County-City Work Plan: Bridge Cross Section Study (Final)

Multnomah County | Earthquake Ready Burnside Bridge Project

Portland, OR

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EARTHQUAKE READY BURNSIDE BRIDGE

Earthquake Ready Burnside Bridge County-City Work Plan: Bridge Cross Section Study (Final)

Prepared for

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Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Annual Daily Traffic
City	City of Portland, Oregon
County	Multnomah County, Oregon
CSZ	Cascadia Subduction Zone
CTF	Community Task Force
EIS	Environmental impact statement
EQRB	Earthquake Ready Burnside Bridge
FHWA	Federal Highway Administration
HV	Heavy volume vehicle
MASH	Manual for Assessing Safety Hardware
MLK	Martin Luther King Jr.
MV	Medium vehicle
NACTO	National Association of Transportation Officials
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHS	National Highway System
OCS	Overhead catenary system
ODOT	Oregon Department of Transportation
PBOT	Portland Bureau of Transportation
Project	Earthquake Ready Burnside Bridge
SL	Senior Leadership
TL-4	Test Level 4
TSP	Transportation System Plan
UPRR	Union Pacific Railroad

Executive Summary

Memorandum Purpose

In preparation for the Earthquake Ready Burnside Bridge (EQRB) Project's Final Design phase, this memorandum serves to document the technical considerations, along with pros and cons of a range of possible bridge cross section options. As developed and adopted by the joint City and County Senior Leadership (SL) group for this work, the purpose of this document is to:

- Identify the range of cross section options.
- Define benefits, impacts, and costs for each option.
- Aspire to find agreement and/or consensus on information shared between the City and County or discovered as part of the technical work.
- Understand and summarize points of differences between the options.
- Present a summary of collaborative work completed for agency leadership to select the bridge cross section.

To achieve this purpose, this memorandum assembles the comprehensive data collected on the topic, describes the relevant criteria and technical considerations for the bridge cross section options studied, evaluates conformance with relevant policy goals and adopted guidance, documents the identified impacts and their conceptual solutions, and provides a summary of findings for decision-makers to select the cross section for advancement into the Final Design phase.

Cross Sections Studied

Six representative cross section options were studied as defined in Table 1. All six options included the same 78-foot clear width. All options included a symmetrical bicycle/pedestrian space on both sides of the bridge. All options include two westbound general-purpose lanes, one eastbound general-purpose lane, and one eastbound bus-only lane. Of the options studied, Option 2b is the only option considered acceptable by PBOT.

Table 1. Cross Section Options

Option	Westbound				Median	Eastbound				Rdwy Total	Overall Total - West Appr. (No barriers)	Overall Total - West Appr. (With barriers)	Overall Total - East Appr. (With barriers + Arch)
	North Bike/Ped	Shldr	Outside Lane	Inside Lane		Inside Lane	Outside Transit Lane	Shldr	South Bike/Ped				
1a	14	2	11	11	2	11	11	2	14	50	78	82	90
1b	14	3	10.5	10.5	2	10.5	10.5	3	14	50	78	82	90
2a	17	1	10	10	2	10	10	1	17	44	78	82	90
2b	17	1	11	10	0	10	11	1	17	44	78	82	90
3a	15.5	2	11	10	1	10	11	2	15.5	47	78	82	90
3b	15.5	1.5	11	10.5	1	10.5	11	1.5	15.5	47	78	82	90

Summary of Findings

Differentiating Features for the Cross Section

For this study, key differentiating features for the cross section were identified to provide decision makers with appropriate technical and policy considerations for each cross section option. Differentiating features include:

- Policy Consistency
- Safety and Operations
- Comfort
- Roadway Drainage
- Maintenance and Inspection

Each option was evaluated against a certain design feature, and Harvey balls were used to identify the degree to which the option meets a particular criterion and to provide a qualitative comparison of the options (Table 2). The full balls indicate that a criterion is met or exceeded, the half balls indicate that a criterion is partially met, and the empty balls indicate that a criterion is not met.

Table 2. Comparison Matrix

Comparative Summary	Option 1a	Option 1b	Option 2a	Option 2b	Option 3a	Option 3b
DIFFERENTIATING FEATURES	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**
1) Active Transportation Space						
a) Policy Consistency						
1. Pedestrian / Bicycling Space	○	○	●	●	○	○
b) Safety						
1. Operating Envelope	○	○	●	●	◑	◑
c) Comfort						
1. Potential for Ped/Bike Conflicts	○	○	●	●	◑	◑
2. Shy Distance	○	○	●	●	○	○
d) Maintenance and Inspection	○	○	●*	●*	●	●
2) Vehicular Space						
a) Policy / Standards Consistency						
1. Exterior Lane + Shoulder	●	◑	○	●	●	●
2. Interior Lane + Median	●	●	●	●	●	●
b) Safety and Operations						
1. Lane Widths	◑	○	◑	●	●	◑
2. Shoulder Width	●	◑	◑	●	●	●
3. Median Width	●	●	●	◑	●	●
c) Drainage						
1. Inlet Maintenance	●	●	○	○	●	●

Note: * - Exceeds the minimum width, supporting Mult Co Maintenance team's request to maximize the bike/ped width

Option 1 (Maximum Vehicular Space Allocation)

This option performed worse in the active transportation evaluation, as it has the least amount of space allocated for people bicycling and people walking. This option does not meet the City's policies and desired minimum widths. The effective width of the bike lane will be narrower than the City's preferred minimum width and as a result there is a higher potential for interactions and conflicts between people bicycling and people walking. This option performed well in the vehicular space criteria.

Option 2 (Maximum Bicycle/Pedestrian Space Allocation)

This option performed the best in the active transportation evaluation and met or exceeded all criteria. This option performed moderately well in the vehicular space evaluation, although Option 2a has sub-standard exterior lane widths.

Option 3 (Compromised Space Allocation)

This option does not meet the City's policies and desired minimum widths. The effective width of the bike lane will be narrower than the City's preferred minimum width and as a result there is a higher potential for interactions and conflicts between people bicycling and people walking. This option performed the best in the vehicular space evaluation.

A detailed summary of each option including pro and con considerations is included in Appendix B**.**

Non-Differentiating Features for the Cross Section

During this study, some important features and considerations were identified that turned out to be non-differentiating for the various cross section options. This means that while important, they did not provide a meaningful differentiating quality to help select amongst the various options. The identified non-differentiating features are as follows, with a further description of each in Section 6:

- All the cross section options accommodate large trucks.
- All the bridge cross section options satisfactorily provide the ability for first responders and other emergency service organizations to provide immediate responsiveness and recovery needs following a major earthquake.
- The various bridge types and bridge appurtenances and devices do not have a negative impact on the vehicular and bicycle/pedestrian spaces for any of the cross section options. Where needed, localized bridge widening will occur to avoid any reductions in the clear spaces for the bicycle/pedestrian and roadway zones.
- All the cross section options possess the same utility impacts and needs.
- All the cross section options have the same minimal impacts to under-bridge transportation facilities (e.g., Naito Parkway, 2nd/3rd Avenues; I-5/I-84; etc.), the Willamette River, TriMet Max, and Parks recreational facilities (e.g., Tom McCall Waterfront Park and Vera Katz Eastbank Esplanade).
- The off-bridge street connectivity does not have a differentiating effect on the range of bridge cross sections.

- All the cross section options provide suitable flexibility for future streetcar section needs.

1 Introduction

1.1 Joint County-City Purpose Statement

As defined by the joint County-City Senior Leadership group, the Work Plan purpose is:

"For City of Portland and Multnomah County Staff to (1) jointly determine the cost, environmental, and timeline impacts and trade-offs of any or no changes to the connection between the EQRB Replacement and the Eastbank Esplanade; as well as to (2) to jointly determine the cost, environmental, and timeline impacts and trade-offs of lane and pedestrian and bicycle space allocation [on the bridge] in order to better inform decision-makers as they determine the feasibility and political implications for those potential options and select an option to advance."

1.2 Burnside Bridge Site

Built in 1926, the Burnside Bridge is an aging structure requiring increasingly frequent and significant repairs and maintenance. The existing Burnside Bridge carries a total of 35,000 vehicles per day, and crosses the Willamette River, Interstate 5, Union Pacific Railroad, multiple City of Portland (City) streets, parking lots, parks, TriMet MAX lines, and other facilities under Burnside Street. The existing bridge carries three eastbound and two westbound lanes of vehicle traffic as well as bicycle lanes and sidewalks in each direction. The total bridge length is approximately 2,307 feet and consists of three separate structures:

- West Approach Bridge (Br. No. 00511A) spans 602 feet
- Main River Bridge (Br. No. 00511) spans 856 feet
- East Approach Bridge (Br. No. 00511B) spans 849 feet

The bridge is designated a historically significant structure and is listed on the National Register of Historic Places.

Regarding the existing connection between the Burnside bridge and the Eastbank Esplanade, a City of Portland-owned staircase facility, constructed in 2001, exists that connects the south side of the bridge (by Multnomah County permit) to the Vera Katz Eastbank Esplanade, located about 50 feet below the bridge.

1.3 History of the EQRB Project

In 2015, the *Willamette River Bridges Capital Improvement Plan 2015–2034* (Multnomah County 2015) prioritized creating a Burnside Street river-crossing that can withstand a major earthquake. The adoption of the improvement plan led to the process to identify and screen alternatives which began in 2016 with the EQRB Feasibility Study documented in the *EQRB Feasibility Study Report* (Multnomah County 2018).

The EQRB project team worked with community and agency stakeholders to develop project objectives and a problem statement, build project awareness through early engagement, and analyze more than 100 options for creating an earthquake ready

Willamette River crossing. Screening criteria were developed and applied (see Appendix C of the *EQRB Feasibility Study Report* (Multnomah County 2018) with the Project's Stakeholder Representative Group, and the results were shared with other project committees (the Senior Agency Staff Group and the Policy Group), as well as with the public through online events and in-person open houses. Following public input, the feasibility study was completed in November 2018, and the Multnomah County Board of Commissioners adopted the draft project purpose and need statement and the range of alternatives for further study.

This process led to the recommendation to advance select bridge alternatives for further study in the environmental process. Following the feasibility study, the project team conducted additional analysis and gathered stakeholder input to further evaluate and refine the project alternatives prior to initiating an environmental impact statement (EIS). To comply with the National Environmental Policy Act (NEPA), an EIS was developed that studied seven alternatives.

Following almost two years of coordination, analysis, and input, in June 2020, the Project's Community Task Force (CTF) recommended that the Draft EIS Long-span Approach Alternative and the No Temporary Bridge Option comprise the Draft EIS Preferred Alternative (see descriptions of this alternative and option in Section 2.2). The CTF's process to reach that recommendation included identifying the community's values, defining evaluation criteria and measures, and reviewing the performance and impacts of the various alternatives and options. It also considered the input from the project team's technical experts, from resource agencies and other participating agencies, and from other stakeholders including the public. In August 2020, the project team solicited input on the CTF's recommendation from multiple stakeholder groups, agencies and the public through online open houses, an online survey and web meetings. This input, which indicated broad support (85 percent) for the Draft EIS Preferred Alternative recommendation, was provided back to the CTF who then reconfirmed their recommendation in September 2020. The recommendation was then unanimously endorsed by the voting members of the Project's Policy Group on October 2, 2020. The Multnomah County Board of Commissioners adopted a resolution on October 29, 2020, expressing approval for the recommended Draft EIS Preferred Alternative. Input received during the Draft EIS comment period confirmed that there was considerably more public support for the Draft EIS Long span Alternative than for any of the other Draft EIS alternatives.

Following the issuance of the Draft EIS, additional cost and funding analysis identified a substantial risk. It was determined that construction costs of any of the build alternatives studied would be too high to reasonably fund. This risk led the County to direct the project team to identify ways to reduce construction costs while still meeting the Project's purpose and need. This additional refined evaluation was conducted and presented in a Supplemental Draft EIS. Initial findings regarding the cost savings, impacts, and tradeoffs of these potential revisions were provided to the public in November and early December 2021. Project committees endorsed the refinements to the Draft EIS Preferred Alternative, and the Multnomah County Board of Commissioners passed a resolution adopting the refinements on March 17, 2022. Elements that were considered as refinement within the SDEIS included:

- A reduction in bridge width (which eliminated one of the existing vehicular lanes and reduced the width of the combined sidewalk/bicycle lane as compared to the Draft EIS cross section).
- The selection of a conventional slab on girder structure type for the West Approach bridge type.
- The selection of a bascule bridge type as the Main River Span movable bridge type.

1.4 Project Purpose and Need

Geologically, Oregon is located in the Cascadia Subduction Zone (CSZ), making it subject to some of the world's most powerful recurring earthquakes. The last major earthquake in Oregon occurred over 300 years ago, in 1700, a timespan that exceeds 75 percent of the intervals between the major earthquakes to hit Oregon over the last 10,000 years. There is a significant risk that the next event will occur relatively soon. The next major earthquake is expected to cause moderate to significant damage to the aging downtown bridges, including the existing Burnside Bridge, rendering them potentially unusable immediately following the earthquake. In their existing condition, all the downtown bridges and/or approaches fail to provide communities and the region with timely and reliable critical emergency response, evacuation, and recovery functions. In response to this risk from a future seismic event, Multnomah County completed its 20-year *Willamette River Bridges Capital Improvement Plan 2015-2034* (Multnomah County 2015); which identified seismic resiliency of the Burnside Bridge as a top priority for Multnomah County in the next 20 years.

Burnside Bridge is designated as the only County-owned Primary Emergency Transportation Route across the Willamette River in downtown Portland in a 1996 report, *Regional Emergency Transportation Routes* (Metro Task Force 1996) to Metro's Regional Emergency Management Group. This group was formed by intergovernmental agreement among the region's cities, counties, Metro, and the Red Cross to improve disaster preparedness, response, recovery, and mitigation plans and programs.

The Burnside Street emergency route is approximately 18.7 miles in length and extends from SW 57th Avenue in Washington County to US Highway 26 in Gresham, crossing the Willamette River via the Burnside Bridge.

Other agency plans have also identified Burnside Street as an important lifeline route. For example, the City's Citywide *Evacuation Plan* (BEM 2017) addresses evacuation needs for general disasters. The Plan identifies Burnside Street as a secondary east-west evacuation route and an emergency transportation route.

The primary purpose of the Project is to create a seismically resilient Burnside Street lifeline crossing of the Willamette River that would remain fully operational and accessible for vehicles and other modes of transportation immediately following a major CSZ earthquake. A seismically resilient Burnside Bridge would support the region's ability to provide rapid and reliable emergency response, rescue, and evacuation after a major earthquake, as well as enable post-earthquake economic recovery. In addition to ensuring that the crossing is seismically resilient, the purpose is also to provide a long-term, low-maintenance safe crossing for all users.

1.5 City of Portland Policy

The 2009 *Climate Action Plan* (BPS and Multnomah County 2009) included a goal for 80 percent reduction of local carbon emissions by 2050. It had a bicycle mode split goal of 25 percent and introduced a green transportation hierarchy. The 2010 *Portland Bicycle Plan for 2030* (PBOT 2010) included policy recommendations to make bicycling more attractive than driving, create conditions that are "safe and comfortable", and to adopt the green transportation hierarchy. The policy goals are ultimately pursued through on-the-ground design.

These policies were formally adopted by Council Resolution in 2018 into the City of Portland Comprehensive Plan. Comprehensive Plan Policy 9.6 (Strategy for People Movement) incorporated the aforementioned "green transportation hierarchy" by stating that the City of Portland is to prioritize "modes for people movement by making transportation system decisions" to favor walking, bicycling and transit, in that order (Comprehensive Plan Policy 9.6). Portland does this in part by "[encouraging] walking as the most attractive mode" (Policy 9.17) by "[improving] the quality of the pedestrian environment" (Policy 9.18) and by "[improving] pedestrian safety, accessibility, and convenience for people of all ages and abilities" (Policy 9.19). For bicycling Portland strives to "create conditions that make bicycling more attractive than driving" (Policy 9.20), by "[creating] a bicycle transportation system that is safe, comfortable, and accessible to people of all ages and abilities" (Policy 9.21). These efforts are in service to Portland's overall mode split goals that aim to reduce driving to no more than 30% of all trips by 2035 (Policy 9.49.f).

The Burnside Bridge carries Portland's highest classifications for bicycling (Major City Bikeway) and walking (Major City Walkway). According to Portland's *2035 Transportation System Plan (TSP)* (City of Portland 2020), Major City Bikeways "should be designed to accommodate large volumes of bicyclists, [and] to maximize their comfort…." Portland is directed by the TSP to "build the highest quality bikeway facilities." "Where conditions warrant and where practical, Major City Bikeways should have separated facilities for bicycles and pedestrians." According to *PedPDX: Portland's Citywide Pedestrian Plan* (PBOT 2019), Major City Walkways "are intended to provide safe, convenient, and attractive pedestrian access…. [with] wide sidewalk on both sides, and a pedestrian realm that can accommodate high volumes of pedestrian activity." According to the *Portland Pedestrian Design Guide* (PBOT 2022), Burnside Bridge is also classified as a "Civic Main Street" and should be able to accommodate high levels of people walking.

1.5.1 Designing to the City's Modal Hierarchy

The City of Portland's *2035 Comprehensive Plan* (City of Portland 2020) includes Policy 9.6 (Transportation strategy for people movement):

Implement a prioritization of modes for people movement by making transportation system decisions according to the following ordered list:

1. Walking
2. Bicycling
3. Transit

4. Fleets of electric, fully automated, multiple passenger vehicles
5. Other shared vehicles
6. Low or no occupancy vehicles, fossil-fueled non-transit vehicles

When implementing this prioritization, ensure that:

- The needs and safety of each group of users are considered, and changes do not make existing conditions worse for the most vulnerable users higher on the ordered list.
- All users' needs are balanced with the intent of optimizing the right of way for multiple modes on the same street.
- When necessary to ensure safety, accommodate some users on parallel streets as part of a multi-street corridor.
- Land use and system plans, network functionality for all modes, other street functions, and complete street policies, are maintained.
- Policy-based rationale is provided if modes lower in the ordered list are prioritized.

1.5.2 Designing to a Bicycle Usage Target

Bicycle mode split in Portland's Inner East Side needs to hit 34 percent in order for Portland to achieve the overall bicycle mode split of 25 percent identified in the 2009 *Climate Action Plan* (BPS and Multnomah County 2009). The bicycle (plus walking and transit) mode splits needed by City section are described in *"Table Array 4: Scenario Analysis Results*" of the 2013 *"White Paper on OHAS and the Path Ahead"* (See Appendix G).

A simple way to identify the outcomes toward which the City is aiming, planning, and designing is to assume that 34 percent of current automobile trips on the Burnside Bridge are converted to bicycling trips. Peak hour volumes were considered given they are the volumes used to inform facility width.

Pre-pandemic and pre-construction peak hour automobile volumes were collected on W Burnside Street, east of 2nd Avenue and are shown in Table 3 along with calculated target peak hour bicycle volumes.

Table 3. Peak Hour Automobile and Target Bicycle Volumes on the Burnside Bridge (Sorted from Most to Least)

table units: vehicles per hour

AM Peak Volumes (Autos Westbound)	Count Date	PM Peak Volumes (Autos Eastbound)	Count Date
1472	November 2015	2105	June 2012
1426	June 2012	1953	February 2011
1286	February 2011	1932	November 2015
1279	August 2016	1783	August 2016
1067	September 2018	1542	May 2022
1306	**= Average Auto Count**	**1863**	**= Average Auto Count**

AM Peak Volumes (Autos Westbound)	Count Date	PM Peak Volumes (Autos Eastbound)	Count Date
444	**= AM Bicycle Peak Volume (i.e., Ave count x 34%) in bicyclists per hour**	**633**	**= PM Bicycle Peak Volume (i.e., Ave count x 34%) in bicyclists per hour**

Source: City of Portland (PBOT), August 8, 2023. https://pdx.maps.arcgis.com/apps/webappviewer/index.html?id=7ce8d1f5053141f1bc0f5bd7905351e6.

Per the City, the EQRB Project should be designed for approximately 445 westbound peak hour bicyclists and 635 eastbound peak hour bicyclists. These volumes fall into the range (150-750 bicyclists/hour) where guidance prefers a bicycling zone width of 8 feet with a minimum of 6.5 feet. As described in the City's *Protected Bicycle Lane Design Guide* (PBOT 2021), designers should:

"Carefully consider the environment in which the 6.5-foot bicycling zone is placed. If between two vertical elements (including curbs) there will be a shy distance to consider that might require additional width to provide 6.5 feet of functional width. This can be partially mitigated by using curbs angled back from the bicycling zone and having a shy distance from other vertical elements. It can also be mitigated by providing 7-foot between vertical elements."

1.5.3 Designing for Bicycle and Pedestrian User Comfort

There is a broad range of people that could be potential bicyclists and the intent of the City's bicycling policies are to attract a broader range of people bicycling from the group of people that may be "interested but concerned." Potential bicyclists include children, seniors, people of all genders, abilities, and demographics, people moving goods or less and more confident bicyclists.

The National Association of Transportation Officials (NACTO) *Designing for All Ages & Abilities - Contextual Guidance for High-Comfort Bicycle Facilities* (NACTO 2017) states that "whether or not people will bicycle is heavily influenced by the stresses they encounter on their trip. These stressors impact their actual physical safety and their perceived comfort level."

A bicyclist's comfort depends on their experience and the type of bicycling facility as it relates to vehicular traffic speed and volume, which are two of the biggest causes of bicyclist stress. These factors are inversely related to comfort and safety; even small increases in either factor can quickly increase stress and potentially increase injury risk.

For all cross section options, the pedestrian/bicycling space is physically separated from vehicular traffic by a crashworthy barrier, which greatly enhances the comfort of these facilities. The comfort of people walking and bicycling will also be influenced by these modes' interaction with one another and other environmental factors such as the proximity of vertical features and surface conditions.

On an active transportation facility in which bicycle and pedestrian space are at the same level, sub-standard space for people bicycling will necessarily result in people using the pedestrian space to bicycle. This is a common occurrence on the Tilikum Crossing (see Appendix F). This impacts the comfort of people walking.

This issue will be especially acute given the rapid uptake of different types and sizes of wheeled devices and higher speed electric bikes and scooters. The larger size of e-cargo, delivery, and other bikes and wheeled devices as well as the speed differential between conventional bikes and electric bikes result in additional operating width and passing space needs.

The NACTO working paper titled, *Designing for Small Things with Wheels* (NACTO 2023) says, "designers need to accommodate more people using bikeways with higher speed and size differentials", it goes on to say, "the new array of vehicle types, sizes, and speeds, requires updated design thinking in four key arenas: lane widths, intersections; surfaces and gradients; and network legibility."

It also warns that, "a bikeway that is too narrow for its particular mix of volume, devices, and speeds can become uncomfortable due to close-passing, even if it meets minimum width standards. Wider protected bike lanes are especially important for children and caregivers, side-by-side riders, people using adaptive devices, and people moving goods."

2 Bridge Definition and Geometrics

2.1 Facility Classifications and Designations

The *2035 Transportation System Plan* (City of Portland 2020), developed as part of the City of Portland's Comprehensive Plan Policy 9.3, establishes design and planning policies that influence the development of the Burnside bridge cross section. In fact, as specified by Comprehensive Plan Policy 9.3, the TSP is to be maintained and implemented as "the decision-making tool for transportation related projects, policies, programs, and street design."

Within the TSP, there are two noteworthy classifications:

1. **Street design classifications:** Maintain and implement street design classifications consistent with land use plans, environmental context, urban design pattern areas, and the Neighborhood Corridor and Civic Corridor Urban Design Framework designations. (Comprehensive Plan Policy 9.1).
2. **Street policy classifications:** Maintain and implement street policy classifications for pedestrian, bicycle, transit, freight, emergency vehicle, and automotive movement, while considering access for all modes, connectivity, adjacent planned land uses, and state and regional requirements. (Comprehensive Plan Policy 9.2).

The use of the street classifications is to plan, develop, implement, and manage the transportation system in accordance with street design and policy classifications outlined in the Transportation System Plan. (Comprehensive Plan Policy 9.4). Furthermore, classification descriptions are used to describe how streets should function for each mode of travel, not necessarily how they are functioning at present. (Comprehensive Plan Policy 9.4.a)

2.1.1 Pedestrian Classification

The Burnside Bridge is within a designated Pedestrian District. Per the TSP, Pedestrian Districts are intended to give priority to pedestrian access in areas where high levels of pedestrian activity exist or are planned, including the Central City, Gateway Regional Center, town centers, neighborhood centers, and transit station areas. Within this district, the following considerations apply:

Land Use: Zoning should allow a transit-supportive density of residential and commercial uses that support lively and intensive pedestrian activity. Auto-oriented development should be discouraged in Pedestrian Districts. Institutional campuses that generate high levels of pedestrian activity may be included in Pedestrian Districts. Exceptions to the density and zoning criteria may be appropriate in some designated historic districts with a strong pedestrian orientation.

Streets within a District: Make walking the mode of choice for all trips within a Pedestrian District. All streets within a Pedestrian District are important in serving pedestrian trips and should have sidewalks on both sides or meet alternative design criteria.

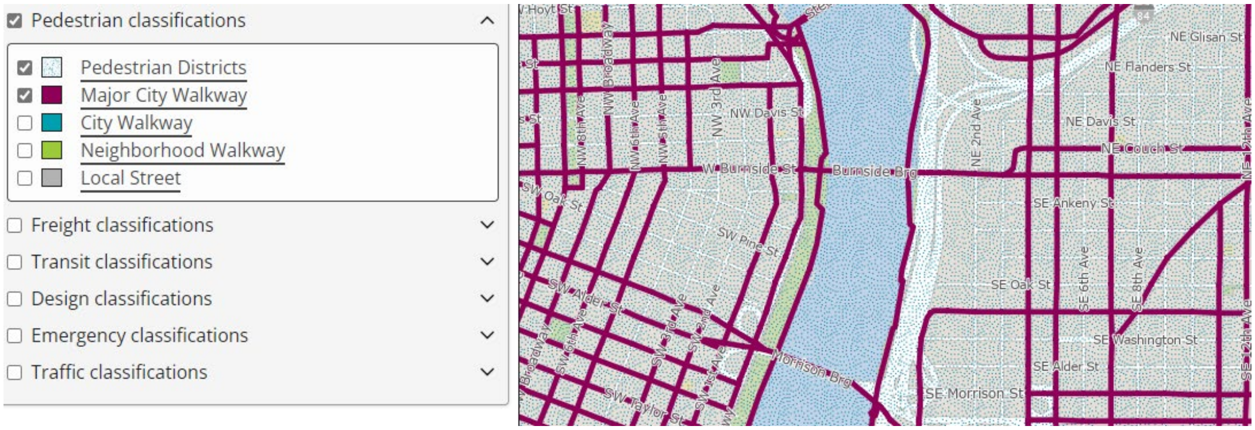
Characteristics: The size and configuration of a Pedestrian District should be consistent with the scale of walking trips. A Pedestrian District includes both sides of the streets along its boundaries, except where the abutting street is classified as a Regional Trafficway. In these instances, the land up to the Regional Trafficway is considered part of the Pedestrian District, but the Regional Trafficway itself is not.

Access to Transit: A Pedestrian District should have, or be planned to have, frequent transit service and convenient access to transit stops.

Improvements: Pedestrian Districts should be designed to provide a safe and comfortable walking environment for high volumes of people walking, with a highly connected and built-out pedestrian network with relatively low levels of delay at signals and other crossings. Major City Walkways and City Walkways within Pedestrian Districts should have closely spaced marked crossings.

The Burnside Bridge is within a designated Major City Walkway classification. Per the TSP, Major City Walkways are intended to provide safe, convenient, and attractive pedestrian access along major streets and trails with a high level of pedestrian activity supported by current and planned land uses. These include Civic and Neighborhood Corridors, Civic and Neighborhood Main Streets, frequent transit lines, high-demand off-street trails, and streets in areas with a high density of pedestrian-oriented uses.

Figure 1. Transportation System Plan (City of Portland GIS) – Major City Walkway



Within the Major City Walkway classification, the following considerations apply:

Land Use: Major City Walkways generally serve areas with the highest density of mixed-use zoning, major commercial areas, and major destinations. Where auto-oriented land uses are allowed on Major City Walkways, site development standards should address the needs of people walking for access.

Improvements: Consider special design treatments for Major City Walkways that are also designated as Civic or Neighborhood Main Streets. Major City Walkways should have regularly spaced marked crossings (with closer spacing in Pedestrian Districts), wide sidewalks on both sides, and a pedestrian realm that can accommodate high volumes of pedestrian activity.

2.1.2 Bicycle Classification

The Burnside Bridge is within a designated Bicycle District. Per the TSP, Bicycle Districts are areas with a dense concentration of commercial, cultural, institutional and/or recreational destinations where the City intends to make bicycle travel more attractive than driving. Within this district, the following considerations apply:

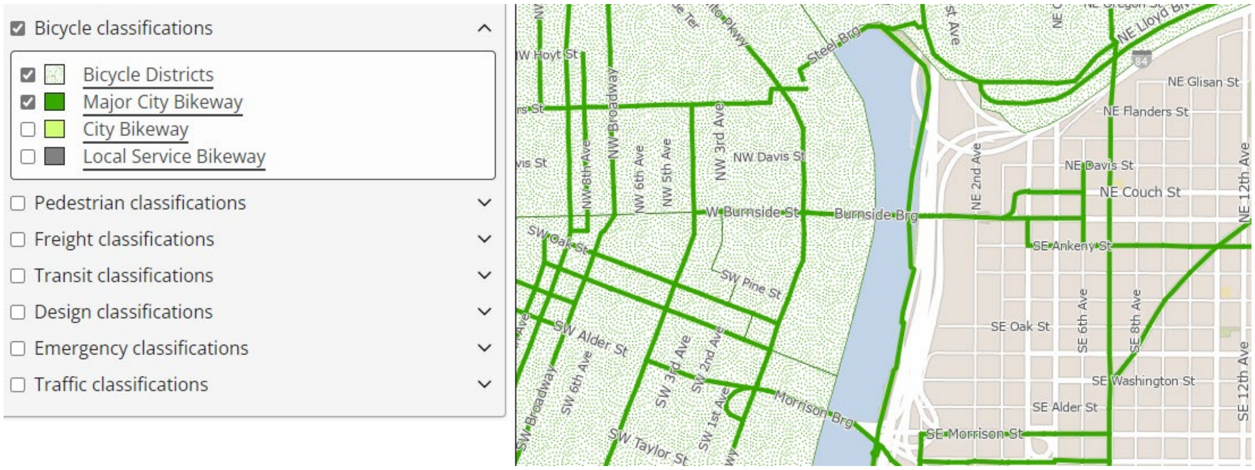
Land Use: High density and mixed-use neighborhoods should be targeted as bicycle districts. Auto-oriented development should be discouraged in Bicycle Districts.

Characteristics: The size and configuration of a Bicycle District should be consistent with the scale of bicycling trips. A Bicycle District includes the streets along its boundaries, except where the abutting street is classified as a Regional Trafficway.

Improvements: All streets within a Bicycle District are important in serving bicycle trips. Appropriate bicycle facilities should be determined for each street based on the desired bicycling conditions and operations. Use the bikeway design and engineering guidelines to design streets within Bicycle Districts.

The Burnside Bridge is within a designated Major City Bikeway classification. Per the TSP, Major City Bikeways form the backbone of the city's bikeway network and are intended to serve high volumes of bicycle traffic and provide direct, seamless, efficient travel across and between transportation districts.

Figure 2. Transportation System Plan (City of Portland GIS) – Major City Bikeway



Within the Major City Bikeway classification, the following considerations apply:

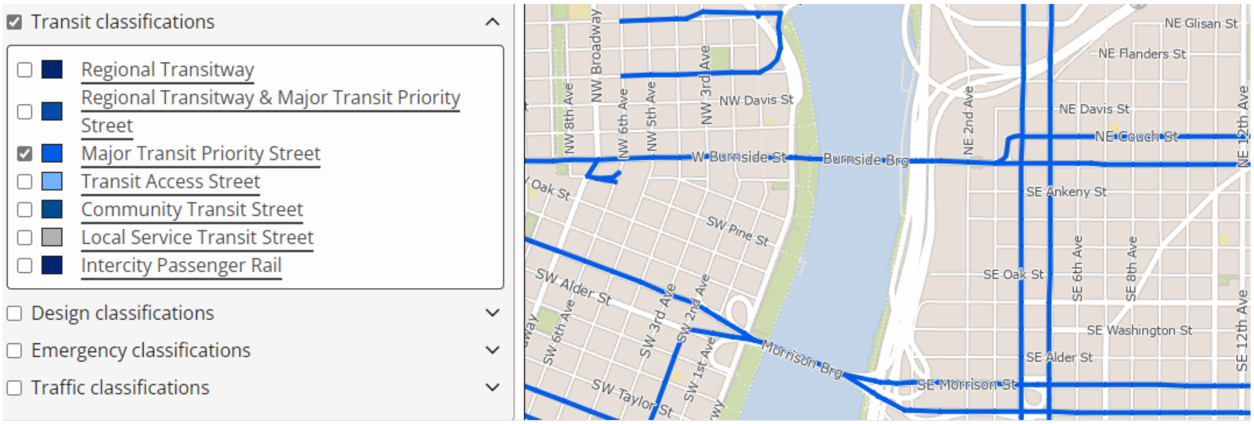
Land Use: Major City Bikeways should support 2040 land use types.

Improvements: Major City Bikeways should be designed to accommodate large volumes of people bicycling, to maximize their comfort and to minimize delays by emphasizing the movement of people bicycling. Build the highest quality bikeway facilities. Motor vehicle lanes and on-street parking may be removed on Major City Bikeways to provide needed width for separated-in-roadway facilities where compatible with adjacent land uses and only after performing careful analysis to determine potential impacts to the essential movement of all modes. Where improvements to the bicycling environment are needed but the ability to reallocate road space is limited, consider alternative approaches that include property acquisition, or dedication, parallel routes and/or less desirable facilities. On Major City Bikeways developed as shared roadways, use all appropriate tools to achieve recommended performance guidelines. Where conditions warrant and where practical, Major City Bikeways should have separated facilities for people bicycling and people walking.

2.1.3 Transit Classification

The Burnside Bridge is within a designated Major Transit Priority classification. Per the TSP, Major Transit Priority Streets facilitate the frequent and reliable movement of transit vehicles that connect Central City, regional centers, and town centers with each other and to other major destinations. Major Transit Priority Streets are provided frequent service or are expected to receive that level of service in the future to support envisioned growth.

Figure 3. Transportation System Plan (City of Portland GIS) - Major Transit Priority Street



Within this classification, the following considerations apply:

Land Use: Transit-oriented land uses should be encouraged to locate along Major Transit Priority Streets, especially in centers. Discourage auto oriented development from locating on a Major Transit Priority Street, except where the street is outside the Central City, center, station community, or main street and is also classified as a Major City Traffic Street. Support land use densities that vary directly with the existing and planned capacity of transit service.

Access to Transit: Provide safe and convenient access for people walking and people bicycling to, across, and along Major Transit Priority Streets. Provide safe and accessible pedestrian crossings at all transit stops along Major Transit Priority Streets.

Improvements: Provide transit signal priority at major intersections, prioritize transit stops or transit lanes over on-street parking, and provide enough lane width to accommodate standard transit vehicles. Consider the use of exclusive or semi-exclusive transit lanes where needed to reduce congestion-related transit delay. Design intersections of Major Transit Priority Streets with other Major Transit Priority Streets or Transit Access Streets to allow turning movements of a standard transit vehicle. Where compatible with adjacent land use designations, right-of-way acquisition or parking removal may occur to accommodate transit-preferential measures or improve access to transit. The use of access management should be considered where needed to reduce conflicts between transit vehicles and other vehicles. Carefully consider any street design changes to Major Transit Priority Streets that impact travel time in light of the potential costs and benefits to transit riders, while also taking into account other adopted goals and policies.

Traffic Slowing: Major Transit Priority Streets are not eligible for new traffic slowing devices such as speed bumps or speed cushions. Existing traffic slowing devices on Major Transit Priority Streets may remain and may be maintained and replaced as needed.

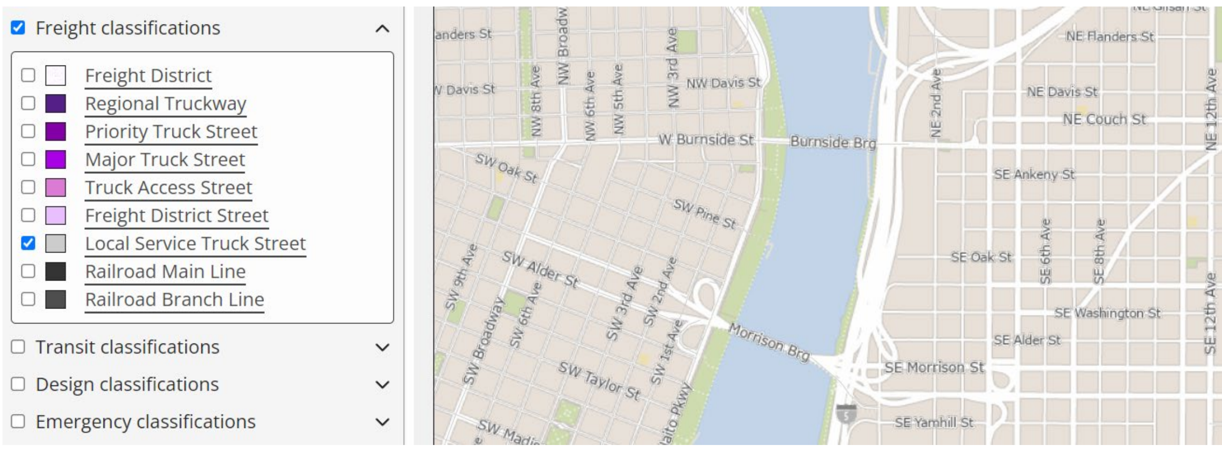
Transfer Points: Provide safe and convenient transfer points with accessible stops, covered waiting areas, transit route information, benches, trash receptacles, enhanced signing, lighting, and telephones.

Bus Stops: Locate bus stops to provide convenient access to neighborhoods and commercial centers. Stops should be located roughly every one-quarter to one-half mile, while taking into account other factors including the need to serve major destinations, activity centers, transfer points and people with disabilities. Stop spacing should also take into account existing sidewalk and street connectivity, with potentially closer stop spacing where sidewalk and street connectivity is more limited. On-street parking should be prohibited at bus stops to provide accessible waiting areas. Passenger amenities should include shelters and route information.

2.1.4 Freight Classification

The Burnside Bridge is within a designated Local Service Truck Street classification. Per the TSP, Local Service Truck Streets are intended to serve local truck circulation and access.

Figure 4. Transportation System Plan (City of Portland GIS) - Local Service Truck Street



Within this classification, the following considerations apply:

Land Use: Local Service Truck Streets provide for goods and service delivery to individual commercial, employment, and residential locations outside of Freight Districts.

Function: Local Service Truck Streets should provide local truck access and circulation only.

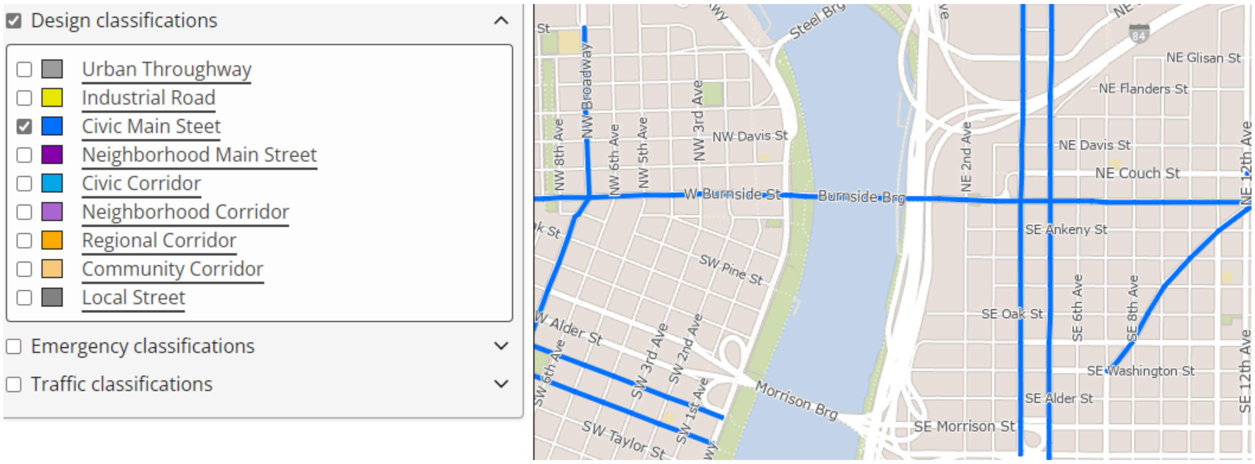
Connections: All streets, outside of Freight Districts, not classified as Regional Truckways, Priority Truck Streets, Major Truck Streets, or Truck Access Streets are classified as Local Service Truck Streets. Local Service Truck Streets with a higher Traffic classification are the preferred route for local access and circulation.

