SR-14 Bingen/White Salmon Circulation Study

BRIEFING MEMORANDUM ON TRAFFIC OPERATIONS

December 2018
FINAL

Prepared for:

Southwest Washington Regional Transportation Council

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Washington State Department of Transportation

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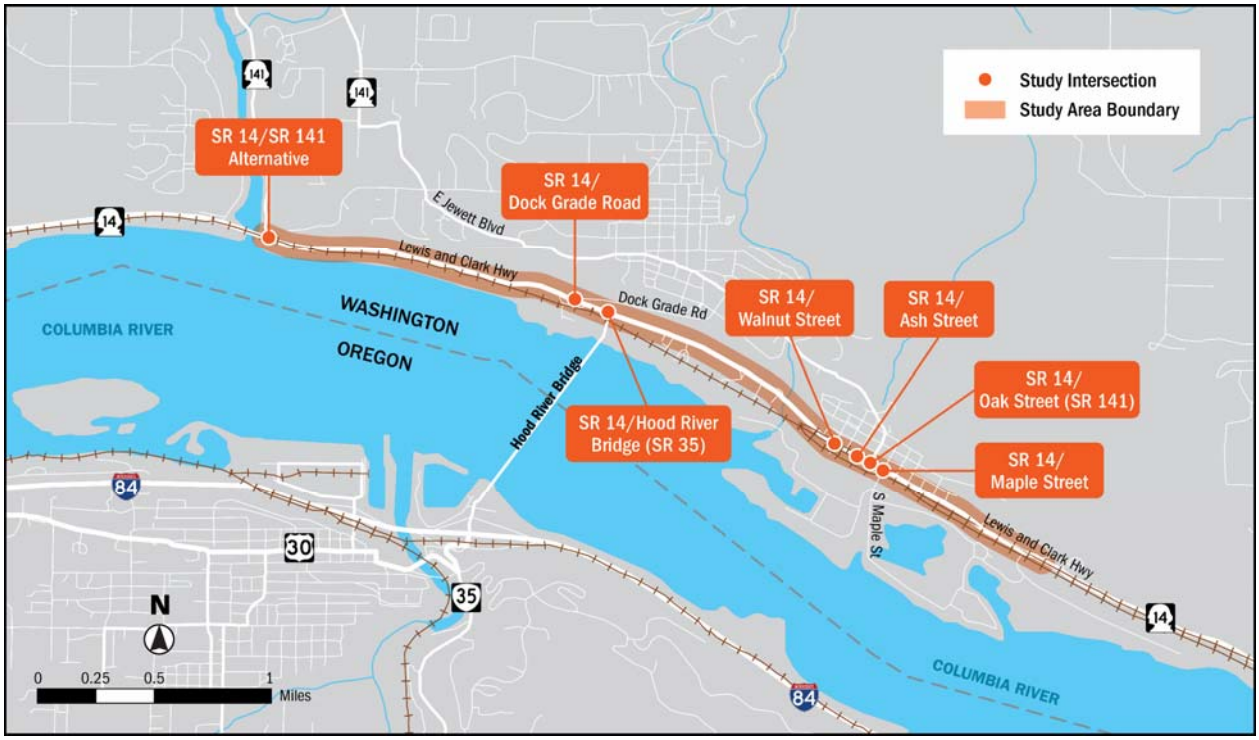
Introduction

Existing and future transportation conditions on SR-14 through Bingen and White Salmon were analyzed to inform local decision-makers considering potential transportation and circulation improvements. The objective of the SR-14 Bingen/White Salmon Circulation Study was to perform a planning-level assessment of travel patterns and trends, document existing traffic conditions, identify future transportation needs, and describe possible alternatives to improve circulation and address current and future travel impacts.

The targeted segment of SR-14 between SR-141 Alternative (Alt) and milepost 67.50 east of the eastern Bingen city limits serves residents and employers in the local area as well as recreationists, tourists, and other visitors during warmer months. In addition, substantial freight truck movement occurs on this segment of SR-14. The study area included seven intersections along SR-14 that includes the Bingen downtown core and intersections with routes that connect SR-14 and White Salmon (Figure 1).

Figure 1. Study Area



The results of the SR-14 Bingen/White Salmon Circulation Study are published in two companion documents.

- This ***Briefing Memorandum on Traffic Operations*** is a focused discussion concerning vehicular traffic operations by SR-14 highway segment and intersection. The purpose of the memorandum is to brief local decision-makers on overall levels of service along SR-

14 and specific movements at intersections that are currently exceeding tolerable delays or will exceed tolerable delays in the future.

- The ***Transportation Summary*** is a comprehensive report that documents the study assumptions, existing and future conditions for all modes (vehicle, truck, transit, pedestrian, bicycle, and rail), historical highway safety data, and existing parking facilities. Detailed data and analysis results, including existing and future freight truck conditions, a stakeholder interview summary, traffic data, and traffic modeling output results are included as appendices.

SR-14 Operations by Highway Segment

The study area was divided into four segments based on highway characteristics (e.g. rural or urban), posted speed limits, and the density of driveways and intersecting roadways. The following segments were analyzed:

- **Segment 1:** SR-141 Alt to the Hood River Bridge access road
- **Segment 2:** Hood River Bridge access road to Walnut Street
- **Segment 3:** Walnut Street to Elm Street
- **Segment 4:** Elm Street to eastern Bingen

Highway Level of Service (LOS) was used to describe existing and future projected SR-14 traffic conditions[1]. This Highway LOS measure provides a relative characterization of the level of congestion and associated flow conditions along the highway (see sidebar for LOS A-F driving conditions). The Highway LOS was further categorized by a highway classification and an arterial classification.

- The **Highway LOS (highway classification)** was calculated for both westbound and eastbound directions based on the directional volume of traffic, average travel speed,

DRIVING CONDITIONS BY HIGHWAY LEVELS OF SERVICE

LOS A-C: Vehicles are traveling individually or beginning to be grouped in platoons, which provides gaps for vehicles on intersecting streets or in driveways to enter the highway.

LOS D: Vehicle platooning increases, gaps between platoons decrease, and highway speeds slow down.

LOS E: The highway is near capacity and vehicles wanting to enter the highway have difficulty finding gaps.

LOS F: The highway capacity has been exceeded and gridlock conditions occur.

[1] Highway Capacity Software (HCS7) was used, which implements the methodology for analyzing two-lane highways as prescribed in the Transportation Research Board Highway Capacity Manual 6th Edition, 2010.

percentage of time each vehicle spent directly following another vehicle, and volume of traffic in the opposing direction that allows for passing opportunities. This highway classifcation was applied to Segments 1 and 4, which have more rural characteristics.

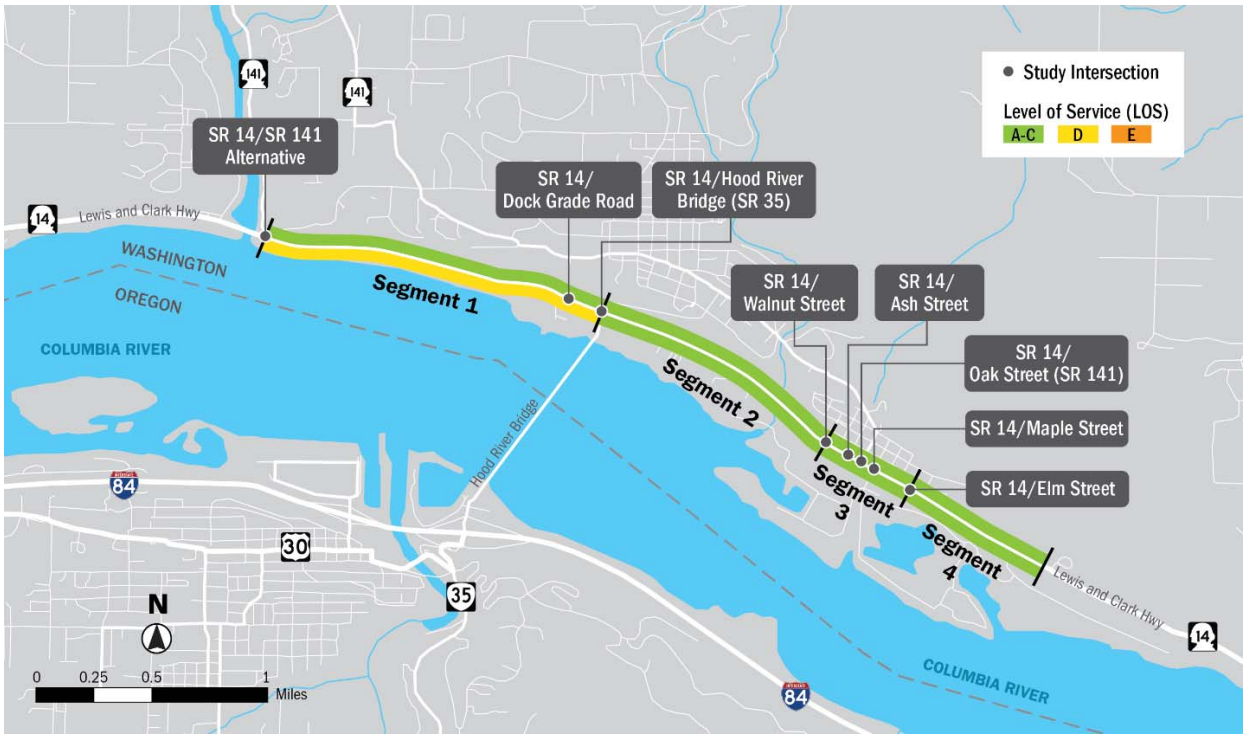
- The **Highway LOS (arterial classifcation)** was calculated based on the estimated speed of vehicles relative to the free flow (posted) speed for both westbound and eastbound directions. This arterial classifcation was applied to Segments 2 and 3, which have more urban characteristics.

WSDOT sets Highway LOS standards for peak hour on state highways of statewide significance, including SR-14 based on RCW 47.06.140(2). The peak hour performance standard set by WSDOT for Klickitat County is LOS C or better (WSDOT 2010).

Existing Conditions (2017)

Under the existing conditions, the SR-14 corridor meets the WSDOT[2] LOS C standard for all segments except the eastbound direction on Segment 1 (SR-141 Alt. to Hood River Bridge) as illustrated in Figure 2. The eastbound traffic on Segment 1 experiences slightly more congestion due to the traffic volume levels approaching the Hood River Bridge access road intersection, the traffic signal at this intersection that constrains traffic flow, and the higher opposing volume in the westbound direction that reduces passing opportunities for eastbound vehicles.

Figure 2. SR-14 Highway Segment Levels of Service – Existing Conditions (2017)



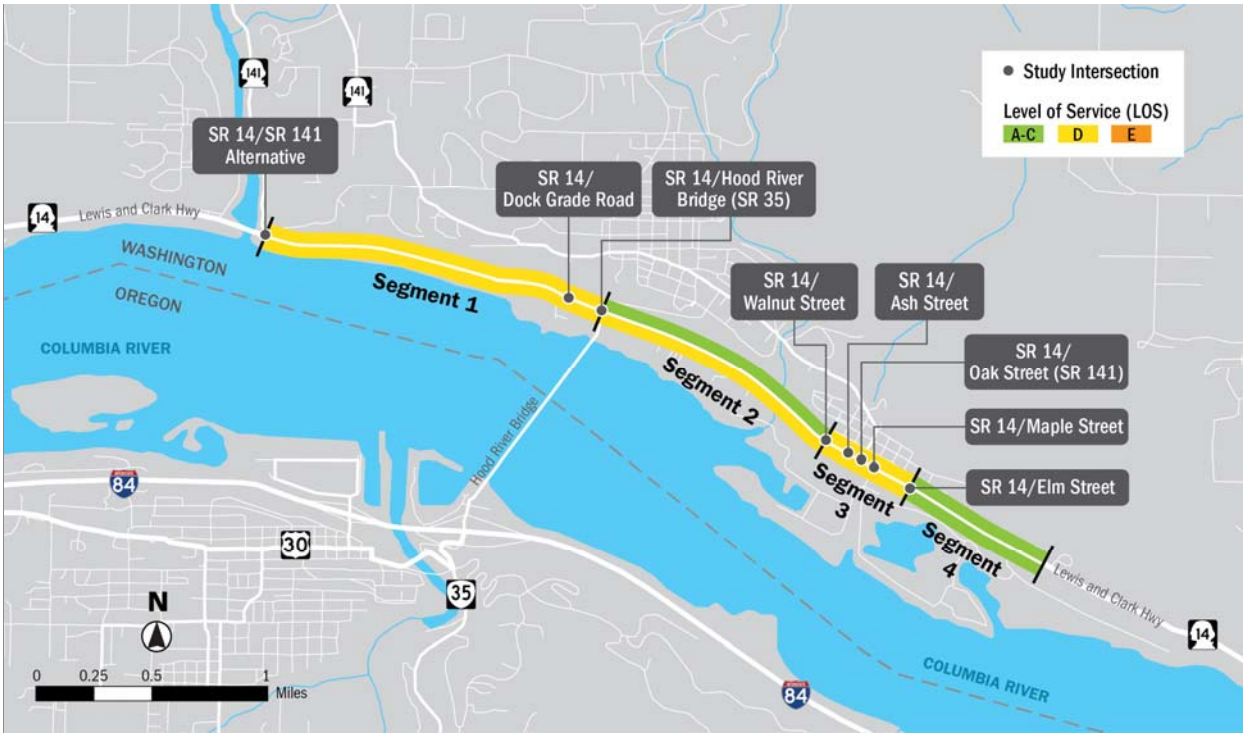
[2] Level of Service Standards for Washington State Highways, 2010.

