Final Technical Memorandum #7

U.S. 20 Bend Facility Plan

Bend, Oregon

January 22, 2025

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Acronyms and Abbreviations

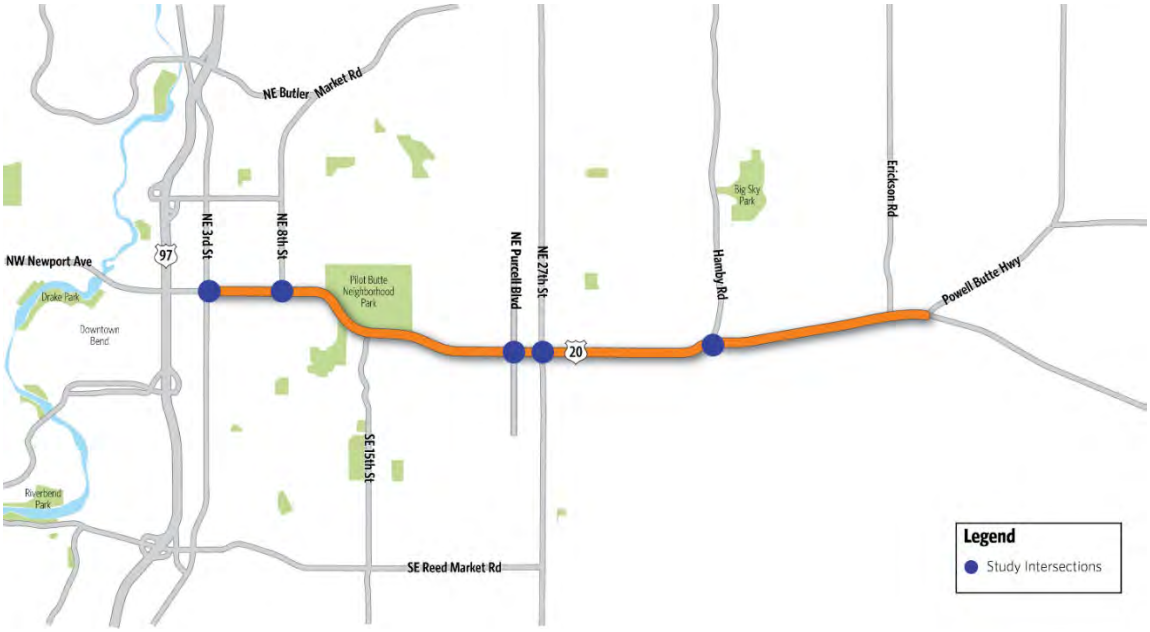
BLOS	Bicycle Level of Service
BLTS	Bicycle Level of Traffic Stress
City	City of Bend
CRF	Crash Reduction Factor
HDM	Highway Design Manual
HCM	Highway Capacity Manual
LOS	level of service
LBI	Leading Bicycle Intervals
LPI	Leading Pedestrian Intervals
LTS	Level of Traffic Stress
MUT	Median U-Turns
ODOT	Oregon Department of Transportation
OHP	Oregon Highway Plan
Plan	U.S. 20 Bend Facility Plan
PLOS	Pedestrian Level of Service
PLTS	Pedestrian Level of Traffic Stress
ROW	right-of-way
TWLTL	two-way left turn lane
v/c	volume-to-capacity

1 Second Level Screening Proposed Alternatives - Introduction

U.S. 20 is an Oregon Department of Transportation (ODOT) facility, while the majority of the side streets that intersect the highway are City of Bend (City) facilities. The highway is located in central Oregon and serves the residents of Bend, freight traffic, and other travelers. As the region has grown, so have congestion and safety concerns. The U.S. 20 Bend Facility Plan (Plan) will identify strategies to improve safety for all users, with an emphasis on improvements for people who walk, bike, and use public transit. The Plan begins at the intersection of 3rd Street and Greenwood Avenue and ends at the intersection of Powell Butte Highway.

This memorandum presents the proposed alternatives at each intersection identified in Figure 1, as well as the traffic and safety analysis for each alternative. Additionally, the Level of Traffic Stress (LTS) analysis for each corridor segment is completed in Section 6.3.

Figure 1. Location of Proposed Intersection Improvements



2 Intersection Operations Analysis Methodology and Assumptions

The intersection operations were analyzed using Synchro/SimTraffic and Sidra software[1] and the Highway Capacity Manual 6th Edition (HCM 6) methodology to assess the level of congestion experienced. The HCM reports are included in Appendix A. Performance measures used for this analysis include volume-to capacity (v/c) ratios and seconds of delay. The performance of each intersection was compared against the adopted mobility targets from Oregon Highway Plan (OHP) and ODOT Highway Design Manual (HDM). The OHP identifies highway mobility targets to ensure acceptable and reliable mobility levels on the state highway system, with the consideration of facility type, location, and functional objectives.[2] The ODOT HDM provides design v/c ratio standards for project development or design which are different from mobility targets from the OHP. The targets in the OHP are used to assist in the planning phase by identifying future system deficiencies, where the values in the HDM aim to provide a mobility solution that corrects those previously identified deficiencies and provides the best investment for the State in establishing a 20-year design life solution.[3]

Vehicle queue lengths on study intersection approaches were simulated using SimTraffic. Notable 95th percentile queues that are near (within 50 feet) or beyond the storage capacity of in place lanes were summarized. Detailed queueing results for the study intersections within the study area are included in the SimTraffic reports in Appendix B. Several bottlenecks along the corridor resulted in queue spillback between intersections under both conditions with no mitigation (no-build) and those with mitigation (build). Improvements in the multimodal transportation network along the study corridor and other City facilities in the area have the potential to encourage people to choose a differing mode of travel and reduce vehicle demand.

Most signalized study intersections were assumed to include leading pedestrian intervals (LPIs) or leading bicycle intervals (LBIs). According to ODOT Traffic Signal Policy and Guidelines[4], LPIs or LBIs provide advanced service to people walking and biking by typically providing them with a head start of three to seven seconds, allowing them to position themselves in the middle of the travel lane before releasing the complementary vehicle phase. While LPIs and LBIs can be activated when detecting the presence of people walking or biking or included as part of regular signal operation, for this analysis, it was assumed LPIs and LBIs were always included.

[1] Synchro/SimTraffic software was used for signalized and stop-controlled study intersections while Sidra was used for roundabouts.

[2] 1999 Oregon Highway Plan, as amended May 2015, Policy 1F: Highway Mobility Policy, Oregon Department of Transportation.

[3] ODOT Highway Design Manual Part 1200, January 2023, Oregon Department of Transportation.

[4] ODOT Traffic Signal Policy and Guidelines, January 2023, Oregon Department of Transportation.

In this operational analysis, an extra five seconds was given to people walking and biking to enter the crosswalk before vehicles are given a green signal indication. LPIs or LBIs were assumed to apply on all approaches at 3rd Street, 8th Street, and Purcell Boulevard, and on the north leg and east leg at 27th Street. However, Synchro software does not accommodate LPIs or LBIs for HCM 6 results. Therefore, a post-processing adjustment was applied to increase lost time when calculating the intersection v/c ratio to approximate the impact of the time when no vehicles are entering the intersection due to an LPI/LBI. Intersection v/c ratio results are reported both with and without the adjustment. In addition, a higher number of people walking (20 total per direction in the peak hour) was assumed on each intersection leg to reflect growth in active transportation users in the future.

Cycle lengths remained unchanged from existing conditions identified at the time of this analysis at all intersections except at Purcell Boulevard and 27th Street, which were assumed to be coordinated with one another with a higher (150 second) cycle length to enhance the corridor operations and better control queueing.

3 Intersection Improvements

Based on the traffic analysis, the following five intersections located in the study area are not expected to meet mobility targets for the design year 2042.

- U.S. 20 / NE 3rd Street
- NE 8th Street
- NE Purcell Boulevard
- NE 27th Street
- Hamby Road

Technical Memorandum #6 (Appendix C) describes the alternatives that were considered and dismissed for each of these intersections as part of the alternatives evaluation process. Potential alternatives identified in technical memorandum #6 are described below and include the traffic and queue analysis for each alternative. If implemented, these alternatives would need to be evaluated further per guidance documents and not all treatments might be compatible with others.

3.1 U.S. 20 at NE 3rd Street

NE 3rd Street is a major north-south arterial parallel to U.S. 97 and its intersection with U.S. 20 is constrained with buildings on all four corners. From the east, U.S. 20 turns and continues north along NE 3rd Street at this intersection before crossing under U.S. 97. NE 3rd Street serves businesses and shopping areas both to the north and south of the U.S. 20/Greenwood Avenue intersection. Any widening or other major geometric changes would have a significant impact on private properties and businesses. Additionally, the City is currently evaluating options for a cross-section re-allocation on Greenwood Avenue which could convert the shared westbound through/right lane to a right turn only lane that is dropped at this intersection and enhance walking and biking routes.

Proposed Alternative

The proposed alternative at 3rd Street is to only provide pedestrian, bicycle and transit improvements as described in Section 6 below that fit within the existing constrained widths. Improvements would be compatible with the proposed cross-section re-allocation that would convert the westbound right most lane to a right turn only lane[5] and enhance walking and biking facilities. A concept drawing of the alternative at 3rd Street is shown in Figure 2.

[5] Midtown Pedestrian and Bicycle Crossings | City of Bend (bendoregon.gov)

Figure 2. Proposed Alternative at NE 3rd Street and U.S. 20/Greenwood Avenue

Pedestrian, Bicycle and Transit Improvements

The proposed active transportation enhancements at this intersection include:

- LPIs on all legs (subject to further analysis relative to ODOT's Signal Policy and Guidelines).
- Green conflict marking in bike lanes at all approaches.
- Add illumination so each approach has lighting.
- Warning signage (Turning Vehicles Yield to Bikes/Peds) on all approaches (per Bend Safety Implementation Plan and ODOT Sign Policy and Guidelines).
- "Right-turn-on-red prohibition" (per 2012 Multimodal Traffic Safety Assessment).
- Transit signal priority (to be implemented upon completion of central signal upgrade).
    - These improvements would tie into a joint ODOT/City project to modify the Greenwood Avenue cross-section immediately west of this intersection, which will add 6-foot bike lanes leading to Bend's downtown core.
    - As this project progresses toward implementation refinements to address bicycle/motor vehicle conflicts on the intersection's northeast corner will be necessary. Potential refinements include a westbound bicycle-only signal phase (concurrent with westbound motor vehicle through movements),

and/or other design/operational measures to address “right-hook” collision potential.

Alternative Safety Analysis

LPIs or LBIs improve walking and biking safety by reducing conflicts with right-turning vehicles and have the potential to reduce walking and biking related crashes by up to 37 percent.[6] The proposed intersection improvement also allows the implementation of a lane reallocation on the west leg of the intersection, which will enhance safety for people biking by providing exclusive bicycle lanes. This will also allow the installation of a two-way left turn lane (TWLTL) along Greenwood Avenue, which may reduce crashes by 29 percent.[7]

Alternative Traffic Analysis

Table 1 and Table 2 present the intersection operation and vehicle queueing results at the intersection. As shown in Table 1, under existing and future no-build conditions, this intersection is not able to meet the adopted mobility target. Under future no-build and future build conditions the intersection is expected to exceed capacity, with a v/c ratio exceeding 1.0. The future build scenario included a westbound right-turn overlap phase and right-turn-on-red restriction. The implementation of a lane reallocation on the west leg of the intersection is expected to increase the overall intersection v/c ratio, although overall intersection delay is relatively unchanged with only a 12 second increase in average delay.

Queueing also increases, particularly in the westbound direction. The vehicle queueing results in Table 2 show the severity of the congestion during the future design hour. Notably, significant queues occur on all approaches and spill back to adjacent intersections, especially the westbound through movement. This area is distinguished by its closer proximity of cross-streets compared to other areas, which could potentially increase existing cut-through traffic. Issues regarding cut-through traffic have been a concern in the past and have led to the implementation of traffic calming measures on side streets. Also, further refinements may be required at the intersection, depending on the evaluation the City is currently conducting.

Table 1. Intersection Operations at U.S. 20 and NE 3rd Street

	Mobility Target [A] (v/c)		v/c	LOS	Delay (Sec)
	OHP	HDM			
Existing (2022)	0.85	0.75	**0.89**	E	68
Future (2042) No-Build	0.85	0.75	**1.06**	F	106
Future (2042) Build	0.85	0.75	**1.18 / 1.25** [B]	F	118

Bold and Red indicate failure to meet mobility target (under Design Hour operations).

[A] For signalized intersection, mobility target and results reported as overall intersection; OHP: Adopted mobility target from the Oregon Highway Plan; HDM: Design mobility standard from the Highway Design Manual.

[B] Convert two westbound-through lanes to one without/with LPI adjustment.

[6] ODOT Crash Reduction Factor List, 2023, ID: BP3.

[7] ODOT Crash Reduction Factor List, 2023, ID: H53.

[C] Intersection v/c reported as without / with LPI adjustment.

Table 2. Vehicle Queueing at U.S. 20 and NE 3rd Street

Movement [A]	95th Percentile Queue (ft) [B]			Approximate Available Storage (ft) [C]
	Existing (2022)	Future (2042) No-Build	Future (2042) Build	
EBL	**200**	**200**	**175**	150
EBTR	**1100**	**>2000**	**>2000**	300 (2nd Street)
WBL	**375**	**400**	**400**	175 (TWLTL)
WBTR/WBT	**750** [D]	**750** [D]	**>1500** [D]	400 (4th Street)
NBL	**400**	**400**	**375**	125 (TWLTL)
NBTR	**>1450**	**>1450**	**>1450**	1450 (Franklin Avenue)
SBL	**350**	**350**	**325**	175 (TWLTL)
SBTR	550	**>1800**	**>1800**	1800 (Olney Avenue)

Bold and Red queue exceeds approximate available storage, TWLTL=Two Way Left Turn Lane.

[A] EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, L = Left, T = Through, R = Right

[B] Notable queue within 50 feet or intersection failed in operational analysis.

[C] Available storage reported as approximate turn bay length or approximate distance to the nearest major intersection.

[D] Included WBTR queue at 4th Street.

Design Constraints and Considerations

This intersection is an interstate freight route, and truck turning movements to and from U.S. 20 to NE 3rd Street must be maintained. Any proposed improvements will need to align with the planned lane reallocation on the east leg of the intersection. The intersection forms a transition along Greenwood from U.S. 20 to a local City of Bend street as it moves west into the downtown area of Bend. Designs are challenged to provide adequate multimodal separation and risk reduction for vulnerable users while also maintaining truck and freight movements.

Sidewalks could be widened to provide bike ramps and a shared use path so people riding can use the path and crosswalks to make turns instead of weaving across the travel lanes. Treatments such as green paint will require appropriate approvals. Additionally, inspection of signals and other electrical equipment in the area is recommended before any upgrades are completed.

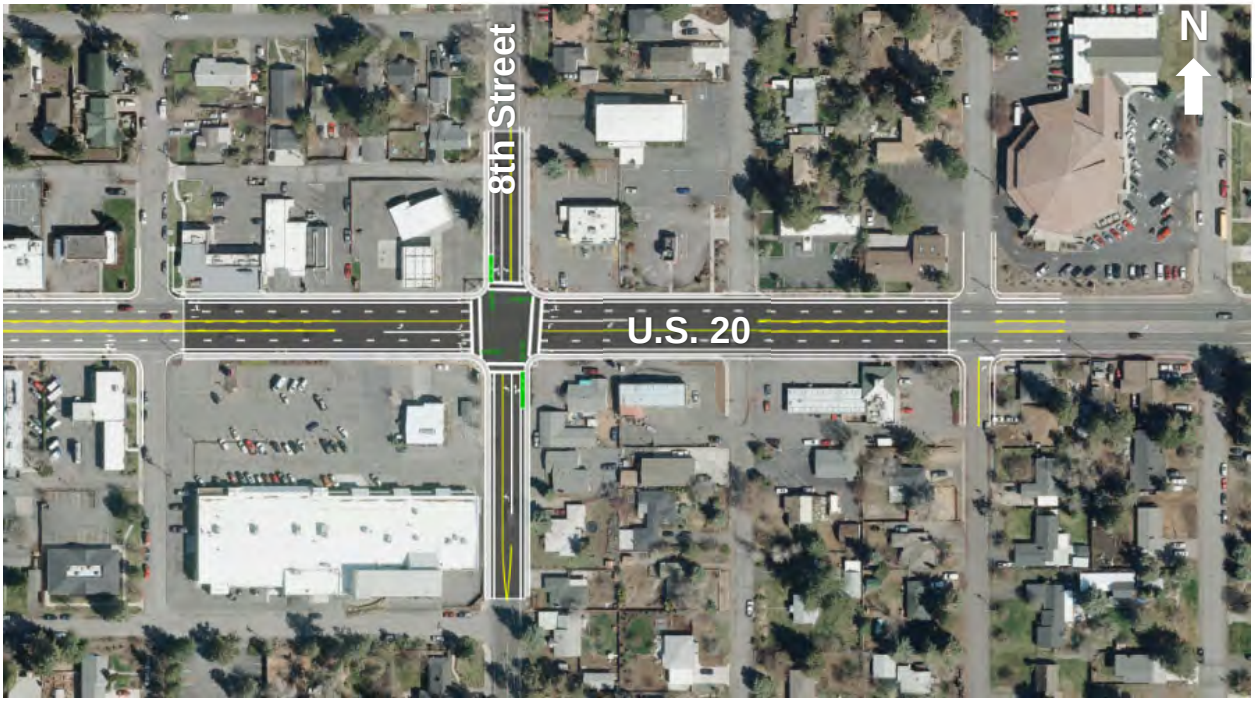
3.2 U.S. 20 at NE 8th Street

NE 8th Street is the next signalized intersection on U.S. 20 to the east of NE 3rd Street and serves as a major access point to residential neighborhoods that are on the north and south of U.S. 20 in this area.

Proposed Alternative

The proposed alternative at NE 8th Street shown in Figure 3 is to maintain the existing number of lanes and access from 8th Street while focusing on reducing risk and conflicts for people walking, bicycling, and accessing transit as identified below. Alternatives that involved restricting access or adding lanes and capacity were rejected due to right-of-way (ROW) impacts and potential impacts to residential streets.

Figure 3. Proposed Alternative at NE 8th Street and U.S. 20



Pedestrian, Bicycle and Transit Improvements

The proposed active transportation enhancements at this intersection include:

- LPIs on all legs (subject to further analysis relative to ODOT's Signal Policy and Guidelines).
- Warning signage (Turning Vehicles Yield to Bikes/Peds) on all approaches.
- Northbound and southbound approaches: green bike lanes (solid fill) immediately upstream from intersection.
- All approaches: green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT State Traffic-Roadway Engineer approval).
- Transit signal priority (to be implemented upon completion of central signal upgrade

Alternative Safety Analysis

As mentioned under the U.S. 20/3rd Street discussion above, implementation of LPIs or LBIs improves safety for people walking and biking that arrive on the red and are waiting to cross.

Alternative Traffic Analysis

Table 3 and Table 4 present the intersection operations and vehicle queueing results at the intersection. As shown in the tables, the intersection was not able to meet the adopted mobility target and had significant congestion and queues under existing and future no-build conditions. The operations with the LPIs or LBIs implementation further worsened the results, with a greater v/c ratio and significant queues. The future no-build eastbound-through queue length appears lower than existing conditions which is likely due to a combination of the effects of future intersection signal optimization and nearby bottlenecks influencing traffic flow patterns and congestion dynamics.

Table 3. Intersection Operations at U.S. 20 and NE 8th Street

	Mobility Target [A] (v/c)		v/c	LOS	Delay (Sec)
	OHP	HDM			
Existing (2022)	0.85	0.75	**0.98**	E	57
Future (2042) No-Build/Build	0.85	0.75	**1.17 / 1.24** [B]	E	73

Bold and Red indicate failure to meet mobility target (under Design Hour operations);

[A] For signalized intersection, mobility target and results reported as overall intersection; OHP: Adopted mobility target from the Oregon Highway Plan; HDM: Design mobility standard from the Highway Design Manual.

[B] Intersection v/c reported as without / with LPI adjustment.

Table 4. Vehicle Queueing at U.S. 20 and NE 8th Street

Movement [A]	95th Percentile Queue (ft) [B]			Approximate Available Storage (ft) [C]
	Existing (2022)	Future (2042) No-Build	Future (2042) Build [D]	
EBL	**350**	**350**	**400**	125 (TWLTL)
EBTR	**>850**	625	**>850**	850 (6th Street)
WBL	**350**	**350**	**400**	125 (TWLTL)
WBTR	**700**	**>800**	**>800**	800 (11th Street)
NBL	**300**	**300**	**300**	175
NBTR	**>1350**	**>1350**	**>1350**	1350 (Franklin Avenue)
SBL	**375**	**375**	**400**	150 (TWLTL)
SBTR	**>1950**	**>1950**	**>1950**	1950 (Olney Avenue)

Bold and Red queue exceeds approximate available storage, TWLTL=Two Way Left Turn Lane.

[A] EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, L = Left, T = Through, R = Right

[B] Notable queue within 50 feet or intersection failed in operational analysis.

[C] Available storage reported as approximate turn bay length or approximate distance to the next major intersection.

[D] Build conditions include LPIs while No-Build conditions do not include LPIs.

Design Constraints and Considerations

NE 8th Street is very constrained and has limited opportunities for capacity or multimodal improvements without impacts to surrounding businesses or residential streets. As redevelopment occurs along this section of U.S. 20 and at NE 8th Street, improvements can be made to the biking and sidewalk infrastructure to provide a more comfortable experience for multimodal users. Sidewalks could be widened to provide bike ramps and a shared use path so people riding can use the path and crosswalks to make turns instead of weaving across the travel lanes. Additional space could also be utilized for a wider bike lane buffer.

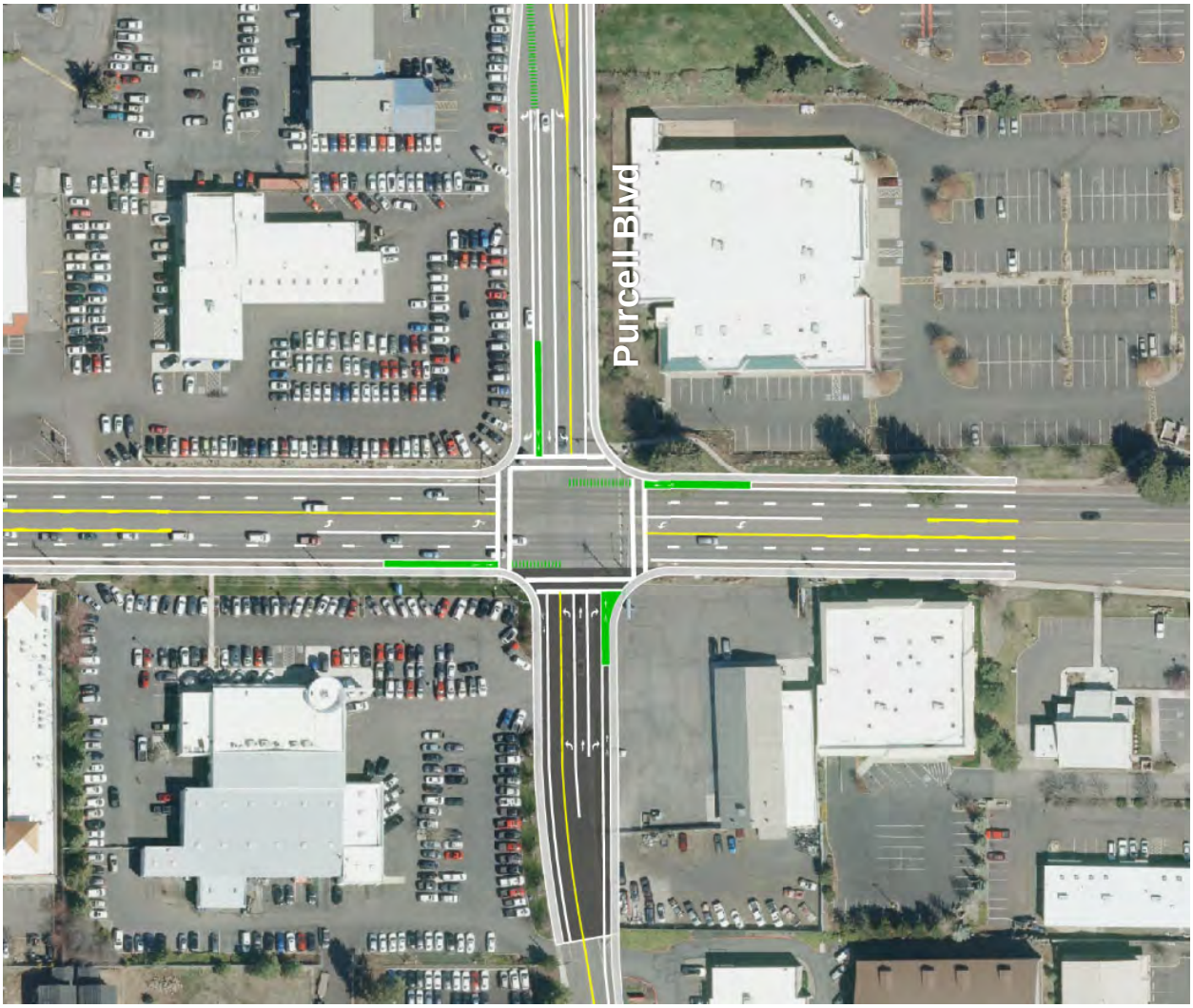
3.3 U.S. 20 at NE Purcell Boulevard

NE Purcell Boulevard is a major signalized intersection just west of NE 27th Street. Several car dealerships and a shopping mall are located at this intersection. North and south of U.S. 20, NE Purcell Boulevard winds through residential neighborhoods.

Proposed Alternative

The proposed alternative at NE Purcell Boulevard is to widen and to provide a dedicated northbound right turn lane as shown in Figure 4. While this will not meet the mobility target, it does improve the operations by decreasing the v/c from 1.05 to 0.93 (as shown in Table 5) with minimal ROW impacts. Minor widening and curb line adjustment is needed for the south leg of the intersection. Bicycles would remain to the right side of the right turn lane and utilize a bike signal. A concrete island would be constructed on the north side of the adjacent intersection with Dean Swift Road to provide Right-in-Right-out channelization. The alternative maintains the current bike lane position for the southbound approach, but the bike lane could be moved to the outside of the right turn lane in conjunction with a bike signal to mirror the northbound approach if desired.

Figure 4. Proposed Minor Widening at NE Purcell Boulevard



Pedestrian, Bicycle and Transit Improvements

The proposed active transportation enhancements at this intersection include:

- LPIs on all legs (subject to further analysis relative to ODOT's Signal Policy and Guidelines).
- Dual curb ramps on the intersection's northwest corner.
- Warning signage (Turning Vehicles Yield to Bikes/Peds) on all approaches.
- Northbound and southbound approaches: green bike lane conflict markings immediately upstream from right turn lanes and at intersections.
- Keeping the bike lane to the outside of the right turn lane and utilizing a bike signal on the northbound approach.

- Eastbound and westbound approaches: green bike lanes (solid fill) immediately upstream from intersection, and green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT approval).
- Upgrades to existing southbound transit stop (upstream from intersection (per Cascades East Transit).
- Transit signal priority (to be implemented upon completion of central signal upgrade).

Alternative Safety Analysis

The widening of northbound NE Purcell Boulevard lengthens the crossing distance and increases the exposure for people walking and biking. However, the implementation of LPIs or LBIs helps improve safety, as discussed under the U.S. 20/3rd Street section. Adding a right-turn lane also has the potential to reduce all crash types by up to four percent.[8]

Alternative Traffic Analysis

Adding an exclusive northbound right-turn lane along with increasing the cycle length is expected to improve the intersection operations. However, the future intersection timing also included the LPIs or LBIs which may contribute to vehicle delay and congestion.

Table 5 and Table 6 show the intersection operation and vehicle queueing results at the intersection. As shown in the tables, the overall intersection v/c ratio and average intersection delay improved with the preferred alternative compared to the future no-build. Under build conditions, the intersection is expected to operate below capacity, although it is still not able to meet the adopted mobility target, indicating congestion still occurs during the future design hour. Implementing coordinated signal timing would likely allocate more green time to eastbound and westbound traffic which results in shorter westbound queues, although southbound queues still extend greater than 500 feet as shown in Table 3. Similar to the NE 8th Street intersection, the future no-build westbound-through queue length appears lower than existing conditions, possibly due to effects of future intersection signal optimization and nearby bottlenecks restricting traffic flow.

Table 5. Intersection Operations at U.S. 20 and NE Purcell Boulevard

	Mobility Target [A] (v/c)		v/c	LOS	Delay (Sec)
	OHP	HDM			
Existing (2022)	0.85	0.75	0.82	D	45
Future (2042) No-Build	0.85	0.75	**1.05**	F	81
Future (2042) Build	0.85	0.75	**0.93 / 0.99** [B]	E	61

Bold and Red indicate failure to meet mobility target (under Design Hour operations);

[A] For signalized intersection, mobility target and results reported as overall intersection; OHP: Adopted mobility target from the Oregon Highway Plan; HDM: Design mobility standard from the HDM.

[B] Intersection v/c reported as without / with LPI adjustment.

[8] ODOT Crash Reduction Factor List, 2023, ID: H4.

Table 6. Vehicle Queueing at U.S. 20 and NE Purcell Boulevard

Movement [A]	95th Percentile Queue (ft) [B]			Approximate Available Storage (ft) [C]
	Existing (2022)	Future (2042) No-Build	Future (2042) Build	
EBL	**375**	**375**	**400**	150 (TWLTL)
EBTR	475	**>650**	**>650**	590 (Dean Swift Road)
WBL	**350**	**350**	**400**	100 (TWLTL)
WBTR	700 [D]	625 [D]	600 [D]	1200 (27th Street)
NBL	**225**	**>250**	**>250**	100
NBTR	450	>600	>600	600 (Twin Knolls Drive)
SBL	225	**375**	**375**	300
SBT	325	**>675**	**>675**	500 (Costco Driveway)

Bold and Red queue exceeds approximate available storage, TWLTL=Two Way Left Turn Lane.
[A] EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, L = Left, T = Through, R = Right
[B] Notable queue within 50 feet or intersection failed in operational analysis.
[C] Available storage reported as approximate turn bay length or approximate distance to the next major intersection.
[D] Includes WBT queue at Windy Knolls Drive.

Design Constraints and Considerations

With MAC support and new signal infrastructure, there is potential to incorporate protected intersection elements including corner islands. Additionally, the sidewalk could be widened along this segment during redevelopment to provide bike ramps and a shared use path so people riding can use the path and crosswalks to make turns instead of weaving across the travel lanes. Additional space could also be utilized for a wider bike lane buffer.