Design: Local Service Truck Streets should give preference to accessing individual properties and the specific needs of property owners and residents along the street. Use of restrictive signage and operational accommodation are appropriate for Local Service Truck Streets.

2.1.1 Street Design Classification

The Burnside Bridge is within a designated Civic Main Street Design classification. Per the TSP, Civic Main Streets serve people throughout the City and are designed to emphasize multimodal access to major activity centers.

Figure 5. Transportation System Plan (City of Portland GIS) – Civic Main Street Design Classification



Within this classification, the following considerations apply:

Land Use: Civic Main Streets are segments of Civic Corridors located within the Central City, Regional Centers, Town Centers, Neighborhood Centers, and other areas of intensive commercial activity. Development consists of a mix of uses that are oriented to the street.

Lanes: Civic Main Streets typically include two to four vehicle lanes, with additional turning lanes as needed. Lanes may be dedicated as transit-only or business-access-transit lanes if needed to improve transit speed and reliability.

Width: Civic Main Streets generally feature a wider right-of-way than Neighborhood Main Streets and are more often able to provide the desired space for each mode and function.

Function: Civic Main Streets should emphasize pedestrian access to adjacent land uses while also accommodating access and mobility for other modes.

Curb zone: The curb zone along Civic Main Streets should emphasize access and place-making functions (such as parking, loading, transit stops, street trees, curb extensions, and street seats) to support adjacent land use and improve the pedestrian realm. The curb zone may be used for mobility functions if space is needed to provide bicycle facilities or provide turn lanes near intersections.

Separation: Civic Main Streets have frequent street connections and support multimodal access to destinations. Sidewalks should be provided, and pedestrian and bicycle crossings should be signalized or improved with median refuge islands or curb extensions as needed to provide safety and comfort. Bicycle facilities should be separated from motor vehicle traffic.

Design Elements: Civic Main Street design should typically include the following: wide sidewalks with a through pedestrian zone, a furnishing zone, and a frontage zone; closely spaced pedestrian crossings; separated bicycle facilities; wayfinding; transit priority treatments as needed; vehicle lanes; low vehicle speeds; medians and/or turn lanes as needed; and limited driveway access.

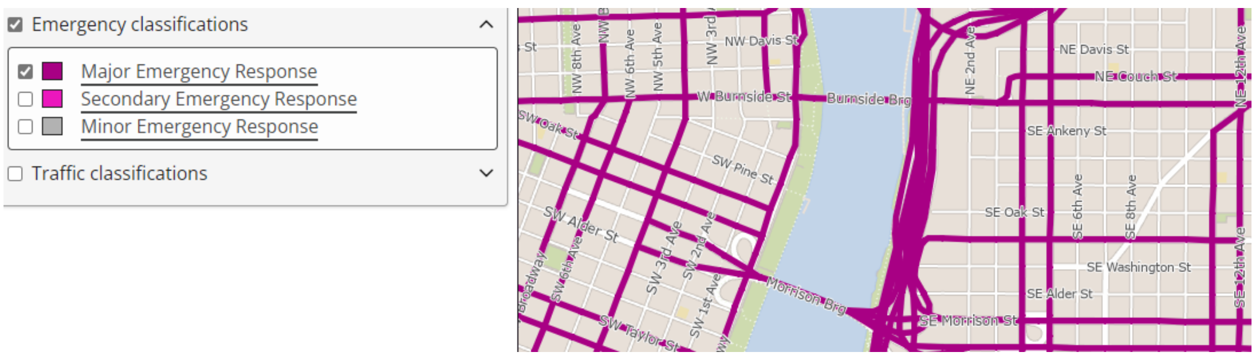
Design Treatment: During improvement projects, the preservation of existing vegetation, topography, vistas and viewpoints, driver perception, street lighting, and sight distance requirements should be considered.

Utilities: Consider undergrounding or reducing the visual impact of overhead utilities along Civic Main Streets.

2.1.2 Emergency Response Classification

Emergency Response Streets are intended to provide a network of streets to facilitate prompt emergency response. The Burnside Bridge is within a designated Major Emergency Response classification. Per the TSP, Major Emergency Response Streets are intended to serve primarily the longer, most direct legs of emergency response trips.

Figure 6. Transportation System Plan (City of Portland GIS) - Major Emergency Response



Within this classification, the following considerations apply:

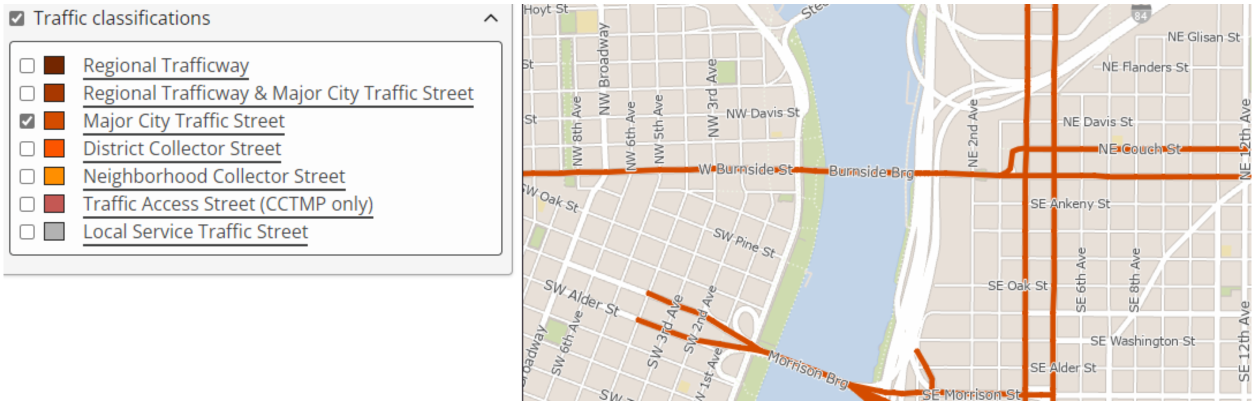
Improvements: Design treatments on Major Emergency Response Streets should enhance mobility for emergency response vehicles by employing preferential or priority treatments.

Traffic Slowing: Major Emergency Response Streets that also have a Local Service or Neighborhood Collector traffic classification are eligible for speed cushions, subject to the approval of Portland Fire and Rescue. Major Emergency Response Streets that also have a District Collector or higher traffic classification are not eligible for traffic slowing devices in the future. Existing speed bumps on Major Emergency Response Streets may remain temporarily and shall be replaced with speed cushions when streets are repaved or undergo other major modifications, subject to the approval of Portland Fire and Rescue. Speed cushions should be designed to achieve a similar level of traffic speed reduction as speed bumps.

2.1.3 Traffic Classification

The Burnside Bridge is within a designated Major City Traffic Street classification. Per the TSP, Major City Traffic Streets are intended to serve as the principal routes for interdistrict traffic that has at least one trip end within a City of Portland transportation district.

Figure 7. Transportation System Plan (City of Portland GIS) – Major City Traffic Street



Within this classification, the following considerations apply:

Safety: Safety should be the highest priority on Major City Traffic Streets. Safety countermeasures should be employed on Major City Traffic Streets to address identified safety risks with a focus on eliminating fatal and serious injury crashes for all modes. Major City Traffic Streets should provide separation between motor vehicles and people walking, bicycling, and using mobility devices, and provide safe multimodal crossings to destinations.

Land Use / Development: Major City Traffic Streets should provide motor vehicle connections among the Central City, regional centers, town centers, industrial areas, and intermodal facilities. Auto-oriented development should locate adjacent to Major City Traffic Streets, except within designated centers, main streets, station areas, and other areas with high pedestrian demand.

Connections: Major City Traffic Streets should serve as primary connections to Regional Trafficways and serve major activity centers in each district. Traffic with no trip ends within a City of Portland transportation district should be discouraged from using Major City Traffic Streets. Where a Major City Traffic Street intersects with a Neighborhood Collector or Local Service Traffic Street, access management and/or turn restrictions may be employed to reduce traffic delay.

On-Street Parking: On-street parking may be removed, and additional right-of-way purchased to provide adequate traffic access when consistent with the street design designation of the street. Evaluate the need for on-street parking to serve adjacent land uses and improve the safety of people walking and people bicycling when making changes to the roadway.

2.2 General Bridge Cross Section

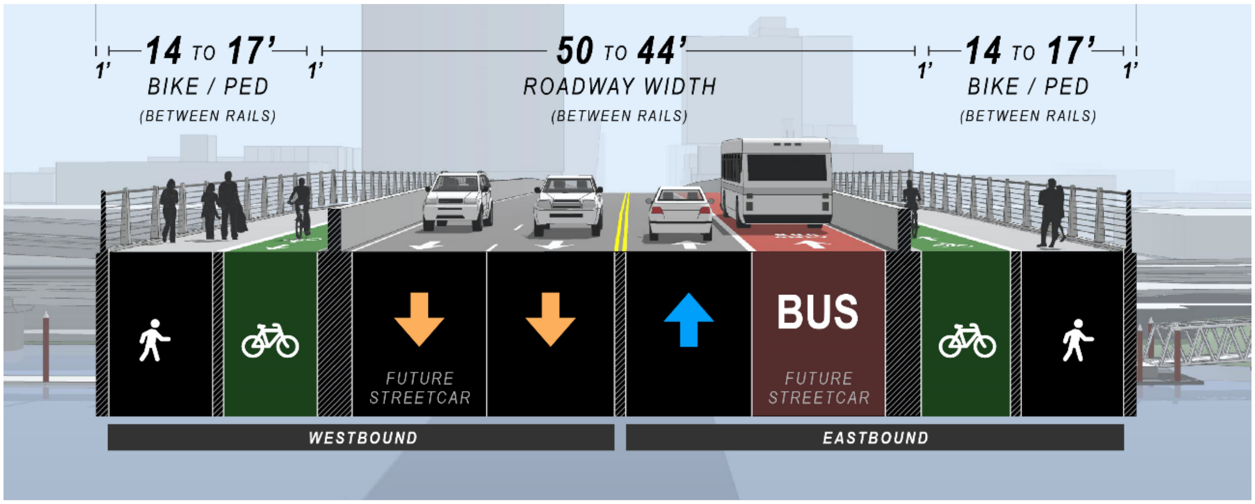
As presently planned, the Burnside Bridge would provide approximately 78 feet of usable width for vehicle lanes, bicycle lanes, and pedestrian space (Figure 8), which is comparable to the existing bridge. This 78-foot bridge width is derived from a cross section that allocates its space to two usable realms:

1. A single interior roadway space has suggested widths ranging from 44 to 50 feet, depending on the selected design option. The Preferred Alternative would accommodate four vehicle lanes. The City of Portland, on July 20, 2022, declared its

preferred lane configuration as two westbound lanes (general-purpose) and two eastbound lanes (one general-purpose and one bus-only lane).

2. Two exterior combined bicycle/pedestrian spaces each have suggested widths ranging from 14 to 17 feet, depending on the selected design option. This space would consist of a single level (i.e., no curb separating the bicycle and sidewalk portions) and be separated by a 1-foot sidewalk buffer (i.e., tactile strip).

Figure 8. Preferred Alt Lane Configuration (West Approach Shown; Others Similar)



Physical barriers would be provided between vehicle lanes and the bicycle lanes in addition to the lane dimensions provided. For the East Approach span, additional width would be required for the above-deck superstructure members, such as arch ribs or cables. For the east and west bridgeheads, the cross sections would widen to add additional traffic lanes at the intersections of 2nd Avenue (west bridgehead) and Martin Luther King Jr (MLK) Boulevard (east bridgehead).

The cross section would accommodate a westbound bus dwell space on the west end of the bridge between Bent 1 and Bent 4. On both the east and west bridgeheads, there are buildings that connect to the bridge deck.

2.3 Bridge Type

The proposed Burnside Bridge consists of three bridge components: the West Approach, the Main River Span, and the East Approach. At this time, the East Approach bridge type has not been selected and could be either a tied arch (Figure 9) or cable-stayed (Figure 10) type. Both bridge type options are being carried forward into the Final Design phase so that the bridge type decision can be informed by more detailed cost information and estimates developed by the selected CM/GC contractor.

Figure 9. Preferred Alternative with Bascule Movable Span (Tied Arch East Approach)

Figure 10. Preferred Alternative with Bascule Movable Span (Cable-stayed East Approach)

2.3.1 West Approach

The proposed Burnside Bridge includes a girder bridge type for the West Approach, which would be about the same width as the existing bridge. It avoids an adverse effect on the Skidmore/Old Town Historic District National Historic Landmark (NHL). The proposed Burnside Bridge would require two sets of larger bridge columns in the park (versus four with the existing bridge). They are located to provide the necessary horizontal offsets from Naito Parkway and the Willamette Greenway Trail that each traverse under the bridge.

2.3.2 Movable Span

The proposed Burnside Bridge has a bascule bridge as its movable span. The Movable Span will satisfy the required U.S. Coast Guard horizontal and vertical navigational clearances for the main span; the requirements include enabling 100 percent of vessel traffic to safely transit under the bridge. The minimum clearances that will allow all vessel traffic to safely transit the bridge are as follows:

- Minimum Vertical Clearance (movable span in the raised position): Elevation 167.0 (NAVD88 datum). This would provide approximately 147 feet of vertical clearance above the ordinary high water mark surface elevation of 20.1 (NAVD88).

- Minimum Vertical Clearance (movable span in the closed position): Elevation 69.0 (NAVD88 datum). This would provide approximately 49 feet of vertical clearance above the ordinary high water mark surface elevation of 20.1 (NAVD88).
- Minimum Horizontal Clearance (permanent condition): 205 feet wide.
- Minimum Horizontal Clearance (temporary construction condition): 165 feet wide.

The Movable Span will be supported by “delta piers,” or trapezoid-shaped piers sized to accommodate a bascule counterweight within the interior void of the pier. The piers will also be equipped with starlings, which are in-water structures that divide and deflect river water and floating debris on the upstream (south) side of the bridge. While these are currently anticipated to be formed starlings, they may alternatively be a smaller structure of equivalent function, such as a dolphin.

2.3.3 East Approach

The proposed Burnside Bridge identified a long-span bridge type for the East Approach but left open the decision for a cable-stayed or tied arch bridge type option.

For the tied arch option, the Long-span Alternative includes a span length that minimizes the risks and reduce costs associated with placing a pier and foundation in the geologic hazard zone that extends from the river to about E 2nd Avenue. The tied arch option places the eastern pier of the tied arch span farther east, thereby increasing the length of the tied arch span but reducing the length and depth of the subsequent girder span to the east.

For the cable-stayed option, the tower is placed as reasonably close to the Union Pacific Railroad (UPRR) tracks as permissible, with the assumption that geotechnical ground improvements are necessary to mitigate the seismic geologic hazards. This results in differing cable-stayed span lengths. Based on the current tower location, UPRR pier protection is not required.

2.3.4 Ancillary Elements

West Side Access to 1st Avenue

Near the west end of the existing bridge, there are County-owned stairs on both sides of the bridge that connect the existing on-bridge bus stop to West 1st Avenue (under the bridge) where the existing Skidmore Fountain MAX station is located. The NEPA phase evaluated replacing the stairs with Americans with Disabilities Act (ADA)-accessible elevators combined with stairs, a ramp, and improving the sidewalks between the end of the bridge and West 1st Avenue to create a safer and more ADA-accessible surface-level pedestrian route. In addition to improving the sidewalks, the range of supplemental connection options includes no additional connection (i.e., using the improved sidewalks to access the bridge); stairs on one or both sides of the bridge; a ramp on the south side of the bridge; or elevators on one or both sides of the bridge. There could also be combinations of these connection types. The proposed Burnside Bridge Project does not include a final selection of access to West 1st Avenue; and a decision on the need for and type of access at this location would be made during the Final Design phase.

Vera Katz Eastbank Esplanade Access

There is agreement between the City and County that there will be no ramp constructed from the bridge to the Eastbank Esplanade as part of the EQRB Project. Further, a decision about whether to maintain or remove the existing stairway is not known at this time but will be made early in the Final Design phase and is subject to applicable laws, regulations and standards, including the Americans with Disability Act.

2.4 Bridge Geometry

2.4.1 Bridge Location

The proposed replacement bridge is placed at approximately the same location as the existing bridge. The total bridge length is approximately 2,290 feet, which is comparable to the existing bridge. The West Approach abutment is located approximately 80 feet east of the current abutment, and the East Approach abutment is located approximately 30 feet east of the existing abutment.

2.4.2 Bridge Horizontal Alignment

General Alignments

The preferred horizontal alignment would generally maintain the existing alignment of Burnside Street across the entire bridge. The existing one-way couplet of NE Couch Street for westbound traffic and E Burnside Street for eastbound traffic would be maintained, including the existing “S” curves for NE Couch Street. Minor alignment differences between Long-span structure types on the East Approach were necessary to accommodate structural components (tied arch ribs and cables), avoid existing buildings on both sides of the river, and to tie into lane transitions for the approach roadway.

Approach Transitions

The four-lane cross section options discussed above apply to the Movable Span and majority of the East and West Approach spans. Exceptions occur where the lanes transition to tie into the existing at grade street system to the west of Naito Parkway and east of E 2nd Avenue. The following discusses the needs for wider cross sections at the approaches.

Transition Geometry

The bridge transitions on both sides of the river are based on Federal Highway Administration (FHWA) *Manual on Uniform Traffic Control Devices (MUTCD)* (FHWA 2009) formulas for low speeds. Assuming 25 mph, the tapers are approximately 10:1.

Figure 11. Transition Locations

West Approach Transition

After multiple discussions with TriMet and the City of Portland it was decided that the existing TriMet westbound bus stop would move west, off the bridge structure. This adjustment eliminated the need for multiple bus pullouts on the bridge and eliminates rider queues within the bridge multi-use path. One of the two TriMet bus pullouts on the existing Burnside Bridge was included in the new design just before the westbound right turn lane. This bus pullout accommodates TriMet's existing operational need for some buses to dwell outside active traffic lanes before going into service.

Other geometry required for transitioning to reduced vehicular lanes and reduced sidewalk width off the bridge is listed below:

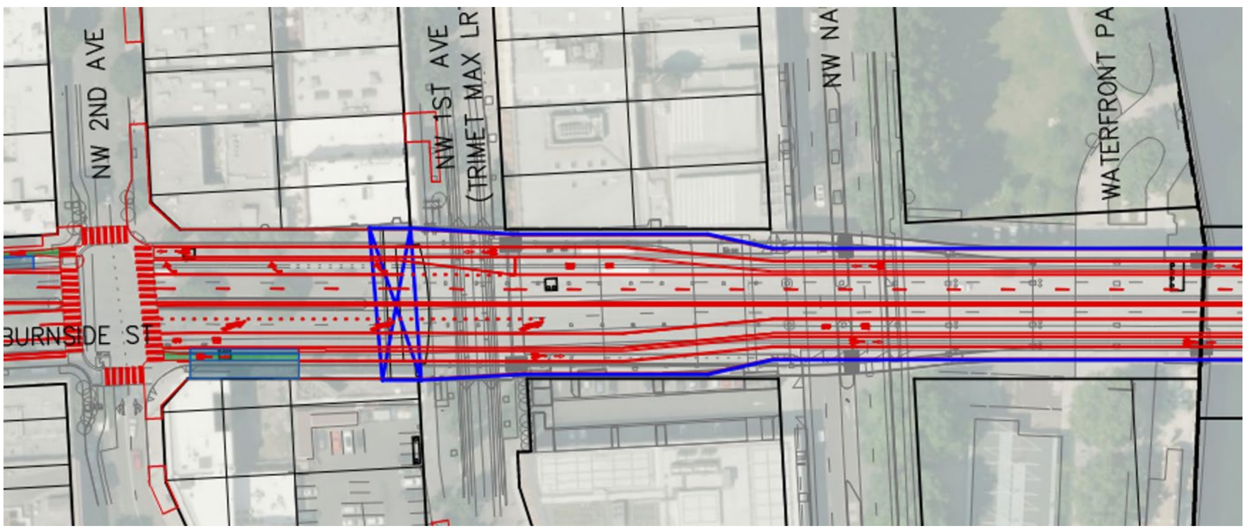
- Transitions from six lanes and four lanes between NW 1st Avenue and NW Naito Parkway.
- Eastbound Direction – There are three existing lanes (two general purpose and one bus-only) at NW 2nd Avenue. For options that reduced to two eastbound lanes on the bridge, the merge needed to occur east of NW 2nd Avenue due to traffic signal

operations. This merge extended onto the West Approach due to merging distance requirements.

- Westbound Direction – Two general purpose lanes and a right -turn lane need to start on the West Approach due to traffic signal operations at NW 2nd Avenue.
- Trees within the median between NW 1st Avenue and NW 2nd Avenue are assumed to be removed to provide wider bicycle/pedestrian facilities. At this location, extra space for people walking is important for the patrons that queue within the NW sidewalk at the Portland Rescue Mission building entrance. Extra space for people bicycling is important in the eastbound direction to accommodate different speeds of users as they climb the bridge approach grade.

See Figure 12 for a snapshot of the West Approach.

Figure 12. West Approach



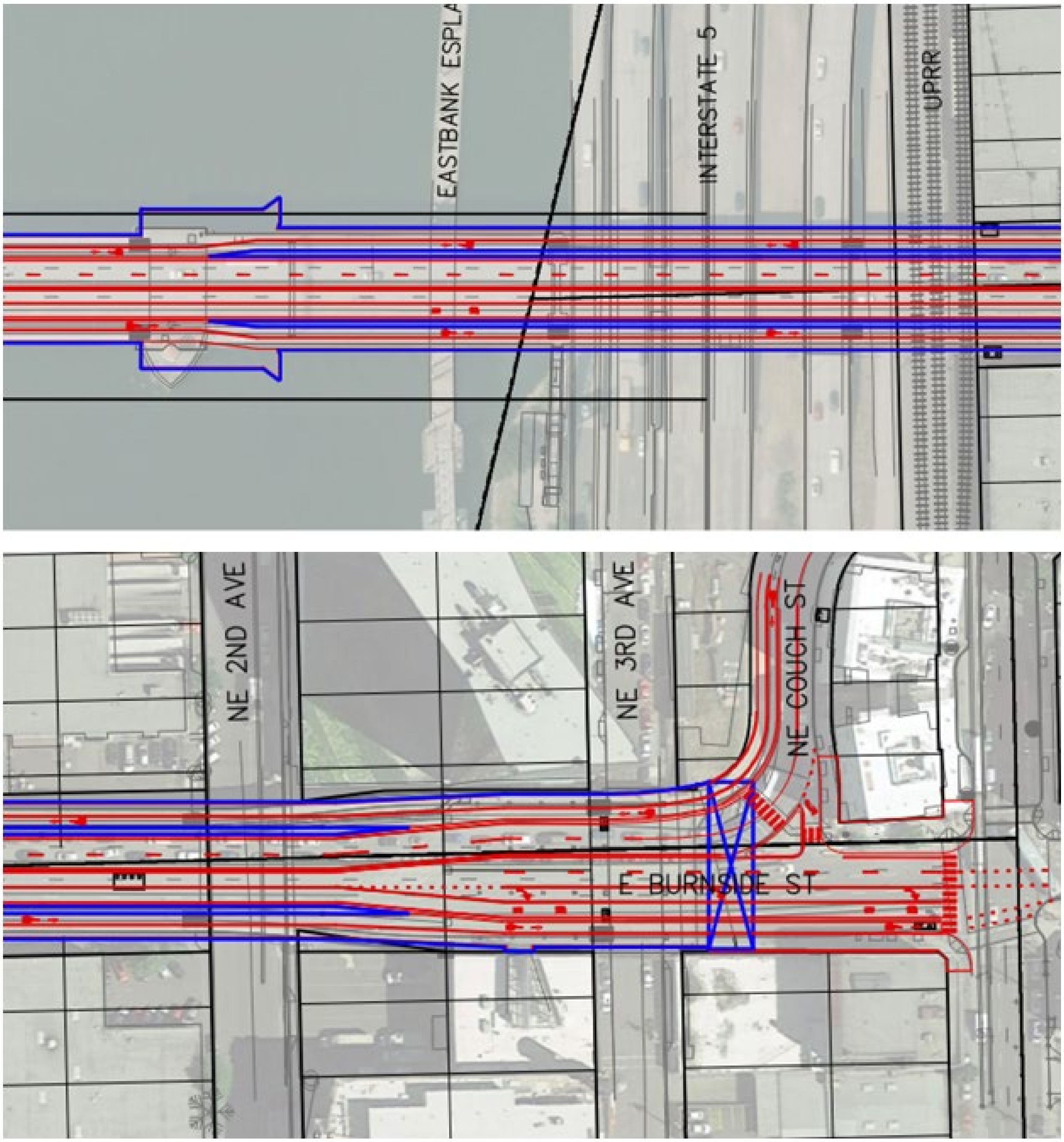
East Approach Transition

Geometry required for transitioning to additional vehicular lanes and reduced sidewalk width off the bridge are listed below:

- Transitions from four lanes and six lanes between NE 2nd Avenue and NE 3rd Avenue.
- Eastbound Direction: East end of the East Approach needs to widen to four eastbound lanes (two general purpose lanes, a right turn lane, and a bus-only lane) due to traffic signal operations at NE MLK Boulevard.
- Westbound Direction: There are two existing lanes at NE Couch Street.

See Figure 13 for a snapshot of the east approach.

Figure 13. East Approach



2.4.3 Bridge Vertical Profile

Various profiles were developed for a low movable bridge alternative located on the existing alignment. The objective of the chosen vertical profile is to maintain or slightly exceed the existing closed bascule span clearance over the navigation channel and satisfy other land transportation mode clearances.

Additionally, the profile needs to maintain existing sidewalk access to adjacent buildings west of NW 1st Avenue, and east of SE 2nd Avenue. Furthermore, profiles studied focused on maximizing vertical clearances over Tom McCall Waterfront Park to provide emergency vehicle access within the park. It is also important to minimize grade as much as possible to encourage walking, biking, and rolling on the bridge. Lastly, for the bascule Movable Span, it is desirable that the high point of the vertical crest curve be placed at the toe/center of the bascule span to ensure stormwater runoff flows away from the open joint at the center of the span.

This resulted in profiles with a maximum grade of 4.60 percent, which is slightly steeper than the existing bridge vertical profile grade of 3.86 percent. While this meets the 5 percent maximum grade requirement for ADA accessibility, less steep grades are typically desired by the ADA community.

Continued design development evaluated opportunities to reduce grade while ensuring the high point was located at the center of the Movable Span and vertical clearance requirements were met.

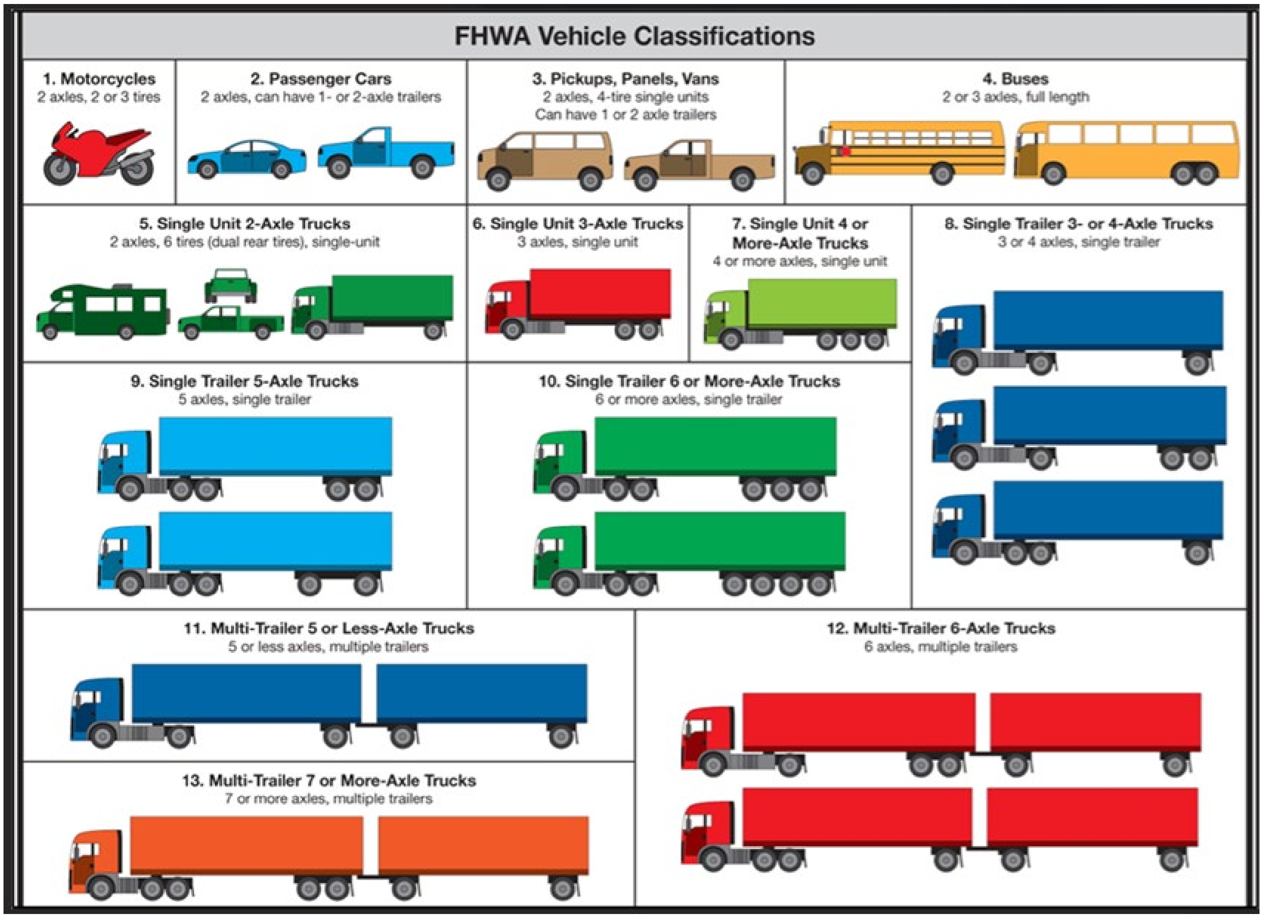
3 Bridge Modal Types and Volumes

3.1 Motorized Vehicle Types

3.1.1 FHWA Vehicle Classifications

FHWA classifies vehicles into one of 13 categories depending on the size of the vehicle. See Figure 14 for the FWHA 13-classification system. Medium trucks include Classes 5-7 and range from 10,000 to 26,000 pounds. In AutoTURN, these are similar to SU-30 vehicles. Heavy trucks include Classes 4, 8-13 and range from 26,000 to 31,000 pounds. In AutoTURN, these are similar to City Bus, WB-40, WB-62, and WB-67 vehicles.

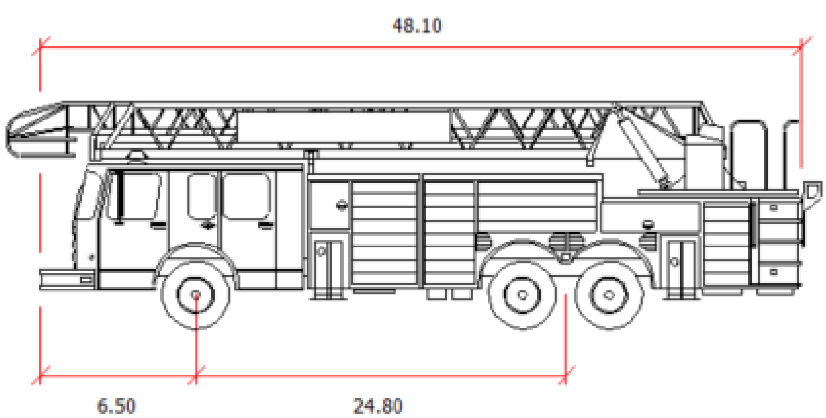
Figure 14. FHWA Vehicle Classifications



3.1.2 Emergency Vehicles

The bridge is classified as a Major Emergency Response Street in the TSP and will see a variety of emergency vehicles including police, ambulance, and Portland Fire and Rescue fire trucks and fire engines. The largest emergency vehicle that will operate on the bridge is the City of Portland T-1 Fire Truck (Figure 15).

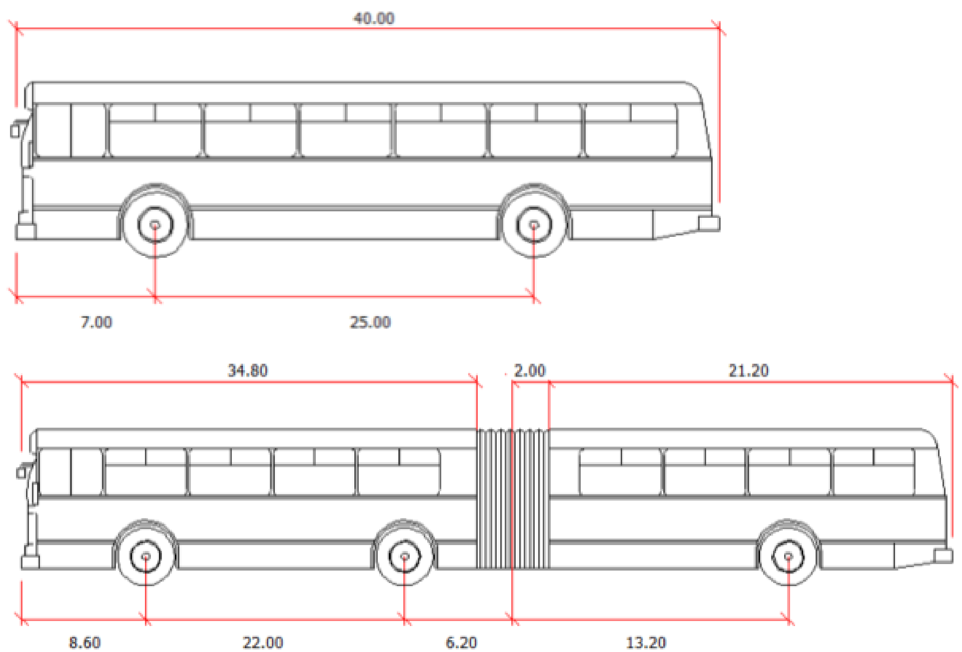
Figure 15. City of Portland T-1 Fire Truck



3.1.3 Transit Vehicles

Standard buses (Figure 16) are the only transit vehicles currently operating on the bridge, however this evaluation considered articulated buses and streetcar vehicles based on potential future operations. Initially, streetcar vehicles were assumed to match existing streetcar vehicles in Portland, which include mirrors and have very limited battery power (thus requiring OCS wires for power). During an August 29, 2023, cross section meeting focused on streetcar, Portland Streetcar representatives indicated that this cross section study should assume that all existing streetcar vehicles will be replaced by newer vehicles that use rear-view cameras instead of mirrors (thus a narrower clearance envelope) and have enough battery capacity to not require OCS wires on the new Burnside Bridge.

Figure 16. Standard Bus and Articulated Bus



3.2 Motorized Vehicle Volumes

Table 4 below displays the Annual Daily Traffic (ADT) estimates for the Burnside Bridge along with other bridges in the downtown area. In addition to showing ADT volumes, Table 4 summarizes the medium and heavy truck volumes and provides these volumes as percentages of the total ADT counts. The Burnside Bridge is estimated to carry 35,000 vehicles per day, with 19,000 eastbound and 16,000 westbound. At 35,000 ADT, the Burnside Bridge is the third busiest non-interstate bridge in the downtown area.

As a percentage of ADT, the Burnside Bridge has 1.3 percent medium volume (MV) trucks and 2.1 percent heavy volume (HV) trucks total. The percentage of HV includes buses so the actual volume of large trucks should be much less than what is included in Table 4**.** The percentage of medium and heavy trucks are similar to the other non-interstate bridges in the downtown area.

Table 4. Daily Vehicle Volumes on Area Bridges 2019

Table 2. Daily Vehicle Volumes on Area Bridges 2019

Average Daily Traffic (ADT), Medium trucks (MV): Classes 5-7, Heavy trucks (HV): Classes 4, 8-13

Vehicle Average Daily Traffic Counts															
	Eastbound					Westbound					Total				
Bridges	ADT	MV	%	HV	%	ADT	MV	%	HV	%	ADT	MV	%	HV	%
Fremont	69,100					73,950					143,050	5,680	4.0	5,880	4.1
Broadway	14,000	170	1.2	175	1.3	14,500	215	1.5	110	0.8	28,500	385	1.4	285	1.0
Steel	7,500	135	1.8	350	4.7	5,500	70	1.3	370	6.7	13,000	205	1.6	720	5.5
Burnside	19,000	240	1.3	375	2.0	16,000	210	1.3	350	2.2	35,000	450	1.3	725	2.1
Morrison	22,500	265	1.2	145	0.6	27,500	365	1.3	240	0.9	50,000	630	1.3	385	0.8
Hawthorne	15,500	180	1.2	340	2.2	15,000	190	1.3	340	2.3	30,500	370	1.2	680	2.2
Marquam	78,500					71,500					150,000	4,425	3.0	10,275	6.9
Ross Island	32,250	585	1.8	370	1.2	39,000	690	1.8	480	1.2	71,250	1,275	1.8	850	1.2

Source: Traffic counts conducted by Key Data Network and historical counts provided by ODOT and City of Portland

3.3 Bicycle / Pedestrian / ADA / Miscellaneous Types

3.3.1 Bicycle

The fleet of vehicles that use bikeways is continually diversifying. Guidance from *Designing for Small Things with Wheels* (NACTO 2023) states that the most common devices people ride in urban bikeways fit into one of four operational categories: mini devices (e.g., electric and non-electric scooters, skateboards, rollerblades, personal mobility devices, wheelchairs, etc.), typical bikes (electric and non-electric, upright and recumbent, etc.), cargo bikes (with and without trailers and often carrying goods or passengers), and extra-large bikes (e.g., freight tricycles, pedicabs, etc.). Devices that require a driver’s license and vehicle registration, such as mopeds, are not considered as potential bikeway users.

These vehicles have different widths, lengths, turning radii, speed profiles, response to surface condition, and other characteristics. To accommodate this diversity bikeway design needs to consider passing widths, queueing lengths, turn needs, grade changes, and surface materials.

3.3.2 Pedestrian / ADA

The width of the pedestrian space needs to accommodate a range of different potential users expected along that street type. This could include people walking in opposing directions, people walking next to each other, people carrying bags or packages, people pushing strollers, carts, or other devices, people jogging and running, and people with mobility devices.

An average adult walking comfortably and in a straight line has a width of around 2.5 feet. Other individuals, including those carrying bags or using mobility devices have wider width requirements, between 3 and 4 feet. A 6-foot-wide pedestrian space allows at least two people to walk side by side or pass each other in opposing directions in relative comfort. An 8-foot-wide pedestrian space allows for three people to walk together or to pass others on the sidewalk.

Special attention needs to be paid to the requirements of the ADA. Sidewalk requirements include grades not exceeding 5-percent and an absolute minimum clear width of 4-feet. All cross section options meet ADA requirements.

3.4 Bicycle Volumes

Predicted bicycling volumes were calculated in the Draft EIS, which estimated 2019 and 2040 bike volumes on all the downtown bridges based on previous counts and growth patterns. Bicycling volumes for the Burnside Bridge were calculated as 1,750 bicyclists per day for base conditions in 2019 and 2,950 bicyclists per day for 2040 future year conditions.

Approximately 10 percent of daily trips typically occur in the peak hour, although this can vary for bicycling from 7 percent to 15 percent depending on the type of location. Daily volumes were multiplied by 10 percent to get peak hour volumes, and then multiplied by a 70 percent/30 percent directional split to identify volumes in the peak direction. This resulted in a 2040 directional peak hour volume prediction of approximately 205 bicyclists per hour in the peak direction. These volumes fall into the range (150-750 bicyclists/hour) where guidance prefers a bicycling zone width of 8 feet with a minimum of 6.5 feet.

This should be considered the low-end of bicycling design volumes. The high-end of these volumes is calculated in Section 1.5.2.

4 Range of Cross Sections Studied

For this study, six representative cross section options were studied as defined in Table 1. All six options included the same 78-foot clear width. All options included a symmetrical bicycle/pedestrian space on both sides of the bridge. All options include two westbound general-purpose lanes, one eastbound general-purpose lane, and one eastbound bus-only lane.

They consist of three options, with sub-options for alternative roadway lanes / shoulder / median widths, as described below, as defined in Table 5, and as illustrated in Appendix A.

4.1.1 Option 1 (Maximum Vehicular Allocation)

This option has the maximum vehicular space (50 feet) and 14 feet bicycle/pedestrian space on each side. Option 1a has four 11-foot lanes and 2-foot shoulders on both sides. In comparison, Option 1b increases shoulders to three feet on both sides by reducing all four lanes to 10.5 feet.

4.1.2 Option 2 (Maximum Bicycle/Pedestrian Allocation)

This option has the maximum bicycle/pedestrian space (17 feet on each side) and 44 feet of vehicular space. Option 2a has 10-foot outside lanes and a 2-foot median. In comparison, Option 2b has 11-foot outside lanes and no median.

