain Blvd EB & Columbia Street	Overall	13	B	0.68	LOS E	Y	-	-	-	Overall	12	B	0.68	LOS E	Y	-	-	-
29	Mill Plain Blvd EB & Washington Street	Overall	10	A	0.43	LOS E	Y	-	-	-	Overall	10	A	0.43	LOS E	Y	-	-	-
30	Mill Plain Blvd EB & Main Street	Overall	10	B	0.61	LOS E	Y	SBLT	190	210	Overall	10	B	0.63	LOS E	Y	SBLT	190	225
31	Mill Plain Blvd EB & Broadway Street	Overall	11	B	0.90	LOS E	Y	EBTR	205	230	Overall	11	B	0.90	LOS E	Y	EBTR/SBL	205/50	235/70
32	Mill Plain Blvd EB & C Street	Overall	10	B	0.52	LOS E	Y	-	-	-	Overall	10	B	0.52	LOS E	Y	EBTR/SBL	215	225
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	28	C	0.62	LOS D	Y	SBL/SBR	1345/1345	1360/1470	Overall	42	D	0.62	LOS D	Y	SBL/SBR	1345/1345	1565/1655
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	19	B	0.62	LOS D	Y	-	-	-	Overall	20	B	0.62	LOS D	Y	-	-	-
35	Mill Plain Blvd & Fort Vancouver Way	Overall	26	C	0.70	LOS E	Y	WBL/NBL	125/75	160/145	Overall	25	C	0.70	LOS E	Y	NBL	75	135
36	Evergreen Blvd & Columbia Street	Overall	8	A	0.42	LOS E	Y	-	-	-	Overall	8	A	0.38	LOS E	Y	-	-	-

Performance Results

AM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
37	Evergreen Blvd & Washington Street	Overall	23	C	0.43	LOS E	Y	SBLT	245	285									
38	Evergreen Blvd & Main Street	Overall	11	B	0.44	LOS E	Y	-	-	-	Overall	12	B	0.44	LOS E	Y	-	-	-
39	Evergreen Blvd & Broadway Street	Overall	15	B	0.68	LOS E	Y	-	-	-	Overall	15	B	0.68	LOS E	Y	-	-	-
40	Evergreen Blvd & C Street	Overall	36	D	0.58	LOS E	Y	WBL/NBL/NBT R/SBTR	50/70/485/24 0	70/140/515/2 75	Overall	47	D	0.57	LOS E	Y	WBL/NBL/NB TR/SBTR	50/70/485/24 0	70/140/515/2 90
41	Evergreen Blvd & Fort Vancouver Way																		
42	8th Street & Columbia Street	Overall	13	B	0.60	LOS E	Y	NBL/NBTR	65/215	165/330	Overall	15	B	0.79	LOS E	Y	NBL/NBTR	65/215	165/335
43	8th Street & C Street	Overall	26	C	0.50	LOS E	Y	NBL/NBT	75/220	120/255	Overall	43	D	0.61	LOS E	Y	NBL/NBT/SBT R	75/220/485	120/255/530
44	7th Street & C Street	EBL				LOS D		-	-	-	EBL						-	-	-
45	6th Street & Grant Street																		
46	6th Street & Esther Street	Overall	6	A	0.19	LOS E	Y	-	-	-									
47	6th Street & Columbia Street	Overall	17	B	0.62	LOS E	Y	NBL/NBTR	55/200	135/240	Overall	17	B	0.72	LOS E	Y	NBL/NBTR	55/200	130/245
48	6th Street & Washington Street	Overall	10	A	0.40	LOS E	Y	-	-	-	Overall	10	A	0.40	LOS E	Y	-	-	-
49	6th Street & Main Street	Overall	5	A	0.25	LOS E	Y	-	-	-	Overall	5	A	0.26	LOS E	Y	-	-	-
50	6th Street & Broadway Street	NBR	6	A	0.05	LOS E	Y	-	-	-									
51	6th Street & C Street/I-5 SB On-Ramp																		
52	5th Street & Washington Street	Overall	6	A	0.47	LOS D	Y	-	-	-									
52A	5th Street & Main St	Overall	5	A	0.24	LOS E	Y	-	-	-									
53	Phil Arnold Way & Esther Street	NBL	7	A	0.37	LOS E	Y	-	-	-									
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	WBL	18	B	0.61	LOS E	Y	SWLR/SWR	140/140	260/185	EBR	22	C	0.68	LOS E	Y	SWLR/SWR	585/585	780/680
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	Overall	5	A	0.40	LOS D	Y	-	-	-	Overall	3	A	0.13	LOS D	Y	-	-	-
55	Columbia Way & Esther Street	Overall	6	A	0.34	LOS E	Y	SBL	55	80									
56	Columbia Way & Columbia Street										Overall	8	A	0.46	LOS E	Y	SBL	100	145
56A	Columbia Way & Main St	Overall	14	B	0.28	LOS E	Y	-	-	-	Overall	10	B	0.32	LOS E	Y	-	-	-
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)																		
58	Columbia Way & Columbia Shores Blvd																		
59	Hayden Island Dr (South) & Center Ave																		
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd																		
61A	Hayden Island Dr (South) & Jantzen Dr																		
62	Center Ave & N Tomahawk Island Dr																		
62A	Tomahawk Island Dr & Arterial Bridge Access																		
64	Tomahawk Island Dr & Jantzen Dr																		
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr																		
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr																		
66	N Portland Rd & W Marine Dr																		
67	N Force Ave & W Marine Dr																		

Performance Results

AM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	[redacted]									[redacted]								
69	Marine Dr & Vancouver Way																		
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St																		
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St																		
69C	N Vancouver Way & N Pier 99 St																		
70	Marine Dr and Anchor Way																		
72	NE MLK & N Union Ct																		
73	Victory Blvd & Expo Rd																		
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp																		
75	Victory Blvd & I-5 SB On-Ramp																		
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd																		
77	Interstate Ave/Denver Ave & Schmeer Rd																		
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp																		
79	N Vancouver Ave & N Columbia Blvd/NE Columbia Blvd																		
80	Columbia Blvd & MLK Blvd																		

[3]The P&R locations are assumed to be the Evergreen Site 1 which is west of I-5 between the Vancouver Community Library and a cinema complex and the Waterfront Site 1 which is between Columbia Street and Washington Street from W 4th Street to W 3rd Street

[4]The P&R locations are assumed to be the Evergreen Site 2 which is bounded by Broadway Street, C Street, E 8th Street, and E 7th Street and the Waterfront Site 2 which would be built underneath I-5 east of Washington Street

Performance Results

PM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
1	Ross Street & Main Street (Hwy 99)	[redacted]									[redacted]								
2	Hazel Dell & Main Street (West) & stop controlled slip ramp																		
3	39th Street & Main Street																		
4	H Street & E 39th Street																		
5	39th Street & I-5 SB On-/Off-Ramps																		
6	39th Street & I-5 NB On-/Off-Ramps																		
7	15th Ave & SR 500 WB Off-Ramp																		
8	15th Ave & SR 500 EB On-Ramp/39th Street																		
9	Saint Johns Blvd & SR 500 WB On-/Off-Ramps																		
10	Saint Johns Blvd & SR 500 EB On-/Off-Ramps																		
11	4th Plain Blvd & Main Street																		
12	4th Plain Blvd & Broadway Street																		
13	W Fourth Plain Blvd & F Street																		
14	4th Plain Blvd & I-5 SB On-/Off-Ramps																		
15	4th Plain Blvd & I-5 NB On-/Off-Ramps																		
16	4th Plain Blvd & Saint Johns Blvd																		
17	4th Plain Blvd & Fort Vancouver Way																		
18	McLoughlin Blvd & Main Street	Overall	7	A	0.51	LOS E	Y	-	-	-	Overall	6	A	0.51	LOS E	Y	-	-	-
19	McLoughlin Blvd & Broadway Street	Overall	6	A	0.38	LOS E	Y	-	-	-	Overall	6	A	0.38	LOS E	Y	-	-	-
20	McLoughlin Blvd & F Street	NBR	3	A	0.01	LOS E	Y	-	-	-	NBR	3	A	0.01	LOS E	Y	-	-	-
21	McLoughlin Blvd & Fort Vancouver Way	Overall	11	B	0.39	LOS E	Y	NBL	80	85	Overall	11	B	0.39	LOS E	Y	NBL	80	90
22	Mill Plain Blvd & Franklin Street	Overall	21	C	0.62	LOS E	Y	NBL/SBL	50/50	65/85	Overall	24	C	0.62	LOS E	Y	NBL/SBL	50/50	65/90
23	Mill Plain Blvd WB & Columbia Street	Overall	17	B	0.48	LOS E	Y	-	-	-	Overall	20	B	0.48	LOS E	Y	-	-	-
24	Mill Plain Blvd WB & Washington Street	Overall	36	D	0.46	LOS E	Y	WBL	200	215	Overall	19	B	0.47	LOS E	Y	-	-	-
25	Mill Plain Blvd WB & Main Street	Overall	50	D	0.67	LOS E	Y	WBLT/WBT/WBTR/SBTR	190/190/190/255	240/200/200/290	Overall	28	C	0.67	LOS E	Y	WBLT/SBTR	190/255	200/265
26	Mill Plain Blvd WB & Broadway Street	Overall	38	D	0.67	LOS E	Y	WBLT/WBT	220/220	275/230	Overall	30	C	0.68	LOS E	Y	WBLT/WBT	220/220	265/240
27	Mill Plain Blvd WB & C Street	Overall	125	F	0.57	LOS E	N	WBLT/WBT/WBTR/SBTR	395/395/395/235	515/510/505/320	Overall	89	F	0.57	LOS E	N	WBLT/WBT/WBTR/SBTR	395/395/395/235	495/495/485/315
28	Mill Plain Blvd EB & Columbia Street	Overall	41	D	0.80	LOS E	Y	EBLT/EBTR/NBTR	390/390/235	440/450/300	Overall	47	D	0.80	LOS E	Y	EBLT/EBTR/NBTR/SBLT	390/390/235/175	415/430/305/180
29	Mill Plain Blvd EB & Washington Street	Overall	25	C	0.51	LOS E	Y	EBT/EBTR/SBLT	230/230/180	260/290/210	Overall	24	C	0.52	LOS E	Y	EBT/EBTR/SBLT	230/230/180	255/290/200
30	Mill Plain Blvd EB & Main Street	Overall	57	E	0.84	LOS E	Y	EBLT/EBT/EBTR/NBTR/SBLT	205/205/205/215/190	245/265/260/270/240	Overall	36	D	0.82	LOS E	Y	EBLT/EBT/EBTR/NBTR/SBLT	205/205/205/215/190	230/245/260/250/220
31	Mill Plain Blvd EB & Broadway Street	Overall	45	D	0.67	LOS E	Y	EBLT/EBT/EBTR/NBTR/SBLT	205/205/205/240/50	230/250/265/335/120	Overall	55	E	0.68	LOS E	Y	EBLT/EBT/EBTR/NBTR/SBL/SBT	205/205/205/240/50/200	235/250/265/330/135/210
32	Mill Plain Blvd EB & C Street	Overall	47	D	0.98	LOS E	Y	EBLT/EBT/EBTR/NBT/NBR/SBL	215/215/215/270/270/195	265/280/280/365/355/260	Overall	53	D	0.97	LOS E	Y	EBLT/EBT/EBTR/NBT/NBR/SBL	215/215/215/270/270/195	280/285/295/365/355/260

Performance Results

PM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
33	Mill Plain Blvd & I-5 SB On-/Off-Ramps	Overall	86	F	1.04	LOS D	N	EBT/SBL/SBR	375/990/990	550/1045/1070	Overall	62	E	1.04	LOS D	N	EBT	375	545
34	Mill Plain Blvd & I-5 NB On-/Off-Ramps	Overall	94	F	1.04	LOS D	N	EBL/NBL/NBLT/NBR	355/595/595/350	400/745/750/630	Overall	72	E	1.04	LOS D	N	EBL/NBL/NBLT/NBR	355/595/595/350	390/690/685/550
35	Mill Plain Blvd & Fort Vancouver Way	Overall	34	C	0.76	LOS E	Y	NBL	75	210	Overall	31	C	0.76	LOS E	Y	NBL	75	210
36	Evergreen Blvd & Columbia Street	Overall	17	B	0.59	LOS E	Y	EBL	50	75	Overall	21	C	0.67	LOS E	Y	EBL/WBL/SBLTR	50/70/225	75/75/230
37	Evergreen Blvd & Washington Street	Overall	20	C	0.48	LOS E	Y	SBLT	245	260	[redacted]								
38	Evergreen Blvd & Main Street	Overall	12	B	0.63	LOS E	Y	-	-	-	Overall	12	B	0.62	LOS E	Y	-	-	-
39	Evergreen Blvd & Broadway Street	Overall	11	B	0.68	LOS E	Y	-	-	-	Overall	11	B	0.68	LOS E	Y	-	-	-
40	Evergreen Blvd & C Street	Overall	17	B	0.72	LOS E	Y	WBL/NBL	50/70	75/130	Overall	41	D	0.71	LOS E	Y	WBL/NBL/NBTR/SBL	50/70/485/65	60/140/575/85
41	Evergreen Blvd & Fort Vancouver Way	[redacted]									[redacted]								
42	8th Street & Columbia Street	Overall	13	B	0.65	LOS E	Y	NBL/NBTR	65/215	75/285	Overall	13	B	0.67	LOS E	Y	NBL/NBTR	65/215	80/290
43	8th Street & C Street	Overall	27	C	0.46	LOS E	Y	NBL/NBT	75/220	100/240	Overall	33	C	0.52	LOS E	Y	NBL/NBT	75/220	130/245
44	7th Street & C Street	EBL				LOS D		-	-	-	EBL						-	-	-
45	6th Street & Grant Street	[redacted]									[redacted]								
46	6th Street & Esther Street	Overall	6	A	0.19	LOS E	Y	-	-	-									
47	6th Street & Columbia Street	Overall	19	B	0.70	LOS E	Y	NBL/NBTR	55/200	110/220	Overall	23	C	0.75	LOS E	Y	NBL/NBTR/SBL	55/200/60	110/215/75
48	6th Street & Washington Street	Overall	12	B	0.45	LOS E	Y	-	-	-	Overall	12	B	0.48	LOS E	Y	-	-	-
49	6th Street & Main Street	Overall	7	A	0.27	LOS E	Y	EBL	50	65	Overall	8	A	0.25	LOS E	Y	EBL	50	75
50	6th Street & Broadway Street	SBL	9	A	0.15	LOS E	Y	-	-	-	[redacted]								
51	6th Street & C Street/I-5 SB On-Ramp	[redacted]																	
52	5th Street & Washington Street	Overall	11	B	0.46	LOS D	Y	-	-	-									
52A	5th Street & Main St	Overall	10	A	0.01	LOS E	Y	EBLTR	200	205									
53	Phil Arnold Way & Esther Street	EBL	9	A	0.27	LOS E	Y	-	-	-									
54	Phil Arnold Way & Columbia Street/SR-14 WB Off-ramp	WBL	13	B	0.02	LOS E	Y	SWLR	140	155	NBT	38	D	0.52	LOS E	Y	NBT/SWLR/SWR	345/140/140	395/235/145
54A	Phil Arnold Way & Main St/SR 14 EB On-Ramp	Overall	5	A	0.40	LOS D	Y	-	-	-	Overall	5	A	0.40	LOS D	Y	-	-	-
55	Columbia Way & Esther Street	Overall	6	A	0.44	LOS E	Y	-	-	-	[redacted]								
56	Columbia Way & Columbia Street	[redacted]									Overall	23	C	0.42	LOS E	Y	EBL	150	160
56A	Columbia Way & Main St	Overall	9	A	0.24	LOS E	Y	-	-	-	Overall	11	B	0.42	LOS E	Y	-	-	-
57	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	[redacted]									[redacted]								
58	Columbia Way & Columbia Shores Blvd																		
59	Hayden Island Dr (South) & Center Ave																		
60A	Hayden Island Dr (South) & Arterial Bridge Access Rd																		
61A	Hayden Island Dr (South) & Jantzen Dr																		
62	Center Ave & N Tomahawk Island Dr																		
62A	Tomahawk Island Dr & Arterial Bridge Access																		

Performance Results

PM Peak Hour		2045 Modified LPA Park and Ride Sites: Evergreen #1, Waterfront #1[3]									2045 Modified LPA Park and Ride Sites: Evergreen #2, Waterfront #2[4]								
#	Intersection	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)	Approach/ Movement	Delay (s)	LOS	ICU/ v/c	Standard	Meets Standard	Queue Movement	Storage Length	95% Queue (ft)
64	Tomahawk Island Dr & Jantzen Dr	[redacted]									[redacted]								
65A	I-5 SB Hayden Island Off-Ramp & Tomahawk Island Dr																		
65B	I-5 NB Hayden Island On-Ramp & Tomahawk Island Dr																		
66	N Portland Rd & W Marine Dr																		
67	N Force Ave & W Marine Dr																		
68	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps																		
69	Marine Dr & Vancouver Way																		
69A	I-5 SB Marine Drive On-Ramp & N Pier 99 St																		
69B	I-5 NB Marine Drive Off-Ramp & N Pier 99 St																		
69C	N Vancouver Way & N Pier 99 St																		
70	Marine Dr and Anchor Way																		
72																			
73	Victory Blvd & Expo Rd																		
74	Victory Blvd & Interstate Ave/Denver Ave NB Off-Ramp																		
75	Victory Blvd & I-5 SB On-Ramp																		
76	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd																		
77	Interstate Ave/Denver Ave & Schmeer Rd																		
78	Columbia Blvd & I-5 NB/SB On-/Off-Ramp																		
79																			
80	Columbia Blvd & MLK Blvd																		

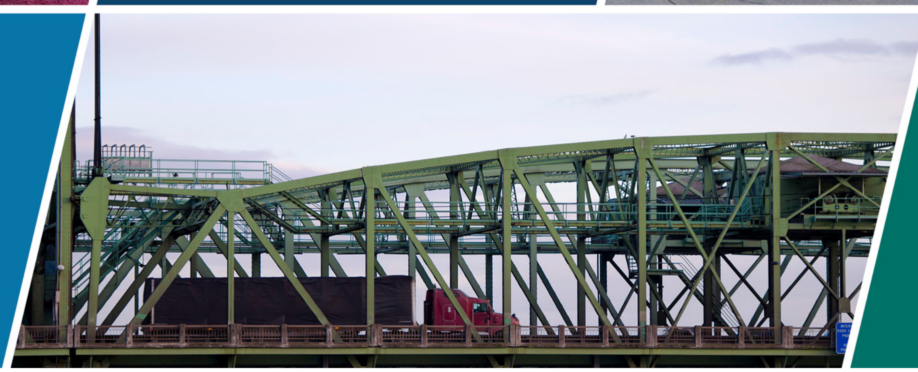
[3]The P&R locations are assumed to be the Evergreen Site 1 which is west of I-5 between the Vancouver Community Library and a cinema complex and the Waterfront Site 1 which is between Columbia Street and Washington Street from W 4th Street to W 3rd Street

[4]The P&R locations are assumed to be the Evergreen Site 2 which is bounded by Broadway Street, C Street, E 8th Street, and E 7th Street and the Waterfront Site 2 which would be built underneath I-5 east of Washington Street

Appendix F. Estimating Active Transportation Bridge Trips

Interstate BRIDGE Replacement Program

A **modern** connection for a growing **community**



Estimating Active Transportation Bridge Trips

September 2024

Oregon

For ADA (Americans with Disabilities Act) or Civil Rights Title VI accommodations, translation/interpretation services, or more information call 503-731-4128, TTY 800-735-2900 or Oregon Relay Service 7-1-1.

Washington

Accommodation requests for people with disabilities in Washington can be made by contacting the WSDOT (Washington State Department of Transportation) Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll-free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equity and Civil Rights Title VI Coordinator by contacting (360) 705-7090.

Estimating Active Transportation Bridge Trips

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

IBR	Interstate Bridge Replacement
VMT	vehicle miles traveled
SR	State Route
I-5	Interstate 5

1. INTRODUCTION

This memo describes the methodology to forecast 2045 bicycle and pedestrian trips across the Columbia River.

The 2045 bicycle and pedestrian trips were determined by evaluating three types of shifts in behavior that might accompany new or improved facilities planned as part of the Interstate Bridge Replacement (IBR) program, including:

- Mode shift: People may switch from driving to walking or biking (CARB 2019; Sevtsuk et al. 2021; Scheepers et al. 2014).
- Activity shift: As a result of reducing gaps in the active transportation network, people may take new trips as they shift activities to walk or bike more (CARB 2019).
- Route shift: Active transportation users may switch from a parallel route to the improved segment (CARB 2019; Sevtsuk et al. 2021). The new route may be safer, more comfortable and more direct.

The range of possible responses to active transportation improvements is tied to a combination of factors that include built context, infrastructure and traveler characteristics.

The two methods used to generate the range of active transportation estimates fall into two categories:

1. Method 1. Short Trips Conversion: Estimates are generated by examining short trip rates across the Interstate bridge that could be converted to active travel. For the purposes of this analysis, a threshold of trip distances less than 3 miles was used to identify convertible trips to yield a conservative estimate for analysis.
2. Method 2. Percent Ridership Inflation: Estimates are based on literature-derived percentage increases in active transportation from similar trail or bridge facility projects. Existing literature documents evidence from resources such as before and after intercept surveys that document percentage increases in total ridership. These same resources also provide data that support the stratification of this increase into feasible rates of mode, route and activity shift.

These two methods were employed to estimate mode shift to active transportation from vehicle trips under optimistic (high), moderate (medium) and conservative (low) scenarios.

2. EXISTING TRIP ESTIMATES AND COUNTS

Both active transportation forecasting methodologies depend on annual average bicycle and pedestrian activity across the Columbia River using the bridge's active transportation facilities. This analysis uses a 24-hour count conducted on October 19, 2022, when a combined total of 296 bicyclists and pedestrians were observed using the facility. This count was collected on a clear day when the ambient temperature was around 75 degrees Fahrenheit; however, the air quality was low due to an extreme wildfire smoke event. Therefore, the fall 2022 count was adjusted up to 410 based on literature review stating the travel impacts that smoke events have on active behavior of bicyclists and pedestrians.

In addition to these counts, the project team reviewed count data of comparable projects to develop supplemental reviews of other datasets and best practices that may aid in the understanding of active traveler activity across the bridge.

2.1 Existing I-5 User Counts

The counts used for this analysis are based on a 24-hour bicycle and pedestrian count on October 19, 2022 (Wednesday), when a combined total of 296 bicyclists and pedestrians was counted during this time period. This count was conducted during a day in October with relatively warm (75 degrees Fahrenheit), clear weather (no rain or similar) but during a significant smoke event. This count looked at southbound and northbound bicycle and pedestrian activity near the I-5 ramps on Hayden Island. Due to poor air quality conditions, adjustments to the counts were necessary.

2.1.1 Adjustments to Count

During this day, nearby wildfires pushed the air quality as measured by sensors at Portland's Roosevelt High School to unhealthy for approximately half the day (see Figure 1). This likely impacted activity across the bridge, but the degree of impact is unclear. To account for this, the project team looked for potential literature on the impact wildfire smoke might have on bicycle and pedestrian activity in the Pacific Northwest. This search yielded a paper looking at changes in activity in eight bicycle counters and two pedestrians counters in 2018 in Seattle during a wildfire smoke event (Doubleday et al. 2021). They reported reductions of up to 36% for bikes and 45.2% for pedestrians. To provide a conservative estimate of the impact smoke might have had on the counts, these values were adjusted up to account for the wildfire event. The project team considered the development of a seasonal estimate after this correction, given that this count was collected in October, but given the unusually temperate weather conditions during this time of the year, a more conservative estimate after the wildfire correction was considered sufficient as a basis for an annualized estimate of existing counts. This is documented in Table 1, which outlines the adjustment factors and the literature sources from which they are derived. Post-adjustment, with rounding to the nearest 10, the project team estimates a reasonable average daily count of 410 active travelers.

Figure 1. Air Quality Index readings from Portland Roosevelt High School, near the Interstate Bridge on October 19, 2022.

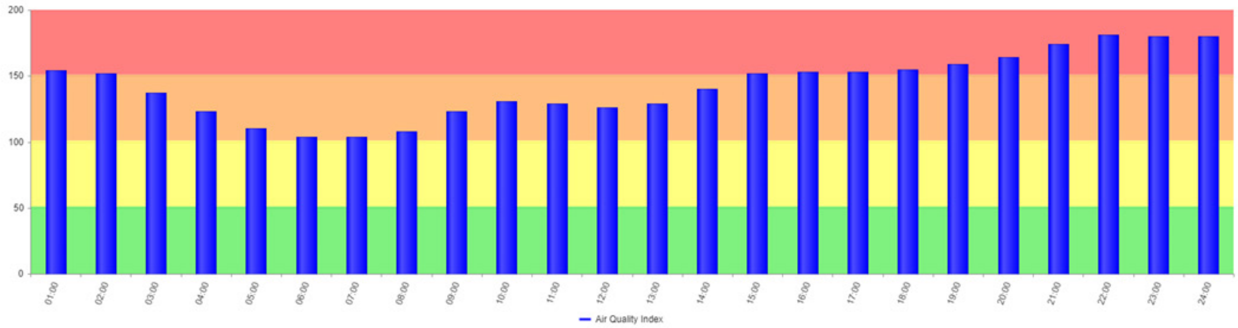


Table 1. Summary of Existing Count Adjustment Factors

	Pedestrians	Bicyclists	Total
Oct. 19 – 24-Hour Count	91	205	296
Air Quality Index Adjustment Factor	1.452[1]	1.3601	-
Air Quality Index Adjusted	132	279	411
Adjusted Count	-	-	410[2]

Notes:

1. Based on maximum reported reductions from Doubleday, Annie, Youngjun Choe, Tania Isaksen, and Nicole Errett (2021). Urban bike and pedestrian activity impacts from wildfire smoke events in Seattle, WA. Journal of Transport & Health. 21. 101033. 10.1016/j.jth.2021.101033.
2. Final totals were rounded to the nearest 10. Seasonal adjustment was not used, and count is assumed to be typical given the good weather and the existing adjustment made here.

2.2 Permanent Counts Review

In addition to collecting new counts, permanent counts were reviewed. Reviewing active transportation counts collected for both State Route 520 (SR 520) on the floating bridge and Interstate 5 (I-5) at the Interstate Bridge revealed several irregularities in the data. SR 520 data had missing values, but the trendline was more reliable than I-5 data. Within the permanent counts, the trendline data displayed troughs and peaks, with the peaks being unreliable.

2.2.1 Context Transfer StreetLight Data

In addition to the review of the permanent count data, the project team completed a comparison analysis with StreetLight Data's bike and pedestrian index from two similar sites. The two sites included the SR 520 trail across Lake Washington and the I-5 Interstate Bridge across the Columbia River. StreetLight Data zones were created for the SR 520 path across Lake Washington and the

Interstate Bridge paths across the Columbia River. This comparison analysis yielded results far outside a reasonable range and therefore the project team did not use the analysis to develop estimates.

3. ACTIVE TRANSPORTATION TRIP FORECAST ESTIMATES

The IBR team used two methods — Method 1: Short Trip Conversion, and Method 2: Percent Ridership Inflation Method — to estimate active transportation mode shift estimates. As mentioned above, two methods were employed to estimate mode shift to active transportation from vehicle trips under optimistic (high), moderate (medium) and conservative (low) scenarios.

3.1 Method 1. Short Trip Conversion

The role of a trip distance's connection to active transportation is well established in research surrounding the influence of the built environment on transportation behavior (Cervero and Kockelman 1997; Saelens et al. 2003; McCormack et al. 2004; Kuzmyak et al. 2014). The short trip estimation method is the most conservative of the two approaches, as it is using a small-distance bandwidth to identify convertible trips relative to the trip distances of cross-bridge trips.

While short trips are indicators of trips that can be met using active modes, it is unrealistic to expect that it would be possible to convert all short trips to active transportation. While many people are forecast to travel across the Interstate Bridge, very few are currently making short trips (less than 3 miles). This is a result of a few factors:

1. Automobile volumes: Volume of regional and interstate traffic.
2. Distance: Length of the Interstate Bridge and distance between local origins and destinations.
3. Land use: Low-density land use on the Portland side of the Interstate Bridge.
4. Barriers: Physical and perceived barriers associated with natural features, grade changes, and highway and interchange environments.
5. Heavy or bulky loads: In many cases, cargo bikes can support many types of grocery or shopping trips, but some heavy loads are often bulky or heavy enough to encourage the use of a vehicle.
    - Travel trip type: Some shared trips are chained in ways where using active transportation for the entire trip is difficult. For example, if one leg of a tour that is part of a chain of trips is too long to consider using an active mode, the entire tour may be better made using a vehicle.
    - Physical impairment: Some members of the community may have an impairment that prevents them from comfortably using active transportation.
    - Personal preference: Some members of the community may elect to never bike or walk even if an all ages and abilities network is provided in a community.

These limitations on active trip potential and literature related to it inform the thresholds for what percentage of short trips can be converted to active modes (Mackett 2003).

The Short Trip Conversion method converts short-distance auto trips to active transportation trips based on improved facilities and travel time. For the purposes of this analysis, a threshold of trip distances less than 3 miles was used to identify convertible trips to yield a conservative estimate for analysis. Figure 2 visualizes existing short trip vehicle flows. As part of this analysis, Big Data from StreetLight pass-through zones were drawn on the north and south ends of the Interstate Bridge. This pass-through analysis was intended to provide estimates of short trips and bicycle and pedestrian activity for comparison. Based on a pass-through zone analysis, there seem to be both short trips and bicycle and pedestrian trips that would use active transportation modes to travel across the river if the facility was improved. Figure 3 visualizes existing bicycle and pedestrian trips.

Based on the StreetLight Data estimate, total vehicle trips across I-5 are estimated to average 143,400, but only 1.6% of those trips are less than 3 miles. This translates roughly to 2,300 trips being within the range considered as potentially available for mode shift. However, the upper limits for this can be estimated by research looking at why people who make short trips might not be using active modes.

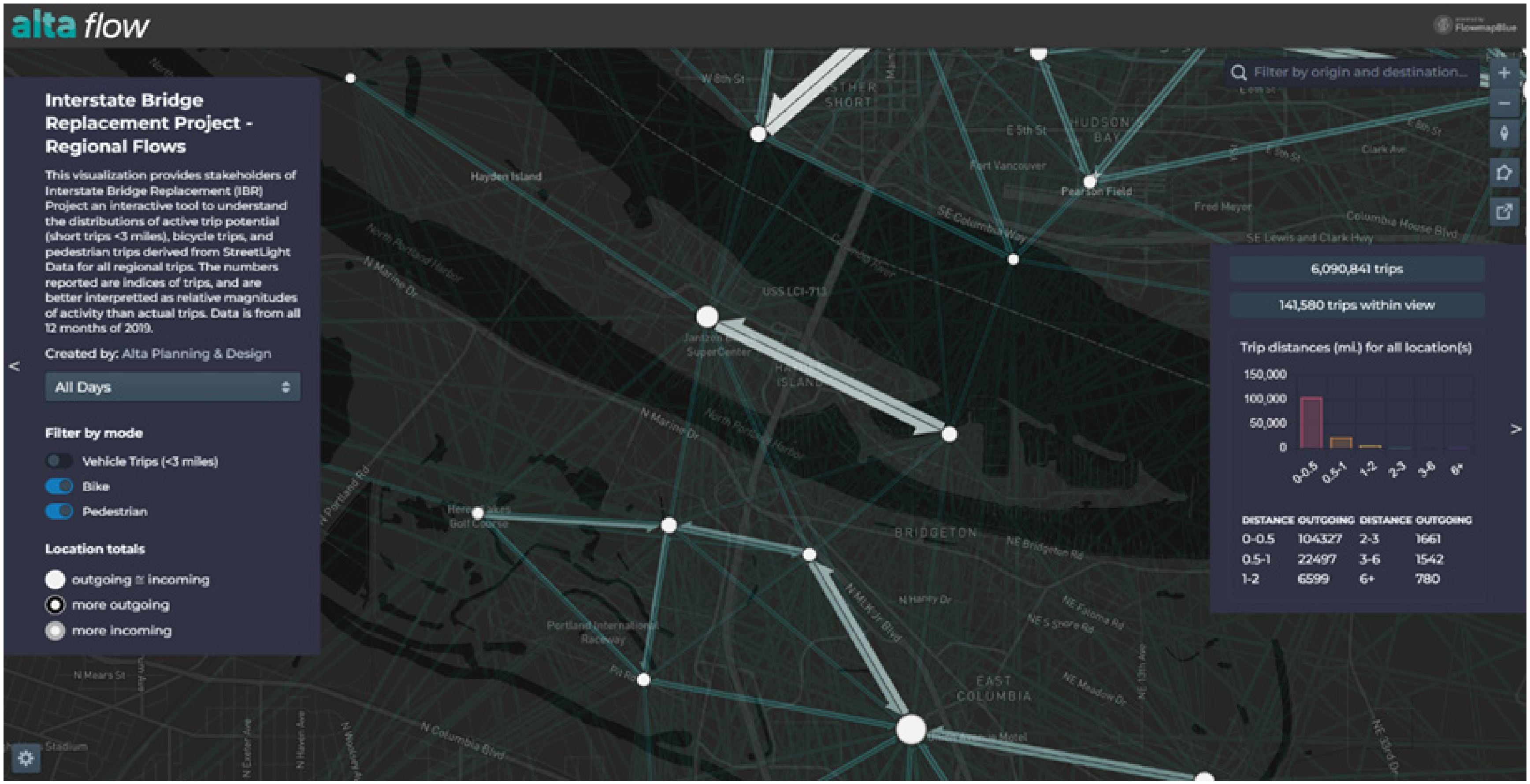
For example, researchers have asked short-trip drivers about their modal alternatives. While 22% considered no alternatives to driving, 31% considered transit, 31% considered walking, and another 7% considered cycling. These survey data are based on people's existing perceptions of travel options, but it could suggest an upper limit of active transportation mode shift of around 40% for active modes (Mackett 2003).

Other research evaluating trip potential of micromobility have suggested scenarios of micromobility usage (15%, 30%, and 44%) among short trips (less than 3 miles) (Harper et al. 2021). The range of conversion to active modes caps at less than half.

The ranges of possible conversion to active modes is based on the thresholds used by Harper et al. but informed by the other research on the topic as well. The short trip estimation method assumes mode shifted trips are converted, and then generated trips identified on top of those converted trips.

Figure 2. Visualization of existing short vehicle trip flows from supplemental zonal analysis. These show regional trips that are less than 3 miles and were provided for a conceptual view of regional short trip flows near the bridge.

Figure 3. Visualization of existing bicycle and pedestrian trips from supplemental zonal analysis.



The estimates of active transportation users and the number of mode-shifted trips from short trip conversion analysis are presented in Table 2.

Table 2. Estimated Active Transportation Trips Using the Short Trip Conversion Method

		Scenario 1: Conservative	Scenario 2: Moderate	Scenario 3: Optimistic
a	Existing Daily Pedestrian and Bicycle Trips [1]	410	410	410
b	Short Car and Motorcycle Daily Trips (<3 miles)	2,300	2,300	2,300
c	*Mode Shift Factor* [2]	*15%*	*30%*	*40%*
d	Mode Substitution Trips (b x c)	350	690	920
e	Existing and Mode Substituted Trips (a + d)	760	1,100	1,330
f	*Generated Trips Factor* [3]	*10%*	*15%*	*20%*
g	Generated Trips (e x f)	80	170	270
h	**TOTAL TRIPS (a + d + g)**	**840**	**1,270**	**1,600**

1 Based on the Green Lanes Study (Monsere et al. 2014) and California Air Resources Board Literature Review of Bike & Pedestrian infrastructure's impact on vehicle miles traveled (VMT) (CARB 2019). Other studies specifically looking at short-trip conversion rates for micromobility were consulted, but the range of percentages is ultimately a range of scenarios intended to inform a range of possible responses to bridge construction. There is no accounting for route shift or trip diversion from other pathways in this estimate because there are no feasible competing crossing options.

2 The counts used for this analysis are based on a 24-hour bicycle and pedestrian count on October 19, 2022 (Wednesday), when a combined total of 296 bicyclists and pedestrians were counted during this time period. This count was conducted during a day in October with relatively warm (75 degrees Fahrenheit), clear weather (no rain or similar) but during a significant smoke event. To account for this, the project team looked for potential literature on the impact wildfire smoke might have on bicycle and pedestrian activity in the Pacific Northwest. This search yielded a paper looking at changes in activity in eight bicycle counters and two pedestrians counters in 2018 in Seattle during a wildfire smoke event (Doubleday et al. 2021). They reported reductions up to 36% for bikes and 45.2% for pedestrians. To provide a conservative estimate to the impact smoke might have had on the counts, these values were used to adjust the counts during this wildfire event up to 410.

3 Based on California Air Resources Board Literature Review of Bike & Pedestrian infrastructure's impact on VMT Modal Substitutional Estimates table using the approximate average percentage of new trips. Ranges for new trips were 2% to 22%. Generated trips are assumed to be a contributor relative to generated existing and converted trips as a type of backward stratification exercise.

3.2 Method 2. Percent Ridership Inflation

The literature-based inflation method references evidence from similar projects (trails/protected bikeways) and attempts to estimate increases in activity from some established baseline (CARB 2019; Monsere et al. 2014). Existing literature documents evidence from resources such as before and after intercept surveys that document percentage increases in total ridership. These same resources also provide data that support the stratification of this increase into feasible rates of mode, route, and activity shift.

The literature used to inform these estimates includes Lessons from Green Lanes Study (Monsere et al. 2014) and a California Air Resources Board Literature Review on the VMT reductions attributable to bicycle projects (CARB 2019). Literature and findings from Chapter 16 (Pedestrian and Bicycle Facilities) Transit Cooperative Research Program (TCRP) Report 95 Traveler Response to Transportation Systems Changes were consulted to inform limitations of source datasets, such as intercept surveys, and as a secondary source of traveler response data (Pratt et al. 2012).

One of the observations made in TCRP Report 95 is that many of the studies recording active transportation before and after studies often can have trouble controlling for exogenous variables or resolving lags in behavior that stabilize maybe 6 to 7 years into the future (Pratt et al. 2012). Additionally, a lack of standardization can be a concern in aggregated results in ridership response from multiple studies (Pratt et al. 2012). These challenges are not unique in transportation research but are considerations for literature-based inflation estimates for active travel.

Previous studies looking at increases in bicycling across 44 facilities (34 bike lanes, six cycle tracks, two paths and two bike boulevards) found a mean 110% ridership change across all facility types (CARB 2019). Within that study, higher-quality facilities that replaced existing bike facilities were shown to have reduced changes in ridership relative to new facilities (CARB 2019). The Lessons from Green Lanes Study found improvements associated with cycle tracks on bike facilities that were two way had increases that ranged from 46% to 126% (Monsere et al. 2014). Studies that did not distinguish between bicyclists and pedestrians looking at increases in traffic on trails (Class I facilities) saw percentage changes of between 38% and 189% (CARB 2019). The high-quality facilities under consideration for the IBR program would see estimates in this range for active transportation use. Based on the rates and the types of projects reported, rates of 20%, 30% and 70% were identified as potential mode shift conversion rates. Except for the optimistic scenario, these assumptions produce similar mode shift estimates to our short trips analysis as a point of comparison.

For the IBR program, the route diversion percentage is assumed to be 0% because there are no realistic routes competing with the bridge connection. Trips that are not mode shift from automobile or generated can either be attributed to mode shift from other modes or be apportioned to generated trips.

The resulting estimates of active travelers and the number of mode-shifted trips from the percent inflation method are summarized in Table 3.

Table 3. Estimated Active Transportation Trips Using Bridge Percent Inflation Mode Shift Method

		Scenario 1: Conservative	Scenario 2: Moderate	Scenario 3: Optimistic
a	Existing Daily Pedestrian and Bicycle Trips [1]	410	410	410
b	*Percent Inflation Factor* [2]	*80%*	*120%*	*160%*
c	New Pedestrian and Bicycle Trips (a x b)	330	490	660
d	*Mode Shift Substitution Percentage* [3]	*20%*	*30%*	*70%*
e	Mode Shifted Trips (c x d)	70	150	460
f	*Generated Trip Percentage* [4]	*15%*	*20%*	*25%*
g	Generated Trips (c x f)	50	100	170
h	*Route Diversion Percentage* [5]	*0%*	*0%*	*0%*
i	Route Diversion Trips (a x h)	0	0	0
j	Other New Trips (c – (e + g + i)) [6]	210	240	30
k	**TOTAL TRIPS (a + c)**	**740**	**900**	**1,070**

1 The counts used for this analysis are based on a 24-hour bicycle and pedestrian count on October 19, 2022 (Wednesday), when a combined total of 296 bicyclists and pedestrians were counted during this time period. This count was conducted during a day in October with relatively warm (75 degrees Fahrenheit), clear weather (no rain or similar) but during a significant smoke event. To account for this, the project team looked for potential literature on the impact wildfire smoke might have on bicycle and pedestrian activity in the Pacific Northwest. This search yielded a paper looking at changes in activity in eight bicycle counters and two pedestrians counters in 2018 in Seattle during a wildfire smoke event (Doubleday et al. 2021). They reported reductions up to 36% for bikes and 45.2% for pedestrians. To provide a conservative estimate to the impact smoke might have had on the counts, these values were used to adjust the counts during this wildfire event up to 410.

2 Based on the Green Lanes Study (Monsere et al. 2014) and California Air Resources Board Literature Review of Bike & Pedestrian infrastructure's impact on VMT (CARB 2019). Percent inflation factors are based on ranges from trails and protected bike lane projects ridership response as a conservative estimate for responses to a high-quality facility. The percentage change from protected bicycle facilities and trails ranged from 21% to 500%, but the average rates of increase for trails and protected bicycle facilities (> 1 mile in length) were 100% and 118%, respectively.

3 Based on CARB's literature review of intercept surveys looking to understand the rates of modal substitution, route shift and new trip taking. Ranges for mode shift substitution from automobile were from 11% to 72%. Numbers selected are based on the range of observed modal substitution rates in the literature and special focus on studies also in Portland, Oregon.

4 Based on CARB's literature review of intercept surveys looking to understand the rates of modal substitution, it is seen that routes have shifted and new trips are not taking longer. Ranges for new trips were 2% to 22%. Induced trips are assumed to be a contributor relative to induced existing and converted trips as a type of backward stratification exercise. Given the quality of facility being proposed, a higher induced trip rate was assumed.

5 Route diversion percentage is assumed to be 0% because there are no realistic routes competing with the bridge connection. Trips that are not mode shift from automobile or induced can be either reattributed to mode shift from other modes or apportioned to induced trips.

6 Other trips are a catchall for all new trips not stratified by this analysis. This could be modal substitution from other modes or other trips not explicitly stratified by literature derived rates. This can be quite high depending on the estimate and could appropriately be reapportioned into the other stratifications if a less conservative estimate was desired for modal substitution or induced trips.

A range of estimates is possible for active travel and mode shift from automobile usage after the construction of a high-quality bicycle and pedestrian facility across the Columbia River. Based on these two methods, future active transportation trips across the bridge in the moderate estimate scenario are estimated to be between 740 and 1,600 per day.

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Appendix G. Safety Data

This appendix contains detailed tables for the total study area intersection crashes by severity, type, and intersection as well as crashes involving people walking and biking from 2015-2019 for Vancouver, Washington and Portland, Oregon. These crash tables are referenced in Sections 3.9.2.3 and 3.9.3.3 of the Transportation Technical Report (TTR).

Table 3-37. Study Area Intersection Crashes by Severity and Type (2015–2019) – Vancouver

ID	Intersection Location	Crash Severity						Crash Type											Total
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Angle	Bicycle	Fixed-Object	Head-On	Other	Overturning	Parking	Pedestrian	Rear-End	Sideswipe	Turning	
1	Ross St and Main St (Hwy 99)	0	0	3	1	3	0	1	1	0	0	2	0	0	1	2	0	0	**7**
2	Hazel Dell and Main St (West) and stop-controlled slip ramp	0	0	1	2	5	0	2	0	0	0	1	0	0	1	2	1	1	**8**
3	39th St and Main St	0	1	3	8	15	1	15	0	1	0	1	0	0	0	7	2	2	**28**
4	39th St and I-5 SB on-/off-ramps	0	0	0	2	7	0	2	0	0	0	0	0	0	0	6	0	1	**9**
5	39th St and I-5 NB on-/off-ramps	0	0	2	6	18	0	5	2	2	0	1	0	0	0	14	2	0	**26**
6	15th Ave and SR 500 WB off-ramp	0	0	0	2	6	0	3	0	3	0	0	0	0	0	1	1	0	**8**
7	15th Ave and SR 500 EB on-ramp/39th St	0	0	0	6	14	0	1	0	0	0	1	0	0	0	5	0	13	**20**
8	St. Johns Blvd and SR 500 WB on-/off-ramps	0	1	4	3	7	1	3	1	1	1	0	0	0	0	8	2	0	**16**
9	St. Johns Blvd and SR 500 EB on-/off-ramps	0	1	0	2	2	0	0	0	1	0	1	0	0	1	2	0	0	**5**
10	Fourth Plain Blvd and Main St	0	0	0	6	6	0	4	0	0	0	0	0	0	0	7	0	1	**12**
11	Fourth Plain Blvd and Broadway St	0	2	0	5	10	1	7	1	0	0	0	0	0	0	4	0	6	**18**
12	Fourth Plain Blvd and I-5 SB on-/off-ramps	0	0	1	3	12	0	1	0	1	0	2	0	1	0	10	0	1	**16**
13	Fourth Plain Blvd and I-5 NB on-/off-ramps	0	1	1	8	22	0	4	0	3	0	2	0	0	0	17	3	3	**32**
14	Fourth Plain Blvd and St. Johns Blvd	0	0	2	5	7	0	5	2	1	0	0	0	0	1	2	0	3	**14**
15	Fourth Plain Blvd and Fort Vancouver Way	0	1	2	4	9	1	7	1	0	0	2	0	0	0	5	0	2	**17**
16	McLoughlin Blvd and Main St	0	0	0	0	3	0	1	0	0	0	0	0	0	0	1	0	1	**3**
17	McLoughlin Blvd and Broadway St	0	0	0	1	2	0	2	0	0	0	0	0	0	0	0	0	1	**3**
18	McLoughlin Blvd and F St	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
19	McLoughlin Blvd and Fort Vancouver Way	0	0	0	5	1	0	2	0	0	0	0	0	0	1	1	0	2	**6**

Table 3-37. Study Area Intersection Crashes by Severity and Type (2015–2019) – Vancouver

ID	Intersection Location	Crash Severity						Crash Type											Total
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Angle	Bicycle	Fixed-Object	Head-On	Other	Overturning	Parking	Pedestrian	Rear-End	Sideswipe	Turning	
20	Mill Plain Blvd and Franklin St	0	1	1	1	4	0	1	1	0	0	0	0	0	2	1	0	2	**7**
21	Mill Plain Blvd WB and Columbia St	0	0	1	2	3	0	3	0	1	0	0	0	0	0	1	0	1	**6**
22	Mill Plain Blvd WB and Washington St	0	0	0	1	6	0	5	0	0	0	0	0	0	0	0	2	0	**7**
23	Mill Plain Blvd WB and Main St	0	0	2	5	4	0	10	0	0	0	0	0	0	0	1	0	0	**11**
24	Mill Plain Blvd WB and Broadway St	0	0	0	1	2	0	3	0	0	0	0	0	0	0	0	0	0	**3**
25	Mill Plain Blvd WB and C St	0	0	1	1	2	0	2	1	0	0	0	0	0	0	0	1	0	**4**
26	Mill Plain Blvd EB and Columbia St	0	0	0	2	8	0	8	0	0	0	0	0	0	0	1	1	0	**10**
27	Mill Plain Blvd EB and Washington St	0	1	0	4	5	0	7	0	0	0	0	0	0	1	1	0	1	**10**
28	Mill Plain Blvd EB and Main St	0	1	0	2	6	0	2	0	1	0	0	0	0	1	3	0	2	**9**
29	Mill Plain Blvd EB and Broadway St	0	0	2	6	10	0	15	1	0	0	0	0	0	1	1	0	0	**18**
30	Mill Plain Blvd EB and C St	0	0	1	1	5	0	5	0	0	0	0	0	0	1	0	0	1	**7**
31	Mill Plain Blvd and I-5 SB on-/off-ramps	0	1	0	8	11	1	3	0	1	0	1	0	0	0	14	0	2	**21**
32	Mill Plain Blvd and I-5 NB on-/off-ramps	0	1	1	7	20	1	5	0	3	0	1	0	0	0	11	1	9	**30**
33	Mill Plain Blvd and Fort Vancouver Way	0	0	0	7	11	0	3	0	1	0	0	0	0	1	10	1	2	**18**
34	Evergreen Blvd and Columbia St	0	0	1	2	2	0	1	0	0	0	0	0	0	1	1	0	2	**5**
35	Evergreen Blvd and Washington St	0	0	3	2	1	0	2	1	0	0	0	0	0	2	0	0	1	**6**
36	Evergreen Blvd and Main St	0	0	2	1	1	0	1	0	0	0	0	0	0	1	0	0	2	**4**
37	Evergreen Blvd and Broadway St	0	0	0	1	1	0	2	0	0	0	0	0	0	0	0	0	0	**2**
38	Evergreen Blvd and C St	0	0	4	1	3	0	4	0	0	0	0	1	0	1	2	0	0	**8**
39	Evergreen Blvd and Fort Vancouver Way	0	0	0	1	0	2	0	0	3	0	0	0	0	0	0	0	0	**3**
40	8th St and Columbia St	0	1	0	1	1	0	1	0	0	0	0	0	1	0	1	0	0	**3**

Table 3-37. Study Area Intersection Crashes by Severity and Type (2015–2019) – Vancouver

ID	Intersection Location	Crash Severity						Crash Type											Total
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Angle	Bicycle	Fixed-Object	Head-On	Other	Overturning	Parking	Pedestrian	Rear-End	Sideswipe	Turning	
41	8th St and C St	0	0	0	0	2	0	1	0	0	0	0	0	0	0	1	0	0	**2**
42	6th St and Grant St	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	**1**
43	6th St and Esther St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
44	6th St and Columbia St	0	0	0	1	4	0	3	0	0	0	0	0	0	0	0	0	2	**5**
45	6th St and Washington St	0	0	2	4	5	0	5	1	0	0	0	0	0	4	1	0	0	**11**
46	6th St and Main St	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	**1**
47	6th St and Broadway St	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
48	6th St and C St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
49	5th St and Washington St/I-5 SB on-ramp	0	0	0	0	3	1	1	0	1	0	0	0	1	0	0	1	0	**4**
50	Phil Arnold Way and Esther St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
51	Phil Arnold Way and Columbia St	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	**2**
52	Columbia Way and Esther St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
53	Columbia Way and Columbia St	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
54	Columbia House Blvd and SR 14 EB/WB on-/off-ramp (SPUI)	0	1	2	2	8	1	2	1	4	0	1	2	0	0	1	2	1	**14**
55	Columbia Way and Columbia Shores Blvd	0	0	0	1	10	0	2	0	1	0	2	0	0	0	3	0	3	**11**

Source: WSDOT and ODOT Crash Database, IBR Analysis.

Ave = avenue; Blvd = boulevard; EB = eastbound; Hwy = highway; SB = southbound; SPUI = single-point urban interchange; St = street; WB = westbound.

Table 3-38. Study Area Intersection Crashes Involving People Walking and Biking by Severity (2015–2019) – Vancouver

ID	Intersection Location	Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Total
1	Ross St & Main St (Hwy 99)	0	0	1	1	0	0	**2**
2	Hazel Dell & Main St (West) & stop controlled slip ramp	0	0	1	0	0	0	**1**
5	39th St & I-5 NB On-/Off-Ramps	0	0	1	1	0	0	**2**
8	Saint Johns Blvd & SR 500 WB On-/Off-Ramps	0	0	0	1	0	0	**1**
9	Saint Johns Blvd & SR 500 EB On-/Off-Ramps	0	0	1	0	0	0	**1**
11	4th Plain Blvd & Broadway St	0	1	0	0	0	0	**1**
14	4th Plain Blvd & Saint Johns Blvd	0	0	0	3	0	0	**3**
15	4th Plain Blvd & Fort Vancouver Way	0	0	0	1	0	0	**1**
18	McLoughlin Blvd & F St	0	0	1	0	0	0	**1**
19	McLoughlin Blvd & Fort Vancouver Way	0	0	0	1	0	0	**1**
20	Mill Plain Blvd & Franklin St	0	1	1	1	0	0	**3**
25	Mill Plain Blvd WB & C St	0	0	1	0	0	0	**1**
27	Mill Plain Blvd EB & Washington St	0	1	0	0	0	0	**1**
28	Mill Plain Blvd EB & Main St	0	1	0	0	0	0	**1**
29	Mill Plain Blvd EB & Broadway St	0	0	2	0	0	0	**2**
30	Mill Plain Blvd EB & C St	0	0	1	0	0	0	**1**
33	Mill Plain Blvd & Fort Vancouver Way	0	0	0	0	1	0	**1**
34	Evergreen Blvd & Columbia St	0	0	1	0	0	0	**1**
35	Evergreen Blvd & Washington St	0	0	2	1	0	0	**3**
36	Evergreen Blvd & Main St	0	0	1	0	0	0	**1**
38	Evergreen Blvd & C St	0	0	1	0	0	0	**1**
45	6th St & Washington St	0	0	2	3	0	0	**5**
51	Phil Arnold Way & Columbia St	0	0	0	1	0	0	**1**
54	Columbia House Blvd & SR 14 EB/WB On-/Off-Ramp (SPUI)	0	0	1	0	0	0	**1**

Source: WSDOT and ODOT Crash Database, IBR Analysis.

Ave = avenue; Blvd = boulevard; EB = eastbound; Hwy = highway; SB = southbound; SPUI = single-point urban interchange; St = street; WB = westbound.

Table 3-37 . Study Area Intersection Crashes by Severity and Type (2015–2019) – Portland

ID	Intersection Location	Crash Severity						Crash Type											Total
		Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Angle	Bicycle	Fixed-Object	Head-On	Other	Overturning	Parking	Pedestrian	Rear-End	Sideswipe	Turning	
56	Hayden Island Dr (South) and Center Ave	0	0	0	5	3	0	1	0	0	1	0	0	0	0	3	1	2	**8**
57	Hayden Island Dr (South) and Hayden Island Dr connector to north	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
58	Hayden Island Dr (North) and Hayden Island Dr connector to south	0	0	1	8	1	0	0	0	0	0	0	0	0	0	3	0	7	**10**
59	I-5 SB Hayden Island off-ramp and Center Ave/Tomahawk Island	0	0	0	1	5	0	0	0	0	0	0	0	0	1	1	2	2	**6**
60	I-5 NB Hayden Island off-ramp and Tomahawk Island Dr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
61	Tomahawk Island Dr and Jantzen Dr	0	0	1	1	1	0	2	0	0	0	0	0	0	0	0	0	1	**3**
62	Center Ave and Jantzen Ave	0	1	0	0	2	0	0	0	1	0	0	0	0	0	0	0	2	**3**
63	Marine Dr/MLK Blvd and I-5 NB/SB on-/off-ramps	0	1	7	16	18	0	0	1	0	0	0	0	0	1	22	2	16	**42**
64	Marine Way and Vancouver Way (loop)	0	1	0	5	6	0	6	0	0	0	0	0	0	0	2	1	3	**12**
65	Marine Dr and Anchor Way	0	1	0	0	2	0	0	0	0	0	0	0	0	0	2	0	1	**3**
66	I-5 NB off-ramp and Union Ct/Marine Way	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	**1**
67	Victory Blvd and Expo Rd	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	**1**
68	Victory Blvd and Interstate Ave/Denver Ave NB off-ramp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
69	Victory Blvd and I-5 SB on-ramp	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	4	**4**
70	Victory Blvd and I-5 NB off-ramp/Whitaker Rd	0	0	2	0	4	0	1	0	0	0	0	0	0	1	0	1	3	**6**
71	Interstate Ave/Denver Ave and Schmeer Rd	0	0	0	2	3	0	0	0	0	0	0	0	0	0	3	0	2	**5**
72	Columbia Blvd and I-5 NB/SB on-/off-ramp	0	0	0	5	5	0	0	0	0	0	0	0	0	0	5	0	5	**10**
73	Columbia Blvd and MLK Blvd	0	2	9	42	34	0	3	0	0	0	2	0	0	1	29	8	44	**87**

Source: WSDOT and ODOT Crash Database, IBR Analysis.

Ave = avenue; Blvd = boulevard; CT = court; Dr = drive; MLK = Martin Luther King Jr.; NB = northbound; Rd = road; SB = southbound;.

Table 3-38. Study Area Intersection Crashes Involving People Walking and Biking by Severity (2015–2019) – Portland

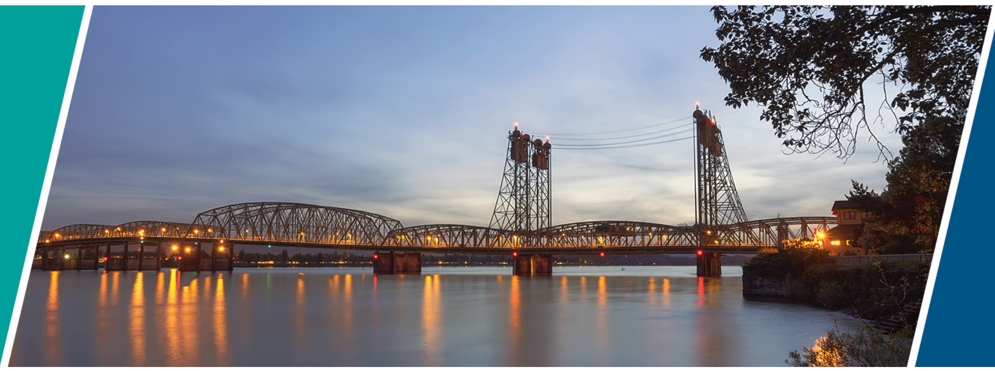
ID	Intersection Location	Fatal	Serious Injury	Minor Injury	Possible Injury	Property Damage Only	Unknown	Total
59	I-5 SB Hayden Island Off-Ramp & Center Ave/Tomahawk Island	0	0	0	1	0	0	**1**
63	Marine Dr/MLK Blvd & I-5 NB/SB On-/Off-Ramps	0	0	2	1	0	0	**3**
70	Victory Blvd & I-5 NB Off-Ramp/Whitaker Rd	0	0	1	0	0	0	**1**
73	Columbia Blvd & MLK Blvd	0	0	0	1	0	0	**1**

Source: WSDOT and ODOT Crash Database, IBR Analysis.

Ave = avenue; Blvd = boulevard; CT = court; Dr = drive; MLK = Martin Luther King Jr.; NB = northbound; Rd = road; SB = southbound;.

Appendix H. Travel Demand Modeling Methods Report

Considering the importance of our natural environment



Travel Demand Modeling Methods Report

September 2024

Oregon

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Travel Demand Modeling Methods Report

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ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

2018 RTP	2018 Regional Transportation Plan jointly developed and adopted by Metro and RTC
CRC	Columbia River Crossing
FHWA	Federal Highway Administration
HOV	high-occupancy vehicle
IBR	Interstate Bridge Replacement
LEHD	Longitudinal Employer-Household Dynamics
Metro	Oregon Metro
MPO	municipal planning organization
NEPA	National Environmental Policy Act
RTC	Southwest Washington Regional Transportation Council
RTDM	regional travel demand model
RTP	Regional Transportation Plan
SEIS	Supplemental Environmental Impact Statement
SOV	single-occupancy vehicle
TAZ	transportation analysis zone
VOT	value of time

EXECUTIVE SUMMARY

This report describes the approach for conducting the travel demand modeling supporting the Supplemental Environmental Impact Analysis (SEIS) for the Interstate Bridge Replacement (IBR) Program. The SEIS is being prepared under the National Environmental Policy Act (NEPA). The travel demand model was used to develop future year forecasts, provide performance measures to evaluate alternatives, and estimate project impacts. Modeled performance measures are a subset of the spectrum of quantitative and qualitative measures established for the IBR Program.

1. TRAVEL DEMAND MODEL DEVELOPMENT

The IBR Program used the Oregon Metro (Metro) regional travel demand model (RTDM) that is developed, maintained, and implemented for projects in the Portland metropolitan region (Figure 1) by staff at Metro. What this means for all project studies conducted in the region is that Metro controls the model process, coding inputs, and running the model through final assignments, at which point model outputs are provided to project teams for development of metrics to support their analysis. This model is jointly developed between Metro, the Portland, Oregon, metropolitan planning organization (MPO) and the Southwest Washington Regional Transportation Commission (RTC), the MPO for southwest Washington. The RTDM for the Portland metropolitan region is a trip-based model that was estimated using 6,500 Portland and Vancouver area samples of household data collected in 2011 in the Oregon Household Activity Survey. The version of the model used for the IBR Program is called *Kate*. High-level details about components of the RTDM are provided below, and full documentation of the model estimation and calibration is included in Attachment A.

As noted, the household survey that is the basis for development of the RTDM was completed in 2011, prior to travel behavior changes related to the COVID-19 pandemic including changes in travel related to working from home. Generally, it is common practice to conduct household surveys every 5 to 10 years which allows a balance between capturing changes in travel behavior and managing the costs and logistics of conducting the surveys. Once survey data are collected, it takes time to synthesize the data and then estimate new models from these data. While the survey used to develop the model was conducted in 2011, the model was calibrated and validated to a base year 2015. The Portland metropolitan region had planned to undertake a new survey in 2020, but that effort was delayed due to the COVID-19 pandemic. Home-based work trips in the base and future year model make up approximately 18% of total daily travel in the Portland metropolitan region, or just under 1 of every 5 trips. ACS one-year census data for 2022 indicates that the percentage of work from home for the Portland metropolitan area was just over 23%, up from 8% prior to the COVID-19 pandemic. While employers in the Portland metropolitan area continue to ask employees to return to work in the office at least part time, the impact of working from home on travel demand and forecasts is still uncertain. Absent new post-COVID travel surveys, the high-level takeaway is that work-from-home trips could increase over current modeling, but the reduction in overall trips would be minimal.

The RTDM is a traditional four-step demand model with trip generation, destination choice, mode choice, and assignment steps.

- There is inherent variability associated with any future year volume forecast, and the purpose for which a forecast is developed influences how that variability can be managed. The RTDM produces forecasts using a set of assumptions developed at a point in time based on reasonably foreseeable conditions for a future year No-Build and Build Alternatives. Great care goes into the development of these assumptions, but there is inherent variability in travel forecasts that stems from a combination of factors that influence people's travel behavior. Several key sources contribute to this variability including the following: Economic factors – growth or recession can lead to changes in employment rates and income levels.
- Technological advancements – innovations in transportation technology (e.g., electric vehicles, autonomous vehicles, ride-sharing services) can change traditional travel patterns and influence demand.

- Land use and development – urban planning and land use policies can influence the locations of households and employment within the region.
- Social and cultural factors – changes in work-from-home trends or shifts in societal values towards sustainability can alter commute patterns.
- Policy and regulation – government policies, regulations, and incentives related to transportation (fuel prices, toll rates, public transportation investments, environmental regulations) can have an impact on travel demand.
- External events – unexpected events such as natural disasters and pandemics such as COVID-19 can disrupt regular commute patterns and influence travel behavior.

While each of these items involves an element of uncertainty, the assumptions that are made for the RTDM have been made in coordination with city, county, regional and state partners along with historical travel behavior trends specific to this region to allow for reasonable comparison between a No-Build and Build condition.

1.1 Trip Generation

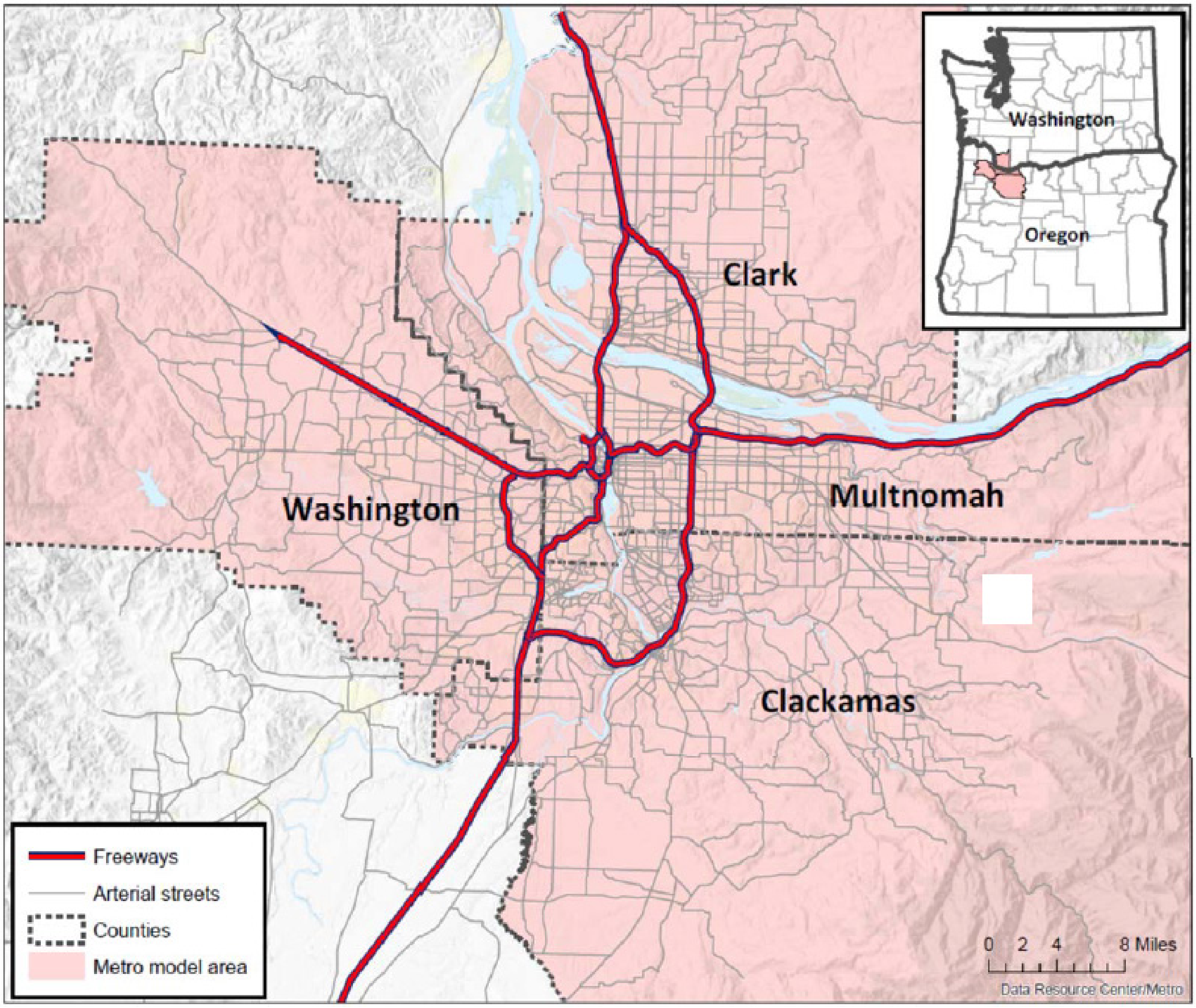
Prior to trip generation, several models must be run to develop inputs that are used in this step. These models include a worker model which estimates the number of households with 0, 1, 2 and 3 or more workers; an auto ownership model which estimates the number of households with 0, 1, 2 and 3 or more vehicles; and a child model which estimates the number of households with 0, 1, 2, and 3 or more school-aged children.

The worker model is based on household characteristics including household size, income level, and age of head of household. This model was estimated from Census Bureau 2012_5yr Public Use Microdata Sample data for the four-county region shown in Figure 1.

The auto ownership model uses household size and income level along with output from the worker model, a measure of transit accessibility, and several attributes designed to represent the urban form of the transportation analysis zone (TAZ) in which a household is located. Where the worker model only uses household characteristics, the auto ownership model also accounts for changes in land use and transit level of service.

The number of children in a household will have an impact on trip generation for the school trip purpose. As such, the child model estimates the number of children based on the household size and age of head of household characteristics.

Figure 1. Metro RTDM Regional Model Area



Source: 2017 Kate v1.0 Trip-Based Demand Model Validation Report for Base Year 2015, Metro 2017

Once these pre-generation models are complete, the trip-generation step estimates average weekday person-trips for eight trip purposes:

- **HBW**, Home-Based Work, uses number of workers output from pre-generation worker model; resulting trips are scaled to total regional employment.
- **HBshop**, Home-Based Shopping, uses household size and number of workers from pre-generation worker model.
- **HBrec**, Home-Based Recreation, uses household size by worker status (e.g., all household members work or not all household members work).
- **HBoth**, Home-Based other, uses household size by worker status (e.g., all household members work or not all household members work).
- **NHBW**, Non-Home-Based Work, uses number of workers from pre-generation worker model.

- **NHBNW**, Non-Home-Based Non-Work, uses household size by worker status (e.g., all household members work or not all household members work).
- **HBcoll**, Home-Based College, uses household size and age of household head.
- **HBSch**, Home-Based School, uses household size and number of children from pre-generation child model.

1.2 Destination Choice

Destination choice in the RTDM connects the productions that are developed in the trip-generation step to attractions. While separate expressions are calculated for each trip purpose, the general structure of the destination choice utilities consists of a multimodal accessibility measure, a series of variables that account for the effects of prominent physical features on travel behavior that extend beyond measurable attributes, and various combinations of zonal input data representing activity opportunities.

At a high level, the variables used in the calculation of the multimodal accessibility functions used in destination choice include time, costs, and income. Each of these is described in more detail below and in the model estimation documentation in Attachment A.

Travel times used as input to destination choice calculations include AM peak and midday travel times for in-vehicle travel as well as out-of-vehicle travel. For auto trips, the out-of-vehicle time is higher in the downtown area compared to the rest of the region (5 minutes vs. 2 minutes). For transit trips, the out-of-vehicle travel times include walk time, initial wait time, and transfer wait time. The calculations for travel time use both AM and midday times weighted by the share of trips that would experience peak vs. off-peak travel. For example, for home-based-work trips that predominantly occur during peak periods, the weight to AM travel times is 63% and to midday is 37%, whereas home-based shopping trips see weights that are very much the opposite with 66% midday and 34% AM. Details on time weights for each purpose are included in Attachment A.

Costs included in the multimodal accessibility functions include auto operating and out-of-pocket costs by mode. All costs in the model are expressed in 2010 dollars. Auto operating cost is the per mile cost of operating a privately owned vehicle and accounts for gas, insurance, maintenance, and tires. Out-of-pocket costs in the model include parking charges, transit fare, and tolls, although the base model development does not include any toll costs because there were and continue to be none in the region for the base year condition. Toll costs only come into the calculations for future year forecasts and are discussed in a later section. For auto costs, drive-alone trips see 100% of the costs while drive-with-passenger and passenger share the costs between them (66.7% to drive-with-passenger and 33.3% to passenger).

Household income level is defined as low (<$25K), medium ($25K to $100K) and high (>$100K) in the destination choice model. As with costs, these levels are expressed in 2010 dollars. Income coefficients are used with costs in home-based calculations in the destination choice model. Non-home-based purposes do not use income as part of the calculations.

In addition to multimodal accessibility functions, destination choice relies on river and hill-crossing variables intended to represent psychological barriers that typically are not captured through observable time and cost attributes. These variables are primarily used to tighten validation of district-to-district flows and average trip lengths from the household travel survey. River and hill-crossing variables are used for trips between Oregon and Washington, between the east and west side of the Willamette River, and between west of the west hills and the rest of the region.

Finally, a range of size variables are used in the destination choice model to represent both the type and magnitude of activity opportunities at potential attraction zones. These tend to be composed of varying combinations of employment by sector, and include total households (HBoth, HBrec, NHBW) and several more customized measures (park acres for HBrec, off-campus enrollment for HBcoll) for certain trip purposes.

Aside from the inclusion of tolling, the variables and calculations for destination choice do not vary between base- and future-year forecasts or between No-Build and Build Alternatives. Destination choice is re-run for both the No-Build and Build alternatives accounting for different multimodal accessibility calculations that would exist under the conditions (e.g., highway changes, transit changes, tolling) in these alternatives.

1.3 Mode Choice

Mode choice in the RTDM calculates the propensity for trips that come out of destination choice to use one of seven discrete travel modes:

- **Drive Alone**, only available to households with at least one car (determined in pre-generation auto ownership model).
- **Drive with Passenger**, only available to households with at least one car (determined in pre-generation auto ownership model).
- **Passenger**.
- **Walk Transit**, only available if total walk distance (access + transfer + egress) does not exceed 1 mile.
- **Drive Transit**, only available if attraction zone has parking cost; only available for home-based non-school trips; utilities and lot usage for formal park-and-ride lots and informal park-and-ride locations are calculated by a nested park-and-ride lot choice model.
- **Bike**, utilities and distances produced by standalone tool based on dedicated bicycle network.
- **Walk**, only available for trips with distance less than 5 miles.

The mode choice model is a multinomial logit model that considers times and costs in the same manner as is described above for destination choice. In addition, the mode choice model utility expressions for non-auto modes include several measures that represent urban form at the attraction zone, calculated as average intersection density interacted with retail and/or total employment.

As previously mentioned, the bicycle mode includes utilities derived from a standalone model. In mode choice, utilities for bicycle are separated into commute and non-commute attractiveness. In addition, the bicycle mode calculations include a factor for a bicycle residential preference area which encompasses much of inner northeast and southeast Portland as well as downtown, inner northwest, and southwest Portland. Trips produced in these areas are given an additional factor that results in more attractiveness in the bike utility.

In mode choice, probabilities are applied to distributed trips to determine the number of trips that will use each mode. Mode choice is re-run for No-Build and Build alternatives to reflect choices that travelers have under these different conditions.

1.4 Assignment

Trips factors were derived from the 2010–2011 household activity survey to apply to trips by purpose from mode choice. These factors were produced for each hour of the day and reflect both production-to-attraction and attraction-to-production trip end travel patterns. Tables including factors by each purpose are in Attachment A.

An adjustment is made after initial factoring by hour is complete that considers the diurnal profile of trips in the region as calculated across a set of screenlines. The screenlines are primarily used as part of calibration and validation and are divided into Tier 1 and Tier 2 cutlines. The diurnal adjustment is made using Tier 1 cutlines.

Initial assignments of these trip tables are completed for all 24 hours of the day. After these initial assignments, an assessment of demand vs. capacity is completed and an additional peak spreading algorithm is used to adjust single-occupancy vehicle (SOV) and high-occupancy vehicle (HOV) trip tables at a regional level. This procedure iteratively assesses the ratio of congested to free-flow travel time for all zone pairs, and in those cases where this ratio exceeds a target threshold, moves trips proportionately from peak to shoulder periods within the 5 a.m. to 8 p.m. time span.

Auto and transit assignments are completed in the Emme software. The auto assignments are completed using a multiclass assignment technique with SOV, HOV, Medium Truck (FHWA Class 4–7, or single-unit trucks) Heavy Truck (FHWA Class 8 and above, or trucks with one or more trailers) classes. In addition to vehicle capacity, free-flow speed, and length, additional truck delay is included on some links to account for factors such as slope and curvature that impact truck path choice. Trucks are assigned as passenger car equivalents to account for the space the vehicles take on the roadway that is different than passenger cars. When reporting volumes from the assignments, these passenger car equivalents are converted back to vehicles.

Transit assignments also use a multipath process in Emme with transit speeds for most routes calculated as a function of underlying auto speed. Exceptions to this are routes that operate on exclusive right of way. Transit time includes walk time, initial and transfer wait time, boarding time, and in-vehicle time. Care has been taken to maintain consistency in path choice and mode choice. This is accomplished by applying factors to wait and in-vehicle time reflecting perceptions of time that vary by stop and vehicle type.

1.5 Special Model Components

The RTDM includes several elements that are developed through external models or calculations. These include a Portland International Airport Model, an External Model, and a Truck Model.

1.5.1 Portland International Airport Model

Trips to and from the TAZ containing the Portland International Airport terminal and associated with air passengers are generated by a separate Airport Passenger Demand Model. The trip tables that are generated by this model are added to the trip tables produced by the RTDM and assigned to mode-specific networks as applicable (SOV, HOV, transit). Details about this model are found in Attachment A.

1.5.2 External Model

External trips are calculated in a separate process from the RTDM. These trips are developed through average weekday volume targets using estimates of shares for five trip components at each of 15 external stations. These components are as follows:

1. External to internal home-based-work trips
2. External to internal non-home-based work trips
3. Internal to external recreational trips
4. Internal to external non-recreational trips
5. External to external trips

External trips are added to the auto trip tables prior to assignment of trips to the network. Details about this model are found in Attachment A.

1.5.3 Truck Model

The Truck Model forecasts the quantity, type, and distribution of truck trips in, out, and within the four-county region. The model is based on a commodity flow database that includes Freight Analysis Framework 3 zone data for Portland and surrounding Oregon counties, as well as for Clark County, Washington. The underlying truck model information in the 2018 Regional Transportation Plan (2018 RTP)[1] and all projects that use this model as the basis for modeling work was updated in 2015. Truck trips that result from this model are separated into medium (FHWA Class 4–7, or single-unit trucks) and heavy (FHWA Class 8 and above, or trucks with one or more trailers) truck trip tables. The trip tables are peaked by time of day and assigned along with the SOV and HOV trips in the multiclass assignments by hour. The truck trips are static trip tables that do not change origin-destination or quantity in a given year regardless of projects in the network or pricing on roadways, although these would impact route choice in the assignment. Details about this model are found in Attachment A.

1.6 Tolling

The incorporation of tolling into the RTDM has been documented in Attachment B which is an addendum to the Trip-Based Demand Model Methodology Report. Information in this addendum was

[1] The 2018 Regional Transportation Plan was jointly developed and adopted by Metro (Metro 2018) and RTC (RTC 2019).

originally developed to document the incorporation of tolling for the Columbia River Crossing (CRC) project under guidance from a special working group that included practitioners from Stantec Inc., RTC, Metro, and other CRC contractors. While some values of time and the toll rates that are being used for the IBR Program have been adjusted through additional research in coordination with other toll projects in the Oregon portion of the region (Attachment D), the general philosophy around the incorporation of tolling in the RTDM remains the same as documented in the addendum in Attachment B and excerpted below. Details around values of time and toll rates specific to the IBR Program are documented below in Sections 3.6 and 3.7, respectively.

Due to the lack of tolling in the existing network, there was no basis for explicitly accounting for traveler responses to it based on observed behavior. Taking this into account, as well as an absence of applicable empirical research or techniques in application in comparable regions with tolling in the base condition, the tolling team made reasoned assumptions about the effects of tolling in the different steps of the RTDM. As the circumstances that led to the development of these assumptions remain unchanged, they continue to be applied consistently to IBR and all current modeling efforts in the region.

Tolling is incorporated into the model as follows:

- 25% of the toll is used in determining trip distribution.
- 75% of the toll is used in determining mode choice.
- 100% of the toll is used in determining route choice.

The toll weights as used in the model reflect the lack of data to estimate a full choice model coefficient for toll prices. The coefficient for other dollar costs (notably parking) were used, but adjustments to the toll rate were made to reflect the observed different effects for tolls compared to other costs.

This set of assumptions is consistent with research from the National Academies of Sciences, Engineering, and Medicine (2012) on *Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand* which found the following:

> *Traveler responses to congestion and pricing depend on the range and attractiveness of available alternatives. From the highest to the lowest propensity to change behavior, these responses are as follows:*
>
> - *Primary. Change lane or route type or make minor shifts in departure time (up to 1 hour earlier or later), or both;*
> - *Secondary. Switch between auto and transit (in transit-rich areas) or change car occupancy (carpooling), or both;*
> - *Tertiary. Cancel, relocate, or reschedule most flexible and discretionary trips and activities (or some combination of these changes); and*
> - *Longer Term. Change the location of home, work, or other important activity; change the number or types of vehicles owned.*
>
> *… The highest propensity to change appears to be between tolled and non-tolled lanes or routes… Somewhat less likely are changes in either travel mode or car occupancy… Less likely responses to changes in congestion or pricing are changes in the choice of destination locations,*

the rescheduling of trips to very different times of day, or changes in the frequency of making trips from home.

To understand the potential impact a change to these toll weights might have on model results, two different sensitivity tests were completed. The first test adjusted toll weights to 100% for all trip purposes for destination choice and mode choice. The second test adjusted toll weights to 100% for only discretionary trips (everything except college- and work-related trips) for destination choice and mode choice. Because route choice was already set to 100%, there was no change made in this step.

Results of these tests show the following:

- With higher toll weights in destination choice, there is a reduction in total person-trips crossing the river. In the sensitivity test with full toll weights for all trip purposes in destination choice and mode choice, the reduction was approximately 9% on an average weekday.
- In the sensitivity test with full toll weights in destination choice and mode choice for only discretionary trip purposes, the reduction was approximately 3% on an average weekday.
- The biggest impact seen in these sensitivity tests is in destination choice where the toll weight is most changed from the base assumption.
- Mode choice does not change much because the toll weight is already at 75% in the base model assumptions.
- Overall changes in transit trips for river crossings with these two runs is only at 1% in both runs.
- As noted, at the assignment level the toll weights remain unchanged and the real difference between the base toll run and the two sensitivity runs is the magnitude of vehicle crossings, but the shares of trips using each bridge is similar with approximately 44% of trips using the I-5 Columbia River Bridges and 55% using the I-205 Glenn Jackson Bridge.
- The current assumptions in the model are reasonable, and sensitivity tests indicate that even if toll weights were changed in destination choice and mode choice, it would not cause different impacts than what are already being evaluated in the technical analysis.

2. MODEL CALIBRATION AND VALIDATION

2.1 Overall Regional Model Calibration and Validation

Note: This section will be updated to respond to comments requesting additional count data in the traffic subarea which are under development. The findings will be developed and reviewed in coordination with ODOT WSDOT, FTA and FHWA prior to the publication of the Draft SEIS.

The RTDM was calibrated and validated to the base year 2015. Full documentation of the RTDM estimation and calibration is included in Attachment A. In addition to the details around calibration found in that document, the Kate v1.0 Trip-Based Demand Model Validation Report for Base Year 2015 is provided in Attachment C. This documentation reports out the reasonable calibration and validation of each of the model components (trip generation, destination choice, mode choice, and assignment).

In the Kate validation report, model results are compared against the following sources of data:

- 2010/2011 Oregon Household Activity Survey
- 2015 American Community Survey
- 2014 Longitudinal Employer-Household Dynamics (LEHD) U.S. Census
- 2014 Highway Performance Monitoring System
- 2015 auto and freight counts
- 2025 TriMet transit counts
- 2014 bike counts

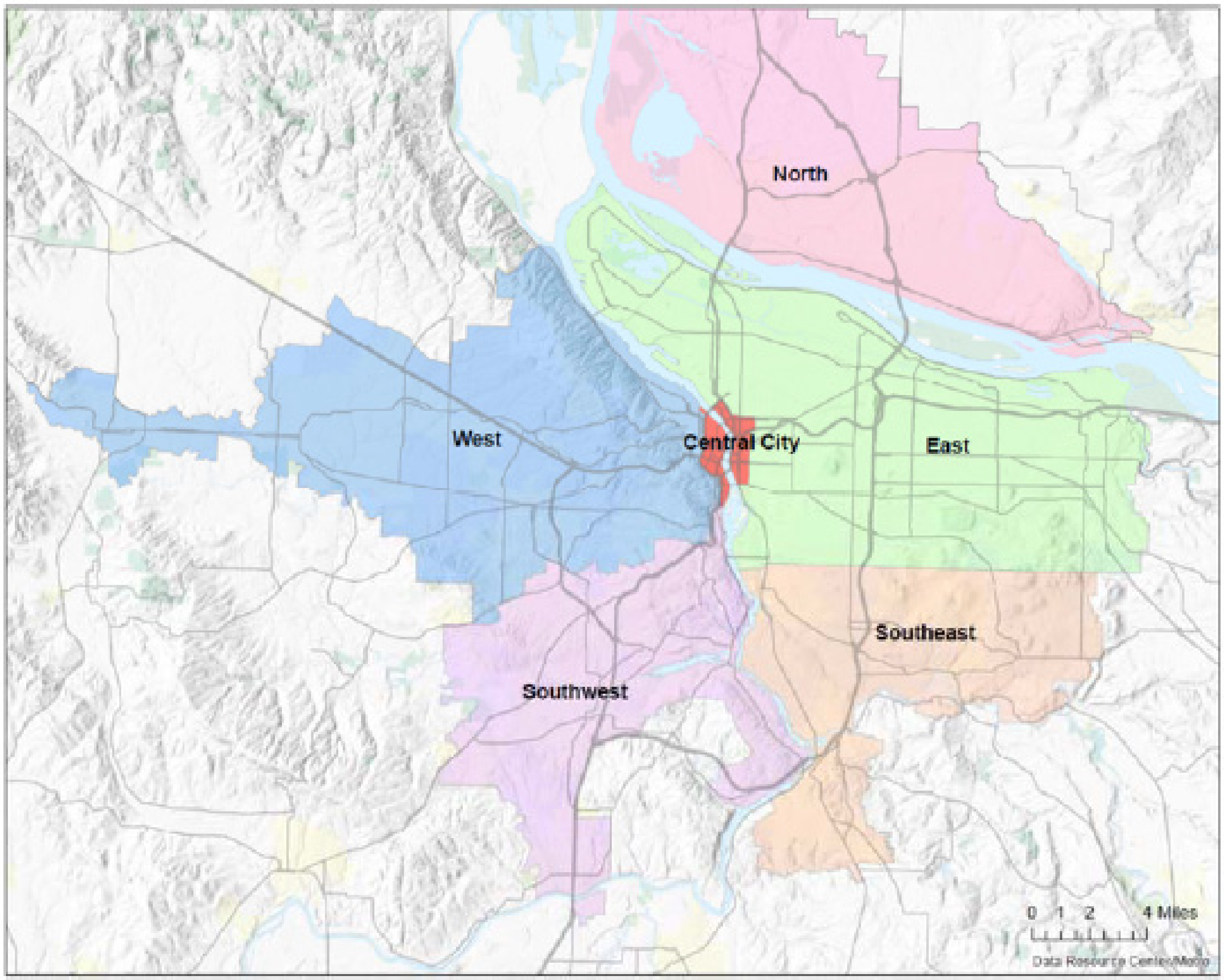
It is noted in the calibration and validation document that comparison of model results to survey does not constitute model validation, but it is a useful means to confirm that model application code behaves properly.

The validation of the assignment model was completed primarily by comparing model flows to counts and count-derived data in the model area. The first comparison was of modeled regional vehicle miles traveled to vehicle miles traveled estimates produced by the Highway Performance Monitoring System. The second comparison was of modeled link volumes across a set of primary regional cutlines to traffic counts corresponding to the same locations. The principal outcome of this comparison was the calculation of root mean squared error for two sets of facilities roughly broken out by daily volumes, highways and arterials. In both cases, it was determined that modeled flows were matching observed and estimated counts reasonably well.

Of interest for the work being completed for the IBR Program is how overall trips between Washington and Oregon match up with observed data for both overall destination choice, as well as how counts compare to actuals for river crossings.

From a destination choice standpoint, district-to-district movements were compared of home-based work trips in the model against 2014 LEHD data. The districts used in the comparisons are shown below in Figure 2. Table 1 shows the comparison of model vs. LEHD. As shown, trips from Oregon (Central City, East, West, Southeast, Southwest) to Washington (North) are all between 0 and 1 percentage point of actual LEHD data. Trips from Washington (North) to Oregon (Central City, East, West, Southeast, Southwest) are between 0 and 3 percentage points of actual LEHD data. The largest difference in trips from Washington to Oregon is for trips to the East where the model is slightly lower (-3).

Figure 2. District Map of Aggregations of Regional Zones Used in Results Comparisons



Source: Metro 2017.

Table 1. Distribution of Home-Based Work Trips

	LEHD 2014	Kate 2015	Point Difference (Kate – LEHD)
Trips *to* north from:			
Central City	2%	1%	-1
East	3%	2%	-1
Southeast	2%	1%	-1
Southwest	1%	1%	0
West	1%	1%	0
Trips *from* north to:			
Central City	7%	7%	0
East	20%	17%	-3
Southeast	3%	2%	-1
Southwest	4%	3%	-1
West	8%	8%	0

Source: Metro 2017.

2.2 StreetLight Data Comparisons

In addition to the model validation documentation from Metro, the IBR Program had access to StreetLight Data used primarily to evaluate travel patterns for trips using the Interstate Bridge. StreetLight Data is a company that specializes in providing transportation analytics by collecting and analyzing data related to traffic and transportation travel patterns with a set of proprietary data processing algorithms that transform the data into contextualized, aggregated, and normalized travel patterns. It uses a variety of sources of information, including mobile phones, connected vehicles, and other location-based technologies along with underlying census data to offer insights into traffic flows and travel patterns.

To evaluate the trips using the bridge, zones were created to capture all movements within the RTDM boundaries so that they could be compared against the 2015 base-year model. The zones used for the StreetLight analysis were developed in coordination with other tolling programs in the region and made so that they would nest into districts that had originally been developed during the CRC project (22-district system). For comparisons between the regional model and StreetLight, this 22-district system was used. Figure 3 shows the 22 district boundaries. The StreetLight data were available only back to the year 2016, so that is the year used to compare with the 2015 RTDM. In both platforms, total regional trips at an origin-destination level were analyzed to confirm overall travel patterns. In a separate analysis, a subset of total regional trips that used the I-5 Columbia River bridges between Oregon and Washington were analyzed. For both the total regional trips and the I-5 Columbia River bridges, select link trips average weekday conditions were compared.

AIn terms of the comparisons between StreetLight and the RTDM, because the data are reported using slightly different metrics, absolute values are difficult to compare. Instead, a comparison was made using the share of origins-destinations for all districts in the region.

Table 2 shows the percentage point difference between the two data sets for average weekday trips for the entire Portland Metropolitan area. In this comparison, only one origin-destination movement was greater than a 1 percentage point difference. When comparing differences for trips crossing the Columbia River, trips to Clark County from Oregon for all districts combined were different by 0.7% point, and trips to Oregon from Clark County for districts combined were different by 0.7% point.

Table 3 shows the percentage point difference between the two data sets for average weekday trips for only those trips that use the I-5 Columbia River bridges for a trip during the day. In this comparison none of the origin-destination movements have a value greater than 1 percentage point difference. When comparing differences for trips crossing the Columbia River, trips to Clark County from Oregon for all districts combined were different by -1.6% point, and trips to Oregon from Clark County for districts combined were different by 1.6% point.

While there are many reasons to be cautious when working with big data, these comparison points were helpful to have as an added point of information in reviewing travel patterns between Oregon and Washington in the RTDM.

Figure 3. 22-District System

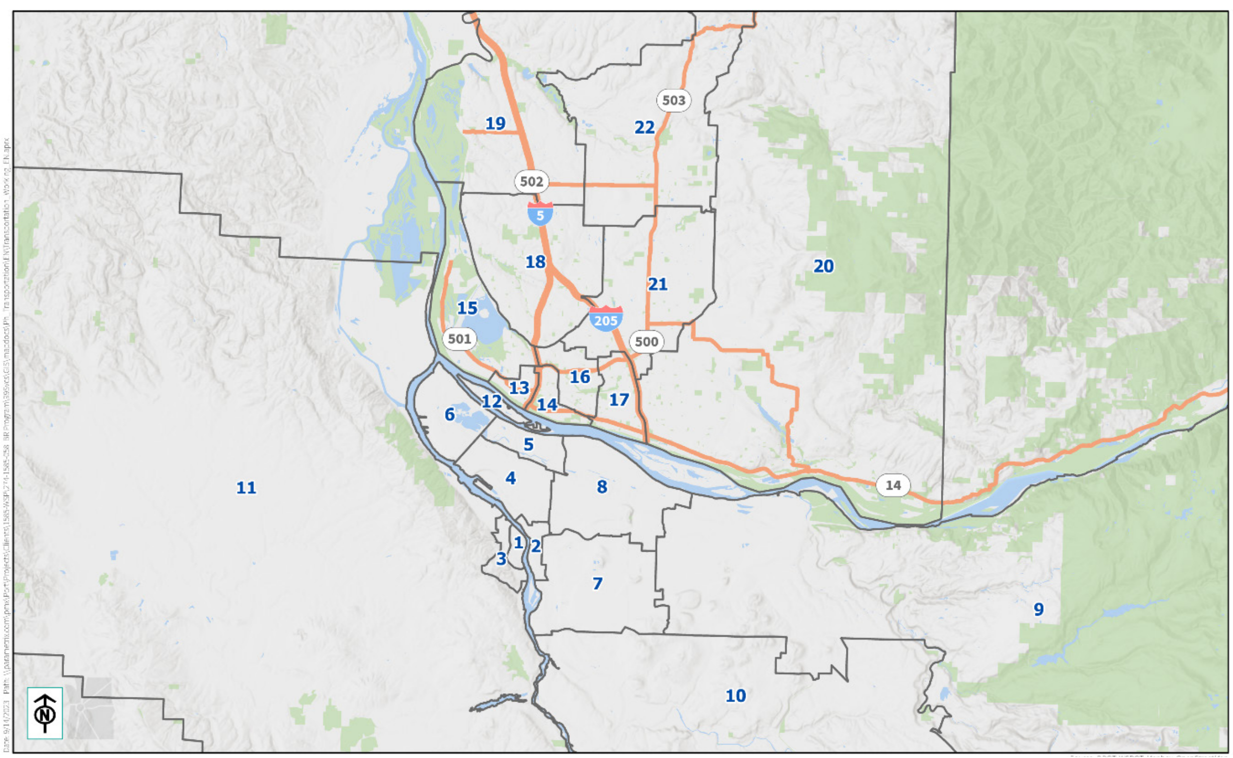


Table 2. 2015 Regional Travel Demand Model Total Average Weekday Origin-Destination Trips Percentage Point Difference to 2016 StreetLight Data

District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
1	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.4%
2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.6%
3	-0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%
4	0.0%	0.0%	0.1%	-0.2%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
6	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
7	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	-0.4%	0.2%	0.1%	0.2%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%
8	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.2%	-0.2%	0.1%	0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.7%
9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	-0.5%	-0.1%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
10	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.2%	0.1%	-0.1%	-5.8%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-4.7%
11	0.0%	0.2%	0.1%	0.3%	0.0%	0.1%	0.5%	0.2%	0.2%	0.7%	-0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.8%
12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%
14	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.1%	0.0%	0.0%	0.4%
15	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
16	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
17	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
18	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%
19	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
20	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.1%
21	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	-0.1%	-0.2%
22	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.5%	-0.6%
Total	**-0.4%**	**0.6%**	**0.4%**	**0.4%**	**0.0%**	**0.0%**	**0.9%**	**0.7%**	**-0.1%**	**-4.8%**	**1.9%**	**-0.1%**	**-0.1%**	**0.4%**	**0.0%**	**0.1%**	**0.3%**	**0.4%**	**0.2%**	**0.0%**	**-0.3%**	**-0.6%**	**0.0%**

Table 3. 2015 Regional Travel Demand Model I-5 Columbia River Bridge Average Weekday Origin-Destination Trips Percentage Point Difference to 2016 StreetLight Data

District	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Total
1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.0%	-0.2%	0.0%	-0.3%	0.1%	-0.2%	-0.1%	0.0%	-0.8%
2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	0.1%	0.0%	0.0%	-0.1%	0.1%	0.0%	-0.1%	0.0%	0.2%
3	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%
4	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.6%	0.1%	0.1%	0.3%	0.0%	0.1%	0.3%	0.0%	0.1%	1.8%
5	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	-0.1%	-0.1%	-0.4%	-0.2%	-0.5%	-0.1%	-0.6%	-0.5%	-0.3%	-3.1%
6	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.3%	0.0%	0.1%	0.1%	0.1%	0.1%	-0.3%	-0.1%	0.1%	0.5%
7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.2%	0.1%	0.1%	0.0%	0.1%	0.1%	-0.1%	-0.1%	0.0%	0.3%
8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.2%	0.1%	0.1%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.4%
9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.3%
10	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.2%
11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.7%	0.4%	0.2%	0.0%	0.2%	0.5%	0.1%	0.0%	0.2%	2.5%
12	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%	-0.2%	-0.2%	-0.5%	-0.2%	-1.0%	0.0%	-0.4%	-0.3%	-0.1%	-3.3%
13	-0.3%	0.0%	0.0%	0.2%	-0.3%	-0.1%	-0.1%	0.0%	-0.1%	0.0%	0.0%	-0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-1.1%
14	0.1%	0.2%	0.1%	0.7%	0.0%	0.2%	0.2%	0.2%	0.0%	0.0%	0.7%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.1%
15	0.0%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.4%
16	-0.2%	0.0%	-0.1%	0.1%	-0.3%	0.1%	0.1%	0.0%	0.0%	-0.1%	0.2%	-0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.7%
17	0.0%	0.0%	0.1%	0.3%	-0.1%	0.1%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%
18	-0.2%	0.1%	0.1%	0.1%	-0.2%	0.1%	0.1%	0.0%	-0.1%	0.0%	0.6%	-0.8%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
19	0.2%	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	1.3%
20	-0.1%	-0.1%	0.0%	0.0%	-0.4%	-0.1%	0.0%	-0.1%	0.0%	0.0%	0.6%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.5%
21	-0.1%	0.0%	0.2%	0.1%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.2%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.3%
22	0.0%	0.0%	0.1%	0.1%	-0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.4%	-0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.5%
Total	**-0.4%**	**0.5%**	**0.6%**	**1.9%**	**-1.8%**	**0.4%**	**0.1%**	**0.1%**	**-0.3%**	**-0.2%**	**3.8%**	**-3.1%**	**-0.3%**	**2.1%**	**0.6%**	**-0.6%**	**-0.1%**	**-1.7%**	**0.9%**	**-1.3%**	**-1.2%**	**0.0%**	**0.0%**

2.3 Volume to Count Comparisons for Columbia River Crossings

When comparing counts (see Table 4) to modeled vehicle volume crossings for the Columbia River overall, daily trips for both crossings are within 6% southbound and -1% northbound and overall PM peak trips are within -2% southbound and 7% northbound.

Table 4. Columbia River Crossing Cutline Summary

	South/West				North/East			
	Kate Volumes	Counts	Difference Kate – Counts	% Change from Counts	Kate Volumes	Counts	Difference Kate – Counts	% Change from Counts
Average Weekday								
I-5 Interstate Bridge, n/o Hayden Island (NB & SB)	81,100	69,300	11,900	17%	76,500	68,200	8,300	12%
I-205 Glenn Jackson Bridge (NB & SB)	77,600	80,400	(2,800)	-3%	71,600	81,400	(9,800)	-12%
Total	158,800	149,600	9,100	6%	148,100	149,600	(1,500)	-1%
PM Peak								
I-5 Interstate Bridge, n/o Hayden Island (NB & SB)	8,800	8,100	700	9%	12,100	10,100	2,000	19%
I-205 Glenn Jackson Bridge (NB & SB)	8,100	9,100	(1,000)	-11%	13,800	14,100	(300)	-2%
Total	16,900	17,200	(300)	-2%	25,900	24,300	1,600	7%

Source: Metro 2017.

3. SUMMARY OF MODEL ASSUMPTIONS FOR THE INTERSTATE BRIDGE REPLACEMENT PROGRAM

The model version being used for the IBR Program is the Kate version of the RTDM as described above, but more specifically is the implementation of the model developed for the 2018 RTP representing model years for 2015 and 2045. This version of the model is the same as the one that has been approved by the Federal Highway Administration (FHWA) for use by other projects in the Portland metropolitan region, including the I-205 Toll Project. The future model years include assumptions about expected land use growth and changes to the regional transportation network, including anticipated projects that are included in the 2018 Financially Constrained Regional Transportation Plan[2] (2018 RTP), as appropriate to the project analysis needs. [3]

3.1 General Assumptions

Table 5 outlines the general modeling assumptions used in the alternatives' analysis in the SEIS. More details about the alternatives can be found in the 2045 IBR No-Build and 2045 IBR Modified Locally Preferred Alternative modeling package memos included in Attachment E.

Table 5. General Modeling Assumptions for IBR Program Alternatives

Model Parameters	Assumptions
Future evaluation year	2045
Land use	Based on growth assumptions consistent with the 2018 RTP for 2040, extrapolated to 2045 with adjustments to reflect City of Portland Comprehensive Plan and Hayden Island Plan assumptions. Land uses are held constant across all alternatives as is the standard practice in this region.
Transportation network	Includes projects in the 2018 RTP Financially Constrained Project list based on project completion year. Transit assignments incorporate a capacity constraint to reflect demand that is consistent with assumed service levels in the 2018 RTP while ongoing work is being completed to identify additional service that could accommodate this demand.

[2] The transportation analysis for the No-Build Alternative and Modified LPA is based on the anticipated regional highway and transit networks and service levels for 2045 as informed by the 2018 Regional Transportation Plan jointly developed and adopted by Metro (Metro 2018) and RTC (RTC 2019). The traffic model applied to this analysis reflects pre-COVID conditions. New surveys and model development efforts that include post-COVID travel behavior are planned to be incorporated in the 2028 RTP update.

[3] The 2018 RTP used a 2040 horizon year while this Project uses a 2045 horizon year based on the most recent land use assumptions developed in 2021 by Metro and RTC in conjunction with partner agencies. These land use assumptions are documented in more detail below.

Model Parameters	Assumptions
Daily conditions	Average weekday conditions.
Value of time	Updated values applied to tolls are summarized in Table 9, segmented by vehicle type, income, and time of day. In the Metro/RTC RTDM, tolls and values of time are expressed in 2010 dollars.
Toll-Paying Vehicle Classes	All modeled vehicle types (SOV, HOV, medium trucks, and heavy trucks) and income classes (low-income, medium-income, and high-income SOV and HOV) will be tolled. Monetary toll rates are summarized in Table 9.
Toll rate pricing	Toll rates are assumed to vary by time of day following a fixed (known) daily schedule by hour. No discounts or exemptions for any modeled vehicle types are assumed. [a]
Toll collection methods	Transponder tags or license-plate reading enforced by cameras. No toll booths or other vehicle delays are assumed.

a While vehicle exemption policies have not been determined at this time, it is important to note that some potentially exempt vehicles (e.g., emergency responders) are not explicitly broken out in the RTDM. Transit vehicles are assigned separately from general motor vehicle traffic and are not assessed a toll charge.

3.2 Evaluation Years

The SEIS analysis that includes results from the RTDM uses a base year 2015 existing condition and a 2045 horizon year. The 2045 Metro RTDM scenarios were developed using the 2018 RTP 2040 financially constrained transportation network and 2045 land use assumptions as described below to reflect appropriate regional socioeconomic growth. The IBR Program team has coordinated with Metro, RTC, and regional partners throughout the modeling process to develop consistent assumptions for the future year modeling and analysis years for related regional projects, and to ensure that the Program is using a modeling approach common to other tolling-related projects in the region.

3.3 Land Use

The 2018 RTP used a base year of 2015 and a 2040 future year. The future year 2040 land use assumptions were modified to arrive at land use assumptions for the year 2045. This 2045 future year land use was assumed for the RTDM used in the SEIS analysis. Details on the development of the 2045 future year land use are provided below. This region assumes land use allocations would be the same between No-Build and Build conditions for project work because they are based on adopted plans (see the Land Use Technical Report Section 6.2 for additional details of the plans. See the Indirect Effects Section 6.3 of the Land Use Technical Report for a plan consistency discussion of the No-Build Alternative and the Modified LPA).

The approach to hold land use constant for a direct impacts analysis of No-Build and Build analyses is typically followed for two primary reasons: (1) future year land use forecasts and subsequent TAZ allocations are based on a set of regionally agreed upon regulatory and market assumptions at a scale that is generally not sensitive to parcel- or block-level effects of individual projects including transit oriented developments; and (2) simultaneously varying land use and network input assumptions renders technical analysis more challenging and less clear in the sense that it is no longer possible to directly associate differences in output metrics and input assumptions. It should also be noted that, for similar reasons, tolling implementation is not assumed to lead to differences in land use assumptions. In addition, this assumption is consistent with past sensitivity testing conducted using Metro's land use tool, MetroScope, that revealed no significant anticipated land use shifts would occur with proposed CRC project improvements and tolling configurations in the region which were assumed to be more aggressive than current assumptions for the IBR Program. A memo detailing an assessment of differences in land use and development completed using the MetroScope tool along with documentation for the tool is provided in Attachment G. The findings of the MetroScope analysis—which included a more ambitious project than the Modified LPA that is currently being analyzed (for both highway and transit elements of the project)—indicated that land use shifts would be small (1%) and would support the assumption of no change in input assumptions between the No-Build Alternative and the Modified LPA. If adjustments were to be made to back out some of the development, the impact of a 1% change would not change comparative findings of the impacts discussed in the Transportation Technical Report. However, as discussed in Section 6.1, Indirect Effects, if the No-Build Alternative occurred, population and employment growth as well as increased multimodal transportation activity related to transit-oriented developments in Hayden Island and downtown Vancouver would likely be slower to be achieved over time or they may not reach the levels anticipated. A sensitivity test was completed to assess the potential impact of a 20% reduction in trip generation from these areas, approximating a No-Build condition in which the development does not reach the levels anticipated. The overall differences for these station areas could end up being a reduction of between 1,200 and 2,800 daily person trips under the No-Build Alternative. This would translate to between 100 and 280 less peak period trips, which would not result in a change to the analysis of long-term effects.

Land use assumptions in the 2018 RTP which was the original basis for the model include jurisdiction-reviewed forecast growth in population, households, and employment. Because the currently adopted 2018 RTP uses a 2040 forecast year, it was necessary to develop land use assumptions that extended for an additional 5 years beyond the adopted RTP. Metro and RTC developed a straight-line growth that was the starting point for IBR and that is consistent with the approach for other projects in the region that are using a 2045 horizon year in advance of a new allocation that will be available with a future RTP adoption.

Once the starting point 2045 was in place, Metro, RTC, and jurisdictional partners, in coordination with the IBR team, reviewed these forecasts. When the 2018 RTP land use allocation was developed, the City of Portland did not have its comprehensive plan in place to help inform the allocation of population, households, and employment to individual TAZs in their jurisdiction. For the IBR program and other forecast-year 2045 work in the region being done ahead of a new RTP being adopted, the City of Portland requested that adjustments be made within their jurisdiction to reflect consistency with their comprehensive plan. The City of Portland had an overall control total for land use for the year 2045 that was the starting point for adjustments. The City of Portland provided TAZ level shares of households and employment that were used to calculate the amount each TAZ would have of the overall control totals. This step included accounting for development of Hayden Island consistent with the Hayden Island Plan. Table 6 provides the regional household and employment totals broken out by 10 districts that are shown in Figure 4. These districts are an aggregation of the 22 districts shown in Figure 3. This aggregation consolidates districts to align more closely with the traffic subarea that is used for analysis in the Transportation Technical Report. Table 6 includes the original RTP land use and the resulting land use after adjustments were made to incorporate the City of Portland Comprehensive Plan and Hayden Island changes.

Figure 4. 10-District System

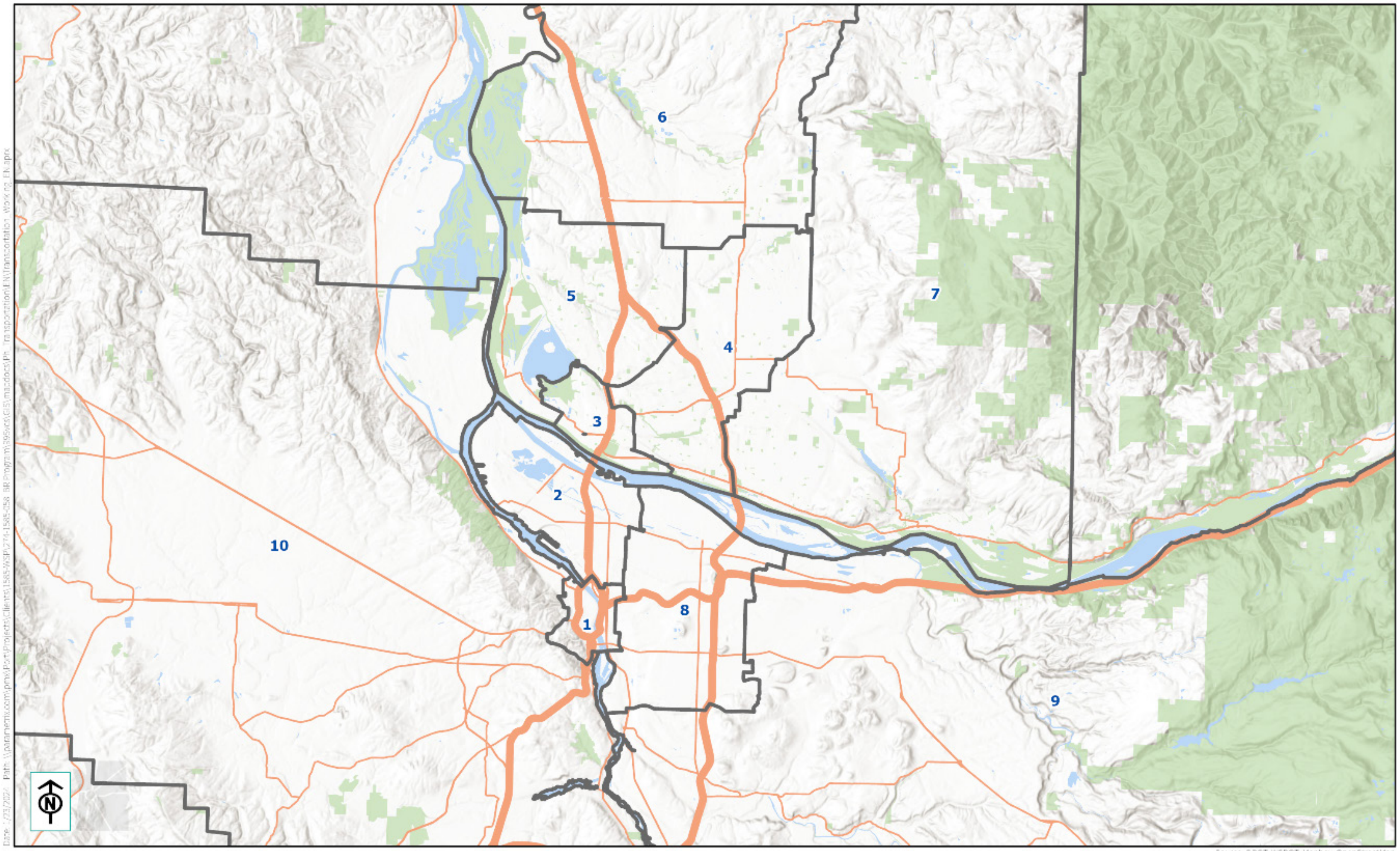


Table 6. 2015 Base, 2045 RTP and Final IBR SEIS Land Use Assumptions

District	2015 RTP Households	2015 RTP Employment	2045 RTP Households	2045 RTP Household Growth vs. 2015	2045 RTP Employment	2045 RTP Employment Growth vs. 2015	2045 IBR SEIS Households	2045 IBR SEIS Household Growth vs. 2015	2045 IBR SEIS Employment	2045 IBR SEIS Employment Growth vs. 2015
Portland Central City (1)	38,518	188,684	68,888	79%	248,675	32%	80,302	108%	245,824	30%
N/NE Portland (2)	40,903	63,435	64,969	59%	84,439	33%	62,372	52%	84,668	33%
Vancouver CBD and Surrounding Area (3)	12,915	28,077	20,448	58%	43,571	55%	20,448	58%	43,571	55%
East Vancouver (4)	49,328	44,731	61,018	24%	66,112	48%	61,018	24%	66,112	48%
Salmon Creek (5)	28,078	20,127	39,985	42%	29,605	47%	39,985	42%	29,605	47%
North Clark County (6)	17,656	11,105	38,109	116%	41,334	272%	38,109	116%	41,334	272%
East Clark County (7)	55,798	39,964	75,594	35%	70,993	78%	75,594	35%	70,993	78%
NE Portland/Mult Co (8)	124,575	136,634	177,425	42%	181,075	33%	173,471	39%	185,837	36%
E Mult Co/Clackamas Co (9)	193,691	174,501	256,377	32%	278,622	60%	263,231	36%	278,367	60%
Westside (10)	289,436	365,667	425,865	47%	547,865	50%	414,148	43%	545,979	49%
Total	**850,898**	**1,072,925**	**1,228,679**	**44%**	**1,592,290**	**48%**	**1,228,679**	**44%**	**1,592,290**	**48%**

Note: Final IBR SEIS land use includes adjustments to City of Portland TAZ allocations to make them consistent with the City's comprehensive plan which was not in place at the time of the original RTP adoption.

3.3.1 Growth in Land Use, Regional and Corridor Trips

Table 7 below provides information on the total change in households and employment compared to the change in person trips for the region and the districts that align with the traffic subarea in the Transportation Technical Report. This information is provided to show that the growth in trips aligns with the growth in households and employment for both the region and the traffic subarea.

Table 7. 2015 Base, 2045 Final IBR SEIS Land Use and Person Trips

	2015 Base Year	2045 Horizon Year
Regionwide Trips		
Total Trips	8,446,150	11,905,150
% Change from 2015		41%
Regionwide Demographics		
Households	850,900	1,228,700
% Change from 2015		44%
Employment	1,072,900	1,592,300
% Change from 2015		48%
Traffic Study Area Trips (Districts 1-5,8)		
Total Trips	2,744,800	4,058,550
Percent of total Region Trips	32%	34%
% Change from 2015		48%
Traffic Study Area Demographics		
Households	294,300	437,600
Percent of total Region Households	35%	36%
% Change from 2015		49%
Employment	481,700	655,600
Percent of total Region Employment	45%	41%
% Change from 2015		36%

3.4 Transportation Network

The transportation network assumes construction of reasonably likely-to-be-funded improvements, based on the 2018 RTP process. As noted in the previous section, the 2045 scenarios were constructed by using the 2018 RTP 2040 financially constrained transportation network, assuming no additional major projects will be completed by 2045 in the study area. Projects included in the underlying 2018 RTP networks for the 2045 horizon year are found in the modeling packages found in Attachment E for both Metro and RTC.

The Metro RTDM modeling efforts for the IBR Program SEIS incorporate network refinements. These include ramp metering rate modifications, mainline capacity and access adjustments along I-5 that will be in place through the study area, and transit modifications. These assumptions were developed jointly in coordination with Metro and RTC.

A screening process was undertaken to reassess transit investment options based on numerous changes in the corridor and transit agency operations that have occurred since the CRC project. The result of this process was the selection of the transit element of the Modified LPA. Of the transit options identified in the screening analysis, the option that included light-rail transit extension (extending from the Expo Center at the current terminus of the Yellow Line light-rail transit in Oregon to Evergreen Station on the west side of I-5 in Washington) and express bus (operating as bus on shoulder in the study area) was selected as the Modified LPA to advance into the SEIS.

In addition to the freeway and transit improvements noted above, two local system changes were made to the Metro/RTC RTDM networks to reflect more current projects that have advanced in the program area:

- Fourth Plain Road Diet in Vancouver, Washington.
- Network adjustments along MLK/Delta Park area to better reflect configurations in place in those areas.

This Modified LPA will be the build alternative for comparison against the No-Build Alternative to assess overall project impacts.

The IBR Program was included in the 2018 RTP financially constrained network using the Locally Preferred Alternative 2013 Record of Decision from CRC. This 2013 CRC ROD has been modified based on new information as described above.

The No-Build Alternative excludes all elements of the IBR Modified LPA including the replacement of the Interstate Bridge, tolling on the bridge, interchange reconfigurations throughout the study area, the supplemental bridge providing access to Hayden Island to and from the south in Oregon, light-rail transit extension, added park-and-ride lots, express bus operating as bus on shoulder, and other associated background transit changes that are part of the Modified LPA. The No-Build Alternative is considered as an alternative in the SEIS and is used as a reference point for potential changes in travel demand identified in the IBR Program.

3.5 Daily Conditions

The Metro RTDM models average weekday conditions. This is consistent with traffic, transit and active transportation analysis being conducted for the IBR Program. Where other measurements may be needed to convert average weekday values to reflect another timeframe (e.g. annualized transit ridership) that will be detailed as part of the specific measure being calculated.

3.6 Value of Time Assumptions

In the Metro RTDM, conversion of toll values between dollars and equivalent minutes occurs twice and relies on assumed values of time (VOTs). For the assignment step, the monetary tolls to be assessed are applied as an equivalent time penalty (disincentive) and saved in matrices ("skimmed") separately from congested travel time. Prior to inclusion in the destination choice and mode choice models, the skimmed time penalties are converted back to monetary tolls using the same VOTs as were used in the initial conversion of dollars to minutes.

The VOTs in use for the RTDM were updated as part of the I-205 Toll Project and incorporated as developed for that work. The I-205 Toll Project had been scheduled to implement an I-205 Travel Preference Survey that was going to be used to update VOT assumptions in the Metro RTDM. Due to the onset of the COVID-19 pandemic and its associated restrictions and economic impacts, the I-205 Travel Preference Survey was suspended indefinitely. In lieu of the stated preference survey, updated VOT assumptions were developed based on detailed literature review, model practices in other regions, and consideration of the results from the most recent similar stated-preference survey in the region.

Different VOTs are applied for travel during peak hours (6 a.m. to 9 a.m. and 4 p.m. to 6 p.m.), shoulder hours (5 a.m. to 6 a.m., 9 a.m. to 10 a.m., 3 p.m. to 4 p.m., and 6 p.m. to 7 p.m.), and off-peak hours.

Details about the development of the VOT assumptions are documented in the I-205 Toll Project Value-of-Time Assumption Review Memorandum in Attachment D. The IBR Program used these same assumptions for the underling RTDM implementation. The main difference between the two tolling programs is in the use of class stratification in final assignments, where the I-205 project included additional stratification that the IBR Program did not. The IBR Program used a single VOT for conversion of the toll to a time equivalent for one SOV class and one HOV class, where the I-205 project used three for SOV and three for HOV (low, middle, high income). The level of detail the I-205 project was using for its evaluations needed this additional stratification where the IBR Program did not in this phase of work. While the income stratification results in some differences in the assignment step, the travel times, with tolls as time equivalents, that are fed back into the model for destination choice and mode choice are the same because only one set of values is converted back to dollars for the demand model. This conversion is based on the high-income VOTs for both SOV and HOV for peak and off-peak as shown in Table 8, and as noted, is consistent between IBR and other toll program work in the region.

Table 8. Value of Time Assumptions (2010 Dollars)

Vehicle Class	Peak Hours	Off-Peak Hours	Shoulder/Transition hours [a]
Single-Occupancy Vehicle Auto	$22/hour	$17/hour	$20/hour
High-Occupancy Vehicle Auto	$38/hour	$25/hour	$34/hour
Medium Trucks	$39/hour	$39/hour	$39/hour
Heavy Trucks	$61/hour	$61/hour	$61/hour

Sources: ODOT PIAU 2017; Metro 2017.

a Shoulder/transition hour VOT estimates use a blended value between peak and off-peak; shown rounded to the nearest integer value.

3.7 Toll Rate Pricing Assumptions

The modeling performed for the SEIS evaluation applies toll rate assumptions on the Interstate Bridge in the Modified LPA to estimate transportation system performance and effects.

The toll rate schedule assumptions used for the IBR SEIS were developed by the IBR finance team to balance the dual purposes of the project; to generate revenue and manage congestion on the Interstate Bridge while considering the overall project objectives. The following assumptions are included in the toll schedule for the Modified LPA SEIS evaluation.

- Higher toll rates during peak hours.
- Lower auto toll rates during off-peak hours.
- Vary toll rates to smooth the transition between peak and off-peak toll levels.
- Increase truck tolls as multiples of the auto toll consistent with other toll facilities.
- Extend the AM peak period to be 3 hours.
- Charge minimal toll ($1) during the overnight period.

Table 9 shows the through-trip toll rate assumptions for the SEIS Modified LPA. Medium trucks pay 2 times the auto toll and heavy trucks pay 4 times the auto toll for all hours of the day. Toll rates are the same for both directions on the Interstate Bridge.

Table 9. Proposed Through-Trip Toll Rate Assumptions by Time Period (FY 2023 dollars)

Period	Hours	Auto Toll	Medium Truck Toll	Heavy Truck Toll
PM Peak	3–7 p.m.	$2.96	$5.92	$11.84
AM Peak	6–9 a.m.	$2.96	$5.92	$11.84
Shoulder	2–3 p.m., 7–8 p.m.	$2.96	$5.92	$11.84
Transition	5–6 a.m., 9–10 a.m., 2–3 p.m., 7–8 p.m.	$2.45	$4.90	$9.80

Period	Hours	Auto Toll	Medium Truck Toll	Heavy Truck Toll
Off-Peak	10 a.m.–2 p.m., 8–11 p.m.	$1.94	$3.88	$7.76
Overnight	11 p.m.– 5 a.m.	$1.43	$2.86	$5.72

During the screening phase that was completed in advance of the development of the Modified LPA, a series of tolling sensitivity analyses were completed to provide information on how the RTDM would respond to varying toll rates and the inclusion of other toll programs under consideration in the region. Details around these tests are found in Attachment F.

3.8 Transit Capacity Constraint

Transit capacity constraints were added to the modeling process because the 2018 RTP model generated estimates of transit ridership across the system that could only be supported in practice with additional capital investment projects beyond those present in the 2018 RTP. The addition of capacity constraint in the model represents a way to ensure that work being completed to assess highway impacts is not understated because transit demand is overstated. The implementation of the capacity constraint assignment was completed for the peak period. The technique assesses the transit demand relative to transit capacity for all transit lines in the system. This is done by comparing the available transit capacity on a line using an assumed capacity by transit vehicle type (LRT, BRT, Express Bus, local bus) for passengers across an hour using planned frequencies. For transit lines where demand exceeds capacity a full model feedback process is implemented that iteratively decreases (i.e., worsen) the frequency of any transit line with a demand overage at its peak load point until the resulting peak load can be accommodated by the original (i.e., planned) frequency. This technique is applied to the No-Build Alternative and the Modified LPA. The time component being used to implement the capacity constraint is associated with the entirety of a given line and not just the segment(s) experiencing the peak load overage, so this technique produces a conservative estimate of transit ridership consistent with the goal of not understating highway impacts.

4. MODELING APPROACH OUTREACH AND REVIEW

Extensive coordination and partner agency outreach on the modeling approach and modeling results was completed during screening and the development of assumptions for the No-Build Alternative and Modified LPA that is the basis for work being completed in the SEIS, including the following:

- Early bi-weekly project modeling team meetings with technical experts from WSDOT, ODOT, Metro, RTC, and the consultant team to coordinate on methods and assumptions that would be used in the modeling that would be completed for the IBR Program. These meetings included coordination aimed at having a consistent model and background set of assumptions that would be used in all current tolling projects in the region that are or will be underway. The group discussed detailed data collection efforts, land use, tolling, and early testing of the model, provided detailed progress updates, and discussed the modeling approach and findings.
- Approximately monthly meetings leading up to the modeling of the SEIS alternatives with technical staff from regional and local partner agencies to summarize modeling efforts and solicit feedback and suggestions on the approach.

In an effort to be transparent and collaborative, raw model data results during screening in advance of the SEIS model runs were shared with technical staff from partner agencies over the course of several months during 2021 and early 2022. While the model results should be considered preliminary, they provide the agency partners with a high-level overview of potential changes in travel patterns.

Both FHWA and the Federal Transit Administration (FTA) have provided feedback and guidance as part of reviews of the materials developed for the Draft SEIS. The IBR team has met with both agencies extensively since the summer of 2023 to update and refine information related to the model and technical work completed to support the findings in the Draft SEIS and supporting materials.

5. REFERENCES

Metro (Oregon Metro). 2017. 2017 Kate v1.0 Trip-Based Travel Demand Model Validation Report for Base Year 2015. See Attachment C.

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Attachment A. 2018 Kate v2.0 Trip-Based Travel Demand Model Methodology Report

2018 Kate v2.0 Trip-Based Travel Demand Model

Methodology Report

May 2020

Metro

Research Center

Jeff Frkonja	Director

Modeling Services

Chris Johnson	Manager I
Cindy Pederson	Manager II
Peter Bosa	Principal Researcher & Modeler
Aaron Breakstone	Principal Researcher & Modeler
Joe Broach	Senior Researcher & Modeler
Kyle Hauger	Senior Researcher & Modeler
Thaya Patton	Senior Researcher & Modeler
Bill Stein	Senior Researcher & Modeler
Maribeth Todd	Senior Researcher & Modeler
Jim Cser	Associate Researcher & Modeler
Bryan Blanc	Assistant Researcher & Modeler

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2017 Kate v1.0 Trip-Based Demand Model

This document summarizes the technical specifications for the travel demand model used in the Portland-Vancouver metropolitan area. It includes descriptions of the model structure, model application, the variables employed in model equations and their coefficients.

This model uses the person trip as the unit of analysis and, as such, does not address the tour-based activity model under development.

On a regular basis, the region's trip-based model is modified to incorporate new data and research findings. Since the last report in 2015, a number of model enhancements have been implemented. The current model offers the following methodological advances:

- All major model components have been re-estimated using data collected in the 2011 Oregon Household Activity Survey (OHAS), Portland and Vancouver area samples.
- The auto and transit access network has been substantially revised. Centroid connector distances are a function of TAZ size, which both improves representation of vehicle-miles driven on local streets and results in median transit walk distances that are consistent with those observed in OHAS. Intra-zonal distances are also a function of zone size and connector lengths rather than the older "nearest neighbor" method.
- TAZ transit coverage factors have been eliminated, and walk access to transit has been added to all non-freeway links. Where previous transit access + egress distances were limited by connector lengths (typically a total of 0.26 miles), walk access + egress is now capped at 1.0 mile, and a new transit mode choice variable discourages trips where out-of-vehicle time exceeds in-vehicle time.
- Walk distance (Wdist) is calculated using the transit access network, which includes pedestrian-only facilities.
- Destination choice logsums now include both travel time and travel cost variables, as well as alternative-specific constants for the available modes to each destination zone.

Features of former models that have been rendered unnecessary by these enhancements include:

- The share of trips by transit from a given TAZ was restricted by transit coverage factors
- Each transit boarding node required a centroid connector. Most transit trips boarded the nearest route, even if walking a few blocks to a more direct route would eliminate a transfer or result in less travel time.

An outline of the document structure is provided below. Most of the document describes the modeling of internal person trips. The flow chart shown in Appendix A gives a visual description of the logic contained in sections B through H. Sections I through K describe models that are independent of the main model structure, although their output is integrated with the main model prior to trip assignment.

- Section A describes the base input data used in all stages of model specification.
- Section B describes pre-generation—the development of household characteristics by TAZ.
- Section C describes the trip generation models for internal person trips by trip purpose.
- Section D describes the multimodal accessibility functions used in the mode choice model.
- Section E describes the destination choice model for internal person trips.
- Section F describes the mode choice model.
- Section G describes the time of day (peaking) factors.
- Section H describes the trip assignment process.
- Section I describes the model for external trips.
- Section J describes the Metro Interim Truck model, used to develop a truck trip table.
- Section K describes the Portland International Airport Model.

A Input Data

Metro's model requires a variety of input data.

A.1 Land Use and Access Measurement Data

A.1.a Socioeconomic and Land Use Data

(For a more complete description**, s**ee *Metro Model Estimation and Application Data*)

The socioeconomic and land use data used in Metro's modeling process are listed below:

- H.I.A. – Sixty-four categories of households are formed when the following characteristics are cross-classified:
  - Household size by four groups (1, 2, 3, 4+)
  - Income class by four groups (< $25K, $25-$50K, $50-$100K, > $100K), 2010 dollars
  - Age of household head by four groups (25<, 25-54,55-64, >65)
- Employment categories
  - Agriculture, Mining, and Forestry
  - Arts, Entertainment, and Recreation
  - Construction
  - Education
  - Food Services and Drinking Places
  - Government
  - Health and Social Services
  - Manufacturing (except high-tech)
  - Manufacturing – High Tech
  - Other Services
  - Professional and Business Services
  - Retail and Consumer Services
  - Transportation, Warehousing, and Utilities
  - Wholesale Trade
- Number of local intersections

A.1.b Accessibility Measure Calculation

The following base accessibility variables are computed for use in the model:

- Number of employees within 30 minutes of transit travel time (includes walk and wait time)
- Households within ½ mile of each zone
- Retail employment within ½ mile of each zone
- Total employment within ½ mile of each zone
- Number of local intersections within ½ mile of each zone

Composite accessibility measures (commonly referred to as "mix" variables) are then developed to account for both the relative magnitudes of and the interactions between three urban design variables known to affect travel behavior. This has an added benefit of eliminating the collinearity problem associated with using these variables individually:

- Household density
- Employment density
- Intersection density (a measure of street connectivity)

Two accessibility variables are computed: one uses retail employment density (MixRet) and the other uses total employment density (MixTot). The household and employment values are normalized to intersection units using geometric means. The natural log is used to transform the variables' units for compatibility with other variables in the auto ownership, multimodal accessibility, and mode choice models. Here is the equation form:

Mix = Ln ((int*(emp*(int.mean / emp.mean)) * (hh*(int.mean / hh.mean))) /
(int + (emp*(int.mean / emp.mean)) + (hh*(int.mean / hh.mean))))

where:

- int = Number of local intersections within ½ mile of each zone
- emp = Retail OR Total employment within ½ mile of each zone
- hh = Households within ½ mile of each zone
- int.mean = Mean int value across all zones
- emp.mean = Mean emp value across all zones
- hh.mean = Mean hh value across all zones

A.1.c Special Trip Generators

Major shopping centers and universities receive special treatment in the generation and distribution models. Due to the unique trip generation characteristics of these locations, the following data are required for each site:

- Shopping center square footage
- College students and staff

A.2 Travel Time Data

Travel time is an important variable in the destination choice and mode choice models.