Alternative intersection types should be explored during redevelopment to improve intersection capacity without adding additional lanes or width to pedestrian crossings.

3.4 U.S. 20 at NE 27th Street

NE 27th Street is a major intersection at U.S. 20. and serves a large shopping area to the north, as well as a hospital at NE Neff Road. NE 27th Street also provides access to many residential homes and neighborhoods both to the north and south of U.S. 20. Currently the City of Bend is pursuing bike and pedestrian improvements along NE 27th Street to the north of U.S. 20 and any improvements at the U.S. 20 and NE 27th Street intersection should accommodate and tie into these improvements.

Proposed Alternative

Two different options are considered at this intersection: minor and major widening. The minor widening alternative adds an eastbound right turn lane with a raised crosswalk and right turn bypass island as shown in Figure 5. The major widening alternative includes the same eastbound right turn lane and dual left turn lanes on all approaches, shown in Figure 6. The traffic analysis results for both these alternatives can be found in Section 6. The minor widening option keeps crossing distances and exposure minimized for pedestrians and people bicycling and provides a slight improvement in vehicular performance over the no build option. The major widening alternative provides a significant increase in vehicular performance but this comes at the expense of an increased crossing distance for pedestrians. This could be offset by enhancing crossings along lower stress walking and biking routes at the narrower adjacent intersections such as Stonebriar to the east and Dean Swift to the west.

The minor widening option is deemed the preferred option since it requires the least amount of widening and ROW impacts and provides a shorter crossing route for pedestrians and cyclists while the major widening option still does not meet mobility targets with the increased pedestrian exposure distance. Additionally, major widening was not preferred because it could encourage higher speeds which is counter to the goals of this project.

Figure 5. Minor widening alternative at NE 27th Street

Figure 6. Major widening at NE 27th Street

Pedestrian, Bicycle and Transit Improvements

The degree to which the U.S. 20/NE 27th Street intersection would be partially or fully rebuilt would depend on the alternative (or combination of alternatives) ultimately advanced from the options described above. A fully rebuilt intersection for instance would provide opportunities to proactively incorporate other active transportation components such as the City of Bend's planned shared use path along NE 27th Street between U.S. 20 and Bear Creek Road. Depending on the final alternative to be advanced, proposed active transportation enhancements at this intersection include:

- LPIs on the east and north legs (subject to further analysis relative to ODOT's Signal Policy).
- Audible pedestrian signals.
- Dual curb ramps on the intersection's northeast and southeast corners.
- Warning signage (Turning Vehicles Yield to Bikes/Peds) on the northbound and westbound approaches.
- Northbound, southbound, and eastbound approaches: green bike lane conflict markings immediately upstream from right turn lanes.
- Westbound approach: green bike lane (solid fill) immediately upstream from intersection, and green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT approval).

- New eastbound transit stop immediately east of intersection (per Cascades East Transit).
- Transit signal priority (to be implemented upon completion of central signal upgrade, or in tandem with full intersection rebuild).
- Sidewalks could be widened to provide bike ramps and a shared use path so people riding can use the path and crosswalks to make turns instead of weaving across the travel lanes and dual left turn lanes. Additional space could also be utilized for a wider bike lane buffer.

Alternative Safety Analysis

As discussed under U.S. 20/Purcell Boulevard section, road widening lengthens the crossing distance and increases exposure for people walking and biking, especially the major widening in Alternative 2. The dual left-turn lanes on all approaches help increase the left-turning capacity and mitigate left-turning vehicles from blocking the through vehicles but significantly increase the crossing distance. As discussed under the U.S. 20/3rd Street section, LPIs or LBIs could improve safety for people walking and biking.

Alternative Traffic Analysis

This intersection has two build alternatives, which both include LPIs/LBIs on the north and east leg and an increased cycle length. Table 7 and Table 8 present the intersection operation and vehicle queueing results. In Alternative 1 (minor widening), adding an exclusive eastbound right-turn lane results in a lower v/c ratio and shorter queue lengths compared to the future no-build condition, but the intersection still exceeds capacity, with substantial queueing and delay. In Alternative 2 (major widening), with an additional exclusive northbound right-turn lane and dual left-turn lanes on all approaches, the v/c ratio and queue lengths significantly improve, especially for westbound and eastbound movements. While the intersection still does not meet the adopted mobility target, the intersection is able to operate below capacity with major widening.

Table 7. Intersection Operations at U.S. 20 and NE 27th Street

	Mobility Target [A] (v/c)		v/c	LOS	Delay (Sec)
	OHP	HDM			
Existing (2022)	0.85	0.75	0.83	D	52
Future (2042) No-Build	0.85	0.75	**1.24**	F	136
Future (2040) Build 1	0.85	0.75	**1.18 / 1.22** [B]	F	112
Future (2042) Build 2	0.85	0.75	**0.90 / 0.93** [B]	E	63

Bold and Red indicate failure to meet mobility target (under Design Hour operations).

[A] For signalized intersection, mobility target and results reported as overall intersection; OHP: Adopted mobility target from the Oregon Highway Plan; HDM: Design mobility standard from the Highway Design Manual.

[B] Intersection v/c reported as without / with LPI adjustment.

Additionally, Alternative 2 was able to serve approximately 10 percent more vehicles and significantly reduces queueing on the eastbound and westbound approaches during the

queueing simulation. Although queues on northbound and southbound are still substantial, Alternative 2 was able to reduce upstream block time[9] by 80 percent on the northbound approach and seven percent on the southbound approach compared to Alternative 1.

Coordinating signals with adjacent streets with queue spillback is essential for optimizing traffic flow along the U.S. 20 segment. Currently, the infrastructure along U.S. 20 allows for potential coordination between signals using twisted pair copper and fiber cables. However, the complexity arises from determining which traffic flow to prioritize, especially given the significant north-south traffic volume on NE 27th Street, potentially comparable to traffic on U.S. 20. Upgrading the corridor to fiber optics presents an opportunity to implement Advanced Traffic Signal Performance Measures that improves signal timing and coordination. Nonetheless, effective detection of queue spillback would require additional equipment beyond the planned radar upgrades at U.S. 20 and NE 27th Street, highlighting the importance of suitable detection methods to ensure comprehensive monitoring and management of traffic queues.

Table 8. Vehicle Queueing at U.S. 20 and NE 27th Street

Movement [A]	95th Percentile Queue (ft) [B]				Approximate Available Storage (ft) [C]
	Existing (2022)	Future (2042) No-Build	Future (2042) Alt 1	Future (2042) Alt 2	
EBL	**350**	**350**	**300**	**350**	150 (TWLTL)
EBTR/EBT	575 [D]	**3450** [E]	**2575** [E]	850	1200 (Purcell Boulevard)
WBL	**375**	**550**	**600**	**300**	150 (TWLTL)
WBTR	450	**600**	**625**	375	550 (Benson Way)
NBL	**300**	**300**	**300**	**425**	275
NBTR/NBT	300	**>1300**	**>1300**	**>1300**	1300 (Bear Creek Road)
SBL	**425**	**425**	**400**	**425**	200
SBT	**>1300**	**>1300**	**>1300**	**>1300**	1300 (Forum Drive)
SBR	**325**	**325**	**350**	**350**	200

Bold and Red queue exceeds approximate available storage, TWLTL=Two Way Left Turn Lane.

[A] EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, L = Left, T = Through, R = Right.

[B] Notable queue within 50 feet or intersection failed in operational analysis.

[C] Available storage reported as approximate turn bay length or approximate distance to the next major intersection.

[D] Included EBT queue at Windy Knolls Drive.

[E] Included EBTR queue at Dean Swift Road, EBTR queue at Purcell Boulevard, and EBT queue at Windy Knolls Drive.

[9] An estimated percentage of the peak hour in which the queue from the study intersection blocks an upstream intersection.

Design Constraints and Considerations

Neither of the proposed alternatives reduce pedestrian crossing distances or exposure across this large intersection. While bicycle facilities should be retained, the broader bike network should be examined in this area to provide alternative routing options that are more comfortable for people bicycling. Improvements to adjacent unsignalized intersections such as turn restrictions or median islands with RRFBs can also serve to improve the multimodal facilities. Additionally, the gas station in the southwest corner could potentially have underground storage tanks that could be impacted by the proposed design and should be avoided.

Currently, a project is under design to update the cross section on 27th Street south of Bear Creek[10]. The new cross section will include a shared use path to the west for bi-directional walking and biking and includes aspirational striping enhancements north of Bear Creek to US 20 that are currently unfunded. As funding sources change and design progresses, the preferred alternative at US 20 should provide an intuitive continuation or transition between cross sections moving north to south for cyclists.

[10] https://www.bendoregon.gov/city-projects/what-s-being-built/bear-creek-and-27th-street-improvements

3.5 U.S. 20 at Hamby Road

Hamby Road is currently a single lane roundabout that was recently constructed in 2022. Hamby Road was converted from a two way stop controlled intersection to a roundabout to reduce vehicular delay and improve safety at the intersection.

Proposed Alternative

The proposed alternative at this location is to modify the existing roundabout to add right turn bypass lanes on the northbound and eastbound approaches as shown in Figure 7. This alternative will reduce the v/c to 0.97 (as shown in Table 9) while maintaining the existing roundabout configuration. Constructing the bypass lanes will also be less impactful during construction than converting the intersection to a signalized intersection.

Figure 7. Hamby Road Proposed Slip Lanes

Pedestrian, Bicycle and Transit Improvements

While infrastructure for people walking, bicycling and accessing transit would remain generally similar to current conditions, the newly added bypass lanes on the eastbound and northbound approaches would also include raised medians/refuge islands, thus enabling nonmotorized users to complete crossing movements in multiple phases.

Alternative Safety Analysis

Widening the existing single-lane roundabout to a full multilane roundabout was not considered at the intersection as multilane roundabouts often do not attain comparable levels of crash reduction as observed in single-lane roundabouts and sufficient capacity

enhancements were provided with the auxiliary right turn lanes.[11] While adding right-turn bypass lanes introduces more conflict points than a single-lane roundabout, particularly for people walking and biking, they introduce fewer conflicts than a full multilane roundabout.

Alternative Traffic Analysis

Table 9 and Table 10 present the intersection operations and vehicle queueing results at Hamby Road. As shown in Table 9, adding northbound and eastbound right-turn bypass lanes at the roundabout significantly reduces intersection delay and improves the worst v/c ratio, bringing the approach below capacity. However, the intersection is still expected to fail to meet the adopted mobility target, with the east leg operating just below capacity. Queueing significantly improves on most approaches, except for the westbound movement, as that approach has the highest v/c ratio after the improvements. In particular, the eastbound approach queueing reduces significantly with the addition of a right turn slip lane though due to the location there is no spillback impact to adjacent streets.

Table 9. Intersection Operations at U.S. 20 and Hamby Road

	Mobility Target [A] (v/c)		v/c	LOS	Delay (Sec)
	OHP	HDM			
Existing (2022)	0.70	0.60	**0.75 (West)**	C	15
Future (2042) No-Build	0.70	0.60	**1.21 (West)**	F	103
Future (2042) Build	0.70	0.60	**0.97 (East)**	F	62

Bold and Red indicate failure to meet mobility target (under Design Hour operations).

[A] For roundabout, mobility target and results reported as the worst leg; OHP: Adopted mobility target from the Oregon Highway Plan; HDM: Design mobility standard from the Highway Design Manual.

[11] The TRB National Cooperative Highway Research Program's *NCHRP Research Report 1043: Guide for Roundabouts,* September 2022.

Table 10. Vehicle Queueing at U.S. 20 and Hamby Road

Movement [A]	95th Percentile Queue (ft) [B]			Approximate Available Storage (ft) [C]
	Existing (2022)	Future (2042) No-Build	Future (2042) Build	
EBLTR/EBLT	325	2700	575	3875 (Dalton Street)
WBLTR	250	725	820	5500 (Erickson Road)
NBLTR/NBLT	50	275	100	1500 (Bear Creek Road)
SBLTR	75	250	250	3600 (Neff Road)

[A] EB = Eastbound, WB = Westbound, NB = Northbound, SB = Southbound, L = Left, T = Through, R = Right.
[B] Notable queue within 50 feet or intersection failed in operational analysis
[C] Available storage reported as approximate turn bay length or approximate distance to the next major intersection.

Design Constraints and Considerations

Recent zone changes in the area could cause an influx of additional traffic over the next 20 years, These increases are likely to exceed the capacity of the single lane roundabout, highlighting the need for ongoing monitoring and evaluation of traffic patterns. The right turn bypass lanes maximize the service life of the single lane roundabout and has lower crash risk. Also, providing a pedestrian refuge area in between the bypass lanes and the through lanes at the roundabout minimizes the crossing distance that pedestrians will have to make in one crossing.

4 Alternative Mobility Targets

Mobility targets from OHP and HDM were used as the adopted mobility targets in the analysis for identifying deficiencies and considering solutions for vehicular mobility on the state system.

As shown in the traffic analysis results, the study intersections along U.S. 20 will not meet the adopted mobility targets by the end of the 20-year planning horizon (2042) even with the preferred alternatives. As per OHP Policy 1F, the ability to meet OHP mobility targets might not align with a community's adopted land use plan, financial capacity, or goals. In such cases, alternative mobility targets can be considered to adjust the long-term performance expectations for a specific roadway facility. Based on the traffic analysis results, there is a need to adopt alternative mobility targets for the study intersections to meet the long-term performance expectations along the study corridor. ODOT's methodology to determine alternative mobility targets will be discussed and analyzed further in the next Technical Memorandum, including the following:

- Gradually increasing the allowed v/c ratio as long as the demand does not exceed the capacity.
- Changing the analysis methodology to consider AWD conditions instead of 30HV.
- Allowing unrestricted congestion for a specific number of hours per day.

This approach allows for a more realistic solution, ensuring that the long-term performance expectations can be met while prioritizing broader community desires.

5 Recommended Cross-Sections

Conditions for people walking and biking along and across U.S. 20 today are higher stress, with limited buffers between vehicles and people walking and biking. To improve conditions for vulnerable roadway users, the Project Team developed recommended cross-sections for the U.S. 20 corridor, organized into five segments based on prevailing land use characteristics and geometric conditions. As outlined in Figure 8 these segments include the following:

- Segment 1: NE 3rd Street to NE 12th Street
- Segment 2: NE 12th Street to NE 15th Street
- Segment 3: NE 15th Street to NE Benson Way
- Segment 4: NE Benson Way to NE Providence Drive
- Segment 5: NE Providence Drive to Powell Butte Highway

Figure 8. U.S. 20 Segments

Described in the sections below, the Project Team developed both “shorter-term” and “longer-term/aspirational” cross-sections for each corridor segment.

Shorter-Term Improvements

The recommended shorter-term cross-sections primarily focus on reorganizing space between the existing curbs in order to facilitate changes at lower implementation costs. Improvements include modifications to existing motor vehicle travel lane widths to enhance the adjacent bikeway. As these improvements would retain the corridor’s existing footprint, no ROW impacts are anticipated. For both scenarios, dimensions for all cross-section elements were informed by ODOT’s Highway Design Manual.

Longer-Term/Aspirational Improvements

The longer-term active transportation enhancements focus on providing greater physical separation between people walking, bicycling, and driving. In most study area segments, these improvements consist of elevating the existing bike lanes and creating shared use paths along both sides of the roadway. These enhancements would be accomplished by adjusting existing curb lines (inward) while expanding the corridor’s total footprint outward to provide the necessary space for other roadway elements. Improvements would likely need to be staged or constructed in pieces as redevelopment occurs along the corridor since the aspirational cross section generally is larger than the existing ROW along the corridor.

For both the shorter- and longer-term proposed cross-sections, these modifications may necessitate coordination with ODOT’s Mobility Advisory Committee and consideration of other policies such as U.S. 20’s designation as a Reduction Review Route. Consideration should also be given to the operational elements of the proposed shared use paths (shown in the longer-term cross-sections), such as one-way versus two-way bicycle travel as well as measures to minimize conflicts between people walking and bicycling and provide sufficient crossings to access one-way facilities.

6 Bicycle and Pedestrian Level of Traffic Stress Analysis

The sections below present findings from the Pedestrian Level of Traffic Stress (PLTS) and Bicycle Level of Traffic Stress (BLTS) analyses conducted for this effort. BLTS and PLTS scores range on a scale from 1 (indicating low stress) to 4 (indicating high stress). As shared use paths are generally classified as low-stress (LTS 1), shared use paths were also evaluated using ODOT's Shared Path Calculator, which evaluates Pedestrian Level of Service (PLOS) and Bicycle Level of Service (BLOS). PLOS and BLOS scores represent the user perception of quality of service of a facility and range from LOS A (best) to LOS F (worst).

LTS analysis was performed for both the shorter-term and longer-term/aspirational cross-section improvements described earlier. The sections below describe dimensional components associated with each scenario, along with corresponding analysis results. Table 11 summarizes the results for existing conditions and for the shorter- and longer-term scenarios.

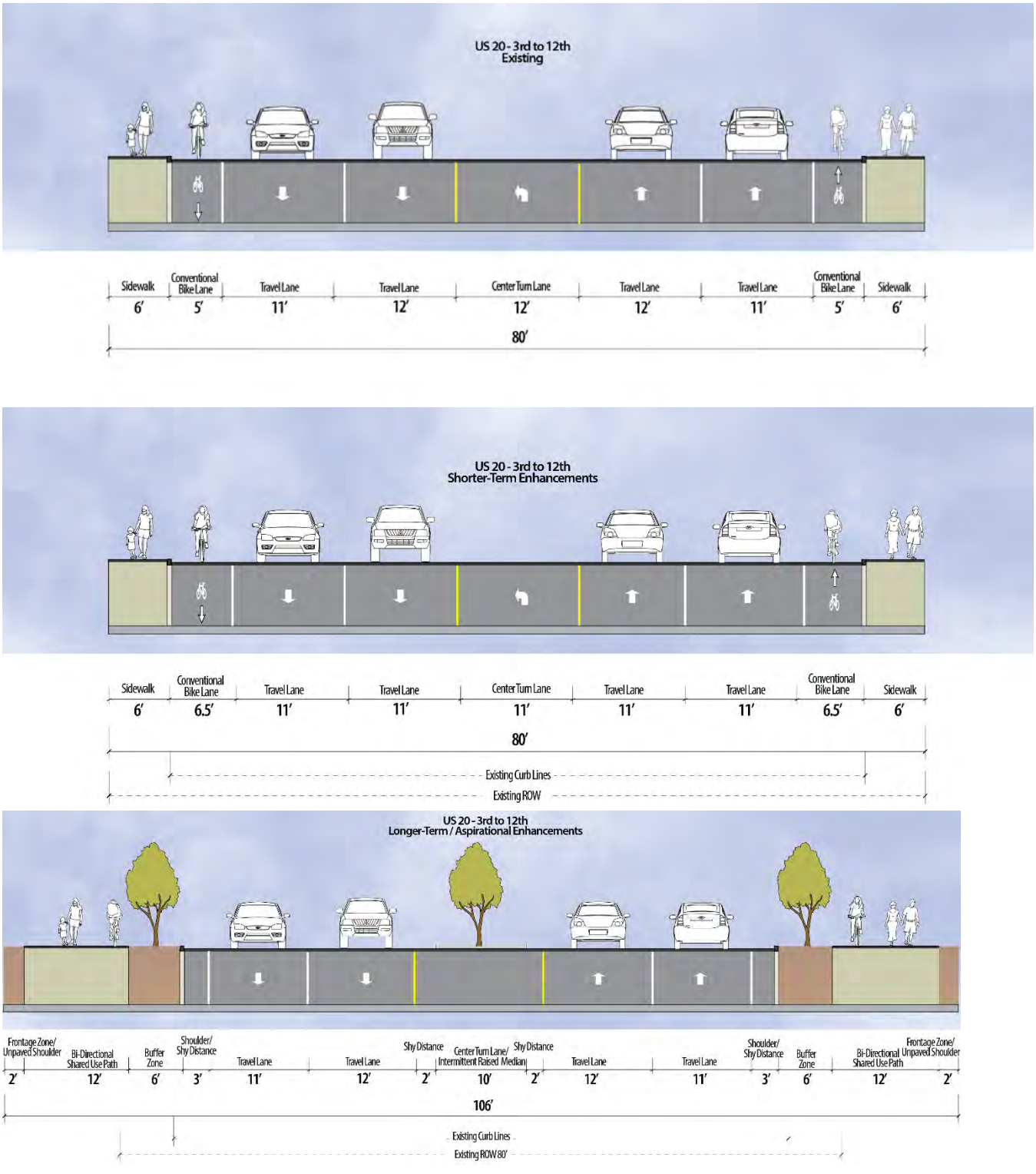
6.1 Shorter-Term Improvements

SEGMENT 1: U.S. 20 – NE 3RD STREET TO NE 12TH STREET

- **Cross-Section Changes:** The width of the center turn lane and both inner travel lanes would be decreased from 12 feet to 11 feet. This space would be used to increase the width of the bike lanes from 5 feet to 6.5 feet.

- **LTS Results:** While these modifications would not decrease the PLTS or BLTS, the bike lane would increase in width and the pedestrian buffer increases from 5 feet to 6.5 feet, thereby providing greater lateral separation for both modes.

Figure 9. Existing and Proposed Cross Section for Segment 1

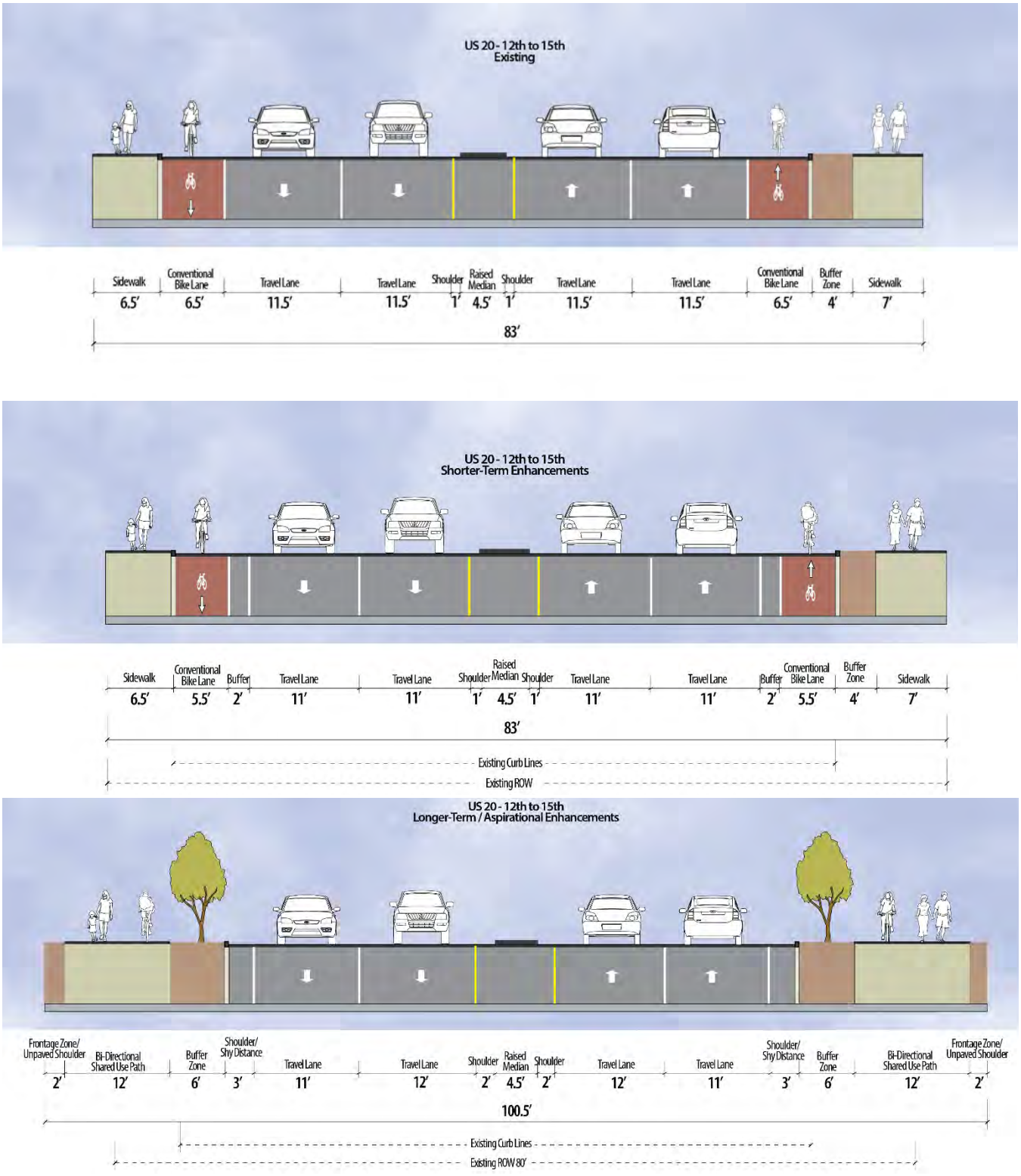


SEGMENT 2: U.S. 20 – NE 12TH STREET TO NE 15TH STREET

- **Cross-Section changes:** All travel lanes widths would be decreased from 11.5 feet to 11 feet. The bike lane width would also be decreased from 6.5 feet to 5.5 feet, however the space reallocated from both the travel lanes and bike lanes would be repurposed as a 2-foot buffer separating the bike lanes and the travel lanes on both sides of the road.

- **LTS Results:** While these modifications would not decrease the PLTS, the buffering between pedestrians and traffic would increase from 6.5 feet to 7.5 feet. The BLTS would improve from BLTS 3 to 2. This segment has connections to other greenways and bicycle facilities.

Figure 10. Existing and Proposed Cross Section for Segment 2

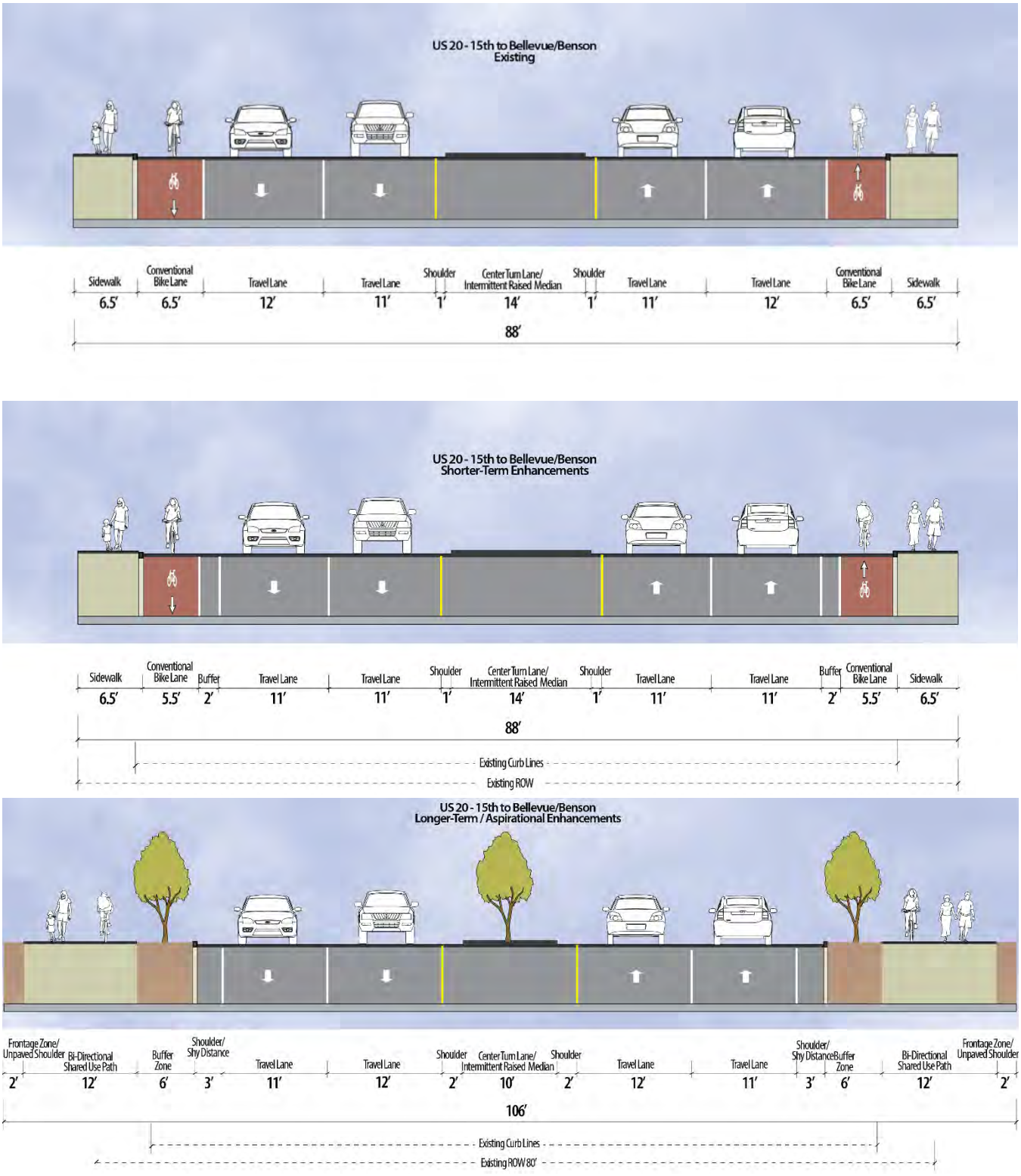


SEGMENT 3: U.S. 20 – NE 15TH STREET TO NE BENSON WAY

- **Cross-Section Changes:** A 2-foot buffer between the travel lanes and bike lanes would be created by reallocating 1 foot from the outer travel lanes (12 feet to 11 feet) and the bike lanes (6.5 feet to 5.5 feet).

- **LTS Results:** The addition of a buffer would improve the comfort for people walking and biking. The PLTS would remain at 3 (however pedestrians would gain an extra foot in buffering from adjacent motor vehicle traffic) and the BLTS would improve from BLTS 3 to 2.