Future No Build Conditions (2037)

Future traffic conditions were modeled by factoring in the projected growth in population and employment along the SR-14 corridor. Without any improvements made in the study area, highway traffic operations on SR-14 would deteriorate from Highway LOS C to LOS D on four segmental directions (Figure 3) compared to the existing conditions. Specifically:

- Westbound Elm Street to Walnut Street (Segment 3) in the core area of Bingen and the Hood River Bridge to SR-141 Alt. (Segment 1), which includes a high volume of traffic coming off the Hood River Bridge and turning onto Dock Grade Road, would experience increased congestion resulting in LOS D compared to LOS C under the existing conditions (2017).
- Eastbound traffic from the Hood River Bridge to Walnut Street (Segment 2) would be more congested for vehicles heading into Bingen resulting in LOS D and eastbound traffic on Segment 1 would remain at LOS D similar to existing conditions.

Figure 3. SR-14 Highway Segment Levels of Service – Future Conditions (2037)

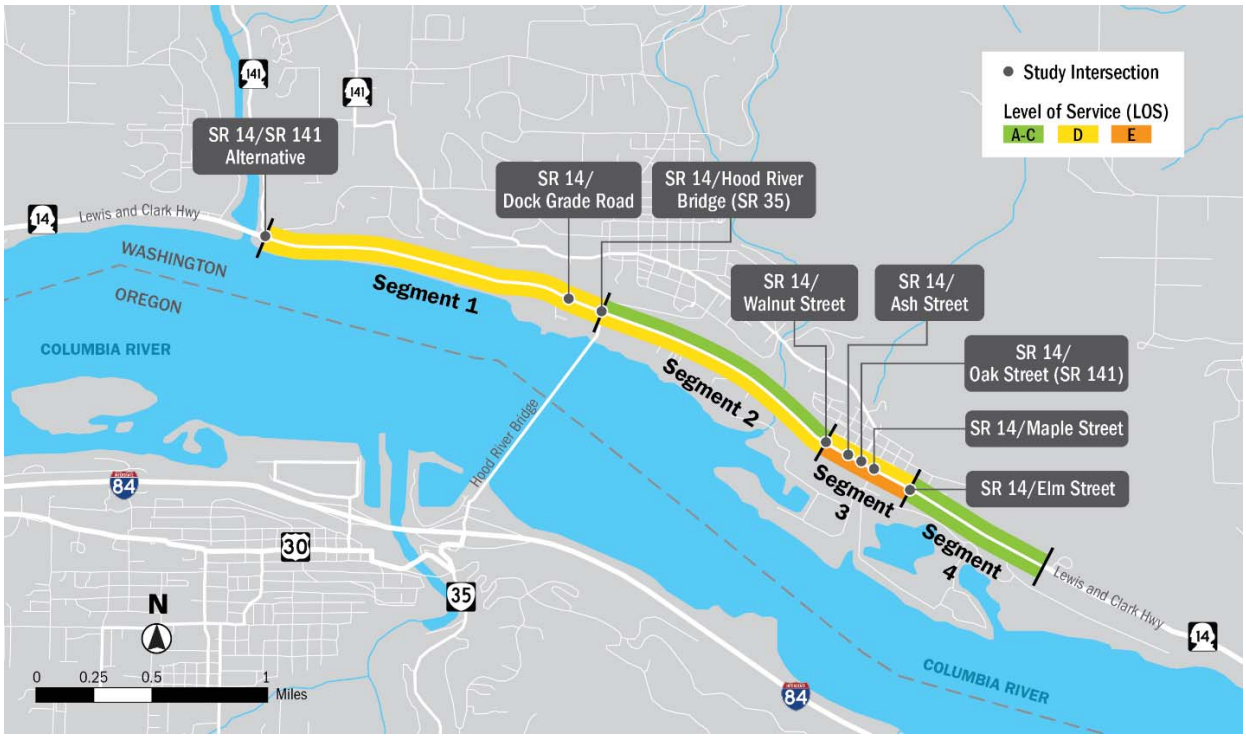


Future Build Conditions (2037)

As part of the SR-14 Bingen/White Salmon Circulation Study, several potential improvements along SR-14 were analyzed. These improvements, or "build concepts,"[3] included adding a roundabout at SR-14/Elm Street and testing various treatments at Oak Street (roundabout, signal, all-way stop control) and Maple Street (signal or all-way stop control).

Under these build concepts, the Highway LOS analysis shows a projected increase in congestion (LOS E) along Segment 3 in the eastbound direction from Walnut Street to Elm Street (Figure 4). This increased congestion would occur because the build concepts include a new roundabout at SR-14/Elm Street to provide additional access to Bingen Point. Approximately 70 percent of the eastbound SR-14 traffic that would turn right onto southbound Maple Street and traffic making the reverse movement (northbound Maple Street to westbound SR-14) would shift from Maple Street to Elm Street. As a result, traffic volumes on SR-14 between Elm Street and Maple Street would increase, which would cause more platooning along Segment 3 and would decrease travel speeds. Westbound traffic operations would be able to maintain a LOS D; however, eastbound traffic operations would degrade to LOS E.

Figure 4. SR-14 Highway Segment Levels of Service – Build Conditions (2037)



[3] See the SR-14 Bingen/White Salmon Circulation Study—Transportation Summary for expanded descriptions and maps of the various build concepts that were analyzed.

Intersection Operations

Intersections along the SR-14 corridor were analyzed to understand how the individual lane movements at the intersecting roadways were affecting local circulation. Intersection LOS measures were analyzed to characterize turning and through movements. It is important to note that Intersection LOS is calculated differently than Highway LOS. Specifically,

- **Intersection LOS** is a measurement of delay, which is the average time (seconds) a vehicle must slow down or stop in traffic compared to freely-flowing conditions. Delay is measured for each intersection movement, such as through, left or right turns, and any combined movement.

The LOS criteria for signalized and unsignalized intersections is presented in Table 1; and, the associated driving conditions for each LOS (A-F) are described in the sidebar.

The following discussion summarizes and illustrates the traffic operations at each study intersection along SR-14. Specific descriptions of the queuing and delays faced by vehicles on local streets trying to turn onto or cross SR-14 are emphasized.

Table 1. LOS Criteria for Intersections

Level of Service	Average Control Delay (seconds/vehicle)	
	Signalized Intersection	Unsignalized Intersection
A	≤ 10	0 – 10
B	> 10 - 20	> 10 – 15
C	> 20 - 35	> 15 - 25
D	> 35 - 55	> 25 – 35
E	> 55 - 80	> 35 - 50
F	> 80	> 50

Source: Transportation Research Board Highway Capacity Manual 2000 (signalized intersections) and 2010 (unsignalized intersections).

DRIVING CONDITIONS BY INTERSECTION LEVELS OF SERVICE

LOS A: Lane movement is free-flowing.

LOS B: Lane movement has stable flow with slight delays. Stable flow occurs when the number of vehicles entering the highway segment is smaller or equal to the number of vehicles leaving the highway segment.

LOS C: Lane movement has stable flow with acceptable delays.

LOS D: Lane movements are approaching unstable flow, which occurs when then number of vehicles entering a highway segment exceeds the number of vehicles leaving the highway segment.

LOS E: Lane movements reach unstable flow with intolerable delays.

LOS F: Lane movements are "forced flow," highly congested, and do not clear. Forced flow occurs when vehicles begin to queue at merge points on the highway.

SR-14/SR-141 Alternate

The SR-14/SR-141 Alternate (Alt) intersection is located at the western end of the study area in a rural setting with no development at the intersection or adjacent driveways. At this three-legged intersection, SR-14 operates at higher speeds (50 mph) and is free-flowing (uncontrolled) while southbound SR-141 Alt is stop-controlled. Some vehicles pull off on the western shoulder of SR-141 Alt to park and access the White Salmon River shoreline. Just east of this intersection, there is a steep rock cliff on the north side of SR-14 that reduces sight visibility for vehicles stopped on southbound SR-141 Alt waiting for gaps in the traffic on SR-14 to turn right or left.

Existing Conditions (2017): During the PM peak hour[4], the highest traffic volume turning movement is westbound SR-14 to northbound SR-141 Alt (160 vehicles). This turning movement is a free-flow right turn and can operate without any delay. Vehicles heading southbound on SR-141 Alt travel in a single lane and can turn either right or left onto SR-14. Southbound turning volumes are approximately 45 vehicles making right turns and 85 vehicles making left turns. As shown in Figure 5, the southbound SR-141 Alt turning movements operate at LOS C with 1-2 vehicles typically queuing and experiencing an average delay of 16 seconds per vehicle to make turns onto SR-14.

Future Conditions (2037): Traffic volumes are projected to increase by approximately 50 percent in all directions at this intersection by 2037. In the PM peak hour, the southbound SR-141 Alt lane would deteriorate to LOS E as a result of the two-fold increase in vehicle queuing and delays (average queue of 4-5 cars and average delay of 38 seconds per vehicle) (Figure 6).

Figure 5. SR-14/SR-141 Alt. Intersection – Existing Conditions

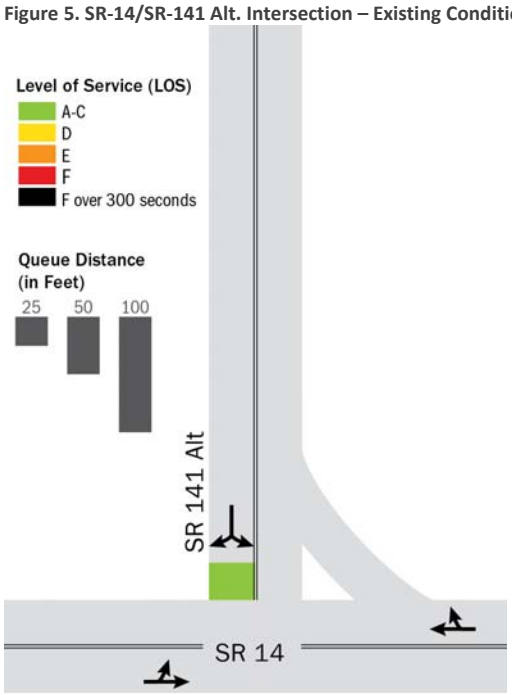
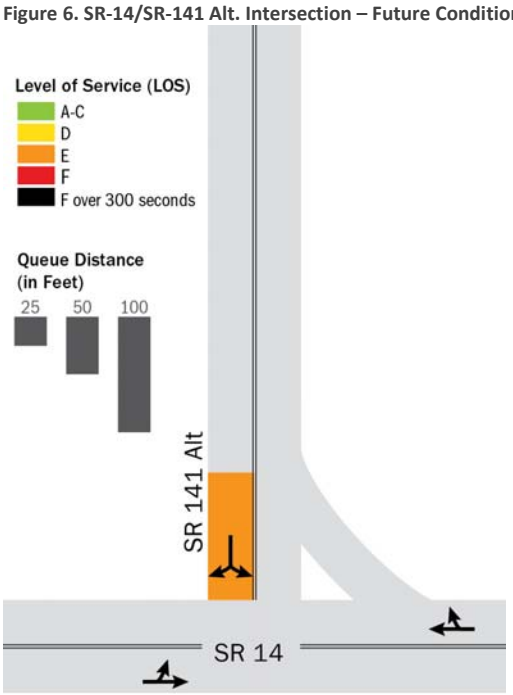


Figure 6. SR-14/SR-141 Alt. Intersection – Future Conditions



[4] The PM peak hour was determined to be from 4:05pm to 5:05pm during the weekdays.

SR-14/Dock Grade Road

The SR-14/Dock Grade Road intersection is located in a rural section of SR-14 with no development at the intersection or adjacent driveways. Dock Grade Road forms the north leg of the intersection and is a one-way northbound single lane road. Dock Grade Road south of SR-14 is a two-way stop-controlled road and forms the south leg of the intersection. SR-14 has a speed limit of 45 mph and is free-flowing (uncontrolled) at this intersection.