Door-to-door travel time is used for the model estimation, and zone-to-zone travel time is used for the calibration. Travel time data in this section refer to zone-to-zone travel time.

For all modes but bike and walk, two sets of weekday travel time matrices are developed:

- Peak: A.M. 2-hour peak (07:00-08:59)
- Off-Peak: Mid-day 1-hour (12:00-12:59)

Household survey data are used to estimate the percentage of peak vs. off-peak travel for each trip purpose (except school). These factors determine which proportion of trips experience peak vs. off-peak travel times in the multimodal accessibility functions and mode choice models:

TABLE 1. Peak Factors Applied to Skims in Mode Choice Models

Trip Purpose		Peak Skims	Off-Peak Skims
HBW	Home-Based Work	0.6346	0.3654
HBshop	Home-Based Shopping	0.3390	0.6610
HBrec	Home-Based Recreation	0.3650	0.6350
HBoth	Home-Based Other	0.3853	0.6147
NHBW	Non-Home-Based Work	0.4623	0.5377
NHBNW	Non-Home-Based Non-Work	0.3495	0.6505
HBcoll	Home-Based College	0.4126	0.5874

A.2.a Auto Skims

Auto skims are prepared using the results of previous Emme assignments.

A.2.b Transit Skims

The peak and off-peak transit skims account for differences in levels of transit service and network congestion. Six transit impedance matrices are developed for each time period:

- In-vehicle time by transit sub-mode
- Walk time
- First wait time
- Transfer wait time
- Number of total boardings
- Number of transfer boardings

Boarding time is calculated as the time equivalent of the coefficient on the number of transfers, with the resulting value of 7.5 minutes applied universally.

For model application, wait times are modeled at 50% of headway. Timed transfer locations receive no special consideration.

Initial wait time, and total accumulated transfer wait time each have a maximum value of 30 minutes. This means that no zone pair with transit access (see Section F) has more than 30 minutes initial wait time or 30 minutes transfer wait time.

Transit is not available for trips between zone pairs where more than 20 minutes' total access and egree walking time is required.

The walk and wait time weights used in the demand model are identical to those applied in pathfinding:

- Transit skim wait time weight: 1.6
- Transit skim auxiliary transit (walk) time weight: 2.76

For each zone pair, in-vehicle time skims are prepared by transit mode; in the case of multimodal journeys and/or path sets, these values represent the individual mode's constituent portion of total in-vehicle time.

A.3 Trip Cost Data

Travel cost is an input to the mode choice model. All cost values are in 2010 dollars.

A.3.a Auto Operating Cost

Auto operating cost varies by mode:

- Drive Alone = ($0.2138 / mile*distance) + (½ of parking charge in attraction zone)
- Shared Ride Driver = [($0.2138 / mile*distance) + (½ of parking charge in attraction zone)] * .667
- Shared Ride Passenger = [($0.2138 / mile*distance) + (½ of parking charge in attraction zone)] * .333
- Park and Ride = $0.2139 / mile*distance (between production zone and lot)

A.3.b Parking Charges

The parking charge used as an input to auto cost varies by trip purpose:

- Home-based work (HBW) and home-based college (HBcoll) use long-term parking charge.
- Other trip purposes use short-term parking charge (½ of long-term parking charge).

A.3.c Transit Fare

Transit fares are based on the average fares charged by the region's transit providers in May 2010. Average fares for all transit providers providing a transit pass option were estimated at 73% of the cash fare price, which is the 2010 ratio for TriMet.

- TriMet
  - Travel within CBD-Lloyd District Free Rail Zone : $0
  - All other travel: $1.678
- C-Tran
  - For intra-Clark County service : $1.095
  - For Clark County-North/Northeast Portland: $1.716
  - For Clark County-Portland premium service: $2.190
    - 2010-2017: to Portland CBD, Lloyd District, Marquam Hill
    - 2018 and beyond: to Marquam Hill only
- Sandy Area Metro (SAM)
  - For Sandy-Rhododendron service: $1.460
- SMART
  - For Wilsonville-Portland service: $2.591
- South Clackamas Transportation District (SCTD)
  - For Molalla-Portland service: $2.678
  - For Molalla-Clackamas Community College service: $1.000

A.4 Transportation Service Inputs

Various transportation service inputs are applied at different stages in the model:

- Average weekday volumes at external station locations
- Household transit coverage factor by TAZ for both the peak and off-peak periods: percent of the households within a zone that are within 0.2 miles of a bus stop or 0.5 miles of a rail station (straight line distances)
- Employment transit coverage factor by TAZ for both the peak and off-peak periods: percent of the jobs within a zone that are within 0.2 miles of a bus stop or 0.5 miles of a rail station (straight line distances)
- Park-and-ride lot locations, capacities, and types

B Pre-Generation

Several models must be run before starting the travel demand process. This stage is called pre-generation and includes the worker model, the auto ownership model, and the children model.

These models were estimated using a multinomial logit procedure. The listed utilities are converted into probabilities to determine the number of workers, cars, and children in each TAZ. The following example probability is used for zero-worker households:

$$Prob_{0\text{-worker HH}} = U_{0\text{-workerHH}} \;/\; (U_{0\text{-workerHH}} + U_{1\text{-workerHH}} + U_{2\text{-workerHH}} + U_{3\text{-workerHH}})$$

B.1 Worker Model

The worker model estimates the number of households with 0, 1, 2, and 3 or more workers.

B.1.a Variable Definitions

HHsize	=	1 person, 2 person, 3 person, 4+ person
Workercl	=	0 worker, 1 worker, 2 worker, 3+ worker
Income1	=	1 if 2010 household income < $25,000
Income2	=	1 if 2010 household income >= $25,000 and < $50,000
Income3	=	1 if 2010 household income >= $50,000 and < $100,000
Income4	=	1 if 2010 household income >= $100,000
Agecat1	=	1 if age of household head 18-24
Agecat2	=	1 if age of household head 25-54
Agecat3	=	1 if age of household head 55-64
Agecat4	=	1 if age of household head >=65

B.1.b Calibrated Choice Utilities

Constants may differ from the original estimation due to the calibration process. These coefficients are the same as in the calibration code.

0 worker households

U = **exp (**8.1802 – 2.1436*HHsize + 6.1394*Income1 + 3.0767*Income2 + 0.9966*Income3 – 6.4436*Agecat1 – 3.7234*Agecat2 – 3.4183*Agecat3 **)**

1 worker households

U = **exp (** 7.2623– 1.8731*HHsize + 3.7194*Income1 + 2.2650*Income2 + 0.7563*Income3 –2.9635*Agecat1 – 0.4402*Agecat2 – 1.3386*Agecat3 **)**

2 worker households

U = **exp (** 5.3724 – 1.2747*HHsize + 1.2257*Income1 + 0.7633*Income2 + 0.2345*Income3 - 0.7721*Agecat1+ 0.6739* Agecat2 – 0.4320*Agecat3 **)**

3+ worker households

U = **exp (** 0 **)**

B.1.c Estimated Variable Coefficients

TABLE 2. Worker Model

Variable	**0 worker**		**1 worker**		**2 worker**	
	Coefficient	Z-Statistic	Coefficient	Z-Statistic	Coefficient	Z-Statistic
Calib Constant	*7.9*		*6.99*		*5.315*	
Constant	8.1802	43.3	7.2623	40.1	5.3724	29.6
HHsize	-2.1436	-50.8	-1.8731	-48.1	-1.2747	-34.1
Income1	6.1394	30.4	3.7194	19.1	1.2257	6.2
Income2	3.0767	28.8	2.2650	24.3	0.7633	8.3
Income3	0.9966	12.9	0.7563	13.3	0.2345	4.4
Agecat1	-6.4436	-32.1	-2.9365	-16.1	-0.7721	-4.1
Agecat2	-3.7234	-27.7	-0.4402	-3.4	0.6739	5.1
Agecat3	-3.4183	--24.3	-1.3386	-9.7	-0.4320	-3.1

The worker model was estimated from 2012_5yr PUMS for the 4-county region. The 3+ worker choice utility is held constant at zero. Income4 and Agecat4 are the reference categories for Income and Agecat

B.2 Auto Ownership Model

Auto ownership is an important input to the mode choice models.

The model estimation dataset includes all (OHAS) surveyed households that reported income and whose locations could be geocoded.

B.2.a Variable Definitions

Hhsize1 = 1 person
Hhsize2 = 2 person
Hhsize3 = 3 person
Hhsize4 = 4+ person
Worker0 = 0 worker
Worker1 = 1 worker
Worker2 = 2 worker
Worker3 = 3+ worker
Income = 1 if 2010 household income < $25,000
= 2 if 2010 household income >= $25,000 and < $50,000
= 3 if 2010 household income >= $50,000 and < $100,500
= 4 if 2010 household income >= $100,000
SFPC = Percentage of TAZ dwellings that are single-family detached units
logMIXTHM = LN (Total employment accessibility within ½ mile + 1) (see Section A.1.b)
Tot30Tk = (Total employment within 20 minutes by mid-day transit) /1000

B.2.b Calibrated Choice Utilities

0 car households

U = **exp** (-3.0278 + 4.9228*h1w0 + 3.8632*h1w1 + 1.6074*h2w0 +0.9721*h2w1 +0.7961*h2w2 +2.6325*h3w0 +0.75*h3w1 +0.4637*h3w2 +h4w0 + 0.5*h4w1 +0.25*h4w2 - 1.6745 * income - 2.0721*sfpc + 0.0169*Tot30Tk + 0.4233*logMIXTHM)

1 car households

U = **exp** (-1.4954 + 6.3568*h1w0 + 5.9245*h1w1 + 4.0594*h2w0 + 3.4905*h2w1 + 2.9585*h2w2 + 3.4712*h3w0 + 3.5113*h3w1 + 2.6011*h3w2 + 2.6011*h3w3 + 2.8079*h4w0 + 3.2346*h4w1 + 2.8861*h4w2 - 0.8833*income -1.5633*sfpc + 0.0102*TOT30Tk + 0.2223*logMIXTHM)

2 car households

U = **exp**(-1.8268 + 2.7548*h1w0 + 2.3944*h1w1 + 2.5439*h2w0 + 2.0346*h2w1 + 1.8537*h2w2 + 2.0169*h3w0 + 1.7867*h3w1 + 1.5335*h3w2 + 0.7326*h3w3 + 1.2802*h4w0 + 2.2461*h4w1 + 2.0506*h4w2 - 0.1749*income + 0.0038*TOT30Tk + 0.1544*logMIXTHM)

3+ car households

U = **exp (** 0 **)**

B.2.c Estimated Variable Coefficients

TABLE 3. Auto Ownership Model

Variable	0 car		1 car		2 car	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	*-3.0278*		*-1.4954*		*-1.8268*	
Constant	-1.3028	-1.63	-1.4954	-1.82	-1.8268	-3.87
HHsize1:Wkr0	4.9228	9.00	6.3568	8.36	2.7548	6.95
HHsize1:Wkr1	3.8632	7.17	5.9245	7.96	2.3944	6.94
HHsize2:Wkr0	1.6074	2.85	4.0594	5.58	2.5439	8.65
HHsize2:Wkr1	0.9721	1.75	3.4905	4.82	2.0346	7.25
HHsize2:Wkr2	0.7961	1.28	2.9585	4.08	1.8537	6.80
HHsize3:Wkr0	2.6325	3.58	3.4712	4.35	2.0169	4.84
HHsize3:Wkr1	0.7500	fixed	3.5113	4.49	1.7867	5.28
HHsize3:Wkr2	0.4637	0.96	2.6011	3.48	1.5335	5.38
HHsize3:Wkr3	--	na	2.6011	3.48	0.7326	1.93
HHsize4:Wkr0	1.0000	fixed	2.8079	3.30	1.2802	2.16
HHsize4:Wkr1	0.5000	fixed	3.2346	4.34	2.2461	7.33
HHsize4:Wkr2	0.2500	fixed	2.8861	3.90	2.0506	7.39
Income	-1.6745	-12.72	-0.8833	-10.36	-0.1749	-2.50
SFPC	-2.0721	-5.23	-1.5633	-6.06	--	na
Tot30Tk	0.0169	7.24	0.0102	5.52	0.0038	2.39
logMIXTHM	0.4233	5.13	0.2223	5.34	0.1544	4.64

The 3+ car choice utility is held constant at zero. HHSize4:Wkr3 is the reference category for Size x Wkr

While the Worker and Children models use only HIA demographic inuts, Auto Ownership is influenced by changes in land use and transit LOS.

B.3 Children Model

The school trip purpose requires the calculation of the number of households with 0, 1, 2, or 3+ children.

B.3.a Variable Definitions

HHsize = 1 person, 2 person, 3 person, 4+ person
Age4 = 1 if age of household head 18-24
= 2 if age of household head 25-54
= 3 if age of household head 55-64
= 4 if age of household head >=65

B.3.b Calibrated Choice Utilities

This model was not changed in calibration.

0 child households

U = **exp (**-4.069012*HHsize + 6.922379*Age4 **)**

1 child households

U = **exp** (-2.425297*HHsize +4.598579 *Age4 **)**

2 child households

U = **exp** (-0.6128247*HHsize + 1.639239*Age4 **)**

3+ child households

U = **exp (** 0 **)**

B.3.c Estimated Variable Coefficients

TABLE 4. Children Model

Variable	0 child		1 child		2 child	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
HHsize	-4.069012	-24.3	-2.425297	-15.5	-0.6128247	-4.0
Agecat4	6.922379	22.8	4.598579	15.5	1.639239	5.5

The 3+ child choice utility is held constant at zero.

C Trip Generation

Average weekday person trips are generated for eight trip purposes:

- HBW – Home-Based Work
- HBshop – Home-Based Shopping
- HBrec – Home-Based Recreation
- HBoth – Home-Based Other (excludes school and college)
- NHBW – Non-Home-Based Work
- NHBNW – Non-Home-Based Non-Work
- HBcoll – Home-Based College
- HBsch – Home-Based School

For each zone, the number of households in each demographic category is multiplied by a production rate. The number of trips is then factored up to match regional control totals by applying a calibration factor which varies by purpose. The demographic categories, production rates, and calibration factors are described by purpose in the following subsections.

Most home-based trips are generated by production zone in the two steps described above, then they are attached to an attraction zone within the destination choice models. Non-home-based trips add an extra step within generation: the allocation of trip productions to zones according to the non-home TAZs where they actually occur. NHBW trip productions are allocated to workplace TAZ's, while NHBNW trip productons are allocated to place of trip origin. Finally, school and college generation models incorporate trip attraction, whereas the other purposes address attraction through the destination choice models.

C.1 HBW (Home-Based Work)

C.1.a Productions

HBW trips are produced solely by the number of workers in a household:

- Input Variable: Number of workers
- Output: Person trips (all modes), by zone of production (home)

TABLE 5. HBW Production Rates

Workers	Rate
1	1.386047
2	2.462282
3+	3.578358

C.1.b Attractions

HBW trip attractions are estimated by the following procedure:

- A regional average trip rate per employee is generated by dividing the sum of HBW productions by total employees.
- Trip attractions are generated by multiplying the average trip rate by the total employment in each TAZ.

C.1.c Scaling

Final HBW trips are generated by the following procedure:

- Total employment (multiplied by a calibration factor of 1.36) is divided by total productions to produce a production factor.
- Final HBW trips are calculated by multiplying the number of productions in each TAZ by the production factor.

C.2 HBshop (Home-Based Shopping)

HBshop productions are generated by a cross-classification model:

- Input Variables: Household size, Number of workers
- Output: Person trips (all modes), by zone of production (home)

TABLE 6. HBshop Production Rates

	Workers			
HHsize	**0**	**1**	**2**	**3+**
1	0.5889655	0.3597194		
2	1.02852	0.7578216	0.6313181	
3	1.371429	1.121711	0.9657534	0.8703704
4+	1.847826	1.260241	0.9130435	1.14375

The resulting trips are multiplied by a calibration factor of 1.025.

C.3 HBrec (Home-Based Recreation)

HBrec productions are generated by a cross-classification model:

- Input Variable: Household size by worker status
- Output: Person trips (all modes), by zone of production (home)

TABLE 7. HBrec Production Rates

HHsize	**all household members work**	**some household members do not work**
1	0.1783567	0.2772414
2	0.4122894	0.5582865
3	0.5462963	0.7933884
4+		1.43126

The resulting trips are multiplied by a calibration factor of 1.025.

C.4 HBoth (Home-Based Other)

HBoth productions are generated by a cross-classification model:

- Input Variable: Household size by worker status
- Output: Person trips (all modes), by zone of production (home)

TABLE 8. HBoth Production Rates

HHsize	all household members work	some household members do not work
1	0.6723447	1.187586
2	1.421209	2.076545
3	1.916667	2.613932
4+		4.027823

The resulting trips are multiplied by a calibration factor of 1.025.

C.5 NHBW (Non-Home-Based Work)

Production of non-home-based trips in trip-based models takes place in two steps. First, household trip generation rates are used to determine how many trips are produced regionally. Then, those productions are spatially allocated to where they actually originate. A set of TAZ allocation weights were estimated using transposed destination choice (i.e., "origin choice") models with TAZ size variables only.

C.5.a Production Totals

Total NHBW productions are initially generated solely by number of workers in the household:

- Input Variable: Number of workers
- Output: Person trips (all modes), regional control totals

TABLE 9. NHBW Household Production Rates

Workers	Rate
0	0.107864
1	0.835659
2	1.723404
3+	2.33209

The resulting trips are multiplied by a calibration factor of 1.025.

C.5.b Production Spatial Allocation

NHBW Productions are allocated to TAZ's using the following production allocation weights shown in Table 10. Total regional productions are scaled to control totals obtained from household productions above. See Section (xxxx) for a description of employment sectors used here and in the Destination Choice models.

TABLE 10. NHBW Production Allocation Weights

TAZ Variable	Coefficient	T-Statistic
AMF,FDS,RCS	1	*(fixed)*
CON,EDU,OSV	4.2631	*9.24*
TWU,PBS	3.2544	*7.70*
WT,MFG,MHT	2.5396	*6.28*
AER,HSS,GOV	1.9232	*4.46*
households	0.3362	*-5.51*

C.6 NHBNW (Non-Home-Based Non-Work)

C.6.a Pre-Production

NHBNW productions are initially estimated by a cross-classification model:

- Input Variables: Household size by worker status
- Output: Person trips (all modes), regional control totals

TABLE 10. NHBNW Production Rates

HHsize	all household members work	some household members do not work
1	0.511022	1.165517
2	0.9187314	1.651685
3	1.425926	1.956316
4+		3.161211

The resulting trips are multiplied by a calibration factor of 1.025.

C.6.b Production Spatial Allocation

NHBNW Productions are allocated to TAZ's using the following production allocation weights shown in Table 12. Total regional productions are scaled to control totals obtained from household productions above. See Section (xxxx) for a description of employment sectors used here and in the Destination Choice models.

TABLE 12. NHBNW Production Allocation Weights

TAZ Variable	Coefficient	T-Statistic
Othser	1.0000	*fixed*
FoodSv	0.4253	*-12.89*
Retcns	0.3263	*-20.00*
Agrfrm	0.2060	*-7.56*
Educat	0.1901	*-25.32*
Areart	0.1604	*-9.05*
Constr	0.1249	*-13.62*
Health	0.0429	*-28.40*
Govmnt	0.0255	*-22.47*
Tranwu	0.0185	*-8.28*
Probns	0.0106	*-11.96*
Wholes	0.0085	*-8.79*
MHitec	0.0005	*-3.71*
Mfacrt	0.0005	*-3.71*

C.7 HBcoll (Home-Based College)

C.7.a Productions

HBcoll productions are generated by a cross-classification model:

- Input Variables: Household size, Age group (age of household head)
- Output: Person trips (all modes), by zone of production (home)

TABLE 11. HBcoll Production Rates

	Age Group			
Hhsize	**<25**	**25-54**	**55-64**	**>65**
1	0.5384615	0.0473684	0.0059761	0.007837
2	0.375	0.1138107	0.0289079	0.0183357
3	0.6666667	0.1226576	0.1610487	0.1413043
4+	0.8333333	0.1359852	0.468254	0.2758621

The resulting trips are multiplied by a calibration factor of 1.5

Note that HBColl productions apply to households only, since group quarters (e.g., dormitories, fraternities) were not surveyed.

C.8 HBsch (Home-Based School)

HBsch productions are generated by a cross-classification model using the combined Portland-Vancouver-Salem-Eugene samples of the 2011 OHAS. HBSchool person-trips include both students and adult escorts for the home-to-school and school-to-home trip.

- Input Variables: Household size, Number of children
- Output: Person trips (all modes), by zone of production (home)

TABLE 12. HBsch Production Rates

	Children			
HHsize	**0**	**1**	**2**	**3+**
1	--	--	--	--
2	--	1.978448	--	--
3	--	1.84793	3.326389	--
4+	--	2.248879	3.441193	5.103783

D Multimodal Accessibility Functions

Modal accessibility functions were estimated for use in the destination choice model. For each trip purpose, they measure the utility of choosing one of seven discrete modes:

Drive alone – only available to households with at least one car
Drive with passenger – only available to households with at least one car
Auto passenger
Transit by walk access – only available if both trip ends are within either 0.2 miles of a bus stop or 0.5 miles of a rail station
Transit by park-and-ride access – only available if destination trip end is within 0.2 miles of a bus stop or 0.5 miles of a rail station; only available for home-based non-school trips; utilities and lot usage for formal park-and-ride lots and informal park-and-ride locations are calculated by a nested park-and-ride lot choice model
Bike – utilities and distances are produced by a stand-alone tool based on a dedicated bicycle network
Walk – only available for trips with a distance less than five miles

The logsum of all modal utilities is a key input to the destination choice model (Section E). It is generated as follows for each trip purpose (and for some purposes, by income group):

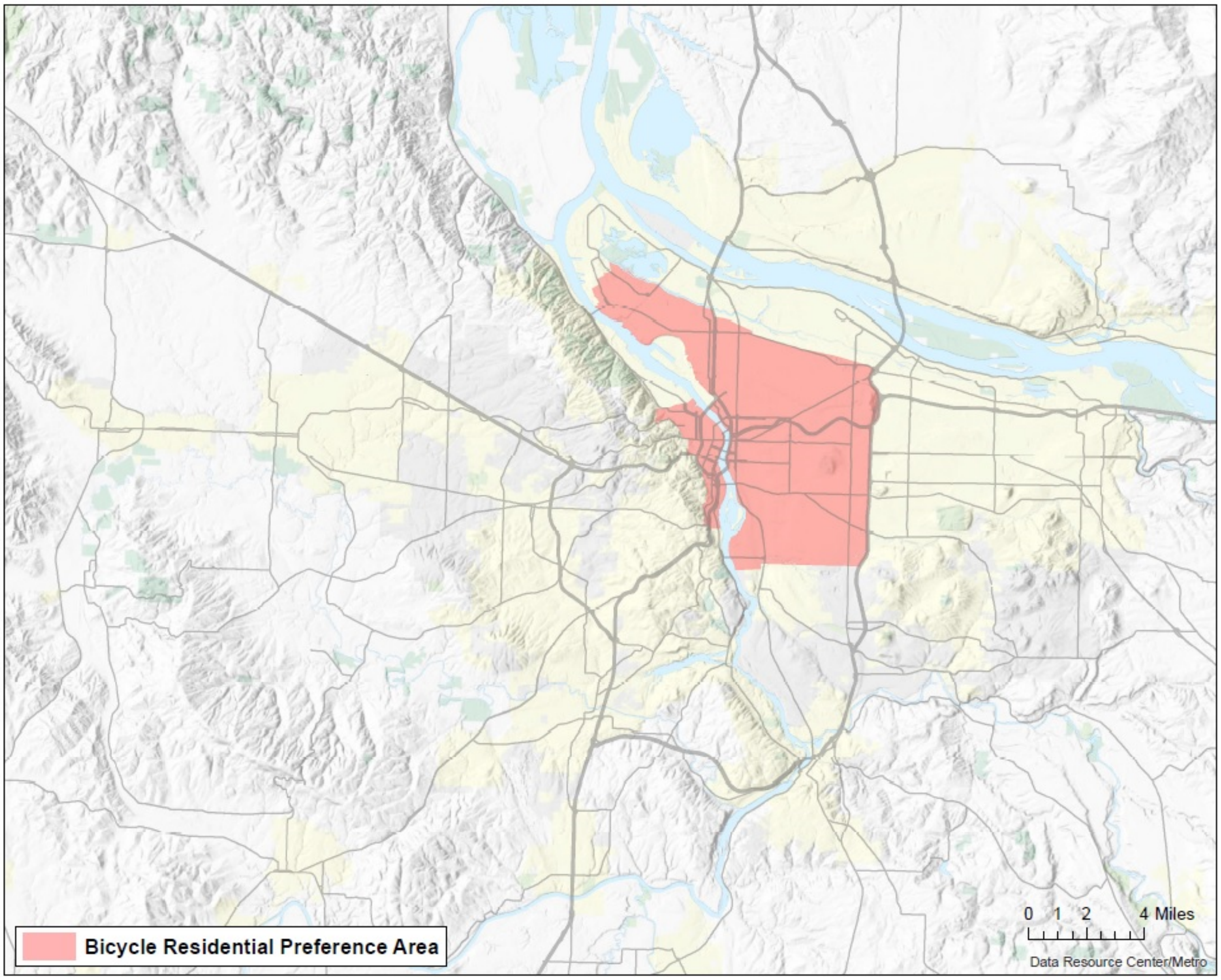
$$\mathbf{Ln}\ (\ U_{\text{Drive Alone}} + U_{\text{Drive with Passenger}} + U_{\text{Auto Passenger}} + U_{\text{Walk to Transit}} + U_{\text{Park\&Ride}} + U_{\text{Bike}} + U_{\text{Walk}}\ )$$

D.1 Variables Used in Multimodal Accessibility Functions

D.1.a Variable Definitions

IvTime	=	In-vehicle travel time (minutes, varies by mode)
WalkTime	=	Walk time (minutes), by mode: Drive Alone: vehicle egress at trip end (5 min in CBD, 2 min elsewhere) Shared Ride: Drive Alone walk time plus 5 minutes Transit Modes: access to first stop plus egress from last stop at 3 mph Walk: zone-to-zone time via key walk-accessible links at 3 mph (for trips < 5 miles)
TranWait1	=	Transit initial wait time (minutes)
TranWait2	=	Transit transfer wait time (minutes)
TranModc	=	Transit mode constant (varies by transit path)
TranStypc	=	Transit stop type constant (varies by transit path)
TranXfrs	=	Transit # of transfers
TrOVIV	=	ratio of total out-of-vehicle time to in-vehicle time
Formal	=	1 if considering formal park-and-ride lots
Informal	=	1 if considering informal park-and-ride locations
Shadow	=	Park-and-ride lot shadow cost (calculated by lot choice model)
BikeDist	=	Bicycle trip distance (miles)
Cbutil	=	Bicycle commute route attractiveness
Nbutil	=	Bicycle non-commute route attractiveness
BikeResPref	=	1 if production zone in bicycle user residential preference area (see Figure 1)
LowInc	=	1 if household income <$25K (2010$)
MidInc	=	1 if household income $25-100K (2010$)
HighInc	=	1 if household income $100K+ (2010$)
OpCost	=	Out-of-pocket cost, by mode: Drive Alone: 100% of $0.211 / mile (2010$) Drive with Passenger: 66.7% of $0.211 / mile (2010$) Auto Passenger: 33.3% of $0.211 / mile (2010$) Walk-access Transit: transit fare (2010$) Park-and-ride: $0.211 / mile for auto leg, transit fare for transit leg
PkgCost	=	Parking cost, by mode: Drive Alone: 100% of long-term parking charge in attraction zone Drive with Passenger: 66.7% of long-term parking charge in attraction zone Auto Passenger: 33.3% of long-term parking charge in attraction zone

FIGURE 1. Bicycle User Residential Preference Area



D.2 HBW (Home-Based Work)

D.2.a Peak / Off-Peak Weights

HBW: 63.46% peak skims, 36.54% off-peak skims

D.2.b Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost**)**

Drive with Passenger

U = **exp (-**3.21 – 0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost**)**

Auto Passenger

U = **exp (-**3.49 – 0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost**)**

Transit by Walk Access

U = **exp (**0.00258 + TranModc + TranStypc – 0.0414*IvTime – 0.0543*TranWait1 – 0.061*TranWait2 – 0.1*WalkTime – 0.16*TranXfrs – 0.4*TrIVOV – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

$$U = \mathbf{exp}\,(1.85 + 0.75*\mathbf{ln}(\mathbf{exp}(Formal*0.5*\mathbf{ln}(\textstyle\sum_{1\to N} [\mathbf{exp}((U_{AutoLeg} + U_{TransitLeg} + Shadow) / (0.5*0.75))]\,)) + \mathbf{exp}(Informal*0.5*\mathbf{ln}(\textstyle\sum_{1\to N} [\mathbf{exp}((-4.5 + U_{AutoLeg} + U_{TransitLeg} + Shadow) / (0.5*0.75))]\,))\,)$$

where

$U_{AutoLeg}$ = -0.03608*2*IvTime – 0.6587*LowInc*OpCost – 0.6097*MidInc*OpCost – 0.4029*HighInc*OpCost

and

$U_{TransitLeg}$ = -0.03608*($IvTime_{Bus}$ + 0.88*$IvTime_{LRT}$ + $IvTime_{SC}$ + 0.88*$IvTime_{Rail}$) – 0.0576*TranWait1 – 0.04002*TranWait2 – 0.09956*WalkTime – 0.3*TranXfrs – 0.6587*LowInc*OpCost – 0.6097*MidInc*OpCost – 0.4029*HighInc*OpCost

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-1.81 – 0.25*BikeDist + 0.0636*Cbutil + 1.35*BikeResPref **)**

Walk

U = **exp (**-0.0511 **–** 0.1*WalkTime**)**

D.2.c Estimated Variable Coefficients

TABLE 13. HBW Multimodal Accessibility Functions – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-3.21			
Constant			-3.27		-3.49	
IvTime	-0.0414	*-4.74*	-0.0414	*-4.74*	-0.0414	*-4.74*
Calib WalkTime	*-0.1*		*-0.1*		*-0.1*	
WalkTime	-0.0791	-14.01	-0.0791	-14.01	-0.0791	-14.01
LowIncOpCost	-0.309	-2.83	-0.309	-2.83	-0.309	-2.83
MidIncOpCost	-0.252	-6.34	-0.252	-6.34	-0.252	-6.34
HighIncOpCost	-0.252	-6.34	-0.252	-6.34	-0.252	-6.34
LowIncPkgCost	-0.509	-13.53	-0.509	-13.53	-0.509	-13.53
MidIncPkgCost	-0.509	-13.53	-0.509	-13.53	-0.509	-13.53
HighIncPkgCost	-0.461	-11.65	-0.461	-11.65	-0.461	-11.65

TABLE 14. HBW Multimodal Accessibility Functions – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	0.00258		*1.85*	
Constant	-0.195		-6.504	-7.3
Ivtime	-0.0414	*-4.74*	-0.03608	-6.3
Wait1	-0.0543	-3.69	-0.0576	-5.8
Wait2	-0.061	-4.66	-0.04002	-5.2
Calib WalkTime	*-0.1*			
WalkTime	-0.0791	-14.01	-0.09956	-9.7
Transfers	-0.16	*fixed*	-0.3	*fixed*
Calib TrIVOV	*-0.4*			
TrIVOV	-0.0519	-2.65		
LowIncOpCost	-0.309	-2.83	-0.6587	-9.5
MidIncOpCost	-0.252	-6.34	-0.6097	-12.1
HighIncOpCost	-0.252	-6.34	-0.4029	-7.1
Nested Park & Ride Lot Choice Model				
Informal Constant			-5.0	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 15. HBW Multimodal Accessibility Functions – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-1.81		-0.0511	
Constant	-1.71		-0.157	
Calib BikeDist	-0.25			
BikeDist	-0.215	-6.19		
Cbutil	-0.0636	2.92		
Calib BikeResPref	1.35			
BikeResPref	0.5	*fixed*		
Calib WalkTime			-0.1	
WalkTime			-0.0791	-14.01

D.3 HBshop, HBrec, HBoth (Other Home-Based)

D.3.a Peak / Off-Peak Weights

HBshop: 33.9% peak skims, 66.1% off-peak skims
HBrec: 36.5% peak skims, 63.5% off-peak skims
HBoth: 38.53% peak skims, 61.47% off-peak skims

D.3.b Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost**)**

Drive with Passenger

U = **exp (**-1.06*Shop – 0.703*Rec – 0.517*Oth -0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost**)**

Auto Passenger

U = **exp (**-1.65*Shop – 1.54*Rec – 1.5*Oth -0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost**)**

Transit by Walk Access

U = **exp (**1.32*Shop + 0.775*Rec + 0.844*Oth + TranModc + TranStypc – 0.0315*IvTime – 0.05*TranWait1 – 0.05*TranWait2 – 0.125*WalkTime – 0.16*TranXfrs – 1*TrIVOV – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

U = **exp (**-3.1*Shop – 2*Rec – 2.2*Oth + 0.75***ln**(**exp**(Formal*0.5***ln**($\sum_{1\rightarrow N}$ [**exp**(($U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) + **exp**(Informal*0.5***ln**($\sum_{1\rightarrow N}$ [**exp**((-4 + $U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) **)**

where

$U_{AutoLeg}$ = -0.0215*2*IvTime – 0.4724*LowInc*OpCost – 0.2457*MidInc*OpCost – 0.2457*HighInc*OpCost

and

$U_{TransitLeg}$ = -0.0215*(IvTime$_{Bus}$ + 0.86*IvTime$_{LRT}$ + IvTime$_{SC}$ + 0.86*IvTime$_{Rail}$) – 0.06847*TranWait1 – 0.0524*TranWait2 – 0.1033*WalkTime – 0.3*TranXfrs – 0.4724*LowInc*OpCost – 0.2457*MidInc*OpCost – 0.2457*HighInc*OpCost

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-1.92*Shop – 1.61*Rec – 2.31*Oth – 0.223*BikeDist + 0.199*Nbutil + 1.03*BikeResPref**)**

Walk

U = **exp (**-0.197*Shop + 0*Rec + 0*Oth – 0.125*WalkTime**)**

D.3.c Estimated Variable Coefficients

TABLE 16. HBshop, HBrec, HBoth Multimodal Accessibility Functions – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Shop			-1.06		-1.65	
Calib Rec			-0.703		-1.54	
Calib Oth			-0.517		-1.5	
Shop			-1.24		-1.88	
Rec			-0.766		-1.29	
Oth			-0.628		-1.46	
IvTime	-0.0315	*-2.16*	-0.0315	*-2.16*	-0.0315	*-2.16*
Calib WalkTime	-0.125		-0.125		-0.125	
WalkTime	-0.0906	-27.55	-0.0906	-27.55	-0.0906	-27.55
LowIncOpCost	-0.255	*-7.47*	-0.255	*-7.47*	-0.255	*-7.47*
MidIncOpCost	-0.255	*-7.47*	-0.255	*-7.47*	-0.255	*-7.47*
HighIncOpCost	-0.174	*-3.99*	-0.174	*-3.99*	-0.174	*-3.99*
LowIncPkgCost	-0.731	*-3.1*	-0.731	*-3.1*	-0.731	*-3.1*
MidIncPkgCost	-0.393	*-5.2*	-0.393	*-5.2*	-0.393	*-5.2*
HighIncPkgCost	-0.393	*-5.2*	-0.393	*-5.2*	-0.393	*-5.2*

TABLE 17. HBshop, HBrec, HBoth Multimodal Accessibility Functions – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic

Calib Shop	1.32		-3.1	
Calib Rec	0.775		-2	
Calib Oth	0.844		-2.2	
Shop	0.91		-7.023	-3.8
Rec	1.01		-7.023	-3.8
Oth	0.615		-7.023	-3.8
IvTime	-0.0315	*-2.16*	-0.0215	-3.2
Calib TranWait1	-0.05			
TranWait1	-0.0824	-4.7	-0.06847	-5.4
Calib TranWait2	-0.05			
TranWait2	-0.074	-4.42	-0.0524	-4.8
Calib WalkTime	-0.125			
WalkTime	-0.0906	-27.55	-0.1033	-8.3
TranXfrs	-0.16	*fixed*	-0.3	*fixed*
Calib TrIVOV	-1			
TrIVOV	-0.121	*-3.11*		
LowIncOpCost	-0.255	*-7.47*	-0.4724	-6.8
MidIncOpCost	-0.255	*-7.47*	-0.2457	-5.2
HighIncOpCost	-0.174	*-3.99*	-0.2457	-5.2
Nested Park & Ride Lot Choice Model				
Informal Constant			-4.5	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 18. HBshop, HBrec, HBoth Multimodal Accessibility Functions – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Shop	-1.92		-0.197	
Calib Rec	-1.61		0	
Calib Oth	-2.31		0	
Shop	-2.09		-0.0767	
Rec	-1.18		1.02	
Oth	-2.18		0.208	
Calib BikeDist	-0.223			
BikeDist	-0.233	-5.38		
Nbutil	0.199	7.88		
Calib BikeResPref	1.03			
BikeResPref	0.5	*fixed*		
Calib WalkTime			-0.125	
WalkTime			-0.0906	-27.55

D.4 NHBW (Non-Home-Based Work)

D.4.a Peak / Off-Peak Weights

NHBW: 46.23% peak skims, 53.77% off-peak skims

D.4.b Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Drive with Passenger

U = **exp (**-2.45 – 0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Auto Passenger

U = **exp (**-3.03 – 0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Transit by Walk Access

U = **exp (**0.759 + TranModc + TranStypc – 0.0452*IvTime – 0.118*TranWait1 – 0.118*TranWait2 – 0.157*WalkTime – 0.16*TranXfrs – 0.194*OpCost – 1*TrOVIV**)**

Bike

U = **exp (**-3.33 **–** 0.22*BikeDist + 0.0841*Nbutil + 1.13*BikeResPref **)**

Walk

U = **exp (**0 – 0.157*WalkTime**)**

D.4.c Estimated Variable Coefficients

TABLE 19. NHBW Multimodal Accessibility Functions – Auto Modes

Variable	**Drive Alone**		**Drive with Passenger**		**Auto Passenger**	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-2.45		-3.03	
Constant			-2.43		-2.99	
IvTime	-0.0452	-2.49	-0.0452	-2.49	-0.0452	-2.49
WalkTime	-0.157	-16.7	-0.157	-16.7	-0.157	-16.7
OpCost	-0.194	-3.33	-0.194	-3.33	-0.194	-3.33
PkgCost	-0.557	-5.41	-0.557	-5.41	-0.557	-5.41

TABLE 20. NHBW Multimodal Accessibility Functions – Transit Modes

Variable	Walk Access	
	Coefficient	T-Statistic
Calib Constant	0.759	
Constant	0.813	
IvTime	-0.0452	-2.49
TranWait1	-0.118	-5.07
TranWait2	-0.118	-5.07
WalkTime	-0.157	-16.7
TranXfrs	-0.16	*fixed*
OpCost	-0.192	-3.33
Calib TrIVOV	-1	
TrIVOV	0	*fixed*

TABLE 21. NHBW Multimodal Accessibility Functions – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-3.33		0	
Constant	-3.21		0.306	
BikeDist	-0.22	-4.06		
Nbutil	0.0841	1.98		
Calib BikeResPref	1.13			
BikeResPref	0.5	*fixed*		
WalkTime			-0.157	-16.7

D.5 NHBNW (Non-Home-Based Non-Work)

D.5.a Peak / Off-Peak Weights

NHBNW: 34.95% peak skims, 65.05% off-peak skims

D.5.b Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Drive with Passenger

U = **exp (**-0.379 – 0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Auto Passenger

U = **exp (**-1.33 – 0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Transit by Walk Access

U = **exp (**0.329 + TranModc + TranStypc – 0.0278*IvTime – 0.0781*TranWait1 – 0.0841*TranWait2 – 0.125*WalkTime – 0.16*TranXfrs – 1*TrIVOV – 0.15*OpCost**)**

Bike

U = **exp (**-2.76 **–** 0.453*BikeDist – 0.13*Nbutil + 1.13*BikeResPref**)**

Walk

U = **exp (**-0.438 – 0.125*WalkTime**)**

D.5.c Estimated Variable Coefficients

TABLE 22. NHBNW Multimodal Accessibility Functions – Auto Modes

Variable	**Drive Alone**		**Drive with Passenger**		**Auto Passenger**	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-0.379		-1.33	
Constant			-0.492		-1.37	
IvTime	-0.0278	-1.63	-0.0278	-1.63	-0.0278	-1.63
Calib WalkTime	-0.125		-0.125		-0.125	
WalkTime	-0.0886	-14.68	-0.0886	-14.68	-0.0886	-14.68
OpCost	-0.15	-2.94	-0.15	-2.94	-0.15	-2.94
PkgCost	-0.335	-5.91	-0.335	-5.91	-0.335	-5.91

TABLE 23. NHBNW Multimodal Accessibility Functions – Transit Modes

Variable	**Walk Access**	
	Coefficient	T-Statistic
Calib Constant	0.329	
Constant	0.0253	
IvTime	-0.0278	-1.63
TranWait1	-0.0781	-2.85
TranWait2	-0.0841	-2.97
Calib WalkTime	-0.125	
WalkTime	-0.0886	-14.68
TranXfrs	-0.16	*fixed*
Calib TrIVOV	-1	
TrIVOV	-0.15	*fixed*
OpCost	-0.15	-2.94

TABLE 24. NHBNW Multimodal Accessibility Functions – Nonmotorized Modes

Variable	**Bike**		**Walk**	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-2.76		-0.438	
Constant	-2.92		-0.592	
BikeDist	-0.453	-3.94		
Nbutil	0.13	2.83		
Calib BikeResPref	1.13			
BikeResPref	0.5	*fixed*		
Calib WalkTime			*-0.125*	
WalkTime			-0.0886	-14.68

D.6 HBcoll (Home-Based College)

D.6.a Peak / Off-Peak Weights

HBcoll: 41.26% peak skims, 58.74% off-peak skims

D.6.b Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost**)**

Drive with Passenger

U = **exp (**-3.24 – 0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost**)**

Auto Passenger

U = **exp (**-2.93 – 0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost**)**

Transit by Walk Access

U = **exp (**0.0169 + TranModc + TranStypc – 0.0346*IvTime – 0.055*TranWait1 – 0.055*TranWait2 – 0.08*WalkTime – 0.15*TranXfrs – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

U = **exp (**2.85 + 0.75***ln**(**exp**(Formal*0.5***ln**($\sum_{1\to N}$ [**exp**(($U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) + **exp**(Informal*0.5***ln**($\sum_{1\to N}$ [**exp**((-5.5 + $U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) **)**

where

$U_{AutoLeg}$ = -0.05319*2*IvTime – 0.1407*OpCost

and

$U_{TransitLeg}$ = -0.05319*($IvTime_{Bus}$ + 0.86*$IvTime_{LRT}$ + $IvTime_{SC}$ + 0.86*$IvTime_{Rail}$) – 0.0652*TranWait1 – 0.05302*TranWait2 – 0.2111*WalkTime – 0.3*TranXfrs – 0.1407*OpCost + 1.022***ln**(Tdist)

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-1.97 – 0.3*BikeDist + 0.05*Cbutil**)**

Walk

U = **exp (**0 – 0.08*WalkTime**)**

D.6.c Estimated Variable Coefficients

TABLE 25. HBcoll Multimodal Accessibility Functions – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-3.24		-2.93	
Constant			-2.92		-2.73	
IvTime	-0.0346	-1.48	-0.0346	-1.48	-0.0346	-1.48
Calib WalkTime	-0.08		-0.08		-0.08	
WalkTime	-0.0615	-4.25	-0.0615	-4.25	-0.0615	-4.25
LowIncOpCost	-0.463	-2.36	-0.463	-2.36	-0.463	-2.36
MidIncOpCost	-0.383	-3.58	-0.383	-3.58	-0.383	-3.58
HighIncOpCost	-0.184	-1.61	-0.184	-1.61	-0.184	-1.61
LowIncPkgCost	-0.463	-2.36	-0.463	-2.36	-0.463	-2.36
MidIncPkgCost	-0.383	-3.58	-0.383	-3.58	-0.383	-3.58
HighIncPkgCost	-0.184	-1.61	-0.184	-1.61	-0.184	-1.61

TABLE 26. HBcoll Multimodal Accessibility Functions – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	0.0169		2.85	
Constant	0.336		-1.175	-3.4
IvTime	-0.0346	-1.48	-0.05319	-2.9
Calib TranWait1	-0.055			
TranWait1	-0.0296	-1.15	-0.05302	-2.3
Calib TranWait2	-0.055			
TranWait2	-0.0296	-1.15	-0.05302	-2.3
Calib WalkTime	-0.08			
WalkTime	-0.0615	-4.25	-0.2111	-3.7
TranXfrs	-0.15	*fixed*	-0.3	*fixed*
Calib TrIVOV	0			
TrIVOV	-0.156	*fixed*		
LowIncOpCost	-0.463	-2.36	-0.1407	-1.2
MidIncOpCost	-0.383	-3.58	-0.1407	-1.2
HighIncOpCost	-0.184	-1.61	-0.1407	-1.2
Nested Park & Ride Lot Choice Model				
Informal Constant			-6.0	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 27. HBcoll Multimodal Accessibility Functions – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-1.97		0	
Constant	-1.94		-0.0824	
Calib BikeDist	-0.3			
BikeDist	-0.153	-2.09		
Cbutil	0.05	*fixed*		
Calib WalkTime			-0.08	
WalkTime			-0.0615	-4.25

E Destination Choice

The destination choice models were developed using a multinomial logit estimation procedure. Only HBW has separate models by income group. For other home-based trip purposes, income-specific LogSums are weighted.

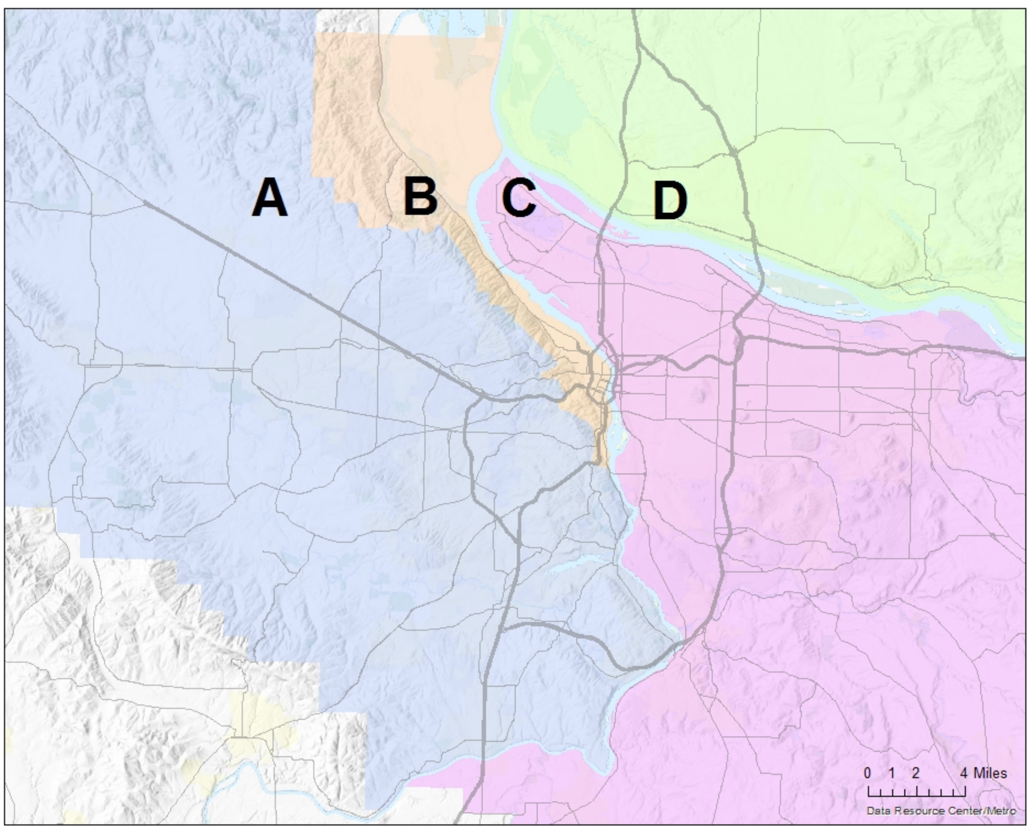
E.1 Variables Used in Destination Choice Models

E.1.a Accessibility Variable Definitions

The letter codes (A/B/C/D) in the hill and river crossing variables refer to Figure 2.

LogSum	=	Logsum of multimodal accessibility functions (all modes)
LogDist	=	Log of [distance (miles) + 1]
OR2WA	=	1 if trip is produced in Oregon (A/B/C) and attracted to Washington (D)
WA2OR	=	1 if trip is produced in Washington (D) and attracted to Oregon (A/B/C)
NoColXing	=	1 if trip does not cross Columbia River between Oregon and Washington
E2W_Hill	=	1 if trip is produced E of Tualatin Hills (B/C/D) and attracted to W of Tualatin Hills (A)
W2E_Hill	=	1 if trip is produced W of Tualatin Hills (A) and attracted to E of Tualatin Hills (B/C/D)
E2W_Riv	=	1 if trip is produced E of Willamette River (C/D) and attracted to W of Willamette River (A/B)
W2E_Riv	=	1 if trip is produced W of Willamette River (A/B) and attracted to E of Willamette River (C/D)

FIGURE 2. River and Hill Crossing Variables Used in Destination Choice



E.1.b Zonal Size Variable Definitions

Zonal size variables are applied at the attraction zone.

TABLE 28. Zonal Size Variables Used in Destination Choice Models

Name	Employment Sectors	NAICS
AerEmp	Arts, Entertainment, and Recreation	71
AmfEmp	Agriculture, Mining & Forestry	11,21
ConEmp	Construction	23
EduEmp	Education	61
FsdEmp	Food Services and Drinking Places	722
GovEmp	Government	All NAICS where owner=public, except 61 (edu), OHSU (hss) and Veterans Hosp (hss)
HssEmp	Health and Social Services	62
MfgEmp	Manufacturing (except high tech)	31-33 (except 334)
MhtEmp	Manufacturing - High tech	334
OsvEmp	Other Services (except Public Administration)	81
PbsEmp	Professional and Business Services	51-56
RcsEmp	Retail and Consumer Services	44,45,721
TwuEmp	Transportation, Warehousing and Utilities	22,48,49
WtEmp	Wholesale Trade	42
Households	Households	
OutAcres	Outdoor Activity Acres	
ParkAcres	Park Acres	
CollEnr	College Enrollment	

E.2 HBW (Home-Based Work)

E.2.a Calibrated Choice Utilities

HBW – Low Income Households

U = **exp (**0.2*LogSum – 1.9*LogDist*OR2WA – 1.8*LogDist*WA2OR – 1.8*LogDist*NoColXing + 0.05*LogDist*E2W_Hill + 0.1*LogDist*W2E_Hill + 0.1*LogDist*E2W_Riv + 0.05*LogDist*W2E_Riv + 0.1237*AerEmp + 1*AmfEmp + 0.5153*ConEmp + 0.5153*EduEmp + 1*FsdEmp + 0.1237*GovEmp + 0.1237*HssEmp + 0.1237*MfgEmp + 0.1237*MhtEmp + 0.5153*OsvEmp + 0.1237*PbsEmp + 0.1237*RcsEmp + 1*TwuEmp + 0.1237*WtEmp**)**

HBW – Middle Income Households

U = **exp (**0.2*LogSum – 1.95*LogDist*OR2WA – 1.78*LogDist*WA2OR – 1.4*LogDist*NoColXing + 0.05*LogDist*E2W_Hill + 0.1*LogDist*W2E_Hill + 0.2*LogDist*E2W_Riv + 0*LogDist*W2E_Riv + 0.2567*AerEmp + 0.4404*AmfEmp + 0.357*ConEmp + 0.3362*EduEmp + 0.0944*FsdEmp + 0.208*GovEmp + 0.1423*HssEmp + 0.1703*MfgEmp + 0.1212*MhtEmp + 1*OsvEmp + 0.2982*PbsEmp + 0.1313*RcsEmp + 0.4115*TwuEmp + 0.0846*WtEmp**)**

HBW – High Income Households

U = **exp (**0.2*LogSum – 1.5*LogDist*OR2WA – 1.78*LogDist*WA2OR – 1.4*LogDist*NoColXing + 0*LogDist*E2W_Hill + 0.1*LogDist*W2E_Hill + 0.2*LogDist*E2W_Riv + 0*LogDist*W2E_Riv +

0.3465*AerEmp + 0.075*AmfEmp + 0.6453*ConEmp + 1*EduEmp + 0.5051*FsdEmp + 0.5051*GovEmp + 0.5051*HssEmp + 0.5051*MfgEmp + 1*MhtEmp + 0.6453*OsvEmp + 1*PbsEmp + 0.075*RcsEmp + 0.5051*TwuEmp + 0.3465*WtEmp**)**

E.2.b Estimated Variable Coefficients

TABLE 29. HBW Destination Choice Model

Variable	Low Income <25K		Middle Income 25-100K		High Income 100K+	
	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
LogSum	0.2	*fixed*	0.2	fixed	0.2	fixed
Calib LogDist * OR2WA	-1.9		-1.95		-1.5	
LogDist * OR2WA	-2.09	-15.27	-2.05	-41.66	-1.66	-34.97
Calib LogDist * WA2OR	-1.8					
LogDist * WA2OR	-2.09	-24.48	-1.78	-74.26	-1.78	-53.52
Calib LogDist * NoColXing	-1.8		-1.4		-1..4	
LogDist * NoColXing	-1.81	-26.53	-1.56	-70.58	-1.53	-46.61
Calib LogDist * E2W_Hill	0.05		0.05			
LogDist * E2W_Hill	0	*fixed*	0	*fixed*	0	*fixed*
Calib LogDist * W2E_Hill	0.1		0.1		0.1	
LogDist * W2E_Hill	0	*fixed*	0	*fixed*	0	*fixed*
Calib LogDist * E2W_Riv	0.1		0.2		0.2	
LogDist * E2W_Riv	0	*fixed*	0	*fixed*	0	*fixed*
Calib LogDist * W2E_Riv	0.05					
LogDist * W2E_Riv	0	*fixed*	0	*fixed*	0	*fixed*
AerEmp	0.1237	-9.77	0.2567	-4.42	0.3465	-4.79
AmfEmp	1	fixed	0.4404	-3.74	0.075	-4.6
ConEmp	0.5153	-3.31	0.357	-6.27	0.6453	-2.95
EduEmp	0.5153	-3.31	0.3362	-10.23	1	fixed
FsdEmp	1	fixed	0.0944	-5.74	0.5051	-9.19
GovEmp	0.1237	-9.77	0.208	-15.08	0.5051	-9.19
HssEmp	0.1237	-9.77	0.1423	-17.04	0.5051	-9.19
MfgEmp	0.1237	-9.77	0.1703	-11.23	0.5051	-9.19
MhtEmp	0.1237	-9.77	0.1212	-7.59	1	fixed
OsvEmp	0.5153	-3.31	1	fixed	0.6453	-2.95
PbsEmp	0.1237	-9.77	0.2982	-12.38	1	fixed
RcsEmp	0.1237	-9.77	0.1313	-11.54	0.075	-4.6
TwuEmp	1	fixed	0.4115	-6.62	0.5051	-9.19
WtEmp	0.1237	-9.77	0.0846	-7.63	0.3465	-4.79

E.3 HBshop, HBrec, HBoth (Other Home-Based)

E.3.a LogSum Weights

TABLE 30. HBshop, HBrec, HBoth LogSum Weights

Income Group	HBShop LogSum Weight	HBRec LogSum Weight	HBoth LogSum Weight
Low Income < $25K	0.19	0.15	0.13
Middle Income $25-100K	0.60	0.58	0.61
High Income $100K+	0.21	0.27	0.26

E.3.b Calibrated Choice Utilities

HBShop

U = **exp (**1.37*LogSum – 2.25*LogDist*OR2WA – 3*LogDist*WA2OR – 1.75*LogDist*NoColXing + 0.1*LogDist*E2W_Hill + 0*LogDist*W2E_Hill + 0.1*LogDist*E2W_Riv + 0.05*LogDist*W2E_Riv + 0.172*FsdEmp + 0.1541*OsvEmp + 1*RcsEmp**)**

HBRec

U = **exp (**0.547*LogSum – 2.78*LogDist*OR2WA – 2.78*LogDist*WA2OR – 2.1*LogDist*NoColXing + 0*LogDist*E2W_Hill + 0*LogDist*W2E_Hill + 0*LogDist*E2W_Riv + 0*LogDist*W2E_Riv + 0.5117*AerEmp + 0.0276*EduEmp + 0.0963*FsdEmp + 0.0048*GovEmp + 0.0063*Households + 0.3499*OutAcres + 1*ParkAcres/10**)**

HBoth

U = **exp (**0.788*LogSum – 1.75*LogDist*OR2WA – 2.75*LogDist*WA2OR – 1.5*LogDist*NoColXing + 0*LogDist*E2W_Hill + 0.0523*LogDist*W2E_Hill + 0*LogDist*E2W_Riv + 0.172*LogDist*W2E_Riv + 0.1262*AerEmp + 0.3712*AmfEmp + 0.0048*ConEmp + 0.1437*EduEmp + 1*FsdEmp + 0.0916*GovEmp + 0.1588*HssEmp + 0.0048*MfgEmp + 0.0048*MhtEmp + 1*OsvEmp + 0.0665*PbsEmp + 0.206*RcsEmp + 0.162*TwuEmp + 0.0048*WtEmp + 0.1044*Households**)**

E.3.c Estimated Variable Coefficients

TABLE 31. HBshop, HBrec, HBoth Destination Choice Models

Variable	HBshop		HBrec		HBoth	
	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
LogSum	1.37	13.26	0.547	5.92	0.788	15.97
Calib LogDist * OR2WA	-2.25		-2.78		-1.75	
LogDist * OR2WA	-3.05	-17.55	-2.74	-34.77	-2.67	-44.21
Calib LogDist * WA2OR	-3		-2.78		-2.75	
LogDist * WA2OR	-2.66	-33.23	-2.74	-34.77	-2.49	-62.25
Calib LogDist * NoColXing	-1.75		-2.1		-1.5	
LogDist * NoColXing	-2.4	-38.36	-2.25	-35.84	-2.17	-70.45
Calib LogDist * E2W_Hill	0.1		0		0	
LogDist * E2W_Hill	0.0767	1.09	-0.185	-2.63	0.0691	2.09
Calib LogDist * W2E_Hill					-0.0523	
LogDist * W2E_Hill	0	*fixed*	0	*fixed*	-0.0398	-1.3
Calib LogDist * E2W_Riv	0.1		0		0	
LogDist * E2W_Riv	-0.228	-3.84	-0.278	-5.68	-0.0839	-3.55
Calib LogDist * W2E_Riv	-0.05		0		-0.172	
LogDist * W2E_Riv	-0.193	-3.82	-0.374	-7.63	-0.174	-6.96
AerEmp			0.5117	-5.9	0.1262	-6.21
AmfEmp					0.3712	-5.06
ConEmp					0.0048	-14.04
EduEmp			0.0276	-15.81	0.1437	-16.96
FsdEmp	0.172	-10.66	0.0963	-21.41	1	*fixed*
GovEmp			0.0048	-16.25	0.0916	-21.67
HssEmp					0.1588	-25.79
MfgEmp					0.0048	-14.04
MhtEmp					0.0048	-14.04
OsvEmp	0.1541	-11.2			1	*fixed*
PbsEmp					0.0665	-20.3
RcsEmp	1	*fixed*			0.206	-13.38
TwuEmp					0.162	-10.94
WtEmp					0.0048	-14.04
Households			0.0063	-32.13	0.1044	-47.87
OutAcres			0.3499	-6.36		
ParkAcres / 10			1	*fixed*		

E.4 NHBW & NHBNW (Non-Home-Based)

E.4.a Calibrated Choice Utilities

NHBW

U = **exp (**1.01*LogSum – 1.15*LogDist*OR2WA – 1.4*LogDist*WA2OR – 1.49*LogDist*NoColXing + 0.1*LogDist*E2W_Hill + 0*LogDist*W2E_Hill + 0.1*LogDist*E2W_Riv + 0*LogDist*W2E_Riv + 0.1153*AerEmp + 0.4033*AmfEmp + 0.0561*ConEmp + 0.192*EduEmp + 1*FsdEmp + 0.0829*GovEmp + 0.0573*HssEmp + 0.0027*MfgEmp + 0.0027*MhtEmp + 0.6114*OsvEmp + 0.0686*PbsEmp + 0.3679*RcsEmp + 0.1013*TwuEmp + 0.0027*WtEmp + 0.0781*Households**)**

NHBNW

U = **exp (**1.13*LogSum – 1.8*LogDist*OR2WA – 2.4*LogDist*WA2OR – 1.8*LogDist*NoColXing + 0*LogDist*E2W_Hill – 0.153*LogDist*W2E_Hill – 0.1*LogDist*E2W_Riv – 0.167*LogDist*W2E_Riv + 0.1604*AerEmp + 0.206*AmfEmp + 0.1249*ConEmp + 0.1901*EduEmp + 0.4253*FsdEmp + 0.0255*GovEmp + 0.0429*HssEmp + 0.0005*MfgEmp + 0.0005*MhtEmp + 1*OsvEmp + 0.0106*PbsEmp + 0.3263*RcsEmp + 0.0185*TwuEmp + 0.0085*WtEmp**)**

E.4.b Estimated Variable Coefficients

TABLE 32. Non-Home-Based Destination Choice Models

Variable	NHBW		NHBNW	
	Coeff	T-Stat	Coeff	T-Stat
LogSum	1.01	15.38	1.13	23.57
Calib LogDist * OR2WA	-1.15		-1.8	
LogDist * OR2WA	-1.67	-31.31	-1.98	-46.26
Calib LogDist * WA2OR	-1.4		-2.4	
LogDist * WA2OR	-1.67	-31.31	-2.49	-52.86
Calib LogDist * NoColXing	-1.49		-1.8	
LogDist * NoColXing	-1.47	-30.39	-1.91	-67.01
Calib LogDist * E2W_Hill	0.1		0	
LogDist * E2W_Hill	0.168	4.05	0.214	6.08
Calib LogDist * W2E_Hill	0			
LogDist * W2E_Hill	-0.101	-2.02	-0.153	-3.93
Calib LogDist * E2W_Riv	0.1		-0.1	
LogDist * E2W_Riv	-0.148	-3.89	-0.203	-6.94
Calib LogDist * W2E_Riv	0			
LogDist * W2E_Riv	-0.101	-3.1	-0.167	-5.78
AerEmp	0.1153	-3.26	0.1604	-9.05
AmfEmp	0.4033	-2.78	0.206	-7.56
ConEmp	0.0561	-4.34	0.1249	-13.62
EduEmp	0.192	-11.02	0.1901	-25.32
FsdEmp	1	*fixed*	0.4253	-12.89
GovEmp	0.0829	-16.75	0.0255	-22.47
HssEmp	0.0573	-16.04	0.0429	-28.4
MfgEmp	0.0027	-7.51	0.0005	-3.71
MhtEmp	0.0027	-7.51	0.0005	-3.71
OsvEmp	0.6114	-2.72	1	*fixed*
PbsEmp	0.0686	-15.42	0.0106	-11.96
RcsEmp	0.3679	-6.75	0.3263	-20
TwuEmp	0.1013	-7.92	0.0185	-8.28
WtEmp	0.0027	-7.51	0.0085	-8.79
Households	0.0781	-26.35		

E.5 HBcoll (Home-Based College)

E.5.a LogSum Weights

TABLE 33. HBcoll LogSum Weights

Income Group	HBcoll LogSum Weight
Low Income < $25K	0.29
Middle Income $25-100K	0.57
High Income $100K+	0.14

E.5.b Calibrated Choice Utility

U = **exp (**0.2*LogSum – 2.01*LogDist*OR2WA – 2.99*LogDist*WA2OR – 1.35*LogDist*NoColXing + 0.55*LogDist*E2W_Hill – 0.0836*LogDist*W2E_Hill – 0*LogDist*E2W_Riv – 0.5*LogDist*W2E_Riv + 1*CollEnr**)**

E.5.c Estimated Variable Coefficients

Variable	**NHBW**	
	Coeff	T-Stat
LogSum	0.2	*fixed*
LogDist * OR2WA	-2.01	-8.13
LogDist * WA2OR	-2.99	-11.83
LogDist * NoColXing	-1.35	-8.99
LogDist * E2W_Hill	-0.55	-2.73
LogDist * W2E_Hill	-0.0836	-0.81
Calib LogDist * E2W_Riv	*0*	
LogDist * E2W_Riv	0.416	4.68
LogDist * W2E_Riv	-0.5	-4.22
CollEnr	1	*fixed*

E.6 HBsch (Home-Based School)

U = **exp (ln (** $ATTR_j$ **)** – $0.6*T_{ij} + 0.012*T_{ij}^2$ **)**

Where:

i = from zone
j = to zone
T = mid-day auto travel time

F Mode Choice Model

Modal accessibility functions were estimated as an input to the destination choice and mode choice models. For each trip purpose, they measure the utility of choosing one of seven discrete modes.

Drive alone – only available to households with at least one car
Drive with passenger – only available to households with at least one car
Auto passenger
Transit by walk access – only available if both trip ends are within 0.2 miles of a bus stop, 0.35 miles of a streetcar or BRT stop, or 0.5 miles of a rail station
Transit by park-and-ride access – only available if destination trip end is within 0.2 miles of a bus stop, 0.35 miles of a streetcar or BRT stop, or 0.5 miles of a rail station; only available for home-based non-school trips; utilities and lot usage for formal park-and-ride lots and informal park-and-ride locations are calculated by a nested park-and-ride lot choice model
Bike – utilities and distances are produced by a stand-alone tool based on a dedicated bicycle network
Walk – only available for trips with a distance less than five miles

Probabilities are applied to distributed trips to determine the number of trips by each mode. An example probability of choosing the Drive Alone mode follows:

$$Prob_{Drive\ Alone} = U_{Drive\ Alone} / (U_{Drive\ Alone} + U_{Drive\ with\ Passenger} + U_{Auto\ Passenger} + U_{Walk\ to\ Transit} + U_{Park\&Ride} + U_{Bike} + U_{Walk})$$

F.1 Variables Used in Mode Choice Models

F.1.a Variable Definitions

IvTime = In-vehicle travel time (minutes, varies by mode)

WalkTime = Walk time (minutes), by mode:

- Drive Alone: vehicle egress at trip end (5 min in CBD, 2 min elsewhere)
- Shared Ride: Drive Alone walk time plus 5 minutes
- Transit Modes: access to first stop plus egress from last stop at 3 mph
- Walk: zone-to-zone time via key walk-accessible links at 3 mph (for trips < 5 miles)

TranWait1 = Transit initial wait time (minutes)

TranWait2 = Transit transfer wait time (minutes)

TranModc = Transit mode constant (varies by transit path)

TranStypc = Transit stop type constant (varies by transit path)

TranXfrs = Transit # of transfers

TrOVIV = ratio of total out-of-vehicle time to in-vehicle time

Formal = 1 if considering formal park-and-ride lots

Informal = 1 if considering informal park-and-ride locations

Shadow = Park-and-ride lot shadow cost (calculated by lot choice model)

BikeDist = Bicycle trip distance (miles)

Cbutil = Bicycle commute route attractiveness

Nbutil = Bicycle non-commute route attractiveness

BikeResPref = 1 if production zone in bicycle user residential preference area (see Figure 1)

LowInc = 1 if household income <$25K (2010$)

MidInc = 1 if household income $25-100K (2010$)

HighInc = 1 if household income $100K+ (2010$)

OpCost = Out-of-pocket cost, by mode:

- Drive Alone: 100% of $0.211 / mile (2010$)
- Drive with Passenger: 66.7% of $0.211 / mile (2010$)
- Auto Passenger: 33.3% of $0.211 / mile (2010$)
- Walk-access Transit: transit fare (2010$)
- Park-and-ride: $0.211 / mile for auto leg, transit fare for transit leg

PkgCost = Parking cost, by mode:

- Drive Alone: 100% of long-term parking charge in attraction zone
- Drive with Passenger: 66.7% of long-term parking charge in attraction zone
- Auto Passenger: 33.3% of long-term parking charge in attraction zone

MixRetP = Retail employment access within ½ mile of production zone (see Section A.1.b)

MixTotA = Total employment access within ½ mile of attraction zone (see Section A.1.b)

Cval0 = 1 if no cars in household

Cval1 = 1 if fewer cars than workers in household (cars > 0)

HH1 = 1 if 1 person household

HH2 = 1 if 2 person household

HH34 = 1 if 3+ person household

Work1 = 1 if one (and only one) worker in household

F.2 HBW (Home-Based Work)

F.2.a Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost – 1.9*Cval1**)**

Drive with Passenger

U = **exp (-**3.62 – 0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost – 1.02*Cval1 - 1.4*HH1 + 0.729*HH34**)**

Auto Passenger

U = **exp (-**4.15 – 0.0414*IvTime – 0.1*WalkTime – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost – 0.509*LowInc*PkgCost – 0.509*MidInc*PkgCost – 0.461*HighInc*PkgCost + 0.299*HH2 + 0.0297*ln(MixRetP) + 0.0506*ln(MixTotA)**)**

Transit by Walk Access

U = **exp (**-1.15 + TranModc + TranStypc – 0.0414*IvTime – 0.0543*TranWait1 – 0.061*TranWait2 – 0.1*WalkTime – 0.16*TranXfrs – 0.4*TrIVOV – 0.309*LowInc*OpCost – 0.252*MidInc*OpCost – 0.252*HighInc*OpCost + 0.08*ln(MixTotA) + 1.34*Cval0 + 0.349*Cval1 + 0.784*Work1**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

U = **exp (**1.85 + 0.75***ln**(**exp**(Formal*0.5***ln**($\sum_{1\rightarrow N}$ [**exp**((U$_{AutoLeg}$ + U$_{TransitLeg}$ + Shadow – 1.498*Cval1) / (0.5*0.75))])) + **exp**(Informal*0.5***ln**($\sum_{1\rightarrow N}$ [**exp**((-4.5 + U$_{AutoLeg}$ + U$_{TransitLeg}$ + Shadow – 1.498*Cval1) / (0.5*0.75))])) **)**

where

$U_{AutoLeg}$ = -0.03608*2*IvTime – 0.6587*LowInc*OpCost – 0.6097*MidInc*OpCost – 0.4029*HighInc*OpCost

and

$U_{TransitLeg}$ = -0.03608*(IvTime$_{Bus}$ + 0.88*IvTime$_{LRT}$ + IvTime$_{SC}$ + 0.88*IvTime$_{Rail}$) – 0.0576*TranWait1 – 0.04002*TranWait2 – 0.09956*WalkTime – 0.3*TranXfrs – 0.6587*LowInc*OpCost – 0.6097*MidInc*OpCost – 0.4029*HighInc*OpCost + 0.09828*ln(MixTotA)

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-2.1 – 0.25*BikeDist + 0.0636*Cbutil + 1.35*BikeResPref + 0.0517*ln(MixTotA)**)**

Walk

U = **exp (**-0.55 **–** 0.1*WalkTime + 0.107*ln(MixRetP)**)**

F.2.b Estimated Variable Coefficients

TABLE 34. HBW Mode Choice Model – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-3.62		-4.15	
Constant			-3.72	-31.72	-4.41	-19.18
IvTime	-0.0414	*-4.74*	-0.0414	*-4.74*	-0.0414	*-4.74*
Calib WalkTime	-0.1		-0.1		-0.1	
WalkTime	-0.0791	-14.01	-0.0791	-14.01	-0.0791	-14.01
LowIncOpCost	-0.309	-2.83	-0.309	-2.83	-0.309	-2.83
MidIncOpCost	-0.252	-6.34	-0.252	-6.34	-0.252	-6.34
HighIncOpCost	-0.252	-6.34	-0.252	-6.34	-0.252	-6.34
LowIncPkgCost	-0.509	-13.53	-0.509	-13.53	-0.509	-13.53
MidIncPkgCost	-0.509	-13.53	-0.509	-13.53	-0.509	-13.53
HighIncPkgCost	-0.461	-11.65	-0.461	-11.65	-0.461	-11.65
Ln(MixRetP)					0.0297	1.46
Ln(MixTotA)					0.0506	2.37
Cval1	-1.9	-18.06	-1.02	-5.07		
HH1			-1.4	-3.3		
HH2					0.299	2.69
HH34			0.729	5.45		

TABLE 35. HBW Mode Choice Model – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-1.15		1.85	
Constant	-2.34	-13.25	-6.504	-7.3
Ivtime	-0.0414	*-4.74*	-0.03608	-6.3
Wait1	-0.0543	-3.69	-0.0576	-5.8
Wait2	-0.061	-4.66	-0.04002	-5.2
Calib WalkTime	-0.1			
WalkTime	-0.0791	-14.01	-0.09956	-9.7
Transfers	-0.16	*fixed*	-0.3	*fixed*
Calib TrIVOV	-0.4			
TrIVOV	-0.0519	-2.65		
LowIncOpCost	-0.309	-2.83	-0.6587	-9.5
MidIncOpCost	-0.252	-6.34	-0.6097	-12.1
HighIncOpCost	-0.252	-6.34	-0.4029	-7.1
Ln(MixTotA)	0.08	*fixed*	0.05178	1.0
Work1	0.784	5.58		
Cval0	1.34	6.22		
Cval1	0.349	2.07	-1.498	-3.3
Nested Park & Ride Lot Choice Model				
Informal Constant			-4.5	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 36. HBW Mode Choice Model – Nonmotorized Modes

Variable	Bike	Walk

	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-2.1		-0.55	
Constant	-2.51	-7.35	-1.82	-4.74
Calib BikeDist	-0.25			
BikeDist	-0.215	-6.19		
Cbutil	0.0636	2.92		
Calib BikeResPref	1.35			
BikeResPref	0.5	*fixed*		
Calib WalkTime			-0.1	
WalkTime			-0.0791	-14.01
Ln(MixTotA)	0.0517	2.18		
Ln(MixRetP)			0.107	2.54

F.3 HBshop, HBrec, HBoth (Other Home-Based)

F.3.a Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost – 0.704*Cval1**)**

Drive with Passenger

U = **exp (**-1.4*Shop – 1*Rec – 0.9*Oth -0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost – 0.436*Cval1 – 1.63*HH1 + 0.889* HH34**)**

Auto Passenger

U = **exp (**-0.85*Shop – 0.15*Rec – 0.6*Oth -0.0315*IvTime – 0.125*WalkTime – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost – 0.731*LowInc*PkgCost – 0.393*MidInc*PkgCost – 0.393*HighInc*PkgCost – 1.41*HH1 + 0.256*HH34**)**

Transit by Walk Access

U = **exp (**-2.84*Shop – 2.7*Rec – 3.45*Oth + TranModc + TranStypc – 0.0315*IvTime – 0.05*TranWait1 – 0.05*TranWait2 – 0.125*WalkTime – 0.16*TranXfrs – 1*TrIVOV – 0.255*LowInc*OpCost – 0.255*MidInc*OpCost – 0.174*HighInc*OpCost + 0.212* ln(MixTotA) + 1.96*Cval0 + 0.665*Cval1**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

U = **exp (**-3.1*Shop – 2*Rec – 2.2*Oth + 0.75***ln**(**exp**(Formal*0.5***ln**($\sum_{1\to N}$ [**exp**(($U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) + **exp**(Informal*0.5***ln**($\sum_{1\to N}$ [**exp**((-4 + $U_{AutoLeg}$ + $U_{TransitLeg}$ + Shadow) / (0.5*0.75))])) **)**

where

$U_{AutoLeg}$ = -0.0215*2*IvTime – 0.4724*LowInc*OpCost – 0.2457*MidInc*OpCost – 0.2457*HighInc*OpCost and

$U_{TransitLeg}$ = -0.0215*(IvTime$_{Bus}$ + 0.86*IvTime$_{LRT}$ + IvTime$_{SC}$ + 0.86*IvTime$_{Rail}$) – 0.06847*TranWait1 – 0.0524*TranWait2 – 0.1033*WalkTime – 0.3*TranXfrs – 0.4724*LowInc*OpCost – 0.2457*MidInc*OpCost – 0.2457*HighInc*OpCost + 0.1664*ln(MixTotA)

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-2.65*Shop – 1.65*Rec – 2.75*Oth – 0.223*BikeDist + 0.199*Nbutil + 1.03*BikeResPref + 0.212*ln(MixTotA)**)**

Walk

U = **exp (**-0.8*Shop + 0.7*Rec + 0*Oth – 0.125*WalkTime + 0.188*ln(MixRetP)**)**

F.3.b Estimated Variable Coefficients

TABLE 37. HBshop, HBrec, HBoth Mode Choice Model – Auto Modes

Variable	**Drive Alone**		**Drive with Passenger**		**Auto Passenger**	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Shop			-1.4		-0.85	
Calib Rec			-1		-0.15	
Calib Oth			-0.9		-0.6	
Shop			-1.56	-32.21	-1.89	-34.42
Rec			-1.17	-20.87	-1.4	-22.98
Oth			-0.983	-28.87	-1.5	-38.77
IvTime	-0.0315	*-2.16*	-0.0315	*-2.16*	-0.0315	*-2.16*
Calib WalkTime	-0.125		-0.125		-0.125	
WalkTime	-0.0906	-27.55	-0.0906	-27.55	-0.0906	-27.55
LowIncOpCost	-0.255	*-7.47*	-0.255	*-7.47*	-0.255	*-7.47*
MidIncOpCost	-0.255	*-7.47*	-0.255	*-7.47*	-0.255	*-7.47*
HighIncOpCost	-0.174	*-3.99*	-0.174	*-3.99*	-0.174	*-3.99*
LowIncPkgCost	-0.731	*-3.1*	-0.731	*-3.1*	-0.731	*-3.1*
MidIncPkgCost	-0.393	*-5.2*	-0.393	*-5.2*	-0.393	*-5.2*
HighIncPkgCost	-0.393	*-5.2*	-0.393	*-5.2*	-0.393	*-5.2*
Cval1	-0.704	-9.07	-0.436	-5.25		
HH1			-1.63	-16.37	-1.41	-14.85
HH34			0.889	22.77	0.256	5.75

TABLE 38. HBshop, HBrec, HBoth Mode Choice Model – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Shop	-2.84		--3.1	
Calib Rec	-2.7		-2	
Calib Oth	-3.45		-2.2	
Shop	-4.95	-9.89	-7.023	-3.8
Rec	-4.4	-8.63	-7.023	-3.8
Oth	-5.03	-10	-7.023	-3.8
IvTime	-0.0315	*-2.16*	-0.0215	-3.2
Calib TranWait1	-0.05			
TranWait1	-0.0824	-4.7	-0.06847	-5.4
Calib TranWait2	-0.05			
TranWait2	-0.074	-4.42	-0.0524	-4.8
Calib WalkTime	-0.125			
WalkTime	-0.0906	-27.55	-0.1033	-8.3
TranXfrs	-0.16	*fixed*	-0.3	*fixed*
Calib TrIVOV	-1			
TrIVOV	-0.121	*-3.11*		
LowIncOpCost	-0.255	*-7.47*	-0.4724	-6.8
MidIncOpCost	-0.255	*-7.47*	-0.2457	-5.2
HighIncOpCost	-0.174	*-3.99*	-0.2457	-5.2
Ln(MixTotA)	0.212	6.18	0.3073	1.5
Ln(MixRetP)	0.203	5.2		
Cval0	1.96	12.4		
Cval1	0.665	3.93		
Nested Park & Ride Lot Choice Model				
Informal Constant			-4	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 39. HBshop, HBrec, HBoth Mode Choice Model – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Shop	-2.65		-0.8	
Calib Rec	-1.65		0.7	
Calib Oth	-2.75		0	
Shop	-3.74	-11.64	-2.6	-15.29
Rec	-2.73	-8.63	-1.41	-8.44
Oth	-3.73	-12.05	-2.15	-13.83
Calib BikeDist	-0.223			
BikeDist	-0.233	-5.38		
Nbutil	0.199	7.88		
Calib BikeResPref	1.03			
BikeResPref	0.5	*fixed*		
Calib WalkTime			-0.125	
WalkTime			-0.0906	-27.55
Ln(MixTotA)	0.212	7.29		
Calib Ln(MixRetP)			0.188	
Ln(MixRetP)			0.229	13.99

F.4 NHBW (Non-Home-Based Work)

F.4.a Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Drive with Passenger

U = **exp (**-2.2 – 0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Auto Passenger

U = **exp (**-2.6 – 0.0452*IvTime – 0.157*WalkTime – 0.194*OpCost – 0.557*PkgCost**)**

Transit by Walk Access

U = **exp (**0.95 + TranModc + TranStypc – 0.0452*IvTime – 0.118*TranWait1 – 0.118*TranWait2 – 0.157*WalkTime – 0.16*TranXfrs – 0.194*OpCost – 1*TrOVIV**)**

Bike

U = **exp (**-3.55 **–** 0.22*BikeDist + 0.0841*Nbutil + 1.13*BikeResPref + 0.1*Ln(MixTotA)**)**

Walk

U = **exp (**-1.15 – 0.157*WalkTime + 0.248*ln(MixRetP)**)**

F.4.b Estimated Variable Coefficients

TABLE 40. NHBW Mode Choice Model – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-2.2		-2.6	
Constant			-2.43	-46.75	-2.99	-48.6
IvTime	-0.0452	-2.49	-0.0452	-2.49	-0.0452	-2.49
WalkTime	-0.157	-16.7	-0.157	-16.7	-0.157	-16.7
OpCost	-0.194	-3.33	-0.194	-3.33	-0.194	-3.33
PkgCost	-0.557	-5.41	-0.557	-5.41	-0.557	-5.41

TABLE 41. NHBW Mode Choice Model – Transit Modes

Variable	Walk Access	
	Coefficient	T-Statistic
Calib Constant	0.95	
Constant	-1.76	-2.76
IvTime	-0.0452	-2.49
TranWait1	-0.118	-5.07
TranWait2	-0.118	-5.07
WalkTime	-0.157	-16.7
TranXfrs	-0.16	*fixed*
OpCost	-0.194	-3.33
Calib TrIVOV	-1	
TrIVOV	0	*fixed*
Calib Ln(MixTotA)	0	
Ln(MixTotA)	-0.161	-6.18

TABLE 42. NHBW Mode Choice Model – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-3.55		-1.15	
Constant	-4.96	-52.56	-2.12	-5.52
BikeDist	-0.22	-4.06		
Nbutil	0.0841	1.98		
Calib BikeResPref	1.13			
BikeResPref	0.5	*fixed*		
WalkTime			-0.157	-16.7
Calib Ln(MixRetP)			0.248	
Ln(MixRetP)			0.2553	10.6
Ln(MixTotA)	0.1	*fixed*		

F.5 NHBNW (Non-Home-Based Non-Work)

F.5.a Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Drive with Passenger

U = **exp (**-0.4 – 0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Auto Passenger

U = **exp (**-0.3 – 0.0278*IvTime – 0.125*WalkTime – 0.15*OpCost – 0.335*PkgCost**)**

Transit by Walk Access

U = **exp (**0.9 + TranModc + TranStypc – 0.0278*IvTime – 0.0781*TranWait1 – 0.0841*TranWait2 – 0.125*WalkTime – 0.16*TranXfrs – 1*TrIVOV – 0.15*OpCost + 0.128*ln(MixTotA) + 0.135*ln(MixRetP)**)**

Bike

U = **exp (**-3.3 **–** 0.453*BikeDist – 0.13*Nbutil + 1.13*BikeResPref + 0.172*ln(MixTotA)**)**

Walk

U = **exp (**-2.25 – 0.125*WalkTime + 0.301*ln(MixRetP)**)**

F.5.b Estimated Variable Coefficients

TABLE 43. NHBNW Mode Choice Model – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-0.4		-0.3	
Constant			-0.491	-18.74	-1.37	-41.17
IvTime	-0.0278	-1.63	-0.0278	-1.63	-0.0278	-1.63
Calib WalkTime	-0.125		-0.125		-0.125	
WalkTime	-0.0886	-14.68	-0.0886	-14.68	-0.0886	-14.68
OpCost	-0.15	-2.94	-0.15	-2.94	-0.15	-2.94
PkgCost	-0.335	-5.91	-0.335	-5.91	-0.335	-5.91

TABLE 44. NHBNW Mode Choice Model – Transit Modes

Variable	**Walk Access**	
	Coefficient	T-Statistic
Calib Constant	0.9	
Constant	-3.8	-4.82
IvTime	-0.0278	-1.63
TranWait1	-0.0781	-2.85
TranWait2	-0.0841	-2.97
Calib WalkTime	-0.125	
WalkTime	-0.0886	-14.68
TranXfrs	-0.16	*fixed*
Calib TrIVOV	-1	
TrIVOV	-0.15	*fixed*
OpCost	-0.15	-2.94
Calib Ln(MixRetP)	0	
Ln(MixRetP)	0.135	2.55
Calib Ln(MixTotA)	0	
Ln(MixTotA)	0.128	2.24

TABLE 45. NHBNW Mode Choice Model – Nonmotorized Modes

Variable	**Bike**		**Walk**	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-3.3		-2.25	
Constant	-4.26	-7.47	-3.73	-11.9
BikeDist	-0.453	-3.94		
Nbutil	0.13	2.83		
Calib BikeResPref	1.13			
BikeResPref	0.5	*fixed*		
Calib WalkTime			*-0.125*	
WalkTime			-0.0886	-14.68
Ln(MixRetP)			0.301	10.1
Ln(MixTotA)	0.172	3.3		

F.6 HBcoll (Home-Based College)

F.6.a Calibrated Choice Utilities

Drive Alone

U = **exp (**-0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost – 1.36*Cval1**)**

Drive with Passenger

U = **exp (**-3.1 – 0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost**)**

Auto Passenger

U = **exp (**-2.45 – 0.0346*IvTime – 0.08*WalkTime – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost – 0.463*LowInc*PkgCost – 0.383*MidInc*PkgCost – 0.184*HighInc*PkgCost**)**

Transit by Walk Access

U = **exp (**0.1 + TranModc + TranStypc – 0.0346*IvTime – 0.055*TranWait1 – 0.055*TranWait2 – 0.08*WalkTime – 0.15*TranXfrs – 0.463*LowInc*OpCost – 0.383*MidInc*OpCost – 0.184*HighInc*OpCost + 0.763*Cval0 + 0.528*Cval1 + 0.1*ln(LogMixTotA)**)**

Park and Ride

Park and Ride uses older model specifications; only the mode-specific constant and informal constant were recalibrated in 2017. The coefficient on auto in-vehicle time is doubled in order to maintain a balance between auto and transit time that is comparable to the observed relationship; otherwise, too many trips include unreasonably high auto times as travelers choose to drive to the periphery of the CBD before boarding transit.

$$U = \mathbf{exp}\,(2.85 + 0.75*\mathbf{ln}(\mathbf{exp}(Formal*0.5*\mathbf{ln}(\textstyle\sum_{1\to N} [\mathbf{exp}((U_{AutoLeg} + U_{TransitLeg} + Shadow) / (0.5*0.75))]\ )) + \mathbf{exp}(Informal*0.5*\mathbf{ln}(\textstyle\sum_{1\to N} [\mathbf{exp}((-5.5 + U_{AutoLeg} + U_{TransitLeg} + Shadow) / (0.5*0.75))]\ ))\ )$$

where

$$U_{AutoLeg} = -0.05319*2*IvTime - 0.1407*OpCost$$

and

$$U_{TransitLeg} = -0.05319*(IvTime_{Bus} + 0.86*IvTime_{LRT} + IvTime_{SC} + 0.86*IvTime_{Rail}) - 0.0652*TranWait1 - 0.05302*TranWait2 - 0.2111*WalkTime - 0.3*TranXfrs - 0.1407*OpCost + 1.022*\mathbf{ln}(Tdist)$$

and

N = number of formal park-and-ride lots or informal par-and-ride locations under consideration

Bike

U = **exp (**-1.9 – 0.3*BikeDist + 0.05*Cbutil **+** 0.1*Ln(MixTotA)**)**

Walk

U = **exp (**0.25 – 0.08*WalkTime + 0.119* ln(MixRetP)**)**

F.6.b Estimated Variable Coefficients

TABLE 46. HBcoll Mode Choice Model – Auto Modes

Variable	Drive Alone		Drive with Passenger		Auto Passenger	
	Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant			-3.1		-2.45	
Constant			-3.08	-12.85	-3.01	-16.8
IvTime	-0.0346	-1.48	-0.0346	-1.48	-0.0346	-1.48
Calib WalkTime	-0.08		-0.08		-0.08	
WalkTime	-0.0615	-4.25	-0.0615	-4.25	-0.0615	-4.25
LowIncOpCost	-0.463	-2.36	-0.463	-2.36	-0.463	-2.36
MidIncOpCost	-0.383	-3.58	-0.383	-3.58	-0.383	-3.58
HighIncOpCost	-0.184	-1.61	-0.184	-1.61	-0.184	-1.61
LowIncPkgCost	-0.463	-2.36	-0.463	-2.36	-0.463	-2.36
MidIncPkgCost	-0.383	-3.58	-0.383	-3.58	-0.383	-3.58
HighIncPkgCost	-0.184	-1.61	-0.184	-1.61	-0.184	-1.61
Cval1	-1.36	-3.5				
Calib HH34					*0*	
HH34					0.2	*fixed*

TABLE 47. HBcoll Mode Choice Model – Transit Modes

Variable	Walk Access		Park and Ride	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	0.1		2.85	
Constant	-2.07	-1.99	-1.175	-3.4
IvTime	-0.0346	-1.48	-0.05319	-2.9
Calib TranWait1	-0.055			
TranWait1	-0.0296	-1.15	-0.05302	-2.3
Calib TranWait2	-0.055			
TranWait2	-0.0296	-1.15	-0.05302	-2.3
Calib WalkTime	-0.08			
WalkTime	-0.0615	-4.25	-0.2111	-3.7
TranXfrs	-0.15	*fixed*	-0.3	*fixed*
Calib TrIVOV	0			
TrIVOV	-0.156	*fixed*		
LowIncOpCost	-0.463	-2.36	-0.1407	-1.2
MidIncOpCost	-0.383	-3.58	-0.1407	-1.2
HighIncOpCost	-0.184	-1.61	-0.1407	-1.2
Calib Ln(MixTotA)	0			
Ln(MixTotA)	0.157	1.79		
Cval0	0.763	1.28		
Cval1	0.528	1.35		
Nested Park & Ride Lot Choice Model				
Informal Constant			-5.5	
Park & Ride Nest			0.75	
Formal Nest			0.5	
Informal Nest			0.5	

TABLE 48. HBcoll Mode Choice Model – Nonmotorized Modes

Variable	Bike		Walk	
	Coefficient	T-Statistic	Coefficient	T-Statistic
Calib Constant	-1.9		0.25	
Constant	-3.73	-7.49	-1.83	-1.29
Calib BikeDist	-0.3			
BikeDist	-0.153	-2.09		
Cbutil	0.05	*fixed*		
Calib WalkTime			-0.08	
WalkTime			-0.0615	-4.25
Ln(MixRetP)			0.119	0.81
Ln(MixTotA)	0.1	*fixed*		

F.7 HBsch (Home-Based School)

The HBsch model is a simple cross-classification into mode by location of production (home). This accounts for varying levels of school bus service provision between school districts. District definitions refer to the 8-district boundaries shown in Appendix B.

TABLE 49. HBsch Mode Choice Model

Location	Dist	Auto Driver	Auto Passenger	Transit	Walk	Bike	School Bus
City of Portland	1,5,7	0.2372	0.3601	0.0558	0.1953	0.0735	0.0781
East Suburbs	4,6	0.1875	0.3254	0.0123	0.131	0.0187	0.3251
West Suburbs	2,3	0.2256	0.3048	0.0027	0.1261	0.0086	0.3322
Clark County	8	0.2214	0.3139	0.0033	0.0682	0.0122	0.381

G Time of Day Factors

Time of day travel is estimated separately for auto and transit, and the factors are direction-specific. Factors can be estimated for any hour by using start time data from the 2010-11 household activity survey. Hourly peaking factors for both Production->Attraction and Attraction->Production trip ends for all trip purposes are provided in the tables on the following pages.

Once an hourly trip table has been calculated using the referenced peaking factors, a final daily adjustment factor is applied to the trip table based on a diurnal profile calculated from traffic counts on all Tier 1 cutlines. These adjustments are made to both SOV and HOV trip tables.

Metro utilizes a peak spreading algorithm as a post-demand model adjustment to all SOV and HOV trip tables. For further documentation on how this algorithm works, please refer to the supporting Kate Peak Spreading Methodology and FAQ document listed in the Table of Contents.

TABLE 50. Hourly peaking factors: HBW and HBO

Time Period	HBW Auto PA	HBW Auto AP	HBW Transit PA	HBW Transit AP	HBO Auto PA	HBO Auto AP	HBO Transit PA	HBO Transit AP
0:00 - 0:59	0.0007	0.0025	-	-	0.0001	0.0017	-	-
1:00 - 1:59	0.0002	0.0032	-	-	0.0001	0.0013	-	-
2:00 - 2:59	0.0000	0.0010	-	-	0.0002	0.0007	-	-
3:00 - 3:59	0.0037	0.0010	0.0017	-	0.0002	0.0001	-	-
4:00 - 4:59	0.0124	0.0012	0.0095	-	0.0021	0.0002	-	-
5:00 - 5:59	0.0395	0.0017	0.0677	-	0.0071	0.0016	0.0062	-
6:00 - 6:59	0.0905	0.0008	0.1249	0.0040	0.0204	0.0032	0.0184	-
7:00 - 7:59	0.1515	0.0036	0.1343	0.0026	0.0441	0.0084	0.0978	0.0029
8:00 - 8:59	0.0841	0.0043	0.0816	0.0000	0.0504	0.0157	0.0865	0.0139
9:00 - 9:59	0.0376	0.0039	0.0430	0.0038	0.0414	0.0172	0.0591	0.0237
10:00 - 10:59	0.0195	0.0077	0.0171	0.0043	0.0324	0.0198	0.0533	0.0186
11:00 - 11:59	0.0110	0.0118	0.0138	0.0034	0.0350	0.0267	0.0455	0.0276
12:00 - 12:59	0.0157	0.0180	0.0019	0.0038	0.0235	0.0253	0.0348	0.0406
13:00 - 13:59	0.0154	0.0173	0.0068	0.0054	0.0280	0.0259	0.0285	0.0398
14:00 - 14:59	0.0135	0.0292	0.0038	0.0175	0.0331	0.0336	0.0385	0.0506
15:00 - 15:59	0.0114	0.0544	0.0024	0.0550	0.0319	0.0465	0.0276	0.0337
16:00 - 16:59	0.0092	0.0809	0.0019	0.0913	0.0340	0.0498	0.0288	0.0208
17:00 - 17:59	0.0085	0.1069	0.0079	0.1757	0.0356	0.0575	0.0211	0.0580
18:00 - 18:59	0.0075	0.0487	0.0027	0.0443	0.0463	0.0446	0.0176	0.0400
19:00 - 19:59	0.0021	0.0209	0.0008	0.0222	0.0195	0.0372	0.0132	0.0141
20:00 - 20:59	0.0016	0.0144	0.0042	0.0175	0.0083	0.0432	0.0000	0.0298
21:00 - 21:59	0.0008	0.0153	0.0006	0.0094	0.0025	0.0259	0.0015	0.0076
22:00 - 22:59	0.0015	0.0065	-	0.0119	0.0019	0.0102	-	-
23:00 - 23:59	0.0004	0.0061	-	0.0013	0.0009	0.0050	-	-

TABLE 51. Hourly peaking factors: HBS and HBR

Time Period	HBS Auto PA	HBS Auto AP	HBS Transit PA	HBS Transit AP	HBR Auto PA	HBR Auto AP	HBR Transit PA	HBR Transit AP
0:00 - 0:59	-	-	-	-	-	0.0044	-	-
1:00 - 1:59	-	-	-	-	-	0.0014	-	-
2:00 - 2:59	-	-	-	-	-	0.0007	-	-
3:00 - 3:59	-	-	-	-	-	-	-	-
4:00 - 4:59	0.0007	-	-	-	0.0066	0.0021	-	-
5:00 - 5:59	0.0010	0.0002	-	-	0.0333	0.0027	0.0114	-
6:00 - 6:59	0.0054	0.0009	0.0110	-	0.0228	0.0140	0.0166	-
7:00 - 7:59	0.0104	0.0048	0.0362	-	0.0232	0.0109	0.0172	-
8:00 - 8:59	0.0187	0.0056	0.0236	0.0305	0.0321	0.0095	0.0257	-
9:00 - 9:59	0.0288	0.0145	0.0605	0.0061	0.0344	0.0224	0.1121	-
10:00 - 10:59	0.0335	0.0369	0.0194	0.0300	0.0326	0.0149	0.0567	0.0050
11:00 - 11:59	0.0349	0.0453	0.0607	0.0202	0.0213	0.0259	0.0173	0.1214
12:00 - 12:59	0.0237	0.0458	0.1112	0.0134	0.0224	0.0145	0.0131	0.0266
13:00 - 13:59	0.0334	0.0473	0.0201	0.0451	0.0118	0.0136	0.0893	0.0122
14:00 - 14:59	0.0327	0.0661	0.0134	0.0603	0.0203	0.0154	0.0313	0.0099
15:00 - 15:59	0.0320	0.0559	0.0400	0.0588	0.0260	0.0207	0.0440	0.0642
16:00 - 16:59	0.0264	0.0800	0.0354	0.0925	0.0484	0.0372	0.0066	0.0635
17:00 - 17:59	0.0249	0.0716	0.0248	0.0923	0.0586	0.0416	0.1061	0.0047
18:00 - 18:59	0.0232	0.0653	0.0061	0.0642	0.0672	0.0691	-	0.0424
19:00 - 19:59	0.0171	0.0372	0.0000	0.0068	0.0254	0.0663	-	0.0450
20:00 - 20:59	0.0079	0.0317	0.0044	0.0086	0.0076	0.0495	-	0.0375
21:00 - 21:59	0.0027	0.0252	-	-	0.0015	0.0405	-	0.0159
22:00 - 22:59	0.0007	0.0067	-	0.0044	0.0025	0.0175	-	0.0044
23:00 - 23:59	-	0.0009	-	-	-	0.0072	-	-

TABLE 52. Hourly peaking factors: College and School

Time Period	College Auto PA	College Auto AP	College Transit PA	College Transit AP	School Auto PA	School Auto AP	School Transit PA	School Transit AP
0:00 - 0:59	-	-	-	-	-	-	-	-
1:00 - 1:59	-	-	-	-	-	-	-	-
2:00 - 2:59	-	-	-	-	-	-	-	-
3:00 - 3:59	-	0.0014	-	-	-	-	-	-
4:00 - 4:59	-	-	-	-	-	-	-	-
5:00 - 5:59	-	-	-	-	0.0004	-	0.0108	-
6:00 - 6:59	0.0075	-	0.0732	-	0.0252	0.0049	0.1175	-
7:00 - 7:59	0.1082	-	0.1507	-	0.2034	0.0454	0.3613	-
8:00 - 8:59	0.0808	0.0013	0.0820	0.0086	0.1549	0.0809	0.0238	-
9:00 - 9:59	0.0630	0.0040	0.1622	0.0219	0.0174	0.0188	0.0098	-
10:00 - 10:59	0.0394	0.0084	0.0077	0.0000	0.0106	0.0057	-	-
11:00 - 11:59	0.0331	0.0089	0.0295	0.0000	0.0128	0.0108	-	-
12:00 - 12:59	0.0314	0.0496	0.0030	0.0219	0.0121	0.0150	-	-
13:00 - 13:59	0.0106	0.0271	0.0188	0.0306	0.0118	0.0070	-	0.0259
14:00 - 14:59	0.0129	0.0645	0.0038	0.0284	0.0667	0.0663	-	0.0395
15:00 - 15:59	0.0074	0.0400	0.0332	0.0717	0.0340	0.0649	-	0.2135
16:00 - 16:59	0.0361	0.0305	0.0066	0.0099	0.0172	0.0188	-	0.1422
17:00 - 17:59	0.0614	0.0445	0.0115	0.0263	0.0169	0.0321	-	0.0157
18:00 - 18:59	0.0300	0.0209	0.0244	0.0384	0.0086	0.0092	-	0.0400
19:00 - 19:59	0.0287	0.0544	-	0.0210	0.0059	0.0037	-	-
20:00 - 20:59	-	0.0485	-	0.0526	0.0026	0.0073	-	-
21:00 - 21:59	-	0.0416	-	0.0575	-	0.0040	-	-
22:00 - 22:59	-	0.0041	-	0.0048	0.0011	0.0014	-	-
23:00 - 23:59	-	-	-	-	-	0.0024	-	-

TABLE 53. Hourly peaking factors: Non-Home, Externals, and Trucks

Time Period	NHBW Auto PA	NHBW Auto AP	NHBW Transit PA	NHBW Transit AP	NHBNW Auto OD	NHBNW Transit OD	Externals	Heavy Trucks	Medium Trucks
0:00 - 0:59	0.0037	-	-	-	0.0004	0.0022	0.0132	0.0151	0.0055
1:00 - 1:59	0.0005	-	-	-	0.0008	-	0.0132	0.0161	0.0048
2:00 - 2:59	-	-	-	-	0.0003	-	0.0132	0.0142	0.0062
3:00 - 3:59	-	0.0002	-	-	0.0059	-	0.0132	0.0166	0.0068
4:00 - 4:59	0.0007	0.0021	-	-	0.0016	-	0.0132	0.0217	0.0140
5:00 - 5:59	0.0002	0.0040	-	-	0.0010	-	0.0132	0.0297	0.0200
6:00 - 6:59	0.0013	0.0171	-	0.0207	0.0053	-	0.0560	0.0445	0.0355
7:00 - 7:59	0.0073	0.0638	0.0088	0.0767	0.0261	0.0020	0.0628	0.0564	0.0540
8:00 - 8:59	0.0155	0.0606	0.0099	0.0537	0.0455	0.0572	0.0628	0.0609	0.0830
9:00 - 9:59	0.0223	0.0384	-	0.0054	0.0509	0.0189	0.0558	0.0721	0.0869
10:00 - 10:59	0.0297	0.0292	0.0050	0.0258	0.0756	0.0944	0.0558	0.0778	0.0847
11:00 - 11:59	0.0585	0.0351	0.0243	0.0106	0.0927	0.1108	0.0558	0.0750	0.0837
12:00 - 12:59	0.0578	0.0541	0.0358	0.0555	0.0845	0.2023	0.0558	0.0717	0.0821
13:00 - 13:59	0.0398	0.0425	0.0591	0.0195	0.1006	0.0798	0.0558	0.0691	0.0791
14:00 - 14:59	0.0483	0.0271	0.0861	0.0385	0.0944	0.0976	0.0596	0.0666	0.0801
15:00 - 15:59	0.0691	0.0228	0.0675	0.0219	0.0967	0.1591	0.0724	0.0573	0.0727
16:00 - 16:59	0.0858	0.0136	0.1887	0.0236	0.0891	0.0747	0.0724	0.0465	0.0551
17:00 - 17:59	0.0806	0.0052	0.0885	0.0226	0.0720	0.0477	0.0724	0.0364	0.0429
18:00 - 18:59	0.0293	0.0043	0.0261	-	0.0688	0.0236	0.0596	0.0352	0.0330
19:00 - 19:59	0.0074	0.0051	0.0106	0.0056	0.0396	0.0212	0.0326	0.0298	0.0227
20:00 - 20:59	0.0059	0.0014	-	-	0.0240	0.0085	0.0326	0.0259	0.0169
21:00 - 21:59	0.0042	0.0010	0.0027	0.0027	0.0187	-	0.0326	0.0228	0.0120
22:00 - 22:59	0.0022	0.0010	-	-	0.0045	-	0.0132	0.0200	0.0099
23:00 - 23:59	0.0014	-	-	0.0040	0.0011	-	0.0132	0.0186	0.0084

FIGURE 3. Tier 1 traffic count cutlines

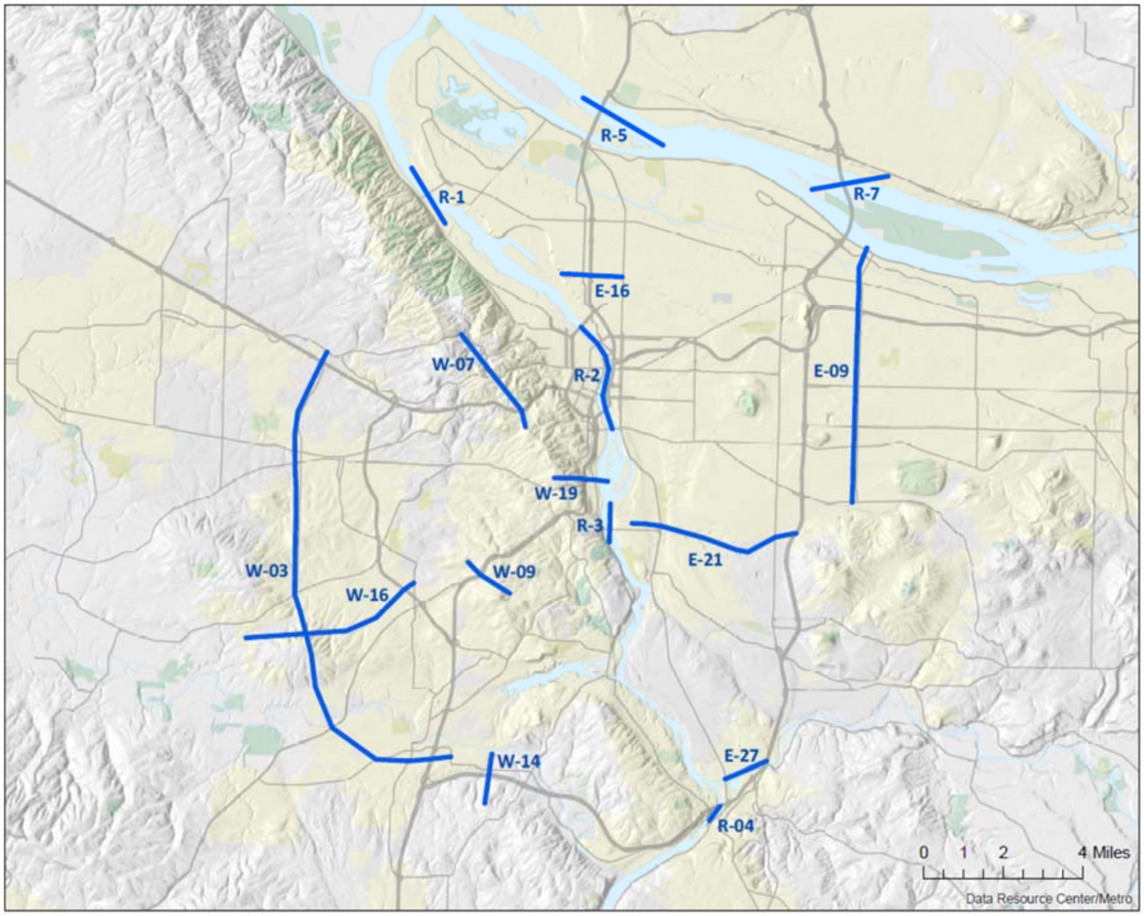


TABLE 54. Count-based adjustment factors

Time Period	Count-based Adjustment Factors	Time Period	Count-based Adjustment Factors
0:00 - 0:59	0.0064	12:00 - 12:59	0.0579
1:00 - 1:59	0.0045	13:00 - 13:59	0.0592
2:00 - 2:59	0.0042	14:00 - 14:59	0.0645
3:00 - 3:59	0.0053	15:00 - 15:59	0.0697
4:00 - 4:59	0.0110	16:00 - 16:59	0.0727
5:00 - 5:59	0.0288	17:00 - 17:59	0.0716
6:00 - 6:59	0.0527	18:00 - 18:59	0.0611
7:00 - 7:59	0.0669	19:00 - 19:59	0.0428
8:00 - 8:59	0.0643	20:00 - 20:59	0.0330
9:00 - 9:59	0.0559	21:00 - 21:59	0.0277
10:00 - 10:59	0.0531	22:00 - 22:59	0.0190
11:00 - 11:59	0.0557	23:00 - 23:59	0.0119

H Assignment

H.1 Auto Assignment

Auto assignment procedures are developed in Emme macro language and run with Emme software. This package has a full capacity-restrained equilibrium path-finding algorithm. The number of lanes, lane capacity, initial speed, and distance are all link attributes. The link capacity, initial speed, and distance are attributes used in estimating the speed under two given flow rates. Autos and trucks are typically assigned simultaneously using a multi-class assignment technique. Additional truck delay is included on various links in the arterial system in order to account for factors such as slope that are known to affect truck path choice. Hence, truck flows tend to use higher order facilities in the path choice algorithm. Trucks are assigned as passenger car equivalents (PCEs) to account for the different space consuming characteristics.

H.2 Transit Assignment

The multi-path transit assignment follows the auto assignment, with transit speed determined as a function of underlying auto speed except where transit vehicles operate on exclusive right-of-way. Transit time consists of auxiliary (walk) time, wait time (initial and transfer), boarding time, and in-vehicle time. Actual wait time at certain nodes and actual in-vehicle time on certain line segments are reduced by applying factors designed to account for perceptions of time that vary by stop and vehicle type. The transit assignment algorithm allocates trips among eligible paths by (1) distributing flow between multiple outgoing centroid connectors using an embedded logit model based on total transit time to the destination; and (2) distributing flow between multiple lines at a stop node by considering frequency and total transit time to destination.

I Portland International Airport Model

Trips to/from the zone containing the Portland International Airport (PDX) terminal are generated by the Airport Passenger Demand Model (APDM). This model is separate from the Kate travel demand model. Documentation for the APDM can be found in the supporting document referenced in the Table of Contents.

The output of the APDM is a set of hourly and daily zone-to-zone trip tables for SOV, HOV, and transit. These tables are added to the appropriate transit trip tables produced by the Kate model time of day programs, and then assigned to the mode-specific networks as applicable.

J External Model

The characteristics of external trips are different from the other purposes, so the procedure to calculate the trips is not the same as the others. The following steps are used to model external trip generation.

1. Calculate Average Weekday (AWD) target volume for each external location
2. Calculate Average Weekday (AWD) target volume for five trip components at each station by using percents from the 1987 external travel survey. The components follow:

- External-Internal Home-Based Work Trips
- External-Internal Non-Home-Based Work Trips
- Internal-External Recreational Trips
- Internal-External Non-Recreational Trips
- External-External Trips

TABLE 55. External Destination Choice Equations

Ext-Int HBW	**Estimation & Calibration**	$U = \exp(\ln(ATTR_j) - 0.135*T_{ij})$
Ext-Int NonHBW	**Estimation & Calibration**	$U = \exp(\ln(ATTR_j) - 0.125*T_{ij})$
Int-Ext Rec	**Estimation & Calibration**	$U = \exp(0.0002448*AWD - 0.03474*T_{ij})$
Int-Ext NonRec	**Estimation & Calibration**	$U = \exp(0.0001106*AWD - 0.07041*T_{ij})$
Ext-Ext	**Calibration**	using percents from 1987 cordon survey

Where:

i = from zone
j = to zone
T = travel time
AWD = average weekday traffic volume

Certain movements are restricted within the externals program; this is done to prevent illogical entry and exit combinations. External trips are added to the auto trip table at the end of the modeling process, but before trip assignment.

K Truck Model

The truck model forecasts the quantity, type, and distribution of truck trips generated by the flow of goods into, out from, and within the 4-county region. The model is based on a commodity flow (CF) database that forecasts annual tonnage flows of 44 commodity groups (2-digit SCTG) by primary mode, origin and destination regions and forecast year (2000 to 2035, in 5-year increments). The CF database was initially prepared for the Port of Portland using Freight Analysis Framework (1997 CFS) data. It was updated in 2005 using FAF2 (2002 CFS) data, then validated and augmented by the regional 2006 trade capacity study. It was most recently updated in December 2015, using a FAF3 (2007 CFS) database provided to the Port in April, 2015

The prepared CF data provides a commodity flow database that includes the FAF3 zone comprising Portland and surrounding Oregon counties, plus isolates freight flows to and from Clark County, WA from another FAF3 zone that includes all of Washington outside the Puget Sound area. Thus, the database includes flows to and from the whole Portland-Vancouver metropolitan region. In the April 2015 update, the contractor also post-processed FAF3 data to parse many of the multi-mode domestic flows into component legs by mode. .

Adjustments to Base Year (2010) Commodity Flows
The Port of Portland maintains annual statistics of freight tonnage entering and leaving Port facilities. Overall tonnage growth between 2005 and 2010 was generally consistent with forecasts flows in the CF database. However, ship-borne vehicle imports and all air freight shipments were reduced to 0.75 times 2005 levels to maintain consistency with Port data.

Adjustments to Future Year (2035) Commodity Flows
Forecasted regional employment growth has been significantly reduced since the time that the CF database was last validated. Accordingly, growth in internal flows of commodity groups associated with each employment sector has been scaled to maintain consistency with employment forecasts, while still allowing for marginal increases in productivity.

K.1 Allocation of Flows to Truck Sub-modes

Where truck is not the primary mode of travel, Port of Portland staff provided estimates of the proportion of each commodity flow that will utilize the truck sub-mode for part of the journey. It is assumed that 100% of air freight entering and leaving the region will utilize trucks to access and egress the airport. Similarly, 100% of rail-truck intermodal freight utilizes trucks. For other rail and for ship and barge, the proportion utilizing a truck submode varies by commodity. About one-fourth of total rail tonnage entering and leaving the region utilizes a truck sub-mode in 2005, increasing to one-third in 2035. About one-half of total water-borne tonnage is assumed to utilize a truck submode. It is assumed that no pipeline-borne commodities utilize a truck sub-mode en route to consumption or processing destinations.

The Port of Portland also provided estimates of the proportion of truck-borne flows in each commodity group that should be allocated to private carriers and truck load shipments with the balance allocated to less-than-truckload shipments.

K.2 Flows Modeled

TABLE 56. Truck flows modeled

FROM: \ TO:	Internal Zones	External	Port Facilities	Rail / Intermodal	PDX
Internal Zones	x	x	x	x	x
External	x	x	x	x	x
Port Facilities	x	x	na	na	na
Rail / Intermodal	x	x	na	na	na
PDX	x	x	na	na	na

K.3 Application of Weekday Factor

A simple 1/264 factor is used to reduce annual flows to daily. No seasonal adjustments are made.

K.4 Allocation of Flows with local Origins/Destinations to TAZs

Metro Data Resource Center provided both base year and forecasted employment by industrial sector for each transportation analysis zone (TAZ). The sector groupings are as follows:

- Agriculture/Farming/Forestry (AGFF)
- Mining (MIN)
- Construction (CON)
- Manufacturing (MAN)
- Transportation/Communications/Public Utilities (TCPU)
- Wholesale (WHLS)
- Retail (RET)
- Finance/Insurance/Real Estate (FIRE)
- Service (SERV)
- Government (GOV)

With guidance from Cambridge Systematics, the SCTG2 commodities were consolidated into 16 commodity groups and allocated to employment sectors as follows:

TABLE 57. Commodity / employment sector associations

Commodity Group	Produced by	Attracted To
Farm	AFM	AFM, MFG
Metallic Minerals*	n/a	n/a
Non-metallic Minerals	CON	MFG
Chemicals	MFG	AFM, MFG
Petroleum	MFG	MFG, TPU
Stone	MIN, MFG	CON, MFG
Food	AFM, MFG	all
Wood	AFM, MFG	CON, MFG, RET
Paper	AFM, MFG	MFG, TPU, RET, FIRE, SERV, GOV
Metals	MFG	MFG
Machinery	MFG	MFG
Transportation Equipment	MFG	TPU
Manufactured Goods	MFG	MFG, RET
Textiles	MFG	RET
Waste Products	all	MFG
Courier	all	all

* no internal trip ends

K.5 Allocation of Flows to Terminals and Other Regional "Gateways"

Trucks carrying commodities that enter or leave the region at specific sites such as railyards, barge terminals, marine facilities, the airport, and external points are assigned one trip end at those places. Based on discussions with the Port staff, each of the specific rail, barge, ship, and air facilities was allocated a predetermined percentage of total flows to that facility type.

Rail flows are allocated about equally to the three main railyards in the region. All commodities are given the same percentage.

TABLE 58. Railyard allocations

Railyard	Percent of Total Rail-Truck Flows
Albina	33%
Brooklyn	33%
Wilbridge	34%

Ship and barge flows are allocated among port terminal facilities as follows:

TABLE 59. Commodity allocations by port facility

Commodity	Port Facility	TAZ #	Flow Portion
Farm Products	POP Terminal 6	128	12%
	POP Terminal 5	129	22%
	POP Terminal 4	162	22%
	Albina Docks	197	22%
	Albina Docks	201	22%
Metallic Minerals		(No Products to/from Port terminals)	
Non-Metalic Minerals	Rivergate	154	80%
	Ross Island	220	20%
Chemicals	Rivergate	154	100%
Petroleum	POP Terminal 2	34	25%
	Wilbridge - South	38	25%
	Wilbridge - North	48	25%
	POV Terminal 2	1508	25%
Stone	POP Terminal 2	34	14%
	Wilbridge - North	48	14%
	Pier 99	134	14%
	Albina Docks	197	14%
	Ross Island	220	15%
	POV Terminal 1	1506	15%
	POV Terminal 3/4/5	1531	14%
Food	POP Terminal 6	128	100%
Wood	POP Terminal 2	34	50%
	POV Terminal 2	1508	50%
Paper	POP Terminal 2	34	72%
	POP Terminal 6	128	25%
	POV Terminal 3/4/5	1531	3%
Metals	POP Terminal 2	34	33%
	POP Terminal 6	128	33%
	Rivergate	154	34%
Machinery	POP Terminal 2	34	100%
Transportation Equipment	POP Terminal 6	128	53%
	POP Terminal 4	162	34%
	POV Terminal 2	1508	13%
Manufactured Goods & Electronics		(No Products to/from Port terminals)	
Textiles	POP Terminal 6	128	100%
Waste Products	POV Terminal 1	1506	33%
	POV Terminal 3/4/5	1531	34%
	Columbia Way	1561	33%
Courier Services		(No Products to/from Port terminals)	

External highway cordon locations are gateways for flows entering or leaving the region by truck. The commodity flow origin-destination database identifies the distribution of each commodity entering or leaving the region by direction. For each direction, the flows are distributed among the various highways, based on available truck count data, as follows:

TABLE 60. External flow allocations

Direction	Facility	Cordon TAZ #	Distribution to/from TAZs and PDX	Distribution to/from Railyards and Port
North	I-5	2149	100%	100%
East	SR 14	2148	11%	0%
	US 26	2161	19%	0%
	I-84	2162	70%	100%
South	Bald Peak Rd.	2154	1%	0%
	OR 219	2155	2%	0%
	I-5	2157	84%	100%
	US 99E	2158	8%	0%
	OR211	2159	3%	0%
	OR 213	2160	2%	0%
West	US 30	2150	45%	55%
	US 26	2151	6%	0%
	OR 6	2152	12%	0%
	US 99W	2156	32%	45%
	OR 47	2153	5%	0%

All **Air Freight** is assumed to enter or leave the region via Portland International Airport (PDX), TAZ 139.

K.6 Linkage of Commodity Flows to Reload Facilities or Terminals

Reload facilities consist of truck terminals and major warehouse and distribution facilities. The model assumes that 60% of LTL shipments and about 6% of TL and PVT shipments are routed through a reload facility. The list of facilities in the region was compiled by the Data Resource Center using both employment security (ES202) data, ESRI Business Analyst data, and other available sources. Facilities were classified by type, and only those locations that are primarily engaged in trucking, warehousing, and distribution, and that have at least 50,000 square feet of floor space or 30 employees were retained. For example, the stores in a grocery chain are not included, but the chain's distribution center is. Actual base year employment, if available, was compiled. Otherwise, employment was estimated by business type and floor area. The employment, which serves as a proxy for level of freight activity at each facility, was summed for each TAZ.

Total LTL and TL/PVT tonnage for reload is calculated and routed from origin TAZs, in proportion to the total employment at reload facilities, and then on to destination TAZs. No unique factors were obtained for separate commodity groups.

K.7 Modeling Pickup and Delivery Tours

Insufficient data were available to simulate pickup and delivery tours, including deliveries of goods and services to houses and apartments. This version of the model does not contain additional processing to replicate this type of trip. However, shipments to and from zones having just a few businesses and employees are accounted for in fractional truck trips, the fraction being determined by the commodity load factor.

K.8 Determine Tonnage Allocation by Vehicle Type

Highway vehicle classification counts were used to develop average percentages of heavy vs. medium trucks on the system. This, combined with average weight carried by each vehicle type produced a vehicle split of 70% heavy truck and 30% medium truck. To obtain this split, about 92% of total commodity tonnage is allocated to heavy trucks and the remainder to medium trucks.

- Medium trucks are defined as FHWA Class 4-7, or single unit trucks
- Heavy trucks are defined as FHWA Class 8 and above, or trucks with one or more trailers

K.9 Determine Number of Trucks by Commodity Type

Separate commodity class tons to truck trip factors were obtained for the heavy and medium trucks using data from the VIUS (Vehicle Inventory and Use Survey) which was provided to us by Cambridge staff. Separate payload factors were developed for internal and external truck trips.

TABLE 61. Load factors / tons per vehicle

	Heavy Trucks		Medium Trucks	
Commodity Group	**Internal**	**External**	**Internal**	**External**
Farm Products	19	22	6	11
Metallic Minerals & Coal	23	23	12	16
Non-metallic Minerals	23	23	12	16
Chemicals	18	21	6	12
Petroleum Products	21	24	5	10
Stone, Clay, Concrete, Ceramic, or Glass	23	23	12	16
Lumber or Wood Products, Furniture	16	19	3	8
Food, Fish, & Marine Products, Tobacco	18	20	4	7
Pulp, Paper, & Printed Matter	18	19	4	9
Primary & Fabricated Metal Products	18	20	4	7
Machinery & Electrical Equipment	17	19	3	5
Transportation Equipment	17	18	3	5
Misc. Manufactures, Instruments, Ordnance	13	17	2	5
Textiles, Apparel, Leather, and Products	15	17	3	7
Waste by-Products	11	16	5	5
Courier Services (packages)	17	19	7	10

These values were in line with the Port's estimate of average FEU weight overall of 21 tons/FEU.
Based on discussions with Port staff, all TL/PVT flows were assigned to heavy trucks, except for those with origins/destinations in high density, central city areas. Flows with origins or destinations in the central city are

assumed to be transported by medium trucks. All LTL and TL/PVT flows were allocated to medium trucks for those TAZs.

K.10 Estimate Additional Vehicle Trip Segment Trip Ends (Unbalanced)

Each matrix of commodity flows was reviewed to determine unbalanced trip origins and destinations. For any given zone, if the origins did not equal the destinations, the smaller of the two was increased to match the other. The purpose of this step is to partially account for empty truck moves.

K.11 Estimate Additional Vehicle Trip Segment Trip Ends (Balanced)

Certain movements such as repositioning and container maintenance require the addition of more truck trips to the trip table(s). However, at this point, there were limited data to estimate such trips. The only additional trips generated in this step were LTL trips to make up the difference between the reload and truck terminal counts (summed by TAZ) and the volumes produced by the tactical model.

K.12 Create Initial Truck Trip Tables

LTL and TL/PVT vehicle tables are combined by truck type. These tables represent average weekday truck vehicle trips having an internal origin and/or destination, and prior to reconciliation of internal-external flows trips with external truck counts or projected volumes.

K.13 Estimate External Truck Trips

External truck base year control totals are currently derived from traffic counts and vehicle classification counts. Future year control totals employ a traffic count growth trends analysis. The results represent total truck volumes at the externals, including internal-external, external-internal, and through-trip shipments.

External-to-external flows which do not involve a mode change inside the region are not included in the strategic model database. Trip tables for medium and heavy truck through-trips were developed independently of the commodity flow model. The 2006 Freight Data Collection study found that about half the total trucks counted while entering or leaving the region on the main Interstate highways and U.S routes were traveling through, with the vast majority of those using I-5. (Since each through-trip passes through 2 counting points, about ¼ of all external truck trips are through-trips) The truck model uses vehicle classification counts at each external station along with estimates of the through-trip percentage and a "seed" matrix that reflects the 2007 FDCS observed distribution of through-trips between stations to produce medium and heavy truck through-trip matrices that account for about half of total observed base year and forecasted future year truck volumes entering and leaving the region. Then, the external-internal and internal-external component of the truck matrices from the commodity flow model are scaled so that the combined E-I, I-E, and through-trips match the observed or forecasted truck counts.

K.14 Estimate Truck Trip Table by Time of Day

Peaking factors were developed using regional highway count data and reload facility counts. A weighted average of all vehicle classification counts was used to develop the following factors as percent of weekday total:

TABLE 62. Diurnal peak factors - trucks

	Heavy Truck	Medium Truck	Reload Facility Midday
AM Peak 2-Hour	11.09%	12.99%	na

Midday 1-Hour	6.68%	8.20%	5.60%
PM Peak 2-Hour	8.52%	9.95%	na

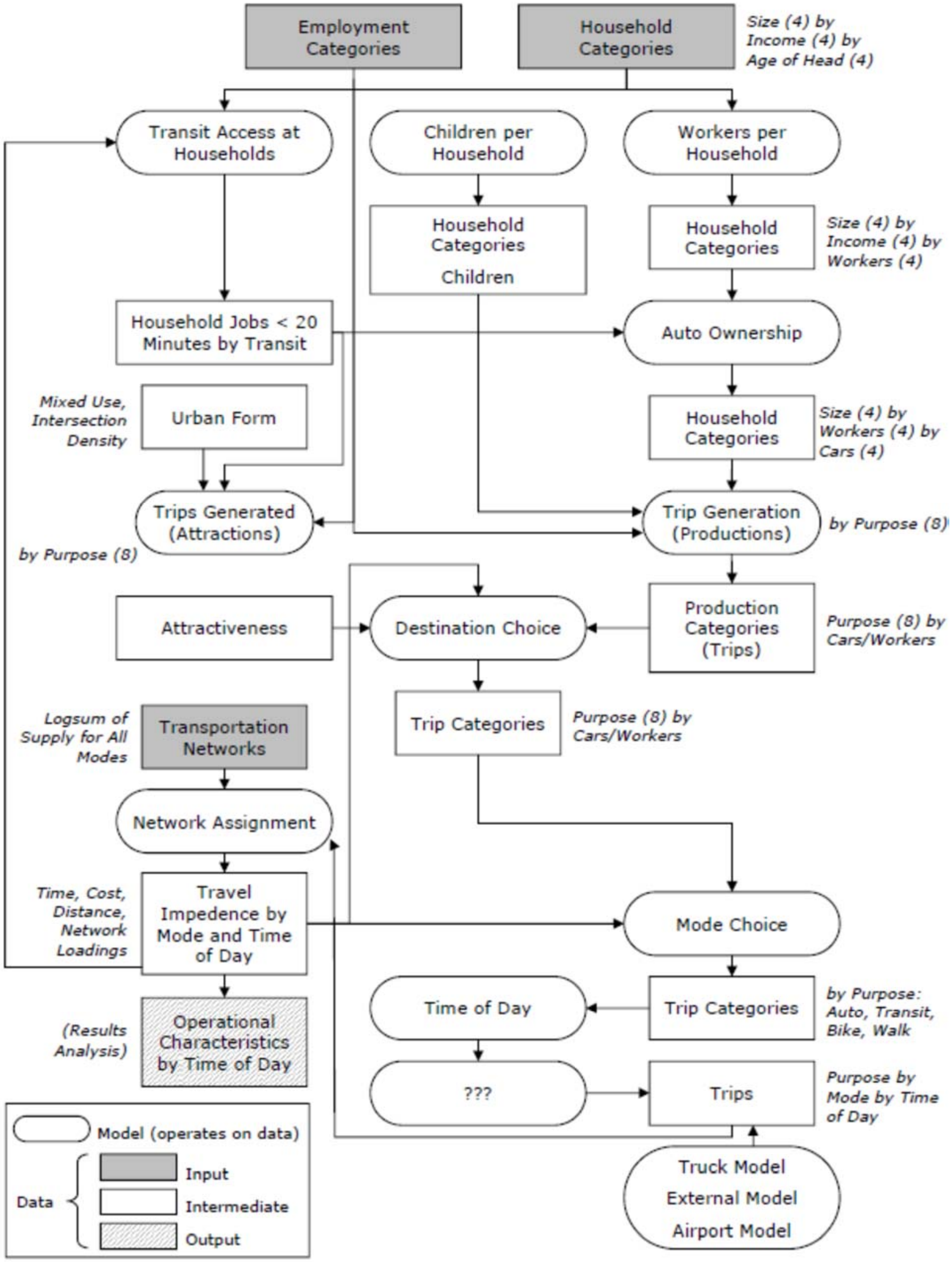
K.15 Assign Truck Trips to Network

Average Weekday (AWD), peak, and off-peak trip tables are prepared for heavy and medium trucks. Prior to assignment to the highway network, a passenger-car equivalent (PCE) factor of 1.7 is applied to account for the extra space trucks take up on the road, the slower acceleration, and longer stopping times.

Heavy and medium truck PCEs are assigned to the roadway network along with other vehicle classes using a multi-class assignment. Coding for the truck mode is removed from links where truck prohibitions are in place. A truck path attribute is used to represent the additional truck travel time associated with steep upgrades, narrow lanes, difficult turns, etc on certain portions of the network.