Figure 11. Existing and Proposed Cross Section for Segment 3

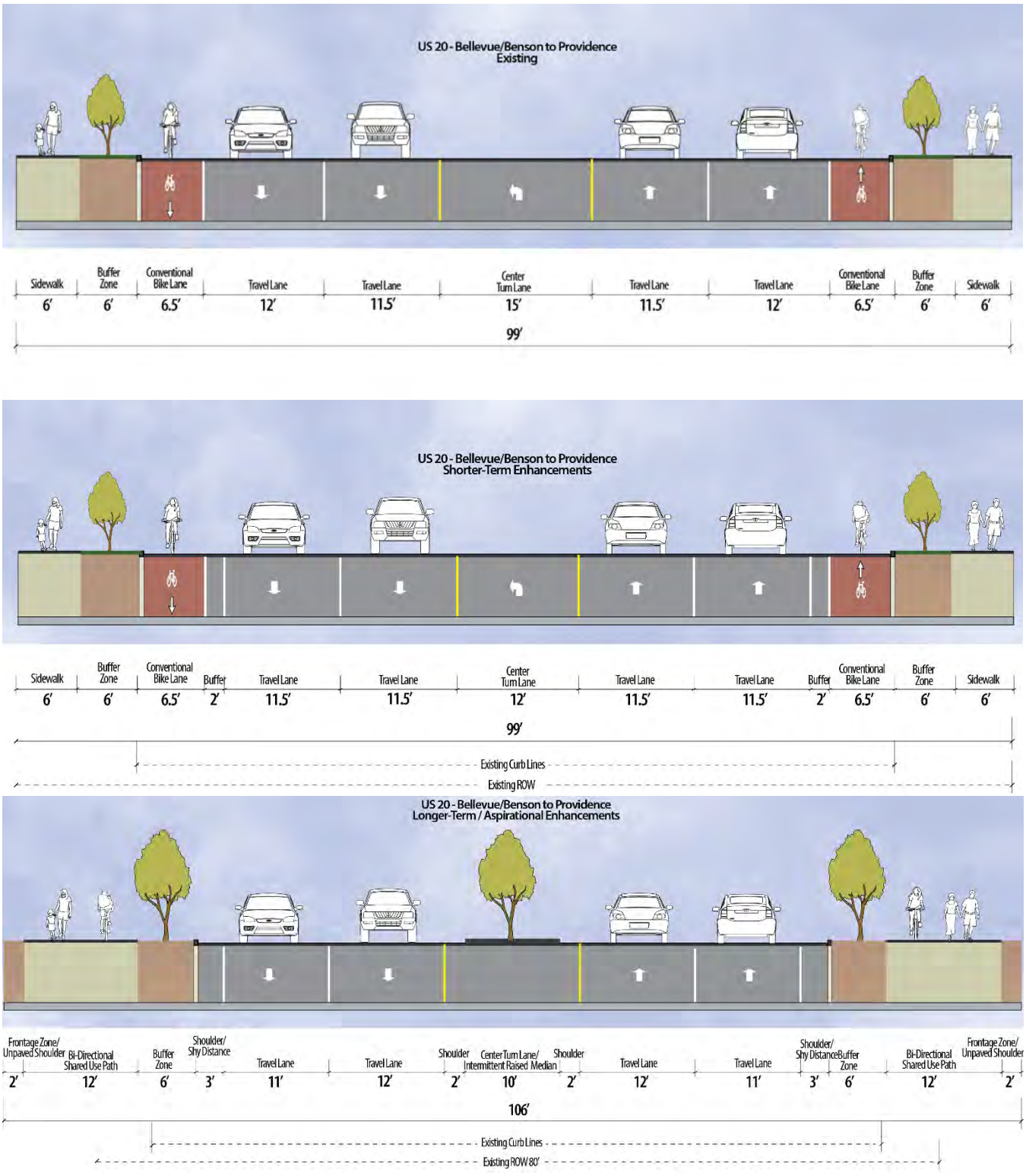


SEGMENT 4: U.S. 20 – NE BENSON WAY TO NE PROVIDENCE DRIVE

- **Cross-Section Changes:** The center turn lane width would be decreased from 15 feet to 12 feet and all travel lanes would be 11.5 feet wide (previously 12 feet for outer travel lanes). A new 2-foot buffer would be created between the bike lane and the travel lanes on both sides of the street.

- **LTS Results:** While these modifications would not decrease the PLTS, people walking and bicycling would gain 2-feet in buffering from adjacent motor vehicle traffic, which would improve BLTS from 3 to 2.

Figure 12. Existing and Proposed Cross Section for Segment 4



SEGMENT 5 : U.S. 20 – NE PROVIDENCE DRIVE TO POWELL BUTTE HIGHWAY

- **Cross-Section Changes:** A 12-foot shared use path would be established on one side of the roadway with a buffer zone of varying width between the path and the existing shoulder. A tactile strip or elevation difference may be needed to safely separate people walking from bicycling.

- **LTS Results:**

    - LTS would improve from PLTS 4 to 2, and BLTS from 4 to 1. Note that regardless of the buffer width, the PLTS would not improve beyond PLTS 2 given the posted speed of adjacent traffic is over 40 miles per hour.

    - ODOT's Crash Reduction Factor (CRF) list[12] does not provide details for the addition of a shared use path. However, the CRF for the addition of a sidewalk is expected to decrease pedestrian crashes by 20 percent. The addition of a separated bike lane or a buffered bike lane has a CRF of 49 percent and 47 percent for bicycle crashes, respectively. As a shared use path functions similar to a sidewalk and separated/buffered bike lane similar safety benefits can be expected.

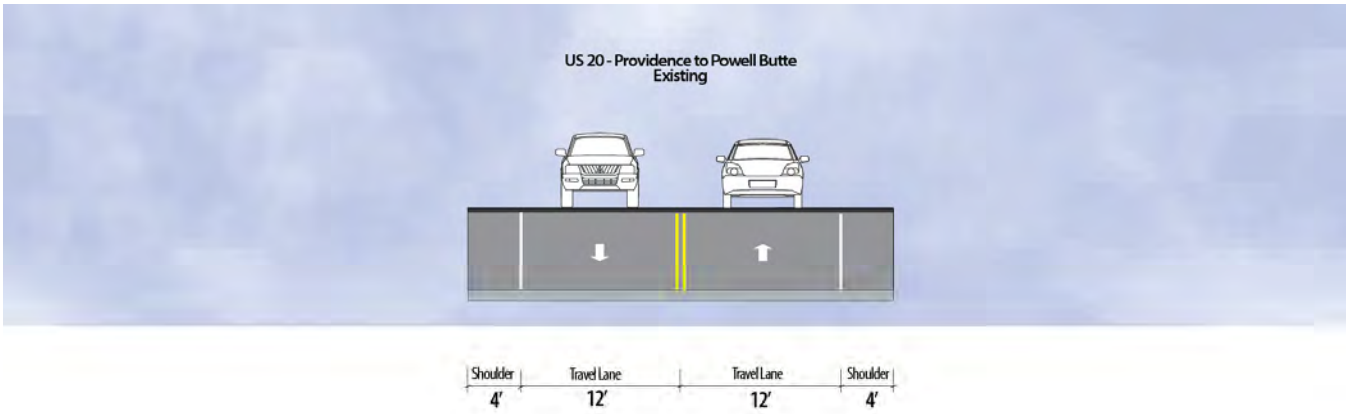
    - The creation of the shared use path would benefit pedestrians by providing a separate and safe walking space away from traffic. People bicycling will have similar safety benefits as they now have a protected and dedicated area away from motor vehicles.

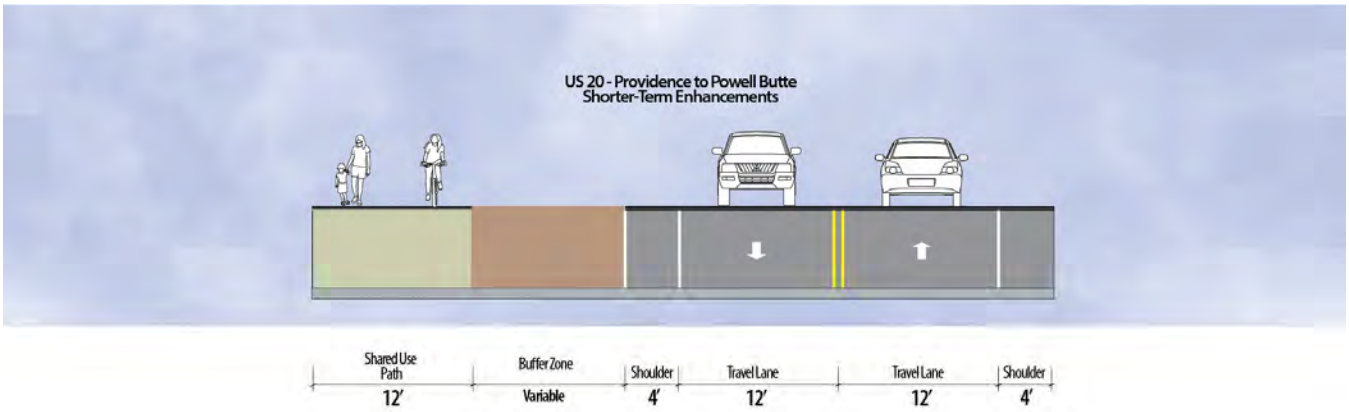
    - Even with a significant volume of active transportation users (75 people or more per hour), the shared use path is expected to operate with a Level of Service B or better for both the PLOS and BLOS measures, indicating the shared use path has good overall conditions, few bicycle conflicts, and can sustain additional riders/pedestrians compared to today's volumes[13].

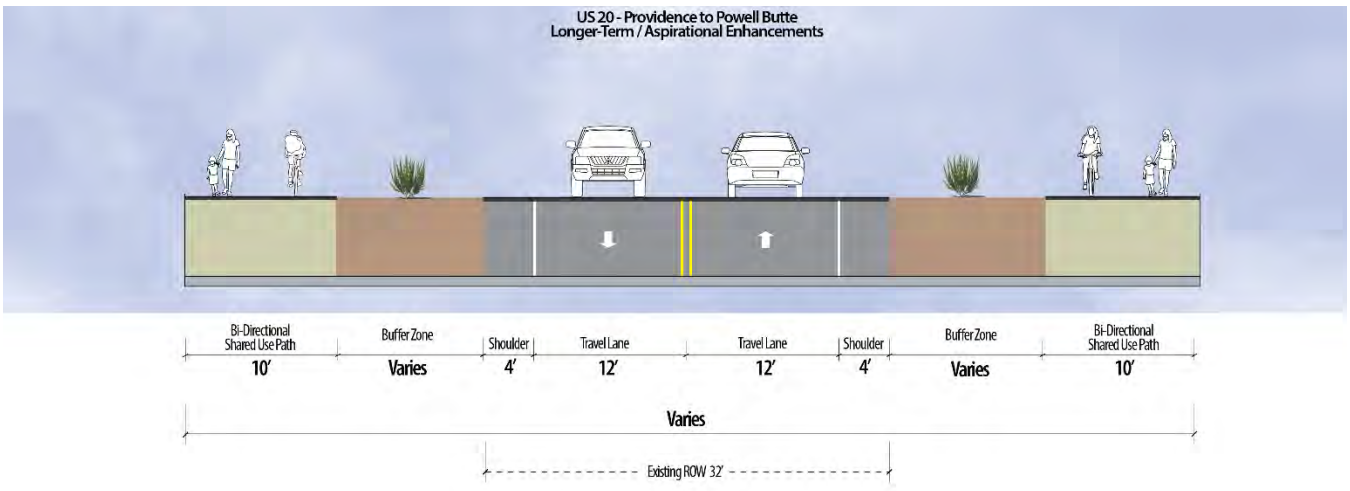
[12] ODOT Crash Reduction Factor List, accessed August 2023: https://www.oregon.gov/odot/engineering/pages/arts.aspx

[13] Determined using the ODOT Shared Path Calculator

Figure 13. Existing and Proposed Cross Section for Segment 5







6.2 Longer-Term Improvements:

SEGMENT 1 THROUGH 4: U.S. 20 – NE 3RD STREET TO NE PROVIDENCE DRIVE

- **Cross-Section Changes:**
    - The center turn lane would vary from 8.5 feet to 14 feet (including shy distance) and would feature an intermittent landscape raised median.
    - Outside travel lanes would remain at 11 feet in width with a 3-foot shoulder/shy distance from the curb, but lanes adjacent to center turn lane would be increased to 12 feet in width.
    - The bike facility would be raised from road to sidewalk level to create a 12-foot wide shared use path with a 6-foot landscaped buffer and a 2-foot frontage zone.
- **LTS Results:**
    - This shared use path is rated PLOS/BLOS B or better.
    - The total pedestrian buffering width would increase to approximately 15 feet if the bikeway and walkway were delineated, which would improve the PLTS to 1 or 2, depending on the speed limit. During the implementation phase, additional design considerations may be necessary to minimize conflicts between people walking and bicycling on the pathway (e.g., delineated separation, one-way versus two-way bicycle travel), as well as ensuring Americans with Disabilities Act accessibility.
    - By raising the bikeway to curb level, people bicycling may experience safer conditions as they are separated from vehicular traffic. Due to the physical separation from motor vehicle traffic, BLTS improves from 3 to 1.

SEGMENT 5: U.S. 20 – NE PROVIDENCE DRIVE TO POWELL BUTTE HIGHWAY

- **Cross-Section Changes:**
    - A 10-foot wide shared use path would be established on both sides of U.S. 20, including a buffering zone of varying width between the road and the path. This shared use path is rated PLOS/BLOS B or better.
    - Shared use paths on both sides of the roadway would provide more direct routing for people on foot and bike, while also reducing instances of people needing to cross the roadway (as would be the case for a pathway on one side only).
- **Results:**
    - The PLTS would decrease from 4 to 2 while the BLTS would decrease from 4 to 1. These changes would render walking and biking as feasible

options by creating separate walking and biking spaces between NE Providence Drive and Powell Butte Highway.

- The PLTS would not be affected by the buffer zone width, as the posted speed on U.S. 20 is over 40 miles per hour. In higher-speed areas such as this segment, additional vertical features could potentially further improve the PLTS score.

6.3 Summary of LTS Analysis Results

Table 11 summarizes the Pedestrian and Bicycle LTS results under existing conditions as well as under the shorter-term and longer-term/aspirational scenarios. .

In the shorter-term, while not all of the modifications would result in lower PLTS or BLTS ratings compared with current conditions, the addition of buffers or wider bike lanes would help people walking and biking by increasing the distance between vulnerable roadway users and adjacent motor vehicle traffic.

In the longer term:

- The BLTS for all segments would improve to BLTS 1, as the bicycle facilities in all segments would be physically separated from the roadway. This would result in bicycling conditions suitable for people of people of all ages and abilities. The City's Low Stress Bicycle Network could be connected to this portion of U.S. 20 through improved intersection crossings, which should be designed to reduce stress for people walking and biking.

- The PLTS for all segments would improve to PLTS 2 or 1 if the walkway and bikeway were delineated. Note that a buffer of 10 feet or greater (between pedestrians and motor vehicle traffic, including bicycle facilities) would be necessary to achieve a PLTS score of 2 or better. Mentioned earlier, additional design considerations may be necessary to minimize pedestrian/bicycle conflicts on the proposed shared use paths (e.g., delineation to distinguish between the walkway and bikeway).

Table 11. Comparison of Existing and Proposed PLTS/BLTS

LOCATION	EXISTING PLTS/BLTS	SHORTER-TERM PLTS/BLTS	LONGER-TERM PLTS/BLTS
SEGMENT 1	3/3	3/3	1/1
SEGMENT 2	3/3	3/2	1/1
SEGMENT 3	3/3	3/2	2/1
SEGMENT 4	2/3	2/2	2/1
SEGMENT 5	4/4	2/1	2/1

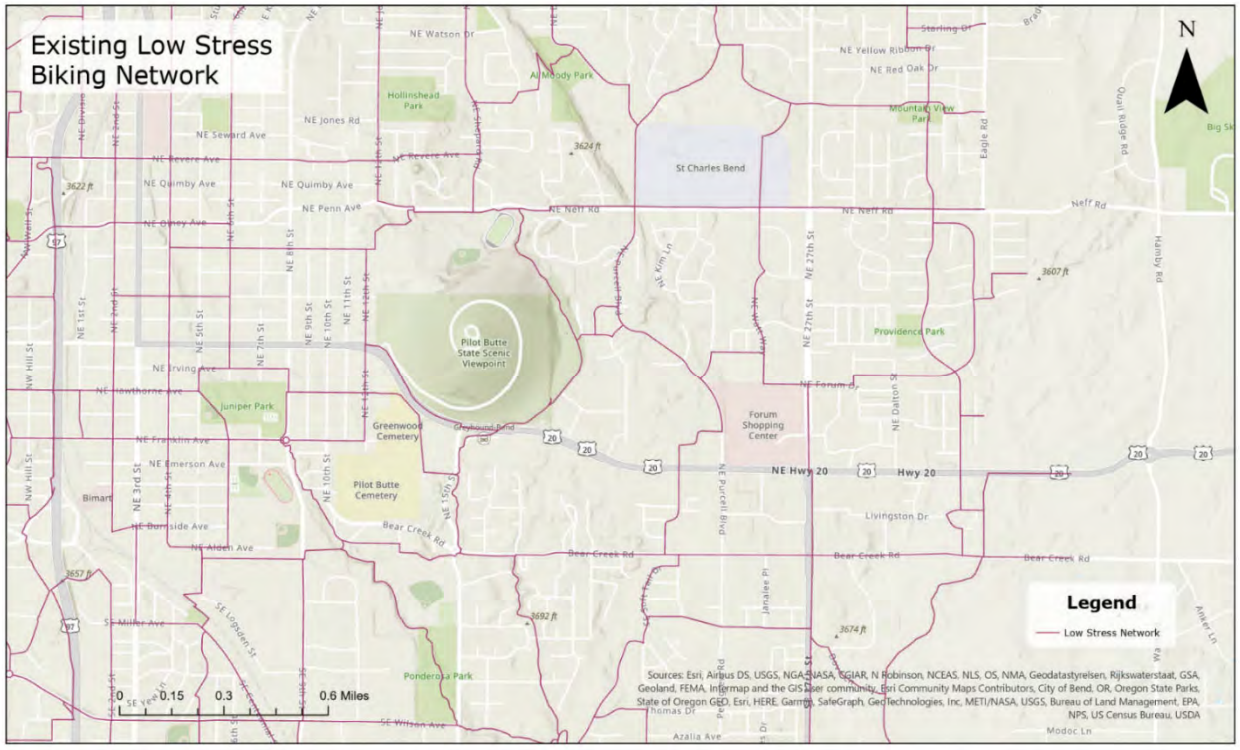
While the LTS analysis for this memorandum focuses on the segment level, it is recognized that conditions for people crossing the corridor hold equal importance. This is particularly evident where U.S. 20 intersects with major north-south streets, as well as other locations that may lack safe and comfortable crossing infrastructure. This is

especially critical at the following intersections where U.S. 20 intersects with the Low Stress Bicycle Network (LSN) in Bend[14] (shown in Figure 14), several of which were flagged for additional enhancements to safely transition people walking and biking to/from the low stress network.

- U.S. 20 and NE 4th Street
- U.S. 20 and NE 6th Street
- U.S. 20 and NE 12th Street
- U.S. 20 and NE 15th Street
- U.S. 20 and Dean Swift Road
- U.S. 20 and NE 27th Street
- U.S. 20 and Stonebriar/ Dalton
- U.S. 20 and NE Providence Drive

Memorandum #5 (Appendix D) describes these locations in greater detail.

Figure 14. Map of Low Stress Bicycle Network in Study Area

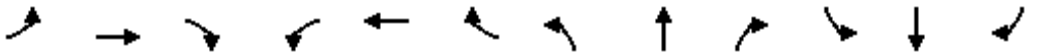


[14] Data taken from the City of Bend Transportation Safety Plan Low Stress Network

Appendix A. HCM Reports

HCM 6th Signalized Intersection Summary
1: NE 3rd St & US 20

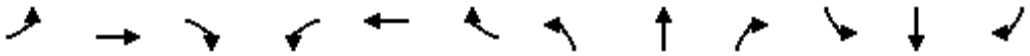
03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Future Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	1.00		0.94
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1900	1885	1870	1900	1870	1885	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	376	882	244	263	753	274	215	726	238	323	849	146
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	0	1	2	0	2	1	1	1	2	0	0
Cap, veh/h	305	970	268	267	629	745	202	655	215	267	876	151
Arrive On Green	0.17	0.35	0.34	0.15	0.33	0.33	0.11	0.25	0.24	0.15	0.29	0.28
Sat Flow, veh/h	1810	2772	766	1781	1900	1533	1795	2619	858	1781	3047	524
Grp Volume(v), veh/h	376	574	552	263	753	274	215	497	467	323	503	492
Grp Sat Flow(s),veh/h/ln	1810	1805	1733	1781	1900	1533	1795	1791	1686	1781	1805	1766
Q Serve(g_s), s	27.0	48.5	48.7	23.6	53.0	18.1	18.0	40.0	40.0	24.0	44.0	44.0
Cycle Q Clear(g_c), s	27.0	48.5	48.7	23.6	53.0	18.1	18.0	40.0	40.0	24.0	44.0	44.0
Prop In Lane	1.00		0.44	1.00		1.00	1.00		0.51	1.00		0.30
Lane Grp Cap(c), veh/h	305	632	607	267	629	745	202	448	421	267	519	508
V/C Ratio(X)	1.23	0.91	0.91	0.98	1.20	0.37	1.06	1.11	1.11	1.21	0.97	0.97
Avail Cap(c_a), veh/h	305	632	607	267	629	745	202	448	421	267	519	508
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	66.5	49.6	49.8	67.8	53.5	26.2	71.0	60.0	60.3	68.0	56.3	56.4
Incr Delay (d2), s/veh	129.4	16.7	17.5	50.4	103.3	0.1	81.4	75.6	76.8	123.6	31.6	32.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	23.6	25.0	24.2	14.6	43.5	6.8	12.8	27.4	26.0	20.1	24.5	24.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	195.9	66.3	67.3	118.2	156.8	26.3	152.4	135.6	137.1	191.6	87.9	88.5
LnGrp LOS	F	E	E	F	F	C	F	F	F	F	F	F
Approach Vol, veh/h		1502			1290			1179			1318	
Approach Delay, s/veh		99.1			121.2			139.2			113.5	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.0	50.0	31.0	57.0	28.0	44.0	28.0	60.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	17.0	45.0	26.0	52.0	23.0	39.0	23.0	55.0
Max Q Clear Time (g_c+I1), s	20.0	46.0	29.0	55.0	26.0	42.0	25.6	50.7
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4

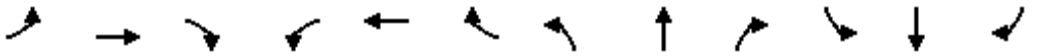
Intersection Summary	
HCM 6th Ctrl Delay	117.0
HCM 6th LOS	F



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Future Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.95	1.00		0.95	1.00		0.95	1.00		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1900	1900	1885	1900	1900	1885	1900	1900	1885	1870
Adj Flow Rate, veh/h	156	1403	57	269	1091	205	65	306	135	382	457	70
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	1	0	0	1	0	0	1	0	0	1	2
Cap, veh/h	229	1429	58	230	1293	242	191	264	116	331	499	76
Arrive On Green	0.07	0.41	0.40	0.09	0.43	0.43	0.05	0.22	0.21	0.15	0.31	0.31
Sat Flow, veh/h	1810	3500	142	1810	2985	558	1810	1219	538	1810	1588	243
Grp Volume(v), veh/h	156	716	744	269	653	643	65	0	441	382	0	527
Grp Sat Flow(s),veh/h/ln	1810	1791	1851	1810	1791	1752	1810	0	1756	1810	0	1831
Q Serve(g_s), s	5.9	47.3	47.7	11.0	39.0	39.5	3.3	0.0	26.0	18.0	0.0	33.3
Cycle Q Clear(g_c), s	5.9	47.3	47.7	11.0	39.0	39.5	3.3	0.0	26.0	18.0	0.0	33.3
Prop In Lane	1.00		0.08	1.00		0.32	1.00		0.31	1.00		0.13
Lane Grp Cap(c), veh/h	229	731	756	230	776	759	191	0	381	331	0	575
V/C Ratio(X)	0.68	0.98	0.98	1.17	0.84	0.85	0.34	0.00	1.16	1.15	0.00	0.92
Avail Cap(c_a), veh/h	229	731	756	230	776	759	201	0	381	331	0	575
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	26.1	35.0	35.1	36.5	30.3	30.6	35.3	0.0	47.2	36.0	0.0	39.7
Incr Delay (d2), s/veh	7.3	28.2	28.8	112.3	8.8	9.5	0.8	0.0	97.0	97.5	0.0	19.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	25.6	26.7	10.7	18.1	18.1	1.5	0.0	21.6	16.8	0.0	17.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	33.5	63.2	63.9	148.8	39.2	40.1	36.1	0.0	144.1	133.5	0.0	59.2
LnGrp LOS	C	E	E	F	D	D	D	A	F	F	A	E
Approach Vol, veh/h		1616			1565			506			909	
Approach Delay, s/veh		60.7			58.4			130.3			90.4	
Approach LOS		E			E			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	53.0	10.3	41.7	12.0	56.0	22.0	30.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	48.0	6.0	36.0	7.0	51.0	17.0	25.0
Max Q Clear Time (g_c+I1), s	13.0	49.7	5.3	35.3	7.9	41.5	20.0	28.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.2	0.0	7.1	0.0	0.0

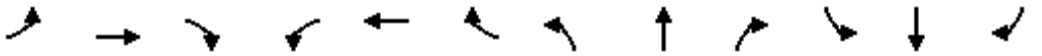
Intersection Summary	
HCM 6th Ctrl Delay	73.4
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Future Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	1.00		0.95	1.00		0.95	1.00		0.96
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1885	1870	1900	1900	1900	1900	1900	1900
Adj Flow Rate, veh/h	309	1511	144	239	1223	108	154	266	88	144	266	231
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	1	1	1	1	2	0	0	0	0	0	0
Cap, veh/h	343	1636	154	263	1504	132	157	310	485	157	310	559
Arrive On Green	0.19	0.50	0.49	0.15	0.45	0.45	0.09	0.16	0.16	0.09	0.16	0.16
Sat Flow, veh/h	1810	3294	311	1795	3315	292	1810	1900	1523	1810	1900	1551
Grp Volume(v), veh/h	309	815	840	239	659	672	154	266	88	144	266	231
Grp Sat Flow(s),veh/h/ln	1810	1791	1813	1795	1791	1816	1810	1900	1523	1810	1900	1551
Q Serve(g_s), s	25.0	63.0	65.2	19.7	47.7	48.1	12.7	20.4	6.3	11.8	20.4	17.0
Cycle Q Clear(g_c), s	25.0	63.0	65.2	19.7	47.7	48.1	12.7	20.4	6.3	11.8	20.4	17.0
Prop In Lane	1.00		0.17	1.00		0.16	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	343	889	901	263	813	824	157	310	485	157	310	559
V/C Ratio(X)	0.90	0.92	0.93	0.91	0.81	0.82	0.98	0.86	0.18	0.92	0.86	0.41
Avail Cap(c_a), veh/h	374	889	901	263	813	824	157	317	490	157	317	564
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	59.4	34.9	35.5	63.0	35.4	35.6	68.4	61.0	37.9	68.0	61.0	36.9
Incr Delay (d2), s/veh	22.5	15.6	17.6	32.0	8.6	8.7	66.2	19.5	0.1	48.2	19.5	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.6	30.6	32.4	11.3	22.5	23.0	8.8	11.6	0.0	7.6	11.5	6.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	81.9	50.4	53.1	95.0	44.0	44.3	134.6	80.5	38.0	116.1	80.5	37.3
LnGrp LOS	F	D	D	F	D	D	F	F	D	F	F	D
Approach Vol, veh/h		1964			1570			508			641	
Approach Delay, s/veh		56.5			51.9			89.6			72.9	
Approach LOS		E			D			F			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.0	78.5	17.0	28.5	32.4	72.1	17.0	28.5
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	21.0	73.0	12.0	24.0	30.0	64.0	12.0	24.0
Max Q Clear Time (g_c+I1), s	21.7	67.2	13.8	22.4	27.0	50.1	14.7	22.4
Green Ext Time (p_c), s	0.0	5.3	0.0	0.2	0.4	10.8	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	60.8
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Future Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.97	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	469	706	0	247	536	65	464	727	224	201	1345	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	362	836		251	550	66	350	1039	320	234	1179	
Arrive On Green	0.33	0.39	0.00	0.14	0.17	0.17	0.19	0.39	0.38	0.13	0.33	0.00
Sat Flow, veh/h	1810	3582	1598	1795	3172	383	1810	2673	824	1781	3610	1610
Grp Volume(v), veh/h	469	706	0	247	299	302	464	487	464	201	1345	0
Grp Sat Flow(s),veh/h/ln	1810	1791	1598	1795	1777	1778	1810	1791	1705	1781	1805	1610
Q Serve(g_s), s	30.0	26.9	0.0	20.6	25.1	25.3	29.0	34.3	34.3	16.6	49.0	0.0
Cycle Q Clear(g_c), s	30.0	26.9	0.0	20.6	25.1	25.3	29.0	34.3	34.3	16.6	49.0	0.0
Prop In Lane	1.00		1.00	1.00		0.22	1.00		0.48	1.00		1.00
Lane Grp Cap(c), veh/h	362	836		251	308	308	350	696	663	234	1179	
V/C Ratio(X)	1.30	0.84		0.98	0.97	0.98	1.33	0.70	0.70	0.86	1.14	
Avail Cap(c_a), veh/h	362	836		251	308	308	350	696	663	249	1179	
HCM Platoon Ratio	1.67	1.67	1.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	49.9	43.3	0.0	64.3	61.6	61.8	60.5	38.5	38.7	63.8	50.5	0.0
Incr Delay (d2), s/veh	152.2	8.8	0.0	51.7	43.4	45.3	165.4	5.8	6.1	23.3	73.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	27.5	11.7	0.0	13.0	15.0	15.3	29.3	16.1	15.4	9.0	33.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	202.2	52.1	0.0	116.0	105.1	107.2	225.9	44.3	44.8	87.1	124.4	0.0
LnGrp LOS	F	D		F	F	F	F	D	D	F	F	
Approach Vol, veh/h		1175			848			1415			1546	
Approach Delay, s/veh		112.0			109.0			104.0			119.5	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	25.0	39.0	33.0	53.0	34.0	30.0	23.7	62.3
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	20.0	34.0	28.0	48.0	29.0	25.0	20.0	56.0
Max Q Clear Time (g_c+I1), s	22.6	28.9	31.0	51.0	32.0	27.3	18.6	36.3
Green Ext Time (p_c), s	0.0	2.9	0.0	0.0	0.0	0.0	0.1	4.7

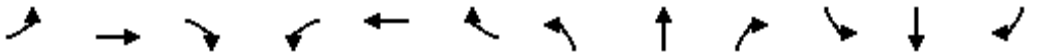
Intersection Summary	
HCM 6th Ctrl Delay	111.5
HCM 6th LOS	F

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
9: SE 27th St/NE 27th St & US 20