Existing Conditions (2017): Traffic heading west on SR-14 turning north onto Dock Grade Road up the hill is a typical PM peak hour travel route for commuter travel—approximately 265 vehicles—destined to White Salmon and points further north. Many commuters choose this route rather than SR-141/Oak Street, which requires travel through Bingen at lower speeds and with more congestion during the PM peak hour. Dock Grade Road is periodically closed when impassable due to inclement winter weather and its steep grade. There is minor queuing (0-1 vehicles) on northbound Dock Grade Road trying to make left turns, right turns, or through movements across SR-14 due to very small volumes of vehicles (approximately 20 vehicles during the PM peak hour) on this roadway. Average delay for this movement is approximately 15 seconds per vehicle (LOS C) (Figure 7).

Figure 7. SR-14/Dock Grade Road Intersection – Existing Conditions

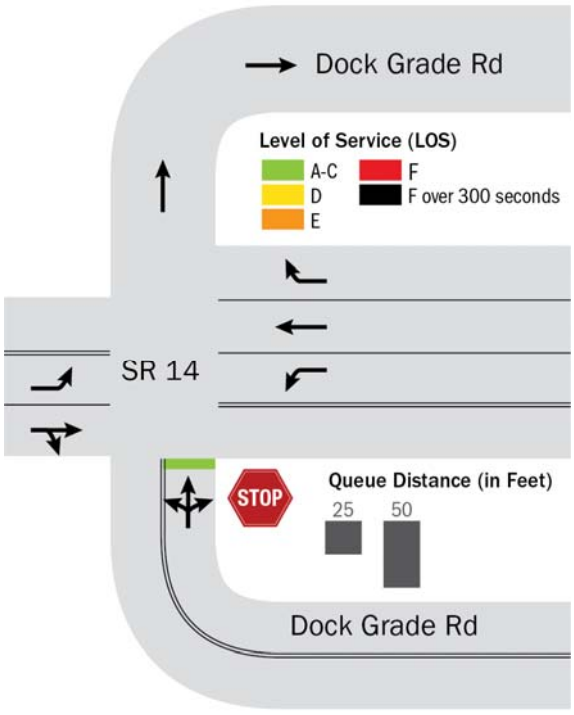
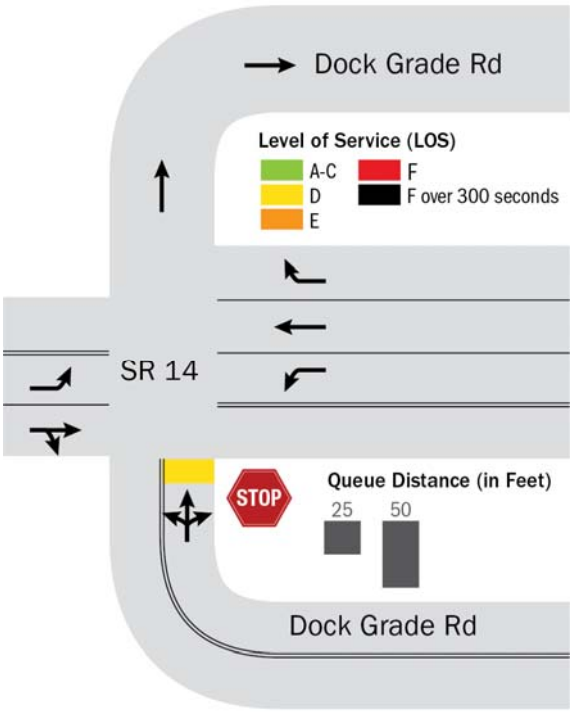


Figure 8. SR-14/Dock Grade Road Intersection – Future Conditions



Future Conditions (2037): With an increase in traffic volumes on SR-14 and the number of vehicles turning north onto Dock Grade Road, there would be fewer gaps on SR-14 that would allow vehicles on Dock Grade Road to turn left or right onto SR-14 or cross SR-14 to continue northbound on Dock Grade Road. A small number of vehicles (approximately 35) would make

these movements so the average queue would remain 0-1 vehicles, but the delay would grow to approximately 27 seconds per vehicle (LOS D) (Figure 8).

SR-14/Hood River Bridge

The signalized intersection of SR-14 and the Hood River Bridge approach road is a noticeable transition for eastbound travelers on a section of rural highway with no stop- or signal-controlled intersections for many miles. This three-legged intersection handles all traffic heading to and coming from the Hood River Bridge via SR-14.

Existing Conditions (2017): Northbound traffic coming from the Hood River Bridge during the PM peak hour is split roughly 3-to-1 with 72 percent (475 vehicles) turning left onto westbound SR-14 and 28 percent (185 vehicles) turning right onto eastbound SR-14 (toward Bingen). For the left turn lane, average queuing during the PM peak hour is approximately 27 vehicles with an average delay of 71 seconds per vehicle (LOS E). The signal phasing is set to allow all or most northbound vehicles to clear the signal in one phase, which means a driver does not have to wait multiple cycles to pass through the intersection. The right turn lane operates better with average queues of 6-7 vehicles and an average delay of 40 seconds per vehicle (LOS D) (Figure 9).

Future Conditions (2037): With 40 percent grown in traffic volumes by 2037, operating conditions for the northbound traffic at this intersection would exceed the roadway capacity of the two northbound turn lanes. The analysis conducted identified and applied signal phasing optimization strategies that would benefit the right turn movements and lessen the deterioration of the left turn lane operations. Average queues in the left-turn lane would be 35 vehicles, and average delays to move northbound through the signal would be 2 minutes per vehicle (LOS F). This length of time would likely translate to some vehicles having to wait through two signal cycles to turn onto SR-14. The right-turn lane would improve with an average queue of 1-2 vehicles and an average delay of less than 10 seconds per vehicle (LOS A) (Figure 10).

There is a separate project underway to replace the Hood River Bridge, which would also include revisions to the SR-14/Hood River Bridge intersection. The traffic analysis and design effort associated with that project would potentially reconfigure the SR-14/Hood River Bridge intersection, including possibly adding capacity, investigating other intersection control types, and applying other methods to optimize traffic flow at this intersection. The timing of implementing the bridge replacement project is dependent on funding availability.

Figure 9. SR-14/Hood River Bridge Intersection – Existing Conditions

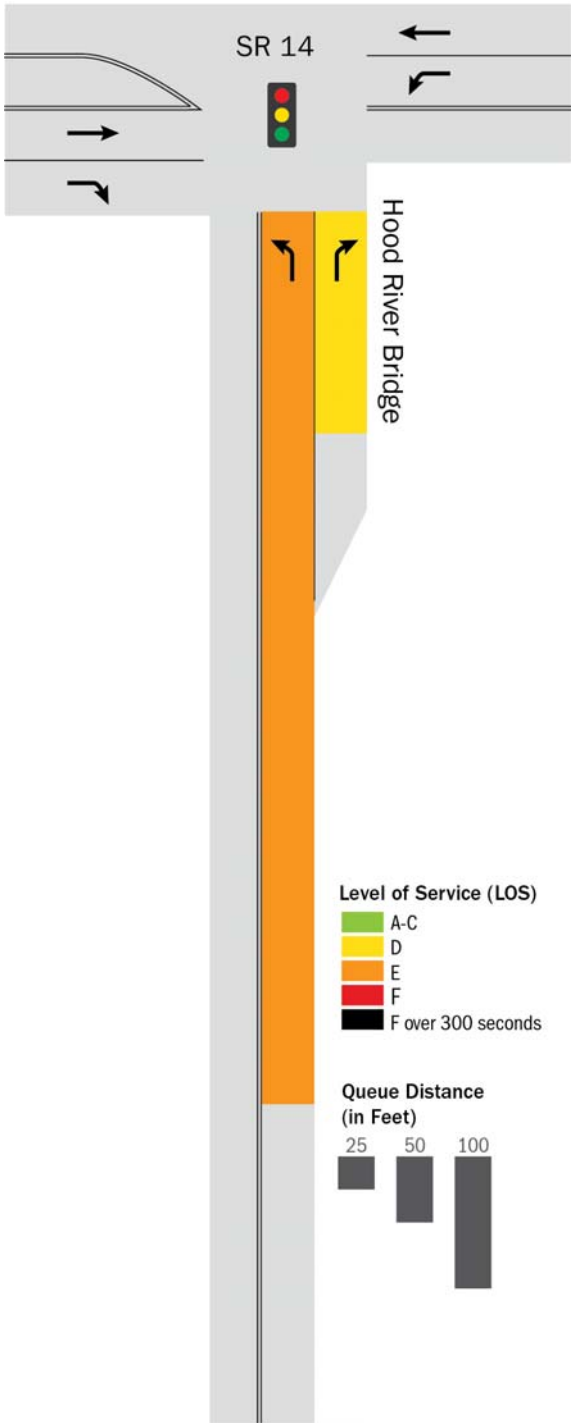
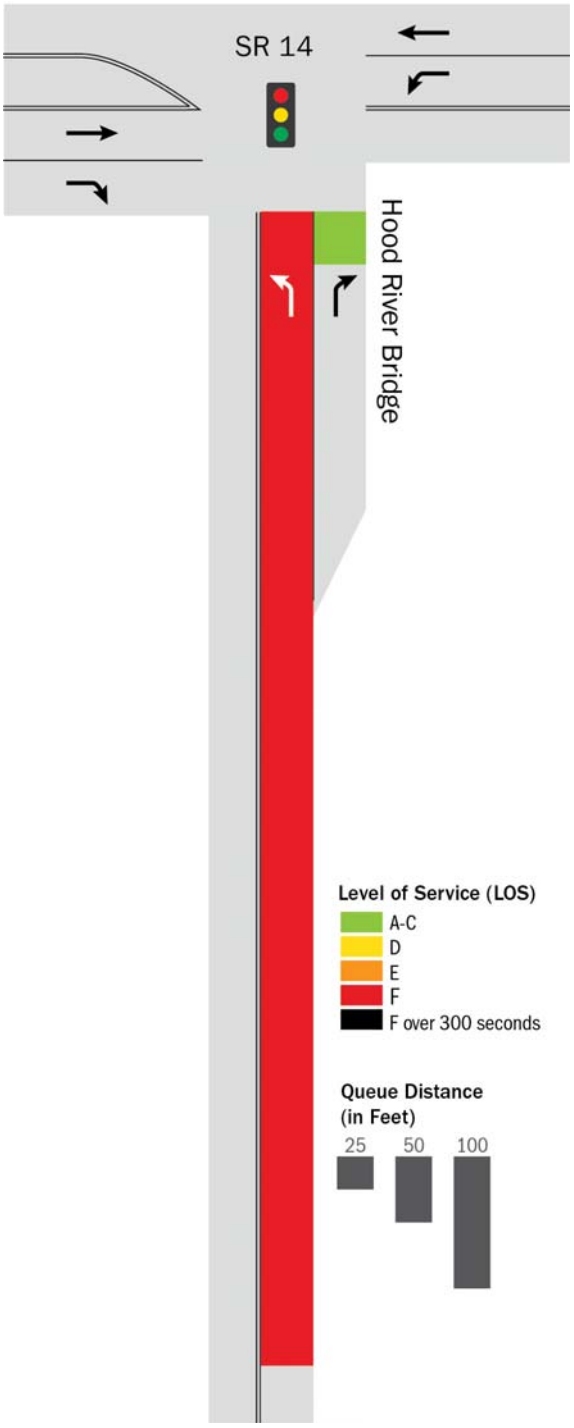


Figure 10. SR-14/Hood River Bridge Intersection – Future Conditions



SR-14/Walnut Street

The SR-14/Walnut Street intersection is a four-legged intersection with stop-control on both northbound and southbound Walnut Street. This intersection is on the western edge of the urbanized part of Bingen and accommodates pedestrian and bicycle travel with sidewalks along SR-14 and crosswalks in all four directions.

Existing Conditions (2017): Traffic volumes on southbound Walnut Street are relatively low with approximately 25 vehicles in the PM peak hour; the majority of vehicles turn right onto SR-14 westbound. Of the 60 vehicles heading northbound on Walnut Street to turn onto or cross SR-14, approximately half (25) turn westbound and half (30) turn eastbound, with a few vehicles (#?) crossing SR-14 to continue north on Walnut Street. All turning and through movements for vehicles on Walnut Street have an average queue of 2 or less vehicles. For southbound vehicles, the average delay is less than 20 seconds per vehicle, northbound vehicles have an average delay of 25 seconds per vehicle (LOS C) (Figure 11).

