TRANSPORTATION SAFETY SUPPLEMENTAL TECHNICAL REPORT

Oregon Department of Transportation

August 15, 2022

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I-5 ROSE QUARTER IMPROVEMENT PROJECT

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Executive Summary

This report identifies elements of the Revised Build Alternative that are potentially different than the Build Alternative and compares the future safety conditions of the Revised Build Alternative with the No-Build Alternative. Many of the Build Alternative elements including full width right shoulders and the addition of new continuous auxiliary lanes on I-5 between the I-84 and I-405 interchanges are also included in the Revised Build Alternative.

The new auxiliary lanes would result in smoother traffic flows and improved traffic operations on mainline segments and at the existing ramp terminal intersections. While the Revised Build Alternative includes reduced median shoulder widths in some areas as compared to the Build Alternative (i.e., to accommodate the relocation of the I-5 southbound exit ramp to N Broadway), in all cases, the Revised Build Alternative would have the same or wider median shoulder widths than No-Build conditions. There are no changes in the proposed right shoulder as compared to the Build Alternative, as the Revised Build Alternative would provide 12-foot shoulders.

The largest safety benefit of the proposed Project results from widening shoulders for the majority of the corridor on both sides of the highway as compared to the No-Build Alternative. Additionally, the Project would substantially reduce emergency braking events, which would reduce the incidence of rapid deceleration that can result in rear-end crashes. The emergency braking analysis indicated the incidence of rapid deceleration decreases because there would be fewer lane changes when auxiliary lanes are provided in both directions. Similar to the findings of the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project, in the opening year the rate of crashes on I-5 under the Revised Build Alternative would be lower than the No-Build conditions. As traffic volumes grow, the crash reduction benefits of the proposed geometric changes would decrease.

The qualitative local street analysis showed that under the Revised Build Alternative, the majority of the local street intersections in the area would have largely the same performance as under the No-Build Alternative. The most substantive changes from the No-Build condition occur at N Broadway/N Vancouver Avenue, N Weidler Street/ N Vancouver Avenue, N Weidler Street/ N Williams Avenue and NE Wheeler Avenue/N Williams Avenue/N Ramsay Way. The Revised Build Alternative would improve safety conditions at the intersection of N Broadway/ N Vancouver Avenue by reducing the complexity of the intersection and converting the intersection into a more traditional four-leg intersection of two one-way streets. At N Weidler Street/ N Vancouver Avenue, the Revised Build Alternative improves conditions by providing separate bike lanes and potentially reducing right-hook crashes by implementing protected bike phasing (i.e., a crash at a corner between a motorist turning right from a street and a bicyclist continuing straight on the same street). The intersections of N Weidler Street/N Williams

Avenue and NE Wheeler Avenue/N Williams Avenue/N Ramsay Way may see more crashes due to increased complexity of the intersections and more traffic traveling through those intersections. The intersection of N Broadway/N Williams Avenue may see an increase in exposure between the pedestrians/bikes and the westbound traffic due to an increase in the number of through lanes that results in a longer crosswalk. The Revised Build Alternative design would mitigate some of these impacts by providing protected bike lanes along N Williams Avenue on the northbound direction and providing bike and pedestrian protected phases at these intersections with the exception of the north leg at NE Weidler Street and N Williams Avenue and the west leg of NE Broadway and N Williams Avenue, where the design assumption is removal of those crossings . As the design process proceeds, the design of these intersections would be refined using best practice treatments for multimodal intersections to reduce conflicts and the potential for crashes.

1.0 INTRODUCTION

The I-5 Rose Quarter Improvement Project (Project) Environmental Assessment (EA) was released in February 2019. The Federal Highway Administration (FHWA) published a Finding of No Significant Impact (FONSI) and Revised EA (REA) for the Build Alternative on November 6, 2020. Since the issuance of the FONSI, the Oregon Department of Transportation (ODOT) has made changes to the design of the proposed Build Alternative to create a Revised Build Alternative and re-evaluated the changes in the context of the FONSI/REA. At the conclusion of the re-evaluation, FHWA and ODOT agreed that the design changes require additional analyses beyond what was presented in the REA, and FHWA rescinded the FONSI on January 18, 2022. This technical report supplements the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project (ODOT 2019) with an evaluation of the Safety impacts of the Revised Build Alternative compared to the No-Build Alternative and Build Alternative.

2.0 BUILD ALTERNATIVE DESIGN CHANGES

Changes to the Build Alternative include modification to the highway cover design and changes associated with advancements in other elements of the project design, some of which require expansion of the Project Area. This section describes the highway cover design changes and design changes that resulted from advancements in project engineering. The evaluation of these changes is presented in Section 6.2 of this supplemental technical report.

2.1 DESIGN PROCESS

Through 2021, ODOT facilitated an Independent Highway Cover Assessment, as directed by the Oregon Transportation Commission, that engaged the Project's advisory committees and community members in a series of collaborative workshops to explore the design opportunities for the highway cover. The purpose of the Independent Highway Cover Assessment was to understand stakeholder goals and objectives within the Project Area, generate potential highway cover scenarios, and assess the impacts and benefits of these scenarios. The Independent Highway Cover Assessment team worked directly with local community members from the historic Albina neighborhood to understand how the highway cover design concepts might best serve the historic Albina community. The Project's Historic Albina Advisory Board (HAAB), Executive Steering Committee (ESC) and the Community Oversight Advisory Board (COAC) also provided input as part of the Independent Highway Cover Assessment process. These sessions explored potential opportunities for economic development in the Albina community and the highway cover design concepts.

In July 2021, Oregon Governor Brown convened a series of meetings with Project stakeholders and community organizations to discuss the design concepts developed in the Independent Highway Cover Assessment. In August 2021, the HAAB—as supported by the ESC and the COAC, and through the Governor-led process—recommended "Hybrid 3" as the preferred highway cover design concept (Figure 1). The Hybrid 3 highway cover design concept represents a proposed community solution to maximize developable space on a single highway cover. The Hybrid 3 highway cover design concept maintains the commitment for the Project to create opportunities for the local community to grow wealth through business ownership and long-term career prospects through the Project's Disadvantaged Business Enterprise and workforce program. Following the community and stakeholder recommendations, in September 2021, the Oregon Transportation Commission directed ODOT to advance further evaluation of the Hybrid 3 highway cover design concept, with conditions related to the Project's funding process and other technical analyses.

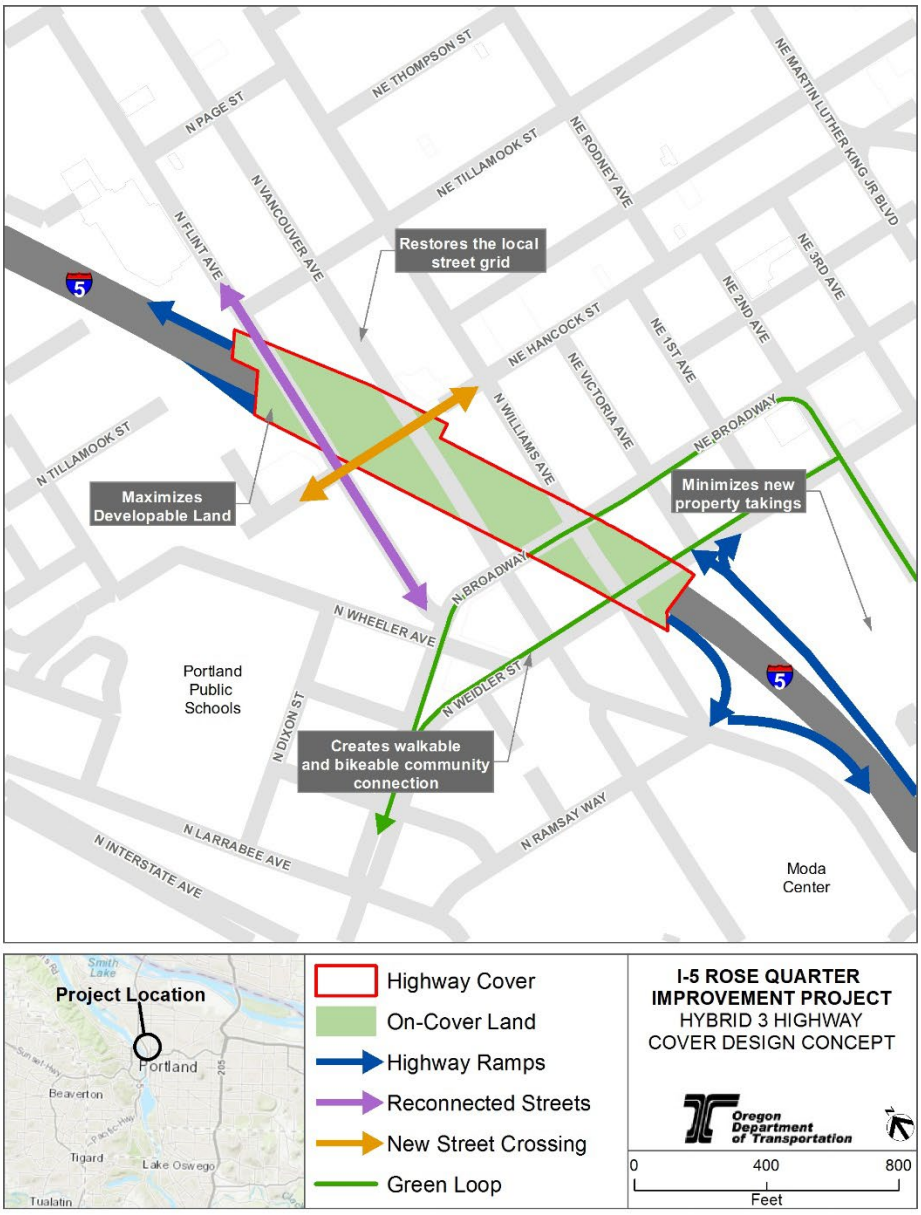
In January 2022, Governor Brown entered into a Letter of Agreement with the City of Portland, Metro, and Multnomah County that demonstrated their shared understanding and collective support for the Hybrid 3 concept as part of the Project. The Letter of Agreement specifically highlights the desire to connect the Lower Albina neighborhood, create buildable space, and enhance wealth-generating opportunities for the community, while simultaneously addressing the area's transportation needs. Additionally, the Letter of Agreement supports the development of a process to define the future development vision for what could ultimately be built on top of the highway cover upon Project completion – this process is referred to as a Community Framework Agreement. The Letter of Agreement states that the City of Portland will lead a Community Framework Agreement process and that it should be between the City of Portland, ODOT, other state agencies and local jurisdictions as necessary, with the participation of organizations that represent the Albina community and Black residents. Any future real estate or open space development on top of the cover would require executing long-term air rights and lease agreements, and that any such actions or decisions are subject at all times to applicable local, state, and federal laws including but not limited to land use and NEPA processes.