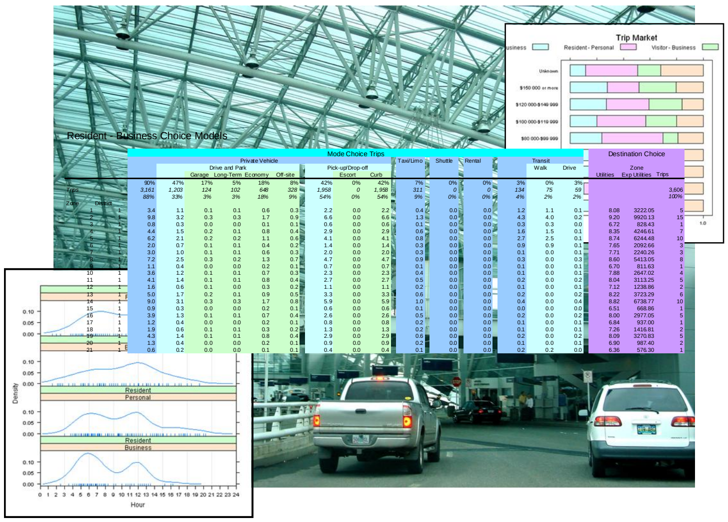
A vehicle classification count program was undertaken as part of the Freight Data Collection program in 2006 which provided validation data for AWD truck volumes. Additional truck volume estimates have been obtained from the ODOT Automatic Traffic Recorder (ATR) database. Assigned truck volumes have typically been 10%-15% lower than counts, which reflects in part the exclusion of non-freight trucks as well as under-representation of pickup and delivery tour stops.

Appendix A – Metro Model Forecasting Model Structure



Airport Passenger Travel Demand Model

User's Guide



Prepared For :

Port of Portland
121 NW Everett Street
Portland, OR 97209-4049

PORT OF PORTLAND
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Submitted By :

PB Americas, Inc.
400 SW Sixth Ave., Suite 802
Portland, Oregon 97204

With:

John Parker Consulting, LLC
6950 SW Hampton St., Suite 318
Tigard, Oregon 97223

JPC
John Parker Consulting, LLC

August 22, 2009

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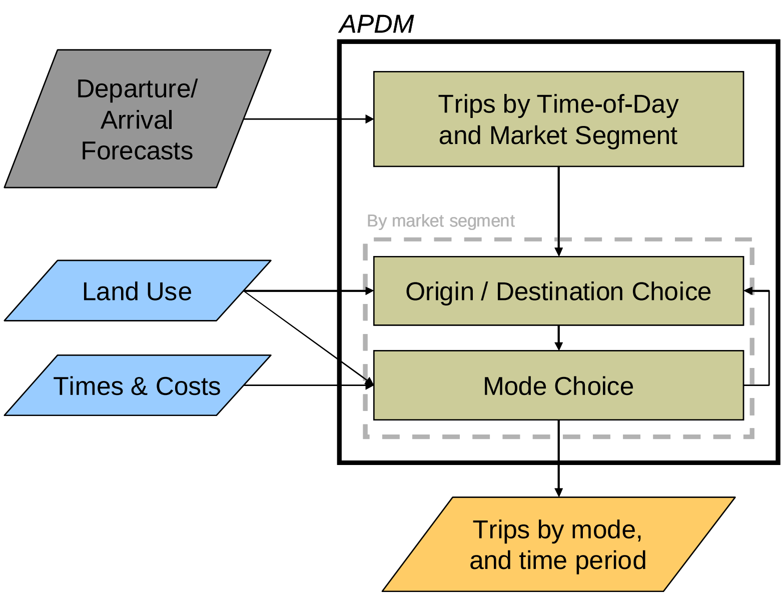
Introduction

The Airport Passenger Demand Model (APDM) is a tool designed to model passenger responses to airport projects and policies and responses to changes in the Portland regional transportation plan. The model is designed for use by the Port in performing scenario tests as part of the PDX Airport Futures long-range plan, and other similar long-range transportation planning activities conducted by the Port of Portland, Portland Metro, and other agencies in the Portland region. The first task in development of this model was a literature review of airport ground access models, documented in a technical memorandum.[1] The model takes forecasted air passengers as an input and predicts trips by mode and time of day to areas within and without of the Portland region as an output. The model assigns trips to the transportation network, provides reports on model results, and also provides inputs to the FTA SUMMIT program to analyze transportation system user benefits.

This process is depicted in Figure 1.



[1] Terminal Survey Data Description. Parsons Brinckerhoff. December 2008.

Figure 1 Model overview

The model works in concert with Portland Metro's regional model. Metro's model predicts employee work trips and truck movements. The combined system provides a comprehensive picture of airport related travel. The model is implemented as a separate component from the regional Metro model in a set of Python scripts, and a simplified version of the model is also implemented as a standalone spreadsheet. This version is designed to allow the Port to quickly conduct policy scenario tests independent of the regional model, though with somewhat less policy sensitivity than the full Python model.

This report is divided into two parts. The first documents the model structures and final parameters. This part discusses the trip generation and choice models in Figure 1. The second part of the report discusses using the model to conduct sensitivity tests. This part reports on the sensitivity tests conducted as part of the model development effort and provides guidance on scenario testing.

1 APDM Design

The design APDM follows the Ports goals for the project. The Port wanted a model that is simple to apply, does not require special data and is responsive to changes in regional land-use, airport demand, airport ground access modes, parking supply, and overall infrastructure. To support the model development effort, the Port commissioned two surveys of airport terminal users in June and September 2008. The surveys were extension to the regular terminal user survey. In order produce a data set suitable for estimation, the number of observations were approximately doubled and the following questions were added to better understand what airport users were doing prior to their airport trip.

1. What is the address, cross street, or landmark nearest to the location where your trip to the airport began TODAY?

1. What time did you leave that location for the airport?

2. Which of the following best describes that location?

In addition to these questions, the model development used information from the standard questions including:

- Where did you park?
- How long do you plan to park?
- What is the primary purpose of your trip?
- Including yourself, how many people in your traveling party are flying today?
- Did anyone come inside the terminal that is not traveling today?
- About how long will you be inside the PDX terminal building during this visit?
- What is the ZIP code of your residence?
- What is the purpose of your visit to PDX today?

The number of observations by date are shown in Table 1.

Date	Day	Observations
6/17/2008	Tuesday	183
6/18/2008	Wednesday	2
6/19/2008	Thursday	300
6/20/2008	Friday	205
6/23/2008	Monday	90
6/24/2008	Tuesday	200
6/25/2008	Wednesday	172
9/21/2008	Sunday	146
9/22/2008	Monday	201
9/25/2008	Thursday	161
9/26/2008	Friday	190
9/27/2008	Saturday	169
Total		2019

Table 1 Observations by Date

The data collected in the survey was merged with regional model land use characteristics, travel times and costs. This section describes how these data were used to development each of the model components: trips from air passenger movements, destination and mode choice, and external trips. The balance of the section describes the model calibration.

1.1 Factoring Procedures

The diagram in Figure 3 depicts the process used to generate air passenger trips from air passenger movements. The process divides the air passengers into three market dimensions: residence status (Resident of Portland Airport capture area or Visitor), purpose (Business or Personal), and model area (internal and external). The airport capture area is shown in Figure 1. Trips are generated by market segment by applying the share of trips by market segment observed from the air passenger survey to forecasted levels of air passenger movements by arrival/departure hour. As a result, trip generation considers the proportion of overall trips by market segment to be exogenous to the model, based entirely on passenger arrivals and departures by hour.

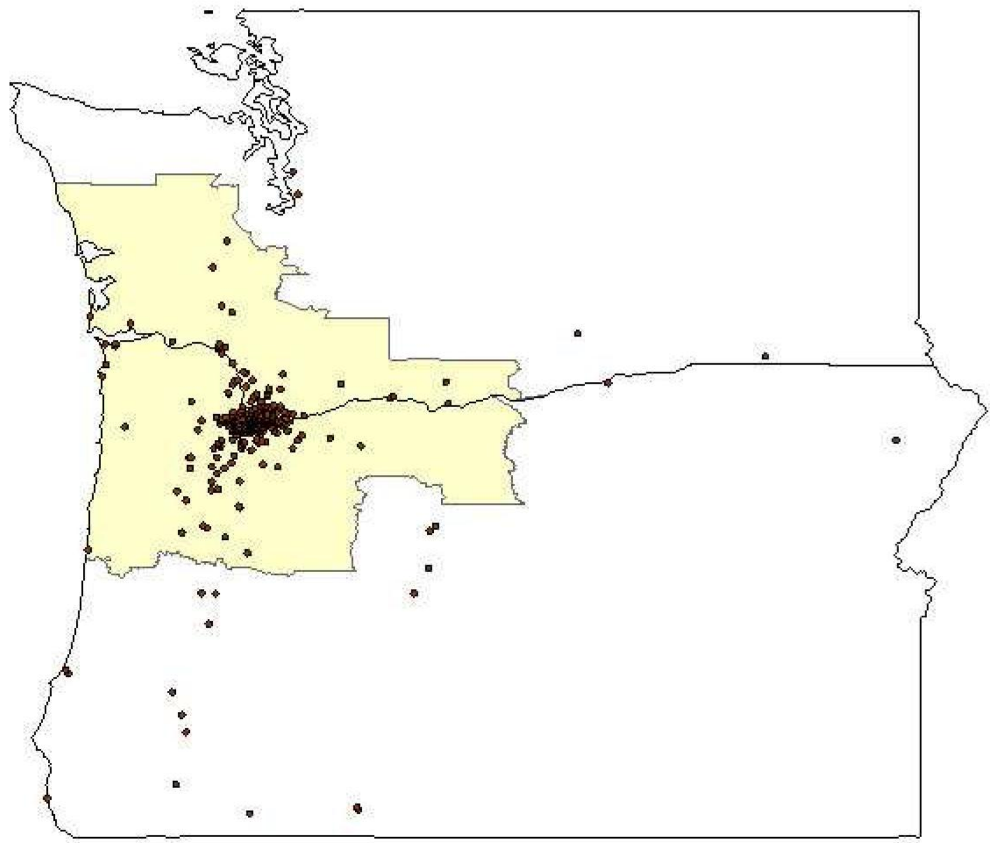


Figure 2 Airport capture area with survey observations

The input air passenger movements consist of connecting passengers and passengers for whom Portland is their origin or final destination. The number of connecting passengers is fixed at 15% of the total number of air passenger movements. The connection rate is based on both existing operations data furnished by the Port as well as future forecasts of aviation activity to 2035 from the Airport Futures process . Removing connecting passengers leaves the total number of air passengers making ground trips to or from the airport.

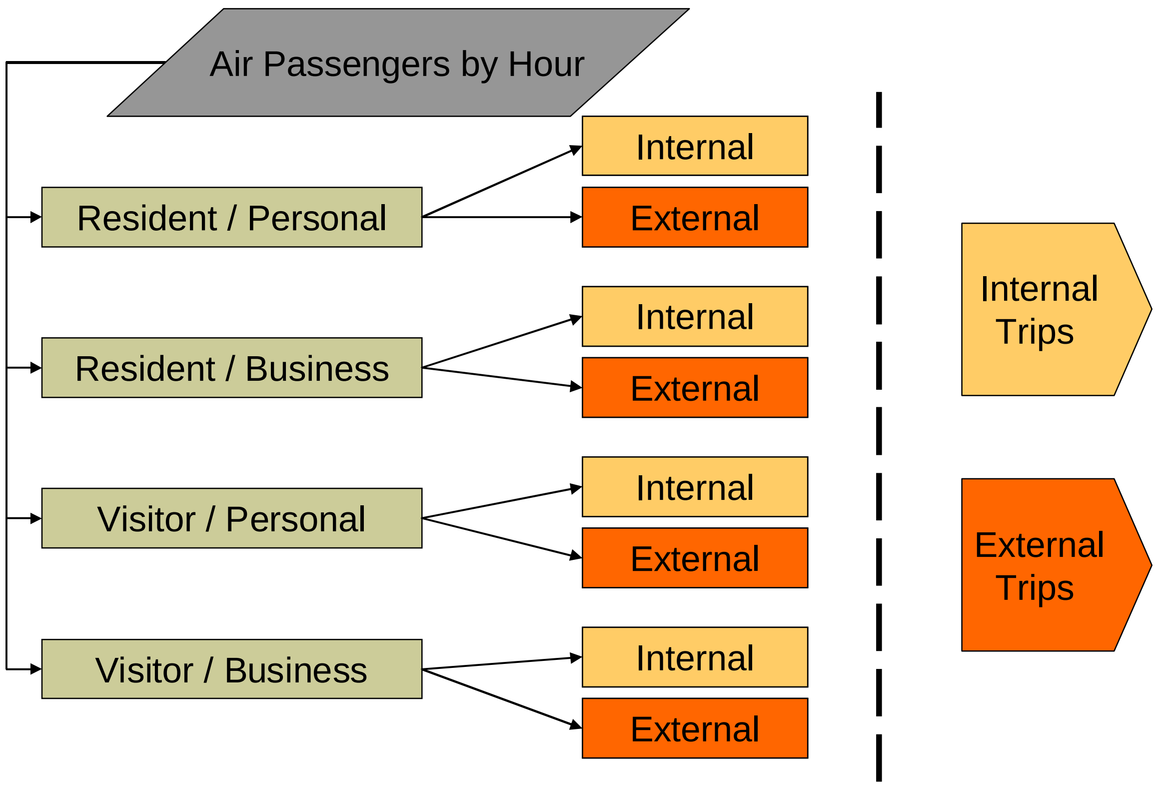


Figure 3 Trip generation process

The remainder of this section presents the details how the trips are split into the segments and time period. The end result of the trip generation process results in trips in origin / destination format. Note that this is different than most aggregate travel demand forecasting models, where trips are in production / attraction format through trip generation, distribution, and mode choice.

1.1.1 Markets

Air passenger trips are segmented into markets along three dimensions: residence status, purpose, and external or internal to the model area. This market segmentation accounts for major differences in the choice sets that travelers face. Residents make fundamentally different choices than visitors. Residents will not, for example, use a rental car for their trip to or from the airport. Business travelers are more likely to stay in downtown hotel locations, choose taxi for travel, and have a small travel party size. Business travelers are also likely to have lower cost sensitivities than visitors. The model area segmentation into internal and external trips reflects the different types of choices that are available to Portland area residents versus non-residents as they access the airport, and the different information that is available to model their behavior. Trips that are internal to the region respond to changes to the transportation and airport infrastructure since their origin or destination transportation analysis zone (TAZ) is known. External trips can not respond to the same changes in travel costs as internal trips since they are only tracked to an external station, and their actual origin destination is not known. Moreover, modal shifts for these trips are less likely since most have only drive and park as a viable modal option.

The process of segmenting trips into markets is done through factoring. Table 2 shows the factors.

Market Segment	Factor
Resident – Business	0.16
Resident – Personal	0.43
Visitor – Business	0.16
Visitor – Personal	0.25

Table 2 Market segmentation factors

1.1.2 Airport Pre-Departure Duration

The review of the survey data showed that the time spent in the airport prior to departure varies by market and time of day. Travelers on personal trips, which includes families on vacation, tend to spend more time in the airport than business travelers. Travelers arrive at the airport a longer time prior to departure when traveling during peak times than those departing during off-peak times, when security delays are generally lower and time spent checking in and passing through security is more predictable. The arrival time factors for departing passengers, by hour and market segment, are shown in Table 3.

Hour	Resident - Business			Resident - Personal			Visitor - Business			Visitor - Personal		
	0 Hour Prior	1 Hour Prior	2 Hour Prior	0 Hour Prior	1 Hour Prior	2 Hour Prior	0 Hour Prior	1 Hour Prior	2 Hour Prior	0 Hour Prior	1 Hour Prior	2 Hour Prior
0:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
1:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
2:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
3:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
4:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
5:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
6:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
7:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
8:00	0.081	0.645	0.274	0.120	0.474	0.407	0.036	0.727	0.236	0.044	0.593	0.363
9:00	0.473	0.527	0.000	0.101	0.434	0.465	0.014	0.786	0.200	0.132	0.358	0.511
10:00	0.473	0.527	0.000	0.101	0.434	0.465	0.014	0.786	0.200	0.132	0.358	0.511
11:00	0.473	0.527	0.000	0.101	0.434	0.465	0.014	0.786	0.200	0.132	0.358	0.511
12:00	0.000	0.482	0.518	0.016	0.425	0.559	0.016	0.653	0.331	0.054	0.592	0.355
13:00	0.000	0.482	0.518	0.016	0.425	0.559	0.016	0.653	0.331	0.054	0.592	0.355
14:00	0.000	0.482	0.518	0.016	0.425	0.559	0.016	0.653	0.331	0.054	0.592	0.355
15:00	0.119	0.478	0.402	0.160	0.568	0.272	0.099	0.561	0.341	0.050	0.554	0.396
16:00	0.119	0.478	0.402	0.160	0.568	0.272	0.099	0.561	0.341	0.050	0.554	0.396
17:00	0.119	0.478	0.402	0.160	0.568	0.272	0.099	0.561	0.341	0.050	0.554	0.396
18:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449
19:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449
20:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449
21:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449
22:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449
23:00	0.000	0.435	0.565	0.155	0.613	0.231	0.078	0.381	0.541	0.096	0.454	0.449

Table 3 Airport Pre-Departure Factors by hour and market segment

There are no departure time factors for arriving passengers, because the terminal survey did not collect data for arriving passengers, and because there is likely less variation in time spent at airport after arrival. Arriving passengers are assumed to leave within the hour that their flight arrives.

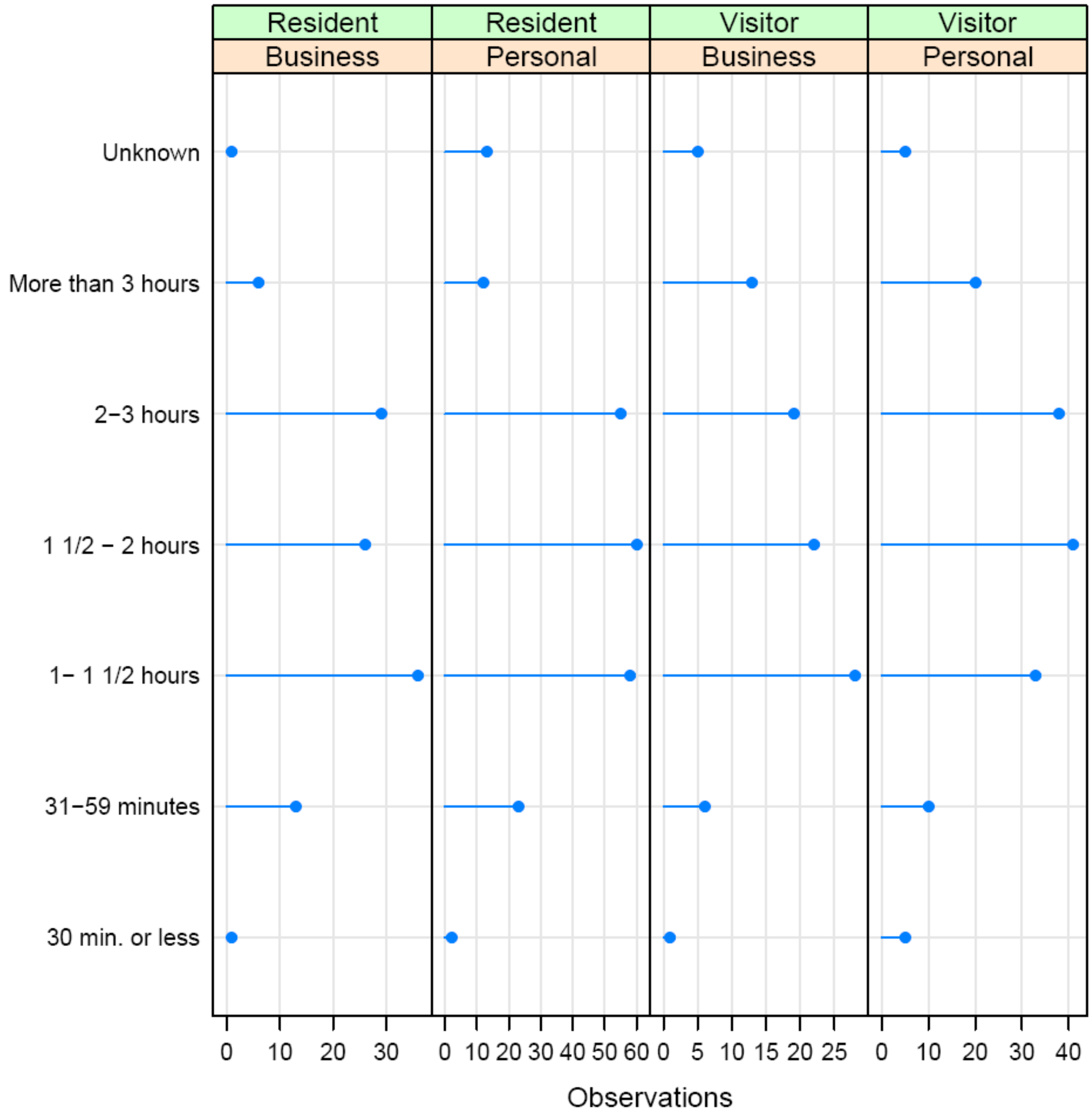


Table 4 Time in airport pre-flight

1.2 Trip Distribution

The trip distribution models predict the non-airport locations of trips. The models were estimated using observations in both the June and September terminal passengers surveys. These models take the form of a discrete choice model as opposed to a gravity model. Each zone is represented as a discrete alternative. The models were estimated using departing passenger data . The model estimation process sought to explain the origin of trips to the airport. The model is in essence an origin choice mode and equivalent to the more common destination choice model. The APDM assumes trips arriving have same the spatial distribution of trips to the airport as departing passengers.

The remainder of this section first describes the mathematical form of the models. Subsequently, estimation results for each of the residency-purpose market combinations are discussed in turn. Each of the models presented here were estimated using maximum likelihood in the R statistical environment[1].

1.2.1 Destination Choice Mathematics

Discrete choice models compute the probability of selecting an alternative amongst an enumerated list of all possible alternatives. Given a list of possible choices, a discrete choice model computes the probability of selecting each alternative. Destination choice models are very similar to mode choice models in that both are based on a type of discrete choice model called the logit model. As applied to destination choice models, the logit formulation is:

$$P_i(k) = \frac{\exp(U_{k|i})}{\sum_{j \in D} \exp(U_{j|i})}$$

where:

$P_i(k)$ is the probability of selecting attraction k, given production zone i,

$j \in D$ are the unique alternatives (attractions) in the sample set, and

U_j is the utility of selecting an attraction zone, given production zone i.

The equation states that given production zone i, the probability of selecting an attraction zone k is a function of the exponential utility of selecting k over the sum of exponential utilities of all

[1] R Development Core Team (2008). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

attractions zones in the choice set. The larger the utility of travel between production zone i and attraction zone j, the greater the probability of travel between the zones.

The utility for a selecting a particular alternative $(U_{k|i})$ is a linear function of the attributes that describe the alternative. In a destination choice model, the attributes that describe the selection of a zone include its accessibility, other variables that describe the quality of the choice, and variables that describe the quantity of activity in the attraction zone:

$$U_{j|i} = \beta_0 \times \beta_1 \times accessibility_{j|i} + \beta_2 \times quality_{j|i} + \ln(\beta_3 \times quantity_{j|i})$$

Utility functions for destination choice look different from the comparable functions for mode choice models due to the logarithmic term. This term is referred to as the size term as it captures the quantity aspects of the attraction zone. As an example, a business purpose model typically uses the amount of employment in the attraction as the size term. Because the size term is represented in a logarithmic form, its effect on the probability of an alternative is directly proportional to the size of the destination.

Three of the models presented below use mode choice logsums to represent accessibility. The measure includes all the information the model knows about travel via each of the modes in the model. Say that there are two competitive modes between a zone pair. The mode choice logsum will have a large overall accessibility change due to changes to either of the modes. If the modes are not competitive, and mode is clearly inferior to the other, than a change to the inferior mode will not result in a large change to mode choice logsum accessibility.

Destination choice models that use mode choice logsums as a measure of impedance have a special interpretation. The destination and mode models can be interpreted as sequentially estimated nested models. Mode choice becomes a nested choice under the choice of destination. The coefficient estimated on the mode choice logsum is interpreted as a nesting coefficient. Thus the coefficient must range be between 0 and 1. A value of 1 implies that there is no nesting. A value greater than 1 implies that the nesting structure is incorrect. A value closer to 0 means that that the lower level alternatives (modes) compete much more heavily with each other within the same destination than between destinations; in other words, the model is less sensitive to mode choice accessibilities than a model where the nesting coefficient is closer to 1.0.

	Resident		Visitor	
	Personal	Business	Personal	Business
MC Logsum	0	0.5	0.1	0
Distance	0	0.015	0	0
Distance < 5	0.3	0	0	0
Distance >= 5	0	0	0.05	0
Distance < 10	0	0	0	0
Distance >= 10	0.03	0	-0.05	0.04
Total Employment		1		
Service Employment		1	1	1.485
Finance Employment		1		2.5
Government Employment		1		2.5
Retail Employment			1	
Other Employment			0	1
Total Households	0	2.8	0	0
income 1	1		1	
income 2	1		1	
income 3	2		1	
income 4	8		5	
CBD	1.4	-0.5	1.7	
Airport Hotel Zone			4.4	
Intersections with 1/2 mile			0	1.8
Retail Employment mix			0	

Table 5 Destination Choice Parameters

1.2.2 Resident Personal

Table 5 presents the final parameters for each of the destination choice models. The destination choice model for resident personal travelers explains the spatial distribution as a function of distance to the airport, the number of households by income level, and whether the zone is a central business district (CBD) zone.

The initial specification of this model called for the use of mode choice logsums as the measure of impedance. However, this was dropped after considering the implications that the term would have on policy testing. If transit or highway accessibility to a zone improved, for example, a model with a mode choice logsum term would produce more trips to the airport. This result ran contrary the intuition of the model development team. Travelers within a metropolitan area are largely insensitive to the distance to the airport, since there is only currently one commercial airport in the Portland region. The terms on distance less than 5 miles and over 10 miles act as constraints on the model to distribute trips in accordance with the observed spatial distribution.

The terms on households by income level reflect that households with larger incomes are more likely to make air travel trips. Further, households in the CBD show a greater propensity for air travel than households outside the CBD. This may be due to the relatively higher presence of affluent residents without children that live in the Portland CBD.

1.2.3 Resident Business

The destination choice model for this market explains the spatial distribution of airport trips for residents making business trips. Business travelers have the choice of leaving from an office or a home location. This makes them sensitive to accessibility changes. Offices locations with improved MAX accessibility to the airport become a more attractive departure point than a home without MAX service. To capture the effect of accessibility of the modes, the models use mode choice logsums as the measure of separation. The model ideally would be sensitive to concentrations of higher income households as higher paying jobs tend to involve more travel. However, estimation results did not prove this to be true.

1.2.4 Visitor Personal

The visitor personal market reflects two distinctly different kinds of travelers to the Portland region. The first type stays with friends or family. The choice of location is independent of accessibility. The location choice is tied to household locations. The second traveler type is people on vacation and staying at hotel lodging. These travelers are somewhat influenced by transportation accessibility. The location choice for some is tied to recreation opportunities. For others, the location choice is tied to airport proximity.

The model parameters in Table 5 show a location choice with service and retail employment as well as households by income in the size term. Both employment and households are included to handle the two types of visitor personal travelers. These employment types are also correlated with cultural attractions and tend to place travelers in zones that act as an attraction to vacation visitors. The parameter mode choice logsums is quite small (0.1). Changes to accessibility should result in only minor changes to location choice. Like other markets, the term on distance is included to better match the observed spatial distribution.

1.2.5 Visitor Business

Visitors on business travel almost exclusively stay at hotel lodging and their choice of location is primarily influenced by the location of their business. This suggests that mode choice accessibility plays a limited role in location choice. Most of the explanatory power should come from land use characteristics. The destination choice model parameters shown in Table 5 reflect these expectations.

The destination model includes service, finance, government, and other employment in its size term. These employment categories are likely to generate more airport travel than other categories (all employment that is not service, finance, or government based). As previously mentioned, the distance term acts as a constraint on the model that better matches the observed spatial distribution of visitor business trips. Mode choice logsums are not included as transit accessibility is not an significant part of the location choice decision. The model also includes a term on intersection density to reflect that these travelers often go to dense urban areas like the CBD. Using this term precluded the need for a CBD constant.

1.2.6 Calibration Results

The destination choice models were calibrated to better reflect the observed trip distribution patterns. Figure 5 to Figure 8 show comparisons between the observed and calibrated trip length frequency and between the observed and calibrated trips by district. The district comparisons use the Metro 8 district system depicted in Figure 4.

The figures show a strong relationship between the observed data and calibrated model. There are several conclusions:

- For each of the markets, the model slightly over predicts the distribution peak.

- Resident travel to district 2 is under predicted. The mode is able to predict that this district produces a large number of air passenger trips. However, the total in the survey shows an even larger amount of trip productions. This may be an artifact of the limited number of survey observations. The under prediction to this district resulted in an over prediction to most other districts.

- The calibration process placed special emphasis on matching the number of trips to the Portland CBD area, district 1. This resulted in dummy variables for both resident purposes and for the visitor – business market.

Table 6 presents aggregate statistics of the trip distribution model performance. For each market, the mean trip length is within 1 mile of the observed value. The correlation statistic measures the correlation between observed and model trips by the Metro 8 District system. Correlations over 0.9 are typically considered excellent, above 0.8 to be good, and above 0.7 to be acceptable. The two business markets perform in the good range while the personal markets are in the acceptable range. Part of the difficultly in getting the visitor – personal market to match observed data might be explained by the category including both travelers visiting family and friends as well as those on vacation and staying at lodging.

Market Segment	Observed Mean Trip Length	Model Mean Trip Length	Correlation
Resident – Business	15.5	14.8	0.83
Resident – Personal	15.0	15.6	0.79
Visitor – Business	12.7	12.7	0.87
Visitor – Personal	14.8	14.0	0.78

Table 6 Trip Distribution Aggregate Statistics

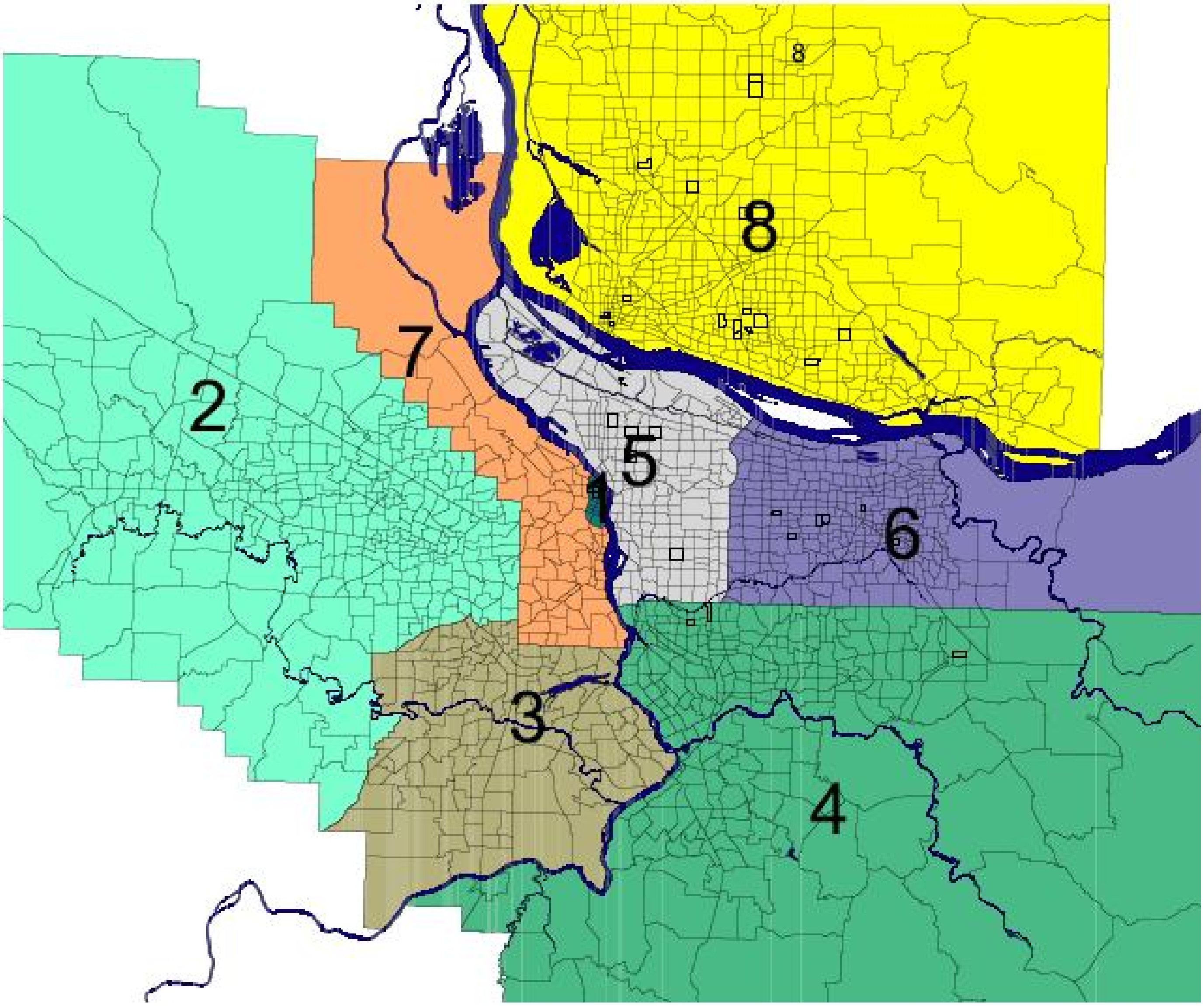
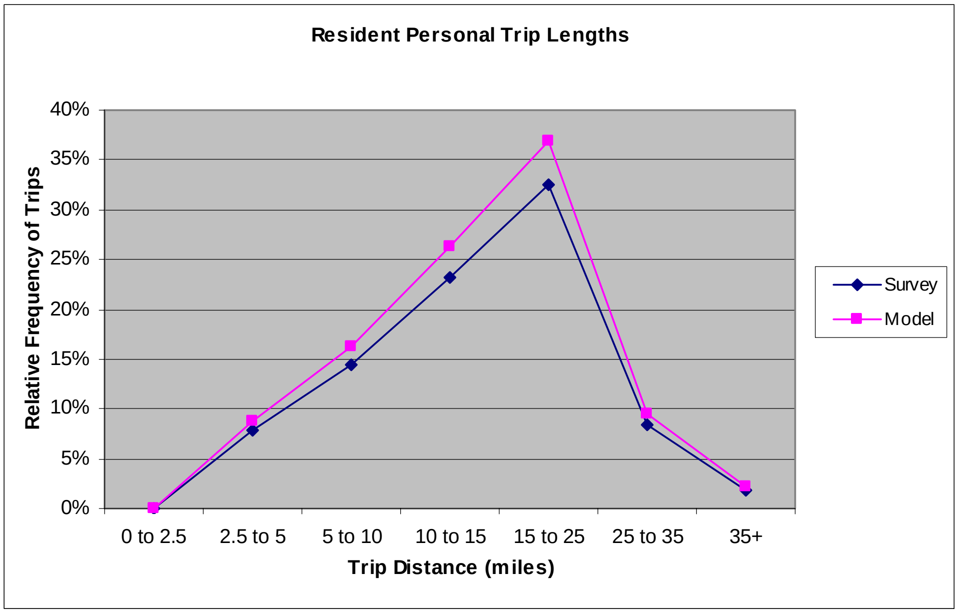


Figure 4 Metro 8 District System



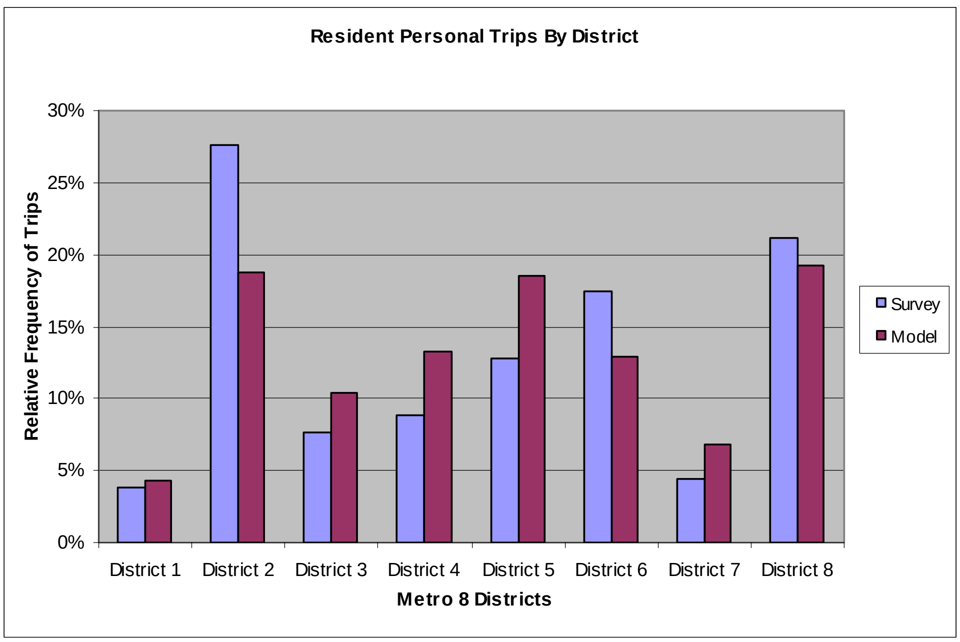
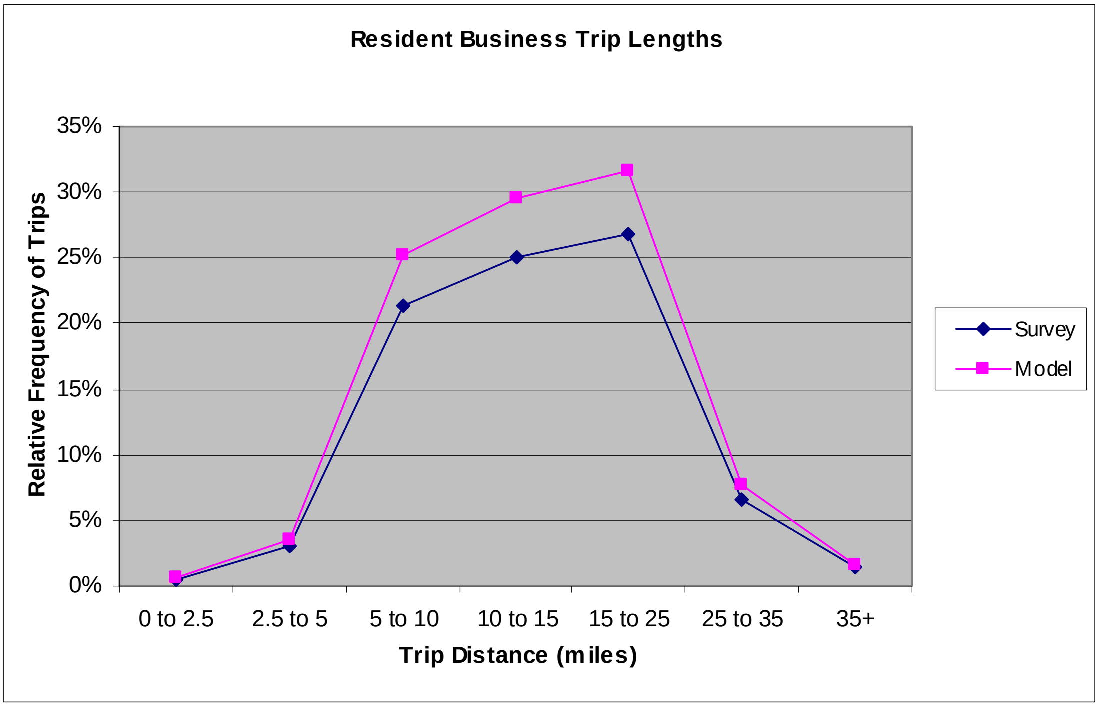


Figure 5 Resident – Personal Distribution Comparison



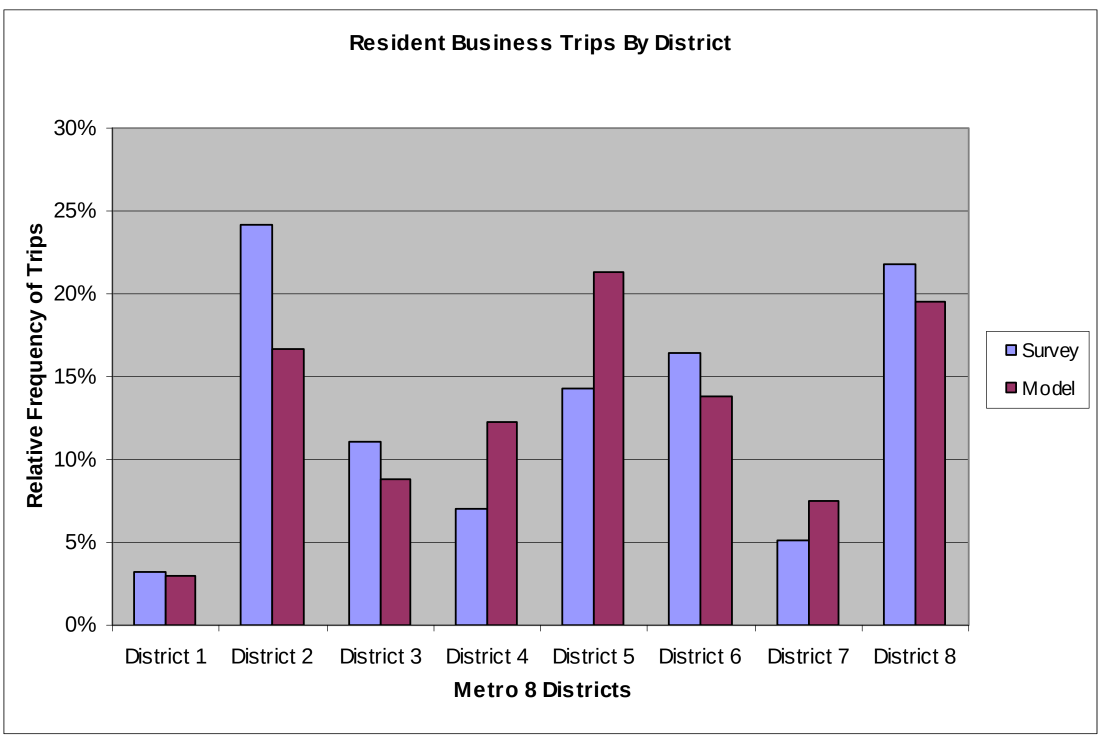
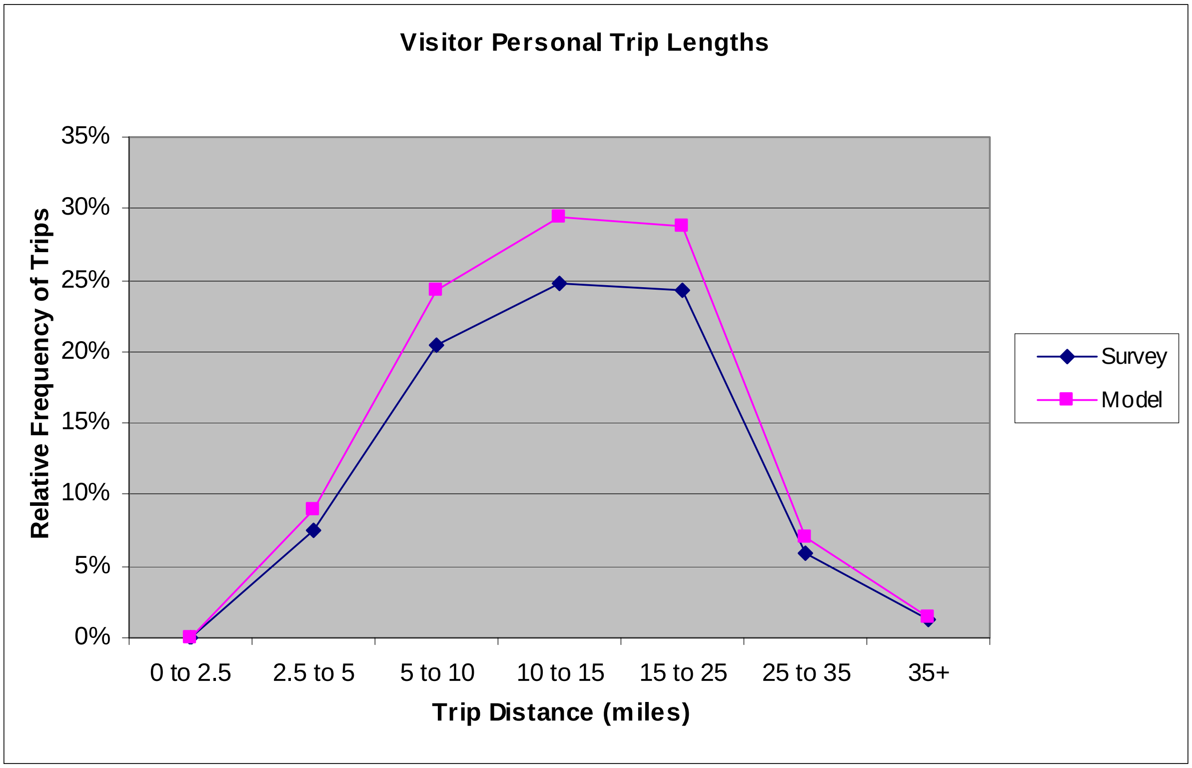


Figure 6 Resident – Business Distribution Comparison



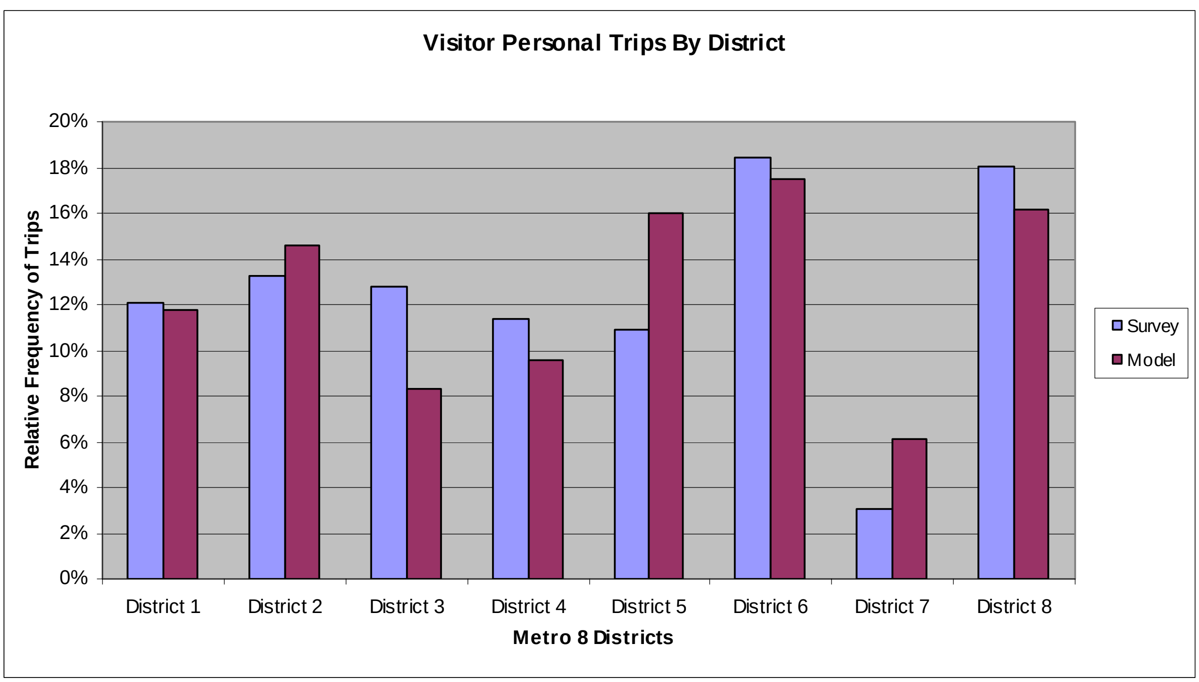
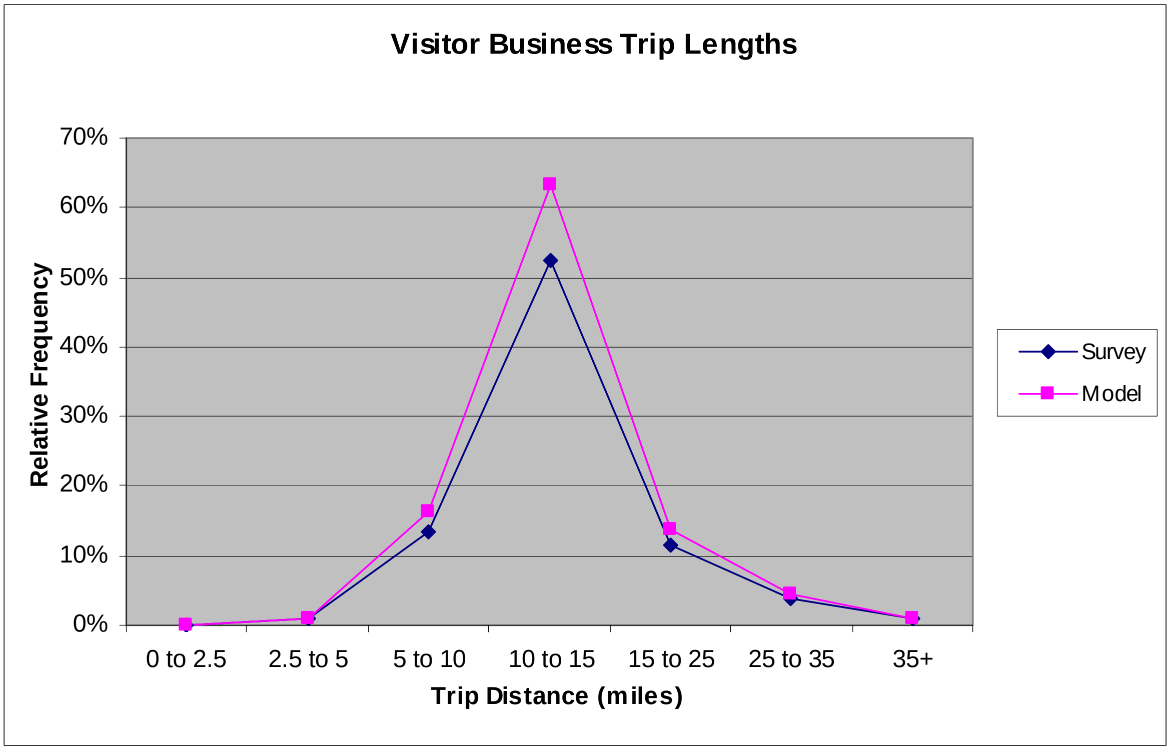


Figure 7 Visitor – Personal Distribution Comparison



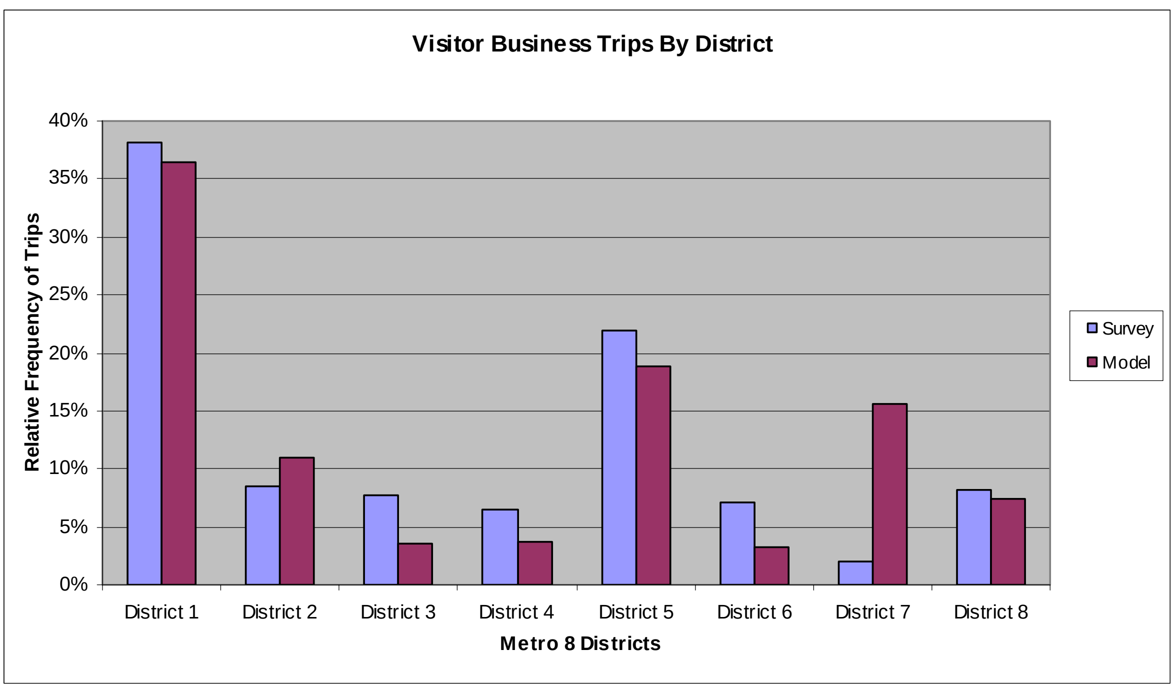


Figure 8 Visitor - Business Distribution Comparison

1.3 Mode Choice Models

The mode choice models explain the model of travel that air passengers use to and from the airport. Like the trip distribution models, the models use the logit model form. The particular form of the logit model used in the APDM is the multinomial nested logit model. Figure 9 shows an example of nesting, using the structure adopted for the APDM. A nested model is used to account substitution between alternatives. The different drive and park options shown in Figure 9 are good substitutes for each other and are thus grouped into a nest. The effect of nesting is that nested modes are more competitive with each other than with other, non-nested modes (nested modes have higher cross-elasticities). .

The drive and park nest includes all alternatives where a member of the travel party parks a vehicle at an airport lot or off-site lot while on the air trip. Each of the lots has an access time associated with travel between the lot and the terminal. For the economy, long-term and off-site lots, the access time includes the time spent waiting for a shuttle. The access time for short-term lot is the time spent walking to the lot. There are also daily and hourly parking rates associated with each of the lots. The travel time to the lot is simplified to be the same as the time to the airport terminal. Section 2.1 describes the parking sensitivity tests and gives more detail on the parking lot alternatives.

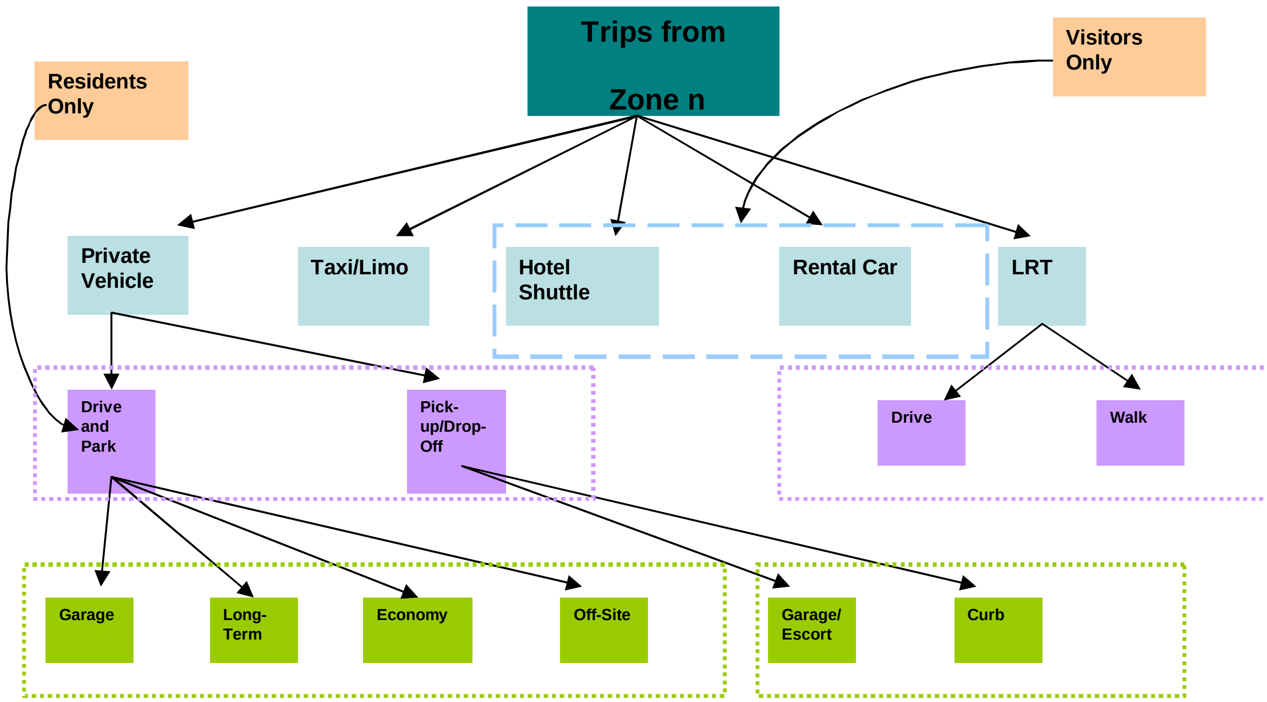


Figure 9 Mode choice nesting structure

The pick-up/drop-off nest describes travelers who are driven to the airport or picked up from the airport by someone not a member of the air travel party. The air travel party is either dropped off or escorted to the terminal from the short-term parking lot (for departing passengers), or picked-up at the curb or met at the terminal and escorted to the short-term parking lot (for arriving passengers). The pick-up/drop-off mode includes chauffer time in the utility expression.

In addition to taxi/limo, transit and personal vehicle, visitors are allowed to choose rental cars and hotel shuttles as modes. The utility for rental cars does not include a measure of distance or time to the airport, because the cost of a rental car is mostly based on the daily fee of use rather than the cost of travel to/from the airport from a particular location in the Portland region. The choice of rental car is conditioned on where a visitor is going as part of the stay in Portland rather than accessibility to the airport. The utility for hotel shuttle includes travel time between the zone and the terminal.

The choice of transit in the mode choice model is limited to walk and drive to MAX light rail transit service, because MAX is the only public transport mode that serves the airport. While it is possible to take a bus to MAX and ride to PDX from there, this is not explicitly modeled for two reasons. First, the survey data does not distinguish between access modes for transit trips. That is, it is not possible to tell if a traveler walked, bussed, or was driven to a MAX station. Second, bus access to transit for airport passenger trips is a relatively small market. The approach taken within the model is to generalize all trips from zones not within walking distance to transit (coded as ½ mile) as being drive to transit. The drive to transit mode paths are found from the non-airport zone to the closest MAX station to that zone.

The nesting parameters varying between 0 and 1. Values closer to 0 reflect greater substitution effects between alternatives within the nest. Values closer to 1 mean that the substitution within the nest is not as strong. Nests with lower nesting parameters see comparatively larger mode shifts between nested alternatives than between non-nested alternatives.

Table 7 presents the parameters for the mode choice models. The text below discusses the particular model for each market. Note that the sensitivity parameters alpha and beta apply to each of the markets. These parameters are discussed in section 1.3.5.

	Resident		Visitor	
	Personal	Business	Personal	Business
Alternative Specific Constants				
Parking	0	0		
Short-term Garage	4.1	0.9000		
Long-term Parking	1.8	-0.3		
Economy Parking	1.1	0.1000		
Off-site Parking	0.6	-0.2000		
Escort	0	0	1.2	0
Curb	-0.1	0	1.8	-3.400
Taxi	-0.4	-0.9000	0	-1.9000
Rental			5.2	0
Shuttle			2	-1.6000
Transit				
Transit Walk	0.1		0	0.8
Transit Drive	-0.7	-2.1	-1.1	-1.2
Transit Peak	0.308	0.0000	0.53	0
Parameters				
In-Vehicle Time	-0.0283	-0.0300	-0.015	-0.0300
Access Time	-0.0843	-0.0600	-0.0255	-0.0600
Cost	-0.1132	-0.0558	-0.06	-0.0225
Transit Wait Time	-0.0843	-0.0600	-0.0255	-0.0480
Transti Walk Time	-0.0843	-0.0600	-0.03	-0.0480
Chauffeur Time	-0.025	-0.0321	-0.012	-0.0150
Taxi mix of total employment			0.17	0.1019
Transit Total Employment Mix			0.05	
Shuttle Distance			-0.1	
Sensibility				
alpha		2		
beta		2		
Nesting Parameters				
Private Vehicle	0.749	0.7490	1	1
Pick up/Drop off	0.42	0.427	0.5	0.5
Drive	0.541	0.541	1	1
Transit	0.5	0.75	0.5	0.5

Table 7 Mode Choice Parameters

1.3.1 Resident Personal

Resident making personal trips to airport are particularly time sensitive. Moreover, they tend to make long trips air trips and are often encumbered by baggage. The model in Table 7 reflects these characteristics.

The mode choice model implies a $15 per hour value of time. This is similar to values of time found in many home-based work models. Travelers are more willing to pay extra to save time then travelers on a shopping trips for example. The parameter on access and wait time spent traveling to the terminal or MAX (-0.0843) is nearly 3 times as great as the parameter on in-vehicle time (-0.0283). This logically follows as access time includes lugging baggage and, in the case of transit, the uncertainty of a train arriving on time.

The alternative specific constants are also shown in Table 7. The constants for the park and drive alternatives need to be put in the context of the parking charges shown in Table 9 on page 35. The large positive constants counter the large negative disutility from parking for nearly a week on average. These constants are explaining the convenience of using a parking lot rather than transit, taxi, or the pick-up/drop-off mode which otherwise costs has much greater utility. Transit in the peak period as a 10-minute equivalent constant that reflects transit providing more dependable service in the peak compared other modes as it is not subject to uncertain congestion effects.

1.3.2 Resident Business

The resident business model is somewhat similar to the resident personal mode choice model. However, there are two key differences in the value of time and the alternative specific constants.

The value of time for this market is $32, which is twice that of the resident personal market. Business travelers are more willing to trade cost for time savings. Business travelers are less sensitive to costs as these are often paid by the employer or expensed.

Business travelers tend to make shorter duration air trips than personal travelers. Thus their parking cost is very much less than that of the personal traveler. As a result, the alternative specific constants on the parking modes are much less than those for the personal traveler.

The alternative specific constants, when expressed in equivalent in-vehicle minutes are not nearly as large as those for resident personal travel , ranging from a 30 minutes of positive utility for short term parking to a 70 minute penalty for drive to transit.

1.3.3 Visitor Personal

The visitor personal market is much different than the resident person market. The mode choice model does not consider drive and park modes for visitors as they logically do not have a personal car available. However, rental car and hotel shuttle are allowed as modes as well as taxi/limo and transit..

The value of time for visitor personal travel is set to be equal to the $15 value of time for resident personal. The assumption is that both groups will make similar time/cost trade-offs. The in-vehicle parameter of -0.015 is lower than that for resident personal travelers. Travel for visitors is typically less time constrained that for residents. There is a negative distance term on hotel shuttles to reduce hotel shuttle as a viable alternative to and from zones not adjacent to the airport.

There are two uses of Metro's "mix" variables. The choice of taxi and transit to increases zone increases when that zone has high mix variables. The terms attempt to explain that travelers to these zones will find taxi and transit travel more convenient.

The alternative specific constant on rental car stands out as being particularly large with an value of 345 equivalent in-vehicle minutes of positive utility. The justification for this constant is that the choice of rental car is not related to accessibility between the airport and non-airport TAZ. Rather, the choice of rental car is related to where a visitor plans on visiting within the Portland region during their entire stay. Visitors to Portland for recreation often travel out of the region to tourist destinations that are not accessible or convenient by transit, leading to a strong preference for rental car.

1.3.4 Visitor Business

The most distinguishing characteristic of visitor business travelers is the much higher value of time that these travelers have over travelers in other markets. The $80 value of time is lower than values of time experienced for the same market in the New York area. Visitors on business travel tend to be “on the clock” for their visit and are very time sensitive.

The parameters for this market are mostly borrowed from other markets or asserted. The coefficient on in-vehicle time at -0.030 which is the same as the resident business and more sensitive than most commuter mode choice models. Like the other markets, access and walk time are more onerous than in-vehicle. Similar to the visitor person market, there is a parameter on the mix variable for taxi travel.

The alternative specific constants use rental car as the reference alternative. The only positive constant is for walk to transit. The largest absolute constant is for pick-up/drop-off at the curb this constant where the value is 113 equivalent minutes less than rental car.

1.3.5 Mode Choice Calibration

Table 8 compares the calibrated mode choice shares against the targets. The calibration process focused on adjusting the alternative specific constants in order to replicate the observed mode shares. As shown in the table, all mode shares are within 2% of the target values.

The walk to LRT calibration targets for both resident purposes are 0% while the calibrated shares are 1% and 2% for personal and business respectively. This reflects an assumption that some of the LRT ridership was walk to LRT, even if this was not observed in the survey.

The modlel calibration exercise showed many transit trips from Clark County Washington. These trips involved driving to the Mount Hood station and riding a short distance on MAX. This trip is not realistic as dropping a passenger off at the airport involves just a couple extra minutes of travel time. To overcome this, a transit sensibility parameter penalizes trips where the access time to in-vehicle time is greater than the beta parameter in Table 7. The expression for transit sensibility is $\left(\max(\beta, \frac{access}{ivt}) - \beta \right)^{\alpha}$.

	Resident				Visitor			
	Personal		Business		Personal		Business	
Mode	Target	Calibrated	Target	Calibrated	Target	Calibrated	Target	Calibrated
Private Vehicle	*87*	*87*	*90*	*90*	*42*	*43*	*12*	*12*
Drive and Park	*25*	*24*	*47*	*48*	*0*	*0*	*0*	*0*
Garage	3	3	17	17	0	0	0	0
Long Term	4	4	5	5	0	0	0	0
Economy	13	13	18	18	0	0	0	0
Off-site	5	5	8	8	0	0	0	0
Pick-up/Drop-off	*61*	*63*	*42*	*41*	*42*	*43*	*12*	*12*
Escort	8	12	0	0	2	6	12	12
Curb	54	51	42	41	39	37	0	0
Taxi/Limo/Town Car	4	4	7	7	6	7	14	14
Shuttle	0	0	0	0	18	18	8	8
Rental Car	0	0	0	0	29	28	49	47
Transit	*9*	*9*	*3*	*3*	*5*	*5*	*18*	*18*
Walk to LRT	0	1	0	2	1	1	13	13
KNR to LRT	8	8	3	1	4	3	5	5
Total	***100***	***100***	***100***	***100***	***100***	***100***	***100***	***100***

Table 8 Target to Modeled Mode Share Comparison

2 Model Application and Scenario Testing

The APDM model exists in two forms. The first is a Microsoft Excel spreadsheet, dubbed "InstantCarma", and is meant as a tool for quick analysis. The second is an application code tied to Metro's regional model. The spreadsheet version is able to test scenarios where the desired model output is the change in trip distribution and mode choice. Changes in regional travel costs need to be imported into the spreadsheet. The application code provides a richer set of outputs including trip tables for assignment, the ability to summarize trips by time period, and FTA User Benefit files.

Both versions of the APDM are necessarily limited in the scope of scenarios that it can test. This section describes some of principal limitations.

- The model assumes that the Portland International Airport is the only viable commercial airport for travelers and is unable to reflect competition between airports.

- Scenarios are not "extreme". Costs that fall well outside of those observed in the base year conditions will yield model results with implausible elasticities. The sections below that describe the parking sensitivity tests further develop this point.

This section of the document serves as a guide to performing scenario tests with the APDM. The first section reports on two sensitivity tests designed to test the parking mechanisms. These sensitivity tests illustrate how to perform a model a scenario and how to interpret the results. The second section outlines how to conduct several tests that may be interest.

2.1 Parking Sensitivity Tests

The choice of parking at an airport is a decision process that on the surface seems to have similarity to park and ride station choice modeling in typical urban travel demand forecasting models. A traveler considers park and ride amongst a group of modal alternatives. The traveler is influenced by the cost of the lot, convenience, availability, and value of time. However the situation at an airport differs in several key areas:

- Dynamic arrival and departures. Travelers parking in a park and ride lot tend to arrive within a short period during the morning peak and leave during the afternoon peak. Parking at an airport is much more fluid. Travelers arrive and depart over the course of the day as show in Figure 10.

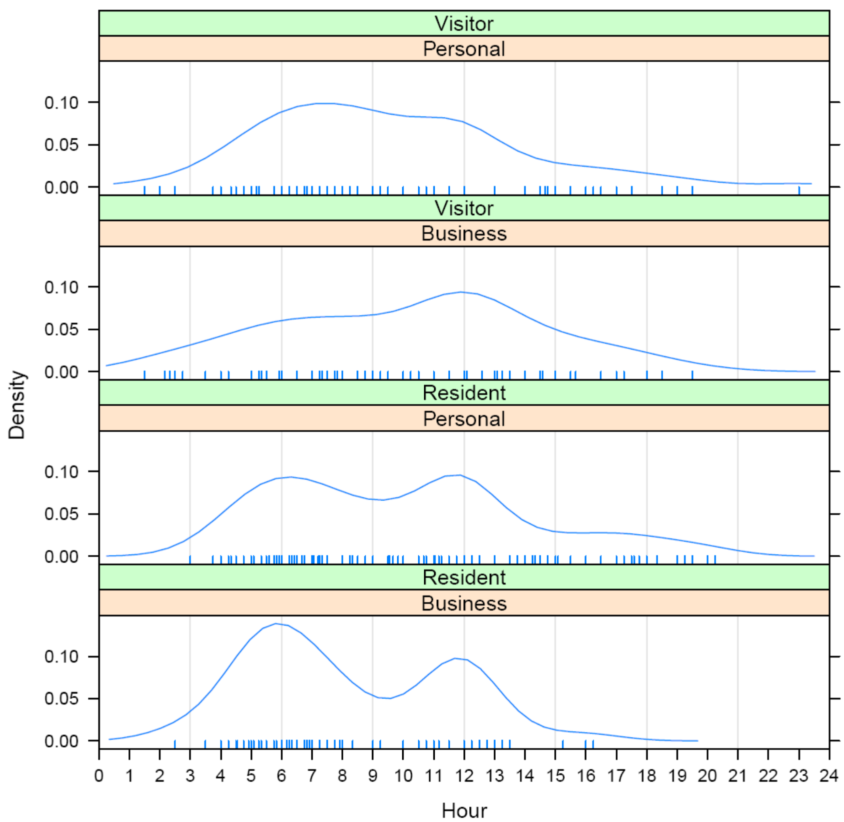


Figure 10 Diurnal distribution of departing trips.

- Parking duration. The parking duration in an urban travel model is constrained to a maximum of one day. Parking duration at an airport ranges from less than one hour for picking up a passenger to a several weeks for someone making an extended trip as shown in Figure 11. As parking charges vary with duration, a traveler to an airport can see a large variation in cost of parking depending on the duration of their trip.

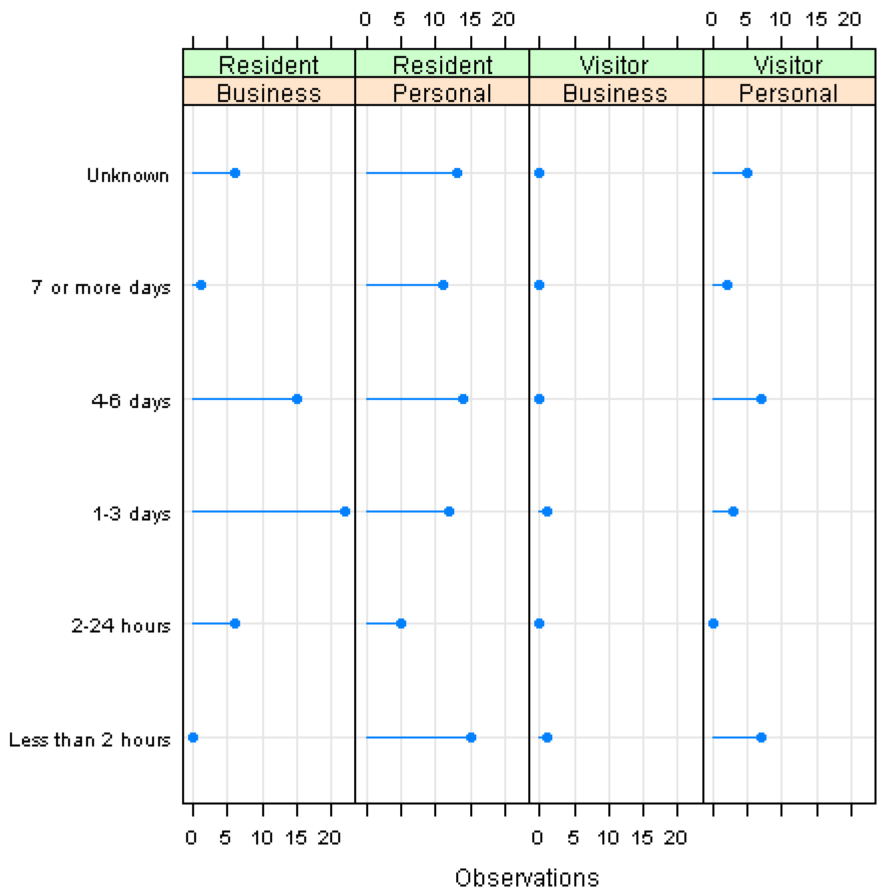


Figure 11 Observed parking durations by trip market

- External trips. Unlike park and ride lots, PDX has a significant amount of trips that are external to the model area. The model treats trips from external areas as fixed, meaning they do not respond to parking availability constraints. Approximately 33% of resident-business trips and 25% of resident-personal trips are external.

The model development effort included two sensitivity tests designed to test the limitations of parking choice model. The first test varied parking fees and the second test varied the overall number of air passengers. The second sensitivity test stressed the shadow pricing mechanism used for parking capacity constraint.

2.1.1 Parking Cost Variation

The sensitivity test on parking was conducted using base year costs and the spreadsheet version of the model. The intention was to understand the mode shifts resulting from increases to parking costs. Table 9 shows the parking costs for residents doing personal and business travel over six levels of parking costs. Each of the scenarios is labeled by the percentage increase to parking charges over the base fees. The results of applying the test to the 2005 observed demand are shown in Table 10.

	Base		1% Increase		5% Increase		10% Increase		50% Increase		100% Increase	
Parking Lot	Personal	Business	Personal	Business	Personal	Business	Personal	Business	Personal	Business	Personal	Business
Escort Garage	$ 3.00	$ 3.00	$ 3.03	$ 3.03	$ 3.15	$ 3.15	$ 3.30	$ 3.30	$ 4.50	$ 4.50	$ 6.00	$ 6.00
Short-term Garage	$ 60.00	$ 36.00	$ 60.60	$ 36.36	$ 63.00	$ 37.80	$ 66.00	$ 39.60	$ 90.00	$ 54.00	$ 120.00	$ 72.00
Long-term Parking	$ 35.00	$ 21.00	$ 35.35	$ 21.21	$ 36.75	$ 22.05	$ 38.50	$ 23.10	$ 52.50	$ 31.50	$ 70.00	$ 42.00
Economy Parking	$ 20.00	$ 12.00	$ 20.20	$ 12.12	$ 21.00	$ 12.60	$ 22.00	$ 13.20	$ 30.00	$ 18.00	$ 40.00	$ 24.00
Off-site Parking	$ 18.00	$ 10.80	$ 18.18	$ 10.91	$ 18.90	$ 11.34	$ 19.80	$ 11.88	$ 27.00	$ 16.20	$ 36.00	$ 21.60

Table 9 Parking fees by lot and travel purpose for each test scenario

	Resident Business					Resident Personal				
Mode	1%	5%	10%	50%	100%	1%	5%	10%	50%	100%
Drive and Park	*-0.58*	*-2.86*	*-5.63*	*-24.52*	*-41.90*	*-2.15*	*-10.15*	*-19.03*	*-63.52*	*-86.87*
Garage	-2.07	-10.04	-19.33	-69.37	-92.21	-8.72	-37.02	-60.84	-99.31	-100.00
Long Term	-0.54	-2.80	-5.83	-33.57	-63.35	-3.82	-18.19	-33.93	-90.51	-99.31
Economy	0.39	1.82	3.34	5.71	-7.20	-0.75	-4.29	-9.57	-54.40	-84.17
Off-site	0.51	2.45	4.63	12.45	5.02	-0.34	-2.26	-5.71	-43.78	-75.94
Pick-up/Drop-off	*0.58*	*2.84*	*5.60*	*24.51*	*42.05*	*0.72*	*3.42*	*6.42*	*21.39*	*29.14*
Escort						0.08	0.15	-0.25	-12.96	-34.87
Curb	0.58	2.84	5.60	24.51	42.05	0.87	4.18	7.95	29.31	43.91
Taxi/Limo/Town Car	0.40	1.98	3.89	16.47	27.46	0.48	2.29	4.28	14.32	19.98
Transit	*0.40*	*1.95*	*3.83*	*16.23*	*27.09*	*0.55*	*2.59*	*4.86*	*16.45*	*23.05*
Walk to LRT	0.38	1.89	3.69	15.59	25.94	0.52	2.44	4.57	15.35	21.41
KNR to LRT	0.41	2.04	4.00	17.05	28.57	0.55	2.61	4.90	16.62	23.31
Rental Car										
Shuttle										
Total	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***

Table 10 Model responses to changes in parking fees as percentage change from base

The model responses are consistent with the structure of the mode choice model. Since only residents park at the airport, only mode choice changes to these markets are shown in Table 10. Interpreting the results requires familiarity with the mode choice nesting structure shown in Figure 9. Also note that parking duration varies by traveler, not by alternative. The parking costs by alternative all reflect an assumed average parking duration[2].

Under the 1% increase scenario, the impact is very small as expected. Only the (short-term) garage lot loses more than 1% of business trips. Personal trips to the garage and long-term lots decrease by a larger percentage, 9% and 4% respectively. the larger impact on personal trips than business trips is consistent with expectations. Personal travelers have a higher sensitivity to costs and tend to park longer. The longer parking duration leads to a larger absolute increase in parking fee.

As parking costs increase there are several interesting trends:

- Business trips move toward the less expensive off-site parking over small increases in parking costs. However, moving from a 50% increase in parking costs to a 100% increase in parking costs yields a decrease in the total number of travelers choosing to park off-site.

- Personal and business travelers see escort as the best substitute to the increased parking fees. This is due to the nesting hierarchy in the mode choice model. Drive and park is grouped with the pick-up/drop alternatives in the private vehicle nest.

[2] Varying the parking fees by alternative is not consistent with the discrete choice framework and, as demonstrated during the model development effort, produces counter-intuitive results. The results showed a movement toward short term parking as a result of increases parking fees. By assuming a duration by lot, the short term parking lot looks, for example, comparatively less expensive than the economy lot as its higher rate is multiplied against a much short average duration.

While this substitution pattern is reasonable over small changes, the pattern is not as well grounded for business travelers over large increases. A more plausible response is that business travelers may be more likely to substitute to taxi rather than ask a family member or business associate to do a pick-up or drop-off trip. As noted, this has implications for the use of the model for testing policies that differ greatly, say an increase in parking charges greater than 10%, from existing conditions.

2.1.2 Air Passenger Demand Variation

The objective of this test was to overwhelm the parking capacity of the airport in order to understand how the model will respond. The test consisted of running the model under four levels of air passenger demand: 2005, 2035 forecast (2035 A), 150% of the 2035 forecast (2035 B), and 200% of the 2035 forecast (2035 C). The test was run using 2035 ground transport costs and the Python application code. The parking model uses a shadow pricing mechanism to constrain parking demand to the number of available spaces.

Parking Measure	2005	2035 A	2035 B	2035 C
Background	*404*	*1,090*	*1,596*	*2,092*
Short-term	43	116	177	238
Long-term	101	278	432	500
Economy	175	491	787	1,101
Off-site	85	205	201	254
Used	*2,018*	*5,452*	*7,980*	*10,460*
Short-term	214	582	883	1,190
Long-term	506	1,392	2,158	2,500
Economy	876	2,456	3,935	5,503
Off-site	423	1,023	1,004	1,268
Free Spaces	*12,878*	*8,758*	*5,724*	*2,748*
Short-term	3,044	2,602	2,240	1,873
Long-term	2,393	1,330	410	1
Economy	6,749	4,853	3,078	1,197
Off-site	692	-27	-5	-322
Shadow Price				
Short-term	1.00	1.00	1.00	1.00
Long-term	1.00	1.00	1.00	0.77
Economy	1.00	1.00	1.00	1.00
Off-site	1.00	0.82	0.22	0.02

Table 11 Parking responses to various

Table 11 summarizes the model parking output for the four scenarios. The background section reports the number of vehicles parked in each of the lots after accounting for the vehicles leaving during the simulation day. The total number of background spaces is the number of spaces that are occupied by vehicles parked from a day prior to the simulation day. The used section reports the number of spaces required to support the traffic generated during the simulation day. The free section reports the number of empty spaces at the end of the simulation day. A negative number in the free section means that the lot is oversubscribed. The shadow price section reports the exponentiated shadow price. The exponentiated shadow price takes values less than or equal to 1 and greater than 0. A value of 1 means that no shadow price is active (as the natural logarithm of 1 is 0). The shadow price term is part of the mode choice utility expression.

Running this sensitivity test exposed an important limitation of the model. The model assumes that trips from areas external to the model will follow patterns similar to those observed in the base year. The model does not explicitly reflect a choice of parking lot for external trips, and the cost and capacity of lots therefore does not affect external trips. The implication is that internal trips will be forced to compensate for the inelastic response of external trips to lots that are full. Under scenario 2035 C, there were more external trips to the off-site lot than total spaces. As a result, the shadow pricing mechanism calculated an extreme value (0.02) and effectively closed the lot to internal trips.

The parking mechanism showed expected substitution patterns.

3 Example Application Scenarios

This section presents several possible scenarios that can be modeled using the APDM. The intention is to show how the model can be used to give insight into its strengths and limitations. The section is meant to be illustrative how to use the model rather than an exhaustive list of steps required to perform analysis.

3.1 Future Year Forecast

APDM will need periodic updating to reflect new forecasts of air passenger demand and changes to auto and transit costs. This section lists where the Python application and InstantCarma need to be updated.

- Air passenger demand changes based to the forecast year or air movement scenario.
    - Spreadsheet: Changed in the PassengerInputs tab.
    - Python: Changed in the file EnplanementsDeplanements.csv

- Travel costs, both auto and transit, change as Metro updates forecasts.

  - Spreadsheet: Changed in the TravelZoneInputs tab. The application program produces an intermediate file `zonalData.csv` with all of the transportation and land use costs by zone.

  - Python: Costs are read directly from the Visum matrices. The `skim.matrix.directory` setting in the configuration file `apdm.conf` points to the directory with travel costs.

- Population, employment, employment, Metro's "mix" variable, and intersection density change by scenario year.

  - Spreadsheet: Changed in the TravelZoneInputs tab.

  - Python: Costs are read directly from the model data files. The `zonal.data.directory` and the `zonal.mix.data.directory` settings in the configuration file `apdm.conf` points to the directory with the zonal data.

- Parking supply and fees change based on airport policies and off-site providers.

  - Spreadsheet: Changed in the ModelInputs tab. The spreadsheet does not respect the parking lot capacity.

  - Python: Changed in the `Parking.csv` file.

- Taxi fares and airport surcharges change in response City of Portland and Port of Portland policies.

- Spreadsheet: Changed in the ModelInputs tab.
- Python: The `taxi.fare` setting in the configuration file `apdm.conf` has the taxi mileage rate and the airport surcharge setting is `taxi.airport.charge` in the same file.

- Rental car fares change in response to private initiatives.
  - Spreadsheet: Changed in the ModelInputs tab.
  - Python: The `rental.car.cost.business` and `rental.car.cost.personal` settings in the configuration file `apdm.conf` control the rental car fees that business and personal travelers experience, respectively. The access time from on-site rental lots is in the `rental.car.access.time` setting in the same file.

3.2 Holiday Travel

During the peak holiday travel season, the airport has a much different mix of travelers than a typical travel day. In order to model transportation during the holiday season adjust the model parameters as follows:

1. Change the enplanements and deplanements to reflect holiday travel levels.

2. Change the market segmentation factors. Holiday travel is predominantly personal related travel. The market segmentation factors should be adjusted to reflect what the airport typically sees during the holiday season. This can either be estimated from survey data or assumed.

3. Apply the model. Pay special attention to parking results.

3.3 New Terminal Location

As part of future airport studies, the Port has expressed interest in modeling the effect of a new terminal location. The APDM was not explicitly designed to account for multiple terminal locations. However, the effect can be simulated by running the model twice, following this procedure using either the Python script or spreadsheet version of the model:

1. Split the arrivals and departures into arrivals and departures for the existing and new terminal locations.

2. For the existing terminal, re-run with the new arrival and departure inputs.

3. For the new terminal, make the following modifications to `adpm.config`:

    a. Update terminal and parking lot zones.

    b. Update the access times between the terminal and lots.

4. Re-run the model for the new terminal and combine results from the two runs.

3.4 Traffic Micro-Simulation Study

Traffic studies using micro-simulation can make use of finer levels of detail than APDM is configured to generate by default. The `adpm.config` file allows an analyst to produce trips by hour. The default configuration is to produce trips in time periods compatible with the regional model. Setting `peak.am.auto.assignment.hours` to 6, for example, changes results in an auto trip table with only the trips in the 6 AM hours.

Additionally, the parking lot and terminal location settings can be changed as described above. Note the model assigns all off-site parking to one lot. The airport is actually served by two off-site parking lot locations; one on 82nd and one east of I-205 on Airport Way. Traffic needs to be manually split between the two locations.

Lastly, the micro-simulation study should consider the hotel shuttle movements. The model does not include these trips as a part of the auto demand matrices.

4 Conclusions and Potential Future Enhancements

The model sensitivity tests determined that the model is reasonably sensitive to inputs within a consistent range of base-year conditions, and will be well-suited to analyzing the policies to are to be tested as part of the PDX Airport Futures project and other long-range planning studies. However, the model development process and sensitivity testing revealed interesting characteristics of the model that can be addressed in subsequent model enhancements. First, it would be helpful to have split visitor-personal trips into those visiting family or friends and those on vacation. As noted above, these groups operate in different travel markets. Additional survey observations are needed to produce statistically valid estimation results a model with these visitor markets. Second, the aggregate nature of the model system limits the ability of the system to accurately represent the effect of overall trip duration of the air passenger on parking cost and how large parking cost changes might affect behavior. The solution to this would be to micro-simulate air passengers, choosing their trip duration from a distribution according to their market segment, and modeling their choice of mode based on that distribution. Finally, the choice of parking lot for the external travel market could be explicitly modeled, to provide a more consistent treatment of all markets within the model system.

Attachment B. Kate CRC Toll Methodology November 2017

Addendum to the Metro Travel Forecasting Trip-Based Demand Model Methodology Report (updated November 2017)

Transportation demand modeling as it relates to tolling in the Columbia River Crossing project

Introduction

The Metro model has been designed to provide the analyst many interfaces to connect tolling characteristics to the choices made by travelers. For example, three distinct income bins are included in the model to capture reactions due to economic factors. Special weights can be applied to the tolls to note their differing impact on destination, mode choice, and route choices.

However, challenges still are plentiful. The modeling of road pricing is nationally seen as one of the biggest challenges requiring research. A few reasons for this follow:

- Values-of-time typically found in models are not equivalent to those derived from economic studies. This is because many other factors beside cost and time influence travel choices within models.
- The relationship between time and cost is not a fixed value in one's daily life. It is an instantaneous effect. The value depends upon the urgency of the trip.
- The traveler response is likely influenced by his/her income profile. Typical models have two or three income ranges identified within the algorithms. In actuality, a much more continuous distribution range is required – not just several bins.
- It is not clear as to how a toll affects trip distribution choices versus mode choices versus path choices. The elasticity is likely not the same for all travel components.

Practical concerns and scientific shortcomings limit the ability of the analyst to specifically address each of the above points. For these reasons (and others), the introduction of a toll variable into a demand model is very dependent on the "philosophy" of the analyst. Consequently, a special working group was formed to define the modeling procedure for the Columbia River Crossing (CRC) project. Agency participants on the working group included Stantec Inc. (formerly Vollmer Associates), Regional Transportation Council (the metropolitan planning organization in Clark County, Washington), Metro (the metropolitan planning organization for the Portland, OR region), and other CRC contractors. This group is hereafter referred to as the CRC Tolling Team.

The following discusses the modeling methodology developed by the CRC Tolling Team that has been implemented in the CRC project. This approach is specific to this project, and does not represent a singular approach towards tolling adopted by Metro.

Toll rates and time penalties

All costs are provided in 2017$ (current year for which this documentation is being updated) and 2010$ (the year to which the Metro Kate travel demand model is estimated).

Toll rates used in the FEIS and New Starts update of the CRC project are shown in Table 1. The Metro model uses assignments from a 2-hour PM peak period and 1-hour midday off-peak period as inputs into the demand model. The PM 2-hour period is 4:00 to 6:00 PM, while the midday is noon to 1:00 PM. The two toll rates of concern for modeling purposes are 3:00 to 7:00 PM and lowest off-peak rates (8:00 PM to Midnight)—both highlighted in Table 1. The CRC Tolling team determined that the floor rates in the off-peak scenario were more appropriate to use within the demand model than the higher 'noon' rates.

To convert the toll rates into time penalties for assignment purposes, several values of time are assumed: For autos, $21.62/hr (2017$) is used for peak periods and $14.38 (2017$) is used for off-peak periods; Trucks use $43.75/hr (2017$). These values are converted to 2010$ for use in the model ($19.27/hr, $12.82/hr and $39/hr, respectively). Table 2 shows the assumed tolls in both dollars and converted penalty minutes.

Tolls vary by time of day, vehicle class, and use of automatic payment radio transponders. Work trips are assumed to have 100% transponder use. Therefore, all work trips see the 'lower' toll rates ($2.00 peak, $1.00 off-peak). All other trips are assumed to have a 75% / 25% split on transponder / non-transponder use. These trips have a toll rate of $2.25 peak, $1.25 off-peak. These inclusion of these transponder / non-transponder rates are discussed in further detail in later sections.

Table 1: Toll structure for CRC project
(Highlighted cells indicate tolls used in CRC model)

		Passenger Car		Trucks with Transponders		Trucks w/o Transponders	
Start	**End**	**w/ Transponder**	**No Transp.**	**Med Truck**	**Heavy Truck**	**Med Truck**	**Heavy Truck**
Midnight	5:00AM	$1.00	$2.00	$2.00	$4.00	$3.00	$5.00
5:00AM	6:00AM	$1.50	$2.50	$3.00	$6.00	$4.00	$7.00
6:00AM	10:00AM	$2.00	$3.00	$4.00	$8.00	$5.00	$9.00
10:00AM	3:00PM	$1.50	$2.50	$3.00	$6.00	$4.00	$7.00
3:00PM	7:00PM	$2.00	$3.00	$4.00	$8.00	$5.00	$9.00
7:00OM	8:00PM	$1.50	$2.50	$3.00	$6.00	$4.00	$7.00
8:00PM	Midnight	$1.00	$2.00	$2.00	$4.00	$3.00	$5.00

Toll influences in four-step model

The CRC Tolling team determined that the impact of the toll on choice depends upon the number of choices one has available. Many choices mean higher elasticity. If a decision maker is not facing immediate consequences from a decision point caused by a toll, it is less likely that the toll will influence the choice. This logic supports a hierarchy of perceived tolls for use in destination choice, mode choice, and route choice.

For example, since relocating to a new job or housing is difficult in the short term, one is much less likely to change destination—especially as home-based work trips are concerned—with the introduction of a toll (at least initially). . Mode choice, however, is a bit more sensitive to tolling, since users have more options of avoiding the full costs of the toll (both monetary and temporal) through transit or HOV use. Finally, route choice is most sensitive to tolling since drivers have the option of completely avoiding the toll by changing their route.

Based on the previous logic, the CRC Tolling Team determined that the effects on route choice should differ from the effects on destination and mode choice. As a result, the following approach was adopted in applying tolling effects within the four-step model:

- The actual toll rate will have the least amount of impact on destination choice. Therefore, only 25% of the toll is used in determining trip distribution.
- The toll rate will have more impact on mode choice. Therefore, commuters see 75% of the toll when determining which travel mode to use.
- The toll rate has the largest impact on route choice. Therefore, auto commuters see 100% of the toll when choosing a route for completing their trip.

Very little research currently exists on tolling—and, more specifically, the impact of tolls on the decisions of commuters in various stages of trip planning. Additionally, tolling is a new phenomenon to the Portland metro region, and so no prior examples exist by which to examine the impact of tolls upon commuters in this particular jurisdiction. Therefore, the above percentages are based on the professional judgment and reasoning of the CRC Tolling Team.

Table 2: Toll assumptions used in CRC model

		SOV & HOV (work trips)	SOV & HOV (non-work trips)	Medium Trucks	Heavy Trucks
Peak Period	***Toll cost (2010$)***	$2.00	$2.25	$4.25	$8.25
	Additional toll time used in assignment (min)	6.84	----	7.28	14.14
Off-peak Period	***Toll cost (2010$)***	$1.00	$1.25	$3.25	$6.25
	Additional toll time used in assignment (min)	4.39	----	5.57	10.71

Network assignment

Within the travel time skims building process and the final trip assignments, tolls are converted to time penalties, which are added to links representing the I-5 Bridge. These time penalties vary according to the time of day being modeled (PM 2-hr peak or MD 1-hr off-peak) and mode (private vehicle, medium truck, or heavy truck). Table 2 shows the appropriate time penalty assessed in each situation. Note that tolls are converted from dollars to minutes using a value of time of $19.27/hr (2010$) for peak period private vehicles, $12.82/hr (2010$) for off-peak period private vehicles, and $39/hr (2010$) for trucks ($19.27/hr, $12.82/hr and $39/hr in 2010$). These values were determined by the CRC Tolling Team to be appropriate for this particular project based on expert opinion, case studies, many rounds of sensitivity analysis, and through a stated preference survey of existing bridge users.

It should be noted that the 100% transponder usage time penalty is assumed for all private vehicles, since trip purpose cannot be assumed in the assignment process.

During skims building, three matrices are created for use in the demand model for both SOV and HOV trips. The first matrix is an O-D weighted toll time based on the percentage of trips between zones using the I-5 Bridge, which represents the ‘perceived’ toll cost for trips crossing the Columbia River. This matrix is passed on to the destination and mode choice models for use in calculating the monetary cost of the toll, which is seen as an additional operating cost (see below).

The second is an O-D tolled travel time matrix, which represents the travel time between zones PLUS the addition of the ‘perceived’ toll cost as calculated in the weighted toll time matrix. This matrix is representative of the path choices created by the introduction of the toll to the I-5 Bridge.

The final matrix is an O-D travel time skim that represents the ‘true’ travel time between zones without the additional toll cost. This matrix is calculated by subtracting the ‘perceived’ weighted toll time matrix from the tolled travel time matrix. The final travel time matrix is passed onto the destination and mode choice models for use in the auto logsum equations as the actual travel time impedance between zones.

Demand model – destination and mode choice

Within the destination and mode choice models, tolls are input as additional operating costs for the SOV and HOV modes. The O-D weighted toll time matrices calculated in the skim building assignment procedure are passed into the model, where they are converted into monetary values using a values of time of $19.27/hr (2010$) for peak period and $15.27/hr (2010$) for off-peak periods. The resulting matrices represent the O-D weighted toll costs for trips between zones that use the I-5 Bridge. Zone pairs in which 100% of all trips use the I-5 Bridge would see 100% of the toll cost, zone pairs with 50% I-5 Bridge use for trips would see 50% of the toll cost, etc.

Since tolls vary by the use of automatic toll payment transponders by vehicles, it was determined by the CRC Tolling Team that the tolls should reflect a mix of transponders. For all work purposes (home based work and non-home based work), it is assumed that transponder use is 100% for all trips. The assumption is that commuters are likely to purchase transponders since their use of the I-5 Bridge would be often (daily) and predictable. All other trip purposes assume a 75% / 25% transponder / no-transponder mix. As a result, toll costs must be adjusted for these trip purposes since the original skim matrices produced in the skim building assignment process assume the lower, 100% transponder use toll values (trip purposes is not distinguished in the initial skim building network assignments).

Table 2 shows the toll costs by trip purpose. To adjust the tolls in the non-work based trip purposes, the costs of the tolls are adjusted up by 12.5% in the PM 2-hr peak period (the difference between $2.00 and $2.25) and 25% in the MD 1-hr off-peak period (the difference between $1.00 and $1.25).

In addition, these costs are then adjusted to reflect the assumed elasticity of tolls in different stages of the demand model. As discussed above, only 25% of the costs are used in the destination choice model. Seventy-five percent of the costs are used within the mode choice model. These adjusted toll costs are added to the vehicle operating costs for use in the logsum utility equations for the destination and mode choice models.

The result of this procedure is that while SOV and HOV trips with an option of using the I-5 Bridge will see an decrease in actual travel time with the introduction of a toll—due to trip diversion from this corridor established in the original skims building network assignment—the additional monetary costs of the toll can be captured in the demand model, often times out-weighting the travel time savings, and leading to changes in destination and mode choice through this corridor.

Final network assignment

Once the demand model is run, and the resulting trip tables are peaked, final SOV, HOV and transit trip tables are produced for the AM 4-hr (6am – 10am), MD 1-hr (12pm –1pm), PM 2-hr (4pm – 6pm), and PM 4-hr (3pm – 7pm) time periods. These tables are then assigned to the network using the full toll time penalties outlined in Table 2.

Assignment classes include SOV, HOV, medium trucks, heavy trucks and transit for each of the time periods mentioned above. Unlike the demand model, no differentiation is made to isolate the income classes or trip purpose of vehicles. This is due to several factors, which range from methodological (*False precision due to the presence of only three distinct income bins – not an income continuum*), to software and hardware constraints (*Each additional segmentation of modes—whether by income class or trip purpose—has a multiplicative effect on runtime and computer resource allocation*).

The MD 1-hr off-peak period has a slightly higher toll than that shown in Table 2, since the toll assumed for the off-peak in all previous steps of the model is based on the lowest toll range (8pm – 12am) highlighted in Table 1. The result is an assumed toll for SOV and HOV of $1.50 (2005$), or 6.59 minutes after conversion using previously discussed VOT assumptions.

Attachment C. 2018 Kate v1.0 Trip-Based Demand Model Validation Report for Base Year 2015

2017 Kate v1.0 Trip-Based Demand Model
Validation Report for Base Year 2015

DRAFT VERSION

August 2017

Research Center

Jeff Frkonja	Director

Modeling Services

Chris Johnson	Manager
Peter Bosa	Senior Researcher & Modeler
Aaron Breakstone	Senior Researcher & Modeler
Jim Cser	Associate Researcher & Modeler
Kyle Hauger	Senior Researcher & Modeler
Thaya Patton	Senior Researcher & Modeler
Cindy Pederson	Principal Researcher & Modeler
Bud Reiff	Principal Researcher & Modeler
Bill Stein	Senior Researcher & Modeler
Maribeth Todd	Senior Researcher & Modeler

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1.0 Introduction

The purpose of this document is to outline a performance assessment and validation of Metro's synthesized travel demand model and assignments. The following pages compare results from a year 2015 model run of the *Kate* version of the travel demand model with observed data from the following sources:

- 2010/2011 Oregon Household Activity Survey (OHAS)
  While it is recognized that comparison of model results to survey data doesn't constitute model validation, it is a useful means to confirm that model application code behaves properly
- 2015 American Community Survey (ACS)
- 2014 Longitudinal Employer-Household Dynamics (LEHD) US Census
- 2014 Highway Performance Monitoring System (HPMS)
- 2015 auto and freight counts
- 2015 TriMet transit counts
- 2014 bike counts

Three model classifications are presented. Socioeconomic/demographic models are used to develop key variables for use in trip generation and mode choice. Travel demand models include the traditional trip generation, destination choice, and mode choice models. Finally, the assignment procedure uses pathfinding algorithms to distribute travel demand matrices on the simulated network.

Two 6 sub-regional district aggregations are frequently referenced in this text. The first contains the following districts: Central City, East City and Suburbs (East), Southeast Suburbs (Southeast), Southwest Suburbs (Southwest), West City and Suburbs (West), and Clark County Suburbs (North). The second aggregation limits the Central City district to just the Central Business District (CBD), and adds the remaining Central City zones to the East City and Suburbs district (East+). Figure 2 shows these two district aggregations.

All trip, volume, and ridership data are for the average weekday (AWD) time period unless stated otherwise.

Metro's trip-based model is enhanced to incorporate new data and research findings on a regular basis.

Figure 1: Metro regional model area

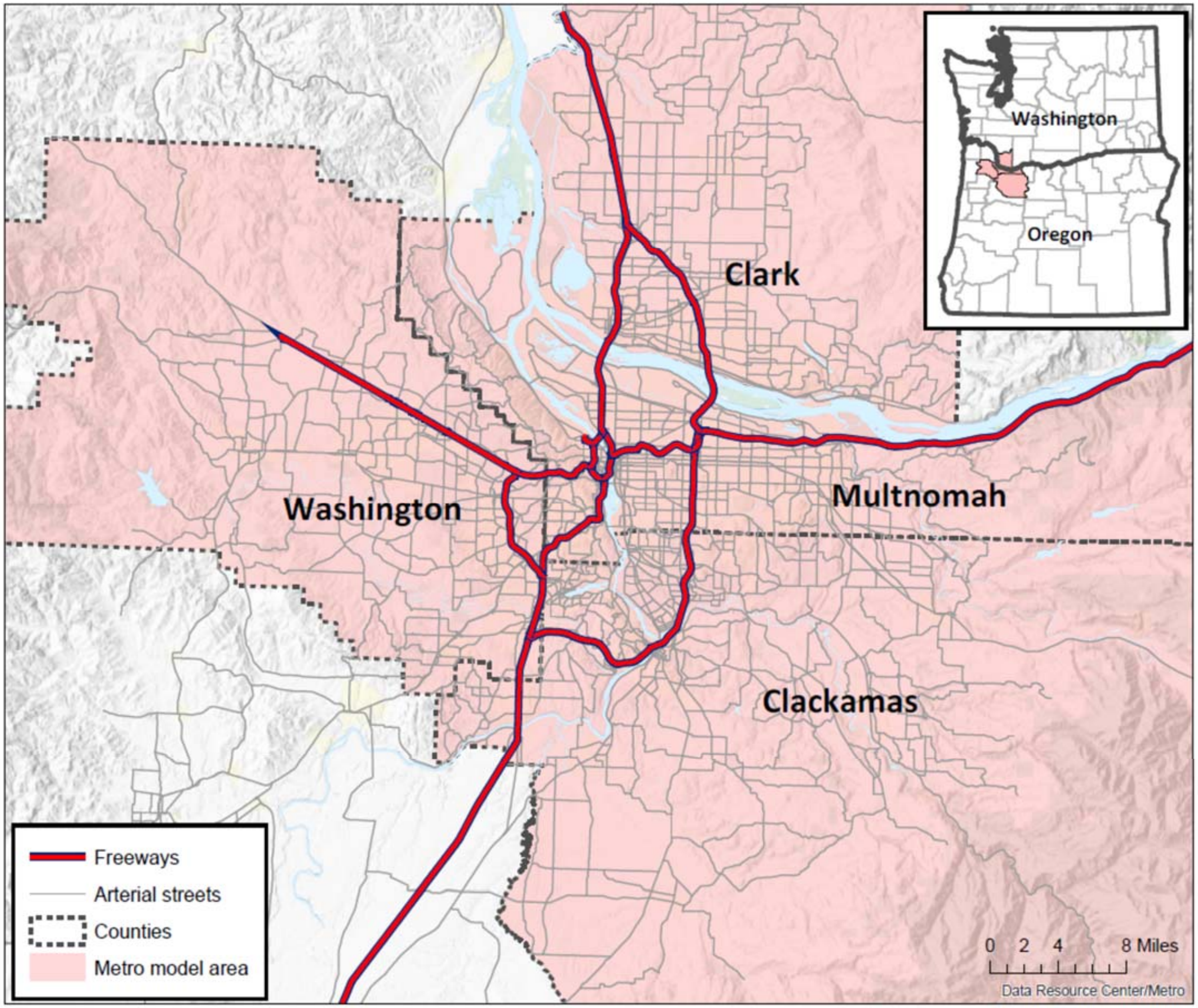
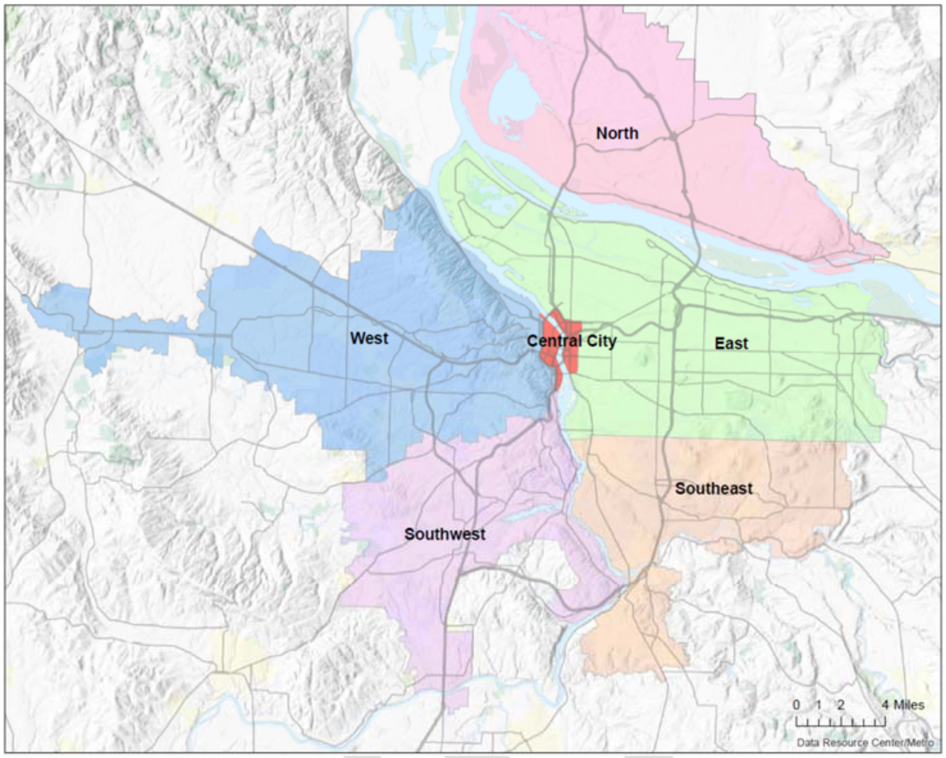
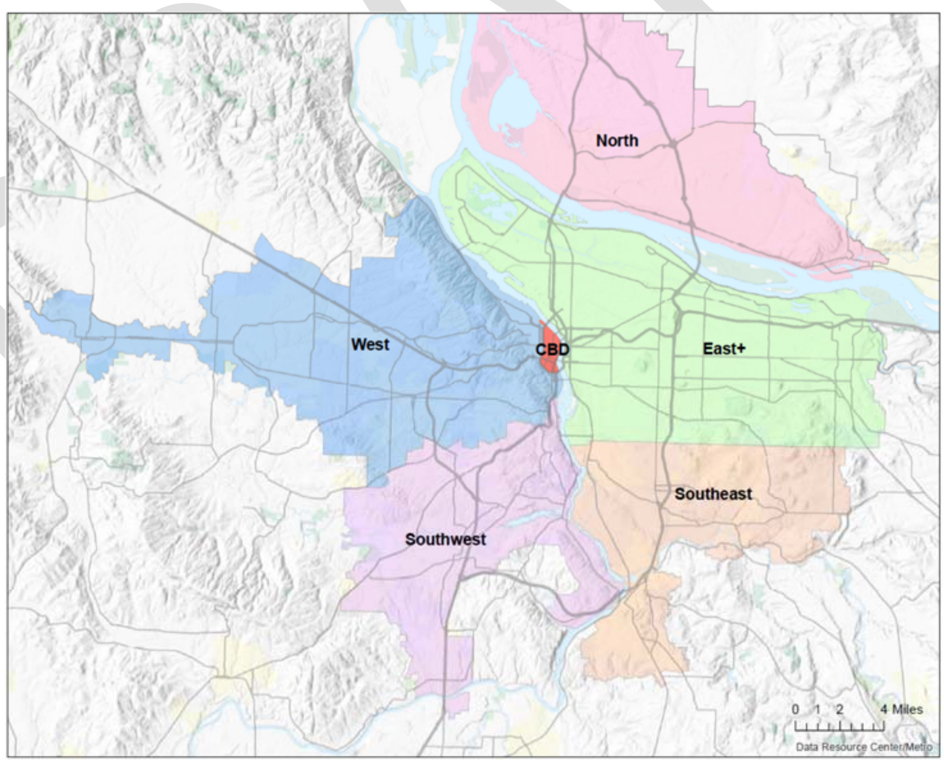


Figure 2: District maps of two aggregations of regional zones used in results comparisons





2.0 Regional Snapshot

The model area includes a large portion of the Portland-Vancouver Primary Metropolitan Statistical Area (PMSA) and corresponds to the boundaries of Clackamas, Multnomah, and Washington counties in Oregon and Clark County in Washington.

Table 1 below provides an overview of the region based on input data and data produced by the socioeconomic/demographic models to be discussed in further detail later in this document.

Table 1: Regional snapshot – year 2015

Input	Total Households	850,898
	Average Household Size	2.6
	Total Employment	1,062,954
	Total Retail Employment	119,646
	Total Non-Retail Employment	943,308
Kate Model	Total Workers	972,899
	Total Cars	1,266,867
	Average Workers Per Household	1.1
	Average Cars Per Household	1.5
	Total Vehicle Trips	5,158,239
	Total Person Trips	8,574,505
	Average Vehicle Trips Per Household	6.1
	Average Person Trips Per Household	10.1

3.0 Socioeconomic/Demographic Models

There are several key models in this classification. Tables 2-4 present a comparison of the results of these models and the most recent survey. The child, worker, and auto ownership models are briefly discussed below.

3.1 Child Model

The number of children per household influences school trip generation. Table 2 shows the percentage of households with zero, one, two, or three plus children.

3.2 Worker Model

The number of workers per household influences trip generation across multiple trip purposes. Table 3 presents the percentage of households in each of four worker category.

3.3 Auto Ownership Model

Auto ownership is a key variable for use in the mode choice models. Table 4 shows the percentage of households in each auto ownership category and cross-classification of auto ownership categories by number of workers.

Table 2: Child Model Validation (2015)

	Kate		Observed*	
Households with:	**Number of HH**	**percent**	**Number of HH**	**percent**
No Children	541,287	63.6%	579,079	69.8%
1 Child	114,613	13.5%	106,700	12.9%
2 Children	143,449	16.9%	96,155	11.6%
3+ Children	51,550	6.1%	46,982	5.7%
Total Households	850,898	100.0%	828,916	100.0%

* from 2015_5yr PUMS

Table 3: Worker Model Validation (2015)

	Kate		Observed*	
Households with:	**Number of HH**	**percent**	**Number of HH**	**percent**
No Workers	202,322	23.8%	200,806	23.9%
1 Worker	323,071	38.0%	321,367	38.2%
2 Workers	271,761	31.9%	262,988	31.2%
3+ Workers	53,745	6.3%	56,524	6.7%
Total Households	850,898	100.0%	841,685	100.0%

* from ACS_15_1yr_B08203

Table 4: Car Ownership Model Validation (2015)

	Kate		Observed*	
Households with:	**Number of HH**	**percent**	**Number of HH**	**percent**
0 - Car	69,261	8.1%	72,733	8.6%
1 - Car	309,182	36.3%	282,560	33.6%
2 - Cars	301,274	35.4%	317,748	37.8%
3+ Cars	171,181	20.1%	168,644	20.0%
Total Households	850,898	100.0%	841,685	100.0%

Households with:	**Number of HH**	**percent**	**Number of HH**	**percent**
No Cars	69,261	8.1%	72,733	8.6%
Cars < Workers	70,900	8.3%	54,461	6.5%
Cars = Workers	316,501	37.2%	335,058	39.8%
Cars > Workers	394,236	46.3%	379,433	45.1%
Total Households	850,898	100.0%	841,685	100.0%

* from ACS_15_1yr_B08203

4.0 Travel Demand Model

The travel demand model consists of several sub-models that determine the number of trips being made, their destinations, and the modes used. This process is completed in the trip generation, destination choice, and mode choice models. The calibration results for each of these modeling steps are outlined below.

4.1 Trip Generation

The number of trips generated by each TAZ is determined in the trip generation model and is a function of unique trip rates applied to various household classifications. Table 5 summarizes the composite trip production rates for each of the following trip purposes:

- Home-based work (HBW)
- Home-based other (HBO)
- Home-based recreation (HBR)
- Home-based shopping (HBS)
- Non-home-based work (NHW)
- Non-home-based non-work (NHNW)
- Home-based college (HBC)

The Kate version of the Metro travel demand model was estimated from the Oregon Household Activity Survey (OHAS), which was conducted during Fall 2010 and Spring 2011. The Kate model is validated for year 2015, which can make a comparison back to 2010/11 difficult. Therefore, Table 5Table 5 also contains model results for a 2010 model year run for Kate.

Total person trips vary from the expanded OHAS dataset, but this is expected since the synthesized population from the OHAS dataset is an estimate. The more important metric is the % of total person trips in each trip purpose, which is closely matched by the 2010 model run, and reasonably close in the 2015 model run.

Table 5: Trip generation by purpose

	# of person trips generated by purpose		
	OHAS 2010/11	Kate 2010	Kate 2015
HBW	1,090,742	1,243,386	1,445,618
HBO	1,699,885	1,802,050	2,003,621
HBR	534,352	556,145	626,256
HBS	645,945	660,281	718,997
NHW	746,945	937,111	1,089,528
NHNW	1,345,362	1,410,255	1,569,365
HBC	94,571	127,658	137,527
Total	6,157,802	6,736,886	7,590,914

	% of total person trips generated by purpose		
	OHAS 2010/11	Kate 2010	Kate 2015
HBW	18%	18%	19%
HBO	28%	27%	26%
HBR	9%	8%	8%
HBS	10%	10%	9%
NHW	12%	14%	14%
NHNW	22%	21%	21%
HBC	2%	2%	2%

4.2 Destination Choice

The destination choice model includes an algorithm used to distribute productions to alternative destinations. The accuracy of this model was evaluated by reviewing trip length frequency distributions and origin-destination patterns. Table 6 contains a comparison of trip lengths by trip purpose.

Trip length frequency histograms were prepared for each trip purpose, comparing weighted trip lengths (by distance). These curves are displayed in Figure 3. While a reasonable match can be observed between the model and survey curves, several recurring discrepancies can be noted. The model frequently underestimates the number of very short trips due to the fact that it functions in aggregate at the TAZ level. As a result, times and distances are subject to TAZ size, which creates a minimum distance within and between even the smallest zones that exceeds many trip distances in the OHAS data set. Survey information is taken from digitized data from which "door-to-door" times and distances can be calculated, meaning that no artificial minimum is set.

Table 7 contains a comparison of district-to-district movements (based on the districts shown in Figure 2) of home-based work trips from the model against 2014 LEHD data. For most district movements, there is a very close match between the model and the validation dataset.

Table 6: Trip length comparison by purpose

	Average trip length (miles) by purpose			
	OHAS 2010/11	**Kate 2015**	**Diff (Kate - OHAS)**	**% diff from OHAS**
HBW	9.1	9.1	0.0	0%
HBW - Low	*7.5*	7.8	*0.3*	*3%*
HBW - Medium	*9.1*	9.2	*0.1*	*1%*
HBW - High	*9.7*	9.2	*-0.5*	*-5%*
HBC	8.0	8.8	0.8	10%
HBS	3.7	4.5	0.8	22%
HBR	4.8	4.7	-0.1	-2%
HBO	5.2	6.0	0.8	15%
NHW	6.0	5.1	-0.9	-15%
NHNW	4.2	4.1	-0.1	-3%
School	3.0	2.5	-0.5	-17%
All Purposes*	5.7	5.9	0.2	4%

***no school trips**

Figure 3: Trip length frequency by trip purpose (miles)

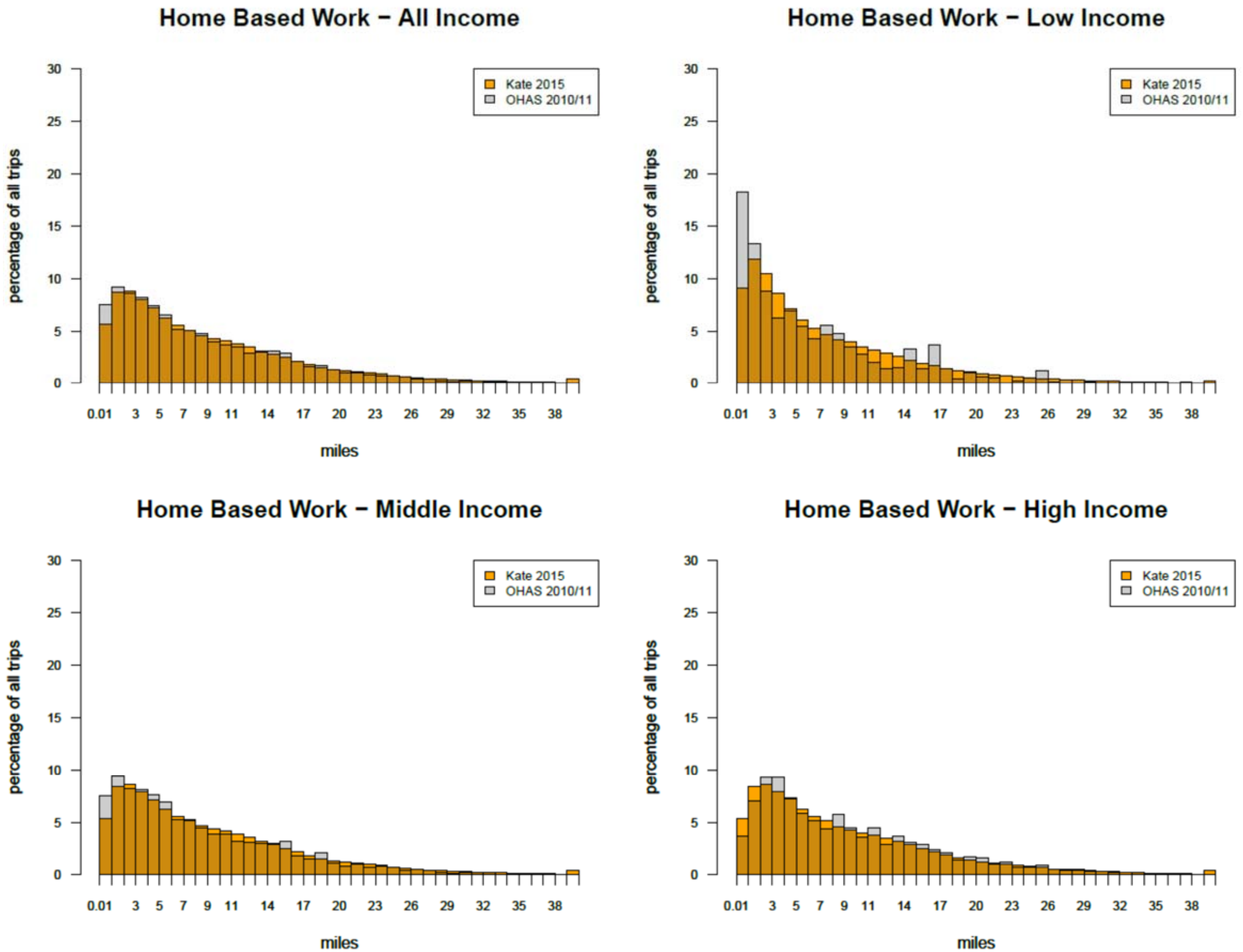


Figure 3 cont'd: Trip length frequency by trip purpose (miles)

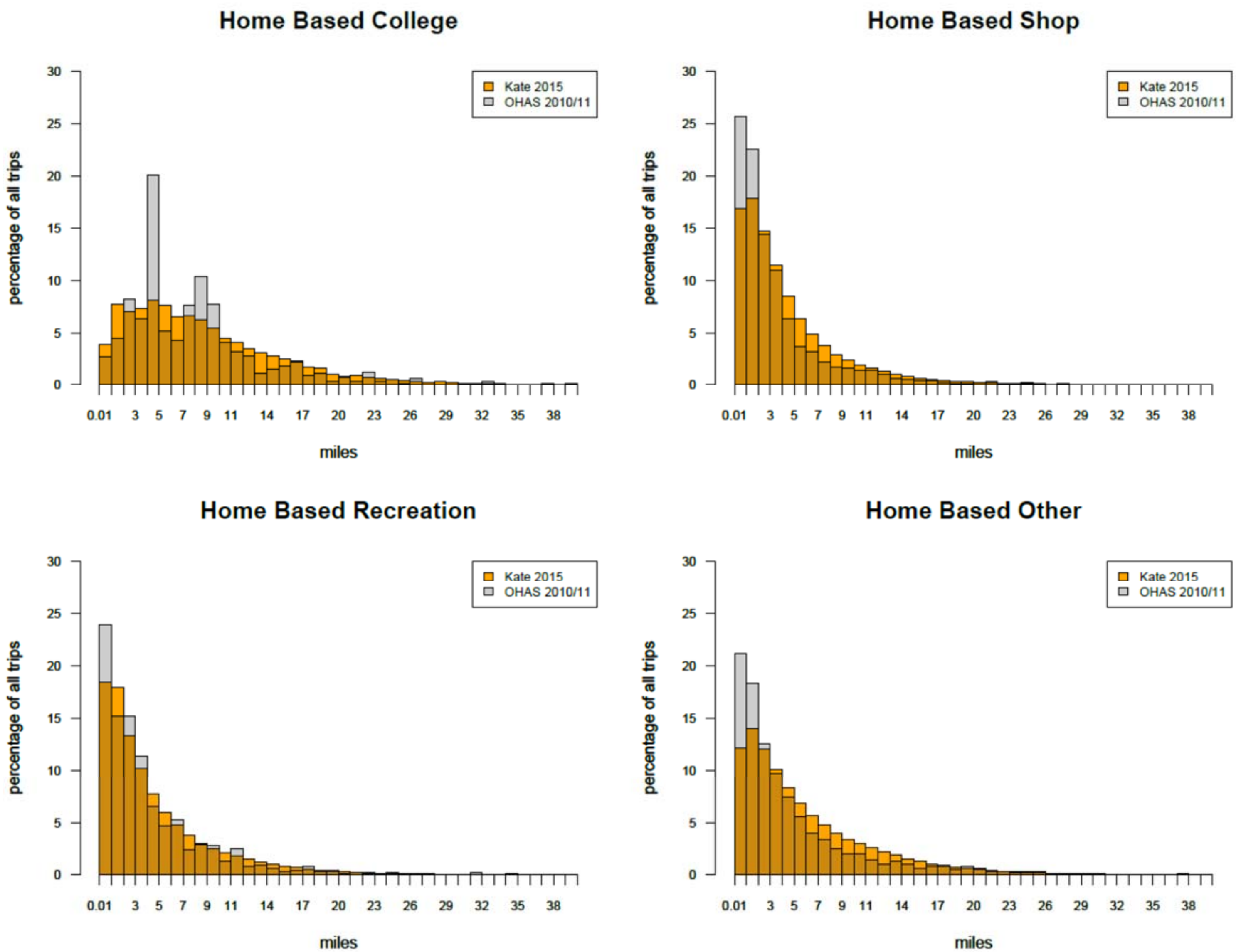


Figure 3 cont'd: Trip length frequency by trip purpose (miles)

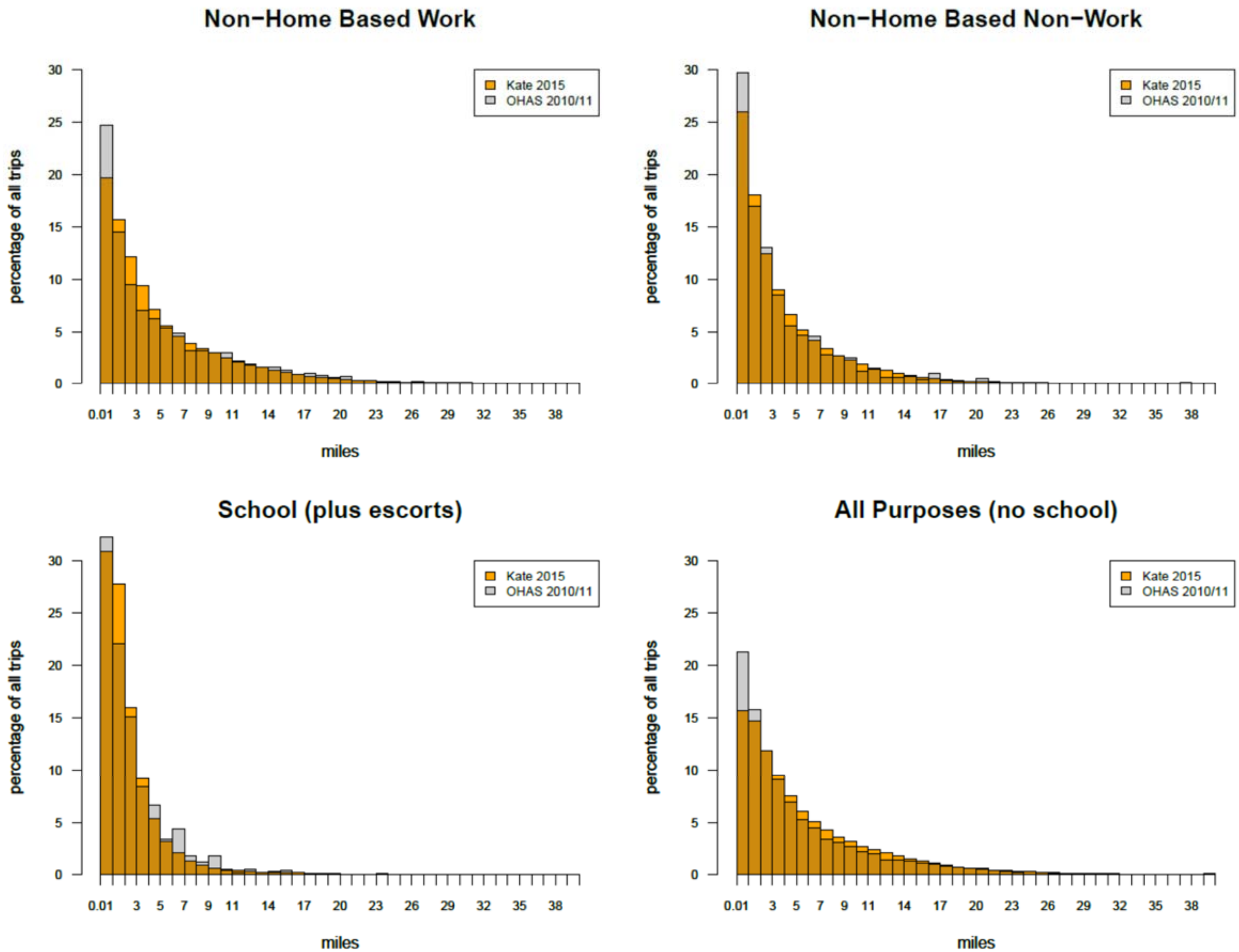


Table 7: Distribution of home based work trips

		Home based work trip distribution		
		LEHD 2014	Kate 2015	Point difference (Kate - LEHD)
Central City to:				
	Central City	34%	43%	9
	East	20%	23%	3
	Southeast	4%	3%	-1
	Southwest	11%	8%	-3
	West	29%	22%	-6
	North	2%	1%	-1
East to:				
	Central City	20%	20%	0
	East	44%	48%	4
	Southeast	8%	7%	0
	Southwest	9%	7%	-1
	West	17%	16%	-1
	North	3%	2%	-1
West to:				
	Central City	13%	12%	-1
	East	14%	13%	0
	Southeast	4%	3%	0
	Southwest	15%	14%	-1
	West	53%	56%	3
	North	1%	1%	0
North to:				
	Central City	7%	7%	0
	East	20%	17%	-3
	Southeast	3%	2%	-1
	Southwest	4%	3%	0
	West	8%	8%	0
	North	57%	62%	5
CBD from:				
	East+	45%	49%	3
	Southeast	8%	8%	1
	Southwest	14%	9%	-4
	West	26%	24%	-2
	North	7%	9%	2

Table 7 cont'd: Distribution of home based work trips

		Home based work trip distribution		
		LEHD 2014	Kate 2015	Point difference (Kate - LEHD)
Southeast to:				
	Central City	12%	13%	0
	East	29%	21%	-8
	Southeast	29%	37%	8
	Southwest	15%	14%	0
	West	14%	13%	0
	North	2%	1%	0
Southwest to:				
	Central City	14%	10%	-4
	East	15%	13%	-2
	Southeast	7%	8%	1
	Southwest	36%	48%	12
	West	26%	19%	-7
	North	1%	1%	0

4.3 Mode Choice

Modal accessibility functions measure the utility of choosing one of nine discrete modes for each trip purpose:

- Drive alone (SOV)
- Drive with passenger (HOV)
- Passenger in car (HOV passenger)
- Walk to transit
- Drive to transit (Park & Ride)
- Walk
- Bike

It should be noted that the park-and-ride mode is not available for the two non-home trip purposes (NHW, NHNW) and, additionally, that the school trip purpose (SCH) includes an exclusive school bus mode.