Figure 11. SR-14/Walnut Street Intersection – Existing Conditions

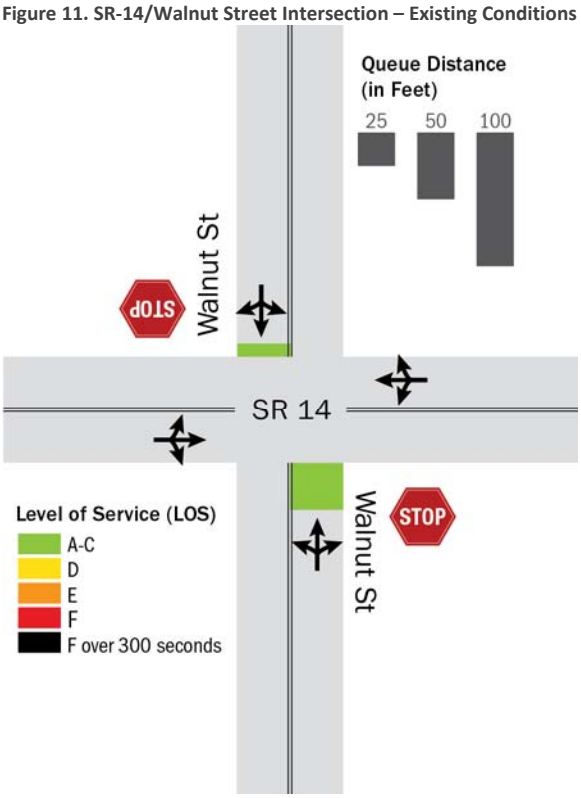
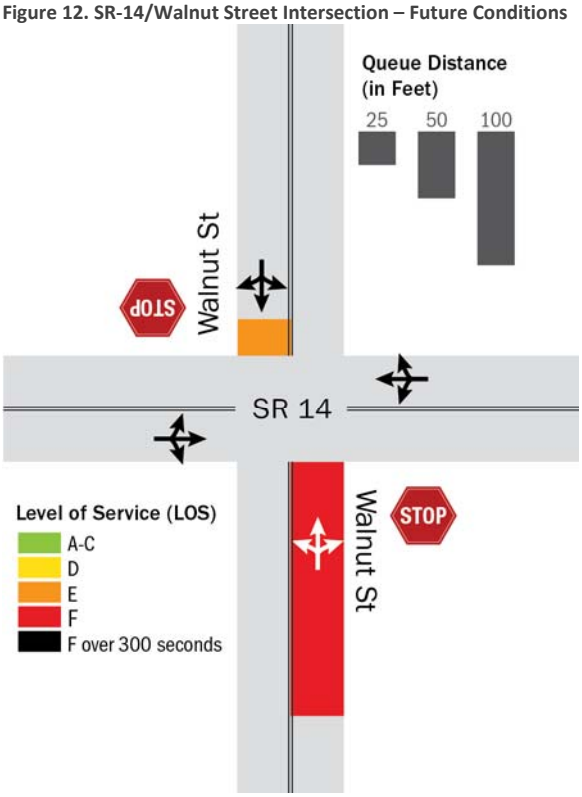


Figure 12. SR-14/Walnut Street Intersection – Future Conditions



Future Conditions (2037): Vehicles on Walnut Street that approach SR-14 would experience worsened conditions when trying to cross or turn onto SR-14 in the future due to increased congestion on SR-14 that provides fewer gaps. Southbound vehicles approaching SR-14 would have an average queue of 1-2 vehicles, but would experience a two-fold increase in delay of approximately 40 seconds per vehicle (LOS E). Northbound vehicles crossing or turning onto SR-

14 would experience an increased average queue of 7-8 vehicles during the PM peak hour and an average delay of over 3 minutes per vehicle (LOS F) (Figure 12).

SR-14/Ash Street

Ash Street intersects SR-14 in the downtown core of Bingen with a two-way street on the north leg and a one-way, southbound street on the south leg. Ash Street north of SR-14 experiences some cut-through traffic that would otherwise travel on Oak Street (SR-141) located one block east.

Existing Conditions (2017): During the PM peak hour, southbound vehicles approaching SR-14 experience an average delay of 17 seconds per vehicle with an average queue of 1 vehicle (LOS C) (Figure 13).

Future Conditions (2037): Increasing congestion on SR-14 in the future would adversely affect southbound vehicles on Ash Street turning onto or crossing SR-14. Average delay in the PM peak hour would grow to approximately 46 seconds per vehicle and the average queue would increase to 3-4 vehicles (LOS E) (Figure 14).

Figure 13. LOS for SR-14/Ash Street – Existing Conditions

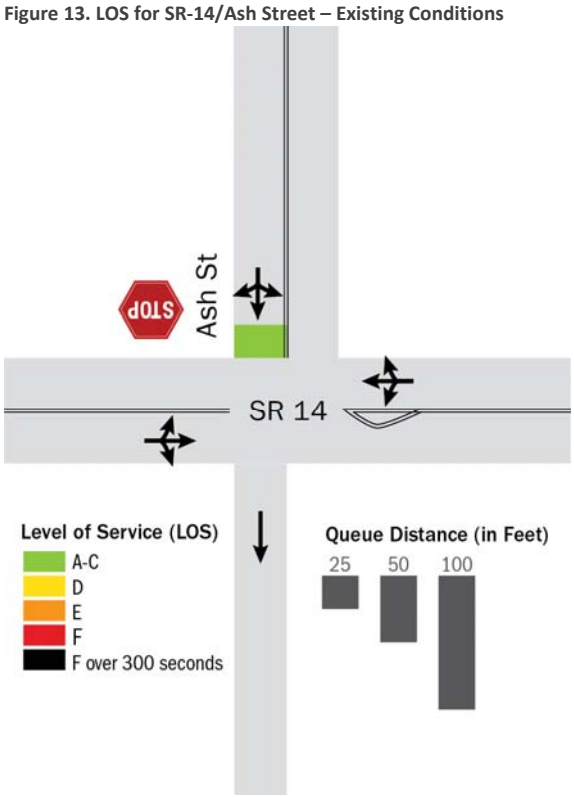
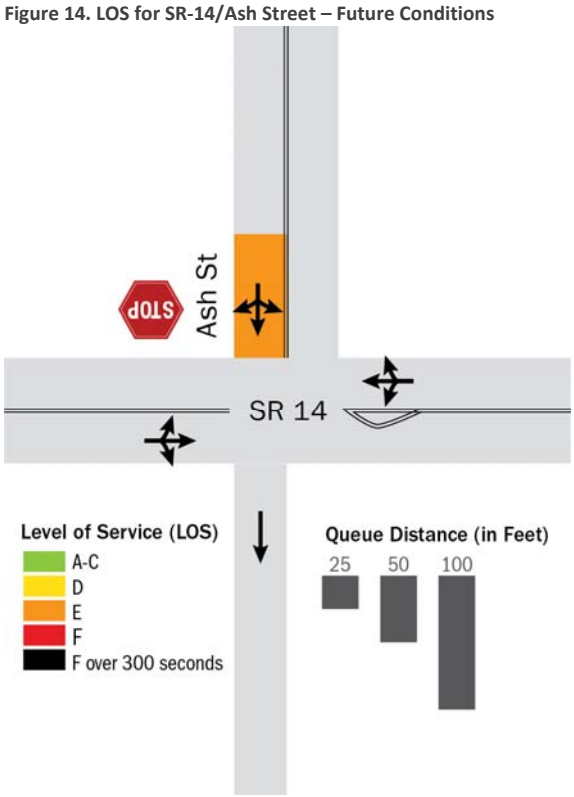


Figure 14. LOS for SR-14/Ash Street – Future Conditions



SR-14/Oak Street and SR-14/Maple Street

The SR-14/Oak Street intersection is a major junction in the Bingen town core where SR-14 and SR-141 connect. Most traffic heading south from White Salmon travels through this intersection to reach Bingen, the Hood River Bridge, and points west or east on SR-14. Northbound traffic headed to White Salmon typically travels through this intersection or can use Dock Grade Road (except when impassable).

Due to the proximity of the SR-14/Maple Street Intersection—the primary access to the Bingen Point Business Park—the traffic operations at both intersections are presented in a combined discussion.

Existing Conditions (2017): The high traffic volume turning movements during the PM peak hour at Oak Street are southbound to westbound SR-14 (250 vehicles) and the reverse movement of eastbound SR-14 to northbound Oak Street (145 vehicles). As shown in Figure 15, the southbound to westbound right turn lane can handle the heavy turning movement volumes with an average queue of 2-3 vehicles and an average delay of 15 seconds per vehicle to enter SR-14 (LOS C). There is more delay experienced for southbound Oak Street vehicles turning left or crossing SR-14 with an average queue of 3 vehicles but an average delay of 56 seconds per vehicle (LOS F). Northbound vehicles crossing SR-14 or making left or right turns experience average delays of 31 seconds per vehicle (LOS D). All directions of travel at Maple Street operate at LOS C or better.

Future Conditions (2037): Traffic operations for all turning movements from Oak Street onto SR-14 severely deteriorate in the future (Figure 16) as a result of increased congestion on SR-14. Southbound queues would increase to 10-14 vehicles; average wait times to make a right turn would be just over 1 minute per vehicle (66 seconds) and wait times to make a left turn would be over 5 minutes per vehicle. Similar queuing conditions and wait times would occur for northbound vehicles on Oak Street. Moreover, northbound vehicles on Maple Street would also experience severe challenges turning left or crossing SR-14. Queues would be average 26 vehicles long with wait times exceeding 5 minutes.

Figure 15. SR-14/Oak Street and SR-14/Maple Street Intersections – Existing Conditions

