ENGINEERING CHANGES VS. NEIGHBORHOOD IMPACT ASSESSMENT

50% Report

Prepared by:

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EXECUTIVE SUMMARY

This report details the analysis of the 800 East corridor in Orem, Utah. Peak traffic flows were determined and traffic counts of intersections along the corridor were performed. Based on the data collected, a traffic model was created in Synchro. The existing two-way stop at 400 North 800 East was modeled as four-way stop, signal stop, and roundabout. The effects of the different designs were recorded. The following tasks were also performed: consideration of past and current populations to predict future volumes and evaluation of current and future Levels of Service. BMK engineers will complete data and cost-benefit analysis to finalize recommendations for a safe, effective design.

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INTRODUCTION

The purpose of this report is to analyze the 800 East Corridor in Orem, Utah, which has experienced increased vehicle delays in recent years, resulting in the potential decrease in level of service. Based on peak hour volumes, the intersections at Center Street and 800 North have been particularly problematic, obtaining levels of service (LOS) C and D, respectively.

The focal point of this analysis is the intersection at 400 North 800 East, which currently functions as a four-way stop along the corridor. BMK Engineers determined how changing the 400 N intersection would affect the peak-hour problems at 800 N and at Center Street. The following tasks have been completed for this 50% report:

- Assessment of current LOS
- The effect of control systems on peak-hour problems at 800 North and at Center Street
- Roundabout, two-way and four-way stop, and signal analysis
- Modification of 400 North intersection to help Northbound flow

Other tasks that will be completed before this project is complete will include:

- Roundabout, two-way and four-way stop, and signal analysis for future growth
- Feasibility analysis of the different intersection types, including the economical and social costs of design implementation
- Report of analysis
- Recommendations to the changes necessary at the proposed intersection

The City of Orem's Transportation Department can expect these analyses and recommendations upon completion of the project.

SITE DESCRIPTION

The site that will be simulated is the intersection of 400 North and 800 East in Orem, Utah. The intersection is located south of the Harmon's grocery store and north of Cascade Elementary School as shown in Figure 1-1 below. The intersection described is controlled by a four-way stop. The intersections at 600 North and 200 North are controlled by a two-way stop, and the intersections at 800 North and Center Street are signalized controlled. The road conditions along the 800 East corridor are slightly fair with some transverse cracking along the road, also with some occasional potholes along the corridor. This could be due to the occasional bus and various single-axle with two tires and single-axle with four tires that are carrying heavier loads than most other common vehicles.

Figure 1-1. An aerial photo of the 800 East Corridor.

Figure 1-2. A current on-site photo of the 400 North 800 East Intersection.

METHODOLOGY

The site was simulated in four different models: two-way stop, four-way stop, signalized, and roundabout. Traffic volume and turning counts were conducted at various peak hour times. A larger and more comprehensive volume count of the 400 N 800 E intersection is also referenced (See Appendix A). The intersections of Center St., 200 North, 400 North, 600 North, and 800 North were modeled along the 800 East corridor in Synchro. The Synchro model provided analysis of speeds and delays along the corridor. Once all simulations were complete, the levels of service were compared. The levels of service, vehicle speeds, and vehicle delays were analyzed together to determine the impact on local neighborhoods. Preliminary recommendations based solely on the data provided in this report are given.

DATA COLLECTION

Traffic Counts

In addition to traffic counts obtained by BMK engineers, previous recorded traffic counts were retrieved from the City of Orem's data collection. The City of Orem provided peak hour traffic counts at a few major intersections including, 800 North 800 East and Center Street 800 East ; this data was used during modeling. A study performed by Christopher Haskell, a graduate student in the Civil Engineering Transportation Department at Brigham Young University, provided peak hour volumes for the intersection of interest, 400 North 800 East (2016). The counts are included in Appendix A. Additional traffic counts were required for the minor intersections along the corridor. The counts were taken by BMK engineers at 200 North 800 East and 600 North 800 East during peak hours and are included in the appendix.

MODELING

The four intersection types were modeled in Synchro based on the actual dimensions and volume counts of the intersections on the 800 East corridor. The assumptions made to complete the model are conservative.