In June 2022, ODOT and the City of Portland executed an Intergovernmental Agreement (IGA), building upon the January 2022 Letter of Agreement. The IGA further states that the City will lead the future highway cover land use, programming and development processes and development of a Community Framework Agreement, in consultation with the ODOT to ensure the highway, local streets and resulting land parcels within the Project are coordinated. As such, ODOT would construct the highway cover as part of the Project and the City of Portland would lead the process to define what is ultimately built on the new land created by the Project's highway cover. In the IGA, both ODOT and the City agreed that ODOT will retain ownership of

the highway cover structure and the new developable area created on the highway cover structure upon Project completion.

The sections below describe the highway cover design changes and the design changes that resulted from advancements in project engineering and are incorporated into the Revised Build Alternative.

Figure 1 Hybrid 3 Highway Cover Design Concept



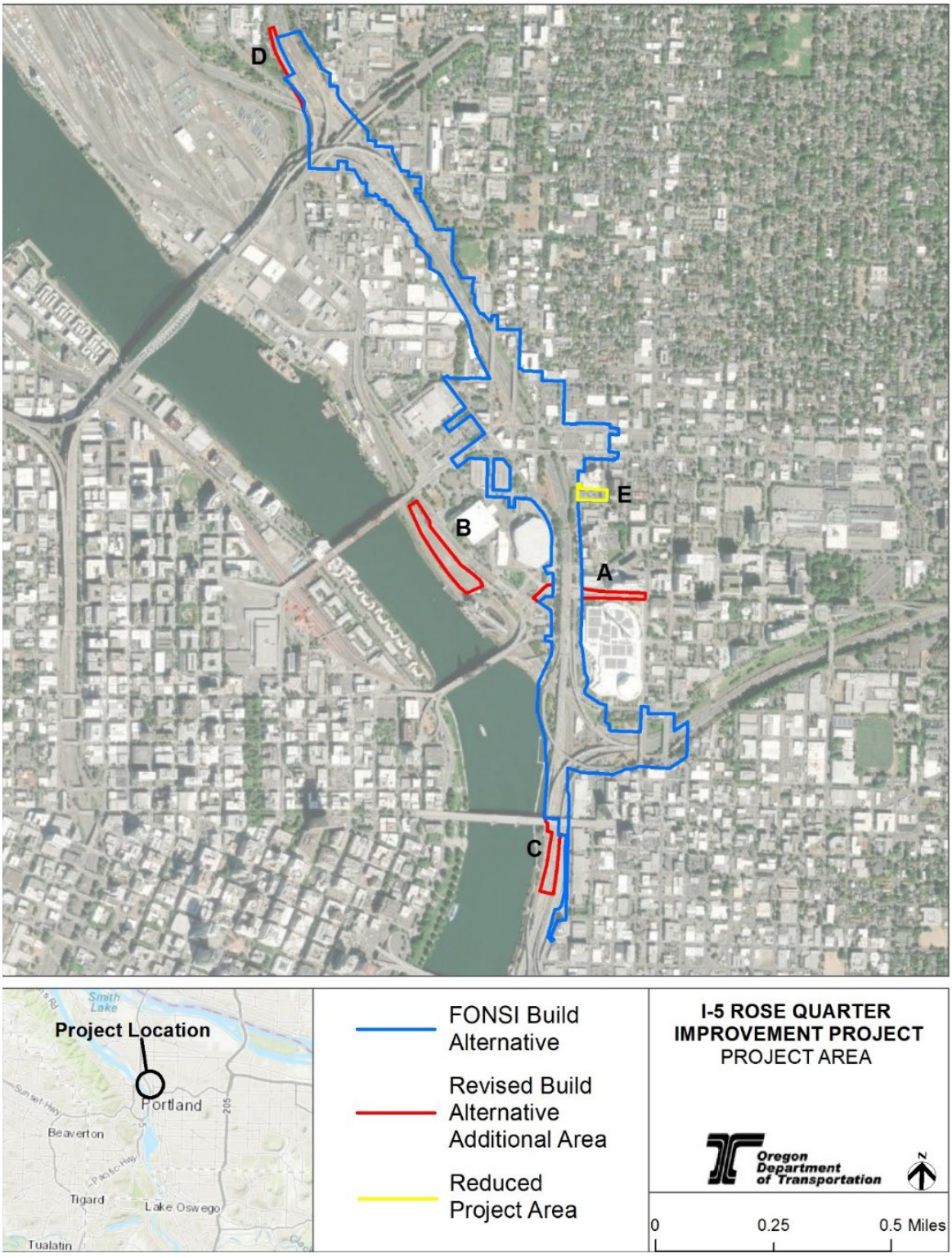
This section describes the highway cover design changes and design changes that resulted from advancements in project engineering and are incorporated into the Revised Build Alternative.

2.2 PROJECT AREA

The Project Area is defined as the area within which improvements are proposed, including where permanent modifications to adjacent parcels may occur and where potential temporary impacts from construction activities could result. As Project design information advanced, some changes required expansion of the Project Area presented in the REA and FONSI, and in one location the Project Area was reduced (Figure 2). In total, approximately 8.7 acres would be added to the Project Area. The changes are as follows, with letter references to the areas shown in Figure 2:

- A: Utility conflicts with Light Rail Transit (LRT) along NE Holladay Street between N Interstate Avenue and NE Martin Luther King Jr. Boulevard required expanding the Project Area by 1.9 acres to include additional overhead utility relocations (label A in Figure 2).
- B: An existing parking lot (known as Aegean Lot) south of N Interstate Avenue and the Broadway Bridge may be used for contractor staging during construction and is added to the Project Area (label B, Figure 2). ODOT identified this 4.3-acre construction staging area for contractor use based on its location, size, and suitability recognizing that, because of the urban setting and high-density land development in the construction area, it would be difficult for a construction contractor to find the space needed near or next to the project work areas for equipment staging, material storage, and the required co-location space for the contractor/construction personnel. This location meets all of the Project requirements: large level open space, proximity to the project work areas, and access for staging/storage of materials and equipment. Any materials stored in the area and site runoff would be subject to the same regulations as required throughout the project site.
- C: The southern end of the Project Area is expanded by 2.4 acres to include the portion of I-5 south of the Burnside Bridge proposed for a retrofit of the existing bridge rail, restriping the existing freeway, and installation of new guide signs (label C, Figure 2).
- D: At the northernmost end of the Project Area, a 1.1-acre area of ODOT right of way along the I-5 shoulders is now included in the Project Area for fiber optic conduit (label D, Figure 2).E: In one location, the Project Area was reduced by 1.0 acre. A parking lot west of the intersection of NE Clackamas Street and NE 2nd Avenue is no longer needed for the Project due to the removal of the Clackamas Bicycle and Pedestrian Crossing (label E, Figure 2).

Figure 2 Previous and Current Project Area.



2.3 I-5 MAINLINE IMPROVEMENTS CHANGES

The Build Alternative included relocation of the I-5 southbound on-ramp at N Wheeler Avenue to N/NE Weidler Street at N Williams Avenue via the new Weidler/Broadway/Ramsay highway cover, construction of auxiliary lanes and full shoulders (12 feet in width) on I-5 between I-405 and I-84 in both directions, and associated improvements to I-5 through the Project Area. The Revised Build Alternative includes the following changes to those elements of the Build Alternative:

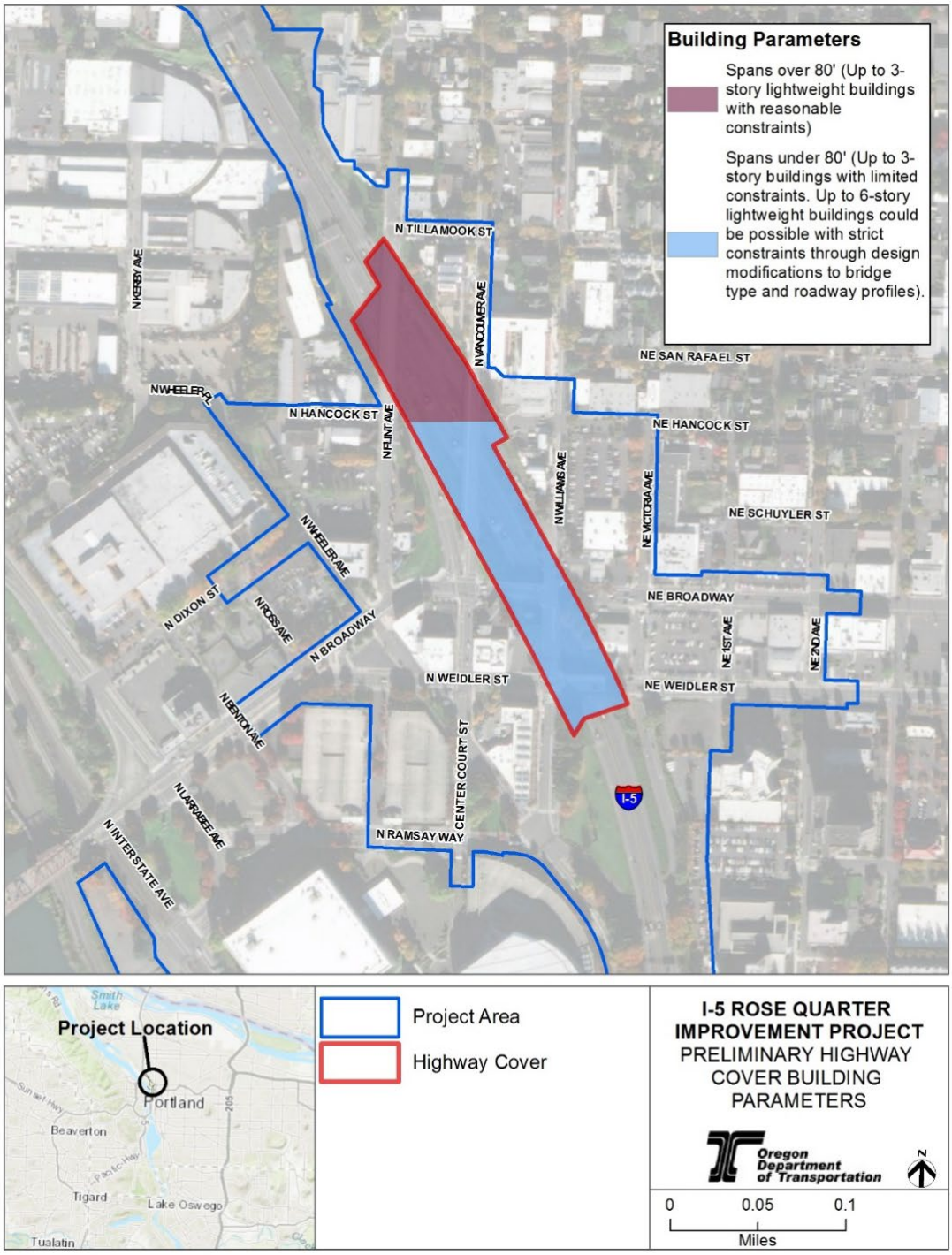
- Move the I-5 southbound exit ramp termini from N Broadway to N Williams Avenue at NE Wheeler Avenue.
- Reduce the freeway median shoulder through the entire Project Area, from 12 feet to 8 feet (4 to 5 feet within highway cover). The outside shoulder width of 12 feet remains unchanged.
- Relocate Noise Wall 24 from N Commercial Avenue near Harriet Tubman Middle School to attach to Walls 1 and 2 along the east edge of I-5.
- Keep the I-5 southbound entrance ramp from NE Wheeler Avenue/N Williams Avenue/ N Ramsay Way on the existing alignment rather than relocate it to parallel N Williams Avenue.
- On I-5 south of the Burnside Bridge: retrofit existing bridge rail, restripe freeway in both the northbound and southbound directions, and install new guide signs on an existing sign structure in the southbound direction.

2.4 HIGHWAY COVER CHANGES

The Build Alternative included the construction of two highway cover structures over I-5 for roadway crossings and other purposes. The Revised Build Alternative , based on Hybrid 3 (see Figure 1), includes the following changes to the highway covers:

- Provide one continuous highway cover over I-5 rather than separate covers at the existing N Flint Avenue, NE Weidler Street, NE Broadway, N Williams Avenue, and the N Vancouver Avenue overcrossings.
- Expand the limits of the highway cover by approximately 35 feet to the west, and approximately 400 feet to the north.
- Design and construct the highway cover to accommodate multi-story buildings. Due to span length and site constraints, design would constrain building size, location, type, and use on portions of the cover (Figure 3). Generally, buildings up to three stories could be accommodated throughout the highway cover. Buildings of up to six stories could be accommodated where span lengths are shorter than 80 feet with strict design constraints.

Figure 3 Building Parameters on the Cover



Future development on the highway cover would follow a community process according to the City-led Community Framework Agreement, as described in Section 2.1. ODOT anticipates this process could continue past completion of cover construction.

As part of the Project, ODOT anticipates programming interim uses on the highway cover for the time period between Project completion and when the City-led development process would be implemented. Upon Project completion, the added surface space created by the highway cover over I-5 could provide an opportunity for new and modern bicycle facilities, making the area more connected, walkable and bike friendly. It could also provide opportunity for various potential types of public spaces, to be precisely determined during the Project's final design phase and through robust community engagement, consisting of one or more of the following types of uses:

- Landscaped areas for active and passing recreation and/or to provide a buffer, backdrop and visual comfort, such as gardens, lawns or planter beds.
- Plazas and hardscaped open space for active and passive recreation, such as courts, plazas, splash pads, picnic areas, and community gathering spaces.
- Interpretive signage, historical markers, landmarks and other areas of historical recognition and narrative such as art pieces and other historical signage/kiosks and pavement focused on the historic Albina community.
- Temporary and lightweight vertical features to support episodic, mobile commercial activities such as a food market shed, eating pavilion, food carts, or picnic venues.

These features may be removed upon implementation of the development determined by the community process or may be incorporated into that development.

2.5 RELATED LOCAL SYSTEM MULTIMODAL IMPROVEMENTS CHANGES

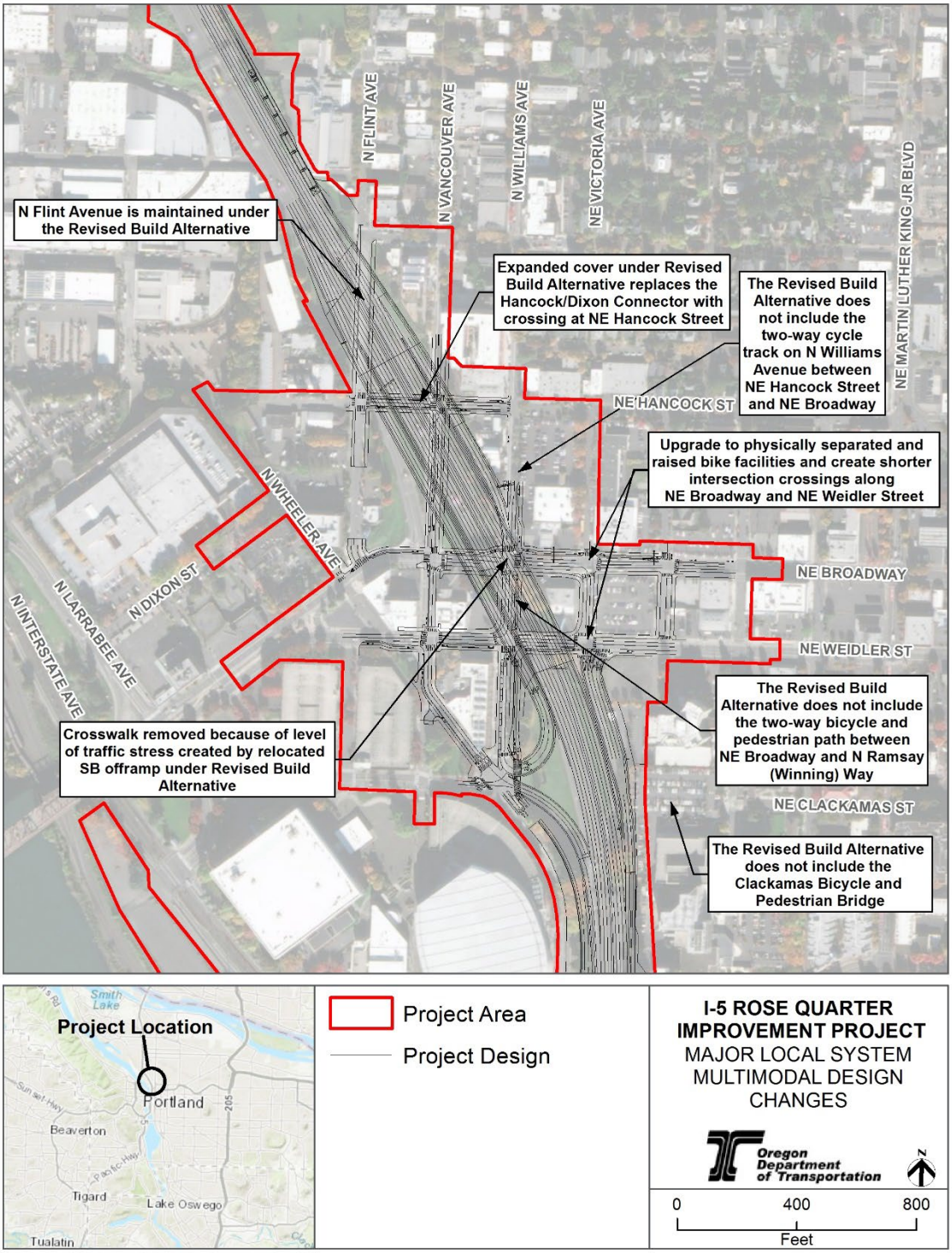
The Build Alternative included construction of a new bicycle and pedestrian bridge over I-5 at NE Clackamas Street and other local street improvements. The Revised Build Alternative includes the following changes to these improvements to accommodate the Hybrid 3 design concept and related changes in traffic patterns (see Figure 4 below):

- Remove the Clackamas Bicycle and Pedestrian Crossing from the Build Alternative.
- Construct wider sidewalks and bike lanes at sidewalk level and physically separated from the roadway with a curb and provide protected bike signal phases at multiple intersections along NE Broadway and NE Weidler Street.
- Connect N Flint Avenue across I-5 from NE Tillamook Street to N Hancock Street and terminate it at N Broadway.
- Remove the NE Hancock Street overcrossing of I-5 from N Williams Avenue to N Dixon Street as proposed in the Build Alternative. NE Hancock Street would be extended across I-5

and reconnect to NE Hancock Street west of N Flint Avenue as part of the expanded highway cover.