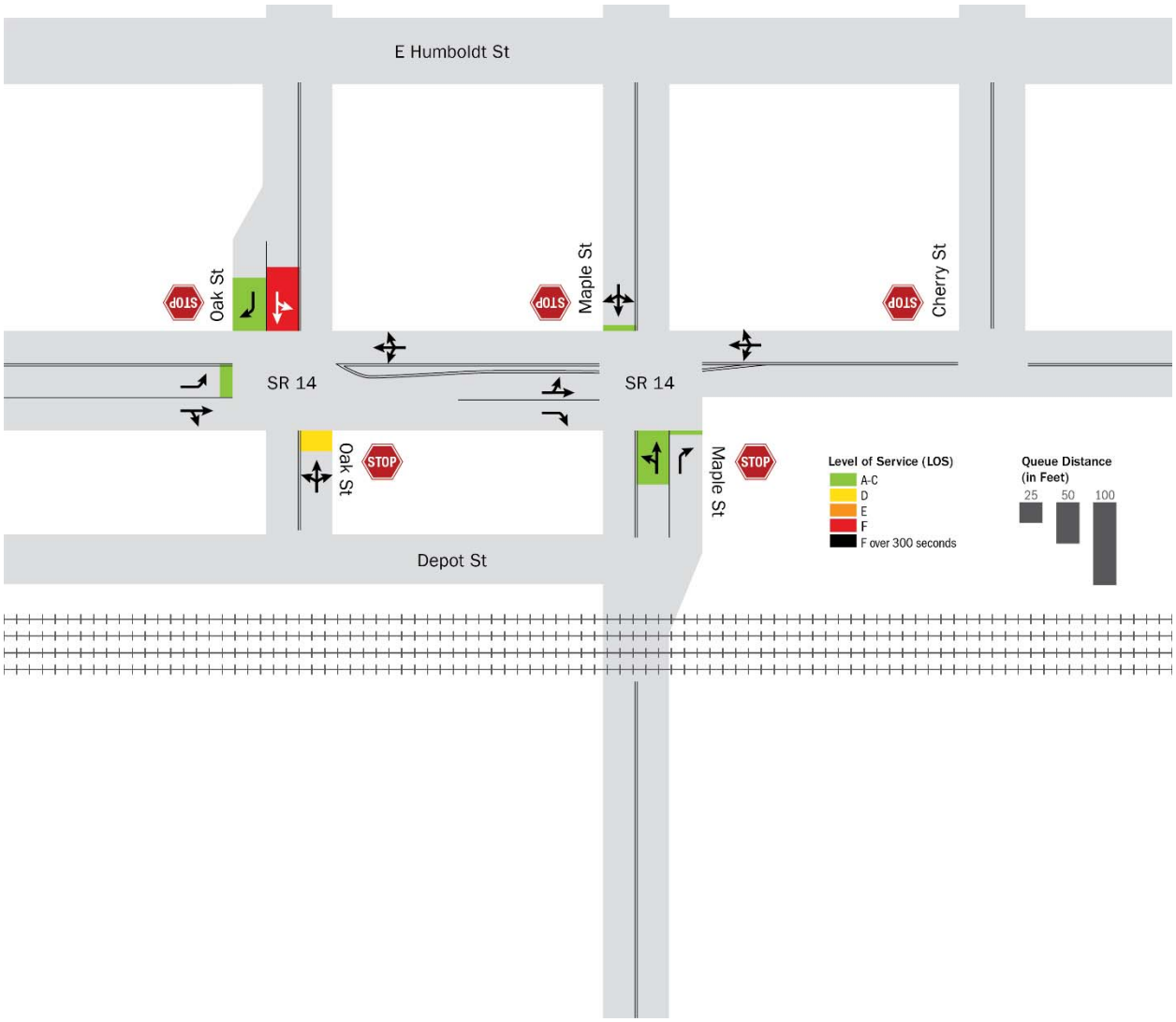
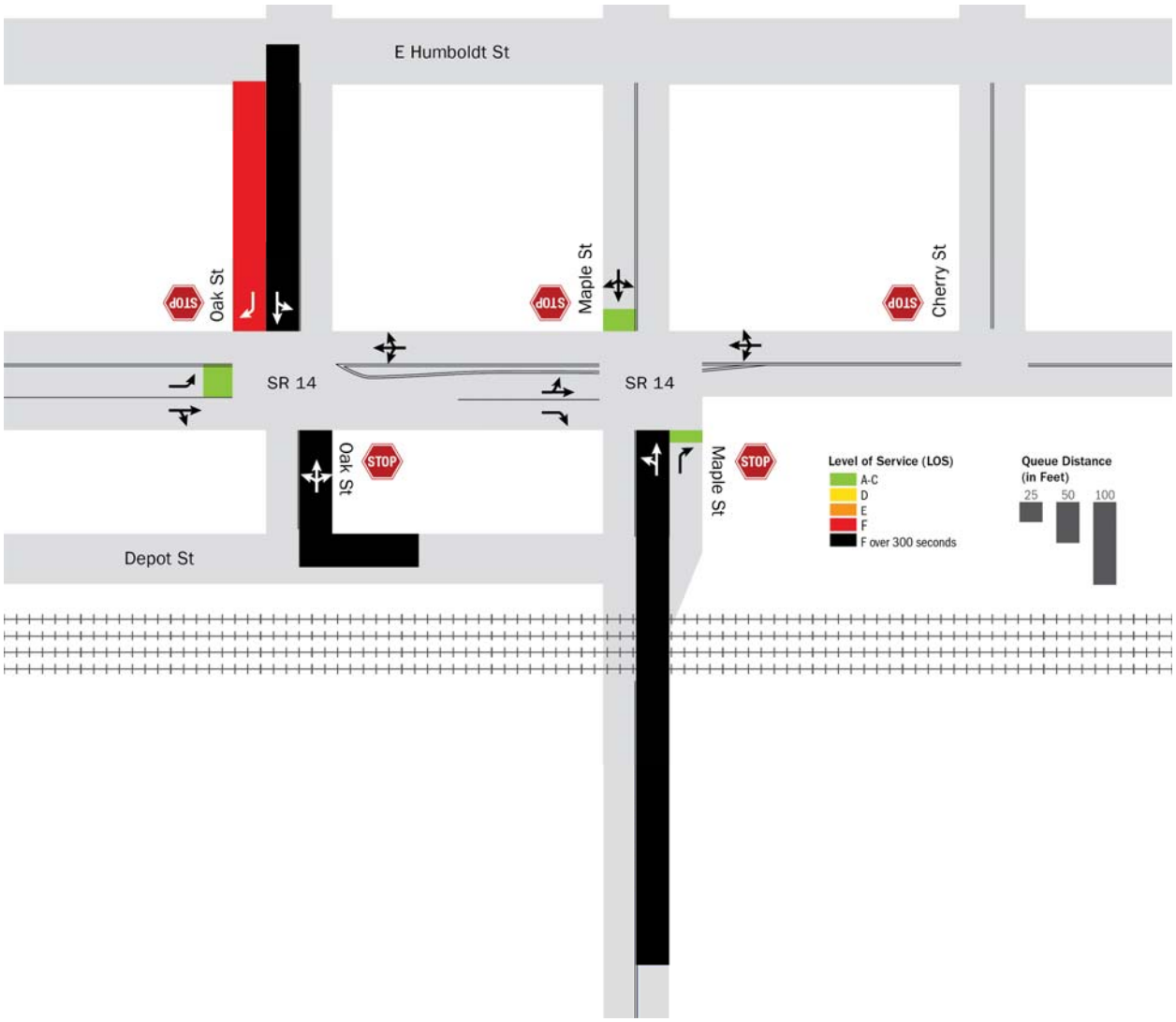


Figure 16. SR-14/Oak Street and SR-14/Maple Street Intersections – Future Conditions

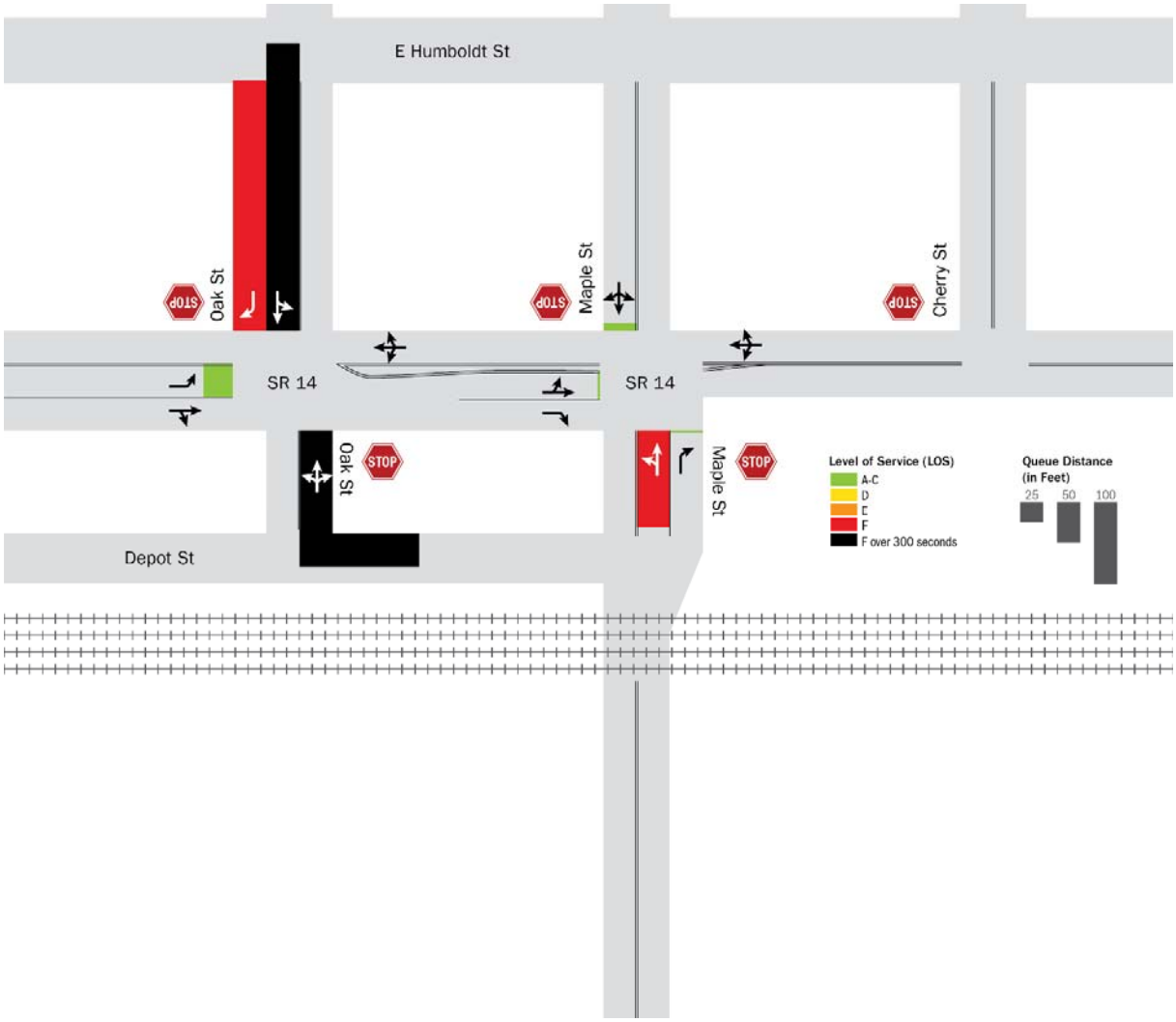


Build Concepts with Various Intersection Controls

Several improvements at the SR-14/Oak Street and SR-14/Maple Street intersections were also analyzed as future build concepts to address the severe backup on Oak Street and Maple Street. Various improvements such as signal timing, pedestrian safety, changes in access, and intersection controls at Oak Street and Maple Street were analyzed. The results are discussed below.

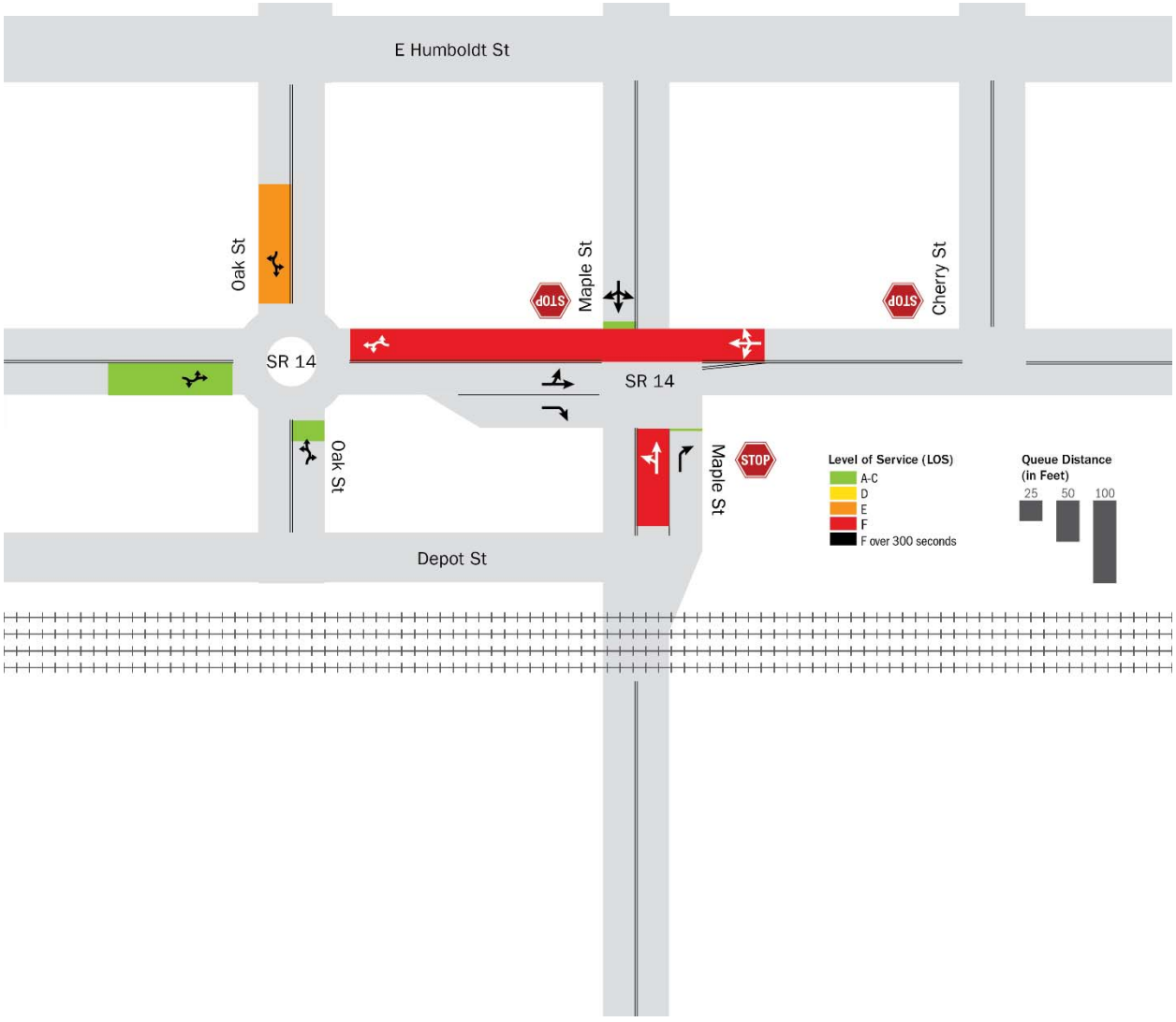
Concept 14—SR-14/Elm Street Roundabout (2037): In a separate project, WSDOT is proposing to construct a new roundabout on SR-14 at Elm Street. With this roundabout, Elm Street would be extended south of SR-14 to provide new access to Bingen Point. Although there would be little to no impact on Oak Street operations in the future, the SR-14/Maple Street intersection would benefit from the shift of approximately 70 percent of traffic to Elm Street. As shown in Figure 17, northbound queuing on Maple Street would lessen to 4-5 vehicles with an average wait time of 80 seconds, which would still operate at LOS F conditions albeit much improved over the 5-plus minute wait without the traffic shift.