03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Future Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.97	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	469	706	0	247	536	63	464	727	190	201	1345	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	468	887		255	598	70	528	1768	884	272	1523	
Arrive On Green	0.09	0.17	0.00	0.07	0.19	0.18	0.15	0.49	0.49	0.08	0.42	0.00
Sat Flow, veh/h	3510	3582	1598	3483	3186	373	3510	3582	1554	3456	3610	1610
Grp Volume(v), veh/h	469	706	0	247	298	301	464	727	190	201	1345	0
Grp Sat Flow(s),veh/h/ln	1755	1791	1598	1742	1777	1782	1755	1791	1554	1728	1805	1610
Q Serve(g_s), s	20.0	28.4	0.0	10.6	24.6	24.8	19.4	19.3	9.0	8.5	51.5	0.0
Cycle Q Clear(g_c), s	20.0	28.4	0.0	10.6	24.6	24.8	19.4	19.3	9.0	8.5	51.5	0.0
Prop In Lane	1.00		1.00	1.00		0.21	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	468	887		255	334	334	528	1768	884	272	1523	
V/C Ratio(X)	1.00	0.80		0.97	0.89	0.90	0.88	0.41	0.21	0.74	0.88	
Avail Cap(c_a), veh/h	468	907		255	344	344	538	1768	884	346	1523	
HCM Platoon Ratio	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	68.3	58.9	0.0	69.3	59.5	59.6	62.4	24.1	16.0	67.6	40.0	0.0
Incr Delay (d2), s/veh	42.1	5.8	0.0	46.9	23.6	24.6	14.9	0.7	0.6	5.3	7.8	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.0	14.0	0.0	6.4	13.2	13.4	9.7	8.4	3.4	4.0	24.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	110.4	64.7	0.0	116.2	83.1	84.3	77.3	24.8	16.6	72.9	47.7	0.0
LnGrp LOS	F	E		F	F	F	E	C	B	E	D	
Approach Vol, veh/h		1175			846			1381			1546	
Approach Delay, s/veh		82.9			93.2			41.3			51.0	
Approach LOS		F			F			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	41.2	26.6	67.3	24.0	32.2	15.8	78.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	37.0	22.0	61.0	19.0	28.0	14.0	69.0
Max Q Clear Time (g_c+I1), s	12.6	30.4	21.4	53.5	22.0	26.8	10.5	21.3
Green Ext Time (p_c), s	0.0	3.7	0.2	4.3	0.0	0.4	0.3	4.8

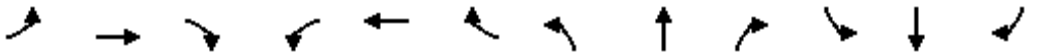
Intersection Summary	
HCM 6th Ctrl Delay	63.1
HCM 6th LOS	E

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
1: NE 3rd St & US 20

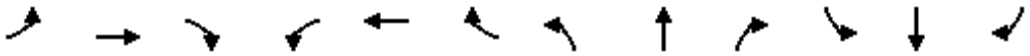
03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	195	655	130	245	530	255	135	600	245	275	540	75
Future Volume (veh/h)	195	655	130	245	530	255	135	600	245	275	540	75
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.98	1.00		0.97	1.00		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1900	1885	1870	1900	1870	1885	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	210	704	129	263	570	237	145	645	234	296	581	75
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	0	1	2	0	2	1	1	1	2	0	0
Cap, veh/h	233	811	149	272	720	298	167	685	248	318	1134	146
Arrive On Green	0.13	0.27	0.27	0.15	0.29	0.29	0.09	0.27	0.27	0.18	0.35	0.35
Sat Flow, veh/h	1810	3034	556	1781	2468	1024	1795	2550	925	1781	3206	413
Grp Volume(v), veh/h	210	419	414	263	417	390	145	453	426	296	326	330
Grp Sat Flow(s),veh/h/ln	1810	1805	1784	1781	1805	1686	1795	1791	1684	1781	1805	1814
Q Serve(g_s), s	17.2	33.3	33.4	22.1	32.0	32.1	12.0	37.3	37.3	24.6	21.5	21.6
Cycle Q Clear(g_c), s	17.2	33.3	33.4	22.1	32.0	32.1	12.0	37.3	37.3	24.6	21.5	21.6
Prop In Lane	1.00		0.31	1.00		0.61	1.00		0.55	1.00		0.23
Lane Grp Cap(c), veh/h	233	483	477	272	526	492	167	481	452	318	639	642
V/C Ratio(X)	0.90	0.87	0.87	0.97	0.79	0.79	0.87	0.94	0.94	0.93	0.51	0.51
Avail Cap(c_a), veh/h	325	528	522	272	526	492	298	488	459	379	639	642
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	64.7	52.6	52.6	63.4	49.1	49.2	67.3	53.9	53.9	60.9	38.4	38.4
Incr Delay (d2), s/veh	17.9	12.5	12.8	44.9	7.4	8.1	5.1	26.2	27.5	25.2	0.7	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.2	16.9	16.8	13.5	15.7	14.8	5.7	20.2	19.1	13.3	9.7	9.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	82.6	65.1	65.4	108.3	56.5	57.2	72.4	80.1	81.4	86.1	39.1	39.1
LnGrp LOS	F	E	E	F	E	E	E	F	F	F	D	D
Approach Vol, veh/h		1043			1070			1024			952	
Approach Delay, s/veh		68.8			69.5			79.6			53.7	
Approach LOS		E			E			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.0	58.3	24.3	48.9	31.9	45.4	28.0	45.2
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	25.0	48.0	27.0	40.0	32.0	41.0	23.0	44.0
Max Q Clear Time (g_c+I1), s	14.0	23.6	19.2	34.1	26.6	39.3	24.1	35.4
Green Ext Time (p_c), s	0.1	8.1	0.1	3.7	0.2	1.1	0.0	4.9

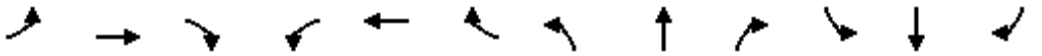
Intersection Summary	
HCM 6th Ctrl Delay	68.2
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	145	1095	55	140	900	115	60	285	135	305	425	70
Future Volume (veh/h)	145	1095	55	140	900	115	60	285	135	305	425	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	1.00		0.96	1.00		0.97	1.00		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1900	1900	1885	1900	1900	1885	1900	1900	1885	1870
Adj Flow Rate, veh/h	156	1177	56	151	968	115	65	306	129	328	457	70
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	1	0	0	1	0	0	1	0	0	1	2
Cap, veh/h	232	1210	58	199	1112	132	245	304	128	357	574	88
Arrive On Green	0.07	0.35	0.35	0.07	0.35	0.35	0.05	0.24	0.24	0.16	0.36	0.36
Sat Flow, veh/h	1810	3474	165	1810	3209	381	1810	1248	526	1810	1592	244
Grp Volume(v), veh/h	156	606	627	151	540	543	65	0	435	328	0	527
Grp Sat Flow(s),veh/h/ln	1810	1791	1848	1810	1791	1799	1810	0	1774	1810	0	1836
Q Serve(g_s), s	6.3	38.3	38.4	6.1	32.4	32.4	3.0	0.0	28.0	16.4	0.0	29.6
Cycle Q Clear(g_c), s	6.3	38.3	38.4	6.1	32.4	32.4	3.0	0.0	28.0	16.4	0.0	29.6
Prop In Lane	1.00		0.09	1.00		0.21	1.00		0.30	1.00		0.13
Lane Grp Cap(c), veh/h	232	624	644	199	620	623	245	0	433	357	0	662
V/C Ratio(X)	0.67	0.97	0.97	0.76	0.87	0.87	0.27	0.00	1.01	0.92	0.00	0.80
Avail Cap(c_a), veh/h	289	624	644	259	624	627	399	0	433	378	0	662
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	27.2	36.9	36.9	28.1	35.1	35.1	31.3	0.0	43.4	32.9	0.0	32.9
Incr Delay (d2), s/veh	3.6	29.2	29.0	8.0	13.3	13.3	0.4	0.0	44.7	26.1	0.0	6.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	21.3	21.9	3.0	16.0	16.1	1.4	0.0	17.6	9.6	0.0	14.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	30.8	66.1	65.9	36.1	48.4	48.5	31.7	0.0	88.1	59.0	0.0	39.4
LnGrp LOS	C	E	E	D	D	D	C	A	F	E	A	D
Approach Vol, veh/h		1389			1234			500			855	
Approach Delay, s/veh		62.1			46.9			80.8			47.0	
Approach LOS		E			D			F			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	13.2	45.0	10.2	46.4	13.4	44.8	23.7	33.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	12.0	40.0	15.0	28.0	12.0	40.0	20.0	28.0
Max Q Clear Time (g_c+I1), s	8.1	40.4	5.0	31.6	8.3	34.4	18.4	30.0
Green Ext Time (p_c), s	0.2	0.0	0.1	0.0	0.2	3.9	0.2	0.0

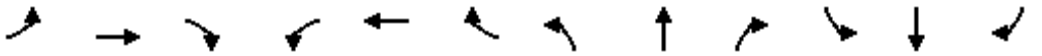
Intersection Summary	
HCM 6th Ctrl Delay	56.5
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	1060	105	125	940	60	100	210	80	125	235	250
Future Volume (veh/h)	290	1060	105	125	940	60	100	210	80	125	235	250
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.96	1.00		0.97	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1885	1870	1900	1900	1900	1900	1900	1900
Adj Flow Rate, veh/h	309	1128	106	133	1000	60	106	223	71	133	250	66
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	1	1	1	1	2	0	0	0	0	0	0
Cap, veh/h	344	1501	141	161	1213	73	133	253	81	161	381	626
Arrive On Green	0.19	0.45	0.45	0.09	0.35	0.35	0.07	0.18	0.18	0.09	0.20	0.20
Sat Flow, veh/h	1810	3299	310	1795	3424	205	1810	1371	437	1810	1900	1598
Grp Volume(v), veh/h	309	612	622	133	523	537	106	0	294	133	250	66
Grp Sat Flow(s),veh/h/ln	1810	1791	1818	1795	1791	1839	1810	0	1808	1810	1900	1598
Q Serve(g_s), s	18.3	31.1	31.2	8.0	29.3	29.3	6.3	0.0	17.4	8.0	13.3	2.9
Cycle Q Clear(g_c), s	18.3	31.1	31.2	8.0	29.3	29.3	6.3	0.0	17.4	8.0	13.3	2.9
Prop In Lane	1.00		0.17	1.00		0.11	1.00		0.24	1.00		1.00
Lane Grp Cap(c), veh/h	344	815	827	161	634	651	133	0	334	161	381	626
V/C Ratio(X)	0.90	0.75	0.75	0.83	0.82	0.82	0.80	0.00	0.88	0.83	0.66	0.11
Avail Cap(c_a), veh/h	411	815	827	163	634	651	165	0	411	165	432	669
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	43.5	24.8	24.8	49.2	32.4	32.4	50.2	0.0	43.6	49.3	40.5	21.3
Incr Delay (d2), s/veh	19.0	6.3	6.3	27.4	11.6	11.3	18.1	0.0	15.9	26.9	2.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.9	14.0	14.3	4.8	14.3	14.7	3.5	0.0	9.2	4.8	6.4	1.1
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	62.5	31.1	31.1	76.7	44.0	43.7	68.3	0.0	59.6	76.2	43.1	21.4
LnGrp LOS	E	C	C	E	D	D	E	A	E	E	D	C
Approach Vol, veh/h		1543			1193			400			449	
Approach Delay, s/veh		37.4			47.5			61.9			49.7	
Approach LOS		D			D			E			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	14.8	55.0	14.8	25.3	25.9	44.0	13.1	27.1
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	45.0	10.0	25.0	25.0	30.0	10.0	25.0
Max Q Clear Time (g_c+I1), s	10.0	33.2	10.0	19.4	20.3	31.3	8.3	15.3
Green Ext Time (p_c), s	0.0	11.2	0.0	0.6	0.6	0.0	0.1	0.9

Intersection Summary	
HCM 6th Ctrl Delay	45.0
HCM 6th LOS	D



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	345	585	175	215	480	50	195	425	160	185	890	305
Future Volume (veh/h)	345	585	175	215	480	50	195	425	160	185	890	305
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	356	603	153	222	495	44	201	438	128	191	918	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	370	775	196	251	694	61	230	761	220	220	996	
Arrive On Green	0.27	0.37	0.37	0.14	0.21	0.21	0.13	0.28	0.28	0.12	0.28	0.00
Sat Flow, veh/h	1810	2815	712	1795	3294	292	1810	2723	788	1781	3610	1610
Grp Volume(v), veh/h	356	383	373	222	266	273	201	287	279	191	918	0
Grp Sat Flow(s),veh/h/ln	1810	1791	1737	1795	1777	1809	1810	1791	1720	1781	1805	1610
Q Serve(g_s), s	21.3	20.8	21.0	13.3	15.3	15.4	12.0	15.1	15.4	11.6	27.2	0.0
Cycle Q Clear(g_c), s	21.3	20.8	21.0	13.3	15.3	15.4	12.0	15.1	15.4	11.6	27.2	0.0
Prop In Lane	1.00		0.41	1.00		0.16	1.00		0.46	1.00		1.00
Lane Grp Cap(c), veh/h	370	493	478	251	374	381	230	501	481	220	996	
V/C Ratio(X)	0.96	0.78	0.78	0.88	0.71	0.72	0.87	0.57	0.58	0.87	0.92	
Avail Cap(c_a), veh/h	370	521	505	261	468	477	230	501	481	227	996	
HCM Platoon Ratio	1.33	1.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	39.6	31.9	31.9	46.4	40.3	40.4	47.2	34.0	34.1	47.3	38.7	0.0
Incr Delay (d2), s/veh	36.6	8.7	9.1	26.9	3.2	3.3	28.5	4.7	5.1	27.3	14.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.5	9.4	9.2	7.7	6.9	7.1	7.2	7.1	7.0	6.7	13.8	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	76.2	40.5	41.0	73.3	43.5	43.6	75.7	38.7	39.1	74.6	53.6	0.0
LnGrp LOS	E	D	D	E	D	D	E	D	D	E	D	
Approach Vol, veh/h		1112			761			767			1109	
Approach Delay, s/veh		52.1			52.2			48.5			57.2	
Approach LOS		D			D			D			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.4	35.3	19.0	35.4	27.5	28.2	18.6	35.8
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	16.0	32.0	14.0	28.0	19.0	29.0	14.0	28.0
Max Q Clear Time (g_c+I1), s	15.3	23.0	14.0	29.2	23.3	17.4	13.6	17.4
Green Ext Time (p_c), s	0.1	7.3	0.0	0.0	0.0	5.5	0.0	2.0

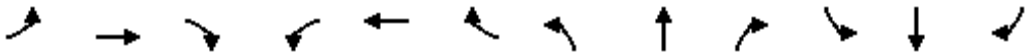
Intersection Summary	
HCM 6th Ctrl Delay	52.9
HCM 6th LOS	D

Notes

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
1: NE 3rd St & US 20

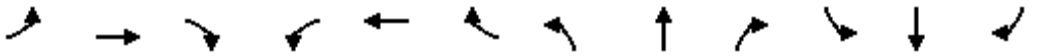
03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Future Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.97	1.00		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1900	1885	1870	1900	1870	1885	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	376	882	245	263	753	249	215	726	238	323	849	145
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	0	1	2	0	2	1	1	1	2	0	0
Cap, veh/h	362	868	241	267	695	230	236	690	226	312	940	161
Arrive On Green	0.20	0.31	0.31	0.15	0.26	0.26	0.13	0.26	0.26	0.17	0.31	0.30
Sat Flow, veh/h	1810	2776	770	1781	2646	875	1795	2627	861	1781	3069	524
Grp Volume(v), veh/h	376	573	554	263	514	488	215	495	469	323	499	495
Grp Sat Flow(s),veh/h/ln	1810	1805	1741	1781	1805	1716	1795	1791	1697	1781	1805	1789
Q Serve(g_s), s	32.0	50.0	50.0	23.6	42.0	42.0	18.9	42.0	42.0	28.0	42.4	42.5
Cycle Q Clear(g_c), s	32.0	50.0	50.0	23.6	42.0	42.0	18.9	42.0	42.0	28.0	42.4	42.5
Prop In Lane	1.00		0.44	1.00		0.51	1.00		0.51	1.00		0.29
Lane Grp Cap(c), veh/h	362	564	544	267	474	450	236	470	445	312	553	548
V/C Ratio(X)	1.04	1.02	1.02	0.98	1.08	1.08	0.91	1.05	1.05	1.04	0.90	0.90
Avail Cap(c_a), veh/h	362	564	544	267	474	450	236	470	445	312	553	548
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	64.0	55.0	55.2	67.8	59.0	59.3	68.6	59.0	59.3	66.0	53.2	53.4
Incr Delay (d2), s/veh	57.8	42.0	43.2	50.4	66.0	67.0	35.2	56.1	57.3	60.7	18.2	18.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	20.7	29.4	28.6	14.6	28.0	26.8	11.0	26.2	25.0	17.9	21.9	21.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	121.8	97.0	98.4	118.2	125.0	126.3	103.8	115.1	116.5	126.7	71.4	71.7
LnGrp LOS	F	F	F	F	F	F	F	F	F	F	E	E
Approach Vol, veh/h		1503			1265			1179			1317	
Approach Delay, s/veh		103.7			124.1			113.6			85.1	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	25.0	53.0	36.0	46.0	32.0	46.0	28.0	54.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	20.0	48.0	31.0	41.0	27.0	41.0	23.0	49.0
Max Q Clear Time (g_c+I1), s	20.9	44.5	34.0	44.0	30.0	44.0	25.6	52.0
Green Ext Time (p_c), s	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0

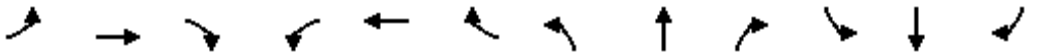
Intersection Summary	
HCM 6th Ctrl Delay	106.2
HCM 6th LOS	F



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Future Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.97	1.00		0.98
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1900	1900	1885	1900	1900	1885	1900	1900	1885	1870
Adj Flow Rate, veh/h	156	1403	57	269	1091	205	65	306	135	382	457	70
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	1	0	0	1	0	0	1	0	0	1	2
Cap, veh/h	230	1430	58	230	1297	243	192	266	117	331	500	77
Arrive On Green	0.07	0.41	0.40	0.09	0.43	0.43	0.05	0.22	0.21	0.15	0.31	0.31
Sat Flow, veh/h	1810	3503	142	1810	2993	560	1810	1228	542	1810	1592	244
Grp Volume(v), veh/h	156	716	744	269	651	645	65	0	441	382	0	527
Grp Sat Flow(s),veh/h/ln	1810	1791	1854	1810	1791	1761	1810	0	1770	1810	0	1835
Q Serve(g_s), s	5.9	47.3	47.6	11.0	38.8	39.3	3.3	0.0	26.0	18.0	0.0	33.2
Cycle Q Clear(g_c), s	5.9	47.3	47.6	11.0	38.8	39.3	3.3	0.0	26.0	18.0	0.0	33.2
Prop In Lane	1.00		0.08	1.00		0.32	1.00		0.31	1.00		0.13
Lane Grp Cap(c), veh/h	230	731	757	230	776	763	192	0	383	331	0	576
V/C Ratio(X)	0.68	0.98	0.98	1.17	0.84	0.84	0.34	0.00	1.15	1.15	0.00	0.91
Avail Cap(c_a), veh/h	230	731	757	230	776	763	202	0	383	331	0	576
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	26.1	35.0	35.1	36.4	30.3	30.6	35.3	0.0	47.2	36.0	0.0	39.7
Incr Delay (d2), s/veh	7.2	28.1	28.5	111.8	8.7	9.2	0.8	0.0	93.6	97.5	0.0	19.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	25.5	26.7	10.7	18.0	18.1	1.5	0.0	21.5	16.8	0.0	17.7
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	33.3	63.1	63.7	148.2	39.0	39.8	36.1	0.0	140.7	133.5	0.0	58.7
LnGrp LOS	C	E	E	F	D	D	D	A	F	F	A	E
Approach Vol, veh/h		1616			1565			506			909	
Approach Delay, s/veh		60.5			58.1			127.3			90.2	
Approach LOS		E			E			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	53.0	10.3	41.7	12.0	56.0	22.0	30.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	48.0	6.0	36.0	7.0	51.0	17.0	25.0
Max Q Clear Time (g_c+I1), s	13.0	49.6	5.3	35.2	7.9	41.3	20.0	28.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.2	0.0	7.3	0.0	0.0

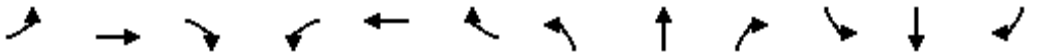
Intersection Summary	
HCM 6th Ctrl Delay	72.9
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Future Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.96	1.00		0.98	1.00		0.99
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1885	1870	1900	1900	1900	1900	1900	1900
Adj Flow Rate, veh/h	309	1511	142	239	1223	106	154	266	134	144	266	222
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	1	1	1	1	2	0	0	0	0	0	0
Cap, veh/h	329	1441	134	196	1209	104	148	258	130	165	432	656
Arrive On Green	0.18	0.44	0.43	0.11	0.36	0.35	0.08	0.22	0.21	0.09	0.23	0.23
Sat Flow, veh/h	1810	3301	307	1795	3324	287	1810	1181	595	1810	1900	1600
Grp Volume(v), veh/h	309	813	840	239	658	671	154	0	400	144	266	222
Grp Sat Flow(s),veh/h/ln	1810	1791	1818	1795	1791	1820	1810	0	1775	1810	1900	1600
Q Serve(g_s), s	18.5	48.0	48.0	12.0	40.0	40.0	9.0	0.0	24.0	8.6	13.8	10.5
Cycle Q Clear(g_c), s	18.5	48.0	48.0	12.0	40.0	40.0	9.0	0.0	24.0	8.6	13.8	10.5
Prop In Lane	1.00		0.17	1.00		0.16	1.00		0.34	1.00		1.00
Lane Grp Cap(c), veh/h	329	781	793	196	651	662	148	0	387	165	432	656
V/C Ratio(X)	0.94	1.04	1.06	1.22	1.01	1.01	1.04	0.00	1.03	0.88	0.62	0.34
Avail Cap(c_a), veh/h	329	781	793	196	651	662	148	0	387	165	432	656
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	44.4	31.0	31.1	49.0	35.0	35.1	50.5	0.0	43.2	49.4	38.2	22.3
Incr Delay (d2), s/veh	33.9	43.2	48.7	136.2	37.7	38.6	85.0	0.0	54.4	36.7	2.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.3	28.9	30.6	12.7	23.5	24.1	7.6	0.0	16.3	5.5	6.6	3.9
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	78.3	74.2	79.8	185.2	72.7	73.7	135.5	0.0	97.5	86.1	40.5	22.5
LnGrp LOS	E	F	F	F	F	F	F	A	F	F	D	C
Approach Vol, veh/h		1962			1568			554			632	
Approach Delay, s/veh		77.2			90.3			108.1			44.6	
Approach LOS		E			F			F			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	16.0	52.0	14.0	28.0	24.0	44.0	13.0	29.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	11.0	47.0	9.0	23.0	19.0	39.0	8.0	24.0
Max Q Clear Time (g_c+I1), s	14.0	50.0	10.6	26.0	20.5	42.0	11.0	15.8
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5

Intersection Summary	
HCM 6th Ctrl Delay	80.8
HCM 6th LOS	F



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Future Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.98	1.00		0.97	1.00		0.98	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	469	706	310	247	536	62	464	727	216	201	1345	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	313	655	288	212	698	80	280	910	270	227	1116	
Arrive On Green	0.17	0.27	0.26	0.12	0.22	0.21	0.15	0.34	0.33	0.13	0.31	0.00
Sat Flow, veh/h	1810	2401	1054	1795	3201	369	1810	2705	804	1781	3610	1610
Grp Volume(v), veh/h	469	527	489	247	297	301	464	481	462	201	1345	0
Grp Sat Flow(s),veh/h/ln	1810	1791	1665	1795	1777	1793	1810	1791	1718	1781	1805	1610
Q Serve(g_s), s	19.0	30.0	30.0	13.0	17.2	17.4	17.0	26.8	26.9	12.2	34.0	0.0
Cycle Q Clear(g_c), s	19.0	30.0	30.0	13.0	17.2	17.4	17.0	26.8	26.9	12.2	34.0	0.0
Prop In Lane	1.00		0.63	1.00		0.21	1.00		0.47	1.00		1.00
Lane Grp Cap(c), veh/h	313	488	454	212	387	391	280	602	578	227	1116	
V/C Ratio(X)	1.50	1.08	1.08	1.16	0.77	0.77	1.66	0.80	0.80	0.89	1.21	
Avail Cap(c_a), veh/h	313	488	454	212	420	424	280	602	578	227	1116	
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	45.5	40.0	40.3	48.5	40.4	40.5	46.5	33.1	33.4	47.2	38.0	0.0
Incr Delay (d2), s/veh	240.7	63.3	64.9	113.1	7.2	7.4	312.0	10.6	11.0	31.2	101.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	29.3	21.4	20.2	12.4	8.2	8.4	31.8	13.1	12.7	7.3	30.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	286.2	103.3	105.2	161.6	47.6	48.0	358.5	43.7	44.4	78.4	139.1	0.0
LnGrp LOS	F	F	F	F	D	D	F	D	D	E	F	
Approach Vol, veh/h		1485			845			1407			1546	
Approach Delay, s/veh		161.7			81.1			147.8			131.2	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.0	34.0	21.0	38.0	23.0	28.0	18.0	41.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	12.0	29.0	16.0	33.0	16.0	25.0	13.0	36.0
Max Q Clear Time (g_c+I1), s	15.0	32.0	19.0	36.0	21.0	19.4	14.2	28.9
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	3.3	0.0	2.8

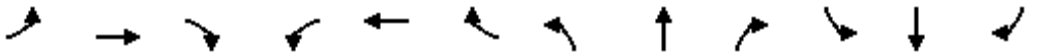
Intersection Summary	
HCM 6th Ctrl Delay	136.2
HCM 6th LOS	F

Notes

Unsignalized Delay for [SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
1: NE 3rd St & US 20

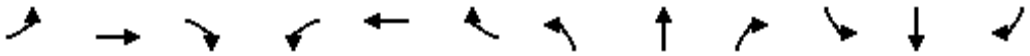
03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Future Volume (veh/h)	350	820	245	245	700	255	200	675	245	300	790	145
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.97	1.00		0.97	1.00		0.96	1.00		0.94
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1900	1885	1870	1900	1870	1885	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	376	882	244	263	753	274	215	726	238	323	849	146
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	0	1	2	0	2	1	1	1	2	0	0
Cap, veh/h	305	970	268	267	629	745	202	655	215	267	876	151
Arrive On Green	0.17	0.35	0.34	0.15	0.33	0.33	0.11	0.25	0.24	0.15	0.29	0.28
Sat Flow, veh/h	1810	2772	766	1781	1900	1533	1795	2619	858	1781	3047	524
Grp Volume(v), veh/h	376	574	552	263	753	274	215	497	467	323	503	492
Grp Sat Flow(s),veh/h/ln	1810	1805	1733	1781	1900	1533	1795	1791	1686	1781	1805	1766
Q Serve(g_s), s	27.0	48.5	48.7	23.6	53.0	18.1	18.0	40.0	40.0	24.0	44.0	44.0
Cycle Q Clear(g_c), s	27.0	48.5	48.7	23.6	53.0	18.1	18.0	40.0	40.0	24.0	44.0	44.0
Prop In Lane	1.00		0.44	1.00		1.00	1.00		0.51	1.00		0.30
Lane Grp Cap(c), veh/h	305	632	607	267	629	745	202	448	421	267	519	508
V/C Ratio(X)	1.23	0.91	0.91	0.98	1.20	0.37	1.06	1.11	1.11	1.21	0.97	0.97
Avail Cap(c_a), veh/h	305	632	607	267	629	745	202	448	421	267	519	508
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	66.5	49.6	49.8	67.8	53.5	26.2	71.0	60.0	60.3	68.0	56.3	56.4
Incr Delay (d2), s/veh	129.4	16.7	17.5	50.4	103.3	0.1	81.4	75.6	76.8	123.6	31.6	32.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	23.6	25.0	24.2	14.6	43.5	6.8	12.8	27.4	26.0	20.1	24.5	24.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	195.9	66.3	67.3	118.2	156.8	26.3	152.4	135.6	137.1	191.6	87.9	88.5
LnGrp LOS	F	E	E	F	F	C	F	F	F	F	F	F
Approach Vol, veh/h		1502			1290			1179			1318	
Approach Delay, s/veh		99.1			121.2			139.2			113.5	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.0	50.0	31.0	57.0	28.0	44.0	28.0	60.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	17.0	45.0	26.0	52.0	23.0	39.0	23.0	55.0
Max Q Clear Time (g_c+I1), s	20.0	46.0	29.0	55.0	26.0	42.0	25.6	50.7
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4

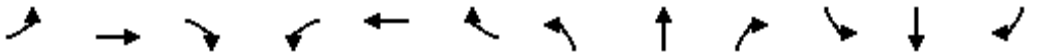
Intersection Summary	
HCM 6th Ctrl Delay	117.0
HCM 6th LOS	F



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Future Volume (veh/h)	145	1305	55	250	1015	205	60	285	140	355	425	70
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.95	1.00		0.95	1.00		0.95	1.00		0.97
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1900	1900	1885	1900	1900	1885	1900	1900	1885	1870
Adj Flow Rate, veh/h	156	1403	57	269	1091	205	65	306	135	382	457	70
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	1	0	0	1	0	0	1	0	0	1	2
Cap, veh/h	229	1429	58	230	1293	242	191	264	116	331	499	76
Arrive On Green	0.07	0.41	0.40	0.09	0.43	0.43	0.05	0.22	0.21	0.15	0.31	0.31
Sat Flow, veh/h	1810	3500	142	1810	2985	558	1810	1219	538	1810	1588	243
Grp Volume(v), veh/h	156	716	744	269	653	643	65	0	441	382	0	527
Grp Sat Flow(s),veh/h/ln	1810	1791	1851	1810	1791	1752	1810	0	1756	1810	0	1831
Q Serve(g_s), s	5.9	47.3	47.7	11.0	39.0	39.5	3.3	0.0	26.0	18.0	0.0	33.3
Cycle Q Clear(g_c), s	5.9	47.3	47.7	11.0	39.0	39.5	3.3	0.0	26.0	18.0	0.0	33.3
Prop In Lane	1.00		0.08	1.00		0.32	1.00		0.31	1.00		0.13
Lane Grp Cap(c), veh/h	229	731	756	230	776	759	191	0	381	331	0	575
V/C Ratio(X)	0.68	0.98	0.98	1.17	0.84	0.85	0.34	0.00	1.16	1.15	0.00	0.92
Avail Cap(c_a), veh/h	229	731	756	230	776	759	201	0	381	331	0	575
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	26.1	35.0	35.1	36.5	30.3	30.6	35.3	0.0	47.2	36.0	0.0	39.7
Incr Delay (d2), s/veh	7.3	28.2	28.8	112.3	8.8	9.5	0.8	0.0	97.0	97.5	0.0	19.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.9	25.6	26.7	10.7	18.1	18.1	1.5	0.0	21.6	16.8	0.0	17.8
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	33.5	63.2	63.9	148.8	39.2	40.1	36.1	0.0	144.1	133.5	0.0	59.2
LnGrp LOS	C	E	E	F	D	D	D	A	F	F	A	E
Approach Vol, veh/h		1616			1565			506			909	
Approach Delay, s/veh		60.7			58.4			130.3			90.4	
Approach LOS		E			E			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	53.0	10.3	41.7	12.0	56.0	22.0	30.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	48.0	6.0	36.0	7.0	51.0	17.0	25.0
Max Q Clear Time (g_c+I1), s	13.0	49.7	5.3	35.3	7.9	41.5	20.0	28.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.2	0.0	7.1	0.0	0.0