Assumptions

The following are key assumptions based upon site observations and standard roadway parameters:

- Percentage of volume that is heavy vehicles: 3%

- Design speeds are the posted speed limits; 25 mph or 35 mph based on the roadway
- Existing signalized intersections are already optimized and synchronized
- The volumes of existing intersections provided by the client are accurate
- Trip generation and distribution is representative of actual conditions

Current Four-Way Stop

The first model created was designed as the current operating intersection: a four-way stop. This model provided the basis for the following theoretical models. It provided a foundation of understanding to improve the LOS of the 400 North 800 East intersection and the other intersections along the corridor. The North and Southbound directions have an exclusive left turn lane along with a shared right-thru lane. The East and Westbound directions have a shared left, thru, and right turn lane. Figure 1-3 below depicts the current layout described.

Priority rules apply to the four-way stop intersection. For example, if vehicle A approaches the intersection going Northbound and vehicle B arrives going Eastbound directly after vehicle A, then vehicle B is designed to stop and wait until vehicle A passes through the intersection.

In the model, there is no design for pedestrian traffic at the intersection. This was decided because the focus is how the traffic flow is influencing the other intersections along the corridor and in the surrounding neighborhoods.

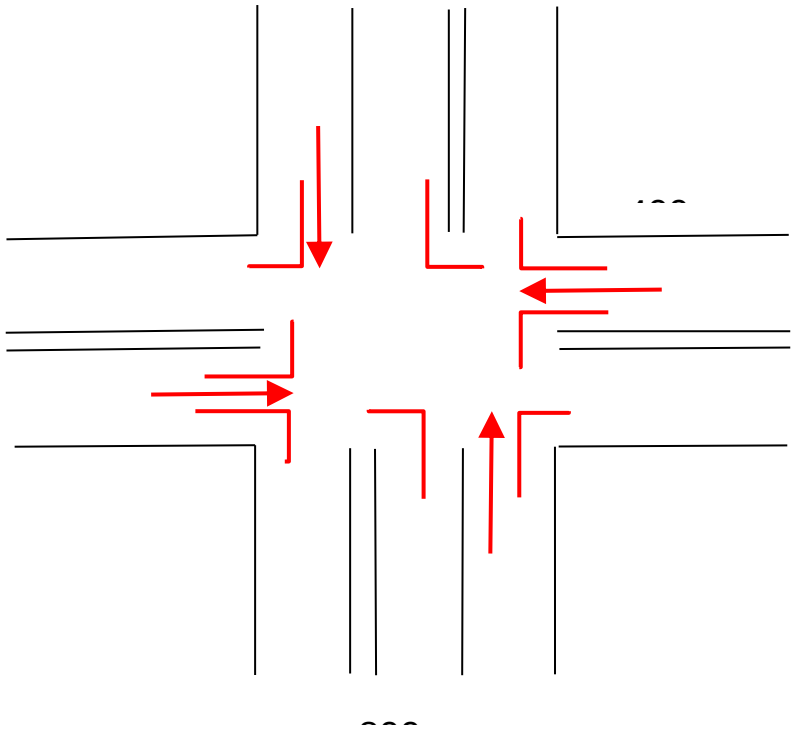


Figure 1-3. Four-way stop control diagram of the 400 North 800 East Intersection.

Two-way Stop Model

The second model created was the two-way stop intersection. This layout was designed to depict the projections of traffic flow, delays of vehicles, and average speeds of the vehicles. The purpose of the two-way stop control was to analyze how the 400 North intersection would behave if it was similar to the 200 North and 600 North intersections along the corridor.

Priority was given to the North and Southbound flow of traffic. This would mean that the only change to be made would be to remove the stop signs for the North and Southbound traffic, which would allow free-flow for those directions. The East and Westbound traffic would be required to perform a complete stop and give priority to the oncoming North and Southbound traffic until the intersection had cleared.

Signalized Intersection Model

The intersection was modeled once for each signal timing mechanism: actuated coordinated, actuated uncoordinated, semi-actuated uncoordinated. The actuated coordinated signal model timing was based on the pre-existing signal timings of the other intersections in the 800 East zone. For all three signalized intersection models, the intersection timing was optimized based on traffic counts and volumes for each direction. The optimization is completed automatically by the Synchro program.

Roundabout Intersection Model

The fourth model created for the project was the intersection model. The lane configuration functioned in a similar manner to the other models. Each approaching roadway consisted of one entry and exit lane and the roundabout had one circulation lane. A figure of the model is included in Appendix A.