Figure 17. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14



Concept 14 A1—SR-14/Elm Street Roundabout and SR-14/Oak Street Roundabout (2037): If the SR-14/Oak Street intersection would be reconfigured as a roundabout, then the traffic operations on both Oak Street and Maple Street would improve (Figure 18) compared to the gridlock conditions when both intersecting streets are controlled by stop signs (Figure 16). Southbound Oak Street queues entering the roundabout would average 12 vehicles with 47 seconds of delay (LOS E). Northbound Maple Street would still operate at LOS F; however, queues would average 4-5 vehicles with an average delay of approximately 80 seconds per vehicle.

Figure 18. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 A1



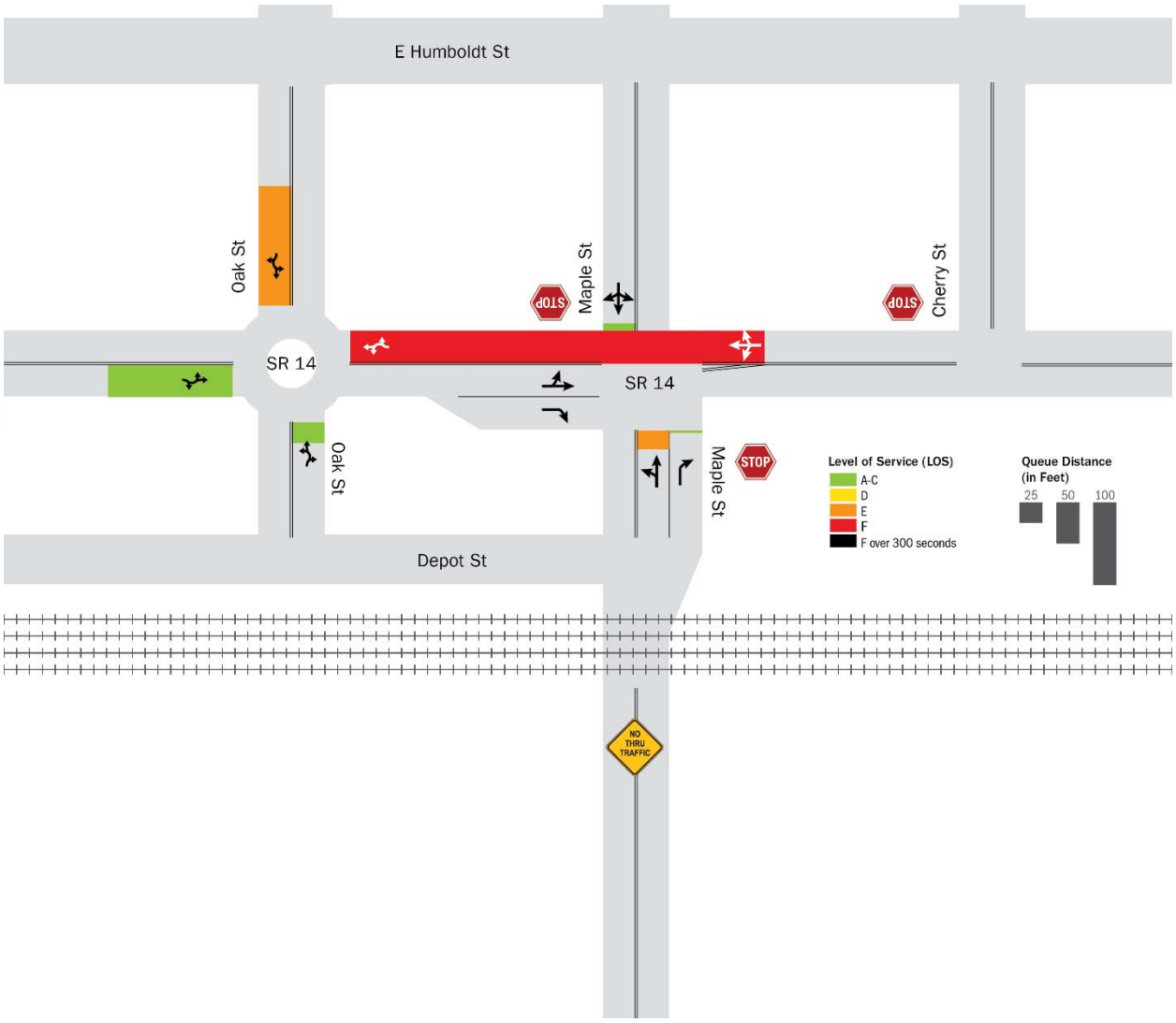
One consequence of providing more opportunity for vehicles to enter SR-14 from Oak Street through the roundabout is the slowing down of eastbound and westbound traffic on SR-14 at this intersection. Without the roundabout at SR-14/Oak Street, the eastbound and westbound SR-14 traffic would operate at LOS A to LOS B conditions during the PM peak hour. However, with the roundabout at SR-14/Oak Street, eastbound SR-14 traffic would have an average queue

of 6 vehicles and an average delay of 17 seconds per vehicle (LOS C). Westbound traffic would have an average queue of 20 vehicles that would spill back through the SR-14/Maple Street intersection with an average delay of 70 seconds per vehicle (LOS F).

Concept 14 A2—SR-14/Elm Street Roundabout and SR-14/Oak Street Roundabout with Partial Restriction on Southbound Maple Street (2037):

Southbound Maple Street would be closed just north of Marina Way, which would shift all traffic destined to or originating from Bingen Point Business Park to Elm Street. Only the traffic associated with SDS Lumber and one other business south of the rail crossing would continue to use Maple Street. The average queuing on northbound Maple Street would decrease to 1 vehicle with an average delay of 46 seconds per vehicle (LOS E) to enter SR-14 (Figure 19). All other movements at Oak Street and Maple Street would be the same as Concept 14 A1.

Figure 19. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 A2



For purposes of this analysis, the partial restriction in access on Maple Street was modeled as a barrier gate closing Maple Street just north of Marina Way. However, there are other options that could be considered to relieve congestion at the SR-14/Maple Street intersection:

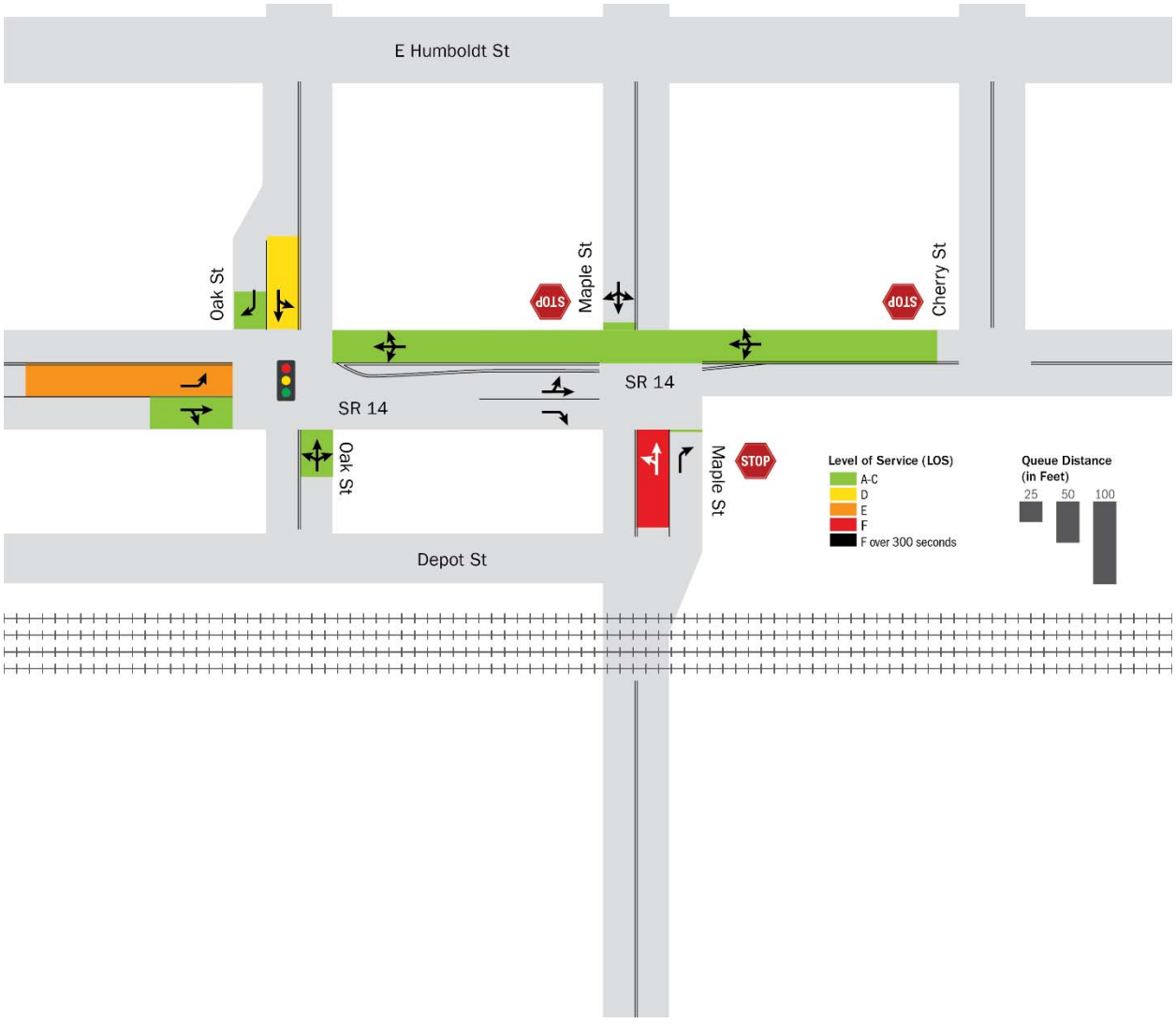
- **Restrict Maple Street to right turns only.** This option would install a barrier in the center median of SR-14 to only allow right turns onto Maple Street and SR-14; all left turns would be prohibited. This treatment would distribute trips to/from Bingen Point Business Park between Maple Street and Elm Street depending on turning movements that drivers would need to make as well as other conditions, including roadway blockage of Maple Street when trains are present.
- **Full closure of the south leg of Maple Street at SR-14.** Maple Street would be closed between SR-14 and Depot Street. Traffic heading south to the Bingen Point Business Park from SR-14 would either use an Oak Street-Depot Street-Maple Street route or use Elm Street.

Both options would maintain Maple Street as a route to Bingen Point in addition to the Elm Street route for traffic able to make right turns onto Maple Street from SR-14 or able to navigate multiple turning movements via the Oak Street-Depot Street- Maple Street route (i.e., passenger vehicles may easily navigate this route compared to freight trucks).

Concept 14 B1—SR-14/Elm Street Roundabout and SR-14/Oak Street Signal (2037): By adding a signal to the SR-14/Oak Street intersection, all directions of travel would be allowed time to move through the intersection. However, the southbound Oak Street through and left turns would experience average queues of 4-5 vehicles with an average delay of 40 seconds per vehicle (LOS D) (Figure 20). The heavier volume southbound right turns would experience average queues of 2-3 vehicles with an average delay under 35 seconds per vehicle (LOS C). Northbound vehicles on Maple Street turning left or crossing SR-14 would have an average queue of 4-5 vehicles and an average delay of 80 seconds per vehicle (LOS F).

