Appendix B. Predictive Safety Analysis for Modified Design of Build Alternative

Memo

Date:	Tuesday, October 06, 2020
Project:	Rose Quarter
To:	Megan Channell (ODOT) and Jeff Buckland (ODOT)
From:	Beth Wemple and Sam Klump (HDR)
Subject:	**Predictive Safety Analysis for Modified Design of Build Alternative**

1.0 Background and Objectives

Since issuance of the Environmental Assessment (EA) in February 2019, the Project design has been modified to avoid impacts to the Eastbank Esplanade. Several comments on the EA, including comments from the City of Portland, were received expressing concern about potential impacts to the Eastbank Esplanade resulting from the proposed I-5 southbound (SB) mainline improvements south of Interstate 84 (I-84), including widening of the existing viaduct to accommodate the Interstate 5 (I-5) SB auxiliary lane and shoulders near the Project's southern boundary. Following receipt of and in response to these comments, this portion of the Project design was reconsidered and modified.

The Project design has been modified to no longer widen the viaduct immediately east of the Eastbank Esplanade between the I-84 off-ramp to the Morrison Bridge/SE Portland/Oregon Museum of Science and Industry off-ramp. Under the modified design, the I-5 SB auxiliary lane in this segment would be added by re-striping the I-5 mainline in both the northbound (NB) and SB directions. The I-5 center median would be shifted to the east, and the existing shoulders on I-5 in the approximately 1,200-foot segment between the two off-ramps would be narrowed to approximately 3 to 9 feet in both the NB and SB directions. No structures would be added south of the I-84 off-ramp in the Project Area. All work on the I-5 SB mainline and the I-84 off-ramp that would have widened the structures and encroached on the air space over the Eastbank Esplanade to the west has been eliminated.

Table 1 highlights the changes in the design elements for the length of the Project.

Table 1. Roadway Design Element Changes by Milepoint

Milepoint Range	Description	No Build	Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	Scenario 2: Build Alternative (2019 EA)
MP 303 to 301.9	Unchanged from 2019 EA	-	-	-
MP 301.9 to 301.8	Horizontal alignment transition and modified shoulder width	No Transition	Shift SB alignment approximately 14’ Shift NB alignment approximately 2’ 11’ to 12' travel lanes 3’ to 12' shoulders	No horizontal transitions 12’ travel lanes 6’ to 12’ shoulders
MP 301.8 to 301.7	Revised cross section	12’ travel lanes 4’ to 9’ shoulders	11’ to 12' travel lanes 3’ to 9' shoulders	12’ travel lanes 6’ to 12’ shoulders
MP 301.7 to 301.6	Transition to matching existing roadway	12’ travel lanes 4’ to 9’ shoulders	Shift SB alignment approximately 14’ Shift NB alignment approximately 2’ 11’ to 12’ travel lanes 3’ to 9’ shoulders	Shift SB alignment approximately 6’ 12’ travel lanes 4’ to 9’ shoulders

This memo describes the revised EA safety analysis to evaluate the effects of the proposed modifications.

2.0 Scope and Methodology

The Highway Safety Manual (HSM) Predictive Method for Freeways[1] was used to predict the annual crash frequency and crash rates for the No Build and Build Scenarios with the Enhanced Interchange Safety Analysis Tool (ISATe). Oregon Department of Transportation (ODOT) does not have calibration factors for the freeway HSM predictive method. As such, the following are not calibrated results and should be considered on a relative basis. The Area of Potential Impact (API) for this analysis is the same as the API for the 2019 EA.

Crashes were predicted as an annual frequency for the year 2045. Crashes were predicted for the 0.30-mile study segment on I-5 from the SB I-84 exit ramp (MP 301.90) to south of the SB Morrison Street exit ramp (MP 301.60) and for the entire I-5 Project corridor. Predicted crashes include crashes on both the freeway segments and freeway ramps. The analysis scenarios, which all have identical annual average daily traffic (AADT), are as follows:

- No Build
  - Four lanes, 12’ lanes, 7’ average inside shoulder, 8’ average outside shoulder (existing cross-section)
- Scenario 1: Build Alternative with Modified Design (2020 Revised EA)
  - Five lanes, 11’ inside lanes, 12’ outside lanes, 3-5’ average inside shoulder, 6.5’ average outside shoulder
- Scenario 2: Build Alternative (2019 EA)
  - Five lanes, 12’ lanes, 9.5’ average inside shoulder, 10.5’ outside shoulder

[1] *Highway Safety Manual, Predictive Method for Freeways.* American Association of State Highway and Transportation Officials. 2014.