Of the options studied, Option 2b is the only option considered acceptable by PBOT.

4.1.3 Option 3 (Compromised Allocation)

This option has a compromised allocation of vehicular and bicycle/pedestrian space: 47 feet of vehicular space, and 15.5 feet of bicycle/pedestrian space on each side. Option 3a has 10-foot inside lanes and 2-foot shoulders on both sides. In comparison, Option 3b has 10.5-foot inside lanes and 1.5-foot shoulders on both sides.

Table 5. Cross Section Options

Option	Westbound				Median	Eastbound				Rdwy Total	Overall Total - West Appr. (No barriers)	Overall Total - West Appr. (With barriers)	Overall Total - East Appr. (With barriers + Arch)
	North Bike/Ped	Shldr	Outside Lane	Inside Lane		Inside Lane	Outside Transit Lane	Shldr	South Bike/Ped				
1a	14	2	11	11	2	11	11	2	14	50	78	82	90
1b	14	3	10.5	10.5	2	10.5	10.5	3	14	50	78	82	90
2a	17	1	10	10	2	10	10	1	17	44	78	82	90
2b	17	1	11	10	0	10	11	1	17	44	78	82	90
3a	15.5	2	11	10	1	10	11	2	15.5	47	78	82	90
3b	15.5	1.5	11	10.5	1	10.5	11	1.5	15.5	47	78	82	90

5 Key Differentiating Considerations

For this study, key differentiating features were identified to provide decision makers with appropriate technical considerations for each cross section option. Differentiating features include:

- Policy Consistency
- Safety and operations
- Comfort
- Roadway Drainage
- Maintenance and Inspection

The features and associated analysis are described in Sections 5.1 and 5.2 below. Each option was evaluated against a certain design feature, and Harvey balls were used to identify the degree to which the Option meets a particular criterion and to provide a qualitative comparison of the options. The full balls indicate that a criterion is met or exceeded, the half balls indicate that a criterion is partially met, and the empty balls indicate that a criterion is not met. A comparison of this evaluation is summarized in Table 6. A detailed summary of each option including pro and con considerations is included in Appendix B.

Table 6. Comparison Matrix

Comparative Summary	Option 1a	Option 1b	Option 2a	Option 2b	Option 3a	Option 3b
DIFFERENTIATING FEATURES	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**	**Evaluation**
1) Active Transportation Space						
a) Policy Consistency						
1. Pedestrian / Bicycling Space	○	○	●	●	○	○
b) Safety						
1. Operating Envelope	○	○	●	●	◑	◑
c) Comfort						
1. Potential for Ped/Bike Conflicts	○	○	●	●	◑	◑
2. Shy Distance	○	○	●	●	○	○
d) Maintenance and Inspection	○	○	●*	●*	●	●
2) Vehicular Space						
a) Policy / Standards Consistency						
1. Exterior Lane + Shoulder	●	◑	○	●	●	●
2. Interior Lane + Median	●	●	●	●	●	●
b) Safety and Operations						
1. Lane Widths	◑	○	◑	●	●	◑
2. Shoulder Width	●	◑	◑	●	●	●
3. Median Width	●	●	●	◑	●	●
c) Drainage						
1. Inlet Maintenance	●	●	○	○	●	●

Note: * - Exceeds the minimum width, supporting Mult Co Maintenance team's request to maximize the bike/ped width

Option 1 (Maximum Vehicular Allocation)

This option performed worse in the active transportation evaluation, as it has the least amount of space allocated for people bicycling and people walking. This option does not meet the City's policies and desired minimum widths. The effective width of the bike lane will be narrower than the City's preferred minimum width and as a result there is a higher potential for interactions and conflicts between people bicycling and people walking. This option performed moderately well in the vehicular space criteria.

Option 2 (Maximum Bicycle/Pedestrian Allocation)

This option performed the best in the active transportation evaluation and meets the City's minimum width standards. This option performed moderately well in the vehicular space evaluation, although Option 2a has sub-standard exterior lane widths.

Option 3 (Compromised Allocation)

This option does not meet the City's policies and minimum widths for active transportation. The effective width of the bike lane will be narrower than the City's preferred minimum width and as a result there is a higher potential for interactions and conflicts between people bicycling and people walking. This option performed the best in the vehicular space evaluation.

5.1 Active Transportation Space

5.1.1 Policy Consistency

Bicycle/Pedestrian Space

The cross section elements of the bicycle/pedestrian space were evaluated for compliance with the City of Portland's current policy and design guidelines and based on the TSP classifications for the bridge.

The City's design guidance reflects national research and local experience. It is provided in order to achieve the policy goals expressed in the City's Comprehensive Plan, Transportation System Plan, and the City-County Climate Action Plan. It informs the recommended dimensions for different active transportation cross section elements on the bridge including:

- Pedestrian space: the recommended minimum sidewalk dimensions are included in the *Portland Pedestrian Design Guide* (PBOT 2022). An 8-foot pedestrian through zone (walkway) is the recommended minimum width for a Civic Main Street. A 6-foot pedestrian through zone allows two people to walk side by side or to pass one another. Widths of 7 feet to 8 feet are sufficient for up to three people to walk together or for people walking to pass others on the sidewalk. Narrower walkways may require people to step into the bicycling space to pass other people walking.
- Bicycling space: recommended bicycling zone widths are included in the *Portland Protected Bicycle Lane Design Guide* (PBOT 2021) and depend on directionality and expected bicycling volumes. For unidirectional bike lanes with expected volumes between 150-750 bicyclists per hour in the peak hour, a minimum bicycling zone width of 6.5 feet and a preferred width of 8 feet are recommended. The Guide also notes that additional width may be required as shy distance from vertical elements to provide 6.5 feet of functional width (see below).

  Reduced bike lane widths are likely to require people bicycling to use the pedestrian space to pass slower moving bicyclists. This is observed on the Tilikum Crossing. There, people bicycling frequently go outside the 7-foot bicycle space and into the 6'4" pedestrian space (people bicycling and people walking are separated by an 8-inch stripe). In-field research conducted by PBOT showed that an 8-foot-wide pathway with no integrated shy distance from a vertical barrier will suffice for side-by-side riding and passing behavior for standard bicycles. See Appendix F.

  Designing for Small Things with Wheels (NACTO 2023) is consistent with PBOT's findings and recommends a one-way riding space of 7-8 feet to allow for comfortable riding and passing space for conventional bicycles and independent of shy distance. Larger bicycles, such as cargo bikes, would require an additional 1-foot to accommodate both riding and passing space. In the absence of that additional width, it is likely they will use the pedestrian space.

  The speed differential between users of the bike space will become increasingly prevalent with the increase of e-bikes, e-scooters, and other devices. This will create increased need for users to pass one another.

- Shy distance: people bicycling tend to ride some distance from vertical features such as the bridge railings that will be on either side of the active transportation space, to avoid striking their handlebars or pedals. Based on industry guidance and field testing conducted by PBOT on the Tilikum Bridge (see Appendix F), this shy distance is at least 1 foot to 2 feet from the face of the railing to where the edge of the bike lane is striped. Accounting for the shy distance, the remaining width is the functional width of the bike lane.
- Sidewalk buffer: the Portland Pedestrian Design Guide (2022) provides design guidance for when pedestrian and bicycling space are provided at the same grade. A sidewalk buffer of 1 foot to 4 feet is required to separate these users. Wider sidewalk buffers provide space for street furniture such as light poles, benches, and other features that can provide more physical separation between users. Narrower buffers and those with less vertical features will result in users moving into the other space if adequate space is not provided for the pedestrian and bicycling spaces. The Burnside Bridge midspan will include a minimum 1-foot tactile sidewalk buffer. Experience on other bridges, such as the Tilikum Bridge, have observed people bicycling passing one another by crossing into the pedestrian space, and vice versa. This is also likely to be more prevalent for options where narrower pedestrian through zone and bike lane dimensions are provided.

Based on the above guidance, the City's minimum bicycle/pedestrian space width is 17.5 feet (8-foot ped + 1-foot buffer + 6.5-foot bike + 2-foot shy) and their preferred width is 19 feet (8-foot ped + 1-foot buffer + 8-foot bike + 2-foot shy). The City, however, has stated that they are willing to accept 17 feet, but they would anticipate bicycle and pedestrian conflicts with any space less than 17 feet. This is based on field testing of needed widths adjacent to vertical barriers conducted by City staff in 2021 and included in Appendix F. The City has further stated that the more this space is reduced, the further that it deviates from its Policy objectives. The dimensions provided above are clear widths between bridge rails, with no reduction for bridge appurtenances. Widths that meet or exceed 17 feet are considered compliant with City guidance, and those less than 17 feet are not considered compliant. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B.

5.1.2 Safety

All bridge cross section options include a crash-worthy barrier to separate people bicycling and people walking from vehicular traffic on the bridge. In this way, there is no safety performance difference expected between options.

Operating Envelope

There will be interactions between people bicycling and people walking that impact the safety and comfort of the pedestrian/bicycling space. Providing a sufficiently wide operating envelope for people bicycling to operate uphill and downhill and to pass one another will result in fewer occasions where people bicycling need to enter the pedestrian space to perform these maneuvers. This reduces the potential for conflict between users.

The minimum bicycling clear zone width identified in PBOT's design guidance is 6.5 feet. However, PBOT's field research and *Designing for Small Things with Wheels* (NACTO 2023) recommends a minimum of 7-8 feet that allows for people bicycling to pass one another within the range of expected bicycling volumes.

A 6-foot pedestrian through zone allows two people to walk side by side or to pass one another. Widths of 7 feet to 8 feet are sufficient for up to three people to walk together or for people walking to pass others on the sidewalk. Narrower sidewalks may require people to step into the bicycling space to pass other people walking.

Widths that meet or exceed 17 feet will, in most instances, provide sufficient width for people walking and people bicycling to operate in their own space with fewer instances of potential conflicts from users moving into each other's space. Narrower widths for the pedestrian/bicycling space will result in more instances of people moving into each other's space and more potential for conflict between users. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.**

5.1.3 Comfort

Separation Between Users

Pedestrian and bicycling comfort are generally associated with the amount of separation provided between modes and in particular physical separation from higher speed and volume vehicular traffic. All bridge cross section options include a crash-worthy barrier to separate people bicycling and people walking from moving vehicles. In this way, there is no difference between options.

Separation between people walking and people bicycling can also influence comfort. A sidewalk buffer should be used to delineate between the pedestrian and bicycling spaces when these are provided at the same grade. Wider sidewalk buffers can provide space for street furniture such as light poles, benches, and other features that can also provide more physical separation between users. The Burnside Bridge midspan will include a minimum 1-foot tactile sidewalk buffer. Experience on other bridges, such as the Tilikum Bridge, have observed people bicycling passing one another by crossing into the pedestrian space, and vice versa. This is likely to be more prevalent for options where narrower pedestrian through zone and bike lane dimensions are provided.

Widths that meet or exceed 17 feet provide sufficient width for people walking and people bicycling to operate in their own space and make for a more comfortable facility. At 17 feet, there are still likely to be instances where people bicycling will enter into the pedestrian space. This is likely to be the case with both cargo bikes, which are wider than conventional bikes, and with electric bikes that have a higher operating speed relative to conventional bikes, encouraging greater separation when passing. Narrower widths for the pedestrian/bicycling space will result in more interaction between modes and a less comfortable facility. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.**

Shy Distance

People bicycling operate at a distance from vertical features, such as the bridge railings that will be on either side of the active transportation space, to avoid striking their handlebars or pedals. Based on industry guidance and field testing conducted by PBOT on the Tilikum Bridge, this shy distance is at least one foot six inches from the face of the railing to where the edge of the bike lane should be striped.

Not accounting for shy distance will mean a reduced clear operating space and more instances of people moving into each other's space and potential for conflict between users. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B.

5.1.4 Maintenance and Inspection

To maintain operations during routine maintenance and inspection activities, a minimum temporary space of 15.5 feet (9.5 feet + 6 feet) within the bicycle/pedestrian area is needed, based on the following:

- Maintenance and inspection vehicles require a temporary 9.5-foot width within the bicycle/pedestrian space [8.5-foot (vehicle + cones) vehicle width + 1-foot clearance from barrier]
- A 6-foot temporary bicycle/pedestrian space is needed for any temporary width reduction.
- County Bridge Maintenance prefer as much space outside the maintenance vehicle as possible.

Bridge maintenance "hatches" (for removal and replacement of movable bridge equipment and machinery) will be needed within the bicycle/pedestrian space. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B.

5.2 Vehicular Space

5.2.1 Policy Consistency

The cross section elements were evaluated for compliance with the City of Portland's current policy and design guidelines based on the TSP classifications (see Table 7). TriMet indicated that they prefer at least 11-foot bus lanes with 1-foot shy to vehicular barriers. However, TriMet noted that they have no objection to temporarily using 10-foot interior lane when the exterior lane is closed.

Table 7. Lane Widths (Table 2.2 Lane Widths, Traffic Design Manual, Volume 1: Permanent Traffic Control and Design, City of Portland, June 2022)

	Typical Lane Width (ft)	Range of Lane Widths (ft)
Freight Routes (TSP class or >10% trucks)**	12*	11 to 12*
Transit Routes (TSP class or existing route)	11*	10 to 12*
All other streets	10*	10 to 12*
Parking/loading lanes, industrial	8	8 to 10
Parking lanes, commercial	8	8
Parking lanes, residential	8	7 to 8

*1-foot shy distance should be added to all lane widths next to curbs.

** National Highway System routes on city streets do not have different lane width requirements.

Exterior Lane and Shoulder

The exterior lanes on the bridge are transit routes in both directions, so 11-foot lanes are typical. The allowable range of lane widths is 10-12 feet and there is 1-foot shy distance required because the lane is next to the bridge barrier. Therefore, the allowable range of lane widths including shy distance is 11-13 feet. The exterior lane and shoulder widths were combined for each option and evaluated against these standards. Lane widths that meet or exceed these standards are considered compliant. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.**

Interior Lane and Median

The range of lane widths for the interior lanes is 10-12 feet. The interior lane width and median widths were combined for each option and evaluated against these standards. Lane widths that meet or exceed these standards are considered compliant. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.** While PBOT does not have a policy that requires a median, PBOT's *Traffic Design Manual* (PBOT 2022) does have guidelines to provide lanes wider than 10 feet in some instances, such as geometric roadway features and horizontal curves).

5.2.2 Safety and Operations

The different options were evaluated for truck design based on the Freight TSP Classification to identify safety concerns and freight operational limitations. This analysis focused on lane taper locations on both sides of the bridge and included modeling a range of simultaneous turning movements using AutoTURN. According to *Designing for Truck Movements and Other Large Vehicles in Portlan*d (PBOT 2008), the suggested design vehicle for a Local Service Truck Street is an SU-30), and the volume of buses and trucks is low (<2 percent of ADT), so there is no reason to design for larger vehicles.

However, turning movements were still analyzed for larger vehicles (WB-40, WB-62, WB-67, Fire Trucks) to confirm that all options can accommodate large trucks. The turning movements analyzed included transit vehicles in the exterior lane with a range of different simultaneous truck movements in the interior lanes. Turning movements were tested with 1-foot and 0.5-foot vehicle buffers, and the buffer conflicts were documented. The results of this AutoTURN analysis were tabulated and are included in Appendix C.

Lane Widths

The lanes widths for each option were determined adequate to accommodate simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles, with each vehicle operating in its own lane. Larger vehicles such as WB-62, WB-67, and Fire Trucks are also accommodated but may offtrack into adjacent lanes when they are in 10-foot lanes at taper locations. This depends on driver behavior when there is a vehicle in the adjacent lanes. Due to the infrequency of these larger vehicles, this is not a safety concern. However, see the Potential Mitigations section below for possible ways to reduce off-tracking.

The City has not done in-depth crash analysis of narrow lanes (10 foot or less) at lane taper locations. In general, the City has not found narrow lane widths to be a contributor to higher rates of injury crashes, and they typically associate them with lower injury crash rates. According to the City, when narrower lanes result in increased space for other uses, they can contribute to safer streets overall.

Another safety consideration is that lanes wider than the recommended ranges may encourage higher vehicle speeds. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.**

Shoulder Width

Shoulder widths were evaluated to determine if bus and streetcar operations are accommodated without impacts to barriers. All options accommodate bus and streetcar movements except for Option 2a. Due to the combined width of the 10-foot exterior lane and 1-foot shoulder in Option 2a, a bus may conflict with the barrier at the taper angle points. This depends on driver behavior when there is a vehicle in the adjacent lane. See the Potential Mitigations section below for possible ways to address this. Another safety consideration is that shoulders wider than the recommended widths may encourage higher vehicle speeds. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.**

Median Width

Median widths were evaluated to determine potential conflicts with truck turning movements and opposing traffic. While larger trucks are accommodated in all options, the exclusion of a median when interior lanes are 10 feet wide may result in off tracking into opposing traffic. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B**.** The use of a median in locations where there are horizontal shifts in the roadway geometry can provide an effective interior lane width of greater than 10 feet to reduce off tracking into opposing traffic.

Potential Mitigations

Even though the AutoTURN analysis showed that all vehicles are accommodated, it still showed some tight spots in the taper areas where off-tracking into adjacent lanes might occur. If needed during final design, the design layout could potentially be modified without changing the cross section. Potential modifications could include:

- Lengthen tapers.
- Add radius to barriers at tapers.
- Add radius to striping at tapers.
- Introduce buffer between opposing lanes by offsetting eastbound/westbound tapers.
- Introduce buffer between thru lane and bus lane by offsetting eastbound/westbound tapers.

5.2.3 Drainage

Inlet Maintenance

This evaluation included comparison of the bus wheel path and drainage facilities. Buses that regularly run over drainage facilities will eventually require deck repair and inlet replacement. Multnomah County's Bridge Maintenance team prefers to avoid any overlap. This could be resolved with narrower inlets, but that would require many more inlets. Multnomah County's Bridge Maintenance team is okay with overlap to avoid adding many more inlets. The results of this evaluation along with pros and cons are summarized in Table 6 and Appendix B.

6 Non-Differentiating Features and Considerations

During this study, some important features and considerations were identified that turned out to be non-differentiating for the various cross section options. This means that while important, they did not provide a meaningful differentiating quality to help select amongst the various options. The identified non-differentiating features are as follows in this section.

6.1 Bridge Type and Appurtenances

The various bridge type and movable bridge appurtenances and devices do not have a negative impact on the vehicular and bicycle/pedestrian spaces for any of the cross section options.

6.1.1 East Approach Bridge Type

As described in Section 2.3.3, the east approach bridge type could either be a tied arch or cable-stayed bridge. Both bridge types can equally accommodate all the cross section options.

6.1.2 Bridge Appurtenances

The design team evaluated bridge appurtenances that might require a reduction in the cross-sectional width available for the roadway and bicycle/pedestrian space. These appurtenances include vehicular barriers, bicycle railings, protective fencing, roadway lighting, future streetcar compatibility including an overhead catenary system (OCS) if needed, and movable bridge signals, bridge gates and barriers. This evaluation determined that none of these appurtenances will impact the cross section decision and, where needed, localized bridge widening will occur to avoid any reductions in the clear spaces for the bicycle/pedestrian and roadway zones. A summary of this evaluation is provided for each appurtenance type as follows.

Vehicular Barriers

Based on County commitments made during the NEPA phase, an interior bridge rail designed to resist vehicular impact will be provided between the roadway and the multi-use paths.

The current roadside safety crash test standard is the American Association of State Highway and Transportation Officials (AASHTO) *Manual for Assessing Safety Hardware 2nd Edition (MASH)* ((AASHTO 2016). Bridge rails for structures on the National Highway System (NHS) must meet a MASH minimum crash test rating of Test Level 4 (TL-4). The Project is on the NHS and therefore must comply with this regulation.

The 42-inch Oregon Department of Transportation (ODOT) standard Vertical Concrete Parapet railing, which is detailed on ODOT Standard Drawing BR222, is proposed for the Project. It complies with the MASH TL-4 requirement and is one-foot-wide, which maximizes cross-sectional width available for the roadway and bicycle/pedestrian spaces.

Protective Fencing (ODOT / UPRR Facilities)

Oregon law mandates protective fencing (or screening) shall be provided on all freeway overpasses. Fencing is also required over UPRR facilities. The ODOT *Bridge Design Manual* (ODOT 2023) requires that fencing be provided a minimum of 10 feet beyond freeway travel lanes and a minimum of 25 feet from the centerline of the nearest railroad track or access road. Based on these requirements, approximately 314 feet of protective fence will be provided on each side of deck over the I-5, I-84, and UPRR corridor on each approach structure.

The height of the fencing must be 10 feet above the walking surface to meet railroad requirements. The fence can be designed to meet aesthetic requirements for the Project and will be incorporated into the exterior multi-use paths bridge rail and therefore not impact the cross-sectional width available for roadway and the bicycle/pedestrian space.

Roadway Lighting

The new bridge will include illumination for all modes of transportation. To avoid narrowing the multi-use paths, all illumination poles are anticipated to be mounted outside of the exterior bridge rail through means of a “blister” or “pedestal.” Based on

ODOT Standard Drawing BR971, the blister will extend one foot ten inches beyond (perpendicular to) the typical exterior edge of deck.

The Project must consider future Portland Streetcar systems on the bridge. Streetcar operations commonly requires an overhead catenary system (OCS) to supply electricity to the car, but discussions with Portland Streetcar have resulted in a conclusion that OCS systems will not be necessary for this Project. Implementation of a streetcar system is well over 10 years away and, by that point, streetcars with battery capacity great enough to cross the Burnside Bridge without OCS will be procured by Portland Streetcar. Had overhead wires been needed, they would have spanned the width of the bridge and been either supported on independent poles or by the proposed illumination poles and associated blister foundation.

Movable Bridge Lifts and Operations

Acknowledging that from a regulatory standpoint, maintaining movable bridge functionality is the highest modal priority of all modal types, the bridge team assessed how the various cross section options might affect the ability for the bridge to operate. The conclusion was that none of the cross section options impaired or influenced the selection in a meaningful way and that this consideration was not differentiating. As such, all cross section options seem to adequately provide the necessary movable bridge functionality.

Movable Bridge Signals

Overhead sign structures will be placed before the movable span to close vehicular operations during a bridge lift, similar to the existing structure signals. These signal structures will also contain signs guiding traffic and could contain County banners and other communication devices. Coordination with PBOT and ODOT will be required during Final Design to identify types and locations of sign structures and other signage. To avoid narrowing the bicycle/pedestrian space, all signal poles are anticipated to be mounted outside of the exterior bridge rail through means of a “blister” or “pedestal.”

Supplemental bells or gongs attached to warning and/or barrier gates will also serve to warn users of a bridge opening.

Movable Bridge Gates and Barriers

To meet the recommendations of the *AASHTO LRFD Movable Highway Bridge Design Specifications*, (AASHTO 2023) it is anticipated that both warning gates and barrier gates will be provided on both the East and West Approaches to the Movable Span. Gates will cross the full width of the roadway as well as the multi-use paths. Warning gates will direct traffic to stop and queue while the bridge opens. They will be marked in accordance with the *MUTCD* (FHWA 2009) and have red signal lights mounted on them. Barrier gates will be located closer to the Movable Span and serve to resist any traffic that may surpass the initial warning gates. They will be marked similarly to the warning gates with red lights and will be designed to resist vehicle impact. Pedestrian gates will be located at both ends of each multi use path to better control pedestrian flows.

It is anticipated that vertical type gates with counterweights will be utilized. The gates may be located in between the vehicular roadway and the bicycle/pedestrian space or at the bridge fascia. The gate housing ranges from approximately 2'x2' to 3'x3' in plan area. Localized widenings of the overall bridge width cross section to accommodate the gates without impacting the width clear space of the bicycle/pedestrian space may be required.

6.2 Post-Seismic Emergency Response

All the bridge cross section options satisfactorily provide the ability for first responders and other emergency service organizations to provide immediate responsiveness and recovery needs following a major earthquake.

Post-earthquake emergency response vehicles were studied for their various effects on the bridge design and cross sectional horizontal and vertical clearances. Vehicles evaluated ranged from fire trucks to non-standard off-highway dump trucks. From a cross-sectional perspective, the design objective is to allow for simultaneous movement of one emergency response vehicle in each direction on the bridge. This criteria supports emergency response and debris clearing activities following the large earthquake and is an increase in structural capacity versus current bridge design standards. The bridge will accommodate heavy vehicular loads defined as EV2 or EV3 vehicles by AASHTO. These vehicles possess a heavier overall weight compared to special haul vehicles that will also be allowed in the future but are currently prohibited on the existing bridge. See Appendix J for a diagram of the cross section containing the EV2 or EV3 vehicles.

6.3 Utility Impacts

All the cross section options possess the same utility impacts and needs. Further, all cross sections can equally accommodate existing relocations and/or proposed utilities.

6.4 Under-bridge Facilities

Because the overall cross section and structure depth is the same for all cross section options, is there is no differentiation between the various options on the facilities below the bridge. As such, all the cross section options have the same insignificant impacts to under-bridge transportation facilities (e.g., Naito Parkway, 2nd / 3rd Avenues; I-5 / I-84; etc.), the Willamette River, TriMet Max, other Parks recreational facilities (Tom McCall Waterfront Park, Vera Katz Eastbank Esplanade, etc.). A synopsis of the facility assessments are as follows:

Willamette River

All the cross section options possess the same overall bridge width and have approximately the same overall weight. Additionally, the City has stated that the stormwater within the bicycle/pedestrian space should be treated in a similar manner to that of the roadway surface. Given these findings, there are no meaningful differentiating effects for the sizing of the in-water piers, impacts to vessels, impacts to stormwater run-off treatment, impacts to the shoreline habitat, or impacts to permitting requirements caused by variations within the cross section options.

ODOT Freeways (I-5 / I-84)

All the cross-section options possess the same overall bridge width, structure depth, and support locations adjacent to ODOT freeway facilities and maintenance roads. Further, all options must comply with the same safety and security requirements, along with freeway signage needs, associated with the bridge rails over ODOT facilities. Given this, there are no meaningful differentiating effects on the ODOT facilities caused variations within the cross section options.

City Roadways (W 1St Ave; Naito Parkway; E 2nd Ave; E 3rd Ave)

All the cross section options possess the same overall bridge width, structure depth, and support locations adjacent to City streets. Further, all options must comply with the same safety and security requirements, along with potential roadway signage and lighting needs. Given this, there are no meaningful differentiating effects on the City roadway facilities caused by the various cross section options.

TriMet Light rail (MAX)

All the cross section options possess the same overall bridge width, structure depth, and support locations adjacent to the TriMet MAX lines at W 1st Ave. Further, all options must comply with the same safety and security and OCS requirements for this facility. Given this, there are no meaningful differentiating effects on the TriMet MAX light rail facilities caused by variations within the cross section options.

Park Facilities

All the cross section options possess the same overall bridge width, structure depth, and support locations adjacent to Tom McCall Waterfront Park and the Vera Katz Eastbank Esplanade. Further, all options must accommodate the same functionality of the various park operations and events below the bridge. Regarding events that use the bridge surface, such as the Rose Parade, Parks has stated that the minimum roadway clear width of 44 feet is satisfactory for future parades and other events, should the Burnside Bridge be used.

There is agreement between the City and County that there will be no ramp constructed from the bridge to the Eastbank Esplanade as part of the EQRB Project. Further, a decision about whether to maintain or remove the existing stairway is not known at this time but will be made early in the Final Design phase and is subject to applicable laws, regulations and standards, including the Americans with Disability Act. Given these findings, there are no meaningful differentiating effects on the park facilities caused by the variations within cross section options.

6.5 Street Connectivity and Interaction with Adjacent Buildings

The off-bridge street connectivity does not have a differentiating effect on the range of bridge cross sections.

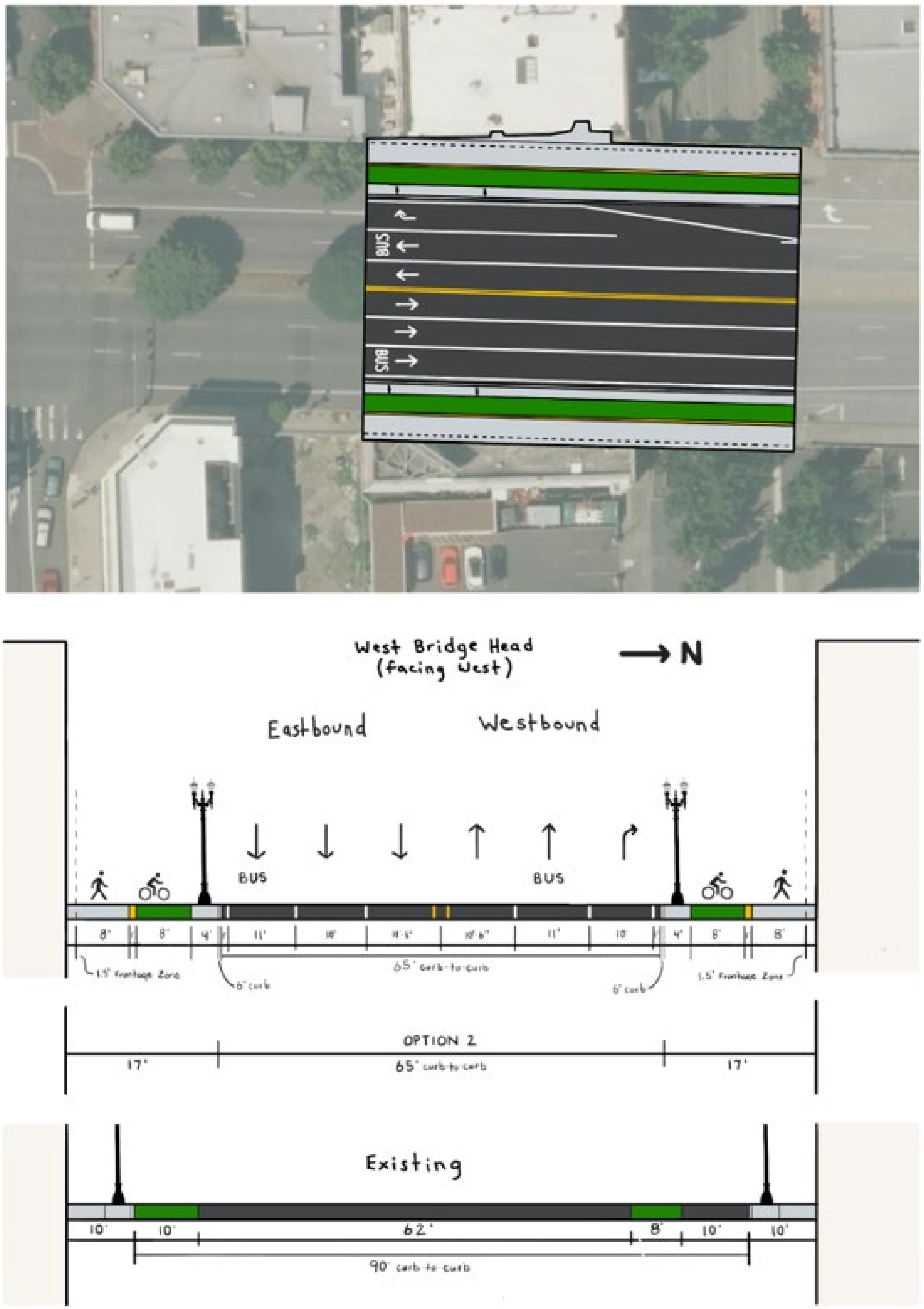
West Bridgehead

The bicycle/pedestrian space needs to be connected into the pedestrian and bicycling networks on the westside of the bridge. People walking will use crossings provided on all legs of the signalized intersection at 2nd Avenue intersection to connect to the existing pedestrian network. This will include upgrading curb ramps and providing an accessible pathway to the Skidmore Fountain MAX station using the sidewalks on NW 2nd Avenue and NW Couch Street. The proposed design will provide people bicycling westbound with a bike signal to cross NW 2nd Avenue and connect with bike facilities on 2nd and 3rd Avenues. People bicycling eastbound will move with the eastbound through movement to connect from existing bike facilities on Burnside Street and 2nd Avenue.

Plan and cross section views of what the west bridgehead connection could look like approaching the W Burnside and 2nd Avenue intersection are shown on Figure 17. The west bridgehead widens from the midspan and to accommodate space for additional transit and general-purpose traffic lanes. The Final Design phase will also refine the allocation of space behind the curb. PBOT's preferred design includes, as a minimum, a 4-feet furnishing zone, an 8-foot sidewalk level bike lane, a 1-foot tactile sidewalk buffer, and an 8-feet pedestrian through zone. Space is also recommended in front of buildings connecting to the bridge to provide a buffer between buildings such as the Portland Rescue Mission and the transportation functions of the sidewalk. Additional width is also desirable for people bicycling eastbound as the west bridgehead is especially important for bicycles moving at different speeds to be able to sort themselves out.

Wayfinding will be provided at key locations on the approaches to the west bridgehead. Wayfinding will be critical at the bridgehead to provide information for how people access Naito Parkway, the TriMet MAX station, and the Vera Katz Eastbank Esplanade.

Figure 17. Westbound Approach to 2nd Avenue at the West End of Bridge with Furniture Zone (assumes Option 3 roadway cross section)



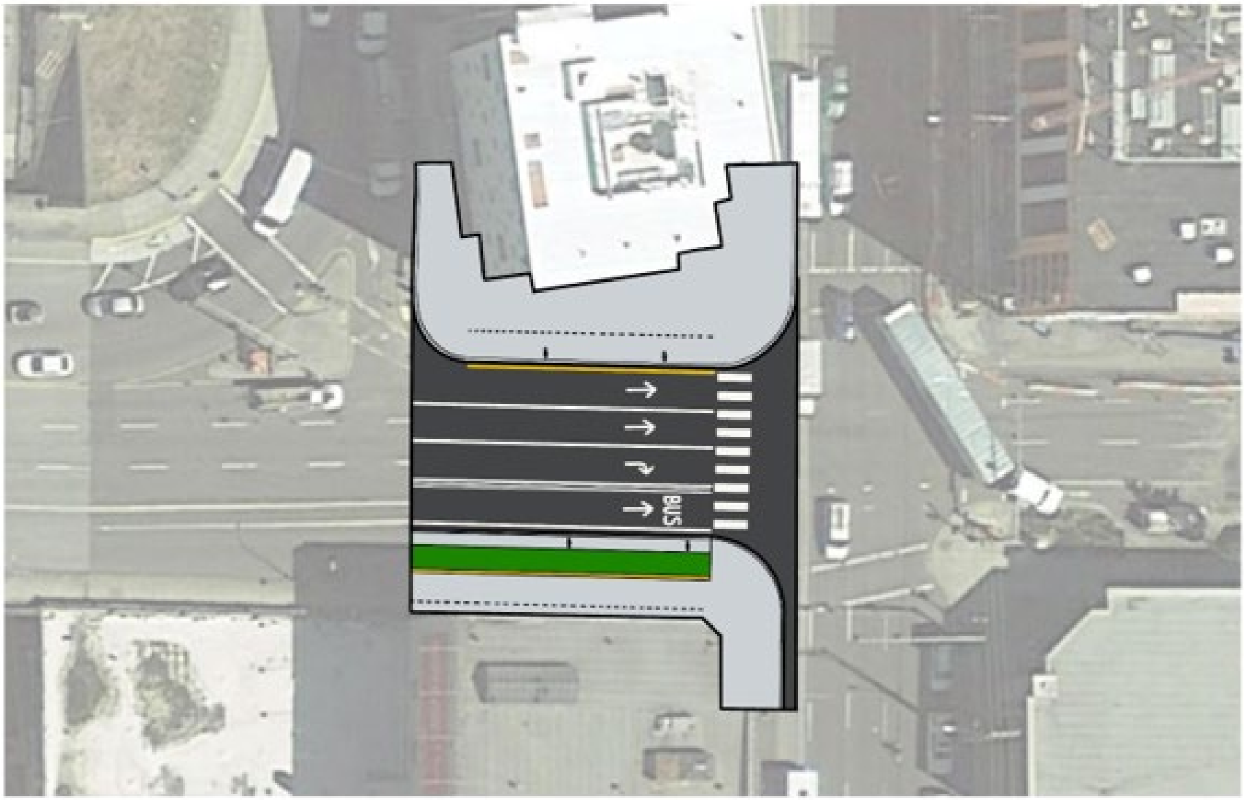
East Bridgehead

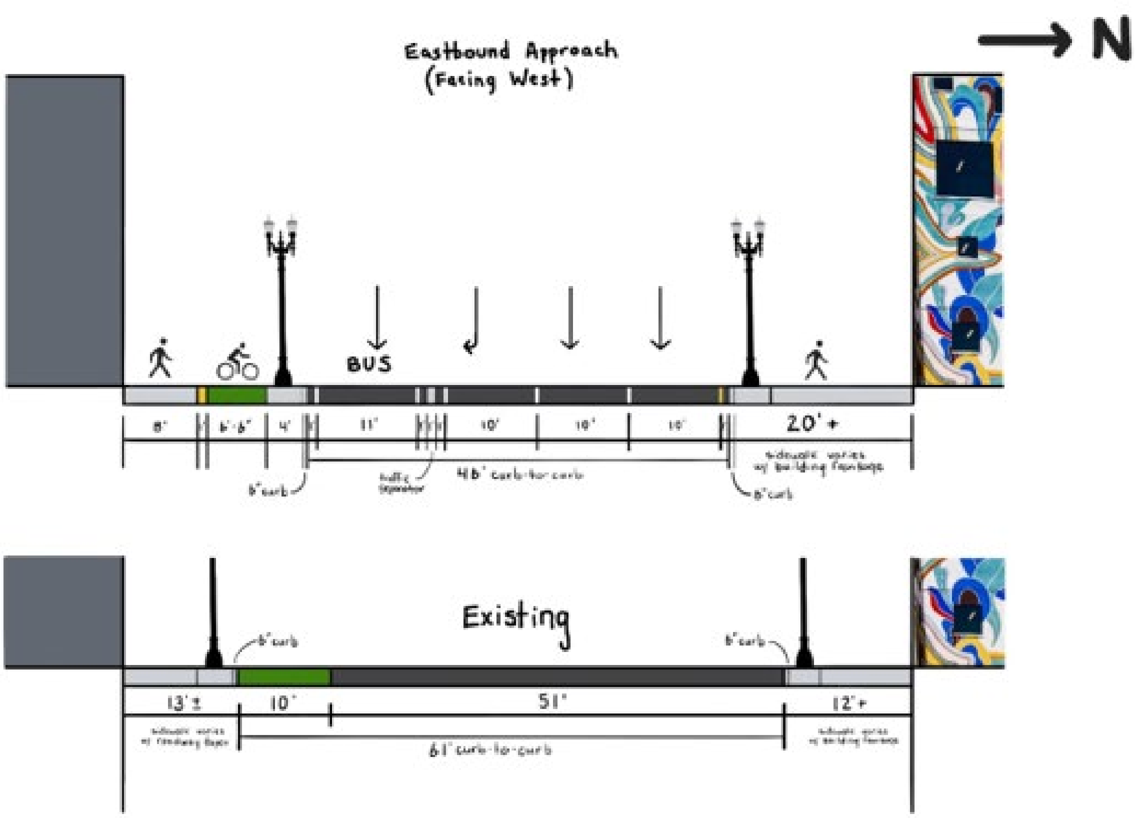
The pedestrian / bicycling space needs to be connected into the pedestrian and bicycling networks on the eastside of the bridge. People walking will use crossings at the MLK Boulevard and Couch Street intersections to connect to the existing pedestrian network. The proposed design will incorporate the existing eastbound bike signal to allow people bicycling to cross MLK Boulevard and connect with bike facilities on E Burnside Street. People bicycling westbound will come from the Couch Street bike lanes or Couch Court and travel through the Couch Street curves to connect to the bridge.

Plan and cross section views of what the east bridgehead connection could look like at the E Burnside Street and MLK Boulevard intersection are shown on Figure 18. The eastern bridge head is constrained to its existing width through the Couch Street Curves, but it widens from the midspan on the approach to MLK Boulevard to accommodate space for additional general purpose traffic lanes. The Final Design phase will also refine the allocation of space behind the curb. PBOT's preferred design includes, as a minimum, a 4-feet furnishing zone, a 6 feet 6-inch wide (or more) sidewalk level bike lane, a 1-foot tactile sidewalk buffer, an 8-feet pedestrian through zone, and a frontage zone to provide a buffer to buildings that front the bridge.

Wayfinding will be provided at key locations on the approaches to the east bridgehead. Wayfinding will be critical at the bridgehead to provide information for how people access Naito Parkway, the TriMet MAX station, and the Vera Katz Eastbank Esplanade.

Figure 18. Eastbound Approach to MLK at the East End of Bridge with Furniture Zone





6.6 Future Cross Section Compatibility

All the cross section options provide suitable flexibility for future street section needs.

