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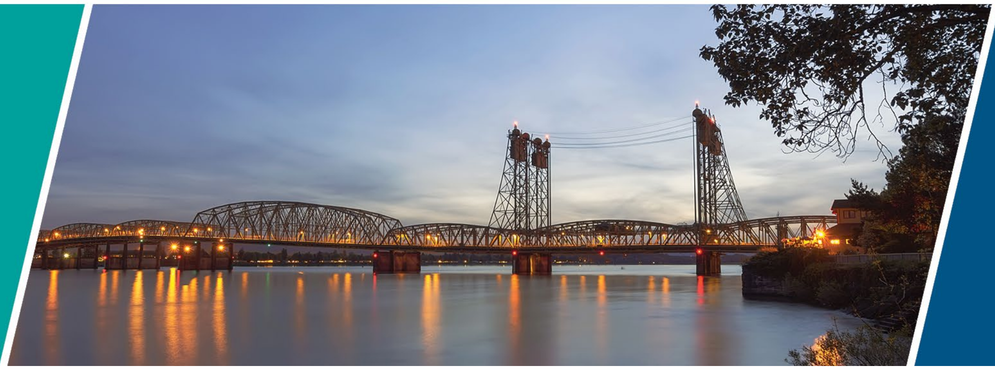

Air Quality Technical Report

September 2024

OREGON

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Air Quality Technical Report

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ACRONYMS AND ABBREVIATIONS

Acronyms/Abbreviations	Definition
AADT	annual average daily traffic
ADA	Americans with Disabilities Act
BRT	bus rapid transit
CAA	Clean Air Act
CO	carbon monoxide
CRC	Columbia River Crossing
CTR	Commute Trip Reduction
C-TRAN	Clark County Public Transit Benefit Area Authority
DEQ	Oregon Department of Environmental Quality
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FSCR	Flood Safe Columbia River
HEI	Health Effects Institute
I-5	Interstate 5
IBR	Interstate Bridge Replacement
IDOT	Illinois Department of Transportation
LPA	Locally Preferred Alternative
LRT	light-rail transit
LRV	light-rail vehicle
MAX	Metropolitan Area Express
MSAT	Mobile Source Air Toxics

Acronyms/Abbreviations	Definition
MTIP	Metropolitan Transportation Improvement Program
NAAQS	National Ambient Air Quality Standards
NAVD 88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation
ORS	Oregon Revised Statutes
OTC	Oregon Transportation Commission
PAH	polycyclic aromatic hydrocarbon
PM_{10}	particulate matter less than or equal to 2.5 microns in diameter
$PM_{2.5}$	particulate matter less than or equal to 2.5 microns in diameter
PMLS	Portland Metro Levee System
PNCD	Preliminary Navigation Clearance Determination
ROD	Record of Decision
RTP	Regional Transportation Plan
SEIS	Supplemental Environmental Impact Statement
SIP	State Implementation Plan
SOV	single-occupancy vehicle
SR	State Route
SWCAA	Southwest Clean Air Agency
TCM	transportation control measure
TOD	transit-oriented development

Acronyms/Abbreviations	Definition
TriMet	Tri-County Metropolitan Transportation District of Oregon
UFSWQD	Urban Flood Safety and Water Quality District
USACE	U.S. Army Corps of Engineers
USC	United States Code
USCG	U.S. Coast Guard
VMT	vehicle miles traveled
VOC	volatile organic compounds
WSDOT	Washington State Department of Transportation
WSTC	Washington State Transportation Commission

1. PROGRAM OVERVIEW

This technical report identifies, describes, and evaluates the existing air quality within the study area and the long-term and temporary effects on air quality from the Interstate Bridge Replacement (IBR) Program. This report also provides mitigation measures for potential effects on air quality when avoidance is not feasible.

The purpose of this 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 will be used to support the Draft Supplemental Environmental Impact Statement (SEIS) for the IBR Program pursuant to 42 USC 4332.

The objectives of this report are to:

- Define the study area and the methods of data collection and evaluation (Chapter 2).
- Describe the existing air quality conditions within the study area (Chapter 3).
- Discuss potential long-term, temporary, and indirect effects on air quality for two types of air pollutants (mobile source air toxics (MSAT) and criteria pollutants) resulting from construction and operation of the Modified Locally Preferred Alternative (LPA) compared to the No-Build Alternative (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).
- Identify federal, state, and local permits and approvals that would be required (Chapter 8).

The IBR Program is a continuation of the previously suspended Columbia River Crossing (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. 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.

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.

Figure 1-3. Modified LPA – Geographic Subareas

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 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 (C-D)[1] roadways, Figure 1-5 shows the location of the C-D 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.

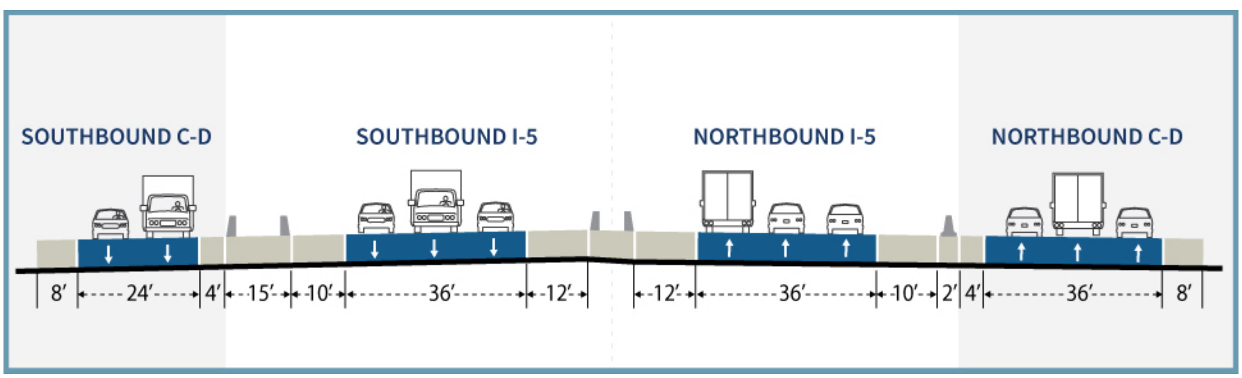
On I-5 northbound, the auxiliary lane that would begin at the on-ramp from Marine Drive would continue across the Columbia River bridge and end at the off-ramp to the C-D roadway, north of SR 14 (see Figure 1-5). The on-ramp from SR 14 westbound would join the off-ramp to the C-D roadway, forming the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

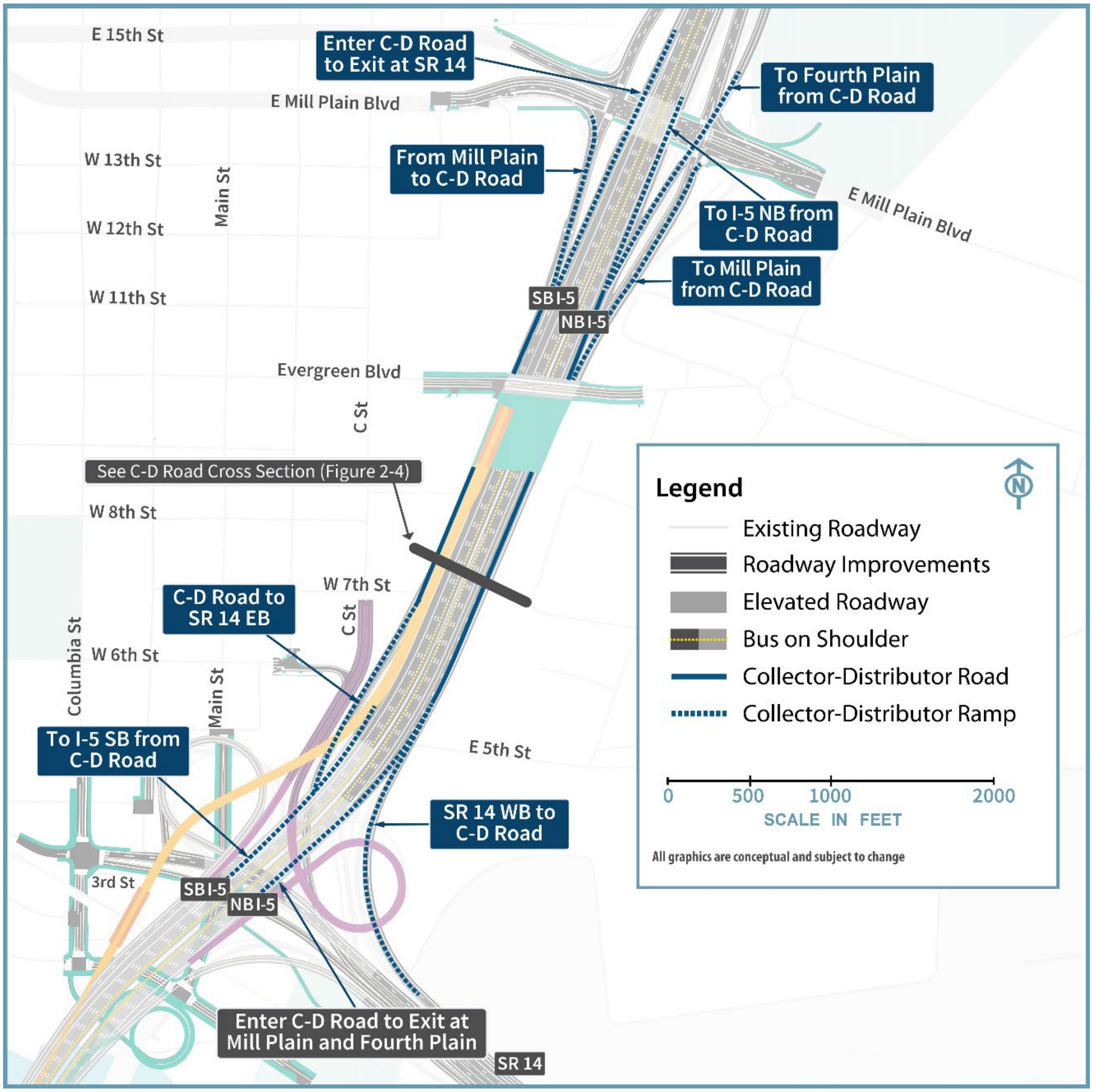
On I-5 southbound, an auxiliary lane would begin at the on-ramp from the C-D roadway and would continue across the southbound Columbia River bridge and end at the off-ramp to Marine Drive. The combined on-ramp from SR 14 westbound and C Street would merge into this auxiliary lane.

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



C-D = 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 C-D 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 C-D roadway, but the first auxiliary lane would continue. A second auxiliary lane would begin again at the southbound I-5 on-ramp from the C-D 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

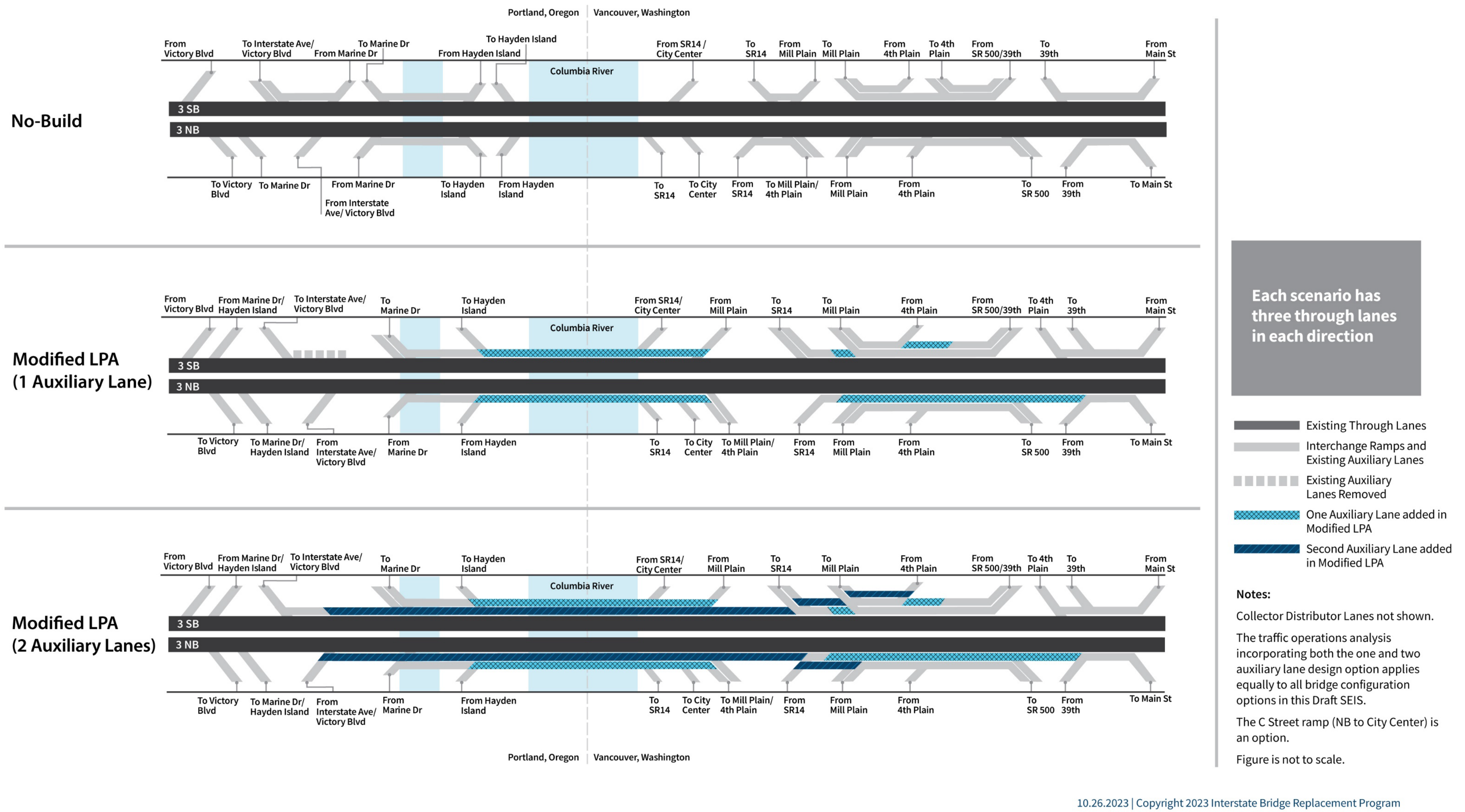
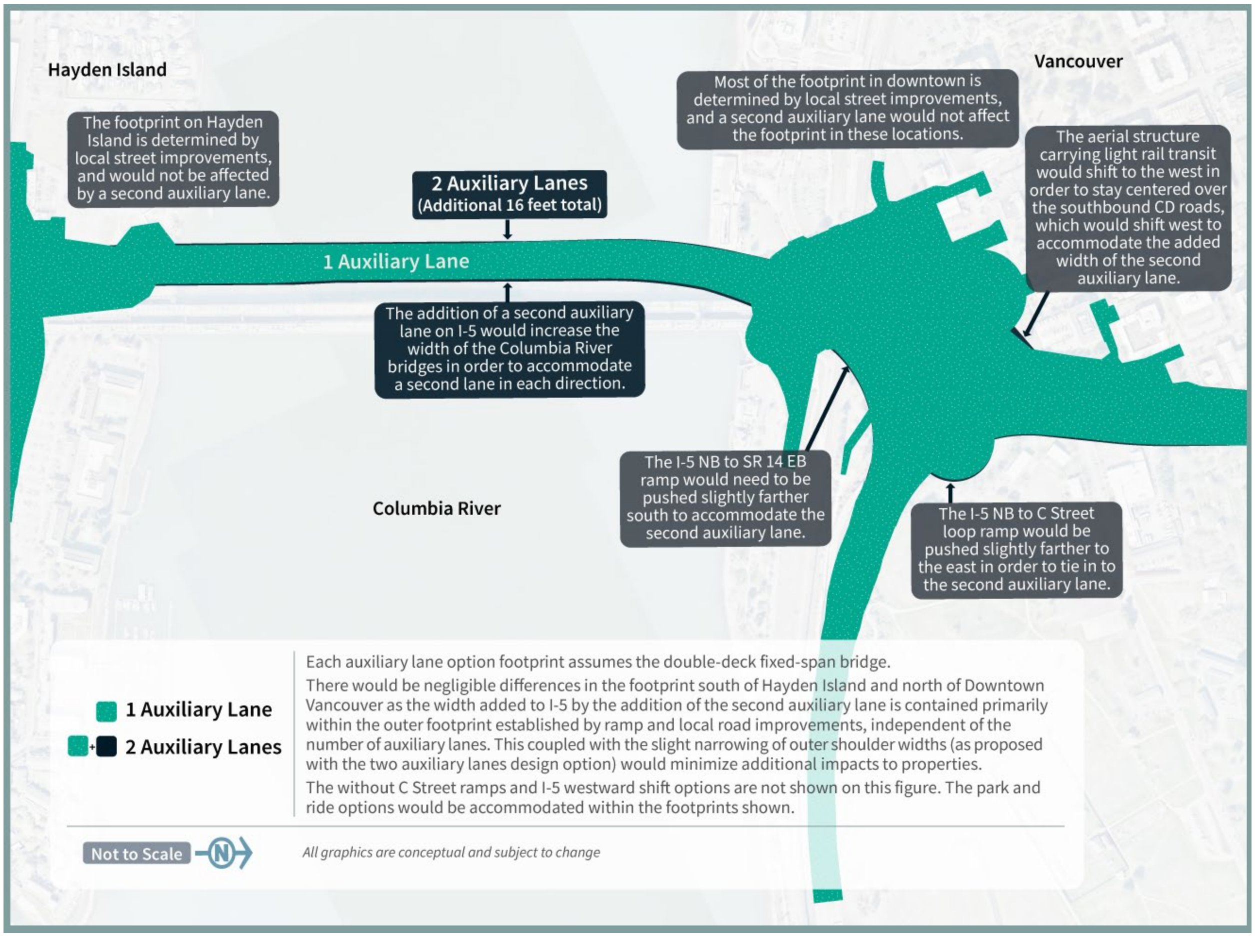


Figure 1-7. Auxiliary Lane Configuration Footprint Differences



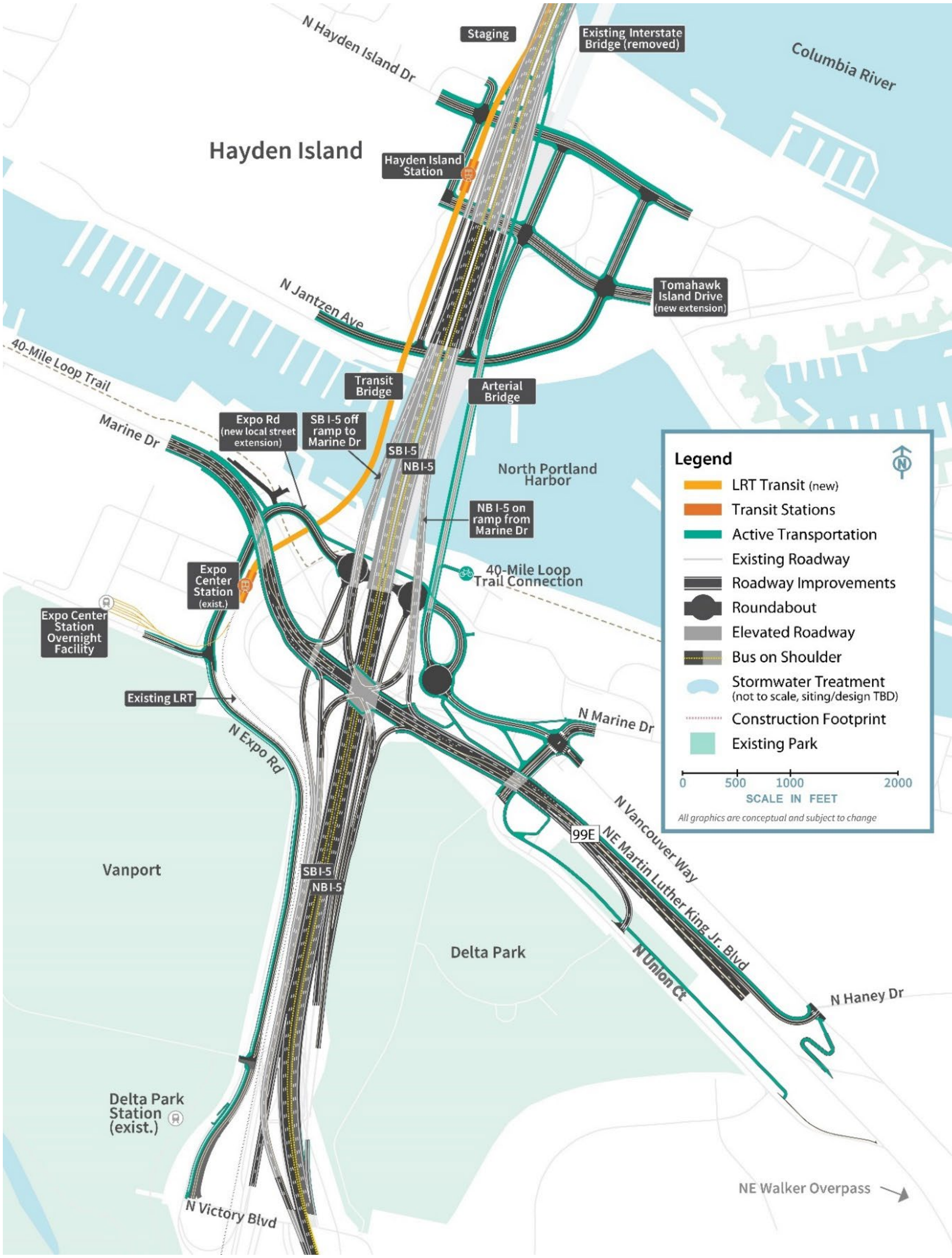
1.1.2 Portland Mainland and Hayden Island (Subarea A)

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 (UFSWQD)[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, UFSWQD is studying raising a low spot in the Cross Levee on the southwest side of the Marine Drive interchange.