- Remove the two-way cycle track on N Williams Avenue between NE Hancock Street and NE Broadway and a two-way bicycle and pedestrian path between NE Broadway and N Ramsay Way from the design and instead convert the on-road bike lane to a protected bike lane, with a transition to the existing on-road bike lane south at or near NE Hancock Street.
- Close the crosswalk across NE Broadway on the west side of N Williams Avenue and the crosswalk across N Williams north of N Weidler Street.

Figure 4 Major Local System Multimodal Design Changes



3.0 REGULATORY FRAMEWORK

The safety related regulatory framework is the same as was evaluated in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. The following documents that describe the regulatory framework in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project have not changed:

- ADA Standards (updated in 2010).
- ODOT 2012 Highway Design Manual (ODOT 2012b).
- ODOT (Oregon Department of Transportation). 1999. Oregon Highway Plan.
- Oregon Transportation Plan – (ODOT 2007).
- NACTO (National Association of City Transportation Officials). 2018. Urban Street Design Guide.
- Oregon Bicycle and Pedestrian Plan (ODOT, 2016).
- Division 51 (ODOT 2012).

The American Association of State Highway and Transportation Officials (AASHTO) guidance document A Policy on Geometric Design of Highways and Streets 6th Edition (AASHTO 2011) has been updated in 2018 to A Policy on Geometric Design of Highways and Streets, 7th Edition (AASHTO 2018). The design and safety criteria related to this project remains unchanged with the new AASHTO 2018 document.

4.0 METHODOLOGY AND DATA SOURCES

The methodology and data sources are the same as those described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

4.1 AREA OF POTENTIAL IMPACT

The API is the same as the Project Area as shown in Figure 2 except along N Broadway, where the API extends west to N Larrabee Avenue. This extension is the same as the area of potential impact shown in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

4.2 EXISTING CONDITIONS ANALYSIS

The existing conditions analysis in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project was not updated in this report. The findings from that work are the same for this report.

4.3 FREEWAY MAINLINE AND RAMP SEGMENTS CRASH ANALYSIS

The methodology and data sources for the freeway mainline analysis are the same as those described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. The AASHTO 2010 Highway Safety Manual (HSM) predictive method for freeways was applied using the Enhanced Interchange Safety Analysis Tool software (ISATe). To understand the change in forecast crash rate that can be attributed to improvements in the roadway cross-section, the 2045 predicted crash rates for No-Build and Revised Build alternatives were evaluated using the No-Build volumes. Because ODOT does not have HSM predictive method calibration factors for freeways, the analysis was performed without calibration factors and considered only relative results between the Revised Build and No-Build alternatives. This methodology is consistent with that used in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project and is standard practice when local calibration factors are not available. The safety models developed in the 2022 Transportation Safety Supplemental Technical Report are more refined than those developed for the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. Specifically, the inside and outside shoulder widths and median widths were estimated with more detail to develop a more refined comparison between the Revised Build Alternative with the No-Build and Build Alternatives.

Except for the I-5 southbound exit ramp, all other ramps in the Revised Build Alternative are very similar to the Build Alternative with only minor changes that would not influence the outcomes of the safety analysis. Therefore, only the I-5 southbound exit ramp is considered in this analysis. The Revised Build Alternative relocates the I-5 southbound exit ramp end point from N Broadway to NE Williams Avenue. While the ramp diverges from the freeway mainline at approximately the same location, the relocated end point extends the length of the ramp from approximately 1,000 feet to approximately 2,000 feet. Figure 5 shows the location and extent of the existing and new ramp. The new ramp also includes a sharper horizontal curve prior to approaching the intersection at N Williams Avenue/N Wheeler Avenue. The ramp then adds a leg to the existing intersection with two right turn lanes channeling exit traffic to northbound Williams Avenue. Due to this change, an HSM Predictive method crash analysis to compare the safety performance of this ramp in the Revised Build Alternative with that in the No-Build Alternative was also conducted. Figure 6 shows highway segments and ramp location considered for this analysis.

Emergency braking events were identified as a surrogate for crashes in the I-5 Broadway/Weidler Interchange Improvements: Traffic Operations Analysis Summary (HDR 2015). In that analysis, an emergency braking event is defined as a vehicle decelerating faster than 14.8 feet per second squared (ft/s^2). This methodology was applied again in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. These emergency braking analysis results from the 2019 evaluation are still valid because freeway traffic operations are expected to be sufficiently similar between the Build Alternative and the Revised Build Alternative. Specifically, the Build Alternative and Revised Build Alternative include the same geographic extents for the auxiliary lanes, similar on and off ramp spacings, and similar traffic volumes.

Figure 5 I-5 Southbound Ramp Relocation

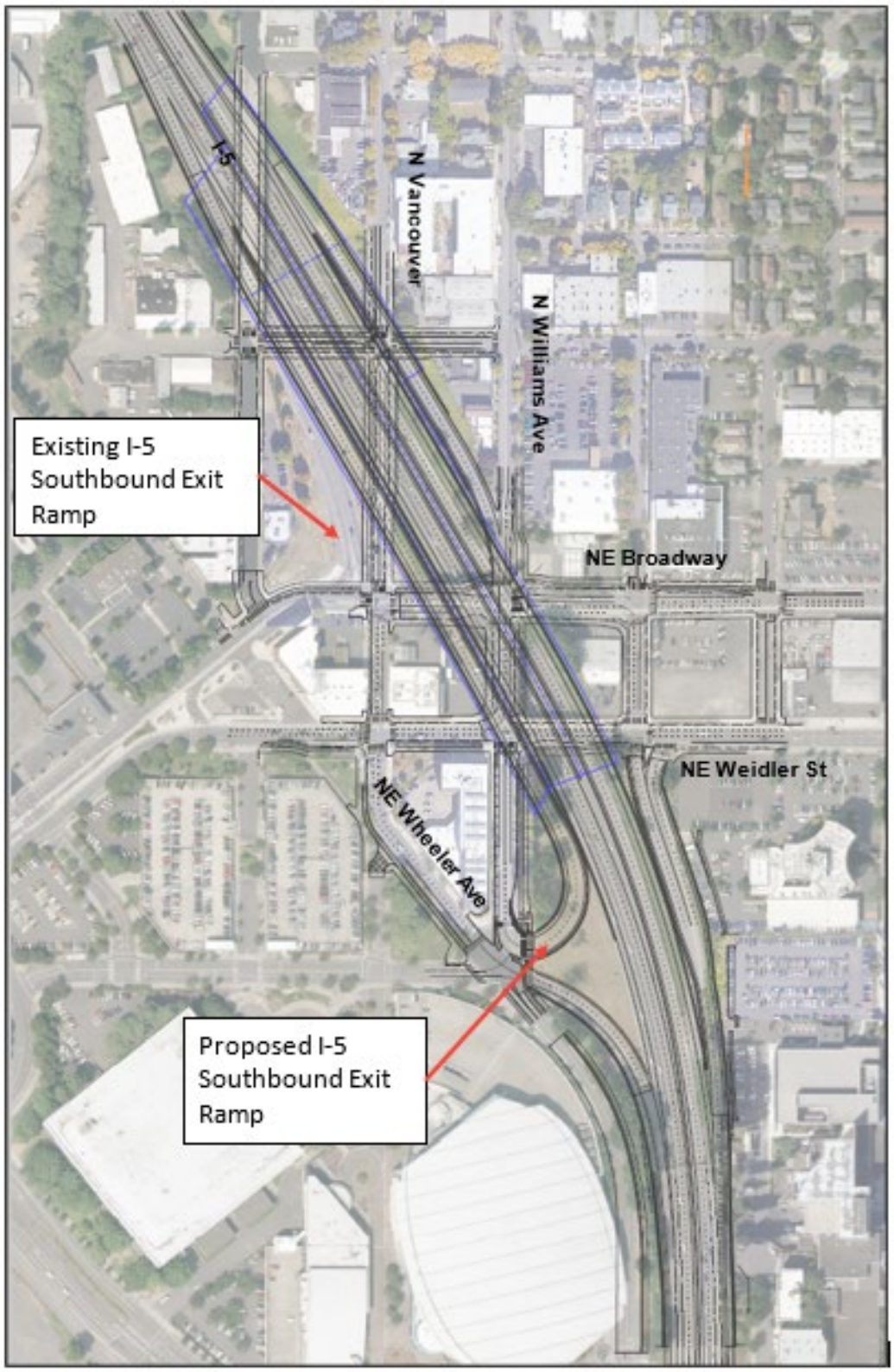


Figure 6 Study Segments and Ramps for Safety Analysis

4.4 LOCAL STREET MULTIMODAL RISK ASSESSMENT

The methodology used for the local street safety assessment is the same as described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. The same framework for exposure, complexity and severity/risk is used to qualitatively evaluate conditions on the local street system in the No-Build and Revised Build Alternative. As any one

of these measures increases, potential risk of a crash increases. These metrics provide a framework for qualitatively considering crash conditions at a site. Exposure is a measure of the number of cars, pedestrians or cyclists traveling through a location. Complexity refers to the physical characteristics of the location and how difficult or easy it is for users to travel through the location. Severity/Risk refers to the mix of speeds of different modes traveling through the intersection.