6.6.1 Future Streetcar

This study included an evaluation of streetcar operations with the lane configurations and roadway geometry in each option. Streetcar alignments were developed, and the dynamic vehicle envelopes were reviewed for conflicts with the vehicular barrier and adjacent traffic. Various streetcar design speeds were used in this analysis, ranging from 15 to 20 miles per hour on the tapers, and less than 10 miles per hour on the curves at the Couch couplet. It was determined that future streetcar can be accommodated with any of the options. However, some options may require design deviations for clearance envelopes and design speeds, as well limitations to bridge appurtenances mounted above the vehicular barrier. During an August 29, 2023, cross section meeting focused on streetcar design, Portland Streetcar Inc representatives were not concerned about the ability of any of the cross sections to accommodate streetcar. Streetcar will be further investigated in final design to optimize streetcar alignment design and bridge taper layout.

7 References

AASHTO (American Association of State Highway and Transportation Officials)

2016 Manual for Assessing Safety Hardware 2nd Edition (MASH). https://aashtojournal.transportation.org/aashto-issues-lrfd-movable-highway-bridge-spec-guide/.

2023 AASHTO LRFD Movable Highway Bridge Design Specifications. https://aashtojournal.transportation.org/aashto-issues-lrfd-movable-highway-bridge-spec-guide/.

BEM (City of Portland Bureau of Emergency Management)

2017 City of Portland Annex D | Evacuation Plan. https://www.portlandoregon.gov/pbem/article/668061

BPS (City of Portland Bureau of Planning and Sustainability) and Multnomah County

2009 Climate Action Plan. https://www.portland.gov/bps/climate-action/documents/2009-climate-action-plan/download.

City of Portland

2020 2035 Comprehensive Plan, Chapter 9. https://efiles.portlandoregon.gov/record/16339697.

2035 Transportation System Plan. https://www.portland.gov/transportation/planning/tsp.

Metro Task Force (Metro Regional Emergency Transportation Routes Task Force).

1996 Regional Emergency Transportation Routes. https://multco.us/file/64350/download.

Multnomah County

2015 Willamette River Bridges Capital Improvement Plan (2015-2034). https://www.multco.us/file/41120/download.

2018 EQRB Feasibility Study Report. https://multco.us/earthquake-ready-burnside-bridge/feasibilitystudy.

NACTO (National Association of Transportation Officials)

2017 Designing for All Ages and Abilities – Contextual Guidance for High-Comfort Bicycle Facilities. https://nacto.org/wp-content/uploads/2017/12/NACTO_Designing-for-All-Ages-Abilities.pdf.

2023 Designing for Small Things with Wheels. https://nacto.org/publication/designing-for-small-things-with-wheels/.

PBOT (City of Portland Bureau of Transportation)

2008 Designing for Truck Movements and Other Large Vehicles in Portland. https://www.portland.gov/transportation/planning/documents/designing-truck-movements-and-other-large-vehicles/download.

2010 Portland Bicycle Plan for 2030. https://nacto.org/wp-content/uploads/2012/06/City-of-Portland-2010-2030-Plan.pdf.

2019 PedPDX Portland's Citywide Pedestrian Plan. https://www.portland.gov/transportation/planning/pedpdx.

2021 Portland Protected Bicycle Lane Planning and Design Guide. https://www.portland.gov/transportation/engineering/documents/portland-protected-bicycle-lane-design-guide/download.

2022 Portland Pedestrian Design Guide. https://www.portland.gov/transportation/engineering/documents/portland-pedestrian-design-guide/download.

2022 Portland Traffic Design Manual, Volume 1: Permanent Traffic Control and Design. https://www.portland.gov/transportation/engineering/documents/pbot-traffic-design-manual-volume-1-permanent-traffic-control/download.

Appendix A. Cross Section Options

Option 1a
East Approach

Option 1a
West Approach
1'
14'
1'
BIKE / PED
(BETWEEN RAILS)
50'
ROADWAY WIDTH
(BETWEEN RAILS)
1'
14'
1'
BIKE / PED
(BETWEEN RAILS)
2'
11'
FUTURE STREETCAR
11'
2'
11'
BUS
11'
FUTURE STREETCAR
2'
WESTBOUND
EASTBOUND


Option 1b
East Approach
1'
14'
BIKE / PED
(BETWEEN RAILS)
5'
50'
ROADWAY WIDTH
(BETWEEN RAILS)
5'
14'
BIKE / PED
(BETWEEN RAILS)
1'
3'
10.5'
FUTURE STREETCAR
10.5'
2'
10.5'
BUS
10.5'
FUTURE STREETCAR
3'
WESTBOUND
EASTBOUND


Option 1b
West Approach
1'
14'
1'
BIKE / PED
(BETWEEN RAILS)
50'
ROADWAY WIDTH
(BETWEEN RAILS)
1'
14'
1'
BIKE / PED
(BETWEEN RAILS)
3'
10.5'
FUTURE
STREETCAR
10.5'
2'
10.5'
BUS
10.5'
FUTURE
STREETCAR
3'
BUS ONLY
WESTBOUND
EASTBOUND

Option 2a
East Approach


Option 2a
West Approach
1'
17'
1'
BIKE / PED
(BETWEEN RAILS)
44'
ROADWAY WIDTH
(BETWEEN RAILS)
1'
17'
1'
BIKE / PED
(BETWEEN RAILS)
1
10'
FUTURE STREETCAR
10'
2'
10'
BUS
10'
FUTURE STREETCAR
1
WESTBOUND
EASTBOUND

Option 2b
East Approach
1'
17'
BIKE / PED
(BETWEEN RAILS)
5'
44'
ROADWAY WIDTH
(BETWEEN RAILS)
5'
17'
BIKE / PED
(BETWEEN RAILS)
1'
1
11'
FUTURE STREETCAR
10'
0
10'
BUS
11'
FUTURE STREETCAR
1
WESTBOUND
EASTBOUND

Option 2b
West Approach

Option 3a
East Approach

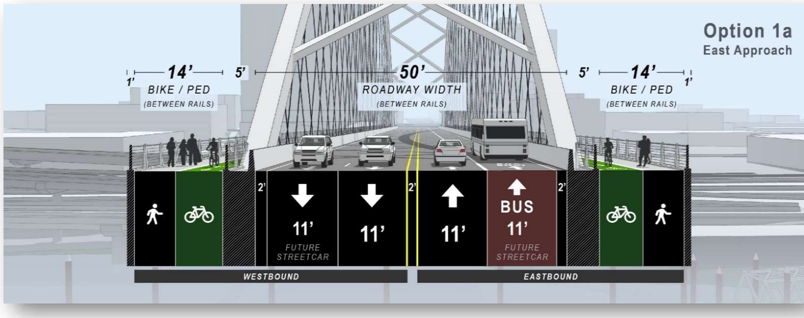

Option 3a
West Approach
1'
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
47'
ROADWAY WIDTH
(BETWEEN RAILS)
1'
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
2'
11'
FUTURE STREETCAR
10'
1
10'
BUS
11'
FUTURE STREETCAR
2'
WESTBOUND
EASTBOUND

Option 3b
East Approach
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
5'
47'
ROADWAY WIDTH
(BETWEEN RAILS)
5'
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
1.5
11'
FUTURE STREETCAR
10.5'
1
10.5'
BUS
11'
FUTURE STREETCAR
1.5
WESTBOUND
EASTBOUND

Option 3b
West Approach
1'
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
47'
ROADWAY WIDTH
(BETWEEN RAILS)
1'
15.5'
1'
BIKE / PED
(BETWEEN RAILS)
1.5
11'
FUTURE STREETCAR
10.5'
1
10.5'
BUS
11'
FUTURE STREETCAR
1.5
WESTBOUND
EASTBOUND

Appendix B. Cross Section Assessment Matrix

Option 1a: MAX ROADWAY (14' - 50' - 14') WITH 11' LANES AND 2' SHOULDERS



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons: Pros:	Cons:
1) Active Transportation Space			
a) Policy Consistency			
1. Pedestrian / Bicycling Space	○	N/A	- 14' does not meet standards outlined in City policies (PPDG & PBLPDG)
b) Safety			
1. Operating Envelope	○	N/A	- Least amount of operating space - Most potential for interaction between people bicycling and people walking
c) Comfort			
1. Potential for Ped/Bike Conflicts	○	N/A	- Most potential for conflict between people walking and people bicycling
2. Shy Distance	○	N/A	- Shy distance has the most impact on reducing the effective width of the bikeway or sidewalk
d) Maintenance and Inspection	○	N/A	- ~4.5' clear next to maintenance & inspection vehicles, so bike/ped detour required
2) Vehicular Space			
a) Policy / Standards Consistency			
1. Exterior Lane + Shoulder	●	- 11' lane width is consistent with City's and TriMet's guidance - 13' combined lane+shoulder width is within City's design standard	N/A
2. Interior Lane + Median	●	- 12' combined lane + half median width is within City's design standard	N/A
b) Safety and Operations			
1. Lane Widths	◑	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles - Larger trucks (WB-62/67) do not offtrack into adjacent lane	- Wider lanes may encourage higher vehicle speeds
2. Shoulder Width	●	- Accommodates buses through tapers	N/A
3. Median Width	●	- Larger trucks (WB-62/67) do not offtrack into opposing lane	N/A
c) Drainage			
1. Inlet Maintenance	●	- Bus wheel path likely has buffer from drainage inlets	N/A

From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):
Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'

From PBOT Traffic Design Manual:
Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.

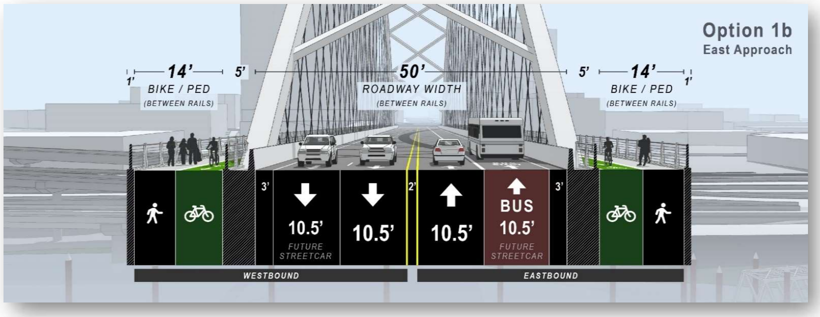
From PBOT Traffic Design Manual:
Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.

See Appendix C for more detail.

See Appendix C for more detail.

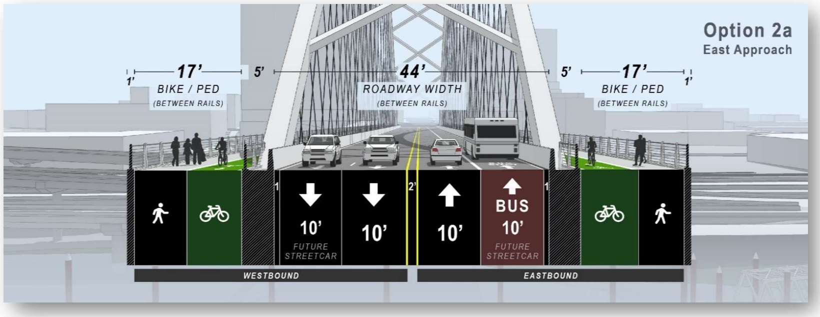
See Appendix C for more detail.

Option 1B: MAX ROADWAY (14' - 50' - 14') WITH 10.5' LANES AND 3' SHOULDERS



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons: Pros:	Cons:	
1) Active Transportation Space				
a) Policy Consistency				
1. Pedestrian / Bicycling Space	○	N/A	- 14' does not meet standards outlined in City policies (PPDG & PBLPDG)	**From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):** Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'
b) Safety				
1. Operating Envelope	○	N/A	- Least amount of operating space - Most potential for interaction between people bicycling and people walking	
c) Comfort				
1. Potential for Ped/Bike Conflicts	○	N/A	- Most potential for conflict between people walking and people bicycling	
2. Shy Distance	○	N/A	- Shy distance has the most impact on reducing the effective width of the bikeway or sidewalk	
d) Maintenance and Inspection	○	N/A	- ~4.5' clear next to maintenance & inspection vehicles, so bike/ped detour required	
2) Vehicular Space				
a) Policy / Standards Consistency				
1. Exterior Lane + Shoulder	◑	- 13.5' combined lane+shoulder width exceeds City's design standard	- 10.5' lane width is less than with City's typical width, and less than TriMet's guidance	**From PBOT Traffic Design Manual:** Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.
2. Interior Lane + Median	●	- 11.5' combined lane + half median width is within City's design standard	N/A	**From PBOT Traffic Design Manual:** Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.
b) Safety and Operations				
1. Lane Widths	○	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles	- Larger trucks (WB-62/67) are accomodated and may offtrack into adjacent lanes, but are less frequent - Wider lanes may encourage higher vehicle speeds	See Appendix C for more detail.
2. Shoulder Width	◑	- Accommodates buses through tapers	- Wider shoulders may encourage higher vehicle speeds	See Appendix C for more detail.
3. Median Width	●	- Larger trucks (WB-62/67) do not offtrack into opposing lane	N/A	See Appendix C for more detail.
c) Drainage				
1. Inlet Maintenance	●	- Bus wheel path likely has buffer from drainage inlets	N/A	

Option 2a: MAX BIKE/PED (17' - 44' - 17') WITH 10' OUTSIDE LANE, 1' SHLDRS AND 2' MEDIAN



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons: Pros:	Cons:
1) Active Transportation Space			
a) Policy Consistency			
1. Pedestrian / Bicycling Space	●	- 17' meets standards outlined in City policies (PPDG & PBLPDG)	N/A
b) Safety			
1. Operating Envelope	●	- Most amount of operating space - Least potential for interaction between people bicycling and people walking	N/A
c) Comfort			
1. Potential for Ped/Bike Conflicts	●	- Least potential for conflict between people walking and people bicycling	N/A
2. Shy Distance	●	- Shy distance has least impact on reducing the effective width of the bikeway or sidewalk	N/A
d) Maintenance and Inspection	●*	- ~7.5' around maintenance & inspection vehicles, so bike/ped detour not required	N/A
2) Vehicular Space			
a) Policy / Standards Consistency			
1. Exterior Lane + Shoulder	○	- 11' combined lane+shoulder width is within City's design standard	- 10' lane width is less than with City's typical width, and less than TriMet's guidance
2. Interior Lane + Median	●	- 11' combined lane + half median width is within City's design standard	N/A
b) Safety and Operations			
1. Lane Widths	◑	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles.	- Larger trucks (WB-62/67) are accomodated and may offtrack into adjacent lanes, but are less frequent
2. Shoulder Width	◑	N/A	- Bus movements are accommodated but constrained and may conflict with the barrier due to combined width of lane+shoulder
3. Median Width	●	- Larger trucks (WB-62/67) do not offtrack into opposing lane	N/A
c) Drainage			
1. Inlet Maintenance	○	N/A	- Bus wheel path likely overlaps drainage inlets

From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):
Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'

* - Exceeds the minimum width, supporting Mult Co Maintenance team's request to maximize the bike/ped width

From PBOT Traffic Design Manual:
Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.

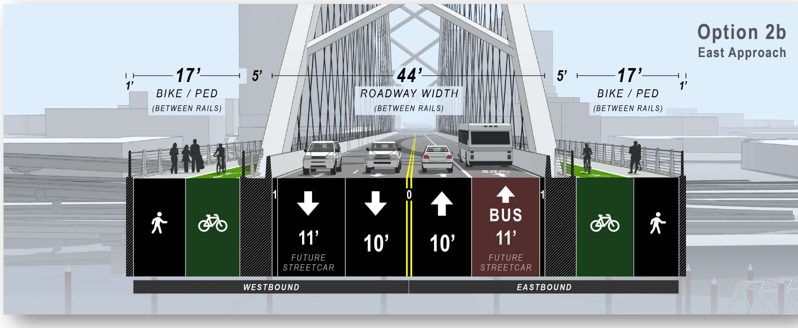
From PBOT Traffic Design Manual:
Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.

See Appendix C for more detail.

See Appendix C for more detail.

See Appendix C for more detail.

Option 2b: MAX BIKE/PED (17' - 44' - 17') WITH 11' OUTSIDE LANE, 1' SHLDRS AND NO MEDIAN



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons: Pros:	Cons:
1) Active Transportation Space			
a) Policy Consistency			
1. Pedestrian / Bicycling Space	●	- 17' meets standards outlined in City policies (PPDG & PBLPDG)	N/A
b) Safety			
1. Operating Envelope	●	- Most amount of operating space - Least potential for interaction between people bicycling and people walking	N/A
c) Comfort			
1. Potential for Ped/Bike Conflicts	●	- Least potential for conflict between people walking and people bicycling	N/A
2. Shy Distance	●	- Shy distance has least impact on reducing the effective width of the bikeway or sidewalk	N/A
d) Maintenance and Inspection	●*	- ~7.5' around maintenance & inspection vehicles, so bike/ped detour not required	N/A
2) Vehicular Space			
a) Policy / Standards Consistency			
1. Exterior Lane + Shoulder	●	- 11' lane width is consistent with City's and TriMet's guidance - 12' combined lane+shoulder width is within City's design standard	N/A
2. Interior Lane + Median	●	- 10' combined lane + half median width is within City's design standard	N/A
b) Safety and Operations			
1. Lane Widths	●	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles	- Larger trucks (WB-62/67) are accomodated and may offtrack into adjacent lanes, but are less frequent
2. Shoulder Width	●	- Accommodates buses through tapers	N/A
3. Median Width	◑	N/A	- Larger trucks (WB-62/67) are accomodated and may offtrack into opposing lanes, but are less frequent
c) Drainage			
1. Inlet Maintenance	○	N/A	- Bus wheel path likely overlaps drainage inlets

From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):
Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'

* - Exceeds the minimum width, supporting Mult Co Maintenance team's request to maximize the bike/ped width

From PBOT Traffic Design Manual:
Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.

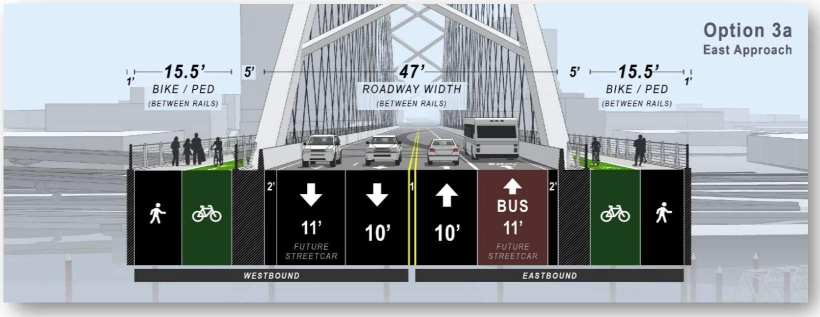
From PBOT Traffic Design Manual:
Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.

See Appendix C for more detail.

See Appendix C for more detail.

See Appendix C for more detail.

Option 3a: MID RANGE (15.5' - 47' - 15.5') WITH 10' INSIDE LANE AND 2' SHOULDERS



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons: Pros:	Cons:
1) Active Transportation Space			
a) Policy Consistency			
1. Pedestrian / Bicycling Space	○	N/A	- 15.5' does not meet standards outlined in City policies (PPDG & PBLPDG)
b) Safety			
1. Operating Envelope	◑	- Medium amount of operating space - Some potential for interaction between people bicycling and people walking	N/A
c) Comfort			
1. Potential for Ped/Bike Conflicts	◑	N/A	- Medium potential for conflicts between people walking and people bicycling
2. Shy Distance	○	N/A	- Shy distance has the most impact on reducing the effective width of the bikeway or sidewalk
d) Maintenance and Inspection	●	- ~6' around maintenance & inspection vehicles, so bike/ped detour not required	N/A
2) Vehicular Space			
a) Policy / Standards Consistency			
1. Exterior Lane + Shoulder	●	- 11' lane width is consistent with City's and TriMet's guidance - 13' combined lane+shoulder width is within City's design standard	N/A
2. Interior Lane + Median	●	- 10.5' combined lane + half median width is within City's design standard	N/A
b) Safety and Operations			
1. Lane Widths	●	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles	- Larger trucks (WB-62/67) are accomodated and may offtrack into adjacent lanes, but are less frequent
2. Shoulder Width	●	- Accommodates buses through tapers	N/A
3. Median Width	●	- Larger trucks (WB-62/67) do not offtrack into opposing lane	N/A
c) Drainage			
1. Inlet Maintenance	●	- Bus wheel path likely has buffer from drainage inlets	N/A

From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):
Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'

From PBOT Traffic Design Manual:
Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.

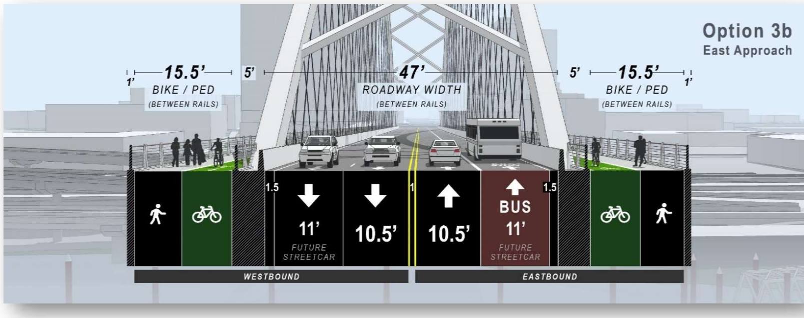
From PBOT Traffic Design Manual:
Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.

See Appendix C for more detail.

See Appendix C for more detail.

See Appendix C for more detail.

Option 3b: MID **RANGE (15.5' - 47' - 15.5') WITH 10.5' INSIDE LANE AND 1.5' SHOULDERS**



DIFFERENTIATING FEATURES	Evaluation	Differentiating Feature Pros / Cons:		
		Pros:	Cons:	
1) Active Transportation Space				
a) Policy Consistency				
1. Pedestrian / Bicycling Space	○	N/A	- 15.5' does not meet standards outlined in City policies (PPDG & PBLPDG)	**From the Portland Pedestrian Design Guide (PPDG) and City of Portland Protected Bike Lane Planning & Design Guide (PBLPDG):** Assumes policy standard = 8' ped space (PTZ) for Civic Main Street + 1' tactile sidewalk buffer + 6'-6" effective bikeway width + 1'-6" shy distance to barrier = 17'
b) Safety				
1. Operating Envelope	◑	- Medium amount of operating space - Some potential for interaction between people bicycling and people walking	N/A	
c) Comfort				
1. Potential for Ped/Bike Conflicts	◑	N/A	- Medium potential for conflicts between people walking and people bicycling	
2. Shy Distance	○	N/A	- Shy distance has the most impact on reducing the effective width of the bikeway or sidewalk	
d) Maintenance and Inspection	●	- ~6' around maintenance & inspection vehicles, so bike/ped detour not required	N/A	
2) Vehicular Space				
a) Policy / Standards Consistency				
1. Exterior Lane + Shoulder	●	- 11' lane width is consistent with City's and TriMet's guidance - 12.5' combined lane+shoulder width is within City's design standard	N/A	**From PBOT Traffic Design Manual:** Typical lane width for transit route is 11', but allowable range of lane width is 10'-12'. 1' shy distance should be added to lanes next to curbs, so allowable range increases to 11'-13'.
2. Interior Lane + Median	●	- 11' combined lane + half median width is within City's design standard	N/A	**From PBOT Traffic Design Manual:** Typical lane width for general purpose is 10', but allowable range of lane width is 10'-12'.
b) Safety and Operations				
1. Lane Widths	◑	- Accommodates simultaneous movements of streetcar, buses, SU-30 and WB-40 vehicles	- Larger trucks (WB-62/67) are accomodated and may offtrack into adjacent lanes, but are less frequent - Wider lanes may encourage higher vehicle speeds	See Appendix C for more detail.
2. Shoulder Width	●	- Accommodates buses through tapers	N/A	See Appendix C for more detail.
3. Median Width	●	- Larger trucks (WB-62/67) do not offtrack into opposing lane	N/A	See Appendix C for more detail.
c) Drainage				
1. Inlet Maintenance	●	- Bus wheel path likely has buffer from drainage inlets	N/A	

Appendix C. AutoTURN Results

AutoTurn Analysis (Tied Arch Bridge)

Option	Eastbound Taper (West Approach)						Eastbound Taper (East Approach)						Westbound Taper (East Approach)					
	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
1a	City Bus	WB-67	No	No	No		City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and Bus at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	City Bus	WB-62	No	No	No		City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and bus at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
1a	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
1a	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
1a	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and Fire Truck at downstream end of taper - potential mirror conflict.	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Fire Truck and City Bus at upstream and downstream end of taper - potential mirror conflict(s).	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-67	No	No	No		A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and Bus at upstream end of taper - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-62	No	No	No		A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and bus at upstream end of taper - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
1a	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
1a	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
1a	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and Fire Truck at downstream end of taper - potential mirror conflict.	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.
1b	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	City Bus	WB-62	No	No	No		City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper. - potential mirror conflict.
1b	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
1b	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
1b	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
1b	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper.- potential mirror conflict.	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Fire Truck and btwn City Bus lane at upstream and downstream end of taper. - potential mirror conflict(s).	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-62	No	No	No		A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
1b	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
1b	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
1b	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream end of taper. - potential mirror conflict.

AutoTurn Analysis (Tied Arch Bridge)

Eastbound Taper (West Approach)

Option	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
2a	City Bus	WB-67	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-62	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-40	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-40 at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier - potential mirror conflict. - potential mirror conflict.
2a	City Bus	SU-30	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	WB-67	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.
2a	A-BUS	WB-62	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at downstream end of taper. - potential mirror conflict.
2a	A-BUS	WB-40	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	SU-30	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2b	City Bus	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and City Bus at downstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.
2b	City Bus	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and City Bus at downstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.
2b	City Bus	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-40 at downstream end of taper. - potential mirror conflict(s).
2b	City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at downstream end of taper. - potential mirror conflict(s).
2b	City Bus	F-450	No	No	No	
2b	City Bus	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic lane throughout entire movement.- potential mirror conflict.
2b	A-BUS	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and Bus at downstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.
2b	A-BUS	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and Bus at downstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.
2b	A-BUS	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and WB-40 at downstream end of taper. - potential mirror conflict(s).
2b	A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at downstream end of taper. - potential mirror conflict(s).
2b	A-BUS	F-450	No	No	No	
2b	A-BUS	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic lane throughout entire movement.- potential mirror conflict.

Eastbound Taper (East Approach)

Option	Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
2a	City Bus	WB-67	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-62	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-40	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-40 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	SU-30	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn City Bus land at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict(s).
2a	A-BUS	WB-67	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at upstream end of taper. - potential mirror conflict.
2a	A-BUS	WB-62	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at upstream end of taper. - potential mirror conflict.
2a	A-BUS	WB-40	No	1' Buffer	1' Buffer	with 1' buffer btwn WB-40 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	SU-30	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn Articulated Bus at downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict(s).
2b	City Bus	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and City Bus at upstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.
2b	City Bus	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and City Bus at upstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.
2b	City Bus	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).
2b	City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).
2b	City Bus	F-450	No	No	No	
2b	City Bus	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.
2b	A-BUS	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and Bus at upstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.
2b	A-BUS	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and Bus at upstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.
2b	A-BUS	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).
2b	A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).
2b	A-BUS	F-450	No	No	No	
2b	A-BUS	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.

Westbound Taper (East Approach)

Option	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
2a	City Bus	WB-67	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-62	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn City Bus and WB-62 at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict
2a	City Bus	WB-40	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-40 at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflicts.
2a	City Bus	SU-30	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn City Bus land at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict(s).
2a	A-BUS	WB-67	No	0.5' Buffer	1' Buffer	with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	WB-62	No	0.5' Buffer	1' Buffer	with 0.5' buffer btwn Articulated Bus and WB-62 at downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict
2a	A-BUS	WB-40	No	1' Buffer	1' Buffer	with 1' buffer btwn Articulated Bus and WB-40 at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflicts.
2a	A-BUS	SU-30	No	No	1' Buffer	with 1' buffer btwn Articulated Bus and SU-30 at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn Articulated Bus land at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict(s).
2b	City Bus	WB-67	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-67 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-67 throughout entire movement. Conflict with 0.5' buffer btwn WB-67 and opposing traffic.- potential mirror conflict.
2b	City Bus	WB-62	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-62 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-62 throughout entire movement. Conflict with 0.5' buffer btwn WB-62 and opposing traffic.- potential mirror conflict.
2b	City Bus	WB-40	No	0.5' Buffer	No	Buffer Only: WB-40 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-40 throughout taper. - potential mirror conflicts.
2b	City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream and downstream end of taper. - potential mirror conflict(s).
2b	City Bus	F-450	No	No	No	
2b	City Bus	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.
2b	A-BUS	WB-67	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-67 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-67 throughout entire movement. Conflict with 0.5' buffer btwn WB-67 and opposing traffic.- potential mirror conflict.
2b	A-BUS	WB-62	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-62 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-62 throughout entire movement. Conflict with 0.5' buffer btwn WB-62 and opposing traffic.- potential mirror conflict.
2b	A-BUS	WB-40	No	0.5' Buffer	No	Buffer Only: WB-40 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-40 throughout taper. - potential mirror conflicts.
2b	A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream and downstream end of taper. - potential mirror conflict(s).
2b	A-BUS	F-450	No	No	No	
2b	A-BUS	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.

AutoTurn Analysis (Tied Arch Bridge)

Option	Eastbound Taper (West Approach)						Eastbound Taper (East Approach)						Westbound Taper (East Approach)					
	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
3a	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: WB-67 movement requires both WB lanes. Conflict with 1' buffer and WB-67 at upstream and downstream end of taper. - potential mirror conflicts.
3a	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: WB-62 movement requires boh WB lanes. Conflict with 1' buffer and WB-62 at upstream and downstream end of taper. - potential mirror conflicts.
3a	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
3a	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
3a	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
3a	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 1' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 1' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.
3a	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer and WB-67 at upstream end of taper. - potential mirror conflicts.	A-BUS	WB-67	No	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer and WB-67 at downstream end of taper. - potential mirror conflicts.
3a	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at downstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer and WB-62 at upstream end of taper. - potential mirror conflicts.	A-BUS	WB-62	No	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer and WB-62 at downstream end of taper. - potential mirror conflicts.
3a	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	1' Buffer	No	Buffer Only: Conflict with 1' buffer btwn Articulated Bus and WB-40 at downstream end of taper - potential mirror conflicts.
3a	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
3a	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
3a	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.
3b	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflicts.
3b	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper - potential mirror conflicts.
3b	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
3b	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
3b	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
3b	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper - potential mirror conflict.	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 1' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.
3b	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67at downstream end of taper. - potential mirror conflict.
3b	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at downstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at downstream end of taper - potential mirror conflict.
3b	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
3b	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
3b	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
3b	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at downstream end of taper - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 1' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.

AutoTurn Analysis (Cable Stay Bridge)

Option	Eastbound Taper (East Approach)						Westbound Taper (East Approach)					
	Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
1a	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and Bus at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and bus at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
1a	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
1a	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
1a	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and Fire Truck throughout entire movement. - potential mirror conflict.	City Bus	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and Bus at upstream end of taper - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and bus at upstream end of taper - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at downstream end of taper - potential mirror conflict.
1a	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
1a	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
1a	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
1a	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.	A-BUS	COP T-1	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper - potential mirror conflict.
1b	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper. - potential mirror conflict.
1b	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
1b	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
1b	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
1b	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Fire Truck and btwn City Bus lane at upstream and downstream end of taper. - potential mirror conflict(s).	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-67 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-62 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-67 at downstream end of taper. - potential mirror conflict.
1b	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
1b	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
1b	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
1b	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream and downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Articulated Bus and Fire Truck at upstream end of taper. - potential mirror conflict.

AutoTurn Analysis (Cable Stay Bridge)

Option	Eastbound Taper (East Approach) Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Westbound Taper (East Approach) Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
2a	City Bus	WB-67	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.	City Bus	WB-67	No	0.5' Buffer	1' Buffer	with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	WB-62	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and outside thru travel lane at upstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.	City Bus	WB-62	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn City Bus and WB-62 at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict
2a	City Bus	WB-40	No	1' Buffer	1' Buffer	with 1' buffer btwn WB-40 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.	City Bus	WB-40	No	0.5' Buffer	1' Buffer	with 0.5' buffer btwn City Bus and WB-40 at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflicts.
2a	City Bus	SU-30	No	1' Buffer	1' Buffer	with 0.1' buffer btwn SU-30 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.	City Bus	SU-30	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.	City Bus	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict.
2a	City Bus	COP T-1	No	0.5' Buffer	1' Buffer	Fire Truck outside thru travel lane and btwn City Bus land at downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict(s).	City Bus	COP T-1	No	0.5' Buffer	1' Buffer	Fire Truck outside thru travel lane and btwn City Bus land at upstream and downstream end of taper. Conflict with 1' buffer btwn City Bus and outside barrier. - potential mirror conflict(s).
2a	A-BUS	WB-67	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-67 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-67	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	WB-62	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-62 at upstream end of taper. - potential mirror conflict.	A-BUS	WB-62	No	0.5' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn Articulated Bus and WB-62 at downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict
2a	A-BUS	WB-40	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-40 and outside thru travel lane at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.	A-BUS	WB-40	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and WB-40 at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflicts.
2a	A-BUS	SU-30	No	1' Buffer	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.	A-BUS	SU-30	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and SU-30 at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.	A-BUS	F-450	No	No	1' Buffer	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict.
2a	A-BUS	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn Articulated Bus at downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict(s).	A-BUS	COP T-1	No	0.5' Buffer	1' Buffer	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Fire Truck outside thru travel lane and btwn Articulated Bus land at upstream and downstream end of taper. Conflict with 1' buffer btwn Articulated Bus and outside barrier. - potential mirror conflict(s).
2b	City Bus	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and City Bus at upstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.	City Bus	WB-67	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-67 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-67 throughout entire movement. Conflict with 0.5' buffer btwn WB-67 and opposing traffic.- potential mirror conflict.
2b	City Bus	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and City Bus at upstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.	City Bus	WB-62	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-62 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-62 throughout entire movement. Conflict with 0.5' buffer btwn WB-62 and opposing traffic.- potential mirror conflict.
2b	City Bus	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).	City Bus	WB-40	No	0.5' Buffer	No	Buffer Only: WB-40 uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and WB-40 throughout taper. - potential mirror conflicts.
2b	City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).	City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and SU-30 at upstream and downstream end of taper. - potential mirror conflict(s).
2b	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
2b	City Bus	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.	City Bus	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.
2b	A-BUS	WB-67	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-67 and Bus at upstream end of taper. Conflict with 1' buffer btwn WB-67 and opposing traffic lane. - potential mirror conflict.	A-BUS	WB-67	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-67 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-67 throughout entire movement. Conflict with 0.5' buffer btwn WB-67 and opposing traffic.- potential mirror conflict.
2b	A-BUS	WB-62	1' Buffer	0.5' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and Bus at upstream end of taper. Conflict with 1' buffer btwn WB-62 and opposing traffic lane. - potential mirror conflict.	A-BUS	WB-62	0.5' Buffer	0.5' Buffer	No	Buffer Only: WB-62 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-62 throughout entire movement. Conflict with 0.5' buffer btwn WB-62 and opposing traffic.- potential mirror conflict.
2b	A-BUS	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).	A-BUS	WB-40	No	0.5' Buffer	No	Buffer Only: WB-40 uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and WB-40 throughout taper. - potential mirror conflicts.
2b	A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).	A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream and downstream end of taper. - potential mirror conflict(s).
2b	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
2b	A-BUS	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.	A-BUS	COP T-1	0.5' Buffer	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn Bus and Fire Truck throughout entire movement. Conflict with 0.5' buffer btwn Fire Truck and opposing traffic at upstream end of taper.- potential mirror conflict.

AutoTurn Analysis (Cable Stay Bridge)

Option	Eastbound Taper (East Approach)						Westbound Taper (East Approach)					
	Outside Lane	Inside Lane (Right Turn)	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description	Outside Lane	Inside Lane	Conflict with vehicle going in opposing direction?	Conflict between vehicles going in same direction?	Conflict between vehicle and barrier?	Description
3a	City Bus	WB-67	No	0.5' Buffer	No	Buffer WB-67 uses both EB lanes. Conflict with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	City Bus	WB-67	no	0.5' Buffer	No	Buffer Only: WB-67 movement requires both WB lanes. Conflict with 0,5' buffer and WB-67 at upstream and downstream end of taper. - potential mirror conflicts.
3a	City Bus	WB-62	No	0.5' BUffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	City Bus	WB-62	no	0.5' Buffer	No	Buffer Only: WB-62 movement requires boh WB lanes. Conflict with 0.5' buffer and WB-62 at upstream and downstream end of taper. - potential mirror conflicts.
3a	City Bus	WB-40	No	No	No		City Bus	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).
3a	City Bus	SU-30	No	No	No		City Bus	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).
3a	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
3a	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.
3a	A-BUS	WB-67	No	0.5' Buffer	No	Buffer WB-67 uses both EB lanes. Conflict with 0.5' buffer btwn WB-67 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	A-BUS	WB-67	no	0.5' Buffer	No	Buffer Only: WB-67 movement requires both WB lanes. Conflict with 0,5' buffer and WB-67 at upstream and downstream end of taper. - potential mirror conflicts.
3a	A-BUS	WB-62	No	0.5' BUffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 0.5' buffer btwn WB-62 and outside thru travel lane at upstream and downstream end of taper - potential mirror conflict.	A-BUS	WB-62	no	0.5' Buffer	No	Buffer Only: WB-62 movement requires boh WB lanes. Conflict with 0.5' buffer and WB-62 at upstream and downstream end of taper. - potential mirror conflicts.
3a	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and WB-40 at upstream end of taper. - potential mirror conflict(s).
3a	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn Bus and SU-30 at upstream end of taper. - potential mirror conflict(s).
3a	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
3a	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.
3b	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflicts.
3b	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper - potential mirror conflict.	City Bus	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper - potential mirror conflicts.
3b	City Bus	WB-40	No	No	No		City Bus	WB-40	No	No	No	
3b	City Bus	SU-30	No	No	No		City Bus	SU-30	No	No	No	
3b	City Bus	F-450	No	No	No		City Bus	F-450	No	No	No	
3b	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	City Bus	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.
3b	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-67 and outside thru travel lane at upstream end of taper - potential mirror conflict.	A-BUS	WB-67	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-67 at downstream end of taper - potential mirror conflicts.
3b	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn WB-62 and outside thru travel lane at upstream end of taper - potential mirror conflict.	A-BUS	WB-62	No	1' Buffer	No	Buffer Only: Movements accomodated within each vehicles travel lane. Conflict with 1' buffer btwn City Bus and WB-62 at downstream end of taper - potential mirror conflicts.
3b	A-BUS	WB-40	No	No	No		A-BUS	WB-40	No	No	No	
3b	A-BUS	SU-30	No	No	No		A-BUS	SU-30	No	No	No	
3b	A-BUS	F-450	No	No	No		A-BUS	F-450	No	No	No	
3b	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both eastbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.	A-BUS	COP T-1	No	0.5' Buffer	No	Buffer Only: Fire Truck uses both westbound lanes. Conflict with 0.5' buffer btwn City Bus and Fire Truck at downstream end of taper. - potential mirror conflict.