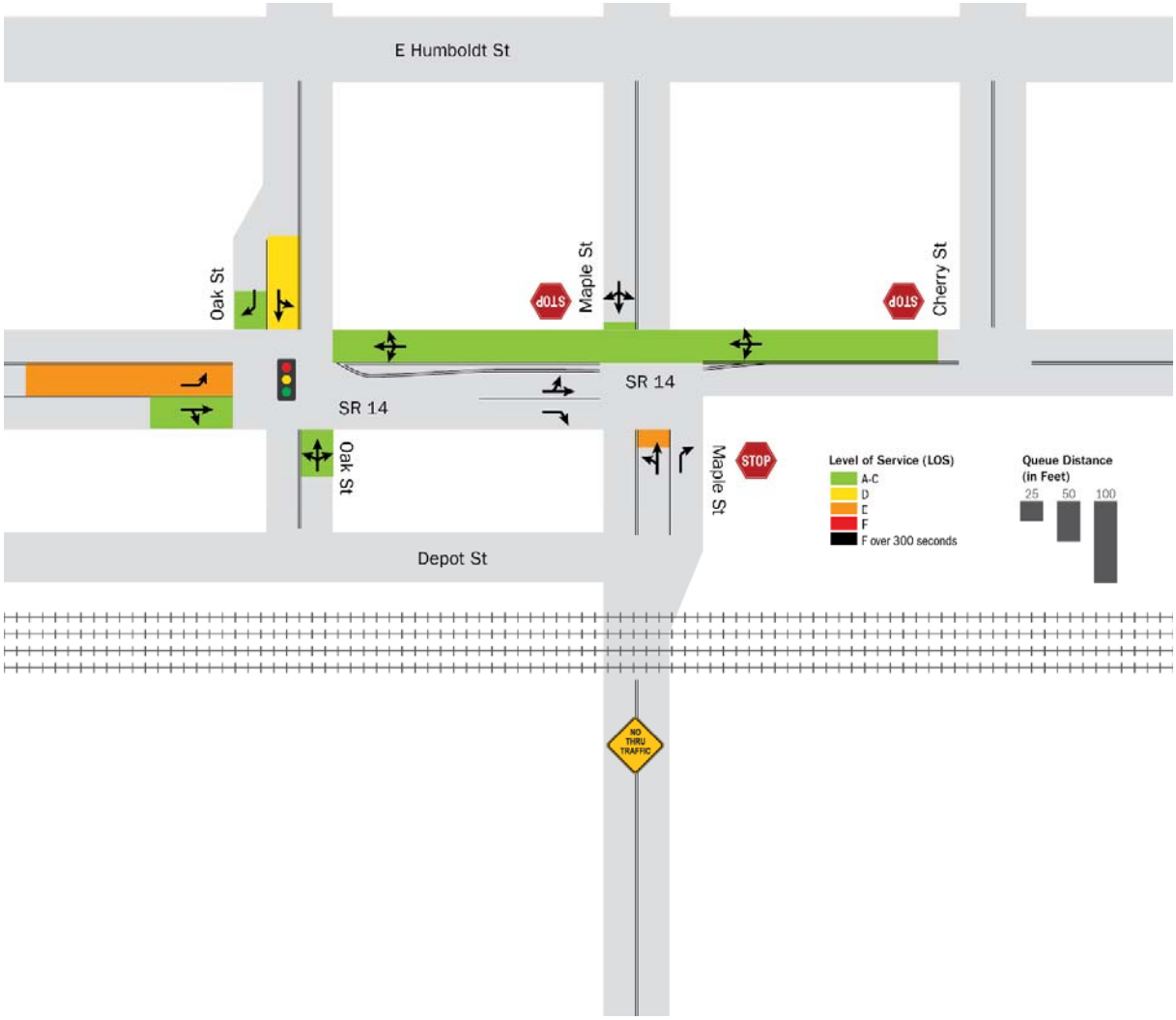
SR-14 eastbound to northbound Oak Street left turn queues would be approximately 10 vehicles with an average delay of 56 seconds per vehicle (LOS E). Westbound through movements on SR-14 would have an average queue of 30 vehicles extending east of Maple Street and an average delay of 34 seconds per vehicle (LOS C) with most vehicles able to clear the signal in one signal cycle.

Figure 20. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 B1



Concept 14 B2—SR-14/Elm Street Roundabout and SR-14/Oak Street Signal with Partial Restriction on Southbound Maple Street (2037): By preventing the use of Maple Street by tenants of the Bingen Point Business Park, most of the traffic on Maple Street south of SR-14 would be shifted to Elm Street. The only difference between this concept and Concept 14 B1 (without restricting access on Maple Street) is the congestion associated with the northbound Maple Street combined left turn/through movement (Figure 21). Thus, the average queuing for northbound traffic would be 1 vehicle with an average delay of 45 seconds per vehicle (LOS E). All other movements at Oak Street and Maple Street would be the same as Improvement B1.

Figure 21. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 B2

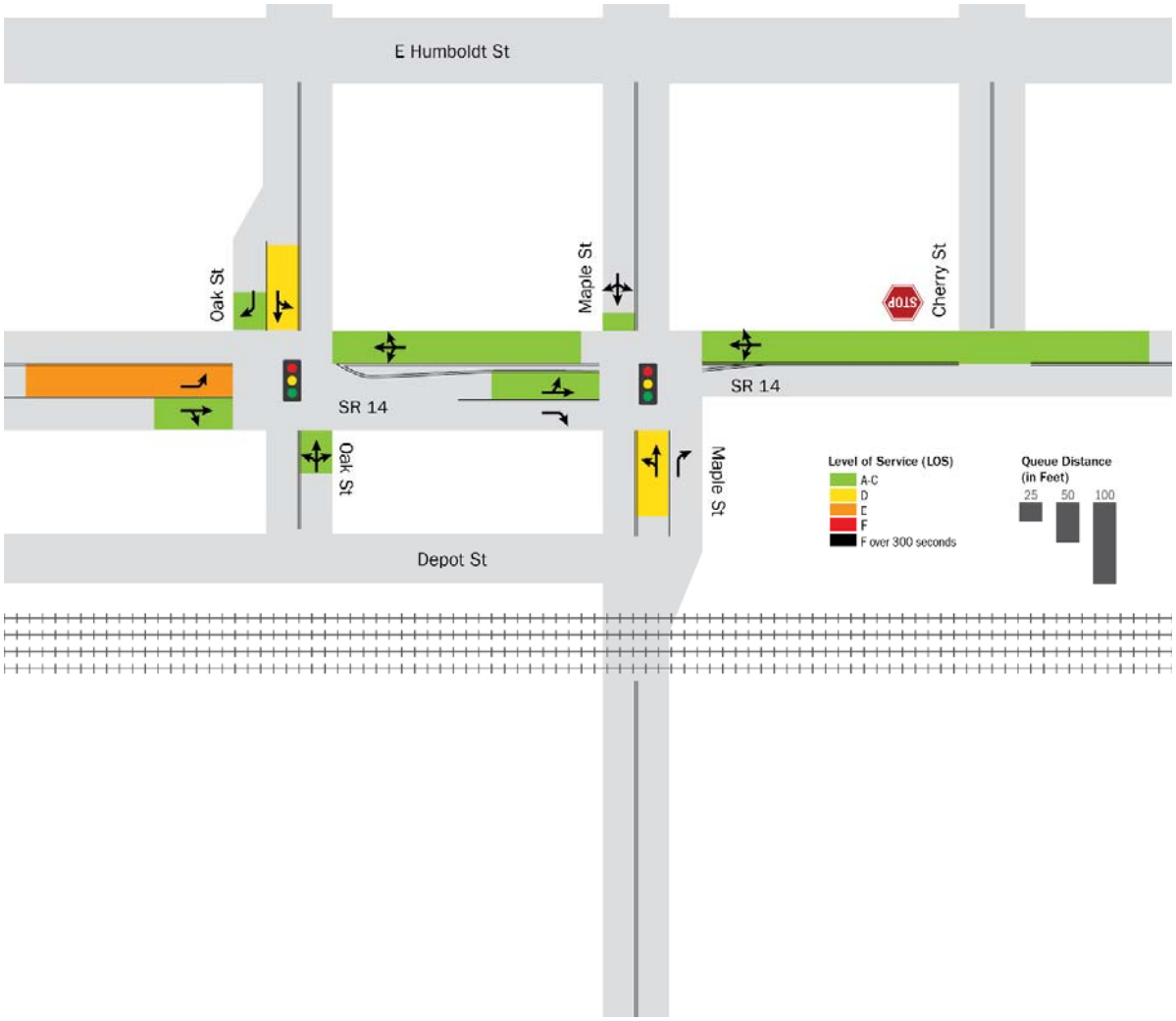


For purposes of this analysis, the partial restriction in access on Maple Street was modeled as a barrier gate closing Maple Street just north of Marina Way. However, there are other treatments that could be considered to relieve congestion at the SR-14/Maple Street intersection (as noted previously in the Concept 14 A1 discussion):

- Installing median barrier on SR-14 at the SR-14/Maple Street intersection to only allow right turns
- Closing the south leg of the SR-14/Maple Street intersection and routing traffic to Oak Street and Depot Street or to Elm Street to access the Bingen Point Business Park.

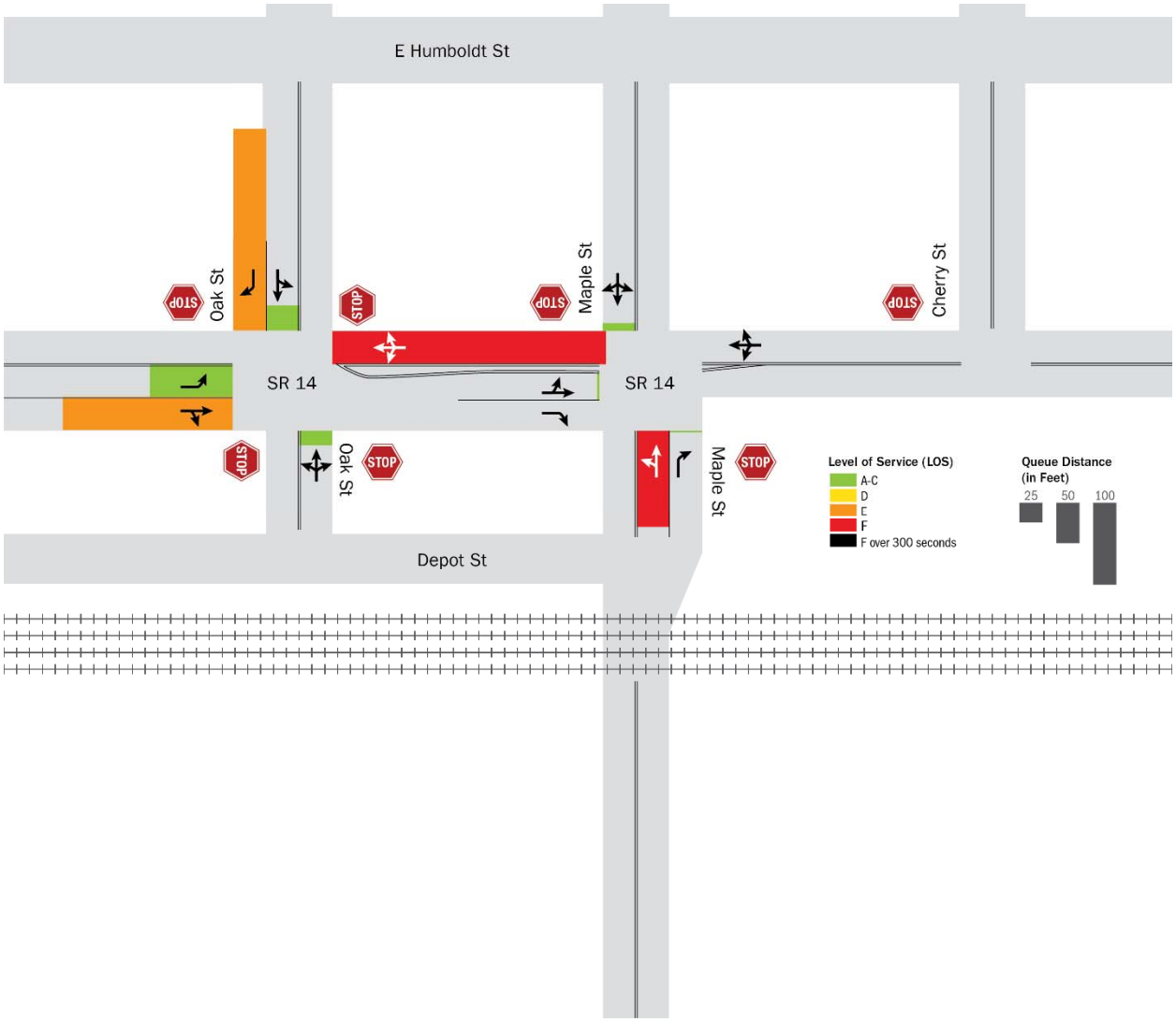
Concept 14 C—SR-14/Elm Street Roundabout and Signals at SR-14/Oak Street and SR-14/Maple Street (2037): Signalizing both Oak Street and Maple Street on SR-14 would provide operational benefits for many of the turning and through movements from local streets when compared to the other improvements analyzed (Figure 22). However, two intersections within 500 feet would require complicated signal phasing to optimize traffic flow for all movements and could require complex signage to assist drivers attempting to position for turning movements from one intersection to the next. In addition, more driver confusion would be present with the SR-14/Elm Street roundabout that would be 0.2 miles east of Maple Street. The overall circulation efficiency would be expected to diminish with two signalized intersections and one roundabout within a one-quarter mile distance.

Figure 22. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 C



Concept 14 D—SR-14/Elm Street Roundabout and SR-14/Oak Street All-Way Stop Control (2037): Providing all-way stop control at the SR-14/Oak Street intersection would allow some movements on Oak Street more opportunity to enter SR-14 compared to having stop control only on Oak Street. However, this would have adverse impacts on other movements. The most affected movement on Oak Street would be the high-volume southbound right turn where the average queue would increase to 9-10 vehicles and average delays to 44 seconds per vehicle (Figure 23).