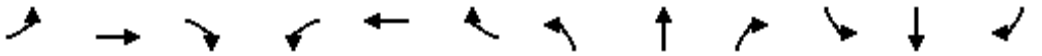
Intersection Summary	
HCM 6th Ctrl Delay	73.4
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Future Volume (veh/h)	290	1420	140	225	1150	105	145	250	145	135	250	250
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		0.96	1.00		0.95	1.00		0.95	1.00		0.96
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1885	1870	1900	1900	1900	1900	1900	1900
Adj Flow Rate, veh/h	309	1511	144	239	1223	108	154	266	88	144	266	231
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	0	1	1	1	1	2	0	0	0	0	0	0
Cap, veh/h	343	1636	154	263	1504	132	157	310	485	157	310	559
Arrive On Green	0.19	0.50	0.49	0.15	0.45	0.45	0.09	0.16	0.16	0.09	0.16	0.16
Sat Flow, veh/h	1810	3294	311	1795	3315	292	1810	1900	1523	1810	1900	1551
Grp Volume(v), veh/h	309	815	840	239	659	672	154	266	88	144	266	231
Grp Sat Flow(s),veh/h/ln	1810	1791	1813	1795	1791	1816	1810	1900	1523	1810	1900	1551
Q Serve(g_s), s	25.0	63.0	65.2	19.7	47.7	48.1	12.7	20.4	6.3	11.8	20.4	17.0
Cycle Q Clear(g_c), s	25.0	63.0	65.2	19.7	47.7	48.1	12.7	20.4	6.3	11.8	20.4	17.0
Prop In Lane	1.00		0.17	1.00		0.16	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	343	889	901	263	813	824	157	310	485	157	310	559
V/C Ratio(X)	0.90	0.92	0.93	0.91	0.81	0.82	0.98	0.86	0.18	0.92	0.86	0.41
Avail Cap(c_a), veh/h	374	889	901	263	813	824	157	317	490	157	317	564
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	59.4	34.9	35.5	63.0	35.4	35.6	68.4	61.0	37.9	68.0	61.0	36.9
Incr Delay (d2), s/veh	22.5	15.6	17.6	32.0	8.6	8.7	66.2	19.5	0.1	48.2	19.5	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.6	30.6	32.4	11.3	22.5	23.0	8.8	11.6	0.0	7.6	11.5	6.5
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	81.9	50.4	53.1	95.0	44.0	44.3	134.6	80.5	38.0	116.1	80.5	37.3
LnGrp LOS	F	D	D	F	D	D	F	F	D	F	F	D
Approach Vol, veh/h		1964			1570			508			641	
Approach Delay, s/veh		56.5			51.9			89.6			72.9	
Approach LOS		E			D			F			E	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.0	78.5	17.0	28.5	32.4	72.1	17.0	28.5
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	21.0	73.0	12.0	24.0	30.0	64.0	12.0	24.0
Max Q Clear Time (g_c+I1), s	21.7	67.2	13.8	22.4	27.0	50.1	14.7	22.4
Green Ext Time (p_c), s	0.0	5.3	0.0	0.2	0.4	10.8	0.0	0.4

Intersection Summary	
HCM 6th Ctrl Delay	60.8
HCM 6th LOS	E



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Future Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.97	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	469	706	0	247	536	65	464	727	224	201	1345	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	362	836		251	550	66	350	1039	320	234	1179	
Arrive On Green	0.33	0.39	0.00	0.14	0.17	0.17	0.19	0.39	0.38	0.13	0.33	0.00
Sat Flow, veh/h	1810	3582	1598	1795	3172	383	1810	2673	824	1781	3610	1610
Grp Volume(v), veh/h	469	706	0	247	299	302	464	487	464	201	1345	0
Grp Sat Flow(s),veh/h/ln	1810	1791	1598	1795	1777	1778	1810	1791	1705	1781	1805	1610
Q Serve(g_s), s	30.0	26.9	0.0	20.6	25.1	25.3	29.0	34.3	34.3	16.6	49.0	0.0
Cycle Q Clear(g_c), s	30.0	26.9	0.0	20.6	25.1	25.3	29.0	34.3	34.3	16.6	49.0	0.0
Prop In Lane	1.00		1.00	1.00		0.22	1.00		0.48	1.00		1.00
Lane Grp Cap(c), veh/h	362	836		251	308	308	350	696	663	234	1179	
V/C Ratio(X)	1.30	0.84		0.98	0.97	0.98	1.33	0.70	0.70	0.86	1.14	
Avail Cap(c_a), veh/h	362	836		251	308	308	350	696	663	249	1179	
HCM Platoon Ratio	1.67	1.67	1.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	49.9	43.3	0.0	64.3	61.6	61.8	60.5	38.5	38.7	63.8	50.5	0.0
Incr Delay (d2), s/veh	152.2	8.8	0.0	51.7	43.4	45.3	165.4	5.8	6.1	23.3	73.9	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	27.5	11.7	0.0	13.0	15.0	15.3	29.3	16.1	15.4	9.0	33.9	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	202.2	52.1	0.0	116.0	105.1	107.2	225.9	44.3	44.8	87.1	124.4	0.0
LnGrp LOS	F	D		F	F	F	F	D	D	F	F	
Approach Vol, veh/h		1175			848			1415			1546	
Approach Delay, s/veh		112.0			109.0			104.0			119.5	
Approach LOS		F			F			F			F	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	25.0	39.0	33.0	53.0	34.0	30.0	23.7	62.3
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	20.0	34.0	28.0	48.0	29.0	25.0	20.0	56.0
Max Q Clear Time (g_c+I1), s	22.6	28.9	31.0	51.0	32.0	27.3	18.6	36.3
Green Ext Time (p_c), s	0.0	2.9	0.0	0.0	0.0	0.0	0.1	4.7

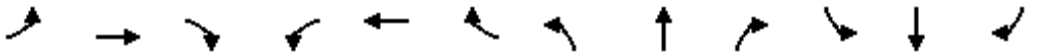
Intersection Summary	
HCM 6th Ctrl Delay	111.5
HCM 6th LOS	F

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

HCM 6th Signalized Intersection Summary
9: SE 27th St/NE 27th St & US 20

03/19/2024



Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Future Volume (veh/h)	455	685	365	240	520	70	450	705	240	195	1305	395
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		0.95	1.00		0.97	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No			No			No			No	
Adj Sat Flow, veh/h/ln	1900	1885	1885	1885	1870	1870	1900	1885	1885	1870	1900	1900
Adj Flow Rate, veh/h	469	706	0	247	536	63	464	727	190	201	1345	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	0	1	1	1	2	2	0	1	1	2	0	0
Cap, veh/h	468	887		255	598	70	528	1768	884	272	1523	
Arrive On Green	0.09	0.17	0.00	0.07	0.19	0.18	0.15	0.49	0.49	0.08	0.42	0.00
Sat Flow, veh/h	3510	3582	1598	3483	3186	373	3510	3582	1554	3456	3610	1610
Grp Volume(v), veh/h	469	706	0	247	298	301	464	727	190	201	1345	0
Grp Sat Flow(s),veh/h/ln	1755	1791	1598	1742	1777	1782	1755	1791	1554	1728	1805	1610
Q Serve(g_s), s	20.0	28.4	0.0	10.6	24.6	24.8	19.4	19.3	9.0	8.5	51.5	0.0
Cycle Q Clear(g_c), s	20.0	28.4	0.0	10.6	24.6	24.8	19.4	19.3	9.0	8.5	51.5	0.0
Prop In Lane	1.00		1.00	1.00		0.21	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	468	887		255	334	334	528	1768	884	272	1523	
V/C Ratio(X)	1.00	0.80		0.97	0.89	0.90	0.88	0.41	0.21	0.74	0.88	
Avail Cap(c_a), veh/h	468	907		255	344	344	538	1768	884	346	1523	
HCM Platoon Ratio	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	68.3	58.9	0.0	69.3	59.5	59.6	62.4	24.1	16.0	67.6	40.0	0.0
Incr Delay (d2), s/veh	42.1	5.8	0.0	46.9	23.6	24.6	14.9	0.7	0.6	5.3	7.8	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.0	14.0	0.0	6.4	13.2	13.4	9.7	8.4	3.4	4.0	24.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	110.4	64.7	0.0	116.2	83.1	84.3	77.3	24.8	16.6	72.9	47.7	0.0
LnGrp LOS	F	E		F	F	F	E	C	B	E	D	
Approach Vol, veh/h		1175			846			1381			1546	
Approach Delay, s/veh		82.9			93.2			41.3			51.0	
Approach LOS		F			F			D			D	

Timer - Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.0	41.2	26.6	67.3	24.0	32.2	15.8	78.0
Change Period (Y+Rc), s	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Max Green Setting (Gmax), s	10.0	37.0	22.0	61.0	19.0	28.0	14.0	69.0
Max Q Clear Time (g_c+I1), s	12.6	30.4	21.4	53.5	22.0	26.8	10.5	21.3
Green Ext Time (p_c), s	0.0	3.7	0.2	4.3	0.0	0.4	0.3	4.8

Intersection Summary	
HCM 6th Ctrl Delay	63.1
HCM 6th LOS	E

Notes

Unsignalized Delay for [EBR, SBR] is excluded from calculations of the approach delay and intersection delay.

Appendix B. SimTraffic Report

Summary of All Intervals

Run Number	1	2	3	4	5	6	7
Start Time	4:15	4:15	4:15	4:15	4:15	4:15	4:15
End Time	5:25	5:25	5:25	5:25	5:25	5:25	5:25
Total Time (min)	70	70	70	70	70	70	70
Time Recorded (min)	60	60	60	60	60	60	60
# of Intervals	3	3	3	3	3	3	3
# of Recorded Intervals	2	2	2	2	2	2	2
Vehs Entered	11697	11662	11665	11988	11702	11944	11609
Vehs Exited	10868	10811	10915	11131	10934	11093	10864
Starting Vehs	1154	1137	1136	1170	1130	1142	1191
Ending Vehs	1983	1988	1886	2027	1898	1993	1936
Travel Distance (mi)	13223	13221	13189	13382	13333	13463	13192
Travel Time (hr)	2878.7	3030.6	2848.6	2819.0	2938.1	2909.1	2931.5
Total Delay (hr)	2473.6	2627.4	2445.6	2410.0	2531.8	2498.6	2529.3
Total Stops	36913	35991	34443	35134	33910	34068	33598
Fuel Used (gal)	998.1	1032.1	990.7	986.6	1013.7	1011.7	1006.9

Summary of All Intervals

Run Number	9	Avg
Start Time	4:15	4:15
End Time	5:25	5:25
Total Time (min)	70	70
Time Recorded (min)	60	60
# of Intervals	3	3
# of Recorded Intervals	2	2
Vehs Entered	11719	11748
Vehs Exited	10876	10936
Starting Vehs	1117	1135
Ending Vehs	1960	1950
Travel Distance (mi)	13321	13291
Travel Time (hr)	3006.1	2920.2
Total Delay (hr)	2599.3	2514.4
Total Stops	38925	35369
Fuel Used (gal)	1028.8	1008.6

Interval #0 Information Seeding

Start Time	4:15
End Time	4:25
Total Time (min)	10

Volumes adjusted by PHF, Growth Factors.

No data recorded this interval.

Interval #1 Information Recording1

Start Time	4:25
End Time	4:40
Total Time (min)	15

Volumes adjusted by PHF, Growth Factors.

Run Number	1	2	3	4	5	6	7
Vehs Entered	3378	3445	3351	3437	3505	3372	3381
Vehs Exited	2854	2837	2885	2919	2892	2862	2808
Starting Vehs	1154	1137	1136	1170	1130	1142	1191
Ending Vehs	1678	1745	1602	1688	1743	1652	1764
Travel Distance (mi)	3466	3533	3403	3572	3645	3548	3545
Travel Time (hr)	399.7	426.0	400.5	421.8	401.0	413.0	428.7
Total Delay (hr)	293.2	318.1	295.5	313.0	290.6	305.3	321.0
Total Stops	8785	9133	8453	9172	8771	8426	8613
Fuel Used (gal)	181.2	188.5	179.9	188.3	184.6	186.2	188.5

Interval #1 Information Recording1

Start Time	4:25
End Time	4:40
Total Time (min)	15

Volumes adjusted by PHF, Growth Factors.

Run Number	9	Avg
Vehs Entered	3546	3428
Vehs Exited	2797	2856
Starting Vehs	1117	1135
Ending Vehs	1866	1715
Travel Distance (mi)	3622	3542
Travel Time (hr)	418.3	413.6
Total Delay (hr)	307.9	305.6
Total Stops	9936	8914
Fuel Used (gal)	188.4	185.7

Interval #2 Information Recording2

Start Time	4:40
End Time	5:25
Total Time (min)	45

Volumes adjusted by Growth Factors, Anti PHF.

Run Number	1	2	3	4	5	6	7
Vehs Entered	8319	8217	8314	8551	8197	8572	8228
Vehs Exited	8014	7974	8030	8212	8042	8231	8056
Starting Vehs	1678	1745	1602	1688	1743	1652	1764
Ending Vehs	1983	1988	1886	2027	1898	1993	1936
Travel Distance (mi)	9757	9688	9785	9811	9688	9915	9647
Travel Time (hr)	2479.0	2604.6	2448.1	2397.1	2537.1	2496.0	2502.8
Total Delay (hr)	2180.4	2309.3	2150.1	2097.0	2241.2	2193.3	2208.2
Total Stops	28128	26858	25990	25962	25139	25642	24985
Fuel Used (gal)	816.9	843.6	810.9	798.2	829.1	825.5	818.4

Interval #2 Information Recording2

Start Time	4:40
End Time	5:25
Total Time (min)	45

Volumes adjusted by Growth Factors, Anti PHF.

Run Number	9	Avg
Vehs Entered	8173	8319
Vehs Exited	8079	8080
Starting Vehs	1866	1715
Ending Vehs	1960	1950
Travel Distance (mi)	9699	9749
Travel Time (hr)	2587.8	2506.6
Total Delay (hr)	2291.4	2208.9
Total Stops	28989	26460
Fuel Used (gal)	840.4	822.9

Arterial Level of Service: EB US 20

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
NE 3rd St	1	356.0	1033.5	0.4	3
NE 4th Street	2	2.1	15.8	0.1	21
NE 6th Street	3	12.9	31.7	0.2	20
NE 8th St	4	93.6	110.7	0.2	6
	21	6.5	23.6	0.2	25
	109	0.6	4.7	0.0	30
SE 15th St	5	56.0	94.6	0.4	15
	111	9.3	33.5	0.2	25
Dean Swift Road	6	45.3	86.6	0.4	17
Purcell Blvd	7	70.3	82.9	0.1	5
NE Windy Knolls Dr	8	49.4	61.6	0.1	7
	16	24.8	30.6	0.1	6
SE 27th St	9	84.3	93.3	0.1	3
NE Bellevue Dr	10	8.7	21.1	0.1	20
	24	4.2	15.8	0.1	32
	119	1.0	7.6	0.1	39
Hamby Rd	11	173.0	220.2	0.7	11
Torkelson Rd	12	12.8	84.4	1.0	43
Powell Butte Rd	13	4.9	19.5	0.2	41
Total		1015.6	2071.8	4.7	12

Arterial Level of Service: WB US 20

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Powell Butte Rd	13	9.8	22.5	0.2	31
Erickson Road	12	22.2	36.2	0.2	22
Hamby Rd	11	518.7	579.2	1.0	6
	119	8.1	62.0	0.7	39
	24	3.4	9.9	0.1	29
NE Benson Way	10	98.5	114.2	0.1	4
NE 27th St	9	273.3	302.2	0.1	1
	16	4.9	13.7	0.1	22
NE Windy Knolls Dr	8	1.7	7.0	0.1	27
Purcell Blvd	7	41.8	53.3	0.1	8
Dean Swift Road	6	5.4	18.4	0.1	24
	111	5.7	48.2	0.4	31
	5	13.5	37.4	0.2	23
	109	8.9	48.3	0.4	29
	21	2.8	7.0	0.0	21
NE 8th St	4	57.0	74.4	0.2	8
NE 6th Street	3	87.4	104.9	0.2	6
NE 4th Street	2	153.3	170.7	0.2	4
NE 3rd St	1	84.2	96.7	0.1	3
Total		1400.6	1806.1	4.5	9

Intersection: 1: NE 3rd St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	R	L	T	TR	L	T	TR
Maximum Queue (ft)	185	2032	2040	325	465	405	325	1453	1457	325	1834	1810
Average Queue (ft)	184	2001	1997	250	454	129	308	1397	1393	323	1650	1636
95th Queue (ft)	187	2153	2166	397	471	303	387	1609	1617	337	2145	2150
Link Distance (ft)		1999	1999		406	406		1413	1413		1779	1779
Upstream Blk Time (%)		89	74		58	2		72	72		65	46
Queuing Penalty (veh)		0	0		348	15		0	0		0	0
Storage Bay Dist (ft)	160			300			300			300		
Storage Blk Time (%)	76	12		4	60		45	46		76	16	
Queuing Penalty (veh)	312	43		24	147		150	92		300	48	

Intersection: 2: NE 4th Street & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	R	R
Maximum Queue (ft)	71	147	85	124	896	906	249	494
Average Queue (ft)	37	18	7	43	827	792	105	478
95th Queue (ft)	75	96	63	112	1027	1062	197	573
Link Distance (ft)		406	406		857	857	562	475
Upstream Blk Time (%)					47	28		88
Queuing Penalty (veh)					272	161		0
Storage Bay Dist (ft)	50			100				
Storage Blk Time (%)	19	0		0	64			
Queuing Penalty (veh)	123	0		2	41			

Intersection: 3: NE 6th Street & US 20

Movement	EB	EB	WB	WB	NB	SB
Directions Served	T	TR	T	TR	R	R
Maximum Queue (ft)	215	224	830	825	137	467
Average Queue (ft)	79	85	469	445	56	251
95th Queue (ft)	376	386	947	939	216	550
Link Distance (ft)	857	857	833	833	555	452
Upstream Blk Time (%)	0		3	2		33
Queuing Penalty (veh)	0		15	14		0
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 4: NE 8th St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	TR
Maximum Queue (ft)	325	748	773	325	668	650	250	1463	375	1937
Average Queue (ft)	197	584	602	245	432	427	142	1415	365	1735
95th Queue (ft)	390	925	931	396	739	724	320	1594	435	2355
Link Distance (ft)		833	833		816	816		1414		1885
Upstream Blk Time (%)		7	8		2	2		93		57
Queuing Penalty (veh)		51	62		14	14		0		0
Storage Bay Dist (ft)	300			300			225		350	
Storage Blk Time (%)	3	42		12	20		0	86	23	41
Queuing Penalty (veh)	18	61		63	49		0	51	112	147

Intersection: 5: SE 15th St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB
Directions Served	T	T	R	L	T	T	L	R
Maximum Queue (ft)	940	980	225	338	418	389	319	385
Average Queue (ft)	550	575	174	194	154	151	205	105
95th Queue (ft)	1013	1043	301	352	349	314	317	256
Link Distance (ft)	1972	1972			1183	1183		933
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			200	350			300	
Storage Blk Time (%)		35	1	5	0		3	0
Queuing Penalty (veh)		110	5	32	1		5	0

Intersection: 6: Dean Swift Road & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	R	LTR
Maximum Queue (ft)	124	1089	1092	117	97	87	621	433
Average Queue (ft)	48	397	378	56	4	5	393	363
95th Queue (ft)	119	1104	1092	107	43	38	776	545
Link Distance (ft)		2099	2099		573	573	602	417
Upstream Blk Time (%)							46	66
Queuing Penalty (veh)							0	0
Storage Bay Dist (ft)	100			100				
Storage Blk Time (%)	0	28		3	0			
Queuing Penalty (veh)	4	19		23	0			

Intersection: 7: Purcell Blvd & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	T	R	L	T	R
Maximum Queue (ft)	325	608	616	325	512	518	315	1299	315	315	1212	315
Average Queue (ft)	294	550	549	228	353	371	248	1082	191	287	1076	115
95th Queue (ft)	385	673	673	378	482	492	393	1659	408	377	1553	336
Link Distance (ft)		573	573		526	526		1280			1193	
Upstream Blk Time (%)		24	22		0	0		50			69	
Queuing Penalty (veh)		216	197		1	1		0			0	
Storage Bay Dist (ft)	300			300			290		290	290		290
Storage Blk Time (%)	14	39		1	13		18	55	0	66	19	0
Queuing Penalty (veh)	97	113		7	30		72	158	2	325	73	1

Intersection: 8: NE Windy Knolls Dr & US 20

Movement	EB	EB	EB	WB	WB	WB	NB
Directions Served	T	T	R	L	T	T	LR
Maximum Queue (ft)	556	565	123	122	195	167	619
Average Queue (ft)	461	409	20	57	25	10	509
95th Queue (ft)	682	695	93	110	126	74	777
Link Distance (ft)	526	526			213	213	600
Upstream Blk Time (%)	19	7			1	0	60
Queuing Penalty (veh)	158	57			8	2	0
Storage Bay Dist (ft)			100	100			
Storage Blk Time (%)		21	0	6	1		
Queuing Penalty (veh)		14	0	44	1		

Intersection: 9: SE 27th St/NE 27th St & US 20

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	R	L	T	TR	L	T	TR	L	T
Maximum Queue (ft)	305	424	397	225	475	586	583	300	1641	1627	335	1943
Average Queue (ft)	304	391	327	167	433	538	537	299	1569	1555	240	1924
95th Queue (ft)	307	427	452	300	597	635	633	301	1823	1849	406	2115
Link Distance (ft)		368	368			547	547		1598	1598		1922
Upstream Blk Time (%)		58	14			55	57		78	41		56
Queuing Penalty (veh)		434	103			223	231		0	0		0
Storage Bay Dist (ft)	280			200	450			275			310	
Storage Blk Time (%)	67	11	30	2	10	65		83	1		0	57
Queuing Penalty (veh)	230	50	109	6	25	156		292	7		2	111

Intersection: 9: SE 27th St/NE 27th St & US 20

Movement	SB	SB
Directions Served	T	R
Maximum Queue (ft)	1955	250
Average Queue (ft)	1925	207
95th Queue (ft)	2114	351
Link Distance (ft)	1922	
Upstream Blk Time (%)	68	
Queuing Penalty (veh)	0	
Storage Bay Dist (ft)		225
Storage Blk Time (%)	58	2
Queuing Penalty (veh)	229	15

Intersection: 10: NE Bellevue Dr/NE Benson Way & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	64	86	45	99	620	608	492	491
Average Queue (ft)	17	4	2	27	359	329	385	372
95th Queue (ft)	51	36	20	87	759	727	644	629
Link Distance (ft)		547	547		674	674	476	472
Upstream Blk Time (%)					5	4	69	61
Queuing Penalty (veh)					20	16	0	0
Storage Bay Dist (ft)	50			75				
Storage Blk Time (%)	1	0		1	55			
Queuing Penalty (veh)	4	0		2	19			

Intersection: 11: Hamby Rd & US 20

Movement	EB	EB	WB	NB	NB	SB
Directions Served	LT	R	LTR	LT	R	LTR
Maximum Queue (ft)	1416	225	4659	325	181	382
Average Queue (ft)	847	161	3131	112	38	202
95th Queue (ft)	1894	325	5555	246	134	400
Link Distance (ft)	3386		5192	559		337
Upstream Blk Time (%)			3	0		22
Queuing Penalty (veh)			22	0		0
Storage Bay Dist (ft)		200			200	
Storage Blk Time (%)	70	1		4	0	
Queuing Penalty (veh)	88	6		7	0	

Intersection: 12: Torkelson Rd/Erickson Road & US 20

Movement	EB	WB	WB	NB	SB
Directions Served	LT	LT	R	LTR	LTR
Maximum Queue (ft)	158	588	65	140	149
Average Queue (ft)	27	126	7	41	47
95th Queue (ft)	98	627	52	120	121
Link Distance (ft)	5192	1102		732	727
Upstream Blk Time (%)		1			
Queuing Penalty (veh)		5			
Storage Bay Dist (ft)			93		
Storage Blk Time (%)	1	13	0		
Queuing Penalty (veh)	0	5	0		

Intersection: 13: US 20 & Powell Butte Rd

Movement	EB	WB	WB	SB	SB
Directions Served	L	T	R	L	R
Maximum Queue (ft)	156	210	41	356	105
Average Queue (ft)	64	16	1	109	93
95th Queue (ft)	120	162	27	307	123
Link Distance (ft)		973		1370	
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)	220		140		80
Storage Blk Time (%)	0	3	0	0	34
Queuing Penalty (veh)	0	0	0	1	2

Intersection: 16: US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	R
Maximum Queue (ft)	124	266	282	65	152	85	460	237
Average Queue (ft)	82	230	170	21	12	4	427	109
95th Queue (ft)	151	270	323	55	90	44	515	195
Link Distance (ft)		213	213		368	368	430	733
Upstream Blk Time (%)		47	11				91	
Queuing Penalty (veh)		406	99				0	
Storage Bay Dist (ft)	100			50				
Storage Blk Time (%)	2	57		4	1			
Queuing Penalty (veh)	17	94		23	0			

Intersection: 21: US 20

Movement	EB	EB	WB	WB	B109	B109	NB	SB
Directions Served	T	TR	T	TR	T	T	LTR	LTR
Maximum Queue (ft)	3	28	99	100	59	63	195	168
Average Queue (ft)	0	1	13	14	11	12	122	58
95th Queue (ft)	3	13	88	92	112	122	201	131
Link Distance (ft)	816	816	150	150	1972	1972	166	200
Upstream Blk Time (%)			2	2			11	1
Queuing Penalty (veh)			18	17			0	0
Storage Bay Dist (ft)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 24: US 20

Movement	EB	EB	WB	WB	NB	SB
Directions Served	L	T	LT	TR	LTR	LTR
Maximum Queue (ft)	80	7	114	82	121	166
Average Queue (ft)	31	0	14	10	43	59
95th Queue (ft)	66	7	81	62	94	133
Link Distance (ft)		674	372	372	235	227
Upstream Blk Time (%)						2
Queuing Penalty (veh)						0
Storage Bay Dist (ft)	100					
Storage Blk Time (%)	0					
Queuing Penalty (veh)	0					

Intersection: 111: US 20

Movement	EB	EB	WB	NB	SB
Directions Served	T	TR	TR	LTR	LTR
Maximum Queue (ft)	18	7	4	73	96
Average Queue (ft)	1	0	0	22	34
95th Queue (ft)	10	7	4	57	68
Link Distance (ft)	1183	1183	2099	341	314
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Network Summary

Network wide Queuing Penalty: 7620

Summary of All Intervals

Run Number	2	3	4	6	7	8	9
Start Time	4:15	4:15	4:15	4:15	4:15	4:15	4:15
End Time	5:25	5:25	5:25	5:25	5:25	5:25	5:25
Total Time (min)	70	70	70	70	70	70	70
Time Recorded (min)	60	60	60	60	60	60	60
# of Intervals	3	3	3	3	3	3	3
# of Recorded Intervals	2	2	2	2	2	2	2
Vehs Entered	12604	12659	12805	12710	12760	12690	12999
Vehs Exited	11855	11818	12017	11779	11713	11644	11934
Starting Vehs	1202	1208	1257	1203	1173	1120	1073
Ending Vehs	1951	2049	2045	2134	2220	2166	2138
Travel Distance (mi)	14164	14362	14315	14232	14256	14054	14334
Travel Time (hr)	2548.0	2608.2	2567.8	2609.9	2639.4	2605.2	2514.1
Total Delay (hr)	2112.7	2169.1	2127.9	2174.4	2204.0	2174.2	2074.5
Total Stops	35389	36679	37236	37740	37997	38355	37751
Fuel Used (gal)	944.8	966.0	953.2	962.4	967.9	952.6	936.9

Summary of All Intervals

Run Number	10	Avg
Start Time	4:15	4:15
End Time	5:25	5:25
Total Time (min)	70	70
Time Recorded (min)	60	60
# of Intervals	3	3
# of Recorded Intervals	2	2
Vehs Entered	12988	12775
Vehs Exited	11962	11841
Starting Vehs	1155	1166
Ending Vehs	2181	2108
Travel Distance (mi)	14380	14262
Travel Time (hr)	2544.8	2579.7
Total Delay (hr)	2103.5	2142.5
Total Stops	38187	37421
Fuel Used (gal)	946.2	953.8

Interval #0 Information Seeding

Start Time	4:15
End Time	4:25
Total Time (min)	10

Volumes adjusted by PHF, Growth Factors.

No data recorded this interval.

Interval #1 Information Recording1

Start Time	4:25
End Time	4:40
Total Time (min)	15

Volumes adjusted by PHF, Growth Factors.

Run Number	2	3	4	6	7	8	9
Vehs Entered	3389	3427	3489	3550	3422	3607	3656
Vehs Exited	2985	2964	3094	3078	2935	2892	2984
Starting Vehs	1202	1208	1257	1203	1173	1120	1073
Ending Vehs	1606	1671	1652	1675	1660	1835	1745
Travel Distance (mi)	3600	3651	3697	3746	3641	3695	3761
Travel Time (hr)	398.0	410.8	414.7	414.5	419.5	405.8	387.0
Total Delay (hr)	287.8	299.0	301.4	299.3	308.5	292.9	272.2
Total Stops	8143	8422	8687	8742	8494	9402	9030
Fuel Used (gal)	184.0	188.1	190.0	191.7	189.5	187.4	184.7

Interval #1 Information Recording1

Start Time	4:25
End Time	4:40
Total Time (min)	15

Volumes adjusted by PHF, Growth Factors.

