WALL CONSULTANT GROUP

Date: August 23, 2023

To: Eric Eby & Tyler Reece, City of Portsmouth

From: Erica Wygonik, PhD, PE; Austin Feula, PE, PTOE

Subject: State Street Two-Way Study – Results

Summary of Findings

Using the downtown Portsmouth microsimulation model, WCG has examined the traffic impacts of converting State Street through the core of the Portsmouth downtown from one-way travel to two-way flow.

The Portsmouth Traffic Microsimulation model has been developed to support a comprehensive assessment of the transportation implications associated with potential future development, parking changes, or roadway configurations or orientations. The model region covers the downtown core of Portsmouth, including, but not limited to, Maplewood Avenue, Market Street, and the Congress/Daniel and State Street one-way loop. It includes detailed information on roadway classification, speeds, geometrics, intersection controls, signal timings, parking, pedestrians, and traffic volumes to best reflect how vehicles would react to various changes.

The following summarizes key findings based on the analysis presented in this memorandum:

- The model is developed to reflect the peak month midweek 5:00 to 6:00 PM period as it corresponds with the highest combined vehicle and pedestrian volumes. The scenario was evaluated during this time period.
- Count volumes were adjusted to represent 2032 conditions considering proposed development projects throughout the downtown, background growth, and travel behavior changes due to COVID. Given the combined impact of these factors, an adjustment of 1% to the 2021 model volumes was applied to reflect likely 2032 conditions.
- For this scenario, State Street and Dutton Avenue were converted to two-way flow between Middle Street and Scott Avenue. The small segment of road allowing for u-turns from Dutton Avenue to Scott Avenue was removed as part of the evaluation.
- Results were compared between the existing one-way and the proposed two-way configuration during a weekday PM peak hour with and without a typical Memorial Bridge drawbridge lift.
- The two-way scenario operates with acceptable congestion during the PM peak hour.
- Minor changes in delay are projected during baseline conditions if State Street is converted to two-way flow. If State Street is converted to two-way flow, more substantial changes are projected following a Memorial Bridge drawbridge lift, with congestion shifting from Market Square to the Middle Street corridor.

- With the conversion to two-way traffic flow, 1 to 2 on-street parking spaces would be eliminated for a right-turn pocket on State Street approaching Middle Street westbound, and westbound trucks would be prohibited from turning right due to an inadequate turning radius on that corner.
- Accounting for construction costs, engineering costs, construction oversight, and contingency, the approximate total cost of improvements to support the conversion is roughly $1.5 million.
- The extent of the area under consideration to shift to two-way traffic is within the urban compact, and thus is under the authority of the city. However, a project on this road (C2492, 1953) has been completed using federal monies, and State Street in this area is a numbered highway (US-1). As such, while decisions regarding the roadway design are largely held with the City, NHDOT has a role in protecting the investment of federal funds and will likely require a review of the design to ensure any proposed changes do not limit the function or use of the road.

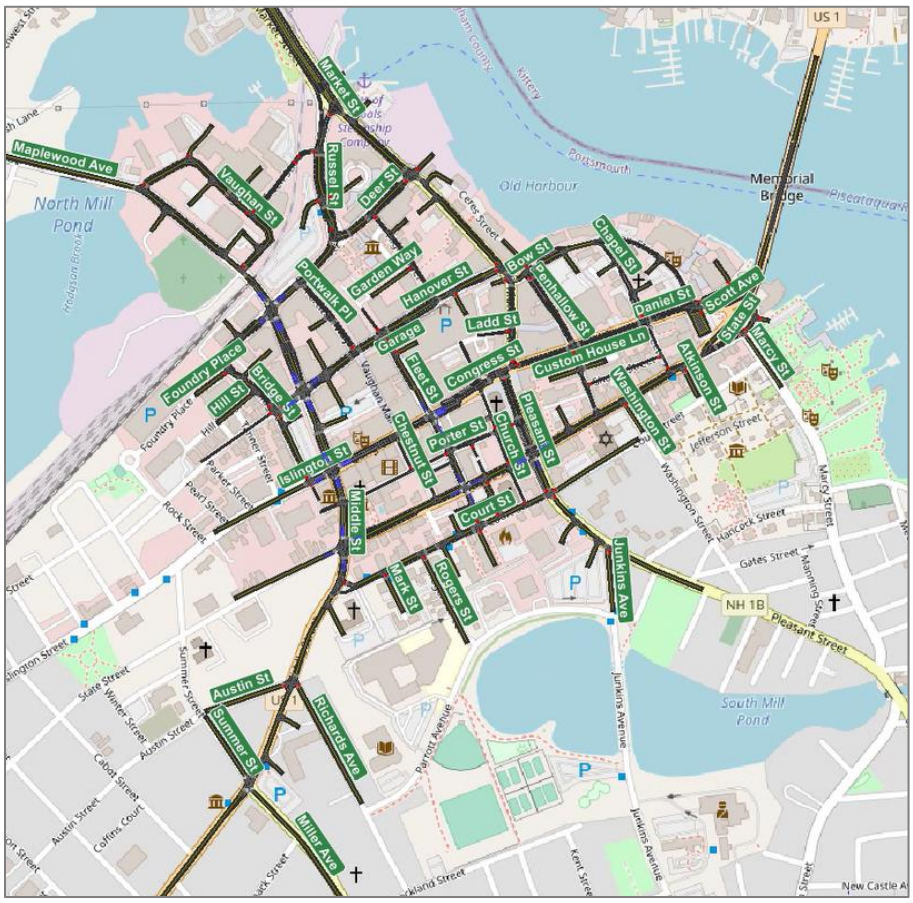
It is important to note the model does not evaluate impacts on non-vehicular modes (bicyclists and pedestrians), emergency vehicles, and loading zones. Currently, truck loading has been observed fully or partially blocking the travel lane due to trucks exceeding the width of loading areas, not fully pulling into loading areas, or using the travel lane instead of loading areas. This behavior is not modeled but would need to be adequately planned for. Additional loading zones and possibly wider loading zones may be required, which would have impacts on the number of lost parking spaces or the sidewalk width. Shifting the curb to accommodate wider loading zones would have significant cost implications.