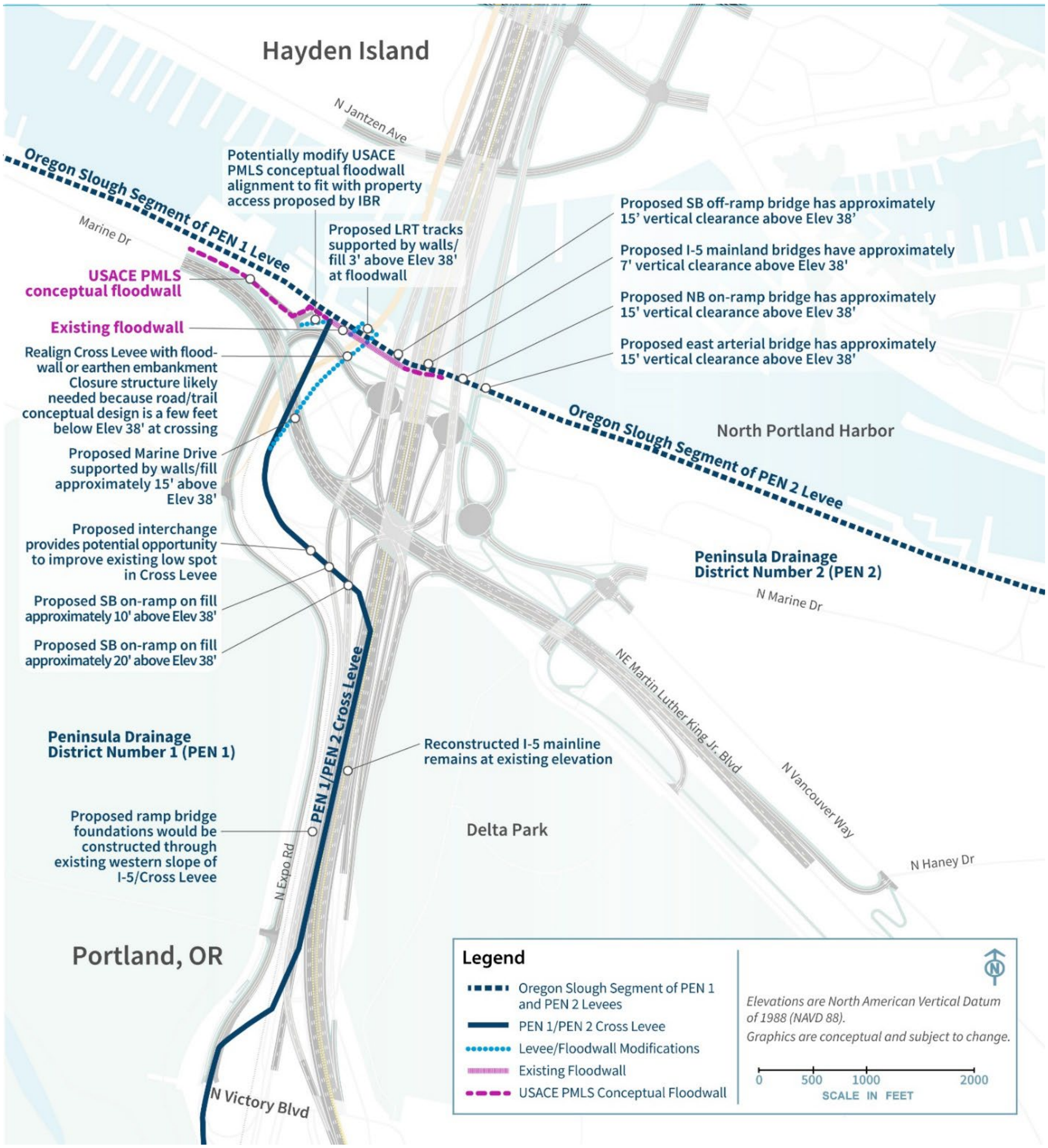
The IBR Program is in close coordination with these concurrent efforts to ensure that the IBR Program's design efforts consider the timing and scope of the PMLS and the FSCR proposed modifications. The intersection of the IBR Program proposed actions to both the existing levee configuration and the anticipated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

[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 UFSWQD.

[4] UFSWQD 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



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.

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

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

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 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.

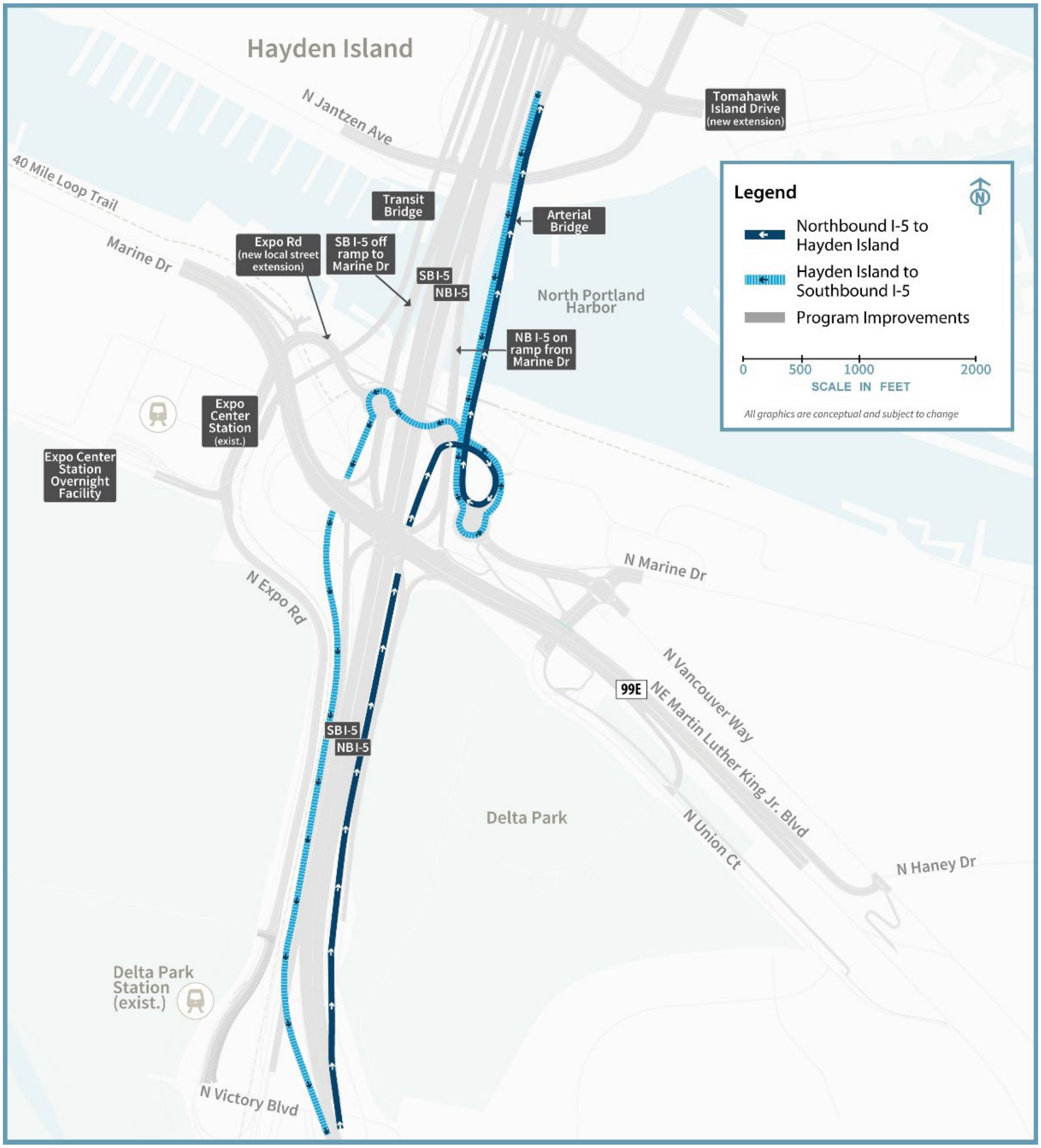
HAYDEN ISLAND INTERCHANGE AREA

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.

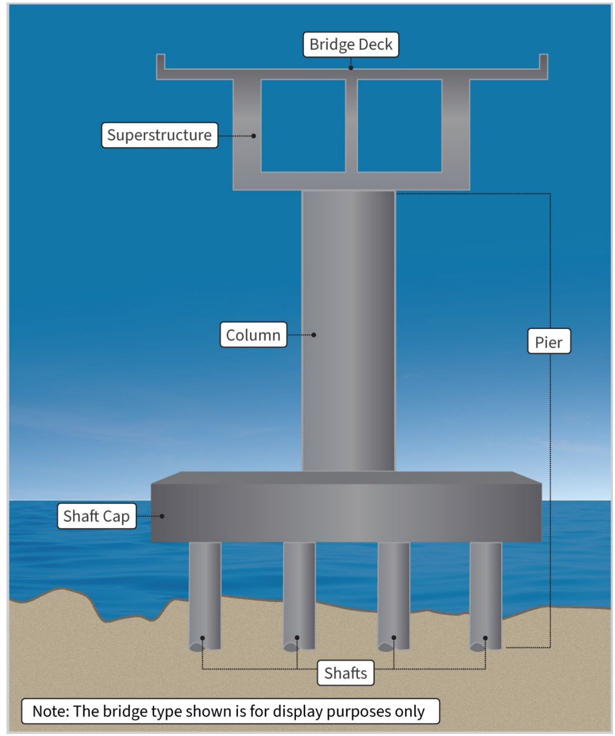
1.1.3.1 Highways, Interchanges, and Local Roadways

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

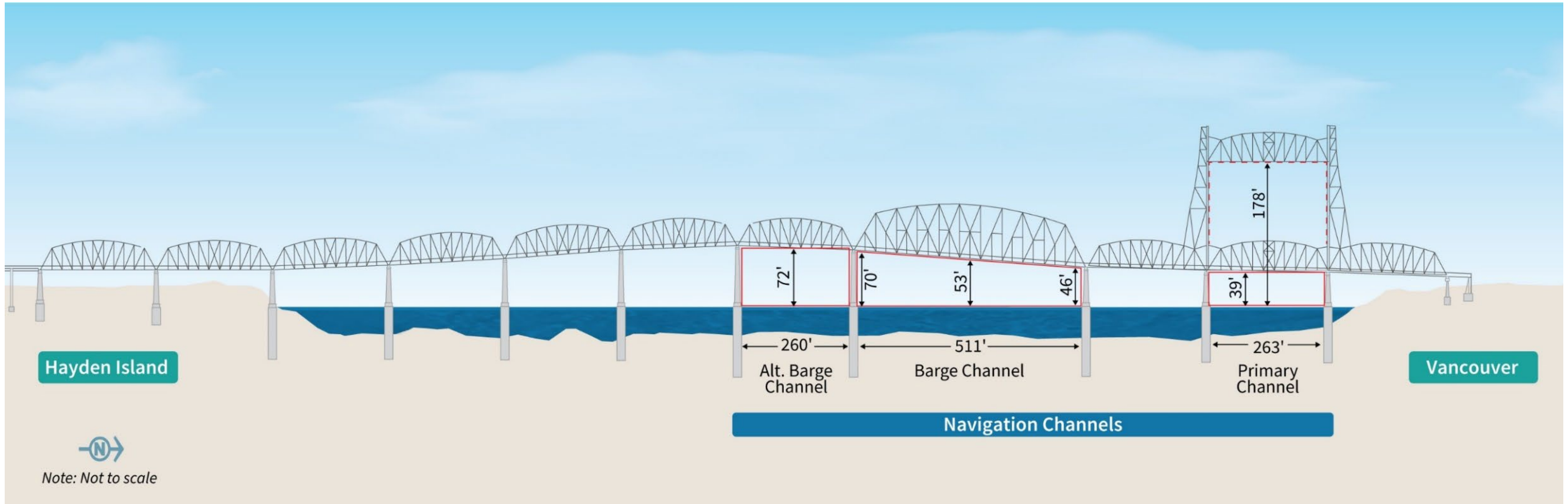
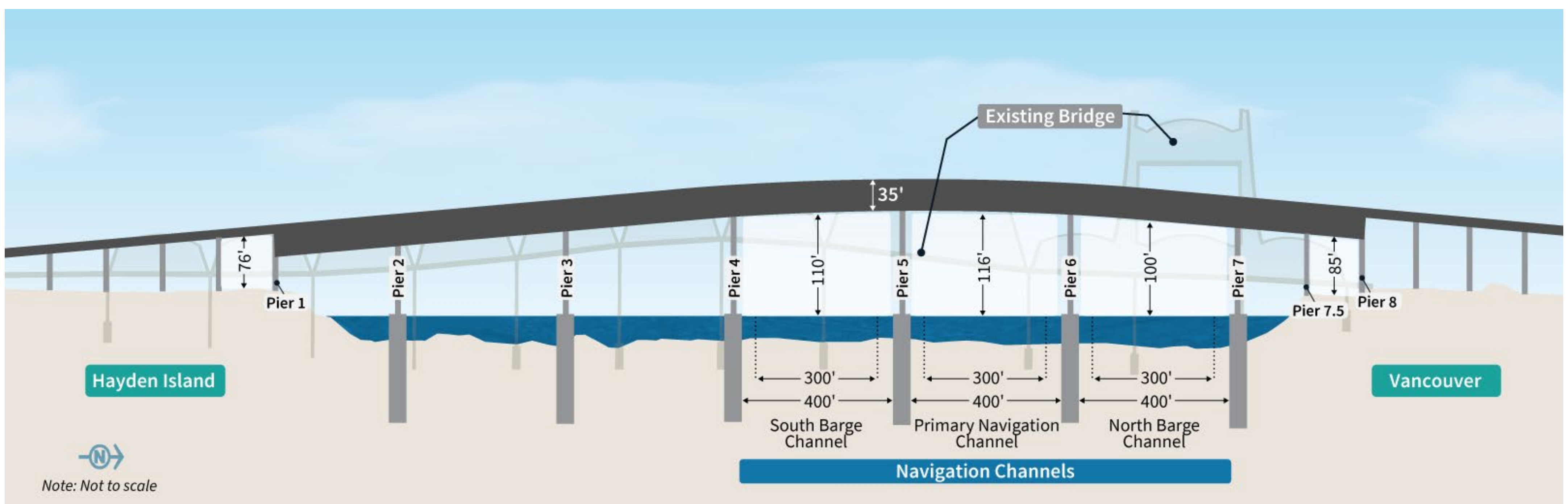


Figure 1-14. Profile and Navigation Clearances of the Proposed Modified LPA Columbia River Bridges with a Double-Deck Fixed-Span Configuration



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]

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.

[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.

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.

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.