The local street assessment in this 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project is conducted at the locations shown in Figure 7. Intersections were identified for analysis in this report if the Revised Build Alternative would change No-Build intersection configurations. All other intersections would remain the same as the No-Build Alternative in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

The 2045 Average Daily Traffic (ADT) volumes were derived based on the conservative assumption that PM peak hour traffic volume is approximately 10 percent of ADT. As described in more detail in the Traffic Analysis Supplemental Technical Report, the Metro Regional Travel Demand Models were used to forecast future demand for the horizon year 2045 including the PM peak hour traffic volumes. Small changes in traffic volumes between the Revised Build Alternative and the Build Alternative resulted in updates in volume ranges for the exposure rating. In addition, as documented in the Traffic Analysis Supplemental Technical Report, the 2045 bicycle volumes were also updated in this analysis. These updates also influenced the volume ranges for the bicycle exposure rating.

The following shows the assumed volume ranges for each mode:

- Motor vehicle exposure ratings were based on the following ranges of 2045 average daily traffic (ADT) (in vehicles per day [vpd]):
  - No-Build:
    - High: 19,684 - 27,900 vpd
    - Moderate: 11,468 - 19,683 vpd
    - Low: 3,250 - 11,467 vpd
  - Revised Build Alternative:
    - High: 20,268 - 29,300 vpd
    - Moderate: 11,234 – 20,267 vpd
    - Low: 2,200 - 11,233 vpd
- Bicycle exposure ratings were based on the following ranges of 2045 PM peak hour (5:00–6:00 PM) bicycle volumes:

  - No-Build:
    - High: 1,081 - 1,570 bicycles per hour
    - Moderate: 591 - 1,080 bicycles per hour
    - Low: 100 - 590 bicycles per hour
  - Revised Build Alternative:
    - High: 1,081 - 1,570 bicycles per hour
    - Moderate: 591 - 1,080 bicycles per hour
    - Low: 100 - 590 bicycles per hour
- Pedestrian exposure ratings were based off the following ranges of 2045 PM peak hour (5:00–6:00 PM) pedestrian volumes:
  - No-Build:
    - High: 346 – 450 pedestrians per hour
    - Moderate: 242 – 345 pedestrians per hour
    - Low: 136 - 241 pedestrians per hour
  - Revised Build Alternative:
    - High: 340 – 440 pedestrians per hour
    - Moderate: 238 - 339 pedestrians per hour
    - Low: 136 – 237 pedestrians per hour

Bicycle and pedestrian volume information was not available for the N Wheeler Avenue/ N Dixon Street and N Vancouver Avenue/N Hancock Street intersections. Pedestrian volume information was not available at the N Williams Avenue/ NE Hancock Street intersection. For these intersections, it was assumed that the volumes would be low based on professional judgement and knowledge of the area, and hence the exposure ratings were assigned as “low.” All of these intersections are unsignalized intersections.

Figure 7 Local Intersections Included in Local Street Multimodal Risk Analysis

5.0 AFFECTED ENVIRONMENT

The affected environment is the same as was evaluated in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

6.0 ENVIRONMENTAL CONSEQUENCES

6.1 NO-BUILD ALTERNATIVE

6.1.1 Direct Impacts

The No-Build Alternative would have the same direct impacts as described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

6.1.2 Indirect Impacts

The No-Build Alternative would have the same indirect impacts as described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

6.2 REVISED BUILD ALTERNATIVE

6.2.1 Direct Impacts

Forecast Freeway Conditions - Mainline

For the purposes of the safety analysis, the relevant differences between the Revised Build and No-Build Alternative on the freeway mainline are the change in inside shoulder width (Figure 8), right shoulder width (Figure 9), and the provision of auxiliary lanes on both I-5 northbound and southbound between I-84 and the N Weidler Street off-ramp. Under No-Build traffic volumes, the forecast crash rates in the Revised Build Alternative would be lower than the forecast crash rates for the No-Build Alternative between approximately the I-405 ramps and the existing southbound I-5 on-ramp from N Winning Way (segments 3 - 7 and 9 on Figure 6). The forecast crash rates for both the Build Alternative and the Revised Build Alternative would be similarly lower than the forecast crash rates for the No-Build Alternative in the same locations. However, the Revised Build Alternative is forecast to have a slightly higher crash rate (up to 9% higher, yet still below No-Build Alternative) as compared to the Build Alternative due primarily to the changes in the inside shoulder widths. Figure 10 shows the differences between the Build and Revised Build inside shoulder width. Outside shoulder widths are the same for both Build and Revised Build alternatives.

There are additional safety benefits of the Revised Build Alternative not captured using the HSM methods. Providing the auxiliary lanes under the Revised Build Alternative would result in enhanced traffic operations, more uniform lane speeds, and reduction in lane changes as compared to the No-Build. As documented in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project under the Build Alternative and Design Year traffic volumes, the number of emergency braking events on the freeway mainline would decrease in both northbound and southbound directions of I-5. In both directions, the analysis shows substantial reduction of emergency braking during peak hours due to the addition of the auxiliary lanes. This analysis of the Build Alternative is also valid to the Revised Build Alternative since they both have the same geographic extents for the auxiliary lanes, similar on and off ramp spacings, and similar traffic volumes. From a safety perspective, fewer emergency braking maneuvers also have the outcome of fewer unexpected driver maneuvers, less rapid acceleration and deceleration, and less potential for rear-end crashes.

As documented in the Traffic Analysis Supplemental Technical Report traffic volumes and improvements in the freeway traffic operations under the Revised Build and Build Alternatives are expected to be similar; therefore, the outcomes from the previous emergency breaking analysis remain valid and the Revised Build Alternative would also have the benefit of fewer emergency braking maneuvers and lower crash risk as compared to the No-Build alternative.

In addition, as compared to the No-Build Alternative, the Revised Build Alternative would improve traffic operations at both I-5 southbound and northbound off-ramps by reducing ramp queue lengths and providing increased ramp storage that would reduce the potential for queues extending onto the I-5 mainline.

Similarly, the HSM analysis method does not capture the safety benefits associated with wider right shoulders in the context of traffic incident management. With wider right shoulders, there is space for vehicles to move to the side of the road in the event a break down or non-injury crash. In addition, this space can be used by emergency vehicles to access crashes or other events. Effectively, the wider shoulder provides space for motorists to move out of the travel lane in unusual situations which would reduce congestion and the potential for secondary rear-end crashes associated with queuing in these situations.

Figure 8 Inside Shoulder Width of Study Corridor for the No-Build and Revised Build Alternatives

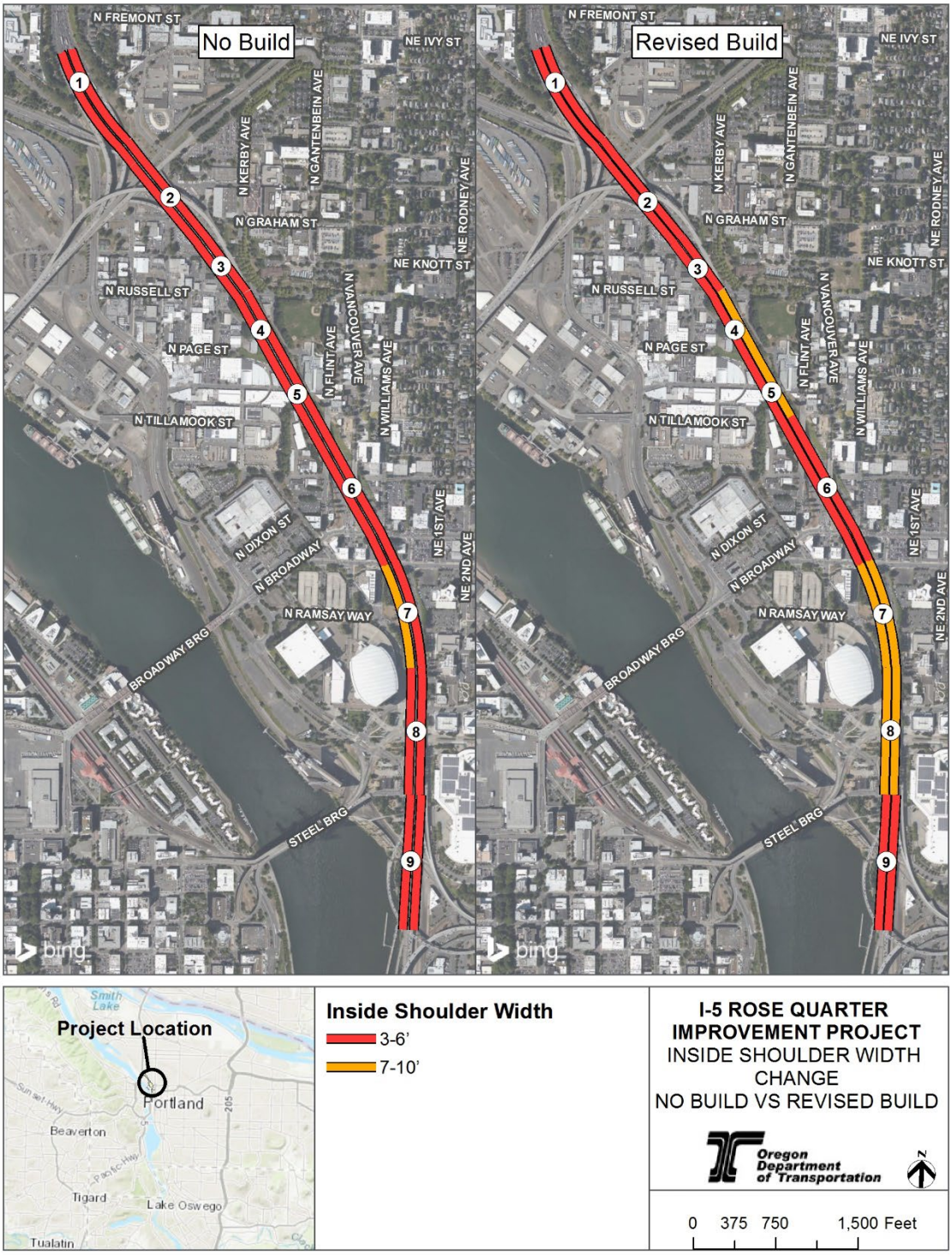


Figure 9 Outside Shoulder Width of Study Corridor for the No-Build and Revised Build Alternatives