Model Background

The Portsmouth Traffic Microsimulation model has been developed to support a comprehensive assessment of the transportation implications associated with potential future development, parking changes, or roadway configurations or orientations.

The model region covers the downtown core of Portsmouth, including, but not limited to, Maplewood Avenue, Market Street, and the Congress/Daniel and State Street one-way loop (Figure 1). The microsimulation model is calibrated to weekday PM peak design hour conditions (5:00 to 6:00 PM) for the peak month and is developed in the TransModeler software program.

Figure 1: Downtown Portsmouth Traffic Microsimulation Model Extent



The model includes detailed information on roadway classification, speeds, geometrics, intersection controls, signal timings, parking, pedestrians, and traffic volumes. The model was initially calibrated to 58 intersection turning movement counts. These counts were collected by Resource Systems Group, the City's consultant on the original project, in June of 2017 and include counts provided by the City of Portsmouth. For more information on the calibration and specifics of this model, please see the Portsmouth Model Calibration Report. The model was recalibrated in 2020 using count data from nine indicator intersections to reflect background growth as well as travel behavior shifts due to the Foundry Place Garage opening and the Sarah Long Bridge re-opening.

Adjustment to 2032 Conditions

For the current analysis, WCG reviewed available count data to determine recommended future growth rates and COVID adjustments to adjust the Downtown Portsmouth Traffic Model to reflect 2032 conditions. The analysis indicated traffic volumes were approximately 9% lower in 2022 than they were pre-COVID during the PM peak hour. In addition, volumes decreased approximately 0.5% per year between 2015 and 2019. However, a robust set of proposed development projects throughout the downtown are anticipated. Given the combined impact of

these factors, an adjustment of 1% was applied to the 2021 model volumes to reflect likely 2032 conditions.

Two-Way State Street Scenario

For this scenario, State Street and Dutton Avenue were converted to two-way flow between Middle Street and Scott Avenue. The small segment of road allowing for u-turns from Dutton Avenue to Scott Avenue was removed for the evaluation as it would no longer be necessary for circulation as vehicles can use State Street to Daniel Street, under the Memorial Bridge, to reverse direction or they can turn onto State Street southbound from the side streets. The roadway changes are shown below in Figure 2. The green dash illustrates the extent of the two-way flow and the red line indicates the u-turn road segment that would be removed.

In this two-way scenario, impacts to on-street parking and roadway cross-sections were minimized. Turn lanes were included only where absolutely necessary, and where they were necessary, their length was minimized to save as many on-street parking spaces as possible. Figure 3 presents the changes that would be required to support the two-way conversion. In the legend in Figure 3, “New Signal Heads” connotes the additional signal infrastructure necessary to support new movements at an intersection. This additional infrastructure may include new signal heads, new mast arms, additional detectors, or additional controller equipment. Similarly, “Intersection Reconstruction” reflects a comprehensive overhaul, which may include curbs, pavement, drainage modifications, changed lane alignments, signal heads, mast arms, detectors, new or additional controller equipment, or striping.

Constructing new signal heads would cost roughly $150,000 per intersection, and a complete intersection reconstruction is estimated to cost roughly $600,000. When accounting for engineering costs, construction oversight, and contingency, the approximate total cost of these improvements is roughly $1.5 million.