Run Number	10	Avg
Vehs Entered	3562	3513
Vehs Exited	3038	2997
Starting Vehs	1155	1166
Ending Vehs	1679	1682
Travel Distance (mi)	3726	3690
Travel Time (hr)	388.1	404.8
Total Delay (hr)	274.0	291.9
Total Stops	8705	8700
Fuel Used (gal)	184.6	187.5

Interval #2 Information Recording2

Start Time	4:40
End Time	5:25
Total Time (min)	45

Volumes adjusted by Growth Factors, Anti PHF.

Run Number	2	3	4	6	7	8	9
Vehs Entered	9215	9232	9316	9160	9338	9083	9343
Vehs Exited	8870	8854	8923	8701	8778	8752	8950
Starting Vehs	1606	1671	1652	1675	1660	1835	1745
Ending Vehs	1951	2049	2045	2134	2220	2166	2138
Travel Distance (mi)	10564	10711	10619	10486	10615	10358	10573
Travel Time (hr)	2150.0	2197.4	2153.1	2195.5	2219.8	2199.4	2127.1
Total Delay (hr)	1824.9	1870.1	1826.5	1875.2	1895.5	1881.3	1802.3
Total Stops	27246	28257	28549	28998	29503	28953	28721
Fuel Used (gal)	760.8	778.0	763.2	770.7	778.4	765.1	752.2

Interval #2 Information Recording2

Start Time	4:40
End Time	5:25
Total Time (min)	45

Volumes adjusted by Growth Factors, Anti PHF.

Run Number	10	Avg
Vehs Entered	9426	9255
Vehs Exited	8924	8842
Starting Vehs	1679	1682
Ending Vehs	2181	2108
Travel Distance (mi)	10653	10572
Travel Time (hr)	2156.7	2174.9
Total Delay (hr)	1829.5	1850.7
Total Stops	29482	28708
Fuel Used (gal)	761.7	766.3

Arterial Level of Service: EB US 20

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
NE 3rd St	1	362.1	1060.0	0.4	3
NE 4th Street	2	2.2	15.9	0.1	21
NE 6th Street	3	4.6	23.4	0.2	27
NE 8th St	4	93.6	110.8	0.2	6
	21	6.6	23.7	0.2	25
	109	0.6	4.7	0.0	30
SE 15th St	5	48.6	87.2	0.4	16
	111	9.4	33.6	0.2	25
Dean Swift Road	6	15.3	57.1	0.4	26
Purcell Blvd	7	52.7	65.2	0.1	7
NE Windy Knolls Dr	8	13.0	25.1	0.1	17
	16	9.6	15.1	0.1	12
SE 27th St	9	76.4	84.8	0.1	4
NE Bellevue Dr	10	13.5	26.2	0.1	16
	24	23.6	35.3	0.1	14
	119	16.1	22.7	0.1	13
Hamby Rd	11	420.9	465.0	0.7	5
Torkelson Rd	12	13.4	84.7	1.0	43
Powell Butte Rd	13	5.0	19.5	0.2	41
Total		1187.2	2259.9	4.7	10

Arterial Level of Service: WB US 20

Cross Street	Node	Delay (s/veh)	Travel time (s)	Dist (mi)	Arterial Speed
Powell Butte Rd	13	4.1	16.7	0.2	42
Erickson Road	12	6.4	20.5	0.2	39
Hamby Rd	11	515.2	571.7	1.0	6
	119	8.4	62.1	0.7	39
	24	1.0	7.6	0.1	39
NE Benson Way	10	1.5	15.7	0.1	32
NE 27th St	9	80.9	92.9	0.1	5
	16	5.9	15.1	0.1	20
NE Windy Knolls Dr	8	4.6	10.0	0.1	19
Purcell Blvd	7	42.6	54.0	0.1	8
Dean Swift Road	6	6.0	19.1	0.1	23
	111	6.6	48.9	0.4	30
	5	28.8	53.4	0.2	16
	109	77.7	115.6	0.4	12
	21	19.0	26.3	0.0	6
NE 8th St	4	116.2	139.2	0.2	5
NE 6th Street	3	116.5	134.0	0.2	5
NE 4th Street	2	152.0	169.9	0.2	4
NE 3rd St	1	83.8	96.3	0.1	3
Total		1277.0	1669.0	4.5	10

Intersection: 1: NE 3rd St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	R	L	T	TR	L	T	TR
Maximum Queue (ft)	185	2024	2031	325	466	429	325	1466	1462	325	1828	1805
Average Queue (ft)	183	2000	1998	271	456	134	310	1397	1392	323	1684	1673
95th Queue (ft)	187	2148	2163	399	470	304	381	1597	1604	342	2114	2121
Link Distance (ft)		1999	1999		406	406		1413	1413		1779	1779
Upstream Blk Time (%)		90	76		57	3		73	72		73	56
Queuing Penalty (veh)		0	0		343	16		0	0		0	0
Storage Bay Dist (ft)	160			300			300			300		
Storage Blk Time (%)	75	14		5	59		53	38		81	13	
Queuing Penalty (veh)	309	50		36	144		179	77		317	39	

Intersection: 2: NE 4th Street & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	R	R
Maximum Queue (ft)	72	163	123	125	884	895	294	494
Average Queue (ft)	35	17	10	42	825	801	110	474
95th Queue (ft)	71	108	79	111	1034	1084	233	581
Link Distance (ft)		406	406		857	857	562	475
Upstream Blk Time (%)		0			49	34		87
Queuing Penalty (veh)		0			283	194		0
Storage Bay Dist (ft)	50			100				
Storage Blk Time (%)	16	0		0	63			
Queuing Penalty (veh)	102	0		1	41			

Intersection: 3: NE 6th Street & US 20

Movement	EB	EB	WB	WB	NB	SB
Directions Served	T	TR	T	TR	R	R
Maximum Queue (ft)	133	148	863	863	72	466
Average Queue (ft)	31	35	584	573	28	261
95th Queue (ft)	155	167	1110	1107	66	558
Link Distance (ft)	857	857	833	833	555	452
Upstream Blk Time (%)			5	6		36
Queuing Penalty (veh)			29	31		0
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 4: NE 8th St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	TR
Maximum Queue (ft)	325	834	847	325	852	863	250	1453	375	1925
Average Queue (ft)	220	602	616	298	729	726	128	1419	365	1740
95th Queue (ft)	391	912	922	404	977	986	307	1548	423	2265
Link Distance (ft)		833	833		816	816		1414		1885
Upstream Blk Time (%)		3	5		24	22		92		50
Queuing Penalty (veh)		25	36		174	157		0		0
Storage Bay Dist (ft)	300			300			225		350	
Storage Blk Time (%)	2	45		28	43		0	86	26	40
Queuing Penalty (veh)	14	65		144	107		0	52	128	141

Intersection: 5: SE 15th St & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB
Directions Served	T	T	R	L	T	T	L	R
Maximum Queue (ft)	835	876	225	375	934	948	319	470
Average Queue (ft)	478	502	163	294	425	411	208	108
95th Queue (ft)	845	886	298	442	987	971	320	291
Link Distance (ft)	1972	1972			1183	1183		933
Upstream Blk Time (%)					1	0		0
Queuing Penalty (veh)					4	3		0
Storage Bay Dist (ft)			200	350			300	
Storage Blk Time (%)		32	0	34	3		4	
Queuing Penalty (veh)		102	4	222	6		8	

Intersection: 6: Dean Swift Road & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	R	LTR
Maximum Queue (ft)	118	507	471	120	153	166	474	436
Average Queue (ft)	38	125	107	64	17	14	251	384
95th Queue (ft)	95	390	363	118	107	91	555	547
Link Distance (ft)		2099	2099		573	573	602	417
Upstream Blk Time (%)							11	74
Queuing Penalty (veh)							0	0
Storage Bay Dist (ft)	100			100				
Storage Blk Time (%)	1	9		6	0			
Queuing Penalty (veh)	5	6		39	0			

Intersection: 7: Purcell Blvd & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	T	R	L	T	R
Maximum Queue (ft)	325	610	606	325	569	568	315	1299	315	315	1212	315
Average Queue (ft)	287	531	520	300	452	439	257	1076	203	252	1053	237
95th Queue (ft)	390	667	661	382	606	596	389	1604	418	385	1493	428
Link Distance (ft)		573	573		526	526		1280			1193	
Upstream Blk Time (%)		10	8		11	4		39			45	
Queuing Penalty (veh)		92	72		83	32		0			0	
Storage Bay Dist (ft)	300			300			290		290	290		290
Storage Blk Time (%)	10	31		35	15		10	62	0	17	55	1
Queuing Penalty (veh)	72	89		198	35		39	180	2	82	212	3

Intersection: 8: NE Windy Knolls Dr & US 20

Movement	EB	EB	EB	WB	WB	WB	NB
Directions Served	T	T	R	L	T	T	LR
Maximum Queue (ft)	526	513	74	124	219	191	427
Average Queue (ft)	165	112	4	75	64	39	214
95th Queue (ft)	482	408	37	133	207	159	487
Link Distance (ft)	526	526			213	213	601
Upstream Blk Time (%)	1	0			4	1	5
Queuing Penalty (veh)	6	2			33	10	0
Storage Bay Dist (ft)			100	100			
Storage Blk Time (%)		2	0	6	9		
Queuing Penalty (veh)		2	0	45	10		

Intersection: 9: SE 27th St/NE 27th St & US 20

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB	NB
Directions Served	L	L	T	T	R	L	L	T	TR	L	L	T
Maximum Queue (ft)	292	305	410	389	225	286	362	452	449	362	374	1085
Average Queue (ft)	202	266	330	299	169	166	194	286	293	330	345	704
95th Queue (ft)	309	361	439	434	294	301	373	462	465	420	431	1507
Link Distance (ft)			361	361				529	529			1592
Upstream Blk Time (%)			22	11				1	1			6
Queuing Penalty (veh)			160	80				2	2			0
Storage Bay Dist (ft)	280	280			200	450	450			350	350	
Storage Blk Time (%)	1	9	28	31	3		0	2		9	37	0
Queuing Penalty (veh)	4	31	128	113	10		0	5		30	129	1

Intersection: 9: SE 27th St/NE 27th St & US 20

Movement	NB	NB	SB	SB	SB	SB	SB
Directions Served	T	R	L	L	T	T	R
Maximum Queue (ft)	1055	224	186	335	1944	1943	250
Average Queue (ft)	641	90	111	203	1926	1925	213
95th Queue (ft)	1437	177	175	420	2025	2027	341
Link Distance (ft)	1592				1916	1916	
Upstream Blk Time (%)	2				51	62	
Queuing Penalty (veh)	0				0	0	
Storage Bay Dist (ft)		350	310	310			225
Storage Blk Time (%)	0	0		0	52	53	3
Queuing Penalty (veh)	0	0		0	102	211	19

Intersection: 10: NE Bellevue Dr/NE Benson Way & US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	LTR
Maximum Queue (ft)	72	304	288	64	33	41	319	313
Average Queue (ft)	33	52	43	17	3	3	122	127
95th Queue (ft)	71	273	241	48	27	23	297	324
Link Distance (ft)		529	529		672	672	470	466
Upstream Blk Time (%)		0	0				5	4
Queuing Penalty (veh)		1	0				0	0
Storage Bay Dist (ft)	50			75				
Storage Blk Time (%)	2	10		0	0			
Queuing Penalty (veh)	8	8		1	0			

Intersection: 11: Hamby Rd & US 20

Movement	EB	EB	B119	B119	WB	NB	NB	SB
Directions Served	LT	R	T		LTR	LT	R	LTR
Maximum Queue (ft)	3446	225	361	62	4945	351	159	364
Average Queue (ft)	2452	210	97	2	3197	120	41	231
95th Queue (ft)	4084	303	364	43	5316	285	148	419
Link Distance (ft)	3386		372	372	5192	559		337
Upstream Blk Time (%)	28		4	0	1	0		27
Queuing Penalty (veh)	221		17	0	6	0		0
Storage Bay Dist (ft)		200					200	
Storage Blk Time (%)	97	1				7	0	
Queuing Penalty (veh)	120	9				12	1	

Intersection: 12: Torkelson Rd/Erickson Road & US 20

Movement	EB	EB	WB	WB	NB	SB
Directions Served	LT	R	LT	R	LTR	LTR
Maximum Queue (ft)	271	11	231	15	110	143
Average Queue (ft)	37	0	23	2	38	47
95th Queue (ft)	135	10	139	23	97	128
Link Distance (ft)	5192		1102		732	727
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)		68		93		
Storage Blk Time (%)	3	0	2	0		
Queuing Penalty (veh)	0	0	1	0		

Intersection: 13: US 20 & Powell Butte Rd

Movement	EB	WB	WB	SB	SB
Directions Served	L	T	R	L	R
Maximum Queue (ft)	134	6	8	355	105
Average Queue (ft)	60	0	0	88	90
95th Queue (ft)	109	6	7	276	122
Link Distance (ft)		973		1370	
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)	220		140		80
Storage Blk Time (%)				0	27
Queuing Penalty (veh)				0	1

Intersection: 16: US 20

Movement	EB	EB	EB	WB	WB	WB	NB	SB
Directions Served	L	T	TR	L	T	TR	LTR	R
Maximum Queue (ft)	124	257	244	73	245	259	455	533
Average Queue (ft)	91	148	95	36	42	27	408	288
95th Queue (ft)	147	310	257	74	174	151	541	672
Link Distance (ft)		213	213		361	361	424	727
Upstream Blk Time (%)		10	2			1	80	14
Queuing Penalty (veh)		83	21			4	0	0
Storage Bay Dist (ft)	100			50				
Storage Blk Time (%)	10	16		12	4			
Queuing Penalty (veh)	76	26		75	2			

Intersection: 21: US 20

Movement	EB	EB	WB	WB	B109	B109	NB	SB
Directions Served	T	TR	T	TR	T	T	LTR	LTR
Maximum Queue (ft)	3	6	244	245	1560	1582	191	211
Average Queue (ft)	0	0	133	133	503	509	121	116
95th Queue (ft)	3	4	311	315	1631	1644	202	235
Link Distance (ft)	816	816	150	150	1972	1972	166	200
Upstream Blk Time (%)			38	33	1	1	10	25
Queuing Penalty (veh)			300	264	11	11	0	0
Storage Bay Dist (ft)								
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 24: US 20

Movement	EB	EB	EB	NB	SB
Directions Served	L	T	TR	LTR	LTR
Maximum Queue (ft)	120	453	410	116	158
Average Queue (ft)	52	111	101	45	56
95th Queue (ft)	113	511	491	91	108
Link Distance (ft)		672	672	235	227
Upstream Blk Time (%)		7	4		0
Queuing Penalty (veh)		34	18		0
Storage Bay Dist (ft)	100				
Storage Blk Time (%)	0	16			
Queuing Penalty (veh)	1	24			

Intersection: 111: US 20

Movement	EB	WB	WB	NB	SB
Directions Served	T	T	TR	LTR	LTR
Maximum Queue (ft)	86	58	64	95	98
Average Queue (ft)	3	6	5	29	37
95th Queue (ft)	69	53	50	83	77
Link Distance (ft)	1183	2099	2099	341	314
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Network Summary

Network wide Queuing Penalty: 7317

Appendix C. Technical Memorandum #6: First Level Screening

Technical Memorandum #6: First Level Screening

U.S. 20 Bend Facility Plan

Bend, Oregon

May 18, 2023

Contents

Figures

Acronyms and Abbreviations

City	City of Bend
LPI	Leading Pedestrian Intervals
MUT	Median U-Turns
ODOT	Oregon Department of Transportation
Plan	U.S. 20 Bend Facility Plan
RCUT	Restricted Crossing U-Turns
ROW	Right-of-Way

1 Introduction

U.S. 20 is an Oregon Department of Transportation (ODOT) facility. The majority of the minor approaches that intersect the highway are City of Bend facilities. The highway is located in central Oregon and serves the residents of Bend, freight traffic, and other travelers. As the region has grown, so have congestion and safety concerns. The U.S. 20 Bend Facility Plan (Plan) will identify strategies to improve safety for all users, with an emphasis on improvements for people who walk, bike and use public transit. The Plan begins at the intersection of 3rd Street and Greenwood Avenue and ends at the intersection of Powell Butte Highway.

This memo presents alternatives at critical intersections that do not meet mobility targets in the future and are displayed in **Error! Reference source not found.**.

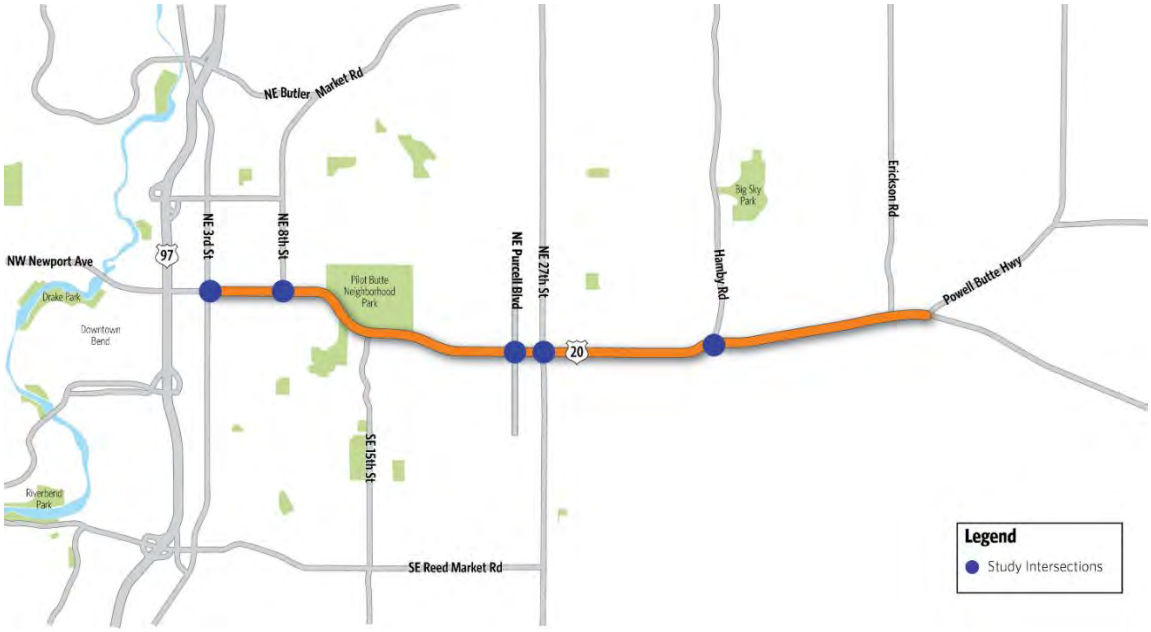
2 Intersection Improvements

Based on the traffic analysis, five intersections along U.S. 20 are expected to not meet mobility targets for the design year 2042:

- NE 3rd Street
- NE 8th Street
- NE Purcell Boulevard
- NE 27th Street
- Hamby Road

The concepts described in Technical Memorandum #5 were considered at each intersection. The subsections below describes the reasons concepts were either dismissed or proposed for further consideration.

Figure 1. Location of Proposed Intersection Improvements



2.1 U.S. 20 at NE 3rd Street

NE 3rd Street is a major north-south arterial parallel to U.S. 97 and its intersection with U.S. 20 is constrained with buildings on all four corners. U.S. 20 turns and continues north along NE 3rd street at this intersection before crossing under U.S. 97.
NE 3rd Street mainly serves businesses and shopping areas both to the north and south of the U.S. 20/Greenwood Avenue intersection. Any widening or other major geometric changes would have a significant impact on private right-of-way (ROW) and businesses.

2.1.1 Alternatives Considered and Dismissed

The bulleted list below describes each concept that was considered at NE 3rd Street and the reason(s) the alternative was not advanced.

- Roundabout
  - Significant ROW impact in all four quadrants
- Removal of lefts
  - Concerns with diversion of traffic onto local roads
  - Left turn volumes are high enough that mitigation would need to be provided
- MUTs/RCUTs
  - No viable U-turn locations
    - Location of U-turn locations along U.S. 20 would have significant impacts to businesses adjacent to NE 1st Street, NE 4th Street, and NE 5th Street.

- Traditional Widening – Major and Minor
    - ROW impacts adjacent to U.S. 20 and NE 3rd Street.
    - Minor widening of adding an eastbound right turn would not provide a significant operational benefit
        - Reduction from v/c of 1.05 in no build to 0.99 which still does not meet the mobility target
    - Major widening would significantly impact the buildings on the northeast and southwest corners of the intersection

2.1.2 Proposed Alternative

The proposed alternative at 3rd Street is to only provide pedestrian, bicycle and transit improvements as described in Section 2.1.3 below. Restricted Crossing U-Turns (RCUTs), Median U-Turns (MUTs), and minor widening will not achieve the mobility target and major widening of U.S. 20 to provide additional through lanes cause significant ROW adjacent to US 20.

2.1.3 Pedestrian, Bicycle and Transit Improvements

The proposed pedestrian treatments at NE 3rd Street include leading pedestrian intervals (LPIs) on all legs, audible pedestrian signals, warning signs on all approaches per the Bend Safety Implementation Plan, and right turn on red prohibition per the 2012 Multimodal Traffic Safety Assessment. Bicycle treatments include a bike box at the westbound approach. Transit signal priority would also be added to the signal timing at this intersection.

2.2 U.S. 20 at NE 8th Street

NE 8th Street is the next signalized intersection on U.S. 20 to the east of NE 3rd Street and serves as a major access point to residential neighborhoods that are on the north and south of U.S. 20 in this area.

2.2.1 Alternatives Considered and Dismissed

The bulleted list below describes each concept that was considered at NE 8th Street and the reason(s) the alternative was not advanced.

- Roundabout
    - Significant ROW impact in all four quadrants
    - Causes a degradation in operations versus a signal
        - v/c of 1.16 in no build to 1.45 with a roundabout.
- MUTs/RCUTs
    - No viable U-turn locations

- Location of U-turn locations along U.S. 20 would have significant impacts to churches on NE 10th Street and businesses adjacent to NE 6th and NE 7th Street

- Traditional Widening – Major and Minor
  - ROW impacts adjacent to U.S. 20 and NE 8th Street
  - Adding dual southbound left turns and a northbound right turn does not meet the mobility target (v/c of 0.98)

2.2.2 Proposed Alternative

The proposed alternative at NE 8th Street is to remove the eastbound and westbound left turns from U.S. 20. A median island is recommended to preclude vehicles from getting into the existing two-way left turn lane (TWLTL) along U.S. 20. The length of the proposed median should consider deceleration and left turn lane storage needs at the adjacent unsignalized intersections. Operationally, NE 8th Street/U.S. 20 is expected to meet mobility targets with a v/c of 0.96.

Figure 2: NE 8th Street Proposed Intersection Concept

2.2.3 Pedestrian, Bicycle and Transit Improvements

Pedestrian treatments at this intersection would include LPIs on all legs and warning signage on all approaches, similar to NE 3rd Street. Bicycle treatments would be limited to enhancing the existing on street bike lanes by providing green paint upstream from the intersection on the northbound and southbound approaches. All approaches would include green bike lane conflict markings traversing the first lane of cross-street traffic. The signal would be upgraded to include transit signal priority.

2.3 U.S. 20 at NE Purcell Boulevard

NE Purcell Boulevard is a major signalized intersection just west of NE 27th Street. Several car dealerships and a shopping mall are located at this intersection. North and south of U.S. 20, NE Purcell Boulevard winds through residential neighborhoods.

2.3.1 Alternatives Considered and Dismissed

The bulleted list below describes each concept that was considered at NE Purcell Boulevard and the reason(s) the alternative was not advanced.

- Roundabout
    - Significant ROW impact in all four quadrants
        - This location would only require impacting parking lots to construct a roundabout, but this would still be a significant ROW cost and impact.
- MUTs/RCUTs
    - U-turn locations would impact ROW and parking near Dean Swift Road and Windy Knolls Drive

2.3.2 Proposed Alternative

The proposed alternative at NE Purcell Boulevard is to widen to provide a dedicated northbound left lane as shown in Figure 3. While this will not meet the mobility target, it does improve the operations by decreasing the v/c from 1.06 to 0.92 with minimal ROW impacts. Bicycles would be accommodated with a keyhole at the right turn bay opening, similar to other treatments along the corridor.

Figure 3: Proposed Minor Widening at NE Purcell Boulevard

2.3.3 Pedestrian, Bicycle and Transit Improvements

Pedestrian treatments at this intersection would include LPIs and audible pedestrian signals on all lets. The SE corner would also be reconstructed to include dual curb ramps. The southbound approach would include green bike lane conflict markings upstream of the southbound right turn lane. Green paint would be used on the upstream bike lanes on both the eastbound and westbound approaches. The signal would be upgraded to include transit priority.

2.4 U.S. 20 at NE 27th Street

NE 27th street is a major intersection at U.S. 20. NE 27th street serves a large shopping area to the north, as well as a hospital at NE Neff Road. NE 27th also provides access to many residential homes and neighborhoods both to the north and south of U.S. 20.

2.4.1 Alternatives Considered and Dismissed

The bulleted list below describes each concept that was considered at NE 27th Street and the reason(s) the alternative was not advanced.

- Roundabout
    - A multilane roundabout would impact the buildings that are located on three corners of the intersection, as well as adjacent driveway access

- MUTs/RCUTs
    - Displacing the eastbound and westbound left turns and providing a U-turn would meet the mobility target (v/c of 0.85) however several impacts were identified:
        - The MUTs would impact parking, driveways, and business access near NE Bellevue Drive and NE Windy Knolls Drive
        - MUTs would need to be designed to accommodate WB-67s, since NE 27th Street is a major route, resulting in larger loons or bulb-outs and opposition from ODOT's Mobility Advisory Committee.
    - Diverting lefts was rejected as an alternative because of the high volume of left turning vehicles, as well as the need to maintain easy access to the hospital located to the north of U.S. 20 along 27th Street.

2.4.2 Proposed Alternative

Two different options were considered at this intersection: minor and major widening. The minor widening alternative added an eastbound right turn lane with a porkchop island as shown in Figure 4. The major widening alternative added the same eastbound right turn lane and added dual left turn lanes on all approaches, shown in Figure 5. The minor widening alternative results in a v/c reduction of 0.2 (1.26 to 0.96). The major widening alternative, while more impactful, will achieve the mobility target with a v/c of 0.8.

Figure 4: Minor widening alternative at NE 27th Street

Figure 5: Major widening at NE 27th Street

2.4.3 Pedestrian, Bicycle and Transit Improvements

Pedestrian treatments at this intersection would include LPIs on the east, north and south legs, and audible pedestrian signals on all legs. The northeast and southeast corners would be rebuilt to include dual curb ramps. Green bike lane conflict markings would be used on the southbound and eastbound approaches before the right turn slip lanes. Solid green bike lanes would be painted upstream on the eastbound, northbound, and westbound approaches. The signal would be upgraded to include transit signal priority.

2.5 U.S. 20 at Hamby Road

Hamby Road is currently a single lane roundabout that was recently constructed in 2022. Hamby Road was converted from a signal to a roundabout to reduce vehicular delay and improve safety at the intersection.

2.5.1 Alternatives Considered and Dismissed

The bulleted list below describes each concept that was considered and the reason(s) the alternative was not advanced.

- Widening to multilane roundabout
    - Widening to a multilane roundabout will require reconstruction of the entire roundabout

- To achieve acceptable lane utilization, widening along U.S. 20 approximately 300 feet upstream and downstream of Hamby Road would be required

- Changing intersection type to signal
  - Reverting to a signal would have a negative public perception since the roundabout was completed recently
  - A signal would not provide the same safety benefits that drove the selection of a roundabout at this location

2.5.2 Proposed Alternative

The proposed alternative at this location is to modify the existing roundabout to add a right turn bypass lanes on the northbound and eastbound approaches as shown in Figure 6. This alternative will reduce the v/c to 0.97 while maintaining the existing roundabout configuration. Constructing the bypass lanes will also be less impactful during construction than converting the intersection to a signalized intersection.

Figure 6: Hamby Road Proposed Slip Lanes

2.5.3 Pedestrian, Bicycle and Transit Improvements

Pedestrian and bicycle treatments would remain similar to the existing configuration and would just be updated to fit with the added slip lanes.

Appendix D. Technical Memorandum #5: Alternatives

Technical Memorandum #5: Alternatives

U.S. 20 Bend Facility Plan

Bend, Oregon

July 28, 2023

Contents

Figures

Tables

Acronyms and Abbreviations

ADA	Americans with Disabilities Act
ATC	Automatic Traffic Control
BUD	Blueprint for Urban Design
City	City of Bend
LPIs	Leading Pedestrian Intervals
MAC	Mobility Advisory Committee
MUT	Median U-Turns
ODOT	Oregon Department of Transportation
Plan	U.S. 20 Bend Facility Plan
RCUT	Restricted Crossing U-Turns
ROW	Right-of-Way
STIP	Statewide Transportation Improvement Program
TSP	Transportation System Plan

1 Introduction

U.S. 20 is located in central Oregon and serves the residents of Bend, freight traffic and other travelers. As the region has grown, so have congestion and safety concerns. The U.S. 20 Bend Facility Plan (Plan) will identify strategies to improve safety for all users, with an emphasis on improvements for people who walk, bike and use public transit. The study area begins at the intersection of U.S. 20 (NE Greenwood Avenue) and NE 3rd Street, and ends at the intersection of U.S. 20 and Powell Butte Highway.

This memorandum introduces intersection and corridor improvement concepts to address capacity, comfort, and safety for all transportation modes along the U.S. 20 corridor. While U.S. 20 is an Oregon Department of Transportation (ODOT) facility, the majority of side street approaches that intersect the highway are City of Bend (City) facilities.

2 Pedestrian, Bicycle and Transit Improvement Concepts

This section identifies locations and briefly describes concepts that would improve the U.S. 20 corridor for people walking, biking or riding transit. Concepts include improvements along and across U.S. 20, on parallel routes, and on key lateral connections between them. The improvement concepts were informed by the following documents and sources:

- Background plans (e.g., Bend Transportation System Plan (TSP), Bend Park and Recreation Plan, Bend Safety Implementation Plan, Key Walking/Bicycling Routes, Low-Stress Network).
- Input received at Technical Advisory Committee and stakeholder meetings.
- Information from ODOT, City and partner agencies outside of project meetings.