The transit modes include service provided by Tri-Met (Oregon), C-Tran (Washington), and several agencies providing limited service in outlying areas. For Portland, intra-CBD movements are included even though little is known about the true patterns occurring in this area.

Table 8 summarizes the regional mode split by trip purpose, comparing model results to survey data.

Figure 4 shows trip length histograms for each of the trip purposes. The same pattern exists with these histograms as those described in the previous section – lengths closely match between the model and validation data, with some exceptions for short trips. This can again be ascribed to the limitations of TAZ size influencing shortest trips allowed in the model.

Table 8: Mode split summary

Purpose	Mode	OHAS 2010/11	Kate 2015
HBW	SOV drive	70.6%	70.8%
	HOV drive	3.9%	4.2%
	HOV passenger	5.0%	5.5%
	Transit walk	8.1%	7.1%
	Transit drive	3.40%	2.40%
	Bike	4.7%	6.0%
	Walk	4.3%	4.0%
	Total share	17.5%	16.9%
HBO	SOV drive	34.5%	35.7%
	HOV drive	23.3%	26.3%
	HOV passenger	28.2%	27.1%
	Transit walk	2.7%	1.8%
	Transit drive	0.24%	0.10%
	Bike	1.6%	2.0%
	Walk	9.5%	7.0%
	Total share	25.3%	23.4%
HBS	SOV drive	43.8%	45.1%
	HOV drive	16.1%	18.0%
	HOV passenger	23.4%	23.7%
	Transit walk	4.0%	3.2%
	Transit drive	0.03%	0.03%
	Bike	2.9%	3.3%
	Walk	9.7%	6.7%
	Total share	9.4%	8.4%
NHW	SOV drive	68.8%	69.6%
	HOV drive	8.1%	8.5%
	HOV passenger	6.6%	6.4%
	Transit walk	2.7%	1.6%
	Bike	2.2%	2.9%
	Walk	11.6%	11.0%
	Total share	10.8%	12.7%
HBC	SOV drive	53.5%	54.4%
	HOV drive	2.9%	4.1%
	HOV passenger	11.7%	12.4%
	Transit walk	17.5%	14.0%
	Transit drive	4.91%	2.84%
	Bike	4.6%	6.0%
	Walk	4.8%	6.2%
	Total share	1.4%	1.6%
HBR	SOV drive	27.5%	27.6%
	HOV drive	18.1%	19.5%
	HOV passenger	33.7%	33.0%
	Transit walk	2.8%	2.5%
	Transit drive	0.15%	0.08%
	Bike	3.7%	4.6%
	Walk	14.1%	12.7%
	Total share	7.6%	7.3%
School	Vehicle	4.3%	21.9%
	HOV passenger	35.9%	32.6%
	Transit walk	2.0%	1.9%
	Bike	2.4%	2.9%
	Walk	14.2%	13.4%
	Bus	41.1%	27.2%
	Total share	8.8%	11.5%
NHNW	SOV drive	33.5%	34.8%
	HOV drive	24.1%	24.8%
	HOV passenger	30.7%	29.3%
	Transit walk	2.2%	1.7%
	Bike	1.5%	1.9%
	Walk	8.1%	7.5%
	Total share	19.3%	18.3%

Table 8 cont'd: Mode split summary

		OHAS 2010/11	Kate 2015
All Trip Purposes (including school)	SOV drive	41.9%	42.2%
	HOV drive	15.4%	18.0%
	HOV passenger	22.7%	21.8%
	Transit walk	3.8%	3.0%
	Transit drive	0.7%	0.5%
	Bike	2.6%	3.2%
	Walk	9.2%	8.2%
	School bus	3.6%	3.1%
	Total vehicles (SOV + HOV)	57.3%	60.2%
	Total transit trips	4.6%	3.5%
	Total active trips (Walk + Bike)	11.8%	11.5%
	Total person trips	100.0%	100.0%

Figure 4: Trip length frequency by mode (miles)

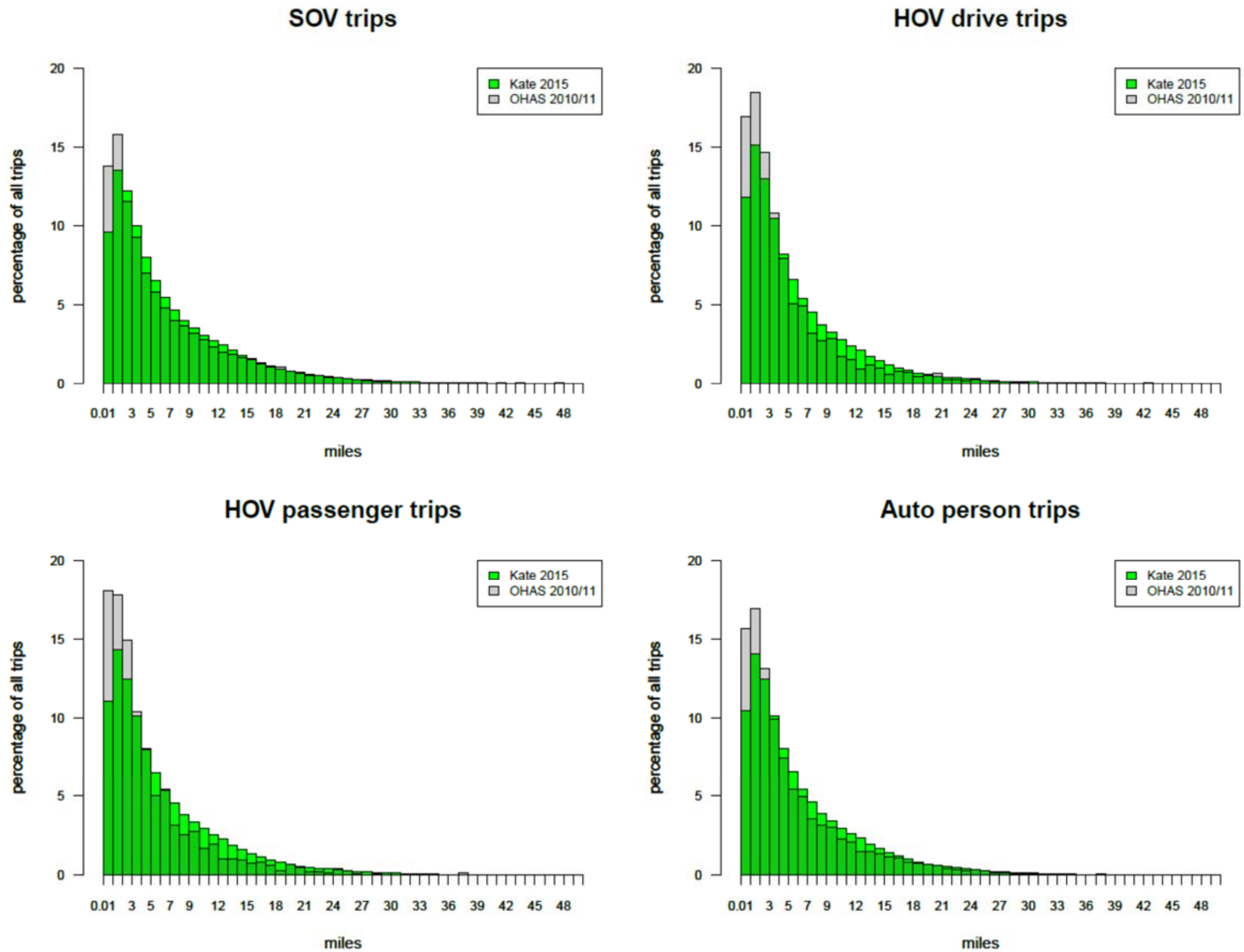


Figure 4 cont'd: Trip length frequency by mode (miles)

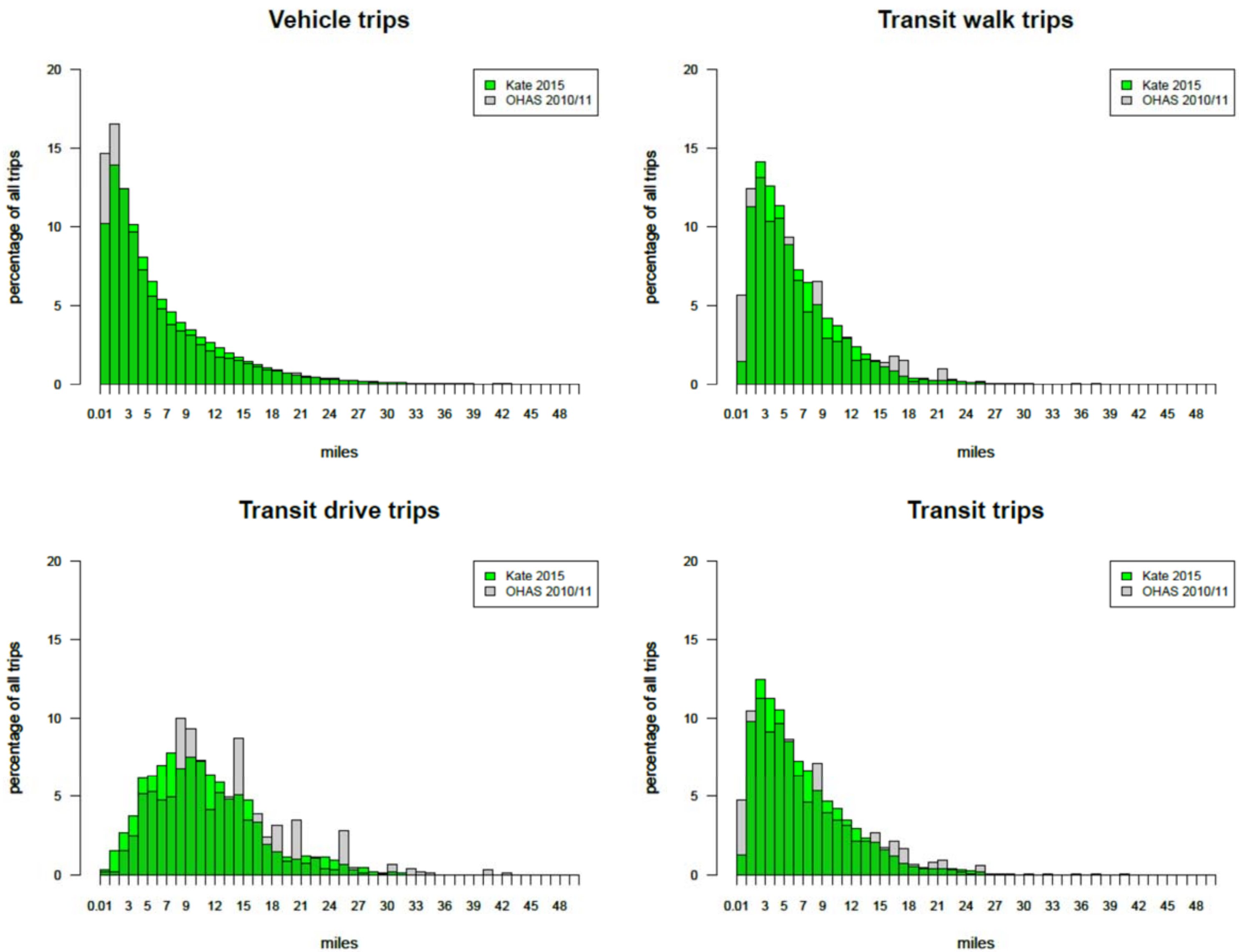
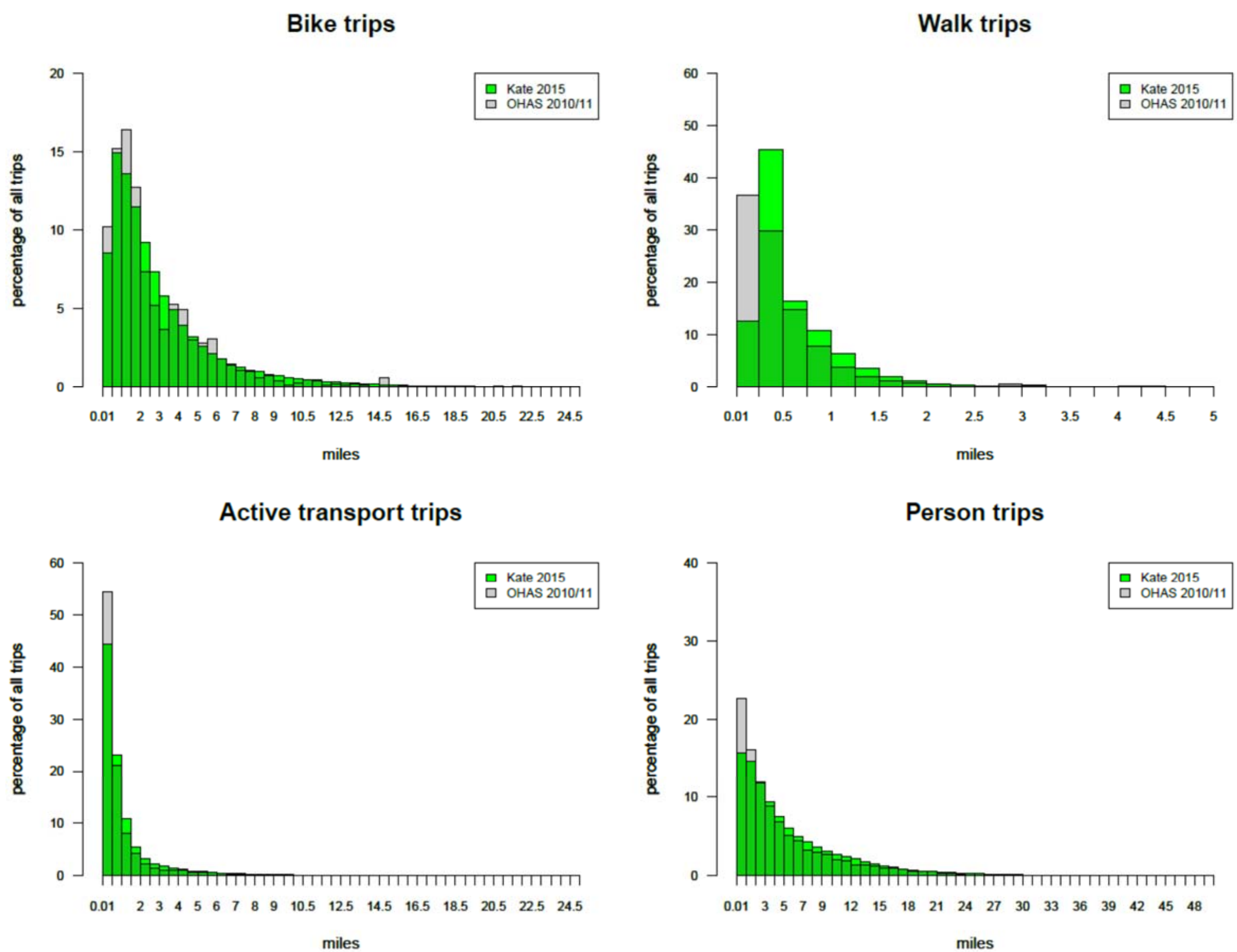


Figure 4 cont'd: Trip length frequency by mode (miles)



5.0 Assignment

The assignment is validated by comparing model flows to count data.

5.1 Auto Assignment Summary Results

The root mean squared error (RMSE) is a statistical measure of accuracy used to compare observed to reference data, in this case modeled volumes to traffic counts. Table 9 contains RMSE for the average weekday, PM 2-hr and AM 2-hr peak periods. Federal Highway Administration (FHWA) literature suggests that an aggregate percent RMSE below 30 percent is acceptable. With the exception of AM 2-hr peak period Arterials, all categories in Table 9 meet this criteria.

Table 10 is a shows that modeled vehicle miles traveled (VMT) on the auto/truck network very closely matches the estimate of VMT from HPMS at both regional and sub-regional levels.

Figure 5 displays the cutline/screenline locations used to validate the auto assignment.

Figure 6: Diurnal count profile across all cutlines (% of daily counts per hour)

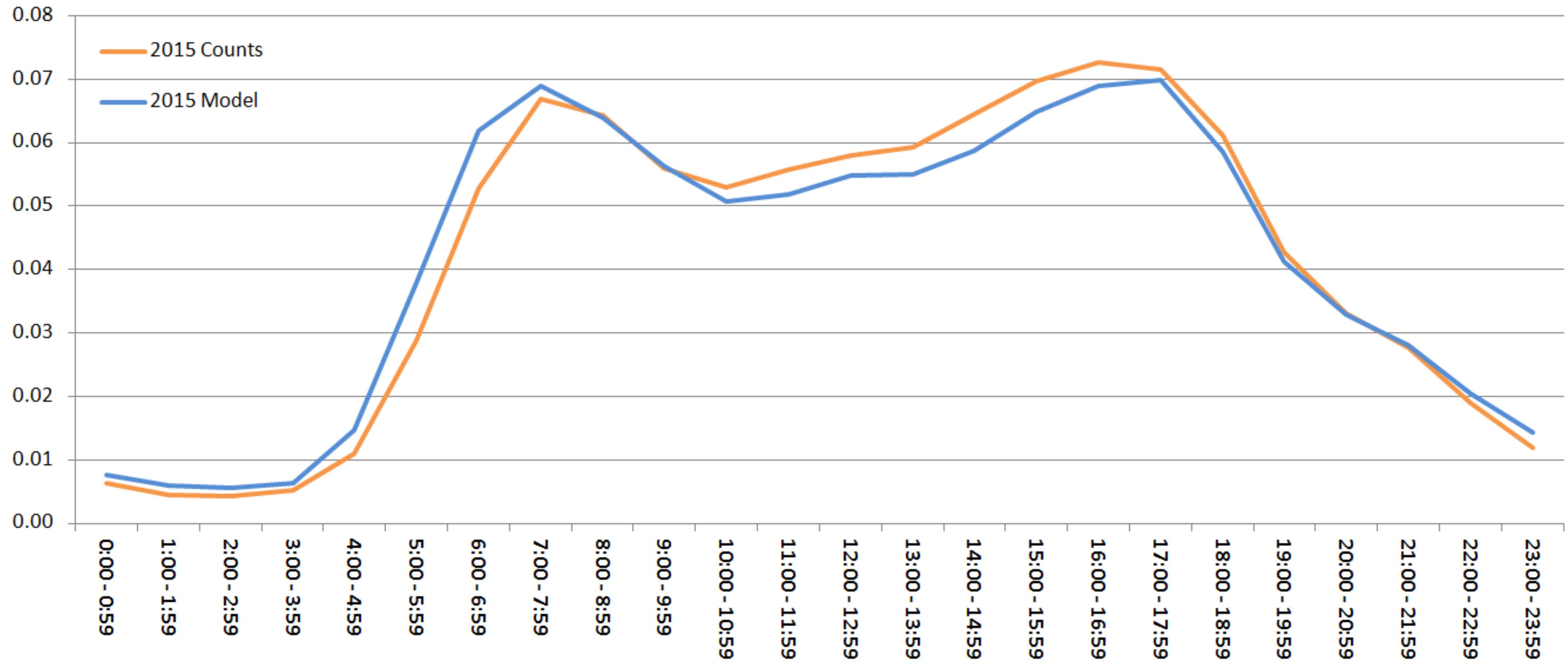


Table 11: Key cutline comparisons – Average Weekday

Cutline	South/West				North/East			
	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	87,275	80,029	7,246	9%	83,506	71,264	12,242	17%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	14,566	9,560	5,006	52%	13,067	7,724	5,343	69%
210: BURNSIDE BRIDGE (eb & wb)	22,625	15,557	7,068	45%	28,688	18,924	9,764	52%
211: MORRISON BRIDGE (eb & wb)	26,964	28,927	-1,963	-7%	22,591	23,661	-1,070	-5%
212: HAWTHORNE BRIDGE (eb & wb)	23,651	15,032	8,619	57%	19,405	17,986	1,419	8%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	91,240	64,249	26,991	42%	98,232	78,348	19,884	25%
214: ROSS ISLAND BRIDGE (eb & wb)	40,188	35,777	4,411	12%	37,690	32,680	5,010	15%
Cutline Summary:	**306,509**	**249,132**	**57,377**	**23%**	**303,179**	**250,587**	**52,592**	**21%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	81,134	69,275	11,859	17%	76,513	68,188	8,325	12%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	77,626	80,367	-2,741	-3%	71,601	81,371	-9,770	-12%
Total Columbia River Crossings	**158,760**	**149,642**	**9,118**	**6%**	**148,114**	**149,559**	**-1,445**	**-1%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	6,271	3,120	3,151	101%	7,238	4,567	2,671	58%
286: W BURNSIDE ROAD (eb & wb)	12,021	9,698	2,323	24%	13,592	9,560	4,032	42%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	106,111	86,736	19,375	22%	99,353	82,350	17,003	21%
289: SW PATTON ROAD (eb & wb)	2,924	3,723	-799	-21%	3,657	4,646	-989	-21%
290: SW TALBOT ROAD (eb & wb)	1,622	2,242	-620	-28%	2,136	1,850	286	15%
Cutline Summary:	**128,949**	**105,519**	**23,430**	**22%**	**125,976**	**102,973**	**23,003**	**22%**

Table 12: Key cutline comparisons – PM2 (4pm - 6pm)

Cutline	South/West				North/East			
	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	10,666	8,960	1,706	19%	12,105	9,029	3,076	34%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	2,134	1,960	174	9%	2,654	1,634	1,020	62%
210: BURNSIDE BRIDGE (eb & wb)	3,026	2,137	889	42%	4,554	3,780	774	20%
211: MORRISON BRIDGE (eb & wb)	3,315	3,315	0	0%	3,886	5,279	-1,393	-26%
212: HAWTHORNE BRIDGE (eb & wb)	3,284	2,188	1,096	50%	3,755	4,150	-395	-10%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	11,009	8,115	2,894	36%	12,899	7,772	5,127	66%
214: ROSS ISLAND BRIDGE (eb & wb)	4,826	4,387	439	10%	5,686	5,989	-303	-5%
Cutline Summary:	**38,260**	**31,062**	**7,198**	**23%**	**45,539**	**37,633**	**7,906**	**21%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	8,801	8,074	727	9%	12,109	10,147	1,962	19%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	8,114	9,121	-1,007	-11%	13,795	14,134	-339	-2%
Total Columbia River Crossings	**16,915**	**17,195**	**-280**	**-2%**	**25,904**	**24,281**	**1,623**	**7%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	1,124	955	169	18%	1,119	817	302	37%
286: W BURNSIDE ROAD (eb & wb)	2,121	2,278	-157	-7%	2,137	1,682	455	27%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	13,598	12,480	1,118	9%	12,364	10,008	2,356	24%
289: SW PATTON ROAD (eb & wb)	768	759	9	1%	682	833	-151	-18%
290: SW TALBOT ROAD (eb & wb)	491	750	-259	-35%	174	275	-101	-37%
Cutline Summary:	**18,102**	**17,222**	**880**	**5%**	**16,476**	**13,615**	**2,861**	**21%**

Table 13: Key cutline comparisons – AM2 (7am – 9am)

Cutline	South/West Kate Volumes	South/West Counts	South/West Difference Kate - Counts	South/West % Δ from Counts	North/East Kate Volumes	North/East Counts	North/East Difference Kate - Counts	North/East % Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	12,916	11,343	1,573	14%	9,781	8,540	1,241	15%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	2,518	1,688	830	49%	1,706	801	905	113%
210: BURNSIDE BRIDGE (eb & wb)	3,780	2,794	986	35%	3,133	1,625	1,508	93%
211: MORRISON BRIDGE (eb & wb)	3,950	5,603	-1,653	-30%	2,093	1,526	567	37%
212: HAWTHORNE BRIDGE (eb & wb)	3,795	3,086	709	23%	2,598	1,778	820	46%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	11,620	9,265	2,355	25%	11,430	10,723	707	7%
214: ROSS ISLAND BRIDGE (eb & wb)	5,650	6,139	-489	-8%	4,217	3,190	1,027	32%
Cutline Summary:	**44,229**	**39,918**	**4,311**	**11%**	**34,958**	**28,183**	**6,775**	**24%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	13,094	9,459	3,635	38%	7,857	6,177	1,680	27%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	15,547	12,908	2,639	20%	7,314	7,375	-61	-1%
Total Columbia River Crossings	**28,641**	**22,367**	**6,274**	**28%**	**15,171**	**13,552**	**1,619**	**12%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	912	272	640	235%	1,134	1,498	-364	-24%
286: W BURNSIDE ROAD (eb & wb)	1,729	1,174	555	47%	2,345	1,967	378	19%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	12,898	11,508	1,390	12%	12,753	11,478	1,275	11%
289: SW PATTON ROAD (eb & wb)	360	426	-66	-15%	812	1,047	-235	-22%
290: SW TALBOT ROAD (eb & wb)	108	309	-201	-65%	598	504	94	19%
Cutline Summary:	**16,007**	**13,689**	**2,318**	**17%**	**17,642**	**16,494**	**1,148**	**7%**

Table 14 shows the average weekday (AWD) and PM peak counts and assigned volumes. Figure 6 contains a comparison of the total traffic counts and model volume across all cutlines for each hour of the day. While there are certainly sub-regional differences in diurnal patterns for each cutline, the totals shown in this figure validate that the model is doing a relatively good job of reflecting overall regional diurnal allocation of traffic to the network, with the size and width of both the AM and PM peaks in model volume closely resembling those of the count data.

Tables 11-16 show cutline level comparisons of model data against count data for Average Weekday (AWD), PM 2-hr peak period (4pm-6pm), and AM 2-hr peak period (7am-9am). Tables 11-13 show three specific cutlines in detail. These cutlines represent major regional movements that can be calibrated within the destination choice model. Tables 14-16 and Figures 7-9 show all cutlines in the region, as well as plots of the volumes-to-counts comparisons and R^2 values.

Table 9: Root mean squared error (RMSE) for assigned traffic volumes across Tier 1 cutlines

	Average Weekday	PM2 (4pm-6pm)	AM2 (7am-9am)
Highway Summary			
(M-C)^2	2,315,293,774	76,257,514	24,243,254
N	38	38	38
Sum(counts)	2,273,549	295,314	288,357
% RMSE	**13**	**18**	**11**
Arterial Summary			
(M-C)^2	820,039,082	20,581,207	20,657,250
N	158	158	158
Sum(counts)	1,323,756	223,929	183,578
% RMSE	**27**	**26**	**31**

Table 10: Highway Performance Monitoring System (HPMS) Vehicle Miles Traveled (VMT)

	HPMS 2014	Kate 2015	Difference
OR + WA VMT	**36,240,086**	**36,292,558**	**0.14%**
OR VMT	**29,698,086**	29,814,732	0.39%
WA VMT	**6,542,000**	6,477,825	-0.98%

Figure 5: Tier 1 auto cutline locations

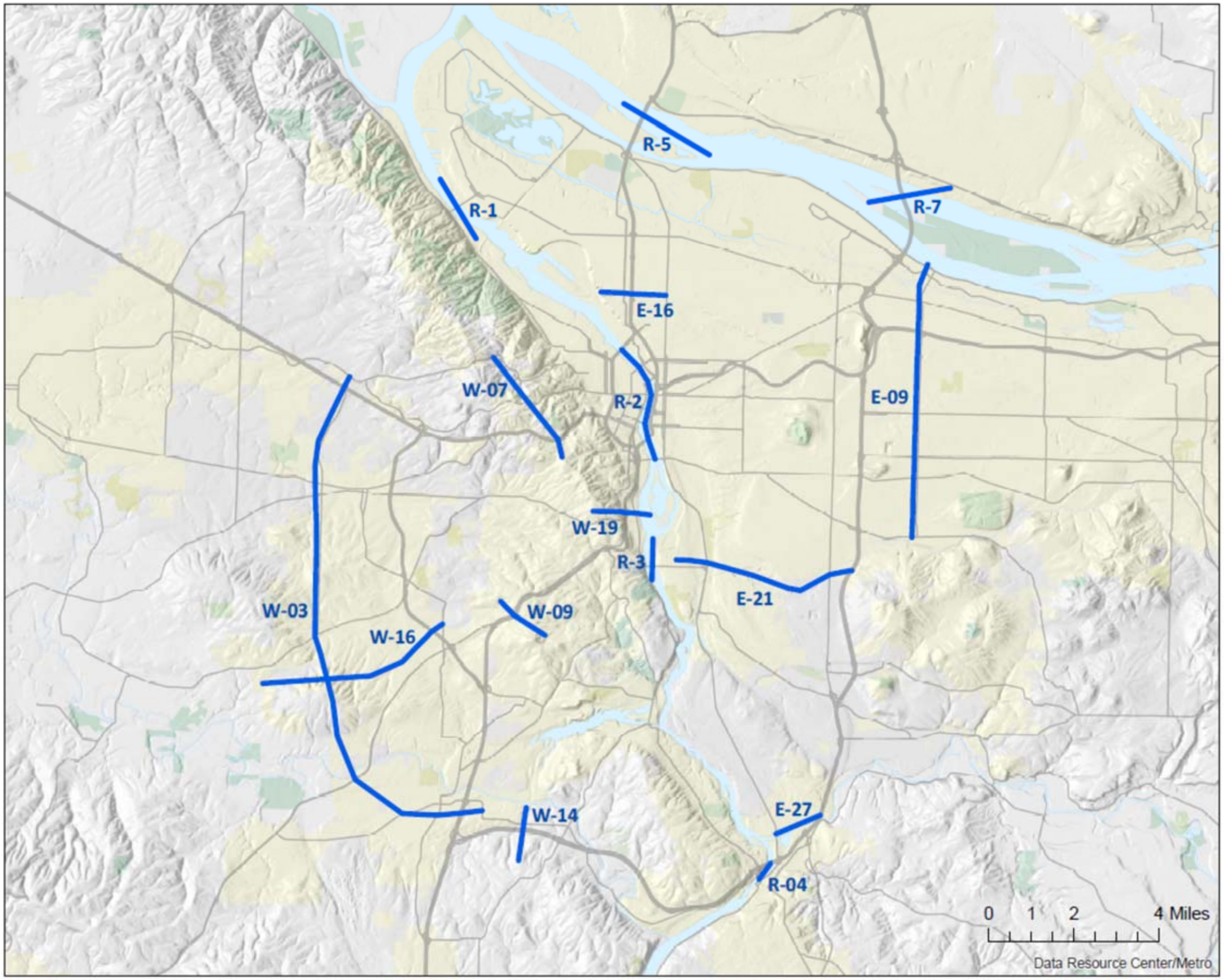


Figure 6: Diurnal count profile across all cutlines (% of daily counts per hour)

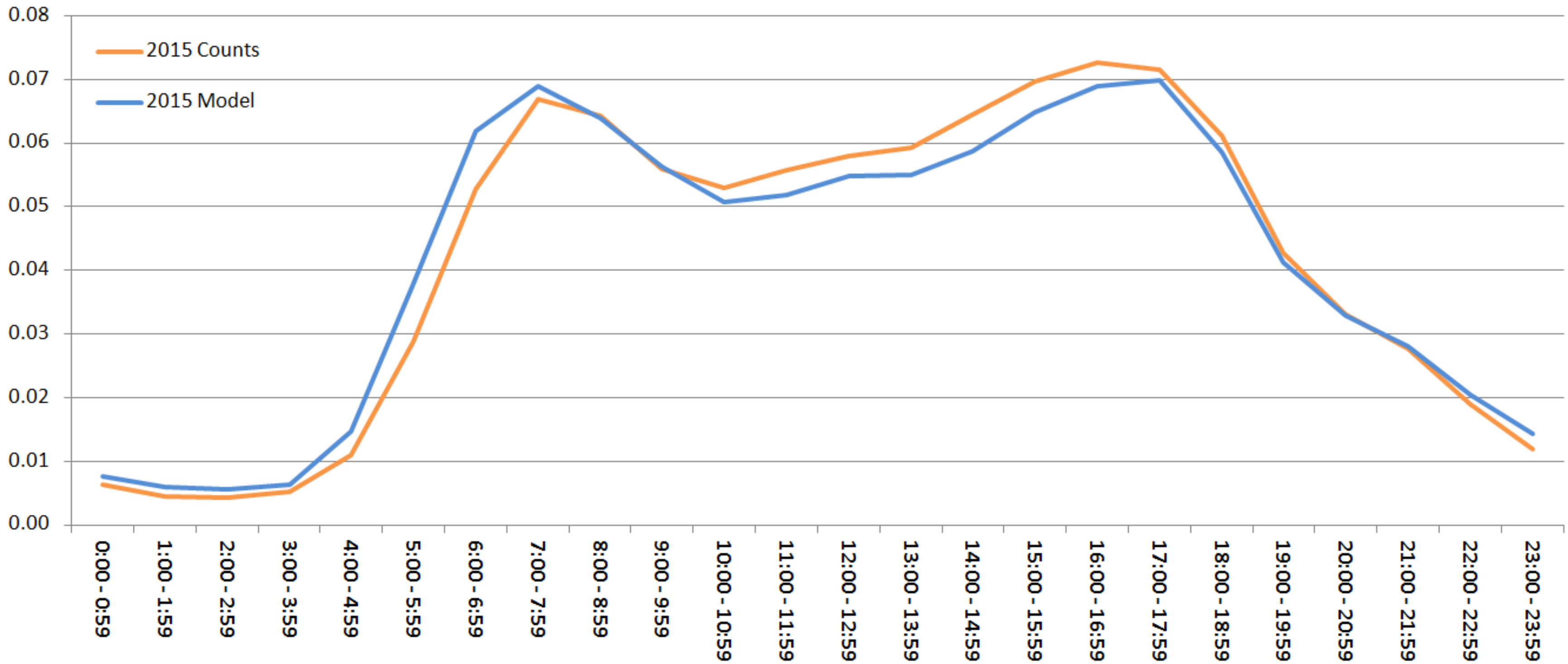


Table 11: Key cutline comparisons – Average Weekday

Cutline	South/West				North/East			
	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	87,275	80,029	7,246	9%	83,506	71,264	12,242	17%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	14,566	9,560	5,006	52%	13,067	7,724	5,343	69%
210: BURNSIDE BRIDGE (eb & wb)	22,625	15,557	7,068	45%	28,688	18,924	9,764	52%
211: MORRISON BRIDGE (eb & wb)	26,964	28,927	-1,963	-7%	22,591	23,661	-1,070	-5%
212: HAWTHORNE BRIDGE (eb & wb)	23,651	15,032	8,619	57%	19,405	17,986	1,419	8%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	91,240	64,249	26,991	42%	98,232	78,348	19,884	25%
214: ROSS ISLAND BRIDGE (eb & wb)	40,188	35,777	4,411	12%	37,690	32,680	5,010	15%
Cutline Summary:	**306,509**	**249,132**	**57,377**	**23%**	**303,179**	**250,587**	**52,592**	**21%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	81,134	69,275	11,859	17%	76,513	68,188	8,325	12%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	77,626	80,367	-2,741	-3%	71,601	81,371	-9,770	-12%
Total Columbia River Crossings	**158,760**	**149,642**	**9,118**	**6%**	**148,114**	**149,559**	**-1,445**	**-1%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	6,271	3,120	3,151	101%	7,238	4,567	2,671	58%
286: W BURNSIDE ROAD (eb & wb)	12,021	9,698	2,323	24%	13,592	9,560	4,032	42%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	106,111	86,736	19,375	22%	99,353	82,350	17,003	21%
289: SW PATTON ROAD (eb & wb)	2,924	3,723	-799	-21%	3,657	4,646	-989	-21%
290: SW TALBOT ROAD (eb & wb)	1,622	2,242	-620	-28%	2,136	1,850	286	15%
Cutline Summary:	**128,949**	**105,519**	**23,430**	**22%**	**125,976**	**102,973**	**23,003**	**22%**

Table 12: Key cutline comparisons – PM2 (4pm - 6pm)

Cutline	South/West				North/East			
	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts	Kate Volumes	Counts	Difference Kate - Counts	% Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	10,666	8,960	1,706	19%	12,105	9,029	3,076	34%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	2,134	1,960	174	9%	2,654	1,634	1,020	62%
210: BURNSIDE BRIDGE (eb & wb)	3,026	2,137	889	42%	4,554	3,780	774	20%
211: MORRISON BRIDGE (eb & wb)	3,315	3,315	0	0%	3,886	5,279	-1,393	-26%
212: HAWTHORNE BRIDGE (eb & wb)	3,284	2,188	1,096	50%	3,755	4,150	-395	-10%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	11,009	8,115	2,894	36%	12,899	7,772	5,127	66%
214: ROSS ISLAND BRIDGE (eb & wb)	4,826	4,387	439	10%	5,686	5,989	-303	-5%
Cutline Summary:	**38,260**	**31,062**	**7,198**	**23%**	**45,539**	**37,633**	**7,906**	**21%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	8,801	8,074	727	9%	12,109	10,147	1,962	19%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	8,114	9,121	-1,007	-11%	13,795	14,134	-339	-2%
Total Columbia River Crossings	**16,915**	**17,195**	**-280**	**-2%**	**25,904**	**24,281**	**1,623**	**7%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	1,124	955	169	18%	1,119	817	302	37%
286: W BURNSIDE ROAD (eb & wb)	2,121	2,278	-157	-7%	2,137	1,682	455	27%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	13,598	12,480	1,118	9%	12,364	10,008	2,356	24%
289: SW PATTON ROAD (eb & wb)	768	759	9	1%	682	833	-151	-18%
290: SW TALBOT ROAD (eb & wb)	491	750	-259	-35%	174	275	-101	-37%
Cutline Summary:	**18,102**	**17,222**	**880**	**5%**	**16,476**	**13,615**	**2,861**	**21%**

Table 13: Key cutline comparisons – AM2 (7am – 9am)

Cutline	South/West Kate Volumes	South/West Counts	South/West Difference Kate - Counts	South/West % Δ from Counts	North/East Kate Volumes	North/East Counts	North/East Difference Kate - Counts	North/East % Δ from Counts
R-02 : Willamette River - No Broadway Bridge count in 2015								
207 (26-027): FREMONT BRIDGE (nb & sb)	12,916	11,343	1,573	14%	9,781	8,540	1,241	15%
208: BROADWAY BRIDGE (nb & sb)	****	****	****	****	****	****	****	****
209: STEEL BRIDGE (eb & wb)	2,518	1,688	830	49%	1,706	801	905	113%
210: BURNSIDE BRIDGE (eb & wb)	3,780	2,794	986	35%	3,133	1,625	1,508	93%
211: MORRISON BRIDGE (eb & wb)	3,950	5,603	-1,653	-30%	2,093	1,526	567	37%
212: HAWTHORNE BRIDGE (eb & wb)	3,795	3,086	709	23%	2,598	1,778	820	46%
213 (26-026): MARQUAM BRIDGE (US I-5) (nb & sb)	11,620	9,265	2,355	25%	11,430	10,723	707	7%
214: ROSS ISLAND BRIDGE (eb & wb)	5,650	6,139	-489	-8%	4,217	3,190	1,027	32%
Cutline Summary:	**44,229**	**39,918**	**4,311**	**11%**	**34,958**	**28,183**	**6,775**	**24%**
R-05 & R-07 : Columbia River								
218 (26-004): US I-5 BRIDGE, n/o Hayden Island (nb & sb)	13,094	9,459	3,635	38%	7,857	6,177	1,680	27%
220 (26-024): US I-205 BRIDGE (Glenn Jackson Bridge) (nb & sb)	15,547	12,908	2,639	20%	7,314	7,375	-61	-1%
Total Columbia River Crossings	**28,641**	**22,367**	**6,274**	**28%**	**15,171**	**13,552**	**1,619**	**12%**
W-07 : West Hills								
285: NW CORNELL ROAD (eb & wb)	912	272	640	235%	1,134	1,498	-364	-24%
286: W BURNSIDE ROAD (eb & wb)	1,729	1,174	555	47%	2,345	1,967	378	19%
288 (26-002): HWY 26 (Sunset), e/o Zoo Rd Interchange (eb & wb)	12,898	11,508	1,390	12%	12,753	11,478	1,275	11%
289: SW PATTON ROAD (eb & wb)	360	426	-66	-15%	812	1,047	-235	-22%
290: SW TALBOT ROAD (eb & wb)	108	309	-201	-65%	598	504	94	19%
Cutline Summary:	**16,007**	**13,689**	**2,318**	**17%**	**17,642**	**16,494**	**1,148**	**7%**

Table 14: Auto cutline comparison – Average Weekday

South/West

Cutline	Kate	Count	Difference
E-09	180,565	198,593	-9%
E-16	128,931	126,973	2%
E-21	147,366	152,016	-3%
E-27	96,159	91,167	5%
R-01	15,826	13,418	18%
R-02	306,509	249,132	23%
R-04	76,107	62,413	22%
R-05	81,134	69,275	17%
R-07	77,626	80,367	-3%
W-03A	205,748	192,403	7%
W-03B	430,734	382,994	12%
W-07	128,949	105,519	22%
W-09	95,072	86,746	10%
W-14	57,742	53,618	8%
W-16	117,809	99,654	18%
W-19	128,926	113,037	14%

North/East

Cutline	Kate	Count	Difference
E-09	178,200	191,821	-7%
E-16	124,338	117,958	5%
E-21	148,171	148,797	0%
E-27	96,792	92,786	4%
R-01	16,805	14,458	16%
R-02	303,179	250,587	21%
R-04	78,110	61,320	27%
R-05	76,513	68,188	12%
R-07	71,601	81,371	-12%
W-03A	204,097	190,539	7%
W-03B	135,700	117,152	16%
W-07	125,976	102,973	22%
W-09	97,182	81,892	19%
W-14	55,349	51,440	8%
W-16	116,750	101,207	15%
W-19	130,177	113,738	14%

Figure 7: Auto cutline comparison – Average Weekday

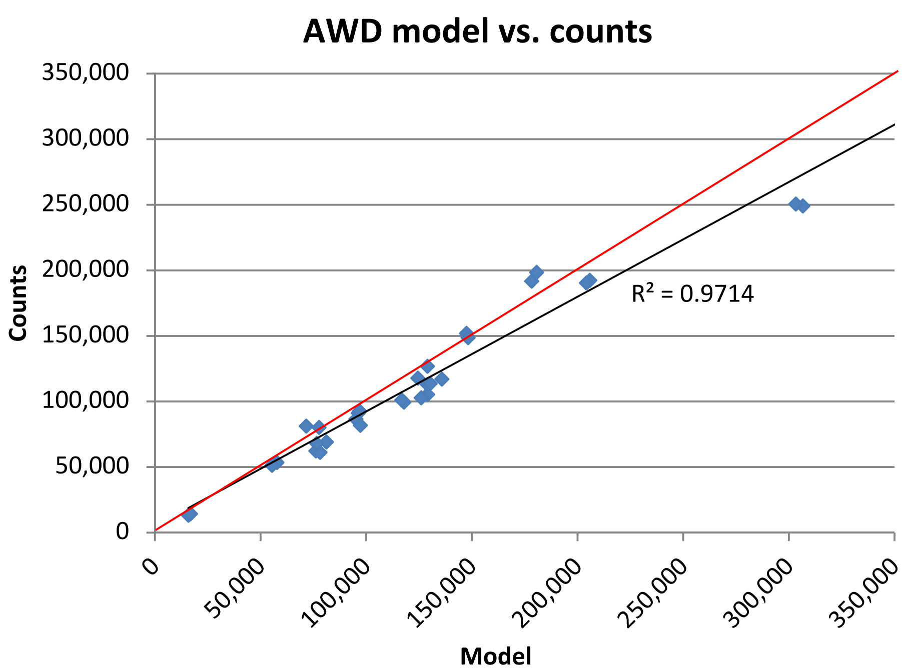


Table 15: Auto cutline comparison – PM2 (4pm - 6pm)

	Cutline	Kate	Count	Difference
South/West	E-09	23,135	25,962	-11%
	E-16	14,571	15,241	-4%
	E-21	20,748	24,028	-14%
	E-27	14,548	14,470	1%
	R-01	2,277	2,162	5%
	R-02	38,260	31,062	23%
	R-04	11,000	8,269	33%
	R-05	8,801	8,074	9%
	R-07	8,114	9,121	-11%
	W-03A	29,783	32,099	-7%
	W-03B	61,634	63,062	-2%
	W-07	18,102	17,222	5%
	W-09	12,017	11,991	0%
	W-14	7,176	6,688	7%
	W-16	15,654	15,600	0%
	W-19	18,170	19,754	-8%

	Cutline	Kate	Count	Difference
North/East	E-09	28,043	31,746	-12%
	E-16	18,589	15,779	18%
	E-21	21,443	19,933	8%
	E-27	13,225	12,960	2%
	R-01	2,816	2,920	-4%
	R-02	45,539	37,633	21%
	R-04	11,286	8,850	28%
	R-05	12,109	10,147	19%
	R-07	13,795	14,134	-2%
	W-03A	27,013	28,559	-5%
	W-03B	18,349	16,286	13%
	W-07	16,476	13,615	21%
	W-09	13,428	11,110	21%
	W-14	8,805	7,290	21%
	W-16	16,692	16,037	4%
	W-19	17,178	13,421	28%

Figure 8: Auto cutline comparison – PM2 (4pm – 6pm)

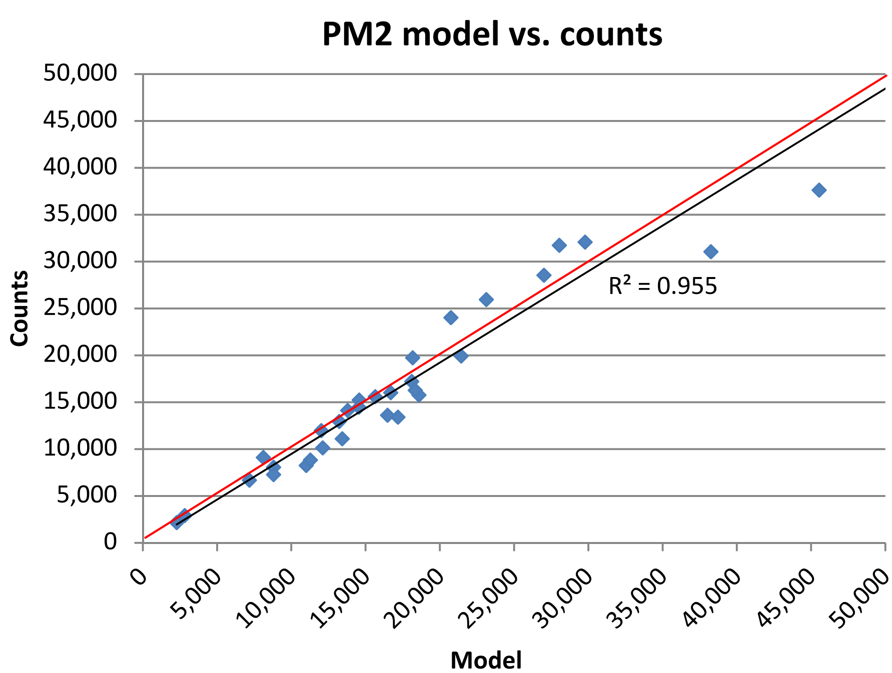


Table 16: Auto cutline comparison – AM2 (7am – 9am)

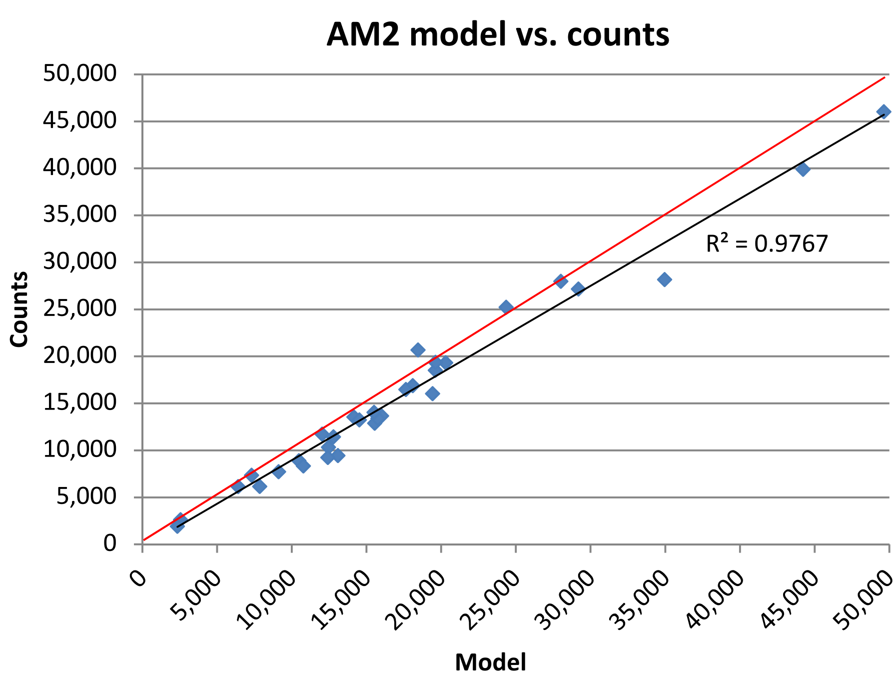
South/West

Cutline	Kate	Count	Difference
E-09	28,014	27,997	0%
E-16	19,606	18,534	6%
E-21	19,431	16,054	21%
E-27	12,454	10,351	20%
R-01	2,561	2,630	-3%
R-02	44,229	39,918	11%
R-04	10,475	8,917	17%
R-05	13,094	9,459	38%
R-07	15,547	12,908	20%
W-03A	24,355	25,243	-4%
W-03B	49,636	46,039	8%
W-07	16,007	13,689	17%
W-09	12,418	9,257	34%
W-14	9,120	7,735	18%
W-16	15,770	13,405	18%
W-19	15,514	14,057	10%

North/East

Cutline	Kate	Count	Difference
E-09	20,308	19,334	5%
E-16	12,795	11,455	12%
E-21	19,622	19,392	1%
E-27	14,157	13,558	4%
R-01	2,346	1,941	21%
R-02	34,958	28,183	24%
R-04	10,773	8,365	29%
R-05	7,857	6,177	27%
R-07	7,314	7,375	-1%
W-03A	29,189	27,176	7%
W-03B	18,094	16,901	7%
W-07	17,642	16,494	7%
W-09	12,033	11,741	2%
W-14	6,410	6,156	4%
W-16	14,527	13,264	10%
W-19	18,449	20,696	-11%

Figure 9: Auto cutline comparison – AM2 (7am – 9am)



5.1 Transit Assignment

Table 17 shows transit boardings on individual MAX and WES rail lines, as well as on aggregate BUS and STREETCAR routes. The transit boardings by rail lines match relatively well between the Kate model and Automatic Passenger Count (APC) data from the transit service providers.

Table 17: Transit ridership

Route / Route Type	2015 Boardings*	Kate	Diff	% Diff
Blue MAX	60,868	73,611	12,743	20.9%
Green MAX	21,834	28,781	6,947	31.8%
Red MAX	21,874	22,766	892	4.1%
Yellow/Orange MAX	25,466	25,385	-81	-0.3%
WES Commuter Rail	1,812	1,097	-715	-39.5%
All rail	131,854	151,640	19,786	15.0%
All bus + Streetcar	232,511	288,436	55,925	24.1%
Total boardings	**364,365**	**440,076**	**75,711**	**20.8%**
Originating rides	**287,666**	**300,330**		
Transfer rate	**1.27**	**1.47**		

***rail boardings approximated from 2015 TriMet daily boardings: one-half of total ons/offs**

Table 18 shows boardings for individual MAX and WES stations. The table has been ordered by station groupings, which represent sections of the rail system sharing similar routes. For most station groupings, the Kate model closely matches TriMet APC data, with exceptions for both the Green MAX and WES Commuter Rail. Discussion for these exceptions is included above. Note that the total rail boardings at all stations for the model differs between this table and the previous table (152,109 and 150,640, respectively). Two stations on the Orange MAX on/near the Tilikum Bridge also share stops with multiple bus routes. Table 18 includes these bus boardings in the analysis due to difficulties associated with isolating these boardings by mode.

Table 18: MAX station boardings (2015) – colors correspond to servicing MAX route(s)

Station Name	TriMet	Kate
Expo Center	267	467
Delta Park/Vanport	1,251	1,026
Kenton/N Denver	551	283
N Lombard TC	1,426	1,080
Rosa Parks	672	464
N Killingsworth	1,073	784
N Prescott	608	502
Overlook Park	535	480
Albina/Mississippi	304	404
Interstate/Rose Qtr	1,650	2,562
Grouping Total	**8,334**	**8,049**
Diff from Trimet		**-3%**
Union Station/NW 5th	960	740
NW 5th and Couch	709	605
SW 5th and Oak	1,211	1,129
Pioneer Place/SW 5th	2,685	1,839
City Hall/SW 5th	1,058	1,654
PSU Urban Center/SW	1,595	1,808
PSU South/SW 5th	818	376
PSU South/SW 6th	706	1,198
PSU Urban Center/SW	1,417	1,966
SW 6th and Madison	914	1,620
Pioneer Courthouse	2,562	2,182
SW 6th and Pine	1,192	1,136
NW 6th and Davis	685	847
Union Station/NW 6th	946	1,056
Grouping Total	**17,455**	**18,153**
Diff from Trimet		**4%**
Clackamas TC	2,590	3,246
SE Fuller	424	1,244
SE Flavel	586	522
Lents/SE Foster	706	735
SE Holgate	622	593
SE Powell	728	1,213
SE Division	780	1,703
SE Main	857	1,802
Grouping Total	**7,291**	**11,057**
Diff from Trimet		**52%**

Station Name	TriMet	Kate
Old Town/Chinatown	1,372	2,309
Skidmore Fountain	1,252	4,464
Oak/ SW 1st	1,184	419
Morrison/SW 3rd	1,305	1,857
Mall/SW 5th	1,996	1,990
Pioneer Square North	2,522	3,950
Galleria/SW 10th	1,783	1,773
Providence Park	1,399	3,208
Grouping Total	**12,811**	**19,968**
Diff from Trimet		**56%**
Hatfield Government	1,376	377
Hillsboro Central	918	1,580
Tuality Hospital	568	411
Washington/SE 12th	537	714
Fairplex/Hillsboro	984	715
Hawthorn Farm	405	422
Orenco/NW 231st	1,036	875
Quatama/NW 205th	1,423	1,088
Willow Creek/SW 185th	2,020	3,013
Elmonica/SW 170th	1,499	1,055
Merlo Rd/SW 158th	1,000	1,502
Beaverton Creek	821	837
Millikan	1,682	1,795
Beaverton Central	819	660
Grouping Total	**15,085**	**15,041**
Diff from Trimet		**0%**
Beaverton TC	5,110	5,836
Sunset TC	3,150	3,161
Washington Park	847	264
Goose Hollow	1,506	1,787
Kings Hill/SW Salmon	800	502
Providence Park	1,157	2,280
Library/SW 9th	1,790	2,981
Pioneer Square South	3,157	2,514
Mall/SW 4th	1,466	2,307
Yamhill District	995	1,331
Grouping Total	**19,975**	**22,961**
Diff from Trimet		**15%**

Table 15 cont'd: MAX station boardings (2015) – colors correspond to servicing MAX route(s)

Station Name	TriMet	Kate
PDX	2,196	1,240
Mt Hood Ave	321	225
Cascades	574	221
Parkrose/Sumner TC	1,124	1,530
Grouping Total	**4,214**	**3,215**
Diff from Trimet		**-24%**
Cleveland Ave	1,220	933
Gresham Central TC	1,132	2,367
Gresham City Hall	723	1,170
Civic Drive	401	579
Ruby Junction/E 197th	593	441
Rockwood/E 188th	1,012	862
E 181st	1,047	719
E 172nd	555	363
E 162nd	1,532	987
E 148th	834	509
E 122nd	1,809	2,398
E 102nd	1,238	1,015
Grouping Total	**12,093**	**12,339**
Diff from Trimet		**2%**
Gateway/NE 99th	7,641	4,760
NE 82nd	2,623	2,922
NE 60th	1,574	2,965
Hollywood/NE 42nd	2,511	6,342
Lloyd Center/NE 11th	4,254	2,816
NE 7th	1,706	2,464
Convention Center	1,969	3,097
Rose Quarter TC	3,915	6,723
Grouping Total	**26,192**	**32,088**
Diff from Trimet		**23%**

Station Name	TriMet	Kate
Wilsonville WES	365	117
Tualatin WES	258	162
Tigard TC	320	235
Hall/Nimbus WES	153	106
Beaverton TC WES	718	480
Grouping Total	**1,812**	**1,098**
Diff from Trimet		**-39%**
Lincoln St/SW 3rd	415	391
S Waterfront	793	645
OMSI/SE Water	314	465
Clinton St/SE 12th	380	739
SE 17th Ave & Rhine	217	478
SE 17th Ave/Holgate	367	503
SE Bybee	451	974
SE Tacoma	708	738
Milwaukie/Main	731	1,123
SE Park	2,220	2,090
Grouping Total	**6,594**	**8,143**
Diff from Trimet		**23%**

	All Stations	
	TriMet	**Kate**
Total boardings	**131,854**	**152,109**
Diff from TriMet		**20,256**
% Diff from TriMet		**15%**

	Non-CBD Stations	
	TriMet	**Kate**
Total boardings	**81,613**	**91,028**
Diff from TriMet		**9,416**
% Diff from TriMet		**12%**

5.2 Bicycle Assignment

Figure 10 shows the extent of the Bicycle Residential Preference Area (BRPA), within which relatively elevated levels of bicycle ownership and usage were observed in the 2010/11 household survey. Anecdotal evidence indicates a degree of self selection in the form of cycling-centric demographic groups choosing to reside within this area. The attractiveness of the bicycle mode is increased in the mode choice model for trips produced and attracted within the BRPA.

Table 19 shows how bike mode share for select markets from both the 2010 and 2015 model correspond to the 2010/11 household survey. The modeled results closely match the survey results, with a reasonable increase in bike mode share from 2010 to 2015.

Table 20 contains the single regional bike count cutline currently in place. It represents Willamette River bridge crossings into/out of Portland's Central Business District.

Figure 10: Bicycle Residential Preference Area (BRPA) – higher propensity for owning/utilizing a bike for travel within this district

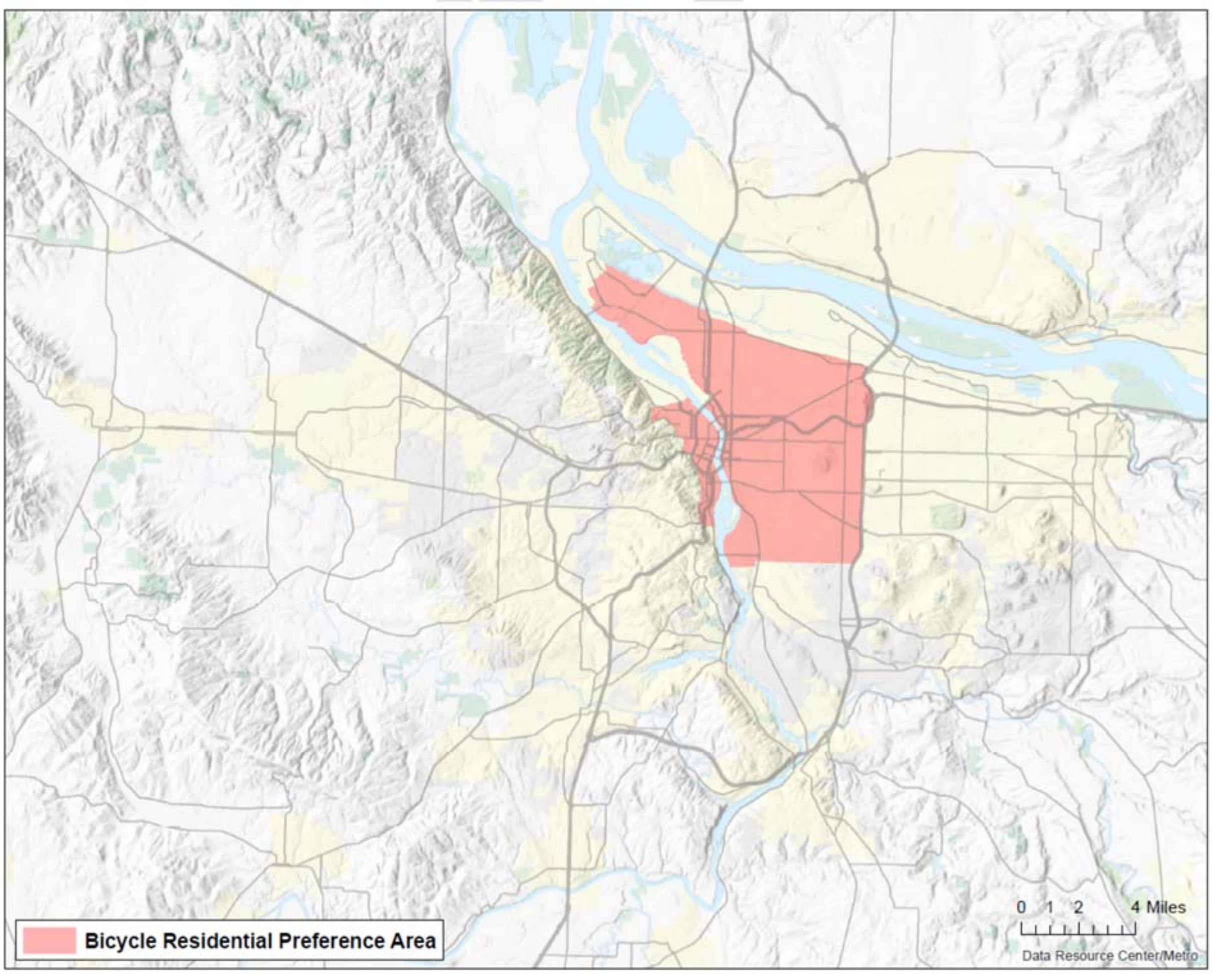


Table 19: Bicycle mode share for select markets

	OHAS 2010/2011		Kate 2010		Kate 2015	
BRPA HBW bike share	--	13.6%	33,097	13.9%	47,202	15.0%
BRPA total bike share	--	7.4%	110,099	7.5%	141,300	7.8%
Regional HBW bike share	--	--	66,805	5.4%	86,970	6.0%
Regional total bike share	--	2.6%	207,293	3.1%	249,802	3.3%

Table 20: Bicycle counts vs. model at CBD Willamette River bridges

Bridge	Count 2014	Kate	Difference	
Broadway	4,501	8,903	4,402	97.8%
Steel	4,559	3,393	-1,166	-25.6%
Burnside	2,345	2,618	273	11.7%
Morrison	805	3,147	2,342	290.9%
Hawthorne	8,287	5,758	-2,529	-30.5%
Tilikum*	2,000	5,292	3,292	164.6%
sum	22,497	29,111	6,614	29.4%

*approximate 2015 count from automated counter reports

Attachment D. Toll Project Value-of-Time Assumption Review Memorandum

I-205 Toll Project

MEMORANDUM

Date	February 22, 2021
To	ODOT Tolling Team
From	WSP Tolling Team
Subject	**Value-of-Time Assumption Review**
CC	Portland Metro Modeling Team

PURPOSE

The impacts of tolling on the transportation system, including changes in traffic routing and congestion, are key concerns. Travel models are essential tools used to estimate how people will behave with tolls in place. These models put a cost (value) on time to represent the choices people make. For example, a daily commuter may choose to take a different route to avoid paying a toll if they do not see enough value in the travel time saved on the tolled route. Meanwhile, a truck driver delivering valuable cargo may elect to pay the toll to save time or avoid the inconvenience of routing off the highway. These value choices can vary widely depending on the characteristics of the travelers, the purpose of the trip, and other situational and environmental factors.

This document provides recommended value-of-time (VOT) assumptions for the National Environmental Policy Act (NEPA) alternatives analysis to be performed for the I-205 Toll Project (Project). The recommended VOT assumptions may also be referred to as Value of Travel Time Savings and represent a range for driver willingness-to-pay a toll and will be applied in the Metro regional travel demand model (RTDM) for analysis of Project toll alternatives. These assumptions are especially relevant for determining changes in vehicle routing (rerouting) in response to tolls, as estimated in the model's traffic assignment step.

This document will be included as an addendum to the I-205 Modeling Methodology Memorandum for the Project NEPA alternatives analysis and modeling. This document first presents an overview of the recommendations and rationale, followed by detailed methodology used to conduct the evaluation and develop recommendations, and an overview of the research and tolling studies that WSP reviewed.

RECOMMENDATIONS SUMMARY

Based on review of previous studies and available guidance materials, WSP recommends that the VOT assumptions presented in Table 1 be applied to the Project's NEPA alternatives analysis and modeling. The VOTs range between $6 and $61 per hour (2010$), depending on the type of vehicle, occupancy class, and time of day. Blended or average values may be applied for peak shoulder hours. All recommended values are rounded to the nearest dollar.

Table 1. Recommended Value-of-Time Assumptions for National Environmental Policy Act Modeling (2010$)

Vehicle Class	Income Segmentation	Peak ($/hour)	Off Peak ($/hour)
Single-Occupancy Vehicle Auto	Low Income (<$25K)	$8	$6
	Medium Income ($25K–$100K)	$17	$14
	High Income (>$100K)	$22	$17
High-Occupancy Vehicle Auto	Low Income (<$25K)	$15	$10
	Medium Income ($25K–$100K)	$30	$20
	High Income (>$100K)	$38	$25
Medium Trucks	Not Applicable	$39	$39
Heavy Trucks	Not Applicable	$61	$61

CURRENT MODELING APPROACH

The RTDM uses VOT ($/hour) to convert monetary toll costs into travel-time penalties (disbenefit) to represent travel choices that include vehicle routing (traffic assignment) in the regional model network. Thus, for the same monetary toll, a higher VOT means a smaller time penalty and therefore fewer diversions via rerouting to untolled roads or shifts in mode choice, trip distribution, and time of day. Conversely, for the same toll, a lower VOT means more diversions.

The RTDM typically includes four vehicle classes for traffic assignment:

- Single-occupancy vehicle (SOV) auto.
- High-occupancy vehicle (HOV) auto.
- Medium truck.
- Heavy truck.

Each vehicle class is associated with a VOT for the peak periods (7:00 a.m. to 10:00 a.m. and 3:00 p.m. to 6:00 p.m.) and for the off-peak periods. The following RTDM trip purposes are used in earlier stages in the model but are combined for the traffic assignment:

- Home-Based Work.
- Home-Based Shopping.
- Home-Based Social/Recreational.
- Home-Based Other.
- Home-Based School.
- Non Home Based.

The RTDM structure does not distinguish between vehicle operating costs for autos and trucks. Consistent with standard practice for regional models, the RTDM represents average weekday conditions and therefore does not reflect potential considerations of travel-time reliability in routing.

Stated preference (SP) surveys conducted for the Columbia River Crossing (CRC) project in 2009 and 2013 serve as the basis of the RTDM's auto VOT assumptions. These differentiate VOT between peak and off-peak travel. For the Project, an SP survey was developed in Spring 2020 but not completed due to the onset of the COVID-19 pandemic. For the Project's screening analysis modeling (conducted using the RTDM), VOT assumptions were further differentiated for SOV and HOV trips, with HOVs assumed to have a 20% higher VOT than SOVs due to the presence of passengers.

For commercial trucks, the screening analysis used a VOT of $26 (2010$) for medium trucks and $28 (2010$) for heavy trucks, based on more recent Oregon Department of Transportation (ODOT) guidance.[1] In previous RTDM applications, including the CRC project, a higher VOT of $39 (2010$) had been applied for both medium and heavy trucks[2,3].

KEY DIFFERENTIATORS FOR VALUE OF TIME

For people driving, willingness-to-pay for travel-time savings varies widely and is affected by a multitude of factors, including income, trip purpose, comfort, and situational factors that can vary from day to day. The model's VOT assumptions reflect a limited range of willingness-to-pay for tolled roads by different users of the tolled facility. While the full complexity and variability of willingness-to-pay cannot be captured in the model, key characteristics can be included to reflect some of the most influential differences.

Income is one of the most significant factors in willingness-to-pay, particularly for routine daily travel (e.g., commutes). Higher-income travelers are typically willing to pay more for travel-time savings than lower-income travelers. Federal VOT guidance for economic analysis[4] as well as VOT assumptions used in other tolling studies typically base VOT either directly on the household income or employee compensation in the facility catchment area or on discrete choice models developed based on SP survey data. The model estimations often directly include income (e.g., toll as a proportion of income) or are segmented by income (e.g., separate model or separate cost coefficient by income group).

Survey research shows that auto VOT varies based on the purpose of the trip. For example, business and airport access trips are generally associated with higher VOTs than commute and leisure trips. Because the composition of trip purposes and travelers may be quite different depending on time of day, VOTs are differentiated for peak versus off-peak travel hours.

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[1] Oregon Department of Transportation Program Implementation and Analysis Unit. November 2016. *The Value of Travel-Time: Estimates of the Hourly Value of Time for Vehicles in Oregon 2015*. https://digital.osl.state.or.us/islandora/object/osl%3A76610

[2] Portland Metro. April 2015. *2015 Trip-Based Travel Demand Model Methodology Report*.

[3] Stantec. September 2009.*Columbia River Crossing: Recommendation for the Selection of the Value of Time to be Used in the Metro Modeling Runs*.

[4] U.S. Department of Transportation. 2016. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis Revision 2 (2016 Update)*. https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf

Truck VOT is more complex than auto VOT. Truck VOT depends on a large number of factors, including shipment terms, employment terms, distance, commodity characteristics, and shipper and receiver characteristics. Truck VOTs can vary greatly depending on the cargo being shipped and supply-chain considerations, including those affected by travel-time reliability. For commercial trucks, federal VOT guidance for economic analysis recommends basing VOT on labor cost but recognizes that higher values that reflect truck operating costs are also used.[5]

PROPOSED SEGMENTATION

Understanding differences in benefits and burdens of tolling is a central issue for the project. A straightforward way to take into consideration VOTs of different user segments in the RTDM is to disaggregate the two auto classes (SOV and HOV) each into three different income classes (2010 dollars):

- Low Income (annual household income of less than $25,000).
- Medium Income (annual household income between $25,000 and $100,000).
- High Income (household income of more than $100,000).[6]

After segmentation, six different vehicle classes for automobile trips and peak and off-peak VOT assumptions would need to be developed for each vehicle class. The two existing commercial truck vehicle classes would remain as previously defined.

FINDINGS

WSP evaluated the VOTs used in the screening analysis and concluded that the auto VOTs were reasonable for average travel characteristics based on a review of Federal VOT guidance for economic analysis,[7] NCHRP 722,[8] and other research and tolling studies for other facilities in the United States (summarized in Table 6 and Table 7). However, to better evaluate tolling impacts for the Project NEPA analysis, the RTDM should apply additional segmentation by income to automobile vehicle classes. WSP also recommends returning to previously identified VOTs for medium trucks and using higher VOTs for heavy trucks. WSP developed recommended VOT

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[5] U.S. Department of Transportation. 2016. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis Revision 2 (2016 Update)*. https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf

[6] Preliminary results of this segmented modeling indicate that I-205 Abernethy Bridge trips are broken out as follows: 8% Low Income SOV, 42% Medium Income SOV, 27% High Income SOV, 2% Low Income HOV, 10% Medium Income HOV, 7% High Income HOV, 1% Medium Truck, 3% Heavy Truck.

[7] U.S. Department of Transportation. 2016. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis Revision 2 (2016 Update)*. https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf

[8] Parsons Brinckerhoff, Inc. 2012. *NCHRP Report 722, Assessing Highway Tolling and Pricing Options and Impacts*. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.360.2910&rep=rep1&type=pdf

assumptions for the eight vehicle classes and two time periods. Table 2 summarizes these values along with key considerations and rationale.

Table 2. Recommended Value-of-Time Assumptions with Rationale (2010$)

Vehicle Class	Income Segmentation	Peak VOT ($/hour)	Off-Peak VOT ($/hour)	Rationale
Single-Occupancy Vehicle (SOV) Auto	Low Income (<$25K)	$8	$6	• Base VOT calculated as 60% of hourly income for top of income bracket ($25,000) to reflect higher incomes of vehicle owners. • Peak VOT calculated as base VOT times 1.1 and off-peak VOT calculated as base VOT times 0.9 to account for different trip purpose mix. • Additional 1.05 factor applied to peak VOT to account for reliability.
	Medium Income ($25K—$100K)	$17	$14	• Base VOT calculated as 50% of hourly income for midpoint of bracket ($62,500). • Peak VOT calculated as base VOT times 1.1 and off-peak VOT calculated as base VOT times 0.9 to account for different trip purpose mix. • Additional 1.05 factor applied to peak VOT to account for reliability.
	High Income (>$100K)	$22	$17	• Base VOT calculated as 30% of hourly income for representative income of $130,000 for the bracket. • Peak VOT calculated as base VOT times 1.1 and off-peak VOT calculated as base VOT times 0.9 to account for different trip purpose mix. • Additional 1.05 factor applied to peak VOT to account for reliability.
High-Occupancy Vehicle (HOV) Auto	Low Income (<$25K)	$15	$10	• Peak HOV VOT calculated as 1.75 times SOV based on NCRHP 722. • Off-Peak HOV VOT calculated as 1.5 times the SOV VOT, assuming higher likelihood of family travel during off-peak.
	Medium Income ($25K—$100K)	$30	$20	
	High Income (>$100K)	$38	$25	
Medium Trucks	Not Applicable	$39	$39	Metro RTDM
Heavy Trucks	Not Applicable	$61	$61	NCHRP 722

Key consideration that led to these recommendations are as follows:

- Based on a review of other tolling studies, research reports and guidance, the relationship between VOT and income varies. The Federal VOT guidance considers a VOT of up to 60% of hourly household income reasonable for personal trips, including commute trips. The review of studies showed that VOTs typically account for a higher share of hourly income for lower-income households than for higher-income households. Based on these considerations, we assumed that the base VOT would account for 60% of hourly income in the lower-income segment, 50% of hourly income in the medium segment, and 30% in higher-income segment. To develop peak and off-peak VOTs, we recommend multiplying these base VOT values by additional factors as described in the following paragraphs.
- The bottom household-income segment in the RTDM is less than $25,000 (2010$), which represents households in or near poverty.[9] Because very low-income households are less likely to have access to an automobile, they are more likely to use transit or other non-motorized travel options. As such, their trips are often less likely to be represented in auto demand matrices. Therefore, users in this income segment who are represented in the model's vehicle traffic assignment are more likely to have an income near the top end of the bracket.
- Employment data for the four counties in the region suggests that a relatively large portion (22%) of the jobs are in high-wage industries: management of companies, financial services and technical and professional services. It is therefore reasonable to expect that household income of many of these workers will exceed the $100,000 threshold for the high-income segment. In the four counties that comprise most of the tolled facility's catchment area, the 2018 5-year American Community Survey (ACS) estimate showed that households with income (2018$) between $100,000 and $150,000 account for 18% of total households while households with incomes between $150,000 and $200,000 and above $200,000 account for 8% and 9%, respectively. Based on these considerations, WSP proposes the use of $130,000 (2010$) household income to represent the top income bracket for purposes of VOT estimation.
- Tolled roads offer travel-time reliability benefits in addition to improved average travel times. By including a buffer time for trips that are time-sensitive (such as business trips and many commute trips), travelers set aside more time for travel than the actual (average) in-vehicle time. Because regional models do not account for reliability improvements offered by tolled roads, it is reasonable to increase VOT to reflect the reliability benefits offered by a tolled roadway, particularly during congested peak hours where travel times are more inconsistent. Federal VOT guidance recognizes that the reliability of travel time is an important consideration that is tied to travel-time savings. The Federal VOT guidance describes adding an allowance to the VOT as a possible approach to take into account reliability in the absence of reliability measures and a specified value of reliability. In the modeling for the CRC project, VOTs from the SP survey were increased by 10% to reflect

[9] The U.S. Census Bureau poverty threshold in 2018 was approximately $25,000 (2018$) for a family of four. Poverty Thresholds, U.S. Census Bureau, 2018, https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html

reliability and the fact that not all drivers have information about the alternative routes available. WSP conservatively increased peak VOTs by 5% to take travel-time reliability into account.

- NCHRP 722 recommends auto-peak VOTs between 1.2 to 1.3 times as large as off-peak VOTs for most trip purposes and income segments. The difference between peak and off-peak VOT may in part reflect the different trip-purpose mix during peak and off-peak periods. Federal VOT guidance recognizes that the conditions of the time saved could affect its value. For example, reducing stressful driving in heavily congested traffic conditions could be more valuable than saving time when there is no traffic congestion. SHRP C04[10] recommends to add weights to congestion delays versus free-flow time of 1.5 to 2.0, if not accounting for reliability explicitly. In line with NCRHP 722 recommendations, the CRC SP Survey[11] conducted in 2013 found that peak VOTs were 1.2 times off-peak VOTs. Based on these considerations, WSP multiplied the base VOT that was developed based on household income by 1.1 for the peak period and by 0.9 for the off-peak period. Combined with the reliability adjustment, the resulting SOV peak VOTs are 1.28 times as large as off-peak VOTs.
- NCHRP 722 recommended HOV VOTs of 1.75 times SOV VOTs for two-person vehicles and 2.5 for higher occupancies. This reflects that some travel parties include children or other persons whose time is not factored into the route choice decision. SHRP C04[12] similarly found a factor of 1.7 for two-person vehicle occupancy and a factor of 2.4 for higher occupancies. WSP conservatively assumed that HOV VOTs equal 1.75 of the SOV VOT during the peak period and 1.5 during the off-peak period. The distinction between the peak and off-peak periods is based on the assumption that during the off-peak periods, HOV trips are more likely to be family trips (including children).
- Studies using SP surveys find a very wide range of VOTs for trucks. NCRHP 925[13] found VOTs that range from $13 to $358 (2010$) based on an SP survey of carriers and shippers. The study recommends using the most recent American Transportation Research Institute truck operational cost as a general VOT, which is $59.3 per hour (2010$), in addition to the value of reliability developed by the study. NCRHP 722 recommends a VOT of $30 for medium trucks and for $61 heavy trucks (2010$). While Federal guidance for truck VOT only includes driver compensation, they recognize that trucks' route choice also includes

[10] National Academies of Sciences, Engineering, and Medicine. 2012. *Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand*. https://doi.org/10.17226/22689

[11] Resource Systems Group, Inc. November 2013. *I-5 Columbia River Crossing Stated Preference Travel Study Report*. http://data.wsdot.wa.gov/accountability/ssb5806/Repository/4_Finance/Investment%20Grade%20Analysis/CRC%20Stated%20Preference%20Survey%20Draft%20Report%202013-11-01.pdf

[12] National Academies of Sciences, Engineering, and Medicine. 2012. *Improving Our Understanding of How Highway Congestion and Pricing Affect Travel Demand*. https://doi.org/10.17226/22689

[13] National Academies of Sciences, Engineering, and Medicine. 2019. *Estimating the Value of Truck Travel Time Reliability*. https://doi.org/10.17226/25655

vehicle operating cost and other factors that depend on the type of commodity, supply-chain considerations, and/or value of the freight. The RTDM truck VOT of $39 was used in in previous studies including CRC and the ODOT Portland Metro Area Value Pricing Feasibility Analysis. Based on the higher VOTs found in other studies and to consider the effect of high vehicle operating costs and high value of reliability on truck route choice, it was reasonable to apply an increase for the heavy truck VOTs. Based on these considerations, WSP recommends using the NCHRP 722 VOT of $61 (2010$) for heavy trucks and the previously applied Metro RTDM VOT of $39 (2010$) for medium trucks.

Table 3 summarizes the differences between the VOT assumptions previously applied in the Project screening analysis and the VOT recommendations for the proposed segmentation by vehicle class, income class, and time of day for the Project's NEPA round of modeling.

Table 3. Value-of-Time Assumptions Comparison (2010$)

Vehicle Class	Income Segmentation	Prior Assumptions*		Recommended Assumptions for NEPA Analysis		Difference in VOT Assumptions	
		Peak ($/hour)	Off-Peak ($/hour)	Peak ($/hour)	Off-Peak ($/hour)	Peak ($/hour)	Off-Peak ($/hour)
Single-Occupancy Vehicle Auto	Low Income (<$25K)	$19	$13	$8	$6	-$11	-$7
	Medium Income ($25K–$100K)			$17	$14	-$2	+$1
	High Income (>$100K)			$22	$17	+$3	+$4
High-Occupancy Vehicle Auto	Low Income (<$25K)	$23	$15	$15	$10	-$8	-$5
	Medium Income ($25K–$100K)			$30	$20	+$7	+$5
	High Income (>$100K)			$38	$25	+$15	+$10
Medium Trucks	Not Applicable	$26	$26	$39	$39	+$13	+$13
Heavy Trucks	Not Applicable	$28	$28	$61	$61	+$33	+$33

* The VOTs shown in the table represent the minimum value applied in the analysis, as specific VOTs varied by hour and direction of travel based on trip characteristic mix estimated in the ODOT Portland Metro Area Value Pricing Feasibility Analysis. The applied VOTs for SOV travel ranged from approximately $13 to $17 in off-peak hours and $19 to $22 in peak hours.

ANALYSIS METHODOLOGY

Overview

This memorandum includes the three approaches used to review the reasonableness of the VOTs used during the screening analysis and to inform the development of recommendations for income-segmented auto VOTs and truck VOTs for the NEPA analysis.

Federal VOT Guidance

WSP applied the Federal guidance on Valuation of Travel Time[14] to estimate the base VOTs for the recommended RTDM income segments. While the guidance was developed for economic analysis, it provides a useful reference point for estimating VOT for the Project. Federal VOT guidance recommends estimating VOT for passenger-vehicle travel based on household income as a simplified and uniform approach to estimate VOT for both personal and business travel by all modes and all time periods.

The recommended VOT for personal trips, which includes commute trips, equals 50% of median hourly household income while the VOT of business trips equals 100% of the median hourly household income. Hourly household income is estimated as annual household income divided by 2,080 hours and does account for household size or number of workers. Plausible ranges of VOT included in the guidance are between 35% and 60% of median hourly household income for personal travel and between 80% and 120% of median hourly household income for business travel. Federal VOT guidance reports that about 5% of local surface trips are business trips while the remainder are personal trips.

For freight transportation, the VOT is more complex, and Federal VOT guidance does not include a recommendation for freight VOT other than to use truck drivers' compensation to represent the VOT of the operator while recognizing that vehicle operating cost and the value and characteristics of the freight also affect the willingness-to-pay for time savings. The Federal VOT guidance reports that the weighted average hourly wage for heavy and light truck drivers from the National Occupational Employment and Wage Estimates is $27.20 (2015$).

Federal VOT guidance recognizes that VOTs also depend on traveler characteristics other than income, and on the circumstances of the trip and the available transportation options. They recognize that the conditions of the time saved could affect its value. That is, reducing stressful driving in heavy traffic could be more valuable than saving time when there is no traffic congestion. Federal VOT guidance also recognizes that the reliability of travel time is an important consideration that is tied to travel-time savings. By including a buffer time for trips that are time-sensitive—such as business trips and many commute trips—travelers set aside more time for travel than the actual in-vehicle time. Federal VOT guidance describes adding an allowance to the VOT as a possible approach to take into account reliability in the absence of reliability measures and a value of reliability.

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[14] U.S. Department of Transportation. *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (2016)* https://www.transportation.gov/sites/dot.gov/files/docs/2016%20Revised%20Value%20of%20Travel%20Time%20Guidance.pdf

Wages

WSP also estimated the VOT for auto travel based on the hourly compensation of workers (employees)[15] to provide an alternative to the above Federal VOT guidance approach based on the household income of residents.[16] As recognized in the Federal VOT guidance, the hourly employee compensation is theoretically equal to the VOT for "on-the-clock" business travel. In a household with more than one worker, household income includes the combined salary and wages of all workers. To implement this alternative approach for developing VOT estimates, WSP reviewed data on wages and industries located in the facility's travel shed. Employee compensation was estimated by increasing wages by 30% to reflect benefits.

Other Studies

Finally, WSP reviewed research reports and tolling studies in other regions and recorded VOTs and methodologies used to estimate the VOTs in those studies that are relevant to the Portland Metro region. This provides points of comparison and reasonableness checks on the VOT recommendations developed.

Federal Value-of-Time Guidance Using Income

As explained previously, Federal VOT guidance for economic analysis recommends estimating the VOT for passenger travel as a proportion of hourly household income, with VOTs for commute and other personal trips accounting for 50% of hourly household income and VOTs for business trips at 100% of hourly household income. While the guidance was developed for economic analysis purposes, it is frequently used to evaluate the reasonableness of the VOTs used in travel demand studies. WSP first reviewed the regional household-income distribution and then applied the Federal VOT guidance recommended approach to the three household-income segments included in the RTDM.

Regional Household-Income Distribution

Based on the 2018 ACS 5-year estimates' census-tract-level data on the number of households by household-income category, the average household income in the model area is estimated as $87,600 (2018$) and the median household income is about $75,000 (2018$). Figure 1 presents the household-income distribution for the model area used to estimate the average household income. This model area includes areas in Multnomah, Washington, and Clackamas Counties in Oregon, and Clark County in Washington.

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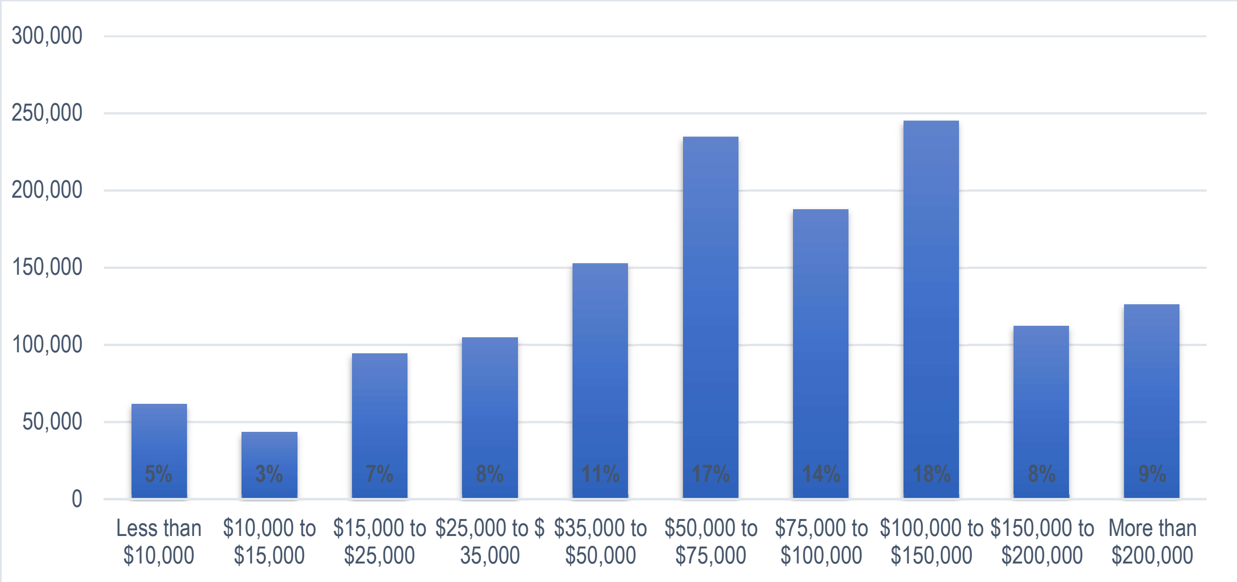
[15] Employee compensation is the income received by employees as remuneration for their work and includes gross (before taxes) salaries and wages, as well supplements to wages, such as employer contributions to health and life insurance and retirement plans.

[16] The U.S. Census Bureau defines household income as money income received by the household on a regular basis (excluding money receipts such as capital gains) before personal income taxes and social security and other deductions. Household income therefore does not include food stamps, health benefits, and subsidized housing

Figure 1. Household-Income Distribution in the Model Area (2018$)



Source: 2018 American Community Survey 5-year estimates

Figure 1 (2018$) shows the following:

- About 15% of model area households had an income of $25,000 or less (2018$, corresponding to $21,000 in 2010$).
- About 50% had incomes between $25,000 (2018s) and $100,000 (2018$, corresponding to $87,000 in 2010$).
- About 35% had an income of more than $100,000 (2018$).

For comparison, preliminary analysis using the segmented modeling assignment of the RTDM was used to obtain an approximate estimate of household-income distribution for drivers on the I-205 Abernethy Bridge.[17] The results indicate that I-205 Abernethy Bridge trips are broken out as follows:

- About 10% were low income (8% SOV and 2% HOV).
- About 52% were medium income (42% SOV and 10% HOV).
- About 34% were high income (27% SOV and 7% HOV).
- About 1% medium trucks.
- About 3% heavy trucks.

The comparison between these data sources for lower-income users on I-205 (10% shown in the RTDM) and regional income characteristics (approximately 18% below $21,000 in 2010$) are generally reasonable. The lower-income corridor users should be expected to be less

[17] A select link analysis was performed using Metro RTDM 2015 base year model, selecting the links that represent the Abernethy Bridge for average weekday daily (24-hour) travel.

represented proportionally, because very low-income households are less likely to have access to an automobile and are therefore less likely to drive.

Figure 2 illustrates relative distribution of origins for AM peak period (7:00 a.m. to 10:00 a.m.) trips across the Abernethy Bridge based on the Metro RTDM traffic analysis zone (TAZ) system. Overlaid is the distribution of household income of its resident in each larger district. AM peak-period trip origin most often represents the trip maker's place of residence. (The household-income distribution in each of the 23 tolling districts is also presented in Attachment B, Table B-1.)

Value-of-Time Calculations

Following Federal VOT guidance, travelers in the low-income segment (annual household income of less than $25,000 in 2010$ would have a VOT of less than $6/hour for personal trips, which includes commute trips, (50% of hourly income) and less than $12/hour for business trips (100% of hourly income). Table 4 shows the VOTs estimated for all three income segments. VOT estimates for peak and off-peak periods would be very similar with this methodology because business trips are expected to account for a small share (5%) of the total trips in the RTDM in both the peak and off-peak periods.

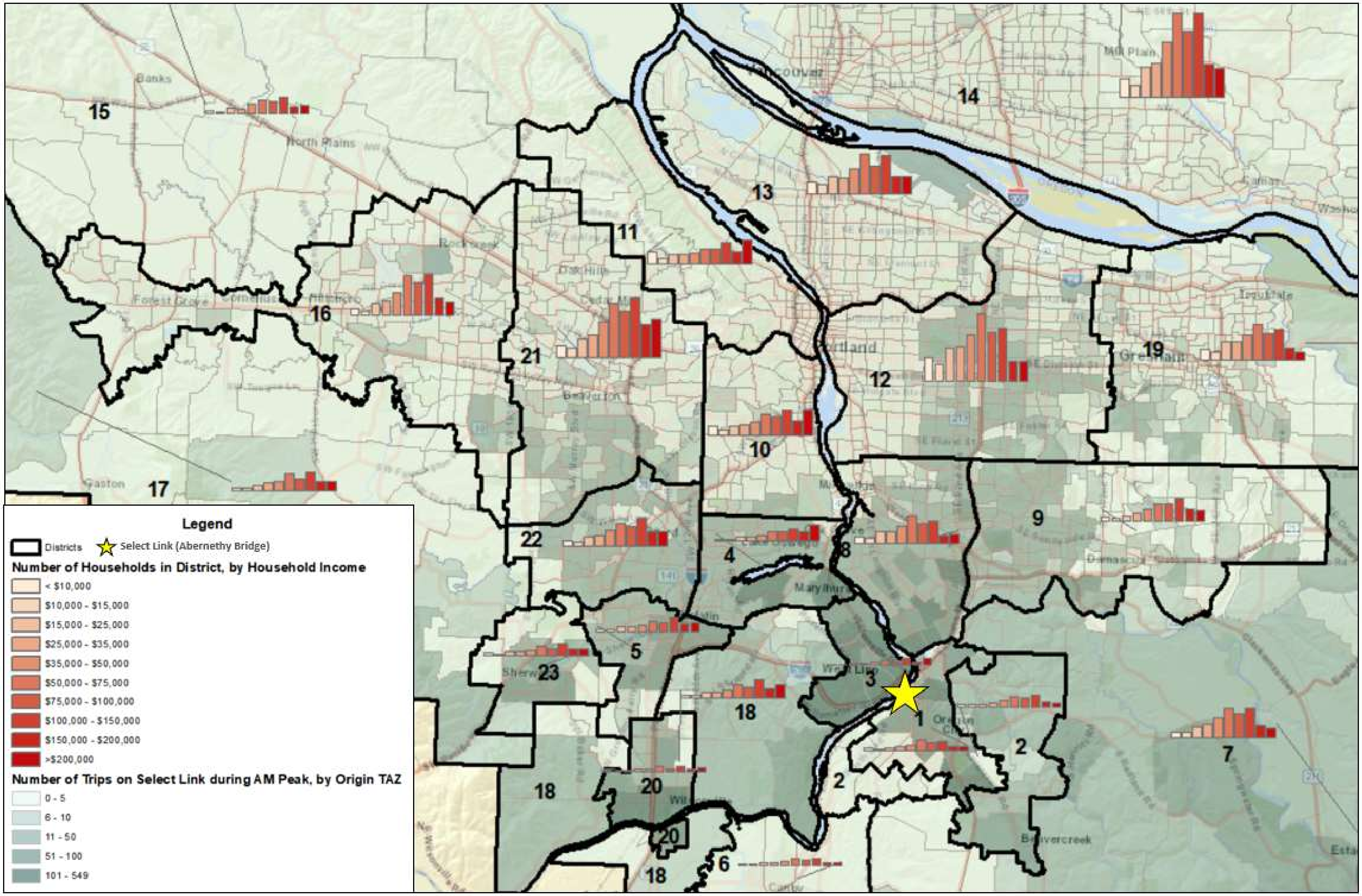
Table 4. Value of Time for Household-Income Segments based on Federal VOT Guidance (2010$)

		SOV Auto - Low Income	SOV Auto - Med Income	SOV Auto - High Income
Model Income Segments		**< $25,000**	**$25,000 to $100,000**	**> $100,000**
Work	Commute	<$6/hour (50% of hourly income based on $25,000 annual income)	$15/hour (50% of hourly income based on $62,500—midpoint of $25,000 to $100,000 range—annual income)	>$24/hour (50% of hourly income based on $100,000 annual income)
	Business	<$12/hour (100% of hourly income based on $25,000 annual income)	$30/hour (100% of hourly income based on $62,500 annual income)	>$48/hour (100% of hourly income based on $100,000 annual income)
Non-Work	Personal	<$6/hour (50% of hourly income based on $25,000 annual income)	$15/hour (50% of hourly income based on $62,500 annual income)	>$24/hour (50% of hourly income based on $100,000 annual income)

Note: Hourly income is estimated as annual household income divided by 2,080.

The regional income distributions based the 2018 5-year ACS estimates show that average income of the households in the $100,000 and above income segment is likely well above the $100,000 minimum threshold. In the four counties that comprise most of the tolled facility's catchment area, households with incomes of $130,000 (2010$) and higher account for 17% of the total households. Therefore, a significant portion of households in the high-income category would have a VOT for commute and non-work trips that is significantly higher than $24 when estimated based on the household-income-based approach of estimating VOT.

Figure 2. Household-Income Distribution and AM Peak Trip Origin Distribution (from Regional Model)



VOT estimates using Wages

In addition to the Federal VOT guidance household-income-based approach, WSP estimated the VOT for auto travel for business purposes based on the hourly compensation of workers employed within the facility catchment area. WSP first reviewed the data on jobs located in the facility catchment area by wage category (low, medium and high) using 2017 Longitudinal Employer Household Data (LEHD[18]). Because the lower limit of the highest income category is relatively low, we also reviewed the number of workers employed in high-wage industries to obtain more information about the highest income category. These data were used to obtain a more detailed picture of the incomes of travelers using the facility.

WSP used the results of an RTDM select link analysis on I-205 Abernethy Bridge users to estimate the wage distribution and prevalence of employment in the high-wage industries for workers using the facility. More specifically, we first summarized the daily trips that use the Abernethy Bridge by origin tolling district and then combined these trips with the wage distributions in that tolling district. Thus, we developed a weighted average wage distribution of jobs in locations accessed via the Abernethy Bridge.

WSP collected LEHD data for jobs located in the four main counties in the travel shed—Clackamas, Multnomah, and Washington Counties, OR; and Clark County, WA—and summarized the jobs by tolling district. For each tolling district, we calculated the percentage share of jobs with low, medium and high wages (Attachment B, Table B-4).

The wage categories are defined as $1,250 per month or less (low wage), between $1,250 and $3,333 per month (medium wage) and more than $3,333 per month or more (high wage) (2017 $). Based on these thresholds, a single earner household with a medium wage job may still fall in the model's low-income household category and a single earner household with a high-wage job may still fall in the model's medium-income category. To obtain more information about higher-income households, WSP calculated the percentage of jobs in three high-wage industries—management of companies and enterprises, finance and insurance, and professional and technical services—in each tolling district (Attachment B, Table B-5). Average wages in these industries are considerably higher (mostly 1.5 times or more) than the average wage for all industries combined (Attachment B, Table B-6).

Figure 3 shows, for each model TAZ, the number of daily trip origins that use the I-205 Abernethy Bridge and, for each tolling district, the number of jobs located in the district (represented by the size of the pie chart) and the split of these jobs by wage category (represented by the pie chart).

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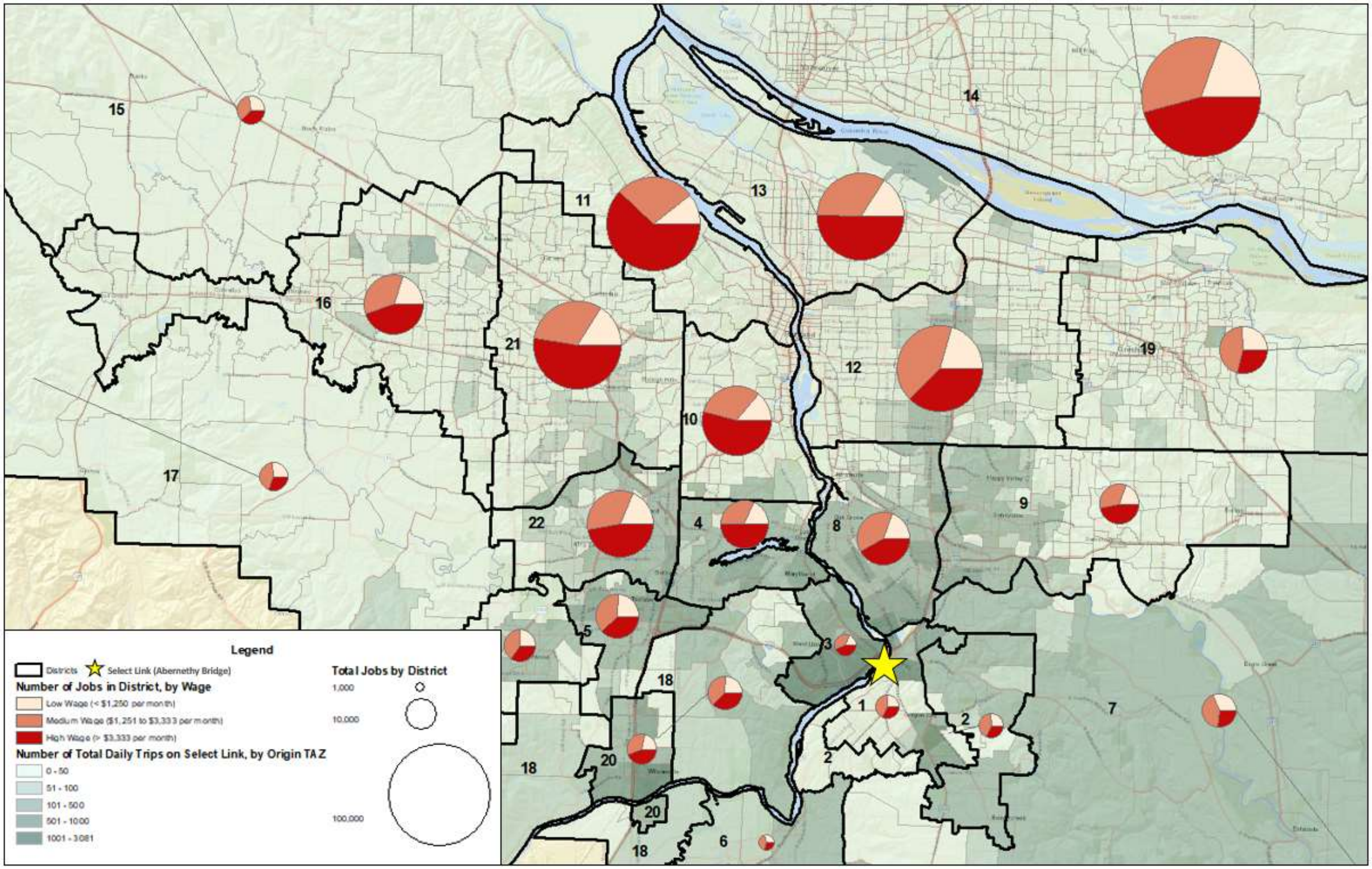
[18] LEHD data is developed by the U.S. Census Bureau in partnership with the states and is based on state unemployment insurance records, additional administrative data and data from censuses and surveys. LEHD includes data on employment at the census tract level broken down into low, medium and high wage jobs as well as broken down by industry.

Figure 3. Origin Total Daily Trips on Select Link and Jobs Distribution by Wage



As shown in Table 5, this approach yields an estimate that low-wage jobs account for 20% of the total jobs, medium-wage jobs account for 37% and high-wage jobs account for 43% of total jobs in the travel shed. Using that same methodology, WSP estimated that jobs in one of the three high-wage industries account for 22% of the jobs in the travel shed.

Table 5. Estimated Wage Distribution and Share of Employment in High-Wage Industries for locations accessed via Abernethy Bridge

Employment Category	Estimated Percentage of Workers	Wage (2017 dollars)	SOV VOT (2017 dollars)	SOV VOT (2010 dollars)
Low Wage	20%	<$15,000	<$9 (business)	<$7.9 (business)
Medium Wage	37%	$15,000 to $39,999	$9 to $25 (business)	$7.9to $21 (business)
High Wage	43%	>$40,000	>$25 (business)	>$21 (business)
Finance & Insurance	7%	$86,938	$55	$46
Management	5%	$106,576	$66	$56
Professional and Technical	10%	$92,347	$57	$48

VOT Calculations

WSP assumed that employee compensation equals 130% of wages and converted annual compensation to hourly by assuming 2,080 work hours per year. WSP estimated business travel VOT as 100% of the hourly compensation.

The results of this approach cannot be directly applied to the income segmentation in the model, which is household-income based. However, the approach is useful because it shows that a relatively large portion (22%) of the workers employed in the locations accessed by the Abernethy Bridge are employed in high-wage industries and thus may be expected to have a higher VOT. Employees with average salaries in those industries would be estimated to have a business VOT of $46 to $56 (2010$), calculated as 100% of hourly compensation. Personal travel and commutes, calculated as 50% of hourly household income, by this same group could have VOTs that are similar to these business VOTs if there is more than one high-income earner in the household.

Other Studies

The project team performed a literature review of other studies and research reports that were identified as potentially relevant to the Project. These provide additional data points for consideration and comparison to the Project's VOT assumptions and recommendations. Attachment A includes summaries of the other tolling studies and research reports reviewed. Summaries of the VOT values are provided in Table 6 for autos and Table 7 for trucks.

Table 6. Overview Value of Time: Autos

Study	Location	Year	VOT ($/hour)	VOT in 2010$	% of hourly income	Note
Columbia River Crossing Stated Preference Travel Study, Resource Systems Group, Inc.	Columbia River Crossing, Oregon/Washington	2009	Auto Peak: $14.68; Auto Off-Peak: $11.43; Commercial: $22.14 (SP Survey)	Peak: $14.92; Off-Peak: $11.62 Commercial: $22.50	40.7% peak, 31.7% off-peak based on sample avg hhinc	VOT from SP Survey was adjusted for the travel demand model to $18.89 for Peak and $15.09 for off-peak (2009$). VOT for commercial truck from survey was not used in the CRC model. Instead the METRO VOT of $35 (2005$) was used for trucks
I-5 Columbia River Crossing Stated Preference Travel Study, Resource Systems Group, Inc.	Columbia River Crossing, Oregon/Washington	2013	Peak: $13.83; Off-Peak:$11.94 (for med (SP Survey)	Peak: $12.95; Off-Peak: $11.18 Commercial:$26.84	32.9% peak, 28.4% off-peak based on sample avg hhinc	
NCHRP Report 722	nationwide	2012	Peak Commute: $7-$8 for household income <$50K; Off-Peak Personal: $5 for household income <$50K (2010$); Peak Commute: $14-$15 household income $50-$100K; Off-Peak Personal: $8-$9 household income $50-$100K (2010$); Peak Commute: $20-$22 for household income $100K+; Off-Peak Personal: $12-$13 for household income $100K+ (2010$)	Summary of Peak VOTs: $6.87, $12.49, and $17.82 respectively for income <$50k, $50k-$100k, and $100k+	> 28.6%, 26% - 51.9%, and <37.1% peak respectively for income <$50k, $50k-$100k, and $100k+	

Study	Location	Year	VOT ($/hour)	VOT in 2010$	% of hourly income	Note
E-470 Investment Grade Traffic and Revenue Study, CDM Smith (updated with E-470 Comprehensive T&R Study in 2020)	Denver	2014	$14 (2013$) Updated Study: $19 (2018$)	$13.10 Updated Study: $16		Separate VOT for each TAZ and time period
The Impact of Adopting Time-of-Day Tolling, Case Study of 183A in Austin, Texas, Light et al.	Austin, Texas	2015	$12 for mandatory trips (2012$); $7 for non-mandatory SOV trips; $10 for non-mandatory HOV trips (2012$)	$11.40 for mandatory trips; $6.65 for non-mandatory trips	mandatory trips: 25% for median sample hhinc of $100K; non-mandatory trips: 15% for median sample hhinc of $100K	
Tampa Hillsborough Expressway Authority Investment Grade Traffic and Revenue Study, Jacobs	Tampa, Florida	2017	about $12 for $50-$75K household income (2015$)	$11.04	33% - 50%	Calculated as up to 50% of hourly wage using household-income distribution
SR 520 Stated Preference Survey, Wilbur Smith Associates (nka CDM Smith)	Seattle, Washington	2009	$12 for household income of $125K; $9 for household income of $60K	$12.00 and $9.00 for households with income at $125k and $60k, respectively	20% and 31% for households with income at $125k and $60k, respectively	Increased VOT used in Tolling model to $18 (2010$)
Atlanta Regional Managed Lane System Plan, Stated Preference Survey Report, HNTB	Atlanta	2010	Average of VOT $7 to $15 depending on facility and based on average household income ($70-$86K) (2007$) and average distance for facility	$11.57	29%	

Table 7. Overview Value of Time: Trucks

Study	Location	Year	VOT($/hour)	VOT in 2010$	Note
ODOT PIAU The Value of Travel-Time: Estimates of the Hourly Value of Time for Vehicles in Oregon	Oregon	2015		Medium Trucks: $26 Heavy Trucks:$28	
E-470 Investment Grade Traffic and Revenue Study, CDM Smith	Denver	2014	$42 (2013$)		
RhodeWorks Truck Tolling Program Investment Grade Traffic and Revenue Study, Louis Berger (nka WSP)	Rhode Island	2016-2017	Average $29 for short distance and $46 for long distance; long distance ranges from $19 to $65 between second and fourth quintile (2016$)	$26.35 (short distance); $42.32 (long distance)	
RhodeWorks Truck Tolling Program Level 2 Traffic and Revenue Study, CDM Smith	Rhode Island	2016	$24	$22.11	Based on driver's wage
Value of Time for Commercial Vehicle Operators in Minnesota, Smalkoski, B. and Levinson, D.	Minnesota (multiple counties)	2005	$49 (2003$)	$58.70	
NCHRP Report 722	Nationwide	2007		Medium Trucks: $30.41 Heavy Trucks: $60.82	
NCHRP Report 925		2019	$15 to $412 (2018$)	$13 to $358	
American Transportation Research Institute		2019	$66.7 (2017$)	$59.60	
Zamparini & Reggiani Meta Analysis	International		$0.80 US (2002) to $47.21 US (2002) with a mean VOT of $20	$0.97 to $57.22, $24 average	
Toledo et al	Indiana, Texas, Ontario	2013	from $30/hour and $235/hour (2012$) between the first and third quintiles.	$28 to $223	
Texas A&M Transportation Institute, Updated Estimate of Roadway User Cost for Personal Vehicles and Commercial Trucks	Texas	2019	$41.33 per vehicle hour and $1.022 cents per mile for each additional mile of travel is added to the value of delay (2019$)	$35 and $0.87 per mile	

RANGE OF POTENTIAL VOT VALUES TO APPLY

WSP developed a range of potential VOT values building on the recommended VOT assumptions identified in Table 1. The ranges presented in Table 8: Recommended Value-of-Time Assumption Range are based on an overall assessment of the methodologies outlined in this memorandum. These could be used in future work to test a range of VOT assumptions and evaluate sensitivity of assumptions to outcomes.

Table 8. Recommended Value-of-Time Assumptions Range (2010$)

Vehicle Class	Income Segmentation	Peak ($/hour)	Off Peak ($/hour)
Single-Occupancy Vehicle Auto	Low Income (<$25K)	$7 to $12 ($8)	$5 to $11 ($6)
	Medium Income ($25K–$100K)	$10 to $30 ($17)	$8 to $27 ($14)
	High Income (>$100K)	$14 to $63 ($22)	$11 to $56 ($17)
High-Occupancy Vehicle Auto	Low Income (<$25K)	$12 to $21 ($15)	$8 to $18 ($10)
	Medium Income ($25K–$100K)	$18 to $53 ($30)	$12 to $45 ($20)
	High Income (>$100K)	$25 to $109 ($38)	$17 to $94 ($25)
Medium Trucks	Not Applicable	$26 to $117 ($39)	$26 to $117 ($39)
Heavy Trucks	Not Applicable	$28 to $183 ($61)	$28 to $183 ($61)

Note: Recommended values identified in Table 1 are shown in parentheses for reference.

For personal vehicles, the ranges of potential VOT assumptions for SOVs are based on the assumed hourly incomes for each income segment that were used to develop the recommended VOT assumptions (Table 2). The same adjustment factors applied to from SOV VOT to HOV VOT were used as for the recommended VOT assumptions, as described in Table 2.

For each of the three income segments ranges, the upper limit corresponds to 100 percent of the assumed hourly income. The upper limit reflects that a small portion of SOV and HOV trips during peak and off-peak periods, such as business trips, can be reasonably expected to be made by drivers with a VOT of 100 percent of their hourly income. The upper limit is supported by the federal VOT guidance, which recommends a VOT of 100 percent of the hourly income for business trips, as discussed in the methodology section.

The range lower limits vary depending on the income segment. For the low-income segment, the lower limit corresponds to 50 percent of the assumed hourly income, which is 10 percentage points lower than for the recommended base VOT for that segment. For the medium income segment, the lower limit corresponds to 30 percent of the assumed hourly income, which is 20 percentage points lower for than the recommended VOT for that segment. For the high-income segment, the lower limit corresponds to 20 percent of the assumed hourly income, which is 10 percentage points lower than the recommended VOT for that segment. The resulting base VOTs were adjusted for peak and off-peak using the assumptions used to develop the recommended peak and off-peak VOTs, as described in Table 2. The percentages to calculate the lower limits are in line with those found in the review of other studies summarized in Table 6.

The literature review indicates a high variance of VOTs for truck travel. As summarized in Table 7, NCHRP 922 (2019) found VOTs between $13 and $358 and Toledo et al (2013) found that VOTs ranged from $28 to $223 between the first and third quintiles. WSP proposes to use the ODOT (2015) medium and heavy truck VOTs as the lower limit. For the upper limit, WSP proposes a value of 3 times the recommended values to ensure that a wide range of VOTs are considered.

Further variation could be applied by varying the real VOT over time. The proposed VOT assumptions do not identify any real changes to future VOT (as expressed in constant 2010$). Although monetary inflation is expected, this implicit assumption in constant real VOT is that purchasing power remains consistent. This means that inflation would have an equivalent effect on wages and costs for goods and services. Alternative assumptions could be evaluated as needed by adjusting VOTs in future year evaluations either uniformly or for specific vehicle classes.

ATTACHMENT A: OTHER STUDIES

I-5 Columbia River Crossing

The VOT obtained from the Columbia River Bridge project SP surveys conducted in 2009[19] and 2013[20] was the primary source of the auto VOT assumptions for the screening analysis of the Project as well as previous applications of the RTDM. The 2009 SP survey was conducted to estimate VOT of trip makers using the existing interstate bridges over the Columbia River on I-5 and I-205, between Oregon and Washington. About 1,900 completed automobile surveys and 330 completed truck surveys were received. The survey data was used to estimate an average VOT of $14.68 for peak trips and $11.43 for off-peak trips (2009$) (Table A-1 Columbia River Crossing Stated Preference Surveys Values of Time). Based on the sample's median annual household income of about $75,000, the peak VOT and off-peak VOT correspond to 41% and 32% of hourly income, respectively. For commercial vehicles, VOT was estimated as $22.14 (2009$).

Table A-1. Columbia River Crossing Stated Preference Surveys Values of Time

Mode	VOT Finding	2009 Survey in 2009$	2009 Survey in 2010	2013 Survey in 2013$	2013 Survey in 2010
Auto	Peak VOT ($/hour)	$15	$15	$14	$13
	Off-Peak VOT($/hour)	$11	$12	$12	$11
	Off-Peak VOT as % of Hourly Median Income	41%		33%	
	Peak VOT as % of Hourly Median Income	32%		28%	
	Median Income	$75,000		$87,500	
Truck	Aggregated VOT ($/hour)	$22	$23	$28.66	$26.84
	2-4 axles VOT ($/hour)			$17.36	$16.26
	5+ axles VOT ($/hour)			$30.33	$28.40

In 2013, a second SP survey was conducted with the purpose to develop VOT estimates for trip makers using the I-5 Bridge to support an investment-grade traffic and revenue study. About 1,940 completed automobile surveys and 320 completed truck surveys were received. The 2013 study found similar results as the 2009 study with estimated average VOT of $13.83 for peak trips and $11.94 for off-peak trips (2013$). The peak and off-peak VOTs correspond to 33% and

[19] Resource Systems Group, Inc. September 2009. *Columbia River Crossing Stated Preference Travel Study Report*.

[20] Resource Systems Group, Inc. November 2013. *I-5 Columbia River Crossing Stated Preference Travel Study Report*. http://data.wsdot.wa.gov/accountability/ssb5806/Repository/4_Finance/Investment%20Grade%20Analysis/CRC%20Stated%20Preference%20Survey%20Draft%20Report%202013-11-01.pdf

28% of the sample's median hourly household income, respectively. The commercial vehicle VOTs were $17.36 for 2 to 4 axles vehicle and $30.22 for vehicles with 5 or more axles (2013$)

For CRC modeling purposes, the VOTs from the 2009 SP Survey were adjusted to reflect reliability and the fact that infrequent or non-local travelers may not be aware of untolled alternative routes.[21] The adjusted VOTs based on the 2009 survey were $19 for peak and $13 for off-peak (2009$) (Table A-2 Columbia River Crossing 2009 Survey and Model Value of Time). These adjusted VOTs were converted to 2010 dollars and used as the basis the I-205 tolling screening analysis, along with adjustments specific to the hour of day and direction estimated specifically for the I-205 Abernethy Bridge during the ODOT Portland Metro Area Value Pricing Feasibility Analysis. The commercial VOTs from the SP survey were not used for the CRC model; instead the previously applied Metro truck VOT of $35 (2005$) was used.

Table A-2. Columbia River Crossing 2009 Survey and Model Value of Time

	2009 SP Survey	CRC Model
	in 2009$	2009$
Auto Peak VOT ($/hour)	$14.68	$18.89
Auto Off-Peak VOT ($/hour)	$11.43	$12.57

Recommended values from NCHRP 722

NCRHP 722[22] provides recommended default VOTs for travel demand models by household-income segment, trip purpose and time of day. Table A-3 summarizes the VOTs into trip purposes (i.e., work/commute, work/business, non-work) that correspond to those used in the household-income-based assessment. These are generic values that are useful primarily as a point of reference and reasonableness check on applied VOT values. Unlike the Federal VOT guidance,[23] which was developed for the purpose of economic analysis, these recommendations were developed for the purpose of travel-demand modeling based on a review of VOTs used in previous studies.

Table A-3. NCHRP 722 Recommended Default Values of Time for Single-Occupancy Vehicles by Household-Income Group, Trip Purpose, Peak/Off-Peak (2010$*)

Household-Income Group		Low	Medium	High
		<$50,000	$50,000 to $100,000	>$100,000
Work/Commute	Peak ($/hour)	$7.10 to $8.11	$13.69 to $15.21	$20.27 to $22.3
	Off-Peak ($/hour)	$6.08	$11.15	$18.25
Work/Business	Peak ($/hour)	$12.16	$20.27	$28.38

[21] Stantec. September 2009. *Columbia River Crossing: Recommendation for the Selection of the Value of Time to be Used in the Metro Modeling Runs*.

[22] Transportation Research Board. 2012. *NCHRP Report 722, Assessing Highway Tolling and Pricing Options and Impacts, Volume 2 Travel Demand Forecasting Tools.*

[23] Ibid.

	Off-Peak ($/hour)	$10.14	$17.23	$24.33
Non-Work	Peak ($/hour)	$5.58 to $6.59	$10.14 to $11.15	$14.19 to $15.21
	Off-Peak ($/hour)	$4.56 to $5.58	$8.11 to $9.12	$12.16 to $13.18

* VOTs in 2010$; income thresholds in 2008$; For peak work trips, the range represents AM (high) and PM (low) peak; For non-work trips, the range represents shopping and personal business trips (high) and leisure trips (low).

Table A-4 presents peak and off-peak VOTs calculated using the NCHRP 722 default VOTs and the trip purpose split in the model area. In the model area, work/college trips account for 45% of trips during the peak and 29% of trips during the off-peak. Taking into account this trip purpose split and using the average of the shopping/personal business VOT and leisure VOT for non-work, the peak VOT is 1.2 to 1.3 times the off-peak VOT. The calculation assumes that business trips account for 5% of work trips during the peak and off-peak. Table A-4 also shows the NCHRP recommended VOTs as a percent of hourly household income. The NCHRP VOTs are generally lower than the business and personal travel VOTs calculated based on the approach from the Federal VOT guidance, which are 100% and 50% of hourly household income, respectively. For the medium-income category, NCHRP peak VOT corresponds to 52% of hourly income for a household with a $50,000 income and to 26% of hourly income for a household with an income of $100,000. For the high-income category, the peak VOT for the lowest income in this category ($100,000) corresponds to 37% of hourly income. For a household in the high-income category with, for instance, an income of $130,000, the peak VOT of $18 equals 29% of the hourly household income.

Table A-4. NCHRP 722 Recommended Default Value of Time for Single-Occupancy Vehicles by Household-Income Group summarized by Peak/Off-Peak (2010$*)

Household-Income Group	Time Period	VOT	Peak VOT/Off-Peak VOT Factor	Percentage of Hourly Household Income
Low (<$50,000)	Peak	$6.87	1.27	>29%
	Off-Peak	$5.42		>23%
Medium $50,000 - $100,000	Peak	$12.49	1.32	26% to 52%
	Off-Peak	$9.44		20% to 39%
High >$100,000	Peak	$17.82	1.24	<37%
	Off-Peak	$14.38		<30%

*Note: VOTs in 2010$; income thresholds in 2008$

The NCRHP report also provides recommendations for VOTs by vehicle type, time of day, income category and trip purpose for multiclass assignment. Table A-5 summarizes the values by vehicle type and time of day. For trucks, the recommendations do not provide a breakdown by time of day.

Table A-5. NCHRP 722 Recommended Values of Times for Multiclass Assignment (2010$)

		Range of VOT	Relative to SOV
Peak	SOV	$10.14 to $20.27	1
	HOV2	$17.74 to $35.48	1.75
	HOV3	$25.34 to $50.69	2.5

Off-Peak	SOV	$8.11 to $15.21	1
	HOV2	$14.19 to $26.61	1.75
	HOV3	$20.27 to $38.01	2.5
Light trucks and commercial vehicles		$30.41	1.5*
Heavy trucks		$60.82	3*

Source: NCHRP 722 (converted to 2010 dollars)
Note:* ratio of Truck VOT to SOV AM Peak VOT. For peak, the range of VOT represents medium/high-income work trips during the AM (high) vs other trips during the PM (low). For off-peak, the range represents medium/high-income work trips (high) vs other trips (low).

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The VOT from ODOT Program Implementation and Analysis Unit was the source of the truck VOT assumptions for the screening analysis of the Project. The VOT estimate for medium and heavy trucks is based on average employee compensation in Oregon for drivers of medium and heavy trucks, average vehicle occupancy, which is estimated as 1.27 persons for medium trucks and 1.02 for heavy trucks and a freight inventory value of $0.18/hour (2015$). The VOT equals $26 for medium trucks and $28 for heavy trucks (2010$).

E-470 2014 Investment Grade Traffic and Revenue Study[25]

E-470 is a 47-mile toll road that runs along the eastern perimeter of the Denver Metro area and is part of the outer circumferential highway around Denver. The road was built in four phases with the first segment opened in 1991 and the last in 2003. In the 2014 study, CDM Smith used 2010 Census data on median household income, number of households and number of hours worked at the census tract level to estimate VOTs for passenger vehicles at the census tract level. They created a weighted VOT for each TAZ based on the split by trip purpose, including a “trip perception factor” for each trip purpose to represent the difference in the VOT by trip purpose. The result was individual VOTs for each TAZ, for each time period. In 2013, the average VOT was $13.99 for personal cars. They do not provide a separate VOT for SOV and HOVs. The model also included a vehicle operating cost (VOC) of $0.233 per mile for passenger cars in 2013. CDM Smith assumed that the VOT for trucks was three times the VOT of personal vehicles. This translates into a VOT of $42 in 2013$. VOC for trucks was assumed to be 3.25 times the VOC of passenger vehicles, or $0.757 per mile.

In 2020 CDM Smith prepared an updated forecast[26] that included VOT of $19.22 in 2019$. CDM Smith estimated the VOT by combining the VOTs developed from E-470 SP surveys conducted in 2017 with county-level VOTs estimates based on U.S. Census Bureau American Community Survey data and with information from the RTDM. Through this process, the relationships between income and VOT, as well as between peak and non-peak period trips obtained from the prior SP surveys were applied to the county-level VOTs developed using the U.S. Census

[24] Oregon Department of Transportation. Program Implementation and Analysis Unit. November 2016. *The Value of Travel-Time: Estimates of the Hourly Value of Time for Vehicles in Oregon 2015*.
[25] E-470 Public Highway Authority. 2014. *E-470 2014 Investment Grade Traffic and Revenue Study*.
[26] E-470 Public Highway Authority. 2020. *E-470 Comprehensive Traffic and Revenue Study*. https://www.e-470.com/app/uploads/2020/10/E-470ComprehensiveTRStudyReport_May312020.pdf

Bureau data. This was done to normalize the VOTs to average incomes in the Denver region. This process produced an estimated VOT of $0.320 per minute, or $19.22 per hour at 2019 levels.

Case Study of 183A, Austin, TX[27]

The 183A Turnpike is a toll road in southwestern Williamson County, TX, that traverses the cities of Leander and Cedar Park, as well as the northern border of Austin. The 183A runs generally parallel to U.S. 183, which is not tolled. The authors of the study conducted an SP survey of current and potential users to develop a tool to quantify how motorists' departure times and route choices would change in response to toll changes. The survey was administered online from February through April 2014. License Plate Reader data was collected and users were invited to participate by mail with follow up phone calls. A total of 550 completed surveys were received.

Using discrete choice analysis techniques, an average VOT of $12.13 (2012$) was estimated for mandatory trips. For the non-mandatory trips, a VOT of $6.89 was estimated for SOVs and $10.28 for HOVs. Based on the sample median household income of about $100,000, the VOT corresponds to 25% of hourly household income for mandatory trips and 15% for non-mandatory trips.

Tampa Hillsborough Expressway Authority Investment Grade Traffic and Revenue Study[28]

Jacobs Engineering developed an investment-grade traffic and revenue study for the Lee Selmon Expressway, which the Tampa Hillsborough Expressway Authority operates. The 14.168-mile toll road connects the South Tampa with Downtown Tampa and a bedroom community to the east of Tampa (Brandon). Jacobs developed a distribution of VOT based on the household-income distribution of the region. They assumed that VOT would correspond to 50% of hourly wage at lower levels of income with decreasing percentage share at higher levels, down to 30%. Figure A-1 Selmon Expressway Value of Time presents the VOT estimated included in the traffic and revenue model.

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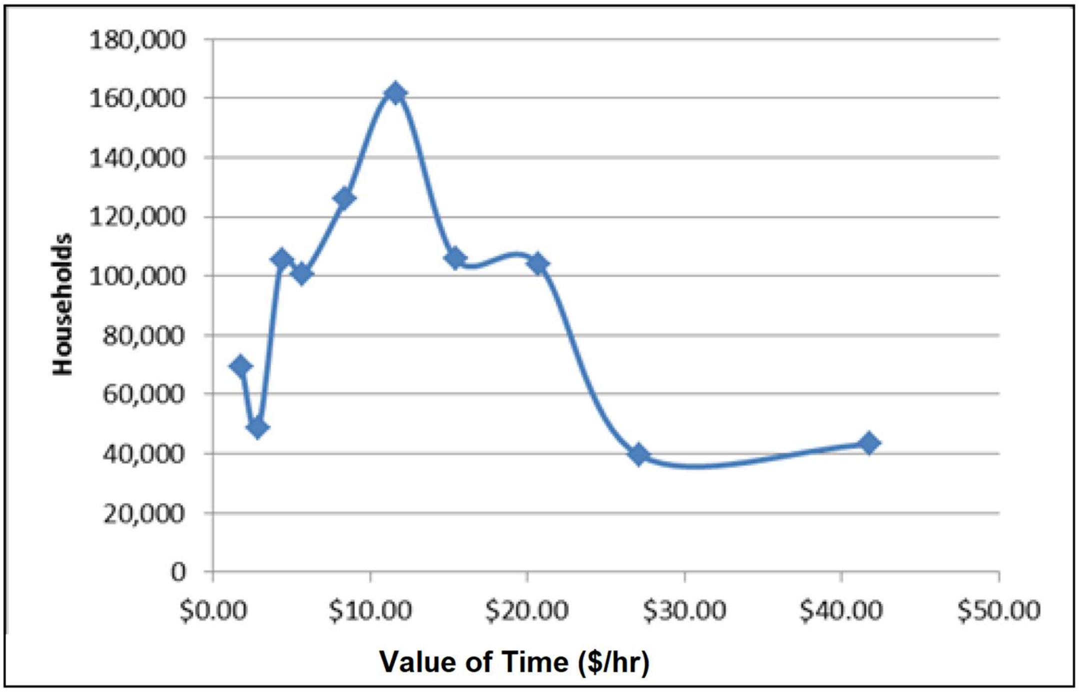
[27] Light, T., Patil, S., Erhardt, G., Tsang, F., Burge, P., Sorensen, P., & Zmud, M. 2015. *The Impact of Adopting Time-of-Day Tolling: Case Study of 183A in Austin, Texas*. RAND Corporation. http://www.jstor.org/stable/10.7249/j.ctt15sk8tk

[28] Tamp Hillsborough Expressway Authority. August 2017. *THEA Investment Grade Traffic and Revenue Study*. https://selmonextension.com/wp-content/uploads/2017/09/THEA-Investment-Grade-Traffic-and-Revenue-Study-FINAL.pdf

Figure A-1. Selmon Expressway Value of Time



SR 520 Stated Preference Surveys

State Route 520 is an east-west highway and bridge that connects Seattle with its Eastside communities on Lake Washington in King County via the SR 520 floating bridge. SP surveys were conducted in 2003 and in 2009 to understand the toll sensitivity of travelers using the non-tolled bridge. The most recent SP survey was conducted by Resource Systems Group, Inc. in 2009 as part of the Traffic and Revenue (T&R) study produced for Washington State Department of Transportation.[29] Survey data were collected in late October and early November 2009. Invitations to participate were sent by email using addresses that were obtained from a previous origin-destination survey of the SR 520 floating bridge. To qualify for the survey, respondents needed to have made a recent weekday trip in a personal vehicle using SR 520 to cross Lake Washington. A total of 1,958 respondents completed the survey. The data was used to estimate the VOTs presented in Table A-6. The table shows that off-peak VOTs were found to be higher than peak VOT for all income segments shown except for the median sample income. For the median sample income, off-peak business VOT was 18% lower than peak business VOT. The aggregate VOT corresponds to 20% of the hourly income for households with an income of $125,000. The percentage is higher for lower-income households with 46% for a $35,000 household income and 32% for a $60,000 household income.

[29] Resource Systems Group Inc. December 2009. *SR 520 Stated Preference Travel Study*.

Table A-6. SR 520 2009 Survey Value of Time (2009$)

Income Group	Annual Income	Value of Time ($/hr)				
		Aggregate	Peak business (includes commute)	Peak non-business	Off-peak business (includes commute)	Off-peak non-business
Median Sample Income (Aggregate)	$125,000	$11.85	$13.59	$9.44	$11.12	$12.95
Low Income	$25,000	$6.83	$6.73	$5	$9.62	$9.47
Low–Medium Income	$35,000	$7.67	$7.79	$5.71	$9.92	$10.11
Medium–High Income	$60,000	$9.22	$9.86	$7.06	$10.41	$12.23

In the 2011 investment-grade T&R study for the SR 520 corridor, CDM Smith points out that the VOTs estimated based on the 2009 stated preference survey were demonstrably lower than VOT results from a similar stated preference survey of SR 520 users in 2003 and too low given the income level of travelers in the corridor, which was estimated as $100,000 on average. Therefore, they made adjustments to the VOTs for the SR 520 T&R forecasting. Based on annual household income and annual number of hours worked for the bridge influence area from the census and perception factors of 30% to 60% to reflect the different VOTs by trip purpose, they estimated a VOT for the highest income group based on an annual household income of $125,000. They then used the survey results to calculate the proportional VOTs for other SOV segments. They also compared their results to the Puget Sound Regional Council VOT, which corresponds to almost 75% of the hourly wage rate and was based on a very small sample of 275 respondents and a non-traditional methodology. The VOTs for peak work trips are presented in Table A-7.