Figure 2: Roadway Changes for the Two-Way State Street Scenario

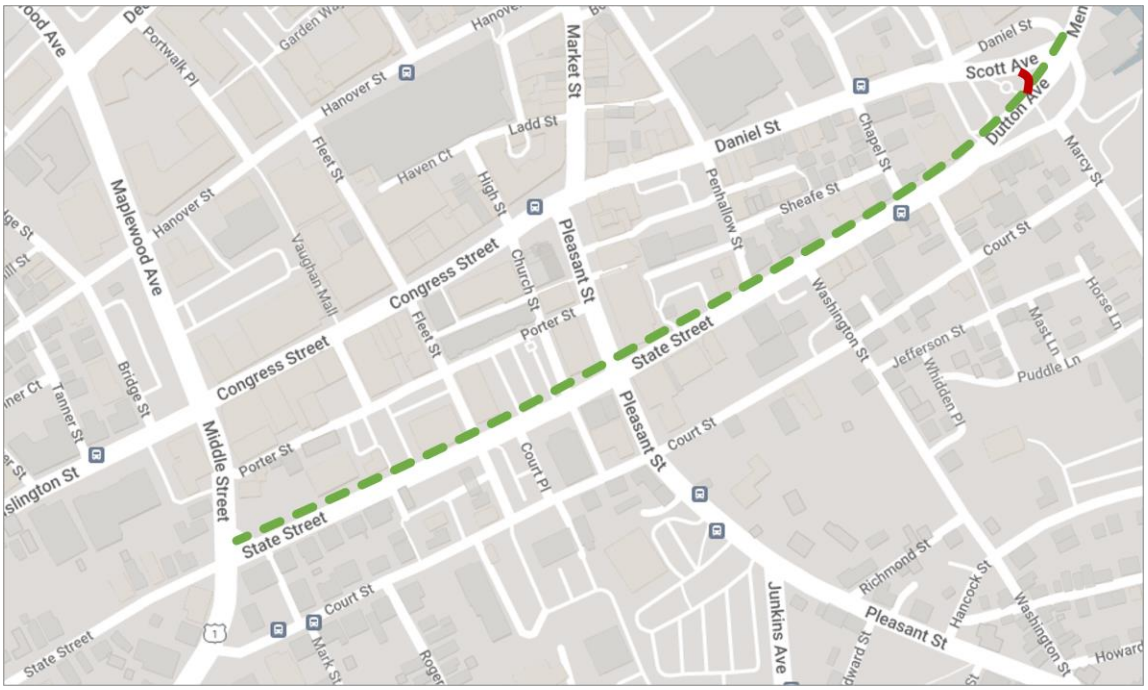
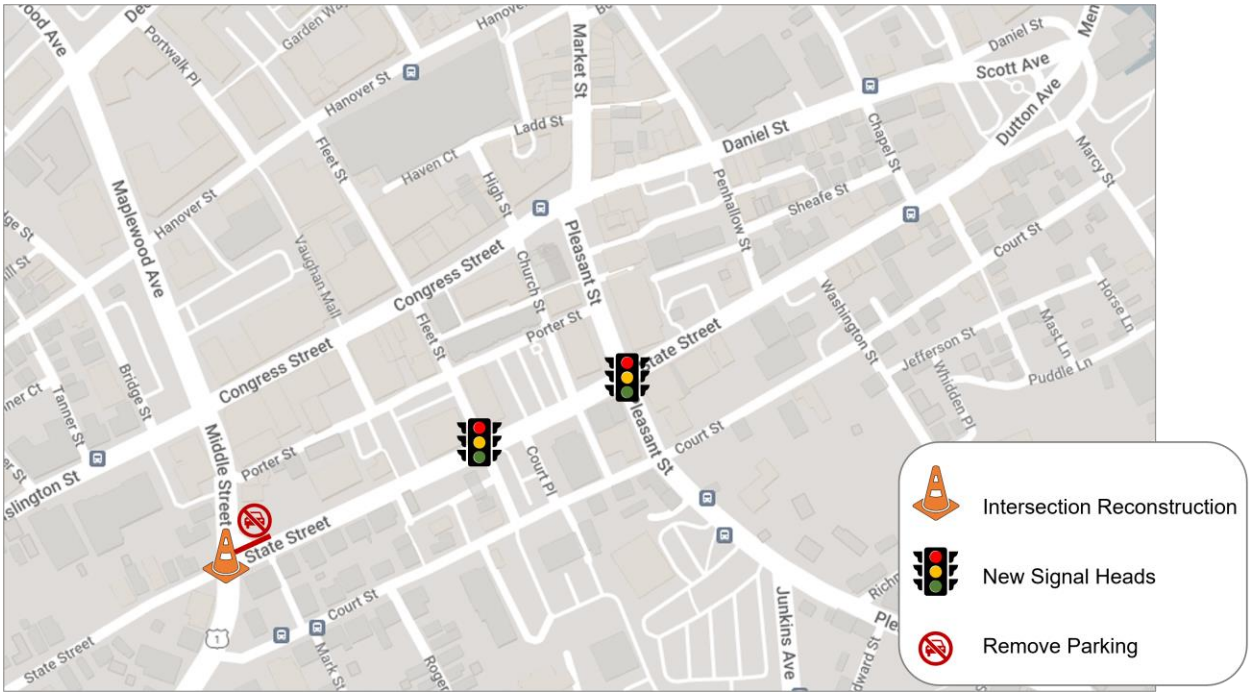