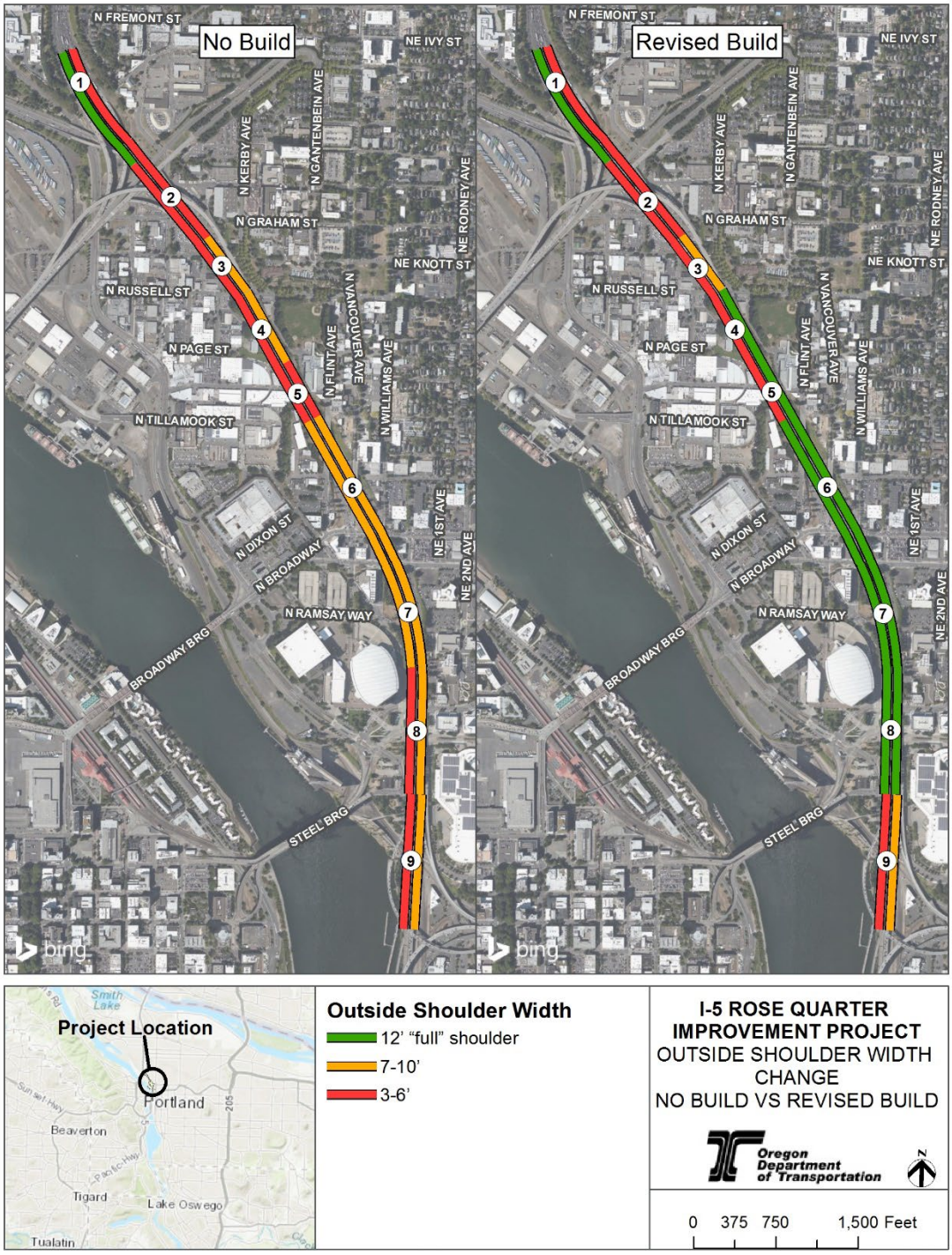
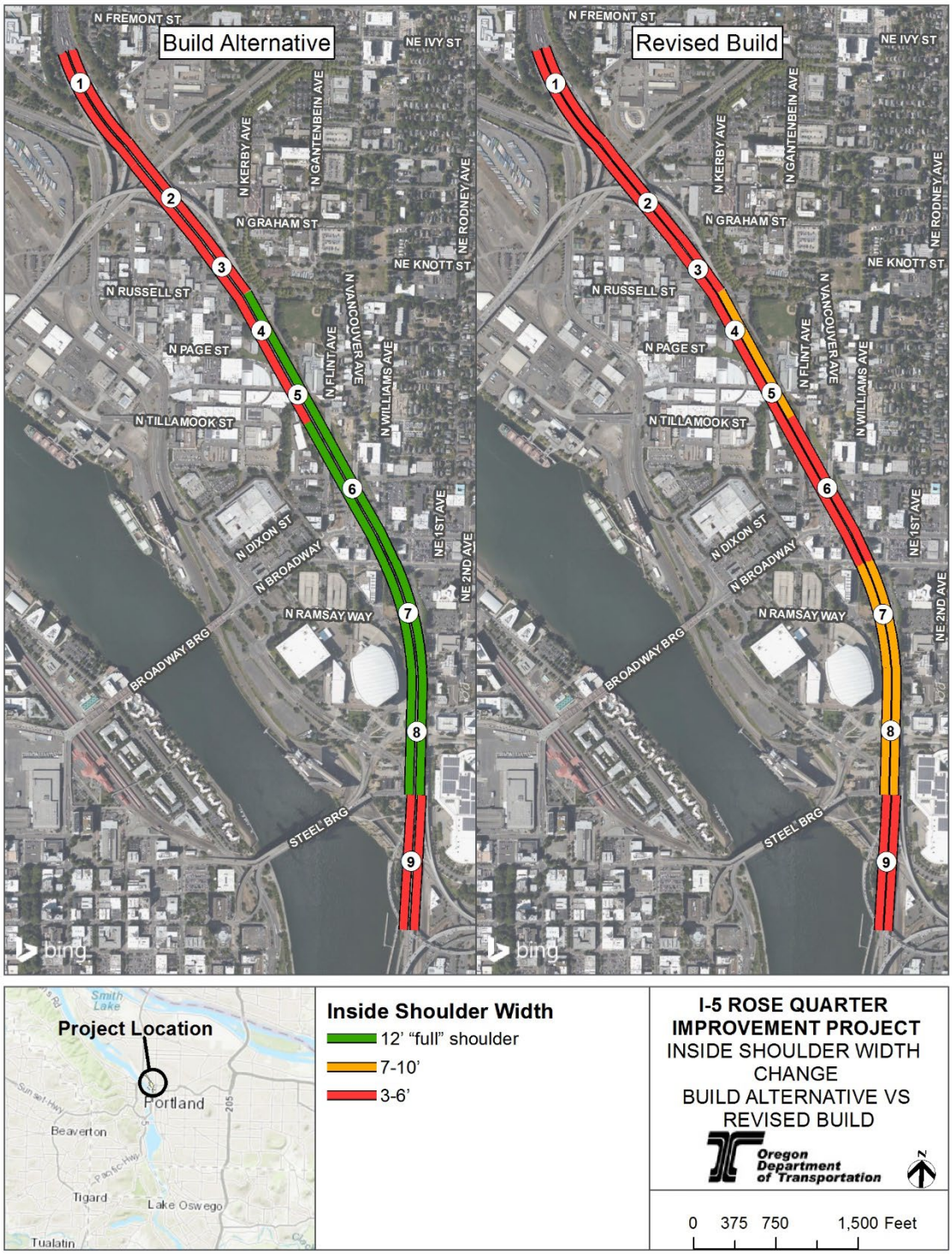


Figure 10 Inside Shoulder Width of Study Corridor for Build Alternative and Revised Build Alternative