Table A-7. SR 520 SP Surveys and Model Peak Work Trip Value-of-Time Comparison (2010$)

	Value of Time ($/hour)
2003 SP Survey	$15.11
2009 SP Survey	$10.72
Puget Sound Regional Council Model	$28.63
SR 520 Tolling Model	$17.70

Decision Making Process and Factors Affecting Truck Routing[30]

An SP survey of truck drivers was conducted at three rest area and truck stop locations along major highways in Texas, Indiana, and Ontario with about 250 responses. The authors found a wide range of VOT with values from $30/hour and $235/hour (2012$) between the first and third quintiles (i.e., excluding the respondents with the lowest and highest VOTs). VOT varied based on employment terms (e.g., method of pay calculation and whether the driver is

[30] Toledo, T., et al. "Decision-Making Process and Factors Affecting Truck Routing," *Freight Transport Modelling*, pp. 233-249. 2013. https://doi.org/10.1108/9781781902868-012

responsible for toll and fuel cost) and shipment terms. The authors found that most drivers are responsible for choosing their routes, both during the planning stage and en-route.

RhodeWorks Truck Tolling Program Traffic and Revenue Study[31]

Rhode Island Department of Transportation (RIDOT) developed RhodeWorks, a road improvement funding program that calls for the repair of the state's bridges. Under the program, a significant portion of the financing of the repairs is expected to be obtained from tolls assessed on tractor trailers. RIDOT engaged the Louis Berger team to develop a level 3 investment-grade T&R study. The level 3 study evaluated 14 toll locations across the state along six major highway corridors (I-95, I-195, I-295, US Route 6, RI Route 146, and RI Route 10).

As part of the study, the Louis Berger team conducted an SP survey to understand willingness-to-pay for travel-time savings associated with not diverting to alternative roads in response to a toll on the highway. Drivers of tractor trailers were intercepted at two locations in Rhode Island in October 2016. To qualify for the full survey, the driver needed to be in charge of the route-planning decision or be authorized to make en-route changes, either independently or with approval of the fleet manager/dispatcher. Of all 437 intercepted tractor trailer drivers who agreed to participate, 75% (327) met these qualifications.

The survey data was used to develop a distribution of VOT for short (less than 2 hours) and long-distance trips (2 hours or more). The distribution of VOT was summarized into quintiles to be incorporated in the Rhode Island Statewide Travel Demand Forecasting Model (RISM) as shown in Table A-8 RhodeWorks Values of Time for Short- and Long-Distance Truck Trips. The RISM was customized to include separate truck-trip tables for short- and long-distance trips for each time period. Each trip table was then further split into five equal-sized trip tables with each trip table being assigned a VOT from one of the five short- or long-distance quintiles.

Table A-8. RhodeWorks Values of Time for Short- and Long-Distance Truck Trips (2016$)

Quintile	Short Distance			Long Distance		
	Upper Threshold			Upper Threshold		
	Percentage	VOT ($/hour)	Average VOT	Percentage	VOT ($/hour)	Average VOT
0 to 20	20%	$12.00	$8.89	20%	$19.00	$13.79
20 to 40	40%	$18.00	$15.45	40%	$29.00	$24.41
40 to 60	60%	$27.00	$22.70	60%	$42.00	$35.60
60 to 80	80%	$41.00	$33.65	80%	$65.00	$52.55
80 to 100	100%	$212.00	$65.48	100%	$336.00	$103.52

To validate the VOT estimates, a literature review on VOT for commercial travel was conducted as part the RhodeWorks report. The review returned a wide range in the reported VOTs based on several different methodological approaches and analytical perspectives. An adaptive stated

[31] *Rhode Island Department of Transportation Investment-Grade Tolling Study Final Report*. November 3, 2017. http://www.dot.ri.gov/documents/news/Investment-Grade-Tolling-Study.pdf

preference study in Minnesota derived the truck VOT at $49/hour[32] while a stated preference study in California estimated the VOT for trucks at $23/hour.[33] Table A-9 RhodeWorks Value of Time Benchmark Comparison compares the RhodeWorks VOTs with those obtained from two comparable studies in the United States: an SP survey conducted as part of the Atlanta Managed Lane System Plan,[34] and the I-710 Study[35] in Los Angeles.

Table A-9. RhodeWorks Study Value of Time Benchmark Comparison (2016$)

	Atlanta Managed Lanes (2010)	I-710 Major Corridor-Los Angeles (2005)	RIDOT Study (2016)	
			Short Distance	Long Distance
Mean	$22.81	$30.00	$28.93	$45.87
Median	$15.32	$18.00	$22.15	$35.12

The RhodeWorks report also compared the VOT to the Level 2 RhodeWorks T&R Study that was completed by CDM Smith in early 2016 and that resulted in the identification of 14 toll locations across the state. The previous Level 2 Study used the driver wage approach set forth in U.S. DOT guidelines to set the VOT assumptions. Starting with an estimated hourly wage of $19.00/hour, a 25% increase was also applied to account for company overhead and other potential opportunity costs. This resulted in a single VOT assumption of $23.76/hour.

NCHRP Report 925: Estimating the Value of Truck Travel-Time Reliability[36]

NCHRP 925 developed a reliability valuation framework for freight transportation that recommends VOT and VOR (Value of Reliability) estimates for benefit-cost and other planning analyses. As part of the study, an SP survey of motor carriers and shippers was conducted with about 1,000 qualified responses. The authors found that VOT and VOR vary widely based on respondent type (i.e., motor carriers, shipper with transportation, shipper without transportation), shipment distance, company size, shipment characteristics and receiver characteristics, and other factors. VOTs based on submodels that focused on a specific segment of the market ranged from $15 to $412/hour. The VOT estimates based on the whole sample were not significant. Therefore, the authors recommended using the American Transportation

[32] Smalkoski, B., Levinson, D. 2005. "Value of Time for Commercial Vehicle Operators in Minnesota," *Journal of the Transportation Research Forum 44:1*, pp. 89-102.

[33] Kawamura, K. January 1, 2000."Perceived Value of Time for Truck Operators," *Transportation Research Record 1725, Paper No. 00-0711*. Transportation Research Board, Washington, D.C.

[34] HNTB for Georgia Department of Transportation. 2010. *Atlanta Regional Managed Lane System Plan, Stated Preference Survey Report.* http://www.dot.ga.gov/BuildSmart/Studies/ManagedLanesDocuments/Stated%20Preference%20Survey.pdf

[35] https://www.metro.net/projects/i-710-corridor-project/

[36] National Academies of Sciences, Engineering, and Medicine. 2019. *NCHRP Report 925: Estimating the Value of Truck Travel Time Reliability*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25655

Research Institute VOT of $66.7 per hour in 2017 dollars.[37] Using the whole sample, the authors estimated a VOR of $160/hour.

Meta Analysis of Freight VOT[38] (2007)

This paper provides 46 estimates of truck VOT from studies in 22 countries. VOTs vary widely in part because they were developed using different methods and in part because of differences in terms of the location of the studies. They found a wide range of VOTs with a mean VOT of $20 (2002$).

Updated Estimate of Roadway User Cost for Personal Vehicles and Commercial Trucks[39]

TxDOT publishes updated values of delay every year. For trucks, the value includes vehicle occupancy, wage, employee benefits and the cost of the additional fuel needed because of slower speed. If the delay increases distance, the value includes the additional operating cost per mile and accident cost, which is based on insurance cost). The 2019 value of delay was estimated as $41.33 per vehicle hour, which includes $36.62 for the value of travel time plus $4.71 due to excess fuel burn in congested traffic, and is based on an average vehicle occupancy of 1.14 persons per vehicle. If rerouting increases the distance traveled, $1.022 cents per mile for each additional mile of travel is added to the value of delay.

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[37] American Transportation Research Institute. November 2019. *An Analysis of the Operational Costs of Trucking: 2019 Update*. https://truckingresearch.org/wp-content/uploads/2019/11/ATRI-Operational-Costs-of-Trucking-2019-1.pdf

[38] Luca Zamparini & Aura Reggiani. 2007. "Freight Transport and the Value of Travel Time Savings: A Meta-analysis of Empirical Studies," Transport Reviews, 27:5, 621-636. https://doi.org/10.1080/01441640701322834

[39] Texas A&M Transportation Institute. March 10, 2020. *Updated Estimate of Roadway User Cost for Personal Vehicles and Commercial Trucks*. https://ftp.txdot.gov/pub/txdot-info/cst/ruc-methodology-memo.pdf

ATTACHMENT B: SUPPORTING DATA

Table B-1. Number of Households by Income Group

Income Group	1	2	3	4	5	6	7	8	9	10
Tolling District	**< $10,000**	**$10,000 to $15,000**	**$15,000 to $25,000**	**$25,000 to $ 35,000**	**$35,000 to $50,000**	**$50,000 to $75,000**	**$75,000 to $100,000**	**$100,000 to $150,000**	**$150,000 to $200,000**	**- > $200,000**
1	779	583	1,095	1,481	2,249	3,967	3,201	3,902	1,443	1,276
2	764	599	1,084	1,504	2,573	4,265	3,494	4,486	1,863	1,631
3	429	326	641	652	1,211	1,864	1,358	2,782	1,583	2,870
4	934	558	1,658	1,800	2,446	3,912	3,848	5,394	3,871	6,763
5	1,078	761	2,317	2,082	2,817	4,563	3,677	5,788	3,065	3,915
6	433	476	1,165	1,273	1,704	3,064	2,462	3,146	1,247	1,271
7	2,305	2,001	4,390	5,479	8,113	12,193	9,837	11,787	5,076	3,790
8	3,027	2,194	4,940	4,989	7,094	11,522	8,203	9,559	3,371	4,051
9	1,312	986	2,039	3,165	4,567	7,115	7,039	9,161	4,597	4,269
10	3,468	1,815	3,862	4,310	5,261	8,548	7,583	10,621	5,892	10,242
11	5,393	2,255	4,022	4,128	4,755	6,433	6,190	9,093	5,041	9,934
12	10,051	7,173	13,820	14,294	19,635	28,001	20,385	22,252	8,493	8,182
13	5,349	3,710	7,021	6,708	10,848	16,432	11,906	15,920	7,119	7,508
14	7,340	5,105	12,783	14,453	23,239	34,921	27,272	35,312	13,621	11,951
15	1,373	980	2,661	2,112	3,984	5,743	5,170	6,805	2,929	3,504
16	2,964	2,134	5,413	6,342	9,743	16,770	13,927	17,430	7,281	5,473
17	1,087	1,098	2,159	3,109	4,133	6,989	5,147	7,718	3,683	3,851
18	959	908	2,088	2,169	3,416	5,639	4,556	7,491	4,044	5,731
19	4,483	3,477	7,599	7,864	10,567	14,652	10,778	12,665	4,661	3,081
20	499	403	790	1,060	1,158	2,589	1,508	2,594	1,436	1,941
21	4,780	3,643	7,871	9,525	14,767	22,608	19,581	24,999	13,700	16,075
22	2,059	1,742	3,824	4,567	6,487	9,538	8,028	11,346	5,782	5,948
23	837	552	1,385	1,594	2,019	3,531	2,800	4,921	2,505	2,878
Total	61,703	43,480	94,628	104,659	152,787	234,858	187,949	245,171	112,304	126,135

Source: 2018 American Community Survey 5-Year Estimates

Table B-2. Personal Travel and Business Travel by Income Group

Income Group	1	2	3	4	5	6	7	8	9	10
	< $10,000	$10,000 to $15,000	$15,000 to $25,000	$25,000 to $ 35,000	$35,000 to $50,000	$50,000 to $75,000	$75,000 to $100,000	$100,000 to $150,000	$150,000 to $200,000	- > $200,000
Midpoint	$8,000	$12,500	$20,000	$30,000	$42,500	$62,500	$87,500	$125,000	$175,000	$202,000
VOT Personal	$1.92	$3.00	$4.81	$7.21	$10.22	$15.02	$21.03	$30.05	$42.07	$48.56
VOT Business	$3.85	$6.01	$9.62	$14.42	$20.43	$30.05	$42.07	$60.10	$84.13	$97.12

Table B- 3. 2015 Select Link (Abernethy Bridge) Trips by Origin District 2015

Model Income Group	SOV Auto - Low Income	SOV Auto - Med Income	SOV Auto - High Income
	< $25,000	$25,000 to $100,000	> $100,000
1	104	670	334
2	31	278	186
3	157	1038	1145
4	59	346	400
5	61	327	226
6	0	0	0
7	85	772	457
8	212	1270	613
9	75	736	547
10	13	85	74
11	0	2	5
12	129	772	296
13	5	56	30
14	6	293	105
15	0	9	8
16	13	209	86
17	3	59	42
18	21	144	190
19	42	415	163
20	62	312	222
21	58	410	224
22	69	390	240
23	21	196	173

Table B-4. Wage Distribution by Tolling District

Tolling District	Low Wage	Medium Wage	High Wage
1	25%	42%	33%
2	27%	47%	26%
3	24%	40%	36%
4	17%	29%	55%
5	22%	38%	40%
6	31%	39%	30%
7	35%	41%	24%
8	21%	41%	38%
9	18%	33%	49%
10	15%	32%	54%
11	10%	26%	65%
12	21%	41%	38%
13	16%	33%	51%
14	20%	34%	46%
15	30%	38%	32%
16	19%	34%	47%
17	31%	44%	25%
18	16%	34%	51%
19	26%	45%	29%
20	24%	35%	41%
21	16%	30%	54%
22	20%	36%	44%
23	32%	43%	25%
Total	18%	35%	47%

Table B-5. Jobs in High-Wage Industries by Tolling District

Tolling District	Number of Jobs				Percentage of Total Jobs			
	Finance & Insurance	Management of Companies and Enterprises	Professional & Technical Services	Total	Finance & Insurance	Management of Companies and Enterprises	Professional & Technical Services	Total
1	308	69	557	6,486	5%	1%	9%	100%
2	256	55	577	6,871	4%	1%	8%	100%
3	270	24	406	5,321	5%	0%	8%	100%
4	3,700	1,200	5,019	27,335	14%	4%	18%	100%
5	1,228	1,347	2,041	22,411	5%	6%	9%	100%
6	130	4	247	2,886	5%	0%	9%	100%
7	481	517	1,024	13,447	4%	4%	8%	100%
8	1,835	1,373	2,558	32,800	6%	4%	8%	100%
9	839	706	1,205	18,742	4%	4%	6%	100%
10	6,520	2,784	9,191	56,503	12%	5%	16%	100%
11	11,211	8,931	24,239	103,849	11%	9%	23%	100%
12	3,964	3,638	8,187	87,141	5%	4%	9%	100%
13	3,461	7,706	8,823	89,040	4%	9%	10%	100%
14	7,105	3,539	10,320	166,600	4%	2%	6%	100%
15	209	341	1,047	9,078	2%	4%	12%	100%
16	2,036	929	3,570	41,193	5%	2%	9%	100%
17	290	81	524	9,495	3%	1%	6%	100%
18	737	432	1,138	13,508	5%	3%	8%	100%
19	2,252	456	1,485	26,562	8%	2%	6%	100%
20	239	535	1,840	10,513	2%	5%	18%	100%
21	6,386	12,863	9,942	91,364	7%	14%	11%	100%
22	7,297	2,176	9,269	51,858	14%	4%	18%	100%
23	388	636	1,184	11,959	3%	5%	10%	100%
Total	61,142	50,342	104,393	904,962	7%	6%	12%	100%

Table B-6. Average Annual Wages by Industry

Job Location	All Industries	Finance & Insurance	Management of Companies and Enterprises	Professional & Technical Services
Clackamas County, Oregon	$51,719	$87,291	$95,570	$97,785
Clark County, Washington	$50,850	$87,166	$106,262	$75,005
Multnomah County, Oregon	$57,171	$94,031	$97,903	$87,122
Washington County, Oregon	$68,162	$75,506	$173,398	$75,177

Attachment E. 2045 IBR No-Build and 2045 IBR Modified Locally Preferred Alternative Modeling Packages

MEMORANDUM

Date: November 15, 2023

To: Aaron Breakstone, Metro
Mark Harrington, RTC

From: Interstate Bridge Replacement Program Transportation Team

Subject: DRAFT 2045 Regional Travel Demand Model Assumptions for SEIS Interstate Bridge Replacement Program No-Build Alternative – REVISED2

OVERVIEW

This memorandum describes, for travel demand modeling purposes only, the modeling assumptions to be included in the Supplemental Draft Environmental Impact Statement run of the Regional Travel Demand Model for the Interstate Bridge Replacement program (previously Columbia River Crossing) No-Build Option. The No-Build Option reflects assumptions for highway and transit absent the Modified Locally Preferred Alternative (MLPA) that was approved by project partners in July 2022. The No-Build Option, described in additional detail below, reflects no replacement of the current Interstate 5 (I-5) bridges, no reconstructed interchanges, no tolls on the I-5 bridges, and no extension of light-rail transit north from the existing MAX Yellow Line alignment into Vancouver.

The starting point for this model run is the 2018 Regional Transportation Plan (RTP) Financially Constrained system jointly developed and adopted by both Metro and the Southwest Washington Regional Transportation Council (RTC) with updates to land use to extend the forecasts to the year 2045. These metropolitan planning organizations have coordinated this process in a manner consistent with underlying comprehensive plans and information provided by their jurisdictions as part of the 2018 RTP process. Additional details on the process to arrive at land use allocation for the future year 2045 are provided in the Travel Demand Modeling Methods Report.

This memorandum includes five attachments:

1. A – 2018 RTP Project List – Metro
2. B – 2019 RTP Project List – Regional Transportation Council
3. C – Ramp Meter Rates
4. D – Transit Line Listing
5. E – Transit Route Coding Maps

HIGHWAY NETWORK DESCRIPTION

The background highway network for this model run is the 2018 RTP Financially Constrained system adopted in December 2018 by the Metro Council and by the RTC Board of Directors in March 2019. The 2018 RTP includes transportation projects from state and local plans that are needed to meet transportation needs over the next 25 years and that are financially constrained, meaning they have funding that is reasonably expected over the funding period to complete the projects. Lists of Metro RTP projects are included as Attachment A, and RTC projects are included as Attachment B. The two metropolitan planning organizations coordinate on project planning for the bi-state region and use a single coordinated network and input assumptions for their respective plans.

For developing a No-Build highway network for the Interstate Bridge Replacement program, the Financially Constrained RTP network is modified to remove the new Interstate Bridge, the North Portland Harbor crossing between Marine Drive and Hayden Island, and all interchange improvements included in the RTP that were associated with the CRC LPA between Victory Boulevard in Oregon and SR 500 in Washington. The I-5 network between Victory Boulevard and SR 500 reflects base year 2015 existing conditions in terms of the number of lanes, capacity, and ramp configurations. The Interstate Bridge crossing reflects three lanes in each direction with an assumed capacity of 5,700 vehicles per hour.

Ramp Meters

Ramp meter rates have been provided by both the Oregon Department of Transportation (ODOT) and the Washington State Department of Transportation (WSDOT) for all ramps in the region that are to include rates in the AM and PM peak time periods. These meters operate generally in the peak period and peak direction. While both ODOT and WSDOT utilize real time data on freeway mainline lanes and ramps to adjust meter rates depending on the traffic flow during hours they are in operation, the regional model uses an average flow per hour calculation that has been provided by both agencies. This average flow per hour reflects a reasonable flow of traffic through each ramp meter based on the configuration of the ramp and the number of vehicles that can be accommodated at the ramp given average traffic conditions by hour. Attachment C provides a list of on-ramp metering rates to be coded along I-5 for this model run. Meter rates for ramps outside of this portion of the regional freeway system have been provided to Metro and RTC separately. Note that there are some differences in ramp meter rates between the No-Build Alternative and the Modified LPA alternative as a result of changes in the I-5 mainline that occur under the Modified LPA.

Tolls

Tolling was included for cars and trucks that use the I-5 river crossing in the Financially Constrained RTP. These tolls will not be assumed in the No-Build Alternative, so they are removed from the networks and assignment procedures.

TRANSIT NETWORK DESCRIPTION

Similar to the highway network, the transit network for this model run is based on the 2018 RTP Financially Constrained system which includes assumed-for increases in background regional transit service by both TriMet and C-TRAN as adopted in the 2018 RTP. A full listing of the transit lines and frequencies is included as Attachment D. This attachment highlights differences between the No-Build Alternative and Modified Locally Preferred Alternative. Service assumptions in and through the corridor are described below.

Light-Rail Network

The No-Build Alternative includes the removal of the 2.9-mile-long light-rail extension from the existing Yellow Line terminus across the North Portland Harbor, over Hayden Island, across the Columbia River, through downtown Vancouver, and terminating near Clark College. In the No-Build Option, the northern terminus for the Yellow Line is the Expo Center. The Yellow Line operates at 12-minute peak and 15-minute off-peak frequencies between Milwaukie and the Expo Center. In addition to this line, a separate route provides 60-minute peak-only service between Milwaukie and Union Station in downtown Portland.

No-Build Bus Network

The bus network for the No-Build Alternative includes regional routes and express service from Clark County extending into Portland. The network is based on the existing transit system with enhancements approved and adopted in the 2018 RTP along with a few adjustments from C-TRAN as noted below. In the existing transit system, C-TRAN operates a regional route (Route 60) that serves downtown Vancouver, Hayden Island, and Delta Park, providing riders from Vancouver with the ability to transfer to the Yellow Line for connections to/through North Portland and into downtown Portland. This route was not in the 2018 RTP network but is included in the No-Build Alternative.

The C-TRAN network in the 2018 RTP includes an expansion of its bus rapid transit (BRT) system to include both Mill Plain BRT and Hwy 99 BRT in addition to the Fourth Plain BRT that is currently in operation.

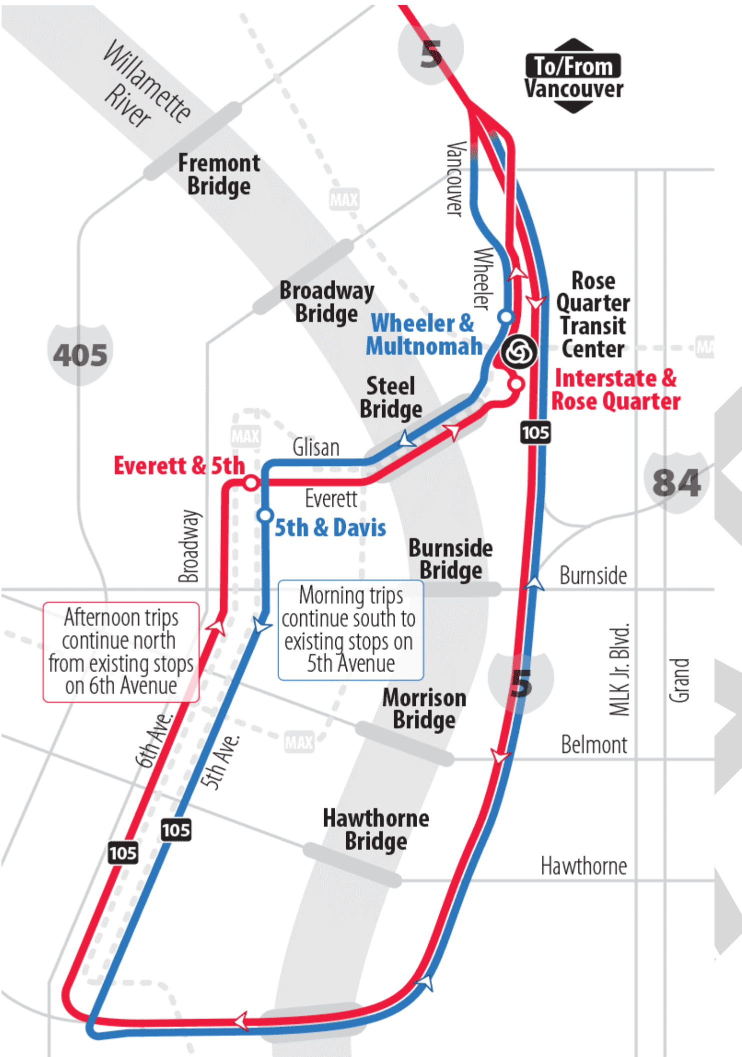
C-TRAN BRT routes are modified compared to what was assumed in the 2018 RTP as follows:

- Hwy 99 BRT with service between downtown Vancouver and the 99th Street Transit Center (TC) in the 2018 RTP extends north from the 99th Street TC to provide service to the Salmon Creek Park & Ride. This service operates along Hwy 99 to NE 134th Street, continues on NE 23rd Avenue to NE 139th Street, and enters the Salmon Creek Park & Ride from NE 139th Street. In downtown Vancouver, Hwy 99 BRT operates southbound on Washington Street and northbound on Broadway Street. This BRT route also makes a loop to provide service through the Vancouver Waterfront area. A map of the routing for the Hwy 99 BRT is provided in Attachment E.
- Mill Plain and Fourth Plain BRT are modified to operate as an interlined route between Turtle Place in downtown and a new Mill Plain TC located at Mill Plain near the Columbia Tech Center. These interlined routes operate with one providing clockwise service and one providing counterclockwise service. The segment between Vancouver Mall and the Mill Plain TC operates along NE Fourth Plain Boulevard to NE

162nd Avenue, and then operates north/south along NE 162nd Avenue between NE Fourth Plain Boulevard and SE Mill Plain Boulevard.

C-TRAN express bus service operates between Clark County and Portland on four routes. These are listed below in Table 1, which includes information on terminus locations, frequencies, and which bridge the route crosses during operation. Route 101 and Route 164 both provide all day service. Route 105 in the 2018 RTP was assumed to truncate in downtown Vancouver, but it is restored to provide service between the Salmon Creek Park & Ride, the 99th Street Transit Center/Park & Ride and the Portland central business district (CBD). Route 105 does not provide service to downtown Vancouver. Several express routes assumed in the 2018 RTP with service to downtown Portland (Route 118, Route 134, Route 157, Route 199) are removed in the No-Build network. New express service between downtown Vancouver and downtown Portland is provided on Route 101 that operates the same as Route 105 in and out of downtown Portland (shown in Figure 1 below). In downtown Vancouver, Route 101 operates northbound on Broadway and southbound on Washington between 5th/6th Streets on the south end and 13th Street on the north end.

Figure 1. Route 101 and Route 105 Operations In and Out of Downtown Portland



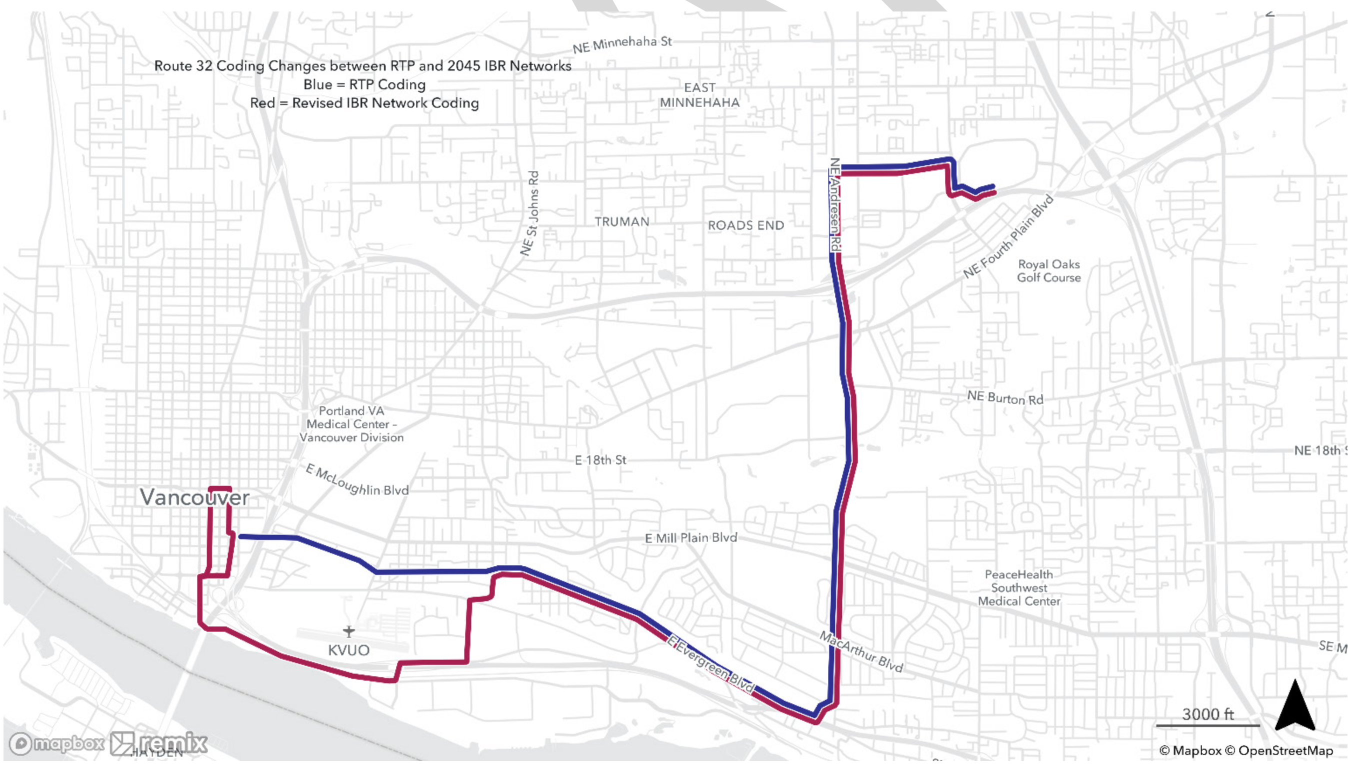
C-TRAN includes bus-on-shoulder operations for express routes on I-5 between 99th Street and the Interstate Bridge. In the No-Build Option, buses use the shoulder operating up to 25 mph when congestion reduces speeds below 25 mph in the general-purpose lanes.

C-TRAN local service in the No-Build Alternative includes one background bus routing change from the underlying assumptions in the 2018 RTP. This change is to the Route 32 which in the 2018 RTP operates from Vancouver Mall Transit Center south on Andresen Boulevard to Evergreen Boulevard and into downtown Vancouver. The adjustment to this route has it no longer providing service all the way into downtown along Evergreen Boulevard but rather extends south on Andresen Boulevard to Evergreen Boulevard where it heads west to Grand Avenue and then proceeds south to Columbia House Boulevard, travels under SR-14 at Columbia Way where it then proceeds along Columbia Way into downtown providing northbound service along Broadway Street and southbound service along Washington Street. The routing change for this is included below in Figure 2.

Table 1. Express Bus Service in No-Build

Route	Service Extents	Frequency	Bridge Used
101	Downtown Vancouver - Portland CBD	15 min peak 30 min off-peak	I-5 southbound I-5 northbound
105	Salmon Creek Park & Ride – 99th Street TC – Portland CBD	10 min peak only	I-5 southbound I-5 northbound
164	Fisher's Landing Park & Ride – Portland CBD	10 min peak 30 min off-peak	I-205 southbound I-5 northbound
190	Andresen Park & Ride – Marquam Hill	10 min peak only	I-5 southbound I-5 northbound

Figure 2. Route 32 Coding Adjusments for 2045 IBR Networks



The TriMet network will not have any bus changes made beyond what is assumed in the current 2018 RTP Financially Constrained system.

PARK-AND-RIDE FACILITIES

The C-TRAN network includes no additional capacity for park and ride in the future-year No-Build condition. Table 2 below shows existing park-and-ride lot locations and capacities under the No-Build Alternative for lots in the Program Area on both the Oregon and Washington side of the river.

Table 2. Park-and-Ride Lots and Capacities

2019 Existing Conditions			2045 No-Build Alternative		
Lot Name	**TAZ***	**Spaces**	**Lot Name**	**TAZ***	**Spaces**
Waterfront Station/SR-14	1484	N/A	Waterfront Station/SR-14	1484	N/A
Evergreen Station/I-5	1499	N/A	Evergreen Station/I-5	1499	N/A
Expo Center	134	100	Expo Center	134	100
Delta Park	135	300	Delta Park	135	300

*TAZ = Transportation Analysis Zone

ATTACHMENT A. RTP PROJECT LIST METRO

Due to the size of the file, please find the file at the following link:

https://www.oregonmetro.gov/sites/default/files/2019/04/02/2018-RTP-Appendices-A-and-B-Constrained-Project-List.pdf

ATTACHMENT B. RTP PROJECT LIST RTC

Due to the size of the file, please find the file at the following link:

https://www.rtc.wa.gov/reports/rtp/Rtp2019Clark.pdf (pages 166 - 180)file://parametrix.com/pmx/Port/Projects/Clients/1585-WSP/274-1585-058 IBR Program/02WBS/Task 5 Transportation Planning/Data/RTC/Rtp2019Clark_AppendixB_ProjectList.pdf

ATTACHMENT C. RAMP METER RATES

I-5 Southbound	AM Peak No-Build	AM Peak Build	PM Peak
Pioneer St. ON	1500	1500	
219th St ON	1500	1500	
179th St ON	1500	1500	
139th St ON	1000	1000	
134th St ON	1000	1000	
99th St ON	1000	1000	
78th St ON	1500	1500	
Main St ON	800	800	
SR 500 ON	2200	2200	
4th Plain ON	1500	1500	
Mill Plain ON	2100	2100	
SR 14 ON	2200	1500	
C St/7th St (Build only)		700	
Hayden Island ON	800	No ramp	
Marine Dr ON	720	1200	
Victory Blvd ON	675	675	
Columbia Blvd ON	1058	1058	
Lombard WB ON	866	866	
Lombard EB ON	1051	1051	
Rose Parks ON	1001	1001	
Alberta St. ON	1001	1001	
Going St ON	938	938	
Greeley ON	938	938	
I-405 ON	No meter	No meter	
Broadway/Weidler ON	1105	1105	1200

I-5 Northbound	PM Peak No-Build	PM Peak Build
McLoughlin ON	665	665
Morrison ON	514	514
I-84 ON	No meter	No meter
Broadway/Weidler ON	839	839
I-405 ON	No meter	No meter
Going ON	529	529
Alberta ON	300	300
Rosa Parks ON	424	424
Victory/Denver ON	550	900
Delta Park	350	900
Marine Dr. ON	1091	1800
Hayden Island ON	889	1000
SR 14 ON	1000	1800
Mill Plain ON	1500	1800
Fourth Plain ON	1200	1500
39th ON	1000	1000
Main St ON	800	800
78th St ON	1200	1200
99th St ON	1200	1200
139th ON	1000	1000
I-205/Hwy 99 ON	No Meter	No Meter
179th ON	1000	1000
219th St ON	1000	1000
Pioneer St. ON	1000	1000

ATTACHMENT D. TRANSIT LINE LISTING

Differences between the No-Build Option and LPA are in shaded cells in the table.

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
TRIMET					
LIGHT-RAIL					
01HGAP - Blue Line (01B)	LRT - (Hillsboro-Gresham) via cross-mall	7	15	7.5	15
01PDXB - Red Line (01R)	LRT - (PIA-BTC) via cross-mall	15	15	15	15
01I205 - Green Line (01G)	LRT - (PCBD/PSU-CTC) via mall	15	15	-	-
01GP1	LRT - (Bridgeport-CTC) via mall	-	-	15	15
01GP2	LRT - (PCBD/Union Station - Tigard) via mall	-	-	30	0
01GP3	LRT - CTC - Tigard via mall	-	-	30	0
01YON	LRT - (MILWAUKIE - EXPO) via mall	15	15	10	15
01O	LRT - (MILWAUKIE - PCBD)	-	-	-	-
01YO	LRT - Milwaukie to I-5/Evergreen Station Terminus Vancouver	-	-	-	-

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
COMMUTER RAIL					
01COMR (01CR)	Commuter Rail (BTC-Wilsonville)	30	-	15	15
STREETCAR					
01SCLW	Streetcar (NW 23rd/Gibbs - N. Macadam)	12	12	12	12
01SCLP	STRCAR EASTSIDE LOOP	15	15	12	12
01SCMP	STRCAR MG Park HOLLYWOOD	-	-	15	15
TRAM					
01TRAM	Tram (North Macadam-OHSU)	5	5	5	5
BRT					
04BRT	Division BRT	-	-	7.5	10
BUS					
02VCBD (02V)	Vermont - (PCBD-Vermont/Shattuck)	30	-	15	30
04DF	Division - Fessenden	12	12	10	10

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
05AP	Alberta/Prescott	-	-	30	30
06M	MLK/Hayden Island	12	15	10	10
06D	MLK/Expo	-	-	-	-
08JN	Jackson Park/NE 15th	12	15	10	10
08JVA (08J)	Jackson Park/VA Hospital - (PCBD-VA Hospital)	30	-	-	-
09P98T	Powell/98th - (PCBD-98th/Powell)	25	-	25	-
09PGTC (09P)	Powell/Gresham TC - (PCBD-Gresham TC) FB	10	15	10	10
10H	Harold - (PCBD-122nd/Foster)	20	30	-	-
10HT	Harold/Thurman	-	-	20	30
11R	Rivergate Marine Dr	60	-	20	30

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
12TP	Tigard/Parkrose	15	15	-	-
12P	PCBD Parkrose	-	-	10	10
14H	Hawthorne - 101st/Foster	7	15	7	10
152M	Milwaukie Shuttle (MTC-CTC)	45	90	30	30
153S	SALAMO-STAFFORD (PCBD/Macadam/LO/Stafford/Willamette-W. Linn)	-	-	30	-
154WILL-OC	Willamette - (Willamette/W. Linn-Oregon City)	60	60	60	60
155S-OTCTC/DAM	Sunnyside/Damascus - (147th/Oregon Trail-CTC)	30	30	15	20
156MR-OTCTC	Mather Rd. - (147th/Oregon Trail-CTC)	60	90	30	30
157HV-OTCTC	Happy Valley - (147th/Oregon Trail-CTC)				
15MG	Montgomery Park Yeon - Gateway	25	30	10	10
15TG	Thurman - Gateway	25	30	-	-
164MT (64MT)	Tigard/Marquam Hill - (OHSU-Tigard)	30	-	-	-
165MB (65BT)	Barbur/Marquam Hill	30	-	-	-

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
166MH (66MH)	Hollywood/Marquam Hill - (OHSU-Hollywood TC)	30	-	30	-
16SS	St Johns - Sauvie Island	45	45	15	20
17HB	Holgate - Broadway - 24th/27th to Dekum	15	20	10	15
18HILL	Hillside - (PCBD-Maclay/Burnside) Off-Mall	60	-	40	-
19W	Woodstock/Glisan	10	20	10	15
20BN	Burnside/NW19th	-	40	-	-
20BSTB	Burnside/Beaverton TC - (BTC-Gresham)	15	40	10	10
21PG / 21S	Parkrose - Gresham TC	30	30	12	20
22ROSE	Parkrose - (Parkrose-Gateway TC)	35	35	20	30

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
23SR223 (23S)	San Rafael/223rd - (Gateway TC-Gresham TC)	80	80	80	80
24F	Fremont/Gateway	30	40	20	20
25G	Glisan/Rockwood - (Gateway TC-Rockwood TC)	70	70	30	30
26CP	Cully/Prescott	-	-	15	20
27W	Webster	-	-	30	30
28JC	Jennings/Carver	-	-	30	30
29L	Lake Webster - (MTC-CTC)	90	90	20	20
30EI	Estacada - CTC Inbound	60	60	30	60
30EO	CTC - Estacada	30	60	60	60

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
32MCC	MTC - CCC	30	70	20	30
33CC	CTC - CCC	15	15	7.5	10
34OC	Linwood River Rd	40	40	30	30
35M	Macadam - Greeley	20	40	10	15
36TCBD (36T)	South Shore - (LakeO-Tual-PCBD) to PCBD	60	-	30	-
36L	Tualatin - Lake Oswego	120	90	30	30
37NSHR (37T)	North Shore - (LakeO-TualPNR) via Cclub/LowerBoones	90	90	-	-
37N	Tigard Transit Center/Lower Boones	-	-	30	30
38BK	Boones Ferry - (PCBD-Tigard TC) Via Kruse/72nd	30	-	30	60
39L	Lewis and Clark - (L&C College-BurlingameTC)	40	40	30	30

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
40BJ	Baseline Jenkins	-	-	15	20
41C	Century/25th	-	-	15	20
43TF (43TW)	Taylors Ferry - (PCBD-WashSq.)	60	60	15	30
44CHWY	Cap Hwy (PCC - RQ)	40	60	-	-
44CM	Cap Hwy Mocks Crest	30	60	10	12
45G	Garden Home - (PCBD-Tigard)	25	70	20	30
46NH	North Hillsboro - (WashCo Fairgrounds-Hillsboro)	60	60	20	30
47BO	Baseline Orenco	30	-	-	-
47B / 47PE	Baseline Evergreen - PCC Rock Creek	30	40	10	15
48C	Cornell Rd (Hillsboro - Sunset TC)	30	30	10	12
48CORN (48CP)	Cornell Rd. - (WillowCrk. /185th-Hillsboro)	30	-	-	-

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
49SB	Sunset Bethany	-	-	15	30
50C	Cedar Mill	30	-	30	-
51CDP	Vista - (PCBD- Council Crest-Patrick Place Dosch)	30	-	30	-
52FARM (52O)	Farmington-185th (BTC-PCC Rock Crk.)	15	20	10	15
53ALLN-BA (53A)	Artic/Allen - (BTC-Allen/Mercer Ind.)	30		20	30
54B	B-H Hwy. (PCBD-BTC) FB	30	30	10	12
55H	Hamilton - (PCBD-Scholls/Hamilton)	60	-	60	-
56S	Scholls Ferry - (PCBD-WashSq.) FB	20	30	-	-
56S	Scholls Ferry - (PCBD - 175th/Roy Rogers)	-	-	20	20
57FFGV	Forest Grove - (BTC-Forest Gr.) FB	15	15	10	10
58CANY (58C)	Canyon Rd. - (PCBD-BTC)	20	30	20	30

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
59WP	Walker/Parkway/Cedar Hills - (Willow Crk. /185th-SunsetTC)	60	-	30	30
61X	BTC-B-H Hwy. - (Marquam Hill/OHSU-BTC)	20	-	20	-
62MURR	Murray Blvd - (WashSq. -Sunset TC)	30	30	15	20
63ZOO	Washington Park (PCBD-Zoo)	60	60	30	30
67J158 (67J)	Jenkins/158th - (BTC-PCC Rock Crk.)	20	40	15	30
68CMH (68C)	Collins Circle - (PCBD-OHSU/VA Hospital) Off-Mall	15	-	15	-
70T13	33rd/12th Ave via 13th	30	30	-	-
70T17	33rd/12th Ave via 17th	30	30	-	-
70T17	Swan Island 12th Ave via 17th	-	-	15	15

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
71P122 (71R)	60th/122nd - (Woodstock/94th-CTC) via Parkrose LRT	15	20	15	20
72K82 (72K)	82nd/Killingsworth - (Swan Is.-CTC) FB	7	12	10	10
73A	122ND	-	-	10	10
74A	162ND	-	-	15	15
75TMTC (75C)	39th/Lombard - (St. Johns-MTC) FB	12	15	10	10
76BVTU	Beaverton/Tualatin - (BTC-Tualatin TC) FB	30	30	10	12
77H	BRDWY/HALSEY Troutdale	15	30	10	15
78B	BEAVERTON/LAKE OSWEGO	30	30	15	20
79CSOR (79C)	CTC/OC - (CTC-Or. City) via Gladstone - South End Loop FB	30	30	15	15

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
80TTRT (80GT)	Kane Rd. - (Gresham TC-Troutdale) via Springwater	60	60	30	30
81T	Troutdale via 257th	60	60	20	30
82T	223rd Gresham	-	-	30	30
84PVL	PV LOOP	45	-	30	-
85SG	Swan Island from Rose Quarter via Interstate/Greeley	30	45	15	20
86O	148th Ave	-	-	15	15
87A	Airport Way 181st	30	60	12	15
88H198 (88H)	198th/Hart - (Willow Crk. /185thTC-BTC)	30	30	15	15

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
89G	S Gresham	-	-	30	30
92XJC (92X)	South Beaverton Express - (Murray Hill-PCBD)	30	-	20	0
93	SHERWOOD PACIFIC OB/INB	-	-	10	20
94XI	SHERWOOD PACIFIC OB	45	45	-	-
94XO	SHERWOOD PACIFIC INB	8	45	-	-
96TCOM (96TC)	Tualatin/I-5 - (PCBD-Tualatin)	20	-	30	40
96TM	TUAL/MOHAWK JEFF/COL	30	-	30	40
97TS	Tualatin Sherwood Rd	-	-	20	30
99PX	McLoughlin Express - (PCBD-OC/CCC)	15	-	15	20

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
SERVICE PROVIDERS OTHER THAN TRIMET					
o2a	SMART-BARBURa	30	60	30	60
o4	SMART/WILSV RD	30	60	30	60
o3	SMART/Canby	60	120	60	120
o5	SMART/95th AVEa	30	-	30	-
o6	SMART/CANYON CREEK	30	-	30	-
oVa	SMART/VILLEBOISa	60	-	60	-
oES	SANDY-ESTACADA SAMa	120	120	120	120
oGR	SANDY-GRESHAM SAMa	30	30	30	30
oMT	SANDY-RHODODEND SAM	120	-	120	-
oMC	MOLALLA/CCC-SCTD	30	60	30	60
oMLC	MOLALLA/CANBY SCTD	30	60	60	60
oCO	CAT-Orange-OREGON CI	60	60	30	60

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
C-TRAN					
BRT					
FPMPcw	Fourth Plain/Mill Plain BRT VCBD - Mill Plain TC interline clockwise	-	-	10	10
FPMPccw	Fourth Plain/Mill Plain BRT VCBD - Mill Plain TC interline counter-clockwise	-	-	10	10
99BRTNE	Hwy 99 BRT to Salmon Creek TC - SCPR > 139th St > 23rd Ave > 134th St > continue on to Highway 99 - revised routing in Vancouver CBD - Northbound Grant >> 8th>> Broadway - Southbound Washington >> 6th >> Columbia	-	-	10	10
EXPRESS BUS					
C101	Vancouver CBD - Portland CBD	-	-	15	30
C105XN	I-5 Express to PCBD with downtown Vancouver service	15	45		
C105XNB	I-5 Express to PCBD with NO downtown Vancouver service (No-Build Bus on Shoulder 25 mph on I-5 from 99th to Columbia River , MPLA Bus on Shoulder 35mph on I-5 from 99th to Victory Boulevard)	-	-	10	-
C134XN	Salmon Creek to PCBD with 99th TC and downtown Vancouver Service	10	-	-	-

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
C157X	BPA to Lloyd Center	30	-	-	-
C164X	Fishers PR to PCBD (return via I-5, SR 14)	10	-	10	30
C177X	Evergreen PR to PCBD (return via I-5, SR 14)	45	-	-	-
C190X	Marquam Hill Express (No-Build Bus on Shoulder 25 mph on I-5 from SR 500 to Columbia River , MPLA Bus on Shoulder 35mph on I-5 from SR 500 to Victory Boulevard)	20	-	10	-
C199X	99th Express to PCBD	15	-	-	-
REGIONAL SERVICE					
C060	Delta Pk LTD	-	-	10	10
C065	Parkrose - Fishers Limited (FLTC / SR14 / I-205 / Parkrose TC / return)	15	30	20	20

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
C067*	Portland Airport - Fishers Limited (FLTC / SR14 / I-205 / PDX / return)			0	30
BUS					
C002	Lincoln/Felida	12	60	45	45
C003A	City Center Kauffman - Columbia	45	45	45	45
C004	Fourth Plain Delta P	15	15	-	-
C007	Battle Ground	45	45	45	45
C09	Felida	60	60	30	30
C019	SALMON CR TO WSUa	30	30	30	30
C025	FRUIT VAL/ST JOHNS	35	35	30	30
C030	Burton	30	30	30	30

Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
C032	Hazel Dell/Evergreen/Andresen	30	30	-	-
C032E	Hazel Dell/Evergreen/Andresen with Waterfront Loop	-	-	45	45
C035	Tech Center	-	-	30	30
C037	Mill Plain	20	20	-	-
C038	Mill PL 192nd Ave	30	30	-	-
C039	Clark Coll/Med Cen	60	60	-	-
C41	Camas Washougal LTD to downtown Vancouver	30	-	120	-
C44	Fourth Plain LTDa - Orchards to Delta Park	35	-	-	-
C47N	Battle Grnd-Yacolt - Delta Park	120	-	-	-

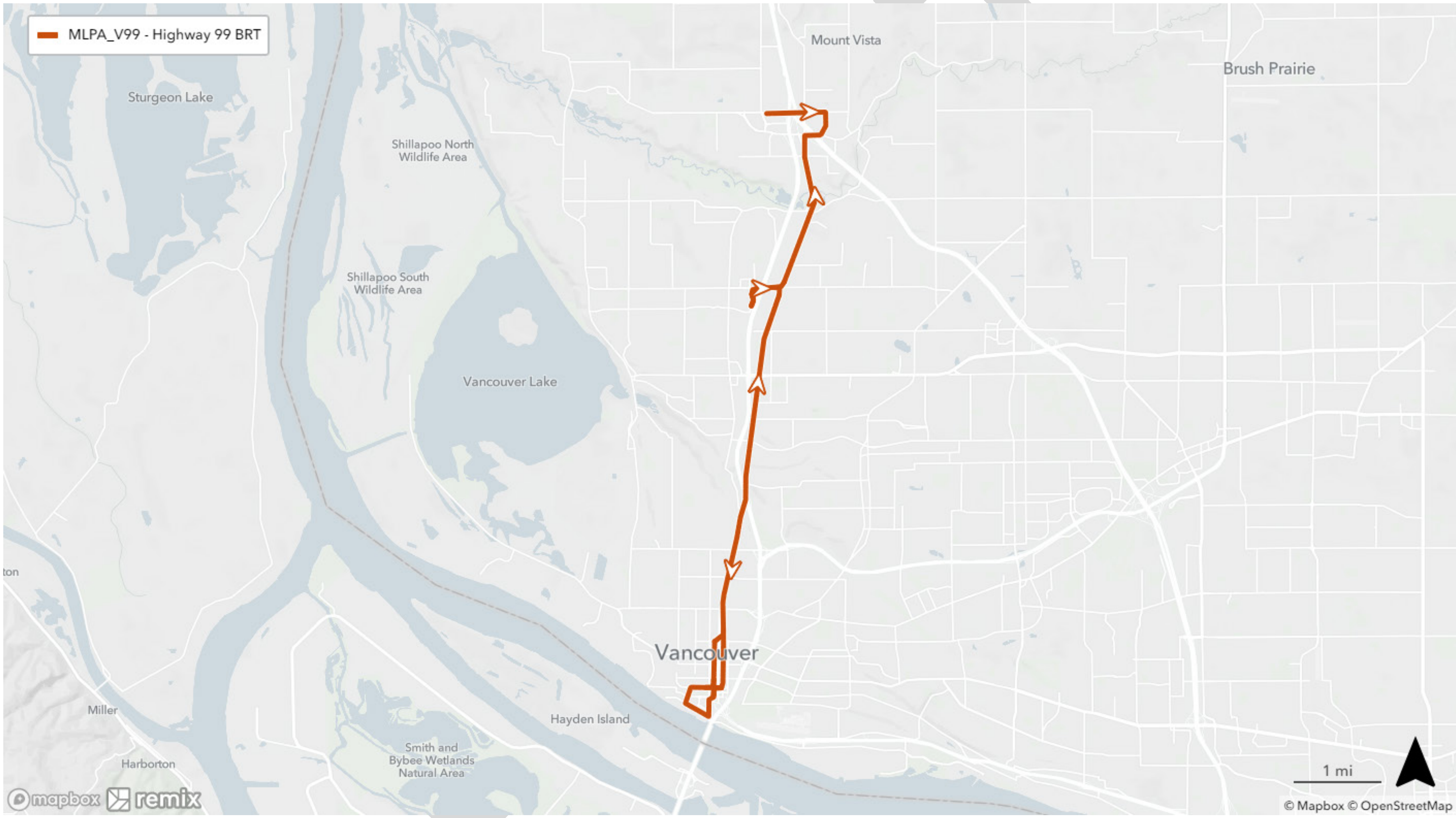
Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway
C47	Battle Grnd-Yacolt to downtown Vancouver	120	-	-	-
C47VM	Battle Ground – Yacolt to Vancouver Mall	-	-	120	120
C48	Van Mall - FL 164th	-	-	-	-
C48B	99th TC – Ridgefield	-	-	60	60
C071	Highway 99	20	20	-	-
C072	Orchards	60	60	60	60
C078	78th Street	60	60	60	60
C080	Van Mall/Fishers	30	30	60	60
C85	FL - 192nd EAST/WEST	-	-	60	60
C092	Camas/Washougal (FLTC / Camas / Washougal)	30	30	60	60

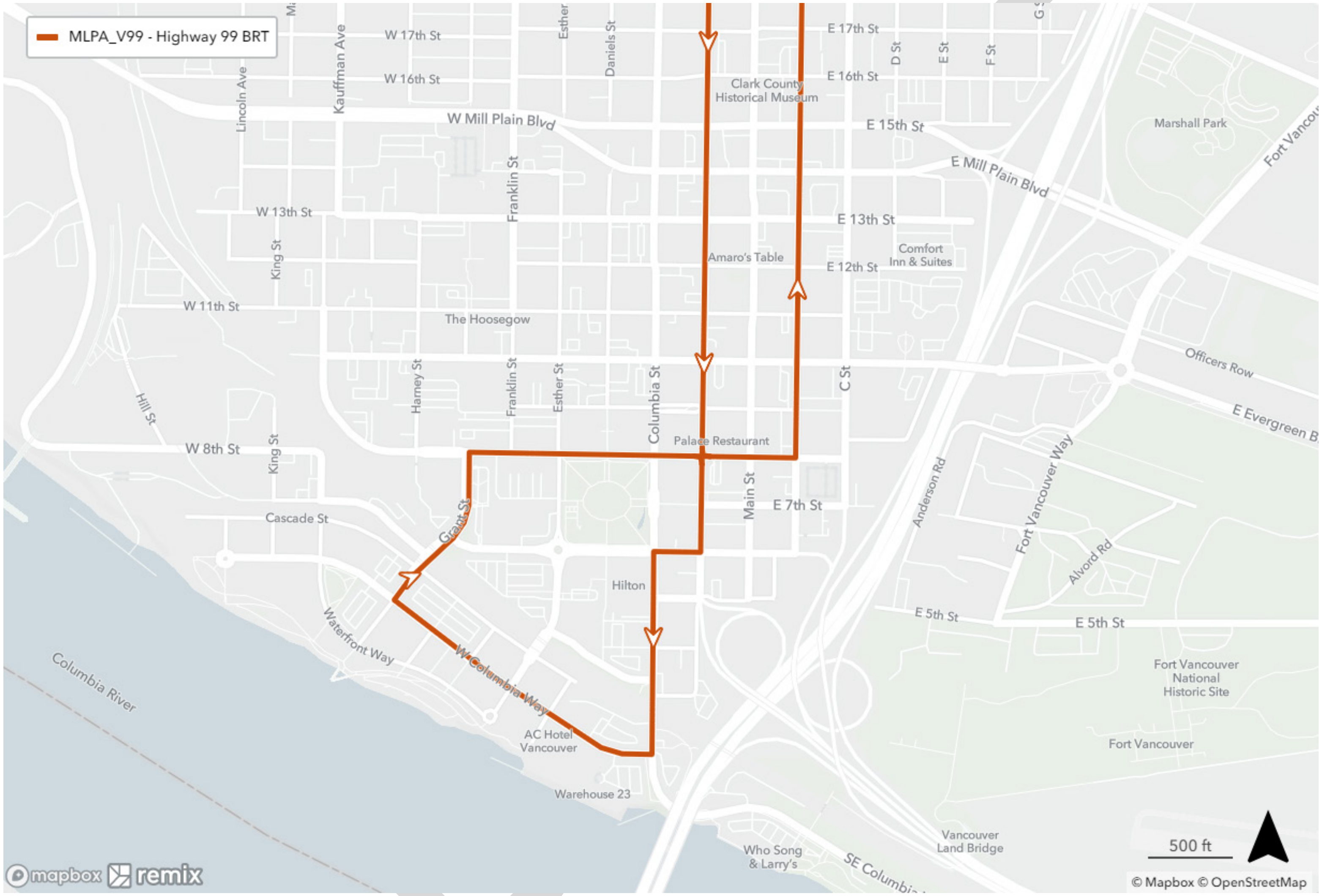
Transit Line	Description	2015 Base		2045 IBR No-Build	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway
C301RQJ	Ridgefield - 99th Street P&R SHRL w/QJ (99PR / Ridgfld)	-	-	-	-
C302LCQ	La Center - 99th PR SHTL w/QJs (99PR / LaCenter)	-	-	90	-

Source: Metro, TriMet, C-TRAN

*Route C67 operates outside of the hours considered in the model, so it does not have a headway listed in this set of assumptions.

ATTACHMENT E. TRANSIT ROUTE CODING MAPS




MLPA_V99 - Highway 99 BRT
W 17th St
W 16th St
W Mill Plain Blvd
W 13th St
W 11th St
W 8th St
Cascade St
E 17th St
E 16th St
E 15th St
E Mill Plain Blvd
E 13th St
E 12th St
E 7th St
E 5th St
Officers Row
Columbia St
Main St
C St
Franklin St
Esther St
Harney St
King St
Kauffman Ave
Lincoln Ave
Daniels St
Hill St
Grant St
Waterfront Way
W Columbia Way
Anderson Rd
Fort Vancouver Way
Alvord Rd
Columbia River
Clark County Historical Museum
Amaro's Table
Comfort Inn & Suites
The Hoosegow
Palace Restaurant
Hilton
AC Hotel Vancouver
Warehouse 23
Marshall Park
Fort Vancouver National Historic Site
Fort Vancouver
Vancouver Land Bridge
Who Song & Larry's
500 ft
© Mapbox © OpenStreetMap

MEMORANDUM

Date: November 15, 2023

To: Aaron Breakstone and Peter Bosa, Metro
Mark Harrington, RTC

From: Interstate Bridge Replacement Program Modeling Team

Subject: DRAFT 2045 Regional Travel Demand Model Assumptions for SEIS Interstate Bridge Replacement Program Modified Locally Preferred Alternative

OVERVIEW

This memorandum describes, for travel demand modeling purposes only, the modeling assumptions to be included in the Supplemental Draft Environmental Impact Statement run of the Regional Travel Demand Model for the Interstate Bridge Replacement program (previously Columbia River Crossing) Modified Locally Preferred Alternative (LPA) Option that was approved by partners in June/July 2022. This Modified LPA Option, described in additional detail below, replaces the current Interstate 5 (I-5) bridges with new structures with three through-lanes in each direction and one auxiliary lane; reconstructs interchanges; establishes tolls priced to manage travel demand as well as provide financing of the project construction, operation, and maintenance; extends light rail transit north from the existing MAX Yellow Line alignment to a terminus at Evergreen Blvd. along I-5 in Vancouver; and provides bicycle and pedestrian investments.

The starting point for this model run is the 2018 Regional Transportation Plan (2018 RTP) Financially Constrained system jointly developed and adopted by both Metro and the Southwest Washington Regional Transportation Council (RTC) with updates to land use to extend the forecasts to the year 2045. These metropolitan planning organizations have coordinated this process in a manner consistent with underlying comprehensive plans and information provided by their jurisdictions as part of the 2018 RTP process. Additional details on the process to arrive at land use allocation for the future year 2045 are provided in the Travel Demand Modeling Methods Report.

This memorandum includes five attachments:

1. A – 2018 RTP Project List – Metro
2. B – 2019 RTP Project List – Regional Transportation Council
3. C – Ramp Meter Rates
4. D – Transit Line Listing
5. E – Bus Rapid Transit Route Coding In Modified LPA

HIGHWAY NETWORK DESCRIPTION

The background highway network for this model run is the 2018 RTP Financially Constrained system adopted in December 2018 by the Metro Council and by the RTC Board of Directors in March 2019. The 2018 RTP includes transportation projects from state and local plans that are needed to meet transportation needs over the next 25 years and that are financially constrained, meaning they have funding that is reasonably expected over the funding period to complete the projects. Lists of Metro RTP projects are included as Attachment A, and RTC projects are included as Attachment B. The two metropolitan planning organizations coordinate on project planning for the bi-state region and use a single coordinated network and input assumptions for their respective plans.

Figure 1 below shows the project area with LPA improvements in the main project area.

Figure 1. IBR Locally Preferred Alternative Components

River Crossings

Columbia River

The Modified LPA includes construction of new bridges over the main channel of the Columbia River, as well as new structures across the North Portland Harbor between Marine Drive and Hayden Island. The new bridges across the Columbia River are separate northbound and southbound structures, each with three through-lanes and one auxiliary (add/drop) lane.

North Portland Harbor Bridges

The existing highway structures over North Portland Harbor would be replaced. Six new, parallel structures would be built across the waterway, one on the east side of the existing North Portland Harbor bridges and five on the west side or overlapping with the existing bridge. Two of the new structures would carry I-5 northbound and southbound lanes. Two of the new structures would carry on- and off-ramps to mainline I-5. The westernmost structure would carry the light rail transit guideway and the easternmost structure would include a two-lane arterial bridge for local traffic between the Oregon mainland via Vancouver Ave and Hayden Island. This structure would also include a shared use path for pedestrians and bicyclists.

Interchange Improvements

The Modified LPA includes improvements to seven interchanges on I-5 between Victory Boulevard in Portland and SR 500 in Vancouver. In addition to interchange improvements, some of the interchange improvements result in reconfiguration of adjacent local streets, new street extensions, added travel lanes, and new and extended turn pockets at key intersections.

Victory Boulevard Interchange

The southern extent of the I-5 project improvements would be two ramps associated with the Victory Boulevard interchange in Portland. The Marine Drive to I-5 southbound on-ramp would be braided over the I-5 southbound to the Victory Boulevard/Denver Avenue off-ramp. The other ramp improvement would lengthen the merge distance for northbound traffic entering I-5 from Denver Avenue.

Marine Drive Interchange

All movements within this interchange would be reconfigured to reduce congestion for motorists entering and exiting I-5 at this location. The new interchange configuration would be a single-point interchange. With this configuration, all four legs of the interchange would converge at a point on Marine Drive, over the I-5 mainline.

Motorists from Marine Drive eastbound would access I-5 southbound at a yield-controlled intersection. Motorists traveling on Martin Luther King Jr. Boulevard westbound to I-5 northbound would access I-5 without stopping at the intersection, except if there is a call to the pedestrian signal crossing of the ramp entrance.

The new interchange configuration would change the westbound Marine Drive and westbound Vancouver Way connections to Martin Luther King Jr. Boulevard and to northbound I-5. These two streets would access westbound Martin Luther King Jr. Boulevard farther east. Martin Luther King Jr. Boulevard would have a new direct connection to I-5 northbound.

In the new configuration, the connections from Vancouver Way and Marine Drive would be served by improving the existing connection to Martin Luther King Jr. Boulevard east of the interchange. The improvements to this connection would allow traffic to turn right from Vancouver Way and accelerate onto Martin Luther King Jr. Boulevard. On the south side of Martin Luther King Jr. Boulevard, the existing loop connection would be replaced with a new connection farther east.

New shared use path connections throughout the interchange area would provide access between the Bridgeton neighborhood, Hayden Island, and the Expo Center light rail station, in addition to providing connections to the existing portions of the 40-Mile Loop trail.

Hayden Island Interchange

All movements for this interchange would be reconfigured. A half diamond interchange would be built on Hayden Island with a northbound I-5 entrance ramp from Jantzen Drive and southbound I-5 exit ramp to Jantzen Drive. Both ramps would be parallel to I-5 mainline, lengthening the ramps and improving merging speeds.

The southbound I-5 entrance ramp and northbound I-5 exit ramps would not be included on Hayden Island. Instead, ramps for those movements would be connected to the new local street that crosses under I-5 just north of Marine Drive. Vehicles traveling northbound on I-5 wanting to access Hayden Island would exit with traffic going to the Marine Drive interchange, cross under Marine Drive to the new local street, and use the arterial bridge to cross North Portland Harbor. Vehicles on Hayden Island looking to enter I-5 southbound would use the arterial bridge to cross North Portland Harbor, cross under I-5 using the new local street, cross under Marine Drive, merge with the Marine Drive southbound entrance ramp, and enter I-5 southbound at the Marine Drive interchange.

Improvements to Jantzen Drive and Hayden Island Drive would include additional left-turn and right-turn lanes, and pedestrian and bicycle facilities. A new local road, Tomahawk Island Drive, would travel east-west through the middle of Hayden Island and under the I-5 interchange, improving connectivity across I-5 on the island. Additionally, a new shared use path would be provided along the arterial bridge on the east side of the Hayden Island interchange. The shared use path would continue adjacent to I-5 across Hayden Island and connect to the shared use path on the Columbia River bridge.

SR 14 Interchange

The function of this interchange would remain largely the same. Direct connections between I-5 and SR 14 would be rebuilt. Access to and from downtown Vancouver would be provided as it is today, but the connection points would be relocated. There are two options for the interchange configuration, as described below. For the purposes of modeling, Option A will be used.

Option A: Downtown Vancouver I-5 access to and from the south would be at C Street, while downtown connections to and from SR 14 would be made by way of Columbia Street at 3rd Street.

Option B: Downtown Vancouver I-5 access to and from the south would be through the Mill Plain interchange, rather than C Street. There would be no east side loop ramp from I-5 northbound to C Street and no directional ramp on the west side of I-5 from C Street to I-5 southbound.
The multi-use bicycle and pedestrian path on the northbound (eastern) I-5 Columbia River bridge would exit the structure at the SR 14 interchange, loop down on the east side of I-5, and then cross back to the west side of I-5 to connect into the existing shared use path on Columbia Street and into Columbia Way.

Mill Plain Interchange

This interchange would be reconstructed as a tight diamond configuration but would otherwise remain similar in function to the existing interchange. The intersections would be sized to accommodate the high, wide, and heavy freight vehicles that travel between the Port of Vancouver and I-5. Northbound traffic from I-5 accesses the Mill Plain ramp via a collector-distributor lane that includes the northbound SR 14 to I-5 movement and the northbound I-5 to Fourth Plain off-ramp movement. Southbound Mill Plain Boulevard accesses southbound I-5 via a collector-distributor lane that includes the southbound I-5 to SR 14 movement.

This interchange would also receive several improvements for bicyclists and pedestrians. These include bike lanes and sidewalks, and clear delineation, and signing.

Fourth Plain Interchange

The improvements to this interchange would be designed to improve vehicle safety and to better accommodate freight mobility. Northbound I-5 traffic exiting to Fourth Plain would continue to use the off-ramp just north of the SR 14 interchange. The southbound I-5 exit to Fourth Plain would be braided with the SR 500 connection to I-5, which would eliminate the non-standard weave between the SR 500 connection and the off-ramp to Fourth Plain as well as the westbound SR 500 to Fourth Plain Boulevard connection. Additionally, several improvements would be made to provide better bicycle and pedestrian mobility and accessibility, including bike lanes, neighborhood connections, and a tie into the planned City of Vancouver road diet and two-way cycle track on Fourth Plain.

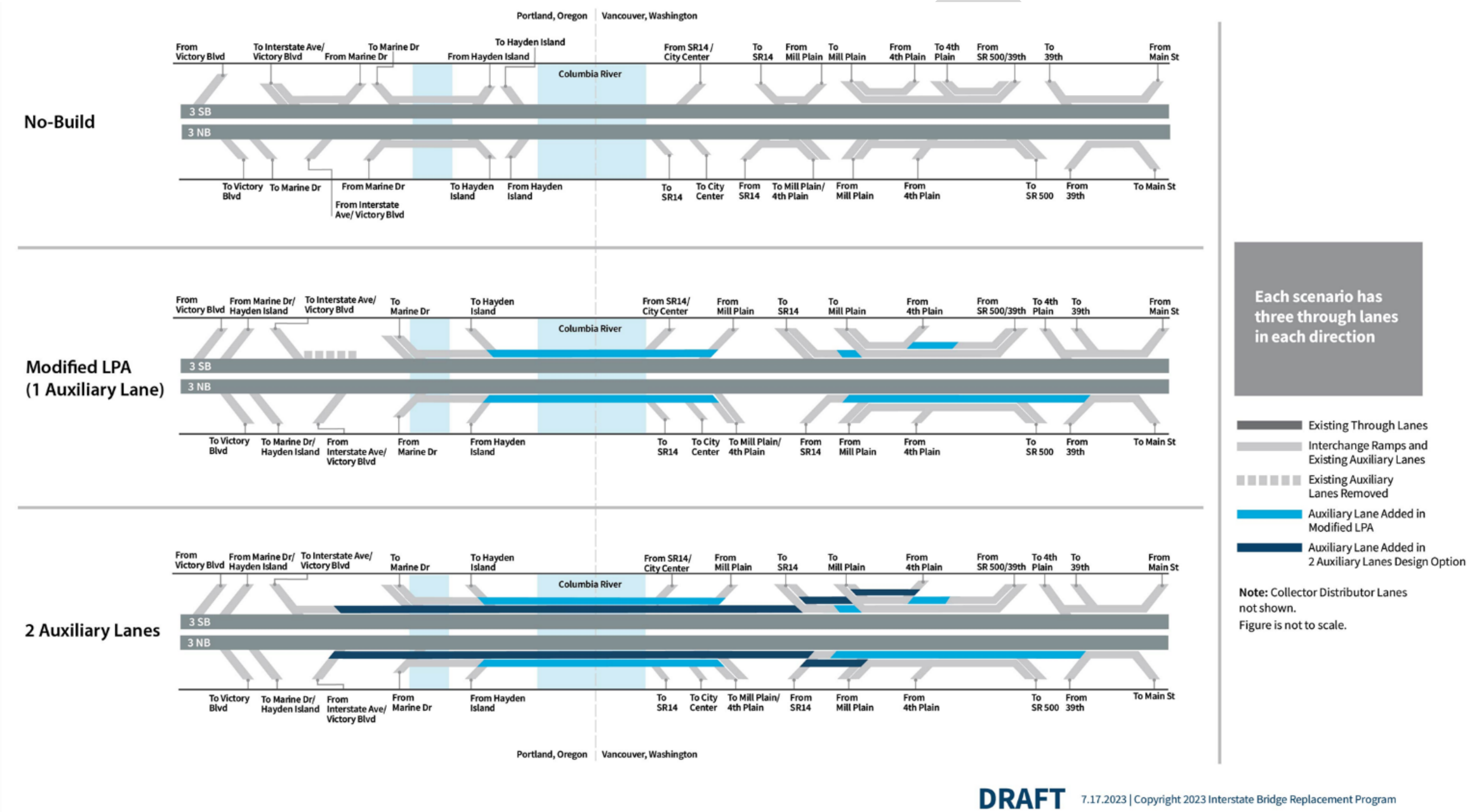
SR 500 Interchange

Minor improvements would be made to the SR 500 interchange, but the IBR project would primarily connect to existing ramps. The exit ramp from I-5 southbound to 39th Street would be reconstructed to establish the beginning of the braided ramps to Fourth Plain and restore the loop ramp to 39th Street. Reconstructed ramps would tie in to existing I-5 northbound to SR500 eastbound and SR500 westbound to I-5 northbound. The existing bridge structures for 39th Street over I-5 and SR500 westbound to I-5 southbound would be retained.

Add/Drop Lanes

In addition to interchange improvements, a series of auxiliary lanes are added and then dropped at locations throughout the corridor. These auxiliary lanes for the Modified LPA with 1 and 2 auxiliary lanes shown in Figure 2 which also includes the No-Build Alternative for comparison.

Figure 2. Add Drop Lanes for No-Build and Modified Locally Preferred Alternative 1 and 2 Auxiliary Lanes



Ramp Meters

Ramp meter rates have been provided by both the Oregon Department of Transportation (ODOT) and the Washington State Department of Transportation (WSDOT) for all ramps in the region that are to include rates in the AM and PM peak time periods. These meters operate generally in the peak period and peak direction. While both ODOT and WSDOT utilize real time data on freeway mainline lanes and ramps to adjust meter rates depending on the traffic flow during hours they are in operation, the regional model uses an average flow per hour calculation that has been provided by both agencies. This average flow per hour reflects a reasonable flow of traffic through each ramp meter based on the configuration of the ramp and the number of vehicles that can be accommodated at the ramp given average traffic conditions by hour. Attachment C provides a list of on-ramp metering rates to be coded along I-5 for this model run. Meter rates for ramps outside of this portion of the regional freeway system have been provided to Metro and RTC separately. Note that there are some differences in ramp meter rates between the No-Build Alternative and the Modified LPA as a result of changes in the I-5 mainline that occur under the Modified LPA.

Tolls

Tolling is included for cars and trucks that use the I-5 river crossing. Toll rates vary by time of day with higher rates during peak periods and lower rates during off-peak periods. Medium and heavy trucks are assigned a higher toll than passenger vehicles, 2 times and 4 times the rate respectively. The toll rates for the Modified LPA are provided below in Table 1. Tolls are expressed in 2010 dollars for use in the model. Additional details on the process to arrive at toll rates for the future year 2045 Modified LPA are provided in the Travel Demand Modeling Methods Report.

Table 1. I-5 Bridge Toll Assumptions and Values of Time for Modified LPA

		IBR SEIS				
Vehicle Class	Income Segmentation	Peak VOT ($/hour)	Off-Peak-VOT ($/hour)	Shoulder/ Transition Hour	Peak Toll Rate (2010$)	Off-Peak Toll Rate (2010$)
Single-Occupancy Vehicle (SOV) Auto	Low Income (<$25K)	$8	$6	$7	$2.41	$1.16
	Medium Income ($25K - $100K)	$17	$14	$16		
	High Income (>$100K)	$22	$17	$20		
High-Occupancy Vehicle (HOV) Auto	Low Income (<$25K)	$15	$10	$13		

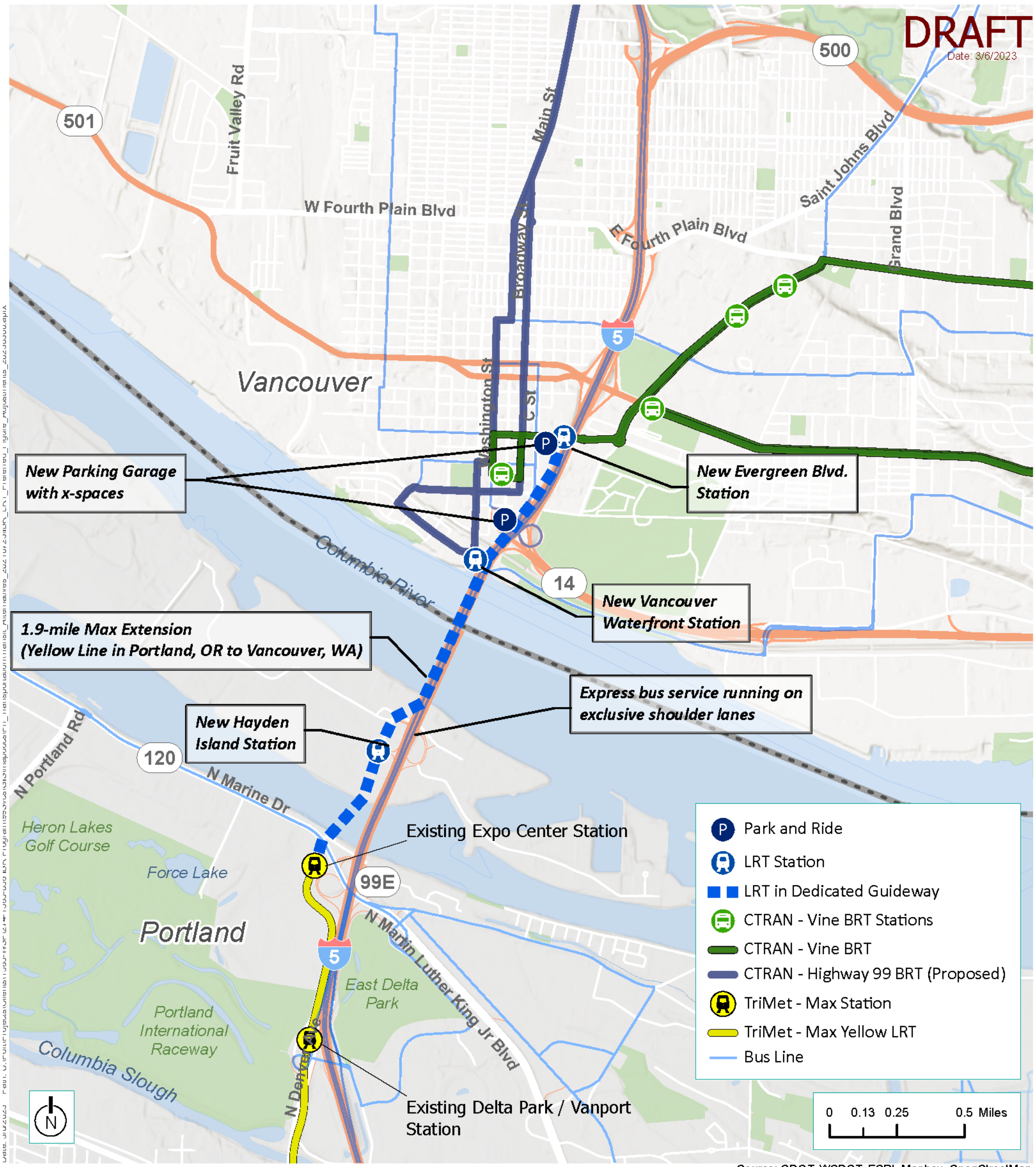
		IBR SEIS				
Vehicle Class	Income Segmentation	Peak VOT ($/hour)	Off-Peak-VOT ($/hour)	Shoulder/ Transition Hour	Peak Toll Rate (2010$)	Off-Peak Toll Rate (2010$)
	Medium Income ($25K - $100K)	$30	$20	$27		
	High Income (>$100K)	$38	$25	$34		
Medium Trucks	Not Applicable	$39	$39	$39	$4.82	$2.32
Heavy Trucks	Not Applicable	$61	$61	$61	$9.64	$4.64

TRANSIT

Similar to the highway network, the transit network for this model run is based on the 2018 RTP Financially Constrained system which includes assumed-for increases in background regional transit service by both TriMet and C-TRAN as adopted in the 2018 RTP. This includes a two-way light rail alignment for northbound and southbound trains constructed to extend from the existing Expo Center MAX station over North Portland Harbor to Hayden Island. Immediately north of the Expo Center, the alignment would curve eastward toward I-5, pass beneath Marine Drive, then rise over the existing levee onto a light rail bridge to cross North Portland Harbor. The two-way guideway over Hayden Island would be elevated at approximately the height of the rebuilt mainline of I-5, as would a new station immediately west of I-5. The alignment would extend northward on Hayden Island along the western edge of I-5, until it transitions into the hollow support structure of the new downstream (western) bridge over the Columbia River.

After crossing the Columbia River, the light rail alignment would exit the highway bridge and be supported by its own smaller structure along the west side of the I-5 mainline. The light rail guideway would cross over the Burlington Northern Santa Fe (BNSF) Railway. An elevated station near the Vancouver waterfront would be situated near the crossing of the BNSF Railway between Columbia Way and 3^{rd} Street. The elevated light rail guideway would continue north with crossings over SR14 interchange ramps and the C St/6^{th} St on-ramp, and then straddle the I-5 southbound collector-distributor roadway. The guideway would continue to the Evergreen Station, which would sit at-grade atop the Evergreen Lid over I-5 just south of Evergreen Boulevard. The Evergreen station would be the terminus of the IBR LRT extension. This alignment is shown in Figure 3. The light rail will operate at 6.7 minute peak and 15 minute off-peak frequencies between downtown Portland and the Evergreen Station in Vancouver.

Figure 3. Modified Locally Preferred Alternative Transit Alignment, Station and Park-and-Ride Locations



Source: ODOT, WSDOT, ESRI, Mapbox, OpenStreetMap

Modified LPA Light Rail

The light rail extension includes new stations as listed below in Table 2. Note that for the Waterfront Park and Ride the location is listed as to be determined. There are a couple of options for locations adjacent or near the station that are still under consideration but for modeling purposes it will be located in the same transportation analysis zone (TAZ) as the station.

Table 2. Light Rail Stations in Modified LPA

Station Location	Direction	Access	Park & Ride
Expo Center (Existing)	Northbound and southbound	Drive, walk, bike, bus transfer	Existing 100-space lot
Hayden Island (New)	Northbound and southbound	Walk, bike	None
Waterfront (New)	Northbound and southbound	Drive, walk, bike, bus transfer	Location near station TBD (570 spaces)
Evergreen Boulevard (New)	Northbound and southbound	Drive, walk, bike, bus transfer	Evergreen (700 spaces)

Light Rail Travel Times

Travel times, speeds, and segment lengths for the LRT extension to Evergreen Boulevard near I-5 in the Modified LPA are shown below in Table 3. These times were developed using LTK run-time simulation software. Note that dwell times listed in the table are for the starting station in the pair corresponding with how they are coded into the model. Dwell times assumed for the LRT extension are consistent with those seen in the rest of the LRT system outside of the Portland CBD which includes slightly higher dwell times to account for operations on the transit mall. LRT travel times between the Expo Center and Milwaukie are the same as those included in the No-Build which did not change from the 2018 RTP.

Table 3. Modified LPA Light Rail Travel Times

Modified LPA LRT– Extension I-5 Alignment to Evergreen Boulevard	**DWELL TIME** (SEC)	**CALC. TRIP TIME W/O DWELL** (MIN)	**CALC. TRIP TIME W/ DWELL** (MIN)	**CALC. TOTAL TRIP TIME** (MIN)	**ADJUSTED* TRIP TIME W/O DWELL** (MIN)	**ADJUSTED* TRIP TIME W/ DWELL** (MIN)	**ADJUSTED* TOTAL TRIP TIME** (MIN)	**SEGMENT LENGTH** (MI)	**TOTAL LENGTH** (MI)	**AVERAGE SPEED W/O DWELL** (MPH)	**AVERAGE SPEED W/ DWELL** (MPH)	**MAX SPEED IN SEGMENT** (MPH)	**ADJUSTED* AVERAGE SPEED W/O DWELL** (MPH)
Expo Station -- Hayden Island Station	0	1.12	1.12	1.12	1.18	1.18	1.18	0.45	0.45	24.11	24.10	43.80	22.96
Hayden Island Station – Columbia Station	20	1.51	1.84	2.96	1.59	1.92	3.10	.89	1.34	35.36	28.97	54.30	33.68
Columbia Street Station – Evergreen Blvd Station	20	1.04	1.37	4.34	1.09	1.43	4.52	.53	1.87	30.58	23.16	48.20	29.12
Totals in minutes:	.67	3.67	4.34		3.85	4.52		1.87					29.1
Average adjusted speed with dwells							**24.8**	mph					

Modified LPA Bus Network

The bus network for the LPA Option includes bus rapid transit (BRT) routes, local routes, and express service from Clark County extending into Portland. The network is based on the existing transit system with enhancements approved and adopted in the 2018 RTP along with a few adjustments from C-TRAN as noted below.

A full listing of the transit lines and frequencies is included as Attachment D. Highlights of service in and through the corridor are described below.

The C-TRAN network in the 2018 RTP includes an expansion of its BRT system to include both Mill Plain BRT and Highway (Hwy) 99 BRT in addition to the Fourth Plain BRT that is currently in operation.

C-TRAN BRT routes are modified compared to what was assumed in the 2018 RTP as follows:

- Hwy 99 BRT with service between downtown Vancouver and the 99th Street Transit Center (TC) in the 2018 RTP extends north from the 99th Street TC to provide service to the Salmon Creek Park & Ride. This service operates along Hwy 99 to NE 134th Street, continues on NE 23rd Avenue to NE 139th Street, and enters the Salmon Creek Park & Ride from NE 139th Street. In downtown Vancouver, Hwy 99 BRT operates southbound on Washington Street and northbound on Broadway Street.
- Mill Plain and Fourth Plain BRT are modified to operate as an interlined route between Turtle Place in downtown and a new Mill Plain TC located at Mill Plain near the Columbia Tech Center. These interlined routes operate with one providing clockwise service and one providing counterclockwise service. In the Modified LPA the coding in and out of downtown is revised to provide service that connects with the new Evergreen Station. This is done through a routing change that has the route operate along Fort Vancouver Way and Evergreen Boulevard rather than along McLoughlin Boulevard for service in and out of downtown. The route will include a new station adjacent to the Evergreen LRT station on Evergreen Boulevard and then proceed in and out of downtown with service along Washington and Broadway to Turtle Place. Stops at Evergreen Boulevard/Broadway Boulevard and Evergreen Boulevard/C Street will no longer be served with the inclusion of new stops at Evergreen Station. The segment between Vancouver Mall and the Mill Plain TC operates along NE Fourth Plain Boulevard to NE 162nd Avenue, and then operates north/south along NE 162nd Avenue between NE Fourth Plain Boulevard and SE Mill Plain Boulevard.

The Hwy 99 BRT route connects with the Modified LPA at the Waterfront Station and the Mill Plain/Fourth Plain BRT connects with the Modified LPA at Evergreen Station.

Maps of the BRT routing for both Hwy 99 and Mill Plain/Fourth Plain are provided in Attachment E.

The extension of the light rail line into Vancouver is supported by bus connections at or near stations along the alignment. Table 4 below shows route connections that are assumed at or near each of these stations.

Table 4. Local Bus Service at LPA Stations

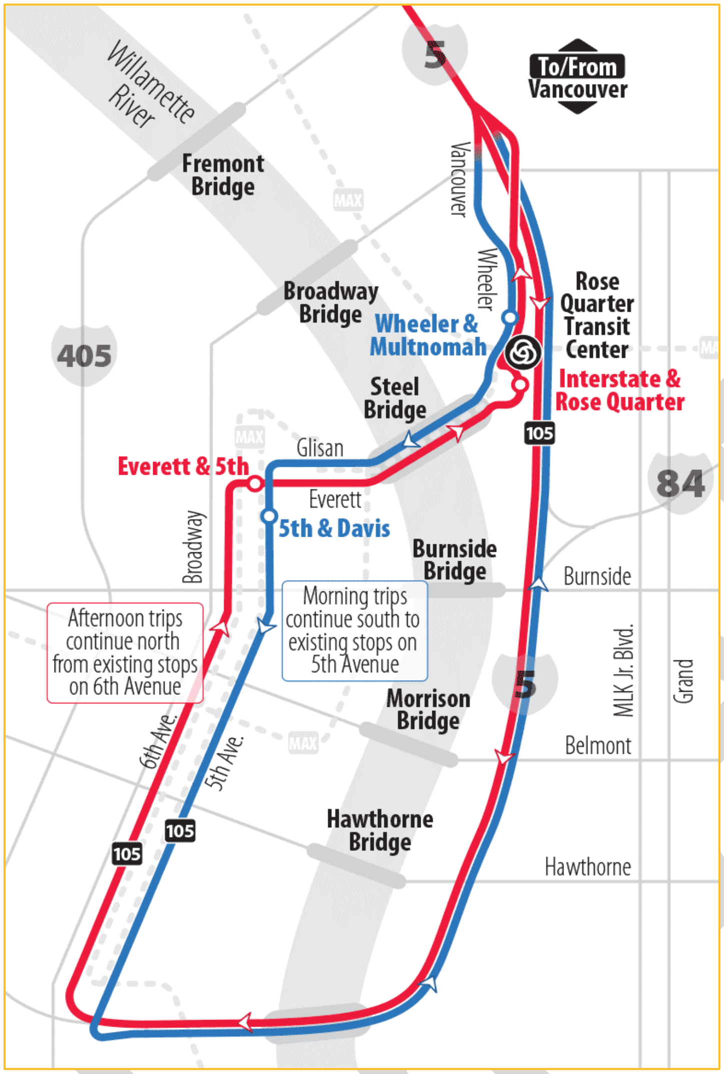
Station Location	Bus Connections	Access	Park & Ride
Expo Center	TM 6, TM 11	Drive, walk, bike, bus	100 spaces
Hayden Island		Walk, bike	None
Waterfront/Columbia Street	Hwy 99 BRT, CT32	Drive, walk, bike, bus transfer	Location near station TBD (570 spaces)
Evergreen Boulevard	CT2, CT3, CT25, CT30, CT32, CT41, CT47, CT101, HWY99 BRT, Mill Plain/Fourth Plain BRT	Drive, walk, bike, bus transfer	Evergreen (700 spaces)

C-TRAN express bus service operates between Clark County and Portland on four routes. These are listed below in Table 5, which includes information on terminus locations, frequencies, and which bridge the route crosses during operation. Route 101 and Route 164 both provide all day service. Route 105 in the 2018 RTP was assumed to truncate in downtown Vancouver, but it is restored to provide service between the Salmon Creek Park & Ride, the 99th Street Transit Center/Park & Ride and the Portland central business district (CBD). Route 105 does not provide service to downtown Vancouver. Several express routes assumed in the 2018 RTP with service to downtown Portland (Route 118, Route 134, Route 157, and Route 199) are removed in the Modified LPA network. New express service between downtown Vancouver and downtown Portland is provided on Route 101. In downtown Vancouver in the Modified LPA, Route 101 operates northbound on C Street and southbound on Washington between 8th Street on the south end and 15th Street on the north end. In the Modified LPA the Washington St on-ramp to I-5 south is no longer in place and access to I-5 south happens via a new ramp from C Street. The Route 101 will use this ramp for access to I-5 south. The southbound route will turn from Washington St. onto 8th St. and then south on C St. to access the ramp. Figure 4 below shows the routing for the Route 101 and Route 105 in and out of downtown Portland.

Table 5. Express Bus Service in Modified LPA

Route	Service Extents	Frequency	Bridge Used
101	Downtown Vancouver - Portland CBD	6 min peak 30 min off-peak	I-5 southbound I-5 northbound
105	Salmon Creek Park & Ride – 99th Street TC – Portland CBD	5 min peak only	I-5 southbound I-5 northbound
164	Fisher's Landing Park & Ride – Portland CBD	10 min peak 30 min off-peak	I-205 southbound I-5 northbound
190	Andresen Park & Ride – Marquam Hill	10 min peak only	I-5 southbound I-5 northbound

Figure 4. Route 101 and Route 105 Operations In and Out of Downtown Portland



With the Modified LPA three C-TRAN local bus routes are modified to provide connections to the new Evergreen Station. Routes 2, 25 and 30 will all be routed to C St. and 9th just to the west of the station. Detailed maps of the routing for these buses are shown in Figure 5, Figure 6 and Figure 7 below.

Figure 5. Route 2 Routing to Evergreen Station in Modified LPA

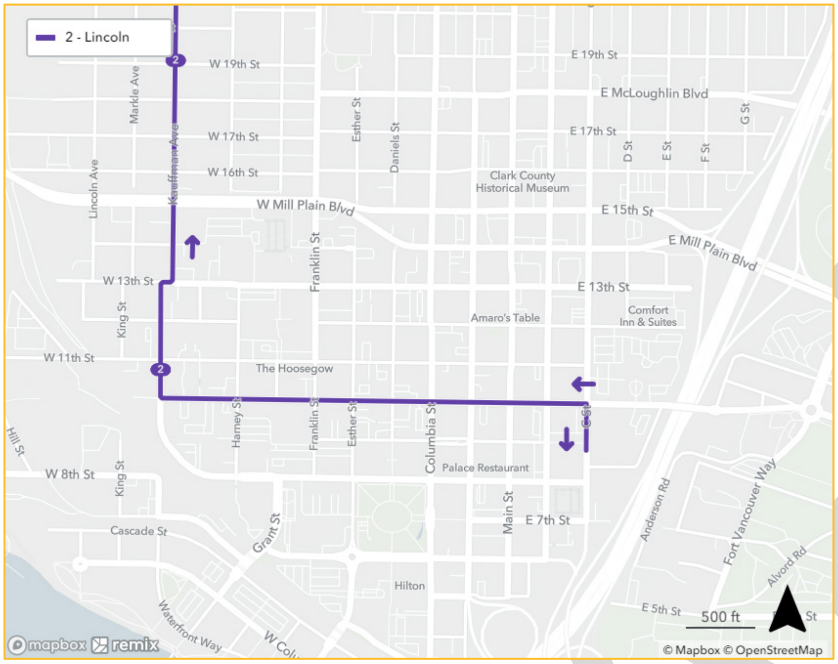


Figure 6. Route 25 Routing to Evergreen Station in Modified LPA

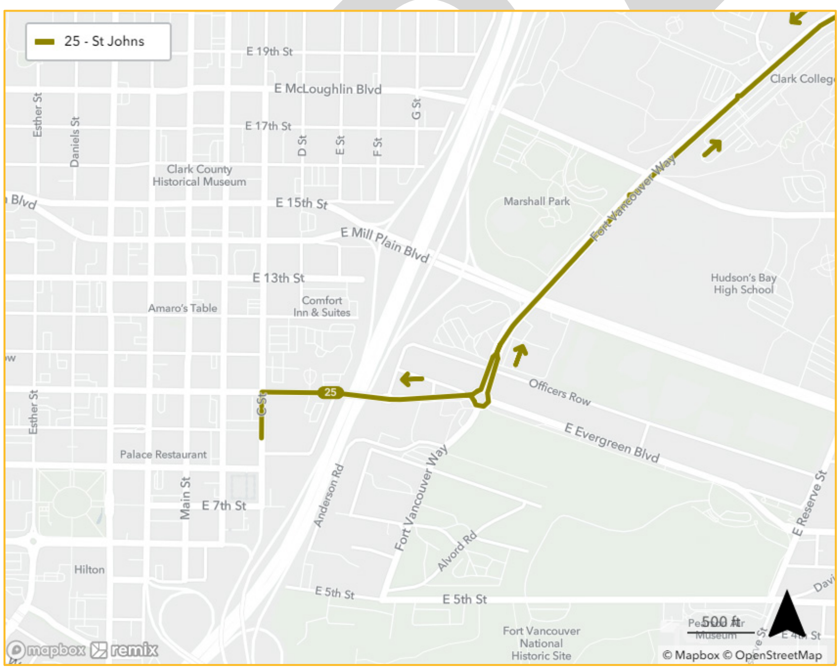
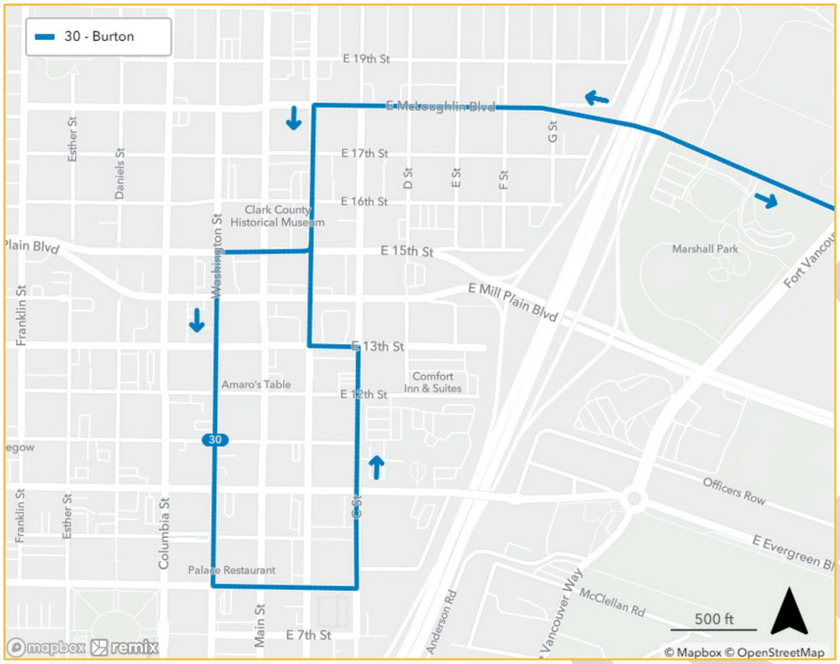
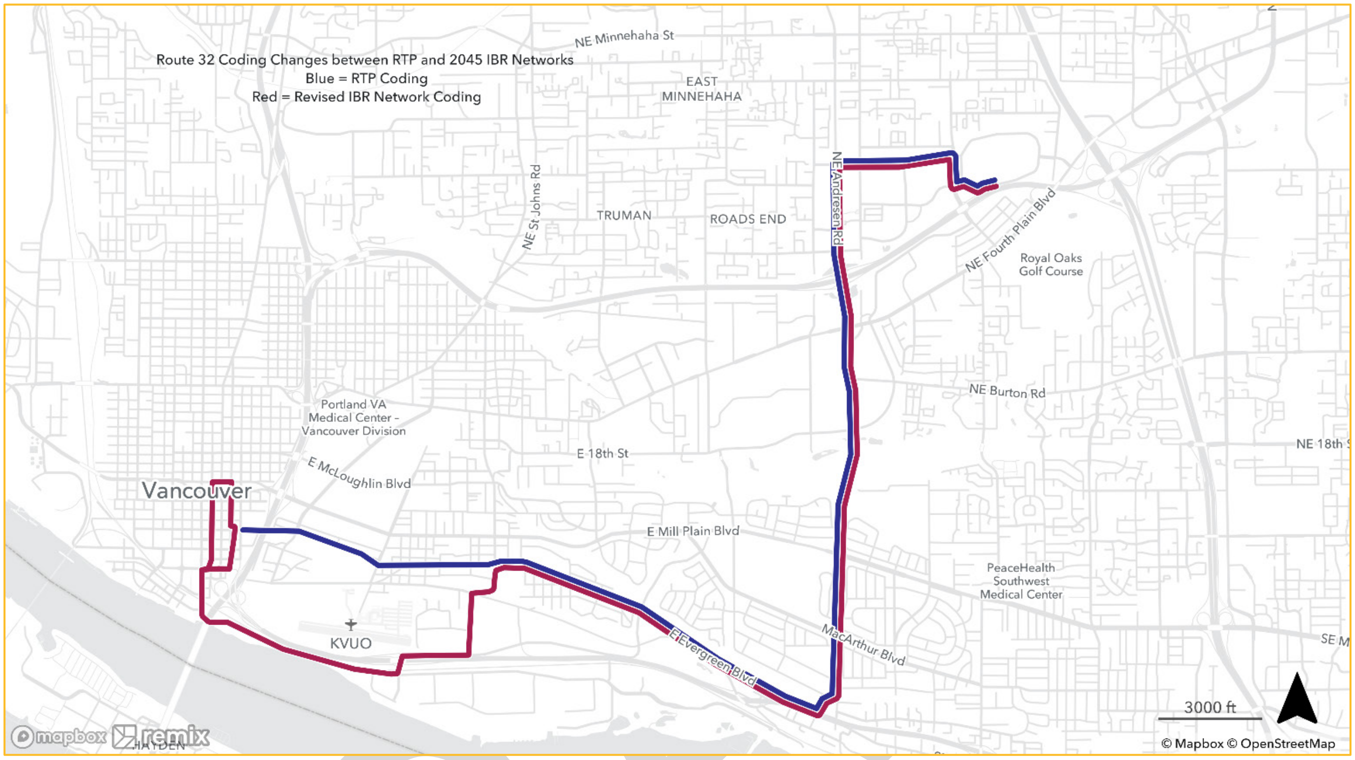


Figure 7. Route 30 Routing to Evergreen Station in Modified LPA



C-TRAN local service also includes on additional background bus routing change from the underlying assumptions in the 2018 RTP. This change is to the Route 32 which in the 2018 RTP operates from Vancouver Mall Transit Center south on Andresen Boulevard to Evergreen Boulevard and into downtown Vancouver. The adjustment to this route has it no longer providing service all the way into downtown along Evergreen Boulevard but rather extends south on Andresen Boulevard to Evergreen Boulevard where it heads west to Grand Avenue and then proceeds south to Columbia House Boulevard, travels under SR-14 at Columbia Way where it then proceeds along Columbia Way into downtown providing northbound service along Broadway Street and southbound service along Washington Street. The routing change for this is included below in Figure 8.

Figure 8. Route 32 Coding Adjustments for 2045 IBR Networks



TriMet service includes one change in addition to the extension of LRT into Vancouver in the Modified LPA compared to what is in the 2018 RTP network. With the extension of LRT providing service to Hayden Island, the Route 6 Martin Luther King Jr. Boulevard route is truncated at the Expo Center and does not cross over to Hayden Island.

PARK AND RIDE FACILITIES

The C-TRAN network includes additional capacity for park and ride in the future-year condition at two new park and ride lots that are associated with the Modified LPA. Table 6 below shows 2019 existing/2045 No-Build and 2045 Modified LPA park and ride lot locations and capacities for lots in the program area on both the Oregon and Washington side of the river.

Table 6. Park and Ride Lots and Capacities

2019 Existing/2045 No-Build			2045 Modified LPA		
Lot Name	**TAZ***	**Spaces**	**Lot Name**	**TAZ***	**Spaces**
Waterfront Station/SR-14	N/A	N/A	Waterfront Station/SR-14	1484	570
Evergreen Station/I-5	N/A	N/A	Evergreen Station/I-5	1499	700
Expo Center	134	100	Expo Center	134	100
Delta Park	135	300	Delta Park	135	300

*TAZ = Transportation Analysis Zone

ATTACHMENT A. RTP PROJECT LIST METRO

Due to the size of the file, please find the file at the following link:

https://www.oregonmetro.gov/sites/default/files/2019/04/02/2018-RTP-Appendices-A-and-B-Constrained-Project-List.pdf

ATTACHMENT B. RTP PROJECT LIST RTC

Due to the size of the file, please find the file at the following link:

https://www.rtc.wa.gov/reports/rtp/Rtp2019Clark.pdf (pages 166 - 180)

ATTACHMENT C. RAMP METER RATES

Differences between No-Build and Modified LPA are in shaded cells in the table.

I-5 Southbound	AM Peak No-Build	AM Peak MLPA	PM Peak
Pioneer St. ON	1500	1500	
219th St ON	1500	1500	
179th St ON	1500	1500	
139th St ON	1000	1000	
134th St ON	1000	1000	
99th St ON	1000	1000	
78th St ON	1500	1500	
Main St ON	800	800	
SR 500 ON	2200	2200	
4th Plain ON	1500	1500	
Mill Plain ON	2100	2100	
SR 14 ON	2200	1500	
C St/7th St (Build only)		700	
Hayden Island ON	800	No ramp	
Marine Dr ON	720	1200	
Victory Blvd ON	675	675	
Columbia Blvd ON	1058	1058	
Lombard WB ON	866	866	
Lombard EB ON	1051	1051	
Rose Parks ON	1001	1001	
Alberta St. ON	1001	1001	
Going St ON	938	938	
Greeley ON	938	938	
I-405 ON	No meter	No meter	
Broadway/Weidler ON	1105	1105	1200

I-5 Northbound	PM Peak No-Build	PM Peak MLPA
McLoughlin ON	665	665
Morrison ON	514	514
I-84 ON	No meter	No meter
Broadway/Weidler ON	839	839
I-405 ON	No meter	No meter
Going ON	529	529
Alberta ON	300	300
Rosa Parks ON	424	424
Victory/Denver ON	550	900
Delta Park	350	900
Marine Dr. ON	1091	1800
Hayden Island ON	889	1000
SR 14 ON	1000	1800
Mill Plain ON	1500	1800
Fourth Plain ON	1200	1500
39th ON	1000	1000
Main St ON	800	800
78th St ON	1200	1200
99th St ON	1200	1200
139th ON	1000	1000
I-205/Hwy 99 ON	No Meter	No Meter
179th ON	1000	1000
219th St ON	1000	1000
Pioneer St. ON	1000	1000

ATTACHMENT D. TRANSIT LINE LISTING

Differences between No-Build and Modified LPA are in shaded cells in the table.

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
TRIMET							
LIGHT RAIL							
01HGAP - Blue Line (01B)	LRT - (Hillsboro-Gresham) via cross-mall	7	15	7.5	15	7.5	15
01PDXB - Red Line (01R)	LRT - (PIA-BTC) via cross-mall	15	15	15	15	15	15
01I205 - Green Line (01G)	LRT - (PCBD/PSU-CTC) via mall	15	15	-	-	-	-
01GP1	LRT - (Bridgeport-CTC) via mall	-	-	15	15	15	15
01GP2	LRT - (PCBD/Union Station - Tigard) via mall	-	-	30	0	30	0
01GP3	LRT - CTC - Tigard via mall	-	-	30	0	30	0
01YON	LRT - (MILWAUKIE - EXPO) via mall	15	15	10	15	-	-
01YO	LRT - Milwaukie to I-5/Evergreen Station Terminus Vancouver	-	-	-	-	10	15
01YPE	LRT – PCBD – I-5/Evergreen Station Terminus Vancouver	-	-	-	-	20	-
COMMUTER RAIL							
01COMR (01CR)	Commuter Rail (BTC-Wilsonville)	30	-	15	15	15	15
STREETCAR							

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
01SCLW	Streetcar (NW 23rd/Gibbs - N. Macadam)	12	12	12	12	12	12
01SCLP	STRCAR EASTSIDE LOOP	15	15	12	12	12	12
01SCMP	STRCAR MG Park HOLLYWOOD	-	-	15	15	15	15
TRAM							
01TRAM	Tram (North Macadam-OHSU)	5	5	5	5	5	5
BRT							
04BRT	Division BRT	-	-	7.5	10	7.5	10
BUS							
02VCBD (02V)	Vermont - (PCBD-Vermont/Shattuck)	30	-	15	30	15	30
04DF	Division - Fessenden	12	12	10	10	10	10
05AP	Alberta/Prescott	-	-	30	30	30	30
06M	MLK/Hayden Island	12	15	10	10	-	-
06ME	MLK/Expo	-	-	-	-	10	10
08JN	Jackson Park/NE 15th	12	15	10	10	10	10
08JVA (08J)	Jackson Park/VA Hospital - (PCBD-VA Hospital)	30	-	-	-	-	-
09P98T	Powell/98th - (PCBD-98th/Powell)	25	-	25	-	25	-

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway	2045 IBR Modified LPA Peak headway	2045 IBR Modified LPA Off-peak headway
09PGTC (09P)	Powell/Gresham TC - (PCBD-Gresham TC) FB	10	15	10	10	10	10
10H	Harold - (PCBD-122nd/Foster)	20	30	-	-	-	-
10HT	Harold/Thurman	-	-	20	30	20	30
11R	Rivergate Marine Dr	60	-	20	30	20	30
12TP	Tigard/Parkrose	15	15	-	-	-	-
12P	PCBD Parkrose	-	-	10	10	10	10
14H	Hawthorne - 101st/Foster	7	15	7	10	7	10
152M	Milwaukie Shuttle (MTC-CTC)	45	90	30	30	30	30
153S	SALAMO-STAFFORD (PCBD/Macadam/LO/Stafford/Willamette-W. Linn)	-	-	30	-	30	-
154WILL-OC	Willamette - (Willamette/W. Linn-Oregon City)	60	60	60	60	60	60
155S-OTCTC/DAM	Sunnyside/Damascus - (147th/Oregon Trail-CTC)	30	30	15	20	15	20
156MR-OTCTC	Mather Rd. - (147th/Oregon Trail-CTC)	60	90	30	30	30	30
157HV-OTCTC	Happy Valley - (147th/Oregon Trail-CTC)						
15MG	Montgomery Park Yeon - Gateway	25	30	10	10	10	10
15TG	Thurman - Gateway	25	30	-	-	-	-

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
164MT (64MT)	Tigard/Marquam Hill - (OHSU-Tigard)	30	-	-	-	-	-
165MB (65BT)	Barbur/Marquam Hill	30	-	-	-	-	-
166MH (66MH)	Hollywood/Marquam Hill - (OHSU-Hollywood TC)	30	-	30	-	30	-
16SS	St Johns - Sauvie Island	45	45	15	20	15	20
17HB	Holgate - Broadway - 24th/27th to Dekum	15	20	10	15	10	15
18HILL	Hillside - (PCBD-Maclay/Burnside) Off-Mall	60	-	40	-	40	-
19W	Woodstock/Glisan	10	20	10	15	10	15
20BN	Burnside/NW19th	-	40	-	-	-	-
20BSTB	Burnside/Beaverton TC - (BTC-Gresham)	15	40	10	10	10	10
21PG / 21S	Parkrose - Gresham TC	30	30	12	20	12	20
22ROSE	Parkrose - (Parkrose-Gateway TC)	35	35	20	30	20	30
23SR223 (23S)	San Rafael/223rd - (Gateway TC-Gresham TC)	80	80	80	80	80	80
24F	Fremont/Gateway	30	40	20	20	20	20

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway	2045 IBR Modified LPA Peak headway	2045 IBR Modified LPA Off-peak headway
25G	Glisan/Rockwood - (Gateway TC-Rockwood TC)	70	70	30	30	30	30
26CP	Cully/Prescott	-	-	15	20	15	20
27W	Webster	-	-	30	30	30	30
28JC	Jennings/Carver	-	-	30	30	30	30
29L	Lake Webster - (MTC-CTC)	90	90	20	20	20	20
30EI	Estacada - CTC Inbound	60	60	30	60	30	60
30EO	CTC - Estacada	30	60	60	60	60	60
32MCC	MTC - CCC	30	70	20	30	20	30
33CC	CTC - CCC	15	15	7.5	10	7.5	10
34OC	Linwood River Rd	40	40	30	30	30	30
35M	Macadam - Greeley	20	40	10	15	10	15
36TCBD (36T)	South Shore - (LakeO-Tual-PCBD) to PCBD	60	-	30	-	30	-
36L	Tualatin - Lake Oswego	120	90	30	30	30	30
37NSHR (37T)	North Shore - (LakeO-TualPNR) via Cclub/LowerBoones	90	90	-	-	-	-

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
37N	Tigard Transit Center/Lower Boones	-	-	30	30	30	30
38BK	Boones Ferry - (PCBD-Tigard TC) Via Kruse/72nd	30	-	30	60	30	60
39L	Lewis and Clark - (L&C College-BurlingameTC)	40	40	30	30	30	30
40BJ	Baseline Jenkins	-	-	15	20	15	20
41C	Century/25th	-	-	15	20	15	20
43TF (43TW)	Taylors Ferry - (PCBD-WashSq.)	60	60	15	30	15	30
44CHWY	Cap Hwy (PCC - RQ)	40	60	-	-	-	-
44CM	Cap Hwy Mocks Crest	30	60	10	12	10	12
45G	Garden Home - (PCBD-Tigard)	25	70	20	30	20	30
46NH	North Hillsboro - (WashCo Fairgrounds-Hillsboro)	60	60	20	30	20	30
47BO	Baseline Orenco	30	-	-	-	-	-
47B / 47PE	Baseline Evergreen - PCC Rock Creek	30	40	10	15	10	15
48C	Cornell Rd (Hillsboro - Sunset TC)	30	30	10	12	10	12
48CORN (48CP)	Cornell Rd. - (WillowCrk. /185th-Hillsboro)	30	-	-	-	-	-
49SB	Sunset Bethany	-	-	15	30	15	30

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
50C	Cedar Mill	30	-	30	-	30	-
51CDP	Vista - (PCBD- Council Crest-Patrick Place Dosch)	30	-	30	-	30	-
52FARM (52O)	Farmington-185th (BTC-PCC Rock Crk.)	15	20	10	15	10	15
53ALLN-BA (53A)	Artic/Allen - (BTC-Allen/Mercer Ind.)	30		20	30	20	30
54B	B-H Hwy. (PCBD-BTC) FB	30	30	10	12	10	12
55H	Hamilton - (PCBD-Scholls/Hamilton)	60	-	60	-	60	-
56S	Scholls Ferry - (PCBD-WashSq.) FB	20	30	-	-	-	-
56S	Scholls Ferry - (PCBD - 175th/Roy Rogers)	-	-	20	20	20	20
57FFGV	Forest Grove - (BTC-Forest Gr.) FB	15	15	10	10	10	10
58CANY (58C)	Canyon Rd. - (PCBD-BTC)	20	30	20	30	20	30
59WP	Walker/Parkway/Cedar Hills - (Willow Crk. /185th-SunsetTC)	60	-	30	30	30	30
61X	BTC-B-H Hwy. - (Marquam Hill/OHSU-BTC)	20	-	20	-	20	-
62MURR	Murray Blvd - (WashSq. -Sunset TC)	30	30	15	20	15	20

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
63ZOO	Washington Park (PCBD-Zoo)	60	60	30	30	30	30
67J158 (67J)	Jenkins/158th - (BTC-PCC Rock Crk.)	20	40	15	30	15	30
68CMH (68C)	Collins Circle - (PCBD-OHSU/VA Hospital) Off-Mall	15	-	15	-	15	-
70T13	33rd/12th Ave via 13th	30	30	-	-	-	-
70T17	33rd/12th Ave via 17th	30	30	-	-	-	-
70T17	Swan Island 12th Ave via 17th	-	-	15	15	15	15
71P122 (71R)	60th/122nd - (Woodstock/94th-CTC) via Parkrose LRT	15	20	15	20	15	20
72K82 (72K)	82nd/Killingsworth - (Swan Is.-CTC) FB	7	12	10	10	10	10
73A	122ND	-	-	10	10	10	10
74A	162ND	-	-	15	15	15	15
75TMTC (75C)	39th/Lombard - (St. Johns-MTC) FB	12	15	10	10	10	10
76BVTU	Beaverton/Tualatin - (BTC-Tualatin TC) FB	30	30	10	12	10	12
77H	BRDWY/HALSEY Troutdale	15	30	10	15	10	15

Transit Line	Description	2015 Base Peak headway	2015 Base Off-peak headway	2045 IBR No-Build Peak headway	2045 IBR No-Build Off-peak headway	2045 IBR Modified LPA Peak headway	2045 IBR Modified LPA Off-peak headway
78B	BEAVERTON/LAKE OSWEGO	30	30	15	20	15	20
79CSOR (79C)	CTC/OC - (CTC-Or. City) via Gladstone - South End Loop FB	30	30	15	15	15	15
80TTRT (80GT)	Kane Rd. - (Gresham TC-Troutdale) via Springwater	60	60	30	30	30	30
81T	Troutdale via 257th	60	60	20	30	20	30
82T	223rd Gresham	-	-	30	30	30	30
84PVL	PV LOOP	45	-	30	-	30	-
85SG	Swan Island from Rose Quarter via Interstate/Greeley	30	45	15	20	15	20
86O	148th Ave	-	-	15	15	15	15
87A	Airport Way 181st	30	60	12	15	12	15
88H198 (88H)	198th/Hart - (Willow Crk. /185thTC-BTC)	30	30	15	15	15	15
89G	S Gresham	-	-	30	30	30	30

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
92XJC (92X)	South Beaverton Express - (Murray Hill-PCBD)	30	-	20	0	20	0
93	SHERWOOD PACIFIC OB/INB	-	-	10	20	10	20
94XI	SHERWOOD PACIFIC OB	45	45	-	-	-	-
94XO	SHERWOOD PACIFIC INB	8	45	-	-	-	-
96TCOM (96TC)	Tualatin/I-5 - (PCBD-Tualatin)	20	-	30	40	30	40
96TM	TUAL/MOHAWK JEFF/COL	30	-	30	40	30	40
97TS	Tualatin Sherwood Rd	-	-	20	30	20	30
99PX	McLoughlin Express - (PCBD-OC/CCC)	15	-	15	20	15	20
SERVICE PROVIDERS OTHER THAN TRIMET							
o2a	SMART-BARBURa	30	60	30	60	30	60
o4	SMART/WILSV RD	30	60	30	60	30	60
o3	SMART/Canby	60	120	60	120	60	120
o5	SMART/95th AVEa	30	-	30	-	30	-
o6	SMART/CANYON CREEK	30	-	30	-	30	-
oVa	SMART/VILLEBOISa	60	-	60	-	60	-
oES	SANDY-ESTACADA SAMa	120	120	120	120	120	120

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
oGR	SANDY-GRESHAM SAMa	30	30	30	30	30	30
oMT	SANDY-RHODODEND SAM	120	-	120	-	120	-
oMC	MOLALLA/CCC-SCTD	30	60	30	60	30	60
oMLC	MOLALLA/CANBY SCTD	30	60	60	60	60	60
oCO	CAT-Orange-OREGON CI	60	60	30	60	30	60
C-TRAN							
BRT							
FPMPcw	Fourth Plain/Mill Plain BRT VCBD - Mill Plain TC interline clockwise	-	-	10	10	-	-
FPMPccw	Fourth Plain/Mill Plain BRT VCBD - Mill Plain TC interline counter-clockwise	-	-	10	10	-	-
FPMPcwE	Fourth Plain/Mill Plain BRT VBD - Mill Plain TC interline clockwise via Evergreen and Fort Vancouver Way.					10	10
FPMPccwE	Fourth Plain/Mill Plain BRT VBD - Mill Plain TC interline counter-clockwise via Evergreen and Fort Vancouver Way.					10	10
99BRTB	Hwy 99 BRT to Salmon Creek TC - SCPR > 139th St > 23rd Ave > 134th St > continue on to Highway 99 - revised routing in Vancouver CBD -Northbound Grant >> 8th>> Broadway - Southbound Washington >> 6th >> Columbia	-	-	10	10	10	10
EXPRESS BUS							
C101	Vancouver CBD - Portland CBD	-	-	15	30	6	30
C105XN	I-5 Express to PCBD with downtown Vancouver service	15	45				

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
C105XNB	I-5 Express to PCBD with NO downtown Vancouver service (No-Build Bus on Shoulder 25 mph on I-5 from 99th to Columbia River , MPLA Bus on Shoulder 35mph on I-5 from 99th to Victory Boulevard)	-	-	10	-	5	-
C134XN	Salmon Creek to PCBD with 99th TC and downtown Vancouver Service	10	-	-	-	-	-
C157X	BPA to Lloyd Center	30	-	-	-	-	-
C164X	Fishers PR to PCBD (return via I-5, SR 14)	10	-	10	30	10	30
C177X	Evergreen PR to PCBD (return via I-5, SR 14)	45	-	-	-	-	-
C190X	Marquam Hill Express (No-Build Bus on Shoulder 25 mph on I-5 from SR 500 to Columbia River , MPLA Bus on Shoulder 35mph on I-5 from Fourth Plain to Victory Boulevard)	20	-	10	-	10	-
C199X	99th Express to PCBD	15	-	-	-	-	-
REGIONAL SERVICE							
C060	Delta Pk LTD	-	-	10	10	-	-
C065	Parkrose - Fishers Limited (FLTC / SR14 / I-205 / Parkrose TC / return)	15	30	20	20	20	20

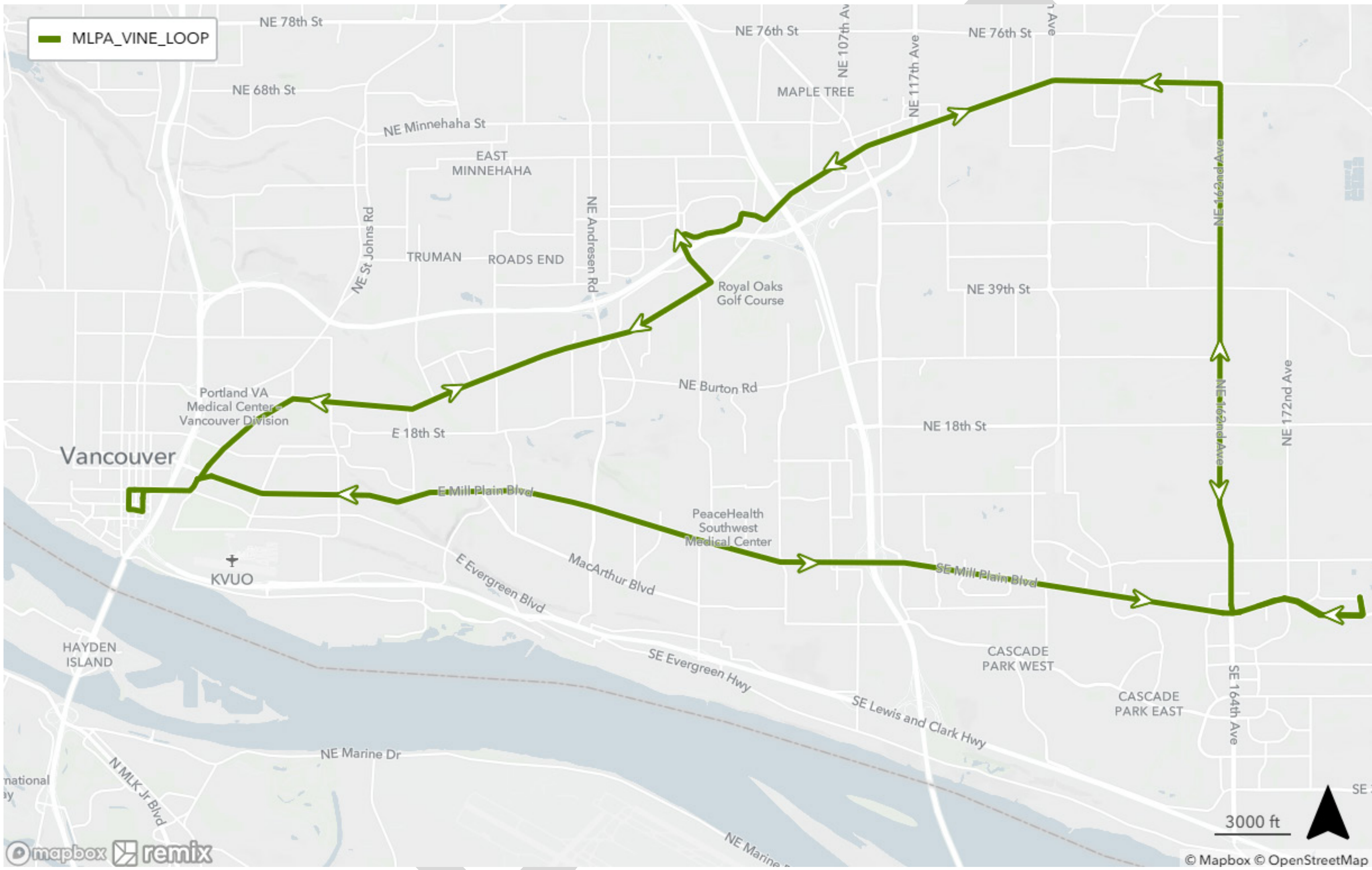
Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
C067*	Portland Airport - Fishers Limited (FLTC / SR14 / I-205 / PDX / return)			0	30	0	30
BUS							
C002	Lincoln/Felida	12	60	45	45	-	-
C002E	Lincoln/Felida – Evergreen / C Street	-	-	-	-	45	45
C003A	City Center Kauffman - Columbia	45	45	45	45	45	45
C004	Fourth Plain Delta P	15	15	-	-	-	-
C007	Battle Ground	45	45	45	45	45	45
C09	Felida	60	60	30	30	30	30
C019	SALMON CR TO WSUa	30	30	30	30	30	30
C025	FRUIT VAL/ST JOHNS	35	35	30	30	-	-
C025E	FRUIT VAL/ST JOHNS – Evergreen / C Street					30	30
C030	Burton	30	30	30	30		
C030E	Burton – Evergreen / C Street					30	30
C032	Hazel Dell/Evergreen/Andresen	30	30	-	-	-	-
C032E	Hazel Dell/Evergreen/Andresen with Waterfront Loop	-	-	45	45	45	45

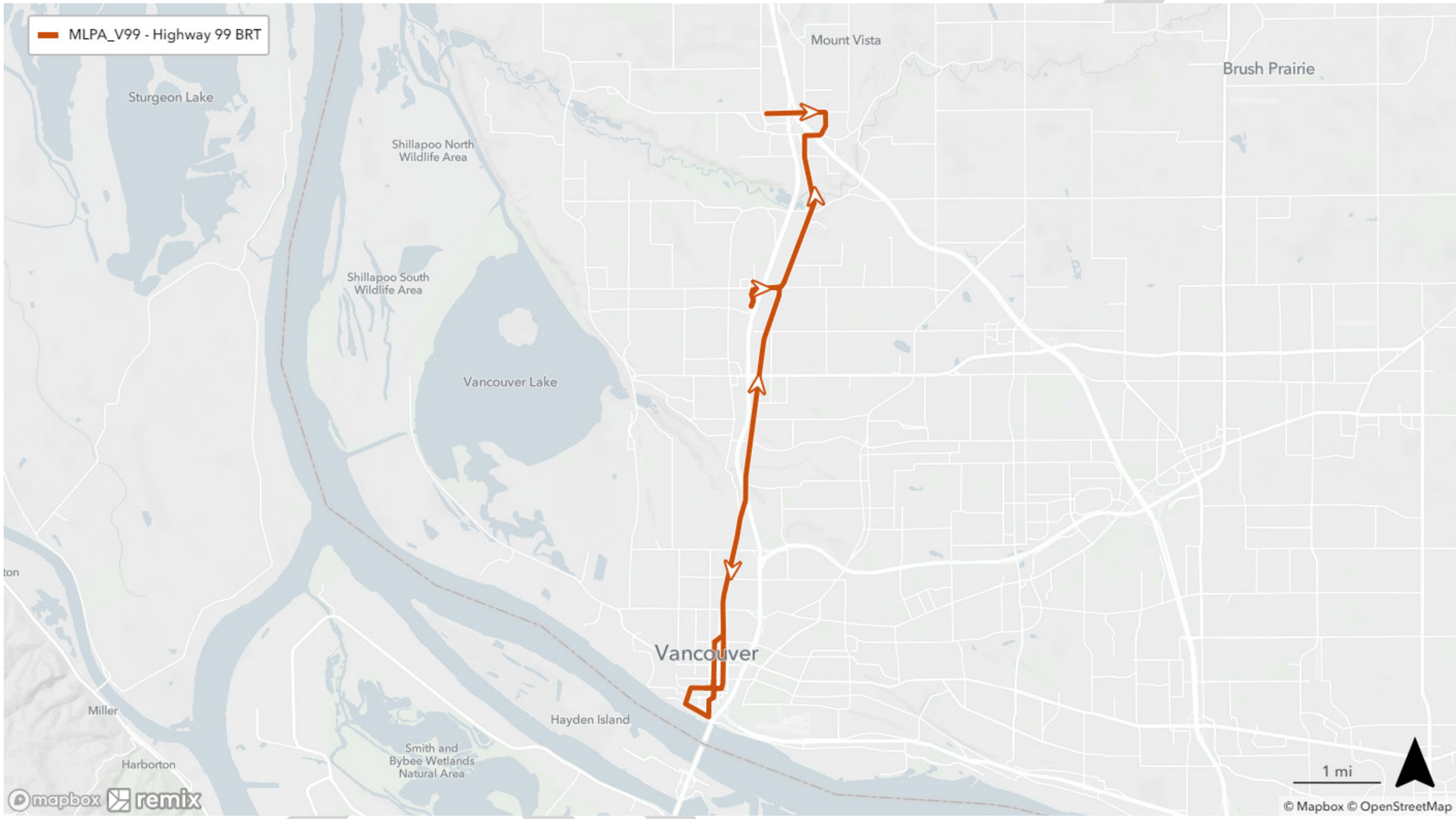
Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
C035	Tech Center	-	-	30	30	30	30
C037	Mill Plain	20	20	-	-	-	-
C038	Mill PL 192nd Ave	30	30	-	-	-	-
C039	Clark Coll/Med Cen	60	60	-	-	-	-
C41	Camas Washougal LTD to downtown Vancouver	30	-	120	-	120	-
C44	Fourth Plain LTDa - Orchards to Delta Park	35	-	-	-	-	-
C47N	Battle Grnd-Yacolt - Delta Park	120	-	-	-	-	-
C47	Battle Grnd-Yacolt to downtown Vancouver	120	-	-	-	-	-
C47VM	Battle Ground – Yacolt to Vancouver Mall	-	-	120	120	120	120
C48	Van Mall - FL 164th	-	-	-	-	-	-
C48B	99TC - Ridgefield	-	-	60	60	60	60
C071	Highway 99	20	20	-	-	-	-
C072	Orchards	60	60	60	60	60	60
C078	78th Street	60	60	60	60	60	60

Transit Line	Description	2015 Base		2045 IBR No-Build		2045 IBR Modified LPA	
		Peak headway	Off-peak headway	Peak headway	Off-peak headway	Peak headway	Off-peak headway
C080	Van Mall/Fishers	30	30	60	60	60	60
C85	FL - 192nd EAST/WEST	-	-	60	60	60	60
C092	Camas/Washougal (FLTC / Camas / Washougal)	30	30	60	60	60	60
C301RQJ	Ridgefield - 99th Street P&R SHRL w/QJ (99PR / Ridgfld)	-	-	-	-	-	-
C302LCQ	La Center - 99th PR SHTL w/QJs (99PR / LaCenter)	-	-	90	-	90	-

*Route C67 operates outside of the hours considered in the model so it does not have a headway listed in this set of assumptions.

ATTACHMENT E. BUS RAPID TRANSIT ROUTE CODING IN MODIFIED LPA




MLPA_V99 - Highway 99 BRT
Mount Vista
Brush Prairie
Sturgeon Lake
Shillapoo North Wildlife Area
Shillapoo South Wildlife Area
Vancouver Lake
Vancouver
Hayden Island
Smith and Bybee Wetlands Natural Area
Miller
Harborton
1 mi
© Mapbox © OpenStreetMap

Attachment F. IBR Screening Level Tolling Sensitivity Report

Tolling Sensitivity Report

September 2024

Oregon

For ADA (Americans with Disabilities Act) or Civil Rights Title VI accommodations, translation/interpretation services, or more information call 503-731-4128, TTY 800-735-2900 or Oregon Relay Service 7-1-1.