Figure 3: Changes Required to Support Two-Way Conversion of State Street



While the infrastructure changes are modest, trucks pose two challenges. First, delivery vehicles have been observed fully or partially blocking a travel lane when loading/loading. If the

road is converted to two-way traffic, additional parking spaces may need to be removed to accommodate additional loading areas, and those spaces may need to be widened slightly to ensure loading vehicles do not extend into the travel lanes. Loading vehicles sometimes block travel lanes because they do not use loading zones and simply stop in the street; more active patrolling might be required to change that behavior.

The second limitation for trucks of converting State Street to two-way travel is the angle between State Street and Middle Street is too sharp to allow for the necessary turning radius for large westbound vehicles to make a right turn. This challenge can be addressed through signage, including posting Truck Route signs upstream to direct them away from the intersection if they are traveling north, and a Trucks No Right Turns sign at the intersection. Posting the Trucks No Right Turn sign may require an ordinance change.

Authority to Modify Roadway Geometry

The extent of the area under consideration to shift to two-way traffic is within the urban compact, and thus is under the authority of the city.[1] However, a project on this road (C2492, 1953) has been completed using federal monies[2], and State Street in this area is a numbered highway (US-1). As such, while decisions regarding the roadway design are largely held with the City, NHDOT has a role in protecting the investment of federal funds. A review by NHDOT will likely be required to ensure any proposed changes do not limit the function or use of the road. Review would be coordinated by the Bureau of Planning & Community Assistance upon a request from the City. As this effort would also review signage changes for US-1, the City should consider their preferences for the future routing of US-1.

Capacity Analysis

Level of service (LOS) is a qualitative measure describing the operating conditions as perceived by motorists driving in a traffic stream. LOS is calculated using the procedures outlined in the Highway Capacity Manual, Sixth Edition: A Guide for Multimodal Mobility Analysis[3] (HCM6). In addition to traffic volumes, key inputs include the number of lanes at each intersection, traffic control type (signalized or unsignalized), and the traffic signal timing plans, if applicable.

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[1] NH RSA 231:2 Class IV Compact Section Highways. – All class IV highways shall be wholly constructed, reconstructed and maintained by the city or town in which they are located, and no state funds shall be expended thereon except as may be authorized by RSA 235.

[2] NH RSA 231:1 Class IV, V and VI. – All class IV highways not financed in whole or in part with federal aid highway funds, and class V and VI highways shall be laid out by the mayor and aldermen of the city, the selectmen of the town or the commissioners of a village district formed for the purpose of RSA 52:1, I(m) in which such highways are located, or by the superior court as hereinafter provided. In the case of a village district formed for the purpose of RSA 52:1, I(m), references in this title to "town" and "selectmen" shall be deemed to be references to "village district" and "village district commissioners", respectively.

[3] The HCM6 does not provide methodologies for calculating intersection delays at certain intersection types including signalized intersections with exclusive pedestrian phases and signalized intersections with non NEMA-standard phasing. Because of these limitations, HCM 2000 and HCM 2010 methodologies are employed where necessary and as noted.

The HCM6 defines six qualitative grades to describe the level of service at an intersection. Level-of-service is based on the average control delay per vehicle. Table 1 shows the various LOS grades and descriptions for signalized and unsignalized intersections.

Table 1: Level-of-Service Criteria for Unsignalized and Signalized Intersections

LOS	CHARACTERISTICS	UNSIGNALIZED CONTROL DELAY (SEC)	SIGNALIZED CONTROL DELAY (SEC)
A	Little or no delay	≤ 10.0	≤ 10.0
B	Short delays	10.1-15.0	10.1-20.0
C	Average delays	15.1-25.0	20.1-35.0
D	Long delays	25.1-35.0	35.1-55.0
E	Very long delays	35.1-50.0	55.1-80.0
F	Extreme delays	> 50.0	> 80.0

The delay thresholds for LOS at signalized and unsignalized intersections differ because of the driver's expectations of the operating efficiency for the respective traffic control conditions.

In a downtown environment like Portsmouth, longer delays and worse level of service are generally acceptable. Congestion and lower vehicle speeds can improve the environment for pedestrians and bicyclists.

Level-of-Service Results

The delay and queuing reports within TransModeler (v5.0) were used to assess traffic congestion at the six key intersections which would be directly affected by the two-way conversion. Figure 4 and Figure 5 present level-of-service results for the current baseline one-way conditions and the two-way scenario, respectively. The level of service is expected to improve at the Market Square intersection due to the conversion and otherwise change minimally at the other 5 study intersections.