Priority was given to the circulating flow. Approaching traffic yielded to vehicles in the roundabout. If vehicles in circulation were not within range of interference for approaching vehicles, the approaching vehicles would not yield to vehicles in circulation. All traffic yielded to pedestrians crossing the intersection.

SIMULATION RESULTS

Upon completion of the models, simulations were performed on the four-way stop, two-way stop, signalized intersection, and roundabout. The simulations resulted in reports measuring

effectiveness. For the analysis, the two measurements used were average speed and the delay time for each vehicle.

Average Vehicle Speed

The first measure of effectiveness from the simulations was the average vehicle speed. The average speeds for the two-way stop, four-way stop, signal, and roundabout at 400 North 800 East were 20 mph, 19 mph, 32 mph and 24 mph, respectively. Table 1 provides the results of the analysis at each intersection. The comparison between each model for the intersection along the 800 East can be seen in Figure 2.

Table 1. Average Vehicle Speed Results

	Center St 800 E	200 N 800 E	400 N 800 E	600 N 800 E	800 N 800 E
Two-Way Stop (mph)	25	27	20	28	25
Four-Way Stop (mph)	25	27	19	27	25
Signal/ Act-coord. (mph)	24	30	32	34	22
Roundabout (mph)	19	26	24	29	10

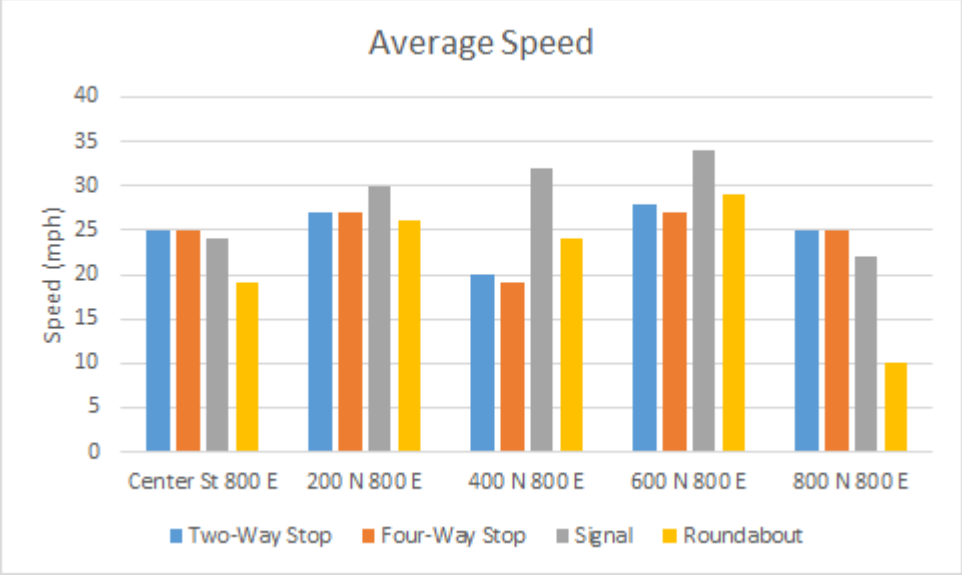


Figure 2. Average vehicle speed comparison.

Average Vehicle Delay

The second measure of effectiveness from the simulations was the average vehicle delay. The average delays for the two-way stop, four-way stop, signal, and roundabout at 400 North 800 East were 1 second, 22.5 seconds, 10 seconds, and 4.4 seconds, respectively. Table 2 provides the results of the analysis at each intersection. The comparison between each model for the intersection along the 800 East can be seen in Figure 3.

Table 2. Average Vehicle Delay Results

	Center St 800 E	200 N 800 E	400 N 800 E	600 N 800 E	800 N 800 E
Two-Way Stop (s/veh)	20.1	5.5	1	5	42.2
Four-Way Stop (s/veh)	20.2	5.3	22.5	5.2	40
Signal (s/veh)	24	0	10	0	42
Roundabout (s/veh)	23	1.8	4.4	0.4	66.8