Washington

Accommodation requests for people with disabilities in Washington can be made by contacting the WSDOT (Washington State Department of Transportation) Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll-free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equity and Civil Rights Title VI Coordinator by contacting (360) 705-7090.

Tolling Sensitivity Report

Prepared for:

Oregon Department of Transportation

Washington State Department of Transportation

Prepared by:

Parametrix

Parametrix
5 SE Martin Luther King Jr. Boulevard, Suite 400
Portland, OR 97214

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

CRC	Columbia River Crossing
I-5	Interstate 5
IBR	Interstate Bridge Replacement
LPA	Locally Preferred Alternative
ODOT	Oregon Department of Transportation
RTP	Regional Transportation Plan
VPFA	Value Pricing Feasibility Analysis
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

This technical report documents the tolling and sensitivity analysis around tolling that was completed for the Interstate Bridge Replacement Program (IBR Program).

As part of the Modified LPA all motor vehicle users on I-5 crossing the Columbia River would pay a toll. This tolling would help fund the IBR Program and be a mechanism for managing congestion in the program area. Tolls would be collected using an electronic toll collection system whereby motorists would either obtain a transponder that would automatically bill the user when they cross the toll collection point, or motorists without a transponder would be charged the toll using a license-plate recognition system that would send a bill to the registered owner of the vehicle. Tolls would be higher for vehicles without transponders to account for the processing cost of the bill.

The modeling for the IBR program assumes time-of-day variable rate tolling on a set schedule would be in place for vehicles using the I-5 Columbia River bridge. This means that tolls would vary by time of day with higher rates during peak travel periods and lower rates at other times of day based on a set schedule. Medium and heavy trucks would be charged a higher toll than passenger vehicles. Final toll rates will be set by the Washington Transportation Commission and Oregon Transportation Commissions.

Analysis was done in advance of the Supplemental Environmental Impact Statement modeling to understand the impact of higher and lower toll rates as well as no tolls on vehicle crossing demand and transit passenger demand over the Columbia River bridges.

The tolling sensitivity testing work should be used to understand the impacts of tolling scenarios on traffic and transit volumes and not be used to produce or feed into revenue estimate work which will be done as part of a separate process.

2. TOLLING SENSITIVITY TESTING OVERVIEW

Tolling sensitivity analysis was completed in the winter and spring of 2022 using toll rates that had been in place in the underlying 2018 Regional Transportation Plan (2018 RTP), jointly developed and adopted by Metro in 2018 and by Southwest Washington Regional Transportation Council (RTC) in 2019. This work was initiated prior to having draft toll rates developed for the IBR program that were used for the Supplemental Environmental Impact Analysis. Information presented below is meant to illustrate overall magnitudes of change in the Regional Travel Demand Model under different tolling conditions and should not be compared directly to the SEIS model results because some of the underlying input assumptions between the SEIS model and tolling sensitivity model are different. However, each tolling sensitivity test completed in this process that assumed a build condition, included the same background highway and transit assumptions.

2.1 Base Toll Rates Used in Sensitivity Testing

Under build alternatives tolling is included for cars and trucks that use the I-5 Columbia River crossing. Toll rates vary by time of day with higher rates during peak periods and lower rates during off-peak periods. Medium and heavy trucks are assigned a higher toll than passenger vehicles, 2 times toll rate and 4 times toll rate respectively. The toll rates that were included in the 2018 Regional Transportation Plan that are the starting point for this analysis are provided below in Table 1. Tolls are expressed in 2010 dollars for use in the model.

Table 1. Base Toll Rates in 2018 RTP Regional Travel Demand Model for I-5 Columbia River Crossing

Time Period	SOV/HOV	Medium Truck	Heavy Truck
Peak Hours			
Value of Time – 2010 dollars	$19.27/hr	$39/hr	$39/hr
Toll Rate	$2.00	$4.25	$8.25
Off-Peak Hours			
Value of Time – 2010 dollars	$12.82/hr	$39/hr	$39/hr
Toll Rate	$1.00	$3.25	$6.25

HOV = high-occupancy vehicle; SOV = single-occupancy vehicle

2.2 Scenarios Analyzed in Sensitivity Testing

Seven different model runs were completed as part of the toll sensitivity testing work. These runs are presented below in Table 2. The background network assumptions for all model runs were from the

2018 Metro Financially Constrained Regional Transportation Plan. Both No-Build and Build scenarios were analyzed.

The No-Build scenario reflected all Financially Constrained assumptions for highway and transit absent the improvements in the 2018 RTP that represented the 2011 Record of Decision for the Columbia River Crossing (CRC). In other words, the No-Build scenario reflected no replacement of the current Interstate 5 (I-5) bridges, no reconstructed interchanges, no tolls on the I-5 bridges, and no extension of light rail transit north from the existing MAX Yellow line alignment into Vancouver.

The Build scenario reflected replacement of the current I-5 bridges with new structures with three through-lanes and two auxiliary lanes in each direction, reconstructed interchanges, tolls priced to manage travel demand as well as provide financing of the project construction, operation, and maintenance; extension of light rail transit north from the existing MAX Yellow Line alignment into Vancouver. All Build tolling sensitivity scenarios included the same elements described above with the exception of the toll rates.

In addition to a No-Build and two Build model runs that included tolling, a Build model run without tolling was completed. This Build model run with no toll was included to understand how much of an impact the toll on its own would have if other background assumptions (highway and transit improvements) were the same. The model runs with different toll assumptions included two with higher toll rates than the base.

Table 2. Scenarios Analyzed in Tolling Sensitivity Analysis

Scenario	Description
No-Build	Background network assumptions in 2018 RTP Financially Constrained system without IBR
No Toll	Build IBR with No Toll (highway capacity and transit improvements in place)
Tolled Scenarios	
LPA	CRC FEIS toll rates on I-5 bridge only – Locally Preferred Alternative as included in the 2018 RTP
Higher Bridge Toll Only	Higher toll rates at I-5 bridge (~approximately 1.5X CRC FEIS rates)

2.3 Evaluation Measures Used in Sensitivity Testing

The following measures were used to evaluate tolling sensitivity.

- **Person Trips:** Daily person trips from the Regional Travel Demand model were analyzed at a district level after the mode choice step of the model to evaluate destination choice changes.
- **Mode Choice:** Daily person trips from the Regional Travel Demand model will be analyzed at a district level after the mode choice step of the model to evaluate shifts in travel mode. Trips will be summarized in total.

- **Vehicle Volumes:** Vehicle volumes on both the I-5 and I-205 bridge will be developed in the regional travel demand model for each hour of an average weekday. Volumes will be post-processed using industry standard post-processing steps as described in the Transportation Methods and Assumptions Report.
- **Transit Volumes**: Transit ridership will be developed from the Regional Travel Demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks for each scenario being analyzed in the EMME software platform. These assignments and resulting outputs will be used to summarize total average weekday transit ridership crossing the Columbia River on I-5 and I-205 to understand shifts to transit with tolling.

3. TOLLING SENSITIVITY ANALYSIS RESULTS

This section discusses the results of the tolling sensitivity analysis, including details for each evaluation measure noted above.

3.1 River Crossing Changes with Tolling Scenarios

When tolling is implemented on the I-5 Columbia River bridge, auto volumes are reduced on I-5 and overall, across the Columbia River. Reductions on I-5 are the result of diversion to the I-205 Columbia River bridge, increased transit trips across the river and changes in destination choice which mean a trip does not cross the river at all. The level of the toll rate impacts the extent to which each of these changes occurs.

Table 3 provides comparisons to the No-Build (no new highway, no new transit , no tolls) scenario including the distribution of trips between the I-5 and I-205 crossings for both vehicle and transit trips.

Table 3. DRAFT IBR Tolling Impacts 2045 Scenarios vs. No-Build

Scenario	I-5 Average Weekday Vehicle Trips		I-205 Average Weekday Vehicle Trips		Total Average Weekday Vehicle Trips		I-5 Total Average Weekday Transit Trips		I-205 Total Average Weekday Transit Trips		Total Average Weekday Transit Trips		Total Average Weekday Trips & River Crossing Change[1]		
	Total (thousands)	% Change[2]	Total (thousands)	% Change[2]	Total (thousands)	% Change[2]	Total (thousands)	% Change[2]	Total (thousands)	% Change[2]	Total (thousands)	% Change[2]	Total (thousands)	Absolute Trip Difference	% Change[2]
No-Build	176.0	-	215.0	-	391.0	-	19.0	-	3.0	-	22.0		412.7	-	-
No Toll[3]	205.0	+16%	200.0	-7%	405.0	+4%	29.0	+48%	2.0	-23%	31.0	+40%	435.7	+23.0	+6%
LPA	175.0	-0.6%	207.0	-4%	382.0	-2%	33.0	+72%	2.0	-19%	35.0	+61%	417.4	+4.7	+1%
Higher Toll Rate	151.0	-14%	213.0	-1%	364.0	-7%	36.0	+87%	2.0	-23%	38.0	+74%	402.2	-10.5	-3%

1. Trips that change crossing the Columbia River because of change in trip distribution due to transit/tolling.
2. Change compared to No-Build Scenario.
3. Assumes IBR is constructed but not tolled ("Build-No-Toll option").

3.2 Person Trip Changes with Tolling Scenarios

River crossing information presented above only provides one snapshot of information by which to assess the impact of tolling on trips. Table 4 below breaks down trips in the region into information by work and non-work trips and presents it for the region as well as for trip movements between Oregon and Washington for an average weekday. This table includes comparisons to the No-Build scenario similar to the tables above. Note that overal daily person trips at a regional level do not change between any of the scenarios.

Key high level changes compared to the No-Build scenario are as follows:

- In the No Toll scenario (with all of the highway and transit improvements but no tolling) regional transit trips for both work and non-work purposes increase, including just the trips between Oregon and Washington (both directions).
- In all tolling scnarios overall person trips between Oregon and Washington are reduced (-0.6% to -6%) compared to the No-Build. Work trips increase but non-work trips (discretionary) decrease more to cause an overall reduction. As tolling increases there is further reduction in the number of daily person trips.
- In tolling scenarios as compared to the No-Build we see overall person trips increase +3% compared to the No-Build for trips between Wasington and Oregon with both work and non-work trips increasing, primarily related to increased transit person trips.
- In all tolling scenarios regional transit trips increase 2 – 3% compared to the No-Build and movements between Oregon and Washington increase 100% -129% and movements between Washington and Oregon increase 46% to 56% increase.
- Transit trip increases between Oregon and Washington are larger for non-work s but for trips from Washington to Oregon the increase in transit trips is higher for work purposes.
- With increasing tolls, there are fewer overall person trips but a higher number of transit trips crossing the river. This is consistent with the information from the river crossing trips presented in Table 3.

Table 4. DRAFT IBR Tolling Person and Work/Non-Work Impacts 2045 Scenarios vs No-Build

	No-Build	No Toll	No Toll vs. No-Build (abs)	No Toll vs. No-Build (%)	LPA	LPA vs. No-Build (abs)	LPA vs No-Build (%)	LPA Higher Toll	LPA+ Higher Toll - NB	LPA Higher Toll - NB%
Daily Persons	11,908,500	11,905,000	(3,500)	0%	11,908,500	-	0%	11,908,500	-	0%
• Daily Work Persons	2,165,500	2,165,500	-	0%	2,165,500	-	0%	2,165,500	-	0%
• Daily Non-Work Persons	9,743,000	9,739,500	(3,500)	0%	9,743,000	-	0%	9,743,000	-	0%
Daily Transit	692,000	702,000	10,000	1%	707,500	15,500	2%	710,500	18,500	3%
• Daily Work Transit	325,500	332,000	6,500	2%	335,500	10,000	3%	337,000	11,500	4%
• Daily Non-Work Transit	366,000	370,000	4,000	1%	372,000	6,000	2%	373,500	7,500	2%
Oregon - Washington										
Daily Persons	180,000	191,000	11,000	6.1%	179,000	(1,000)	-0.6%	169,500	(10,500)	-6%
• Daily Work Persons	34,500	36,500	2,000	6%	36,000	1,500	4%	35,500	1,000	3%
• Daily Non-Work Persons	145,500	154,500	9,000	6%	143,000	(2,500)	-2%	134,000	(11,500)	-8%
Daily Transit	3500	5500	2,000	57%	7000	3,500	100%	8000	4,500	129%
• Daily Work Transit	2000	2500	500	25%	3000	1,000	50%	3500	1,500	75%
• Daily Non-Work Transit	1500	3000	1,500	100%	4000	2,500	167%	4000	2,500	167%
Washington to Oregon										
Daily Persons	203,500	215,000	11,500	6%	209,000	5,500	3%	203,500	-	0.0%
• Daily Work Persons	122,000	124,000	2,000	2%	123,000	1,000	1%	122,500	500	0%
• Daily Non-Work Persons	81,500	91,000	9,500	12%	85,500	4,000	5%	81,000	(500)	-1%
Daily Transit	19,500	25,500	6,000	31%	28,500	9,000	46%	30,500	11,000	56%
• Daily Work Transit	17,500	21,500	4,000	23%	24,500	7,000	40%	26,000	8,500	49%
• Daily Non-Work Transit	2,500	3,500	1,000	40%	4,000	1,500	60%	4,500	2,000	80%

3.3 Hourly Vehicle Volumes for I-5 and I-205 with Tolling Scenarios

Figure 1 through Figure 4 below show the hourly distribution of trips for both I-5 and I-205 by direction under each of the scenarios evaluated during tolling sensitivity testing. Hourly vehicle trips on I-5 are highest with the No Toll scenario compared to all other scenarios. The Modified LPA scenario, which introduces tolls, reduces hourly volumes across the entire day, but the reduction is more pronounced outside of peak travel periods because trips will divert to an uncongested I-205 corridor. The higher toll scenario further reduces volumes on the I-5 corridor throughout the day with greater diversion to I-205.

Figure 1. Average Weekday Hourly I-5 Southbound River Crossing Vehicle Volumes for Toll Sensitivity Scenarios

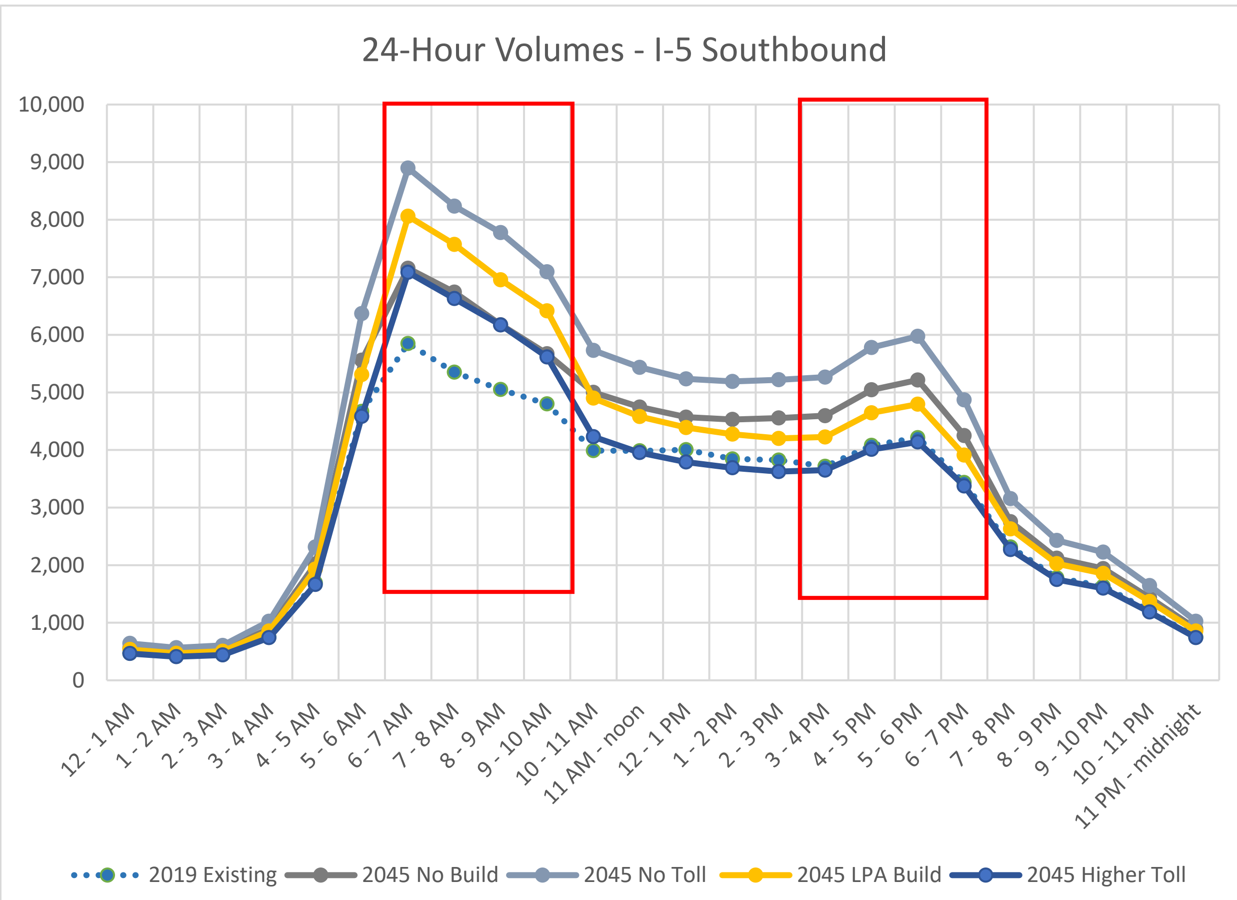


Figure 2. Average Weekday Hourly I-5 Northbound River Crossing Vehicle Volumes for Toll Sensitivity Scenarios

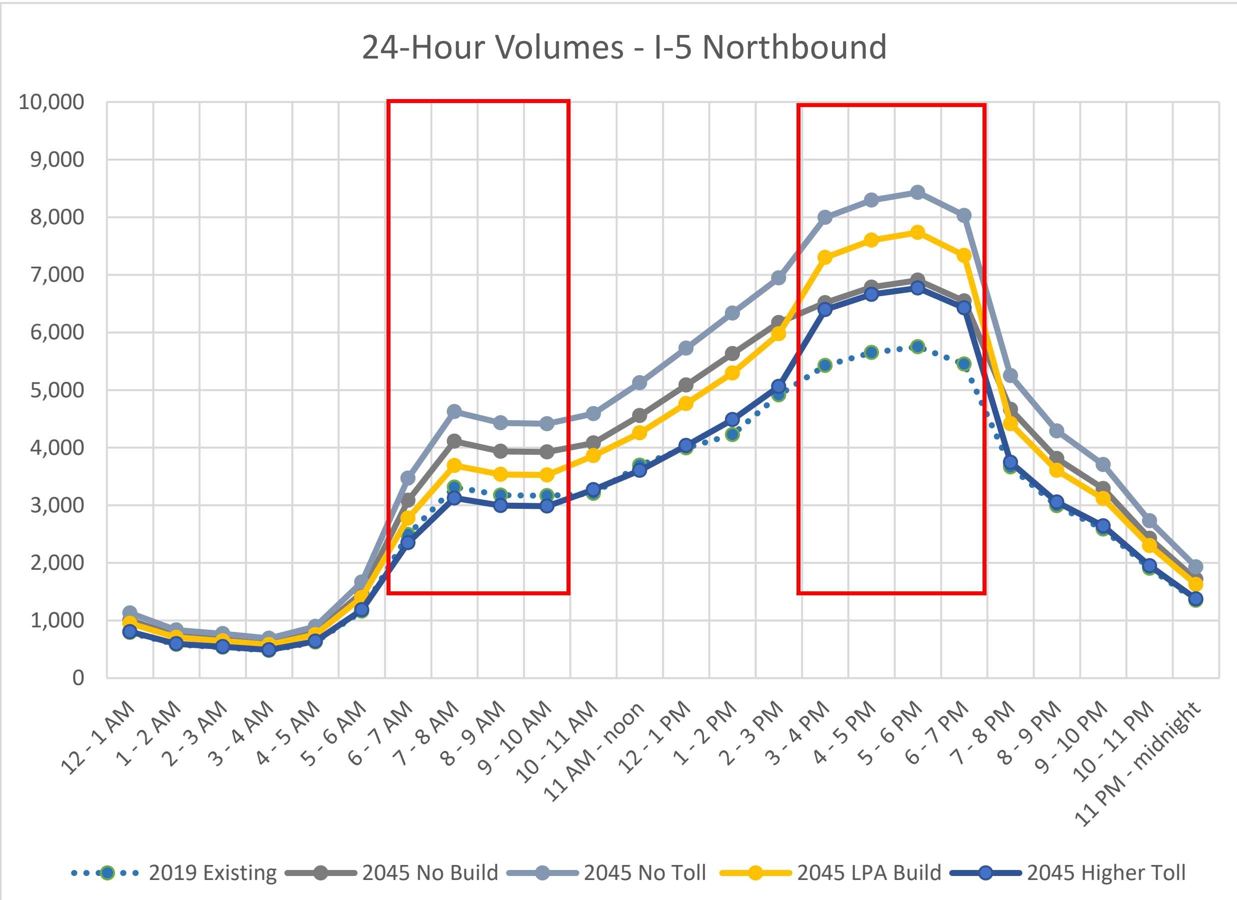


Figure 3. Average Weekday Hourly I-205 Southbound River Crossing Vehicle Volumes for Toll Sensitivity Scenarios

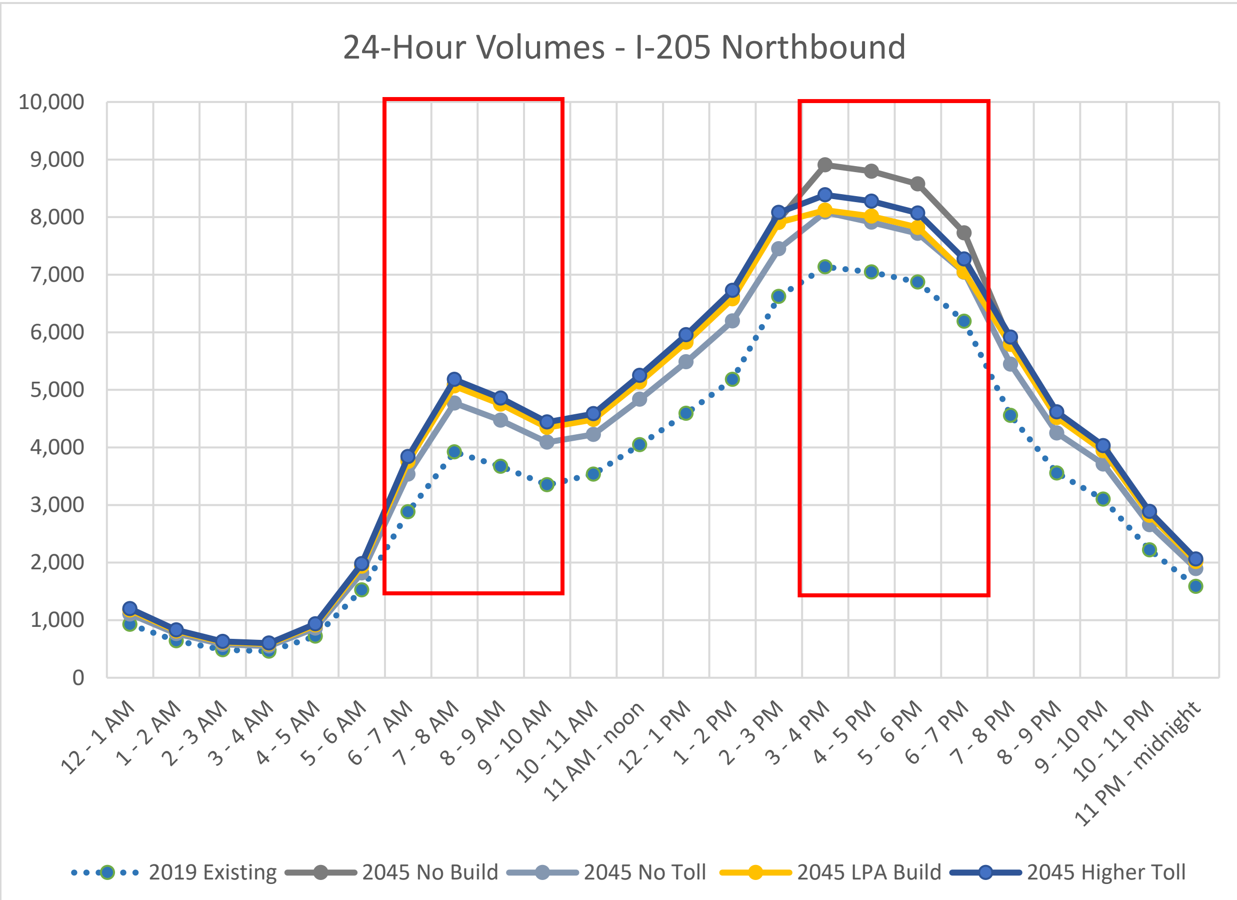
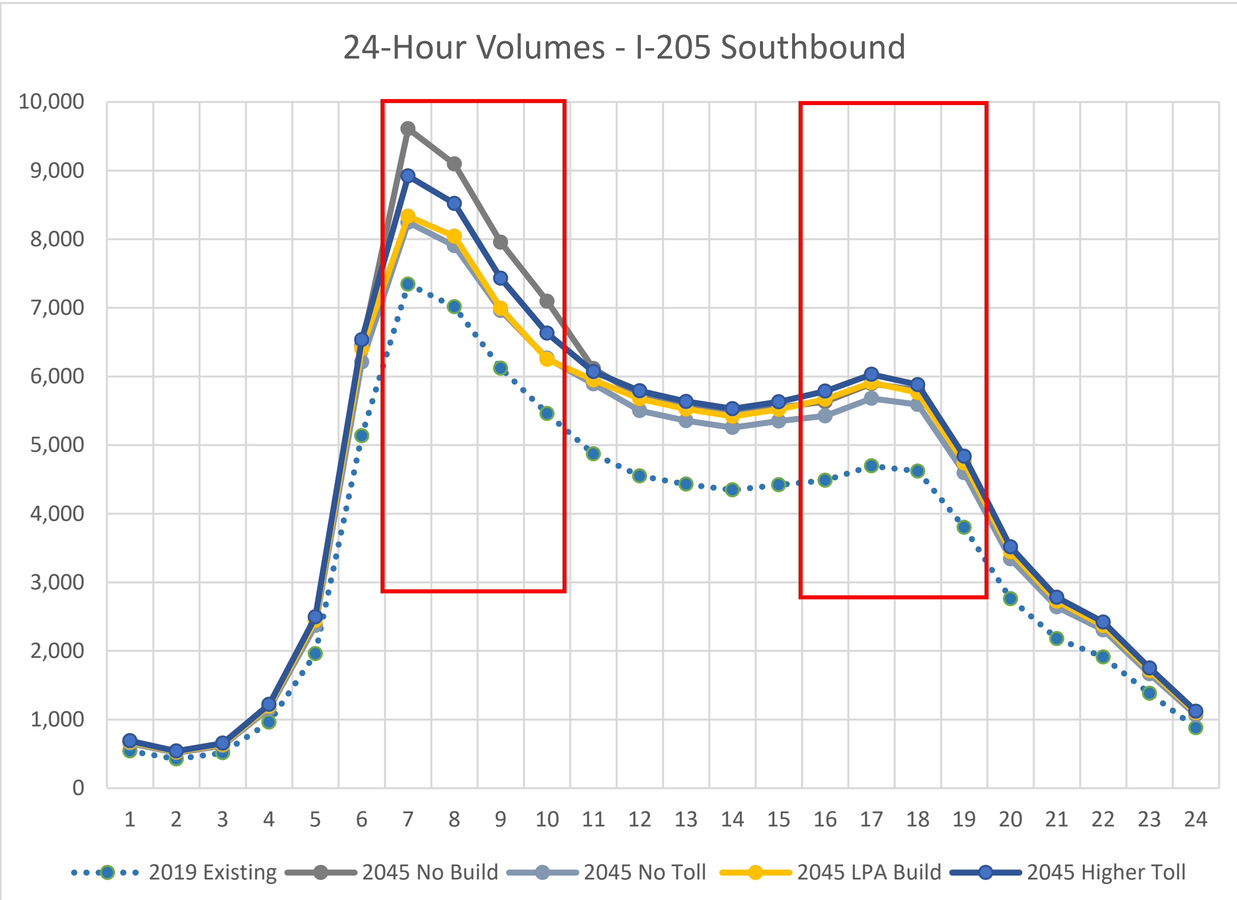


Figure 4. Average Weekday Hourly I-205 Northbound River Crossing Vehicle Volumes for Toll Sensitivity Scenarios



4. CONCLUSION

The results of sensitivity testing around tolling, including higher tolls on just the I-5 Columbia River bridge produced results that made sense given the changes that were implemented. When tolls were introduced in a Build condition we saw reductions in vehicle trips, diversion to alternative routes (I-205 Columbia River bridge) and increases in transit. The higher the tolls were increased, the more each of these was impacted.

Final toll rates will be set by the Washington State Transportation Commission and Oregon Transportation Commission and are likely to be different than what was assumed in this technical analysis. The rates included in this analysis were meant to provide an understanding of responses to tolling and impacts of tolling scenarios on traffic and transit volumes on I-5 and I-205 and will not be used to produce or feed into revenue estimate work which will be done as part of a separate process.

Attachment G. Induced Development Memo and CRC Economic Impacts

G1. Induced Development Memo

Metro
600 NE Grand Ave.
Portland, OR 97232-2736

Memo

Date: Thursday, January 24, 2024

From: Matt Bihn, Metro Modeling & Forecasting Manager

Subject: IBR Induced Development Assessment

This memo is intended to address questions related to the potential for new real estate development demand being induced by improved auto and transit accessibility associated with the Interstate Bridge Replacement (IBR) project. It is primarily based on an analysis conducted for the previous project seeking to replace the I-5 bridge crossing over the Columbia River between Portland, Oregon, and Vancouver, Washington – the Columbia River Crossing (CRC). That analysis relied on MetroScope, Metro's now retired integrated transportation and land use forecasting model, and is summarized in a 2010 white paper prepared for the North American Regional Science Council Conference.

A new land use model is currently being developed at Metro and Metro's modeling team is, as of this writing, not prepared to publish an updated land use forecast for the IBR project. Nevertheless, the Metro modeling team feels confident that the primary findings of the previous analysis remain relevant to IBR because the design elements of the IBR modified locally preferred alternative (LPA) assume less improvement to multimodal accessibility than the CRC did:

- The IBR design would add one freeway lane in each direction to the bridge, whereas the CRC would have added two lanes in each direction,
- The IBR design would add three new light rail station with one near downtown Vancouver, while the CRC would have added five new stations with three in downtown Vancouver, and
- The IBR design would add 1,270 park and ride spaces, whereas the CRC would have added 2,900 spaces.

<u>MetroScope Analysis and Findings</u>

The MetroScope analysis tested three alternatives: a no-build baseline, a build with toll, and a build without a toll. The build with no toll was not a true alternative considered in the CRC project; it was a hypothetical comparison alternative used in the MetroScope analysis to assess the impact of the toll.

The analysis found:

- The CRC project without a toll would have very small land use impacts, at less than 1% on a regional scale,
- Without a toll, the CRC project compared to the no-build would result in small increases in single family home development in the urban periphery in Clark County primarily at the expense of multi-family in the central areas of the region. Home prices for single family would increase slightly in Clark County and decrease elsewhere. Land use shifts would be small: +1% for dwelling units and -1.0 – 3.5% for real estate prices.
- With the toll, the CRC project compared to the no-build would reverse those land use impacts. It would also have the salutary effect of reducing home prices, discouraging development at the urban periphery and encouraging higher density multi-family development within the urban core.

G2. CRC Land Use and Transportation Impacts

DRAFT VERSION 1

Title: Land Use and Transportation Impacts of the Columbia River Crossing Project – Results from an Integrated Model

Authors: Conder, Sonny D. - Economic and Land Use Forecasting – Portland Metro (Corresponding Author)
Bosa, Peter – Travel Demand Forecasting – Portland Metro
Cser, Jim – Economic and Land Use Forecasting – Portland Metro
Pederson, Cindy – Travel Demand Forecasting – Portland Metro
Todd, Maribeth – Economic and Land Use Forecasting – Portland Metro
Walker, Richard – Manager, Travel Demand Forecasting – Portland Metro
Yee, Dennis – Manager, Economic and Land Use Forecasting – Portland Metro

Abstract: Abstract: The Columbia River Crossing Project consists of replacing an existing 6 lane, over-age, I-5 Corridor Bridge with a 12 lane bridge with additional capacity for light rail, bicycles and pedestrians. We used an integrated transportation and land use model (MetroScope) to evaluate the land use and travel impacts of the bridge replacement. We tested three alternatives – a no build baseline, a build with no toll and a build with toll alternative. Overall, the bridge alternatives compared to no build produced impacts as expected – growth was shifted to areas experiencing the greatest travel time savings and real estate prices shifted accordingly; higher in benefited areas and lower in areas receiving little or no benefit. However, the land use shifts were small; 1% for dwelling units and -1.0 – 3.5% for real estate prices. The small changes were consistent with the travel time savings resulting from the project: 1.7% region-wide and 7.0% in Clark County, the most heavily impacted area. Imposing a $2 toll on the new bridge alleviated the land use changes; reduced overall housing prices and shifted demand slightly from single family at the urban edge to multi-family along the I-5 Corridor. Relative to the no build alternative building without a toll increased regional 2030 per capita VMT 0.6% and building with a toll reduced per capita VMT -1.9%.

Keywords: Location modeling, transportation, tolling, induced travel, land use impacts

October 27, 2010

Prepared for presentation to the North American Regional Science Council Conference, Denver Colorado, November 10 – 13th, 2010.

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Introduction

Purpose

In this paper we report on the results of using an integrated transportation and land use model to simulate the future impacts of an expanded capacity replacement for the I-5 Interstate Columbia River Crossing (CRC). We evaluated the CRC project in regard to three factors widely discussed in the literature and often mentioned in public discussions prior to our study. These factors are induced traffic, impacts on land use and effects of tolling on traffic and land use. Our intent in performing the simulations was to provide substantive answers to questions that have arisen as part of the CRC planning process and have produced substantial controversy and potential project delay or abandonment. A corollary purpose is to provide an example of how the new generation of integrated transportation and land use models may be employed to provide useful information in the context of major infrastructure improvements. To perform the regional traffic and land use simulations we make use of MetroScope, a Portland Metro developed integrated transportation and land use model[1].

Background

The Columbia River Crossing planning process was initiated in 2005 and continues through the present date. As of July "nearly 100 million has been spent on planning alone…"[2]. Figure 1 displays the location and extent of the project as it is presently designed.

Figure 1: The CRC project replaces a 6 lane bridge with a 10 - 12 lane bridge, LRT and pedestrian/bike facilities and connector improvements.

The present design calls for replacing a 3 lane bridge built in 1917 and another 3 lane bridge built in 1958 with a 10 – 12 lane bridge estimated to cost between 3.5 and 4.0 billion dollars depending on configuration. The cost estimates include bike/pedestrian facilities and extending the present light rail line from the Oregon to the Washington side of the Columbia River.

Beyond engineering and design issues, the CRC project has aroused a number of controversies that may be summarized under the headings of induced traffic growth, unintended land use impacts and the efficacy and equity of tolling alternatives. Induced traffic as generally defined in the literature is that increase in traffic volume that results from a transportation improvement reducing travel times (effective price of travel) and thereby producing more travel than would otherwise be the case. Unintended land use impacts may be loosely regarded as the corollary of induced traffic as land uses increase in intensity due to the gain in access associated with the transportation improvement. Finally, beyond being a source of project revenue, tolling alternatives have been proposed as a means of reducing congestion, reducing induced traffic and remedying whatever land use impacts may be associated with a transportation improvement. In the context of the CRC projects all three issues have been cited by opponents and proponents of any particular CRC design.

While these controversies surfaced quite early in the CRC planning process, the planning team was reluctant to directly address the issues of induced traffic and land use impacts and did not release a tolling report until late 2009[3]. It was only in the spring of 2010 after insistence by local officials that the planning team contracted with Metro travel demand and economic and land use forecasting to perform the tests for approximately $70,000. The work was completed within a 5 week period in the early summer of 2010 and involved several runs on a 5 year and 10 year basis of both the traditional 4 step travel model and the MetroScope integrated transportation and land use model.

MetroScope Description

Before getting into the details of the CRC study, it is helpful to provide a brief description of MetroScope, the integrated transportation and land use model used for the study. MetroScope is an in-house model, developed in the late 1990's that has been in continuous use in several versions at Metro since the year 2000. Since 2007 MetroScope has a built in 400 zone travel demand model as well as residential and nonresidential real estate modules. Recent performance allows a complete model run in 5 year increments from 2005 to 2040 in under 15 hours. Figure 2 below provides a highly generalized schematic showing the models various modules and how they operate.

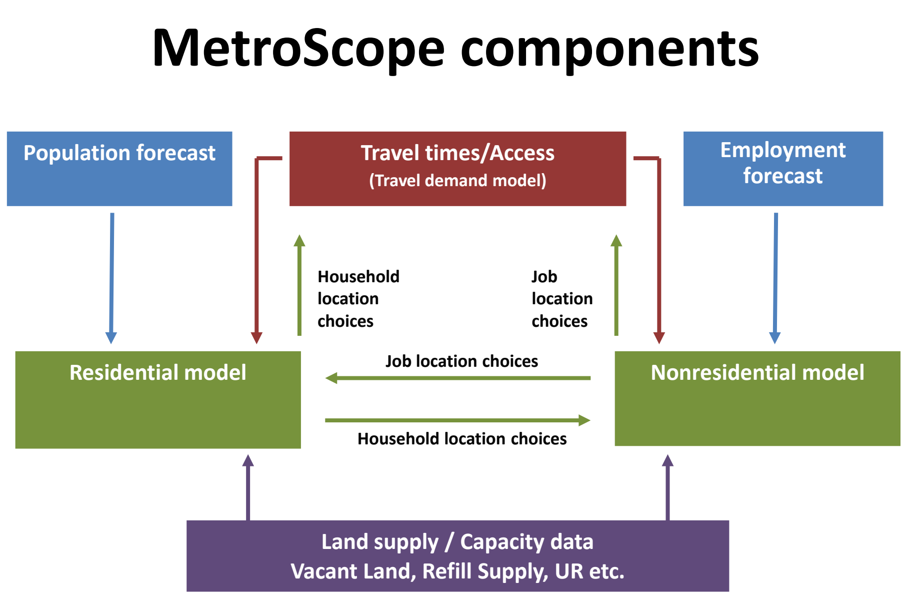


Figure 2: MetroScope in each iteration exchanges information between the transportation demand, residential real estate and nonresidential real estate modules so that all outputs are consistent with one another.

As noted in the schematic, MetroScope uses external region-wide control totals for population/households and employment generated from a region-wide econometric model. Likewise MetroScope uses a set of external policy driven assumptions about land use regulation and supply, redevelopment and infill and the level of urban renewal and subsidy to be incorporated in any particular scenario. The associated travel model in addition to infrastructure capacity provides for tolling, travel demand management and transit options.

MetroScope belongs to a class of market based, aggregate, supply and demand models that determine a vector of real estate prices that equilibrate real estate demand and supply in any iteration cycle while the travel demand model equilibrates travel times over the transport network. Information in any particular 5 year iteration cycle is passed between the residential, nonresidential and transportation modules such that prices, travel and real estate allocations are consistent between modules.

For the CRC study we elected to substitute the far more extensive 2000 plus TAZ travel demand model for the smaller but faster built in 400 zone travel model. This substitution allowed us to include all significant travel network detail and a full treatment of all non vehicle modes of travel. This enabled us to fully reflect the detailed transit and tolling changes associated with the CRC project in both the travel and real estate modules. In return for much greater usable detail, we accepted that the larger model procedure runs much slower; taking up to a week compared to 12 – 16 hours for the code integrated MetroScope version.

Literature Review

Relevance to MetroScope CRC Results

Important to interpreting the results of any urban simulation model such as the traditional 4 step travel demand model or the newer integrated models, is an ability to assess the validity of their results. Internally, at Portland Metro we find it helpful to regard simulation models as but one leg of the 3 legged evidence stool with the 3 legs being: one – empirical studies, two – simulation model results and three- theoretical model results. By way of explanation empirical studies are based on observable data but rarely are controlled or even uncontrolled experiments. Parameter identification, specification, self-selection and scale problems all engender considerable ambiguity in interpreting measurement results. Similarly, most simulation models incorporate some level of theoretical structure in a casual way and also rely on empirically based parameters. In addition, well designed simulation models can be used to “run experiments” with different policy options. However, due to the eclectic and casual nature of their construction, they leave doubts as to the validity of their results. Finally, theoretical models while rigorous and dependent only on well defined parameters, are most usually unrealistically limited and restricted by the requirements for mathematical solutions. As a consequence we regard no one source as particularly compelling and look for support from all three if possible.

We need also point out that the literature in the areas of induced traffic, land use impacts and even tolling (road pricing, TDM, etc.) is very large with 100’s of studies cited. Here we cite but a few of the studies and reviews of studies that reflect a range of empirical, simulation and theoretical results.

Induced Traffic

Littman (2010, p. 9)[4] publishes an extensive review of 22 empirical induced traffic studies and reports a range of "elasticities"[5]from .2 to 1.2. Lower elasticities are interpreted as a short term response to infrastructure induced changes in travel times and high elasticities presume an underlying change in land use to accompany the change in access. Littman in summarizing the studies also notes that elasticities decline as the size of the study area increases. He also points out that traditional travel demand simulation models do not incorporate longer run land use impacts. Fulton, Noland, Meszler, & Thomas (2000, p.13)[6] accounting for a variety of population and density differences estimate an elasticity range of .2 through .6 for the Mid-Atlantic region. Outside of empirical studies both simulation and theoretical models incorporate the outcomes that raising prices (increasing travel times) decrease consumption and lowering prices (decreasing travel times) increase consumption. At any rate it is reasonable to expect the travel response to improved CRC access to be positive but limited in extent.

Impact on Land Use

Littman (2010 (2), p.16)[7] cites several empirical studies of the 1980's illustrating the impact of transportation improvements (freeways of the 50 and 60's) on land use development and densities. Most of these studies based on data from the 50's through 80's cite substantial impacts from the Interstate Highway System (Baum-Snow, 2007)[8]. Iacono and Levinson (2009) [9]looking at recent data report much lower impacts of transportation on land use relative to existing and neighboring land uses. Many empirical studies of the impact of transportation on land use are fairly local in nature such as impact of rail transit on station areas (Cervero, 1993)[10]. Interestingly, most of the large scale studies of the impact of transportation on land use involve the use of simulation models. For instance, Vogt, Troy, Miles, Reiss (2009, p. 91)[11] report real estate changes on the order of -1.0 to 5.0% as travel times were allowed to fluctuate from constant assumptions over a 40 year period using the UrbanSim integrated model. Similarly, May, Shepard, *et.al.*(2005, p. 135)[12] found small impacts of transport strategies on land use in a number of European cities using a simulation model. Weidner, Knudson, Picado, Hunt (2009, p. 114)[13] find that a state wide regime of increased highway capacity dispersed households and employment, reduced central city prices and increased those of outlying areas. Overall shifts of 1 to 2% were observed with increased highway capacity within a 100 mile corridor. Moving to theoretical models the relationship between land use and transportation has always been completely explicit. Since the 1950's (for instance Stevens, 1958, 1960)[14] we have modeled transportation and land use as reverse sides of the same coin – minimizing transportation maximizes location rents – a classic primal-dual programming problem. Large numbers of urban and regional theoretical models have been developed since but the role between transportation and land use has remained pivotal. However, theoretical models provide no guidance on the degree to which land use should change in response to particular infrastructure improvements.

Based on a fairly limited literature review it appears that studies of impacts of transportation improvements on land use conducted on post war through 1980's data, suggest a much larger impact than do studies and simulation models calibrated on recent data.

Tolling Studies

Langer and Winston (2008, p. 156)[15] report on an empirically based study of the impacts of a widespread tolling regime on land use. Based on national data they find that tolling increases urban densities, decreases home prices and decreases VMT. Zhou and Kockelman (2009, p. 80)[16] in a simulation model study found that a region wide combination of tolling and road user charges reduced VMT 15%. Kalmanje and Kockelman (2004, pp. 50 – 51)[17] found that a general regime of congestion pricing produced home price reductions on the order of 1.5 to 6.0% in the Austin Texas region. Significantly, their model predicted a slight increase in CBD home prices (p. 51). Anas and Xu (1999, p. 470)[18] construct a theoretical model that predicts that congestion pricing results in increased densities and increased rents and wages in the central area. Similarly, Anas and Rhee (2006, pp 19, 27, 28)[19] develop another theoretical model that indicates that tolling results in increased rents, increased densities and decreased VMT. In sum existing literature points to some level of tolling (congestion pricing) as decreasing VMT, increasing densities and decreasing home prices with the possible exception of central locations.

What We Did

In order to evaluate the impacts of the CRC project we performed 3 runs of MetroScope in conjunction with the full Portland Metro travel demand model. The first run consisted of a "no build" scenario (Scenario 1033) which kept the bridge in its current configuration. The second run consisted of the "build with no tolling" scenario (Scenario 1063) which consisted of adding the 12 lane bridge configuration, the light rail line extension, and pedestrian/bike facilities. The final scenario (Scenario 1053) consisted of adding the same facilities but with the addition of a $2.00 toll for crossing the bridge. Significant is that the alternative Columbia River crossing, the Interstate 205 Bridge, was not tolled in this scenario leaving the possibility of cost sensitive travelers the option of diverting to the I- 205 corridor. Also following contemporary practice the toll was imposed during the traffic assignment phase of the 4 step model and further reflected in the trip distribution module as well.

To fully reflect the effects of tolling and the transit additions in the build alternatives, we modified the travel times that MetroScope is calibrated for by converting the logsum impedances back into travel times that account for the utility changes of the additional transit and the bridge toll. Figure 3 below illustrates the change in travel times resulting from the procedure.

Tolling and Transit Adapted to Travel Time in Land Use Modules – Logsums "Reverse Engineered" Back to Travel Times – More Transit Reduces Time; Tolling Increases It.

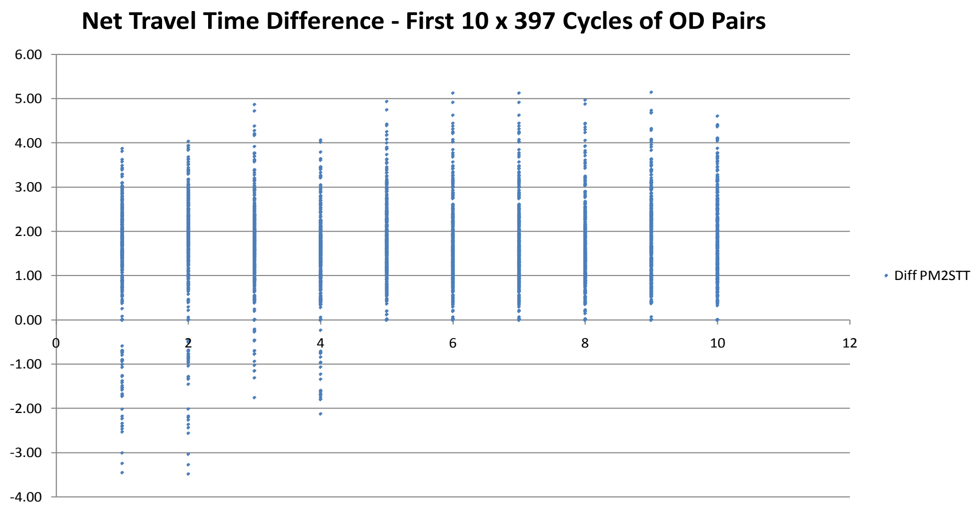


Figure 3: We transformed zone pair auto travel times to account for tolling and enhanced transit effects by adjusting travel time up and down as indicated.

Figure 3 indicates that for zone pairs with the transit additions but not subject to the toll, the "effective" travel time dropped between 0 and 4 minutes. For zones pairs subject to the toll effective travel time increased from 0 to approximately 3.5 minutes. Interestingly enough, zone pairs between the Portland CBD and Clark County experiencing both the toll and the transit improvements had very little change in net travel time as the transit roughly canceled out the toll.

What We Found

Induced Traffic and Travel Times

A fortuitous attribute of using regional simulation models is that we can examine outcomes from several perspectives at various spatial scale levels. The first helpful piece of information that we should know is just how much travel time savings does 3.5 – 4.0 billion dollars buy these days? Figure 4 below summarizes the impact of building the CRC project with and without tolling.

Results – Change in "Impedance" Measured in Minutes of Commute Travel Time

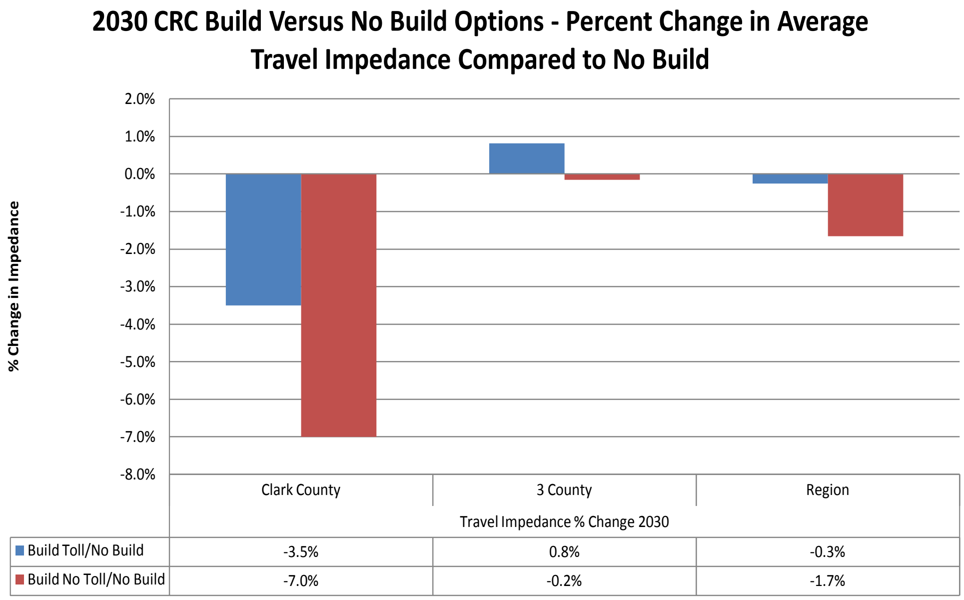


Figure 4: The CRC project slightly reduces travel "impedance" within the region. Imposing tolls minimizes the reduction in impedance.

In Figure 4 we compare the "impedance change" measured in minutes of travel time for 3 levels of geography – the 4 county region, the 3 Oregon Counties and the County most directly impacted – Clark County in Washington. Looking first at the largest scale – the region, the answer to our question is: not much. Without tolling the regional average reduction in travel time amounts to 1.7%. Furthermore, we note that the 3 Oregon Counties experience almost no gain while Clark County shows a 7.0% drop in travel time. Imposing a toll at the I-5 bridge reduces the impact even further – a .3% drop region-wide, an .8% increase on the Oregon side and a 3.5% decrease in Clark County.

Since the native geography of MetroScope is the census tract, we may also look at the travel time impacts on a more detailed spatial scale. Figure 5 displays the average travel time savings (impedance savings) by census tract.

Build with No Toll Benefits Clark County

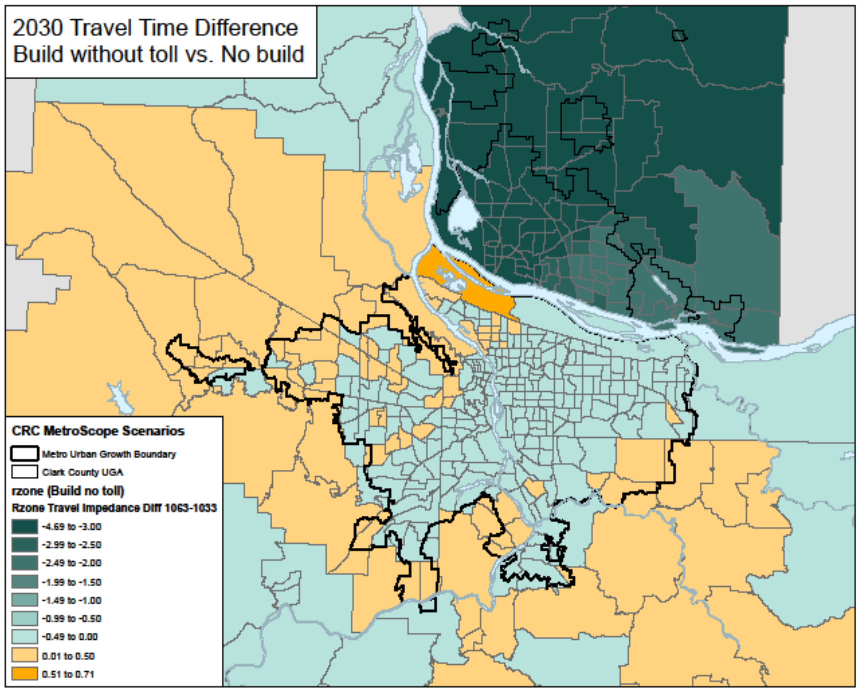


Figure 5: The limited travel impedance savings are concentrated in Clark County.

As widely anticipated with the Portland Metro Region the 12 lane CRC project does indeed provide the largest travel time (impedance) savings to Clark County while a few freeway dependent Oregon census tracts experience minor increases in travel time. Significantly, no Clark County census tract achieves a travel time reduction in excess of 5 minutes.

Figure 6 provides the same information for the Build with Toll option.

Build with Toll Reduces Travel Time Effects

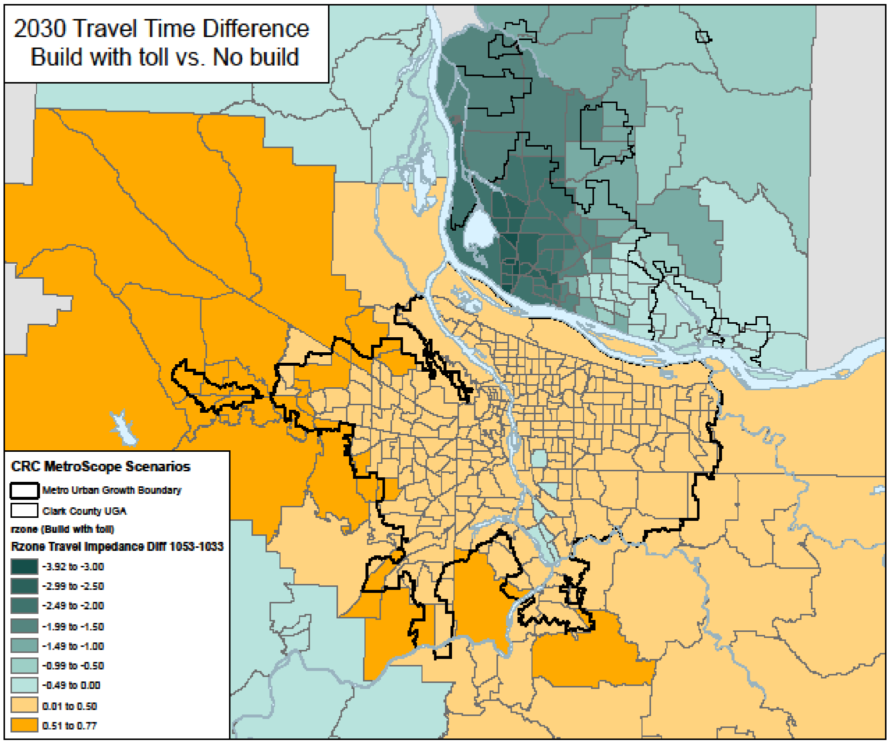


Figure 6: Tolling reduces the impedance savings throughout the region with the Oregon side experiencing increases in impedance relative to the no build option.

Figure 6 shows that while Clark County still experiences reductions in travel time (impedance), far fewer census tracts experience even a 3 minute drop in impedance. The Oregon side almost uniformly experiences a slight increase over the no build option. The impact on Oregon owes to freeway queuing effects resulting from diversion from I-5 to I-205 with increased freeway use in general disproportionately affecting peripherally located and freeway dependent census tracts in Oregon. Examining the results displayed in Figures 5 and 6 raises the issue of what is it that the CRC project is intended to achieve? Measured as travel time savings, the project in whatever configuration appears to have a very modest effect.

Moving directly to the question of induced traffic we first measure the change in commute trip lengths from the MetroScope land use modules to make an estimate of traffic change generated from land use changes. Figure 7 displays these results.

Induced Traffic – Effects of Land Use Change

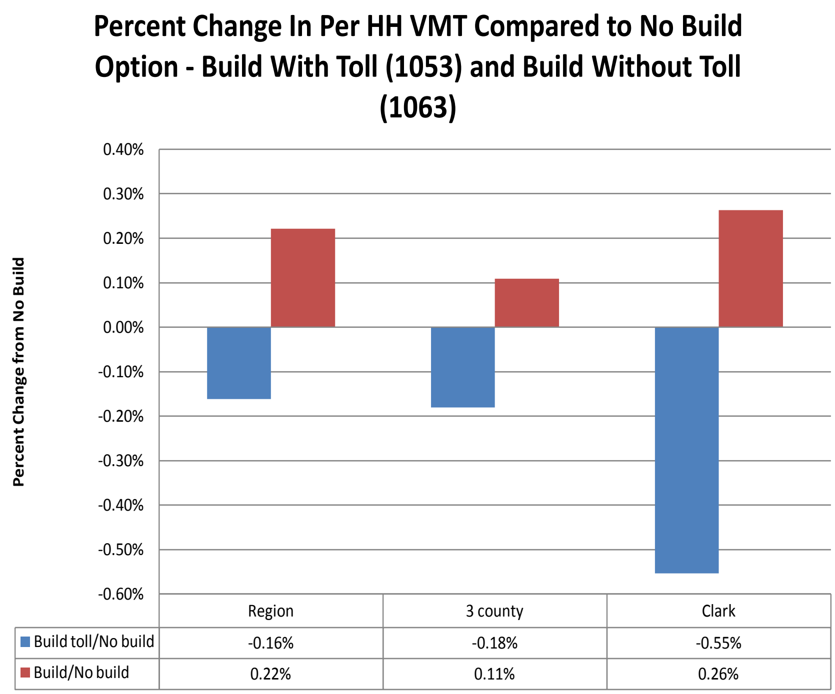


Figure 7: The CRC project produces a small increase in per HH VMT but imposing a toll decreases VMT below the no build alternative.

Figure 7 indicates that induced traffic effects exist but like travel time savings they are quite small. Region-wide the build without toll option lengthens commute trip lengths .22% with the range being .26% in Clark County and .11% on the Oregon side. The tolling alternative reduces commute trip lengths throughout the region relative to the no build alternative and up to .55% in Clark County.

Figure 8 provides a more comprehensive view of the travel impacts measured from the travel demand model and including all travel within the region.

Induced Travel – Total Effects Tolling and No Tolling Compared to No Build

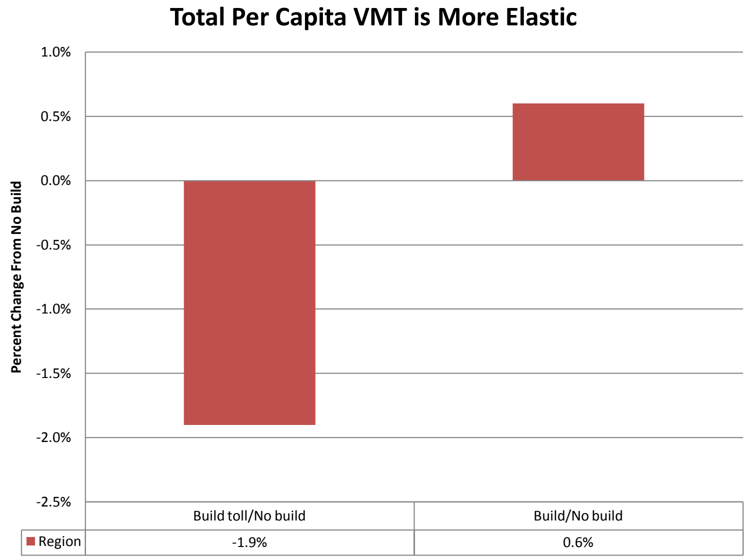


Figure 8: Comprehensive VMT estimates from the travel model indicate a regional increase in VMT of .6% without the toll and a reduction of 1.9% with the toll for the entire 4 County region.

Figure 8 indicates that the build without toll option induces a .6% increase in vehicle miles traveled region-wide while building with the toll in place results in a 1.9% reduction. The build with no toll result suggests an "elasticity" of about .3; on the low side of the literature range but not unprecedented. The build with toll result however is much stronger than the change in travel times would suggest but may be explained by the change in location and housing type selection associated with the tolling option and reported on later.

In sum, at the most general level our results indicate that the CRC project produces a modest change in travel times over a limited area of the region and accordingly results in an even more modest impact on traffic generation. Our results also support the presumption that the impacts may be alleviated or even reversed by imposing tolls on the CRC project.

Land Use Impacts

Next we move on to land use impacts. We note here that we do not report on the nonresidential side but simply to note that there do exist equally voluminous data that point to the same results. Figure 9 presents the outcomes for the build with no toll option compared to the no build.

Land Use Impacts – Build with No Toll – Small (1%) Change Favoring Single Family on the Urban Edge

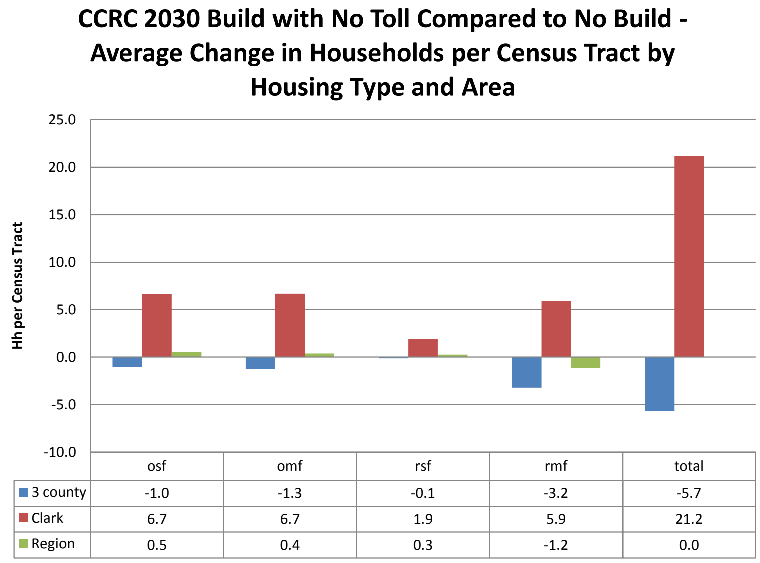


Figure 9: CRC building with no toll increases demand in Clark County; decreases growth slightly on the Oregon side and favors osf and omf (owner single family, owner mullti-family) over rmf (rental multi-family).

The most salient aspect of Figure 9 is that the land use impacts move in the direction we anticipate to Clark County and away from the Oregon Counties. Like travel time savings, the impacts are very small; usually less than 1/3 the size (measured as percentages) of the travel time impacts. In Figure 9 to enhance contrast we measure actual dwelling unit differences rather than percentages. We note that Clark County census tracts on average gain 21 units and Oregon census tracts lose about 6 units through 2030. Consistent with the claims of many new urbanists, we also see a shift from denser renter multi-family products towards more land consuming single family owner products located in the urban periphery. However, while consistent across space, these effects are very small and would likely not be detectable in an after the fact empirical measurement.

Figure 10 provides the spatial detail for owner single family (OSF) and owner multi-family (OMF) production.

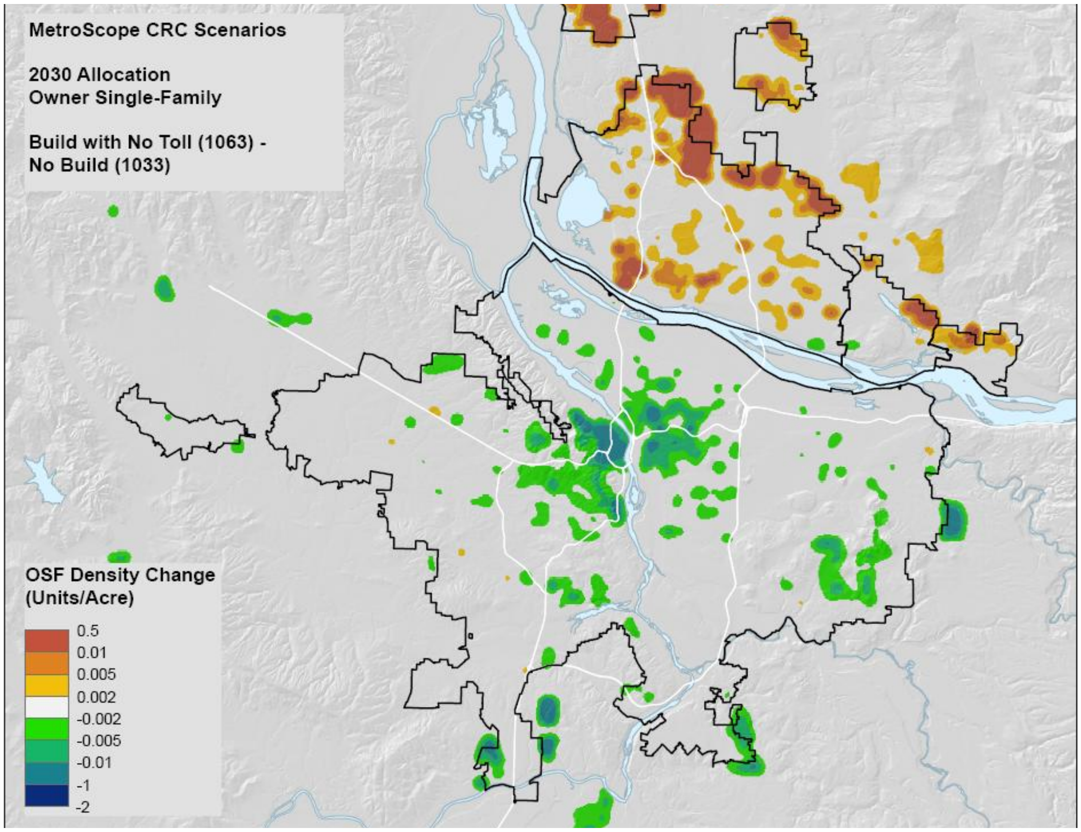
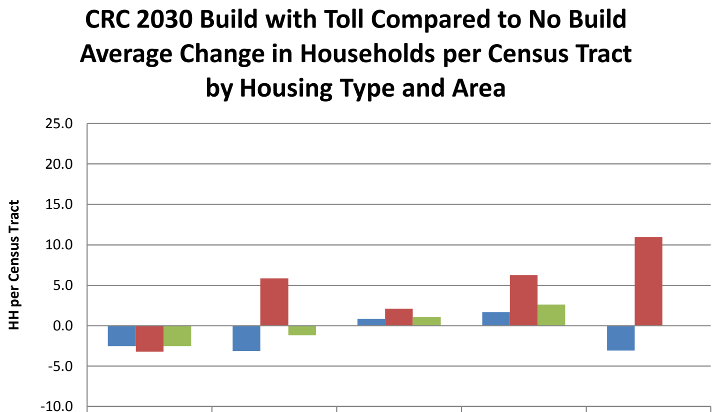


Figure 10: Compared to no build, the build without toll option clearly shifts osf allocation from Oregon central city locations northward to the edge of the Clark County Growth Management Area.

Figure 10 indicates that building the CRC without tolling reduces densities within the CBD on the Oregon side and increases them in Clark County, particularly at the edge of the Growth Management Area.

Figure 11 presents the land use impacts for the build with tolling option.

Land Use Impacts – Build with Toll –Small but Favoring Multi-Family and Central Locations



	osf	omf	rsf	rmf	total
3 county	-2.5	-3.1	0.9	1.7	-3.1
Clark	-3.2	5.8	2.1	6.2	11.0
Region	-2.5	-1.2	1.1	2.6	0.0

Figure 11: Tolling cuts in 1/2 the land use impacts of the CRC project and favors renter and multi-family over owner and single family.

Mirroring the travel time savings results the tolling option produces smaller effects than the build with no tolling option. Intriguingly, the tolling option also shifts housing production slightly in favor of renter and higher density multi-family products. Region-wide owner occupied products decrease and renter increase. Moreover, even in Clark County owner occupied single family output decreases relative to the no build baseline.

Figures 12 and 13 provide the details for owner single family and renter multi-family output.

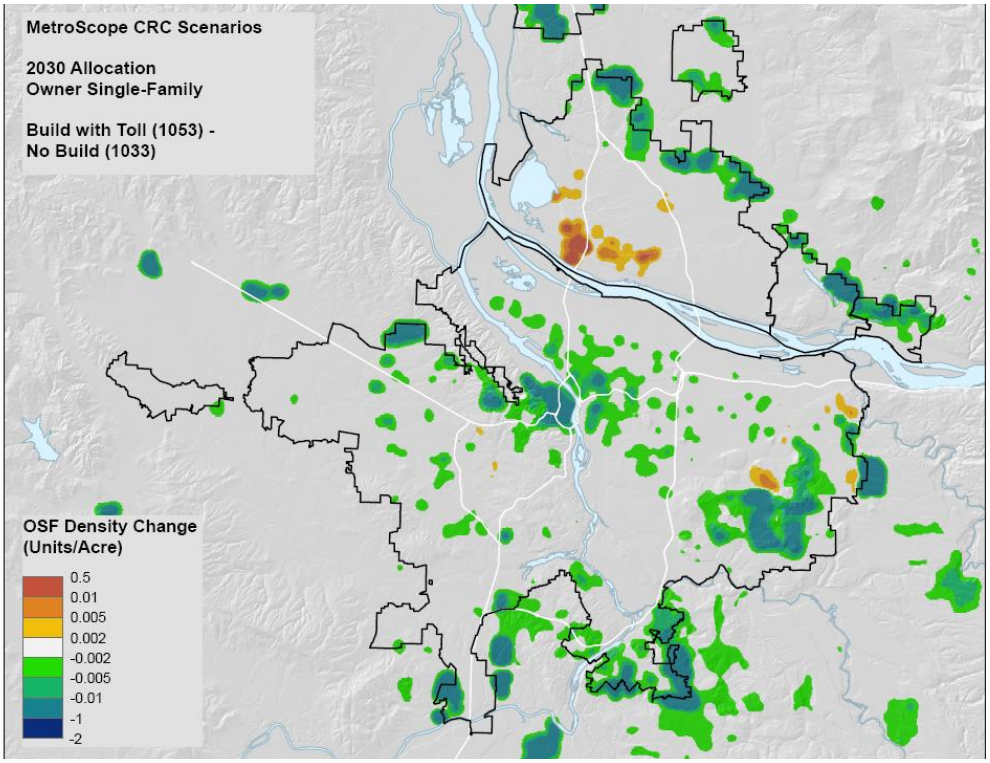


Figure 12: Tolling reduces single family most everywhere particularly at the urban edges. Only the Vancouver CBD has increases.

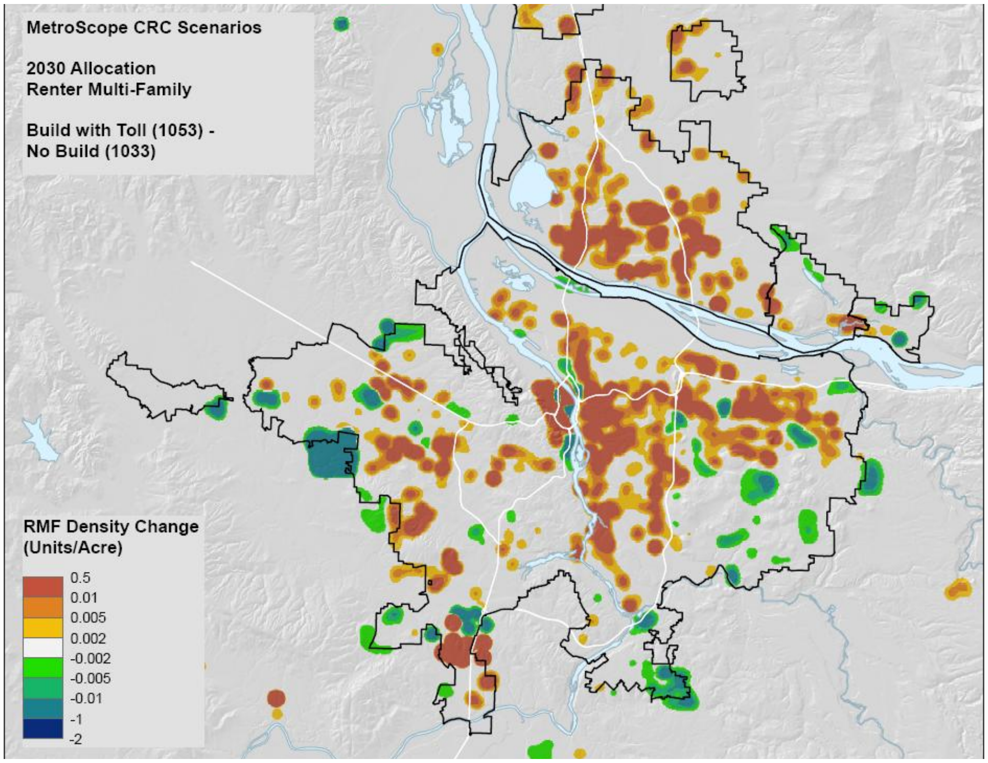


Figure 13: Tolling increases renter multi-family throughout the region particularly in dense central areas and along transit corridors.

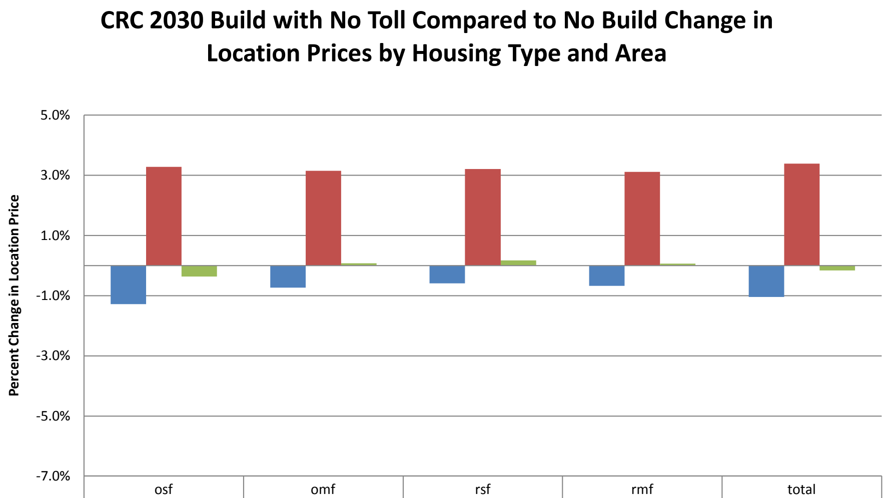
In Figures 12 and 13 we may discern that the effect of the CRC tolling option is to shift from owner to renter and to higher density, more centrally located areas. Though the effects are small, they are consistent across housing types and space.

In terms of land use impacts the MetroScope runs indicate that though the CRC project does have small land use impacts in the direction presumed these impacts like travel time savings are very small. Furthermore, not only are these impacts ameliorated with a tolling option, the tolling option suggests shifts to higher density, more centrally located housing products than would be expected with the no build option.

Tolling and Housing Prices

MetroScope belongs to the class of aggregate, static, neoclassical equilibrium models. As such the model simulations are driven by price changes as the model for a set of input initial conditions and policy options, seeks to balance demand and supply by changing prices. Literally, for every action there is an equal reaction. If the CRC project benefits Clark County, then not only dwelling unit allocations but housing prices must rise. Equivalently, if the Oregon side loses dwelling units, then housing prices must decline. This equilibrium seeking, built into the model, reduces the impact of any particular policy option. Figure 14 displays housing price changes of the build without tolls option relative to the no build scenario.

Housing Prices – Build with No Toll – Increase for Clark; Decrease for Region



	osf	omf	rsf	rmf	total
3 county	-1.3%	-0.7%	-0.6%	-0.7%	-1.0%
Clark	3.3%	3.1%	3.2%	3.1%	3.4%
Region	-0.4%	0.1%	0.2%	0.1%	-0.2%

Figure 14: Building the CRC project without tolling increases Clark County housing prices and reduces housing prices on the Oregon side.

Figure 14 indicates that prices change much as expected for all dwelling unit types within the Oregon side and Clark County. Clark County goes up 3.4% (compared to a 1% dwelling unit gain) and the Oregon side goes down 1% (compared to about 1/3 of a percent loss of DU.) Overall, housing prices drop .2% compared to the no build.

Figure 15 illustrates the spatial distribution of the price effects.

Owner Prices – Build with No Toll – Up in Clark and Down in Oregon

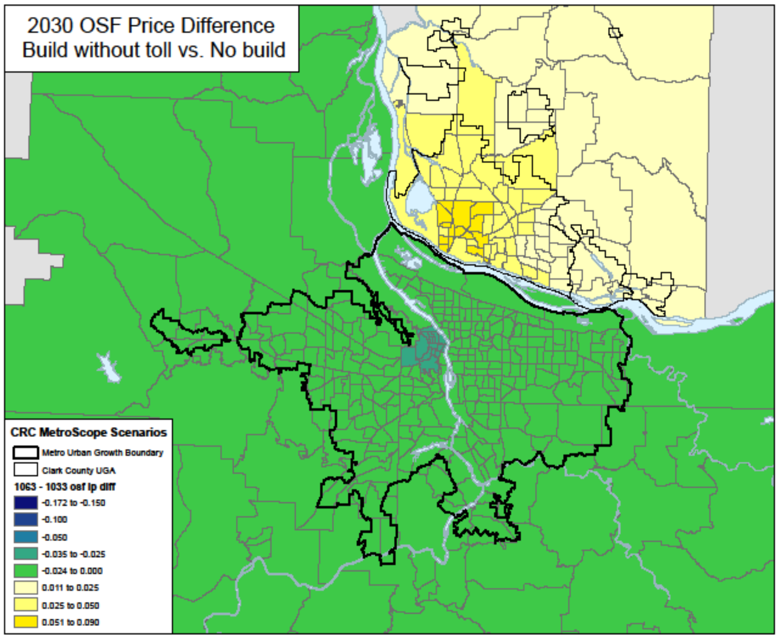
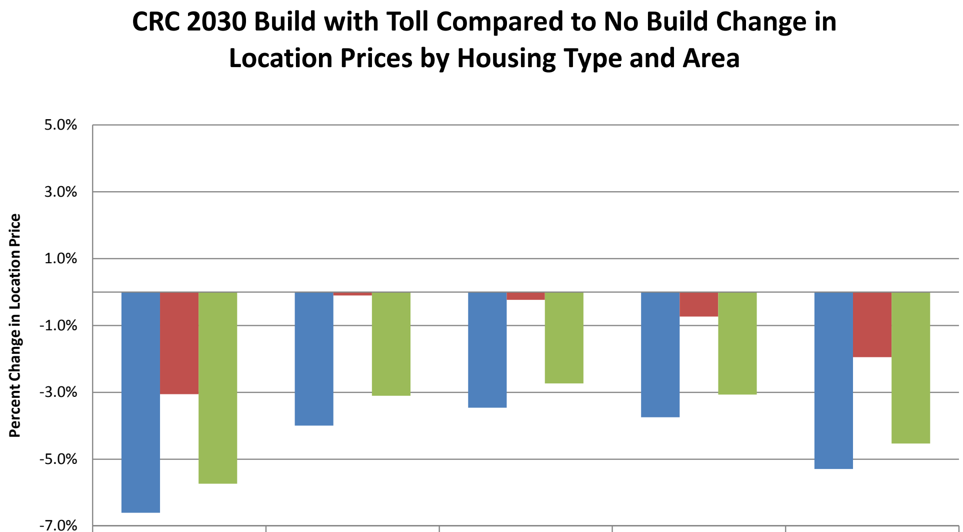


Figure 15: Building with no toll results in lowered prices on the Oregon side and increases on the Clark County side. The Portland CBD experiences the largest drop while the Vancouver CBD exhibits the largest increase.

Figure 15 indicates the largest price drops are in the Portland CBD and the largest price increases are in the Vancouver CBD closest to the CRC project. Building the CRC project without using a toll has very straight forward effects – a small bit of welfare is transferred from the Oregon side to the Washington side. Those familiar with the planning and political background of the project will not find this surprising. What is surprising is the very small size of the impact.

We now move to the question of how tolling impacts housing prices given the shift toward renter and higher density, more centrally located products that we previously discussed. Figure 16 provides the tabular results.

Housing Prices – Build with Toll – All Prices Drop with Largest Effect for Single Family



	osf	omf	rsf	rmf	total
3 county	-6.6%	-4.0%	-3.5%	-3.7%	-5.3%
Clark	-3.1%	-0.1%	-0.2%	-0.7%	-1.9%
Region	-5.7%	-3.1%	-2.7%	-3.1%	-4.5%

Figure 16: Tolling the CRC project drops housing prices throughout the region with owner single family dropping the most.

Figure 16 provides an outcome rarely seen in a price response to a public policy option; namely a *drop in prices*. Region-wide prices drop 4.5% in response to a 2 dollar toll very few commuters actually pay. Furthermore, the drop is spread across all housing types in most areas. Significantly, the largest drops are in the single family category that experienced the largest drop in demand with the tolling option.

Figure 17 provides the spatial distribution of the price impact for owner single family.

Owner Prices with Toll – Lower Everywhere Except Vancouver CBD (Transit Effect)

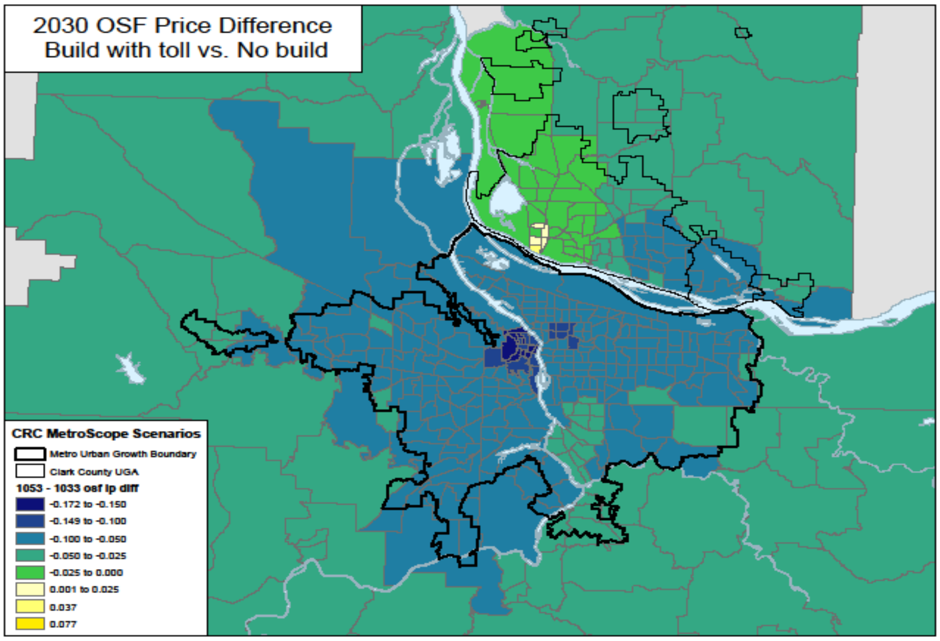


Figure 17: Only the Vancouver CBD sees an increase in prices with the tolling option.

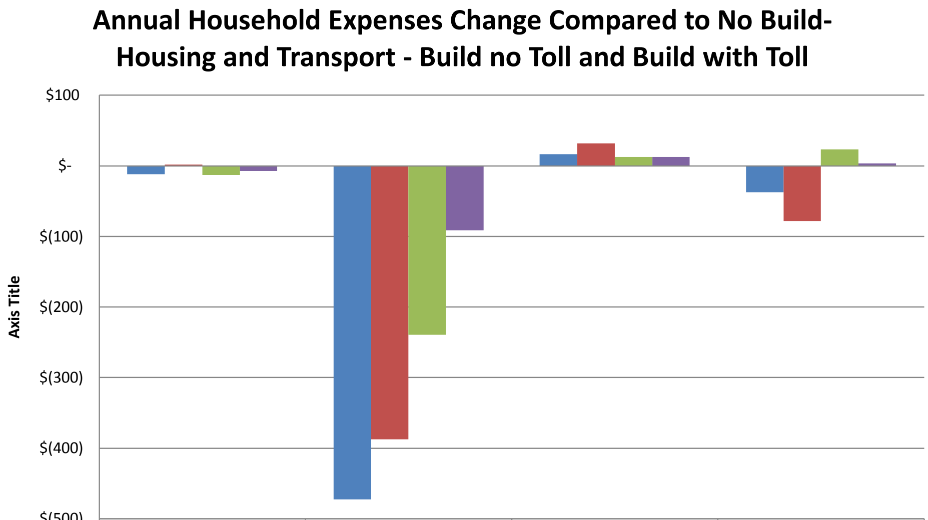
Figure 17 indicates that owner prices have dropped throughout the region with the exception of several census tracts immediately north of the CRC project in the Vancouver CBD area. The largest price reductions occur in the Portland CBD and in another area 2 miles to the east that also has a high degree of centrality.

Since the tolling option is applied only to the CRC project, it is presumptuous to assert any generality for its effect. It may indeed be an idiosyncratic effect limited to the very long trips that we both model and observe in reality for commuters who tradeoff high housing consumption for long travel times. Also, since the toll is only applied in one place, commuters using the alternative 1-205 bridge route certainly contribute to queuing and increased travel times throughout the region.

Public Welfare Effects of Tolling Options

The tolling options both shift slightly housing output toward higher density products and reduce somewhat the prices of all housing products. Examining the square footage of physical housing output indicated no decrease in consumption with increased size of single family housing offsetting the shift to smaller high density multi-family products. We also tabulate for all classes of households, census tract locations and housing types the annual household expenditure for transportation and housing. Figure 18 below summarizes those calculations for the build no toll and the build with toll compared to the no build alternative.

Public Welfare Impacts – Annual Household Housing and Transport Cost with and without Tolling



	Transport Build toll	Housing Build toll	Transport Build	Housing Build
osf	$(12)	$(473)	$16	$(37)
omf	$2	$(388)	$32	$(78)
rsf	$(13)	$(239)	$13	$23
rmf	$(7)	$(91)	$13	$3

Figure 18: Tolling the CRC project results in substantial annual housing expense savings throughout the region.

Figure 18 displays slightly higher annual transportation costs for the build alternative and mixed results for annual housing costs. Transport costs with the toll option fall slightly and housing costs fall substantially with the largest impacts for owner single family and owner multi-family (condos). In Figure 19 we have converted these annual costs into a discounted lump sum estimate of the dollar value of the reduced housing prices assuming no net effect on aggregate housing consumption.

Public Welfare Effects – Net Present Value of Tolling Savings and No Tolling Savings over No Build

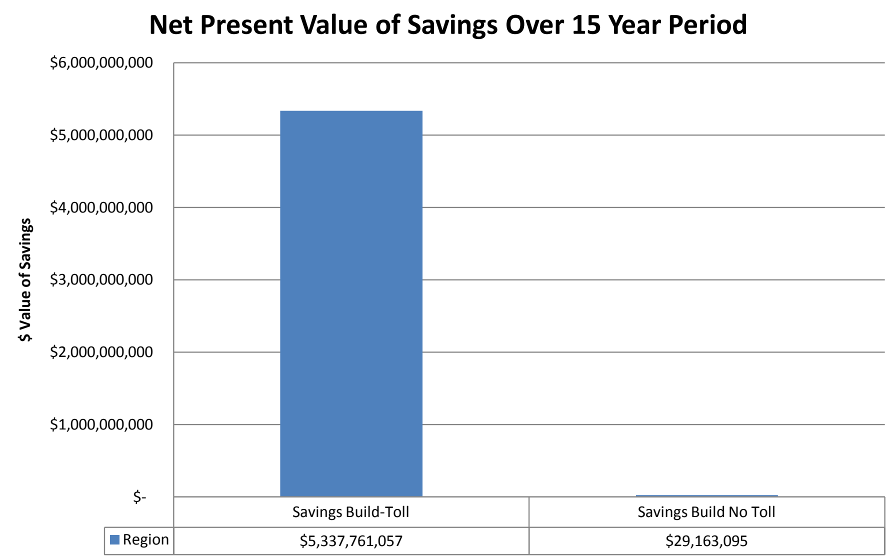


Figure 19: The present value of the tolling option summed over the entire region amounts to over 5 billion $.

Though not an exact measure of consumer surplus, the annualized cost savings of the tolling option amount to over 5 billion dollars; considerable in excess of the 3.5 – 4.0 billion $ cost of the CRC project.

Summary and Evaluation

In regard to the CRC project we used our in house integrated transportation and land use model, MetroScope, to evaluate three types of impacts associated with the the project. These are: induced travel, impacts on land use and the effect of tolls on travel and land use. Our results are as follows:

- Induced travel – Our results imply a change of about .3% growth of VMT for every 1% reduction in travel time. This is consistent on the low side with the results reported for other studies. Overall, growth of VMT in the region resulting from the CRC project is very small consistent with our measurements of the small regional travel time savings associated with the project.
- Impacts on land use - Impacts on land use occur but they are very limited and much less percentage wise (less than 1% at the regional scale) than the change in travel time. The CRC project produces small increases in single family home development in the urban periphery in Clark County primarily at the expense of

multi-family in the central areas of the region. Home prices for single family increase slightly in Clark County and decrease elsewhere.

- Effects of tolling on the CRC project – Applying tolls to the CRC project reverses the induced travel and land use impacts. It also has the salutary effect of reducing home prices, discouraging development at the urban periphery and encouraging higher density multi-family development within the urban core.

In our evaluation of these impacts we feel most comfortable with the induced travel outcomes as being consistent with findings elsewhere. The impacts on land use seem plausible given the fairly small regional reductions in travel time. Land use impacts are also consistent with other simulation model results and measurements from recent time periods. Given the widespread expectation that land use impacts are very large and some evidence from the pre 1990's era that they have been, we feel the issue is not completely settled. We conjecture at this point that fragmentary evidence points to the proposition that the value of access has declined since 1980's and that simulation models using recent parameters and calibrations are reflecting that outcome.

The most enticing yet speculative results involve the impacts of tolling. Given the interest in land use and transportation policies that mitigate GHG emissions, increasing the efficiency of existing transportation services, the need to fund replacement of aging infrastructure and supply new; the tolling results provide a strong incentive to declare tolling as a solution to our problems. However, we have considerable reservations regarding the generality of these results given the limited application of our tolling exercise. Also, while consistent in application with the approved methods of the previous CRC tolling study, one may argue that the traditional 4 step model with the tolling charge as an impedance add on within the traffic assignment module, does not fully reflect the behavioral aspects of the tolling choice. For these reasons we would urge extreme caution when interpreting the tolling results. Far more empirical measurement, simulation experiments and relevant theoretical investigations need be done.

End Notes - Bibliography

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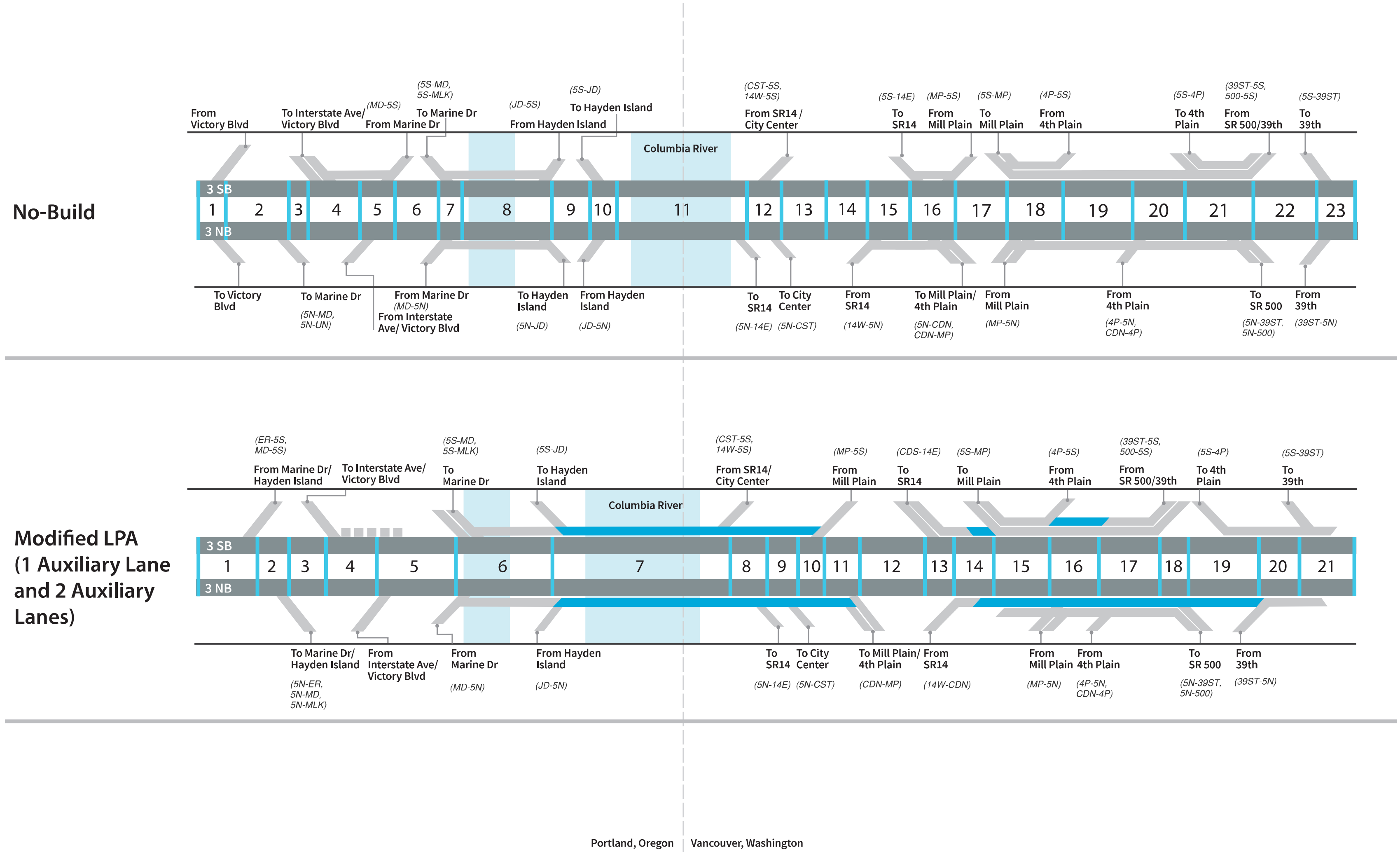
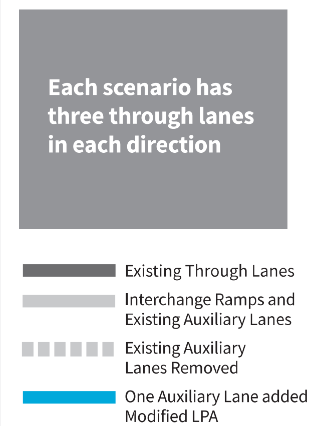
Appendix I. HSM Safety Analysis (Inputs and Outputs)

ISATe Safety Analysis Mainline Segmentation





Notes:

Collector Distributor Lanes not shown.

The traffic operations analysis incorporating both the one and two auxiliary lane design option applies equally to all bridge configuration options in this Draft SEIS.

The C Street ramp (NB to City Center) is an option.

Figure is not to scale.

DRAFT

2045 No Build Conditions: I-5 Mainline ISATe Inputs

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period	Segment 10 Study Period	Segment 11 Study Period	Segment 12 Study Period	Segment 13 Study Period	Segment 14 Study Period	Segment 15 Study Period	Segment 16 Study Period	Segment 17 Study Period	Segment 18 Study Period	Segment 19 Study Period	Segment 20 Study Period
Basic Roadway Data																				
Number of through lanes (n):	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	8	8	8
Freeway segment description:	164+83.98-16	162+12.49-15	151+09.28-14	140+00-130+	130+60.68-12	128+44.76-11	112+92.05-10	A108+35.489	A96+72.32-85	85+33.98-80+	17+20.57-48+	48+84.79-52+	52+51.748-57	110+38.02-12	121+12.85-12	125+71.64-13	130+12.99-15	156+56.9-166	166+27.56-17	176+88.86-18
Segment length (L), mi:	0.051419	0.208941	0.210091	0.177902	0.040894	0.294074	0.08647	0.220297	0.215595	0.101133	0.599284	0.0695	0.095466	0.203566	0.086892	0.083589	0.500741	0.183837	0.201004	0.064653
Alignment Data																				
Horizontal Curve Data ↖See note																				
1 Horizontal curve in segment?:	No	Both Dir.	Both Dir.	No	No	Both Dir.	Both Dir.	No	Both Dir.	No	Both Dir.	Both Dir.	No	Both Dir.	Both Dir.	No	Both Dir.	Both Dir.	Both Dir.	No
Curve radius (R_1), ft:		2795	2795			5729.58	5730		7247		1400	1400		3400	3400		2800	2800	2800	
Length of curve (L_{c1}), mi:		0.157888	0.157888			0.116477	0.116477		0.09154		0.09618	0.09618		0.23227	0.23227		0.205398	0.205398	0.205398	
Length of curve in segment ($L_{c1,seg}$), mi:		0.002611	0.155277			0.004845	0.111633		0.09154		0.04025	0.05593		0.203566	0.028704		0.007558	0.183837	0.014002	
2 Horizontal curve in segment?:		No	No			No	No		Both Dir.		No	No		No	No		No	No	No	
Curve radius (R_2), ft:									7247											
Length of curve (L_{c2}), mi:									0.09154											
Length of curve in segment ($L_{c2,seg}$), mi:									0.09154											
3 Horizontal curve in segment?:									No											
Curve radius (R_3), ft:																				
Length of curve (L_{c3}), mi:																				
Length of curve in segment ($L_{c3,seg}$), mi:																				
Cross Section Data																				
Lane width (W_l), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Outside shoulder width (W_s), ft:	10	10	10	10	10	10	10	10	10	10	4	13	13	13	13	13	13	13	13	13
Inside shoulder width (W_{is}), ft:	8	8	8	8	8	8	8	8	8	8	2	12	12	12	12	12	12	12	12	12
Median width (W_m), ft:	18	18	18	18	18	18	18	18	18	18	4	37	26	26	26	26	26	26	26	26
Rumble strips on outside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Rumble strips on inside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Presence of barrier in median:	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center
1 Length of barrier ($L_{ib,1}$), mi:	0.051419	0.208941	0.210091	0.177902	0.040894	0.294074	0.08647	0.220297	0.215595	0.101133	0.599284	0.0695	0.095466	0.203566	0.086892	0.083589	0.500741	0.183837	0.201004	0.064653
Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	8	8	8	8	8	8	8	8	8	8	2	12	12	12	12	12	12	12	12	12
2 Length of barrier ($L_{ib,2}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:																				
3 Length of barrier ($L_{ib,3}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:																				
4 Length of barrier ($L_{ib,4}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:																				
5 Length of barrier ($L_{ib,5}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:																				
Median barrier width (W_{ib}), ft:	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:																				
Roadside Data																				
Clear zone width (W_{hc}), ft:																				
Presence of barrier on roadside:	None	Full	Some	Some	Full	Some	Full	None	Some	None	Full	Some	None	None	None	Some	Some	None	None	None
1 Length of barrier ($L_{ob,1}$), mi:			0.125519	0.04054		0.061356			0.015119			0.010661				0.007214	0.0619			
Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			10	10		10			10			13				13	13			
2 Length of barrier ($L_{ob,2}$), mi:			0.04054	0.177902		0.054407											0.075371			
Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			10	10		10											13			
3 Length of barrier ($L_{ob,3}$), mi:			0.210091			0.019992														
Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			10			10														
4 Length of barrier ($L_{ob,4}$), mi:						0.185364														
Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:						10														
5 Length of barrier ($L_{ob,5}$), mi:						0.025116														
Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:						10														
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:		10			10		10				4									
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:		10			10		10				4									
Ramp Access Data																				
Travel in Increasing Milepost Direction																				
Entrance Ramp: Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	No	Lane Add	No	No	S-C Lane	No	No	No	No	Lane Add	No	No	Lane Add	No	S-C Lane
Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:	999	999	999	999		0.040894		0.08647	0.306767		0.101133	0.700417	0.769916	0.865383		0.086892	0.170481		0.183837	
Length of ramp entrance ($L_{en,inc}$), mi:					0.062468					0.05375										0.155489
Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:					0.040894					0.05375										0.064653
Entrance side?:					Right					Right										Right
Exit: Ramp exit in segment? (If yes, indicate type.):	No	S-C Lane	No	No	No	No	No	Lane Drop	No	No	S-C Lane	No	No	No	No	Lane Drop	No	No	No	No

Ramp	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:		999		0.819636	0.641735	0.600841	0.306767	0.220297		0.700417	0.599284		0.469514	0.374047	0.170481	0.083589		0.685613	0.501776	0.300773	0.236119
	Length of ramp exit ($L_{ex,inc}$), mi:			0.02929									0.027255									
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			0.02929									0.027255									
	Exit side?:			Right									Right									
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No	Yes
	Length of weaving section ($L_{wev,inc}$), mi:																0.168089	0.168089				0.297489
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:																0.0845	0.083589				0.064653
Travel in Decreasing Milepost Direction																						
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		S-C Lane	No	No	No	Lane Add	No	No	Lane Add	No	No	No	S-C Lane	No	No	No	Lane Add	No	S-C Lane	No	No
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			0.428886	0.218795	0.040894		0.306767	0.220297		0.769916	0.668784	0.0695		0.374047	0.170481	0.083589		0.183837		0.300773	0.236119
	Length of ramp entrance ($L_{en,dec}$), mi:		0.135441											0.097381						0.052964		
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:		0.135441											0.0695						0.052964		
	Entrance side?:		Right											Right						Right		
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		No	No	No	Lane Drop	No	No	Lane Drop	No	No	S-C Lane	No	No	No	No	No	Lane Drop	No	Lane Drop	No	No
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:		999	999	999		0.177902	0.218795		0.08647	0.306767		0.101133	0.700417	0.769916	0.865383	1.068949		0.083589		0.183837	0.384841
	Length of ramp exit ($L_{ex,dec}$), mi:											0.033364										
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:											0.033364										
	Exit side?:											Right										
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No
	Length of weaving section ($L_{wev,dec}$), mi:																			0.157888		
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:																			0.157888		
Traffic Data		**Year**																				
Proportion of AADT during high-volume hours (P_{hv}):																						
Freeway Segment Data		2045	112800	108500	106300	116100	132600	130200	176200	176200	159700	180000	180000	162100	133200	133200	151800	175600	138000	173400	164600	174400
Average daily traffic ($AADT_{fs}$) by year, veh/d:		2046																				
(enter data only for those years for which		2047																				
it is available, leave other years blank)		2048																				
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Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**																				
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045					16500	16500	22900	22900	22900	8100	8100	8100	8100	8100	18600	18600	18600	18200	18200	9800
(enter data only for those years for which		2046																				
it is available, leave other years blank)		2047																				
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Exit Ramp Data for Travel in Increasing Milepost Direction		**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:		2045		2200	7800	7800	7800	7800	7800	7800	17900	17900	17900	4600	18900	18900	18900	18900	28700	28700	28700	28700
(enter data only for those years for which		2046																				
it is available, leave other years blank)		2047																				

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Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**																				
Average daily traffic ($AADT_{e,ent}$) by year, veh/d:	2045	3900	2400	2400	2400	2400	8700	8700	8700	24300	24300	24300	24300	18700	18700	18700	18700	8800	8800	27600	27600
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045				9800	9800	9800	23100	23100	23100	12200	12200	12200	12200	12200	12200	23800	23800	17200	17200	17200
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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	2067																				
	2068																				
Crash Data	**Year**	Segment Crashes -->																			
Count of Fatal-and-Injury (FI) Crashes by Year																					
Multiple-vehicle crashes	2045																				
(not ramp related) ($N_{o,fs,n,mv,fi}$)	2046																				
	2047																				
	2048																				
	2049																				
Single-vehicle crashes	2045																				

2045 No Build Conditions: I-5 Mainline ISATe Inputs

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14	Segment 15	Segment 16	Segment 17	Segment 18	Segment 19	Segment 20
		Study Period	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data																					
Number of through lanes (n):		8	6	6																	
Freeway segment description:		180+30.29-19	192+77-215+6	215+65.46-219+92.04																	
Segment length (L), mi:		0.236119	0.43342	0.080792																	
Alignment Data																					
Horizontal Curve Data	←See note																				
1	Horizontal curve in segment?:	No	Both Dir.	No																	
	Curve radius (R_1), ft:		2600																		
	Length of curve (L_{c1}), mi:		0.142811																		
	Length of curve in segment ($L_{c1,seg}$), mi:		0.142811																		
2	Horizontal curve in segment?:		No																		
	Curve radius (R_2), ft:																				
	Length of curve (L_{c2}), mi:																				
	Length of curve in segment ($L_{c2,seg}$), mi:																				
3	Horizontal curve in segment?:																				
	Curve radius (R_3), ft:																				
	Length of curve (L_{c3}), mi:																				
	Length of curve in segment ($L_{c3,seg}$), mi:																				
Cross Section Data																					
Lane width (W_l), ft:		12	12	12																	
Outside shoulder width (W_s), ft:		13	13	13																	
Inside shoulder width (W_{is}), ft:		12	12	12																	
Median width (W_m), ft:		26	26	26																	
Rumble strips on outside shoulders?:																					
	Length of rumble strips for travel in increasing milepost direction, mi:																				
	Length of rumble strips for travel in decreasing milepost direction, mi:																				
Rumble strips on inside shoulders?:																					
	Length of rumble strips for travel in increasing milepost direction, mi:																				
	Length of rumble strips for travel in decreasing milepost direction, mi:																				
Presence of barrier in median:		Center	Center	Center																	
1	Length of barrier ($L_{ib,1}$), mi:	0.236119	0.43342	0.080792																	
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	12	12	12																	
2	Length of barrier ($L_{ib,2}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:																				
3	Length of barrier ($L_{ib,3}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:																				
4	Length of barrier ($L_{ib,4}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:																				
5	Length of barrier ($L_{ib,5}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:																				
Median barrier width (W_{ib}), ft:		2	2	2																	
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:																					
Roadside Data																					
Clear zone width (W_{hc}), ft:																					
Presence of barrier on roadside:		None	Some	Some																	
1	Length of barrier ($L_{ob,1}$), mi:		0.006657	0.065718																	
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:		13	13																	
2	Length of barrier ($L_{ob,2}$), mi:		0.05578	0.042996																	
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:		13	13																	
3	Length of barrier ($L_{ob,3}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:																				
4	Length of barrier ($L_{ob,4}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:																				
5	Length of barrier ($L_{ob,5}$), mi:																				
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:																				
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:																					
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:																					
Ramp Access Data																					
Travel in Increasing Milepost Direction																					
Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	Lane Add																	

Ramp	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:		0.064665	0.300784																		
	Length of ramp entrance ($L_{en,inc}$), mi:																					
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:																					
	Entrance side?:																					
Exit	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No																	
Ramp	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			999	999																	
	Length of ramp exit ($L_{ex,inc}$), mi:																					
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:																					
	Exit side?:																					
Weave	Type B weave in segment?:		Yes	No	No																	
	Length of weaving section ($L_{wev,inc}$), mi:		0.297489																			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:		0.232824																			
Travel in Decreasing Milepost Direction																						
Entrance	Ramp entrance in segment? (If yes, indicate type.):		Lane Add	No	No																	
Ramp	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			999	999																	
	Length of ramp entrance ($L_{en,dec}$), mi:																					
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:																					
	Entrance side?:																					
Exit	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	Lane Drop																	
Ramp	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			0.236119																		
	Length of ramp exit ($L_{ex,dec}$), mi:																					
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:																					
	Exit side?:																					
Weave	Type B weave in segment?:		Yes	No	No																	
	Length of weaving section ($L_{wev,dec}$), mi:		0.236119																			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:		0.236119																			
Traffic Data		**Year**																				
Proportion of AADT during high-volume hours (P_{hv}):																						
Freeway Segment Data		2045	187000	130700	146900																	
Average daily traffic ($AADT_{fs}$) by year, veh/d:		2046																				
(enter data only for those years for which		2047																				
it is available, leave other years blank)		2048																				
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Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**																				
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045	9800	9800	7000																	
(enter data only for those years for which		2046																				
it is available, leave other years blank)		2047																				
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Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	28700																			
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	27600																			
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
	2048																				
	2049																				
	2050																				
	2051																				
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	2062																				
	2063																				
	2064																				
	2065																				
	2066																				
	2067																				
	2068																				
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045	12600	12600	8200																	
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
	2048																				
	2049																				
	2050																				
	2051																				
	2052																				
	2053																				
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	2058																				
	2059																				

2045 No Build Conditions: I-5/SR 500 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data										
Number of through lanes (n):		1	1	1	1	2	2	2	2	
Ramp segment description:		5N-39ST	39ST-5N	5S-39ST	39ST-5S	5N-500 1	5N-500 2	500-5S 1	500-5S 2	
Segment length (L), mi:		0.153443	0.182214	0.200317	0.202322	0.171793	0.263369	0.374235	0.089203	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Exit	Entrance	C-D Road	Connector	Connector	C-D Road	
Type of control at crossroad ramp terminal:		Signal	Signal	Stop	Yield					
Alignment Data										
Horizontal Curve Data ←See notes →										
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	1050	160	2600	180	1000	1000	800	3000	
	Length of curve (L_{c1}), mi:	0.033874	0.030811	0.026013	0.027347	0.191909	0.191909	0.167398	0.013513	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.033874	0.030811	0.026013	0.027347	0.045472	0.146438	0.167398	0.013513	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.009602	0	0.027471	0.104152	0.104152	0.175098	0.374235	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	No	No	No	No	
	Curve radius (R_2), ft:	2500	300	150	550					
	Length of curve (L_{c2}), mi:	0.027776	0.057926	0.092559	0.081723					
	Length of curve in segment ($L_{c2,seg}$), mi:	0.027776	0.057926	0.092559	0.081723					
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.078352	0.05135	0.080289	0.073497					
3	Horizontal curve?:	No	No	No	No					
	Curve radius (R_3), ft:									
	Length of curve (L_{c3}), mi:									
	Length of curve in segment ($L_{c3,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:									
4	Horizontal curve?:									
	Curve radius (R_4), ft:									
	Length of curve (L_{c4}), mi:									
	Length of curve in segment ($L_{c4,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:									
5	Horizontal curve?:									
	Curve radius (R_5), ft:									
	Length of curve (L_{c5}), mi:									
	Length of curve in segment ($L_{c5,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:									
Cross Section Data										

Lane width (W_l), ft:		15	15	15	15	12	12	12	12	
Right shoulder width (W_{rs}), ft:		8	8	8	8	9.5	9.5	10	10	
Left shoulder width (W_{ls}), ft:		4	7	7.5	4	4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:									
Roadside Data										
Presence of barrier on right side of roadway:		Yes	Yes	No	Yes	No	Yes	Yes	No	
1	Length of barrier ($L_{rb,1}$), mi:	0.004843	0.131093		0.083847		0.263369	0.374235		
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8		8		9.5	10		
2	Length of barrier ($L_{rb,2}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:									
3	Length of barrier ($L_{rb,3}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:									
4	Length of barrier ($L_{rb,4}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:									
5	Length of barrier ($L_{rb,5}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:									
Presence of barrier on left side of roadway:		No	No	Yes	Yes	No	Yes	Yes	No	
1	Length of barrier ($L_{lb,1}$), mi:			0.133805	0.16371		0.263369	0.374235		
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:			7.5	4		4	4		
2	Length of barrier ($L_{lb,2}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:									
3	Length of barrier ($L_{lb,3}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:									
4	Length of barrier ($L_{lb,4}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:									
5	Length of barrier ($L_{lb,5}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:									
Ramp Access Data	↖ See note									
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No	No	S-C Lane	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:								0.087121	
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:					0.038826				
Weaving Section	Weave section in collector-distributor road segment?:					No			No	
	Length of weaving section (L_{wev}), mi:									
	Length of weaving section in segment ($L_{wev,seg}$), mi:									
Traffic Data	**Year**									
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	5400	7000	8200	5200	23300	28700	22400	27600	
(enter data only for those years for which	2046									
it is available, leave other years blank)	2047									

2045 No Build Conditions: I-5/4th Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data						
Number of through lanes (n):		2	1	1	1	
Ramp segment description:		5S-4P	4P-5S	4P-5N	CDN-4P	
Segment length (L), mi:		0.232566	0.155464	0.15328	0.429999	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	C-D Road	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal		
Alignment Data						
Horizontal Curve Data	← See notes →					
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	350	200	800	2000	
	Length of curve (L_{c1}), mi:	0.086924	0.068577	0.027493	0.0346	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.086924	0.068577	0.027493	0.0346	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.074465	0.046985	0.039827	0.060504	
2	Horizontal curve?:	In Seg.	No	In Seg.	No	
	Curve radius (R_2), ft:	400		3000		
	Length of curve (L_{c2}), mi:	0.052324		0.064786		
	Length of curve in segment ($L_{c2,seg}$), mi:	0.052324		0.064786		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.161241		0.088494		
3	Horizontal curve?:	No		No		
	Curve radius (R_3), ft:					
	Length of curve (L_{c3}), mi:					
	Length of curve in segment ($L_{c3,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:					
4	Horizontal curve?:					
	Curve radius (R_4), ft:					
	Length of curve (L_{c4}), mi:					
	Length of curve in segment ($L_{c4,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:					
5	Horizontal curve?:					
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		12	16	14	14	
Right shoulder width (W_{rs}), ft:		9	7.5	8	12	
Left shoulder width (W_{ls}), ft:		4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					
Roadside Data						
Presence of barrier on right side of roadway:		No	No	No	Yes	
1	Length of barrier ($L_{rb,1}$), mi:				0.246212	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:				12	
2	Length of barrier ($L_{rb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:					
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

5	Length of barrier ($L_{rb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:					
Presence of barrier on left side of roadway:		No	No	No	Yes	
1	Length of barrier ($L_{lb,1}$), mi:				0.246212	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:				4	
2	Length of barrier ($L_{lb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:					
3	Length of barrier ($L_{lb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:					
4	Length of barrier ($L_{lb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:					
5	Length of barrier ($L_{lb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:					
Ramp Access Data	↖ See note					
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:					
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:					
Weaving Section	Weave section in collector-distributor road segment?:				No	
	Length of weaving section (L_{wev}), mi:					
	Length of weaving section in segment ($L_{wev,seg}$), mi:					

Traffic Data	Year					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	12600	8800	9800	10300	
(enter data only for those years for which	2046					
it is available, leave other years blank)	2047					
	2048					
	2049					
	2050					
	2051					
	2052					
	2053					
	2054					
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	2056					
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	2062					
	2063					
	2064					
	2065					
	2066					
	2067					
	2068					

Crash Data		Year		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 No Build Conditions: I-5/Mill Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data						
Number of through lanes (n):		2	1	2	2	2
Ramp segment description:		5N-CDN	CDN-MP	MP-5N	5S-MP	MP-5S
Segment length (L), mi:		0.078877	0.158604	0.228287	0.312571	0.194533
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60
Segment type (ramp or collector-distributor road):		C-D Road	Exit	Entrance	Exit	Entrance
Type of control at crossroad ramp terminal:			Signal	Signal	Signal	Signal
Alignment Data						
Horizontal Curve Data	←See notes →					
1	Horizontal curve?:	No	In Seg.	In Seg.	In Seg.	In Seg.
	Curve radius (R_1), ft:		700	600	2000	1500
	Length of curve (L_{c1}), mi:		0.04732	0.037336	0.081974	0.089149
	Length of curve in segment ($L_{c1,seg}$), mi:		0.04732	0.037336	0.081974	0.089149
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.04732	0.127147	0.019928	0.105384
2	Horizontal curve?:		No	In Seg.	No	No
	Curve radius (R_2), ft:			3000		
	Length of curve (L_{c2}), mi:			0.028409		
	Length of curve in segment ($L_{c2,seg}$), mi:			0.028409		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:			0.199877		
3	Horizontal curve?:			No		
	Curve radius (R_3), ft:					
	Length of curve (L_{c3}), mi:					
	Length of curve in segment ($L_{c3,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:					
4	Horizontal curve?:					
	Curve radius (R_4), ft:					
	Length of curve (L_{c4}), mi:					
	Length of curve in segment ($L_{c4,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:					
5	Horizontal curve?:					
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		16	16	12.5	12	12
Right shoulder width (W_{rs}), ft:		10	10	10	10	9
Left shoulder width (W_{ls}), ft:		4	4	3	4	5
Presence of lane add or lane drop by taper:		No	No	No	No	Lane Drop
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					0.024621
Roadside Data						
Presence of barrier on right side of roadway:		No	No	No	No	No
1	Length of barrier ($L_{rb,1}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:					
2	Length of barrier ($L_{rb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:					
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

5	Length of barrier ($L_{rb,5}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:						
Presence of barrier on left side of roadway:			No	No	No	No	No
1	Length of barrier ($L_{lb,1}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:						
2	Length of barrier ($L_{lb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:						
3	Length of barrier ($L_{lb,3}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:						
4	Length of barrier ($L_{lb,4}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:						
5	Length of barrier ($L_{lb,5}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:						
Ramp Access Data	↖ See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	No	No	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		Lane Drop	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:		No				
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data		**Year**					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:		2045	18900	10300	18200	17200	18700
(enter data only for those years for which		2046					
it is available, leave other years blank)		2047					
		2048					
		2049					
		2050					
		2051					
		2052					
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		2067					
		2068					

Crash Data		**Year**		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 No Build Conditions: I-5/SR 14 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period
Basic Roadway Data								
Number of through lanes (n):	1	1	2	1	1	1	1	1
Ramp segment description:	5N-14E	5N-CST 1	5N-CST 2	14W-5N	14W-5S	CST-5S	14W-5S 2	5S-14E
Segment length (L), mi:	0.260708	0.26542	0.224131	0.438496	0.272789205	0.067596	0.120804	0.565598
Average traffic speed on the freeway (V_{frwy}), mi/h:	60	60	60	60	60	60	60	60
Segment type (ramp or collector-distributor road):	Connector	C-D Road	Exit	Connector	Connector	Entrance	Connector	Connector
Type of control at crossroad ramp terminal:			Signal			Signal		
Alignment Data								
Horizontal Curve Data ↖See notes ↗								
1 Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.
Curve radius (R_1), ft:	340	210	600	625	200	160	200	4000
Length of curve (L_{c1}), mi:	0.097027	0.200343	0.103087	0.156144	0.172898485	0.006856	0.172898	0.125609
Length of curve in segment ($L_{c1,seg}$), mi:	0.097027	0.200343	0.103087	0.156144	0.126867424	0.006856	0.046031	0.125609
Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.033382	0.065078	0	0.125535	0.14592178	0	0.145922	0
2 Horizontal curve?:	No	No	In Seg.	No	No	In Seg.	No	In Seg.
Curve radius (R_2), ft:			400			160		600
Length of curve (L_{c2}), mi:			0.036195			0.01511		0.088748
Length of curve in segment ($L_{c2,seg}$), mi:			0.036195			0.01511		0.088748
Ramp-mile of beginning of curve in direction of travel (X_2), mi:			0.175498			0.007621		0.140369
3 Horizontal curve?:			No			No		In Seg.
Curve radius (R_3), ft:								625
Length of curve (L_{c3}), mi:								0.109617
Length of curve in segment ($L_{c3,seg}$), mi:								0.109617
Ramp-mile of beginning of curve in direction of travel (X_3), mi:								0.340294
4 Horizontal curve?:								In Seg.
Curve radius (R_4), ft:								10000
Length of curve (L_{c4}), mi:								0.057223
Length of curve in segment ($L_{c4,seg}$), mi:								0.057223
Ramp-mile of beginning of curve in direction of travel (X_4), mi:								0.507756
5 Horizontal curve?:								No
Curve radius (R_5), ft:								
Length of curve (L_{c5}), mi:								
Length of curve in segment ($L_{c5,seg}$), mi:								
Ramp-mile of beginning of curve in direction of travel (X_5), mi:								
Cross Section Data								
Lane width (W_l), ft:	16	16	12	15	17	12	17	14
Right shoulder width (W_{rs}), ft:	7	7	10	7	9	9	9	6
Left shoulder width (W_{ls}), ft:	4	4	4	4.5	5	5	5	4
Presence of lane add or lane drop by taper:	No	No	No	No	No	No	No	No
Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:								
Roadside Data								
Presence of barrier on right side of roadway:	Yes	No	Yes	Yes	No	No	No	Yes
1 Length of barrier ($L_{rb,1}$), mi:	0.046284		0.109506	0.157335				0.565598
Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	7		10	7				6
2 Length of barrier ($L_{rb,2}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:								
3 Length of barrier ($L_{rb,3}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:								
4 Length of barrier ($L_{rb,4}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:								
5 Length of barrier ($L_{rb,5}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:								
Presence of barrier on left side of roadway:	Yes	No	Yes	Yes	Yes	No	No	Yes
1 Length of barrier ($L_{lb,1}$), mi:	0.020917		0.139801	0.212227	0.021039773			0.565598
Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4		4	4.5	5			4
2 Length of barrier ($L_{lb,2}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:								
3 Length of barrier ($L_{lb,3}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:								
4 Length of barrier ($L_{lb,4}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:								
5 Length of barrier ($L_{lb,5}$), mi:								
Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:								
Ramp Access Data ↖See note								

Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	Lane Add	No	No	No	S-C Lane	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:								0.072917	
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		No	No	No	No	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:									
Weaving Section	Weave section in collector-distributor road segment?:			No						
	Length of weaving section (L_{wev}), mi:									
	Length of weaving section in segment ($L_{wev,seg}$), mi:									

Traffic Data	**Year**								
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	17900	4600	9300	18600	9100	15200	24300	23800
(enter data only for those years for which	2046								
it is available, leave other years blank)	2047								
	2048								
	2049								
	2050								
	2051								
	2052								
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	2063								
	2064								
	2065								
	2066								
	2067								
	2068								

Crash Data		**Year**		Segment Crashes -->							
Count of Fatal-and-Injury (FI) Crashes by Year											
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045									
		2046									
		2047									
		2048									
		2049									
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045									
		2046									
		2047									
		2048									
		2049									
Count of Property-Damage-Only (PDO) Crashes by Year											
	Multiple-vehicle crashes ($N_{o,w,n,mv,pdo}$)	2045									
		2046									
		2047									
		2048									
		2049									
	Single-vehicle crashes ($N_{o,w,n,sv,pdo}$)	2045									
		2046									
		2047									
		2048									
		2049									

Advisory Messages

2045 No Build Conditions: I-5/Hayden Island IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period
Basic Roadway Data										
Number of through lanes (n):		1	2	2	2	1	2			
Ramp segment description:		5N-JD 1	5N-JD 2	5N-JD 3	JD-5N	5S-JD	JD-5S			
Segment length (L), mi:		0.116307	0.023964	0.058298	0.188114	0.145833	0.174401			
Average traffic speed on the freeway (V_{frwy}), mi/h:		55	55	55	55	55	55			
Segment type (ramp or collector-distributor road):		C-D Road	C-D Road	Exit	Entrance	Exit	Entrance			
Type of control at crossroad ramp terminal:				Signal	Signal	Signal	Signal			
Alignment Data										
Horizontal Curve Data ←See notes →										
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.			
	Curve radius (R_1), ft:	238.732	199.16	199.16	477.47	160	159.153			
	Length of curve (L_{c1}), mi:	0.080409	0.03961	0.064301	0.030553	0.028409	0.026721			
	Length of curve in segment ($L_{c1,seg}$), mi:	0.080409	0.014918	0.058298	0.030553	0.028409	0.026721			
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.035898	0.009046	0	0	0.075758	0.041174			
2	Horizontal curve?:	No	No	No	In Seg.	No	No			
	Curve radius (R_2), ft:				160					
	Length of curve (L_{c2}), mi:				0.094697					
	Length of curve in segment ($L_{c2,seg}$), mi:				0.094697					
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:				0.030553					
3	Horizontal curve?:				No					
	Curve radius (R_3), ft:									
	Length of curve (L_{c3}), mi:									
	Length of curve in segment ($L_{c3,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:									
4	Horizontal curve?:									
	Curve radius (R_4), ft:									
	Length of curve (L_{c4}), mi:									
	Length of curve in segment ($L_{c4,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:									
5	Horizontal curve?:									
	Curve radius (R_5), ft:									
	Length of curve (L_{c5}), mi:									
	Length of curve in segment ($L_{c5,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:									
Cross Section Data										

Lane width (W_l), ft:			12.5	12.5	12.5	14	17	16			
Right shoulder width (W_{rs}), ft:			4	4	10	4	2	4			
Left shoulder width (W_{ls}), ft:			4	4	4	4	2	2			
Presence of lane add or lane drop by taper:			Lane Add	No	No	Lane Drop	Lane Add	Lane Drop			
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:		0.035985			0.028409	0.023674	0.028409			
Roadside Data											
Presence of barrier on <u>right</u> side of roadway:			Yes	No	No	Yes	Yes	Yes			
1	Length of barrier ($L_{rb,1}$), mi:		0.025292			0.075758	0.090909	0.069112			
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:		4			4	2	4			
2	Length of barrier ($L_{rb,2}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:										
3	Length of barrier ($L_{rb,3}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:										
4	Length of barrier ($L_{rb,4}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:										
5	Length of barrier ($L_{rb,5}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:										
Presence of barrier on <u>left</u> side of roadway:			No	No	No	No	No	No			
1	Length of barrier ($L_{lb,1}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:										
2	Length of barrier ($L_{lb,2}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:										
3	Length of barrier ($L_{lb,3}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:										
4	Length of barrier ($L_{lb,4}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:										
5	Length of barrier ($L_{lb,5}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:										
Ramp Access Data	↖ See note										
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	S-C Lane	No	No	No			
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:				0.011364						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		S-C Lane	No	No	No	No	No			
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:		0.037879								
Weaving Section	Weave section in collector-distributor road segment?:		No	No							
	Length of weaving section (L_{wev}), mi:										
	Length of weaving section in segment ($L_{wev,seg}$), mi:										
Traffic Data		**Year**									
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:		2045	7800	7800	7800	8100	12200	8700			
(enter data only for those years for which		2046									
it is available, leave other years blank)		2047									

2045 No Build Conditions: I-5/Marine Drive IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11
	Study Period	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data											
Number of through lanes (n):	1	1	1	2	1	2	1	1	1	1	
Ramp segment description:	5N-MD 1	5N-MD 2	5N-UN	MD-5N 1	MD-5N 2	MD-5N 3	5S-MLK 1	5S-MLK 2	5S-MD	MD-5S	
Segment length (L), mi:	0.439275	0.433712	0.251136	0.059555	0.061553	0.344708	0.249346	0.159422	0.094697	0.347348	
Average traffic speed on the freeway (V_{frwy}), mi/h:	55	55	55	55	55	55	55	55	55	55	
Segment type (ramp or collector-distributor road):	C-D Road	Exit	Exit	Entrance	Entrance	C-D Road	C-D Road	Exit	Exit	Entrance	
Type of control at crossroad ramp terminal:		Signal	Stop	Signal	None			None	Signal	Signal	
Alignment Data											
Horizontal Curve Data ← See notes →											
1 Horizontal curve?:	No	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	
Curve radius (R_1), ft:		260	270	238.732	173	238.732	286.424	220	300	325	
Length of curve (L_{c1}), mi:		0.11553	0.109848	0.027233	0.061553	0.027233	0.131733	0.094697	0.0625	0.125947	
Length of curve in segment ($L_{c1,seg}$), mi:		0.11553	0.109848	0.020035	0.061553	0.007198	0.131733	0.094697	0.0625	0.125947	
Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.049242	0.046402	0.007049	0	0.007049	0.11765	0	0	0.029735	
2 Horizontal curve?:		In Seg.	No	No	No	In Seg.	No	No	No	In Seg.	
Curve radius (R_2), ft:		270				220.357				330	
Length of curve (L_{c2}), mi:		0.120265				0.180027				0.075758	
Length of curve in segment ($L_{c2,seg}$), mi:		0.120265				0.180027				0.075758	
Ramp-mile of beginning of curve in direction of travel (X_2), mi:		0.183712				0.088313				0.193561	
3 Horizontal curve?:		In Seg.				No				No	
Curve radius (R_3), ft:		350									
Length of curve (L_{c3}), mi:		0.083333									
Length of curve in segment ($L_{c3,seg}$), mi:		0.083333									
Ramp-mile of beginning of curve in direction of travel (X_3), mi:		0.350379									
4 Horizontal curve?:		No									
Curve radius (R_4), ft:											
Length of curve (L_{c4}), mi:											
Length of curve in segment ($L_{c4,seg}$), mi:											
Ramp-mile of beginning of curve in direction of travel (X_4), mi:											
5 Horizontal curve?:											
Curve radius (R_5), ft:											
Length of curve (L_{c5}), mi:											
Length of curve in segment ($L_{c5,seg}$), mi:											
Ramp-mile of beginning of curve in direction of travel (X_5), mi:											
Cross Section Data											
Lane width (W_l), ft:	16	16	16	12	16	12	16	16	13	16	
Right shoulder width (W_{rs}), ft:	6	6	6	10	4	4	6	6	6	6	
Left shoulder width (W_{ls}), ft:	6	6	4	4	6	4	4	4	4	4	