A full delay and queuing summary by approach is provided in the appendix.

Figure 4: Baseline One-Way State Street – 2032 PM Peak Hour Level-of-Service

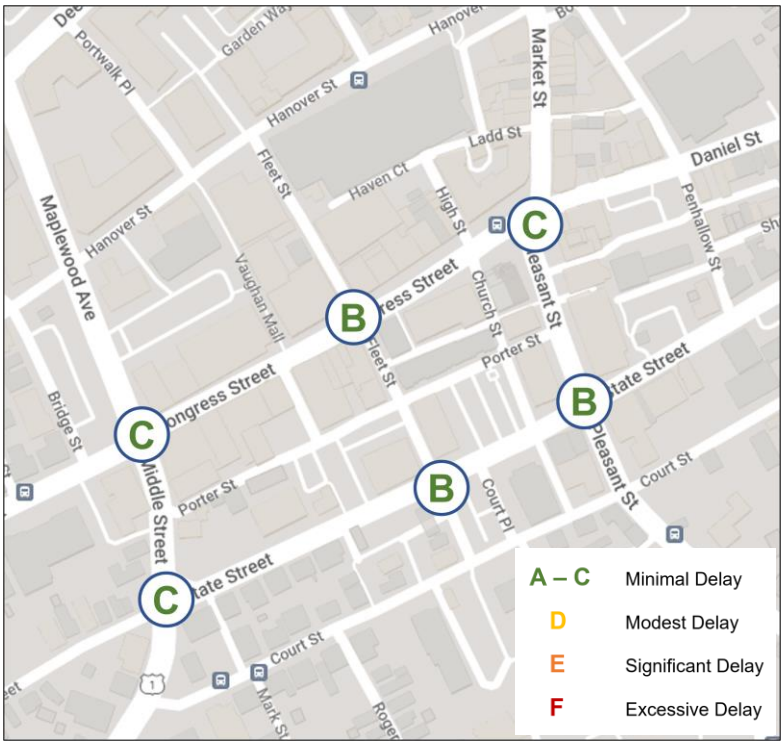
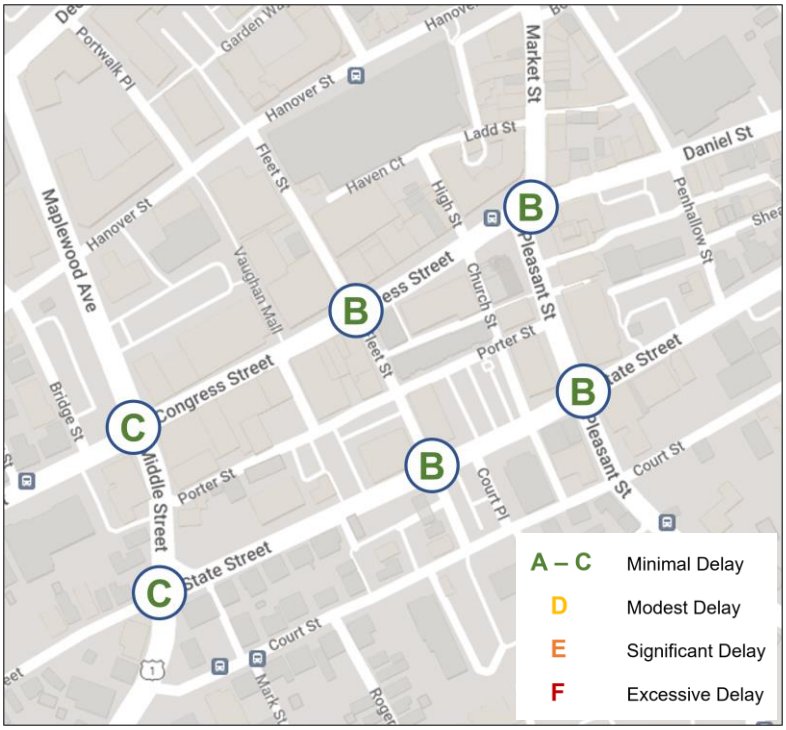


Figure 5: Baseline Two-Way State Street Scenario – 2032 PM Peak Hour Level-of-Service



Drawbridge Scenario Results

In addition to the base network, a scenario was modeled where the Memorial Bridge is temporarily closed due to a drawbridge lift. This occurrence results in significant queuing along State Street, followed by a large surge of traffic along Daniel Street into Market Square when the drawbridge re-opens. Converting State Street to two-way traffic would only be viable if doing so still provides enough space to serve anticipated queues and allows traffic to clear efficiently following closures.

The congestion level is higher following a bridge closure than in the baseline condition, with the Market Square intersection operating at LOS D in the one-way State Street condition when a drawbridge lift occurs. If State Street is converted to two-way traffic, operations at Market Square improve and that intersection is projected to operate at LOS B. However, congestion shifts west to the Middle Street corridor – the intersection of Congress Street/Maplewood Avenue/Islington Street/Middle Street intersection drops to LOS D from LOS C, and the State Street & Middle Street intersection drops to LOS E from LOS C. The level of service at the three other study intersections is not changed. Level-of-service results are presented below in Figure 6 and Figure 7.