Appendix D. Safety Results

City of Portland, Bureau of Transportation
Accident History Export

Export Date: 8/22/2023
Exported By: johudson
Crash Count: 9

Total Fatal	Total A	Total B	Total C	Total Bikes	Total Peds
0	0	3	2	0	0

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1832507	2/4/2019 0:00	10PM	O-STRGHT	INJ	LEFT-CTR, T	0	0	1	0	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3451251	STRGHT	NE to SW	NONE

ParticipantID
3931431

VehicleID	Movement	FromTo	Action
3451252	STRGHT	SW to NE	NONE

ParticipantID
3931432

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1923106	3/30/2021 0:00	1AM	FIX OBJ	INJ	RECKLESS	0	0	1	0	0	0	NW BROADWAY	NW LOVEJOY ST

VehicleID	Movement	FromTo	Action
3614237	STRGHT	NE to SW	NONE

ParticipantID
4110725

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1824428	10/25/2018 0:00	4PM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3436046	STRGHT	NE to SW	NONE

ParticipantID
3913673

VehicleID	Movement	FromTo	Action
3436047	STRGHT	NE to SW	NONE

ParticipantID
3913674

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1941944	2/11/2021 0:00	4PM	S-STRGHT	PDO	F AVOID	0	0	0	0	0	0	NW BROADWAY	NW LOVEJOY ST

VehicleID	Movement	FromTo	Action
3648932	STRGHT	SW to NE	NONE

ParticipantID
4151549

VehicleID	Movement	FromTo	Action
3648933	STRGHT	SW to NE	NONE

ParticipantID
4151550

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1849391	8/24/2019 0:00	6PM	S-STRGHT	INJ	IMP LN C	0	0	1	1	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3483482	STRGHT	NE to SW	NONE

ParticipantID
3969620

VehicleID	Movement	FromTo	Action
3483483	STRGHT	NE to SW	NONE

ParticipantID
3969621
3969622

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1843180	6/1/2019 0:00	10PM	S-STRGHT	INJ	IMP LN C	0	0	0	1	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3471590	STRGHT	SW to NE	NONE

ParticipantID
3955359

VehicleID	Movement	FromTo	Action
3471591	STRGHT	SW to NE	NONE

ParticipantID
3955360

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1856966	1/19/2019 0:00	2AM	FIX OBJ	PDO	OTHR-IMP	0	0	0	0	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3497252	STRGHT	NE to SW	NONE

ParticipantID
3984972

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1868511	7/10/2019 0:00	12PM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	NW BROADWAY	NW LOVEJOY ST

VehicleID	Movement	FromTo	Action
3517693	STRGHT	E to W	NONE

ParticipantID
4004760

VehicleID	Movement	FromTo	Action
3517694	STRGHT	E to W	NONE

ParticipantID
4004761

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1872739	12/27/2019 0:00	11PM	FIX OBJ	PDO	CARELESS	0	0	0	0	0	0	BR BROADWAY BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3525149	STRGHT	W to E	NONE

ParticipantID
4011942

City of Portland, Bureau of Transportation
Accident History Export

Export Date: 8/22/2023
Exported By: johudson
Crash Count: 14

Total Fatal	Total A	Total B	Total C	Total Bikes	Total Peds
0	0	4	3	0	0

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1861020	4/26/2019 0:00	2PM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3504438	STRGHT	E to W	NONE

ParticipantID
3991916

VehicleID	Movement	FromTo	Action
3504439	STRGHT	E to W	NONE

ParticipantID
3991917

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1936874	10/9/2021 0:00	1AM	S-STRGHT	INJ	IMP LN C	0	0	2	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3639897	STRGHT	W to E	NONE

ParticipantID
4141535
4141536

VehicleID	Movement	FromTo	Action
3639898	STRGHT	W to E	NONE

ParticipantID
4141537

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1853691	12/1/2019 0:00	11PM	S-STRGHT	INJ	F AVOID	0	0	0	1	0	0	BR BURNSIDE BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3491584	STRGHT	W to E	NONE

ParticipantID
3979272

VehicleID	Movement	FromTo	Action
3491585	STRGHT	W to E	NONE

ParticipantID
3979273

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1787563	5/27/2018 0:00	4AM	FIX OBJ	INJ	FATIGUE	0	0	1	0	0	0	BR BURNSIDE BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3369126	STRGHT	W to E	NONE

ParticipantID
3839930

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1897580	2/28/2020 0:00	10AM	FIX OBJ	PDO	OTHR-IMP	0	0	0	0	0	0	E BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3569725	STRGHT	W to E	NONE

ParticipantID
4063669

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1855166	1/11/2019 0:00	4PM	O-OTHER	PDO	NO-YIELD	0	0	0	0	0	0	BR BURNSIDE BRG	UNKNOWN

VehicleID	Movement	FromTo	Action

3494143	STRGHT	E to W	SKIDDED

ParticipantID
3981942

VehicleID	Movement	FromTo	Action
3494144	U-TURN	W to W	NONE

ParticipantID
3981943

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1765862	9/3/2017 0:00	9PM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3329489	STRGHT	W to E	NONE

ParticipantID
3794662

VehicleID	Movement	FromTo	Action
3329490	STRGHT	W to E	NONE

ParticipantID
3794663

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1873452	12/14/2019 0:00	2PM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3526371	STRGHT	E to W	NONE

ParticipantID
4013137

VehicleID	Movement	FromTo	Action
3526372	STRGHT	E to W	NONE

ParticipantID
4013138

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1806405	3/25/2018 0:00	12AM	O-STRGHT	PDO	LEFT-CTR	0	0	0	0	0	0	BR BURNSIDE BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3404778	STRGHT	E to W	NONE

ParticipantID
3883191

VehicleID	Movement	FromTo	Action
3404779	STRGHT	W to E	NONE

ParticipantID
3883192

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1872631	10/24/2019 0:00	6AM	S-STRGHT	PDO	F AVOID	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3524963	STRGHT	E to W	NONE

ParticipantID
4011764

VehicleID	Movement	FromTo	Action
3524964	STRGHT	E to W	SLOW DN

ParticipantID
4011765

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1789645	7/22/2018 0:00	10PM	S-STRGHT	INJ	IMP LN C	0	0	0	2	0	0	BR BURNSIDE BRG	UNKNOWN

VehicleID	Movement	FromTo	Action
3373042	STRGHT	E to W	NONE

ParticipantID
3844884

VehicleID	Movement	FromTo	Action
3373043	STRGHT	E to W	NONE

ParticipantID
3844885
3844886

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1933933	11/20/2021 0:00	11PM	FIX OBJ	INJ	OTHR-IMP	0	0	1	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3634346	STRGHT	E to W	NONE

ParticipantID
4134945

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1942233	2/18/2021 0:00	7AM	S-STRGHT	PDO	IMP LN C	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

VehicleID	Movement	FromTo	Action
3649387	STRGHT	E to W	NONE

ParticipantID
4151995

VehicleID	Movement	FromTo	Action
3649388	STRGHT	E to W	NONE

ParticipantID
4151996

CrashID	Date	Time	CrashType	Severity	Causes	NumFatal	NumInjA	NumInjB	NumInjC	NumBikes	NumPeds	Street1	Street2
1751220	1/12/2017 0:00	3PM	S-STRGHT	PDO	TOO-FAST	0	0	0	0	0	0	W BURNSIDE ST	UNKNOWN

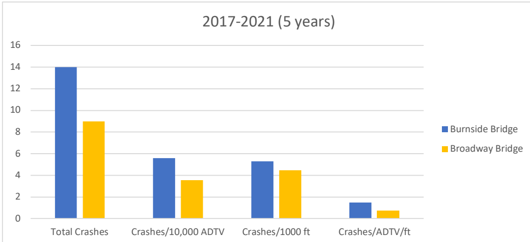
VehicleID	Movement	FromTo	Action
3303379	STRGHT	E to W	NONE

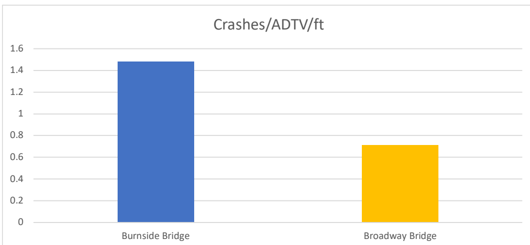
ParticipantID
3769123

VehicleID	Movement	FromTo	Action
3303380	STRGHT	E to W	NONE

ParticipantID
3769124

	Length (ft)	EB ADTV	WB ADTV	Total ADTV	ADTV/ft	Total Crashes	Crashes/10,000 ADTV	Crashes/1000 ft	Crashes/ADTV/ft	Serious Crashes/ADTV/ft	Bike	Ped
Burnside Bridge	2650	15186	9821	25007	9.44	14	5.60	5.28	1.483584596	0	0	0
Broadway Bridge	2010	12334	13025	25359	12.62	9	3.55	4.48	0.713356205	0	0	0





The purpose was to determine whether the existing cross-section of the Broadway Bridge, which is much like what we have proposed for Burnside, experiences an unusual pattern of crashes of type that might be expected from narrow lanes – sideswipe, head-on, and fixed object.

Crashes are counted and then normalized for the different traffic volumes and bridge lengths of the two bridges to produce a rate per length x volume. The rate on the Broadway is less than Burnside, by quite a bit. Of course, other factors influence crash rates, and not all crashes are reported, but this does seem to validate that that cross-section of the Broadway does not present any unusual risk of those crash types based on the available crash data.

TriMet Mirror Strike Data on Bridges (January 1, 2018 to May 31st, 2023)

Location	2018	2019	2020	2021	2022	2023 (up to May 31st)	Total
ST JOHNS BRIDGE	5	7	1	2	3	0	18
ROSS ISLAND BRIDGE	1	2	1	1	2	3	10
BURNSIDE BRIDGE	3	0	1	1	0	1	6
SW MACADAM & SELLWOOD BRIDGE	0	0	2	0	0	0	2
HAWTHORNE BRIDGE	0	0	0	1	0	0	1
HAWTHORNE BRIDGE	0	0	0	1	0	0	1
Sum	9	9	5	6	5	4	38

Note: No reported mirror strikes in Broadway Bridge

Appendix E. City Policy Rationale Presentation

Earthquake Ready Burnside Bridge Project (EQRB)

Design Tech Meeting June 13, 2023

PBOT
PORTLAND BUREAU OF TRANSPORTATION

Agenda:

- **Policy**
  - Per modal hierarchy (Ped, Bike, Transit, Freight, Auto)
- **How We Got Here**
  - Why/How the Policies and Guidelines were adopted
  - Relevance to EQRB
- **Design Guidelines**
  - Support City Policy
  - Per modal hierarchy

Active Transportation Space on EQRB - Policy

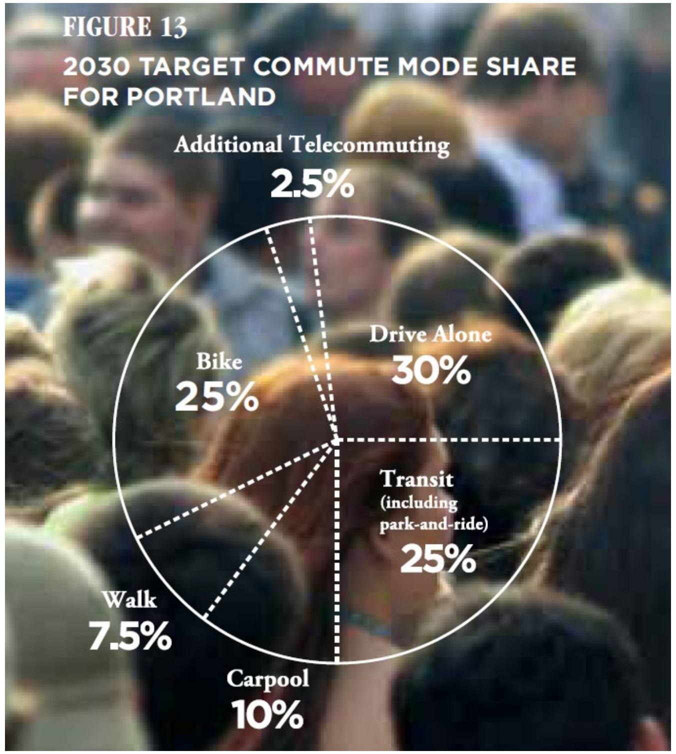
Portland Policy Guidance

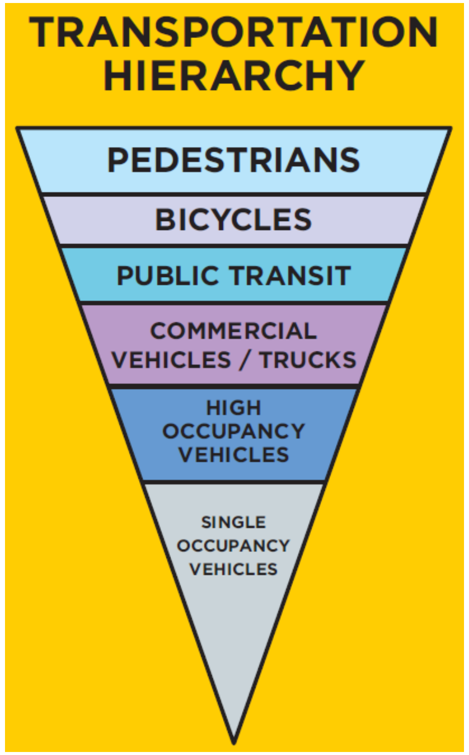
2009 City of Portland Multnomah County Climate Action Plan

- Goal: **80% reduction of local carbon emissions** by 2050
  - Bicycle mode split goal of **25%**
  - **Green Transportation Hierarchy**

2010 Portland Bicycle Plan for 2030

- Embraced **25%** bicycle mode split
- Embraced **green transportation hierarchy**
- Policy recommendations
  - Bicycling **more attractive than driving**
  - Create conditions that are **"safe and comfortable"**
  - Adopt green transportation hierarchy





Active Transportation Space on EQRB - Policy

Portland Policy Guidance

2016 (and 2018) City of Portland 2035 Comprehensive Plan

- Policy 9.6 Transportation strategy for people movement = “**Green transportation hierarchy**”
- Policy 9.20 Bicycle transportation
  - Create conditions that **make bicycling more attractive than driving**…
- Policy 9.21 Accessible bicycle system
  - …safe comfortable and accessible for **people of all ages and abilities**
- Policy 9.5 Mode share goals and Vehicle Miles Traveled (VMT) reduction
  - Increase the share of trips made using active and low-carbon transportation modes. Reduce VMT to achieve targets set in the most current **Climate Action Plan** and Transportation System Plan and meet or exceed Metro’s mode share and VMT targets.

Active Transportation Space on EQRB - Policy

Portland Policy Guidance

2016 (and 2018) City of Portland 2035 Comprehensive Plan

- Encourage walking as the most attractive mode by improving the quality of the pedestrian environment (Policies 9.18, 9.18)

- Improve the pedestrian safety, accessibility, and convenience for people of all ages and abilities (Policy 9.19)

Active Transportation Space on EQRB - Policy

Portland Policy Guidance

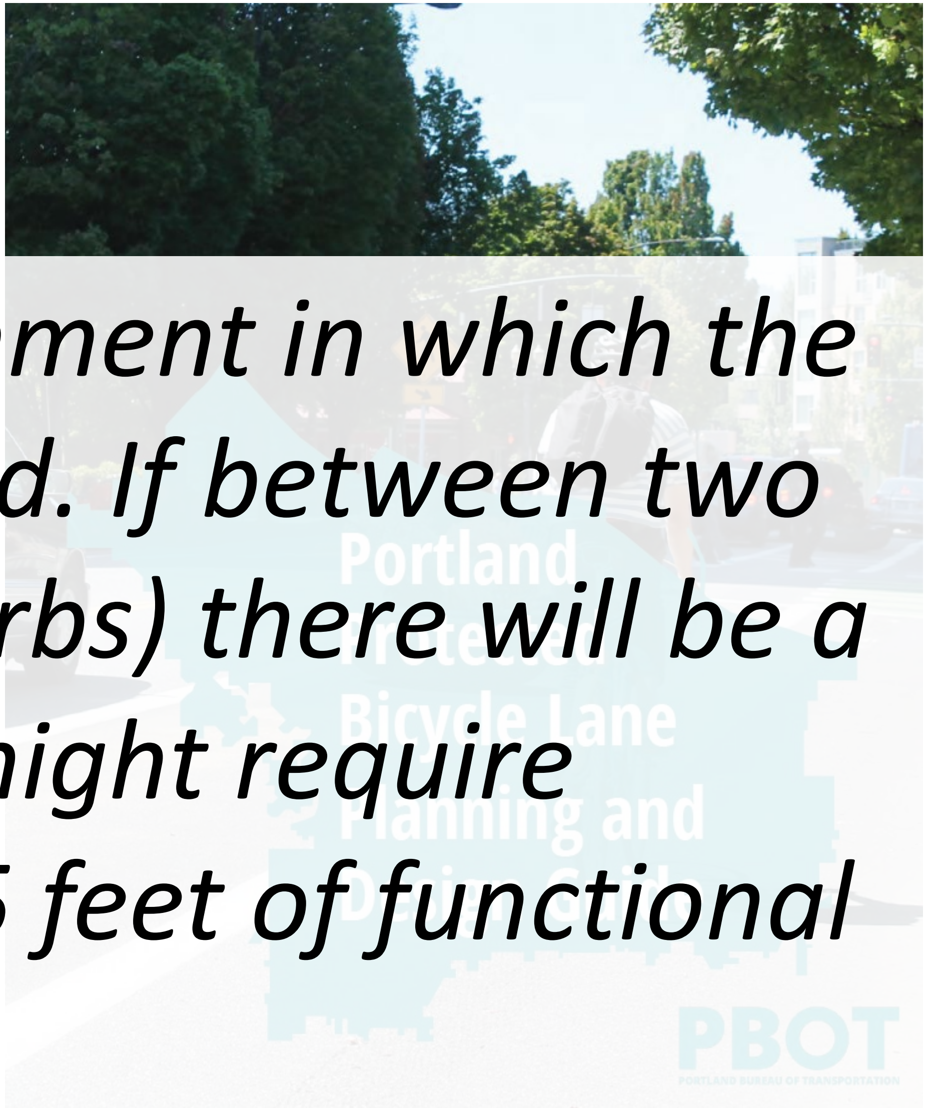
<u>Portland Transportation System Plan</u>

- Burnside Bridge carriers Portland's highest classifications for bicycling and walking
  - **Major City Walkway**
    - Provide safe, convenient, and attractive pedestrian access
    - Wide sidewalks on both sides
    - Can accommodate high volumes of pedestrian activity (*PedPDX*)
    - Also designated a **Civic Main Street** (*Pedestrian Design Guide*)
  - **Major City Bikeway**
    - Should have separated facilities for bicyclists and pedestrians (where conditions warrant)
    - Designed to accommodate large volumes of bicyclists and maximize their comfort
    - Build highest quality bikeway facilities

Active Transportation Space on EQRB - Policy

Portland Design Guidance

Portland Protected Bicycle Lane Planning and Design Guide



"Carefully consider the environment in which the 6.5-foot bicycling zone is placed. If between two vertical elements (including curbs) there will be a shy distance to consider that might require additional width to provide 6.5 feet of functional width…."

Active Transportation Space on EQRB - Policy

Case Study – Copenhagen

- Portland's bikeways have been inspired and influenced by designs implemented in some of the world's be cycling cities, including Copenhagen
- CPHers consistently cite insufficient space as a deterrent to biking

From CPH's 2006 "Cycle Account":

57% of the cyclists who did not feel safe biking in Copenhagen said that cars were the cause. Forty-five percent (predominantly women) felt that other cyclists were the cause of their insecurity. "Generally speaking cyclists feel that there are three factors that are particularly annoying in traffic: 27% are annoyed by other road users' aggressive conduct, 25% are annoyed by too many cyclists and 24% are annoyed by too many cars."

Active Transportation Space on EQRB - Policy

Case Study – Copenhagen

- Portland's bikeways have been inspired and influenced by designs implemented in some of the world's be cycling cities, including Copenhagen
- CPHers consistently cite insufficient space as a deterrent to biking

From CPH's 2006 "Cycle Account":

More people will cycle if conditions improve

"Cycle track width should be increased on the relatively few kilometers of the cycle track network where the cycle tracks do not have the capacity to accommodate the growing number of cyclists. This would help enhance cycling security on those sections, and perhaps also contribute to creating a generally more positive attitude towards cycling security in Copenhagen."

Active Transportation Space on EQRB - Policy

Case Study – Copenhagen

- Portland's bikeways have been inspired and influenced by designs implemented in some of the world's be cycling cities, including Copenhagen
- CPHers consistently cite insufficient space as a deterrent to biking

From CPH's 2018 "Cycle Account":

"As bicycle traffic increases, cycle tracks and cycle stands for parking become increasingly congested. We must make a concerted effort to create space for everyone regardless of whether they are bicycle commuters, six-year-olds on their first bike, the elderly at a leisurely pace, or newcomers who have just moved here from abroad."

Active Transportation Space on EQRB - Policy

Case Study – Copenhagen

- Portland's bikeways have been inspired and influenced by designs implemented in some of the world's be cycling cities, including Copenhagen
- CPHers consistently cite insufficient space as a deterrent to biking
- In response, city planners have widened bicycle facilities to create safer and more comfortable conditions
- Need to plan for needs in 100 years – this requires more space for higher volumes and larger bicycles
- Competition for space can be seen on the Tilikum Bridge


Riding comfortably side-by-side on the 14’-wide Tilikum path.
Replacing the 8” stripe with a 12” detectable strip will push the person on the right further to the right
7’
8”
6’4”
20” shy
5’4”
14’

Riding comfortably side-by-side on the 14’-wide Tilikum path.

Riding comfortably side-by-side on the 14’-wide Tilikum path.

Bike trailer in the bike space on the 14’-wide Tilikum pathway

Riding comfortably side-by-side on the 14’-wide Tilikum path.

Cyclist passing positioning on Tilikum Crossing


Walking and biking spacing
on the 14’-wide Tilikum path


Walking and biking spacing on the 14’-wide Tilikum path.

Cyclists passing in pedestrian space.

Cyclist positioning on the 14’-wide Tilikum path.

Cyclists passing in pedestrian space.


Pedestrian positioning on 6’4” pedestrian space.
People walking/running passing in bike space.

Walking and biking spacing on the 14’-wide Tilikum path.

Cyclists passing in pedestrian space.

Active Transportation Space on EQRB – Design Guidance

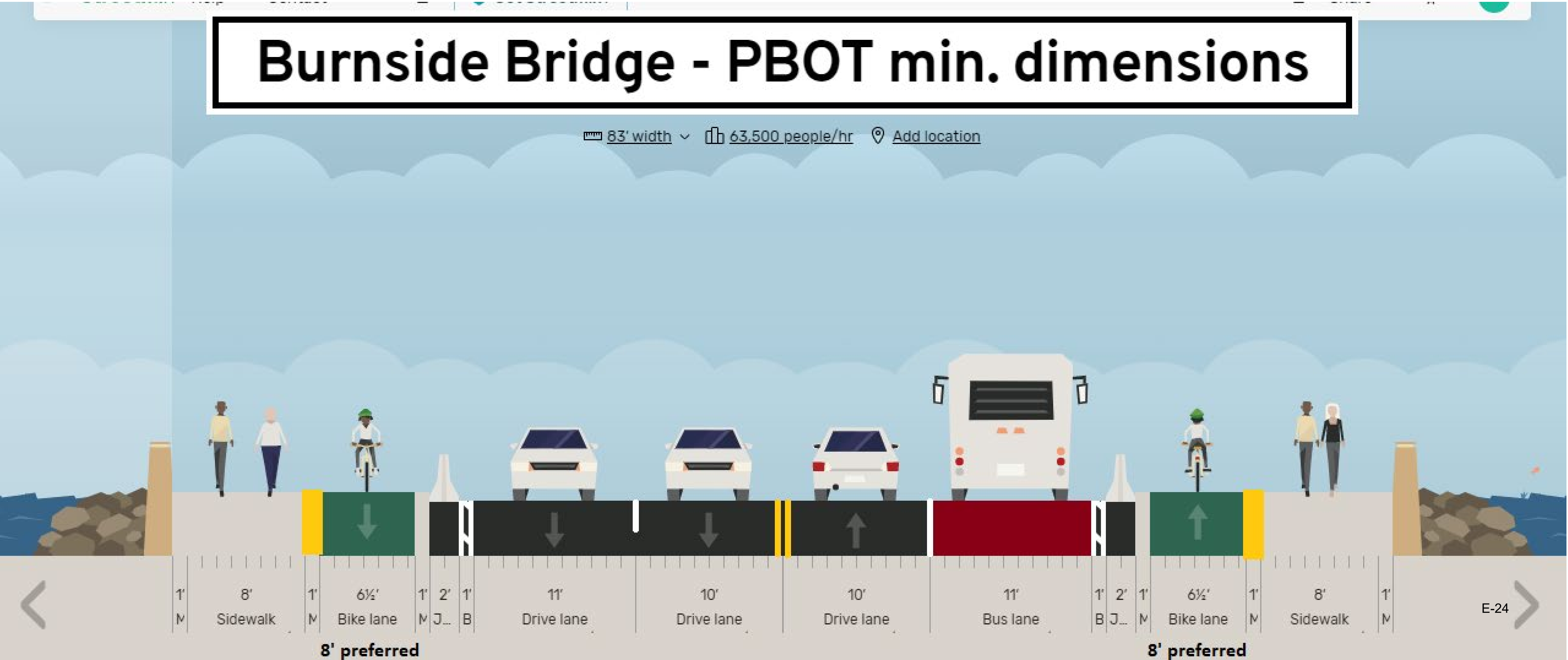
PBOT Design Guidance

Designations and Conditions	Design Treatment
Civic Main Street designation	Minimum 8’ width for a pedestrian through zone
Adjacent sidewalk-level bicycle facility	Minimum 1’ sidewalk buffer furnishing zone; filled with yellow detectable strip
Adjacent to barrier wall	Additional shy distance of 1’ to 2’
Directional bikeway with peak hourly volumes of 150 – 750	Preferred bikeway width is 8’. Minimum width of 6.5’
If between two vertical elements (including curbs)	Include shy distance of 1’ to 2’ to attain functional width of 6.5’

Preferred width of at least 19’ and a minimum of 17.5’ on EQRB

Locally Preferred Alternative

Typical Cross Section



Active Transportation Space on EQRB – Design Guidance

Testing Facility Widths

- 8-foot directional bikeway immediately adjacent to a barrier is sufficient to handle most side-by-side cyclists (including passing and social riding)
- Requires one bicyclists to ride closer to the barrier than normal
    - Normal (observed, comfortable) shy distance is approximately 3 to 3.5 feet
    - To comfortably operate within the 8-feet cycling zone requires the cyclists closer to the wall to be within 2 feet
    - If a cyclist operated at the normal distance, then a passing cyclists handlebars extended past the 8-foot envelope.

Auto/Transit Space on EQRB

Roadway Sizing

Design consistent with City preferred design guidelines would use 10-foot inner lanes and 11-foot outer lanes

- Preferred lane width for 4 lanes of motor vehicle travel is typically 10 feet
- 11-foot outer lanes are considered on transit routes when feasible but are not required
- Burnside Bridge is not a freight route
- 1-foot shy lane should be added to all lane widths next to curbs
- Vehicles will encounter 10-foot lanes on both sides of the bridge
    - Only section with 11-foot outer lanes is W Burnside to Washington County

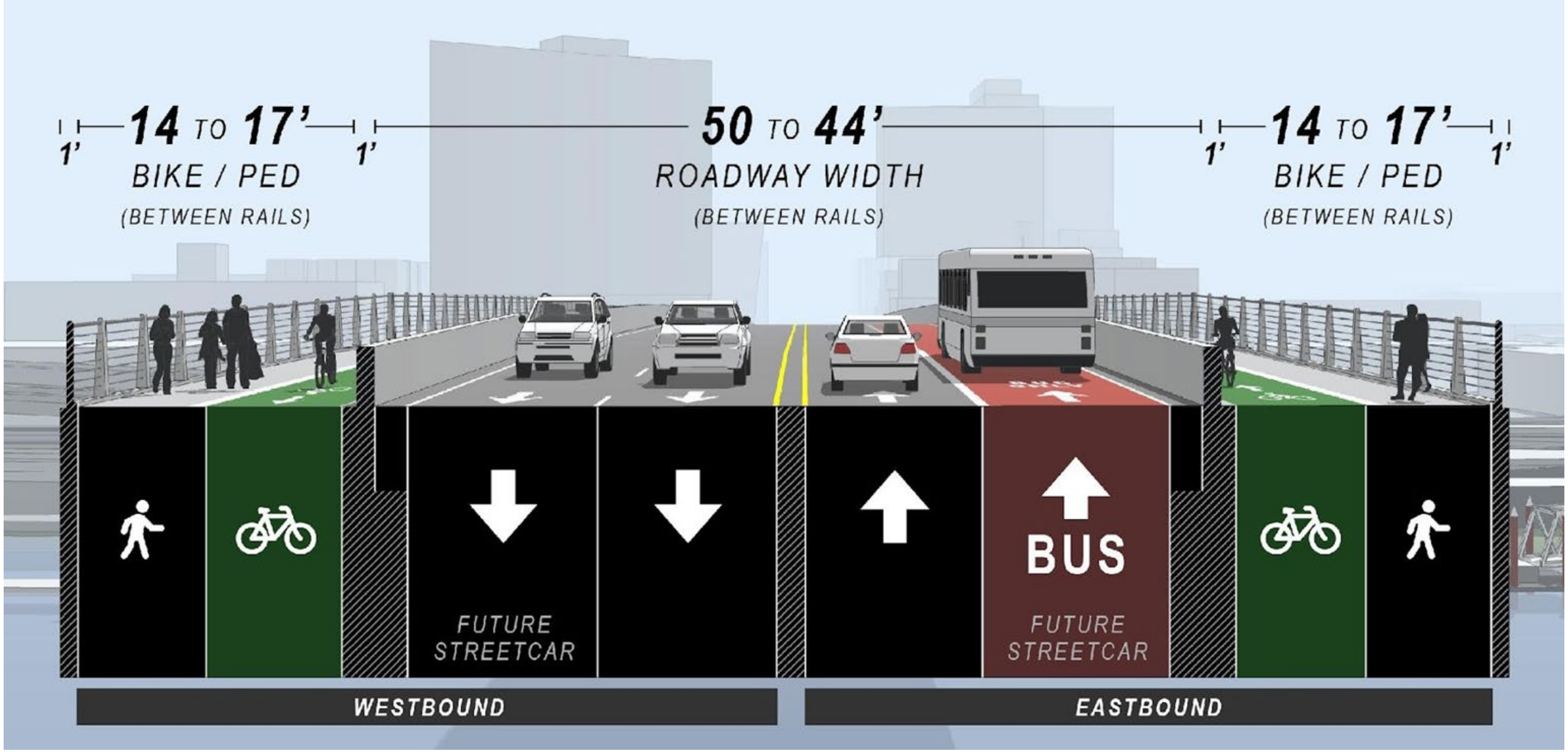
Active Transportation Space on EQRB

Unsupportive of PBOT Policies

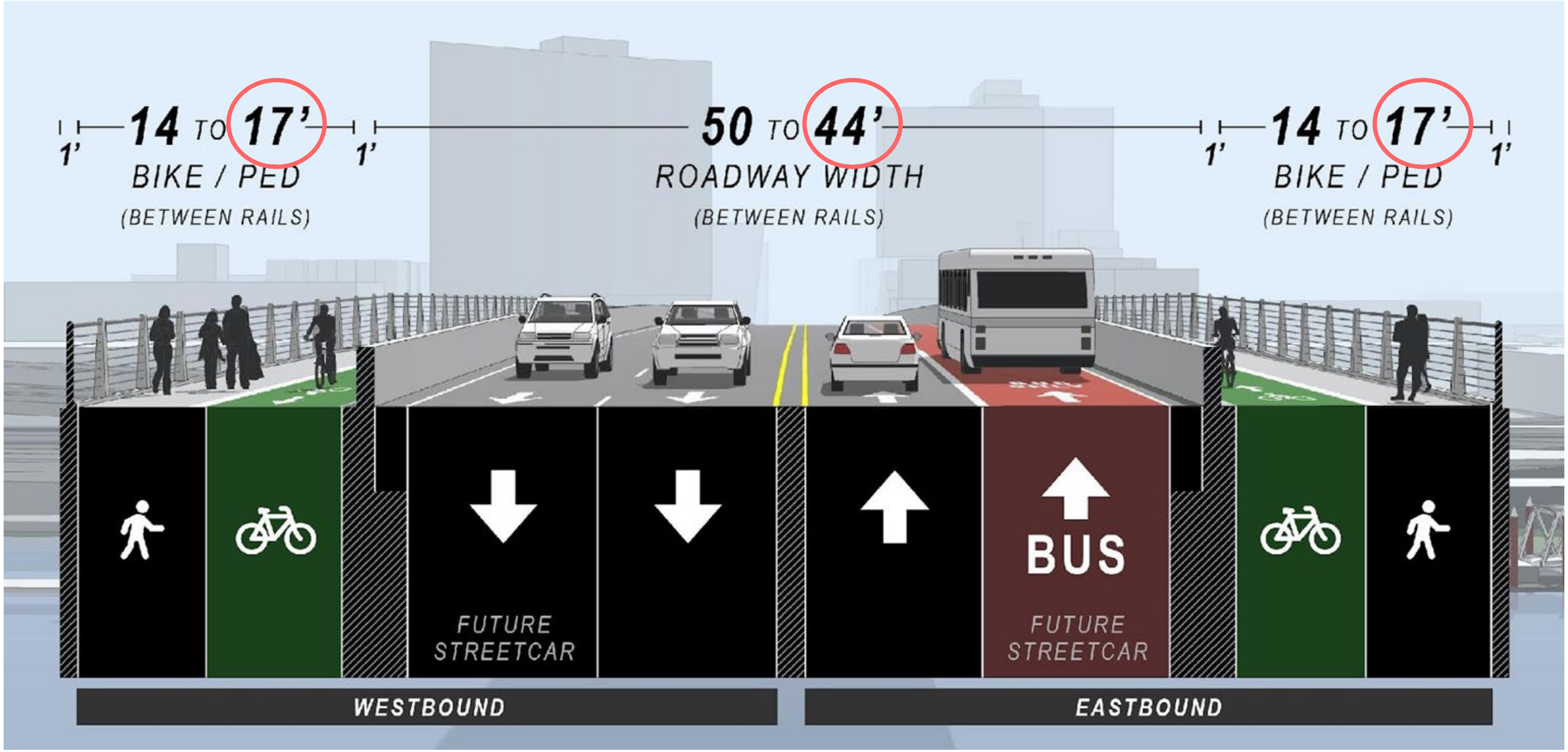
- Under-sizing of the bicycle and pedestrian space will result in conditions that are unsafe, uncomfortable, and unattractive for people
- Encroachment of bikes and degradation to pedestrian space
- Does not prioritize pedestrians
- Bicycle facilities will need to accommodate larger bicycles
- Does not address climate action plan
- See Tilikum Bridge Example

Locally Preferred Alternative

Typical Cross Section



Traffic Configuration on Bridge



Appendix F. Testing Needed Width on Sidewalk Level Bikeway Bordered with a Vertical Element

PBOT Field Test: Needed width on sidewalk level bikeway bordered with a vertical element

On Friday, September 17th, Patrick Sweeney, Gregory Mallon and Roger Geller conducted a field assessment to identify width requirements for directional sidewalk-level bikeways adjacent to a barrier. This assessment was conducted to inform width requirements for the proposed sidewalk-level bikeway to be built as part of the Earthquake Ready Burnside Bridge project.

This assessment was broken out into five distinct elements, as follows. Data from each of these elements is presented in five tables. Following those five tables is a discussion and recommendations.

Assessment

Methodology
The assessment was conducted on two bridge pathways, the width of which provided similarities to what is proposed for the Burnside Bridge. The first four assessments were conducted on the Morrison Bridge. The Morrison was chosen because it has no existing markings on it, allowing for a blank slate.

The second bridge was the Tilikum Crossing, which is marked with a 20" stripe from the inside rail to inform a shy distance from that rail for people bicycling[1]. Each Tilikum Crossing pathway is also marked with a stripe centered 7'9" from the inside rail to divide the overall 14'-wide pathway into a directional bikeway and two-way pedestrian space.

In all test cases, below, two people rode under various conditions. A third person marked the wheel path on pavement with tape. Following all series run, the distances from the tape to the wall was measured and recorded. In the tests in which one cyclist passed a slower-moving cyclist the slower moving cyclist stayed closer to the wall (the "inside" of the bike lane) with the passing cyclist closer to the open space (the "outside" of the bike lane). While this violates the general practice of "faster vehicles to the left" it reproduces how people ride on both the left-side North Williams buffered bicycle lane as well as observed behavior on the Tilikum Crossing. In both those instances slower-moving cyclists tend to stay to the left/inside and allow faster-moving cyclists more open space/outside to effect their pass.

<u>Test Series A (Morrison Bridge): Minimum shy distance from wall, unmarked pathway</u>
This first test involved the cyclists riding as close as possible to the barrier both uphill and downhill. They were instructed to ride as close to the wall as they were comfortable doing so. In this instance, and in subsequent instances, they rode with the barrier to their left so as to mimic the conditions that will

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[1] This marking was determined in a test conducted jointly by PBOT and TriMet. Multiple members of the City of Portland's Bicycle Advisory Committee rode the Tilikum pathway prior to opening to determine minimum shy distance to the inside barrier. They were instructed to ride as close as comfortably possible to the inside barrier on the bridge. The resulting stripe was then placed several inches inside the observed wheel path. As noted in an account of that test "with only one exception all people bicycling were a minimum of 2' away from the face of the rail post." The stripe was placed inside that mark rather than directly on it because of people's observed reluctance to ride directly on a painted stripe. *[Based on 7/10/15 email from Roger Geller to Jeff Owen, Bob Hastings (both TriMet) and Michelle Dellinger (PBOT).]*

ultimately be installed on the Burnside Bridge. Each of two cyclists rode uphill three times and downhill twice.

<u>Test Series B1 (Morrison Bridge): Distance from wall when passing other rider; unmarked pathway; passed rider riding as close as possible to wall.</u>
This test measured the distance from the wall of a passing cyclist. One person would bicycle as close as possible to the wall and would then be passed by the second cyclist. This was done both uphill and downhill with the two people trading roles on each trial.

<u>Test Series B2 (Morrison Bridge): Distance from wall when passing other rider; pathway marked 8' from wall.</u>
In this test, an 8' pathway was defined from the wall using blue masking tape on pavement. The cyclists were instructed to pass within that area with the slower-moving, overtaken cyclist staying as close to the wall as comfortably possible.

<u>Test Series C (Morrison Bridge): Distance from wall when passing other rider; pathway marked at 8' from wall; slower cyclist instructed to ride at comfortable distance from wall.</u>
In this final series on the Morrison Bridge the slower-moving cyclist was instructed to ride at a comfortable distance from the wall. That was to mimic more typical riding conditions. More on that to follow.

<u>Test Series D (Tilikum Crossing): Distance from wall when passing other rider; slower cyclist riding at comfortable distance from wall.</u>
In this series on the Tilikum the test was conducted in an environment with existing striping, as described above.

<u>Cyclists in the Wild</u>
A number of people bicycling rode past the test on both the Morrison Bridge and Tilikum Crossing. The project team took note of and measured their wheel paths relative to the barrier walls.

Table 1. Series A; Morrison Bridge: Minimum shy distance from wall/barrier; unmarked pathway (inches, measured at wheelpath)

	uphill		downhill	
Rider:	1	2	1	2
Trial				
Test Series A; Ride 1	14	18	22.5	24
Test Series A; Ride 2	13.5	22	18.5	21.5
Test Series A; Ride 3	20.5	24.5		
average	16	21.5	20.5	22.75
overall average (in)	**19**		**22**	
overall average (ft)	**1 ft. 7 in.**		**1 ft. 10 in.**	

Table 2. Series B1; Morrison Bridge: Distance from wall when passing other rider; unmarked pathway (inches, measured at wheelpath)

	uphill	downhill	average separation distance*	
Trial			uphill	downhill
Test Series B1; Ride 1	64	73		
Test Series B1; Ride 2	60	80		
Test Series B1; Ride 3	61.5	73		
average (in)	**62**	**75**	43	53
average (ft)	**5 ft. 2 in.**	**6 ft. 3 in.**	**3 ft. 7 in.**	**4 ft. 5 in.**

*separation distance assumes slower rider rode at average shy distances from wall identified in Series A

Table 3. Series B2; Morrison Bridge: Distance from wall when passing other rider; pathway marked at 8' from wall (inches, measured at wheelpath)

	uphill	downhill	average separation distance*	
Trial			uphill	downhill
Test Series B2; Ride 1	67	75		
Test Series B2; Ride 2	71	81		
Test Series B2; Ride 3	78	93		
average (in)	**72**	**83**	53	61
average (ft)	**6 ft. 0 in.**	**6 ft. 11 in.**	**4 ft. 5 in.**	**5 ft. 1 in.**

*separation distance assumes slower rider rode at average shy distances from wall identified in Series A

Table 4. Series C; Morrison Bridge: Distance from wall when passing other rider; pathway marked at 8' from wall slower cyclist riding at comfortable distance from wall (inches, measured at wheelpath)

	uphill	downhill
Trial		
Test Series C; Ride 1	81.5	85.5
Test Series C; Ride 2	81.5	87
Test Series C; Ride 3	81.5	87.5
average (in)	**82**	**87**
average (ft)	**6 ft. 10 in.**	**7 ft. 3 in.**

Table 5. Series D; Tilikum Crossing: Distance from wall when passing other rider; slower cyclist riding at comfortable distance from wall (inches, measured at wheelpath)

	uphill	downhill
Trial		
Test Series D; Ride 1	85.5	91
Test Series D; Ride 2	87	87
average (in)	**86**	**89**
average (ft)	**7 ft. 2 in.**	**7 ft. 5 in.**

Table 6. Cyclists in the "wild"; positioning relative to vertical wall (inches, measured at wheelpath)

	Morrison Bridge	Tilikum Bridge
	36	32
	36	40
	40	38
	34	54
		54
average (in)	**37**	**44**
average (ft)	**3 ft. 1 in.**	**3 ft. 8 in.**
combined average (in)	**40**	
combined average (ft)	**3 ft. 4 in.**	

Table 7. Summary of Findings

		wheel path	outside handlebar*
Average minimum shy distance from wall	uphill	**1 ft. 7 in.**	**2 ft. 7 in.**
	downhill	**1 ft. 10 in.**	**2 ft. 10 in.**
Average distance from wall by passing cyclist; minimum shy distance	uphill	**5 ft. 2 in.**	**6 ft. 2 in.**
	downhill	**6 ft. 3 in.**	**7 ft. 3 in.**
Average distance from wall by passing cyclist; minimum shy distance and marked 8' area	uphill	**6 ft. 0 in.**	**7 ft. 0 in.**
	downhill	**6 ft. 11 in.**	**7 ft. 11 in.**
Average distance from wall by passing cyclist; comfortable shy distance and marked 8' area	uphill	**6 ft. 10 in.**	**7 ft. 10 in.**
	downhill	**7 ft. 3 in.**	**8 ft. 3 in.**
Average distance from wall by passing cyclist; comfortable shy distance	uphill	**7 ft. 2 in.**	**8 ft. 2 in.**
	downhill	**7 ft. 5 in.**	**8 ft. 5 in.**

*This width to outside handlebar determined by adding twelve inches (12") to the wheelpath measurement.