Presence of lane add or lane drop by taper:		No	No	No	No	No	No	No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:											
Roadside Data												
Presence of barrier on right side of roadway:		Yes	Yes	No	No	No	Yes	No	Yes	No	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.367305	0.230303				0.044866		0.070455		0.102491	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	6	6				4		6		6	
2	Length of barrier ($L_{rb,2}$), mi:						0.111441				0.027727	
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:						4				6	
3	Length of barrier ($L_{rb,3}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:											
4	Length of barrier ($L_{rb,4}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:											
5	Length of barrier ($L_{rb,5}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:											
Presence of barrier on left side of roadway:		Yes	Yes	Yes	No	No	Yes	Yes	No	Yes	Yes	
1	Length of barrier ($L_{lb,1}$), mi:	0.367305	0.116477	0.124053			0.160561	0.052909		0.051136	0.110038	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	6	6	4			4	4		4	4	
2	Length of barrier ($L_{lb,2}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:											
3	Length of barrier ($L_{lb,3}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:											
4	Length of barrier ($L_{lb,4}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:											
5	Length of barrier ($L_{lb,5}$), mi:											
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:											
Ramp Access Data	↖ See note											
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	S-C Lane	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						0.018939					
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	S-C Lane	No	No	No	No	No	S-C Lane	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:	0.036932						0.028409				
Weaving Section	Weave section in collector-distributor road segment?:	No					No	No				
	Length of weaving section (L_{wev}), mi:											
	Length of weaving section in segment ($L_{wev,seg}$), mi:											
Traffic Data	Year											
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	2200	1760	440	12400	10500	22900	23100	13900	9200	2400	
(enter data only for those years for which	2046											
it is available, leave other years blank)	2047											
	2048											
	2049											
	2050											
	2051											
	2052											
	2053											
	2054											

2045 No Build Conditions: I-5 Ramp Terminal Intersection ISATe Inputs

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

			Terminal 1 **Study Period**	Terminal 2 **Study Period**	Terminal 3 **Study Period**	Terminal 4 **Study Period**	Terminal 5 **Study Period**	Terminal 6 **Study Period**
Basic Intersection Data								
Ramp terminal configuration:			B2	D4	A2	D4	D4	D4
Ramp terminal description:			SR 500 SB Ra	SR 500 NB Ra	4th SB Ramps	4th NB Ramps	MP SB Ramps	MP NB Ramps
Ramp terminal traffic control type:			One stop	Signal	Signal	Signal	Signal	Signal
Is a non-ramp public street leg present at the terminal (I_{ps})?:				No	No	No	No	No
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:			0					
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.04	0.08	0.12	0.24	0.12	0.11
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.15	0.15	0.17	0.17	0.12	0.12
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:		No		Yes	Yes	Yes
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:			Yes			
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Stop	Yield	Free	Yield	Free	Signal
Cross Section Data								
Crossroad median width (W_m), ft:			12	12	12	12	14	14
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	2	2	3	3	6	5
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):		1	1	1	3	2
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):		1	2	2	3	3
Ramp	Exit ramp approach	All lanes (n_{ex}):	1	1	2	2	2	2
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:			Yes			
	Outside approach	Channelization present ($I_{ch,out}$)?:		No		Yes	Yes	Yes
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:		Yes	Yes	Yes	Yes	No
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes		Yes	Yes	Yes
		Width of lane or bay ($W_{b,in}$), ft:	12	12		12	14	26
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:			Yes			
		Width of lane or bay ($W_{b,out}$), ft:			12			
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:			Yes			
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	No	No		No	Yes	No
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):				0	0	0	0	0
Number of public street approaches on the outside crossroad leg (n_{ps}):			2					
Traffic Data		**Year**						
Inside Crossroad Leg Data		2045	25000	19200	27200	20900	40800	31300
Average daily traffic ($AADT_{in}$) by year, veh/d:		2046						
(enter data only for those years for which		2047						
it is available, leave other years blank)		2048						
		2049						
		2050						
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	2065						
	2066						
	2067						
	2068						
Outside Crossroad Leg Data	2045	21600	21800	29900	20900	58000	22600
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
	2050						
	2051						
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	2064						
	2065						
	2066						
	2067						
	2068						
Exit Ramp Data	2045	8200	5400	12600	10300	17200	8600
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For a B4 terminal configuration, enter the AADT for the	2050						
diagonal exit ramp (not the loop exit ramp).	2051						
	2052						
	2053						
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	2064						
	2065						
	2066						
	2067						
	2068						
Entrance Ramp Data	2045	5200	7000	8800	9800	18700	18200
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For an A4 terminal configuration, enter the AADT for the	2050						
diagonal entrance ramp (not the loop entrance ramp).	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values | Check Input Values

(View results in Column T) (View results in Advisory Messages)

			Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period
Basic Intersection Data							
Ramp terminal configuration:			A2	D3ex			
Ramp terminal description:			HI Dr & NB Ra	Union & NB Off			
Ramp terminal traffic control type:			Signal	One stop			
Is a non-ramp public street leg present at the terminal (I_{ps})?:			No				
Alignment Data							
Exit ramp skew angle (I_{sk}), degrees:				0			
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.04	0.1			
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.18	0.08			
Traffic Control							
Left-Turn Operational Mode							
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:					
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:	Yes				
Right-Turn Control Type							
Ramp	Exit ramp approach	Right-turn control type:	Signal	Stop			
Cross Section Data							
Crossroad median width (W_m), ft:			10	0			
Number of Lanes							
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	2	3			
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	1				
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	1		0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2	2			
Right-Turn Channelization		see note: →					
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:	No				
	Outside approach	Channelization present ($I_{ch,out}$)?:					
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:	No				
Left-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:					
		Width of lane or bay ($W_{b,in}$), ft:					
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:	No				
		Width of lane or bay ($W_{b,out}$), ft:					
Right-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:	Yes				
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:					
Access Data							
Number of driveways on the outside crossroad leg (n_{dw}):			0				
Number of public street approaches on the outside crossroad leg (n_{ps}):			2				
Traffic Data		**Year**					
Inside Crossroad Leg Data		2045	12100	12800			
Average daily traffic ($AADT_{in}$) by year, veh/d:		2046					
(enter data only for those years for which		2047					
it is available, leave other years blank)		2048					
		2049					
		2050					
		2051					
		2052					
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	2067					
	2068					
Outside Crossroad Leg Data	2045	5400	12400			
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
	2050					
	2051					
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	2067					
	2068					
Exit Ramp Data	2045	7800	400			
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For a B4 terminal configuration, enter the AADT for the	2050					
diagonal exit ramp (not the loop exit ramp).	2051					
	2052					
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	2061					
	2062					
	2063					
	2064					
	2065					
	2066					
	2067					
	2068					
Entrance Ramp Data	2045	8100				
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For an A4 terminal configuration, enter the AADT for the	2050					
diagonal entrance ramp (not the loop entrance ramp).	2051					

Output Summary

General Information

Project description:	Mainline Corridor Pt 1 - No Build				
Analyst:	0	Date:	2/16/2024	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	243.7	0.8	2.2	14.7	54.3	171.7
Estimated average crash freq. during Study Period, crashes/yr:	243.7	0.8	2.2	14.7	54.3	171.7

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	20	243.7	0.8	2.2	14.7	54.3	171.7
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	243.7	0.8	2.2	14.7	54.3	171.7
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
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	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.7	0.0	0.0	0.1	0.3	0.3
	Right-angle crashes:	4.2	0.0	0.1	0.3	1.3	2.6
	Rear-end crashes:	138.3	0.5	1.2	8.4	30.9	97.2
	Sideswipe crashes:	47.7	0.1	0.3	2.0	7.4	37.8
	Other multiple-vehicle crashes:	5.0	0.0	0.1	0.3	1.3	3.3
	Total multiple-vehicle crashes:	195.9	0.6	1.7	11.2	41.2	141.2
Single vehicle	Crashes with animal:	0.7	0.0	0.0	0.0	0.0	0.7
	Crashes with fixed object:	34.3	0.1	0.4	2.5	9.4	21.8
	Crashes with other object:	5.2	0.0	0.0	0.2	0.7	4.3
	Crashes with parked vehicle:	0.7	0.0	0.0	0.1	0.2	0.5
	Other single-vehicle crashes	6.9	0.0	0.1	0.7	2.8	3.2
	Total single-vehicle crashes:	47.8	0.2	0.5	3.5	13.1	30.5
	Total crashes:	243.7	0.8	2.2	14.7	54.3	171.7

Output Summary

General Information

Project description:	Mainline Corridor Pt 2 - No Build				
Analyst:	0	Date:	9/27/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	51.5	0.2	0.5	3.3	11.7	35.8
Estimated average crash freq. during Study Period, crashes/yr:	51.5	0.2	0.5	3.3	11.7	35.8

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	3	51.5	0.2	0.5	3.3	11.7	35.8
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	51.5	0.2	0.5	3.3	11.7	35.8
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Right-angle crashes:	1.0	0.0	0.0	0.1	0.3	0.5
	Rear-end crashes:	31.0	0.1	0.3	2.1	7.4	21.1
	Sideswipe crashes:	10.5	0.0	0.1	0.5	1.8	8.1
	Other multiple-vehicle crashes:	1.1	0.0	0.0	0.1	0.3	0.7
	Total multiple-vehicle crashes:	43.7	0.2	0.4	2.8	9.8	30.5
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with fixed object:	5.6	0.0	0.1	0.4	1.3	3.8
	Crashes with other object:	0.9	0.0	0.0	0.0	0.1	0.7
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.1	0.0	0.0	0.1	0.4	0.6
	Total single-vehicle crashes:	7.8	0.0	0.1	0.5	1.8	5.3
	Total crashes:	51.5	0.2	0.5	3.3	11.7	35.8

Output Summary

General Information

Project description:	SR 500 Interchange Area - No Build				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	18.1	0.1	0.4	2.0	4.4	11.1
Estimated average crash freq. during Study Period, crashes/yr:	18.1	0.1	0.4	2.0	4.4	11.1

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	8	18.1	0.1	0.4	2.0	4.4	11.1
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	18.1	0.1	0.4	2.0	4.4	11.1
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	6.4	0.0	0.1	0.7	1.9	3.6
	Sideswipe crashes:	2.7	0.0	0.0	0.1	0.3	2.2
	Other multiple-vehicle crashes:	1.2	0.0	0.0	0.1	0.4	0.7
	Total multiple-vehicle crashes:	10.5	0.1	0.2	1.0	2.7	6.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	6.0	0.1	0.2	0.7	1.2	3.9
	Crashes with other object:	0.2	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.3	0.0	0.1	0.3	0.4	0.6
	Total single-vehicle crashes:	7.7	0.1	0.2	1.0	1.7	4.6
	Total crashes:	18.1	0.1	0.4	2.0	4.4	11.1

Output Summary

General Information

Project description:	4th Plain Interchange Area - No Build				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	4.2	0.0	0.1	0.6	0.9	2.7
Estimated average crash freq. during Study Period, crashes/yr:	4.2	0.0	0.1	0.6	0.9	2.7

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	4	4.2	0.0	0.1	0.6	0.9	2.7
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	4.2	0.0	0.1	0.6	0.9	2.7
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
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	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.5	0.0	0.0	0.1	0.1	0.3
	Sideswipe crashes:	0.2	0.0	0.0	0.0	0.0	0.2
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	0.9	0.0	0.0	0.1	0.2	0.6
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	2.6	0.0	0.1	0.3	0.5	1.7
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.6	0.0	0.0	0.1	0.2	0.3
	Total single-vehicle crashes:	3.3	0.0	0.1	0.4	0.7	2.0
	Total crashes:	4.2	0.0	0.1	0.6	0.9	2.7

Output Summary

General Information

Project description:	Mill Plain Interchange Area - No Build				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	4.8	0.0	0.1	0.5	1.0	3.1
Estimated average crash freq. during Study Period, crashes/yr:	4.8	0.0	0.1	0.5	1.0	3.1

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	5	4.8	0.0	0.1	0.5	1.0	3.1
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	4.8	0.0	0.1	0.5	1.0	3.1
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	1.1	0.0	0.0	0.1	0.2	0.7
	Sideswipe crashes:	0.5	0.0	0.0	0.0	0.0	0.4
	Other multiple-vehicle crashes:	0.2	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	1.8	0.0	0.0	0.2	0.3	1.3
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	2.4	0.0	0.1	0.3	0.5	1.5
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.5	0.0	0.0	0.1	0.2	0.2
	Total single-vehicle crashes:	3.0	0.0	0.1	0.4	0.7	1.8
	Total crashes:	4.8	0.0	0.1	0.5	1.0	3.1

Output Summary

General Information

Project description:	SR 14 Interchange Area - No Build				
Analyst:	0	Date:	2/15/2024	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	15.2	0.1	0.4	2.3	3.6	8.8
Estimated average crash freq. during Study Period, crashes/yr:	15.2	0.1	0.4	2.3	3.6	8.8

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	8	15.2	0.1	0.4	2.3	3.6	8.8
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	15.2	0.1	0.4	2.3	3.6	8.8
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	4.8	0.0	0.1	0.8	1.3	2.5
	Sideswipe crashes:	1.9	0.0	0.0	0.1	0.2	1.5
	Other multiple-vehicle crashes:	0.9	0.0	0.0	0.2	0.3	0.5
	Total multiple-vehicle crashes:	7.8	0.1	0.2	1.2	1.9	4.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	5.8	0.0	0.1	0.8	1.3	3.6
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.3	0.0	0.0	0.3	0.4	0.5
	Total single-vehicle crashes:	7.4	0.1	0.2	1.1	1.8	4.3
	Total crashes:	15.2	0.1	0.4	2.3	3.6	8.8

Output Summary

General Information

Project description:	Hayden Island Interchange Area - No Build				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		8.7	0.1	0.2	1.1	1.9	5.3
Estimated average crash freq. during Study Period, crashes/yr:		8.7	0.1	0.2	1.1	1.9	5.3
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	6	8.7	0.1	0.2	1.1	1.9	5.3
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	8.7	0.1	0.2	1.1	1.9	5.3
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.8	0.0	0.0	0.1	0.2	0.5
	Sideswipe crashes:	0.3	0.0	0.0	0.0	0.0	0.3
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	1.3	0.0	0.0	0.1	0.3	0.8
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	5.8	0.1	0.2	0.7	1.2	3.8
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.3	0.0	0.1	0.2	0.4	0.6
	Total single-vehicle crashes:	7.4	0.1	0.2	1.0	1.6	4.5
	Total crashes:	8.7	0.1	0.2	1.1	1.9	5.3

Output Summary

General Information							
Project description:	Marine Drive Interchange Area - No Build						
Analyst:	0	Date:	10/3/2023		Area type:	Urban	
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp terminals	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	20.4	0.2	0.6	2.8	4.9	11.9
Estimated average crash freq. during Study Period, crashes/yr:	20.4	0.2	0.6	2.8	4.9	11.9

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	10	20.4	0.2	0.6	2.8	4.9	11.9
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	20.4	0.2	0.6	2.8	4.9	11.9
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
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	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	4.9	0.0	0.1	0.7	1.5	2.5
	Sideswipe crashes:	2.0	0.0	0.0	0.1	0.3	1.6
	Other multiple-vehicle crashes:	0.9	0.0	0.0	0.1	0.3	0.5
	Total multiple-vehicle crashes:	8.0	0.1	0.2	1.0	2.1	4.6
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	9.8	0.1	0.3	1.3	2.0	6.1
	Crashes with other object:	0.2	0.0	0.0	0.0	0.0	0.2
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	2.2	0.0	0.1	0.5	0.7	0.9
	Total single-vehicle crashes:	12.4	0.1	0.4	1.8	2.8	7.3
	Total crashes:	20.4	0.2	0.6	2.8	4.9	11.9

Output Summary

General Information

Project description:	Ramp Terminal Intersections Pt. 1 - No Build				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	86.4	0.0	0.7	4.7	24.4	56.5
Estimated average crash freq. during Study Period, crashes/yr:	86.4	0.0	0.7	4.7	24.4	56.5

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	6	86.4	0.0	0.7	4.7	24.4	56.5

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	86.4	0.0	0.7	4.7	24.4	56.5
	2046						
	2047						
	2048						
	2049						
	2050						
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	2052						
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	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.8	0.0	0.0	0.1	0.3	0.4
	Right-angle crashes:	21.7	0.0	0.2	1.4	7.0	13.1
	Rear-end crashes:	47.6	0.0	0.4	2.7	14.5	30.0
	Sideswipe crashes:	9.3	0.0	0.0	0.2	1.0	8.1
	Other multiple-vehicle crashes:	1.4	0.0	0.0	0.0	0.2	1.1
	Total multiple-vehicle crashes:	80.8	0.0	0.7	4.4	22.9	52.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.3	0.0	0.0	0.2	1.0	3.1
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.2	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.0	0.0	0.0	0.1	0.5	0.5
	Total single-vehicle crashes:	5.6	0.0	0.0	0.3	1.5	3.8
	Total crashes:	86.4	0.0	0.7	4.7	24.4	56.5

Output Summary

General Information

Project description:	Ramp Terminals Pt. 2 - No Build				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	3.2	0.0	0.0	0.2	1.0	1.9
Estimated average crash freq. during Study Period, crashes/yr:	3.2	0.0	0.0	0.2	1.0	1.9

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	2	3.2	0.0	0.0	0.2	1.0	1.9

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	3.2	0.0	0.0	0.2	1.0	1.9
	2046						
	2047						
	2048						
	2049						
	2050						
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	2052						
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	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.8	0.0	0.0	0.1	0.3	0.4
	Rear-end crashes:	1.8	0.0	0.0	0.2	0.6	1.0
	Sideswipe crashes:	0.3	0.0	0.0	0.0	0.0	0.3
	Other multiple-vehicle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Total multiple-vehicle crashes:	3.0	0.0	0.0	0.2	1.0	1.8
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.0	0.0	0.0	0.0	0.0	0.0
	Total single-vehicle crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Total crashes:	3.2	0.0	0.0	0.2	1.0	1.9

2045 mLPA 1 Aux Conditions: I-5 Mainline ISATe Inputs

Clear | Echo Input Values | Check Input Values

(View results in Column AV) (View results in Advisory Messages)

Input Worksheet for Freeway Segments	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period	Segment 10 Study Period	Segment 11 Study Period	Segment 12 Study Period	Segment 13 Study Period	Segment 14 Study Period	Segment 15 Study Period	Segment 16 Study Period	Segment 17 Study Period	Segment 18 Study Period	Segment 19 Study Period	Segment 20 Study Period
Basic Roadway Data																				
Number of through lanes (n):	6	6	6	6	6	8	8	8	8	8	6	6	6	8	8	10	10	8	7	8
Freeway segment description:	70+00.00-78+	78+95.82-85+	85+49.53-98+	98+37.96-106	106+00.00-14	140+27.78-15	155+01.16-17	176+66.56-18	185+21.88-19	190+79.39-19	192+80.4-199	199+43.7-228	228+00.00-23	236+15.37-24	243+98.73-25	255+52.037-2	267+81.61-27	277+09.81-28	281+38.2-305	305+72.35-308
Segment length (L), mi:	0.169663	0.123809	0.244021	0.144326	0.649201	0.279022	0.410114	0.161992	0.105589	0.03807	0.125625	0.540966	0.154426	0.148364	0.218429	0.232874	0.175795	0.081134	0.461013	0.050256
Alignment Data																				
Horizontal Curve Data ← See note																				
1 Horizontal curve in segment?:	No	No	Both Dir.	No	Both Dir.	Both Dir.	Both Dir.	Both Dir.	Both Dir.	No	Both Dir.	Both Dir.	No	No	Both Dir.	No	No	No	Both Dir.	No
Curve radius (R_1), ft:			2865		6304	6307	6307	2399	2399		2400	2400			2800				2600	
Length of curve (L_{c1}), mi:			0.179766		0.124834	0.109936	0.109936	0.210496	0.210496		0.201569	0.201569			0.205335				0.142811	
Length of curve in segment ($L_{c1,seg}$), mi:			0.179766		0.124834	0.03523	0.074706	0.109248	0.101248		0.043688	0.157881			0.205335				0.142811	
2 Horizontal curve in segment?:			No		No	No	No	No	No		No	No			No				No	
Curve radius (R_2), ft:																				
Length of curve (L_{c2}), mi:																				
Length of curve in segment ($L_{c2,seg}$), mi:																				
3 Horizontal curve in segment?:																				
Curve radius (R_3), ft:																				
Length of curve (L_{c3}), mi:																				
Length of curve in segment ($L_{c3,seg}$), mi:																				
Cross Section Data																				
Lane width (W_l), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Outside shoulder width (W_s), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Inside shoulder width (W_{is}), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Median width (W_m), ft:	26	26	26	26	37	44	44	42	36	33	31	26	26	26	26	26	26	26	26	26
Rumble strips on outside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Rumble strips on inside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Presence of barrier in median:	Some	Center	Center	Center	Some	Some	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center
1 Length of barrier ($L_{ib,1}$), mi:	0.108286	0.123809	0.244021	0.144326	0.286553	0.179008	0.410114	0.161992	0.105589	0.03807	0.125625	0.540966	0.154426	0.148364	0.218429	0.232874	0.175795	0.081134	0.461013	0.050256
Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2 Length of barrier ($L_{ib,2}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:																				
3 Length of barrier ($L_{ib,3}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:																				
4 Length of barrier ($L_{ib,4}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:																				
5 Length of barrier ($L_{ib,5}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:																				
Median barrier width (W_{ib}), ft:		2	2	2			2	2	2	2	2	2	2	2	2	2	2	2	2	2
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:																				
Roadside Data																				
Clear zone width (W_{hc}), ft:																				
Presence of barrier on roadside:	Some	Some	Some	Some	Some	Some	Full	Some	None	None	Some	Some	Some	Some	Some	Some	Some	None	Some	None
1 Length of barrier ($L_{ob,1}$), mi:	0.108286	0.084114	0.189195	0.042089	0.316919	0.278964		0.185299			0.125023	0.526691	0.022439	0.074369	0.059083	0.142616	0.175795		0.183002	
Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:	12	12	12	12	12	12		12			12	12	12	12	12	12	12		12	
2 Length of barrier ($L_{ob,2}$), mi:	0.051364		0.079348	0.129767	0.020684	0.279049		0.201604			0.094032	0.050061	0.041386	0.148364	0.055693					
Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:	12		12	12	12	12		12			12	12	12	12	12					
3 Length of barrier ($L_{ob,3}$), mi:					0.316828							0.445525	0.154426							
Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:					12							12	12							
4 Length of barrier ($L_{ob,4}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:																				
5 Length of barrier ($L_{ob,5}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:																				
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:							12													
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:							12													
Ramp Access Data																				
Travel in Increasing Milepost Direction																				
Entrance: Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	Lane Add	S-C Lane	No	No	No	No	No	No	Lane Add	No	Lane Add	S-C Lane	No	No	S-C Lane

Ramp	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:		999	999	999	999				0.410114	0.572106	0.677695	0.715765	0.84139	1.382356		0.148364			0.175795	0.25693	
	Length of ramp entrance ($L_{en,inc}$), mi:						0.098309		0.202546										0.131222			0.09472
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:						0.098309		0.202546										0.131222			0.050256
	Entrance side?:						Right		Right										Right			Right
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		S-C Lane	No	No	No	No	No	No	S-C Lane	S-C Lane	No	Lane Drop	No	No	No	No	No	No	Lane Drop	No	No
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			1.888703	1.644682	1.500356	0.851155	0.572106	0.161992			0.163695		1.011023	0.856597	0.708233	0.489804	0.88193	0.081134		999	999
	Length of ramp exit ($L_{ex,inc}$), mi:		0.038981							0.032991	0.042787											
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:		0.038981							0.032991	0.042787											
	Exit side?:		Right							Right	Right											
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No
	Length of weaving section ($L_{wev,inc}$), mi:																	0.408669	0.408669			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:																	0.232874	0.175795			
Travel in Decreasing Milepost Direction																						
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		S-C Lane	No	No	No	No	No	S-C Lane	No	No	Lane Add	No	No	No	No	S-C Lane	No	Lane Add	No	No	No
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			1.72671	1.482689	1.338364	0.689163	0.410114		0.143659	0.03807		1.062185	0.521219	0.366793	0.218429		0.175795		999	999	999
	Length of ramp entrance ($L_{en,dec}$), mi:		0.097646						0.148434								0.122771					
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:		0.097646						0.148434								0.122771					
	Entrance side?:		Right						Right								Right					
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		No	No	No	S-C Lane	No	Lane Drop	S-C Lane	No	No	No	No	No	No	Lane Drop	Lane Drop	No	No	No	No	No
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:		999	999	999		0.144326			0.410114	0.572106	0.677695	0.715765	0.84139	1.382356			0.218429	0.451303	0.627098	0.708233	1.169246
	Length of ramp exit ($L_{ex,dec}$), mi:					0.042845			0.040896													
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:					0.042845			0.040896													
	Exit side?:					Right			Right													
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No
	Length of weaving section ($L_{wev,dec}$), mi:																0.218429					
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:																0.218429					
Traffic Data		**Year**																				
Proportion of AADT during high-volume hours (P_{hv}):																						
Freeway Segment Data		2045	98600	89200	81700	91700	108700	154500	175000	150100	132300	127600	114100	99800	99800	135900	156300	172600	183600	183600	125000	132300
Average daily traffic ($AADT_{fs}$) by year, veh/d:		2046																				
(enter data only for those years for which		2047																				
it is available, leave other years blank)		2048																				
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Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**																				
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045					17000	22200	8100	15600	15600	15600	15600	15600	15600	15600	25300	25300	11000	7300	7300	7300
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it is available, leave other years blank)		2047																				
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Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	7500	17800	17800	17800	17800	17800	17800	17800	4700	14300	14300	30000	30000	30000	30000	30000	30000	30000		
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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	2068																				
Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	9400	24900	24900	24900	24900	24900	24900	13500	13500	13500	9000	9000	9000	9000	9000	28600	28600			
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
	2048																				
	2049																				
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	2063																				
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	2065																				
	2066																				
	2067																				
	2068																				
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045				10000	10000	23600	12400	12400	12400	12400	12400	12400	12400	20500	20500	20500	20500	20500	20500	20500
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
	2048																				
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2045 mLPA 1 Aux Conditions: I-5 Mainline ISATe Inputs

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period
Basic Roadway Data				
Number of through lanes (n):		8		
Freeway segment description:		308+37.7-334+76.131		
Segment length (L), mi:		0.499703		
Alignment Data				
Horizontal Curve Data	See note			
1	Horizontal curve in segment?:	No		
	Curve radius (R_1), ft:			
	Length of curve (L_{c1}), mi:			
	Length of curve in segment ($L_{c1,seg}$), mi:			
2	Horizontal curve in segment?:			
	Curve radius (R_2), ft:			
	Length of curve (L_{c2}), mi:			
	Length of curve in segment ($L_{c2,seg}$), mi:			
3	Horizontal curve in segment?:			
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
Cross Section Data				
Lane width (W_l), ft:		12		
Outside shoulder width (W_s), ft:		12		
Inside shoulder width (W_{is}), ft:		12		
Median width (W_m), ft:		26		
Rumble strips on outside shoulders?:				
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Rumble strips on inside shoulders?:				
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Presence of barrier in median:		Center		
1	Length of barrier ($L_{ib,1}$), mi:	0.499703		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	12		
2	Length of barrier ($L_{ib,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:			
3	Length of barrier ($L_{ib,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:			
4	Length of barrier ($L_{ib,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:			
5	Length of barrier ($L_{ib,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:			
Median barrier width (W_{ib}), ft:		2		

Nearest distance from edge of traveled way to barrier face (W_{near}), ft:				
Roadside Data				
Clear zone width (W_{hc}), ft:				
Presence of barrier on roadside:		None		
1	Length of barrier ($L_{ob,1}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			
2	Length of barrier ($L_{ob,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			
3	Length of barrier ($L_{ob,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			
4	Length of barrier ($L_{ob,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:			
5	Length of barrier ($L_{ob,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:			
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:				
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:				
Ramp Access Data				
Travel in Increasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:	0.050256		
	Length of ramp entrance ($L_{en,inc}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:	999		
	Length of ramp exit ($L_{ex,inc}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,inc}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:			
Travel in Decreasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:	999		
	Length of ramp entrance ($L_{en,dec}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	Lane Drop		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			
	Length of ramp exit ($L_{ex,dec}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,dec}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:			
Traffic Data	**Year**			

Proportion of AADT during high-volume hours (P_{hv}):				
Freeway Segment Data	2045	154300		
Average daily traffic ($AADT_{fs}$) by year, veh/d:	2046			
(enter data only for those years for which	2047			
it is available, leave other years blank)	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
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	2068			
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:	2045	7300		
(enter data only for those years for which	2046			
it is available, leave other years blank)	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
	2055			
	2056			
	2057			
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	2064			
	2065			
	2066			
	2067			
	2068			
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**			

Average daily traffic ($AADT_{e,ext}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2045			
	2046			
	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
	2055			
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	2064			
	2065			
	2066			
	2067			
	2068			
Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{e,ent}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2045			
	2046			
	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
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	2063			
	2064			
	2065			
	2066			
	2067			
	2068			
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**			
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045	22000		

2045 mLPA 1 Aux Conditions: I-5 C-D ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period	Segment 10 Study Period	Segment 11 Study Period	Segment 12 Study Period
Basic Roadway Data												
Number of through lanes (n):	2	2	2	1	2	2	2					
Ramp segment description:	5N-CDN	CDN 1	CDN 2	CDN-5N	5S-CDS	CDS	CDS-5S					
Segment length (L), mi:	0.095926	0.328534	0.061099	0.23999	0.236354	0.212678	0.314884					
Average traffic speed on the freeway (V_{frwy}), mi/h:	60	60	60	60	60	60	60					
Segment type (ramp or collector-distributor road):	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road					
Type of control at crossroad ramp terminal:												
Alignment Data												
Horizontal Curve Data ← See notes →												
1 Horizontal curve?:	In Seg.	In Seg.	No	No	No	No	In Seg.					
Curve radius (R_1), ft:	2446	2462					2345					
Length of curve (L_{c1}), mi:	0.038003	0.090955					0.191746					
Length of curve in segment ($L_{c1,seg}$), mi:	0.038003	0.048147					0.191746					
Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0					0.041635					
2 Horizontal curve?:	In Seg.	No					No					
Curve radius (R_2), ft:	800											
Length of curve (L_{c2}), mi:	0.014847											
Length of curve in segment ($L_{c2,seg}$), mi:	0.014847											
Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.038003											
3 Horizontal curve?:	In Seg.											
Curve radius (R_3), ft:	2462											
Length of curve (L_{c3}), mi:	0.090955											
Length of curve in segment ($L_{c3,seg}$), mi:	0.042808											
Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.05285											
4 Horizontal curve?:	No											
Curve radius (R_4), ft:												
Length of curve (L_{c4}), mi:												
Length of curve in segment ($L_{c4,seg}$), mi:												
Ramp-mile of beginning of curve in direction of travel (X_4), mi:												
5 Horizontal curve?:												
Curve radius (R_5), ft:												
Length of curve (L_{c5}), mi:												
Length of curve in segment ($L_{c5,seg}$), mi:												
Ramp-mile of beginning of curve in direction of travel (X_5), mi:												
Cross Section Data												
Lane width (W_l), ft:	12	12	12	12	12	12	12					
Right shoulder width (W_{rs}), ft:	8	8	8	8	8	8	8					
Left shoulder width (W_{ls}), ft:	4	4	4	4	4	4	4					
Presence of lane add or lane drop by taper:	No	No	No	No	No	No	Lane Drop					
Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:							0.075313					
Roadside Data												
Presence of barrier on <u>right</u> side of roadway:	Yes	Yes	No	Yes	Yes	Yes	Yes					
1 Length of barrier ($L_{rb,1}$), mi:	0.095926	0.328534		0.23999	0.179814	0.212678	0.059795					
Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8		8	8	8	8					
2 Length of barrier ($L_{rb,2}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:												
3 Length of barrier ($L_{rb,3}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:												
4 Length of barrier ($L_{rb,4}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:												
5 Length of barrier ($L_{rb,5}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:												
Presence of barrier on <u>left</u> side of roadway:	No	Yes	Yes	Yes	Yes	Yes	Yes					
1 Length of barrier ($L_{lb,1}$), mi:		0.280387	0.061099	0.087286	0.145659	0.212678	0.154661					
Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		4	4	4	4	4	4					
2 Length of barrier ($L_{lb,2}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:												
3 Length of barrier ($L_{lb,3}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:												
4 Length of barrier ($L_{lb,4}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:												
5 Length of barrier ($L_{lb,5}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:												
Ramp Access Data ← See note												
Ramp Entrance: Ramp entrance in segment? (If yes, indicate type.):	No	Lane Add	No	No	No	Lane Add	No					
Length of entrance s-c lane in segment ($L_{en,seg}$), mi:												
Ramp Exit: Ramp exit in segment? (If yes, indicate type.):	No	Lane Drop	Lane Drop	No	No	Lane Drop	No					
Length of exit s-c lane in segment ($L_{ex,seg}$), mi:												
Weaving Section: Weave section in collector-distributor road segment?:	No	Yes	No	No	No	Yes	No					
Length of weaving section (L_{wev}), mi:		0.280387				0.212678						
Length of weaving section in segment ($L_{wev,seg}$), mi:		0.280387				0.212678						
Traffic Data — Year												
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d: 2045	14300	34400	20100	15600	20500	39700	13500					
(enter data only for those years for which it is available, leave other years blank) 2046												
2047												
2048												
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2054												
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2057												

2045 mLPA 1 Aux Conditions: I-5/SR 500 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data										
Number of through lanes (n):		1	1	1	1	2	2	2	2	2
Ramp segment description:		5N-39ST	39ST-5N	5S-39ST	39ST-5S	5N-500 1	5N-500 2	500-5S 1	500-5S 2	5S-39ST/4P
Segment length (L), mi:		0.153443	0.182214	0.156574	0.202322	0.171793	0.263369	0.374235	0.089203	0.177765
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60	60	60	60	60
Segment type (ramp or collector-distributor road):		Exit	Entrance	Exit	Entrance	C-D Road	Connector	Connector	C-D Road	C-D Road
Type of control at crossroad ramp terminal:		Signal	Signal	Stop	Yield					
Alignment Data										
Horizontal Curve Data ←See notes →										
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	No
	Curve radius (R_1), ft:	1050	160	135	173	1000	1000	800	3000	
	Length of curve (L_{c1}), mi:	0.033874	0.030811	0.04446	0.026283	0.191909	0.191909	0.167398	0.013513	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.033874	0.030811	0.04446	0.026283	0.045472	0.146438	0.167398	0.013513	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.009602	0.043119	0.027471	0.104152	0.104152	0.175098	0.374235	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	No	No	No	No	
	Curve radius (R_2), ft:	2500	300	157	550					
	Length of curve (L_{c2}), mi:	0.027776	0.057926	0.036326	0.085076					
	Length of curve in segment ($L_{c2,seg}$), mi:	0.027776	0.057926	0.036326	0.085076					
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.078352	0.05135	0.092706	0.073118					
3	Horizontal curve?:	No	No	No	No					
	Curve radius (R_3), ft:									
	Length of curve (L_{c3}), mi:									
	Length of curve in segment ($L_{c3,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:									
4	Horizontal curve?:									
	Curve radius (R_4), ft:									
	Length of curve (L_{c4}), mi:									
	Length of curve in segment ($L_{c4,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:									
5	Horizontal curve?:									
	Curve radius (R_5), ft:									
	Length of curve (L_{c5}), mi:									
	Length of curve in segment ($L_{c5,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:									
Cross Section Data										

Lane width (W_l), ft:		15	15	12	15	13	13	12	12	17
Right shoulder width (W_{rs}), ft:		11	8	12	8	10	10	10	10	8
Left shoulder width (W_{ls}), ft:		4	6	10	4	5.5	5.5	4	4	4
Presence of lane add or lane drop by taper:		No	No	No	No	No	No	No	No	No
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:									
Roadside Data										
Presence of barrier on <u>right</u> side of roadway:		Yes	No	No	Yes	No	Yes	Yes	No	No
1	Length of barrier ($L_{rb,1}$), mi:	0.098106			0.078449		0.263369	0.374235		
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	11			8		10	10		
2	Length of barrier ($L_{rb,2}$), mi:				0.032197					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:				8					
3	Length of barrier ($L_{rb,3}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:									
4	Length of barrier ($L_{rb,4}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:									
5	Length of barrier ($L_{rb,5}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:									
Presence of barrier on <u>left</u> side of roadway:		Yes	No	No	Yes	No	Yes	Yes	No	Yes
1	Length of barrier ($L_{lb,1}$), mi:	0.188561			0.044129		0.121688	0.306201		0.097388
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4			4		5.5	4		4
2	Length of barrier ($L_{lb,2}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:									
3	Length of barrier ($L_{lb,3}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:									
4	Length of barrier ($L_{lb,4}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:									
5	Length of barrier ($L_{lb,5}$), mi:									
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:									
Ramp Access Data	↖ See note									
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No	No	S-C Lane	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:								0.087121	
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	S-C Lane	No	No	No	Lane Drop
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:					0.038826				
Weaving Section	Weave section in collector-distributor road segment?:					No			No	No
	Length of weaving section (L_{wev}), mi:									
	Length of weaving section in segment ($L_{wev,seg}$), mi:									
Traffic Data	**Year**									
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	4800	7300	8700	5300	30000	25200	23300	28600	22000
(enter data only for those years for which	2046									
it is available, leave other years blank)	2047									

2045 mLPA 1 Aux Conditions: I-5/4th Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period
Basic Roadway Data						
Number of through lanes (n):		1	1	2	1	
Ramp segment description:		5S-4P	4P-5S	4P-5N	CDN-4P	
Segment length (L), mi:		0.759903	0.175609	0.194324	0.652587	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	
Alignment Data						
Horizontal Curve Data	←See notes →					
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	1400	152	1025	2400	
	Length of curve (L_{c1}), mi:	0.075473	0.054231	0.040989	0.048609	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.075473	0.054231	0.040989	0.048609	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.036282	0.039613	0.038655	0.044099	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_2), ft:	1400	3000	3000	1820	
	Length of curve (L_{c2}), mi:	0.070973	0.081766	0.057045	0.108758	
	Length of curve in segment ($L_{c2,seg}$), mi:	0.070973	0.081766	0.057045	0.108758	
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.156801	0.093844	0.12915	0.148154	
3	Horizontal curve?:	In Seg.	No	No	In Seg.	
	Curve radius (R_3), ft:	8500			8000	
	Length of curve (L_{c3}), mi:	0.120783			0.175378	
	Length of curve in segment ($L_{c3,seg}$), mi:	0.120783			0.175378	
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.339797			0.296969	
4	Horizontal curve?:	In Seg.			In Seg.	
	Curve radius (R_4), ft:	360			400	
	Length of curve (L_{c4}), mi:	0.076382			0.052492	
	Length of curve in segment ($L_{c4,seg}$), mi:	0.076382			0.052492	
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:	0.635383			0.585053	
5	Horizontal curve?:	No			No	
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		15	15	12.5	15	
Right shoulder width (W_{rs}), ft:		8	8	10	8	
Left shoulder width (W_{ls}), ft:		4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					
Roadside Data						
Presence of barrier on right side of roadway:		Yes	No	Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.73282		0.164426	0.641244	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8		10	8	
2	Length of barrier ($L_{rb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:					
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

5	Length of barrier ($L_{rb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:					
Presence of barrier on left side of roadway:		Yes	Yes	No	Yes	
1	Length of barrier ($L_{lb,1}$), mi:	0.647991	0.088286		0.495453	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4		4	
2	Length of barrier ($L_{lb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:					
3	Length of barrier ($L_{lb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:					
4	Length of barrier ($L_{lb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:					
5	Length of barrier ($L_{lb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:					
Ramp Access Data	↖ See note					
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:					
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:					
Weaving Section	Weave section in collector-distributor road segment?:					
	Length of weaving section (L_{wev}), mi:					
	Length of weaving section in segment ($L_{wev,seg}$), mi:					

Traffic Data	**Year**					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	13300	9000	11000	8500	
(enter data only for those years for which	2046					
it is available, leave other years blank)	2047					
	2048					
	2049					
	2050					
	2051					
	2052					
	2053					
	2054					
	2055					
	2056					
	2057					
	2058					
	2059					
	2060					
	2061					
	2062					
	2063					
	2064					
	2065					
	2066					
	2067					
	2068					

Crash Data		**Year**		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 mLPA 1 Aux Conditions: I-5/Mill Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period
Basic Roadway Data						
Number of through lanes (n):		2	2	2	2	
Ramp segment description:		5S-MP	MP-CDS	MP-5N	CDN-MP	
Segment length (L), mi:		0.305919	0.201423	0.652519	0.240069	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	
Alignment Data						
Horizontal Curve Data	←See notes →					
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	2739	1000	3000	2400	
	Length of curve (L_{c1}), mi:	0.047703	0.021251	0.055963	0.048644	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.047703	0.021251	0.055963	0.048644	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.029962	0.135901	0.053242	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_2), ft:	2400	3000	2861	675	
	Length of curve (L_{c2}), mi:	0.044774	0.07387	0.220676	0.032426	
	Length of curve in segment ($L_{c2,seg}$), mi:	0.044774	0.07387	0.220676	0.032426	
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.140034	0.106262	0.261556	0.181141	
3	Horizontal curve?:	In Seg.	No	No	No	
	Curve radius (R_3), ft:	1000				
	Length of curve (L_{c3}), mi:	0.033051				
	Length of curve in segment ($L_{c3,seg}$), mi:	0.033051				
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.237717				
4	Horizontal curve?:	No				
	Curve radius (R_4), ft:					
	Length of curve (L_{c4}), mi:					
	Length of curve in segment ($L_{c4,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:					
5	Horizontal curve?:					
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		12.5	12.5	12.5	12.5	
Right shoulder width (W_{rs}), ft:		8	12	8	8	
Left shoulder width (W_{ls}), ft:		4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					
Roadside Data						
Presence of barrier on right side of roadway:		Yes	Yes	No	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.091873	0.105084		0.178275	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	12		8	
2	Length of barrier ($L_{rb,2}$), mi:	0.072589				
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:	8				
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

		Year						
5	Length of barrier ($L_{rb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:							
Presence of barrier on left side of roadway:				No	No	Yes	No	
1	Length of barrier ($L_{lb,1}$), mi:					0.174068		
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:					4		
2	Length of barrier ($L_{lb,2}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:							
3	Length of barrier ($L_{lb,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:							
4	Length of barrier ($L_{lb,4}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:							
5	Length of barrier ($L_{lb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:							
Ramp Access Data	↖ See note							
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):			No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:							
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):			No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:							
Weaving Section	Weave section in collector-distributor road segment?:							
	Length of weaving section (L_{wev}), mi:							
	Length of weaving section in segment ($L_{wev,seg}$), mi:							
Traffic Data			**Year**					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:			2045	20500	19200	25300	10200	
(enter data only for those years for which			2046					
it is available, leave other years blank)			2047					
			2048					
			2049					
			2050					
			2051					
			2052					
			2053					
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			2065					
			2066					
			2067					
			2068					
Crash Data		**Year**		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes	2045						
	($N_{o,w,n,mv,fi}$)	2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes	2045						
	($N_{o,w,n,sv,fi}$)	2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 mLPA 1 Aux Conditions: I-5/SR 14 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data								
Number of through lanes (n):		1	1	1	1	1	2	2
Ramp segment description:		5N-14E	5N-CST	14W-5S	CST-5S 1	CST-5S 2	14W-CDN	CDS-14E
Segment length (L), mi:		0.435441	0.510031	0.320606	0.247669	0.224811	0.40041	0.363653
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60	60	60
Segment type (ramp or collector-distributor road):		Connector	Exit	Connector	Entrance	C-D Road	C-D Road	C-D Road
Type of control at crossroad ramp terminal:			Signal		Signal			
Alignment Data								
Horizontal Curve Data ←See notes →								
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.
	Curve radius (R_1), ft:	2343	180	1025	330	2557	2478	2000
	Length of curve (L_{c1}), mi:	0.080683	0.15546	0.022739	0.032914	0.156535	0.102696	0.029184
	Length of curve in segment ($L_{c1,seg}$), mi:	0.080683	0.15546	0.022739	0.032914	0.156535	0.102696	0.029184
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.089815	0	0.033114	0.068399	0	0.039115
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	No	In Seg.	In Seg.
	Curve radius (R_2), ft:	603	500	210	1580		700	740
	Length of curve (L_{c2}), mi:	0.15544	0.129384	0.178708	0.080846		0.174326	0.196659
	Length of curve in segment ($L_{c2,seg}$), mi:	0.15544	0.129384	0.178708	0.080846		0.174326	0.196659
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.080683	0.245275	0.074419	0.166823		0.162603	0.142897
3	Horizontal curve?:	In Seg.	In Seg.	In Seg.	No		No	No
	Curve radius (R_3), ft:	3641.863	342	210				
	Length of curve (L_{c3}), mi:	0.134139	0.034111	0.013884				
	Length of curve in segment ($L_{c3,seg}$), mi:	0.134139	0.034111	0.013884				
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.301302	0.442806	0.253127				
4	Horizontal curve?:	No	No	In Seg.				
	Curve radius (R_4), ft:			1567.5				
	Length of curve (L_{c4}), mi:			0.053595				
	Length of curve in segment ($L_{c4,seg}$), mi:			0.053595				
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:			0.267011				
5	Horizontal curve?:			No				
	Curve radius (R_5), ft:							
	Length of curve (L_{c5}), mi:							
	Length of curve in segment ($L_{c5,seg}$), mi:							
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:							
Cross Section Data								
Lane width (W_l), ft:		15	15	15	15	15	16	15
Right shoulder width (W_{rs}), ft:		8	8	8	8	8	8	8
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	4	4
Presence of lane add or lane drop by taper:		No	No	No	No	No	Lane Drop	Lane Drop
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						0.047348	0.074637
Roadside Data								
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{rb,1}$), mi:	0.435441	0.510031	0.260811	0.058273	0.219195	0.40041	0.363653
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	8	8	8	8	8
2	Length of barrier ($L_{rb,2}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:							
3	Length of barrier ($L_{rb,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:							
4	Length of barrier ($L_{rb,4}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:							
5	Length of barrier ($L_{rb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:							
Presence of barrier on <u>left</u> side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{lb,1}$), mi:	0.291193	0.510031	0.260811	0.060714	0.224811	0.40041	0.363653
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4	4	4	4	4	4
2	Length of barrier ($L_{lb,2}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:							
3	Length of barrier ($L_{lb,3}$), mi:							

	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:							
4	Length of barrier ($L_{lb,4}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:							
5	Length of barrier ($L_{lb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:							

Ramp Access Data ← See note

Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:							
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:							
Weaving Section	Weave section in collector-distributor road segment?:					No	No	No
	Length of weaving section (L_{wev}), mi:							
	Length of weaving section in segment ($L_{wev,seg}$), mi:							

Traffic Data	Year							
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	17800	4700	15600	9300	24900	20100	26200
(enter data only for those years for which	2046							
it is available, leave other years blank)	2047							
	2048							
	2049							
	2050							
	2051							
	2052							
	2053							
	2054							
	2055							
	2056							
	2057							
	2058							
	2059							
	2060							
	2061							
	2062							
	2063							
	2064							
	2065							
	2066							
	2067							
	2068							

Crash Data	Year		Segment Crashes -->						
Count of Fatal-and-Injury (FI) Crashes by Year									
Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045								
	2046								
	2047								
	2048								
	2049								
Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045								
	2046								
	2047								
	2048								
	2049								
Count of Property-Damage-Only (PDO) Crashes by Year									
Multiple-vehicle crashes ($N_{o,w,n,mv,pdo}$)	2045								
	2046								
	2047								
	2048								
	2049								
Single-vehicle crashes ($N_{o,w,n,sv,pdo}$)	2045								
	2046								
	2047								
	2048								
	2049								

Advisory Messages

2045 mLPA 1 Aux Conditions: I-5/Hayden Island IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data				
Number of through lanes (n):		2	1	
Ramp segment description:		JD-5N	5S-JD	
Segment length (L), mi:		0.385083	0.337104	
Average traffic speed on the freeway (V_{frwy}), mi/h:		50	50	
Segment type (ramp or collector-distributor road):		Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	
Alignment Data				
Horizontal Curve Data	← See notes →			
1	Horizontal curve?:	In Seg.	In Seg.	
	Curve radius (R_1), ft:	11459.16	6364.45	
	Length of curve (L_{c1}), mi:	0.061602	0.078598	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.061602	0.078598	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.190861	0	
2	Horizontal curve?:	In Seg.	No	
	Curve radius (R_2), ft:	6250.45		
	Length of curve (L_{c2}), mi:	0.088563		
	Length of curve in segment ($L_{c2,seg}$), mi:	0.088563		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.296519		
3	Horizontal curve?:	No		
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:			
4	Horizontal curve?:			
	Curve radius (R_4), ft:			
	Length of curve (L_{c4}), mi:			
	Length of curve in segment ($L_{c4,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:			
5	Horizontal curve?:			
	Curve radius (R_5), ft:			
	Length of curve (L_{c5}), mi:			
	Length of curve in segment ($L_{c5,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:			
Cross Section Data				
Lane width (W_l), ft:		12	14	
Right shoulder width (W_{rs}), ft:		8	8	
Left shoulder width (W_{ls}), ft:		4	4	
Presence of lane add or lane drop by taper:		Lane Drop	No	

	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:	0.075758		
Roadside Data				
Presence of barrier on right side of roadway:		Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.236563	0.178447	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	
2	Length of barrier ($L_{rb,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:			
3	Length of barrier ($L_{rb,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:			
4	Length of barrier ($L_{rb,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:			
5	Length of barrier ($L_{rb,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:			
Presence of barrier on left side of roadway:		Yes	Yes	
1	Length of barrier ($L_{lb,1}$), mi:	0.247246	0.053663	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4	
2	Length of barrier ($L_{lb,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:			
3	Length of barrier ($L_{lb,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:			
4	Length of barrier ($L_{lb,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:			
5	Length of barrier ($L_{lb,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:			
Ramp Access Data	See note			
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:			
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:			
Weaving Section	Weave section in collector-distributor road segment?:			
	Length of weaving section (L_{wev}), mi:			
	Length of weaving section in segment ($L_{wev,seg}$), mi:			

Traffic Data	**Year**			
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	8100	12400	
(enter data only for those years for which it is available, leave other years blank)	2046			
	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
	2055			
	2056			

2045 mLPA 1 Aux Conditions: I-5/Marine Drive IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14	Segment 15	Segment 16	Segment 17
	Study Period	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**	**Study Period**
Basic Roadway Data																	
Number of through lanes (n):	1	1	1	2	1	1	2	2	2	2	1	2	2	1	1	1	
Ramp segment description:	5N-ER 1	5N-ER 2	5N-MDW 1	5N-MDW 2	5N-MLK	MDW-5N	MDE-5N 1	MDE-5N 2	5S-MLK 1	5S-MLK 2	5S-MDW	MDW-5S 1	MDW-5S 2	MDW-5S 3	MDE-5S	ER-5S	
Segment length (L), mi:	0.312067	0.388392	0.184441	0.137943	0.095008	0.100494	0.108178	0.355387	0.376729	0.119396	0.070387	0.099721	0.173258	0.484265	0.095841	0.38491	
Average traffic speed on the freeway (V_{frwy}), mi/h:	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	
Segment type (ramp or collector-distributor road):	C-D Road	Exit	C-D Road	Exit	Exit	Entrance	Entrance	C-D Road	C-D Road	Exit	Exit	Entrance	C-D Road	C-D Road	Entrance	Entrance	
Type of control at crossroad ramp terminal:		Yield		Signal	Yield	None	Signal			Signal	Yield	Signal			None	None	
Alignment Data																	
Horizontal Curve Data ← See notes →																	
1 Horizontal curve?:	No	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	
Curve radius (R_1), ft:		2864.79	11459.16	535	159.15	159.15	225	3274.04	2864.79	525	159.15	200	2083.48	818.51	159.15	572.96	
Length of curve (L_{c1}), mi:		0.012574	0.108858	0.099713	0.056342	0.034153	0.0703	0.047211	0.055905	0.098263	0.070387	0.061466	0.011558	0.017748	0.02755	0.013927	
Length of curve in segment ($L_{c1,seg}$), mi:		0.012574	0.108858	0.099713	0.056342	0.034153	0.0703	0.047211	0.055905	0.098263	0.070387	0.061466	0.011558	0.017748	0.02755	0.013927	
Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.027911	0.016305	0.038229	0.038666	0	0	0.175188	0.219089	0.021133	0	0	0.07892	0.246876	0	0.145581	
2 Horizontal curve?:		In Seg.	No	No	No	No	No	No	No	No	No	No	No	No	No	In Seg.	
Curve radius (R_2), ft:		1909.86														954.93	
Length of curve (L_{c2}), mi:		0.041148														0.011878	
Length of curve in segment ($L_{c2,seg}$), mi:		0.041148														0.011878	
Ramp-mile of beginning of curve in direction of travel (X_2), mi:		0.280901														0.269083	
3 Horizontal curve?:		No														No	
Curve radius (R_3), ft:																	
Length of curve (L_{c3}), mi:																	
Length of curve in segment ($L_{c3,seg}$), mi:																	
Ramp-mile of beginning of curve in direction of travel (X_3), mi:																	
4 Horizontal curve?:																	
Curve radius (R_4), ft:																	
Length of curve (L_{c4}), mi:																	
Length of curve in segment ($L_{c4,seg}$), mi:																	
Ramp-mile of beginning of curve in direction of travel (X_4), mi:																	
5 Horizontal curve?:																	
Curve radius (R_5), ft:																	
Length of curve (L_{c5}), mi:																	
Length of curve in segment ($L_{c5,seg}$), mi:																	
Ramp-mile of beginning of curve in direction of travel (X_5), mi:																	
Cross Section Data																	
Lane width (W_l), ft:	16	16	12	12	16	16	12	12	12	12	16	12	12	12	16	16	
Right shoulder width (W_{rs}), ft:	8	8	6	6	8	7.5	8	8	12	12	8	6	6	6	8	8	
Left shoulder width (W_{ls}), ft:	4	4	4	4	4	4	4	4	6	6	4	4	4	4	4	4	
Presence of lane add or lane drop by taper:	No	No	Lane Add	No	No	No	No	Lane Drop	Lane Add	No	No	No	No	No	No	No	
Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:			0.015155					0.069145	0.022624								
Roadside Data																	
Presence of barrier on right side of roadway:	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	
1 Length of barrier ($L_{rb,1}$), mi:	0.175605	0.099816	0.182634		0.095008	0.02942		0.355072	0.330688	0.119396	0.070387		0.04868	0.484265	0.0744	0.359593	
Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	6		8	7.5		8	12	12	8		6	6	8	8	
2 Length of barrier ($L_{rb,2}$), mi:																	
Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:																	
3 Length of barrier ($L_{rb,3}$), mi:																	
Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:																	
4 Length of barrier ($L_{rb,4}$), mi:																	
Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:																	
5 Length of barrier ($L_{rb,5}$), mi:																	
Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:																	
Presence of barrier on left side of roadway:	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	

1	Length of barrier ($L_{lb,1}$), mi:	0.175605	0.281909	0.051246	0.044663		0.036722	0.066943	0.240379	0.04035	0.049337		0.063038	0.173373	0.321886		0.187305	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4	4	4		4	4	4	6	6		4	4	4		4	
2	Length of barrier ($L_{lb,2}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:																	
3	Length of barrier ($L_{lb,3}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:																	
4	Length of barrier ($L_{lb,4}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:																	
5	Length of barrier ($L_{lb,5}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:																	
Ramp Access Data	← See note																	
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No	No	S-C Lane	No	No	No	No	S-C Lane	S-C Lane	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:								0.056989					0.030404	0.056818			
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	S-C Lane	No	S-C Lane	No	No	No	No	No	Lane Drop	No	No	No	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:	0.041004		0.026412														
Weaving Section	Weave section in collector-distributor road segment?:	No		No					No	No				No	No			
	Length of weaving section (L_{wev}), mi:																	
	Length of weaving section in segment ($L_{wev,seg}$), mi:																	
Traffic Data	**Year**																	
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	7500	5200	2300	1400	900	9900	12300	22200	23600	14300	9300	2500	3200	9400	700	6200	
(enter data only for those years for which	2046																	
it is available, leave other years blank)	2047																	
	2048																	
	2049																	
	2050																	
	2051																	
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Crash Data		**Year**		Segment Crashes -->																
Count of Fatal-and-Injury (FI) Crashes by Year																				
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045																		
		2046																		
		2047																		
		2048																		
		2049																		
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045																		
		2046																		
		2047																		
		2048																		
		2049																		
Count of Property-Damage-Only (PDO) Crashes by Year																				
	Multiple-vehicle crashes ($N_{o,w,n,mv,pdo}$)	2045																		
		2046																		
		2047																		
		2048																		
		2049																		
	Single-vehicle crashes ($N_{o,w,n,sv,pdo}$)	2045																		
		2046																		

2045 mLPA 1 Aux Conditions: I-5 Ramp Terminal Intersection ISATe Inputs

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

	Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Basic Intersection Data						
Ramp terminal configuration:	B2	D4	A2	D4	D4	D4
Ramp terminal description:	SR 500 SB Ra	SR 500 NB Ra	4th SB Ramps	4th NB Ramps	MP SB Ramps	MP NB Ramps
Ramp terminal traffic control type:	One stop	Signal	Signal	Signal	Signal	Signal
Is a non-ramp public street leg present at the terminal (I_{ps})?:		No	No	No	No	No
Alignment Data						
Exit ramp skew angle (I_{sk}), degrees:	0					
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:	0.04	0.08	0.14	0.24	0.12	0.14
Distance to the adjacent ramp terminal (L_{rmp}), mi:	0.15	0.15	0.15	0.15	0.1	0.1
Traffic Control						
Left-Turn Operational Mode						
Crossroad – Inside approach – Protected-only mode ($I_{p,lt,in}$)?:		No		Yes	Yes	Yes
Crossroad – Outside approach – Protected-only mode ($I_{p,lt,out}$)?:			Yes			
Right-Turn Control Type						
Ramp – Exit ramp approach – Right-turn control type:	Stop	Yield	Signal	Yield	Free	Yield
Cross Section Data						
Crossroad median width (W_m), ft:	12	12	12	24	36	36
Number of Lanes						
Crossroad – Both approaches – Lanes serving through vehicles (n_{th}):	2	2	4	4	6	6
Crossroad – Inside approach – Lanes serving through vehicles ($n_{th,in}$):		1	2	2	2	2
Crossroad – Outside approach – Lanes serving through vehicles ($n_{th,out}$):		1	2	2	4	4
Ramp – Exit ramp approach – All lanes (n_{ex}):	1	1	1	2	2	2
Right-Turn Channelization see note: →						
Crossroad – Inside approach – Channelization present ($I_{ch,in}$)?:			Yes			
Crossroad – Outside approach – Channelization present ($I_{ch,out}$)?:		No		Yes	Yes	Yes
Ramp – Exit ramp approach – Channelization present ($I_{ch,ex}$)?:		Yes	No	Yes	Yes	Yes
Left-Turn Lane or Bay						
Crossroad – Inside approach – Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes		Yes	Yes	Yes
Crossroad – Inside approach – Width of lane or bay ($W_{b,in}$), ft:	12	12		24	24	24
Crossroad – Outside approach – Lane or bay present ($I_{bay,lt,out}$)?:			Yes			
Crossroad – Outside approach – Width of lane or bay ($W_{b,out}$), ft:			12			
Right-Turn Lane or Bay						
Crossroad – Inside approach – Lane or bay present ($I_{bay,rt,in}$)?:			Yes			
Crossroad – Outside approach – Lane or bay present ($I_{bay,rt,out}$)?:	No	No		No	Yes	Yes
Access Data						
Number of driveways on the outside crossroad leg (n_{dw}):		0	0	0	0	0
Number of public street approaches on the outside crossroad leg (n_{ps}):	2					

Traffic Data	**Year**						
Inside Crossroad Leg Data	2045	25300	18300	28600	20700	51500	37200
Average daily traffic ($AADT_{in}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
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Outside Crossroad Leg Data	2045	21300	21000	31400	21800	70000	23400
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
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Exit Ramp Data	2045	8700	4800	13300	8500	20500	10200
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For a B4 terminal configuration, enter the AADT for the	2050						
diagonal exit ramp (not the loop exit ramp).	2051						
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Entrance Ramp Data	2045	5300	7300	9000	11000	19200	25300
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For an A4 terminal configuration, enter the AADT for the	2050						
diagonal entrance ramp (not the loop entrance ramp).	2051						
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	2061						

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

			Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Basic Intersection Data								
Ramp terminal configuration:			D3ex	D3en	D3en	D3ex		
Ramp terminal description:			N Jantzen & S	N Janzten & NB	LR & SB On	LR & NB Off		
Ramp terminal traffic control type:			Signal	Signal	Signal	Signal		
Is a non-ramp public street leg present at the terminal (I_{ps})?:			No	No	No	No		
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:								
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.15	0.18	0.07	0.13		
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.04	0.04	0.11	0.11		
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:		No	Yes			
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Signal			Signal		
Cross Section Data								
Crossroad median width (W_m), ft:			0	0	0	0		
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	2	2	2	2		
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):	1	1	1	1		
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):	1	1	1	1	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):	2			1		
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:						
	Outside approach	Channelization present ($I_{ch,out}$)?:		No	No			
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:	No			No		
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:		No	No			
		Width of lane or bay ($W_{b,in}$), ft:						
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:						
		Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:						
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:		No	No			
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):			0	0	0	0		
Number of public street approaches on the outside crossroad leg (n_{ps}):								

Traffic Data	Year						
Inside Crossroad Leg Data	2045	11600	8300	11000	7900		
Average daily traffic ($AADT_{in}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
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Outside Crossroad Leg Data	2045	8800	7500	5100	12800		
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
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Exit Ramp Data	2045	12400			5200		
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For a B4 terminal configuration, enter the AADT for the	2050						
diagonal exit ramp (not the loop exit ramp).	2051						
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Entrance Ramp Data	2045		8100	6200			
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For an A4 terminal configuration, enter the AADT for the	2050						
diagonal entrance ramp (not the loop entrance ramp).	2051						
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Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

			Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period
Basic Intersection Data							
Ramp terminal configuration:			SPUI				
Ramp terminal description:			Marine Dr				
Ramp terminal traffic control type:			Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:							
Alignment Data							
Exit ramp skew angle (I_{sk}), degrees:							
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.5				
Distance to the adjacent ramp terminal (L_{rmp}), mi:							
Traffic Control							
Left-Turn Operational Mode							
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:					
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:					
Right-Turn Control Type							
Ramp	Exit ramp approach	Right-turn control type:					
Cross Section Data							
Crossroad median width (W_m), ft:							
Number of Lanes							
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):					
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):					
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):		0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):					
Right-Turn Channelization		see note: →					
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:					
	Outside approach	Channelization present ($I_{ch,out}$)?:					
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:					
Left-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:					
		Width of lane or bay ($W_{b,in}$), ft:					
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:					
		Width of lane or bay ($W_{b,out}$), ft:					
Right-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:					
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:					
Access Data							
Number of driveways on the outside crossroad leg (n_{dw}):							
Number of public street approaches on the outside crossroad leg (n_{ps}); Number of exit ramps with free-flow right turns onto crossroad (SPUI Only):			2				
Traffic Data		**Year**					
Inside Crossroad Leg Data		2045	42000				
Average daily traffic ($AADT_{in}$) by year, veh/d:		2046					
(enter data only for those years for which		2047					
it is available, leave other years blank)		2048					
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Outside Crossroad Leg Data	2045	42600				
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
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	2068					
Exit Ramp Data	2045	19400				
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For a B4 terminal configuration, enter the AADT for the	2050					
diagonal exit ramp (not the loop exit ramp).	2051					
	2052					
For a SPUI or TDI terminal configuration, enter AADT for both	2053					
exit ramps combined	2054					
	2055					
	2056					
	2057					
	2058					
	2059					
	2060					
	2061					
	2062					
	2063					
	2064					
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	2067					
	2068					
Entrance Ramp Data	2045	33900				
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For an A4 terminal configuration, enter the AADT for the	2050					

Output Summary

General Information							
Project description:	Mainline Corridor Pt 1 - Modified LPA 1 Aux						
Analyst:	0	Date:	9/27/2023		Area type:		Urban
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp terminals	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	195.2	0.8	2.3	14.9	44.2	133.0
Estimated average crash freq. during Study Period, crashes/yr:	195.2	0.8	2.3	14.9	44.2	133.0

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	20	175.8	0.7	1.9	12.8	38.5	121.8
Ramp segments, crashes:	7	19.4	0.1	0.4	2.1	5.6	11.2
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	195.2	0.8	2.3	14.9	44.2	133.0
	2046						
	2047						
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	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.7	0.0	0.0	0.1	0.3	0.3
	Right-angle crashes:	2.9	0.0	0.0	0.3	0.9	1.7
	Rear-end crashes:	101.1	0.4	1.2	8.1	24.2	67.1
	Sideswipe crashes:	35.3	0.1	0.3	1.9	5.6	27.4
	Other multiple-vehicle crashes:	5.2	0.0	0.1	0.5	1.5	3.1
	Total multiple-vehicle crashes:	145.2	0.6	1.7	10.9	32.5	99.5
Single vehicle	Crashes with animal:	0.7	0.0	0.0	0.0	0.0	0.7
	Crashes with fixed object:	36.1	0.2	0.4	2.9	8.4	24.2
	Crashes with other object:	5.4	0.0	0.0	0.2	0.6	4.6
	Crashes with parked vehicle:	0.8	0.0	0.0	0.1	0.2	0.5
	Other single-vehicle crashes	7.1	0.0	0.1	0.9	2.5	3.6
	Total single-vehicle crashes:	50.1	0.2	0.6	4.0	11.7	33.6
	Total crashes:	195.2	0.8	2.3	14.9	44.2	133.0

Output Summary								
General Information								
Project description:	Mainline Corridor Pt 2 - Modified LPA 1 Aux							
Analyst:	0	Date:	9/27/2023		Area type:		Urban	
First year of analysis:	2045							
Last year of analysis:	2045							
Crash Data Description								
Freeway segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp segments	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			
Ramp terminals	Segment crash data available?			No	First year of crash data:			
	Project-level crash data available?			No	Last year of crash data:			

Estimated Crash Statistics							
Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		23.7	0.1	0.2	1.6	5.1	16.6
Estimated average crash freq. during Study Period, crashes/yr:		23.7	0.1	0.2	1.6	5.1	16.6
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	1	23.7	0.1	0.2	1.6	5.1	16.6
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	23.7	0.1	0.2	1.6	5.1	16.6
	2046						
	2047						
	2048						
	2049						
	2050						
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	2052						
	2053						
	2054						
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	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.4	0.0	0.0	0.0	0.1	0.2
	Rear-end crashes:	12.9	0.0	0.1	0.9	2.9	8.9
	Sideswipe crashes:	4.4	0.0	0.0	0.2	0.7	3.4
	Other multiple-vehicle crashes:	0.5	0.0	0.0	0.0	0.1	0.3
	Total multiple-vehicle crashes:	18.2	0.1	0.2	1.2	3.8	12.9
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with fixed object:	3.9	0.0	0.0	0.3	0.9	2.6
	Crashes with other object:	0.6	0.0	0.0	0.0	0.1	0.5
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	0.8	0.0	0.0	0.1	0.3	0.4
	Total single-vehicle crashes:	5.5	0.0	0.1	0.4	1.3	3.7
	Total crashes:	23.7	0.1	0.2	1.6	5.1	16.6

Output Summary

General Information

Project description:	SR 500 Interchange Area - Modified LPA 1 Aux				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	16.6	0.1	0.4	1.9	3.8	10.5
Estimated average crash freq. during Study Period, crashes/yr:	16.6	0.1	0.4	1.9	3.8	10.5

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	9	16.6	0.1	0.4	1.9	3.8	10.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	16.6	0.1	0.4	1.9	3.8	10.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	6.5	0.0	0.1	0.8	1.8	3.8
	Sideswipe crashes:	2.8	0.0	0.0	0.1	0.3	2.3
	Other multiple-vehicle crashes:	1.2	0.0	0.0	0.1	0.3	0.7
	Total multiple-vehicle crashes:	10.7	0.1	0.2	1.1	2.5	6.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.7	0.0	0.1	0.6	0.9	3.0
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.0	0.0	0.0	0.2	0.3	0.5
	Total single-vehicle crashes:	5.9	0.1	0.2	0.8	1.3	3.6
	Total crashes:	16.6	0.1	0.4	1.9	3.8	10.5

Output Summary

General Information

Project description:	4th Plain Interchange Area - Modified LPA 1 Aux				
Analyst:	0	Date:	9/29/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	8.0	0.1	0.2	1.1	2.0	4.5
Estimated average crash freq. during Study Period, crashes/yr:	8.0	0.1	0.2	1.1	2.0	4.5

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	4	8.0	0.1	0.2	1.1	2.0	4.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	8.0	0.1	0.2	1.1	2.0	4.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.6	0.0	0.0	0.1	0.1	0.4
	Sideswipe crashes:	0.3	0.0	0.0	0.0	0.0	0.2
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	1.0	0.0	0.0	0.1	0.2	0.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	5.4	0.1	0.2	0.8	1.3	3.1
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.3	0.0	0.1	0.3	0.5	0.5
	Total single-vehicle crashes:	7.0	0.1	0.2	1.1	1.8	3.8
	Total crashes:	8.0	0.1	0.2	1.1	2.0	4.5

Output Summary

General Information

Project description:	Mill Plain Interchange Area - Modified LPA 1 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	10.1	0.1	0.2	1.1	2.3	6.4
Estimated average crash freq. during Study Period, crashes/yr:	10.1	0.1	0.2	1.1	2.3	6.4

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	4	10.1	0.1	0.2	1.1	2.3	6.4
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	10.1	0.1	0.2	1.1	2.3	6.4
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	2.6	0.0	0.1	0.3	0.6	1.6
	Sideswipe crashes:	1.2	0.0	0.0	0.1	0.1	1.0
	Other multiple-vehicle crashes:	0.5	0.0	0.0	0.1	0.1	0.3
	Total multiple-vehicle crashes:	4.4	0.0	0.1	0.5	0.9	2.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.5	0.0	0.1	0.5	1.0	2.9
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.0	0.0	0.0	0.2	0.4	0.4
	Total single-vehicle crashes:	5.8	0.1	0.2	0.7	1.4	3.5
	Total crashes:	10.1	0.1	0.2	1.1	2.3	6.4

Output Summary

General Information

Project description:	SR 14 Interchange Area - Modified LPA 1 Aux					
Analyst:	0	Date:	10/3/2023	Area type:	Urban	
First year of analysis:	2045					
Last year of analysis:	2045					

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	27.4	0.2	0.6	3.1	6.7	16.7
Estimated average crash freq. during Study Period, crashes/yr:	27.4	0.2	0.6	3.1	6.7	16.7

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	7	27.4	0.2	0.6	3.1	6.7	16.7
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	27.4	0.2	0.6	3.1	6.7	16.7
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
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	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	8.8	0.1	0.2	1.0	2.4	5.0
	Sideswipe crashes:	3.8	0.0	0.0	0.2	0.4	3.1
	Other multiple-vehicle crashes:	1.7	0.0	0.0	0.2	0.5	0.9
	Total multiple-vehicle crashes:	14.4	0.1	0.2	1.5	3.5	9.2
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	10.2	0.1	0.2	1.2	2.4	6.3
	Crashes with other object:	0.3	0.0	0.0	0.0	0.0	0.2
	Crashes with parked vehicle:	0.2	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	2.3	0.0	0.1	0.4	0.8	1.0
	Total single-vehicle crashes:	13.0	0.1	0.3	1.7	3.3	7.6
	Total crashes:	27.4	0.2	0.6	3.1	6.7	16.7

Output Summary

General Information

Project description:	Hayden Island Interchange Area - Modified LPA 1 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	2.6	0.0	0.1	0.3	0.6	1.5
Estimated average crash freq. during Study Period, crashes/yr:	2.6	0.0	0.1	0.3	0.6	1.5

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	2	2.6	0.0	0.1	0.3	0.6	1.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	2.6	0.0	0.1	0.3	0.6	1.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
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	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.4	0.0	0.0	0.0	0.1	0.2
	Sideswipe crashes:	0.2	0.0	0.0	0.0	0.0	0.2
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Total multiple-vehicle crashes:	0.6	0.0	0.0	0.1	0.1	0.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	1.5	0.0	0.0	0.2	0.4	0.9
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.4	0.0	0.0	0.1	0.1	0.1
	Total single-vehicle crashes:	2.0	0.0	0.1	0.3	0.5	1.1
	Total crashes:	2.6	0.0	0.1	0.3	0.6	1.5

Output Summary

General Information

Project description:	Marine Drive Interchange Area - Modified LPA 1 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	19.5	0.2	0.5	2.3	4.5	12.1
Estimated average crash freq. during Study Period, crashes/yr:	19.5	0.2	0.5	2.3	4.5	12.1

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	16	19.5	0.2	0.5	2.3	4.5	12.1
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	19.5	0.2	0.5	2.3	4.5	12.1
	2046						
	2047						
	2048						
	2049						
	2050						
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	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	5.2	0.0	0.1	0.6	1.4	3.0
	Sideswipe crashes:	2.2	0.0	0.0	0.1	0.3	1.9
	Other multiple-vehicle crashes:	1.0	0.0	0.0	0.1	0.3	0.6
	Total multiple-vehicle crashes:	8.5	0.0	0.2	0.8	1.9	5.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	8.7	0.1	0.2	1.1	1.9	5.4
	Crashes with other object:	0.2	0.0	0.0	0.0	0.0	0.2
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	2.0	0.0	0.1	0.4	0.7	0.8
	Total single-vehicle crashes:	11.0	0.1	0.3	1.5	2.6	6.5
	Total crashes:	19.5	0.2	0.5	2.3	4.5	12.1

Output Summary

General Information

Project description:	Ramp Terminal Intersections Pt. 1 - Modified LPA 1 Aux				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	86.7	0.1	0.9	5.5	28.9	51.4
Estimated average crash freq. during Study Period, crashes/yr:	86.7	0.1	0.9	5.5	28.9	51.4

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	6	86.7	0.1	0.9	5.5	28.9	51.4

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	86.7	0.1	0.9	5.5	28.9	51.4
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
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	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.8	0.0	0.0	0.1	0.3	0.4
	Right-angle crashes:	22.1	0.0	0.2	1.6	8.3	12.0
	Rear-end crashes:	48.1	0.0	0.5	3.2	17.2	27.2
	Sideswipe crashes:	8.7	0.0	0.0	0.2	1.2	7.3
	Other multiple-vehicle crashes:	1.4	0.0	0.0	0.1	0.3	1.0
	Total multiple-vehicle crashes:	81.1	0.0	0.8	5.2	27.2	47.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.2	0.0	0.0	0.2	1.1	2.8
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.2	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.1	0.0	0.0	0.1	0.5	0.4
	Total single-vehicle crashes:	5.6	0.0	0.1	0.3	1.7	3.5
	Total crashes:	86.7	0.1	0.9	5.5	28.9	51.4

Output Summary

General Information							
Project description:	Ramp Terminals Pt. 2 - Modified LPA 1 Aux						
Analyst:	0	Date:	9/28/2023		Area type:	Urban	
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		
Ramp segments	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		
Ramp terminals	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		

Estimated Crash Statistics

Crashes for Entire Facility		Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:		7.3	0.0	0.1	0.7	3.1	3.4
Estimated average crash freq. during Study Period, crashes/yr:		7.3	0.0	0.1	0.7	3.1	3.4
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	4	7.3	0.0	0.1	0.7	3.1	3.4
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	7.3	0.0	0.1	0.7	3.1	3.4
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	1.8	0.0	0.0	0.2	0.8	0.7
	Rear-end crashes:	4.3	0.0	0.1	0.4	1.9	1.8
	Sideswipe crashes:	0.7	0.0	0.0	0.0	0.1	0.5
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	6.9	0.0	0.1	0.6	2.9	3.2
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.3	0.0	0.0	0.0	0.1	0.2
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.1	0.0	0.0	0.0	0.1	0.0
	Total single-vehicle crashes:	0.4	0.0	0.0	0.0	0.2	0.2
	Total crashes:	7.3	0.0	0.1	0.7	3.1	3.4

Output Summary

General Information

Project description:	Ramp Terminal Intersections: Marine Dr SPUI - Modified LPA 1 Aux				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Ramp terminals	Site crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	12.1	0.0	0.1	0.8	2.0	9.2
Estimated average crash freq. during Study Period, crashes/yr:	12.1	0.0	0.1	0.8	2.0	9.2

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Crossroad ramp terminals, crashes:	1	12.1	0.0	0.1	0.8	2.0	9.2

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	12.1	0.0	0.1	0.8	2.0	9.2
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Right-angle crashes:	1.1	0.0	0.0	0.1	0.3	0.7
	Rear-end crashes:	8.8	0.0	0.1	0.5	1.3	6.8
	Sideswipe crashes:	1.1	0.0	0.0	0.0	0.1	1.0
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	11.3	0.0	0.1	0.7	1.7	8.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.6	0.0	0.0	0.0	0.1	0.4
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.3	0.0	0.0	0.1	0.2	0.0
	Total single-vehicle crashes:	0.8	0.0	0.0	0.1	0.2	0.5
	Total crashes:	12.1	0.0	0.1	0.8	2.0	9.2

2045 mLPA 2 Aux Conditions: I-5 Mainline ISATe Inputs

Input Worksheet for Freeway Segments Clear / Echo Input Values (View results in Column AV) / Check Input Values (View results in Advisory Messages)	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period	Segment 10 Study Period	Segment 11 Study Period	Segment 12 Study Period	Segment 13 Study Period	Segment 14 Study Period	Segment 15 Study Period	Segment 16 Study Period	Segment 17 Study Period	Segment 18 Study Period	Segment 19 Study Period	Segment 20 Study Period
Basic Roadway Data																				
Number of through lanes (n):	6	6	6	7	8	10	10	10	10	10	8	8	8	10	10	10	10	9	7	7
Freeway segment description:	70+00.00-78+	78+95.82-85+	85+49.53-98+	98+37.96-106	106+00.00-14	140+27.78-15	155+01.16-17	176+66.56-18	185+21.88-19	190+79.39-19	192+80.4-199	199+43.7-228	228+00.00-23	236+15.37-24	243+98.73-25	255+52.037-2	267+81.61-27	277+09.81-28	281+38.2-305	305+72.35-308
Segment length (L), mi:	0.169663	0.123809	0.244021	0.144326	0.649201	0.279022	0.410114	0.161992	0.105589	0.03807	0.125625	0.540966	0.154426	0.148364	0.218429	0.232874	0.175795	0.081134	0.461013	0.050256
Alignment Data																				
Horizontal Curve Data ↖See note																				
1 Horizontal curve in segment?:	No	No	Both Dir.	No	Both Dir.	Both Dir.	Both Dir.	Both Dir.	Both Dir.	No	Both Dir.	Both Dir.	No	No	Both Dir.	No	No	No	Both Dir.	No
Curve radius (R_1), ft:			2865		6304	6307	6307	2399	2399		2400	2400			2800				2600	
Length of curve (L_{c1}), mi:			0.179766		0.124834	0.109936	0.109936	0.210496	0.210496		0.201569	0.201569			0.205335				0.142811	
Length of curve in segment ($L_{c1,seg}$), mi:			0.179766		0.124834	0.03523	0.074706	0.109248	0.101248		0.043688	0.157881			0.205335				0.142811	
2 Horizontal curve in segment?:			No		No	No	No	No	No		No	No			No				No	
Curve radius (R_2), ft:																				
Length of curve (L_{c2}), mi:																				
Length of curve in segment ($L_{c2,seg}$), mi:																				
3 Horizontal curve in segment?:																				
Curve radius (R_3), ft:																				
Length of curve (L_{c3}), mi:																				
Length of curve in segment ($L_{c3,seg}$), mi:																				
Cross Section Data																				
Lane width (W_l), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Outside shoulder width (W_s), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Inside shoulder width (W_{is}), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Median width (W_m), ft:	26	26	26	26	37	44	44	42	36	33	31	26	26	26	26	26	26	26	26	26
Rumble strips on outside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Rumble strips on inside shoulders?:																				
Length of rumble strips for travel in increasing milepost direction, mi:																				
Length of rumble strips for travel in decreasing milepost direction, mi:																				
Presence of barrier in median:	Some	Center	Center	Center	Some	Some	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center	Center
1 Length of barrier ($L_{ib,1}$), mi:	0.108286	0.123809	0.244021	0.144326	0.286553	0.179008	0.410114	0.161992	0.105589	0.03807	0.125625	0.540966	0.154426	0.148364	0.218429	0.232874	0.175795	0.081134	0.461013	0.050256
Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
2 Length of barrier ($L_{ib,2}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:																				
3 Length of barrier ($L_{ib,3}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:																				
4 Length of barrier ($L_{ib,4}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:																				
5 Length of barrier ($L_{ib,5}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:																				
Median barrier width (W_{ib}), ft:		2	2	2			2	2	2	2	2	2	2	2	2	2	2	2	2	2
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:																				
Roadside Data																				
Clear zone width (W_{hc}), ft:																				
Presence of barrier on roadside:	Some	Some	Some	Some	Some	Some	Full	Some	None	None	Some	Some	Some	Some	Some	Some	Some	None	Some	None
1 Length of barrier ($L_{ob,1}$), mi:	0.108286	0.084114	0.189195	0.042089	0.316919	0.278964		0.185299			0.125023	0.526691	0.022439	0.074369	0.059083	0.142616	0.175795		0.183002	
Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:	12	12	12	12	12	12		12			12	12	12	12	12	12	12		12	
2 Length of barrier ($L_{ob,2}$), mi:	0.051364		0.079348	0.129767	0.020684	0.279049		0.201604			0.094032	0.050061	0.041386	0.148364	0.055693					
Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:	12		12	12	12	12		12			12	12	12	12	12					
3 Length of barrier ($L_{ob,3}$), mi:					0.316828							0.445525	0.154426							
Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:					12							12	12							
4 Length of barrier ($L_{ob,4}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:																				
5 Length of barrier ($L_{ob,5}$), mi:																				
Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:																				
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:							12													
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:							12													
Ramp Access Data																				
Travel in Increasing Milepost Direction																				
Entrance: Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	Lane Add	Lane Add	S-C Lane	No	No	No	No	No	No	Lane Add	No	S-C Lane	S-C Lane	No	No	S-C Lane

Ramp	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:		999	999	999	999				0.410114	0.572106	0.677695	0.715765	0.84139	1.382356		0.148364			0.175795	0.25693	
	Length of ramp entrance ($L_{en,inc}$), mi:								0.202546									0.227273	0.131222			0.09472
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:								0.202546									0.227273	0.131222			0.050256
	Entrance side?:								Right									Right	Right			Right
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		S-C Lane	No	No	No	No	No	No	S-C Lane	S-C Lane	No	Lane Drop	No	No	No	No	No	No	Lane Drop	No	No
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			1.888703	1.644682	1.500356	0.851155	0.572106	0.161992			0.163695		1.011023	0.856597	0.708233	0.489804	0.88193	0.081134		999	999
	Length of ramp exit ($L_{ex,inc}$), mi:		0.038981							0.032991	0.042787											
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:		0.038981							0.032991	0.042787											
	Exit side?:		Right							Right	Right											
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No	No
	Length of weaving section ($L_{wev,inc}$), mi:																	0.255682	0.255682			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:																	0.232874	0.022808			
Travel in Decreasing Milepost Direction																						
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):		S-C Lane	No	No	No	No	No	S-C Lane	No	No	Lane Add	No	No	No	No	Lane Add	No	Lane Add	No	No	No
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			1.72671	1.482689	1.338364	0.689163	0.410114		0.143659	0.03807		1.062185	0.521219	0.366793	0.218429		0.175795		999	999	999
	Length of ramp entrance ($L_{en,dec}$), mi:		0.097646						0.148434													
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:		0.097646						0.148434													
	Entrance side?:		Right						Right													
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):		No	No	No	Lane Drop	No	Lane Drop	S-C Lane	No	No	No	No	No	No	Lane Drop	Lane Drop	No	No	No	No	No
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:		999	999	999		0.144326			0.410114	0.572106	0.677695	0.715765	0.84139	1.382356			0.218429	0.451303	0.627098	0.708233	1.169246
	Length of ramp exit ($L_{ex,dec}$), mi:								0.040896													
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:								0.040896													
	Exit side?:								Right													
Weave	Type B weave in segment?:		No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No	No	No	No	No
	Length of weaving section ($L_{wev,dec}$), mi:																0.218429					
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:																0.218429					
Traffic Data		**Year**																				
Proportion of AADT during high-volume hours (P_{hv}):																						
Freeway Segment Data		2045	98600	89200	81700	91700	108700	154500	175000	150100	132300	127600	114100	99800	99800	135900	156300	172600	183600	183600	125000	132300
Average daily traffic ($AADT_{fs}$) by year, veh/d:		2046																				
(enter data only for those years for which		2047																				
it is available, leave other years blank)		2048																				
		2049																				
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Entrance Ramp Data for Travel in Increasing Milepost Dir.		**Year**																				
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:		2045					17000	22200	8100	15600	15600	15600	15600	15600	15600	15600	25300	25300	11000	7300	7300	7300
(enter data only for those years for which		2046																				
it is available, leave other years blank)		2047																				
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	2068																				
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	7500	17800	17800	17800	17800	17800	17800	17800	4700	14300	14300	30000	30000	30000	30000	30000	30000	30000		
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
	2048																				
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	2066																				
	2067																				
	2068																				
Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**																				
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2045	9400	24900	24900	24900	24900	24900	24900	13500	13500	13500	9000	9000	9000	9000	9000	28600	28600			
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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	2067																				
	2068																				
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**																				
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045				10000	10000	23600	12400	12400	12400	12400	12400	12400	12400	20500	20500	20500	20500	20500	20500	20500
(enter data only for those years for which	2046																				
it is available, leave other years blank)	2047																				
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2045 mLPA 2 Aux Conditions: I-5 Mainline ISATe Inputs

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period
Basic Roadway Data				
Number of through lanes (n):		8		
Freeway segment description:		308+37.7-334+76.131		
Segment length (L), mi:		0.499703		
Alignment Data				
Horizontal Curve Data	←See note			
1	Horizontal curve in segment?:	No		
	Curve radius (R_1), ft:			
	Length of curve (L_{c1}), mi:			
	Length of curve in segment ($L_{c1,seg}$), mi:			
2	Horizontal curve in segment?:			
	Curve radius (R_2), ft:			
	Length of curve (L_{c2}), mi:			
	Length of curve in segment ($L_{c2,seg}$), mi:			
3	Horizontal curve in segment?:			
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
Cross Section Data				
Lane width (W_l), ft:		12		
Outside shoulder width (W_s), ft:		12		
Inside shoulder width (W_{is}), ft:		12		
Median width (W_m), ft:		26		
Rumble strips on outside shoulders?:				
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Rumble strips on inside shoulders?:				
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Presence of barrier in median:		Center		
1	Length of barrier ($L_{ib,1}$), mi:	0.499703		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:	12		
2	Length of barrier ($L_{ib,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:			
3	Length of barrier ($L_{ib,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:			
4	Length of barrier ($L_{ib,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:			
5	Length of barrier ($L_{ib,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:			
Median barrier width (W_{ib}), ft:		2		

Nearest distance from edge of traveled way to barrier face (W_{near}), ft:				
Roadside Data				
Clear zone width (W_{hc}), ft:				
Presence of barrier on roadside:		None		
1	Length of barrier ($L_{ob,1}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			
2	Length of barrier ($L_{ob,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			
3	Length of barrier ($L_{ob,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			
4	Length of barrier ($L_{ob,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:			
5	Length of barrier ($L_{ob,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:			
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:				
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:				
Ramp Access Data				
Travel in Increasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:	0.050256		
	Length of ramp entrance ($L_{en,inc}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:	999		
	Length of ramp exit ($L_{ex,inc}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,inc}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:			
Travel in Decreasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:	999		
	Length of ramp entrance ($L_{en,dec}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	Lane Drop		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			
	Length of ramp exit ($L_{ex,dec}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,dec}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:			
Traffic Data	**Year**			

Proportion of AADT during high-volume hours (P_{hv}):				
Freeway Segment Data	2045	154300		
Average daily traffic ($AADT_{fs}$) by year, veh/d:	2046			
(enter data only for those years for which	2047			
it is available, leave other years blank)	2048			
	2049			
	2050			
	2051			
	2052			
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	2068			
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:	2045	7300		
(enter data only for those years for which	2046			
it is available, leave other years blank)	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
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	2066			
	2067			
	2068			
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**			

Average daily traffic ($AADT_{e,ext}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2045			
	2046			
	2047			
	2048			
	2049			
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	2051			
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	2066			
	2067			
	2068			
Entrance Ramp Data for Travel in Decreasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{e,ent}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2045			
	2046			
	2047			
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	2049			
	2050			
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	2068			
Exit Ramp Data for Travel in Decreasing Milepost Direction	**Year**			
Average daily traffic ($AADT_{b,ext}$) by year, veh/d:	2045	22000		

2045 mLPA 2 Aux Conditions: I-5 C-D ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

	Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period	Segment 6 Study Period	Segment 7 Study Period	Segment 8 Study Period	Segment 9 Study Period	Segment 10 Study Period	Segment 11 Study Period	Segment 12 Study Period
Basic Roadway Data												
Number of through lanes (n):	2	2	2	1	2	2	2					
Ramp segment description:	5N-CDN	CDN 1	CDN 2	CDN-5N	5S-CDS	CDS	CDS-5S					
Segment length (L), mi:	0.095926	0.328534	0.061099	0.23999	0.236354	0.212678	0.314884					
Average traffic speed on the freeway (V_{frwy}), mi/h:	60	60	60	60	60	60	60					
Segment type (ramp or collector-distributor road):	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road	C-D Road					
Type of control at crossroad ramp terminal:												
Alignment Data												
Horizontal Curve Data ← See notes →												
1 Horizontal curve?:	In Seg.	In Seg.	No	No	No	No	In Seg.					
Curve radius (R_1), ft:	2446	2462					2345					
Length of curve (L_{c1}), mi:	0.038003	0.090955					0.191746					
Length of curve in segment ($L_{c1,seg}$), mi:	0.038003	0.048147					0.191746					
Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0					0.041635					
2 Horizontal curve?:	In Seg.	No					No					
Curve radius (R_2), ft:	800											
Length of curve (L_{c2}), mi:	0.014847											
Length of curve in segment ($L_{c2,seg}$), mi:	0.014847											
Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.038003											
3 Horizontal curve?:	In Seg.											
Curve radius (R_3), ft:	2462											
Length of curve (L_{c3}), mi:	0.090955											
Length of curve in segment ($L_{c3,seg}$), mi:	0.042808											
Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.05285											
4 Horizontal curve?:	No											
Curve radius (R_4), ft:												
Length of curve (L_{c4}), mi:												
Length of curve in segment ($L_{c4,seg}$), mi:												
Ramp-mile of beginning of curve in direction of travel (X_4), mi:												
5 Horizontal curve?:												
Curve radius (R_5), ft:												
Length of curve (L_{c5}), mi:												
Length of curve in segment ($L_{c5,seg}$), mi:												
Ramp-mile of beginning of curve in direction of travel (X_5), mi:												
Cross Section Data												
Lane width (W_l), ft:	12	12	12	12	12	12	12					
Right shoulder width (W_{rs}), ft:	8	8	8	8	8	8	8					
Left shoulder width (W_{ls}), ft:	4	4	4	4	4	4	4					
Presence of lane add or lane drop by taper:	No	No	No	No	No	No	Lane Drop					
Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:							0.075313					
Roadside Data												
Presence of barrier on <u>right</u> side of roadway:	Yes	Yes	No	Yes	Yes	Yes	Yes					
1 Length of barrier ($L_{rb,1}$), mi:	0.095926	0.328534		0.23999	0.179814	0.212678	0.059795					
Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8		8	8	8	8					
2 Length of barrier ($L_{rb,2}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:												
3 Length of barrier ($L_{rb,3}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:												
4 Length of barrier ($L_{rb,4}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:												
5 Length of barrier ($L_{rb,5}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:												
Presence of barrier on <u>left</u> side of roadway:	No	Yes	Yes	Yes	Yes	Yes	Yes					
1 Length of barrier ($L_{lb,1}$), mi:		0.280387	0.061099	0.087286	0.145659	0.212678	0.154661					
Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		4	4	4	4	4	4					
2 Length of barrier ($L_{lb,2}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:												
3 Length of barrier ($L_{lb,3}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:												
4 Length of barrier ($L_{lb,4}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:												
5 Length of barrier ($L_{lb,5}$), mi:												
Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:												
Ramp Access Data ← See note												
Ramp Entrance: Ramp entrance in segment? (If yes, indicate type.):	No	Lane Add	No	No	No	Lane Add	No					
Ramp Entrance: Length of entrance s-c lane in segment ($L_{en,seg}$), mi:												
Ramp Exit: Ramp exit in segment? (If yes, indicate type.):	No	Lane Drop	Lane Drop	No	No	Lane Drop	No					
Ramp Exit: Length of exit s-c lane in segment ($L_{ex,seg}$), mi:												
Weaving Section: Weave section in collector-distributor road segment?:	No	Yes	No	No	No	Yes	No					
Weaving Section: Length of weaving section (L_{wev}), mi:		0.280387				0.212678						
Weaving Section: Length of weaving section in segment ($L_{wev,seg}$), mi:		0.280387				0.212678						

Traffic Data	Year	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	14300	34400	20100	15600	20500	39700	13500					
(enter data only for those years for which	2046												
it is available, leave other years blank)	2047												
	2048												
	2049												
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	2055												
	2056												
	2057												

2045 mLPA 2 Aux Conditions: I-5/SR 500 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data										
Number of through lanes (n):		1	1	1	1	2	2	2	2	2
Ramp segment description:		5N-39ST	39ST-5N	5S-39ST	39ST-5S	5N-500 1	5N-500 2	500-5S 1	500-5S 2	5S-39ST/4P
Segment length (L), mi:		0.153443	0.182214	0.156574	0.202322	0.171793	0.263369	0.374235	0.089203	0.177765
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60	60	60	60	60
Segment type (ramp or collector-distributor road):		Exit	Entrance	Exit	Entrance	C-D Road	Connector	Connector	C-D Road	C-D Road
Type of control at crossroad ramp terminal:		Signal	Signal	Stop	Yield					
Alignment Data										
Horizontal Curve Data ← See notes →										
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	No
	Curve radius (R_1), ft:	1050	160	135	173	1000	1000	800	3000	
	Length of curve (L_{c1}), mi:	0.033874	0.030811	0.04446	0.026283	0.191909	0.191909	0.167398	0.013513	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.033874	0.030811	0.04446	0.026283	0.045472	0.146438	0.167398	0.013513	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.009602	0.043119	0.027471	0.104152	0.104152	0.175098	0.374235	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	No	No	No	No	
	Curve radius (R_2), ft:	2500	300	157	550					
	Length of curve (L_{c2}), mi:	0.027776	0.057926	0.036326	0.085076					
	Length of curve in segment ($L_{c2,seg}$), mi:	0.027776	0.057926	0.036326	0.085076					
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.078352	0.05135	0.092706	0.073118					
3	Horizontal curve?:	No	No	No	No					
	Curve radius (R_3), ft:									
	Length of curve (L_{c3}), mi:									
	Length of curve in segment ($L_{c3,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:									
4	Horizontal curve?:									
	Curve radius (R_4), ft:									
	Length of curve (L_{c4}), mi:									
	Length of curve in segment ($L_{c4,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:									
5	Horizontal curve?:									
	Curve radius (R_5), ft:									
	Length of curve (L_{c5}), mi:									
	Length of curve in segment ($L_{c5,seg}$), mi:									
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:									

Lane width (W_l), ft:			15	15	12	15	13	13	12	12	17
Right shoulder width (W_{rs}), ft:			11	8	12	8	10	10	10	10	8
Left shoulder width (W_{ls}), ft:			4	6	10	4	5.5	5.5	4	4	4
Presence of lane add or lane drop by taper:			No	No	No	No	No	No	No	No	No
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:										
Roadside Data											
Presence of barrier on right side of roadway:			Yes	No	No	Yes	No	Yes	Yes	No	No
1	Length of barrier ($L_{rb,1}$), mi:		0.098106			0.078449		0.263369	0.374235		
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:		11			8		10	10		
2	Length of barrier ($L_{rb,2}$), mi:					0.032197					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:					8					
3	Length of barrier ($L_{rb,3}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:										
4	Length of barrier ($L_{rb,4}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:										
5	Length of barrier ($L_{rb,5}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:										
Presence of barrier on left side of roadway:			Yes	No	No	Yes	No	Yes	Yes	No	Yes
1	Length of barrier ($L_{lb,1}$), mi:		0.188561			0.044129		0.121688	0.306201		0.097388
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		4			4		5.5	4		4
2	Length of barrier ($L_{lb,2}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:										
3	Length of barrier ($L_{lb,3}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:										
4	Length of barrier ($L_{lb,4}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:										
5	Length of barrier ($L_{lb,5}$), mi:										
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:										
Ramp Access Data	↖ See note										
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	No	No	No	No	No	S-C Lane	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:									0.087121	
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		No	No	No	No	S-C Lane	No	No	No	Lane Drop
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						0.038826				
Weaving Section	Weave section in collector-distributor road segment?:						No			No	No
	Length of weaving section (L_{wev}), mi:										
	Length of weaving section in segment ($L_{wev,seg}$), mi:										
Traffic Data		**Year**									
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:		2045	4800	7300	8700	5300	30000	25200	23300	28600	22000
(enter data only for those years for which		2046									
it is available, leave other years blank)		2047									

2045 mLPA 2 Aux Conditions: I-5/4th Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period
Basic Roadway Data						
Number of through lanes (n):		1	1	2	1	
Ramp segment description:		5S-4P	4P-5S	4P-5N	CDN-4P	
Segment length (L), mi:		0.759903	0.175609	0.194324	0.652587	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	
Alignment Data						
Horizontal Curve Data	←See notes →					
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	1400	152	1025	2400	
	Length of curve (L_{c1}), mi:	0.075473	0.054231	0.040989	0.048609	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.075473	0.054231	0.040989	0.048609	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.036282	0.039613	0.038655	0.044099	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_2), ft:	1400	3000	3000	1820	
	Length of curve (L_{c2}), mi:	0.070973	0.081766	0.057045	0.108758	
	Length of curve in segment ($L_{c2,seg}$), mi:	0.070973	0.081766	0.057045	0.108758	
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.156801	0.093844	0.12915	0.148154	
3	Horizontal curve?:	In Seg.	No	No	In Seg.	
	Curve radius (R_3), ft:	8500			8000	
	Length of curve (L_{c3}), mi:	0.120783			0.175378	
	Length of curve in segment ($L_{c3,seg}$), mi:	0.120783			0.175378	
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.339797			0.296969	
4	Horizontal curve?:	In Seg.			In Seg.	
	Curve radius (R_4), ft:	360			400	
	Length of curve (L_{c4}), mi:	0.076382			0.052492	
	Length of curve in segment ($L_{c4,seg}$), mi:	0.076382			0.052492	
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:	0.635383			0.585053	
5	Horizontal curve?:	No			No	
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		15	15	12.5	15	
Right shoulder width (W_{rs}), ft:		8	8	10	8	
Left shoulder width (W_{ls}), ft:		4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					
Roadside Data						
Presence of barrier on right side of roadway:		Yes	No	Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.73282		0.164426	0.641244	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8		10	8	
2	Length of barrier ($L_{rb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:					
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

		Year					
5	Length of barrier ($L_{rb,5}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:						
Presence of barrier on left side of roadway:			Yes	Yes	No	Yes	
1	Length of barrier ($L_{lb,1}$), mi:		0.647991	0.088286		0.495453	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		4	4		4	
2	Length of barrier ($L_{lb,2}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:						
3	Length of barrier ($L_{lb,3}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:						
4	Length of barrier ($L_{lb,4}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:						
5	Length of barrier ($L_{lb,5}$), mi:						
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:						
Ramp Access Data	↖ See note						
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:						
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:						
Weaving Section	Weave section in collector-distributor road segment?:						
	Length of weaving section (L_{wev}), mi:						
	Length of weaving section in segment ($L_{wev,seg}$), mi:						
Traffic Data		**Year**					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:		2045	13300	9000	11000	8500	
(enter data only for those years for which		2046					
it is available, leave other years blank)		2047					
		2048					
		2049					
		2050					
		2051					
		2052					
		2053					
		2054					
		2055					
		2056					
		2057					
		2058					
		2059					
		2060					
		2061					
		2062					
		2063					
		2064					
		2065					
		2066					
		2067					
		2068					

		Year		Segment Crashes -->				
Crash Data		**Year**		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045						
		2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 mLPA 2 Aux Conditions: I-5/Mill Plain IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period	Segment 4 Study Period	Segment 5 Study Period
Basic Roadway Data						
Number of through lanes (n):		2	2	2	2	
Ramp segment description:		5S-MP	MP-CDS	MP-5N	CDN-MP	
Segment length (L), mi:		0.305919	0.201423	0.652519	0.240069	
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	
Segment type (ramp or collector-distributor road):		Exit	Entrance	Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	Signal	Signal	
Alignment Data						
Horizontal Curve Data	←See notes →					
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:	2739	1000	3000	2400	
	Length of curve (L_{c1}), mi:	0.047703	0.021251	0.055963	0.048644	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.047703	0.021251	0.055963	0.048644	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.029962	0.135901	0.053242	
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_2), ft:	2400	3000	2861	675	
	Length of curve (L_{c2}), mi:	0.044774	0.07387	0.220676	0.032426	
	Length of curve in segment ($L_{c2,seg}$), mi:	0.044774	0.07387	0.220676	0.032426	
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.140034	0.106262	0.261556	0.181141	
3	Horizontal curve?:	In Seg.	No	No	No	
	Curve radius (R_3), ft:	1000				
	Length of curve (L_{c3}), mi:	0.033051				
	Length of curve in segment ($L_{c3,seg}$), mi:	0.033051				
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.237717				
4	Horizontal curve?:	No				
	Curve radius (R_4), ft:					
	Length of curve (L_{c4}), mi:					
	Length of curve in segment ($L_{c4,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:					
5	Horizontal curve?:					
	Curve radius (R_5), ft:					
	Length of curve (L_{c5}), mi:					
	Length of curve in segment ($L_{c5,seg}$), mi:					
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:					
Cross Section Data						
Lane width (W_l), ft:		12.5	12.5	12.5	12.5	
Right shoulder width (W_{rs}), ft:		8	12	8	8	
Left shoulder width (W_{ls}), ft:		4	4	4	4	
Presence of lane add or lane drop by taper:		No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:					
Roadside Data						
Presence of barrier on right side of roadway:		Yes	Yes	No	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.091873	0.105084		0.178275	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	12		8	
2	Length of barrier ($L_{rb,2}$), mi:	0.072589				
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:	8				
3	Length of barrier ($L_{rb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:					
4	Length of barrier ($L_{rb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:					

5	Length of barrier ($L_{rb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:					
Presence of barrier on left side of roadway:		No	No	Yes	No	
1	Length of barrier ($L_{lb,1}$), mi:			0.174068		
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:			4		
2	Length of barrier ($L_{lb,2}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:					
3	Length of barrier ($L_{lb,3}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:					
4	Length of barrier ($L_{lb,4}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:					
5	Length of barrier ($L_{lb,5}$), mi:					
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:					

Ramp Access Data	↖ See note					
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:					
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:					
Weaving Section	Weave section in collector-distributor road segment?:					
	Length of weaving section (L_{wev}), mi:					
	Length of weaving section in segment ($L_{wev,seg}$), mi:					

Traffic Data	**Year**					
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	20500	19200	25300	10200	
(enter data only for those years for which	2046					
it is available, leave other years blank)	2047					
	2048					
	2049					
	2050					
	2051					
	2052					
	2053					
	2054					
	2055					
	2056					
	2057					
	2058					
	2059					
	2060					
	2061					
	2062					
	2063					
	2064					
	2065					
	2066					
	2067					
	2068					

Crash Data		**Year**		Segment Crashes -->				
Count of Fatal-and-Injury (FI) Crashes by Year								
	Multiple-vehicle crashes	2045						
	($N_{o,w,n,mv,fi}$)	2046						
		2047						
		2048						
		2049						
	Single-vehicle crashes	2045						
	($N_{o,w,n,sv,fi}$)	2046						
		2047						
		2048						
		2049						
Count of Property-Damage-Only (PDO) Crashes by Year								
	Multiple-vehicle crashes	2045						

2045 mLPA 2 Aux Conditions: I-5/SR 14 IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data								
Number of through lanes (n):		1	1	1	1	1	2	2
Ramp segment description:		5N-14E	5N-CST	14W-5S	CST-5S 1	CST-5S 2	14W-CDN	CDS-14E
Segment length (L), mi:		0.435441	0.510031	0.320606	0.247669	0.224811	0.40041	0.363653
Average traffic speed on the freeway (V_{frwy}), mi/h:		60	60	60	60	60	60	60
Segment type (ramp or collector-distributor road):		Connector	Exit	Connector	Entrance	C-D Road	C-D Road	C-D Road
Type of control at crossroad ramp terminal:			Signal		Signal			
Alignment Data								
Horizontal Curve Data ←See notes →								
1	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.
	Curve radius (R_1), ft:	2343	180	1025	330	2557	2478	2000
	Length of curve (L_{c1}), mi:	0.080683	0.15546	0.022739	0.032914	0.156535	0.102696	0.029184
	Length of curve in segment ($L_{c1,seg}$), mi:	0.080683	0.15546	0.022739	0.032914	0.156535	0.102696	0.029184
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0	0.089815	0	0.033114	0.068399	0	0.039115
2	Horizontal curve?:	In Seg.	In Seg.	In Seg.	In Seg.	No	In Seg.	In Seg.
	Curve radius (R_2), ft:	603	500	210	1580		700	740
	Length of curve (L_{c2}), mi:	0.15544	0.129384	0.178708	0.080846		0.174326	0.196659
	Length of curve in segment ($L_{c2,seg}$), mi:	0.15544	0.129384	0.178708	0.080846		0.174326	0.196659
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.080683	0.245275	0.074419	0.166823		0.162603	0.142897
3	Horizontal curve?:	In Seg.	In Seg.	In Seg.	No		No	No
	Curve radius (R_3), ft:	3641.863	342	210				
	Length of curve (L_{c3}), mi:	0.134139	0.034111	0.013884				
	Length of curve in segment ($L_{c3,seg}$), mi:	0.134139	0.034111	0.013884				
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:	0.301302	0.442806	0.253127				
4	Horizontal curve?:	No	No	In Seg.				
	Curve radius (R_4), ft:			1567.5				
	Length of curve (L_{c4}), mi:			0.053595				
	Length of curve in segment ($L_{c4,seg}$), mi:			0.053595				
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:			0.267011				
5	Horizontal curve?:			No				
	Curve radius (R_5), ft:							
	Length of curve (L_{c5}), mi:							
	Length of curve in segment ($L_{c5,seg}$), mi:							
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:							
Cross Section Data								
Lane width (W_l), ft:		15	15	15	15	15	16	15
Right shoulder width (W_{rs}), ft:		8	8	8	8	8	8	8
Left shoulder width (W_{ls}), ft:		4	4	4	4	4	4	4
Presence of lane add or lane drop by taper:		No	No	No	No	No	Lane Drop	Lane Drop
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:						0.047348	0.074637
Roadside Data								
Presence of barrier on right side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{rb,1}$), mi:	0.435441	0.510031	0.260811	0.058273	0.219195	0.40041	0.363653
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	8	8	8	8	8
2	Length of barrier ($L_{rb,2}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:							
3	Length of barrier ($L_{rb,3}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:							
4	Length of barrier ($L_{rb,4}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:							
5	Length of barrier ($L_{rb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:							
Presence of barrier on left side of roadway:		Yes	Yes	Yes	Yes	Yes	Yes	Yes
1	Length of barrier ($L_{lb,1}$), mi:	0.291193	0.510031	0.260811	0.060714	0.224811	0.40041	0.363653
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4	4	4	4	4	4
2	Length of barrier ($L_{lb,2}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:							
3	Length of barrier ($L_{lb,3}$), mi:							

	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:							
4	Length of barrier ($L_{lb,4}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:							
5	Length of barrier ($L_{lb,5}$), mi:							
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:							
Ramp Access Data	See note							
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	No	No	No	No	No
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:							
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	No	No	No	No	No
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:							
Weaving Section	Weave section in collector-distributor road segment?:					No	No	No
	Length of weaving section (L_{wev}), mi:							
	Length of weaving section in segment ($L_{wev,seg}$), mi:							

Traffic Data	Year							
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	17800	4700	15600	9300	24900	20100	26200
(enter data only for those years for which it is available, leave other years blank)	2046							
	2047							
	2048							
	2049							
	2050							
	2051							
	2052							
	2053							
	2054							
	2055							
	2056							
	2057							
	2058							
	2059							
	2060							
	2061							
	2062							
	2063							
	2064							
	2065							
	2066							
	2067							
	2068							

Crash Data		Year		Segment Crashes -->						
Count of Fatal-and-Injury (FI) Crashes by Year										
	Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045								
		2046								
		2047								
		2048								
		2049								
	Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045								
		2046								
		2047								
		2048								
		2049								
Count of Property-Damage-Only (PDO) Crashes by Year										
	Multiple-vehicle crashes ($N_{o,w,n,mv,pdo}$)	2045								
		2046								
		2047								
		2048								
		2049								
	Single-vehicle crashes ($N_{o,w,n,sv,pdo}$)	2045								
		2046								
		2047								
		2048								
		2049								

Advisory Messages

2045 mLPA 2 Aux Conditions: I-5/Hayden Island IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments		Segment 1	Segment 2	Segment 3
Clear / Echo Input Values (View results in Column CJ) / Check Input Values (View results in Advisory Messages)		Study Period	Study Period	Study Period
Basic Roadway Data				
Number of through lanes (n):		2	1	
Ramp segment description:		JD-5N	5S-JD	
Segment length (L), mi:		0.385083	0.337104	
Average traffic speed on the freeway (V_{frwy}), mi/h:		50	50	
Segment type (ramp or collector-distributor road):		Entrance	Exit	
Type of control at crossroad ramp terminal:		Signal	Signal	
Alignment Data				
Horizontal Curve Data	←See notes →			
1	Horizontal curve?:	In Seg.	In Seg.	
	Curve radius (R_1), ft:	11459.16	6364.45	
	Length of curve (L_{c1}), mi:	0.061602	0.078598	
	Length of curve in segment ($L_{c1,seg}$), mi:	0.061602	0.078598	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:	0.190861	0	
2	Horizontal curve?:	In Seg.	No	
	Curve radius (R_2), ft:	6250.45		
	Length of curve (L_{c2}), mi:	0.088563		
	Length of curve in segment ($L_{c2,seg}$), mi:	0.088563		
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:	0.296519		
3	Horizontal curve?:	No		
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:			
4	Horizontal curve?:			
	Curve radius (R_4), ft:			
	Length of curve (L_{c4}), mi:			
	Length of curve in segment ($L_{c4,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:			
5	Horizontal curve?:			
	Curve radius (R_5), ft:			
	Length of curve (L_{c5}), mi:			
	Length of curve in segment ($L_{c5,seg}$), mi:			
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:			
Cross Section Data				
Lane width (W_l), ft:		12	14	
Right shoulder width (W_{rs}), ft:		8	8	
Left shoulder width (W_{ls}), ft:		4	4	
Presence of lane add or lane drop by taper:		Lane Drop	No	

	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:	0.075758		
Roadside Data				
Presence of barrier on <u>right</u> side of roadway:		Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.236563	0.178447	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	
2	Length of barrier ($L_{rb,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:			
3	Length of barrier ($L_{rb,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:			
4	Length of barrier ($L_{rb,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:			
5	Length of barrier ($L_{rb,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:			
Presence of barrier on <u>left</u> side of roadway:		Yes	Yes	
1	Length of barrier ($L_{lb,1}$), mi:	0.247246	0.053663	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:	4	4	
2	Length of barrier ($L_{lb,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:			
3	Length of barrier ($L_{lb,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:			
4	Length of barrier ($L_{lb,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:			
5	Length of barrier ($L_{lb,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:			
Ramp Access Data	↖ See note			
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:			
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:			
Weaving Section	Weave section in collector-distributor road segment?:			
	Length of weaving section (L_{wev}), mi:			
	Length of weaving section in segment ($L_{wev,seg}$), mi:			

Traffic Data	**Year**			
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:	2045	8100	12400	
(enter data only for those years for which it is available, leave other years blank)	2046			
	2047			
	2048			
	2049			
	2050			
	2051			
	2052			
	2053			
	2054			
	2055			
	2056			

2045 mLPA 2 Aux Conditions: I-5/Marine Drive IC Ramp Segment ISATe Inputs

Input Worksheet for Ramp Segments

Clear | Echo Input Values (View results in Column CJ) | Check Input Values (View results in Advisory Messages)

		Segment 1	Segment 2	Segment 3	Segment 4	Segment 5	Segment 6	Segment 7	Segment 8	Segment 9	Segment 10	Segment 11	Segment 12	Segment 13	Segment 14	Segment 15	Segment 16	Segment 17
		Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period	Study Period
Basic Roadway Data																		
	Number of through lanes (n):	1	1	1	2	1	1	2	2	2	2	1	2	2	1	1	1	
	Ramp segment description:	5N-ER 1	5N-ER 2	5N-MDW 1	5N-MDW 2	5N-MLK	MDW-5N	MDE-5N 1	MDE-5N 2	5S-MLK 1	5S-MLK 2	5S-MDW	MDW-5S 1	MDW-5S 2	MDW-5S 3	MDE-5S	ER-5S	
	Segment length (L), mi:	0.312067	0.388392	0.184441	0.137943	0.095008	0.100494	0.108178	0.355387	0.376729	0.119396	0.070387	0.099721	0.173258	0.484265	0.095841	0.38491	
	Average traffic speed on the freeway (V_{frwy}), mi/h:	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	
	Segment type (ramp or collector-distributor road):	C-D Road	Exit	C-D Road	Exit	Exit	Entrance	Entrance	C-D Road	C-D Road	Exit	Exit	Entrance	C-D Road	C-D Road	Entrance	Entrance	
	Type of control at crossroad ramp terminal:		Yield		Signal	Yield	None	Signal			Signal	Yield	Signal			None	None	
Alignment Data																		
Horizontal Curve Data	←See notes →																	
1	Horizontal curve?:	No	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	In Seg.	
	Curve radius (R_1), ft:		2864.79	11459.16	535	159.15	159.15	225	3274.04	2864.79	525	159.15	200	2083.48	818.51	159.15	572.96	
	Length of curve (L_{c1}), mi:		0.012574	0.108858	0.099713	0.056342	0.034153	0.0703	0.047211	0.055905	0.098263	0.070387	0.061466	0.011558	0.017748	0.02755	0.013927	
	Length of curve in segment ($L_{c1,seg}$), mi:		0.012574	0.108858	0.099713	0.056342	0.034153	0.0703	0.047211	0.055905	0.098263	0.070387	0.061466	0.011558	0.017748	0.02755	0.013927	
	Ramp-mile of beginning of curve in direction of travel (X_1), mi:		0.027911	0.016305	0.038229	0.038666	0	0	0.175188	0.219089	0.021133	0	0	0.07892	0.246876	0	0.145581	
2	Horizontal curve?:		In Seg.	No	No	No	No	No	No	No	No	No	No	No	No	No	In Seg.	
	Curve radius (R_2), ft:		1909.86														954.93	
	Length of curve (L_{c2}), mi:		0.041148														0.011878	
	Length of curve in segment ($L_{c2,seg}$), mi:		0.041148														0.011878	
	Ramp-mile of beginning of curve in direction of travel (X_2), mi:		0.280901														0.269083	
3	Horizontal curve?:		No														No	
	Curve radius (R_3), ft:																	
	Length of curve (L_{c3}), mi:																	
	Length of curve in segment ($L_{c3,seg}$), mi:																	
	Ramp-mile of beginning of curve in direction of travel (X_3), mi:																	
4	Horizontal curve?:																	
	Curve radius (R_4), ft:																	
	Length of curve (L_{c4}), mi:																	
	Length of curve in segment ($L_{c4,seg}$), mi:																	
	Ramp-mile of beginning of curve in direction of travel (X_4), mi:																	
5	Horizontal curve?:																	
	Curve radius (R_5), ft:																	
	Length of curve (L_{c5}), mi:																	
	Length of curve in segment ($L_{c5,seg}$), mi:																	
	Ramp-mile of beginning of curve in direction of travel (X_5), mi:																	
Cross Section Data																		
	Lane width (W_l), ft:	16	16	12	12	16	16	12	12	12	12	16	12	12	12	16	16	
	Right shoulder width (W_{rs}), ft:	8	8	6	6	8	7.5	8	8	12	12	8	6	6	6	8	8	
	Left shoulder width (W_{ls}), ft:	4	4	4	4	4	4	4	4	6	6	4	4	4	4	4	4	
	Presence of lane add or lane drop by taper:	No	No	Lane Add	No	No	No	No	Lane Drop	Lane Add	No	No	No	No	No	No	No	
	Length of taper in segment ($L_{add,seg}$ or $L_{drop,seg}$), mi:			0.015155					0.069145	0.022624								
Roadside Data																		
	Presence of barrier on <u>right</u> side of roadway:	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	
1	Length of barrier ($L_{rb,1}$), mi:	0.175605	0.099816	0.182634		0.095008	0.02942		0.355072	0.330688	0.119396	0.070387		0.04868	0.484265	0.0744	0.359593	
	Distance from edge of traveled way to barrier face ($W_{off,r,1}$), ft:	8	8	6		8	7.5		8	12	12	8		6	6	8	8	
2	Length of barrier ($L_{rb,2}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,r,2}$), ft:																	
3	Length of barrier ($L_{rb,3}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,r,3}$), ft:																	
4	Length of barrier ($L_{rb,4}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,r,4}$), ft:																	
5	Length of barrier ($L_{rb,5}$), mi:																	
	Distance from edge of traveled way to barrier face ($W_{off,r,5}$), ft:																	
	Presence of barrier on <u>left</u> side of roadway:	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	

1	Length of barrier ($L_{lb,1}$), mi:		0.175605	0.281909	0.051246	0.044663		0.036722	0.066943	0.240379	0.04035	0.049337		0.063038	0.173373	0.321886		0.187305	
	Distance from edge of traveled way to barrier face ($W_{off,l,1}$), ft:		4	4	4	4		4	4	4	6	6		4	4	4		4	
2	Length of barrier ($L_{lb,2}$), mi:																		
	Distance from edge of traveled way to barrier face ($W_{off,l,2}$), ft:																		
3	Length of barrier ($L_{lb,3}$), mi:																		
	Distance from edge of traveled way to barrier face ($W_{off,l,3}$), ft:																		
4	Length of barrier ($L_{lb,4}$), mi:																		
	Distance from edge of traveled way to barrier face ($W_{off,l,4}$), ft:																		
5	Length of barrier ($L_{lb,5}$), mi:																		
	Distance from edge of traveled way to barrier face ($W_{off,l,5}$), ft:																		
Ramp Access Data	See note																		
Ramp Entrance	Ramp entrance in segment? (If yes, indicate type.):		No	No	No	No	No	No	No	S-C Lane	No	No	No	No	S-C Lane	S-C Lane	No	No	
	Length of entrance s-c lane in segment ($L_{en,seg}$), mi:									0.056989					0.030404	0.056818			
Ramp Exit	Ramp exit in segment? (If yes, indicate type.):		S-C Lane	No	S-C Lane	No	No	No	No	No	Lane Drop	No	No	No	No	No	No	No	
	Length of exit s-c lane in segment ($L_{ex,seg}$), mi:		0.041004		0.026412														
Weaving Section	Weave section in collector-distributor road segment?:		No		No					No	No				No	No			
	Length of weaving section (L_{wev}), mi:																		
	Length of weaving section in segment ($L_{wev,seg}$), mi:																		
Traffic Data		**Year**																	
Average daily traffic ($AADT_r$ or $AADT_c$) by year, veh/d:		2045	7500	5200	2300	1400	900	9900	12300	22200	23600	14300	9300	2500	3200	9400	700	6200	
(enter data only for those years for which		2046																	
it is available, leave other years blank)		2047																	
		2048																	
		2049																	
		2050																	
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		2068																	

Crash Data	**Year**		Segment Crashes -->																
Count of Fatal-and-Injury (FI) Crashes by Year																			
Multiple-vehicle crashes ($N_{o,w,n,mv,fi}$)	2045																		
	2046																		
	2047																		
	2048																		
	2049																		
Single-vehicle crashes ($N_{o,w,n,sv,fi}$)	2045																		
	2046																		
	2047																		
	2048																		
	2049																		
Count of Property-Damage-Only (PDO) Crashes by Year																			
Multiple-vehicle crashes ($N_{o,w,n,mv,pdo}$)	2045																		
	2046																		
	2047																		
	2048																		
	2049																		
Single-vehicle crashes ($N_{o,w,n,sv,pdo}$)	2045																		
	2046																		

2045 mLPA 2 Aux Conditions: I-5 Ramp Terminal Intersection ISATe Inputs

Input Worksheet for Crossroad Ramp Terminals

Clear	Echo Input Values (View results in Column T)	Check Input Values (View results in Advisory Messages)	Terminal 1 **Study Period**	Terminal 2 **Study Period**	Terminal 3 **Study Period**	Terminal 4 **Study Period**	Terminal 5 **Study Period**	Terminal 6 **Study Period**
Basic Intersection Data								
Ramp terminal configuration:			B2	D4	A2	D4	D4	D4
Ramp terminal description:			SR 500 SB Ra	SR 500 NB Ra	4th SB Ramps	4th NB Ramps	MP SB Ramps	MP NB Ramps
Ramp terminal traffic control type:			One stop	Signal	Signal	Signal	Signal	Signal
Is a non-ramp public street leg present at the terminal (I_{ps})?:				No	No	No	No	No
Alignment Data								
Exit ramp skew angle (I_{sk}), degrees:			0					
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.04	0.08	0.14	0.24	0.12	0.14
Distance to the adjacent ramp terminal (L_{rmp}), mi:			0.15	0.15	0.15	0.15	0.1	0.1
Traffic Control								
Left-Turn Operational Mode								
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:		No		Yes	Yes	Yes
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:			Yes			
Right-Turn Control Type								
Ramp	Exit ramp approach	Right-turn control type:	Stop	Yield	Signal	Yield	Free	Yield
Cross Section Data								
Crossroad median width (W_m), ft:			12	12	12	24	36	36
Number of Lanes								
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):	2	2	4	4	6	6
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):		1	2	2	2	2
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):		1	2	2	4	4
Ramp	Exit ramp approach	All lanes (n_{ex}):	1	1	1	2	2	2
Right-Turn Channelization		see note: →						
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:			Yes			
	Outside approach	Channelization present ($I_{ch,out}$)?:		No		Yes	Yes	Yes
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:		Yes	No	Yes	Yes	Yes
Left-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:	Yes	Yes		Yes	Yes	Yes
		Width of lane or bay ($W_{b,in}$), ft:	12	12		24	24	24
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:			Yes			
		Width of lane or bay ($W_{b,out}$), ft:			12			
Right-Turn Lane or Bay								
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:			Yes			
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:	No	No		No	Yes	Yes
Access Data								
Number of driveways on the outside crossroad leg (n_{dw}):				0	0	0	0	0
Number of public street approaches on the outside crossroad leg (n_{ps}):			2					
Traffic Data		**Year**						
Inside Crossroad Leg Data		2045	25300	18300	28600	20700	51500	37200
Average daily traffic ($AADT_{in}$) by year, veh/d:		2046						
(enter data only for those years for which		2047						
it is available, leave other years blank)		2048						
		2049						
		2050						
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	2068						
Outside Crossroad Leg Data	2045	21300	21000	31400	21800	70000	23400
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
	2050						
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Exit Ramp Data	2045	8700	4800	13300	8500	20500	10200
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For a B4 terminal configuration, enter the AADT for the	2050						
diagonal exit ramp (not the loop exit ramp).	2051						
	2052						
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	2068						
Entrance Ramp Data	2045	5300	7300	9000	11000	19200	25300
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For an A4 terminal configuration, enter the AADT for the	2050						
diagonal entrance ramp (not the loop entrance ramp).	2051						
	2052						
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	2059						
	2060						
	2061						

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

	Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period	Terminal 6 Study Period
Basic Intersection Data						
Ramp terminal configuration:	D3ex	D3en	D3en	D3ex		
Ramp terminal description:	N Jantzen & S	N Janzten & N	LR & SB On	LR & NB Off		
Ramp terminal traffic control type:	Signal	Signal	Signal	Signal		
Is a non-ramp public street leg present at the terminal (I_{ps})?:	No	No	No	No		
Alignment Data						
Exit ramp skew angle (I_{sk}), degrees:						
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:	0.15	0.18	0.07	0.13		
Distance to the adjacent ramp terminal (L_{rmp}), mi:	0.04	0.04	0.11	0.11		
Traffic Control						
Left-Turn Operational Mode						
Crossroad — Inside approach — Protected-only mode ($I_{p,lt,in}$)?:		No	Yes			
Crossroad — Outside approach — Protected-only mode ($I_{p,lt,out}$)?:						
Right-Turn Control Type						
Ramp — Exit ramp approach — Right-turn control type:	Signal			Signal		
Cross Section Data						
Crossroad median width (W_m), ft:	0	0	0	0		
Number of Lanes						
Crossroad — Both approaches — Lanes serving through vehicles (n_{th}):	2	2	2	2		
Crossroad — Inside approach — Lanes serving through vehicles ($n_{th,in}$):	1	1	1	1		
Crossroad — Outside approach — Lanes serving through vehicles ($n_{th,out}$):	1	1	1	1	0	0
Ramp — Exit ramp approach — All lanes (n_{ex}):	2			1		
Right-Turn Channelization (see note: →)						
Crossroad — Inside approach — Channelization present ($I_{ch,in}$)?:						
Crossroad — Outside approach — Channelization present ($I_{ch,out}$)?:		No	No			
Ramp — Exit ramp approach — Channelization present ($I_{ch,ex}$)?:	No			No		
Left-Turn Lane or Bay						
Crossroad — Inside approach — Lane or bay present ($I_{bay,lt,in}$)?:		No	No			
Crossroad — Inside approach — Width of lane or bay ($W_{b,in}$), ft:						
Crossroad — Outside approach — Lane or bay present ($I_{bay,lt,out}$)?:						
Crossroad — Outside approach — Width of lane or bay ($W_{b,out}$), ft:						
Right-Turn Lane or Bay						
Crossroad — Inside approach — Lane or bay present ($I_{bay,rt,in}$)?:						
Crossroad — Outside approach — Lane or bay present ($I_{bay,rt,out}$)?:		No	No			
Access Data						
Number of driveways on the outside crossroad leg (n_{dw}):	0	0	0	0		
Number of public street approaches on the outside crossroad leg (n_{ps}):						

Traffic Data	Year						
Inside Crossroad Leg Data	2045	11600	8300	11000	7900		
Average daily traffic ($AADT_{in}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
	2050						
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Outside Crossroad Leg Data	2045	8800	7500	5100	12800		
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
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	2068						
Exit Ramp Data	2045	12400			5200		
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For a B4 terminal configuration, enter the AADT for the	2050						
diagonal exit ramp (not the loop exit ramp).	2051						
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	2068						
Entrance Ramp Data	2045		8100	6200			
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046						
(enter data only for those years for which	2047						
it is available, leave other years blank)	2048						
	2049						
For an A4 terminal configuration, enter the AADT for the	2050						
diagonal entrance ramp (not the loop entrance ramp).	2051						
	2052						
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	2060						
	2061						

Input Worksheet for Crossroad Ramp Terminals

Clear | Echo Input Values (View results in Column T) | Check Input Values (View results in Advisory Messages)

			Terminal 1 Study Period	Terminal 2 Study Period	Terminal 3 Study Period	Terminal 4 Study Period	Terminal 5 Study Period
Basic Intersection Data							
Ramp terminal configuration:			SPUI				
Ramp terminal description:			Marine Dr				
Ramp terminal traffic control type:			Signal				
Is a non-ramp public street leg present at the terminal (I_{ps})?:							
Alignment Data							
Exit ramp skew angle (I_{sk}), degrees:							
Distance to the next public street intersection on the outside crossroad leg (L_{str}), mi:			0.5				
Distance to the adjacent ramp terminal (L_{rmp}), mi:							
Traffic Control							
Left-Turn Operational Mode							
Crossroad	Inside approach	Protected-only mode ($I_{p,lt,in}$)?:					
	Outside approach	Protected-only mode ($I_{p,lt,out}$)?:					
Right-Turn Control Type							
Ramp	Exit ramp approach	Right-turn control type:					
Cross Section Data							
Crossroad median width (W_m), ft:							
Number of Lanes							
Crossroad	Both approaches	Lanes serving through vehicles (n_{th}):					
	Inside approach	Lanes serving through vehicles ($n_{th,in}$):					
	Outside approach	Lanes serving through vehicles ($n_{th,out}$):		0	0	0	0
Ramp	Exit ramp approach	All lanes (n_{ex}):					
Right-Turn Channelization		see note: →					
Crossroad	Inside approach	Channelization present ($I_{ch,in}$)?:					
	Outside approach	Channelization present ($I_{ch,out}$)?:					
Ramp	Exit ramp approach	Channelization present ($I_{ch,ex}$)?:					
Left-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,lt,in}$)?:					
		Width of lane or bay ($W_{b,in}$), ft:					
	Outside approach	Lane or bay present ($I_{bay,lt,out}$)?:					
		Width of lane or bay ($W_{b,out}$), ft:					
Right-Turn Lane or Bay							
Crossroad	Inside approach	Lane or bay present ($I_{bay,rt,in}$)?:					
	Outside approach	Lane or bay present ($I_{bay,rt,out}$)?:					
Access Data							
Number of driveways on the outside crossroad leg (n_{dw}):							
Number of public street approaches on the outside crossroad leg (n_{ps}); Number of exit ramps with free-flow right turns onto crossroad (SPUI Only):			2				
Traffic Data		**Year**					
Inside Crossroad Leg Data		2045	42000				
Average daily traffic ($AADT_{in}$) by year, veh/d:		2046					
(enter data only for those years for which it is available, leave other years blank)		2047					
		2048					
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Outside Crossroad Leg Data	2045	42600				
Average daily traffic ($AADT_{out}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
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Exit Ramp Data	2045	19400				
Average daily traffic ($AADT_{ex}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For a B4 terminal configuration, enter the AADT for the	2050					
diagonal exit ramp (not the loop exit ramp).	2051					
	2052					
For a SPUI or TDI terminal configuration, enter AADT for both	2053					
exit ramps combined	2054					
	2055					
	2056					
	2057					
	2058					
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	2068					
Entrance Ramp Data	2045	33900				
Average daily traffic ($AADT_{en}$) by year, veh/d:	2046					
(enter data only for those years for which	2047					
it is available, leave other years blank)	2048					
	2049					
For an A4 terminal configuration, enter the AADT for the	2050					

Output Summary

General Information						
Project description:	Mainline Corridor Pt 1 - Modified LPA 2 Aux					
Analyst:	0	Date:	9/27/2023	Area type:	Urban	
First year of analysis:	2045					
Last year of analysis:	2045					

Crash Data Description				
Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	176.6	0.8	2.3	15.1	38.9	119.6
Estimated average crash freq. during Study Period, crashes/yr:	176.6	0.8	2.3	15.1	38.9	119.6

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	20	157.2	0.7	1.9	13.0	33.2	108.4
Ramp segments, crashes:	7	19.4	0.1	0.4	2.1	5.6	11.2
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	176.6	0.8	2.3	15.1	38.9	119.6
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.6	0.0	0.0	0.1	0.2	0.2
	Right-angle crashes:	2.5	0.0	0.0	0.3	0.7	1.4
	Rear-end crashes:	85.8	0.4	1.2	7.8	20.3	56.1
	Sideswipe crashes:	30.0	0.1	0.3	1.8	4.7	23.1
	Other multiple-vehicle crashes:	4.6	0.0	0.1	0.5	1.3	2.7
	Total multiple-vehicle crashes:	123.6	0.6	1.6	10.5	27.4	83.5
Single vehicle	Crashes with animal:	0.8	0.0	0.0	0.0	0.0	0.7
	Crashes with fixed object:	38.2	0.2	0.5	3.3	8.3	26.0
	Crashes with other object:	5.8	0.0	0.0	0.2	0.6	4.9
	Crashes with parked vehicle:	0.8	0.0	0.0	0.1	0.2	0.6
	Other single-vehicle crashes	7.5	0.1	0.1	1.0	2.5	3.8
	Total single-vehicle crashes:	53.1	0.3	0.7	4.6	11.5	36.0
	Total crashes:	176.6	0.8	2.3	15.1	38.9	119.6

Output Summary

General Information

Project description:	Mainline Corridor Pt 2 - Modified LPA 2 Aux				
Analyst:	0	Date:	9/27/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	23.7	0.1	0.2	1.6	5.1	16.6
Estimated average crash freq. during Study Period, crashes/yr:	23.7	0.1	0.2	1.6	5.1	16.6

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	1	23.7	0.1	0.2	1.6	5.1	16.6
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	23.7	0.1	0.2	1.6	5.1	16.6
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
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	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.4	0.0	0.0	0.0	0.1	0.2
	Rear-end crashes:	12.9	0.0	0.1	0.9	2.9	8.9
	Sideswipe crashes:	4.4	0.0	0.0	0.2	0.7	3.4
	Other multiple-vehicle crashes:	0.5	0.0	0.0	0.0	0.1	0.3
	Total multiple-vehicle crashes:	18.2	0.1	0.2	1.2	3.8	12.9
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with fixed object:	3.9	0.0	0.0	0.3	0.9	2.6
	Crashes with other object:	0.6	0.0	0.0	0.0	0.1	0.5
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	0.8	0.0	0.0	0.1	0.3	0.4
	Total single-vehicle crashes:	5.5	0.0	0.1	0.4	1.3	3.7
	Total crashes:	23.7	0.1	0.2	1.6	5.1	16.6

Output Summary

General Information

Project description:	SR 500 Interchange Area - Modified LPA 2 Aux				
Analyst:	0	Date:	9/28/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	16.6	0.1	0.4	1.9	3.8	10.5
Estimated average crash freq. during Study Period, crashes/yr:	16.6	0.1	0.4	1.9	3.8	10.5

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	9	16.6	0.1	0.4	1.9	3.8	10.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	16.6	0.1	0.4	1.9	3.8	10.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	6.5	0.0	0.1	0.8	1.8	3.8
	Sideswipe crashes:	2.8	0.0	0.0	0.1	0.3	2.3
	Other multiple-vehicle crashes:	1.2	0.0	0.0	0.1	0.3	0.7
	Total multiple-vehicle crashes:	10.7	0.1	0.2	1.1	2.5	6.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.7	0.0	0.1	0.6	0.9	3.0
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.0	0.0	0.0	0.2	0.3	0.5
	Total single-vehicle crashes:	5.9	0.1	0.2	0.8	1.3	3.6
	Total crashes:	16.6	0.1	0.4	1.9	3.8	10.5

Output Summary							
General Information							
Project description:	4th Plain Interchange Area - Modified LPA 2 Aux						
Analyst:	0	Date:	9/29/2023		Area type:	Urban	
First year of analysis:	2045						
Last year of analysis:	2045						

Crash Data Description				
Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	8.0	0.1	0.2	1.1	2.0	4.5
Estimated average crash freq. during Study Period, crashes/yr:	8.0	0.1	0.2	1.1	2.0	4.5

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	4	8.0	0.1	0.2	1.1	2.0	4.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	8.0	0.1	0.2	1.1	2.0	4.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.6	0.0	0.0	0.1	0.1	0.4
	Sideswipe crashes:	0.3	0.0	0.0	0.0	0.0	0.2
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	1.0	0.0	0.0	0.1	0.2	0.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	5.4	0.1	0.2	0.8	1.3	3.1
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.3	0.0	0.1	0.3	0.5	0.5
	Total single-vehicle crashes:	7.0	0.1	0.2	1.1	1.8	3.8
	Total crashes:	8.0	0.1	0.2	1.1	2.0	4.5

Output Summary							
General Information							
Project description:	Mill Plain Interchange Area - Modified LPA 2 Aux						
Analyst:	0	Date:	10/3/2023		Area type:	Urban	
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp terminals	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			

Estimated Crash Statistics							
Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		10.1	0.1	0.2	1.1	2.3	6.4
Estimated average crash freq. during Study Period, crashes/yr:		10.1	0.1	0.2	1.1	2.3	6.4
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	4	10.1	0.1	0.2	1.1	2.3	6.4
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	10.1	0.1	0.2	1.1	2.3	6.4
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	2.6	0.0	0.1	0.3	0.6	1.6
	Sideswipe crashes:	1.2	0.0	0.0	0.1	0.1	1.0
	Other multiple-vehicle crashes:	0.5	0.0	0.0	0.1	0.1	0.3
	Total multiple-vehicle crashes:	4.4	0.0	0.1	0.5	0.9	2.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.5	0.0	0.1	0.5	1.0	2.9
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	1.0	0.0	0.0	0.2	0.4	0.4
	Total single-vehicle crashes:	5.8	0.1	0.2	0.7	1.4	3.5
	Total crashes:	10.1	0.1	0.2	1.1	2.3	6.4

Output Summary

General Information

Project description:	SR 14 Interchange Area - Modified LPA 2 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	27.4	0.2	0.6	3.1	6.7	16.7
Estimated average crash freq. during Study Period, crashes/yr:	27.4	0.2	0.6	3.1	6.7	16.7

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	7	27.4	0.2	0.6	3.1	6.7	16.7
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	27.4	0.2	0.6	3.1	6.7	16.7
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
	2057						
	2058						
	2059						
	2060						
	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	8.8	0.1	0.2	1.0	2.4	5.0
	Sideswipe crashes:	3.8	0.0	0.0	0.2	0.4	3.1
	Other multiple-vehicle crashes:	1.7	0.0	0.0	0.2	0.5	0.9
	Total multiple-vehicle crashes:	14.4	0.1	0.2	1.5	3.5	9.2
Single vehicle	Crashes with animal:	0.1	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	10.2	0.1	0.2	1.2	2.4	6.3
	Crashes with other object:	0.3	0.0	0.0	0.0	0.0	0.2
	Crashes with parked vehicle:	0.2	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	2.3	0.0	0.1	0.4	0.8	1.0
	Total single-vehicle crashes:	13.0	0.1	0.3	1.7	3.3	7.6
	Total crashes:	27.4	0.2	0.6	3.1	6.7	16.7

Output Summary

General Information

Project description:	Hayden Island Interchange Area - Modified LPA 2 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	2.6	0.0	0.1	0.3	0.6	1.5
Estimated average crash freq. during Study Period, crashes/yr:	2.6	0.0	0.1	0.3	0.6	1.5

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	2	2.6	0.0	0.1	0.3	0.6	1.5
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	2.6	0.0	0.1	0.3	0.6	1.5
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
	2055						
	2056						
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	2061						
	2062						
	2063						
	2064						
	2065						
	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.0	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	0.4	0.0	0.0	0.0	0.1	0.2
	Sideswipe crashes:	0.2	0.0	0.0	0.0	0.0	0.2
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Total multiple-vehicle crashes:	0.6	0.0	0.0	0.1	0.1	0.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	1.5	0.0	0.0	0.2	0.4	0.9
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.4	0.0	0.0	0.1	0.1	0.1
	Total single-vehicle crashes:	2.0	0.0	0.1	0.3	0.5	1.1
	Total crashes:	2.6	0.0	0.1	0.3	0.6	1.5

Output Summary

General Information

Project description:	Marine Drive Interchange Area - Modified LPA 2 Aux				
Analyst:	0	Date:	10/3/2023	Area type:	Urban
First year of analysis:	2045				
Last year of analysis:	2045				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	19.5	0.2	0.5	2.3	4.5	12.1
Estimated average crash freq. during Study Period, crashes/yr:	19.5	0.2	0.5	2.3	4.5	12.1

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	16	19.5	0.2	0.5	2.3	4.5	12.1
Crossroad ramp terminals, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2045	19.5	0.2	0.5	2.3	4.5	12.1
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
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	2061						
	2062						
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	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Rear-end crashes:	5.2	0.0	0.1	0.6	1.4	3.0
	Sideswipe crashes:	2.2	0.0	0.0	0.1	0.3	1.9
	Other multiple-vehicle crashes:	1.0	0.0	0.0	0.1	0.3	0.6
	Total multiple-vehicle crashes:	8.5	0.0	0.2	0.8	1.9	5.5
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	8.7	0.1	0.2	1.1	1.9	5.4
	Crashes with other object:	0.2	0.0	0.0	0.0	0.0	0.2
	Crashes with parked vehicle:	0.1	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	2.0	0.0	0.1	0.4	0.7	0.8
	Total single-vehicle crashes:	11.0	0.1	0.3	1.5	2.6	6.5
	Total crashes:	19.5	0.2	0.5	2.3	4.5	12.1

Output Summary							
General Information							
Project description:	Ramp Terminal Intersections Pt. 1 - Modified LPA 2 Aux						
Analyst:	0	Date:	9/28/2023	Area type:	Urban		
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp segments	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			
Ramp terminals	Segment crash data available?		No	First year of crash data:			
	Project-level crash data available?		No	Last year of crash data:			

Estimated Crash Statistics							
Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		86.7	0.1	0.9	5.5	28.9	51.4
Estimated average crash freq. during Study Period, crashes/yr:		86.7	0.1	0.9	5.5	28.9	51.4
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	6	86.7	0.1	0.9	5.5	28.9	51.4
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	86.7	0.1	0.9	5.5	28.9	51.4
	2046						
	2047						
	2048						
	2049						
	2050						
	2051						
	2052						
	2053						
	2054						
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	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.8	0.0	0.0	0.1	0.3	0.4
	Right-angle crashes:	22.1	0.0	0.2	1.6	8.3	12.0
	Rear-end crashes:	48.1	0.0	0.5	3.2	17.2	27.2
	Sideswipe crashes:	8.7	0.0	0.0	0.2	1.2	7.3
	Other multiple-vehicle crashes:	1.4	0.0	0.0	0.1	0.3	1.0
	Total multiple-vehicle crashes:	81.1	0.0	0.8	5.2	27.2	47.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	4.2	0.0	0.0	0.2	1.1	2.8
	Crashes with other object:	0.1	0.0	0.0	0.0	0.0	0.1
	Crashes with parked vehicle:	0.2	0.0	0.0	0.0	0.0	0.1
	Other single-vehicle crashes	1.1	0.0	0.0	0.1	0.5	0.4
	Total single-vehicle crashes:	5.6	0.0	0.1	0.3	1.7	3.5
	Total crashes:	86.7	0.1	0.9	5.5	28.9	51.4

Output Summary

General Information							
Project description:	Ramp Terminals Pt. 2 - Modified LPA 2 Aux						
Analyst:	0	Date:	9/28/2023		Area type:		Urban
First year of analysis:	2045						
Last year of analysis:	2045						
Crash Data Description							
Freeway segments	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		
Ramp segments	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		
Ramp terminals	Segment crash data available?			No	First year of crash data:		
	Project-level crash data available?			No	Last year of crash data:		

Estimated Crash Statistics							
Crashes for Entire Facility		**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:		7.3	0.0	0.1	0.7	3.1	3.4
Estimated average crash freq. during Study Period, crashes/yr:		7.3	0.0	0.1	0.7	3.1	3.4
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Ramp segments, crashes:	0	0.0	0.0	0.0	0.0	0.0	0.0
Crossroad ramp terminals, crashes:	4	7.3	0.0	0.1	0.7	3.1	3.4
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	7.3	0.0	0.1	0.7	3.1	3.4
	2046						
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	2048						
	2049						
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	2066						
	2067						
	2068						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.1	0.0	0.0	0.0	0.0	0.0
	Right-angle crashes:	1.8	0.0	0.0	0.2	0.8	0.7
	Rear-end crashes:	4.3	0.0	0.1	0.4	1.9	1.8
	Sideswipe crashes:	0.7	0.0	0.0	0.0	0.1	0.5
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	6.9	0.0	0.1	0.6	2.9	3.2
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.3	0.0	0.0	0.0	0.1	0.2
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.1	0.0	0.0	0.0	0.1	0.0
	Total single-vehicle crashes:	0.4	0.0	0.0	0.0	0.2	0.2
Total crashes:		7.3	0.0	0.1	0.7	3.1	3.4

Output Summary

General Information						
Project description:	Ramp Terminal Intersections: Marine Dr SPUI - Modified LPA 2 Aux					
Analyst:	0	Date:	9/28/2023	Area type:	Urban	
First year of analysis:	2045					
Last year of analysis:	2045					

Crash Data Description

Ramp terminals	Site crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility		Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:		12.1	0.0	0.1	0.8	2.0	9.2
Estimated average crash freq. during Study Period, crashes/yr:		12.1	0.0	0.1	0.8	2.0	9.2
Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Crossroad ramp terminals, crashes:	1	12.1	0.0	0.1	0.8	2.0	9.2
Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2045	12.1	0.0	0.1	0.8	2.0	9.2
	2046						
	2047						
	2048						
	2049						
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	2068						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	0.2	0.0	0.0	0.0	0.1	0.1
	Right-angle crashes:	1.1	0.0	0.0	0.1	0.3	0.7
	Rear-end crashes:	8.8	0.0	0.1	0.5	1.3	6.8
	Sideswipe crashes:	1.1	0.0	0.0	0.0	0.1	1.0
	Other multiple-vehicle crashes:	0.1	0.0	0.0	0.0	0.0	0.1
	Total multiple-vehicle crashes:	11.3	0.0	0.1	0.7	1.7	8.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	0.6	0.0	0.0	0.0	0.1	0.4
	Crashes with other object:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with parked vehicle:	0.0	0.0	0.0	0.0	0.0	0.0
	Other single-vehicle crashes	0.3	0.0	0.0	0.1	0.2	0.0
	Total single-vehicle crashes:	0.8	0.0	0.0	0.1	0.2	0.5
	Total crashes:	12.1	0.0	0.1	0.8	2.0	9.2

Appendix J. Diversion Analysis Report

Interstate BRIDGE Replacement Program

A **modern** connection for a growing **community**

Diversion Analysis Report

September 2024

Oregon

For ADA (Americans with Disabilities Act) or Civil Rights Title VI accommodations, translation/interpretation services, or more information call 503-731-4128, TTY 800-735-2900 or Oregon Relay Service 7-1-1.