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

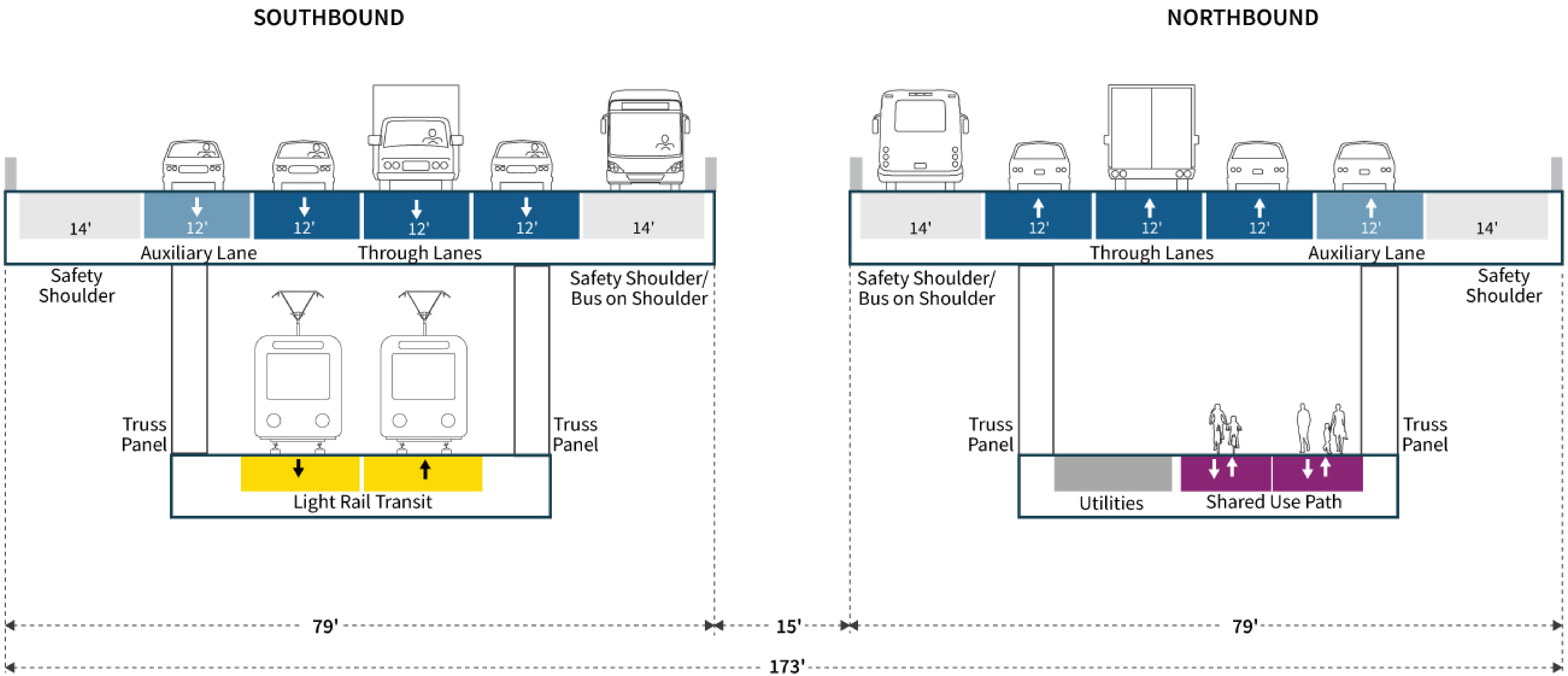
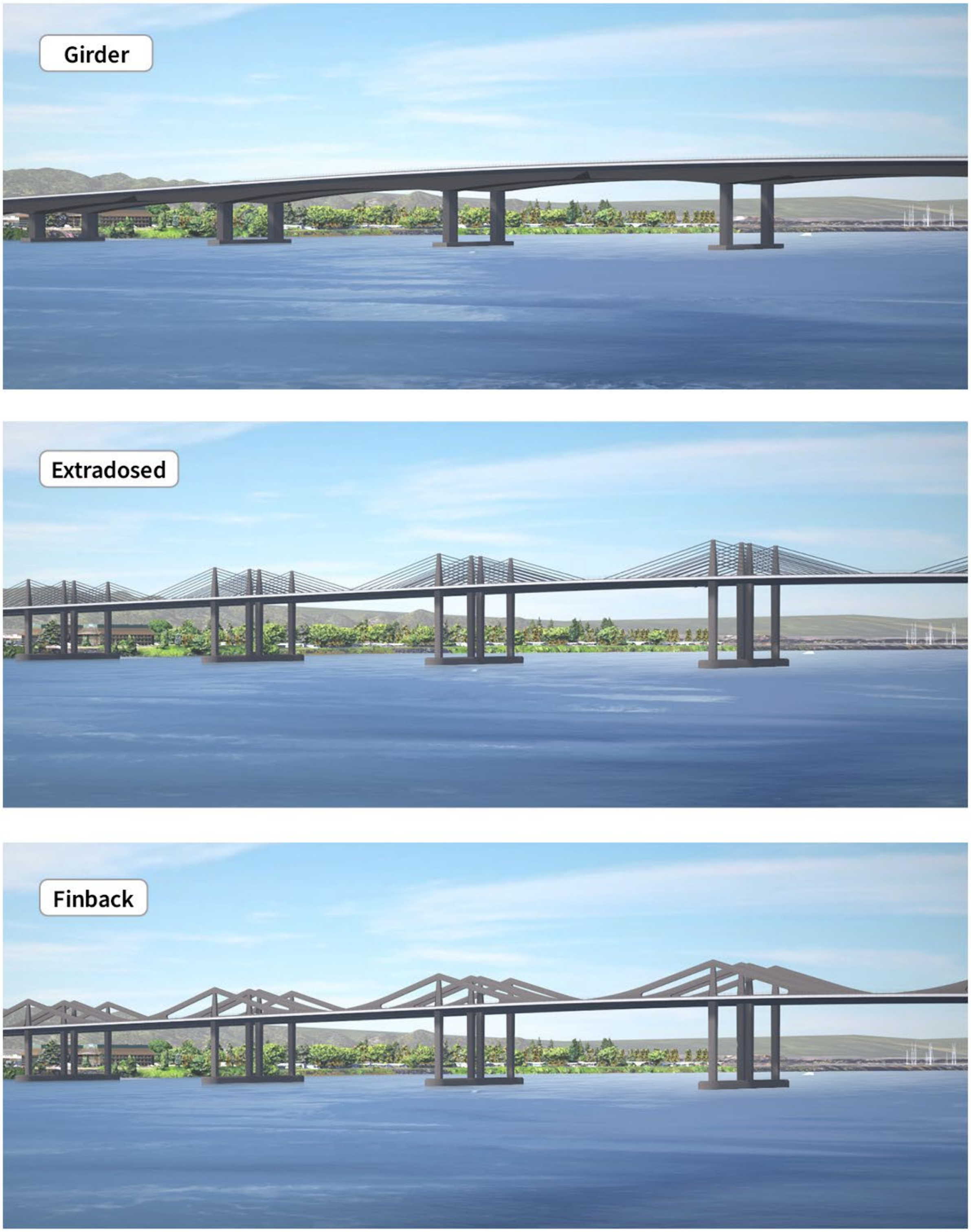
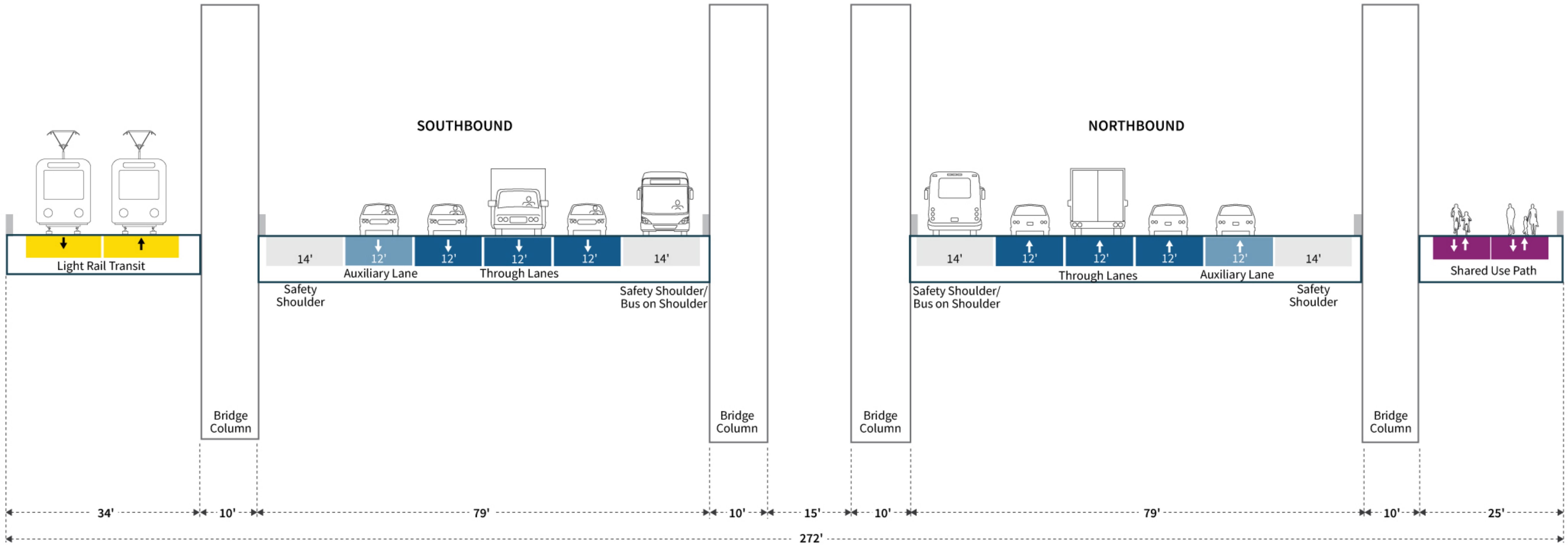


Figure 1-17. Conceptual Drawings of Single-Level Fixed-Span Bridge Types



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.

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 span 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.

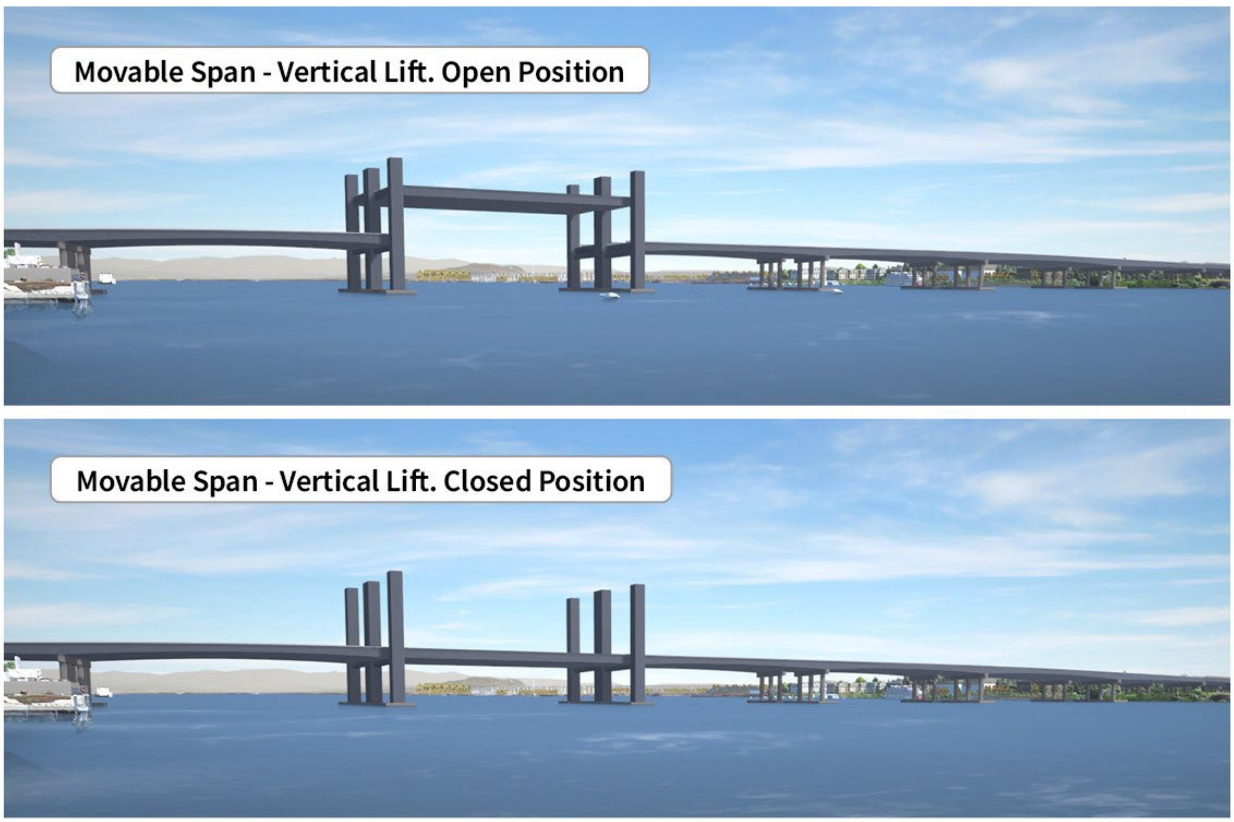
The vertical lift-span towers would be approximately 243 feet high; this is shorter than the existing lift-span towers, which are 247 feet high. This height of the vertical lift-span towers would not impede takeoffs and landings by aircraft using Portland International Airport. At Pearson Field, the 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.

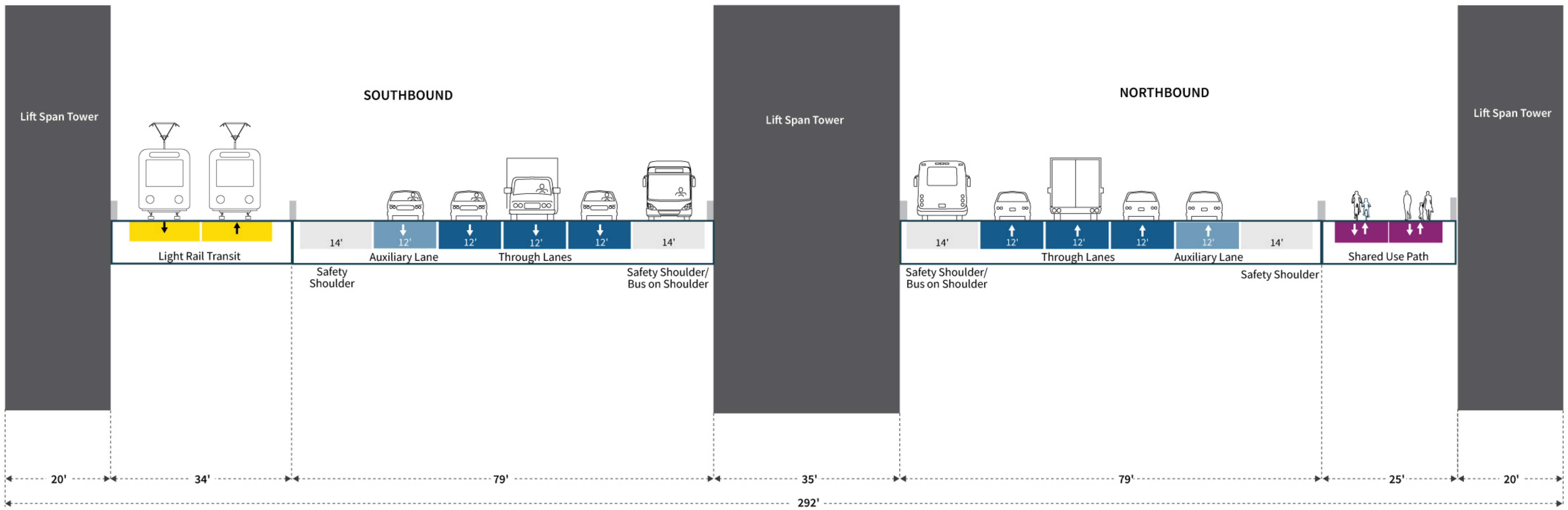
Figure 1-19. Conceptual Drawings of Single-Level Movable-Span Configurations in the Closed and Open Positions



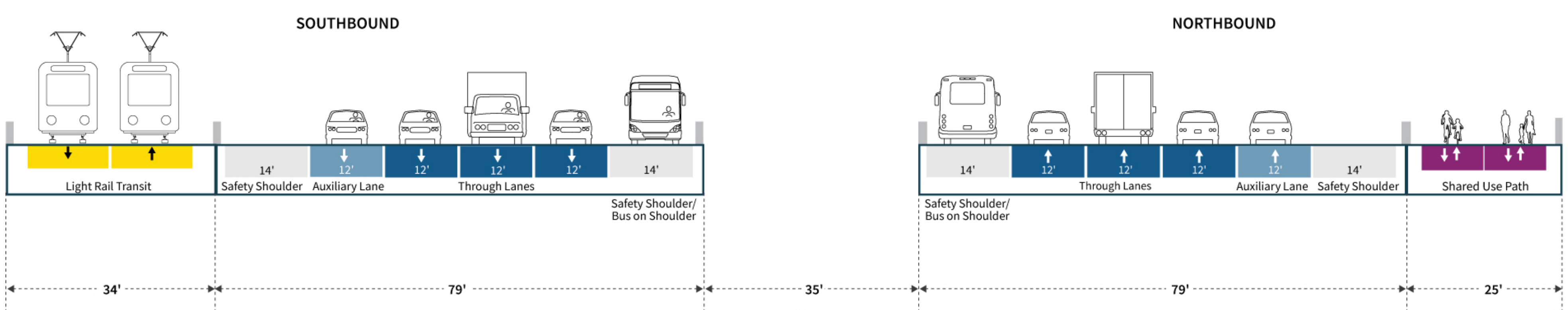
Note: Visualizations are for illustrative purposes only. They do not reflect property impacts or represent final design. Visualization is looking southeast (upstream) from Vancouver.

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

Single-level Bridge with Movable Span - Vertical Lift Span Cross-section (Piers 5 and 6)



Single-level Bridge with Movable Span - Fixed Spans Cross-section (Piers 2, 3, 4, and 7)