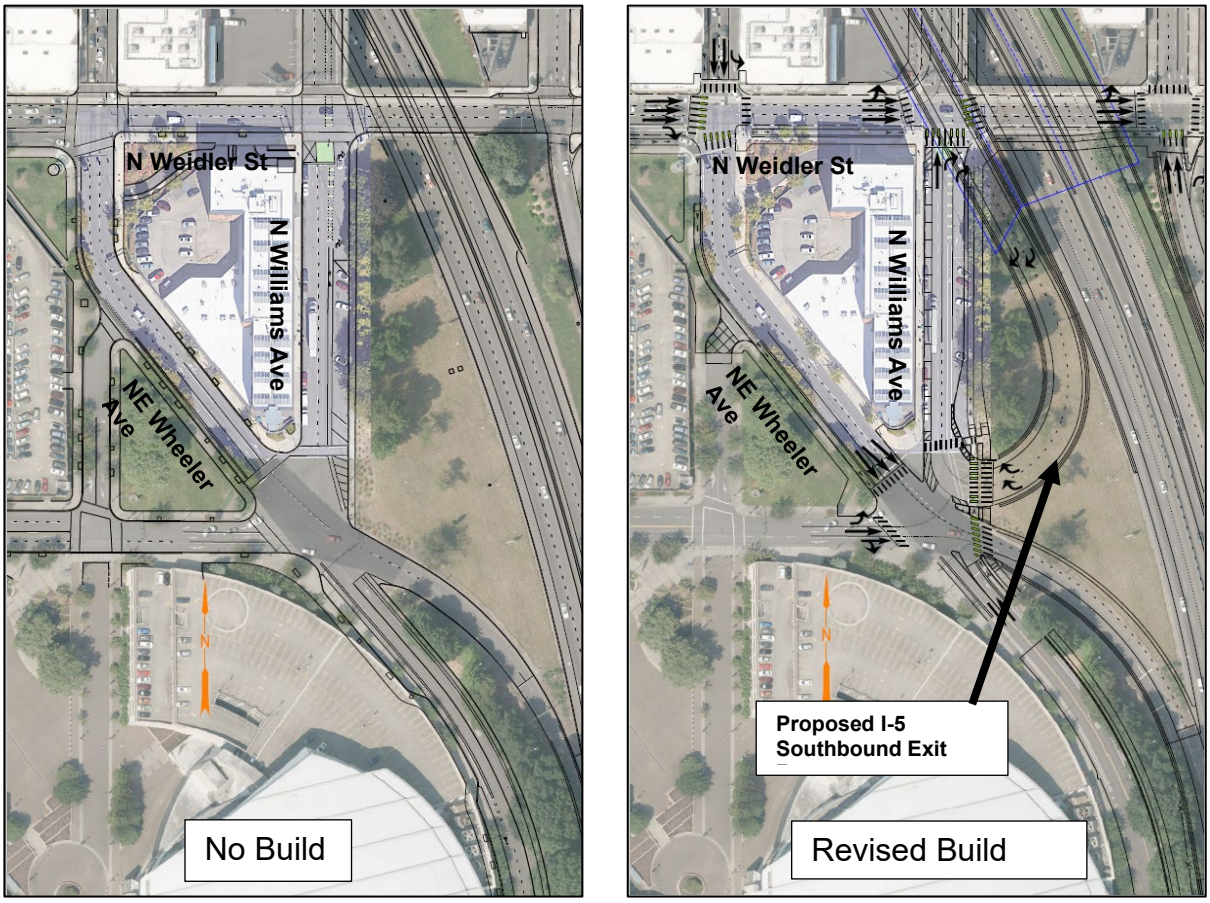
Forecast Freeway Conditions - Ramps

The HSM predictive method for ramps is used to evaluate relative safety performance on the relocated I-5 southbound exit ramp from N Broadway to NE Williams Avenue in the Revised Build Alternative as compared to No-Build Alternative. This ramp is investigated in this 2022 Transportation Safety Supplemental Technical Report because it is substantially different from the configuration in the No-Build and Build Alternatives.

Under the HSM method, the number of crashes which may occur on a ramp is sensitive to geometric conditions, traffic volume, and length of the ramp. There are no major changes in geometry in the I-5 southbound exit ramp between the No-Build and Build conditions, hence they have similar forecast crash rates. However, as proposed in the Revised Build Alternative, relocating the I-5 southbound exit-ramp connection to the local system from N Broadway to NE Wheeler Avenue would increase the ramp length from approximately 1,000 feet in the No-Build conditions to approximately 2,000 feet in the Revised Build conditions, which would provide 1,000 feet of additional traffic queue storage. The new ramp design also includes wider shoulders than existing conditions. Based on the HSM, the forecast crash rate at this location would be approximately 13 % higher than the No-Build and Build condition. In the HSM, the number of crashes on a facility is highly sensitive to volume and length. As the length of this ramp increases, the forecast number of crashes increases and therefore so too does the crash rate. However, from a traffic operation perspective, the additional storage on the I-5 southbound exit-ramp would reduce the potential for queue spill-back onto the freeway. Under the No-Build Alternative, queue on the exit ramp is expected to propagate upstream onto the freeway mainline, creating a safety concern. The additional storage provided in the Revised Build Alternative would be able to accommodate the queue on the ramp without encroaching onto the freeway. This is particularly beneficial during peak hours and event conditions. In addition, the lengthening of the ramp will allow motorist to decelerate to a safer speed allowing them to safely navigate through the horizontal curve.

The final 250 feet of this ramp includes a horizontal curve prior to the ramp terminal intersection. The proposed curve would not meet ODOT's HDM minimum radius for exit ramp curves and could also result in truck off tracking that extends outside of a standard travel lane. Therefore, to mitigate these considerations, the design detail of this curve would include wider shoulders and lanes than other sections of the ramp. Adequate delineation, signing, markings and lighting to inform drivers of the sharp curve as they approach the ramp terminal intersection would also be considered. These design treatments would be refined in the design process as the project proceeds. Figure 11 shows the existing N Williams Avenue/ NE Wheeler Avenue/ N Ramsay Way intersection and the lane configuration for the proposed I-5 southbound terminal.

Figure 11 Existing Intersection vs Proposed I-5 Southbound Exit Ramp Terminal



Other ramps within the Project Area would have similar improvements to those included in the Build Alternative, including wider shoulders and additional lane storage as compared to the No-Build Alternative. For example, the I-5 northbound off-ramp to N Broadway would have wider shoulders and additional storage with the addition of a second right turn lane and longer though lanes approaching the intersection. Also, to eliminate conflicts between the northbound dual right turns at this intersection, the project would provide channelized right turn lane with pedestrian island, signalize right turns and provide protected bike and pedestrian crossings across the dual right turn movements (with prohibition of right turns on red). Similarly, the I-5 southbound on and off-ramp to N Williams Avenue would have wider shoulders and additional storage to better accommodate queues during peak hours. The operational improvements at specific ramps are expected to improve traffic flow and minimize weaving maneuvers, improving the overall safety of these ramps.

6.3 LOCAL STREET MULTIMODAL RISK ASSESSMENT

Appendix A provides the detailed tabular summary of No-Build and Revised Build condition ratings for each of the intersections influenced by the Revised Build Alternative. In summary, it is estimated that as compared to the No-Build Alternative, the Revised Build Alternative is expected to improve safety conditions at the intersections of N Broadway/N Vancouver Avenue, and N Weidler Street/N Vancouver Avenue.

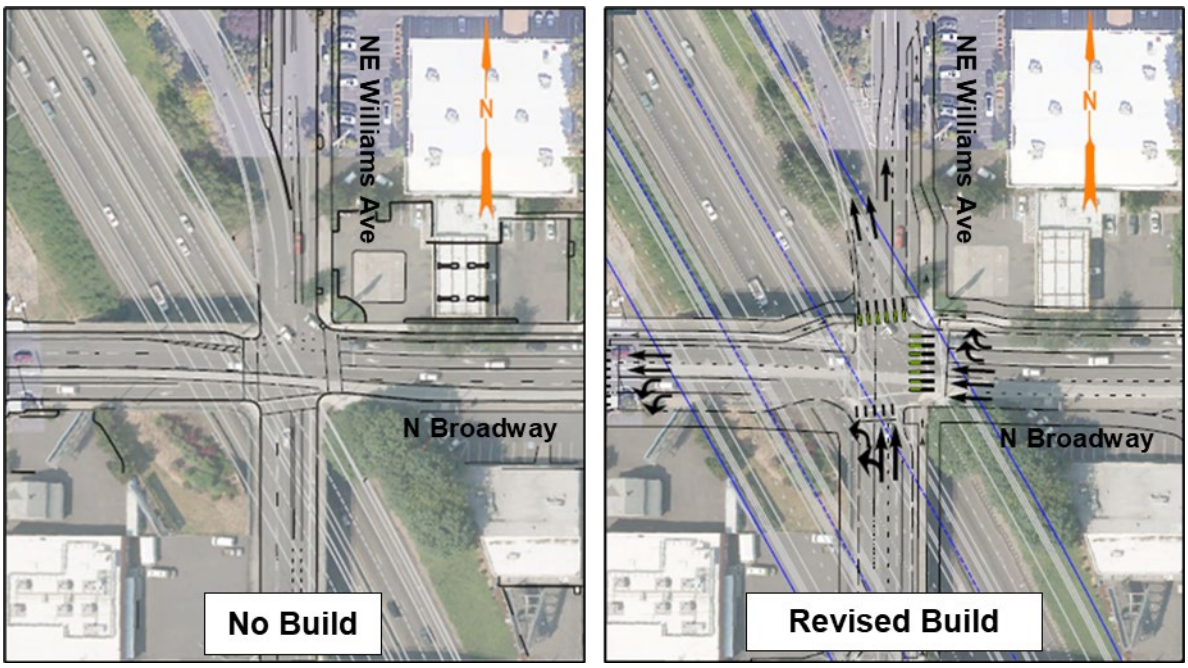
As compared to the No-Build Alternative, the Revised Build Alternative may change or degrade conditions at:

- **NE Weidler Street / N Williams Avenue –** The proposed changes would increase the traffic volume in the Revised Build Alternative compared to No-Build. Most of the increase would be in the northbound traffic. It is likely that the conflict between the dual northbound right-turns and pedestrian and bicyclists on the crosswalk would increase, hence increasing potential incidence of crashes. To mitigate this conflict, the project would design signalized northbound dual right turns with protected pedestrian and bicycle signal phases (with prohibition of right turns on red). In addition, the northbound sidewalk-level bike lane would improve the safety of bicyclists on the north and south leg of the intersection by providing additional separation to traffic. Details of bicycle storage at this intersection will be considered and addressed in the design phase of the project.
- **NE Wheeler Avenue / N Williams Avenue / N Ramsay Way –** As shown in Figure 11, the I-5 southbound off-ramp in the Revised Build Alternative would be part of a six-leg signalized intersection from a five-leg signalized intersection in the No-Build Alternative due to relocation of the I-5 southbound exit ramp from N Broadway to NE Williams Avenue. This will increase the traffic volume, thus increasing exposure to all modes of transportation traveling through this intersection. This intersection would be one of the most complex intersections within the Project Area. To mitigate these multiple conflicts, the intersection design considers dual right turns to be signalized as well as protected signal phases for bike and peds (with prohibition of right turns on red) and extending sidewalk corners to provide shorter crosswalks. Signing, striping, and lighting would be other important design elements that would be refined with the design to provide clear information to drivers and way finding to pedestrians and bicyclists.
- **N/NE Broadway / N Williams Avenue –** As shown in Figure 12 at this intersection, the Revised Build Alternative configuration would have three westbound through lanes from two in the No-Build Alternative which might increase the exposure between bicyclists, pedestrian, and the motor-vehicle traffic. In addition, to mitigate the conflicts between vehicular traffic and the bikes, the intersection design considers protected bike lanes on

east side of Williams Avenue with bike protected phases as well as maintaining the westbound protected bike phase (with prohibition of right turns on red).