3.0 Results

3.1 Predicted Crashes for Study Segment

This section shows the results of the predictive analysis for the study segment on I-5 from the SB I-84 exit ramp to south of the SB Morrison exit ramp.

Predicted total crashes and predicted crashes by severity for the 2045 design year are shown in Table 2. The analysis predicts 10 total crashes for the No Build scenario, approximately 10 crashes for Scenario 1, and approximately 9 crashes for Scenario 2. Table 2 also shows the relative change in predicted crashes compared to the No Build scenario. Compared to No Build, predicted crashes are approximately the same for Scenario 1 and one crash/year fewer for Scenario 2 (12 percent fewer).

The decreased lane and shoulder widths under Scenario 1 increase predicted crash frequency due to less recoverable area for vehicles, but the additional auxiliary lane decreases predicted crash frequency due to congestion relief, resulting in approximately no net change in predicted crash frequency relative to the No Build Scenario. Scenario 2 has wider lanes and shoulder widths than Scenario 1, as well as the additional auxiliary lane, resulting in a prediction of one fewer crash per year in the future design year.

While the total crash frequency is approximately the same for No Build and Scenario 1, there are slight changes in crash severity. Low severity crashes (i.e., “B” [non-incapacitating injury] and “C” [possible injury]) increase slightly, and property damage only crashes (i.e., “O” crashes) decrease slightly.

Table 2. Predicted 2045 Crashes by Severity and Relative Change, Study Segment

Scenario	Total	K	A	B	C	O
No Build	10.0	0.0	0.1	0.6	2.3	7.0
Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	9.9	0.0	0.1	0.7	2.4	6.8
Percent Change Compared to No Build	-0.1 (0% change)	0.0	0.0	+0.1	+0.1	-0.2
Scenario 2: Build Alternative (2019 EA)	8.8	0.0	0.1	0.6	2.0	6.2
Percent Change Compared to No Build	-1.2 (-12% change)	0.0	0.0	0.0	-0.3	-0.8

Table 3 shows the predicted crash rates by severity. Predicted crash rates for the No Build and Scenario 1 are approximately equal crash rates by severity, while Scenario 2 has a lower total crash rate by 0.12 crashes/million vehicle miles traveled (VMT). As the AADT is the same for all scenarios, the difference in crash rates is due to cross-sectional differences.

The crash rate for B severities is slightly higher, while the crash rate for O severities is slightly lower, for Scenario 1 compared to No Build.

Table 3. Predicted 2045 Crash Rates per Million VMT, Study Segment

Scenario	Total Crash Rate (crashes/million VMT)	K	A	B	C	O
No Build	0.99	0.00	0.01	0.06	0.23	0.69
Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	0.99	0.00	0.01	0.07	0.23	0.67
Scenario 2: Build Alternative (2019 EA)	0.87	0.00	0.01	0.05	0.19	0.61

Table 4 shows the predicted annual crash costs by scenario. Compared to the No Build scenario, the crash cost in the design year for Scenario 1 is approximately $30k higher, while the crash cost for Scenario 2 is approximately $50k lower. Due to the slightly higher crash severities for Scenario 1 compared to No Build, the crash cost is higher as well. Crash costs by severity were used from the ODOT "Benefit Cost Analysis Form" for countermeasure evaluation.[2] The costs shown are in 2020 dollars.

Table 4. Design Year Predicted Crash Costs, Study Segment

Scenario	Total Crash Cost (2045)	Difference From No Build (2045)
No Build	$477,417	N/A
Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	$505,075	+$27,658
Scenario 2: Build Alternative (2019 EA)	$426,680	-$50,737

3.2 Predicted Crashes for Draft EA API

The corridor-wide crash prediction originally conducted for the 2019 EA was updated for the Revised EA Build condition. This section shows the results of the predictive analysis for the entire I-5 EA API.