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

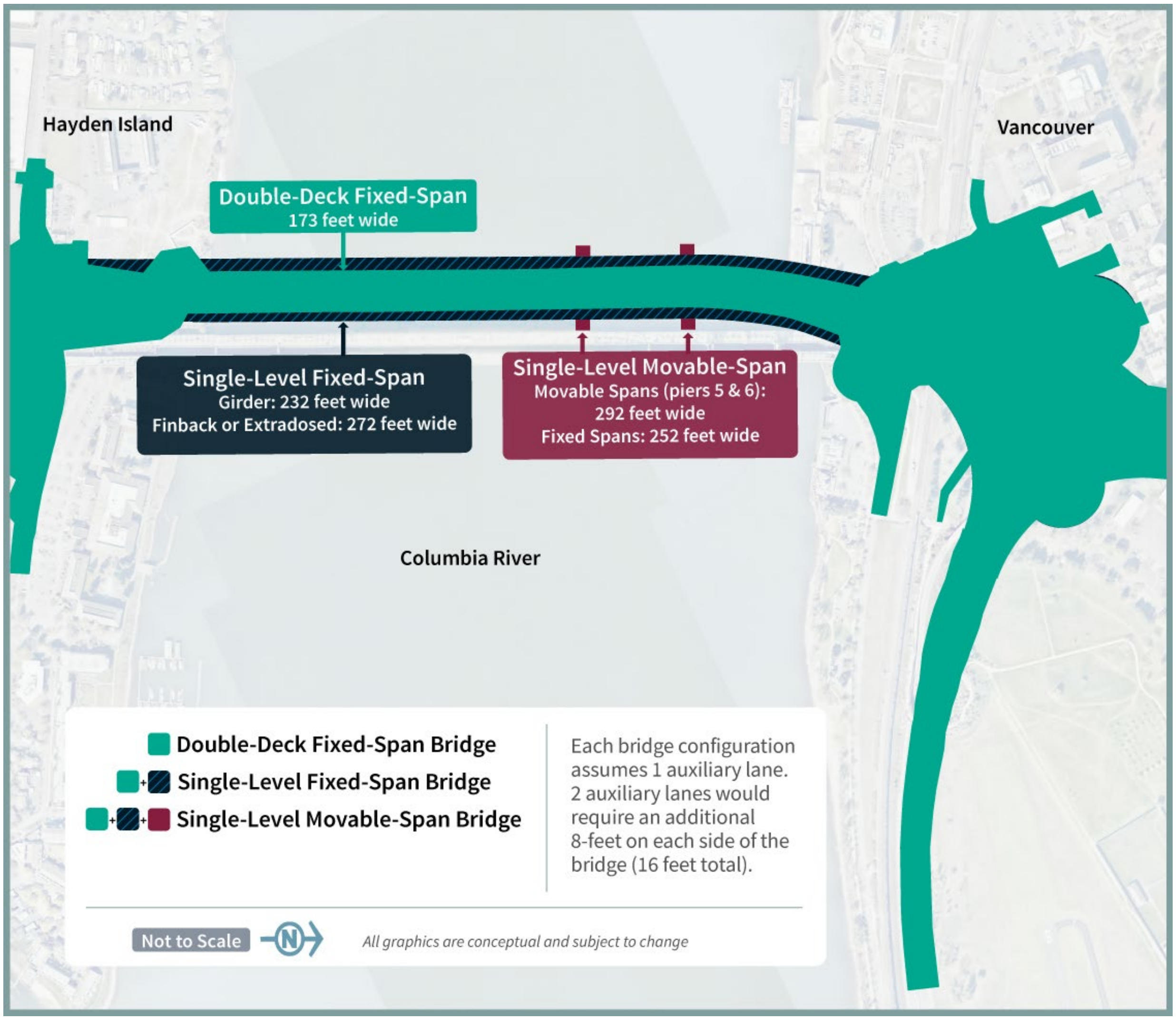
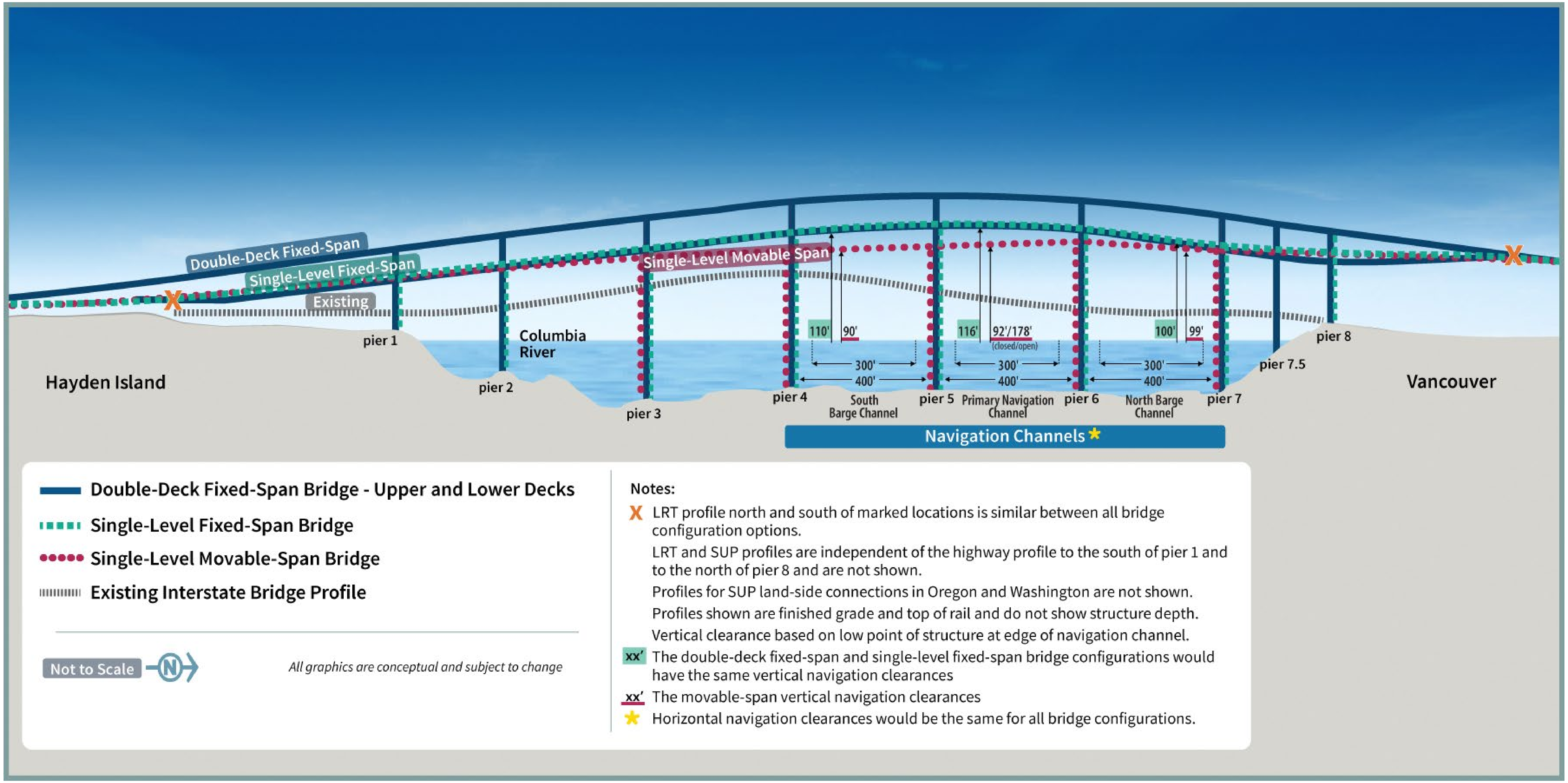


Figure 1-22. Bridge Configuration Profile Comparison



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.
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.

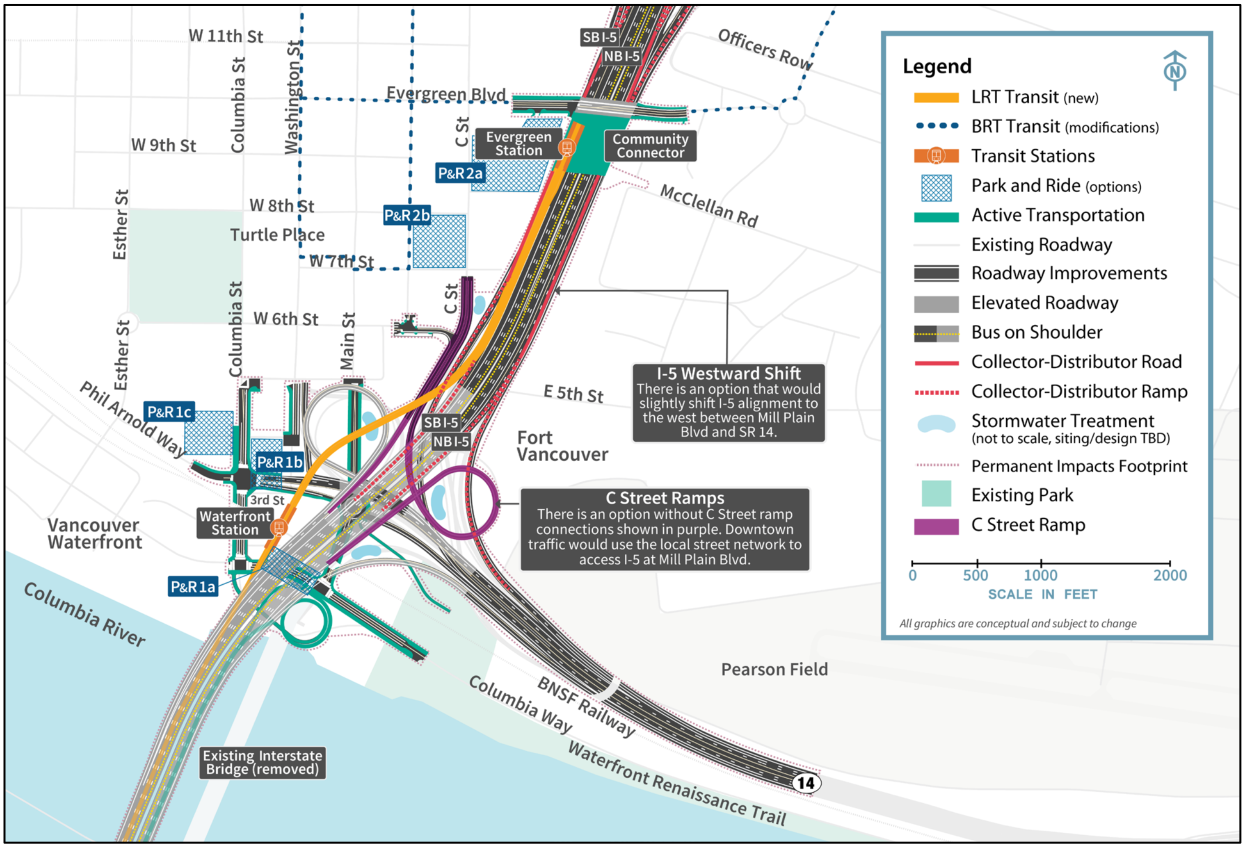
Main Street would be extended between 5th Street and Columbia Way. Vehicles traveling from downtown Vancouver to access SR 14 eastbound would use the new extension of Main Street to the roundabout underneath I-5. If coming from the west or south (waterfront) in downtown Vancouver, vehicles would use 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 C-D 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 C-D road that would continue north, crossing over Mill Plain Boulevard, to provide access to Fourth Plain Boulevard via a C-D 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

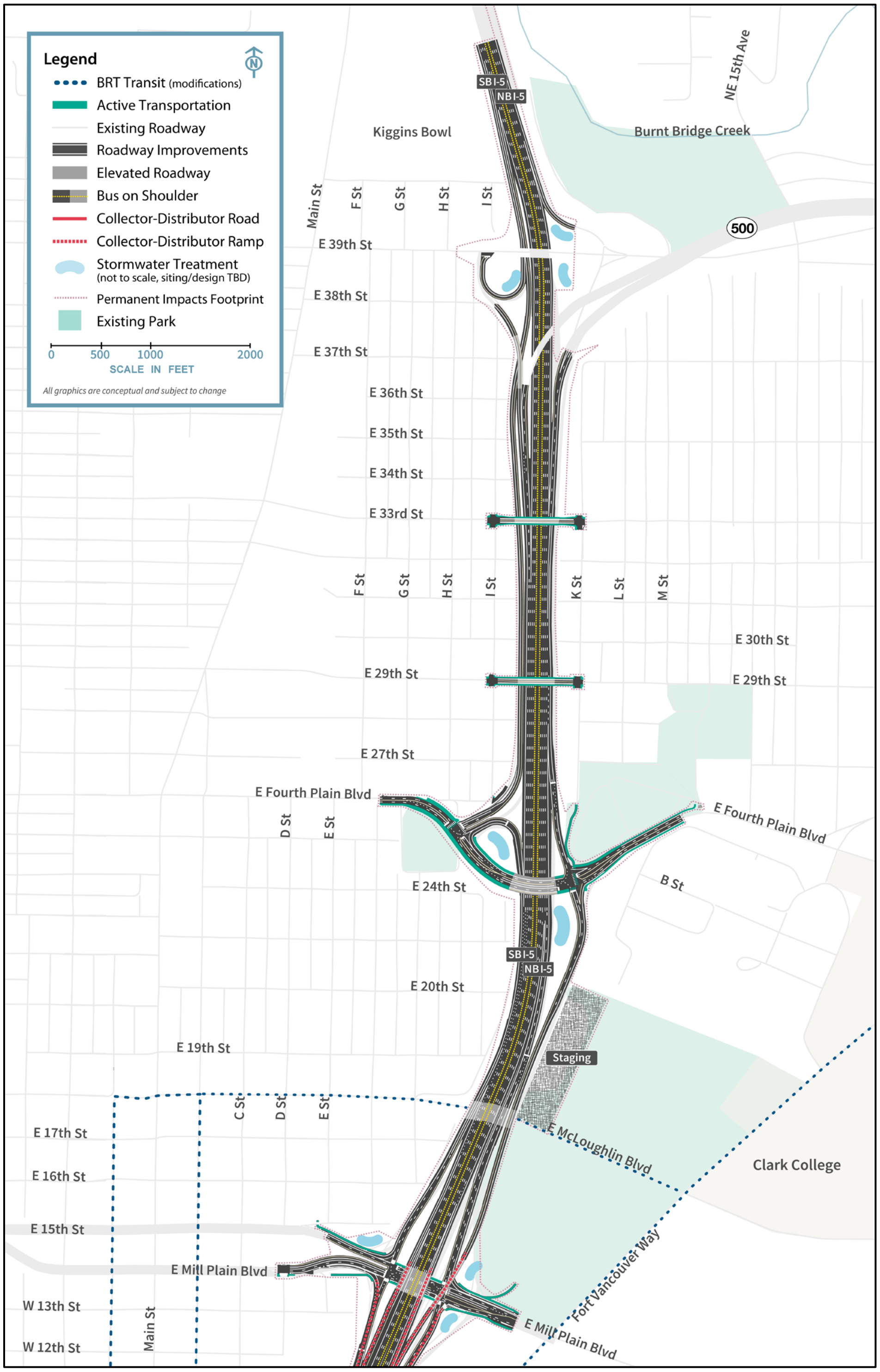
At the Fourth Plain Boulevard interchange (Figure 1-24), improvements would include reconstruction of the overpass of I-5 and the ramp terminal intersections. Northbound I-5 traffic exiting to Fourth Plain Boulevard would first exit to the northbound C-D roadway which provides off-ramp access to Fourth Plain Boulevard and Mill Plain Boulevard. The westbound SR 14 to northbound I-5 on-ramp also joins the northbound C-D 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

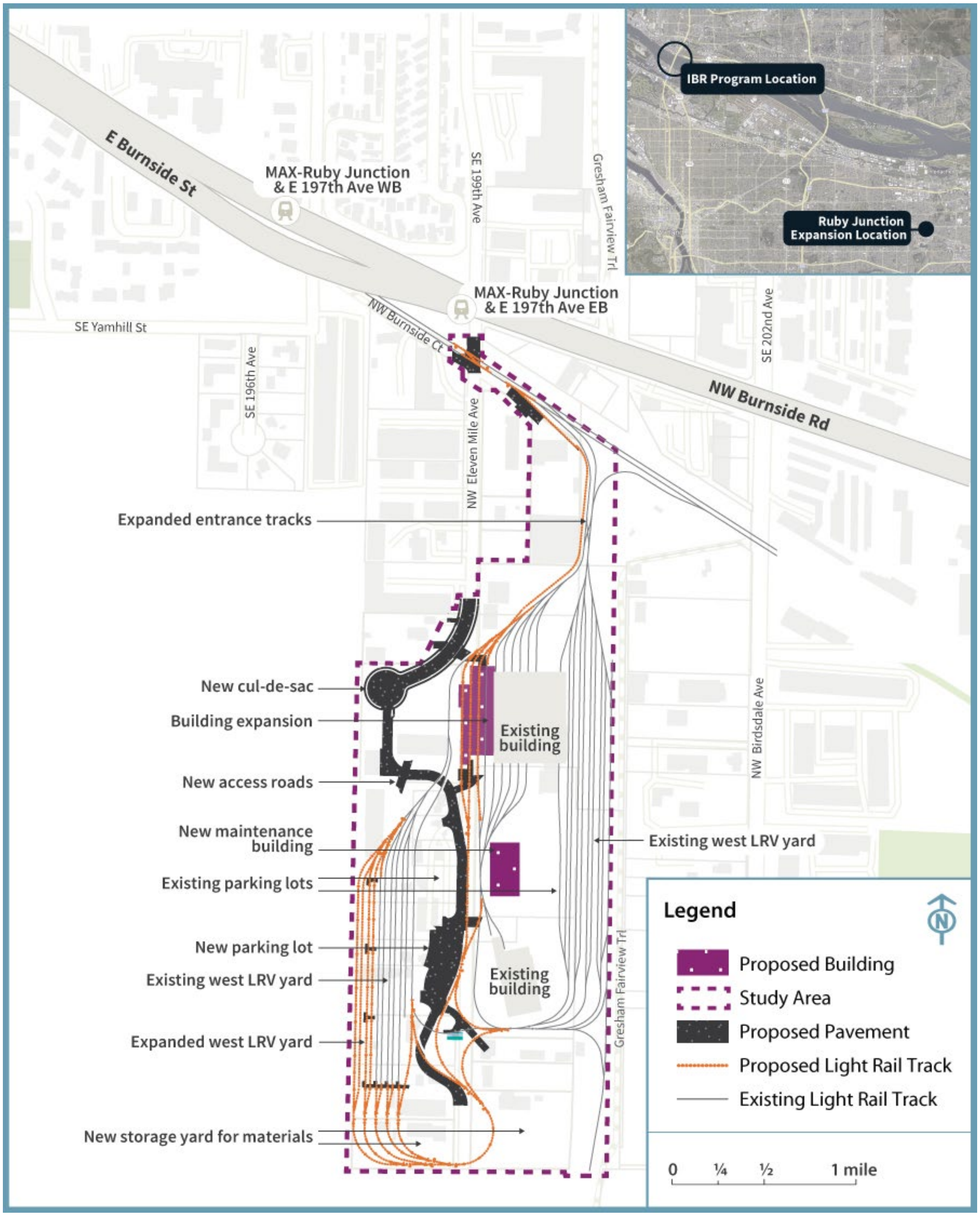
1.1.6.1 Ruby Junction Maintenance Facility Expansion

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.

Figure 1-25. Ruby Junction Maintenance Facility Study Area



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

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.

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. Mid-day 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 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.
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/counterclockwise 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.

Bus Route	Existing Route	Changes with Modified LPA
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 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-occupant vehicles.

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.

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.

Component	Estimated Duration	Notes
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. 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.

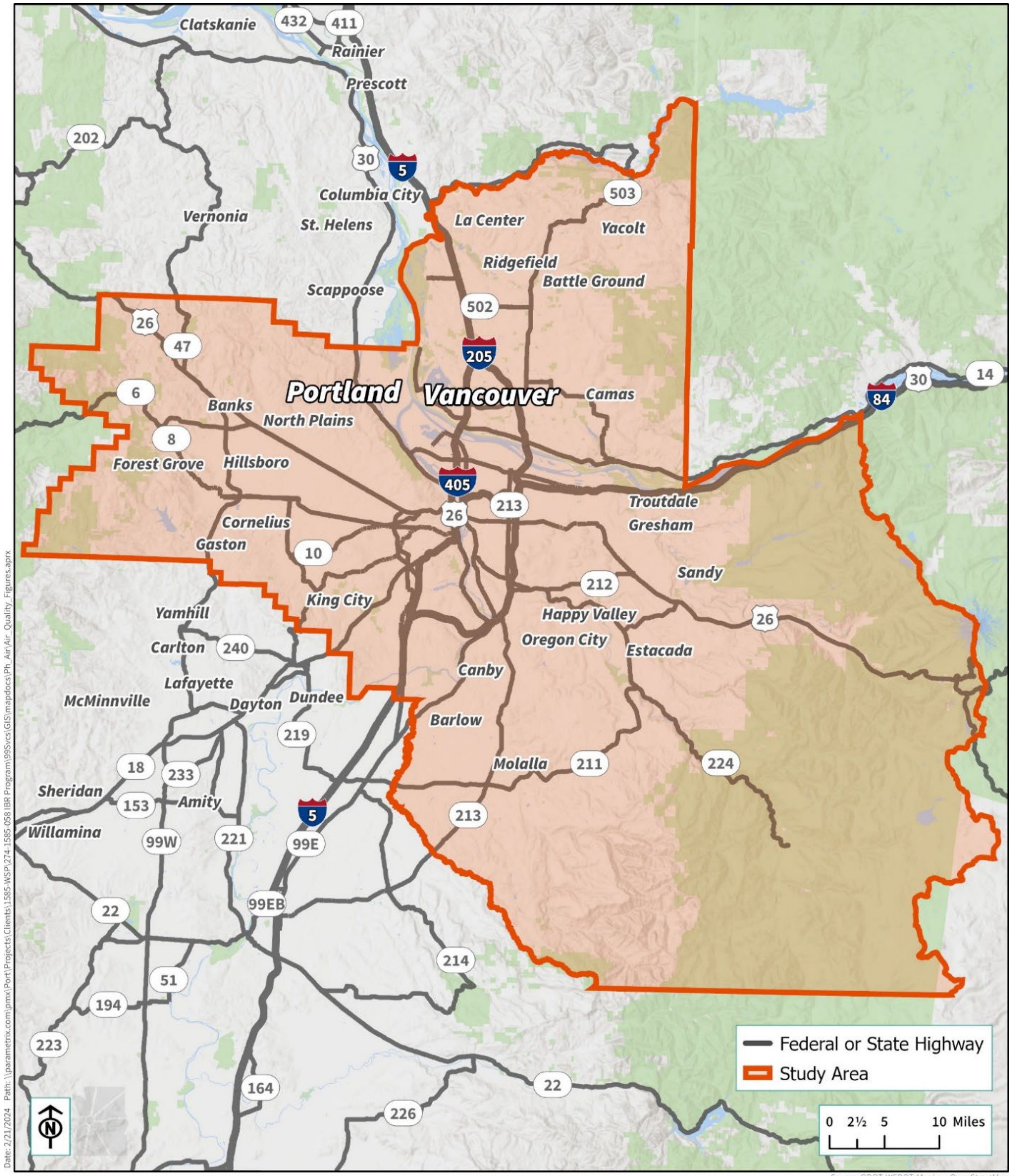
2. METHODS

This chapter describes the methods used to evaluate air quality impacts from the Modified LPA.