With the increase in traffic volumes on N William Avenue, there is potential for queues extending to adjacent intersection and onto the ramp. Design refinements will continue to focus on providing adequate progression along N Williams Avenue to alleviate congestion and minimize crashes associated with standing queues.

Figure 12 Existing Intersection vs Proposed N Broadway at N Williams Avenue



As design continues, the following options are provided as a menu of possible treatments to improve pedestrian, bicycle and vehicular traffic safety, access and mobility:

- Verify signal timing provides sufficient crossing time
- Address potential bicycle/motor vehicle conflicts through proactive signing, striping, and signal phasing (e.g., leading pedestrian interval, or pedestrian or bicycle protected signal phasing). Bicycle storage requirements at signalized intersection will be carefully assessed and integrated into the design.
- Review and adjust, if necessary, adjacent on-street parking to improve stopping and intersection sight distance
- Verify intersection turning radii are consistent with desired interactions between motorists, pedestrians, and bicyclists.

These treatments would be considered for improving safety during all conditions including conditions during both Moda Center event ingress and egress conditions.

6.3.1 Indirect Impacts

Similar to the Build Alternative, no indirect safety impacts are anticipated under the Revised Build Alternative.

6.3.2 Cumulative Impacts.

The cumulative impact analysis considers the Project's impacts combined with other past, present, and reasonably foreseeable future actions that would result in the environmental impacts in the Project Area. The travel demand model for this project is based on the 2014 Metro Regional Transportation Plan (RTP) and changes from the 2014 and 2018 RTP have been evaluated and reviewed. There are no changes in the projects considered for the RFFA list and therefore there are no updates on the trip generation, travel demand, or modeling used in the evaluation the safety of the Project. Therefore, the cumulative impacts of the Revised Build Alternative would be the same as those reported in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

6.4 CONCLUSION

The proposed geometric changes (increased shoulder width and auxiliary lane additions) along the whole corridor would reduce crash rates and address existing crash issues identified in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project. The auxiliary lanes would provide traffic operation benefits including more uniform lane speeds and fewer lane changes that may reduce the potential for congestion related rear-end crashes. The emergency braking analysis forecasts that the number of emergency braking events under future Build traffic volumes would decrease as compared to No-Build conditions. In the opening year (i.e., No-Build traffic volumes), the rate of crashes on I-5 under the Revised Build Alternative would be lower than the No-Build conditions. As traffic volumes grow, the crash reduction benefits of the proposed geometric changes would decrease.

As compared to the No-Build Alternative, the new auxiliary lanes under the Revised Build Alternative would result in smoother traffic flows, and the operational improvements at the existing ramp terminal intersections would reduce the potential for ramp queueing extending onto the highway resulting in a reduced risk of congestion related crashes.

The Revised Build Alternative would relocate the I-5 southbound ramp terminal from N Broadway to NE Wheeler Avenue. In the Revised Build condition, this ramp would be approximately 2,000 feet long. This would provide ample storage for forecast queues and the additional storage space would reduce the potential for queue spillback onto the freeway. As

design proceeds, potential mitigations for the curve at the end of this ramp include positive guidance along the ramp, advance guide signs, enhanced delineation, pavement markings, and illumination. All of these elements would be included as part of the Revised Build Alternative and would be refined through the Preliminary Design phase of the project.

The qualitative safety analysis rates the local intersections for exposure (i.e., number of people), complexity (i.e., user experience and familiarity with physical characteristics, modal separation) and risk (i.e., posted speed limits). The Refined Build Alternative would increase/change potential crash risk at the intersections of N/NE Wheeler Avenue / N Williams Avenue / N Ramsay Way, N/NE Broadway / N Williams Avenue and N/NE Weidler Street / N Williams Avenue. As design continues, the following options are provided as a menu of possible treatments to improve pedestrian and bicycle access and mobility:

- Verify signal timing provides sufficient crossing time
- Address potential bicycle/motor vehicle conflicts through proactive signing, striping, and signal phasing (e.g., leading pedestrian interval, or pedestrian or bicycle protected signal phasing). Bicycle storage requirements at signalized intersection will be carefully assessed and integrated into the design.
- Review and adjust, if necessary, adjacent on-street parking to improve stopping and intersection sight distance
- Verify intersection turning radii are consistent with desired interactions between motorists, pedestrians, and bicyclists

7.0 AVOIDANCE, MINIMIZATION, AND MITIGATION MEASURES

This section is the same as described in the 2019 Transportation Safety Technical Report I-5 Rose Quarter Improvement Project.

8.0 PREPARERS

NAME	DISCIPLINE	EDUCATION	YEARS OF EXPERIENCE
Elizabeth Wemple	Transportation Safety	• Bachelor of Science, Civil Engineering • Master of Science, Transportation Engineering, • Master City Planning	30
Harshala Sardar	Transportation	• Bachelor of Technology, Civil Engineering • Master of Science, Transportation Engineering	5
Marcela Rodriguez	Transportation	• Bachelor of Science, Civil Engineering • Master of Science, Civil Engineering	17

9.0 REFERENCES

AASHTO (American Association of State Highway and Transportation Officials). 2010. Highway Safety Manual. First Edition. Washington D.C.

HDR. 2015. Broadway/Weidler Interchange Improvements: Traffic Operations Analysis Summary.

HDR Transportation Safety Technical Report, January 2019

NCHRP 17-45 Safety Prediction Methodology and Analysis Tool for Freeways and Interchanges, Texas Transportation Institute, May 2012,

Transportation Research "Safety aspects of freeway weaving sections" Transportation Research Part A 38 (2004) 35-51

Appendix A. Local Street Multimodal Risk Analysis

Table 1 shows the qualitative ratings (i.e., low, moderate, and high) for the No-Build and Revised Build Alternative at those study intersections where: 1) two of three criteria were rated as moderate or higher (including two of three modes in the exposure category), and 2) there is a possible change in criteria rating between the Revised Build Alternative compared to the No-Build. *Note, according to the City of Portland's Vision Zero Program, Broadway is a high crash street for all modes.*

Table 1 Study Intersections for Local Street Multimodal Risk Assessment

STUDY INTERSECTION	SCENARIO	EXPOSURE (MOTORIST, BICYCLE, PEDESTRIAN)	COMPLEXITY	RISK	IMPACT OF PROPOSED PROJECT
N Broadway / N Vancouver Avenue	No-Build	H, L, L	H	H	Due to ramp relocation in the Revised Build Alternative, the intersection is proposed to be 4-leg signalized intersection instead of skewed 5-leg intersection
	Revised Build Alternative	M, L, L	M	H	
N Weidler Street / N Vancouver Avenue	No-Build	H, H, M	H	H	Traffic volume decreases due to ramp relocation
	Revised Build Alternative	M, M, M	M	H	
N/NE Weidler Street / N Williams Avenue	No-Build	M, H, H	M	H	Traffic volume patterns would change with likely a heavier northbound right turn movement. Proper pedestrian facilities can address this.
	Revised Build Alternative	M, H, H	L	H	

N/NE Wheeler Avenue / N Williams Avenue / N Ramsay Way	No-Build	M, H, M	H	L	Increase in traffic volume due to relocation of the current N Broadway ramp making this a six-leg signalized intersection.
	Revised Build Alternative	H, M, M	H	L	
N/NE Broadway & N Williams Avenue	No-Build	H, H, H	M	M	Exposure between WB traffic and pedestrian/bikes increases due to increase in number of WB through lanes.
	Revised Build Alternative	H, H, M	H	M	

Notes: H = high; L = low; M = moderate

Exposure is the number of people traveling through the site, complexity reflects the user experience and familiarity with physical characteristics of the site, and severity (risk) is mix of posted speed limits on cross streets.

A green letter indicates an improvement from the previous alternatives; a red letter indicates a worsening of conditions from the previous alternatives.

In summary:

- **N Broadway / N Vancouver Avenue -** The relocation of the current N Broadway exit ramp would reduce the complexity for pedestrian and bicyclists at the N Broadway/ N Vancouver Avenue intersection. With no-skewed intersection and separate one-directional bike lanes, the transition of road users through this intersection would be more familiar and easier to navigate.
- **N Weidler Street / N Vancouver Avenue –** The proposed separate bus and bike lanes in the Revised Build Alternative would improve the safety conditions for bicyclists by eliminating the potential of right hook crashes compared to the current shared bus and bike lane.
- **N/NE Weidler Street / N Williams Avenue –** The proposed changes might increase the traffic volume in the Revised Build Alternative compared to No-Build. The majority of the increase would be in the northbound traffic. It is likely that the conflict between the northbound right-turn and pedestrian and bicyclists on the crosswalk would increase, hence affecting their safety. Providing separate pedestrian and bicycle signal phases would mitigate the potential conflict. In addition, the northbound protected bike lane would improve the safety of bicyclists on the north and south leg of the intersection.
- **N/NE Wheeler Avenue / N Williams Avenue / N Ramsay Way –** The current N Broadway exit ramp is proposed to be relocated to the N Williams Avenue/ N/NE Wheeler Avenue/ N Ramsay Way intersection in the Revised Build Alternative. This would make it a six-leg

signalized intersection with an increase in traffic volume increasing exposure to all modes of transportation traveling through this intersection.

- **N Broadway / N Williams Avenue –** At this intersection, the proposed configuration would have three westbound through lanes which might increase the exposure between bicyclists, pedestrian, and the motor-vehicle traffic. In addition, the proposed protected bike lanes on east side of N Williams Avenue would mitigate the existing conflict between northbound traffic and the bikes.