The length of the queues is another important metric during a drawbridge closure as well as during the recovery period when a surge of traffic enters Portsmouth from the Memorial Bridge. As shown in Figure 8, initial queues from the drawbridge closure are slightly longer in the two-way scenario than with the existing one-way configuration. While vehicles only have one lane to queue in during a bridge lift, vehicles no longer need to use State Street to reverse direction onto Daniel Street to travel westbound. In addition, allowing for westbound traffic on State Street allows for some vehicles to avoid the eastern end of the city when it is congested. For these reasons, the queues are longer if State Street is converted to two-way travel, but they are not twice as long. Figure 9 illustrates the secondary queues resulting from the surge of traffic entering Portsmouth once the Memorial Bridge reopens and shows how congestion shifts to the west.

Figure 6: Drawbridge One-Way State Street – 2032 PM Peak Hour Level-of-Service

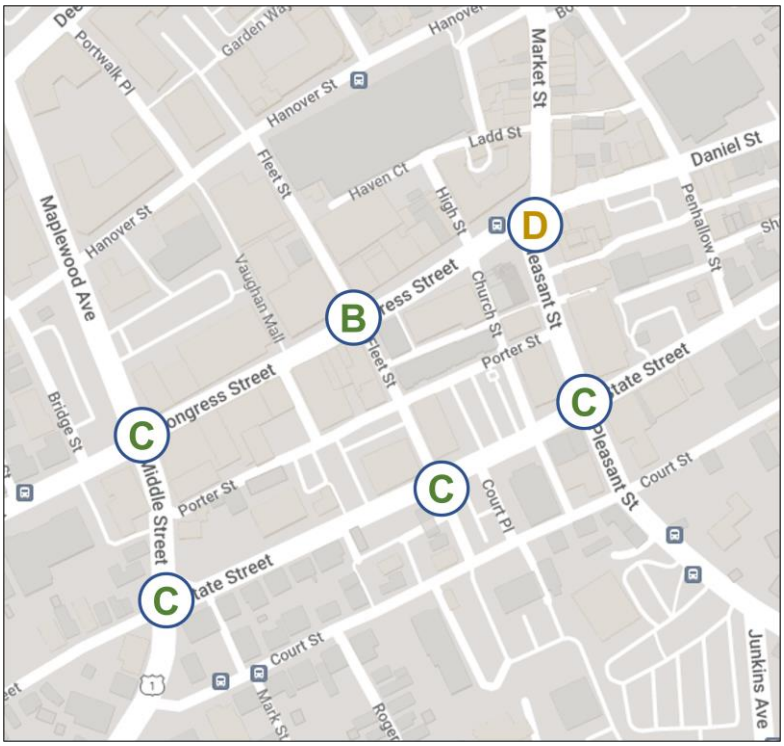


Figure 7: Drawbridge Two-Way State Street Scenario – 2032 PM Peak Hour Level-of-Service