2.1 Study Area

The study area for air quality is shown in Figure 2-1. Air quality impacts are closely tied to traffic impacts. Air quality impacts from the IBR Program were evaluated based on the boundaries of Metro's regional travel-demand model that encompasses Multnomah, Clackamas, Washington, and Clark Counties. Air quality modeling analyses used a refined set of data meant to capture differences in emissions due to the Modified LPA, as described in more detail in Section 2.4.1.1.

Figure 2-1. Air Quality Study Area



2.2 Relevant Laws and Regulations

2.2.1 Criteria Air Pollutants

As required by the Clean Air Act (CAA), the National Ambient Air Quality Standards (NAAQS) have been established for six major air pollutants: carbon monoxide (CO), nitrogen dioxide, ozone, particulate matter (less than or equal to 2.5 microns in diameter [$PM_{2.5}$] and 10 microns in diameter [PM_{10}]), sulfur dioxide, and lead. Table 2-1 summarizes these standards. “Primary” standards have been established to protect public health; “secondary” standards are intended to protect the nation’s welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the general welfare. An air quality impact would occur if the NAAQS were violated.

Geographic areas where pollutant concentrations exceed the ambient air quality standards (i.e., do not attain the standards) are classified as “nonattainment” areas. Previously designated nonattainment areas that are now in compliance with air quality standards are classified as “attainment” areas with a maintenance plan (commonly referred to “maintenance areas”), because they have maintenance plans to prevent regressing air quality conditions. Areas that meet the standards (attain standards) are classified as attainment areas. Federal regulations require states to prepare State Implementation Plans (SIPs) that identify emission-reduction strategies for nonattainment and maintenance areas.

Table 2-1. National Ambient Air Quality Standards

Criteria Pollutant		Primary/ Secondary [a]	Averaging Time	Level	Form
Carbon monoxide (CO)		Primary	8-hour	9 ppm	Not to be exceeded more than once per year
			1-hour	35 ppm	
Lead (Pb)		Primary and secondary	Rolling 3-month average	0.15 µg/m³ [b]	Not to be exceeded
Nitrogen dioxide (NO_2)		Primary	1-hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Primary and secondary	Annual	53 ppb [c]	Annual mean
Ozone (O_3)		Primary and secondary	8-hour	0.070 ppm [d]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
Particulate matter	$PM_{2.5}$	Primary	Annual	12 µg/m³	Annual mean, averaged over 3 years
		Secondary	Annual	15 µg/m³	Annual mean, averaged over 3 years
		Primary and secondary	24-hour	35 µg/m³	98th percentile, averaged over 3 years
	PM_{10}	Primary and secondary	24-hour	150 µg/m³	Not to be exceeded more than once per year on average over 3 years
Sulfur dioxide (SO_2)		Primary	1-hour	75 ppb [e]	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
		Secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year

Source: EPA 2023

a "Primary" standards have been established to protect public health; "secondary" standards are intended to protect the nation's welfare and account for air pollutant effects on soil, water, visibility, materials, vegetation, and other aspects of the general welfare.

b Final rule signed October 15, 2008. The 1978 Pb standard (1.5 µg/m³ as a quarterly average) remains in effect until one year after an area is designated for the 2008 standard, except that in areas designated nonattainment for the 1978 year, the 1978 standard remains in effect until implementation plans to attain or maintain the 2008 standard are approved.

c The official level of the annual NO_2 standard is 0.053 ppm, equal to 53 ppb, which is shown here for the purpose of clearer comparison to the 1-hour standard.

d Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

e The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: a) any area for which it is not yet one year since the effective date of designation under the current (2010) standards, and b) any area for which implementation plans providing for attainment of the current (2010) standard have not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of a SIP call under the previous SO_2 standards (40 Code of Federal Regulations 50.4(3)). A SIP call is an EPA action requiring a state to resubmit all or part of its SIP to demonstrate attainment of the required National Ambient Air Quality Standard.

CO = carbon monoxide; EPA = U.S. Environmental Protection Agency; NO_2 = nitrogen dioxide; O_3 = ozone; Pb = lead; PM = particulate matter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PM_{10} = particulate matter less than or equal to 10 microns in diameter particulate matter; ppb = parts per billion; ppm = parts per million; SIP = State Implementation Plan; SO_2 = sulfur dioxide; µg/m³ = micrograms per cubic meter

During the 1970s, pollutant concentrations in the Portland and Vancouver metropolitan areas exceeded the NAAQS for CO on one out of every three days, and ozone levels were often as high as 50% over the federal standard. Programs and regulations to control air pollutant emissions have been effective, and air quality in the area has improved. The area was redesignated from a nonattainment area to a maintenance area for CO in 1997. In October 2017, the 20-year CO maintenance planning period ended in Portland. In the city of Vancouver, the CO maintenance period ended on October 21, 2016, and the ozone maintenance period ended on June 18, 2017.

The Portland metropolitan region received a nonattainment designation for the 1-hour ozone standard, but subsequently EPA revoked the 1-hour ozone standard in 2005. As a result, the Portland region has obligations to an ozone SIP, which includes transportation strategies to address ozone pollution.

The Oregon Department of Environmental Quality (DEQ) and the Southwest Clean Air Agency (SWCAA) cooperate on management of air quality in the Portland metropolitan area. Because the Portland metropolitan area is in attainment for all NAAQS, the region is not subject to the transportation conformity requirements of 40 Code of Federal Regulations Part 93 subpart A as was the case during evaluation of the CRC project. Compared to the CRC project's analysis, some documentation requirements are no longer needed and are not included in this report because transportation projects are no longer required to demonstrate NAAQS compliance. However, the terms of the maintenance plan remain in effect, and the DEQ and SWCAA must comply with all measures and requirements contained in the regional 2007 Carbon Monoxide Maintenance Plan until each state and the U.S. Environmental Protection Agency (EPA) revise them and approve the changes. These ongoing measures in Oregon's SIP are discussed in Section 3.2.4.

In 2005, the EPA revoked the 1-hour ozone standard. At that time, the region was designated as attainment with a maintenance plan. Although the region no longer has a requirement to demonstrate air quality conformity for ozone, the maintenance plan is still in place, including transportation strategies to which the region has committed.

2.2.2 Mobile Source Air Toxics

In addition to the criteria pollutants that the EPA regulates through the NAAQS, the EPA also regulates air toxics. Toxic air pollutants are pollutants known or suspected to cause cancer or other serious health effects. Most air toxics originate from humanmade sources, including on-road mobile sources, non-road mobile sources (e.g., airplanes), area sources (e.g., dry cleaners), and stationary sources (e.g., factories or refineries).

Controlling air toxic emissions became a national priority with the passage of the CAA Amendments of 1990, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in its latest rule—Control of Hazardous Air Pollutants from Mobile Sources (72 Federal Register 8427, February 26, 2007)—and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (EPA 2021). In addition, the EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers in their 2011 National Air Toxics Assessment (EPA 2011). These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. While the Federal Highway Administration (FHWA) considers these the priority MSAT, the list is subject to change and may be adjusted in consideration of future EPA rules. The Federal Transit Administration does not have additional requirements for MSAT emissions.

The 2007 EPA rule mentioned above requires controls that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines. Using the EPA's MOVES3 model, as shown in Figure 2-2, the FHWA estimates that even if vehicle miles traveled (VMT) increases by 31% from 2020 to 2060 as forecast, a combined reduction of 76% in the total annual emissions for the priority MSATs is projected for the same time period.

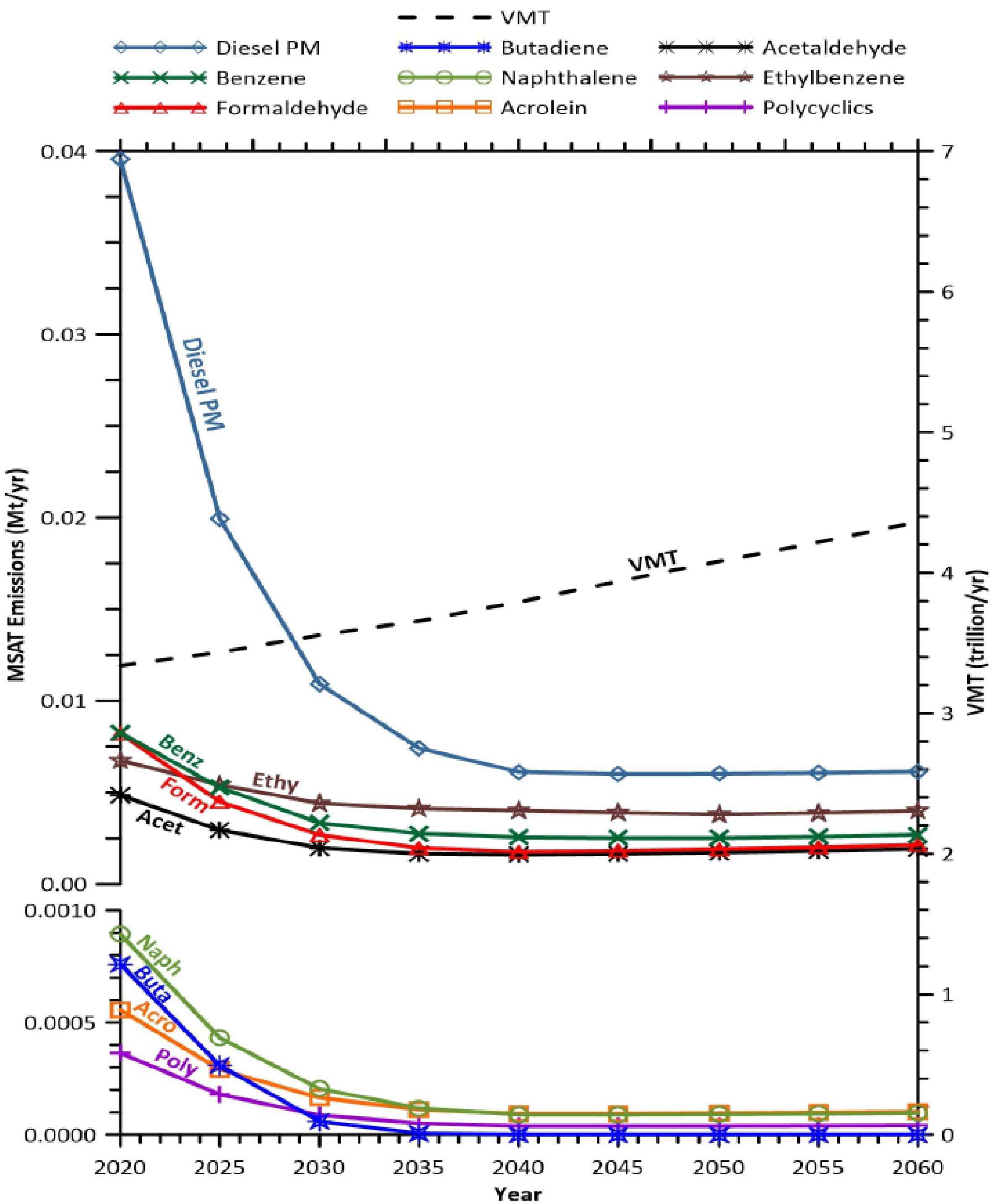
On February 3, 2006, the FHWA released Interim Guidance on Air Toxic Analysis in NEPA Documents. This guidance was superseded on January 18, 2023, by the FHWA's Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents (FHWA 2023a). The purpose of this guidance is to advise when and how to analyze MSATs in the NEPA environmental review process for highways. This guidance is considered interim because MSAT science is still evolving. As the science progresses, the FHWA will update the guidance.

A quantitative analysis provides a basis for identifying and comparing the potential differences among MSAT emissions, if any, from the various alternatives. The FHWA's Updated Interim Guidance groups projects into the following tiers:

- Tier 1 – No analysis for projects without potential for meaningful MSAT effects.
- Tier 2 – Qualitative analysis for projects with low potential MSAT effects.
- Tier 3 – Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.

Based on the FHWA's recommended tiering approach, the Modified LPA falls within the Tier 3 approach. In accordance with FHWA's guidance, estimated annual MSAT emissions were calculated for the Modified LPA and No-Build Alternative.

Figure 2-2. Projected National Mobile Source Air Toxics Emission Trends (2020 to 2060)



Note: Trends for specific locations may be different, depending on locally derived information representing vehicle-miles travelled, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors.

Source: EPA MOVES3 model runs conducted by FHWA, March 2021.

Source: FHWA 2023a

2.2.3 Additional Air Quality Regulations

In addition to NAAQS compliance and conformity requirements, the following air quality regulations directly or indirectly apply:

- The SWCAA requires permitting of non-road engines that remain at "any single site at a building, structure, or installation" for more than 12 consecutive months. This regulation could affect construction equipment in Washington and requires dispersion modeling of emissions. The regulation excludes mobile cranes and pile drivers.
- Asbestos regulations that the DEQ and SWCAA administer could affect demolition activities. The DEQ and SWCAA require notification of potential asbestos removal activities and the use of certified contractors.
- Although there is not a specific air quality regulation (except for compliance with the NAAQS) governing emissions of lead from demolition activities during construction, control of potential lead emissions is addressed in the construction contracts.
- Oregon House Bill 2007, known as the "Clean Diesel Bill," authorizes the Environmental Quality Commission of the DEQ to adopt rules for certification of approved retrofit technologies of diesel engines that power medium-duty and heavy-duty trucks. The legislation includes prohibitions on registering and titling older diesel engines in Clackamas, Multnomah, and Washington Counties after specified deadlines, unless the older diesel engines are equipped with retrofit technologies established by the Environmental Quality Commission or DEQ. This bill also includes policy for clean diesel in public contracts, requiring at least 80% of the total fleet vehicles and equipment to be powered by model year 2010 or newer engines and meet EPA Tier 4 exhaust emission standards.

The Oregon State Air Toxics Program establishes ambient benchmark concentrations for 52 air toxics of concern to Oregon. These benchmarks provide consistent health-based goals, as the DEQ develops strategies to reduce air toxics. Estimates of MSATs emitted by the vehicle network are included in this air quality analysis, but the resulting concentrations of MSATs or other air toxics are not calculated as part of this analysis. The FHWA prepared information to explain how current scientific techniques, tools, and data are not sufficient to accurately estimate human health impacts that could result from a transportation project in a way that would be useful to decision-makers. This FHWA language is included in Section 4.1.1 of this report.

2.3 Data Collection Methods

The air quality analysis used secondary data (traffic information) and assumptions about the local vehicle fleet and fuel specifications to estimate regional pollutant emissions. Pollutant emissions data were estimated using the EPA's MOVES model version MOVES3.1.0.[9] MOVES input files were acquired from DEQ and the Washington State Department of Ecology (Ecology) that are consistent with

[9] As of August 2023, MOVES 4 is now the EPA's regulatory emissions modeling system. The EPA has provided a two-year grace period, such that MOVES 3 is still an acceptable and appropriate model for regional emissions analyses.

regional emissions modeling used for transportation planning purposes. The IBR Program team developed input files using detailed traffic data from regional travel-demand modeling. Detailed model inputs and options are described in this air quality technical report. In addition, model run specification files and input and output databases will be available electronically.

2.4 Analysis Methods

An operational impacts analysis provides information to the public and decision-makers on emissions of pollutants as required by federal regulations and state guidelines. Additional analyses described in the following sections address concerns that the public expressed related to health impacts and equity. The pollutant emissions were estimated for analysis year 2015 to represent existing conditions, which corresponds to the base year of the regional travel-demand model that is the basis for the regional emissions analysis. Emissions for the Modified LPA and the No-Build Alternative were estimated for the 2045 analysis year. This comparison demonstrates the potential effects of the alternatives and describes how this information relates to potential health risks.

2.4.1 Mobile Source Air Toxics

As noted in Section 2.2.2, based on the FHWA's recommended tiering approach for MSAT, the Modified LPA falls within Tier 3, and a quantitative analysis was performed. The quantitative analysis is consistent with FHWA's *Frequently Asked Questions (FAQs): FHWA Recommendations for Conducting Quantitative MSAT Analysis for FHWA NEPA Documents* (referred to herein as FHWA FAQ) (FHWA 2023b).

2.4.1.1 MSAT Study Area

The MSAT study area is a subset of the area covered by the regional travel-demand model. Analyzing a metropolitan area's entire roadway network would result in emissions estimates for many roadway links that would not be affected, which would dilute the results of the analysis and not allow for a meaningful comparison between the Modified LPA and the No-Build Alternative. The FHWA recommends analyzing a subset of the regional data by including all segments associated with the Modified LPA plus those segments expecting meaningful changes (i.e., ± 10% or more) in MSAT emissions.

FHWA recommends defining the affected network using available program-specific information considering changes in the following metrics outlined in the FHWA FAQ (FHWA 2023b):

- ± 5% or more change in annual average daily traffic (AADT) on congested highway links.
- ± 10% or more in AADT on uncongested highway links of Level of Service C or better.
- ± 10% or more in travel time.
- ± 10% or more in intersection delay.

The study area was determined by comparing traffic volumes for all links in the regional model between the No-Build Alternative and the Modified LPA. Using the recommendations described above, highway links (congested and uncongested) with traffic volume differences of ± 5%, along with professional judgment and local knowledge of the IBR Transportation Team, were used to develop one roadway analysis network for a thorough review of the Modified LPA. Travel time and intersection delays were not used to develop the roadway analysis network. The traffic data used to develop the roadway analysis network included changes from traffic diverted onto other local routes to avoid tolling. Travel time and delay were not used to determine the MSAT analysis network because they were not estimated for the entire region included in the regional traffic data.