Washington

Accommodation requests for people with disabilities in Washington can be made by contacting the WSDOT (Washington State Department of Transportation) Diversity/ADA Affairs team at wsdotada@wsdot.wa.gov or by calling toll-free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equity and Civil Rights Title VI Coordinator by contacting (360) 705-7090.

Diversion Analysis Report

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

CBD	central business district
IBR	Interstate Bridge Replacement
LPA	locally preferred alternative
ODOT	Oregon Department of Transportation
WSDOT	Washington State Department of Transportation

1. INTRODUCTION

This technical report documents the diversion analysis completed to support an understanding of travel changes between the Interstate Bridge Replacement Program (IBR Program) No-Build Alternative and Modified Locally Preferred Alternative (LPA).

2. DIVERSION ANALYSIS OVERVIEW

In the context of travel demand modeling, diversion typically is thought of as the rerouting of traffic flows in response to changes in the transportation network. Travel demand models are used to simulate and predict the movement of trips within a transportation network including where trips will go (destination choice), how they will travel (mode choice) and finally what paths they will take (route choice). Some of the details around these levels of diversion are provided in the tolling and diversion section of the Transportation Technical Report but are summarized in the context of a specific metric where this section will provide a summary of how the Modified LPA with highway, transit, active transportation and tolling elements impact each of these different types of diversion as compared to the No-Build Alternative.

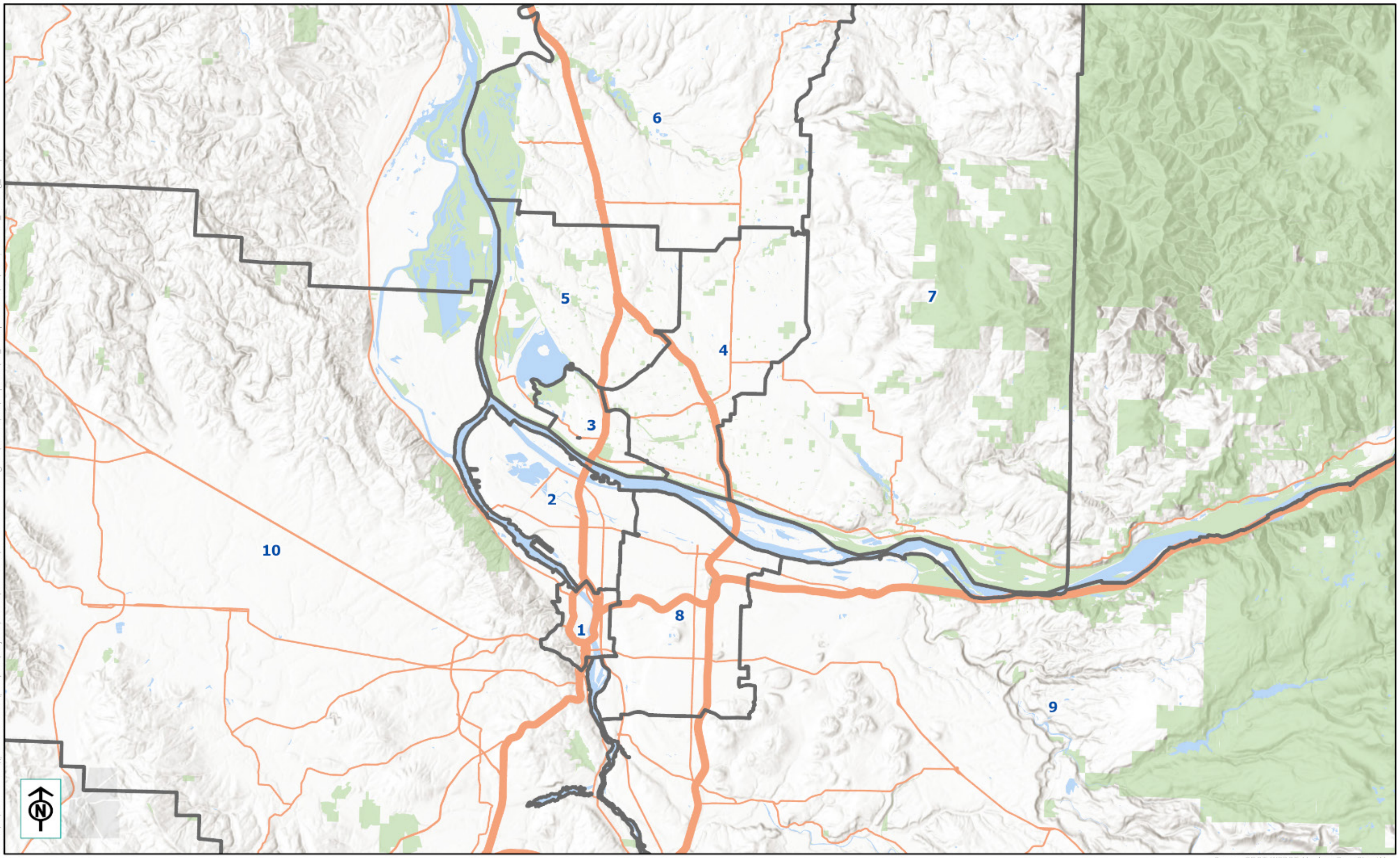
2.1 Evaluation Measures Used in Diversion Analysis

The following measures were used to evaluate diversion.

- **Person-Trips**: Daily person-trips from the Regional Travel Demand model are analyzed at a district level to evaluate destination choice changes for both work and non-work trips.
- **Mode Choice**: Daily person-trips from the Regional Travel Demand model are analyzed at a district level after the mode choice step of the model to evaluate shifts in travel mode. Trips are summarized by mode for work and non-work trips.
- **Vehicle Volumes**: Vehicle volumes for trips using both the I-5 and I-205 bridge will be saved from final assignments in the regional travel demand model for each hour of an average weekday. Volumes will be saved into O-D matrices that will be summarized at a district level. Trip purpose is not retained for assignments so these matrices will not include trip purpose but will be summarized by auto (SOV and HOV) and truck (medium, heavy).
- **Transit Volumes**: Transit ridership will be developed from the Regional Travel Demand model transit assignments that are done at the end of the modeling process. These assignments use transit trip tables developed in mode choice that are then separated into time of day to reflect peak and off-peak demand. This demand is assigned on respective transit networks for each scenario being analyzed in the EMME software platform. These assignments and resulting outputs will be used to summarize total average weekday transit ridership crossing the Columbia River on I-5 and I-205 to understand shifts to transit with tolling.

Figure 1 below shows the 10 district system that each of the measures listed above will be aggregated to for tables in the report below.

Figure 1. Ten-District System



Source: ODOT, WSDOT, Mapbox, OpenStreetMap

3. DESTINATION CHOICE RESULTS

This section discusses the results of the No-Build Alternative and Modified LPA for changes in destination choice. Destination choice reflects travel between production areas and attraction areas and at this point are not separated out by travel mode. Gray-shaded cells in tables below represent cross-river movement changes.

3.1 Total Person-Trip Changes

Table 1 and Table 2 provide district movements for all person-trips in the No-Build Alternative and Modified LPA respectively. Table 3 provides the difference between the Modified LPA and the No-Build Alternative.

Green shading in Table 3 indicates that there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there is a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative. What we can see is that increases more than 500 involve all but one district in Vancouver going to the Portland Central City (District 1). In addition, there are increases of more than 500 trips between Vancouver CBD and Surrounding Area (District 3) and NE Portland/Multnomah County (District 8). Trip increases in some district to district movements mean there will be decreases in others. Decreases of more than -500 trips are shown in the table in red shading. Where trips in Clark County increase to Oregon, we see corresponding decreases within Clark County. In the case of these Clark County districts that show increases to Oregon the place where trips decrease are primarily intra-district, meaning trips that occurred completely within the district.

For trips produced in Clark County we see an increase of over 7,150 daily person-trips to Oregon. These trips in the No-Build Alternative stayed within Clark County. The largest district to district movement increase is between Vancouver central business district (CBD) (District 3) and the Portland Central City area (District 1). The corresponding decrease in trips from Vancouver CBD were previously being made to other districts along I-5 (Vancouver CBD & Surrounding Area District 3, East Vancouver District 4 and Salmon Creek District 5). All districts in Clark County show increases in trips to all districts in Oregon except East Multnomah County District 9 which shows small decreases under the Modified LPA.

In terms of changes in trips that are produced in Oregon and attracted to Clark County, we see smaller changes with the primary gains coming in productions from outer areas of Portland (District 8), East Multnomah County/Clackamas County (District 9) and the Westside (District 10) attracted to the Vancouver CBD and Surrounding Areas (District 3).

Figure 2 displays a map of the differences in total trip productions between the Modified LPA and the No-Build Alternative for movements that cross the river. This figure shows that the largest increases in trips across the river are from the Vancouver CBD and Surrounding Areas (District 3), East Vancouver (District 4), and Salmon Creek (District 5). The trip increases from Washington to Oregon are shifts in trips that were being made within Clark County for nearly all district movements under the No-Build

Alternative. Figure 2 also shows reductions in river crossing trips from Oregon. The trips that no longer cross the river from the Oregon side are primarily staying within the Portland Central City (District 1) and North/Northeast Portland (District 2).

Table 1. Total Person-Trips No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	466,400	60,850	4,750[a]	5,500[a]	2,800[a]	950[a]	3,600[a]	157,800	33,300	126,350	862,350
N/NE Portland (2) *Productions*	92,400	35,850	14,250[a]	12,900[a]	6,500[a]	1,800[a]	5,800[a]	96,600	25,550	60,600	552,250
Vancouver CBD and Surrounding Area (3) *Productions*	4,950[a]	12,300[a]	97,250	41,050	22,650	3,300	10,800	6,850[a]	3,000[a]	5,250[a]	207,500
East Vancouver (4) *Productions*	8,250[a]	9,100[a]	51,700	315,650	48,200	33,150	84,450	14,250[a]	9,050[a]	8,750[a]	582,500
Salmon Creek (5) *Productions*	6,900[a]	6,700[a]	36,200	65,450	188,350	31,400	17,350	6,100[a]	4,250[a]	7,400[a]	370,050
North Clark County (6) *Productions*	4,900[a]	3,400[a]	14,600	45,700	39,900	271,300	20,750	4,900[a]	4,400[a]	6,250[a]	416,150
East Clark County (7) *Productions*	11,600[a]	7,400[a]	30,650	124,450	22,500	29,400	466,850	20,800[a]	14,900[a]	12,100[a]	740,550
NE Portland/Mult Co (8) *Productions*	198,650	84,450	7,350[a]	15,100[a]	4,600[a]	2,350[a]	15,100[a]	805,600	233,250	117,300	1,483,750
E Mult Co/Clackamas Co (9) *Productions*	116,850	41,500	6,050[a]	15,600[a]	4,600[a]	3,150[a]	16,350[a]	350,850	1,773,200	216,050	2,544,200
Westside (10) *Productions*	241,350	75,850	8,950[a]	10,200[a]	5,150[a]	2,750[a]	7,600[a]	162,250	176,650	3,455,000	4,145,750
Total	1,152,250	537,350	271,700	651,650	345,300	379,550	648,650	1,626,000	2,277,500	4,015,050	11,905,050

a The gray shading in this cell represents cross-river travel movements.

Table 2. Total Person-Trips Modified LPA

District	Portland Central City (1) Attractions	N/NE Portland (2) Attractions	Vancouver CBD & Surrounding Area (3) Attractions	East Vancouver (4) Attractions	Salmon Creek (5) Attractions	North Clark County (6) Attractions	East Clark County (7) Attractions	NE Portland/ Multnomah County (8) Attractions	E Multnomah/ Clackamas County (9) Attractions	Westside (10) Attractions	Total
Portland Central City (1) *Productions*	466,350	61,100	4,750 [a]	5,400 [a]	2,750 [a]	900 [a]	3,550 [a]	157,700	33,250	126,550	862,350
N/NE Portland (2) *Productions*	92,700	236,400	13,750 [a]	12,600 [a]	6,350 [a]	1,750 [a]	5,600 [a]	96,700	25,600	60,750	552,250
Vancouver CBD and Surrounding Area (3) *Productions*	5,950 [a]	12,400 [a]	96,000	40,500	22,600	3,300	10,650	7,500 [a]	3,050 [a]	5,450 [a]	207,500
East Vancouver (4) *Productions*	9,250 [a]	9,850 [a]	51,150	314,550	48,050	33,100	84,100	14,500 [a]	8,950 [a]	9,050 [a]	582,500
Salmon Creek (5) *Productions*	7,950 [a]	7,000 [a]	36,000	65,100	187,400	31,250	17,200	6,350 [a]	4,200 [a]	7,600 [a]	370,050
North Clark County (6) *Productions*	5,600 [a]	3,500 [a]	14,600	45,600	39,800	270,700	20,650	4,900 [a]	4,350 [a]	6,400 [a]	416,150
East Clark County (7) *Productions*	11,900 [a]	7,600 [a]	30,750	124,450	22,550	29,450	466,250	20,800 [a]	14,750 [a]	12,050 [a]	740,550
NE Portland/Mult Co (8) *Productions*	198,050	84,700	7,800 [a]	15,200 [a]	4,750 [a]	2,400 [a]	15,000 [a]	805,150	233,250	117,500	1,483,750
E Mult Co/Clackamas Co (9) *Productions*	116,150	41,550	6,200 [a]	15,650 [a]	4,650 [a]	3,200 [a]	16,300 [a]	350,850	1,773,450	216,200	2,544,200
Westside (10) *Productions*	240,600	76,100	9,100 [a]	10,100 [a]	5,100 [a]	2,800 [a]	7,600 [a]	162,350	176,750	3,455,350	4,145,750
Total	1,154,500	540,200	270,100	649,150	344,000	378,850	646,900	1,626,800	2,277,600	4,016,900	1,905,050

a The gray shading in this cell represents cross-river travel movements.

Table 3. Difference in Total Person-Trips Between Modified LPA and No-Build Alternative

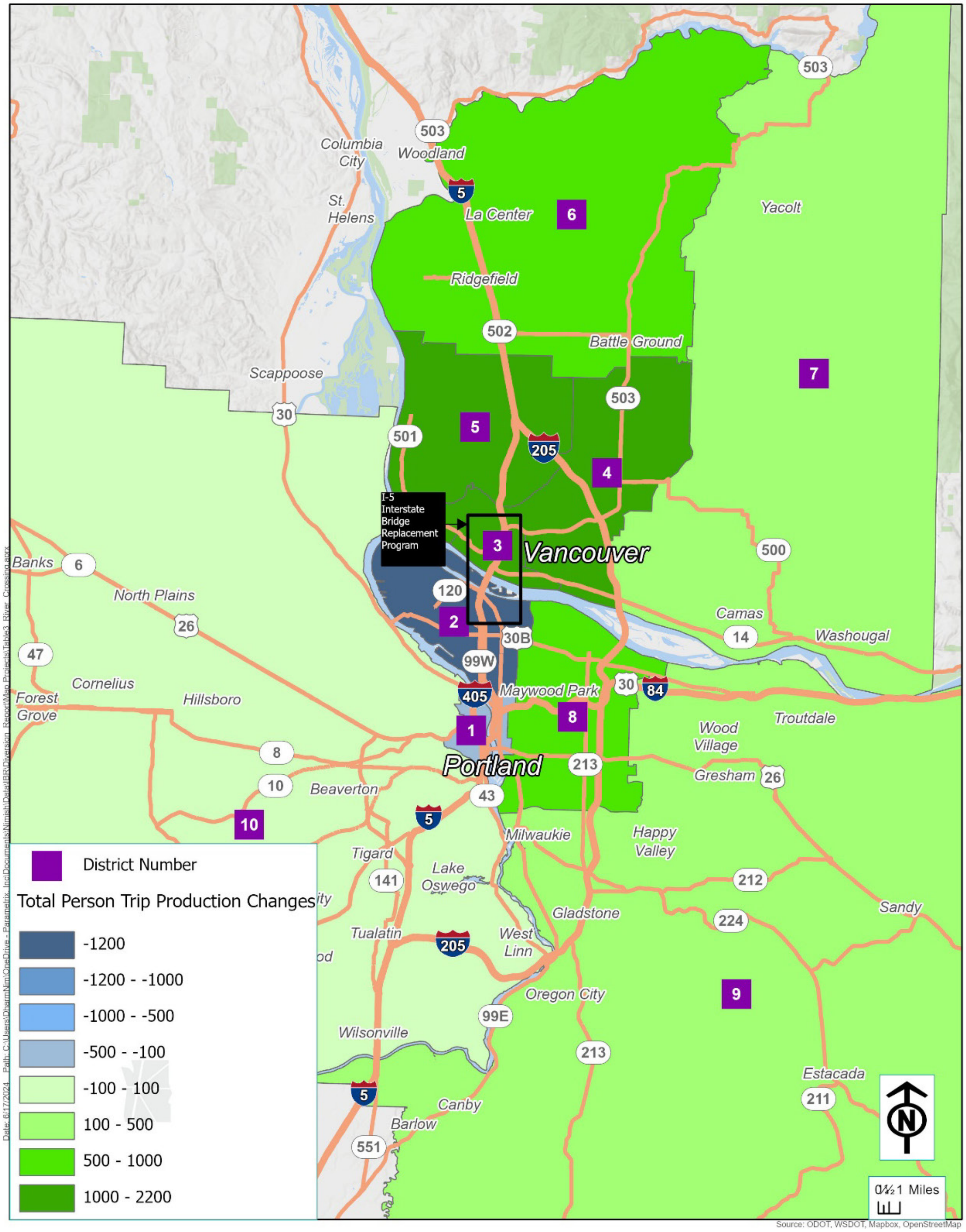
District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	(50)	250	**-**[a]	**(100)**[a]	**(50)**[a]	**(50)**[a]	**(50)**[a]	(100)	(50)	200	-
N/NE Portland (2) *Productions*	300	550	**(500)**[a]	**(300)**[a]	**(150)**[a]	**(50)**[a]	**(200)**[a]	100	50	150	-
Vancouver CBD and Surrounding Area (3) *Productions*	**1,000**[a,b]	**100**[a]	(1,250)[c]	(550)[c]	(50)	-	(150)	**650**[a,b]	**50**[a]	**200**[a]	-
East Vancouver (4) *Productions*	**1,000**[a,b]	**750**[a]	(550)[c]	(1,100)[c]	(150)	(50)	(350)	**250**[a]	**(100)**[a]	**300**[a]	-
Salmon Creek (5) *Productions*	**1,050**[a,b]	**300**[a]	(200)	(350)	(950)[c]	(150)	(150)	**250**[a]	**(50)**[a]	**200**[a]	-
North Clark County (6) *Productions*	**700**[a,b]	**100**[a]	-	(100)	(100)	(600)[c]	(100)	**-**[a]	**(50)**[a]	**150**[a]	-
East Clark County (7) *Productions*	**300**[a]	**200**[a]	100	-	50	50	(600)[c]	**-**[a]	**(150)**[a]	**(50)**[a]	-
NE Portland/Mult Co (8) *Productions*	(600)[c]	250	**450**[a]	**100**[a]	**150**[a]	**50**[a]	**(100)**[a]	(450)	-	200	-
E Mult Co/Clackamas Co (9) *Productions*	(700)[c]	50	**150**[a]	**50**[a]	**50**[a]	**50**[a]	**(50)**[a]	-	250	150	-
Westside (10) *Productions*	(750)[c]	250	**150**[a]	**(100)**[a]	**(50)**[a]	**50**[a]	**-**[a]	100	100	350	-
Total	2,250	2,800	(1,650)	(2,450)	(1,250)	(700)	(1,750)	800	50	1,850	**-**
Percentage Change vs. No-Build Alternative	0.2%	0.5%	-0.6%	-0.4%	-0.4%	-0.2%	-0.3%	0.0%	0.0%	0.0%	-

a Bold text in this cell indicates cross-river movements.

b Green shading in this cell indicates increases of more than 500 trips.

c Red shading in this cell indicates decreases of more than -500 trips.

Figure 2. Difference in Cross-River Person-Trip Productions Between Modified LPA and No-Build Alternative



3.2 Total Work Person-Trip Changes

Table 4 and Table 5 provide district movements for all work person-trips in the No-Build Alternative and Modified LPA respectively. In both alternatives, work trips make up just over 18% of total person-trips. Table 6 provides the difference between the Modified LPA and the No-Build Alternative for work trips.

Green shading in Table 6 indicates that there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there is a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative. The only place where we see increases or decreases of more the +/- 500 trips are to the Portland Central City.

Similar to total person-trips we see increases for work trips produced in Clark County attracted to Oregon (1,900 trips) but the increases on the work trip side are primarily to the Portland Central City (District 1) and N/NE Portland (District 2) with some decreases to other Oregon districts farther from I-5 in the program area. These work trip increases to Oregon make up approximately 26% of the total trip increases from Clark County to Oregon. Total work person-trips increases were highest between North Clark County (District 6) to Portland CBD (District 1). As trip attractions in Oregon go up for work trips produced in Clark County, trips that stay within Clark County decrease.

In terms of changes in work trips that are produced in Oregon and attracted to Clark County, we see smaller changes with the primary gains coming in productions from outer areas of Portland (District 8), East Multnomah County/Clackamas County (District 9) and the Westside (District 10) attracted to the Vancouver CBD and Surrounding Areas (District 3).

Figure 3 shows the difference in river crossing work person-trip productions between the Modified LPA and No-Build Alternative. Figure 3 shows that all districts except East Clark County (District 7) show an increase in total trip productions.

Table 4. Total Work Person-Trips No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	53,750	8,600	700[a]	450[a]	200[a]	150[a]	400[a]	14,250	7,750	23,000	109,200
N/NE Portland (2) *Productions*	25,550	25,350	1,850[a]	1,000[a]	400[a]	250[a]	600[a]	14,100	7,500	19,900	96,500
Vancouver CBD and Surrounding Area (3) *Productions*	2,800[a]	2,850[a]	11,750	4,100	1,900	800	1,700	1,800[a]	1,200[a]	2,600[a]	31,500
East Vancouver (4) *Productions*	6,250[a]	4,350[a]	11,750	32,450	6,150	5,900	13,600	6,500[a]	5,200[a]	6,650[a]	98,800
Salmon Creek (5) *Productions*	5,550[a]	3,600[a]	10,550	12,250	17,250	7,200	5,000	3,450[a]	2,950[a]	5,950[a]	73,800
North Clark County (6) *Productions*	4,050[a]	2,050[a]	5,250	9,700	6,700	32,250	6,400	2,950[a]	3,100[a]	5,300[a]	77,850
East Clark County (7) *Productions*	9,250[a]	4,250[a]	9,750	22,550	4,900	7,050	60,900	10,350[a]	9,000[a]	9,950[a]	147,950
NE Portland/Mult Co (8) *Productions*	68,000	18,350	1,650[a]	1,600[a]	500[a]	450[a]	1,800[a]	85,700	47,450	47,650	273,150
E Mult Co/Clackamas Co (9) *Productions*	61,400	15,350	1,900[a]	2,550[a]	800[a]	850[a]	3,000[a]	63,600	222,700	90,600	462,800
Westside (10) *Productions*	97,750	30,150	4,050[a]	3,300[a]	1,450[a]	1,350[a]	3,200[a]	49,950	71,550	531,150	793,950
Total	334,450	114,900	59,250	89,950	40,300	56,250	96,600	252,700	378,500	742,650	2,165,500

a The gray shading in this cell represents cross-river travel movements.

Table 5. Total Work Person-Trips Modified LPA

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	53,500	8,600	700[a]	500[a]	200[a]	150[a]	400[a]	14,300	7,800	23,050	109,200
N/NE Portland (2) *Productions*	25,400	25,250	1,950[a]	1,050[a]	450[a]	250[a]	600[a]	14,150	7,550	19,900	96,500
Vancouver CBD and Surrounding Area (3) *Productions*	3,200[a]	2,850[a]	11,500	4,000	1,850	800	1,650	1,850[a]	1,200[a]	2,600[a]	31,500
East Vancouver (4) *Productions*	6,900[a]	4,500[a]	11,550	32,250	6,150	5,900	13,450	6,350[a]	5,000[a]	6,700[a]	98,800
Salmon Creek (5) *Productions*	6,350[a]	3,650[a]	10,350	12,050	17,050	7,100	4,900	3,500[a]	2,850[a]	6,000[a]	73,800
North Clark County (6) *Productions*	4,700[a]	2,100[a]	5,200	9,600	6,650	32,100	6,300	2,900[a]	3,000[a]	5,350[a]	77,850
East Clark County (7) *Productions*	9,400[a]	4,300[a]	9,800	22,700	5,000	7,100	61,000	10,050[a]	8,750[a]	9,800[a]	147,950
NE Portland/Mult Co (8) *Productions*	67,400	18,250	1,800[a]	1,700[a]	550[a]	500[a]	1,850[a]	85,850	47,600	47,650	273,150
E Mult Co/Clackamas Co (9) *Productions*	60,700	15,250	2,050[a]	2,650[a]	850[a]	900[a]	3,150[a]	63,700	223,050	90,550	462,800
Westside (10) *Productions*	96,850	30,100	4,400[a]	3,450[a]	1,550[a]	1,450[a]	3,300[a]	50,100	71,750	531,100	793,950
Total	334,450	114,900	59,250	89,950	40,250	56,250	96,600	252,700	378,500	742,650	2,165,500

a The gray shading in this cell represents cross-river travel movements.

Table 6. Difference in Total Work Person-Trips Between Modified LPA and No-Build Alternative

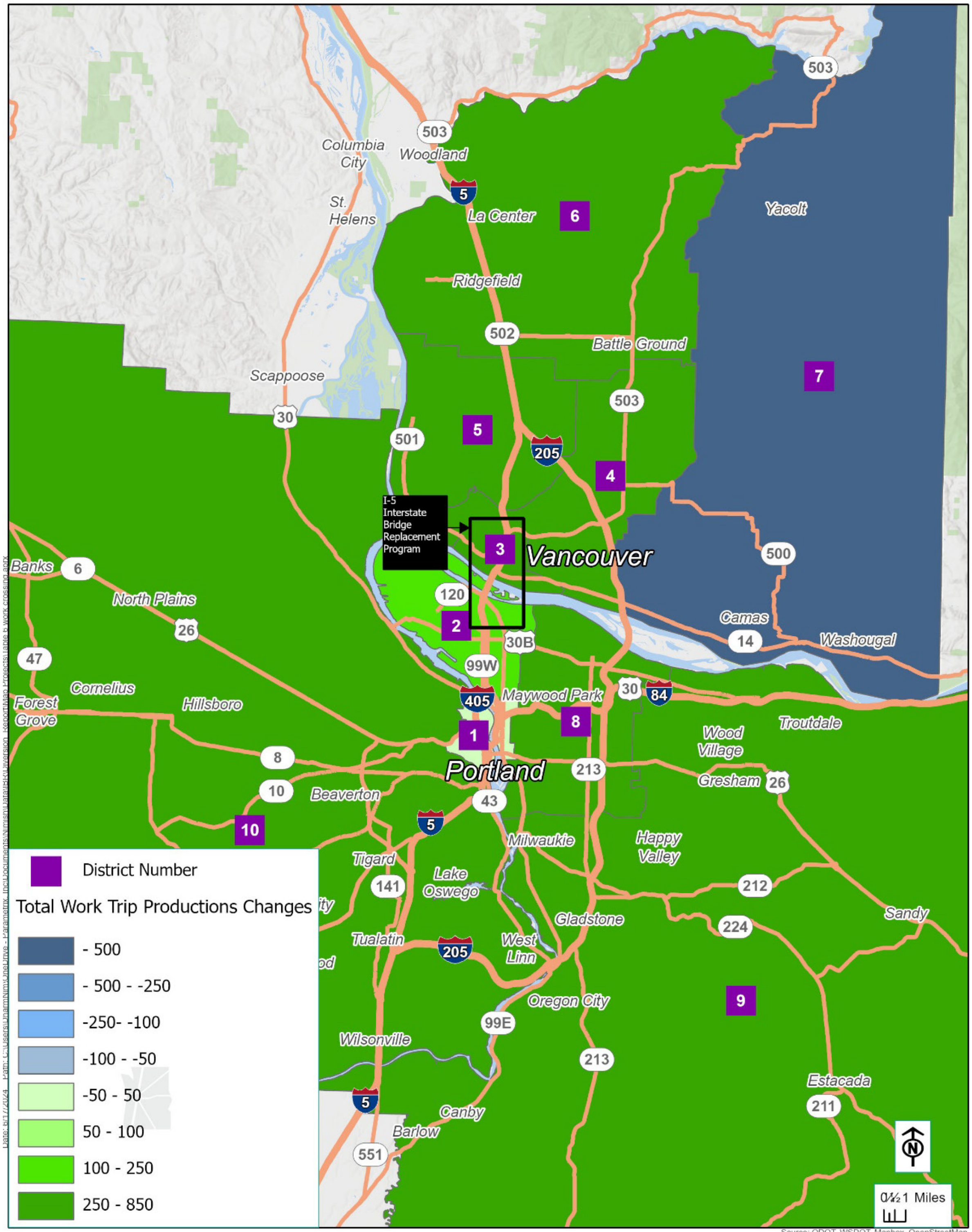
District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	(250)	-	**-** [a]	**50** [a]	**-** [a]	**-** [a]	**-** [a]	50	50	50	-
N/NE Portland (2) *Productions*	(150)	(100)	**100** [a]	**50** [a]	**50** [a]	**-** [a]	**-** [a]	50	50	-	-
Vancouver CBD and Surrounding Area (3) *Productions*	**400** [a]	**-** [a]	(250)	(100)	(50)	-	(50)	**50** [a]	**-** [a]	**-** [a]	-
East Vancouver (4) *Productions*	**650** [a,b]	**150** [a]	(200)	(200)	-	-	(150)	**(150)** [a]	**(200)** [a]	**50** [a]	-
Salmon Creek (5) *Productions*	**800** [a,b]	**50** [a]	(200)	(200)	(200)	(100)	(100)	**50** [a]	**(100)** [a]	**50** [a]	-
North Clark County (6) *Productions*	**650** [a,b]	**50** [a]	(50)	(100)	(50)	(150)	(100)	**(50)** [a]	**(100)** [a]	**50** [a]	-
East Clark County (7) *Productions*	**150** [a]	**50** [a]	50	150	100	50	100	**(300)** [a]	**(250)** [a]	**(150)** [a]	-
NE Portland/Mult Co (8) *Productions*	(600) [c]	(100)	**150** [a]	**100** [a]	**50** [a]	**50** [a]	**50** [a]	150	150	-	-
E Mult Co/Clackamas Co (9) *Productions*	(700) [c]	(100)	**150** [a]	**100** [a]	**50** [a]	**50** [a]	**150** [a]	100	350	(50)	-
Westside (10) *Productions*	(900) [c]	(50)	**350** [a]	**150** [a]	**100** [a]	**100** [a]	**100** [a]	150	200	(50)	-
Total	-	-	-	-	-	-	-	-	-	-	-
Percent Change vs. No-Build Alternative	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	

a Bold text in this cell indicates cross-river movements.

b Green shading in this cell indicates increases of more than 500 trips.

c Red shading in this cell indicates decreases of more than -500 trips.

Figure 3. Difference in Cross-River Work Person-Trip Productions Between Modified LPA and No-Build Alternative



3.3 Total Non-Work Person-Trip Changes

Table 7 and Table 8 below provide district movements for all non-work person-trips in the No-Build Alternative and Modified LPA respectively. Non-work trips include trip purposes that do not include a work trip end (e.g. other, shopping, recreation). In both alternatives, non-work trips make up just over 82% of total person-trips. Table 9 provides the difference between the Modified LPA and the No-Build Alternative for non-work trips.

Green shading in Table 9 indicates that there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there is a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative.

Similar to total person and work trips we see increases for non-work trips produced in Clark County attracted to Oregon (5,400 trips) with increases to all districts. The non-work trip increases to Oregon make up approximately 74% of the total trip increases from Clark County to Oregon. For non-work trips the highest production district for trips to Oregon is the Vancouver CBD & Surrounding Area (District 3). Similar to total and work trips, as non-work trip attractions in Oregon go up for trips produced in Clark County, non-work trips that stay within Clark County decrease.

In terms of changes in non-work trips that are produced in Oregon and attracted to Clark County, we see smaller changes with the primary gains coming in productions from outer areas of Portland (District 8), East Multnomah County/Clackamas County (District 9) and the Westside (District 10) attracted to the Vancouver CBD and Surrounding Areas (District 3). Non-work trips from the Portland CBD District 1 and N/NE Portland District 2 to all districts in Clark County go down between the No-Build Alternative and Modified LPA. Corresponding increases occur for district movements within the Portland Central City (District 1) and N/NE Portland (District 2). Accessibility for travel within these districts is improved as a result of the improved frequency on the Yellow Line.

Differences in total non-work trip productions for trips that cross the river as described above are shown in Figure 4.

Table 7. Total Non-Work Person-Trips No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	412,650	52,200	4,100[a]	5,050[a]	2,600[a]	800[a]	3,200[a]	143,600	25,550	103,400	753,100
N/NE Portland (2) *Productions*	66,850	210,500	12,400[a]	11,950[a]	6,050[a]	1,550[a]	5,200[a]	82,500	18,050	40,700	455,750
Vancouver CBD and Surrounding Area (3) *Productions*	2,150[a]	9,450[a]	85,500	36,950	20,750	2,550	9,100	5,050[a]	1,800[a]	2,650[a]	176,000
East Vancouver (4) *Productions*	2,000[a]	4,800[a]	39,950	283,200	42,050	27,250	70,850	7,750[a]	3,850[a]	2,150[a]	483,700
Salmon Creek (5) *Productions*	1,350[a]	3,100[a]	25,600	53,200	171,150	24,200	12,350	2,600[a]	1,250[a]	1,400[a]	296,250
North Clark County (6) *Productions*	800[a]	1,350[a]	9,350	36,000	33,200	239,000	14,350	1,900[a]	1,300[a]	950[a]	338,300
East Clark County (7) *Productions*	2,350[a]	3,150[a]	20,850	101,900	17,550	22,350	405,950	10,450[a]	5,900[a]	2,150[a]	592,650
NE Portland/Mult Co (8) *Productions*	130,600	66,100	5,700[a]	13,500[a]	4,100[a]	1,900[a]	13,300[a]	719,900	185,750	69,700	1,210,600
E Mult Co/Clackamas Co (9) *Productions*	55,450	26,100	4,150[a]	13,100[a]	3,800[a]	2,300[a]	13,350[a]	287,250	1,550,500	125,450	2,081,400
Westside (10) *Productions*	143,600	45,700	4,850[a]	6,900[a]	3,700[a]	1,400[a]	4,400[a]	112,300	105,100	2,923,850	3,351,800
Total	817,850	422,450	212,450	561,750	305,000	323,300	552,050	1,373,300	1,899,000	3,272,400	9,739,550

a The gray shading in this cell represents cross-river travel movements.

Table 8. Total Non-Work Person-Trips Modified LPA

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	412,850	52,500	4,050[a]	4,900[a]	2,550[a]	750[a]	3,150[a]	143,400	25,450	103,500	753,100
N/NE Portland (2) *Productions*	67,300	211,150	11,800[a]	11,550[a]	5,900[a]	1,500[a]	5,000[a]	82,550	18,100	40,900	455,750
Vancouver CBD and Surrounding Area (3) *Productions*	2,750[a]	9,550[a]	84,500	36,500	20,750	2,500	9,000	5,650[a]	1,900[a]	2,850[a]	176,000
East Vancouver (4) *Productions*	2,400[a]	5,300[a]	39,600	282,300	41,900	27,150	70,650	8,150[a]	3,900[a]	2,350[a]	483,700
Salmon Creek (5) *Productions*	1,600[a]	3,350[a]	25,650	53,050	170,400	24,100	12,350	2,900[a]	1,300[a]	1,550[a]	296,250
North Clark County (6) *Productions*	900[a]	1,450[a]	9,400	35,950	33,150	238,650	14,350	2,050[a]	1,300[a]	1,100[a]	338,300
East Clark County (7) *Productions*	2,450[a]	3,300[a]	20,950	101,750	17,600	22,300	405,250	10,750[a]	6,000[a]	2,250[a]	592,650
NE Portland/Mult Co (8) *Productions*	130,650	66,450	5,950[a]	13,500[a]	4,200[a]	1,900[a]	13,150[a]	719,300	185,650	69,850	1,210,600
E Mult Co/Clackamas Co (9) *Productions*	55,450	26,250	4,150[a]	13,000[a]	3,800[a]	2,300[a]	13,200[a]	287,150	1,550,400	125,700	2,081,400
Westside (10) *Productions*	143,700	46,000	4,700[a]	6,650[a]	3,600[a]	1,350[a]	4,350[a]	112,250	105,000	2,924,250	3,351,800
Total	820,100	425,250	210,800	559,200	303,800	322,550	550,400	1,374,100	1,899,050	3,274,300	9,739,550

Note: Gray shading in table represents cross-river travel movements.

Table 9. Difference in Total Non-Work Person-Trips Between Modified LPA and No-Build Alternative

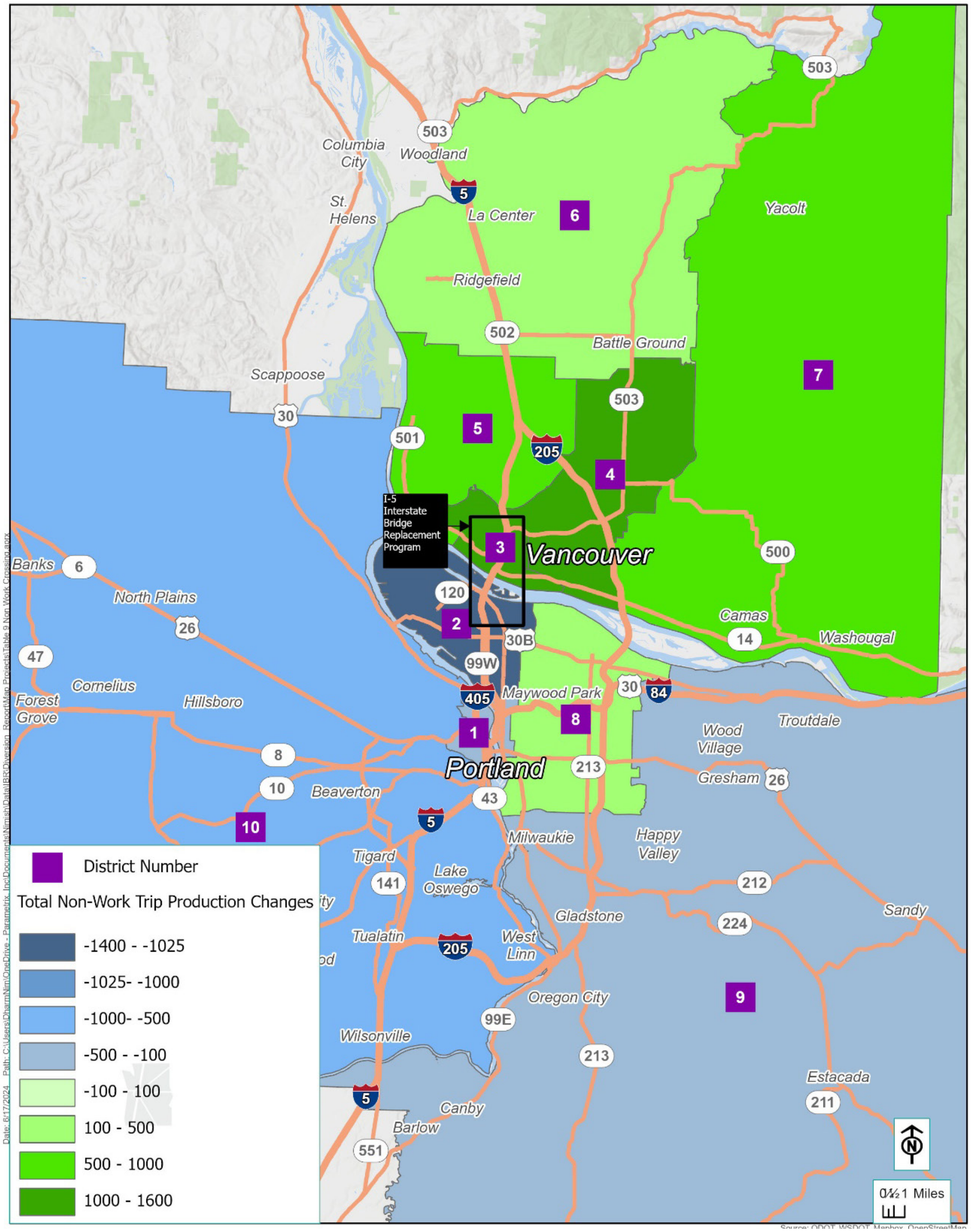
District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	200	300	**(50)**[a]	**(150)**[a]	**(50)**[a]	**(50)**[a]	**(50)**[a]	(200)	(100)	100	-
N/NE Portland (2) *Productions*	450	650	**(600)**[a,c]	**(400)**[a]	**(150)**[a]	**(50)**[a]	**(200)**[a]	50	50	200	-
Vancouver CBD and Surrounding Area (3) *Productions*	**600**[a,b]	**100**[a]	(1,000)[c]	(450)	-	(50)	(100)	**600**[a]	**100**[a]	**200**[a]	-
East Vancouver (4) *Productions*	**400**[a]	**500**[a]	(350)	(900)[c]	(150)	(100)	(200)	**400**[a]	**50**[a]	**200**[a]	-
Salmon Creek (5) *Productions*	**250**[a]	**250**[a]	50	(150)	(750)[c]	(100)	-	**300**[a]	**50**[a]	**150**[a]	-
North Clark County (6) *Productions*	**100**[a]	**100**[a]	50	(50)	(50)	(350)	-	**150**[a]	**-**[a]	**150**[a]	-
East Clark County (7) *Productions*	**100**[a]	**150**[a]	100	(150)	50	(50)	(700)[c]	**300**[a]	**100**[a]	**100**[a]	-
NE Portland/Mult Co (8) *Productions*	50	350	**250**[a]	**-**[a]	**100**[a]	**-**[a]	**(150)**[a]	(600)[c]	(100)	150	-
E Mult Co/Clackamas Co (9) *Productions*	-	150	**-**[a]	**(100)**[a]	**-**[a]	**-**[a]	**(150)**[a]	(100)	(100)	250	-
Westside (10) *Productions*	100	300	**(150)**[a]	**(250)**[a]	**(100)**[a]	**(50)**[a]	**(50)**[a]	(50)	(100)	400	-
Total	2,250	2,800	(1,650)	(2,550)	(1,200)	(750)	(1,650)	800	50	1,900	-
Percent Change vs. No-Build Alternative	0.3%	0.7%	-0.8%	-0.5%	-0.4%	-0.2%	-0.3%	0.1%	0.0%	0.1%	

a Bold text in this cell indicates cross-river movements.

b Green shading in this cell indicates increases of more than 500 trips.

c Red shading in this cell indicates decreases of more than -500 trips.

Figure 4. Difference in Cross-River Non-Work Person-Trip Productions Between Modified LPA and No-Build Alternative



4. MODE CHOICE RESULTS

This section discusses the results of the No-Build Alternative and Modified LPA for changes in mode choice. After the model determines where trips will travel between production areas and attraction areas trips are separated out by travel mode. Modes reflected in tables below include auto person-trips, transit person-trips and walk/bike (active transportation) person-trips.

Table 10 provides an overall look at differences in mode shares between the No-Build Alternative and Modified LPA. Overall mode share to auto and walk/bike trips decrease between the No-Build and Modified LPA and transit shares increase. This is the result of the inclusion of a toll for auto trips across the I-5 Columbia River bridges along with transit improvements. Transit improvements include the extension of the Yellow Line light rail north from the Expo Center in Portland to a terminus at Evergreen Boulevard in Vancouver which includes the addition of three new stations at Hayden Island, Vancouver Waterfront and Evergreen Boulevard. as well as improved frequency and operations of Express Bus operating in bus on shoulder across the new I-5 Columbia River bridges.

Table 10. Mode Share Comparison No-Build Alternative and Modified LPA

Mode	2045 No-Build Alternative	Mode Share %	2045 Modified LPA	Mode Share %	2045 Modified LPA – 2045 No-Build	Percent Change 2045 Modified LPA – 2045 No-Build Alternative
Auto	9,981,812	83.85%	9,971,176	83.76%	-10,636	-0.09%
Transit	623,594	5.24%	636,178	5.34%	12,585	0.11%
Walk/Bike	1,299,647	10.92%	1,297,699	10.90%	-1,949	-0.02%

4.1 Total Auto Person-Trip Changes

Table 11 and Table 12 provide district movements for all auto person-trips in the No-Build Alternative and Modified LPA respectively. Table 13 provides the difference between the Modified LPA and the No-Build Alternative for all auto trips and Table 14 and Table 15 further break down the difference in auto trips by work and non-work trips.

Green shading in Table 13, Table 14, and Table 15 indicates that there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there is a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative. Unlike total person-trips which reflected increases in trips produced in Clark County attracted to Oregon, auto person-trips for the same movements decrease for nearly all district-to-district movements between the No-Build Alternative and the Modified LPA. There are no district movements with increases in auto trips greater than 500 trips in Table 13 (total auto trips). There are seven district-to-district movements with decreases of more than -500 auto trips. The district-to-district movement with the largest decrease in auto person-trips N/NE Portland (District 2) to Vancouver CBD and Surrounding Areas (District 3) with -1,150 auto trips. As with person-trips, the majority of the reduction is in non-work trips which make up 82% of the total decrease.

The highest decrease in the Work Auto Person-Trips is from East Vancouver (District 4) to Portland Central City (District 1). This is the only district-to-district movement with greater than -500 trip change between the Modified LPA and the No-Build Alternative. Work Auto Person-Trips show small increases in trips from NE Portland/Multnomah (District 8), E Multnomah (District 9), and Westside (District 10) to Clark County districts.

While work trips show a decrease from Clark County to Oregon, non-work trips show an increase in trips from Clark County to Oregon. None of these increases is greater than 500 trips. Only one district-to-district movement shows an increase of more than 500 trips. This is trips that stay within N/NE Portland (District 2).

Figure 5, Figure 6, and Figure 7 show the difference in river crossings for total auto-trip productions, work auto-trips productions and non-work trip productions between the Modified LPA and No-Build Alternative as described above.

Table 11. Total Auto Trips No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	138,850	49,600	4,400[a]	5,300[a]	2,750[a]	950[a]	3,450[a]	127,050	27,850	101,050	461,300
N/NE Portland (2) *Productions*	46,550	177,100	13,300[a]	12,650[a]	6,400[a]	1,800[a]	5,700[a]	84,350	23,400	55,250	426,400
Vancouver CBD and Surrounding Area (3) *Productions*	2,750[a]	11,700[a]	68,950	38,700	21,650	3,300	10,350	6,650[a]	2,950[a]	5,050[a]	172,050
East Vancouver (4) *Productions*	4,650[a]	8,800[a]	45,950	275,300	47,150	32,400	81,050	13,900[a]	8,900[a]	8,450[a]	526,600
Salmon Creek (5) *Productions*	3,750[a]	6,550[a]	33,350	64,100	168,050	31,150	17,150	6,000[a]	4,200[a]	7,150[a]	341,450
North Clark County (6) *Productions*	3,550[a]	3,400[a]	14,250	45,000	39,650	245,350	20,700	4,850[a]	4,400[a]	6,200[a]	387,350
East Clark County (7) *Productions*	6,300[a]	7,250[a]	28,500	120,550	22,300	29,300	420,150	20,300[a]	14,700[a]	11,700[a]	680,950
NE Portland/Mult Co (8) *Productions*	86,350	72,400	6,900[a]	14,850[a]	4,550[a]	2,350[a]	14,800[a]	634,950	206,850	102,650	1,146,600
E Mult Co/Clackamas Co (9) *Productions*	62,250	39,550	5,950[a]	15,550[a]	4,600[a]	3,150[a]	16,250[a]	328,300	1,551,150	206,050	2,232,750
Westside (10) *Productions*	130,900	71,450	8,600[a]	10,100[a]	5,100[a]	2,750[a]	7,500[a]	150,600	168,500	3,050,750	3,606,300
Total	485,950	447,750	230,200	602,050	322,300	352,500	597,100	1,376,900	2,012,850	3,554,300	9,981,800

a Gray shading in this cell represents cross-river travel movements.

Table 12. Total Auto Trips Modified LPA

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	138,850	49,750	3,900[a]	4,950[a]	2,550[a]	900[a]	3,350[a]	126,850	27,750	101,250	460,100
N/NE Portland (2) *Productions*	46,400	177,500	12,150[a]	12,000[a]	6,100[a]	1,750[a]	5,400[a]	84,300	23,350	55,250	424,250
Vancouver CBD and Surrounding Area (3) *Productions*	2,500[a]	11,350[a]	68,250	38,300	21,650	3,250	10,250	7,050[a]	2,950[a]	4,900[a]	170,550
East Vancouver (4) *Productions*	4,050[a]	9,100[a]	45,750	274,250	47,050	32,350	80,700	14,000[a]	8,750[a]	8,400[a]	524,450
Salmon Creek (5) *Productions*	3,450[a]	6,650[a]	33,600	63,800	167,250	31,000	17,050	6,150[a]	4,100[a]	7,000[a]	339,900
North Clark County (6) *Productions*	3,700[a]	3,450[a]	14,300	44,850	39,550	244,850	20,550	4,900[a]	4,300[a]	6,300[a]	386,800
East Clark County (7) *Productions*	5,800[a]	7,250[a]	28,650	120,550	22,400	29,300	419,600	20,300[a]	14,500[a]	11,550[a]	679,900
NE Portland/Mult Co (8) *Productions*	86,250	72,600	6,950[a]	14,800[a]	4,600[a]	2,350[a]	14,700[a]	634,500	206,850	102,800	1,146,400
E Mult Co/ Clackamas Co (9) *Productions*	61,900	39,550	6,000[a]	15,500[a]	4,600[a]	3,200[a]	16,200[a]	328,250	1,551,350	206,250	2,232,750
Westside (10) *Productions*	130,750	71,600	8,300[a]	9,800[a]	4,950[a]	2,750[a]	7,500[a]	150,600	168,550	3,051,150	3,606,000
Total	483,650	448,750	227,800	598,850	320,750	351,700	595,350	1,376,850	2,012,500	3,554,900	9,971,200

a Gray shading in this cell represents cross-river travel movements.

Table 13. Difference in Total Auto Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	-	150	**(500)**[a]	**(350)**[a]	**(200)**[a]	**(50)**[a]	**(100)**[a]	(200)	(100)	200	(1,150)
N/NE Portland (2) *Productions*	(150)	400	**(1,150)**[a,b]	**(650)**[a,b]	**(300)**[a]	**(50)**[a]	**(300)**[a]	(50)	(50)	-	(2,300)
Vancouver CBD and Surrounding Area (3) *Productions*	**(250)**	**(350)**	(700)[b]	(400)	-	(50)	(100)	**400**[a]	-[a]	**(150)**[a]	(1,600)
East Vancouver (4) *Productions*	**(600)**[a,b]	**300**[a]	(200)	(1,050)[b]	(100)	(50)	(350)	**100**[a]	**(150)**[a]	**(50)**[a]	(2,150)
Salmon Creek (5) *Productions*	**(300)**[a]	**100**[a]	250	(300)	(800)[b]	(150)	(100)	**150**[a]	**(100)**[a]	**(150)**[a]	(1,400)
North Clark County (6) *Productions*	**150**[a]	**50**[a]	50	(150)	(100)	(500)	(150)	**50**[a]	**(100)**[a]	**100**[a]	(600)
East Clark County (7) *Productions*	**(500)**[a]	-[a]	150	-	100	-	(550)[b]	-[a]	**(200)**[a]	**(150)**[a]	(1,150)
NE Portland/Mult Co (8) *Productions*	(100)	200	**50**[a]	**(50)**[a]	**50**[a]	-[a]	**(100)**[a]	(450)	-	150	(250)
E Mult Co/Clackamas Co (9) *Productions*	(350)	-	**50**[a]	**(50)**[a]	-[a]	**50**[a]	**(50)**[a]	(50)	200	200	-
Westside (10) *Productions*	(150)	150	**(300)**[a]	**(300)**[a]	**(150)**[a]	-[a]	-[a]	-	50	400	(300)
Total	(2,250)	1,000	(2,300)	(3,300)	(1,500)	(800)	(1,800)	(50)	(450)	550	(10,900)
Percent Change vs. No-Build Alternative	-0.5%	0.2%	-1.0%	-0.5%	-0.5%	-0.2%	-0.3%	0.0%	0.0%	0.0%	-

a Bold text in this cell indicates cross-river movements.

b Red shading in this cell indicates decreases of more than -500 trips.

Figure 5. Difference in Cross-River Auto-Trip Productions Between Modified LPA and No-Build Alternative

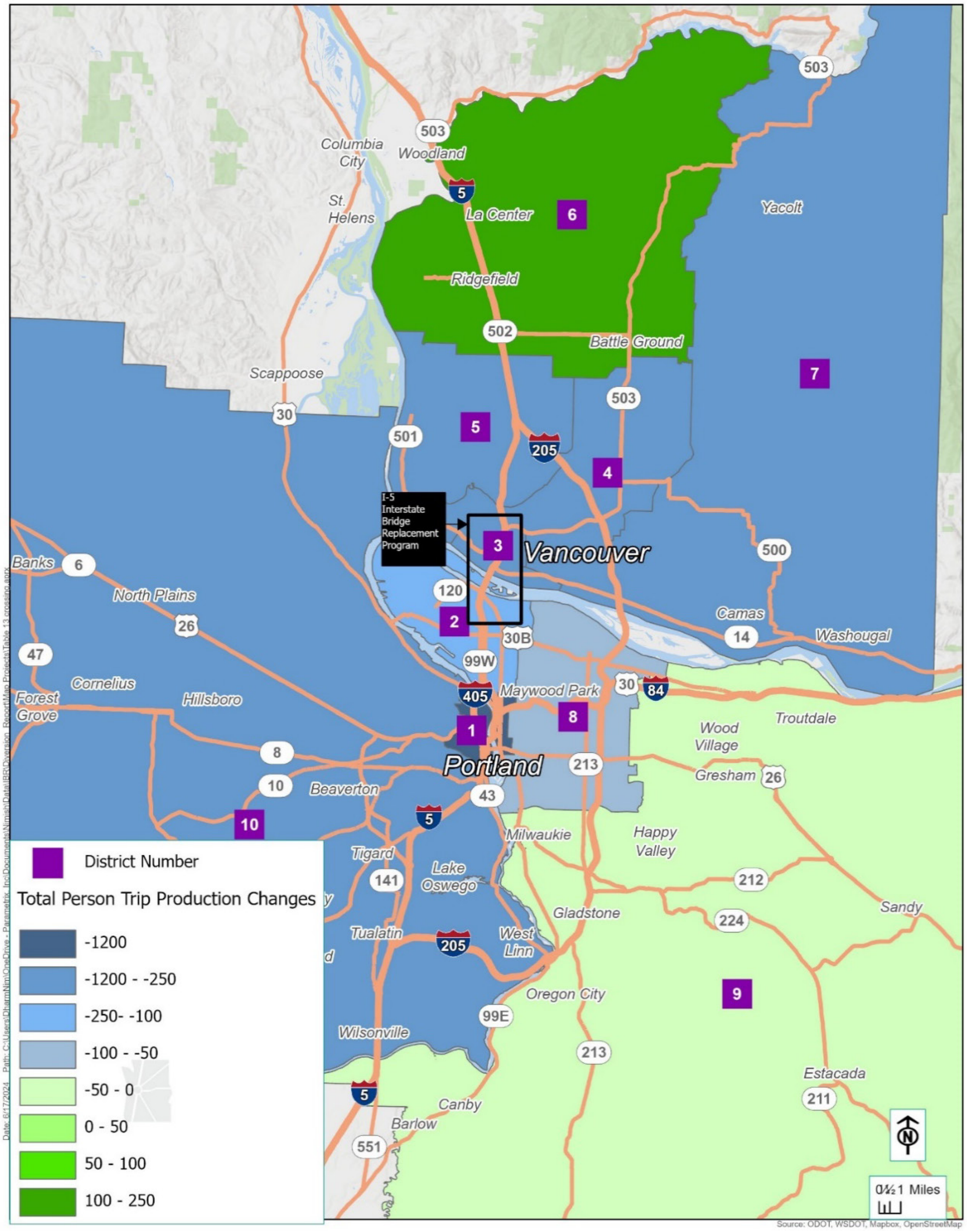


Table 14. Difference in Total Work Auto Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	(50)	-	**(100)**[a]	**(50)**[a]	**(50)**[a]	**-**	**-**	50	50	50	(100)
N/NE Portland (2) *Productions*	(150)	(150)	**(200)**[a]	**(50)**[a]	**(50)**[a]	**-**	**-**	(50)	-	(50)	(700)
Vancouver CBD and Surrounding Area (3) *Productions*	**(350)**[a]	**(250)**[a]	(100)	(50)	(50)	-	(50)	**(50)**[a]	**(50)**[a]	**(250)**[a]	(1,200)
East Vancouver (4) *Productions*	**(750)**[a,b]	**(50)**[a]	(50)	(150)	-	-	(150)	**(250)**[a]	**(250)**[a]	**(250)**[a]	(1,900)
Salmon Creek (5) *Productions*	**(400)**[a]	**(100)**[a]	100	(200)	(150)	(100)	(100)	**(100)**[a]	**(100)**[a]	**(300)**[a]	(1,450)
North Clark County (6) *Productions*	**50**[a]	**-**[a]	-	(100)	(50)	(150)	(150)	**(100)**[a]	**(100)**[a]	**-**[a]	(600)
East Clark County (7) *Productions*	**(500)**[a]	**(50)**[a]	50	150	50	50	100	**(250)**[a]	**(250)**[a]	**(250)**[a]	(900)
NE Portland/Mult Co (8) *Productions*	(100)	(100)	**-**[a]	**50**[a]	**-**[a]	**-**[a]	**50**[a]	100	100	50	150
E Mult Co/Clackamas Co (9) *Productions*	(350)	(150)	**50**[a]	**100**[a]	**-**[a]	**50**[a]	**100**[a]	50	250	(50)	50
Westside (10) *Productions*	(250)	(100)	**-**[a]	**50**[a]	**-**[a]	**50**[a]	**100**[a]	100	100	(50)	-
Total	(2,850)	(950)	(250)	(250)	(300)	(100)	(100)	(500)	(250)	(1,100)	(6,650)
Percentage Change vs. No-Build Alternative	-3.5%	-1.0%	-0.6%	-0.4%	-0.4%	0.0%	-0.1%	-0.3%	-0.1%	-0.2%	-

a Bold text in this cell indicates cross-river movements.

b Red shading in this cell indicates decreases of more than -500 trips.

Figure 6. Difference in Cross-River Work Auto-Trip Productions Between Modified LPA and No-Build Alternative

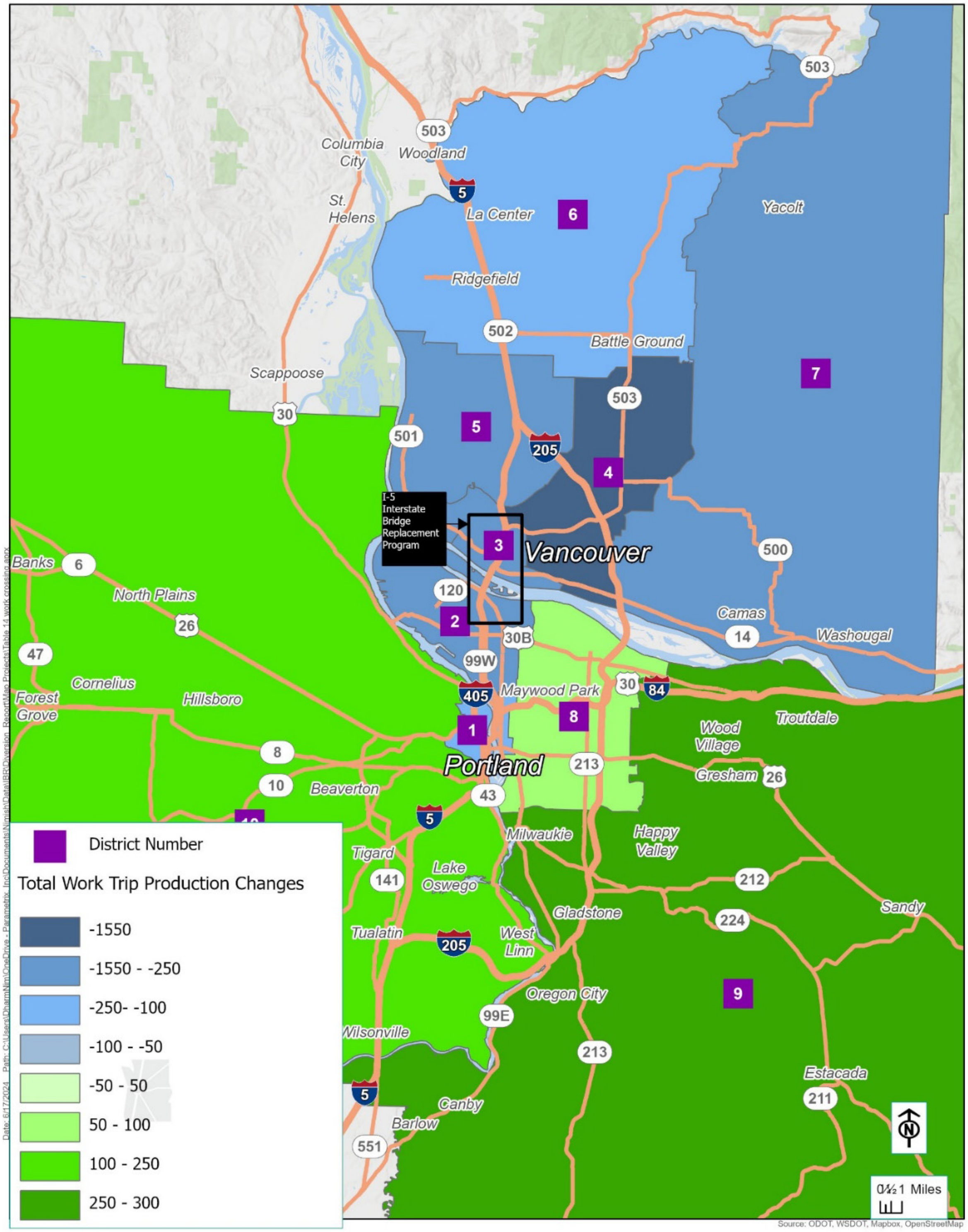


Table 15. Difference in Total Non-Work Auto Trips Between Modified LPA and No-Build Alternative

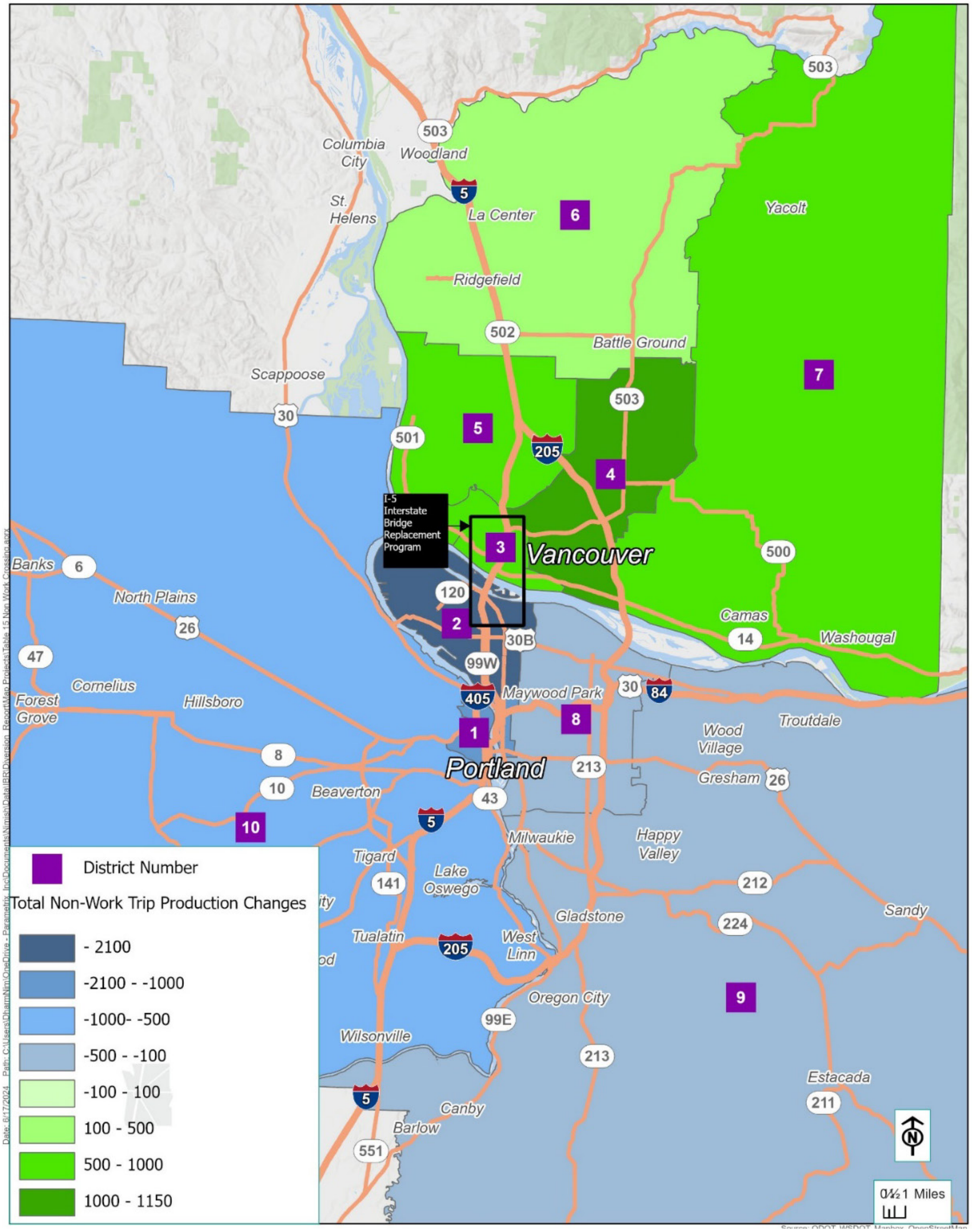
District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	(100)	150	**(400)**[a]	**(300)**[a]	**(200)**[a]	**(50)**[a]	**(100)**[a]	(250)	(100)	150	(1,200)
N/NE Portland (2) *Productions*	(100)	550[b]	**(950)**[a,c]	**(600)**[a,c]	**(250)**[a]	**(50)**[a]	**(250)**[a]	(100)	-	100	(1,650)
Vancouver CBD and Surrounding Area (3) *Productions*	**100**[a]	**(100)**[a]	(600)[c]	(300)	-	-	(100)	**450**[a]	**100**[a]	**100**[a]	(350)
East Vancouver (4) *Productions*	**100**[a]	**400**[a]	(150)	(850)[c]	(150)	(100)	(200)	**350**[a]	**100**[a]	**200**[a]	(300)
Salmon Creek (5) *Productions*	**150**[a]	**200**[a]	100	(100)	(650)[c]	(100)	-	**250**[a]	**50**[a]	**150**[a]	50
North Clark County (6) *Productions*	**-**[a]	**100**[a]	50	-	(100)	(350)	-	**150**[a]	**-**[a]	**150**[a]	-
East Clark County (7) *Productions*	**100**[a]	**100**[a]	100	(150)	50	(50)	(600)[c]	**300**[a]	**100**[a]	**100**[a]	50
NE Portland/Mult Co (8) *Productions*	50	300	**50**[a]	**(100)**[a]	**50**[a]	**-**[a]	**(200)**[a]	(500)	(50)	150	(250)
E Mult Co/Clackamas Co (9) *Productions*	(400)	150	**-**[a]	**(150)**[a]	**-**[a]	**-**[a]	**(150)**[a]	(100)	(100)	(400)	(1,150)
Westside (10) *Productions*	650[b]	250	**(300)**[a]	**(300)**[a]	**(200)**[a]	**(50)**[a]	**(100)**[a]	(50)	(100)	1,050	850
Total	550	2,100	(2,100)	(2,850)	(1,450)	(750)	(1,700)	500	-	1,750	(3,950)
Percentage Change vs. No-Build Alternative	0.1%	0.6%	-1.2%	-0.6%	-0.5%	-0.2%	-0.3%	0.0%	0.0%	0.1%	-

a Bold text in this cell indicates cross-river movements.

b Green shading in this cell indicates increases of more than 500 trips.

c Red shading in this cell indicates decreases of more than -500 trips.

Figure 7. Difference in Cross-River Non-Work Auto-Trip Productions Between Modified LPA and No-Build Alternative



4.2 Total Transit Person-Trip Changes

Table 16 and Table 17 provide district movements for all transit person-trips in the No-Build Alternative and Modified LPA, respectively. Table 18 provides the difference between the Modified LPA and the No-Build Alternative for all auto trips, and Table 19 and Table 20 further break down the difference in transit trips by work and non-work trips.

Green shading in Table 18, Table 19, and Table 20 indicates that there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there is a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative.

In terms of total transit-trip differences, the district movements that show increases of more than 500 trips are all of the Clark County Districts (3, 4, 5, 6, 7) to the Portland Central City (District 1). There are no district movements with reductions in transit trips of more than -500 trips.

Work transit trips play an important role in the increase in the total transit person-trips. They represent approximately 64% of the total trip increase. Both work and non-work transit trips show an increase from Clark County to Oregon and from Oregon to Clark County. The highest increase in transit trips increase is from East Vancouver (District 4) to Portland Central City (District 1) with an increase of 1,850 trips. With increases in transit trips from Clark County to Oregon, there are decreases for transit trips within Clark County. There are small increases in transit trips from Portland Central City (District 1) and North/Northeast Portland District 2 to nearly all districts which are the result of improved frequencies on the Yellow Line. There are small decreases in transit trips from other Oregon districts (8–10) to the Portland Central City (District 1) and North/Northeast Portland and increase from the same districts (8–10) to Clark County Districts (3–5 and 7). These trends are true for both work and non-work transit trips.

Figure 8 shows the difference in river crossing transit-trip productions between the Modified LPA and the No-Build Alternative. When considering river crossings by transit, there are increases in all districts.

Figure 9 shows the difference in river crossings for work transit-trip productions between the Modified LPA and the No-Build Alternative. Figure 9 shows a similar highest increase in East Vancouver (District 4).

Figure 10 shows the difference in river crossings for non-work transit-trip productions between the Modified LPA and the No-Build Alternative. The highest increase in Figure 10 is in the Vancouver CBD and surrounding areas (District 3). These figures help to illustrate where trip productions have changed with respect to river crossings and work and non-work trips.

Table 16. Total Transit Trips No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	64,300	7,400	250[a]	150[a]	50[a]	-[a]	100[a]	19,050	4,950	17,500	113,750
N/NE Portland (2) *Productions*	32,000	5,750	300[a]	150[a]	50[a]	-[a]	50[a]	6,150	1,700	4,600	50,750
Vancouver CBD and Surrounding Area (3) *Productions*	1,700[a]	250[a]	2,150	1,350	650	-	400	100[a]	50[a]	150[a]	6,900
East Vancouver (4) *Productions*	2,900[a]	150[a]	3,300	2,050	300	100	1,000	150[a]	100[a]	250[a]	10,200
Salmon Creek (5) *Productions*	2,750[a]	100[a]	2,050	400	650	-	100	50[a]	50[a]	200[a]	6,400
North Clark County (6) *Productions*	1,250[a]	-[a]	300	100	-	-	50	-[a]	-[a]	50[a]	1,800
East Clark County (7) *Productions*	4,750[a]	100[a]	1,800	1,400	150	50	1,000	300[a]	150[a]	350[a]	10,050
NE Portland/Mult Co (8) *Productions*	75,650	5,900	200[a]	100[a]	50[a]	-[a]	150[a]	29,550	14,650	12,900	139,150
E Mult Co/Clackamas Co (9) *Productions*	46,350	1,700	100[a]	50[a]	-[a]	-[a]	50[a]	14,200	27,150	7,800	97,350
Westside (10) *Productions*	83,550	3,600	250[a]	100[a]	50[a]	-[a]	100[a]	10,100	6,100	83,350	187,200
Total	315,200	24,950	10,700	5,850	1,950	150	3,000	79,650	54,900	127,150	623,600

a Gray shading in this cell represents cross-river travel movements.

Table 17. Total Transit Trips Modified LPA

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	64,650	7,550	750[a]	400[a]	200[a]	-[a]	150[a]	19,100	4,950	17,550	115,350
N/NE Portland (2) *Productions*	32,700	5,950	700[a]	400[a]	150[a]	-[a]	150[a]	6,350	1,750	4,750	52,950
Vancouver CBD and Surrounding Area (3) *Productions*	3,100[a]	650[a]	1,750	1,200	650	-	350	350[a]	100[a]	500[a]	8,600
East Vancouver (4) *Productions*	4,750[a]	500[a]	2,950	2,150	250	100	1,000	300[a]	150[a]	600[a]	12,750
Salmon Creek (5) *Productions*	4,200[a]	250[a]	1,650	350	650	-	100	200[a]	100[a]	550[a]	8,050
North Clark County (6) *Productions*	1,800[a]	50[a]	250	100	-	-	50	-[a]	-[a]	100[a]	2,400
East Clark County (7) *Productions*	5,650[a]	300[a]	1,750	1,450	100	50	1,000	350[a]	200[a]	500[a]	11,300
NE Portland/Mult Co (8) *Productions*	75,400	5,950	550[a]	250[a]	100[a]	-[a]	200[a]	29,600	14,650	12,900	139,600
E Mult Co/Clackamas Co (9) *Productions*	46,200	1,750	200[a]	100[a]	50[a]	-[a]	100[a]	14,200	27,200	7,750	97,500
Westside (10) *Productions*	83,150	3,700	700[a]	250[a]	150[a]	-[a]	100[a]	10,150	6,150	83,350	187,700
Total	321,550	26,650	11,250	6,600	2,350	250	3,150	80,600	55,200	128,550	636,200

a Gray shading in this cell represents cross-river travel movements.

Table 18. Difference in Total Transit Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total	Percentage Difference
Portland Central City (1) *Productions*	350	150	**500**[a]	**250**[a]	**150**[a]	**-**[a]	**50**[a]	50	-	50	1,600	1.4%
N/NE Portland (2) *Productions*	700[b]	200	**400**[a]	**250**[a]	**100**[a]	**-**[a]	**100**[a]	200	50	150	2,200	4.3%
Vancouver CBD and Surrounding Area (3) *Productions*	**1,400**[a,b]	**400**[a]	(400)	(150)	-	-	(50)	**250**[a]	**50**[a]	**350**[a]	1,700	24.9%
East Vancouver (4) *Productions*	**1,850**[a,b]	**350**[a]	(350)	100	(50)	-	-	**150**[a]	**50**[a]	**350**[a]	2,550	24.7%
Salmon Creek (5) *Productions*	**1,450**[a,b]	**150**[a]	(400)	(50)	-	-	-	**150**[a]	**50**[a]	**350**[a]	1,650	26.2%
North Clark County (6) *Productions*	**550**[a,b]	**50**[a]	(50)	-	-	-	-	**-**[a]	**-**[a]	**50**[a]	600	33.0%
East Clark County (7) *Productions*	**900**[a,b]	**200**[a]	(50)	50	(50)	-	-	**50**[a]	**50**[a]	**150**[a]	1,250	12.3%
NE Portland/Mult Co (8) *Productions*	(250)	50	**350**[a]	**150**[a]	**50**[a]	**-**[a]	**50**[a]	50	-	-	450	0.3%
E Mult Co/Clackamas Co (9) *Productions*	(150)	50	**100**[a]	**50**[a]	**50**[a]	**-**[a]	**50**[a]	-	50	(50)	150	0.2%
Westside (10) *Productions*	(400)	100	**450**[a]	**150**[a]	**100**[a]	**-**[a]	**-**[a]	50	50	-	500	0.3%
Total	6,300	1,700	500	750	400	50	150	950	300	1,350	12,600	-
Percentage Change vs. No-Build Alternative	2.0%	6.9%	5.1%	12.7%	20.9%	18.3%	5.7%	1.2%	0.6%	1.1%	-	-

a Bold text in this cell indicates cross-river movements.

b Green shading in this cell indicates increases of more than 500 trips.

Figure 8. Difference in Cross-River Transit-Trip Productions Between Modified LPA and No-Build Alternative

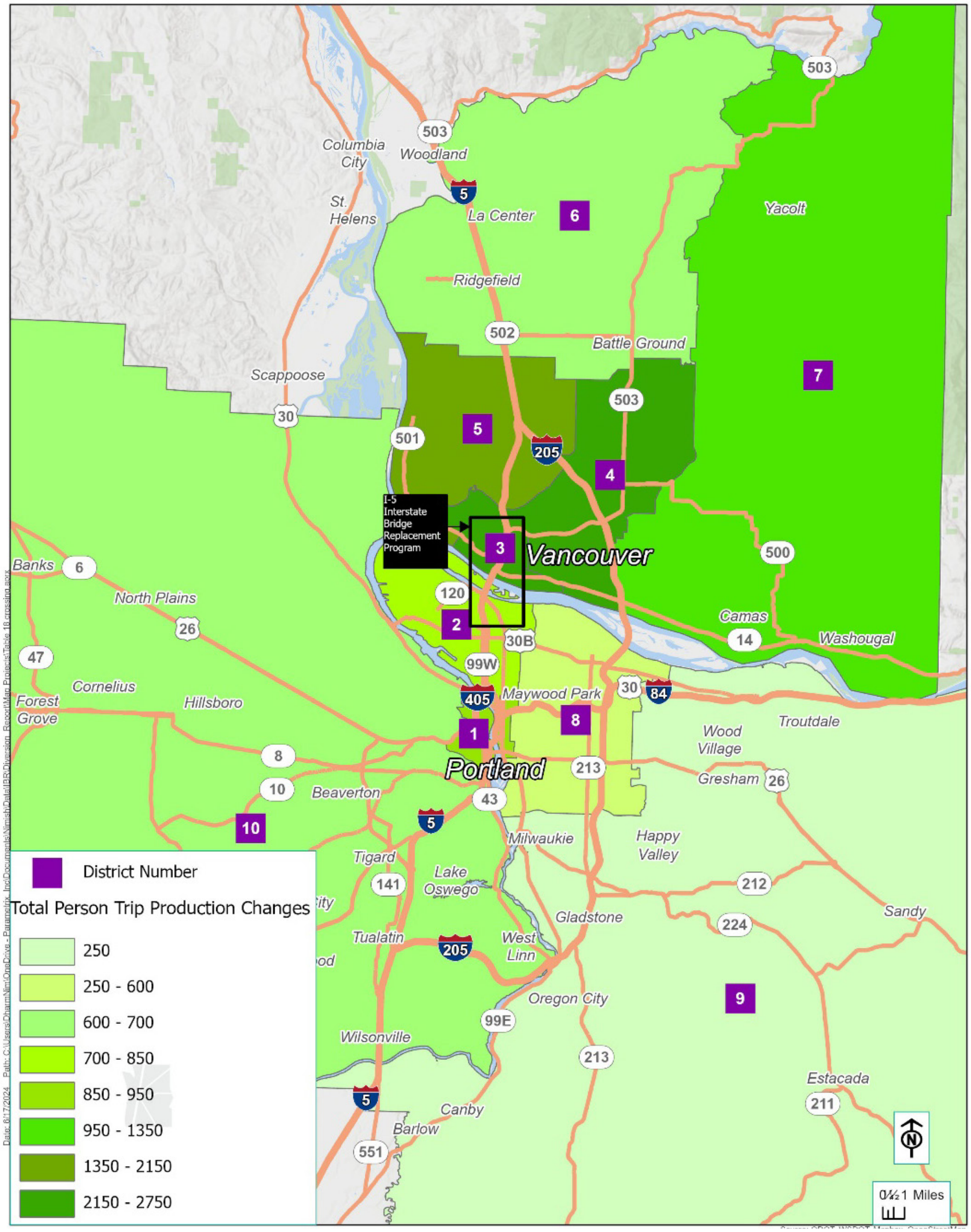


Table 19. Difference in Total Work Transit Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total	Percentage Difference
Portland Central City (1) *Productions*	-	-	**150**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	50	-	-	350	1.1%
N/NE Portland (2) *Productions*	250	100	**200**[a]	**50**[a]	**50**[a]	**-**[a]	**50**[a]	50	50	100	850	4.0%
Vancouver CBD and Surrounding Area (3) *Productions*	**900**[a,b]	**200**[a]	(200)	-	-	-	-	**100**[a]	**50**[a]	**250**[a]	1,350	40.4%
East Vancouver (4) *Productions*	**1,550**[a,b]	**250**[a]	(150)	-	-	-	-	**150**[a]	**50**[a]	**300**[a]	2,150	38.9%
Salmon Creek (5) *Productions*	**1,250**[a,b]	**150**[a]	(300)	-	-	-	-	**100**[a]	**-**[a]	**300**[a]	1,500	33.2%
North Clark County (6) *Productions*	**600**[a,b]	**50**[a]	(50)	-	-	-	-	**-**[a]	**-**[a]	**50**[a]	550	37.1%
East Clark County (7) *Productions*	**800**[a,b]	**150**[a]	(50)	-	-	-	-	**-**[a]	**-**[a]	**150**[a]	1,050	15.2%
NE Portland/Mult Co (8) *Productions*	(300)	-	**150**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	50	50	(50)	-	0.1%
E Mult Co/Clackamas Co (9) *Productions*	(100)	50	**100**[a]	**50**[a]	**-**[a]	**-**[a]	**-**[a]	50	50	-	50	0.1%
Westside (10) *Productions*	(450)	50	**350**[a]	**100**[a]	**100**[a]	**-**[a]	**50**[a]	50	-	-	200	0.2%
Total	4,450	1,000	150	300	150	50	100	600	250	1,150	8,050	
Percentage Change vs. No-Build Alternative	2.6%	12.5%	2.9%	14.6%	25.0%	24.6%	4.5%	2.3%	1.2%	2.0%		

a Bold text indicates cross-river movements.

b Green shading indicates increases of more than 500 trips.

Figure 9. Difference in Cross-River Work Transit-Trip Productions Between Modified LPA and No-Build Alternative

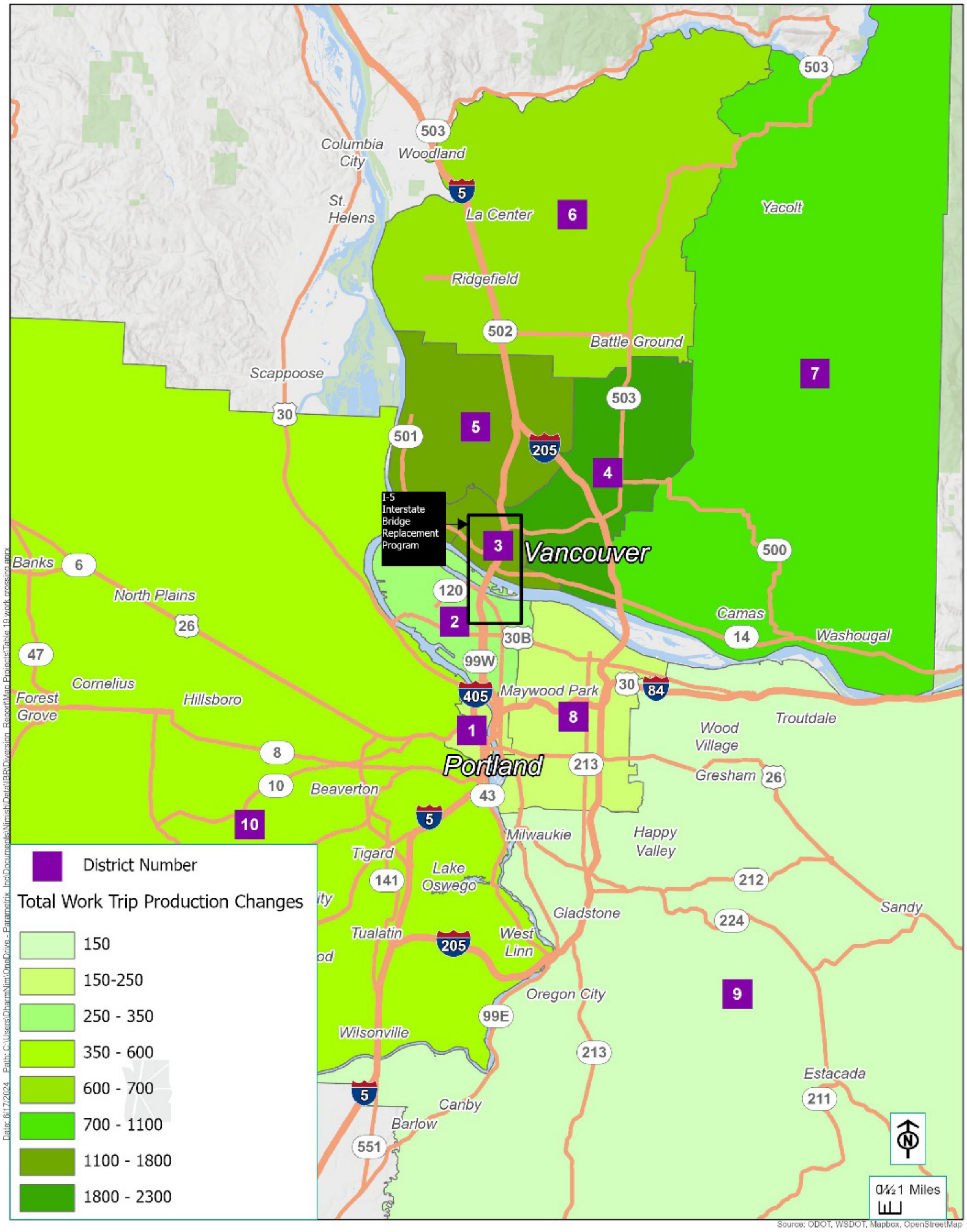


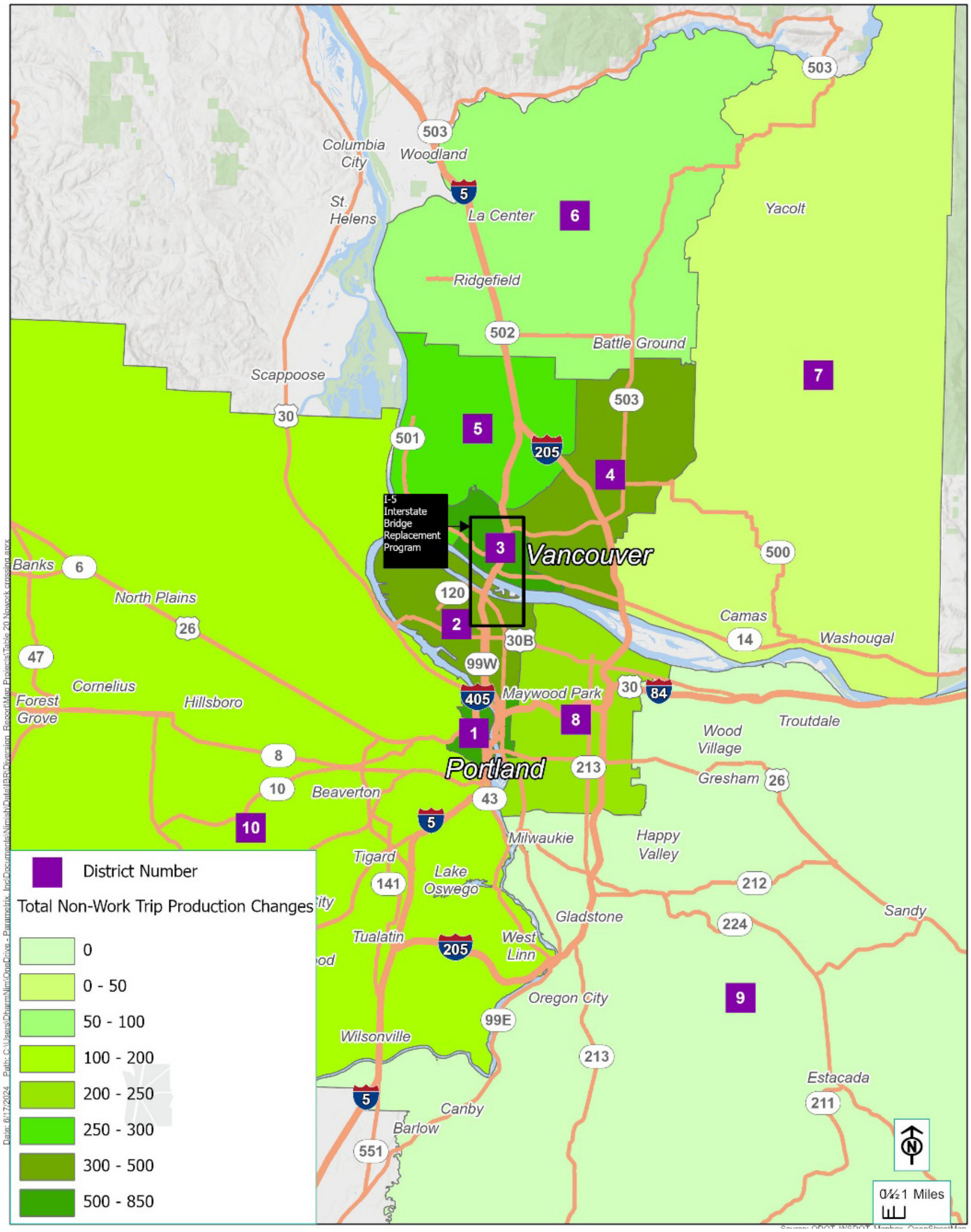
Table 20. Difference in Total Non-Work Transit Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total	Percentage Difference
Portland Central City (1) *Productions*	400	150	**350**[a]	**200**[a]	**100**[a]	**-**[a]	**50**[a]	50	-	-	1,250	1.5%
N/NE Portland (2) *Productions*	600	100	**250**[a]	**150**[a]	**50**[a]	**-**[a]	**50**[a]	200	50	100	1,500	5.1%
Vancouver CBD and Surrounding Area (3) *Productions*	**550**[a, b]	**100**[a]	(300)	(150)	(50)	-	(50)	**100**[a]	**-**[a]	**100**[a]	400	10.5%
East Vancouver (4) *Productions*	**300**[a]	**100**[a]	(150)	50	-	-	-	**50**[a]	**-**[a]	**50**[a]	400	8.5%
Salmon Creek (5) *Productions*	**150**[a]	**50**[a]	(100)	-	-	-	-	**50**[a]	**-**[a]	**50**[a]	150	7.0%
North Clark County (6) *Productions*	**100**[a]	**-**[a]	-	-	-	-	-	**-**[a]	**-**[a]	**-**[a]	100	47.2%
East Clark County (7) *Productions*	**-**[a]	**50**[a]	50	-	(50)	-	-	**-**[a]	**-**[a]	**-**[a]	100	2.7%
NE Portland/Mult Co (8) *Productions*	-	50	**150**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	-	-	-	350	0.5%
E Mult Co/Clackamas Co (9) *Productions*	400	50	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	600	1,150	2.7%
Westside (10) *Productions*	(500)	50	**100**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	(50)	-	(600)	(900)	-1.0%
Total	1,900	750	400	450	250	-	150	350	100	200	4,500	-
Percentage Change vs. No-Build Alternative	1.3%	4.3%	7.0%	11.8%	19.2%	9.8%	6.5%	0.6%	0.2%	0.3%	-	-

a Bold text in this cell indicates cross-river movements.

b Red shading in this cell indicates decreases of more than -500 trips.

Figure 10. Difference in Cross-River Transit Non-Work Trip Productions Between Modified LPA and No-Build Alternative



4.3 Total Walk/Bike Person-Trip Changes

Table 21 and Table 22 provide district movements for all walk/bike person-trips in the No-Build Alternative and Modified LPA respectively. Table 23 provides the difference between the Modified LPA and the No-Build Alternative for all walk/bike trips, and Table 24 and Table 25 further break down the difference in walk/bike trips by work and non-work trips.

Green shading in Table 23, Table 24, and Table 25 indicates that there would be an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates that there would be a decrease of more than -500 trips in the Modified LPA compared to the No-Build Alternative. There are no district movements in any of these tables that reflect either increases or decreases that warrant this shading. As shown in Table 18, total walk/bike trips would decrease from the No-Build to Modified LPA scenario. The maximum decrease can be seen in the trips coming to Portland Central City (District 1). The majority (approximately 74%) of the walk/bike trip decreases from the No-Build to Modified LPA would be from work trips.

Table 21. Total Walk/Bike Trips No-Build Alternative

District	Portland Central City (1) Attractions	N/NE Portland (2) Attractions	Vancouver CBD & Surrounding Area (3) Attractions	East Vancouver (4) Attractions	Salmon Creek (5) Attractions	North Clark County (6) Attractions	East Clark County (7) Attractions	NE Portland/ Multnomah County (8) Attractions	E Multnomah/ Clackamas County (9) Attractions	Westside (10) Attractions	Total
Portland Central City (1) *Productions*	263,250	3,850	100 [a]	50 [a]	- [a]	- [a]	- [a]	11,750	500	7,800	287,250
N/NE Portland (2) *Productions*	13,850	53,000	650 [a]	150 [a]	50 [a]	- [a]	50 [a]	6,100	500	750	75,100
Vancouver CBD and Surrounding Area (3) *Productions*	500 [a]	350 [a]	26,150	1,000	300	-	50	100 [a]	- [a]	50 [a]	28,550
East Vancouver (4) *Productions*	700 [a]	150 [a]	2,450	38,300	700	650	2,400	150 [a]	50 [a]	50 [a]	45,650
Salmon Creek (5) *Productions*	400 [a]	100 [a]	750	1,000	19,650	250	50	50 [a]	- [a]	50 [a]	22,250
North Clark County (6) *Productions*	100 [a]	- [a]	50	650	200	25,900	50	- [a]	- [a]	- [a]	26,950
East Clark County (7) *Productions*	550 [a]	50 [a]	350	2,500	50	100	45,700	200 [a]	50 [a]	50 [a]	49,550
NE Portland/Mult Co (8) *Productions*	36,650	6,150	250 [a]	150 [a]	50 [a]	- [a]	150 [a]	141,150	11,750	1,800	198,000
E Mult Co/Clackamas Co (9) *Productions*	8,250	250	- [a]	50 [a]	- [a]	- [a]	50 [a]	8,350	194,900	2,250	214,100
Westside (10) *Productions*	26,850	800	50 [a]	- [a]	- [a]	- [a]	- [a]	1,550	2,050	320,850	352,200
Total	351,100	64,700	30,800	43,850	21,000	26,900	48,500	169,400	209,800	333,650	1,299,650

a Gray shading in this cell represents cross-river travel movements.

Table 22. Total Walk/Bike Trips Modified LPA

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total
Portland Central City (1) *Productions*	262,850	3,800	100[a]	50[a]	-[a]	-[a]	-[a]	11,750	500	7,800	**286,900**
N/NE Portland (2) *Productions*	13,550	52,950	850[a]	200[a]	100[a]	-[a]	50[a]	6,100	500	750	**75,050**
Vancouver CBD and Surrounding Area (3) *Productions*	350[a]	400[a]	26,000	1,000	300	-	50	100[a]	-[a]	50[a]	**28,350**
East Vancouver (4) *Productions*	500[a]	200[a]	2,450	38,150	700	650	2,400	150[a]	50[a]	50[a]	**45,300**
Salmon Creek (5) *Productions*	350[a]	100[a]	800	950	19,500	250	50	50[a]	-[a]	50[a]	**22,100**
North Clark County (6) *Productions*	100[a]	-[a]	50	650	200	25,850	50	-[a]	-[a]	-[a]	**26,900**
East Clark County (7) *Productions*	450[a]	50[a]	350	2,500	50	100	45,650	200[a]	50[a]	50[a]	**49,400**
NE Portland/Mult Co (8) *Productions*	36,350	6,150	300[a]	150[a]	50[a]	-[a]	150[a]	141,100	11,750	1,750	**197,750**
E Mult Co/Clackamas Co (9) *Productions*	8,050	250	-[a]	50[a]	-[a]	-[a]	50[a]	8,350	194,900	2,200	**213,950**
Westside (10) *Productions*	26,700	800	100[a]	50[a]	-[a]	-[a]	-[a]	1,550	2,050	320,800	**352,050**
Total	**349,300**	**64,750**	**31,000**	**43,700**	**21,000**	**26,850**	**48,450**	**169,350**	**209,850**	**333,500**	**1,297,700**

a Gray shading in this cell represents cross-river travel movements.

Table 23. Difference in Total Walk/Bike Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total *Attractions*	Percentage Difference
Portland Central City (1) *Productions*	(400)	(50)	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(350)	-0.1%
N/NE Portland (2) *Productions*	(300)	(50)	**200**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	-	-	-	(50)	-0.1%
Vancouver CBD and Surrounding Area (3) *Productions*	**(150)**[a]	**50**[a]	(150)	-	-	-	-	**-**[a]	**-**[a]	**-**[a]	(200)	-0.7%
East Vancouver (4) *Productions*	**(200)**[a]	**50**[a]	-	(150)	-	-	-	**-**[a]	**-**[a]	**-**[a]	(350)	-0.8%
Salmon Creek (5) *Productions*	**(50)**[a]	**-**[a]	50	(50)	(150)	-	-	**-**[a]	**-**[a]	**-**[a]	(150)	-0.7%
North Clark County (6) *Productions*	**-**[a]	**-**[a]	-	-	-	(50)	-	**-**[a]	**-**[a]	**-**[a]	(50)	-0.2%
East Clark County (7) *Productions*	**(100)**[a]	**-**[a]	-	-	-	-	(50)	**-**[a]	**-**[a]	**-**[a]	(150)	-0.4%
NE Portland/Mult Co (8) *Productions*	(300)	-	**50**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	(50)	-	(50)	(250)	-0.1%
E Mult Co/Clackamas Co (9) *Productions*	(200)	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	(50)	(150)	-0.1%
Westside (10) *Productions*	(150)	-	**50**[a]	**50**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	(50)	(150)	0.0%
Total	(1,750)	50	200	(100)	(50)	(50)	(100)	(100)	50	(50)	(1,950)	-
Percentage Change vs. No-Build Alternative	-0.5%	0.1%	0.5%	-0.3%	-0.4%	-0.2%	-0.1%	0.0%	0.0%	0.0%	-	-

a Bold text in this cell indicates cross-river movements.

Table 24. Difference in Total Work Walk/Bike Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total *Attractions*	Percentage Difference
Portland Central City (1) *Productions*	(250)	(50)	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(250)	-0.7%
N/NE Portland (2) *Productions*	(250)	(50)	**100**[a]	**50**[a]	**50**[a]	**-**[a]	**-**[a]	-	50	-	(200)	-0.9%
Vancouver CBD and Surrounding Area (3) *Productions*	**(150)**[a]	**50**[a]	-	-	-	-	-	**-**[a]	**-**[a]	**-**[a]	(150)	-2.9%
East Vancouver (4) *Productions*	**(200)**[a]	**50**[a]	-	(50)	-	-	-	**(50)**[a]	**-**[a]	**-**[a]	(250)	-2.9%
Salmon Creek (5) *Productions*	**(50)**[a]	**-**[a]	-	-	(50)	-	-	**-**[a]	**-**[a]	**-**[a]	(50)	-1.7%
North Clark County (6) *Productions*	**-**[a]	**-**[a]	-	-	-	-	-	**-**[a]	**-**[a]	**-**[a]	(50)	-0.2%
East Clark County (7) *Productions*	**(100)**[a]	**-**[a]	-	-	-	-	50	**-**[a]	**-**[a]	**-**[a]	(100)	-1.0%
NE Portland/Mult Co (8) *Productions*	(250)	-	**50**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(200)	-0.4%
E Mult Co/Clackamas Co (9) *Productions*	(150)	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	50	-	(150)	-0.4%
Westside (10) *Productions*	(150)	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(150)	-0.2%
Total	(1,550)	-	150	-	-	-	-	-	50	(50)	(1,450)	-
Percentage Change vs. No-Build Alternative	-2.0%	-0.1%	2.1%	0.0%	-0.5%	-0.3%	0.3%	0.1%	0.1%	-0.1%	-	-

a Bold text in this cell indicates cross-river movements.

Table 25. Difference in Total Non-Work Walk/Bike Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) *Attractions*	N/NE Portland (2) *Attractions*	Vancouver CBD & Surrounding Area (3) *Attractions*	East Vancouver (4) *Attractions*	Salmon Creek (5) *Attractions*	North Clark County (6) *Attractions*	East Clark County (7) *Attractions*	NE Portland/ Multnomah County (8) *Attractions*	E Multnomah/ Clackamas County (9) *Attractions*	Westside (10) *Attractions*	Total *Attractions*	Percent Difference
Portland Central City (1) *Productions*	(150)	-	**-**[a]	**50**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(100)	-21.3%
N/NE Portland (2) *Productions*	(50)	-	**100**[a]	**50**[a]	**-**[a]	**-**[a]	**50**[a]	-	-	-	150	24.4%
Vancouver CBD and Surrounding Area (3) *Productions*	**-**[a]	**50**[a]	(150)	-	-	-	-	**-**[a]	**-**[a]	**-**[a]	-	-8.9%
East Vancouver (4) *Productions*	**-**[a]	**-**[a]	-	(150)	-	-	-	**-**[a]	**-**[a]	**-**[a]	(150)	-31.0%
Salmon Creek (5) *Productions*	**-**[a]	**50**[a]	(50)	-	(100)	-	-	**-**[a]	**-**[a]	**-**[a]	(50)	-16.9%
North Clark County (6) *Productions*	**-**[a]	**-**[a]	-	-	-	(50)	-	**-**[a]	**-**[a]	**-**[a]	(50)	-8.1%
East Clark County (7) *Productions*	**-**[a]	**-**[a]	-	-	-	-	(100)	**-**[a]	**-**[a]	**-**[a]	(100)	-18.4%
NE Portland/Mult Co (8) *Productions*	(50)	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	(100)	(50)	-	(50)	-16.5%
E Mult Co/Clackamas Co (9) *Productions*	(50)	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	-	-3.7%
Westside (10) *Productions*	-	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	-	0.5%
Total	(150)	50	50	(100)	(50)	(50)	(100)	(100)	-	-	(500)	-
Percent Change vs. No-Build Alternative	-0.1%	0.0%	1.6%	0.0%	-0.3%	-0.2%	0.0%	-0.1%	0.0%	0.0%	0.0%	-

a Bold text in this cell indicates cross-river movements.

5. ASSIGNMENT RESULTS

5.1 Total River Crossing Changes

Auto and transit assignments are the final step in the modeling process where trips by auto or transit are assigned to the transportation network for each alternative under consideration. Differences to be discussed below include shifts in auto or transit trips on the I-5 Columbia River Bridges and the I-205 Glenn Jackson Bridge between the No-Build Alternative and the Modified LPA. As shown in Table 10 above, overall auto person-trips decrease, and transit person-trips increase between the No-Build and the Modified LPA. Auto persons are converted to vehicles for assignment to account for the fact that some auto person-trips are passengers in a vehicle.

Year 2045 volumes were developed using the four-step Metro-RTC regional travel demand model, with adjustments reflecting differences between observed existing traffic counts and the traffic volumes simulated by the Metro-RTC regional travel demand model. Year 2045 forecast volumes were developed for the No-Build Alternative and the Modified LPA. The forecast volumes do not differ among the design options. The Transportation Technical Report has additional information on the methods used and the results predicted.

Table 26 shows aggregate year 2045 average weekday vehicle volumes for I-5, I-205, and total Columbia River crossings.

Table 26. 2045 Forecast Average Weekday Daily Traffic Volumes on I-5 and I-205

Location	Existing AWDT	2045 No-Build AWDT [a]	2045 Modified LPA AWDT [b]
Total River Crossing	313,000	400,000 (+28%)	389,000 (-3%)
I-5 Bridge	143,400	180,000 (+26%)	175,000 (-3%)
I-205 Bridge	169,600	220,000 (+30%)	214,000 (-3%)

Source: ODOT and WSDOT, Metro-RTC Regional Travel Demand Model, IBR Transportation Technical Report

a Percentages reflect change from existing conditions.

b Percentages reflect change from 2045 No-Build Alternative.

AWDT = average weekday daily traffic

Table 27, Table 28, and Table 29 show the district-to-district movement differences in vehicle volumes for total Columbia River crossings, I-5 and I-205. Green shading in Table 27, Table 28, and Table 29 indicate where there is an increase of more than 500 trips in the Modified LPA compared to the No-Build Alternative. Red shading indicates where there is a decrease of more than -500 trips in the Modified LPA compared to the No Build Alternative.

Only six district-to-district movements are shaded in Table 27, reflecting decreases in total river crossings for trips between Oregon and Washington. The two largest changes are decreases of trips between East Clark County (District 7) and Westside (District 10) for both directions of travel.

Between the No-Build and Modified LPA overall auto vehicle trips crossing the Columbia River on both bridges is reduced. Highlights of these changes include the following:

- The majority of these auto reductions (99%) are single-occupancy vehicles.
- There are reductions in vehicle trips crossing the Columbia River Bridges for nearly all district movements between Clark County districts and Oregon districts. District movements with increases are all less than 100 daily trips.
- District movements with the largest changes include:
  - Reductions in vehicle trips between the Westside (District 10) and East Vancouver (District 4) and East Clark County (District 7)
  - Reductions in vehicle Trips between East Clark County (District 7) and N/NE Portland (District 2) and the Westside (District 10)

For differences in trips using the I-5 bridge, shown in Table 28, there are no district movements with greater than 500 increase or -500 decrease. The largest change in district-to-district movements on the I-5 bridge is the Westside (District 10) to East Clark County (District 7) with a reduction of approximately 500 daily vehicles.

For differences in trips using the I-205 Glenn Jackson Bridge, shown in Table 29, there are five district-to-district movements with changes of more than 500 trips. All of these movements reflect decreases in daily river crossings for the Modified LPA as compared to the No Build Alternative and are the same locations that show overall total daily crossing differences in Table 27.

Table 27. Difference in Total River Crossing Vehicle Trips Between Modified LPA and No-Build Alternative

District	Portland Central City (1) Destinations	N/NE Portland (2) Destinations	Vancouver CBD & Surrounding Area (3) Destinations	East Vancouver (4) Destinations	Salmon Creek (5) Destinations	North Clark County (6) Destinations	East Clark County (7) Destinations	NE Portland/ Multnomah County (8) Destinations	E Multnomah/ Clackamas County (9) Destinations	Westside (10) Destinations	Total
Portland Central City (1) Origins	-	-	**(100)** [a]	**(300)** [a]	**(50)** [a]	**(50)** [a]	**(300)** [a]	-	-	-	(850)
N/NE Portland (2) Origins	-	-	**(250)** [a]	**(250)** [a]	**(100)** [a]	**(50)** [a]	**(900)** [a,b]	-	-	-	(1,500)
Vancouver CBD and Surrounding Area (3) Origins	**(100)** [a]	**(250)** [a]	-	-	-	-	-	**(300)** [a]	**(100)** [a]	**(150)** [a]	(900)
East Vancouver (4) Origins	**(250)** [a]	**(300)** [a]	-	-	-	-	-	**(50)** [a]	**50** [a]	**(750)** [a,b]	(1,300)
Salmon Creek (5) Origins	**(100)** [a]	**(100)** [a]	-	-	-	-	-	**(100)** [a]	**-** [a]	**(100)** [a]	(350)
North Clark County (6) Origins	**(50)** [a]	**(50)** [a]	-	-	-	-	-	**(50)** [a]	**-** [a]	**(150)** [a]	(300)
East Clark County (7) Origins	**(100)** [a]	**(850)** [a,b]	-	-	-	-	-	**100** [a]	**50** [a]	**(1,450)** [a,b]	(2,200)
NE Portland/ Mult Co (8) Origins	-	-	**(350)** [a]	**(100)** [a]	**(100)** [a]	**(50)** [a]	**100** [a]	-	-	-	(550)
E Mult Co/Clackamas Co (9) Origins	-	-	**(100)** [a]	**-** [a]	**-** [a]	**-** [a]	**50** [a]	-	-	-	(50)
Westside (10) Origins	-	-	**(100)** [a]	**(950)** [a,b]	**(100)** [a]	**(150)** [a]	**(1,650)** [a,b]	-	-	-	(3,000)
Total	(550)	(1,500)	(850)	(1,600)	(400)	(300)	(2,750)	(400)	-	(2,600)	(11,000)

a Bold text in this cell indicates cross-river movements.

b Red shading in this cell indicates decreases of more than -500 trips.

Table 28. Difference in Total River Crossing Vehicle Trips Between Modified LPA and No-Build Alternative on I-5

District	Portland Central City (1) Destinations	N/NE Portland (2) Destinations	Vancouver CBD & Surrounding Area (3) Destinations	East Vancouver (4) Destinations	Salmon Creek (5) Destinations	North Clark County (6) Destinations	East Clark County (7) Destinations	NE Portland/ Multnomah County (8) Destinations	E Multnomah/ Clackamas County (9) Destinations	Westside (10) Destinations	Total
Portland Central City (1) *Productions*	-	-	**(100)**[a]	**(150)**[a]	**(50)**[a]	**(50)**[a]	**(100)**[a]	-	-	-	(450)
N/NE Portland (2) *Productions*	-	-	**(250)**[a]	**(150)**[a]	**(100)**[a]	**(50)**[a]	**(300)**[a]	-	-	-	(800)
Vancouver CBD and Surrounding Area (3) *Productions*	**(100)**[a]	**(250)**[a]	-	-	-	-	-	**(100)**[a]	**-**[a]	**(100)**[a]	(550)
East Vancouver (4) *Productions*	**(150)**[a]	**(150)**[a]	-	-	-	-	-	**(50)**[a]	**-**[a]	**(300)**[a]	(650)
Salmon Creek (5) *Productions*	**(50)**[a]	**(100)**[a]	-	-	-	-	-	**(50)**[a]	**-**[a]	**(100)**[a]	(300)
North Clark County (6) *Productions*	**(50)**[a]	**(50)**[a]	-	-	-	-	-	**-**[a]	**-**[a]	**(50)**[a]	(150)
East Clark County (7) *Productions*	**(50)**[a]	**(300)**[a]	-	-	-	-	-	**-**[a]	**-**[a]	**(450)**[a]	(800)
NE Portland/Mult Co (8) *Productions*	-	-	**(100)**[a]	**(50)**[a]	**(50)**[a]	**-**[a]	**-**[a]	-	-	-	(200)
E Mult Co/Clackamas Co (9) *Productions*	-	-	**-**[a]	**-**[a]	**-**[a]	**-**[a]	**-**[a]	-	-	-	(50)
Westside (10) *Productions*	-	-	**(100)**[a]	**(350)**[a]	**(50)**[a]	**(50)**[a]	**(500)**[a]	-	-	-	(1,100)
Total	(400)	(800)	(550)	(700)	(250)	(150)	(900)	(200)	(50)	(1,000)	(5,000)

a Bold text in this cell indicates cross-river movements.

Table 29. Difference in Total River Crossing Vehicle Trips Between Modified LPA and No-Build Alternative on I-205 Glenn Jackson Bridge

District	Portland Central City (1) Destinations	N/NE Portland (2) Destinations	Vancouver CBD & Surrounding Area (3) Destinations	East Vancouver (4) Destinations	Salmon Creek (5) Destinations	North Clark County (6) Destinations	East Clark County (7) Destinations	NE Portland/ Multnomah County (8) Destinations	E Multnomah/ Clackamas County (9) Destinations	Westside (10) Destinations	Total
Portland Central City (1) Origins	-	-	-	**(150)** [a]	**-** [a]	**(50)** [a]	**(200)** [a]	-	-	-	(400)
N/NE Portland (2) Origins	-	-	-	**(100)** [a]	**-** [a]	**-** [a]	**(600)** [a,b]	-	-	-	(700)
Vancouver CBD and Surrounding Area (3) Origins	**-** [a]	**-** [a]	-	-	-	-	-	**(250)** [a]	**(50)** [a]	**(50)** [a]	(350)
East Vancouver (4) Origins	**(100)** [a]	**(100)** [a]	-	-	-	-	-	**-** [a]	**50** [a]	**(500)** [a]	(650)
Salmon Creek (5) Origins	**-** [a]	**-** [a]	-	-	-	-	-	**(50)** [a]	**-** [a]	**-** [a]	(100)
North Clark County (6) Origins	**-** [a]	**-** [a]	-	-	-	-	-	**(50)** [a]	**-** [a]	**(100)** [a]	(150)
East Clark County (7) Origins	**(50)** [a]	**(550)** [a,b]	-	-	-	-	-	**100** [a]	**50** [a]	**(1,000)** [a,b]	(1,400)
NE Portland/Mult Co (8) Origins	-	-	**(250)** [a]	**(50)** [a]	**(100)** [a]	**(50)** [a]	**100** [a]	-	-	-	(350)
E Mult Co/Clackamas Co (9) Origins	-	-	**(50)** [a]	**-** [a]	**-** [a]	**-** [a]	**50** [a]	-	-	-	(50)
Westside (10) Origins	-	-	**-** [a]	**(650)** [a,b]	**-** [a]	**(100)** [a]	**(1,150)** [a]	-	-	-	(1,900)
Total	(150)	(700)	(300)	(900)	(100)	(150)	(1,850)	(250)	50	(1,600)	(6,000)

a Bold text indicates cross-river movements.

b Red shading indicates decreases of more than -500 trips.