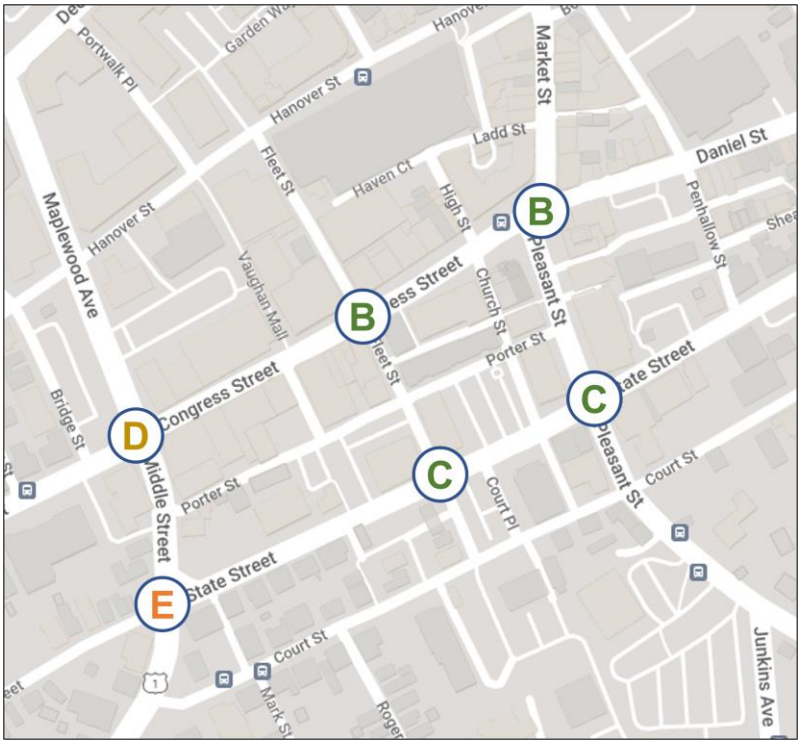


Figure 8: Drawbridge Scenario – Average Maximum Queue Lengths

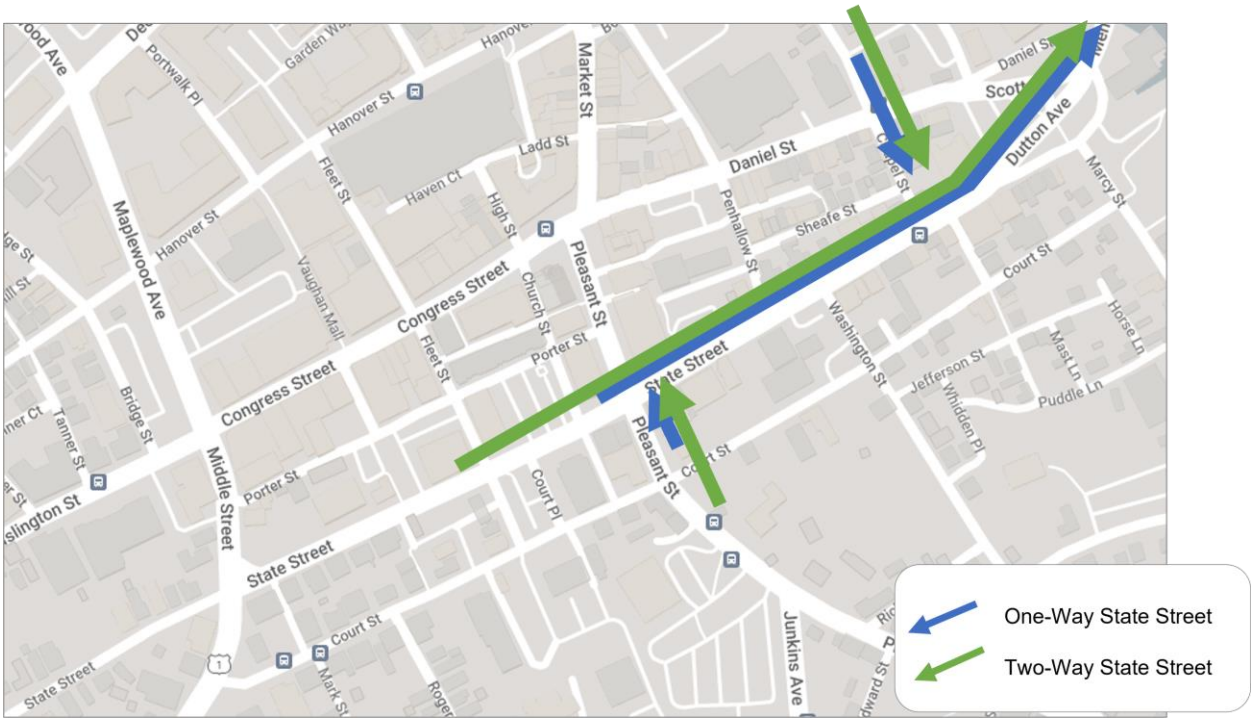
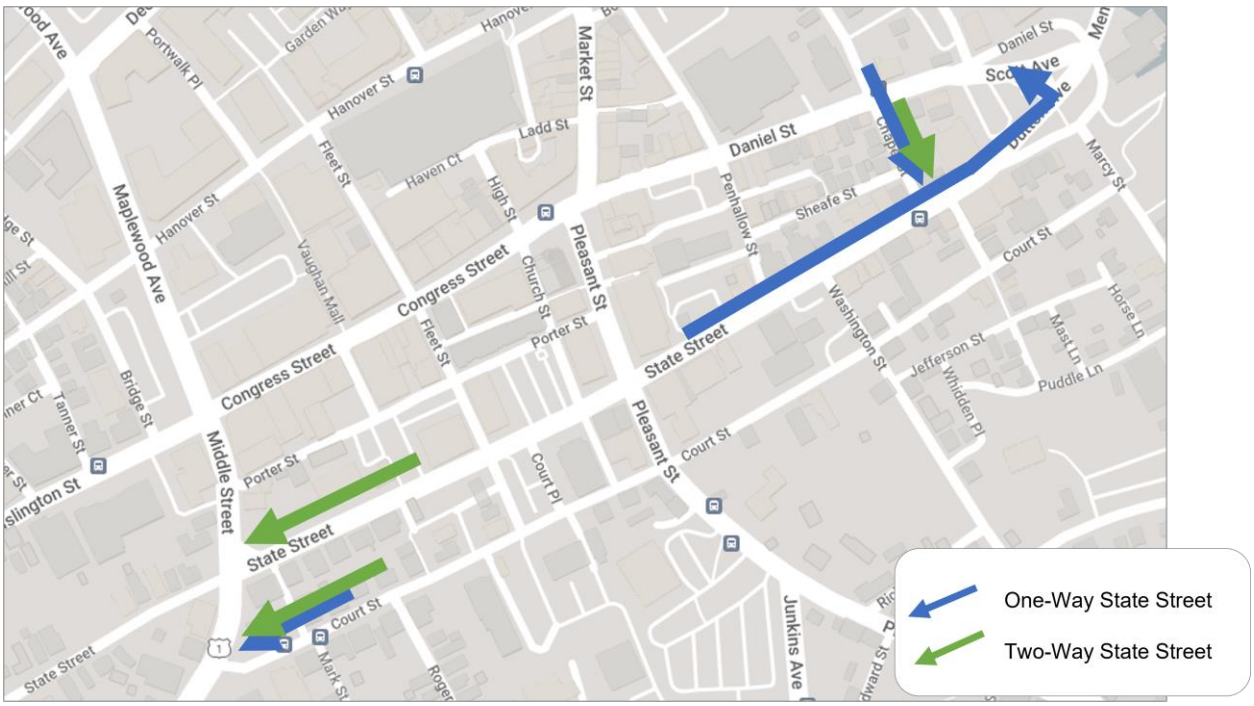