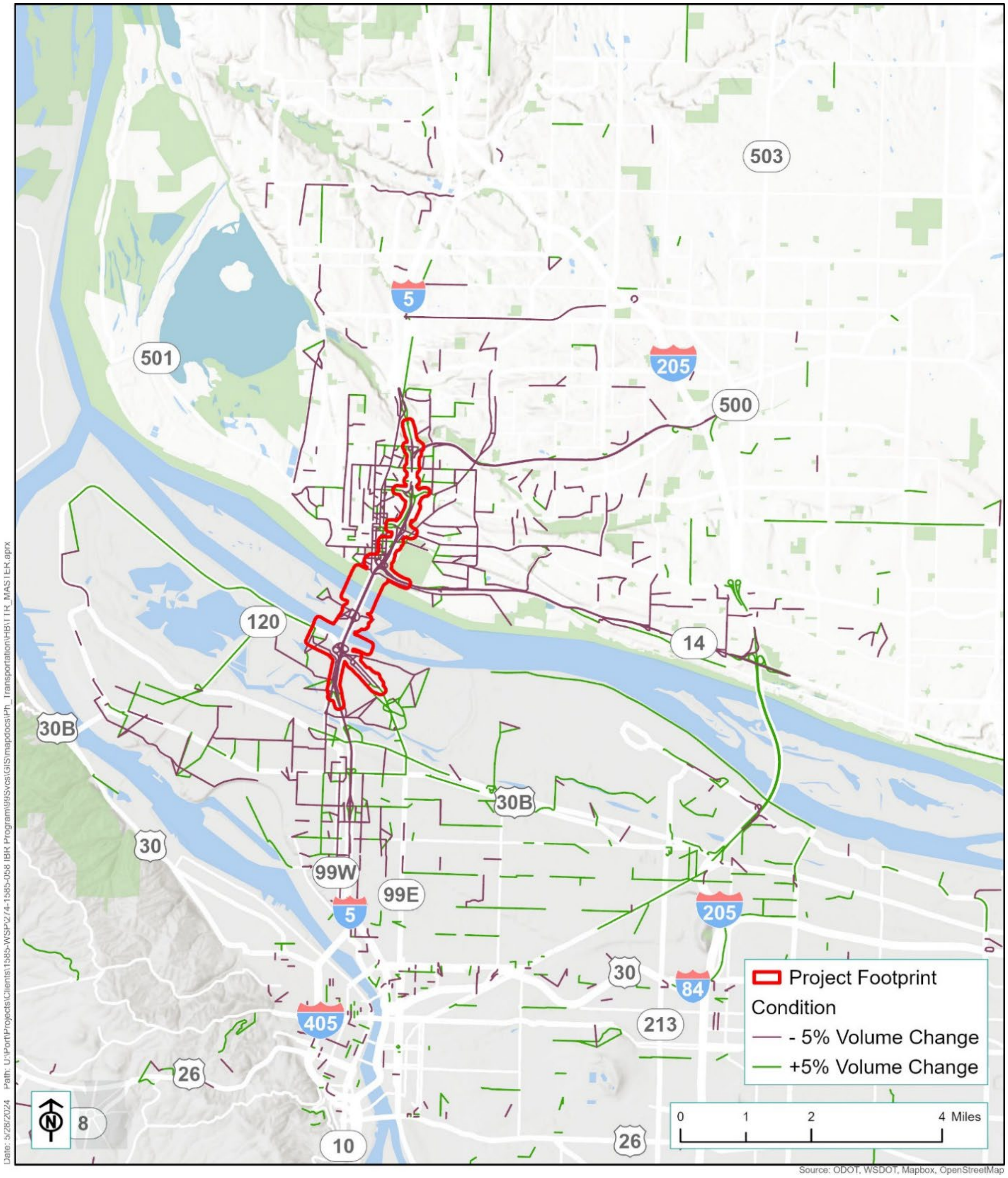
Figure 2-3 shows the MSAT study area, including the segments with a predicted change in AADT greater than 5% or less than negative 5% that were used to determine the affected network. All roadway links were considered, but only the highlighted links within the boundary were included in emissions calculations. Figure 2-3 provides a closer look at the MSAT study area to more clearly show individual roadway links adjacent to the study area that met or did not meet the criteria described above.

2.4.1.2 Model Inputs and Options

The EPA's MOVES model version MOVES3.1.0 was used to estimate emissions from the affected roadway analysis network. Quantities of pollutant emissions in tons per year were calculated for the roadways identified; concentrations of MSATs are not calculated as part of this analysis. MOVES input files were provided by DEQ and Ecology, consistent with their regional emissions analyses. Link-by-link traffic data were retrieved from regional travel-demand modeling and used to develop program-specific input files to demonstrate the effects of the No-Build Alternative and Modified LPA.

The link-by-link traffic data indicate the link length and facility type, and they include volume and speed data for an average weekday. The volume and speed data were provided by time period and vehicle type, as available from the regional travel-demand model. Section 2.4.3 presents specific modeling inputs, options, and data sources.

Figure 2-3. Mobile Source Air Toxics – Roadway Emissions Analysis Network



MOVES was used to estimate the total emissions from the MSAT network for the Modified LPA. The VMT within the MSAT study area and the emissions of each MSAT pollutant are provided in results tables in Section 4.1.1 for comparison. MSAT burdens were calculated for the following MSATs, as required by the FHWA:

- 1,3 Butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Diesel particulate matter
- Ethylbenzene
- Formaldehyde
- Naphthalene
- Polycyclic organic matter

Section 4.1.1 includes a discussion of ongoing MSAT research efforts, strategies to minimize emissions, and an explanation of the incomplete or unavailable information for a specific MSAT health impacts analysis.

2.4.2 Criteria Pollutants

Under the CAA Amendments of 1990, the U.S. Department of Transportation cannot fund, authorize, or approve federal actions to support programs or projects that are not first found to conform to the pertinent SIP. Highway projects in attainment areas are in conformity with the CAA and are not required to perform detailed microscale air quality modeling or regional air quality analysis.

In response to public concerns about the health impacts from criteria pollutants, a quantitative analysis of the criteria pollutant emissions at the regional scale was conducted. This analysis used the same methodology described for the MSAT analysis. Emissions are reported for the same roadway segments included in the MSAT study, because this was the FHWA's suggestion to provide a regional estimate that demonstrates potential changes in emissions between alternatives.

MOVES was used to estimate the total annual emissions from the study area. Emissions burdens were calculated for the following criteria pollutants and their precursors:

- CO
- Oxides of nitrogen
- Oxides of sulfur
- Volatile organic compounds (a precursor for ozone)
- Particulate matter (PM_{10} and $PM_{2.5}$)

The results were used for informational purposes to compare the emissions of the Modified LPA and the No-Build Alternative.

2.4.3 Emissions Modeling Inputs

EPA's MOVES model version MOVES3.1.0 was used to estimate MSAT emissions from the roadway links included in the MSAT study network. MOVES is the EPA's state-of-the-art tool for estimating emissions from highway vehicles. The model is based on analyses of millions of emission test results and considerable advances in the EPA's understanding of vehicle emissions. Compared to previous versions, MOVES3.1.0 incorporates the latest emissions data; applies more sophisticated calculation algorithms; accounts for new regulations, including the Heavy-Duty Greenhouse Gas Phase 2 rule and the Safer Affordable Fuel Efficient Vehicles Rule; and provides an improved user interface. Table 2-2 summarizes the MOVES run specifications as recommended in the FHWA FAQ (FHWA 2023b).

Table 2-2. MOVES Run Specification Options

MOVES Tab	Model Selections
Scale	• County Scale. • Inventory Calculation Type.
Time Span	• Hourly time aggregation including all months, days, and hours. • Analysis years 2015 and 2045.
Geographic Bounds	• Multnomah County was used to represent emissions from segments in Oregon, consistent with Metro's regional emissions model. [a] • Clark County was used to represent emissions from segments in Washington.
Vehicles/Equipment	• All on-road vehicle and fuel type combinations.
Road Type	• Rural restricted, rural unrestricted, urban restricted, and urban unrestricted.
Pollutants and Processes	• FHWA's nine priority MSAT pollutants (1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter) were selected, as well as precursor pollutants needed to make the calculations. • Diesel particulate matter was represented by Primary Exhaust PM_{10}. • Criteria pollutants: volatile organic compounds, carbon monoxide, oxides of nitrogen, primary exhaust $PM_{2.5}$-Total, Primary $PM_{2.5}$-Brakewear Particulate, Primary $PM_{2.5}$-Tirewear Particulate, Primary Exhaust PM_{10}-Total, Primary PM_{10}-Brakewear Particulate, Primary PM_{10}-Tirewear Particulate, sulfur dioxide, and all applicable precursor pollutants. • Processes included running exhaust, crankcase running exhaust, evaporative permeation, and evaporative fuel leaks.
Advanced Features	• MOVES Advanced Features option was used to create database for each state that identifies the year of adoption of California's Low Emission Vehicle program.

MOVES Tab	Model Selections
Output	• Output was in an annual inventory of pollutant emissions by roadway type and vehicle type.

a Although the study area spans multiple counties in Oregon, Multnomah County was used to represent all Oregon emissions in the metropolitan Portland area, which is consistent with Metro's approach to regional emissions modeling.

FHWA = Federal Highway Administration; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PM_{10} = particulate matter less than or equal to 2.5 microns in diameter

MOVES input files were developed using data provided by DEQ and Ecology, output from the traffic analysis, and EPA defaults. MOVES model runs combined data representing regional conditions and project-specific data characterizing the differences in traffic volumes and speeds. For the Modified LPA and the No-Build Alternative, two MOVES runs were created to determine the emissions on Oregon roadway segments using Oregon regional conditions and the emissions on Washington roadway segments using Washington regional conditions. Table 2-3 summarizes specific inputs and their sources.

Table 2-3. MOVES County Data Manager Inputs

County Data Manager Tab	Data Source – Oregon	Data Source – Washington
Source Type Population	DEQ	Ecology
Age Distribution	DEQ and MOVES county defaults	Ecology and MOVES county defaults
Fuel	DEQ	Ecology
Inspection/Maintenance Programs	DEQ	Ecology
Meteorological Data	MOVES county defaults	MOVES county defaults
Road Type Distribution	Created from project data for segments located in Oregon	Created from project data for segments located in Washington
Average Speed Distribution	Created from project data for segments located in Oregon	Created from project data for segments located in Washington
Vehicle Type VMT	Created from project data for segments located in Oregon	Created from project data for segments located in Washington

DEQ = Oregon Department of Environmental Quality; Ecology = Washington State Department of Ecology; VMT = vehicle miles traveled

The following agency-supplied input files were modified for the analysis:

- Source Type Population: DEQ provided the population of registered vehicles in the metropolitan area for analysis year 2020. Ecology provided the population of registered vehicles in Clark County for 2017. The same population data were used for each analysis year because MOVES does not use these values to calculate running emissions, but a value must be entered for the model to run.
- Age Distribution: DEQ provided the age distribution of all vehicle types in the metropolitan area for analysis year 2020, and Ecology provided the same data for Clark County for the year 2017. These distributions were used to represent existing and future conditions.

- Fuel: MOVES defaults for Multnomah County were used for fuel supply, fuel usage fraction, and fuel type and technology allocations. Default fuel formulation data was adjusted as recommended by DEQ to reflect the local biodiesel formulation details. These data were used for Oregon and Washington, which is consistent with Ecology's regional modeling methodology that assigns Multnomah County fuel defaults to Clark County. The EPA does not provide MOVES defaults for electric vehicle use and conservatively assumes that no electric vehicles are in the fleet. As recommended by the Oregon Department of Transportation (ODOT) and Washington State Department of Transportation (WSDOT) to provide a conservative air pollutant emissions estimate, no electric vehicles were considered in this emissions analysis.
- Inspection/Maintenance Programs: DEQ prepared MOVES input files characterizing required vehicle inspection/maintenance programs in the metropolitan area for analysis year 2019. These files were modified for the program analysis years 2015 and 2045 by adjusting the ending model years as recommended by the EPA to assume the programs would remain in place with consistent grace periods and exemptions based on vehicle age. No inspection/maintenance program was used for Washington emissions because the state does not have an inspection/maintenance program.
- Meteorological Data: MOVES defaults for Multnomah County and Clark County were used for the temperature and humidity profiles.

Link-by-link traffic data developed as part of the traffic analysis were used to create input files to demonstrate the effects of the No-Build Alternative and Modified LPA:

- Existing (2015)
- No-Build Alternative (2045)
- Modified LPA (2045)

The link-by-link traffic data indicated the link length and roadway type and included volume and average modeled speed data for every hour of an average weekday. These average weekday values were applied to all days throughout the analysis year. Volumes were provided by vehicle type and accounted for expected changes to the vehicle mix with or without the Modified LPA. The data were processed for use in MOVES using the following assumptions:

- Road Type Distribution – The roadway types and locations were mapped to the four MOVES roadway types: rural restricted, rural unrestricted, urban restricted, and urban unrestricted. The off-network road type was not used for this analysis.
- Average Speed Distribution – The link-level traffic data was provided for each hour of an average weekday. Speeds were mapped to respective MOVES 5-mile-per-hour speed bins. In the absence of weekend speed estimates, the average weekday speed profile was applied to all days in the analysis year.
- Vehicle Type VMT – VMT from each hour was added to develop a daily VMT value for the No-Build Alternative and Modified LPA. Three vehicle types provided the link-level volume data: passenger vehicle, medium truck, and heavy truck. The VMT from these three types were

allocated to the 13 MOVES source types using MOVES county defaults to determine the distribution of each vehicle type. For example, the Oregon passenger vehicle VMT was divided among the appropriate MOVES source types (i.e., motorcycles, passenger cars, passenger trucks) using the percentages in the MOVES default VMT for Multnomah County.

2.4.3.1 MOVES Electric Vehicle Use

The MOVES modeling performed for this air quality analysis does not include existing and future electric vehicle use. This is a conservative approach because it does not incorporate the benefits of future electric vehicle use and would likely show higher future pollutant emissions compared to an analysis that includes assumptions of electric vehicle use.

2.4.4 Maintenance Base Operations

Stationary sources such as bus and light-rail maintenance facilities are subject to the permitting regulations of either the DEQ or SWCAA. The existing permitting regulations are designed to protect the health of the public. Consequently, no impacts are expected as a result of maintenance base operations, and they are not evaluated as part of this analysis.

2.4.5 Temporary Effects

The analysis of direct, short-term air quality impacts that would occur during construction of the Modified LPA consists of a qualitative discussion of typical sources of pollutant emissions from the anticipated types of construction activities.

3. AFFECTED ENVIRONMENT

This section describes existing air quality conditions and trends in the air quality study area.

3.1 General Climate Conditions

The climate within the study area is characterized by short, dry, warm summers, with a typically cool and wet spring, fall, and winter. The Coast Range offers limited shielding from the Pacific Ocean storms, while the Cascades provide an orographic lift of moisture-laden westerly winds, resulting in moderate rainfall. As monitored at the Portland International Airport by the National Oceanic and Atmospheric Administration, nearly 90% of the average annual rainfall of approximately 36 inches occurs from October through May (NOAA n.d.). Average monthly temperatures taken at the Portland International Airport vary from approximately 41 degrees Fahrenheit (°F) in January to 70°F in August (NOAA n.d.).

The area experiences winter inversion conditions that lead to higher concentrations of CO and particulate matter as emissions accumulate from vehicles and home heating, particularly from wood-burning. Extended periods of high summer temperatures can lead to high ozone levels with emissions of volatile organic compounds (VOCs) and oxides of nitrogen from vehicles and industrial sources.

3.2 Monitored Air Quality Concentrations

3.2.1 Criteria Pollutant Monitoring

DEQ measures air pollutant levels by operating a network of air monitoring and sampling equipment at more than 40 sites throughout Oregon. The Tualatin Near-Road monitor is near I-5 (about 15 miles from the bridge), and the monitor on SE Lafayette Street is about 8 miles southeast of the bridge in a location more representative of local roadways. For pollutants that were not measured at these monitors, concentrations at the nearest monitor were provided.

Ecology operates 75 monitoring sites as part of the Washington network. These sites are located to meet monitoring objectives throughout the state at various scales of population density. Ecology does not operate many monitors in the Vancouver area because the monitors operated by DEQ fulfill the federal monitoring requirements for the metropolitan area.

Monitor data for Washington are provided in the following tables where available. Table 3-1 through Table 3-6 summarize the criteria pollutant monitor data for the three most recent years of validated measurements. CO and ozone concentrations were above the standards in the Portland metropolitan area in 2020 due to wildfires. As discussed in the DEQ's 2021 Oregon Air Quality Monitoring Annual Report, concentrations of CO, ozone, and $PM_{2.5}$ were elevated that year due to wildfire smoke (DEQ 2023). Some specific concentration data have been removed because DEQ received exceptions from the EPA. The remaining exceedances of the NAAQS were likely the result of wildfire smoke as well, but these values have not completed the process to receive an exception from the EPA. For the remainder of 2020, CO, ozone, and other criteria pollutants were below the federal health standard. These pollutants have been trending mostly downward for most locations over the last 10 years.

Table 3-1. Carbon Monoxide Measured Concentrations in Parts per Billion

Pollutant Monitor Location	Value	2019	2020[a]	2021
5824 SE Lafayette Street, Portland, OR	1-hour Maximum	1.9	15.3	2.6
	1-hour 2nd Maximum	1.8	15.1	2.1
	# of 1-hour Exceedances	0	0	0
	8-hour Maximum	1.6	1.5[a]	1.7
	8-hour 2nd Maximum	1.4	1.4[a]	1.4
	# of 8-hour Exceedances	0	0[a]	0
6745 Bradbury Court, Tualatin, OR	1-hour Maximum	1.3	14.7	1.4
	1-hour 2nd Maximum	1.2	14.6	1.3
	# of 1-hour Exceedances	0	0	0
	8-hour Maximum	1	1[a]	1
	8-hour 2nd Maximum	1	0.9[a]	0.9
	# of 8-hour Exceedances	0	0[a]	0

Source: EPA 2022

a Elevated concentrations occurred during wildfire impacts. Eight-hour carbon monoxide standard of 9 parts per million is not to be exceeded more than once per year. Wildfire data flagged by DEQ (DEQ 2023) have been removed from data table.

Table 3-2. PM_{10} Measured Concentrations in Micrograms per Cubic Meter

Monitor Location	Value	2019	2020	2021
5824 SE Lafayette Street, Portland, OR	24-hour Maximum	33	35	31
	24-hour 2nd Maximum	29	35	29
	# of Exceedances	0	0	0
4915 N Gantenbein Avenue, Portland, OR	24-hour Maximum	29	23	27
	24-hour 2nd Maximum	28	22	24
	# of Exceedances	0	0	0

Source: EPA 2022

PM_{10} = particulate matter less than or equal to 10 microns in diameter. 24-hour PM_{10} standard of 150 micrograms per cubic meter is not to be exceeded more than once per year on average over three years.

Table 3-3. $PM_{2.5}$ Measured Concentrations in Micrograms per Cubic Meter

Monitor Location	Value	2019	2020[a]	2021
5824 SE Lafayette Street, Portland, OR	24-Hour 98th percentile	20.0	31.0	16.0
	Mean Annual	6.5	10.7	6.4
6745 Bradbury Court, Tualatin, OR	24-Hour 98th percentile	21.0	18.1[a]	18.0
	Mean Annual	6.9	6.8[a]	6.7
1149 NE Grant Street, Hillsboro, OR	24-Hour 98th percentile	24.0	18.0[a]	15.0
	Mean Annual	6.7	6.1[a]	5.8
2722 NE 84th Avenue, Vancouver, WA	24-Hour 98th percentile	25.0	**147.0[a]**	16.0
	Mean Annual	7	13.9	5.7

Source: EPA 2022

a Elevated concentrations occurred during wildfire impacts. 24-hour $PM_{2.5}$ standard is exceeded when the 98th percentile, averaged over three years, is greater than 35 µg/m^3. Wildfire data flagged by DEQ (DEQ 2023) has been removed from data table.