Because U.S. 20 is an ODOT facility, ODOT's Highway Design Manual/Blueprint for Urban Design (BUD) plays a prominent role in prioritizing modes and informing the corridor's broader planning and design features, which are also largely informed by the land use contexts through which the corridor passes. As described in the Existing Conditions Memo, the BUD's land use contexts for the study area corridor include Urban Mix, Commercial, Residential Corridor and Rural Community. Upon defining a corridor's land use context, the BUD's subsequent sections present guidance for the location and design of typical roadway features such as motor vehicle travel lanes, turn lanes, center medians, bicycle facilities, sidewalks and formalized pedestrian crossings. While typology and design guidance for most roadway features are similar for most land use contexts, the BUD guidance for pedestrian crossing spacing varies, as shown in Table 1.

Table 1. BUD Land Use Contexts and Pedestrian Crossing Spacing Guidance for U.S. 20

Land Use Context	Section	Target Pedestrian Crossing Spacing (feet)
Urban Mix	NE 3rd Street to NE 12th Street	250-550
Commercial Corridor	NE 12th Street to NE Benson Way	500-1,000
Residential Corridor	NE Benson Way to NE Providence Drive	500-1,000
Rural Community	NE Providence Drive to Powell Butte Highway	250-750

Figure 1 presents an overview of the study area and identifies potential pedestrian, bicycle and transit improvement concepts. Table 2 summarizes the concepts by location. Most concepts located along U.S. 20 focus on reducing the corridor's barrier effect with improved multimodal crossings, including new crossings and enhancements to existing crossings. As a result, most corridor segments would fall within the BUD's target pedestrian crossing spacing parameters. It should be noted that, given the multitude of new or improved crossings, Figure 1 identifies priority locations for which ODOT and its partners may elect to focus nearer-term investments.

While this Plan generally identifies opportunities for enhanced crossings, the following should be considered as projects advance toward implementation:

- Further engineering analysis will be necessary to determine particular crossing enhancements and design elements at most locations; this subsequent analysis should consider criteria set forth in ODOT's Traffic Manual, Traffic Line Manual, Signal Policy, Sign Policy and ODOT overall engineering judgement.
- Depending on circumstances, Region or State Traffic/Roadway Engineer approval will be necessary for most concept elements presented in Table 2.
- As U.S. 20 is a Statewide Freight Route and a Reduction Review Route, engagement with ODOT's Mobility Advisory Committee (MAC) may be necessary.

Figure 1. Pedestrian, Bicycle and Transit Improvement Concepts Location Overview

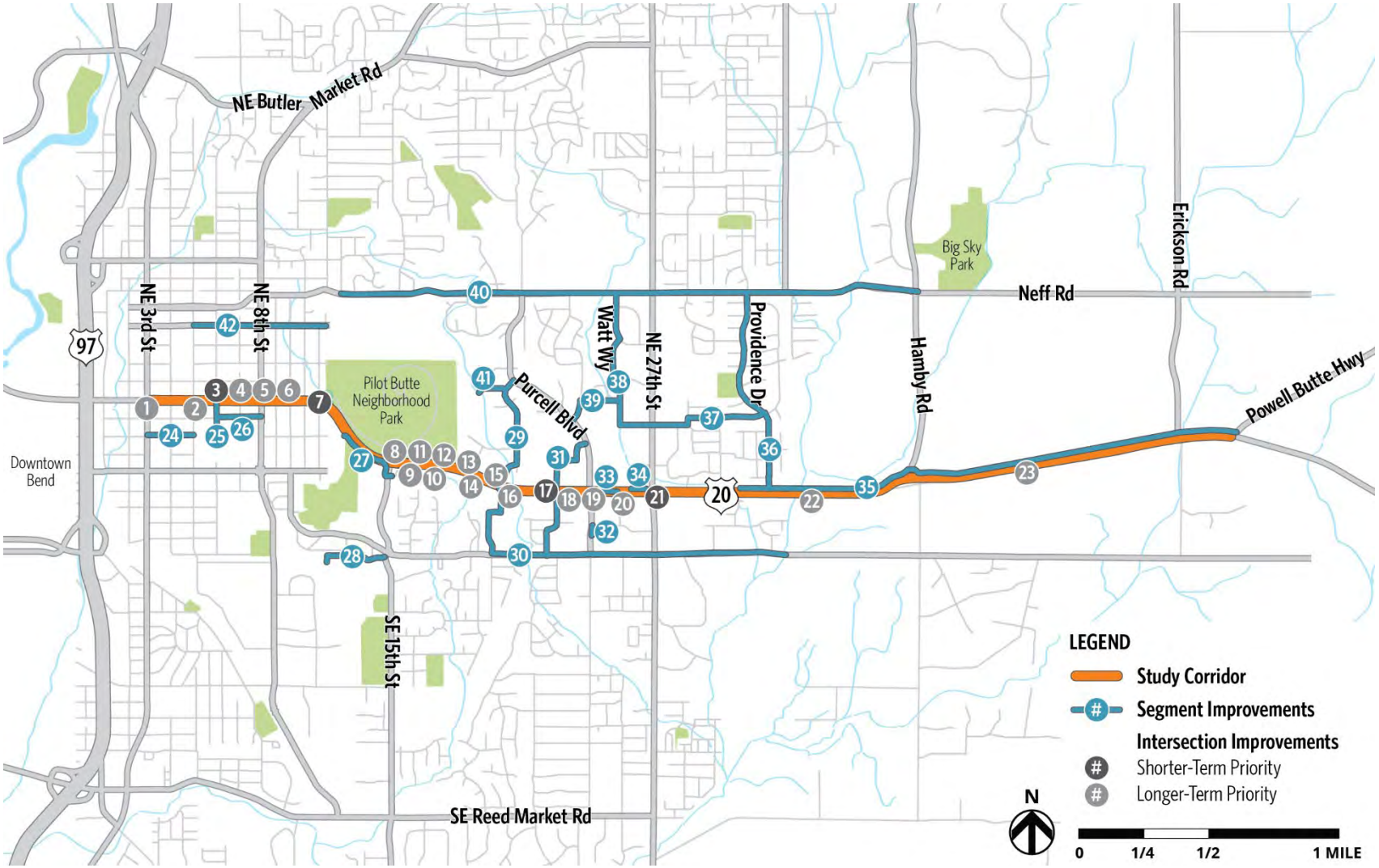


Table 2. Pedestrian, Bicycle and Transit Improvement Concepts

Map #	Reference/Location	Description
1	U.S. 20 at NE 3rd Street	Pedestrian treatments: • Leading Pedestrian Intervals (LPIs) on all legs (subject to analysis relative to ODOT Signal Policy). • Warning signage on all approaches (Turning Vehicles Yield to Bikes/Peds) (per Bend Safety Implementation Plan). • Right-turn-on-red prohibition (per 2012 Multimodal Traffic Safety Assessment). Transit treatments: • Transit signal priority implemented with Automatic Traffic Control (ATC) upgrade.
2	U.S. 20 at NE 5th Street	New enhanced crossing at (or in vicinity of) intersection.
3	U.S. 20 at NE 6th Street	Per Bend Safety Implementation Plan: • Modified median refuge to include bicycle cut-through(s). • Rectangular Rapid Flashing Beacon.
4	U.S. 20 at NE 7th Street	New enhanced crossing at (or in vicinity of) intersection.
5	U.S. 20 at NE 8th Street	Pedestrian treatments: • LPIs on all legs (subject to analysis relative to ODOT Signal Policy). • Warning signage on all approaches (Turning Vehicles Yield to Bikes/Peds). Bicycle treatments: • NB and SB approaches: green bike lanes (solid fill) immediately upstream from intersection. • All approaches: green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT approval). Transit treatments: • Transit signal priority (to be implemented upon completion of ATC upgrade). Note: TSP Project #C-30 (details not specified).
6	U.S. 20 at NE 10th Street	New enhanced crossing at (or in vicinity of) intersection.
7	U.S. 20 at NE 12th Street	Modified median refuge to include bicycle cut-through(s).
8	U.S. 20 at NE 15th Street	Pedestrian treatments: • LPIs on all legs (subject to analysis relative to ODOT Signal Policy). • Warning signage on EB and NB approaches (Turning Vehicles Yield to Bikes/Peds) Bicycle treatments: • EB approach: green bike lane conflict markings immediately upstream from EB right turn lane (subject to ODOT approval). • NB approach: shared lane marking in NB left turn lane. Transit treatments: • Transit signal priority (to be implemented upon completion of ATC upgrade).
9	Larkspur Trail Stairway Connection	Consider adding stairway along existing demand path to streamline pedestrian connections between U.S. 20 and the Larkspur Trail (note: may require supplemental Americans with Disabilities Act (ADA) accessible ramp connection).
10	Larkspur Trail Bicycle Connection	Add ramp to facilitate direct linkage between Larkspur Trail south of US 20 and the U.S. 20 EB bike lane.
11	EB Transit Stop Consolidation	Consider removal of existing EB transit stop, and consolidate with existing EB transit stops at NE 15th Street and/or NE Azure Drive.
12	Larkspur Trail Bicycle	Add ramp to facilitate direct linkage between Larkspur Trail north of US

Map #	Reference/Location	Description
	Connection	20 and the U.S. 20 WB bike lane.
13	WB Transit Stop Consolidation	Consider removal of existing WB transit stop, and consolidate with existing WB transit stops at NE Azure Drive and/or NE 15th Street.
14	U.S. 20 at NE Arnett Way	New enhanced crossing at (or in vicinity of) intersection; potential to leverage existing pedestrian cut-through on west leg.
15	WB Transit Stop Enhancement	Lengthen existing concrete pad to serve rear-door passenger alighting.
16	U.S. 20 at NE Azure Drive	New enhanced crossing at (or in vicinity of) intersection.
17	U.S. 20 at Dean Swift Road	New enhanced crossing at (or in vicinity of) intersection.
18	EB Transit Stop Consolidation	Consider removal of existing EB transit stop, and consolidate with existing EB transit stops at NE Azure Drive and/or NE Purcell Boulevard
19	U.S. 20 at NE Purcell Boulevard	Pedestrian treatments: • LPIs on all legs (subject to analysis relative to ODOT Signal Policy). • Dual curb ramps on NW corner. • Warning signage on all approaches (Turning Vehicles Yield to Bikes/Peds). Bicycle treatments: • SB approach: green bike lane conflict markings immediately upstream from SB right turn lane (pending required approvals). • EB and WB approaches: green bike lanes (solid fill) immediately upstream from intersection, and green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT approval.) Transit treatments: • Upgrades to existing SB transit stop (upstream from intersection) (per Cascades East Transit). • Transit signal priority (to be implemented upon completion of ATC upgrade).
20	U.S. 20 at NE Windy Knolls Drive	New enhanced crossing at (or in vicinity of) intersection.
21	U.S. 20 at NE 27th Street	Pedestrian treatments: • LPIs on east, north and south legs (subject to analysis relative to ODOT Signal Policy). • Audible pedestrian signals. • Dual curb ramps on NE and SE corners. • Warning signage on EB, NB, WB approaches (Turning Vehicles Yield to Bikes/Peds). Bicycle treatments: • SB approach: green bike lane conflict markings on SB slip lane. • EB, NB, WB approaches: green bike lanes (solid fill) immediately upstream from intersection, and green bike lane conflict markings traversing the first lane of cross-street traffic (subject to ODOT approval). Transit treatments • Transit signal priority (to be implemented upon completion of ATC upgrade). • New EB transit stop immediately east of intersection. Note: Specific design elements to be coordinated with the City's pending project to develop a shared use path on NE 27th Street between U.S. 20 and Bear Creek Road.
22	U.S. 20 at Future "Hanson to Big Sky Trail" Crossing	Future trail undercrossing (to be confirmed upon finalizing trail alignment) (per Bend Park and Recreation District Comprehensive Plan).

Map #	Reference/Location	Description
23	U.S. 20 at Future Trans-Canada Trail Crossing-	Future trail crossing (specific crossing type to be confirmed upon finalizing trail alignment) (per Bend Park and Recreation District Comprehensive Plan).
24	Hawthorne Neighborhood Greenway	Hawthorne Neighborhood Greenway (portion of TSP Project #R6-A).
25	NE 6th Street Neighborhood Greenway Extension	Extend Neighborhood Greenway south to Juniper Swim and Fitness Center.
26	NE Irving Avenue	Neighborhood Greenway.
27	Larkspur Trail/Hawthorne Neighborhood Linkage	Shared use path linking the Larkspur Trail and Hawthorne Neighborhood Greenway (project includes new crosswalk at NE 15th Street).
28	Bear Creek Safe Routes to Schools	Larkspur Trail/Coyner Trail Connection (TSP Project #R2-D).
29	NE Cessna Drive/ NE Azure Drive/ NE Savannah Drive	Enhanced bikeway.
30	NE Bear Creek Road	Shared use path adjacent to roadway; sidewalk infill (TSP Project #R2-E).
31	Dean Swift Road	Enhanced bikeway.
32	NE Purcell Boulevard	Sidewalk infill.
33	Ped Crossing Enhancement	Remove EB deceleration lane, tighten EB turn radius (pending engineering study).
34	Bike Lane Gap Closure	Remove WB deceleration lane, tighten WB turn radius, add WB bike lane (pending engineering study).
35	U.S. 20 Shared Use Path	Shared use path (north or south side of U.S. 20) between Bend city limits vicinity and Powell Butte Highway.
36	NE Providence Drive	Enhanced bikeway.
37	NE Forum Drive/ NE Locksley Drive	Enhanced bikeway.
38	NE Forum Drive/ NE Watt Way/ Medical Center	Enhanced bikeway (corridor identified as Key Walking/Bicycling Route in Bend TSP).
39	NE Paula Drive/ NE Donegon Road	Enhanced bikeway.
40	NE Neff Road	Shared use path adjacent to roadway; sidewalk infill (TSP Project # R3-C).
41	NE Parkview Court	Shared use path connection to Larkspur Trail; enhanced bikeway on NE Parkview Court.
42	NE Norton Avenue Neighborhood Greenway	Neighborhood Greenway (TSP Project #R-3A).

2.1 U.S. 20 Cross-Section Improvements

Supplementing the multimodal improvements described above, the Project Team developed cross-section concepts for the entirety of U.S. 20 within the study area. Illustrated in Figure 2 through Figure 16, the concepts are organized by roadway segment, beginning at the study area's west end. In developing the concepts, the Project Team considered the following primary factors:

- The Project's principal vision of improving conditions for vulnerable roadway users, notably people walking, bicycling and accessing transit along and across U.S. 20.
- Maintaining a relatively consistent concept design theme while responding to local conditions where necessary.
- Balancing aspirations with cost as well as other practical considerations and Facility design guidance established in the BUD, tied to the land use contexts established to the U.S. 20 corridor.

For each corridor segment, the figures below display three cross-section concepts:

- The **existing cross-section** (with approximate measurements).
- **Shorter-term enhancements**.
    - To minimize costs, these enhancements would maintain the outside curb lines while remaining within the existing right-of-way (ROW). Improvements would primarily consist of striping modifications to widen the existing bike lanes or add delineated buffers. In the rural segment of U.S. 20 (east of NE Providence Drive) a shared use path on one side would serve foot and bicycle traffic. These shorter-term enhancements would be compatible with the crossing upgrades described earlier in this memo.
    - The following should be noted when considering these concepts:
        - In order to retain the existing curb lines and avoid ROW acquisition needs, this concept omits the BUD's recommended Sidewalk Frontage Zone.
        - While the corridor's motor vehicle volumes and speeds exceed ODOT's thresholds for separated bike lanes, the provision of conventional and buffered bike lanes may derive limited level-of-comfort benefits for interested-but-concerned riders.
        - As U.S. 20 is a designated Statewide Freight Route and Reduction Review Route, further feasibility analysis and MAC engagement may be necessary.
- **Longer-term/aspirational enhancements**.
    - While remaining within the existing ROW, these enhancements would involve more substantial cross-section adjustments to improve vulnerable roadway user comfort and safety, notably the creation of physically-separated shared use paths.

- The following should be noted when considering these concepts:
  - As with the shorter-term enhancements, most corridor segments in this concept omit the BUD's recommended Sidewalk Frontage Zone (in order to remain within the existing ROW). If ROW acquisition is feasible, this feature should be added on both sides of the corridor.
    - If additional ROW acquisition is feasible, an additional Buffer Zone between the shared use path and the curb is recommended in order to provide more lateral separation between motorized and non-motorized users while providing a zone for the placement of signs, fire hydrants and luminaires. Depending on location, this space could also accommodate driveway aprons, thereby enabling the shared use path to remain at sidewalk level.
  - Access management, particularly on U.S. 20 between NE 3rd Street and NE 12th Street, will be critical for minimizing conflicts between path users and motor vehicles entering and exiting driveways.