For the API, total crash frequencies for all severities are lower for Scenario 1 and Scenario 2 compared to No Build (Table 5). Total crashes are 11 percent and 12 percent lower for Scenario 1 and Scenario 2 compared to No Build, respectively. Since the only difference between Scenario 1 and Scenario 2 is the study segment cross-section (Section 3.1), the difference in API predicted crashes is the same as the difference in the study segment predicted crashes for these scenarios.

[2] *All Roads Transportation Safety. Benefit Cost Analysis Form.* Oregon Department of Transportation. Accessed 2020. https://www.oregon.gov/ODOT/Engineering/Pages/ARTS.aspx

Table 5. Predicted 2045 Crashes by Severity and Relative Change, Draft EA API

Scenario	Total	K	A	B	C	O
No Build	113.2	0.4	1.2	7.6	25.7	78.4
Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	100.4	0.4	1.2	7.4	22.9	68.5
Percent Change Compared to No Build	-12.8 (-11% change)	0.0	0.0	-0.2	-2.7	-9.9
Scenario 2: Build Alternative (2019 EA)	99.2	0.4	1.2	7.3	22.5	67.9
Percent Change Compared to No Build	-14.0 (-12% change)	0.0	0.0	-0.3	-3.1	-10.5

Since AADT is the same for all scenarios and crash frequencies for Scenario 1 and Scenario 2 are lower or equal for all severities compared to No Build, crash rates are lower or equal as well for these scenarios, for all severities (Table 6).

Table 6. Predicted Crash Rates per Million VMT, Entire Corridor

Scenario	Total Crash Rate (crashes/million VMT)	K	A	B	C	O
No Build	1.56	0.01	0.02	0.10	0.35	1.08
Scenario 1: Build Alternative with Modified Design (2020 Revised EA)	1.38	0.01	0.02	0.10	0.32	0.94
Scenario 2: Build Alternative (2019 EA)	1.37	0.01	0.02	0.10	0.31	0.93

Crash costs for the API are shown in Table 7. Crash costs are lower for Scenario 1 and Scenario 2 compared to No Build, by approximately $430k and $510k, respectively.

Table 7. Design Year Predicted Crash Costs, Entire Corridor

Scenario	Total Crash Cost (2045)	Difference From No Build (2045)
No Build	$5,861,991	N/A
Scenario 1: Revised EA Build	$5,429,584	-$432,407
Scenario 2: Draft EA Build	$5,351,190	-$510,802

4.0 Conclusions

Along the study segment, this analysis shows the Scenario 1: Build Alternative with Modified Design (2020 Revised EA) condition is predicted to have approximately the same crash frequency and total crash rate as No Build. While the decreased lane and shoulder widths slightly increase predicted crash frequency, this is counterbalanced by the slight decrease in predicted crash frequency associated with the auxiliary lane. Since crash severities are slightly higher under Scenario 1, the annual crash cost is approximately $30k higher than No Build. The predicted crash frequency and crash rate are lower for Scenario 2: Build Alternative (2019 EA) condition compared to No Build and Scenario 1, due to the wider lanes and shoulders and the additional auxiliary lane.

For the Draft EA API, both Scenario 1 and Scenario 2 have predicted total crash rates that are lower than or equal to No Build. The predicted lower crash rate is a result of overall wider shoulders throughout the corridor.

The findings of this analysis are consistent with the conclusions of the 2019 EA for the Build Alternative ("Scenario 2: Build Alternative (2019 EA)" in this analysis) in terms of safety, which stated, "it is estimated that the crash rate under the Build Alternative would be lower than under the No-Build Alternative, providing an overall safety benefit in the corridor" (Section 3.14.2.3, I-5 Rose Quarter Improvement Project Environmental Assessment, February 15, 2019). As such, no errata are required for safety in the Revised EA.

Design exceptions for Scenario 1: Build Alternative with Modified Design (2020 Revised EA) will be required by ODOT and FHWA in the future Project design phase.