µg/m^3 = micrograms per cubic meter; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter

Table 3-4. Ozone Measured Concentrations in Parts per Million

Monitor Location	Value	2019	2020[a]	2021[a]
5824 SE Lafayette Street, Portland, OR	1st Highest	0.066	**0.075[a]**	**0.072[a]**
	2nd Highest	0.065	0.066	0.066
	3rd Highest	0.06	0.064	0.066
	4th Highest	0.058	0.059	0.060
	# of days standard exceeded	0	1	1
6745 Bradbury Court, Tualatin, OR	1st Highest	0.065	**0.076[a]**	**0.070[a]**
	2nd Highest	0.054	0.063	0.057
	3rd Highest	0.05	0.062	0.056
	4th Highest	0.05	0.059	0.056
	# of days standard exceeded	0	1	0
1500 SE Blairmont Drive (Mountain View High School), Vancouver, WA	1st Highest	0.065	0.059	0.068
	2nd Highest	0.065	0.059	0.064
	3rd Highest	0.061	0.057	0.057
	4th Highest	0.058	0.054	0.057
	# of days standard exceeded	0	0	0

Source: EPA 2022

a Elevated concentrations occurred during wildfire impacts. Ozone standard is exceeded when the annual fourth-highest daily maximum 8-hour concentration, averaged over three years, is greater than 0.070 parts per million.

Table 3-5. Nitrogen Dioxide Measured Concentrations in Parts per Billion

Monitor Location	Value	2019	2020	2021
5824 SE Lafayette Street, Portland, OR	1-hour Maximum	43	35	36
	1-hour 2nd Maximum	37	33	33
	98th Percentile	32	29	31
	Annual Mean	7.73	6.36	6.64
6745 Bradbury Court, Tualatin, OR	1-hour Maximum	41	42	38
	1-hour 2nd Maximum	35	37	36
	98th Percentile	33	30	30
	Annual Mean	10.57	10.17	9.23

Source: EPA 2022

Note: 1-hour nitrogen dioxide standard is exceeded when the 98th percentile of 1-hour daily maximum concentrations, averaged over three years, is greater than 100 parts per billion.

Table 3-6. Sulfur Dioxide Measured Concentrations in Parts per Billion

Monitor Location	Value	2019	2020	2021
5824 SE Lafayette Street, Portland, OR	1-hour Maximum	3.2	3	3
	24-hour Maximum	1.3	1.5	1.9
	# of days standard exceeded	0	0	0
8678 NE Sumner Street, Portland, OR	Maximum 24 hours	12	8	NA
	2nd Maximum	5.6	3.5	NA
	# of Exceedances	0	0	NA

Source: EPA 2022

Note: 1-hour sulfur dioxide standard is exceeded when the 99th percentile of 1-hour daily maximum concentrations, averaged over three years, is greater than 75 parts per billion.

NA = pollutant not monitored during this period

3.2.2 Attainment Status

An area's attainment status is based on data collected by the state monitoring network on a pollutant-by-pollutant basis. Areas that have a history of monitored concentrations above the NAAQS may be designated by the EPA as nonattainment areas.

The study area spans four counties in the Portland and Vancouver metropolitan areas, which the EPA designates as in attainment for all criteria pollutants. The Portland metropolitan area was subject to a Carbon Monoxide Maintenance Plan. The 20-year transportation conformity planning period associated with the Carbon Monoxide Maintenance Plan was completed as of October 2, 2017. All measures and requirements contained in the Carbon Monoxide Maintenance Plan must be complied with until the EPA approves a revision to the state plan; however, transportation projects are no longer required to demonstrate NAAQS compliance with the transportation conformity requirements of 40 Code of Federal Regulations Part 93 subpart A. In Vancouver, the CO maintenance period ended in October of 2016. All measures and requirements contained in the Carbon Monoxide Maintenance Plan must be complied with until the EPA approves a revision to the state plan; however, transportation projects are no longer required to demonstrate NAAQS compliance with localized “hot-spot” air modeling analysis.

The region was also subject to an ozone maintenance plan. The 1-hour ozone standard was revoked by the EPA in 2005. The region is considered in attainment of this standard, but it is still subject to the requirements of the maintenance plan that was in effect at the time of revocation.

The monitor data above indicate that the NAAQS were exceeded for some monitor periods for ozone and CO because of wildfires in 2020. Individual exceedances do not change an area’s attainment status. A change in attainment status can be defined only by the EPA, and the process usually occurs when new or revised NAAQS are promulgated.

3.2.3 Toxic Air Pollutants Monitoring

DEQ implements several programs that regulate emissions of air toxics and monitors ambient levels present at various locations across Oregon. Washington does not monitor concentrations of toxic air pollutants in this region. DEQ (n.d.) details information about Oregon’s air toxics program.

DEQ operates long-term air toxic monitoring stations and rotates annual sites that operate for a one-year period. As part of DEQ’s air toxics monitoring program, 109 air toxics are measured at each monitoring site. Four monitoring sites are in the Portland metropolitan area, and the closest monitor to the Modified LPA location, as identified by the 2018 Oregon Air Toxics Monitoring Summary (DEQ 2020), is the Portland National Air Toxics Trends Station at the Humboldt School. Table 3-7 summarizes annual concentrations for each pollutant that exceeded the DEQ ambient benchmark concentration at this monitor during 2018, the most recently reported monitor period. Air toxics are not criteria pollutants and do not have NAAQS, but Oregon has established benchmarks for air toxics that represent levels that would not pose more than one in a million excess lifetime cancer risk if a person breathed air with that level every day for a lifetime. DEQ uses the benchmarks to provide consistent health-based goals, as the agency develops strategies to reduce air toxics. DEQ developed annual ambient benchmark concentrations for 52 air toxics of concern in Oregon. The benchmarks are based on concentration levels that protect the health of the state’s most sensitive individuals that equate to a one-in-a-million chance of cancer or other detrimental health effects. These benchmarks provide consistent health-based goals, as DEQ develops strategies to reduce air toxics that continue to exceed the benchmarks.

Table 3-7. 2018 Concentrations of Air Toxics at the Humboldt School Portland National Air Toxics Trends Site

Pollutant	Monitored Concentration ($\mu g/m^3$)	DEQ Benchmark ($\mu g/m^3$)	Mobile Source Air Toxic
Arsenic	0.000719	0.0002	No
1,3-Butadiene	0.095	0.03	Yes
Acrylonitrile	0.109	0.111	No
Benzene	0.457	0.13	Yes
Carbon Tetrachloride	0.336	0.2	No
Naphthalene	0.03906	0.03	Yes
Acetaldehyde	1.283	0.45	Yes
Formaldehyde	1.828	0.2	Yes

Source: DEQ 2020
$\mu g/m^3$ = microgram per cubic meter

3.2.4 Oregon State Implementation Plan[10]

As part of Oregon's SIPs for ozone, control strategies were identified to reduce emissions of VOCs and oxides of nitrogen, which are precursors to the formation of ozone (DEQ 2020). Although transportation conformity is no longer required after the ozone standard was revoked, the following strategies that apply to the roadway network are still in place:

- Motor Vehicle Inspection Program (Oregon Administrative Rules [OAR] 340-256-0300 through 0470) that defines the emissions testing programs required for vehicles registered in Portland.
- Public education and outreach that encourages people to voluntarily reduce emissions, such as not mowing lawns and driving less on Clean Air Action Days (now called Air Pollution Advisories).
- Employee Commute Options Program (OAR 340-242-0010 through 0290): Program requirements now focus on larger employers (100 or more employees) and reduce the survey requirements from annual to every two years.

As part of Oregon's SIP for carbon monoxide, Transportation Control Measures (TCMs) were identified to reduce emissions by reducing vehicle use (DEQ 2004). Although transportation conformity is no longer required after the 20-year maintenance period, the following TCMs were applicable between the years of 2006 and 2017 and are examples of strategies that have been used to reduce emissions:

[10] The Washington SIP is not discussed because in 2021, EPA approved a request from Ecology to remove the vehicle inspection/maintenance program and regulation from the SIP. There are no other transportation control measures in the SIP.

- Transit Service Increase: Regional transit service revenue hours (weighted by capacity) are increased 1% per year. The increase is assessed on the basis of a five-year rolling average of actual hours for assessments conducted between 2006 and 2017.
- Bicycle Paths: Jurisdictions and government agencies must program a minimum total of 28 miles of bicycle paths or trails within the Portland metropolitan area between the years 2006 and 2017. Bicycle paths must be consistent with state and regional bikeway standards. A cumulative average of 5 miles of bikeways or trails per biennium must be funded from all sources in each Metropolitan Transportation Improvement Program. Facilities subject to this TCM must be in addition to those required for expansion or reconstruction projects under Oregon Revised Statutes 366.514.
- Pedestrian Paths: Jurisdictions and government agencies must program at least 9 miles of pedestrian paths in mixed-use centers between the years 2006 and 2017, including the funding of a cumulative average of 1.5 miles in each biennium from all sources in each Metropolitan Transportation Improvement Program. Facilities subject to this TCM must be in addition to those required for expansion or reconstruction projects under Oregon Revised Statutes 366.514, except where such expansion or reconstruction is located within a mixed-use center.

3.2.5 Sensitive Receptors

While air quality effects on all members of the population are evaluated, potential effects on sensitive receptors are of particular concern. Sensitive receptors are facilities that house or attract children, the elderly, people with illnesses, or others who are especially sensitive to the effects of air pollutants. Hospitals, schools, and assisted living facilities are examples of sensitive receptors. Table 3-8 lists the hospitals, schools, and assisted living facilities located near the Program footprint. Many of these facilities are located in downtown Vancouver, west of the Program footprint.

Table 3-8. Sensitive Receptors Near the Program Footprint

Facility	Address
Hospitals and other Healthcare Facilities	
Portland VA Health Care System- Vancouver	1601 E 4th Plain Blvd, Vancouver, WA 98661
Providence Esther Short - Vancouver	700 Washington St Suite 105, Vancouver, WA 98660
ZoomCare	781 W Columbia Way, Vancouver, WA 98660
Sea Mar Community Health Center- CSNW Rose Village	2502 E 4th Plain Blvd, Vancouver, WA 98661
Schools	
Discovery Middle School	800 E 40th St, Vancouver, WA 98663
Vancouver School of Arts and Academics	3101 Main St, Vancouver, WA 98663
Washington State School for the Blind	2214 E 13th St, Vancouver, WA 98661

Facility	Address
Hudson's Bay High School	3528, 1601 E McLoughlin Blvd, Vancouver, WA 98663
VITA Elementary School	1111 Fort Vancouver Way, Vancouver, WA 98663
Clark College	1933 Fort Vancouver Way, Vancouver, WA 98663
Assisted Living	
Rose Village Adult Care Home	3810 S St, Vancouver, WA 98663
Knights of Pythias Retirement Center	3409 Main St, Vancouver, WA 98663
The Oaks at Timberline	400 E 33rd St, Vancouver, WA 98663
The Evergreen Inn	500 Main St, Vancouver, WA 98660
The Springs at The Waterfront	655 W Columbia Way Suite 602, Vancouver, WA 98660
Van Vista	410 W 13th St Apt, Vancouver, WA 98660

4. LONG-TERM EFFECTS

This chapter describes and compares the long-term impacts expected from the No-Build Alternative and Modified LPA, which are combinations of highway, Columbia River bridge crossing, transit, and active transportation elements. This discussion focuses on how the No-Build Alternative or Modified LPA would affect air quality in the study area. The traffic data used in the analysis are based on regional models for land use and employment and include traffic from all sources and potential growth as a result of the alternatives. Consequently, the results analyzed and discussed in this section include both direct and indirect effects, with additional qualitative discussion of indirect effects in Chapter 6. All analysis of the Modified LPA in this section applies to all configurations (double-deck fixed-span, single-level fixed-span, and single-level movable-span) and design options (one or two auxiliary lanes, with or without the C Street ramps, centered I-5 or I-5 westward shift, and with any of the park-and-ride facility options) unless otherwise specified.

4.1 No-Build Alternative and Modified LPA

The pollutant emissions estimated by the MOVES model are summarized in Table 4-1 (MSAT) and Table 4-2 (criteria pollutants) for the No-Build Alternative and the Modified LPA and the differences between them. The results represent the annual emissions from vehicles using the roadway segments included in the MSAT network described in Section 2.4.1.1.

The results of the emissions analysis show that for the No-Build Alternative and the Modified LPA, emissions from the analysis network are expected to be substantially lower than existing emissions for all MSAT, CO, NO_X, and $PM_{2.5}$. Although the daily VMT in the MSAT study area would increase by approximately 66% under the No-Build Alternative compared to existing conditions, MSAT emissions would decrease substantially with fuel and engine regulations being implemented, as described in Section 2.2.2. Emissions of SO_2, VOC, and total PM_{10} emissions do not show the same trend because emission factors associated these pollutants have a more modest decrease over time that would not outpace the increase in VMT growth.

Differences between the future 2045 emissions for the No-Build Alternative and the Modified LPA are negligible within the accuracy of the estimation methods. The emissions shown for the roadway segments defined in Section 2.4.1.1 are meant to present the difference between the No-Build and Modified LPA, and the MOVES model results do not represent the total emissions for the entire regional study area.

The MOVES model results follow the expected reduction in MSAT emissions shown in Figure 2-2 due to the 2007 EPA rule that will dramatically decrease MSAT emissions through cleaner fuels and cleaner engines as compared to existing conditions. Emissions of monitored MSAT pollutants (including those shown in Table 3-7) should decline, depending on the contribution of mobile source emissions to the monitored concentration that includes all sources of toxic air pollutants. The pollutant emissions estimated by the MOVES model correlate to the monitored CO, ozone, and other criteria pollutant emissions that have been trending mostly downward for most locations over the last 10 years.

Table 4-1. Mobile Source Air Toxics Emissions (Tons per Year)[a]

Pollutant	Existing (2015)	No-Build Alternative (2045)	Modified LPA (2045)	No-Build Alternative Difference from Existing	Modified LPA Difference from Existing	Modified LPA Difference from No-Build Alternative
MSAT Study Area Daily VMT	2,128,200	3,537,900	3,455,400	66%	62%	-2%
1,3-Butadiene	0.7	0.0	0.0	-100%	-100%	0%
Acetaldehyde	2.4	0.4	0.4	-82%	-85%	-14%
Acrolein	0.23	0.03	0.02	-89%	-90%	-12%
Benzene	14.2	4.3	4.3	-69%	-70%	-1%
Diesel Particulate Matter	10.8	1.6	1.3	-86%	-88%	-14%
Ethylbenzene	19.0	13.5	13.4	-29%	-29%	-1%
Formaldehyde	3.61	0.51	0.45	-86%	-88%	-12%
Naphthalene	0.47	0.03	0.03	-93%	-94%	-7%
Polycyclic Organic Matter	0.19	0.01	0.01	-93%	-96%	-42%

a The data for the Modified LPA applies to all design options except the two auxiliary lane option.
LPA = Locally Preferred Alternative; MSAT = Mobile Source Air Toxics; VMT = vehicle miles traveled; Percentage differences calculated prior to rounding.

Figure 2-2 shows that diesel particulate matter is the pollutant that will have the greatest decline in the next 10 years. With the DEQ clean truck rule and other state and federal actions, diesel particulate matter will continue to decrease under the Modified LPA. Additional actions to reduce emissions of diesel particulate matter are recommended by local groups, such as Portland Clean Air.

The Transportation Technical Report evaluates the long-term effects of all modes (on-road, transit, and active transportation), each of which demonstrates reductions in VMT or improvements in travel times, which are factors generally conducive to improved air quality. The air quality impacts of the Modified LPA, which were analyzed for the system as a whole, demonstrate that the combination of improvements to each mode (on-road, transit and active transportation) result in an overall decrease in pollutant emissions. Furthermore, this analysis conservatively assumes that there are no electric vehicles in the fleet. WSDOT and ODOT expect that the vehicle fleets in Oregon and Washington in 2045 will have a significant increase in electric vehicles, which would result in a large reduction in air pollutant emissions compared to the modeled results.

Table 4-2. Criteria Pollutant Emissions (Tons per Year)[a]

Pollutant	Existing (2015)	No-Build Alternative (2045)	Modified LPA (2045)	No-Build Alternative Difference from Existing	Modified LPA Difference from Existing [b]	Modified LPA Difference from No-Build Alternative [b]
MSAT Study Area Daily VMT	2,128,200	3,537,900	3,455,400	66%	62%	-2.3%
Carbon Monoxide	4,355	1,687	1,597	-61%	-63%	-5.3%
Nitrogen Dioxide	897	226	184	-75%	-79%	-18.5%
Sulfur Dioxide	2.4	2.8	2.6	16%	9%	-5.7%
Volatile Organic Compounds	662	830	826	26%	25%	-0.6%
Total PM_{10} [c]	46.0	67.1	55.9	46%	21%	-16.6%
Total $PM_{2.5}$ [d]	18.5	11.3	9.6	-39%	-48%	-14.5%

a The data for the Modified LPA applies to all design options except the two auxiliary lane option.
b Percentage differences calculated prior to rounding.
c Total PM_{10} emissions are the sum of PM_{10} exhaust, PM_{10} brake wear, and PM_{10} tire wear.
d Total $PM_{2.5}$ emissions are the sum of $PM_{2.5}$ exhaust, $PM_{2.5}$ brake wear, and $PM_{2.5}$ tire wear.
MSAT = Mobile Source Air Toxics; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PM_{10} = particulate matter less than or equal to 10 microns in diameter; VMT = vehicle miles traveled

Additional details are provided in Appendix A that present the emissions for each pollutant by highway, non-highway, and off-network sources. Off-network emissions are from evaporative processes (vapors that escape from the fuel tank) that are not specific to a roadway type.

4.1.1 Mobile Source Air Toxics Health Effects

Within the study area, there may be localized areas where ambient concentrations of MSAT could be different under the Modified LPA compared to the No-Build Alternative. The traffic data used to develop the roadway analysis network included changes from traffic diverted onto other local routes to avoid tolling; see the Transportation Technical Report for more information. The localized changes in MSAT concentrations would likely be most pronounced on roadway links where traffic volumes would increase under the Modified LPA relative to the No-Build Alternative from vehicles diverted from highways to avoid tolling. However, the magnitude and duration of these potential localized concentration increases compared to the No-Build Alternative cannot be reliably quantified because of incomplete or unavailable information in forecasting project-specific MSAT concentrations and related health impacts. Furthermore, as discussed below, any predicted difference in health impacts between alternatives are likely to be much smaller than the uncertainties associated with predicting the impacts.

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation than by any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

The EPA is responsible for protecting public health and welfare from any known or anticipated effect of an air pollutant. The EPA is the lead authority for administering the CAA and its amendments and has specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA continually assesses human health effects, exposures, and risks posed by air pollutants. It maintains the Integrated Risk Information System, which identifies and characterizes the health hazards of chemicals found in the environment. Each report in this database contains assessments of cancerous and non-cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSAT, including the Health Effects Institute (HEI). Appendix D of the FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* summarizes several HEI studies (FHWA 2023a). Among the adverse health effects linked to MSAT compounds at high exposures are cancer in humans in occupational settings; cancer in animals; and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious are the adverse human health effects of MSAT compounds at current environmental concentrations (HEI 2007) or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include (1) emissions modeling, (2) dispersion modeling, (3) exposure modeling, and (4) determination of health impacts, with each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70-year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time because such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways, to determine the portion of time that people are exposed at a specific location, and to establish the extent attributable to a proposed action, especially given that some of the information needed is unavailable.

Considerable uncertainties are associated with the existing estimates of toxicity of the various MSAT compounds because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by the HEI (HEI 2007). As a result, there is no national consensus on air dose-response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel particulate matter. The EPA states that with respect to diesel engine exhaust, "[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk" (EPA 2003).