Findings and Discussion

See above tables for recorded the measurements of the above series.

Summary of Findings

- The most important finding is that an 8-foot wide directional bikeway seems of sufficient width to handle two side-by-side cyclists whether they are riding socially or if one is passing the other. This applies to people riding standard, two-wheeled bicycles.
- Both shy distance and passing distance increased in the downhill (higher speed) direction.
- The minimum shy distance measured on the Morrison Bridge is close to that identified on the Tilikum Crossing.
- The minimum shy distance to a wall, at approximately 19 to 22 inches (uphill/downhill, respectively), is much closer than normal riding distance from a wall, which measured at between 3-3.5 feet.
- All wheel paths of passing cyclists were less than eight feet from the wall.
- When the total envelope of the cyclist was taken into account (ie. to edge of handlebars), then the needed width exceeded eight feet.

Detailed Findings

Shy distance. Series A and "Cyclists in the Wild" Findings. People bicycling are able to get quite close to a vertical barrier when instructed to do so. Series A shows distances comparable to those identified for the Tilikum Crossing in 2015. However, when people are naturally riding in a comfortable space relative to the wall, that distance tends to be closer to three feet (3'). This is pertinent because people being overtaken on a pathway will not naturally be riding close to the barrier. They are likely to be riding closer to the three foot mark.

Width needed for passing. Series B1, B2, C and D Findings. When people stay at a minimum shy distance from a wall, then the average width from the wall of passing cyclists was between approximately five and six feet (uphill / downhill, respectively). The passing cyclist was between approximately 3.5 feet and 4.5 feet from the overtaken cyclist.

When an eight-foot space was defined for bicycling, and the slower cyclist maintained a minimum shy distance, then the total width required for passing was between six feet and seven feet. Presumably the defined space created more comfortable conditions for passing and encouraged the overtaking cyclist to increase their separation from the slower cyclist to between 4.5 and five feet.

When the overtaken cyclist was instructed to ride at a comfortable distance from the wall, and not try to maintain a minimum shy distance, then the overall width required was between seven feet and 7.5 feet.

It is worth noting that when we take the combined average width from the wall of 3 ft 4 in—observed from nine people riding independent of these tests—and apply to that the passing widths ranging from a minimum of 3 ft 7 in (uphill) to 5 ft 1 in (downhill) [from Tables 2 and 3, respectively], then the range of width required ranged from 6 ft 11 in to 7 ft 5 in. These are wheel path measurements, and do not include the full envelope of the cyclist, which extends another foot from the wheel path, nor does it account for larger bicycles, such as cargo bikes or bikes pulling trailers.

Using just the measurements recorded by test riders, it appears that the wheel paths of two people bicycling—either side-by-side or with one passing another—will fit within an eight-foot width. When considering the entire envelope of the outside cyclist, then the width required extends beyond the eight-foot width and would intrude slightly into the one-foot separation between bicycle and pedestrian spaces.

Discussion

This test seems to favorably resolve the consideration of whether an eight-foot wide pathway with no integrated shy distance from a vertical barrier will suffice for side-by-side riding and passing behavior. The answer appears to be "yes", with caveats. Those caveats are:

This applies to standard bicycles, only, and does not take into account the growing fleet of cargo bikes and people pulling trailers on bikes. Those types of bikes are likely to be those that will more frequently be passed because of their slower speeds.

When considering the entire envelope of the bicycle, the passing maneuver just barely fits into the eight-foot width, and indeed exceeds it, slightly overlapping into the one-foot separation between bicycle and pedestrian spaces.

The eight-foot width is consistent with guidance in Portland's Protected Bicycle Lane Planning and Design Guide, which identifies a preferred with of eight feet for directional bikeways when the peak hour bicycle volumes are between 150 and 750 people per peak hour. It is worth noting that peak hour directional bicycle volumes on the Burnside Bridge were 214 in 2014, 275 in 2015 and 197 in 2019 (first year post-construction). At 750 people per hour the preferred bikeway width would expand to ten feet. This guidance is based on draft and expected guidance in the ongoing update to the national bicycle guide published by the American Association of State Highway and Transportation Officials (AASHTO).

While we can hope for those higher volumes within the lifetime of the bridge, it is safe to assume that the City of Portland, Metro and Multnomah County will all work toward achieving an outcome of high bicycle use. It is also worth noting that the desired outcome of a specific level of high bicycle use in this region—defined as 25% bicycle commute mode split—was first identified jointly by Multnomah County and City of Portland in the jointly-produced 2009 Climate Action Plan. That desired outcome has since been codified in the City of Portland Comprehensive Plan in service to a desired outcome of 30% bicycle commute mode split by 2035.

That the desired outcome should be reflected in design—the idea of "outcome-based design"—is enshrined in the Metro Regional Transportation Plan (RTP) and in the Metro regional design document: "Designing Livable Streets and Trails Guide". That document includes a policy section titled "Design for desired outcomes" (section 2.4). That section includes the statement: "Streets and trails are designed to provide a variety of transportation choices that are safe, comfortable and easily accessible." Given the previously recorded bicycle volumes, the local (and to be national) guidance that is intended to create safe and comfortable conditions for biking and walking, and the results of this test and observations, it appears that an eight-foot space for bicycling, separated from a pedestrian space by a one-foot buffer, will address both current bicycling volumes as well as the city's, county's and region's desired outcomes.

Appendix G. PBOT White Paper on OSHA and Path Ahead

What Does the Oregon Household Activity Survey Tell Us About the Path Ahead for Active Transportation in the City of Portland?

a White Paper by Roger Geller

March 2013

Introduction

In assessing the existing structure of Portland's transportation system and planning for the future some large questions arise: has the city been successful in advancing non-automotive means of transportation? Will the city and region be able to achieve policy and mode split goals as elucidated in the Portland Plan, the Climate Action Plan, the Portland Bicycle Plan for 2030 and the Regional Transportation Plan? What are the appropriate strategies to advance toward those goals? What are the costs of not achieving them? This paper uses Oregon Household Activity Survey (OHAS) data recently provided by Metro to suggest some directions to consider in seeking answers.

In October 2012 Metro made available initial data from the OHAS, which was conducted in Portland in 2011. The most recent survey of comparable depth and quality was conducted in 1994. A comparison of the data from these two time periods demonstrates that Portland has been successful in advancing non-automotive transportation. This analysis is encouraging of the ability of the city to achieve its goals related to bicycling and active transportation. The data tells us that active transportation and transit have contributed significantly to the continuing livability and attractiveness of Portland and the region. Specifically:

- In 1994 19 percent of trips by Portlanders were either walking (12 percent) transit (5.5 percent) or bicycling (1.6 percent).
- In 2011 28 percent of trips by Portlanders were either walking (15 percent) transit (7 percent) or bicycling (6 percent).
- There were approximately 162 million more annual trips taken by Portland residents in 2011 than in 1994, an increase of 24 percent
- 47 million of those additional trips were walking trips (29 percent), 36 million were bicycling trips (22 percent) and 20 million were transit trips (12 percent). Together, walking, bicycling and transit accounted for 64 percent of trips added since 1994
- Walking added the most new non-automotive trips, bicycling increased the most per capita
- Total annual motor vehicle miles traveled by Portland residents seems to have dropped from 2.35 billion in 1994 to 2.26 billion in 2011

This analysis also indicates that the costs to the city and the region of not reaching targets for active transportation and transit are high:

- If active transportation and transit had not advanced since 1994, then Portlanders would have made 211,000 more weekday automotive trips in 2011 than they actually did. This is 1.5 times higher than the daily traffic volume on I-5 at the Marquam Bridge (2010 volumes)
- If active transportation and transit do not continue to advance, then by 2035 there will be more than 1,000,000 more daily automotive trips than there would otherwise be; this would the equivalent of the daily traffic on approximately 23 additional Powell Boulevards.

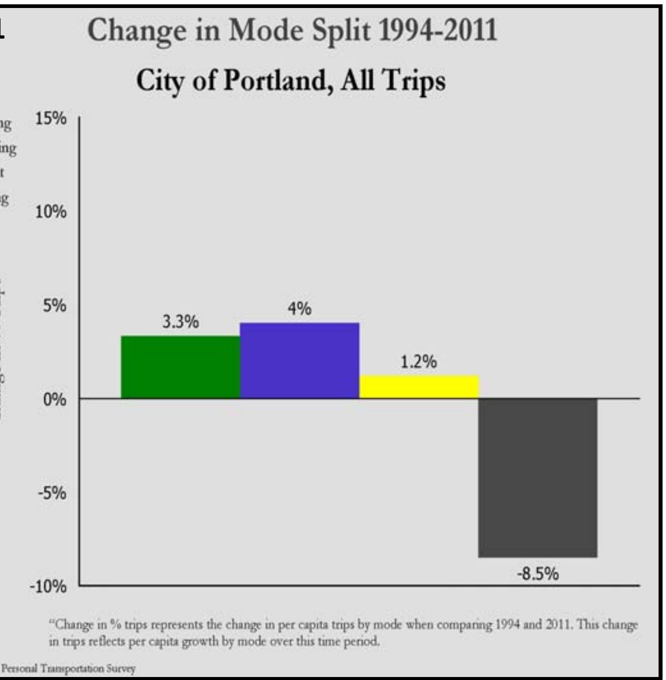
Finally, this paper points to suggestions for advancing bicycle transportation, in part by recognizing that:

- The potential for bicycle transportation in Portland remains largely untapped, and
- The potential for the greatest gains in reduction in vehicle miles traveled (VMT) is in the household- and trip-rich east side (between the Willamette River and I-205).

Active transportation as largest contributor to reduction in per capita driving trips.
The addition of more than 53,000 Portland households since 1994 is the reason why Portland residents took 162 million more annual trips in 2011 than they did in 1994. Of these new trips walking (29 percent) and bicycling (22 percent) together outnumbered driving (36 percent).

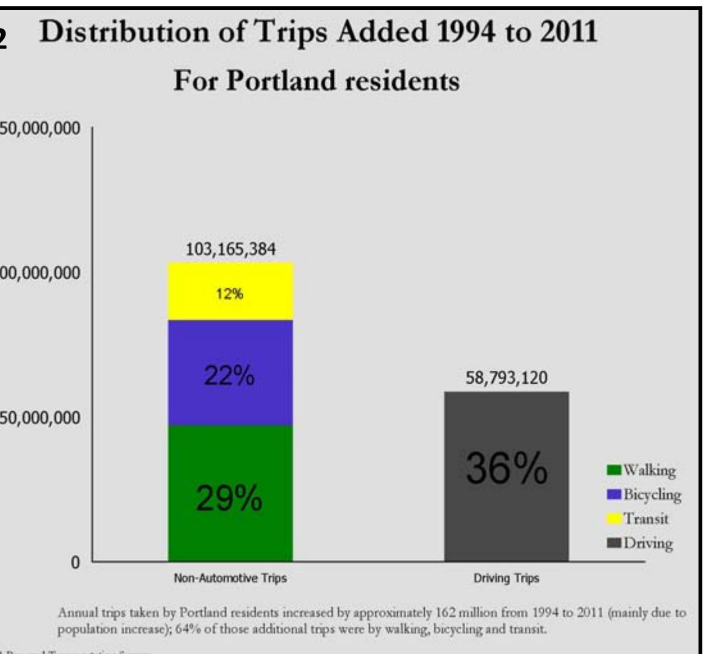
Per capita driving trips declined 3.5 percent for the region and 8.5 percent for the City of Portland[1]. Bicycle transportation contributed 4 percent of the change for the city (transit and walking contributed 1.2 percent and 3.3 percent, respectively, see Figure 1). Based on Metro's reported numbers, bicycle transportation contributed 47 percent of the per capita drop in driving in the City of Portland, with walking and transit contributing 39 percent and 15 percent, respectively.

Figure 1



This mode shift meant more than 72 million fewer driving trips by Portland residents per year, or more than 200,000 fewer driving trips on the typical weekday.

Figure 2



Bicycle use grew unevenly across the city (see map of sectors in Appendix Figure A-1). The highest growth was in the area defined by Metro as "Portland Central City (not including the Central Business District [CBD])", which saw bicycle use more than quadruple (364 percent growth) and account for a change in per capita trips of more than 10 percent. The smallest growth and change in trips was in the Portland CBD (39 percent growth, 0.7 percent change in per capita trips). Because of the paucity of trips originating from the relatively few households in these areas (representing 4% and 1 percent of all city trips, respectively) neither change effectively moved the needle for overall bicycle mode splits in the city.

[1] This drop, when combined with reported shorter trip distances traveled, seems to have produced a drop in overall automobile vehicle miles traveled for by Portland residents in 2011 compared to 1994.

The area defined as “Portland: Outside the Central City, east of river to I-205” had the greatest growth in the number of bicycle trips. That area experienced a 6.1 percent change in per capita bicycle trips reflecting more than 300 percent growth since 1994. Because this is a household- and trip-rich area (approximately 55

Table Array 1: Data from 2011 Metro OHAS compared to Data from 1994 Personal Transportation Survey

All Trip Mode Split Data 2011

based on Metro's 2011 Travel Activity Survey

	Portland CBD				Portland Central City (not including CBD)			
	1994	2011	Change	Growth	1994	2011	Change	Growth
Walk	39.5%	47.0%	7.5%	19%	35.6%	22.7%	-12.9%	-36%
Bike	1.8%	2.5%	**0.7%**	39%	2.8%	13.0%	**10.2%**	364%
Transit	15.9%	16.2%	0.3%	2%	10.0%	22.0%	12.0%	120%
Drive	42.8%	34.3%	-8.5%	-20%	51.6%	42.3%	-9.3%	-18%

	Portland: Outside CC, east of river to I-205				Portland, outside CC, west of river			
	1994	2011	Change	Growth	1994	2011	Change	Growth
Walk	11.7%	16.2%	4.5%	38%	14.6%	10.5%	-4.1%	-28%
Bike	2.0%	8.1%	**6.1%**	305%	1.3%	2.0%	0.7%	54%
Transit	6.0%	6.0%	0.0%	0%	3.1%	6.1%	3.0%	97%
Drive	80.3%	69.7%	-10.6%	-13%	81.0%	81.4%	0.4%	0%

	East Portland				Entire Region			
	1994	2011	Change	Growth	1994	2011	Change	Growth
Walk	6.8%	10.3%	3.5%	51%	8.7%	9.2%	0.5%	6%
Bike	0.5%	1.8%	1.3%	260%	1.1%	2.8%	**1.7%**	155%
Transit	5.1%	6.9%	1.8%	35%	2.9%	4.2%	1.3%	45%
Drive	87.6%	81.0%	-6.6%	-8%	87.3%	83.8%	-3.5%	-4%

	Entire City of Portland (based on assumptions about #hholds and daily trips)				Contribution to growth in non-auto trips
	1994	2011	Change	% Change	
Walk	11.9%	15.2%	3.3%	28%	38.8%
Bike	1.6%	5.5%	4.0%	254%	46.6%
Transit	5.6%	6.9%	1.2%	22%	14.6%
Drive	80.9%	72.4%	-8.5%	-11%	

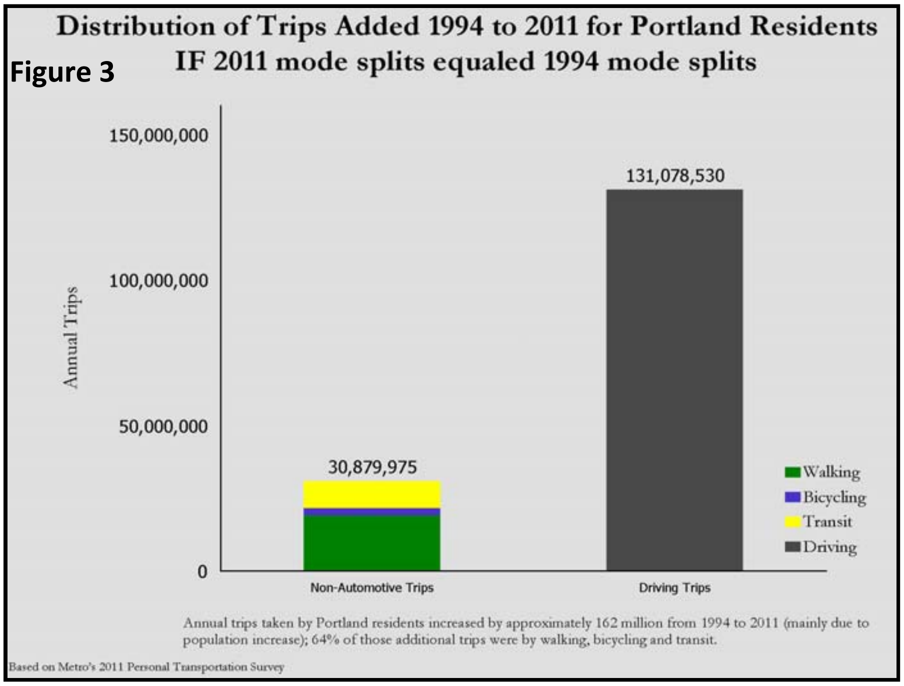
percent of all households in the city) it is likely that the growth in bicycle use in this area drove both the region's and city's bicycle contribution to motor vehicle trip reduction. This area accounted for 80 percent of all bicycle trips in Portland for 2011[2].

Scenarios for Future Growth

This analysis shows that future Portland residents—largely because of projected household growth—could reasonably be expected to generate almost 500,000 and 1.2 million more transportation trips per day by 2020 and 2035, respectively, than they generated in 2011 (see Appendix A). In planning for future growth the questions then become:

- Can the city achieve its desired targets for non-automotive and automotive transportation?
- What are the appropriate strategies to advance toward those targets?

Figure 3



Transit, walking and bicycle trips for Portlanders respectively increased 22%, 28% and 254% between 1994 and 2011. The benefit of that increase is demonstrated by comparing Figures 2 and 3; if active transportation and transit use had remained at 1994 levels, then the difference for car trips between actual levels and those shown in Figure 3 would have been 1.5 times the traffic volumes handled on I-5 at the Marquam Bridge (see Figure 10, too).

For the city to achieve targeted levels of bicycle mode split, the east side of Portland between the river and I-205 will have to play a prominent role. This is because of its density, population and land use that results in short trips[3]. For example, 75% growth in bicycle mode share in the east side to I-205 (growing from current 8.1% to 14%[4]) by 2020 would result in a city-wide mode split increase of 9%. Doubling trips elsewhere in the city would raise the city-wide bicycle mode split to 10%, representing an overall 80% growth in bicycle mode split (See Table Arrays 3 and 4).

Table Array 2 displays growth by non-automotive modes 1994-2011 and assumptions for continued growth to higher non-automotive transportation in 2020 and 2035. Table Array 4 shows the results of these assumptions. The assumptions and results are discussed more thoroughly in Appendix A.

[2] This area also accounted for 62% of all walking trips, 54% of all transit trips and 56% of all driving trips.

[3] At an average of 3.2 miles per trip it is second only to the CBD and almost two miles less than the region-wide average.

[4] The 2006-2010 ACS shows that much of this area already has between 10-13% bicycle commute mode split.

Table Array 2: Scenario Assumptions

Input Assumptions for Non-Automotive Mode Growth

	Growth Scenarios: Bike Growth		
	1994-2011	**2011-2020**	**2011-2035**
CBD	**38.9%**	100.0%	300.0%
Central (not CBD)	**364.3%**	75.0%	100.0%
East to I-205	**305.0%**	75.0%	320.0%
West	**53.8%**	100.0%	400.0%
East PDX	**260.0%**	100.0%	800.0%
City Wide	254%	79%	346%

	Growth Scenarios: Transit Growth		
	1994-2011	**2011-2020**	**2011-2035**
CBD	**1.9%**	3.0%	3.0%
Central (not CBD)	**120.0%**	50.0%	50.0%
East to I-205	**0.0%**	20.0%	40.0%
West	**96.8%**	50.0%	100.0%
East PDX	**35.3%**	50.0%	110.0%
City Wide	22%	37%	74%

	Growth Scenarios: Pedestrian Growth		
	1994-2011	**2011-2020**	**2011-2035**
CBD	**19.0%**	10.0%	19.0%
Central (not CBD)	**-36.2%**	10.0%	20.0%
East to I-205	**38.5%**	10.0%	38.0%
West	**-28.1%**	10.0%	10.0%
East PDX	**51.5%**	10.0%	20.0%
City Wide	28%	11%	32%

These results show that if walking and bicycling grew at somewhat faster paces between 2011 and 2035 than they did in the period 1994-2011, then those modes could together account for approximately 45 percent of all trips taken by Portland residents in 2035. Growth in transit use would have to be more dramatic—growing at approximately 3.4 times the pace of growth it experienced 1994-2011—to achieve an overall 12 percent transit mode split in 2035 among Portland residents (see Table 3)[5].

Table 3

Mode	Growth 1994-2011	Growth 2011-2035	Achieved mode split in 2035	2011-2035 growth relative to 1994-2011 growth
Walking	28%	32%	20%	1.1 times greater
Bicycling	254%	346%	25%	1.4 times greater
Transit	22%	74%	12%	3.4 times greater

[5] See Appendix A for further discussion about the pace of growth. Though relatively small in percentage terms, the pace of growth for bicycling suggested here is quite steep.

Table Array 4: Scenario Analysis Results

All Trip Mode Split Data 1994-2011 and Projections

based on Metro's 1994 and 2011 Travel Activity Surveys and Assumption about Growth

	4%	Portland CBD		94,700
	1994	2011	2020	2035
Walk	39.5%	47.0%	52%	56%
Bike	1.8%	2.5%	**5%**	**10%**
Transit	15.9%	16.2%	**17%**	**17%**
Drive	42.8%	34.3%	27%	17%

	1%	Central City (not CBD)		37,200
	1994	2011	2020	2035
Walk	35.6%	22.7%	25%	27%
Bike	2.8%	13.0%	**23%**	**26%**
Transit	10.0%	22.0%	**33%**	**33%**
Drive	51.6%	42.3%	19%	14%

	55%	Inner East Side		1,379,600
	1994	2011	2020	2035
Walk	11.7%	16.2%	18%	22%
Bike	2.0%	8.1%	**14%**	**34%**
Transit	6.0%	6.0%	**7%**	**8%**
Drive	80.3%	69.7%	61%	35%

	15%	West Portland		374,700
	1994	2011	2020	2035
Walk	14.6%	10.5%	12%	12%
Bike	1.3%	2.0%	**4%**	**10%**
Transit	3.1%	6.1%	**9%**	**12%**
Drive	81.0%	81.4%	75%	66%

	24%	East Portland		599,600
	1994	2011	2020	2035
Walk	6.8%	10.3%	11%	12%
Bike	0.5%	1.8%	**4%**	**16%**
Transit	5.1%	6.9%	**10%**	**14%**
Drive	87.6%	81.0%	75%	57%

Mode Splits City of Portland: 1994, 2011 and Projected Showing Growth

	Entire City of Portland				1994-2011		2011 to 2020		2011-2035	
	1994	2011	2020	2035	Change	Growth	Change	Growth	Change	Growth
Walk	11.9%	15.2%	17%	20%	3.3%	27.7%	2%	11%	5%	32%
Bike	1.6%	5.5%	**10%**	**25%**	4.0%	254.2%	4%	79%	19%	346%
Transit	5.6%	6.9%	9%	12%	1.2%	22.1%	3%	37%	5%	74%
Drive	80.9%	72.4%	64%	43%	-8.5%	-10.5%	-9%	-12%	-29%	-40%
MVMT billion miles	2.35	2.26	2.39	2.06						

This scenario construction and analysis point out some interesting observations and considerations. First, is that even dramatic growth in bicycle transportation in West Portland and East Portland households will still produce bicycle use levels that are well below citywide targets for non-automotive trips[6]. It is the trip- and household-rich inner east neighborhoods (between the Willamette River and I-205) that will have to carry a disproportionate share of the non-automotive trips if Portland is to approach a 25% mode split for bicycle transportation. To achieve that, the pace of growth in bicycle transportation for those neighborhoods between now and 2035 will have to slightly exceed the pace of growth seen in those neighborhoods between 1994 and 2011. Growth in East Portland will have to skyrocket to achieve a 16% bicycle mode split, while growth in West Portland will have to similarly accelerate to achieve a 10% mode split.

Second, is that even dramatic increases in the pace of growth in transit use will result in only approximately 12% of trips by Portland residents being made by transit.

Third, is the overall drop in motor vehicle miles traveled (MVMT) by 2035 relative to 2011 despite an increase in the number of households. The assumptions modeled here produce by 2035 a continued drop in motor vehicle miles traveled by Portland residents relative to 1994.

Fourth, is that the above scenarios modeled here do not show an obvious means to achieving the goal of a 70% non-automotive mode split for city residents, as called for in The Portland Plan.

The Potential for Bicycling in Portland Remains Largely Untapped

That the potential for bicycling remains largely untapped, and that the greatest gains are to be had in the inner East is based on modeling of home-based work (HBW) trips for transportation analysis zones (TAZ) in inner SE Portland and East Portland as shown in Figure 4[7]. This analysis is more fully described in Appendix B.

This analysis shows a clear difference in the trip profiles for HBW trips in these areas as well as for the potential for future trips with current land use patterns. Figures 5 and 6 show the number of trips at each trip length as well as the proportion of trips that can be taken on the existing and funded low-, medium- and high-stress bikeway networks. Figure 5 shows what the bicycle commute capture might look like to produce the known 18.3% bicycle commute mode split in inner SE Portland. Figure 6 shows what the bicycle commute capture might look like in the East Portland study area with ridership assumptions identical to those used to in Inner SE Portland to produce the known 18.3% bicycle commute mode split. Because of a different trip distance profile and bikeway network quality the bicycle commute mode split achieved in East Portland is 7% rather than 18%.

Figures 7 and 8 address the question of “what if the entire bikeway network consisted of low-stress facilities?” Then, using the same ridership assumptions as before, the mode split in Inner SE rises to 32% and in East Portland to 14%. The lower value in East Portland is again, largely attributable to generally longer trip distances. This simple analysis shows a higher proportion of shorter trips in the inner neighborhoods and thus a higher potential for bicycle trips than for East Portland.

One element of this analysis not readily apparent from these graphs is the smaller population base in the East Portland area compared to the Inner SE area that can easily access the bikeway network. This is apparent when all data bicycle commute data are displayed on one graph with the same scale, as in Figure 9.

What does this analysis tell us? It tells us that:

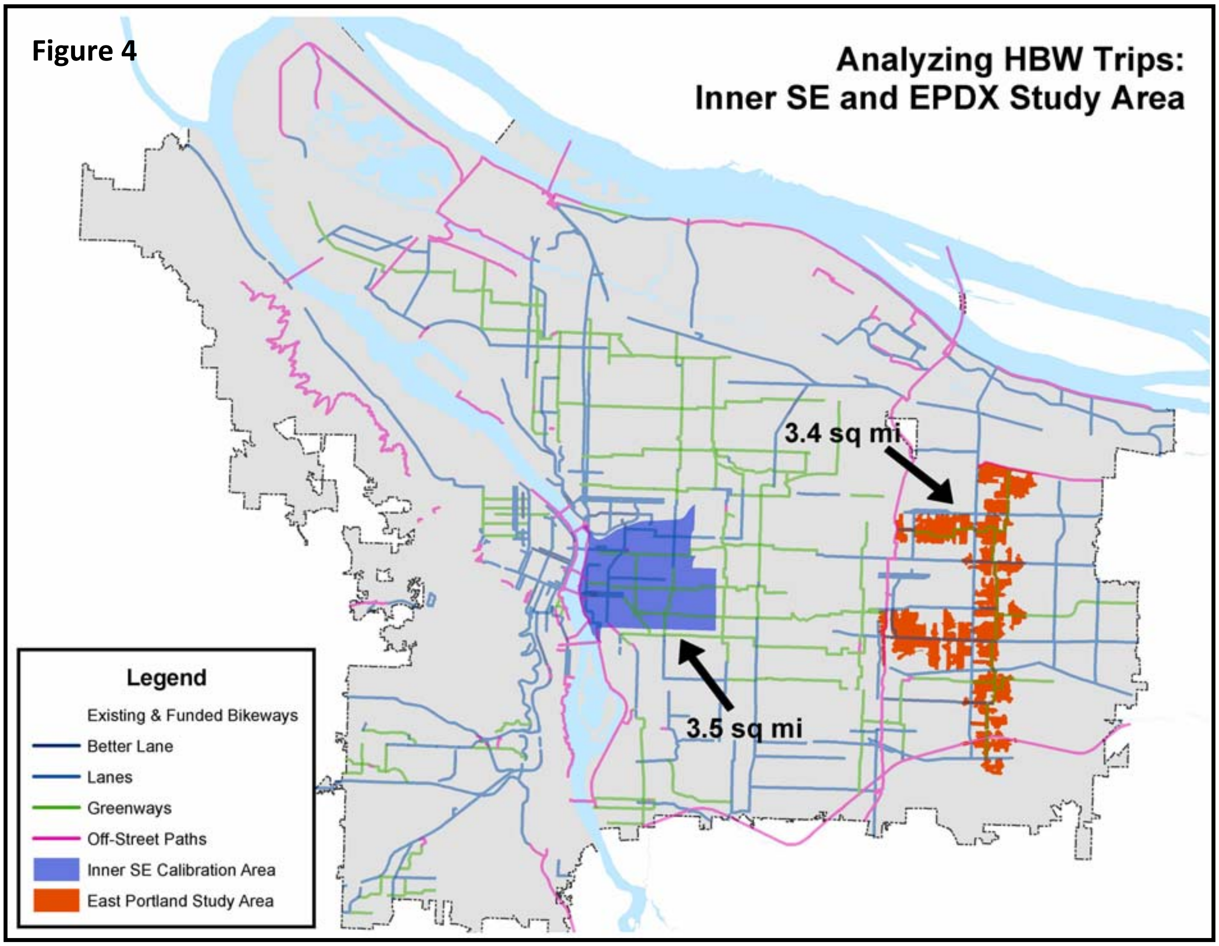
---

[6] The City of Portland and Multnomah County Climate Action Plan 2009 calls for commute mode shares of 25% for bicycling, 25% for transit and 7.5% for walking by 2030. The Portland Plan calls for the same commute mode splits by 2035. The Portland Bicycle Plan for 2030 calls for 25% of all trips to be made by bicycle by 2030.

[7] See Appendix B for a more complete description of this analysis.

- While the potential for bicycling growth in both areas is significant, it will be easier for a higher proportion of trips to be made by bicycle in the closer-in neighborhoods than in the outer neighborhoods, principally because of trip distance, which relates to land use
- Because of higher population density and better access to the city's bikeway network, each percentage point increase in the inner neighborhoods represents more trips than it does in the outer neighborhoods, and
- A foundational element to maximizing bicycle use is to create a network of low-stress bikeways; when that occurs then potential HBW bicycle trips in both areas essentially double.

Figure 4



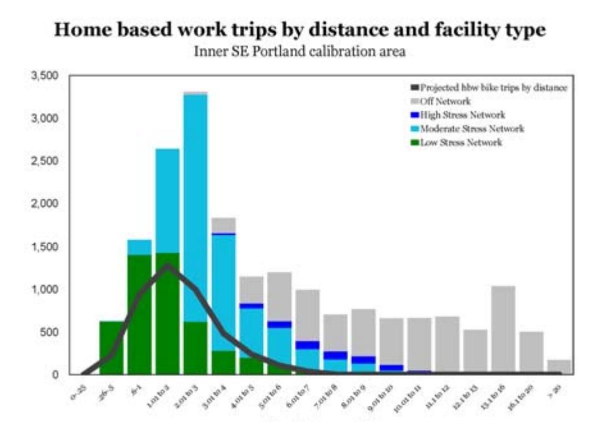


Figure 5

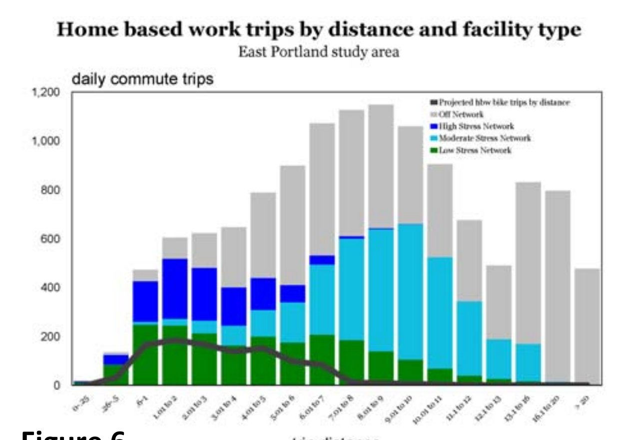


Figure 6

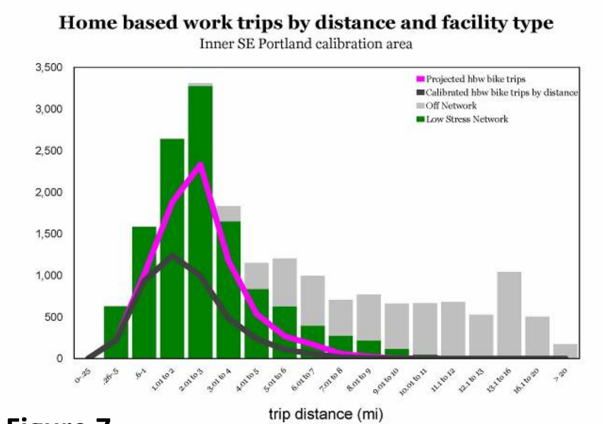


Figure 7

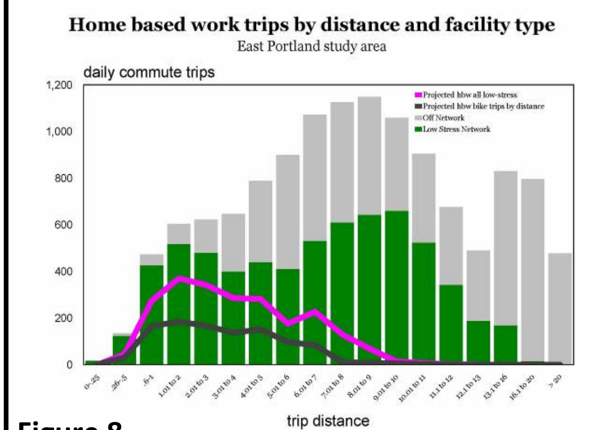


Figure 8

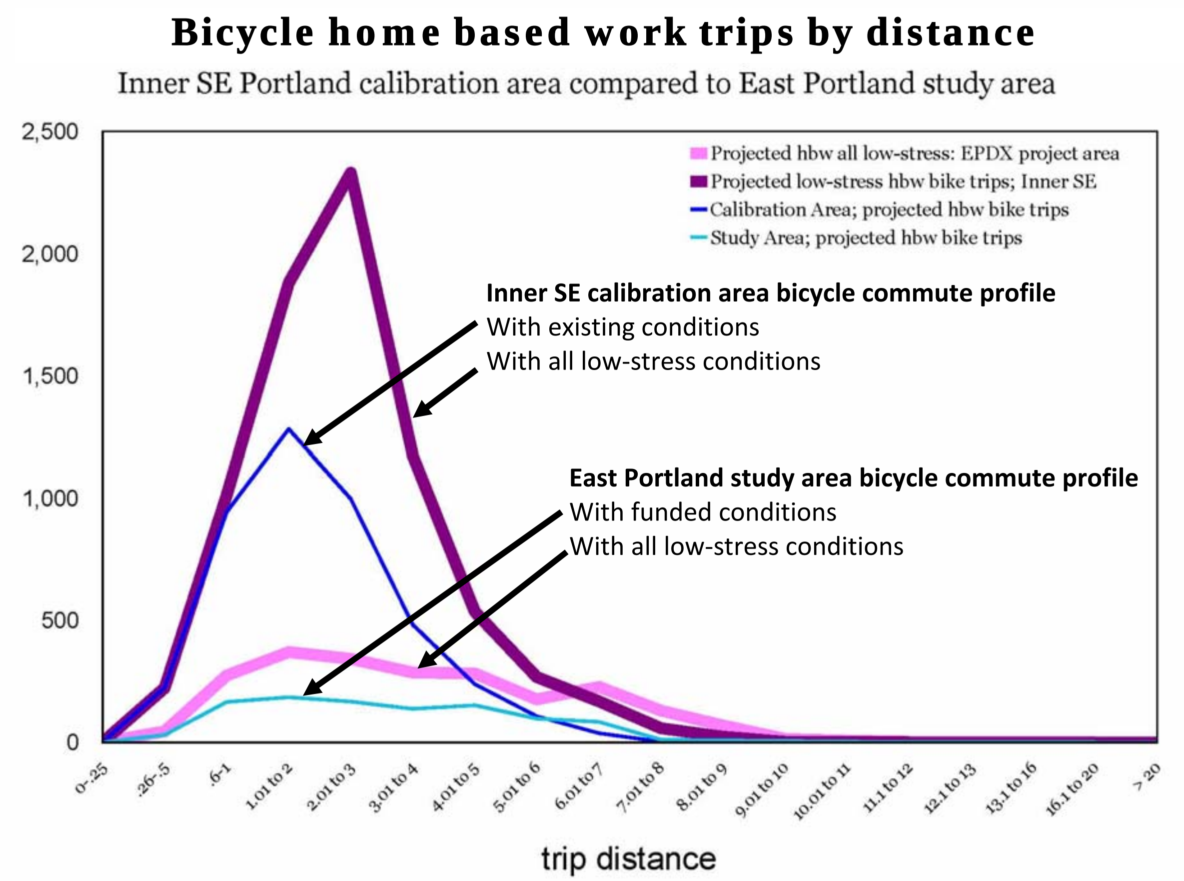


Figure 9

The implications of not achieving non-automotive mode splits

Because of expected population growth, the number of trips taken by Portland residents in 2035 is going to be significantly greater than in 2011. This model shows a growth from 2.5 million daily weekday trips in 2011 to 2.9 million in 2020 and to 3.6 million by 2035. Figure 10 shows the actual distribution of trips for 1994 and 2011 and the projected distributions of trips in 2020 and 2035 at the higher non-automotive mode splits projected in this paper. The graph also projects daily traffic in 2020 and 2035 under conditions in which active transportation and transit mode splits remain as they were in 2011 (identified as “@2011 levels” in the graph).

Figure 10 shows that only through significant growth in non-automotive means of transportation can city residents keep their motor vehicle miles traveled near (in 2020) or below (in 2035) levels that existed in 2011. If there is no additional change in mode split by 2035, then city streets will need to accommodate more than 1,000,000 daily weekday automobile trips in 2035 beyond what this model projects can be achieved. This is equivalent to the traffic on approximately 23 Powell Boulevards. This has significant implications for congestion, health, safety, movement of goods and greenhouse gas emissions.

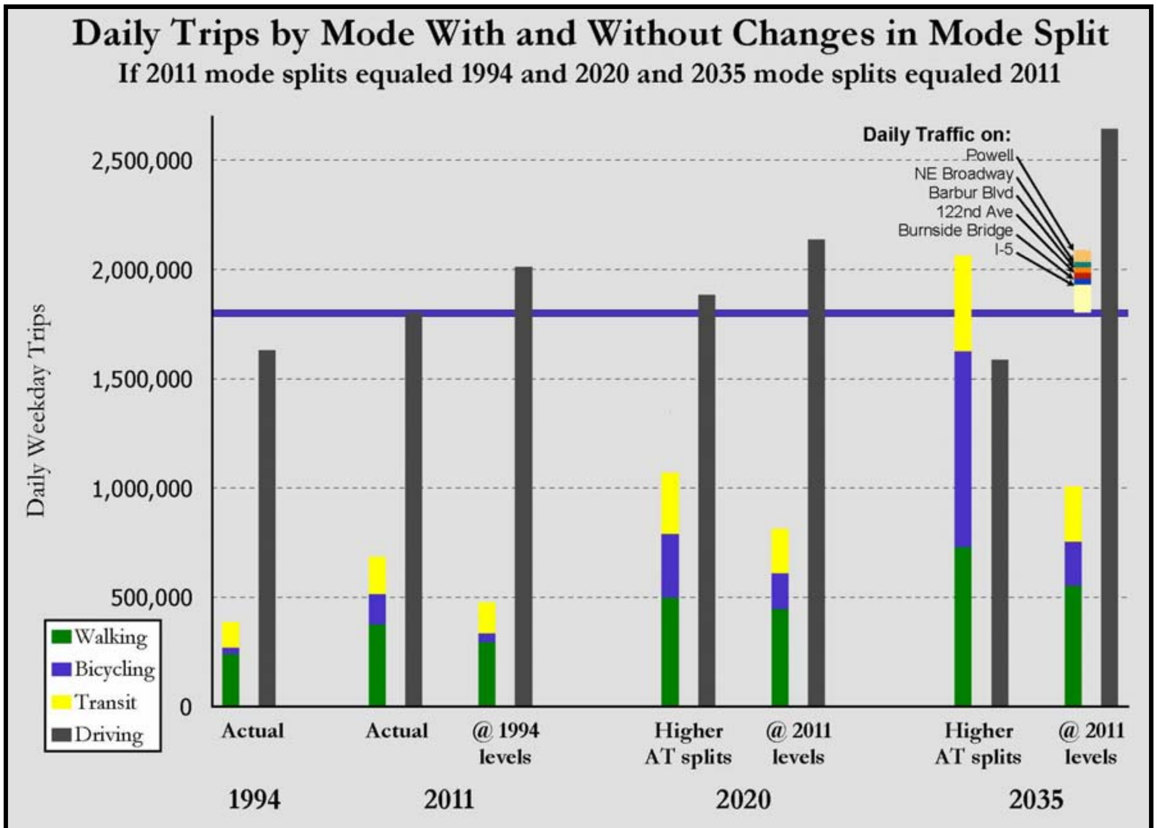


Figure 10

Based on Metro's 2011 Personal Transportation Survey

Conclusion

This modeling exercise demonstrates the rapid advances that occurred for both bicycling and walking, the great potential for increased growth in bicycle transportation and the costs of not achieving significantly higher non-automotive mode splits in the future.