Figure 9: Drawbridge Scenario Secondary Queues – Average Maximum Queue Lengths



Conclusions

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Appendix

Intersections	PM Peak Hour - No Drawbridge					
	2032 Baseline			2032 Two-Way		
	LOS	Delay	Queue	LOS	Delay	Queue
Maplewood Ave/Middle St & Congress St/Islington St						
Overall	C	23	-	C	22	-
EB, along Islington St	D	42	110	D	41	100
WB, along Congress St	D	40	180	D	38	150
NB, along Middle St	A	5	50	A	6	70
SB, along Maplewood Ave	B	11	150	A	8	120
Middle St & State St						
Overall	C	25	-	C	27	-
EB, along State St	D	36	90	E	56	110
WB, along State St				E	74	130
NB, along Middle St	C	26	150	B	20	140
SB, along Middle St	C	23	210	C	21	220
Congress St & Fleet St						
Overall	B	12	-	B	13	-
WB, along Congress St	B	11	100	B	11	100
NB, along Fleet St	C	23	60	C	23	50
SB, along Fleet St	A	<1	0	B	16	90
State St & Fleet St						
Overall	B	18	-	B	19	-
EB, along State St	B	18	130	A	8	120
WB, along State St				B	17	50
NB, along Fleet St	B	13	40	C	27	50
SB, along Fleet St	B	19	80	E	70	150
Congress St/Daniel St & Pleasant St/Market Sq						
Overall	C	17	-	B	13	-
WB, along Daniel St	C	17	130	B	15	110
NB, along Pleasant St	B	15	70	B	13	70
SB, along Market Sq	C	16	110	B	12	90
State St & Pleasant St						
Overall	B	18	-	B	16	-
EB, along State St	B	19	140	A	9	80
WB, along State St				B	17	40
NB, along Pleasant St	B	18	130	C	29	160

Intersections	PM Peak Hour - Drawbridge					
	2032 Baseline			2032 Two-Way		
	LOS	Delay	Queue	LOS	Delay	Queue
Maplewood Ave/Middle St & Congress St/Islington St						
Overall	C	23	-	D	36	-
EB, along Islington St	D	39	110	F	>100	250
WB, along Congress St	D	41	180	D	50	190
NB, along Middle St	A	6	60	B	12	120
SB, along Maplewood Ave	A	10	150	B	16	230
Middle St & State St						
Overall	C	22	-	E	59	-
EB, along State St	D	36	90	F	85	150
WB, along State St				F	>100	420
NB, along Middle St	C	23	140	D	50	210
SB, along Middle St	C	20	200	D	47	280
Congress St & Fleet St						
Overall	B	13	-	B	13	-
WB, along Congress St	B	11	100	A	10	80
NB, along Fleet St	C	22	70	C	22	60
SB, along Fleet St	B	12	60	B	20	70
State St & Fleet St						
Overall	C	21	-	C	30	-
EB, along State St	C	21	150	C	33	410
WB, along State St				B	18	100
NB, along Fleet St	B	12	40	C	33	60
SB, along Fleet St	C	24	120	F	91	130
Congress St/Daniel St & Pleasant St/Market Sq						
Overall	D	28	-	B	12	-
WB, along Daniel St	D	32	200	B	14	90
NB, along Pleasant St	C	17	70	B	10	60
SB, along Market Sq	C	24	170	B	11	100
State St & Pleasant St						
Overall	C	29	-	C	32	-
EB, along State St	C	30	210	D	35	230
WB, along State St				D	43	160
NB, along Pleasant St	C	29	150	C	32	160