Figure 2. NE 3rd to NE 12th – Existing Cross Section

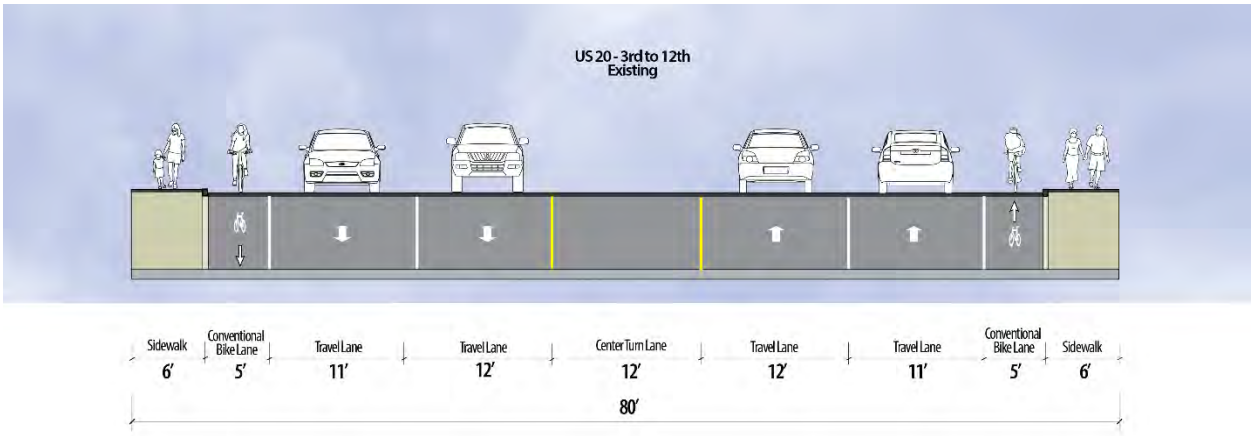


Figure 3. NE 3rd to NE 12th – Shorter-Term Cross Section

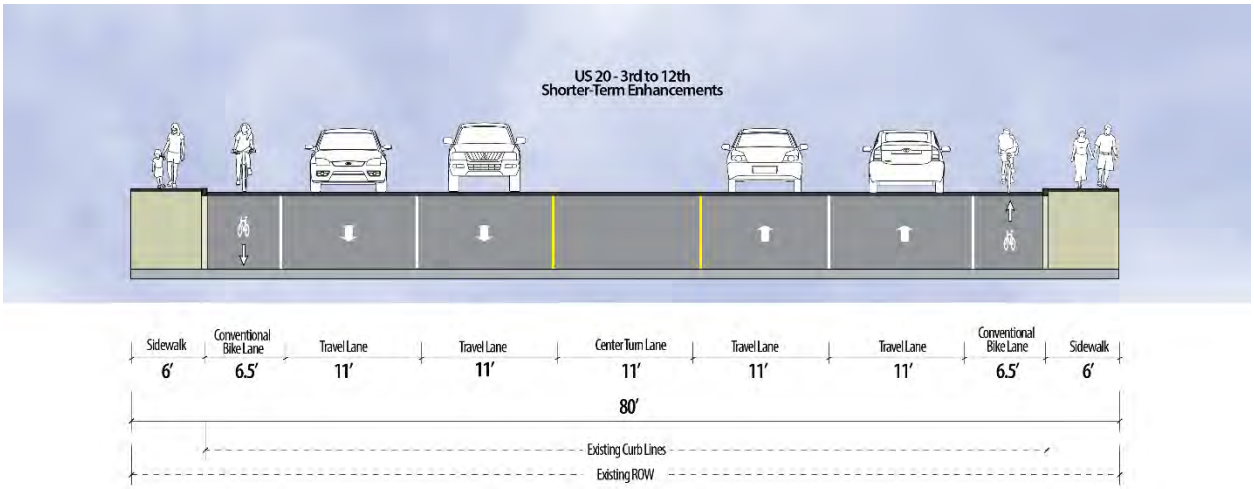


Figure 4. NE 3rd to NE 12th – Longer-Term Cross Section

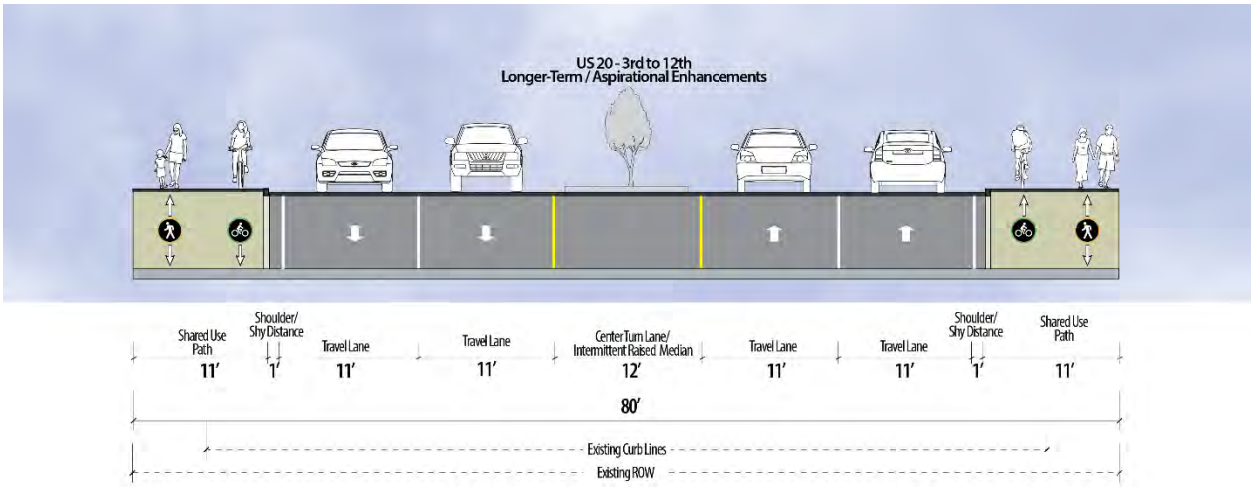


Figure 5. NE 12th to NE 15th – Existing Cross Section

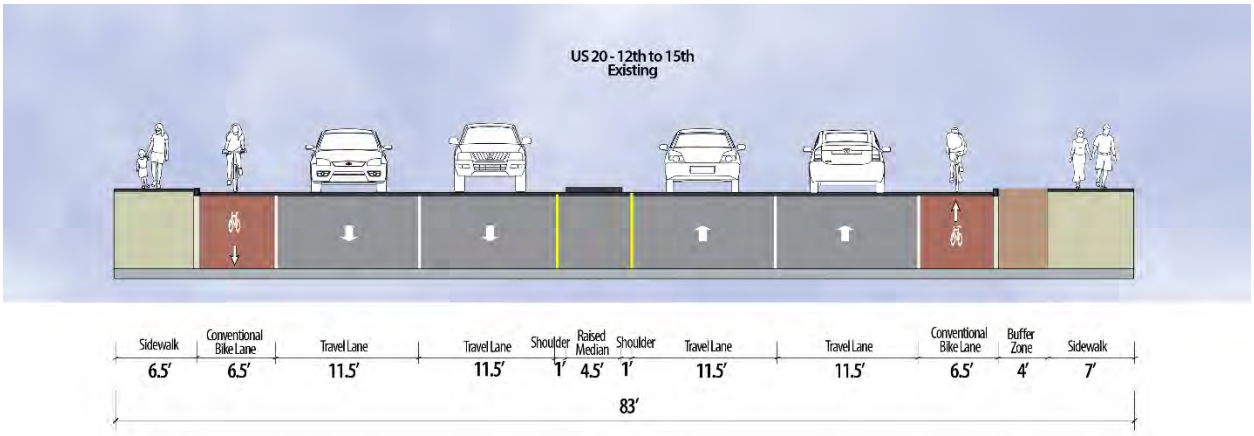


Figure 6. NE 12th to NE 15th – Shorter-Term Cross Section

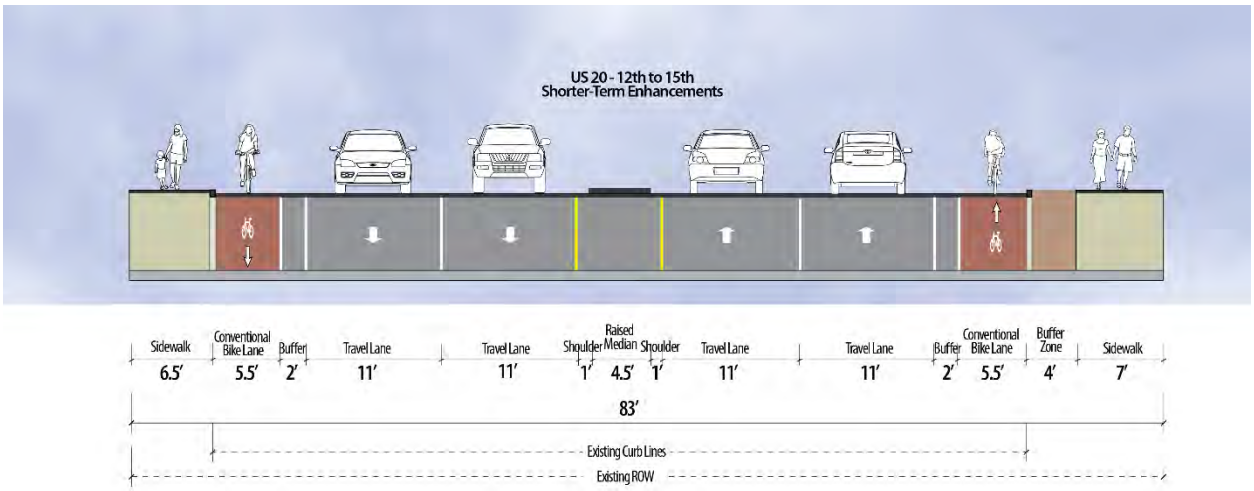


Figure 7. NE 12th to NE 15th – Longer-Term Cross Section

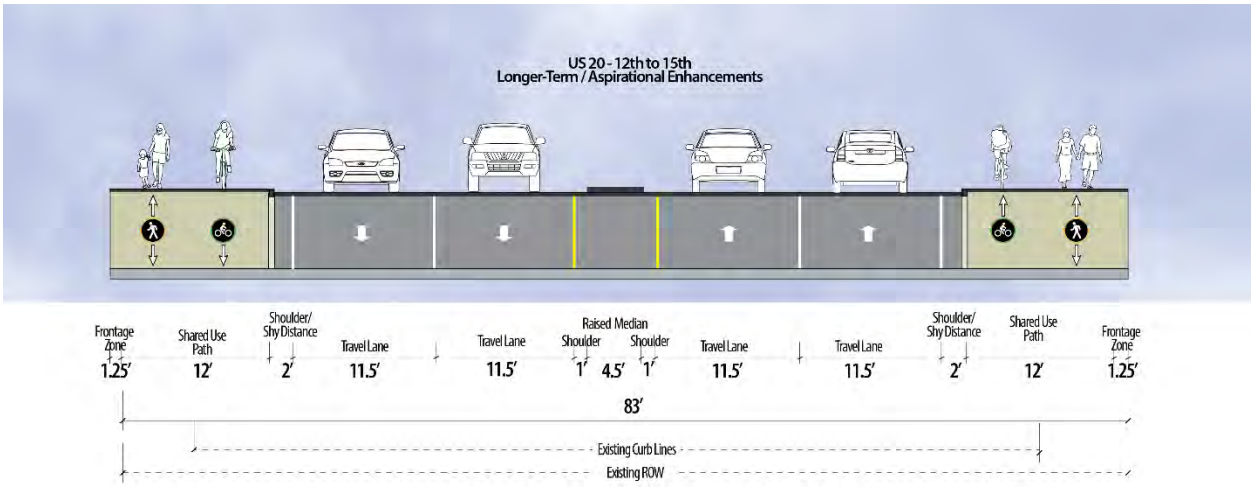


Figure 8. NE 15th to NE Bellevue/NE Benson – Existing Cross Section

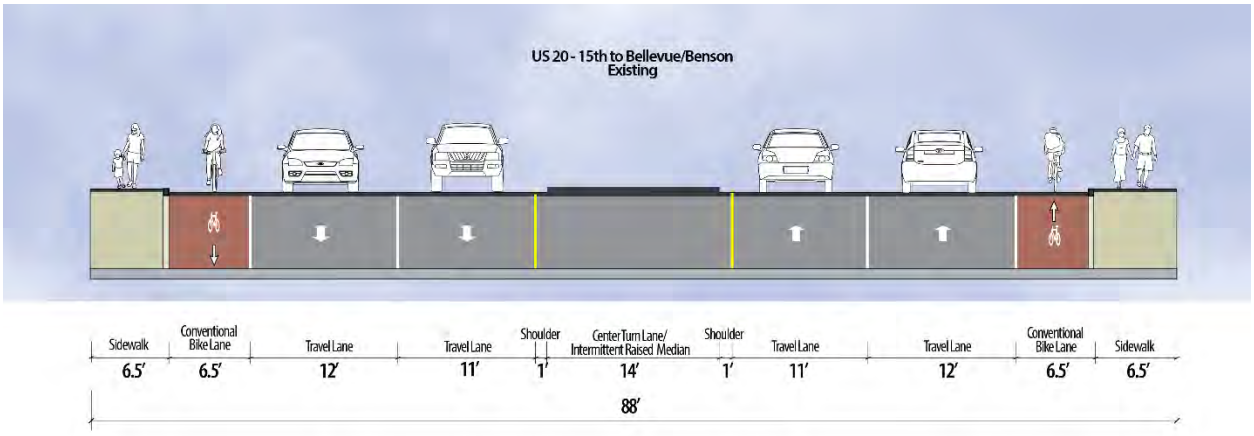


Figure 9. NE 15th to NE Bellevue/NE Benson – Shorter-Term Cross Section

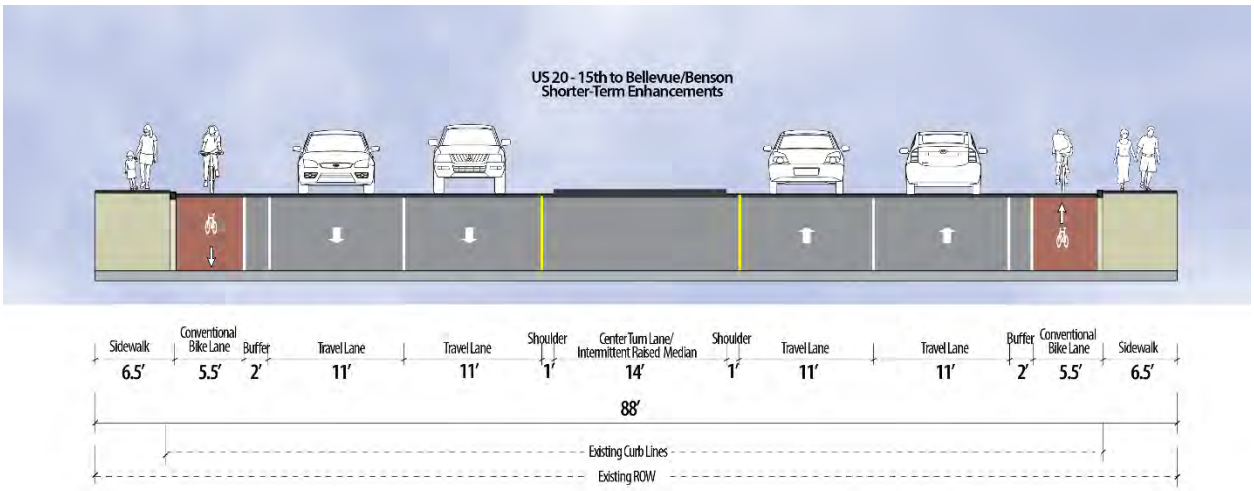


Figure 10. NE 15th to NE Bellevue/NE Benson – Longer-Term Cross Section

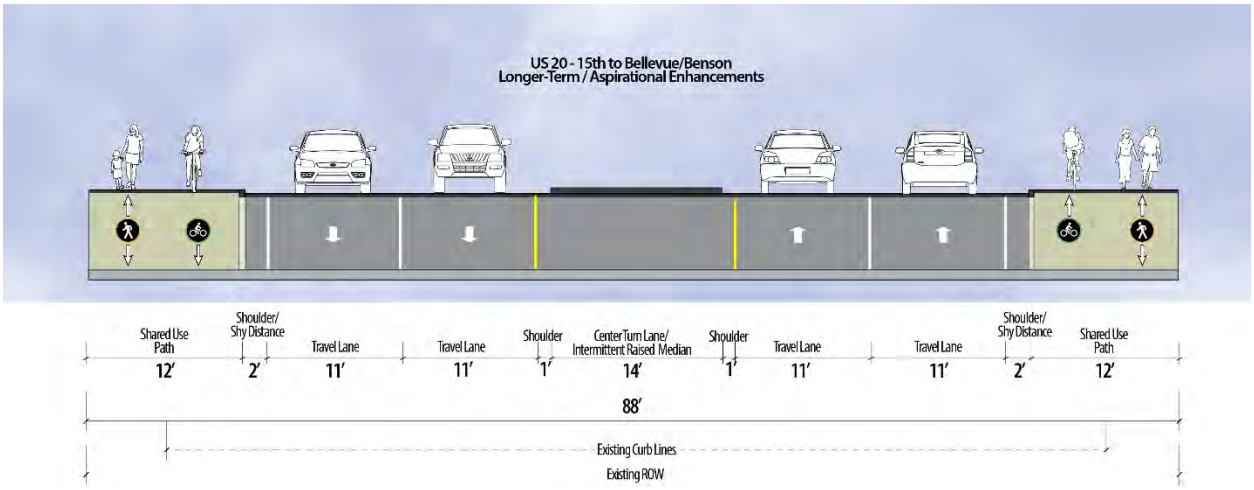


Figure 11. NE Bellevue/NE Benson to NE Providence – Existing Cross Section

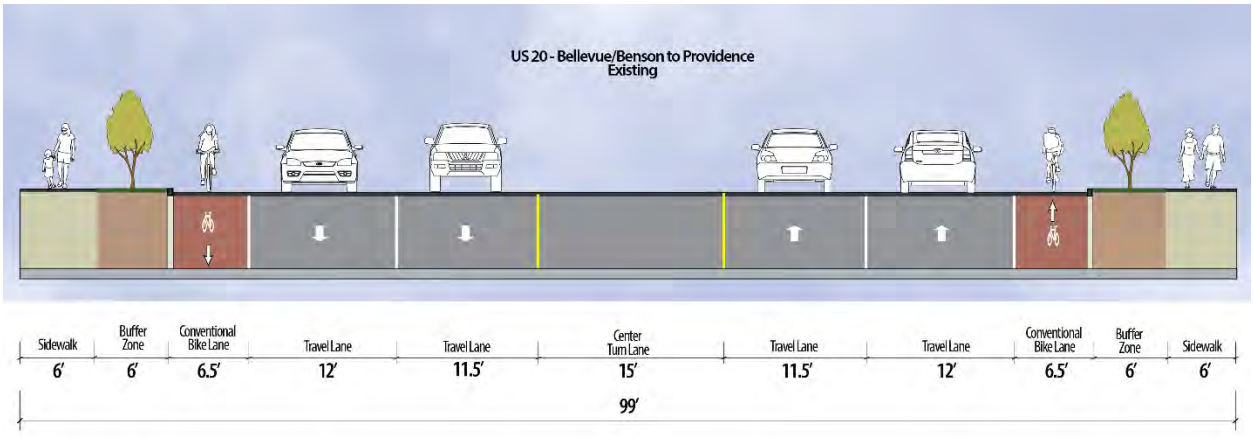


Figure 12. NE Bellevue/NE Benson to NE Providence – Shorter-Term Cross Section

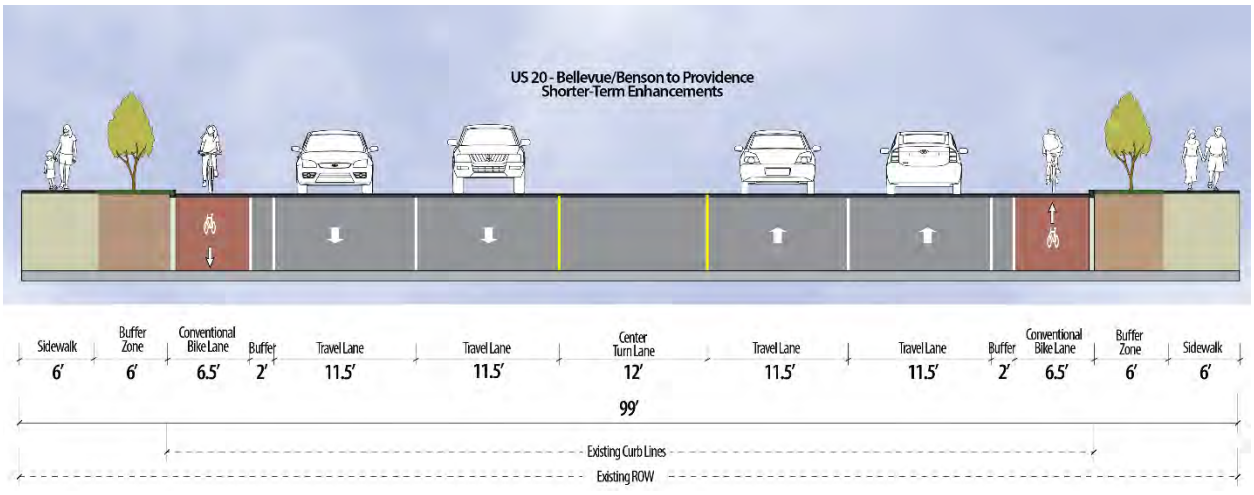


Figure 13. NE Bellevue/NE Benson to NE Providence – Longer-Term Cross Section

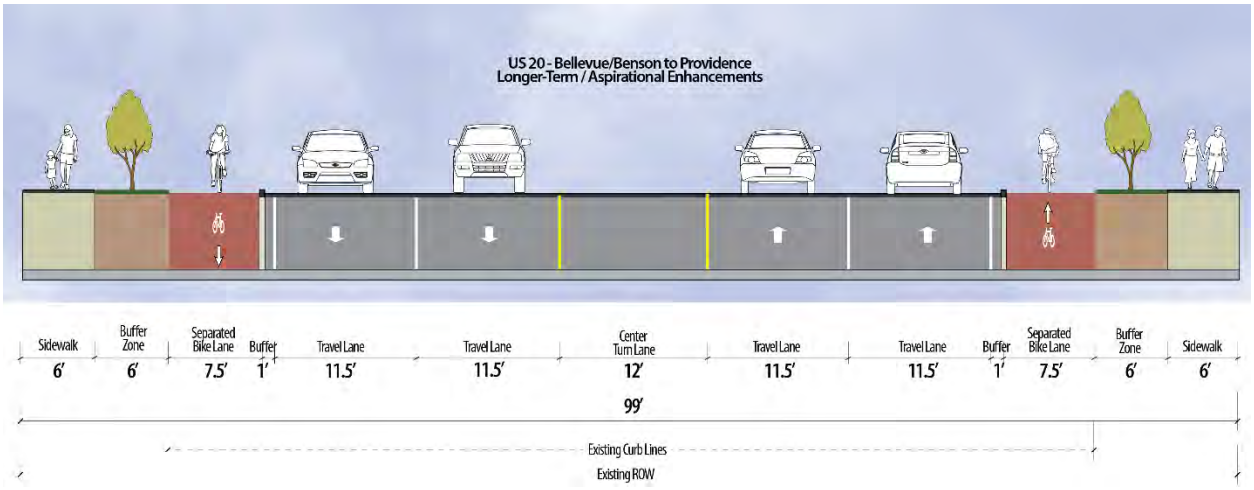


Figure 14. NE Providence to Powell Butte – Existing Cross Section

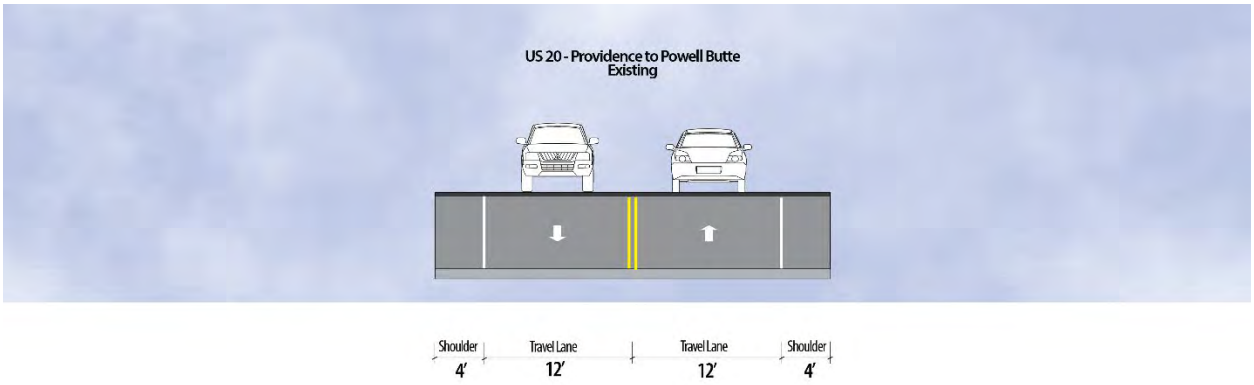


Figure 15. NE Providence to Powell Butte – Shorter-Term Cross Section

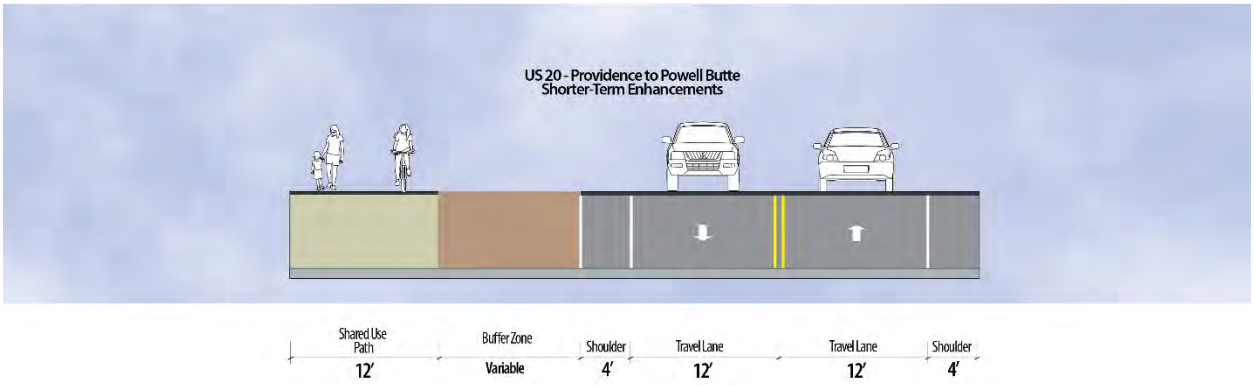
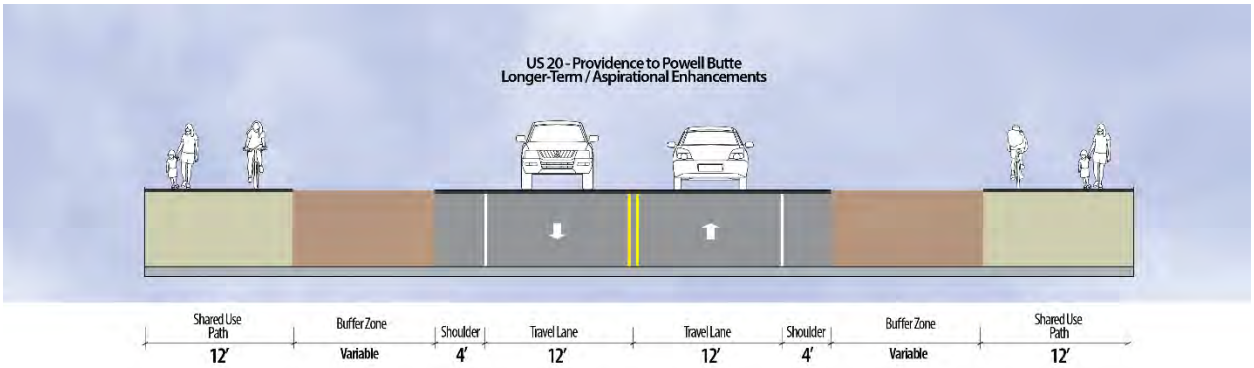


Figure 16. NE Providence to Powell Butte - Longer-Term Cross Section



2.2 Other Pedestrian, Bicycle and Transit Improvements

In addition to the cross-section concepts and other location-specific improvements described above, the following pedestrian, bicycle, and transit enhancements would apply to larger corridor segments or corridor-wide:

- Access management/driveway consolidation (to be partially addressed in ODOT's upcoming Statewide Transportation Improvement Program (STIP) project on U.S. 20 between NE 3rd Street and NE 15th Street).
- Sidewalk surface improvements.
- Removal or relocation of sidewalk obstructions (e.g., light poles and signs).
- Curb ramp upgrades at locations where existing ramps are not ADA accessible and not covered in upcoming STIP projects.
- Consideration of colored bike lanes throughout the corridor's entirety to increase their visibility while providing design continuity.
- Protected intersection treatments (pending further analysis and MAC engagement), particularly as adjacent properties redevelop thereby providing opportunities for strategic ROW acquisition.
- Transit stop infrastructure improvements (e.g., shelters, lighting, passenger information and enhanced crosswalks).

3 Intersection Improvements

In addition to bicycle and pedestrian improvements, operational improvements were also evaluated at major intersections and crossings along the corridor. These were evaluated to work in harmony with the proposed bicycle and pedestrian improvements and were intended to improve vehicular operations as well as safety and connectivity. Select intersection treatments were analyzed at each location and are discussed in sections 3.1 to 3.4.

The following intersections were evaluated:

- U.S. 20 at 3rd Street – signalized
- U.S. 20 at 8th Street – signalized
- U.S. 20 at Purcell Boulevard – signalized
- U.S. 20 at Dean Swift Road – unsignalized, minor approach stop-controlled
- U.S. 20 at 27th Street – signalized
- U.S. 20 at Benson Way – signalized
- U.S. 20 at Hamby Road – roundabout

3.1 Roundabout

Roundabouts were considered at each intersection as they can benefit safety, capacity and traffic flow. In accordance with the TSP, roundabouts are the City's preferred intersection treatment. However, many intersections along this corridor are constrained by the existing ROW and built environment, making roundabouts less feasible. The demand volume at several intersections may also make roundabouts infeasible. Additionally, U.S. 20 is a National Highway System Freight Route and will require coordination with the ODOT MAC. Garnering MAC support of roundabouts is feasible as long as the roundabouts are designed to accommodate the appropriate design vehicles.

3.2 Traditional Widening at Intersections

Traditional widening includes both major widening and minor widening. Major widening necessitates widening to accommodate multiple additional turn lanes to the intersection, significantly impacting adjacent ROW. Minor widening includes widening the intersection to provide a single additional turn lane and pedestrian and bicyclist improvements.

3.3 Median U-Turn/Restricted Crossing U-Turn

Median U-turns (MUT) and restricted crossing U-turns (RCUT) improve safety and increase capacity at signalized and unsignalized intersections. A MUT diverts the left turns from either the major, minor, or both approaches at the main intersection. The left turns are then diverted downstream to a location where the U-turn is accommodated. At locations with a narrow median ranging from 16 to 30 feet, a loon or bulb-out is required to accommodate the U-turn for the design vehicle. Cyclists make the left turn at the main intersection using a two-stage crossing and bike boxes. Pedestrians cross the main intersection using the typical crosswalks.

RCUTs divert both the left turn and through movements from the minor approach, forcing all vehicles from the minor approach to turn right. The left turns and through movements are then diverted downstream to a location where the U-turn is accommodated. A median island is constructed within the center of the main intersection, channelizing the major approach left turning vehicles and the minor approach movements. Similar to the MUT, a loon or bulb-out is often required to accommodate the design vehicle. When signalized, the signal operation only requires two phases, improving vehicular capacity.

People on bikes turning left to or from the minor approach and travelling through on the minor approach are to dismount the bicycle and utilize the multiple stage Z-crossing as a pedestrian.

RCUTs and MUTs improve safety by reducing the number of conflict points at the intersection and increases vehicular capacity by reducing signal phasing and lose time. Although RCUTs do increase the pedestrian delay, the pedestrian exposure to vehicles is often reduced compared to traditional intersection widening to increase capacity. Signalized MUTs and RCUTs can also provide an additional protected pedestrian crossing along the corridor at the dedication U-turn intersections.

Along U.S. 20, RCUTs and MUTs might be difficult to accommodate without impacts to ROW and adjacent buildings due to the highly urban nature of a portion of the corridor, and the need to provide adequate turning space for larger vehicles.

3.4 Remove Lefts

This Plan considered removing lefts at intersections while leaving the through movements. The option to remove lefts at intersections would benefit intersection operations but would force left turning vehicles to find an alternate route. Unlike RCUTs or MUTs, this option would not provide a signal protected or designated U-turn location along U.S. 20 that would replace the left turn at the intersection. This would require less ROW and be less impactful than RCUTs or MUTs since no U-turn widening would be needed but might add additional traffic to residential or side streets.

4 Evaluation Metrics

The intersection treatments will be evaluated based on the following criteria. Each treatment will be given a score from -2 to 2, indicating whether the treatment achieves the desired metric. The treatments will be evaluated independently of the intersections at first, in order to quickly determine if they meet the overall goals of the project.

- Increase system functionality.
  - Provide for efficient travel for traffic utilizing U.S. 20.
  - Reduce U.S. 20’s barrier effect by enhancing walking and bicycling accessibility along and across the corridor.
  - Enhance transit mobility and accessibility.
- Improve safety for vulnerable users.
  - Reduce serious injuries and fatalities.
  - Maximize safety and comfort for vulnerable roadway users.
  - Move in the direction of meeting ODOT’s adopted access spacing standards along U.S. 20 or meet the standards where feasible.
- Support economic development.

  - Maintain effective access to properties along U.S. 20 in a manner that supports the economic development objectives of existing and future businesses.
  - Provide for efficient freight movement throughout the corridor.
- Protect livability and ensure equity and access.
  - Incorporate a complete streets and complete network approach on U.S. 20 and other study area corridors.
  - Reduce the burden of regional motor vehicle traffic on adjacent residential neighborhoods.
  - Strive for people of all income levels and abilities to have access to the transportation options that best meet their daily needs.
- Steward the environment.
  - Reduce vehicle emissions through reduction of vehicular delay, improved connections in the local system, and the use of alternative travel modes.
  - Prioritize solutions that avoid or minimize adverse environmental impacts.
- Develop solutions that are cost-effective and implementable.
  - Prioritize lower-cost, high-benefit solutions.
  - Prioritize solutions that leverage partnerships, existing planned projects and programs.
  - Develop solutions that are constructable in phases and can be reasonably maintained.

Appendix E. Alternative Cost Estimate

Description of US20 at NE 3rd Street

Road diet. Provide pedestrian, bicycle and transit improvements at 3rd St intersection.

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt		*TON*	$ 160.00	$ -	*Includes asphalt (11 inches)*
Aggregate Base	-	*TON*	$ 70.00	$ -	*Assume 12"*
Concrete Curb, Standard	2,567	*FOOT*	$ 45.00	$ 115,515.00	*assume mountable/standard the same (same cost)*
Concrete Islands	300	*SQFT*	$ 20.00	$ 6,000.00	*Assumes islands and truck apron square footage*
Concrete Walks	15,240	*SQFT*	$ 18.00	$ 274,320.00	*Includes sidewalk and aggregate base*
Curb Ramps	8	*EACH*	$ 5,000.00	$ 40,000.00	
Green Bicycle Paint at Intersection	1,200	*SQFT*	$ 2.00	$ 2,400.00	
Signal	-	*EACH*	$ 425,000.00	$ -	*assume all new signal equipment*
Subtotal				**$ 438,235.00**	
Permanent Striping/Signing			5%	$ 21,911.75	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 21,911.75	
Landscaping			5%	$ 21,911.75	
Traffic Signal			5%	$ 21,911.75	*Bike signals, ped pushbuttons, conduit, wiring, detection.*
Temporary Traffic Control			10%	$ 43,823.50	
Illumination			10%	$ 43,823.50	
Erosion Control			2%	$ 8,764.70	
Site Preparation			2%	$ 8,764.70	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 8,764.70	
Construction Subtotal				**$ 639,823.10**	
Design & Construction Management			25%	$ 159,955.78	
Mobilization			10%	$ 63,982.31	
ROW		EACH		$ -	
Contingency			50%	$ 319,911.55	
Total				**$ 1,183,672.74**	

Description of US20 at NE 8th Street

Maintain the existing number of lanes and access and focus improvements on alternative mobility options. Add bike green paint on US20.

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt		*TON*	$ 160.00	$ -	*Includes asphalt (11 inches). Paving between 7th and 9th.*
Aggregate Base		*TON*	$ 70.00	$ -	*Assume 12"*
Concrete Curb, Standard		*FOOT*	$ 45.00	$ -	*assume mountable/standard the same (same cost)*
Concrete Islands		*SQFT*	$ 20.00	$ -	
Concrete Walks		*SQFT*	$ 18.00	$ -	*Includes sidewalk and aggregate base*
Green Bicycle Paint at Intersection	800	*SQFT*	$ 2.00	$ 1,600.00	
Curb Ramps		*EACH*	$ 5,000.00	$ -	
Signal Modification	1	*EACH*	$ 100,000.00	$ 100,000.00	*Lump sum including adding LPIs, transit signal priority etc.*
Subtotal				**$ 101,600.00**	
Permanent Striping/Signing			5%	$ 5,080.00	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 5,080.00	
Landscaping			5%	$ 5,080.00	
Traffic Signal			5%	$ 5,080.00	*Bike signals, ped pushbuttons, conduit, wiring, detection.*
Temporary Traffic Control			10%	$ 10,160.00	
Illumination			10%	$ 10,160.00	
Erosion Control			2%	$ 2,032.00	
Site Preparation			2%	$ 2,032.00	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 2,032.00	
Construction Subtotal				**$ 148,336.00**	
Design & Construction Management			25%	$ 37,084.00	
Mobilization			10%	$ 14,833.60	
ROW				$ -	
Contingency			50%	$ 74,168.00	
Total				**$ 274,421.60**	

Description of US20 at NE Purcell Boulevard

The proposed alternative at NE Purcell Boulevard is to widen to provide a dedicated northbound right turn lane.

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt	1,209	*TON*	$ 160.00	$ 193,457.00	*Includes asphalt (11 inches). Repave south leg.*
Aggregate Base	249	*TON*	$ 70.00	$ 17,441.67	*Assume 12"*
Concrete Curb, Standard	463	*FOOT*	$ 45.00	$ 20,835.00	*assume mountable/standard the same (same cost)*
Concrete Islands	531	*SQFT*	$ 20.00	$ 10,620.00	
Concrete Walks	3,332	*SQFT*	$ 18.00	$ 59,976.00	*Includes sidewalk and aggregate base. SW and SE corners.*
Curb Ramps	7	*EACH*	$ 5,000.00	$ 35,000.00	
Signal		*EACH*	$ 425,000.00	$ -	*assume all new signal equipment*
Subtotal				**$ 337,329.67**	
Permanent Striping/Signing			5%	$ 16,866.48	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 16,866.48	
Landscaping			5%	$ 16,866.48	
Traffic Signal			5%	$ 16,866.48	*Bike signals, ped pushbuttons, conduit, wiring, detection.*
Temporary Traffic Control			10%	$ 33,732.97	
Illumination			10%	$ 33,732.97	
Erosion Control			2%	$ 6,746.59	
Site Preparation			2%	$ 6,746.59	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 6,746.59	
Construction Subtotal				**$ 492,501.31**	
Design & Construction Management			25%	$ 123,125.33	
Mobilization			10%	$ 49,250.13	
ROW					
Contingency			50%	$ 246,250.66	
Total				**$ 911,127.43**	

Description of US20 at NE 27th Street - Minor Widening

The minor widening alternative added an eastbound right turn lane with a porkchop island

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt	1,464	*TON*	$ 160.00	$ 234,190.00	*Includes asphalt (11 inches)*
Aggregate Base	938	*TON*	$ 70.00	$ 65,683.33	*Assume 12"*
Concrete Curb, Standard		*FOOT*	$ 45.00	$ -	*assume mountable/standard the same (same cost)*
Concrete Islands	1,645	*SQFT*	$ 20.00	$ 32,900.00	
Concrete Walks	3,140	*SQFT*	$ 18.00	$ 56,520.00	*Includes sidewalk and aggregate base. Only SW corner.*
Curb Ramps	8	*EACH*	$ 5,000.00	$ 40,000.00	
Signal		*EACH*	$ 425,000.00	$ -	*assume all new signal equipment*
Subtotal				**$ 429,293**	
Permanent Striping/Signing			5%	$ 21,465	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 21,465	
Landscaping			5%	$ 21,465	
Temporary Traffic Control			10%	$ 42,929	
Traffic Signal			5%	$ 21,464.67	*Bike signals, ped pushbuttons, conduit, wiring, detection.*
Illumination			10%	$ 42,929	
Erosion Control			2%	$ 8,585.87	
Site Preparation			2%	$ 8,585.87	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 8,586	
Construction Subtotal				**$ 626,768**	
Design & Construction Management			25%	$ 156,692	
Mobilization			10%	$ 62,677	
ROW					
Contingency			50%	$ 313,384	
Total				**$ 1,159,521**	

Description of US20 at NE 27th Street - Major Widening

The major widening alternative added the same eastbound right turn lane and added dual left turn lanes on all approaches.

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt	8,842	*TON*	$ 160.00	$ 1,414,787.00	*Includes asphalt (11 inches)*
Aggregate Base	1,189	*TON*	$ 70.00	$ 83,257.22	*Assume 12"*
Concrete Curb, Standard	2,842	*FOOT*	$ 45.00	$ 127,890.00	*assume mountable/standard the same (same cost)*
Concrete Islands	1,645	*SQFT*	$ 20.00	$ 32,900.00	
Concrete Walks	13,414	*SQFT*	$ 18.00	$ 241,452.00	*Includes sidewalk and aggregate base.*
Curb Ramps	12	*EACH*	$ 5,000.00	$ 60,000.00	
Signal	1	*EACH*	$ 425,000.00	$ 425,000.00	*assume all new signal equipment*
Subtotal				**$ 2,385,286**	
Permanent Striping/Signing			5%	$ 119,264	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 119,264	
Landscaping			5%	$ 119,264	
Temporary Traffic Control			10%	$ 238,529	
Traffic Signal				$ -	*Bike signals, ped pushbuttons, conduit, wiring, detection.*
Illumination			10%	$ 238,529	
Erosion Control			2%	$ 47,705.72	
Site Preparation			2%	$ 47,705.72	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 47,706	
Construction Subtotal				**$ 3,363,254**	
Design & Construction Management			25%	$ 840,813	
Mobilization			10%	$ 336,325	
ROW					
Contingency			50%	$ 1,681,627	
Total				**$ 6,222,019**	

Description of US20 at NE Hamby Road

The proposed alternative at this location is to modify the existing roundabout to add a right turn bypass lanes on the northbound and eastbound approaches

Item	Qty	Unit	Unit Cost	Total	Notes
Asphalt	2,356	*TON*	$ 160.00	$ 377,036.00	*Includes asphalt (11 inches). Bypass lanes and asphalt walks.*
Aggregate Base	1,904	*TON*	$ 70.00	$ 133,295.56	*Assume 12"*
Concrete Curb, Standard	500	*FOOT*	$ 45.00	$ 22,500.00	*assume mountable/standard the same (same cost)*
Concrete Islands	4,745	*SQFT*	$ 20.00	$ 94,900.00	
Concrete Walks		*SQFT*	$ 18.00	$ -	*Includes sidewalk and aggregate base*
Curb Ramps	9	*EACH*	$ 5,000.00	$ 45,000.00	
Signal	-	*EACH*	$ 425,000.00	$ -	*assume all new signal equipment*
Subtotal				**$ 672,732**	
Permanent Striping/Signing			5%	$ 33,637	*Bicycle markers, arrows, lane striping, pavement bar*
Drainage and Sewers			5%	$ 33,637	
Landscaping			5%	$ 33,637	
Temporary Traffic Control			15%	$ 100,910	
Illumination			10%	$ 67,273	
Erosion Control			2%	$ 13,454.63	
Site Preparation			2%	$ 13,454.63	*Includes pavement removal, clearing and grubbing, removal of obstacles*
Construction Survey Work			2%	$ 13,455	
Construction Subtotal				**$ 982,188**	
Design & Construction Management			25%	$ 245,547	
Mobilization			10%	$ 98,219	
ROW			0%	$ -	*Assume ROW is owned by ODOT (not impacting soundwall)*
Contingency			50%	$ 491,094	
Total				**$ 1,817,048**	