There are three primary mobility modes planned for and funded in the City of Portland: automobiles, transit and bicycling. Of the three, increases in driving are actively discouraged by local, regional, county and state policies. Our transportation goals, as elucidated in the Climate Action Plan and Portland Plan call for an automotive mode split of 30%. The scenarios presented in this paper provide a discussion point and demonstrate one way to achieve a 43% automotive mode split by 2035. Achieving that assumes respective future growth in bicycling and walking that is 1.4 and 1.1 times greater, respectively, and in transit that is 3.4 times greater than the growth experienced by each of the modes 1994-2011.

In regard to bicycle transportation, the experience of cities around the world demonstrates that a 25% mode split is achievable with high quality bikeways that provide a comfortable and safe experience. Compared to the world's best bicycle transportation cities, Portland's bicycle network is largely substandard and incomplete. Most of that 250% growth in bicycling in Portland since 1994 occurred in the face of bicycle facilities now recognized as inadequate for most people, that fail to match best practices in bikeway design and that do not directly serve the destinations found on most of Portland's commercially zoned streets[8]. This is why, at 5.5% of trips city-wide, the potential for increases in bicycle transportation is largely untapped.

Will the city achieve 25% of all trips by bicycle by 2035? This paper demonstrates that there is a pathway to that goal and that there are still tremendous gains to be made in bicycle transportation. The juxtaposition of the potential for bicycle transportation together with the cumulative regional capital expenditures made in the period 1995-2010 (Figure 11) paint a clear picture about the affordability of bicycle transportation and the large return on investment it offers. In the world of non-automotive travel, bicycling is the low-hanging fruit. In order to achieve our goals for climate change, health, equity, and movement of goods we need to dramatically increase our heretofore limited investments in bicycling and active transportation.

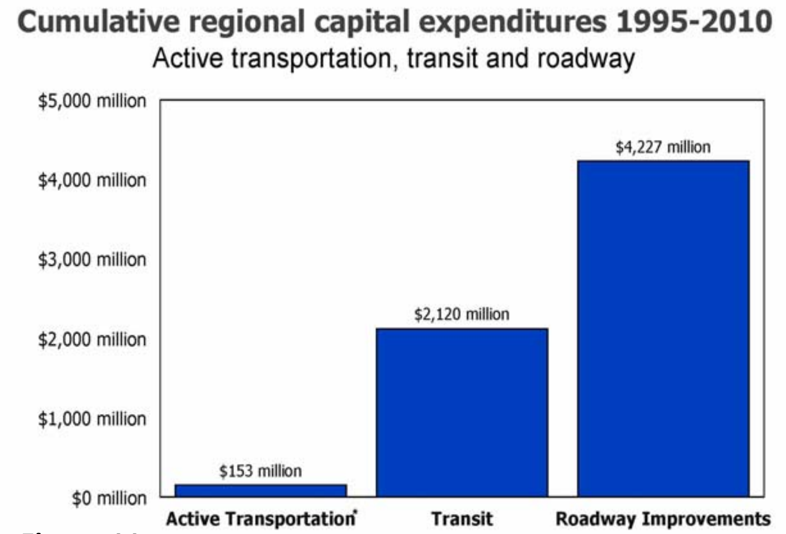


Figure 11

Source: Metro. Expenditures are for federal and state sources and are allocated by Metro, ODOT, Trimet and local agencies Local funding sources, such as SDC or local gas taxes are not inlcuded.

*Active Transportation includes both bicycle and pedestrain improvements.

Additional analysis/questions

How can transit achieve a 20% or 30% mode split? What would the size of the fleet need to be? What would the headways on bus routes have to be? What capital outlays would be required and what would the annual operating costs be to support such a system?

Beyond capital investments, where should the city target encouragement activities to promote active transportation and transit?

Developing a trip length profile for all trips originating in Portland would more fully flesh out the potential for active transportation.

Continuing to refine and run the Metro transportation model will also shed light on the potential for active transportation to reduce previously projected automobile trips.

[8] The Portland Bicycle Plan for 2030 identified that most commercially-zoned roadways in Portland are not currently served by bicycle facilities. See Section 3.1.4 of the 2030 Plan (p 43) which identifies that in 2008 "only 33 percent of designated main streets in Portland's Transportation System Plan and only 20 percent of the streets in Metro's 2040 Growth Concept centers had a developed bicycle facility…."

Appendices

Appendix A: **Estimating City of Portland Mode Splits and Modeling Future Transportation Behavior**

Appendix B: **Estimating bicycle demand in response to low-stress bikeways**

Appendix C: **Summary of 2011 Travel Activity Survey Results from Metro**

Appendix A

Estimating City of Portland Mode Splits and Modeling Future Transportation Behavior

Metro Regional Government provided data from the 2011 and 1994 personal transportation surveys in late 2012. They provided data about five areas within the city of Portland, but not for the city as a whole. Those five areas are displayed in Table A-1 and in the map shown in Figure A-1.

Figure A-1

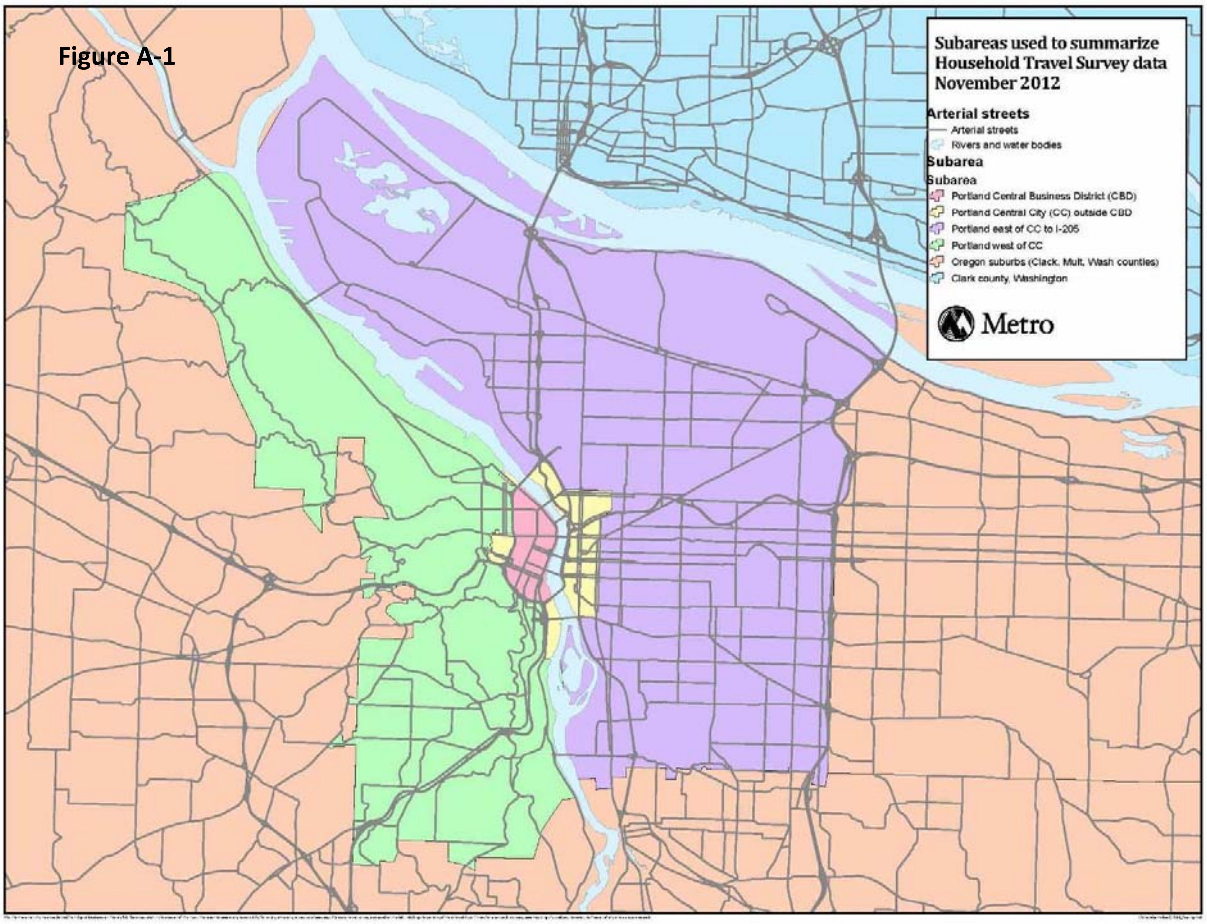


Table A-1 **Data Inputs**

	Households 1994	Households 2011	Households 2020 (interpolated value)	Households 2035 (Metro Forecast)	Trips/hhold	Trip Length 1994	Trip Length 2011
CBD	7,078	15,783	20,700	28,075	6.0	2.1	2.4
Central (not CBD)	4,237	6,525	14,599	26,710	5.7	3.9	3.5
East to I-205	126,181	146,768	167,462	198,503	9.4	3.7	3.2
West	36,664	45,693	51,182	59,415	8.2	3.8	3.8
East PDX	42,100	55,011	68,726	89,297	10.9	5.8	4.6
City Wide	216,260	269,781	322,668	402,000	9.2	4.2	3.6

Table A-1 is the basis for determining an overall City of Portland mode split data for 1994 and 2011.

The analysis undertaken based on this data comes with a several understandable caveats:

- First is the uncertainty inherent with any survey based on sampling methods, survey weights, reporting accuracy, etc.
- Second is that the suggested growth rates shown in Table Array 2 (Scenario Assumptions) are used as multipliers on the mode split percentages (in Table Array 1) that, though presented as absolute values, should more accurately be reported as a range of values.

For example, Metro provided an estimate of overall City of Portland mode splits using a different methodology than that used in this paper. That methodology produced the results shown in Table A-2. Table A-3 displays the differences between these values and those calculated and displayed in Table Array 1. According to Metro modelers presented with this data, these are essentially the same numbers as they fall well within confidence levels. However, the discrepancies highlight that there can be slight differences when analyzing data and that it is possible that small differences in the foundational data can be enhanced when that data is then multiplied.

Table A-2: Entire City of Portland **(reported by Metro January 2013)**

	1994	2011	Change	% Change
Walk	13%	15%	2%	15%
Bike	1.6%	6%	4.4%	268%
Transit	5.5%	6.6%	1.1%	19%
Drive	79.8%	72.4%	-7.4%	-9.3%

Table A-3: Entire City of Portland: Differences in mode split between two methodologies

	1994	2011
Walk	1.2%	-0.2%
Bike	0.1%	0.5%
Transit	-0.1%	-0.3%
Drive	-1.1%	0.0%

The intent of this paper is two-fold: to demonstrate the trends in transportation of Portland residents in the period 1994-2011 and to identify a pathway by which the city may reasonably achieve it's policy goals for transportation. While understanding the limits of this data and of the model, this remains an analysis that achieves those two purposes.

Calculating Entire City of Portland Mode Splits

Households 2011 data for 2010 was provided by analysts at the Portland Bureau of Planning and Sustainability (BPS)[a]. Using the geometries for the areas defined by Metro as shown in Figure A-1 and the city's Buildable Lands Inventory (BLI) they calculated the number of households. Household data is based on the 2010 Decennial Census and was aggregated though an extensive GIS model to the analysis geography (250' x 250' used in the BLI). Household size (shown in Table A-4) was developed based on 2010 census data about population for each of the defined city areas. This analysis simply applied these 2010 values to the Oregon Household Activity Survey (OHAS) data that was collected in Portland in 2011.

[a] Based on a series of email communications with Derek Miller at BPS, 11/7/12-12/13/12.

Households 1994 numbers resulted from interpolating households from the 1990 and 2000 Decennial Censuses. 1990 data was pulled from census block groups while 2000 data was pulled from census blocks. Population per Metro geographies for 1990 and 2000 was similarly calculated and provided by BPS.
Households 2035 was similarly provided by BPS staff based on Metro's 2035 population and household forecast.
Households 2020 was interpolated from 2035 and 2010 data.
Trips per household (Trips/hhold). Metro OHAS data reported an average of 9.2 trips per household per day across the region, and that these rates are comparable to what was found in 1994, "given the variance in survey methodologies." In subsequent conversations, Metro staff indicated that trips per household varies directly with household size. To determine trips per household in the five subareas of Portland household size was used to apportion the average 9.2 trips. This was done for 2010 values. These trips per household for each sector were then applied to all years of analysis (1994, 2011, 2020 and 2035).

It is likely that because the 9.2 trips per household reflects a regional, rather than a City of Portland average, the numbers used here skew bigger than reality. This is because of the influence of the "Oregon Suburbs" outside of East Portland and Clark County. The presumption is that both areas likely tend toward the higher end of the 9.2 average trips per day. More accurate information specific to the City of Portland can easily be incorporated into the above assumptions.

Table A-4 Population and Household Size

Metro Sub-area	Population				Household Size			
	1990	1994 (interpolated value)	2000	2010	1990	1994 (interpolated value)	2000	2010
CBD	10,316	11,823	14,083	22,691	1.69	1.67	1.65	1.44
Central (not CBD)	6,828	6,484	5,969	8,954	1.54	1.53	1.51	1.37
East to I-205	299,876	305,363	313,592	328,635	2.43	2.42	2.41	2.24
West	74,373	77,761	82,842	90,155	2.13	2.12	2.10	1.97
East PDX (Oregon Suburbs)	102,834	110,132	121,078	143,673	2.57	2.62	2.68	2.61
City Wide	494,228	511,562	537,564	594,109	2.36	2.37	2.37	2.20

Household size was based on population per sector, as shown in Table A-4. Population data was provided by BPS analysts, as noted above.

Trip Length 1994 and 2011. These numbers were provided by Metro for each sector. The calculated average total for both1994 and 2011 are shorter than the regional averages reported by Metro (Metro reported 5.1 miles/trip and 4.4 miles/trip for 1994 and 2011, respectively). This is likely because of the influence of parts of the region—Oregon Suburbs not a part of East Portland and Clark County—that likely have longer trip distances. Though shorter, the trip average trips length produced for Portland in 1994 and 2011 display the same ratio as for those years for the region.

All trip mode split data for the Entire City of Portland (as shown in Table Array 1) is based on using the data in Table A-1 with the mode splits provided by Metro as also shown in Table Array 1. Trip length informed the calculations for total motor vehicle miles traveled in all scenarios and shown at the bottom of Table Array 2.

Determining Annual Trips
Mode split and trip data provided by Metro was based on average weekday behavior. Because travel behavior on holidays, school holidays and weekends is different from average weekday travel, there needs to be a corrective factor used to estimate total annual trips. The simple method used by Metro, and also in this model, is to multiply average weekday trips by 342 to estimate total annual trips.[b]

Input Assumptions for Non-Automotive Mode Growth
It is important to remember that the OHAS data, and thus this scenario analysis, is based on the travel behavior of households within each sector and not necessarily on the overall travel behavior within each sector.

The proportion of trips taken by automobile in this model are based on the number of trips "left-over" after all non-automotive trips are accounted for.

The initial focus of this paper was to determine an approach to produce by 2035 and in stages the 25% bicycle mode split called for in various City of Portland, regional and County planning and policy documents. The first stage would be to achieve a 10% bicycle mode split, ostensibly by 2020. A secondary focus was to determine how and where non-automotive transportation would have to grow to demonstrate how active transportation and transit together could achieve the 70% non-automotive mode split called for in the Portland Plan.

The assumptions about future growth were based on what the OHAS data tells us about the 17-years of growth by mode by sector between 1994 and 2011 and the potential for future growth based on expected and desired development of the city and its transportation infrastructure.

<u>Bicycle Growth</u>
Citywide bicycle use will have to grow 80% from current levels to achieve a 10% bicycle mode split. Most of that growth will result from modest increases (75%) from current levels in Inner East Portland (from today's 8% to 14% by 2020). Much of that area already experiences bicycle commute rates at and above 14%, as measured by the US Census. For bicycle use to exceed 20% city wide, bicycle use will have to more than quadruple from current levels.

Though Portland experienced tremendous growth in bicycle use 1994-2011 the expectation is that because the facilities for bicycling are of relatively poor quality compared to world's best practices, there remains significant room for growth. This was a foundational assumption in the Portland Bicycle Plan for 2030: that with continued effort to create low-stress bikeways more people will bicycle.

<u>CBD</u>. Because of short trip distances walking is expected to continue to dominate travel behavior for trips originating in households in this sector. However, bicycle use is projected to grow beyond the 39% growth experienced since 1994 principally because of the coming introduction of bike share in the CBD. That, together with the ending of fareless transit in the central city and the assumption of world-class bikeways has the bicycle mode split in CBD households rising from 2.5% in 2011 to 5% by 2020 and 10% by 2035.
<u>Central City (not CBD)</u>. This part of the city already experienced very high growth in bicycle use and has a mode split of 13%. Similar to reasons noted above, bicycle use in this area is presumed to continue to grow and is projected to double by 2035. However, this is also an area where transit and walking will continue to play large roles in transportation.
<u>East to I-205</u>. This area, along with the CBD and Central City (not CBD), offers the most bicycle-supportive land uses in the city and the densest existing bikeway network. Trips in this area are not too long to require an automobile, but also not so short as to tend to walking. Though extensive, the bikeway network is of

[b] Based on email communication with Anthony Buczek at Metro 12/14/12

generally low-quality. Improvements to the bikeway network consistent with the Portland Bicycle Plan for 2030 will be necessary to dramatically expand mode splits. The mode splits modeled for 2020 (14%) and 2035 (34%) are consistent with potential for the district.

In 1994 76% of bicycle trips in Portland originated in households in this sector. In 2011 the number was 82%. Projected future scenarios in 2020 and 2035 have 76% and 71% of all Portland bicycle trips, respectively, originating from households in this sector. For Portland to meet its bicycle mode split goals, this part of town will have to carry a disproportionate share of trips. Portland's Cycle Zone Analysis[c] indicated that this part of the city has the highest potential for future bicycle use. This jibes well with the conditions found there: tight street grid, lots of commercial, employment and retail activity to produce short trip distances, high population density. Growth in bicycle use out to 2035 is expected to follow a similar trajectory experienced in the area 1994-2011. To do so will require significant improvements to the city's bikeway network and focused encouragement efforts.

West Portland. Significant growth in bicycle use in West Portland will be dependent on developing the flatter routes in those areas identified in the Cycle Zone Analysis as having good potential for growth (Capitol, Barbur, B-H highway, Vermont). Even the significant growth called for (400% from 2011 to 2035) produces an overall 10% bicycle mode split there.

East Portland. This model assumes dramatic growth for East Portland (800%) by 2035. This is based on the great potential for the area based on: topography, access to high-capacity transit and the development potential for the Lents Town Center and Gateway Regional Center, both of which are urban renewal areas. East Portland is relatively flat. Bicycle transportation there is principally challenged by the lack of close destinations and a very poor-quality bikeway network. By addressing both these issues it is not unreasonable to project a 16% bicycle mode split for East Portland. Doubling bicycle use in East Portland by 2020 seems reasonable given the approximate $12 million the city is preparing to invest in bicycle capital improvements and encouragement programs.

Transit Growth

Portland and the region have made significant investments in transit over the 17-year period beginning in 1994. Given the 26% per-capita growth in transit use between 1994 and 2011 it seems reasonable to suggest modest though accelerated growth in transit use into the future. The projections in this paper are for transit to grow 37% between 2011 and 2020 and 74% between 2011 and 2035.

CBD. Transit in the CBD grew 1.9% between 1994 and 2011. It is not expected to grow at rapid rates given the ease of walking, the elimination of fareless transit travel and the coming introduction of bike share.

Central City (not CBD). The 120% growth in transit in this part of the city likely reflects the development of west side streetcar. East side streetcar will encourage continued growth in transit.

East to I-205. Like other non-automotive modes, transit must grow in this sector if it is to demonstrate significant advances city-wide. Growth estimates of 20% to 2020 and 40% to 2035 reflect a hope that changes in transit service will overcome the zero per capita growth in transit 1994 to 2011.

West Portland and East Portland. These areas are modeled to show essentially the same growth in transit 2011-2035 as experienced 1994-2011.

Walking Growth

Growth in walking was modest in most locations of the city. In the absence of better information, future projections maintained the pace of growth in walking experienced 1994-2011 with the exception of the Central City (not including the CBD) and West Portland. In those two areas per capita walking trips declined. This model projected modest growth in per capita walking trips in both these sections of the city.

[c] See Appendix C of the Portland Bicycle Plan for 2030 and page 7-21 of "Portland's Platinum Bicycle Master Plan Existing Conditions Report" at this link: http://www.portlandoregon.gov/transportation/article/369982

Pace of growth for bicycle transportation

This paper suggests that for Portland to achieve its policy goal of a 25 percent bicycle mode split by 2035 will require a pace of growth for bicycle transportation between 2011 and 2030 that is 1.4 times faster than the pace of growth 1994 to 2011. This is an aggressive pace of growth, as demonstrated in Figure A-2. Though the average annual rate of growth 2011-2035 is projected to be comparable to that for the period 1994-2011 it is more challenging to have high percentage growth when the mode share is higher. In other words, it will be a challenge to achieve our policy goal of 25% bicycle mode split.

Figure A-3 projects a slower pace of growth for bicycling. This pace, resulting in a 15% overall bicycle mode split by 2035, reflects a slower annual and slower overall growth in bicycle use than the city experienced 1994-2011. The overall growth would be 181% from 2011 to 2035. This growth rate is 0.7 times the rate from 1994-2011.

Bicycle-friendly cities around the world have demonstrated that achieving high bicycle mode splits and following a steep growth curve are both possible. Figure A-4 shows several higher-population European cities with high bicycle mode splits and the growth curves they realized to achieve those levels.

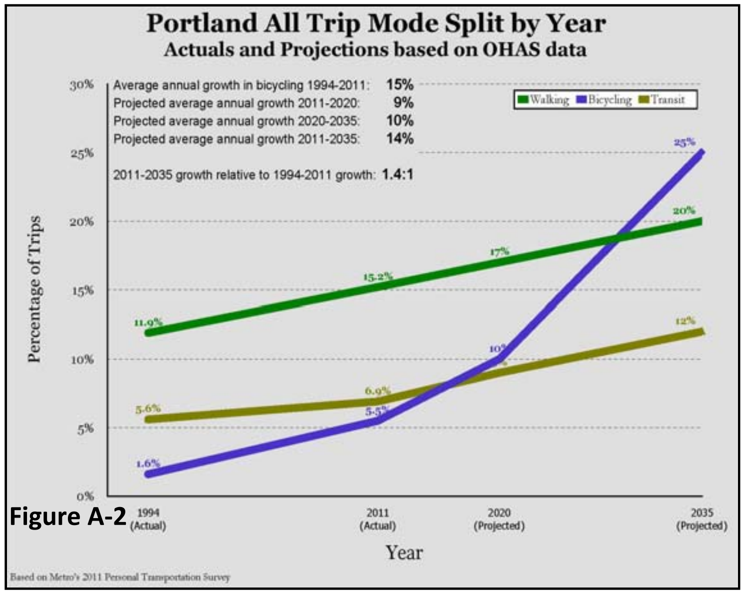


Figure A-2

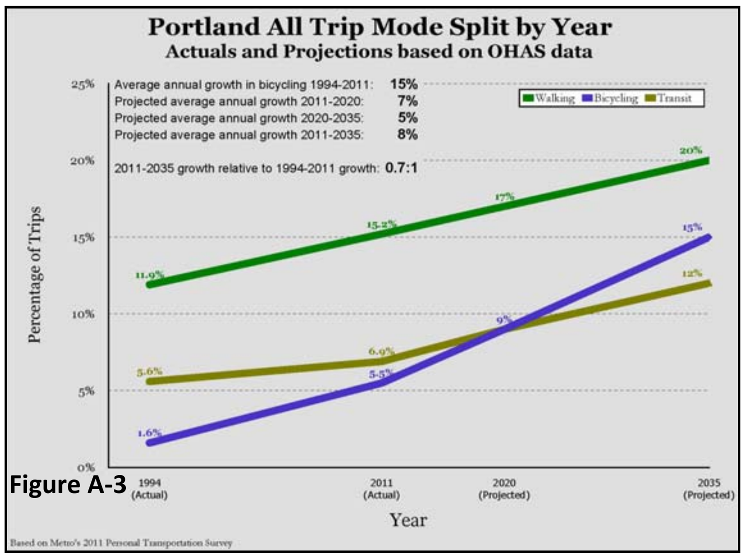


Figure A-3

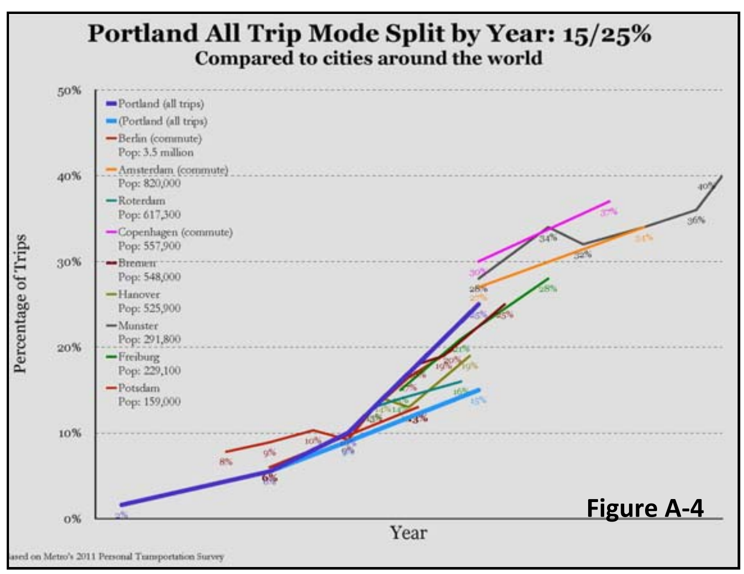


Figure A-4

Appendix B
Estimating bicycle demand in response to low-stress bikeways; describing bicycle demand model

The analysis identifying that the potential for bicycling remains largely untapped in Portland—resulting in Figures 4-9 in the main report, resulted from an effort to identify the potential demand for bikeway facilities to be developed in East Portland as part of the regionally-funded *East Portland Active Transportation to Transit* project. That effort resulted in a desktop model that could account for distances traveled, facility types and the willingness of people to use a bicycle on different facilities. All that was in service to providing an estimate for assessing the potential quantitative benefits that accrue from increases in bicycle use.

The model uses an origin-destination (OD) analysis of Transportation Analysis Zones (TAZ) for the home-base work trip (HBW). The home-base work trip was used because census data at the block level allowed the model to be calibrated to known bicycle commute levels in a high-bicycle-use area of inner SE Portland. The area in Figure 4 in the main report, identified as the "East Portland Study Area", represents those areas where households have low-stress access[d] to the city's existing and funded bikeway network—particularly to the network to be developed as part of the East Portland Active Transportation to Transit project.

The model uses three variables to estimate potential bikeway demand: the proportion of the population willing to ride at a certain distance; the percent of the population willing to ride on bikeways of different types (low-stress, medium-stress or "conventional" and high-stress bikeways[e]) and general availability to ride on any given day. The modelers developed values for these variables through a calibration process that focused on an area of Portland recognized as having a high—if not the highest—concentration of low-stress bikeways in the city: Inner SE Portland (identified as the "Inner SE Calibration Area" on Figure 4).

Based on data from the American Community Survey that area is known to have had an average bicycle commute rate of 18.3% for the period 2005-2009. We manipulated the variables based on considerations of the Four Types of Cyclists[f] and professional knowledge about reasonable trip distances for bicycle trips. Table B-1 shows the values that successfully reproduced in the model the known 18.3% bicycle commute rate for the calibration area.

The values for the variables shown in Table B-1 were then applied to the conditions in the East Portland study area to provide an estimate of expected commute behavior with the network characteristics shown in Figure 6 of the main report.

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[d] The model used network analyst tools to define low-stress access to bikeways as routes that used either existing low-stress bikeways or local neighborhood streets and excluded high-stress route choices, such as travel along high speed roads without bikeways or crossing such roadways at non-enhanced crossings.

[e] The low-stress network is comprised of bicycle boulevards, (known locally as "Neighborhood Greenways"), off-street pathways and enhanced "separated in-roadway" bikeways (such as buffered bicycle lanes, or cycle tracks). Medium-stress, or the conventional network include facilities made up of conventional bicycle lanes found on Portland's smaller collector streets. These bikeways are typically on roadways with relatively low collector volumes with posted speeds ranging from 30-35 mph. The high-stress network consists of standard minimum-width bicycle lanes on high-speed, high-volume roadways. They are on Portland's largest collectors with high 85th percentile speeds and higher traffic volumes. The principal distinction between the convention and high stress networks is the volumes and speeds of motor vehicle traffic on the roadways where they are striped.

[f] See: http://www.portlandoregon.gov/transportation/44597?a=237507 and http://web.pdx.edu/~jdill/Types_of_Cyclists_PSUWorkingPaper.pdf

That the assigned values produced a defensible result is based on two factors. First is that they were able to reproduce the known bicycle commute trip values for the calibration area. Second is that the trip distance profiles they produced for both the calibration and study areas are almost identical to the trip distance profile for trips to work and school in Copenhagen, as shown in Table B-2.

Table B-1. Assigning Model Variables

Distance (mi)	Proportion of population willing to ride at distance	Network Type	Percent of Population Willing to ride
0-0.25	0%	Low-Stress	79%
0.26-0.5	50%	Conventional	23%
0.6-1.0	90%	High Stress	1%
1.01-2.0	100%		
2.01-3.0	100%	**Availability to ride**	90%
3.01-4.0	90%		
4.01-5.0	60%		
5.01-6.0	60%		
6.01-7.0	30%		
7.01-8.0	15%		
8.01-9.0	3%		
9.01-10.0	2%		
10.01-11.0	1%		
11.01-12.0	1%		
12.01-13.0	1%		
13.01-16.0	1%		
16.01-20	1%		
> 20	1%		

Table B-2. Assessing effectiveness of Calibration

	Bicycle Mode Split by Distance (excluding transit)			
Trip Distance (mi)	Modeled output (low stress)	Copenhagen (excluding transit)	Calibration Area	Study Area
0-.25	0%			
.26-.5	36%	**51%**	56%	56%
.6-1	64%			
1.01 to 2	71%	**74%**	71%	71%
2.01 to 3	71%			
3.01 to 4	71%			
4.01 to 5	64%	**61%**	61%	58%
5.01 to 6	43%			
6.01 to 7	43%			
7.01 to 8	21%	**27%**	27%	25%
8.01 to 9	11%			
9.01 to 10	2%			
10.01 to 11	1%			
11.1 to 12	1%			
12.1 to 13	1%	**1%**	1%	1%
13.1 to 16	1%			
16.1 to 20	1%			
> 20	1%			

In addition to the interpretation of these results presented in the body of the report, several additional points jump out from Figures 4-9:

1) The trip distance profile in inner SE is much shorter and displays a strong mode at a distance of 2-3 miles. In comparison, East Portland shows much longer trip distances and the trip distance profile is more plateau-like, with a large number of trips ranging from 5-11 miles.
2) The average modeled trip distance in inner SE was 2.1; in East Portland it was 3.6 miles.
3) There are many more trips in the area in inner SE than in East Portland, likely because of the ability to access the low-stress bikeway network.
4) The longer trip distances in East Portland contribute to the low modeled bicycle commute mode split compared to inner SE
5) While creating entire bikeway networks that are low-stress dramatically increases modeled bicycle commute trips in both areas, the high level of commute trips (32%) and larger population served in inner SE compared to

East Portland result in dramatically more reduction in vehicle miles traveled. This is graphically displayed on Figure 9, which uses the same scale for inner SE and East Portland.

6) Even in one of the travel sheds with the highest existing bicycle commute mode splits in the city, the ingredients can be put into place that will bring bicycle use in that area to world-class levels.
7) A clear path to increasing bicycle use in inner SE appears to be improving the quality of the bikeway network. The dominant issue for East Portland would seem to be land use in order to create a greater share of short trips.

Caveats. This is a "back-of-the envelope" model based on data that is already being produced by a TAZ analysis. The only trip considered was the home based work trip, as that is the only trip with reliable (national) data that would allow for a measure of model calibration.

Appendix C: Summary of 2011 Travel Activity Survey Results from Metro

The following 8 pages were provided by Metro and constitute the initial report of their analysis of OHAS data for the Portland Metropolitan Region.

Metro | *Research Center*

TRANSPORTATION RESEARCH & MODELING SERVICES

Summary of 2011 Travel Activity Survey Results

SURVEY CHARACTERISTICS

Survey completed 2011
- Last survey record – December 2011
- Data delivered to Metro – May/June 2012

Why so long since last survey (1994)?
- Transit mall construction/MAX Green line completion
- Difficulty in securing funding
- Coordination with other state MPOS and ODOT

How is survey data used?
- Ensure that travel model reflects the correct value system of the travelers (elasticities between variables – time v. cost v. demographics v. urban form)
- Create large scale snapshot of travel characteristics. Not possible to report characteristics at fine grain geographies due to constrained sample size (see below).

Number of households
- Multnomah/Clackamas/Washington counties – appx 4800 households
- Clark county – appx 1650 households
- Less than 1% sampling rate

Sampling method
- Choice based methods – certain types of households and modes were oversampled in order to gain statistically relevant information about the specific group

Data capture techniques – place survey v. activity survey
- Activity survey (1994) – listed all personal activities of the day – eating, home maintenance, work (in home or not), etc. Question stream: “What did you do next? Where did that activity take place?” Solicited detail led to fatigue and non-reported information. “Time use” surveys were in vogue then.
- Place survey (2011) – focus on places – Question stream: “Where did you go next? What did you do when you went to that place?” This technique is more intuitive and direct – leads to more complete reporting.
- Visual mapping utilized when data captured – survey questioner could “see” the place location on a map – leads to more trip chain continuity and accurate placement of places

Confidentiality
- The information captured is sensitive
- Safeguards are in place to preserve confidentiality

PERSON TRIP MAKING

How many trips are made from households per day?

9.2 trips per HH per day

Note: 2011 v. 1994 rates appear comparable, given the variance in survey methodologies.

What influences trip making?

HH size

- 1 person hh – 3.3 trips per day
- 2 person hh – 6.2
- 3 person hh – 11.4
- 4 person hh – 17.5
- 5 person hh – 22.8
- G.T. 5 persons per hh – 26.8

Income

- L.T $35K – 6.9 trips per day
- $35K to $75K – 8.7
- G.T. $75K – 11.6

Number of children

- 0 children – 5.6
- 1 child – 14.0
- 2 children – 17.4
- G.T 2 children – 25.0

Household vehicles

- 0 veh – 5.3
- 1 veh – 6.5
- 2 veh – 10.9
- 3 veh – 11.9
- G.T. 3 veh – 12.1

CROSS-COLUMBIA RIVER TRAVEL PATTERNS

Who uses the Columbia River bridges?

	2011
Pct of Clark County travelers to Clackamas, Multnomah, or Washington counties:	17.9%
Pct of Clackamas, Multnomah, or Washington County travelers to Clark county:	2.0%

AUTO

How has regional mode share for persons in autos changed?

	1994	2011
Commuter	90.0%	80.9% (820,000)
All	87.3%	83.7% (5,730,000)

How has mode share for persons in autos going to the CBD changed?

	1994	2011
Commuter	58.4%	43.9% (30,000)
All	56.3%	46.0% (120,000)

Who forms carpools?

	2011
Intra-household members	85%
Non-household members	15%

How big are carpools?

	2011
2 persons	67%
3 persons	22%
4 persons	8%
5+ persons	3%

Has VMT per driver changed since 1994?

1994	2011
21.1	17.1

Has VMT per HH changed since 1994?

1994	2011
30.9	22.7

Has average trip length (miles) changed?

1994	2011
5.1	4.4

TRANSIT

How has regional transit mode share changed?

	1994	2011
Commuter	5.6%	10.9% (110,000)
All	2.9%	4.2% (290,000)

How has transit mode share to the CBD changed?

	1994	2011
Commuter	33.6%	44.5% (30,000)
All	14.4%	21.4% (60,000)

How does transit mode share vary by place of residence?

	1994	2011
Portland CBD	15.9%	16.2%
Portland Central City (excl CBD)	10.0%	22.0%*
Portland: outside CC, E. of river to I-205	6.0%	6.0%
Portland: outside CC, W. of river	3.1%	6.1%**
Oregon suburbs	2.0%	4.2%
Clark County	1.0%	1.4%

* Why big increase? More LRT service to Lloyd Center, Goose Hollow; transit Center at Rose Quarter; streetcar to NW/SW Portland.

** Why increase? WS LRT, improved bus service.

Does vehicle ownership affect transit mode share?

	1994	2011
0 car HH	34.8%	31.3%*
1 car HH	4.5%	7.0%
3 car HH	1.5%	2.2%

*Why decrease? Car share programs and diversion to bike are possibilities. Difference could be potentially due to survey noise.

How does transit mode share vary by household income?

	2011
L.T. $25,000	9.0%
$25,000 to $75,000	4.4%
G.T. $75,000	2.3%

How does transit modes share vary by age?

	1994	2011
0 to 14	1.1%	2.1%
15 to 24	4.9%	9.5%
25 to 34	4.2%	8.2%
35 to 44	2.3%	5.3%
45 to 54	2.9%	4.0%
55 to 64	3.7%	3.5%
G.T. 64	2.1%	3.3%

NON-MOTORIZED TRAVEL

How has the walk and bike mode share for the region changed?

		1994	2011
Commuter	Walk	3.3%	3.7% (approximately 40,000 trips per day)
	Bike	1.0%	4.6% (50,000)
All	Walk	8.7%	9.2% (630,000)
	Bike	1.1%	2.8% (190,000)

How has the walk and bike mode share to and within the CBD changed?

		1994	2011
Commuter	Walk	6.4%	3.9%*
	Bike	1.6%	7.7%
All	Walk	27.4%	26.9%
	Bike	1.9%	5.8%

*Why decrease? Potentially due to switch to bike use – provides more flexibility in tours; significant transit investment – streetcar, LRT, etc.

How does walk and bike mode share vary by place of residence?

Walk	1994	2011
Portland CBD	39.5%	47.0%
Portland Central City (excl CBD)	35.6%	22.7%*
Portland: outside CC, E. of river to I-205	11.7%	16.2%
Portland: outside CC, W. of river	14.6%	10.5%**
Oregon suburbs	6.4%	7.7%
Clark County	6.9%	4.7%

Bike	1994	2011
Portland CBD	1.8%	2.5%
Portland Central City (excl CBD)	2.8%	13.0%***
Portland: outside CC, E. of river to I-205	2.0%	8.1%
Portland: outside CC, W. of river	1.3%	2.0%
Oregon suburbs	0.7%	1.5%
Clark County	1.1%	1.0%

*Why decrease? Potentially due to better transit and bike infrastructure; significant increase between cross river travel between CBD and Lloyd District (non-walk movement) is also a factor.

** Why decrease? Potentially due to more disperse development; better transit service is a factor.

*** Why big increase? Potentially due to bike infrastructure investments; people matching housing location with lifestyle choices.

Is bike ownership significant?