Figure 23. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 D

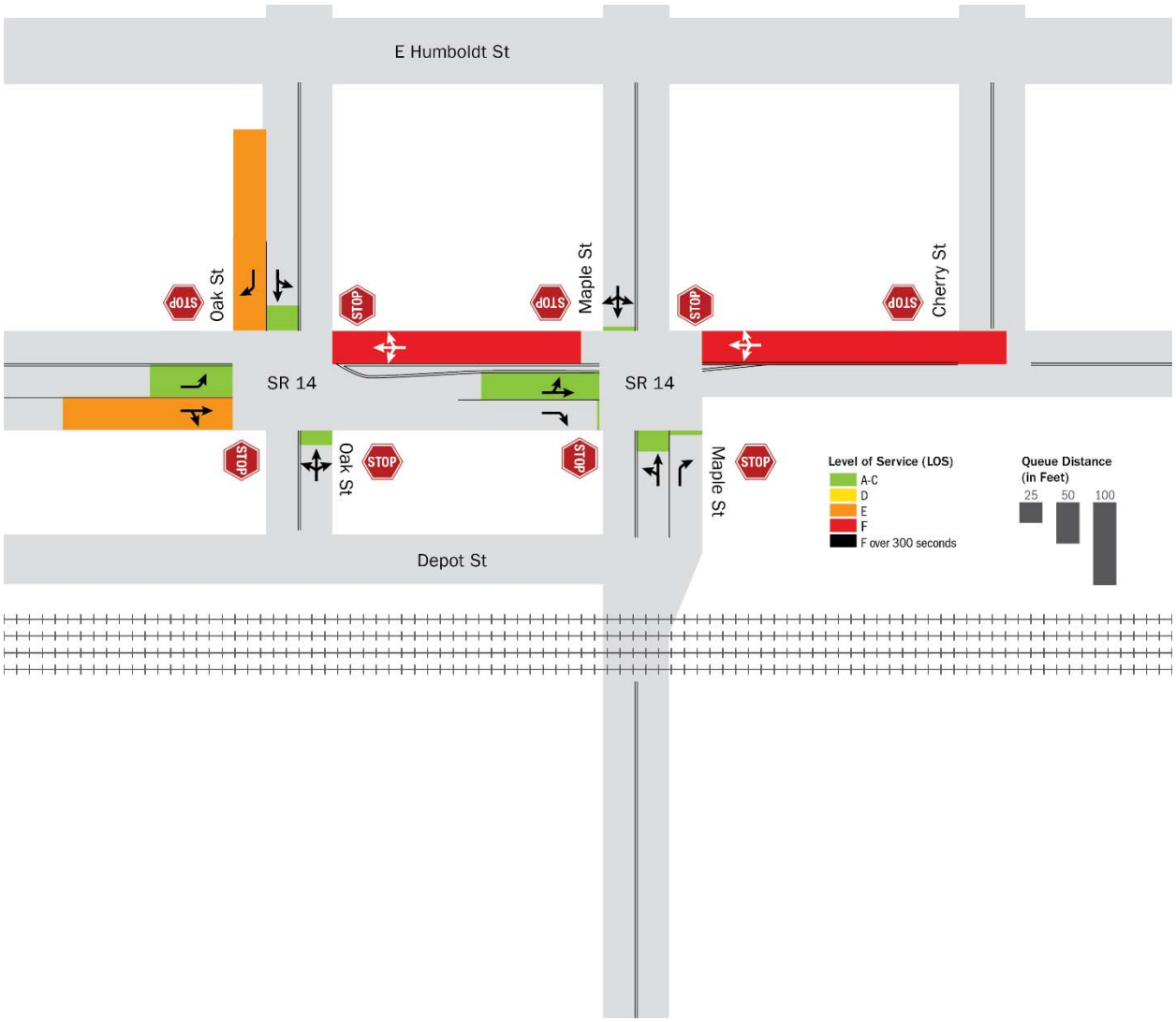


The eastbound and westbound through movements at the intersection would degrade to LOS E and LOS F conditions, respectively. Westbound through movements in this scenario would also queue into the SR-14/Maple Street intersection. In addition, the introduction of an all-way stop control intersection at Oak Street may create a confusing driving experience and an incompatible operating system with the roundabout at SR-14/Elm Street, which is 0.25 mile east of Oak Street. The incompatibility would occur at the highway segment level traffic operations,

where one intersection (SR-14/Elm Street) would operate well, but the adjacent controlled intersection (SR-14/Oak Street) would operate poorly.

Concept 14 E—SR-14/Elm Street Roundabout and All-Way Stop Control at SR-14/Oak Street and SR-14/Maple Street (2037): Using an all-way stop control at both the SR-14/Oak Street and SR-14/Maple Street intersections would exacerbate congestion on westbound SR-14 despite providing improvement for northbound vehicles on Maple Street (Figure 24). In addition, the introduction of all-way stop control intersections at the Oak Street and Maple Street intersections could create a confusing driving experience and an incompatible operating system on SR-14 with the roundabout at SR-14/Elm Street (located 0.25 miles east of Oak Street and 0.2 miles from Maple Street).

Figure 24. SR-14/Oak Street and SR-14/Maple Street Intersections – Concept 14 E



Conclusion

In the existing conditions (2017) analysis, traffic flow on SR-14 in the study area meets the highway operational standard of LOS C during the PM peak hour except for the eastbound segment from the SR-14/SR-141 Alt intersection to the SR-14/Hood River Bridge intersection. Under the Future No Build conditions (2037), vehicle volumes, average vehicle delay, and congestion would increase, negatively impacting traffic flow along other highway segments as well as intersection operations within the study area.

In August 2017, WSDOT identified Concept 14 as the preferred new grade-separated railroad crossing for access to the Bingen Point. This concept would provide a new railroad undercrossing and roundabout on SR-14 at Elm Street—roughly 0.2 miles east of Maple Street. Compared to the Future No Build Conditions and another concept studied (Concept 2), Concept 14 is expected to have the highest utilization of trips from/to Bingen Point and would provide the greatest opportunity to avoid delays associated with train crossings at Maple Street.

Various concepts were analyzed at the Oak Street and Maple Street intersections on SR-14 that could be paired with WSDOT's Concept 14, including adding a roundabout, signal, or all-way stop control at one or both intersections. Based on the operational analysis in this study as well as consideration of other transportation facilities along SR-14, the following potential improvements are presented for consideration to reduce congestion, improve connectivity, and enhance mobility along SR-14. The construction costs included below are planning-level estimates intended to provide only a magnitude of scale and do not include costs for design, engineering, or right-of-way acquisition.

Potential improvements that could improve traffic operations along SR-14 include:

- **Upgrade traffic control at the SR-14/Oak Street intersection –** The existing conditions analysis indicates the SR-14/Oak Street intersection experiences long delays for southbound through and left turn movements on Oak Street at SR-14. With the increase in traffic volumes in the future (2037), the intersection would experience even higher delays for all Oak Street movements onto or across SR-14. The Future Build (2037) analysis indicates that either a signal (as analyzed in Concepts 14 B1 and 14 B2) or a roundabout (as analyzed in Concepts 14 A1 and 14 A2) at this intersection would substantially decrease delays. The approximate cost of these types of improvements would be $250,000 to $500,000.
- **Partially or fully restrict access on Maple Street south of SR-14**
    - The Future Build (2037) analysis indicates that the SR-14/Maple Street intersection would considerably benefit by partially restricting traffic on Maple Street, and thereby, preventing the use of Maple Street by Bingen Point Business Park tenants with the installation of a barrier gate immediately north of Marina Way (as analyzed in Concepts 14 A2 and 14 B2). This partial restriction on Maple Street would require vehicles originating from or destined to locations

on or south of Marina Way to use the new SR-14/Elm Street roundabout. This route change reduces the volume of vehicles traveling on Maple Street, which would decrease delays at the SR-14/Maple Street intersection. The approximate cost of this improvement would be $5,000.

  - Another improvement that would partially restrict access to Maple Street would be the installation of barrier in the center median of SR-14 between Oak Street and Elm Street. Turning movements would be limited to right-in/right-out turning movements, which would require drivers to use other routes via Oak Street or Elm Street to make left turns.
  - Full restriction at Maple Street would involve closing the south leg of the intersection. Maple Street would be closed between SR-14 and Depot Street, which would require drivers to use other routes such as Oak Street or Elm Street to access the Bingen Point Business Park.

- **Revise and update SR-14 and Hood River Bridge intersection signal timing** – The existing conditions analysis indicates that vehicles coming off the Hood River Bridge face lengthy delays to turn onto SR-14 at the signalized SR-14/Hood River Bridge intersection. To address the current delay at this intersection, a signal phasing revision was tested as a potential mitigation measure that introduces an overlap phase for the northbound-to-eastbound right turn movement. This right turn protected phase would run concurrently with the westbound-to-southbound left turn movement from SR-14 to the Hood River Bridge and provide additional approach capacity for northbound movements. The findings of the signal phasing mitigation test show that overall average intersection delays could be reduced to approximately 42 seconds per vehicle (LOS D) based on the current capacity of the right turn lane. The approximate cost of this improvement would be $20,000.
- **Add a rectangular rapid flashing beacon (RRFB) at SR-14 and Alder Street crosswalk** – An RRFB at the SR-14/Alder Street crosswalk is recommended to enable the pedestrians to cross SR-14 safely. In addition to improving pedestrian safety, use of this facility could occasionally introduce gaps in SR-14 traffic when pedestrians cross the highway that in turn enable turning and cross movements at Walnut Street (one block west) and Ash Street (one block east) to occur. The approximate cost of this improvement would be $30,000.
- **Improve striping and install a radar speed sign at the SR-14/SR-141 Alt intersection** – Vehicles currently travel higher than the posted speed limit within this portion of the study area. In addition, the steep cliff to the east of the intersection impedes sight visibility for vehicles turning from SR-141 Alt onto SR-14. Both speed and limited sight visibility pose safety concerns. Adding an eastbound left turn pocket through striping and installing a westbound radar speed sign at the SR-14/SR-141 Alt intersection could improve safety. The approximate cost of this improvement would be $25,000.

- **Add radar speed signs on SR-14 entering town –** Radar speed signs would help reduce speeds through the Bingen downtown area, thereby creating a safer environment for vehicles, pedestrians and bicyclists. The approximate cost of this improvement would be $20,000.

In the future, the SR-14 corridor could also benefit by implementing the following higher cost improvements:

- **Create downtown boulevard (complete street)** – Repurposing the existing right-of-way could have a calming effect on driving behavior as well as reallocate space for protected turns, which increases mobility and safety. Specific elements of a downtown boulevard could include:
    - Reconfigure angled parking to parallel parking to reallocate space to a median (some loss of on-street parking could result)
    - Construct center left turn lane through downtown so turning vehicles would be in protected lanes and through traffic flow could improve
    - Restrict SR-14 driveways to right in/right out to improve traffic flow and safety
    - Upgrade traffic control, such as adding signals or roundabouts, at additional intersections
    - Add streetscape/landscaping treatments to promote slower speeds, encourage driver awareness of being in a downtown area where more vehicle movements and pedestrian and bicycle traffic may be present, and buffer sidewalks to enhance pedestrian circulation.
- **Widen SR-14 for additional through lane(s) –** Acquire property to widen the roadway right of way so that one or more through lanes could be added on SR-14. Additional through lanes would increase roadway capacity to alleviate congestion, but may not be desirable in terms of encouraging slow travel speeds, pedestrian and bicycle travel, private property acquisition, or meeting other downtown goals by the City of Bingen.
- **Realign Maple Street to Oak Street south of SR-14 or Close Maple Street between SR-14 and Depot Street –** By realigning these two streets, north-south and turning movements could be consolidated in one intersection. Traffic flow on SR-14 could improve by replacing two closely spaced intersections with a single intersection.

In addition, the study also identified the following pedestrian and bicycle improvements:

- **Complete sidewalk along eastbound SR-14 to new SR-14/Elm Street roundabout** – Sidewalk along SR-14 eastbound begins just west of the SR-14/Hood River Bridge intersection and continues until the SR-14/Maple Street intersection. Pedestrians wishing to continue walking on a sidewalk would need to cross SR-14 at Maple Street and continue walking east along the north side of SR-14. The proposed SR-14/Elm Street roundabout would include crosswalks and continued sidewalks south on Elm Street.

Adding sidewalk along eastbound SR-14 from Maple Street to the new SR-14/Elm Street roundabout (3 blocks) would improve connectivity and encourage safe pedestrian circulation in the study area. The approximate cost of this improvement would be $125,000.

- **Construct multi-use path through town parallel to SR-14** – To enhance pedestrian and bicycle connectivity and experience in the study area, one consideration would be to locate a parallel multi-use path further away from SR-14.

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