There is also no national consensus on an acceptable level of risk. The current context is the process used by the EPA, as provided by the CAA, to determine whether more stringent controls are required to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires the EPA to determine an "acceptable" level of risk caused by emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than one in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than one in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld the EPA's approach to addressing risk in its two-step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable (United States Court of Appeals 2008).

Because of the described limitations in the methodologies for forecasting health impacts, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision-makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

4.1.2 Design Options

Other than the Modified LPA with two auxiliary lanes, none of the other design options (configurations/bridge types, I-5 mainline shift, park-and-ride sites, and C Street ramp) would affect regional VMT or speed, so they were not modeled for air quality.

As discussed in the Navigation Technical Report, the configuration and bridge type ultimately selected would affect navigation patterns. However, emissions from marine vessels were not evaluated because it is anticipated there would be no change in vessel idling emissions. Currently, bridge openings are scheduled as needed so vessels can pass with limited need for idling. The Modified LPA incorporating any of the configuration or bridge types would result in either the same or less emissions from idling vessels. It is possible that marine traffic could increase if the need for bridge openings is eliminated; while the potential increase in marine traffic is beyond the scope of this project to predict it would be anticipated that the increased marine traffic would not require a bridge opening and therefore not result in marine idling.

4.1.2.1 Two Auxiliary Lanes

The Modified LPA with two auxiliary lanes was evaluated using the same methodology as the Modified LPA with one auxiliary lane. Analysis of the long-term effects of the two-auxiliary-lane design option using the regional travel-demand model shows no statistical difference in pollutant emissions compared to the Modified LPA with one auxiliary lane (Table 4-3 and Table 4-4); pollutant emissions are within a 1.5% difference. There would be no additional impacts or benefits associated with the two-auxiliary-lane design option.

Table 4-3. Mobile Source Air Toxics Emissions for the Modified LPA with One or Two Auxiliary Lanes (Tons per Year)[a]

Pollutant	Modified LPA with One Auxiliary Lane (2045)	Modified LPA with Two Auxiliary Lanes (2045)	Difference between Modified LPA with One and Two Auxiliary Lanes
MSAT Study Area Daily VMT	3,455,400	3,462,400	0.2%
1,3-Butadiene	0.00	0.00	0.0%
Acetaldehyde	0.4	0.4	-0.9%
Acrolein	0.02	0.02	-0.6%
Benzene	4.3	4.3	0.0%
Diesel Particulate Matter	1.3	1.3	-0.9%
Ethylbenzene	13.4	13.4	0.0%
Formaldehyde	0.45	0.45	-0.7%
Naphthalene	0.03	0.03	-0.2%
Polycyclic Organic Matter	0.01	0.01	0.0%

a Data in this table apply to all design options, unless otherwise indicated.
LPA = Locally Preferred Alternative; MSAT = Mobile Source Air Toxics; VMT = vehicle miles traveled

Table 4-4. Regional Criteria Pollutant Emissions for the Modified LPA with One or Two Auxiliary Lanes (Tons per Year)[a]

Pollutant	Modified LPA with One Auxiliary Lane (2045)	Modified LPA with Two Auxiliary Lanes (2045)	Difference between Modified LPA with One and Two Auxiliary Lanes
MSAT Study Area Daily VMT	3,455,400	3,462,400	0.2%
Carbon Monoxide	1,597	1,596.1	0.0%
Nitrogen Dioxide	184	181.6	-1.4%
Sulfur Dioxide	2.6	2.6	0.0%
Volatile Organic Compounds	826	825.5	0.0%
Total PM_{10}[b]	55.9	55.3	-1.2%
Total $PM_{2.5}$[c]	9.6	9.5	-1.0%

a Data in this table apply to all design options, unless otherwise indicated.
b Total PM_{10} emissions are the sum of PM_{10} exhaust, PM_{10} brake wear, and PM_{10} tire wear.
c Total $PM_{2.5}$ emissions are the sum of $PM_{2.5}$ exhaust, $PM_{2.5}$ brake wear, and $PM_{2.5}$ tire wear.
LPA = Locally Preferred Alternative; MSAT = mobile source air toxics; $PM_{2.5}$ = particulate matter less than or equal to 2.5 microns in diameter; PM_{10} = particulate matter less than or equal to 10 microns in diameter; VMT = vehicle miles traveled

4.1.2.2 Single-Level Fixed-Span Configuration

The Modified LPA with the single-level fixed-span configuration (any bridge type) would be the same as the Modified LPA with the double-deck fixed-span configuration, except:

- There would be fewer operational emissions due to the reduced profile grade of the bridges (approximately 29 feet lower height and 1% lower grade). The lower roadway deck would reduce the steepness of the bridge, which in turn would reduce acceleration and braking of vehicles crossing the bridges and result in fewer emissions.
- The shared-use path would be at the same grade as the vehicle travel lanes, which would increase the potential for path users to be exposed to air pollutant emissions when wind conditions are from the west.

4.1.2.3 Single-Level Movable-Span Configuration

The Modified LPA with the single-level movable-span configuration would result in vehicle roadway emissions similar to those of the Modified LPA with the single-level fixed-span configuration. A vertical navigation clearance higher than the existing bridge could result in fewer bridge openings and less idling than the No-Build Alternative. However, the single-level movable-span would result in a greater amount of idling than either the double-deck fixed-span configuration or the single-level fixed-span configuration.

4.1.2.4 State Route 14 Interchange without Interstate 5 C Street Ramps

The Modified LPA with I-5 C Street ramps at the State Route (SR) 14 interchange would have the same long-term effects on air quality as the Modified LPA without I-5 C Street ramps at the SR 14 interchange. There would be no additional impacts or benefits associated with this design option.

4.1.2.5 Interstate 5 Mainline Westward Shift

The westward shift of the mainline of I-5 would have the same long-term effects on air quality as the Modified LPA. There would be no additional impacts or benefits associated with this design option.

4.1.2.6 Park and Rides

The addition of park-and-ride facilities could encourage transit use, which would generally have a beneficial effect on air quality. The site options for park-and-ride locations in downtown Vancouver would not result in different or additional air quality impacts or benefits.

4.1.2.7 Sensitive Receptors

Some occupants of hospitals, schools, assisted living facilities and other sensitive receptors are more susceptible to the adverse effects of air pollutants than the general public. All of the design options would have the same air quality effect on sensitive receptors in the area, except the Modified LPA with the I-5 Westward Shift, which would bring the mainline closer to the sensitive receptors located west of the Program footprint. Because the Portland and Vancouver metropolitan areas are in attainment for NAAQS, no further analysis is necessary to confirm that the Modified LPA would not result in pollutant concentrations in excess of the NAAQS.

5. TEMPORARY EFFECTS

The following is a qualitative discussion of the potential temporary effects on air quality from construction of the Modified LPA.

5.1 No-Build Alternative

The No-Build Alternative would not involve construction and therefore would not result in construction-related air quality effects.

5.2 Modified LPA

Activities related to construction of the Modified LPA under any of the design options would include increases in particulate matter in the form of fugitive dust (from demolition, ground clearing and preparation, grading, stockpiling of materials, on-site movement of equipment, and transportation of construction materials), as well as exhaust emissions from material delivery trucks, construction equipment, and workers' private vehicles. Dust emissions typically occur during dry weather, construction activities, or high wind conditions. Temporary impacts to air quality from construction activities would occur during the 9- to 15-year Program-wide construction period, which is expected to last from 2 to 10 years at any one location. Although this construction duration is longer than the 5 years usually considered as temporary under transportation conformity rules (40 Code of Federal Regulations 93.123), these rules do not apply to areas like Portland, which are in attainment for all NAAQS. Elevated emissions would likely occur immediately adjacent to the construction activities, staging areas, and material hauling routes. All design options of the Modified LPA are expected to have similar temporary construction effects.

5.2.1 Construction Sequencing and Duration

At this design stage, the IBR Program has not developed detailed construction sequencing plans, which would depend on funding, permitting, and other future considerations. Once these plans are developed, some areas, including sensitive receptors, located near concentrations of construction activity may be exposed to elevated levels of emissions. Since the construction sequencing of the Modified LPA is currently unknown, the construction of the Dan Ryan Expressway, a project similar in scope to the Modified LPA, was examined as an example, as described below. Based on the results of air quality monitoring during construction of the Dan Ryan Expressway, construction of the Modified LPA under any of the design options would not be expected to result in violations of air quality standards or pose an undue health risk to the neighboring communities.

5.2.1.1 Dan Ryan Expressway Example

The Dan Ryan Expressway is the busiest expressway in Chicago and is the major transportation artery from downtown through the City's South Side, accommodating over 300,000 vehicles per day at full capacity. In comparison, the I-5 corridor carries about 150,000 vehicles per day. In 2006 and 2007, the

Illinois Department of Transportation (IDOT) reconstructed the entire length of the Dan Ryan Expressway, including the addition of a travel lane from 47th Street to 95th Street. The project was the largest expressway reconstruction plan in Chicago's history, with a total cost of $975 million. Construction included:

- Complete rebuilding of 28 east-west bridges over the expressway.
- Redesigned and rebuilt interchange with the Chicago Skyway (I-90).
- Addition of a lane in each direction.
- Construction of longer exit and entrance ramps.
- Improved drainage infrastructure to reduce pavement flooding and traffic tie-ups during heavy rains.

The construction activities required for the Dan Ryan Expressway project were similar to those anticipated for the Modified LPA: bridge rebuilding, pile driving, earth moving, and large quantities of concrete pavement replacement. Because the Chicago area is a non-attainment area for the annual $PM_{2.5}$ standard, construction monitoring was required. Chicago is in attainment for the 24-hour $PM_{2.5}$ standard. Air monitoring was conducted at 27 sites located at schools, parks, public housing, and public facilities where the population, such as children and the elderly, was expected to be more sensitive to air contaminants. The monitored pollutants included total dust, respirable silica, lead, asbestos, polycyclic aromatic hydrocarbons (PAHs) (as diesel components), PM_{10}, and $PM_{2.5}$.

Baseline air quality monitoring was performed from September through December 2004 in areas where no reconstruction activities were occurring. Project action levels were set for each pollutant. If these levels were exceeded, then the contractor attempted to identify the source and notified an IDOT project official and mitigating measures were then executed to reduce emissions. Concentrations above project action levels did not constitute a violation, but rather were used to identify periods of elevated concentrations and implement mitigation (if deemed necessary) to reduce the project's possible effects. Air monitoring during construction began in January 2005 and continued until October 2007. In March 2006, the monitoring of asbestos was discontinued due to no detections above laboratory detection limits, and PAH sampling was reduced due to no detections of certain constituents above laboratory detection limits.

In general, the number of times the project action levels were exceeded was low. In many instances, the exceedance could be linked to instrument issues or regional scale events. In other cases, no obvious activity could be associated with the exceedance. For example, in 2007, there were 14 days with elevated $PM_{2.5}$ levels. All of the elevated readings appeared to be related to the regional air quality in the Chicago Metropolitan area and were not directly related to the Dan Ryan Expressway reconstruction activities (EDI 2008). Even on days with elevated concentrations, the air quality standards were maintained and not exceeded.

The results from the Dan Ryan Expressway project indicate that the construction activities for the Modified LPA should not result in violations of air quality standards and should not pose an undue health risk to the neighboring communities, including sensitive populations.

6. INDIRECT EFFECTS

The air quality analysis presented in Chapter 4, Long-term Effects, is based on traffic modeling, which includes forecasted land use changes and employment growth by the Metropolitan Planning Organizations (Metro for the Portland area and the Southwest Washington Regional Transportation Council for the Vancouver area). The air quality analysis discussed in Chapter 4, Long-term Effects, evaluated impacts on I-5 as well as traffic diverted onto other local routes to avoid tolling. Traffic generated by potential future development as represented in traffic modeling based on approved future land uses is likely to be small compared to the existing and anticipated interstate and local traffic volumes within the study area.

The degree to which the Modified LPA would indirectly affect development and result in an increase or decrease in motor vehicle trips in the region, in subareas, and near specific intersections would determine whether it would have a beneficial or adverse indirect impact on air quality compared to the No-Build Alternative. The Modified LPA, under any of the design options, may indirectly encourage development, particularly in light-rail station areas, due to improved bicycle, pedestrian, highway, and transit access in Portland and Vancouver.

Consistent with local land use plans, the Modified LPA would be anticipated to encourage development activity primarily near light-rail transit stations specifically, and in urban areas with transit service generally, rather than dispersed, automobile-oriented development at the urban periphery. As such, it can be qualitatively assumed that over the long term, automobile trips and emissions in the region would be reduced relative to the No-Build Alternative. At the neighborhood or intersection level, a transit-oriented development (TOD) or other development may result in more jobs and residences, which could result in more automobile trips. However, increases in automobile trips at these more localized locations would be expected to be limited by the convenience of the light-rail extension proposed by the Modified LPA, as well as other existing transit service in these areas. It is assumed that many of those traveling to a TOD's retail and office uses, and many of those traveling from a TOD's residential uses, would do so via transit, biking, and walking.

Indirect impacts also include the potential for growth-inducing effects and other effects related to induced changes in patterns of land use, population density, or population growth rate. The Land Use Technical Report evaluates the potential for induced land use growth associated with the Modified LPA.

7. MITIGATION

7.1 Long-Term Effects

7.1.1 Regulatory Requirements

The requirements of Oregon's and Washington's SIP would continue to be implemented by the state; there are no regulatory requirements that would be directly implemented by the IBR Program.

7.1.2 Program-Specific Mitigation

Long-term air quality impacts are not expected to occur because of the Modified LPA, and Program-specific mitigation for long-term impacts is not proposed.

7.2 Temporary Effects

There are no thresholds associated with the temporary effects to air quality. Although there is no mitigation required to meet applicable emissions thresholds, measures would be required to protect and minimize temporary effects on air quality during construction. ODOT, WSDOT, and all project contractors would comply with standard and regulatory mitigation measures. As construction phasing plans and mitigation measures are further developed, potential air quality impacts to sensitive receptors will be considered, particularly those due to prolonged construction emissions and/or simultaneous or sequential construction activities. Best management practices would be implemented to reduce and mitigate air quality emissions during construction, including strategies to reduce fugitive dust and reduce vehicle idling.

7.2.1 Regulatory Requirements

To protect and minimize temporary effects on air quality during construction, standard and regulatory mitigation measures such as best management practices would be implemented.

Construction contractors would be required to comply with the following standard and regulatory air quality measures in Oregon:

- Division 208 of OAR 340.
- ODOT Standard Specifications Section 290.
- The Clean Diesel Construction Standard (OAR-731-005-0800).
- Oregon House Bill 2007, known as the "Clean Diesel Bill."
- The City of Portland Clean Air Construction Program to reduce diesel emissions by implementing a standard set of idle reduction and diesel equipment requirements on job sites.

Standard and regulatory mitigation measures for air quality in Washington include:

- WSDOT Standard Specifications for Road, Bridge, and Municipal Construction, Section 1.07.5(4).
- Fugitive dust control best management practices set forth in the Associated General Contractors of Washington Education Foundation and Fugitive Dust Task Force pamphlet, “Guide to Handling Fugitive Dust From Construction Projects.”

7.2.2 Program-Specific Mitigation

- Through contract specifications, encourage all contractors to minimize impacts to surrounding communities such as using newer low-emitting construction equipment and electric equipment, and avoiding haul routes through residential areas.

8. PERMITS AND APPROVALS

8.1 Stationary Source Permits

Stationary sources such as concrete and asphalt mix plants are generally required to obtain air permits from the DEQ or SWCAA and to comply with regulations to control dust and other pollutant emissions. As a result, their operations are typically well controlled and do not require project-specific mitigation measures. This would also be true for demolition of asbestos-containing structures because this activity is regulated.

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APPENDIX A. AIR POLLUTANT EMISSIONS BY ROADWAY TYPE

Existing (2015) Criteria Pollutant and MSAT Emissions by Roadtype

	Freeway	Non-Freeway	Off-Network	Total
Annual VMT (mi/year)	487,168,000	289,630,132	N/A	776,798,132
Criteria Pollutants (tons/year)				
CO	2,412	1,794	148	4,355
NO_x	566	305	26	897
SO_2	1.4	0.9	0.2	2.4
VOC	83	65.0	513.8	662
Total PM_{10}[a]	24.2	20.7	1.2	46
Total $PM_{2.5}$[b]	10.8	6.7	1.1	19
Mobile Source Air Toxics (tons/year)				
1,3-Butadiene	0.36	0.28	0.06	0.70
Acetaldehyde	1.28	0.89	0.22	2.39
Acrolein	0.13	0.08	0.02	0.23
Benzene	2.70	2.16	9.33	14.19
Diesel Particulate Matter	6.74	3.03	1.00	10.77
Ethylbenzene	1.50	1.22	16.28	18.99
Formaldehyde	1.97	1.29	0.35	3.61
Naphthalene	0.0002	0.0001	0.0000	0.0003
Polycyclic Organic Matter	0.11	0.069	0.019	0.19

	2045 No Build				2045 Build MLPA				2045 Percent Change from No Build		
	Freeway	Non-Freeway	Off-Network	Total	Freeway	Non-Freeway	Off-Network	Total	Freeway	Non-Freeway	Total
Annual VMT (mi/year)	894,784,000	395,622,143	N/A	1,290,406,143	857,643,000	402,664,321	N/A	1,260,307,321	-4.2%	1.8%	-2.3%
Criteria Pollutants (tons/year)											
CO	1,104	560	22	1,687	1,003	573	21	1,597	-9.1%	2.3%	-5.3%
NO_x	160	42	25	226	119	43	22	184	-25.5%	2.4%	-18.5%
SO_2	1.8	0.8	0.2	2.8	1.7	0.8	0.2	2.6	-9.1%	1.5%	-5.7%
VOC	31	16	784	830	25	16	784	826	-16.9%	3.1%	-0.6%
Total PM_{10}[a]	42.8	24.1	0.2	67	31.1	24.7	0.2	56	-27.4%	2.5%	-16.6%
Total $PM_{2.5}$[b]	7.3	3.76	0.15	11	5.6	3.8	0.1	10	-23.3%	2.2%	-14.5%
Mobile Source Air Toxics (tons/year)											
1,3-Butadiene	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	N/A	N/A	N/A
Acetaldehyde	0.281	0.090	0.057	0.427	0.223	0.092	0.051	0.366	-20.3%	2.2%	-14.3%
Acrolein	0.018	0.006	0.002	0.026	0.014	0.006	0.002	0.023	-17.8%	2.1%	-12.1%
Benzene	0.499	0.266	3.564	4.329	0.436	0.274	3.563	4.27	-12.6%	2.7%	-1.3%
Diesel Particulate Matter	1.20	0.30	0.07	1.56	0.98	0.30	0.06	1.34	-18.0%	1.5%	-13.9%
Ethylbenzene	0.489	0.262	12.721	13.472	0.408	0.270	12.719	13.4	-16.5%	3.1%	-0.5%
Formaldehyde	0.331	0.124	0.057	0.512	0.271	0.127	0.051	0.45	-18.1%	2.2%	-12.3%
Naphthalene	0.00004	0.00002	0.000003	0.000	0.00004	0.00002	0.00000	0.000	-6.5%	1.3%	-4.0%
Polycyclic Organic Matter	0.008	0.004	0.001	0.013	0.007	0.004	0.001	0.012	-10.6%	1.7%	-6.5%