	2011
Pct of adults in Clack., Mult., Wash. owning a bike	28.5%

NEXT STEPS

- Use survey data to update travel models
- Prepare a report of regional travel behavior statistics
- Prepare a report of travel behavior statistics for several subareas
- Begin long term planning for small “focused topic” surveys

Key Indicators from the 1994 & 2011 Houehold Travel Surveys
Four county metro area - Clackamas, Clark, Multnomah, Washington
11/02/2012 addendum to data provided to Metro Council 10/23/2012

Auto Mode Share

Pct of travel by auto produced by HHs in:	1994	2011
Portland - Central Business District (CBD)	42.9%	34.3%
Portland - Central City (CC), outside CBD*	51.6%	42.4%
Portland - outside CC, east of river to I-205	80.3%	69.7%
Portland - outside CC, west of river	81.0%	81.4%
Oregon Suburbs (other Clack/Mult/Wash)	90.9%	86.7%
Clark County, Washington	91.0%	92.8%
Regional Average	**87.3%**	**83.8%**

Average Trip Length

Average length of all person trips (miles) by HHs in:	1994	2011
Portland - Central Business District (CBD)	2.1	2.4
Portland - Central City (CC), outside CBD*	3.9	3.5
Portland - outside CC, east of river to I-205	3.7	3.2
Portland - outside CC, west of river	3.8	3.8
Oregon Suburbs (other Clack/Mult/Wash)	5.8	4.6
Clark County, Washington	5.2	5.1
Regional Average	**5.1**	**4.4**

*** Central City outside CBD = Goose Hollow, South Waterfront, Central Eastside, Lloyd**

2011 Household Activity Survey weights provided by NuStats

Appendix H. City Rationale for 17-foot Bicycle/Pedestrian Space

PBOT rationale for minimum 17’ active transportation facilities on the Burnside Bridge

Prepared by PBOT staff

How the city operationalizes its policies

Policy background. Portland’s policies around bicycle and pedestrian transportation are clear. Portland is to prioritize “modes for people movement by making transportation system decisions” to favor walking, bicycling and transit, in that order (Comprehensive Plan Policy 9.6). We do this in part by “[encouraging] walking as the most attractive mode” (Policy 9.17) by “[improving] the quality of the pedestrian environment” (Policy 9.18) and by “[improving] pedestrian safety, accessibility, and convenience for people of all ages and abilities” (Policy 9.19). For bicycling we strive to “create conditions that make bicycling more attractive than driving” (Policy 9.20), by “[creating] a bicycle transportation system that is safe, comfortable, and accessible to people of all ages and abilities” (Policy 9.21). These efforts are in service to our overall mode split goals that aim to reduce driving to no more than 30% of all trips by 2035 (Policy 9.49.f).

The Burnside Bridge carries Portland’s highest classifications for bicycling (Major City Bikeway) and walking (Major City Walkway). According to Portland’s Transportation System Plan (TSP) Major City Bikeways “should be designed to accommodate large volumes of bicyclists, [and] to maximize their comfort….” We are directed by the TSP to “build the highest quality bikeway facilities”. “Where conditions warrant and where practical, Major City Bikeways should have separated facilities for bicycles and pedestrians.” Major City Walkways “are intended to provide safe, convenient, and attractive pedestrian access….[with] wide sidewalk on both sides, and a pedestrian realm that can accommodate high volumes of pedestrian activity.” (From *PedPDX: Portland’s Citywide Pedestrian Plan*). The Burnside Bridge is also classified as a “Civic Main Street” and should be able to accommodate high levels of pedestrian use. (*Portland Pedestrian Design Guide*).

Design guidance. Portland’s design guidance is intended to operationalize the above polices by creating the environments that favor walking and bicycling, that create attractive, safe and comfortable conditions and that can accommodate the appropriate volume of people by mode.

The minimum width for a pedestrian through zone on a Civic Main Street is eight feet (8’; *Portland Pedestrian Design Guide*). When there is an adjacent sidewalk-level bicycle facility then a 1’ minimum “sidewalk buffer furnishing zone” is to be provided in order to create positive separation between people bicycling and walking. When that buffer furnishing zone is at the minimum 1’, then that space should be filled with a yellow detectable strip, as has been employed on the Madison Street frontage of the Multnomah County Courthouse. The facility should include an additional shy distance to the barrier wall, typically 1-2 feet.

The width requirements for the cycling environment are spelled out in both the *Portland Protected Bicycle Lane Planning and Design Guide* and in the *Portland Traffic Design Manual*. For a directional bikeway with expected peak hourly volumes of 150-750, the preferable bikeway width is eight feet (8’), with a minimum width of six-and-a-half feet (6.5’). The guidance also states that designers should “carefully consider the environment in which the 6.5-foot bicycling zone is placed. If between two vertical elements (including curbs) there will be a shy distance to consider that might require additional width to provide 6.5 feet of functional width.” Shy distance to a barrier wall is typically an additional 1-2 feet.

The facility on the Burnside Bridge will include a vertical barrier that will induce a shy distance as well as a detectable surface that deter riding. It will also offer a clear space to ride when passing slower-moving people: the pedestrian zone.

The combination of widths defined in Portland's design guidance produce a preferred clear width for the Burnside facility with directional bikeway of at least 19', with a minimum clear width of 17.5'. PBOT staff has indicated that a width of 17' is a reasonable compromise width given the County's financial constraints for the bridge project and the competing demands of space needed for the roadway portion of the bridge.

City testing of facility widths

The initial design of the active transportation environment on the Burnside Bridge was twenty feet (20'), apportioned to provide an 8' pedestrian through zone, an 8' cycling zone, a 1'-2' shy distance to the barrier wall and a 2'-3' furnishing zone between the walking and bicycling zones. When the project team began considering a narrower bridge PBOT staff conducted some field tests to assess the ability of a reduced width facility to accommodate people walking and bicycling (provided to project team under separate cover).

<u>Results of testing</u>. Our field testing determined that an 8-foot directional bikeway immediately adjacent to a barrier is of sufficient width to handle most two side-by-side cyclists whether they are riding socially or if one is passing the other. The ability to do so requires that people bicycling ride closer to the barrier that people normally operate. The "normal" shy distance from a barrier—as measured in the field—was approximately 3-3.5'. Being able to operate comfortably within the 8' cycling zone requires that the cyclist closer to the wall be within 2' of the wall. When people bicycling operated at a more comfortable shy distance, i.e., further from the barrier, then the passing cyclist's handlebars extended past the 8' envelope.

<u>Likely results of inadequate facilities</u>. So, what does this mean for the proposed Burnside facility? It means that under most circumstances a 17'-wide facility will work adequately for both people bicycling and people walking. Each foot narrower than that means the facility will work less well. For example, due to the 1' detectable strip, a 14' facility will have 13' of usable space to apportion between people bicycling and walking. If the through pedestrian zone is 8', then the bikeway will be 5', etc.

With people on bikes operating at a comfortable shy distance from the wall, a total cycling width of more than 7' was required for passing. With less than required design space for bicycles (less than 8'), people wishing to pass others will avoid the 1' detectable strip and intrude into the pedestrian space. This will create an uncomfortable environment for all users. Undersized shared facilities (Eastbank Esplanade, Hawthorne Bridge sidewalks, Springwater Corridor) generate numerous complaints—typically from people walking—about discomfort with being passed closely by people bicycling. If the bicycle space is sized at 8'--allowing people bicycling to stay within that space--then the pedestrian spacewill be below minimum spacing and be an uncomfortable environment for two-way pedestrian travel. Should there be two mobility devices traveling in opposite directions, it will necessitate one of them intruding into the bike space.

Roadway sizing

The County's proposed design includes four motor vehicle travel lanes across the bridge span. The City of Portland's preferred lane width is typically 10 feet on roadways with lane markings. 11-foot outer lanes are typically considered on transit routes such as the Burnside Bridge when feasible but are not required. Burnside is not a freight route, so no additional lane width for freight is appropriate. A 1-foot shy should be added to all lane widths next to curbs. Vehicles using the Burnside Bridge will encounter 10-foot lanes on both sides of the bridge. The only route available with 11-foot lanes is W Burnside Street to Washington County – all other streets on both sides of the bridge lead to 10-foot lanes.

A design consistent with City preferred design guidelines would use 10-foot inner lanes, 11-foot outer lanes, and 1-foot shy to the barrier walls, for a total of 44 feet of clear width. Additional width is not typically reserved for lane striping – this is inclusive in the lane width. It is allowable to use wider lanes, shoulders, or add width for the centerline, but this would exceed the preferred widths. Exceeding preferred widths may encourage higher vehicle speeds, which may be in conflict with the stated intent to reduce the bridge speed to 25 mph.

Conflict with policies
Under-sizing of the bicycle and pedestrian space will result in conditions that are neither attractive nor comfortable for people using the policy-prioritized modes of travel across the Burnside Bridge. It will be in contravention of the above-referenced design guidance and, will be inconsistent with city policies to prioritize walking and bicycling . Under-sizing the bicycle and pedestrian space while exceeding preferred widths for motor vehicle space is a conflict with city policies.

Why Tilikum dimensions are not a good basis for comparison
At 14'-wide, the Tilikum shared pathways do indeed provide the widest sidewalk-level facilities of any bridge crossing the Willamette. However, the bridge that provides the most space for people bicycling and walking is the Sellwood Bridge. That bridge assigns a total of 19' to people bicycling and walking on each side of the bridge. There is a 7' buffered bicycle lane for people bicycling fast and a 12' shared use path for people walking and bicycling more slowly (or who are uncomfortable biking in the roadway).

The Tilikum is at 14' because to go wider—as the city desired—would have required a larger super structure for the bridge. As the design was somewhat advanced by the time we began discussing modifying the planned 10' pathway (based on the width of the Hawthorne Bridge sidewalks, which were the widest facilities of their type at the time), building a larger super structure was out of the question.

The 14' on the Tilikum is apportioned to provide 7' for people biking, an 8" stripe, and 6'4" for people walking. The cycling area includes a 20" shy distance marked from the inside barrier, so the usable space for bicycling is closer to 5'4". On the Tilikum people bicycling regularly intrude into the pedestrian space in order to pass people bicycling slower. My observation is that people are able and willing to ride close and even on the 8" stripe because it is just a stripe and doesn't present an unpleasant riding surface as do detectable warning strips.

The Tilikum is also at a steep grade. Though the growing popular adoption of e-bikes will likely change the equation, the steep uphill grade results in less passing because it's difficult to go especially fast. The steep downhill grade also seems to deter passing because people are uniformly moving at a good clip. Still, when passing does occur, it occurs in the pedestrian space.

Three factors for the Burnside will contribute to a demand for frequent passing: the bridge will be relatively flat so people can ride at a wider range of speeds; the use of e-bikes is growing, which will allow even faster speeds (for some) and higher speed differentials; because the bridge is in the heart of the central city it will continue to see high and growing volumes.

Based on field assessments, seventeen feet for the sidewalk level facilities is the minimum width that will allow <u>most</u> bicycle and pedestrian movements to happen solely within their own spaces. That is the available width that best follows Portland's design guidance, which was formulated to best honor our policies to achieve our overarching goals.

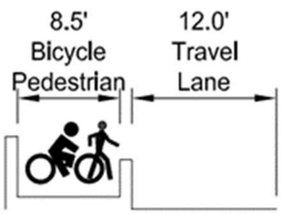
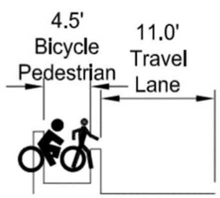
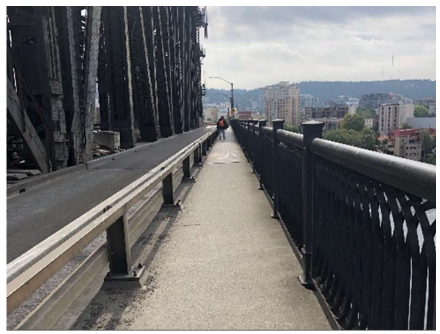
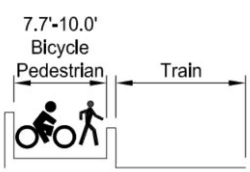
The intent of our policies is to honor those not driving. The intent of our design guidance is to create the conditions that encourage every growing demand for biking and walking. Creating cramped conditions on the bridge isn't honoring that guidance. An undersized design guaranteed to lead to complaints isn't honoring our policies and intent in developing our guidance. There is a reason why there is such an emphasis on comfort: providing comfortable conditions is necessary to increase biking and walking.

Appendix I. Bicycle/Pedestrian Width Comparison to Other Existing Willamette River Bridges

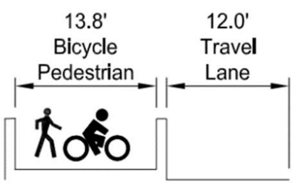
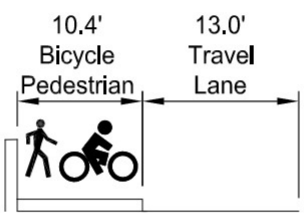
EARTHQUAKE READY BURNSIDE BRIDGE

Multnomah County

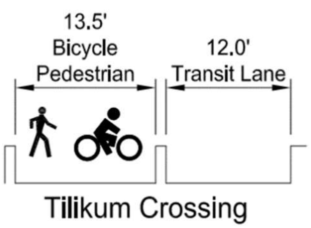
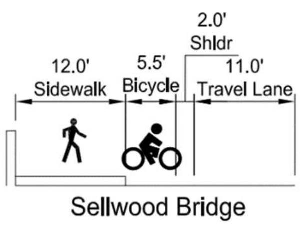
Bridge Bike / Ped Space Comparison Table

Bridge (Sequenced North to South)	Measurements	Photo	Existing Volume (daily**)	2040 Volume (daily)	Characteristics
 Broadway Bridge	8’-6” through zone; 3’ buffer / railing		Peds: 1,250 Bikes: 5,500	Peds: 2,200 Bikes: 7,700	One-way Ped / bikes combined Barrier separation
 Steel Bridge (Top Deck)	4’-6” through zone; 1’ barrier [upper deck]		Peds: N/A Bikes: N/A	Peds: N/A Bikes: N/A	Bi-directional Ped / bikes combined Separate pathway
 Steel Bridge (Bottom Deck)	10’ at widest; 7’-8” on moving span; 7’-2” at gate		Peds: 2,250 Bikes: 3,200	Peds: 4,050 Bikes: 4,150	Bi-directional Peds / bikes combined Bridge narrows at moving deck

Bridge Bike / Ped Space Comparison Table

Bridge (Sequenced North to South)	Measurements	Photo	Existing Volume (daily**)	2040 Volume (daily)	Characteristics
Proposed: Clear width ranges from 14' to 17' in each direction (TBD)	7'-2" sidewalk; 5'-5" bike lane [existing]		Peds: 1,400 Bikes: 1,750	Peds: 2,750 Bikes: 2,950	One-way Peds / bikes separated by vertical curb Buffered bike lane to separate from traffic
 Morrison Bridge	13'-10" (9'-4" bike path and 4'-6" sidewalk) [southside]		Peds: 800 Bikes: 500	Peds: 1,650 Bikes: 700	Bi-directional Ped / bikes combined Barrier separation
 Hawthorne Bridge	10'-5"		Peds: 2,750 Bikes: 5,200	Peds: 3,350 Bikes: 6,800	One-way Ped / bikes combined Vertical curb

Bridge Bike / Ped Space Comparison Table

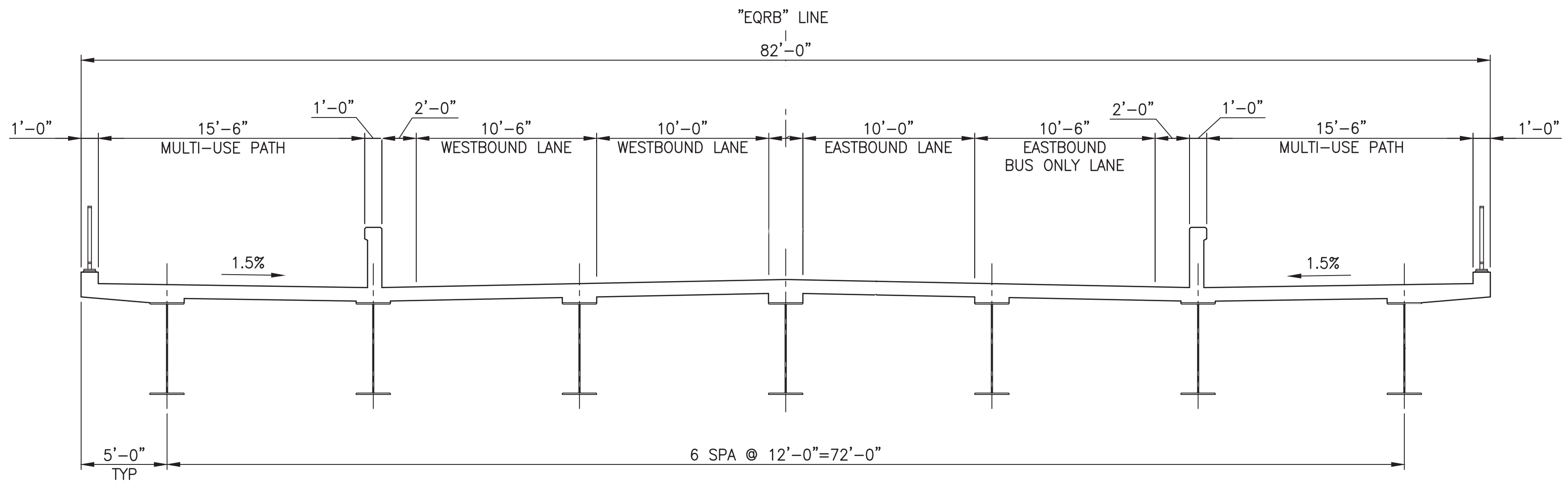
Bridge (Sequenced North to South)	Measurements	Photo	Existing Volume (daily**)	2040 Volume (daily)	Characteristics
	13'-6"		Peds: 2,250 Bikes: 2,250	Peds: 4,100 Bikes: 4,200	One-way Peds / bikes separated Barrier separation
	11'-9" raised path/sidewalk; 5'-5" bike lane with 2' buffer*		Peds: N/A Bikes: N/A	Peds: N/A Bikes: N/A	One-way Peds / bikes separated Vertical curb Bikes at roadway grade

Notes:

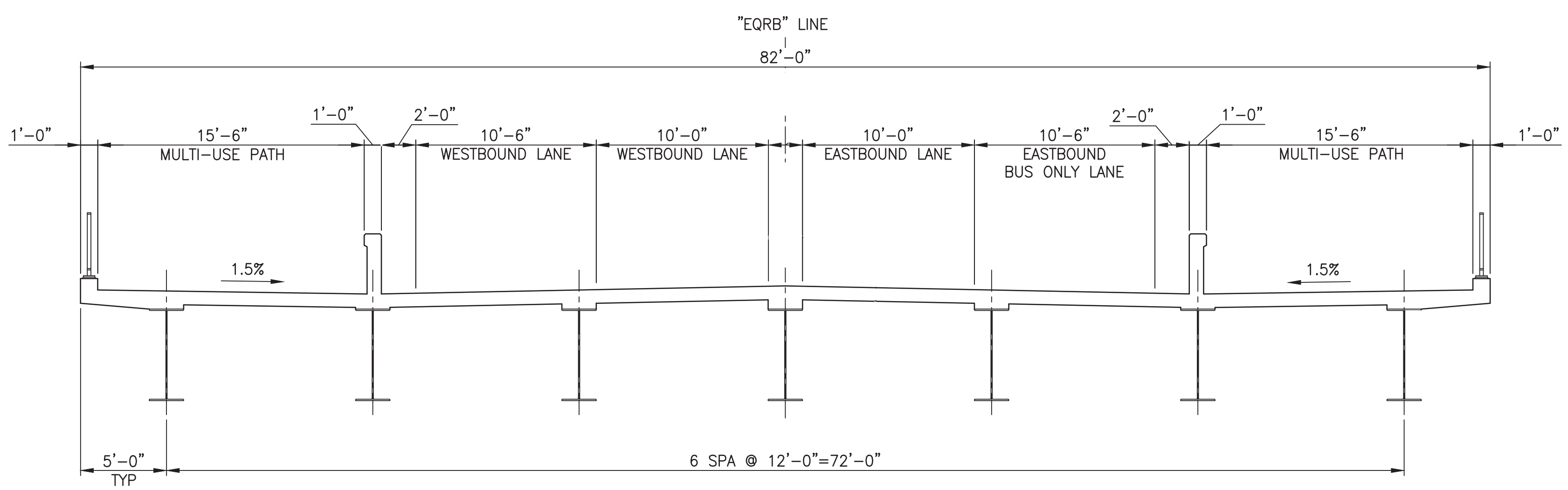
* Outside buffer stripe has worn away for most of the bridge length and is basically extra width in the travel lane

** Existing volume daily volumes are based on magnified May, 2019 count data

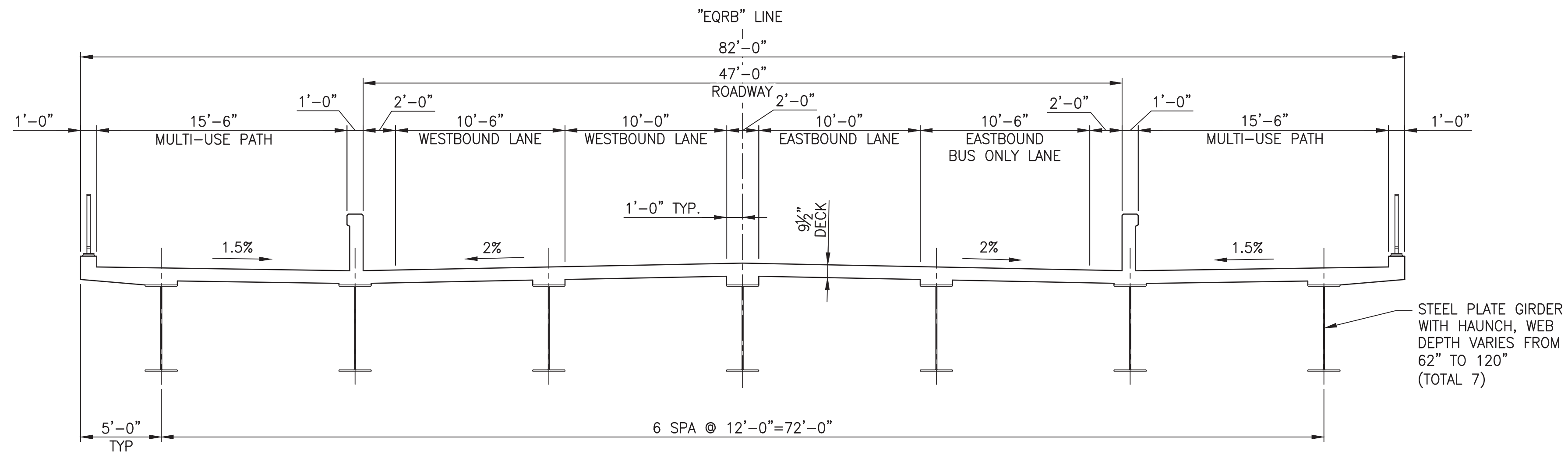
Appendix J. Post Earthquake Emergency Recovery Vehicles



TYPICAL SECTION - SPAN 3 THRU 4
SCALE: 1" = 5'-0"
(MIDSPAN)



TYPICAL SECTION - SPAN 3 THRU 4
SCALE: 1" = 5'-0"
(MIDSPAN)



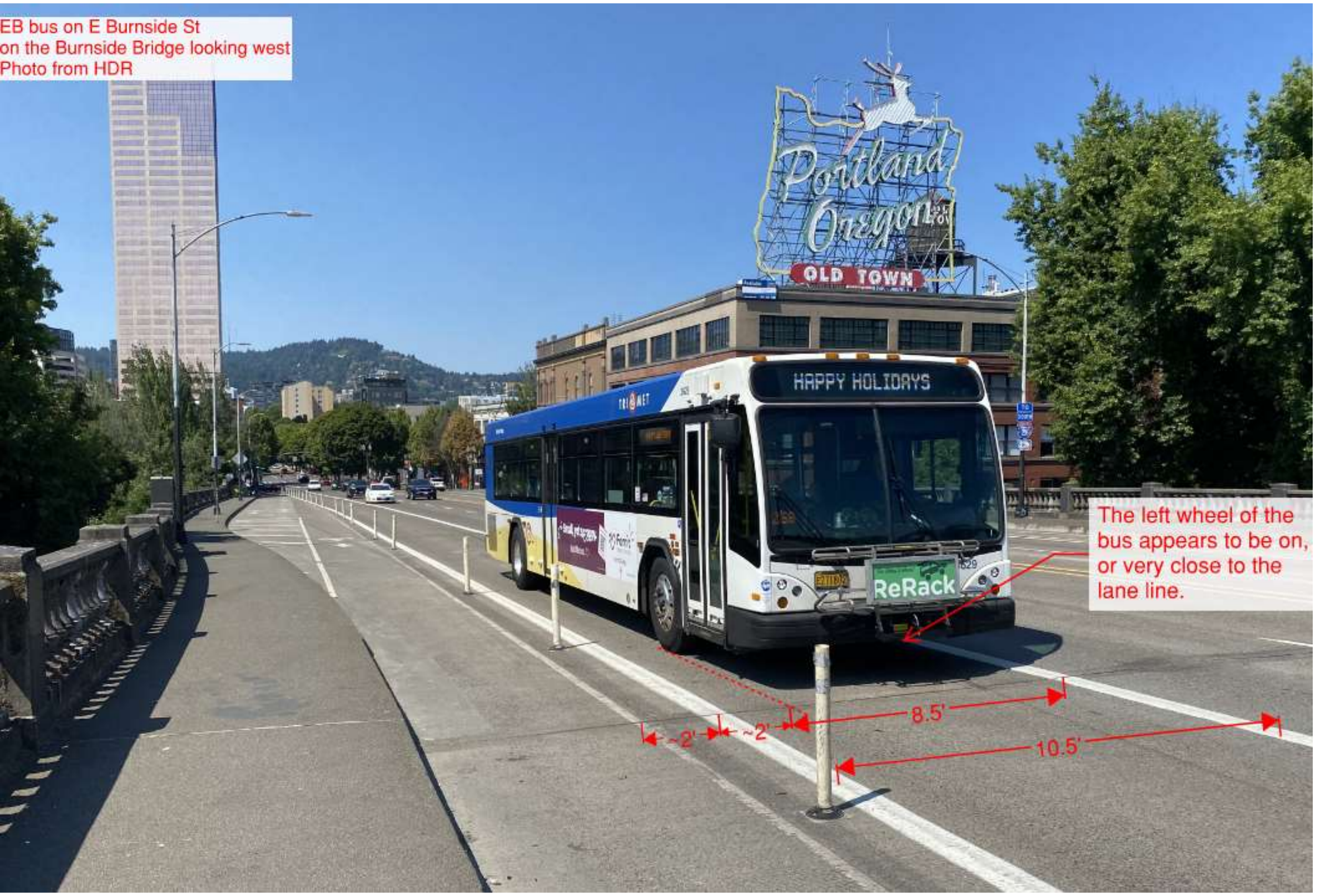
TYPICAL SECTION - SPAN 3 THRU 4

SCALE: 1" = 5'-0"
(MIDSPAN)

Appendix K. Field Observations

Field Observations: Burnside Bridge

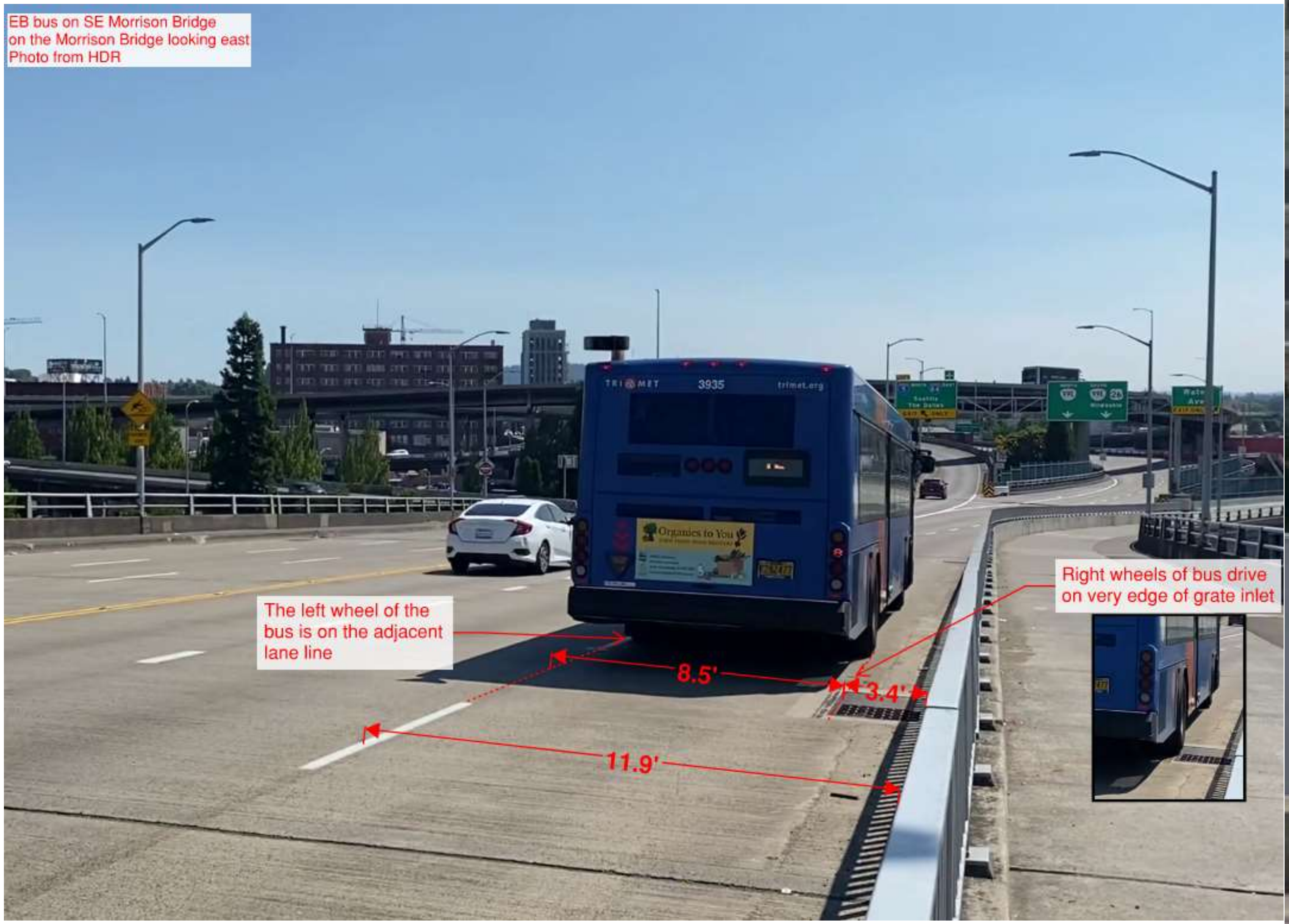
Off-Peak Traffic



Peak Traffic

Field Observations: Morrison Bridge

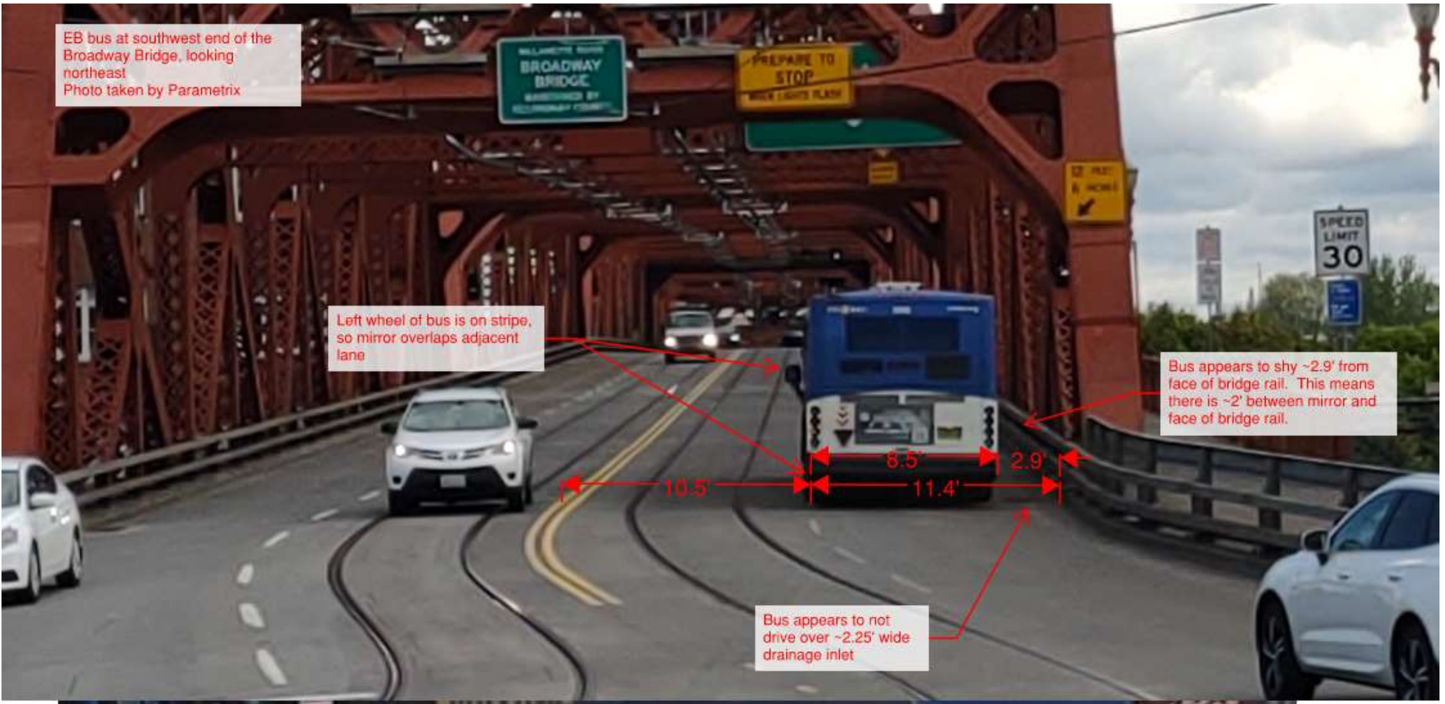
Off-Peak Traffic

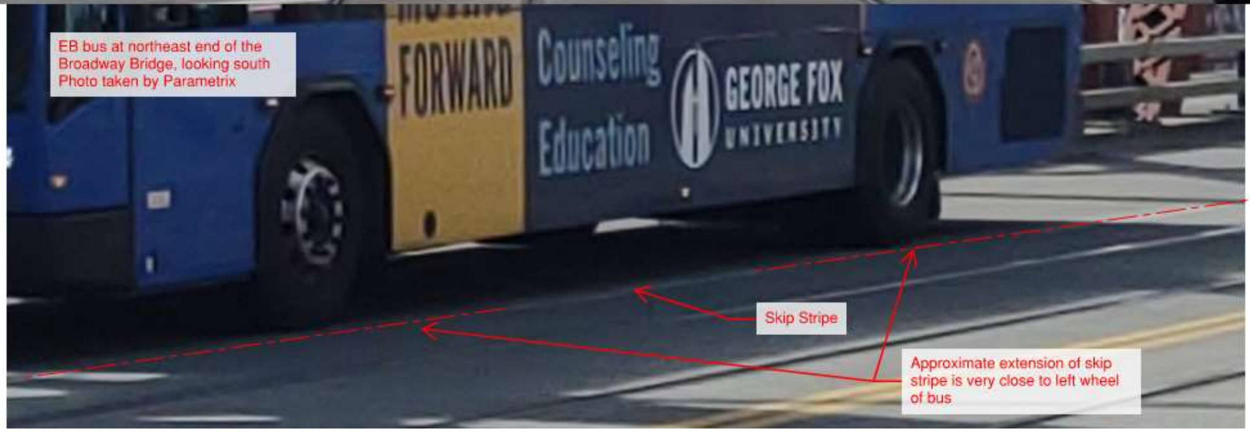


Peak Traffic

Field Observations: Broadway Bridge

Off-Peak Traffic





Peak Traffic

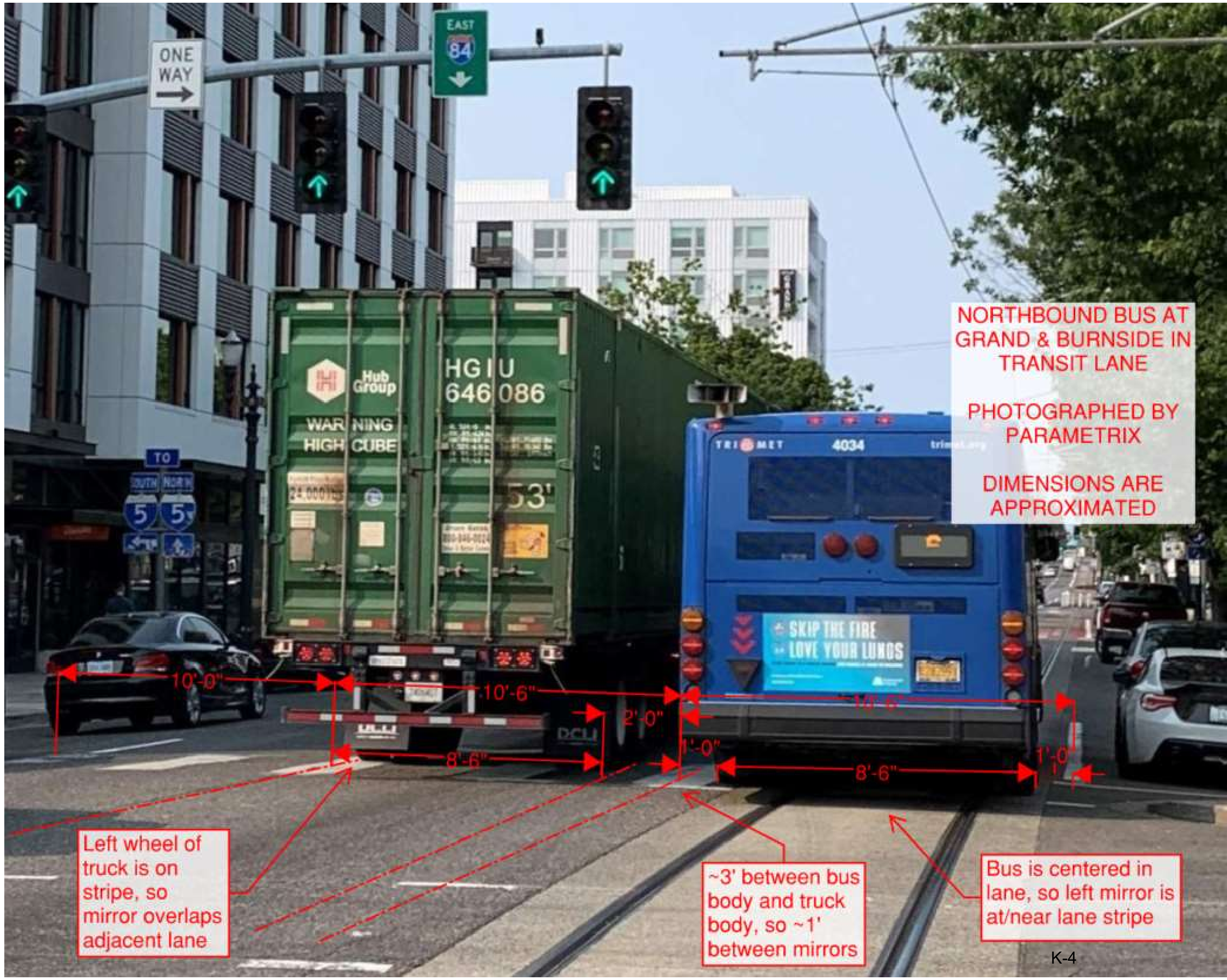
Not Observed

Field Observations: Grand Ave

Off-Peak Traffic

Not Observed

Peak Traffic



Appendix L. Stakeholder Meetings List

The following Stakeholders Meetings were conducted to support the development of this Report:

- 5/24/23 – Technical Coordination Kickoff Meeting #1
- 5/30/23 – Technical Coordination Kickoff Meeting #2
- 5/31/23 – USCG Coordination Meeting
- 6/21/23 – PBOT / PBEM Coordination Meeting
- 7/12/23 – Joint Technical / Senior Leadership Team Coordination Meeting
- 8/8/23 – EQRB Bike-Ped Connectivity Meeting #1
- 8/9/23 – Technical Coordination (Data Needs) Meeting
- 8/15/23 – Ramp Environmental Impacts and Permitting Meeting
- 8/17/23 – TriMet Coordination Meeting
- 8/22/23 – Ramp Cost Estimate Meeting
- 8/28/23 – Technical Coordination (Cross Section Focus) Meeting
- 8/29/23 – Portland Streetcar Coordination Meeting
- 9/9/23 – EQRB Bike-Ped Connectivity Meeting #2
- 9/11/23 – County Bridge Maintenance Meeting
- 9/14/23 – ODOT Bridge Inspection (John Fickett) Meeting
- 9/20/23 – Technical Team (Ramp Connection Focus) Meeting
- 9/27/23 – Technical Team (Cross Section Focus) Meeting

The following Stakeholders coordination was conducted to support the development of this Report:

- Parks / PBOT (by PBOT)
- Portland Freight (by PBOT)
- Portland Fire and Rescue (by PBOT)
- Multnomah County Office of Emergency Management (County)