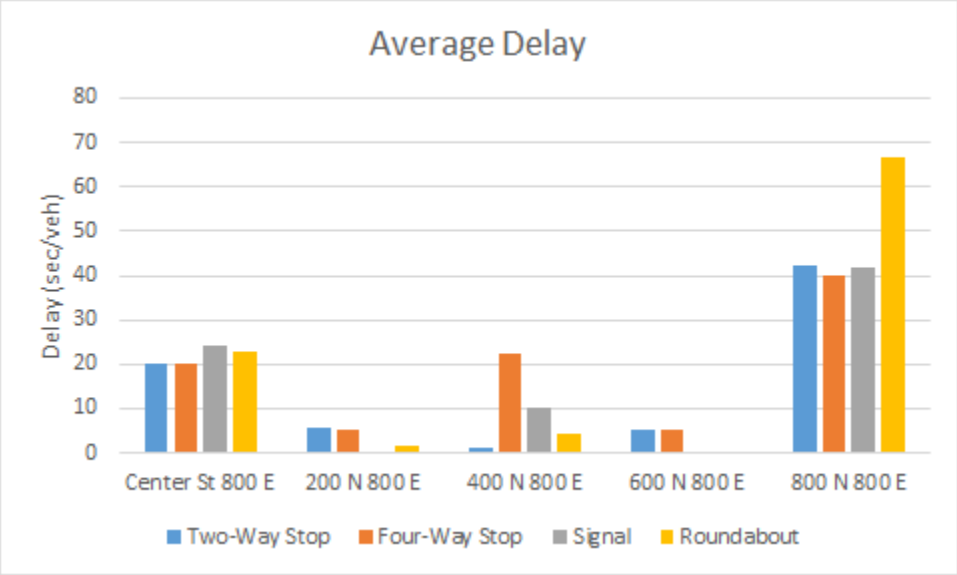


Figure 3. Average vehicle delay comparison.

Interpretation of Results

Upon comparison of the results, it was determined that a four-way stop control and a two-way stop control would perform in a similar manner as it stands currently for the 400 North and 800 East intersection. The East and Westbound directions would continue to perform well, but the performance of the North and Southbound directions would decline. This is because there

would not be much change in the traffic volume east and westbound, but the north and southbound traffic would greatly increase. The results reveal that the conversion of the four-way stop control intersection into a two-way stop or signal would produce better results. The average vehicle delay would decrease and the average speed would increase, thus, causing the intersection to perform at a more acceptable level of service.

Average speeds are higher for the signalized intersection than the other intersection types. This is because the vehicles have right of way based on the green light timing. This allows them to move faster on average. The two-way stop would provide the highest speeds for just the vehicles moving the north/south direction, but this average speed is reduced when the east/west directions are added.

RECOMMENDATIONS

The following recommendations are based solely upon the analysis that has been completed and described in this report. There are no recommendations based on future volume or feasibility. These recommendations address the impact of the intersection types on the neighborhoods.

Average delay times per vehicle are a major factor in determining the suitability of an intersection type for the neighborhoods along the 800 East corridor. The two and four way stop signs offer reduced delay times. The signalized intersection also offers relatively low delay time. Since the signal can be coordinated with 800 N and Center street, there should be less delay at those intersections in general.

The roundabout option has mixed results and could benefit the neighborhood wait times. The conflict with the roundabout is that the vehicles can move along the 800 corridor relatively quick, but end up waiting at the 800 N 800 E intersection for longer periods of time. This situation is undesirable because this intersection has the lowest level of service.

Based on this preliminary analysis, it is recommended that the actuated-coordinated signal is used at the intersection of 400 N 800 E. This recommendation can change, especially after the analysis for the 2040 volumes and feasibility is complete.

CONCLUSION

The intersections along the 800 East Corridor in Orem, Utah were studied to determine the best approach to resolving issues with traffic flow. Data was collected from the City of Orem and a Civil Engineering graduate student, and new counts were taken by BMK Engineering. Four different models were created: a four-way stop, two-way stop, signal, and roundabout. Simulations were run and results reported the measure the effectiveness at the major

intersections along the corridor including Center St. 800 E, 200 N 800 E, 400 N 800 E, 600 N 800 E, and 800 N 800 E. The two measurements used for analysis were the average vehicle speed and delay time. The results verified a two-way stop, signal, or roundabout would decrease the average vehicle delay and increase the average speed in most cases. The signal offers minimal delay time to the cars at all four approaches at the 400 N 800 E intersection as well as other intersections on the corridor and is recommended to be used.

REFERENCES

Haskell, Christopher K. (2016). *800 East 400 North Simulations* (Master's Research Project). Retrieved from City of Orem Transportation Department.

Appendix A

INTERSECTION TURNING MOVEMENTS

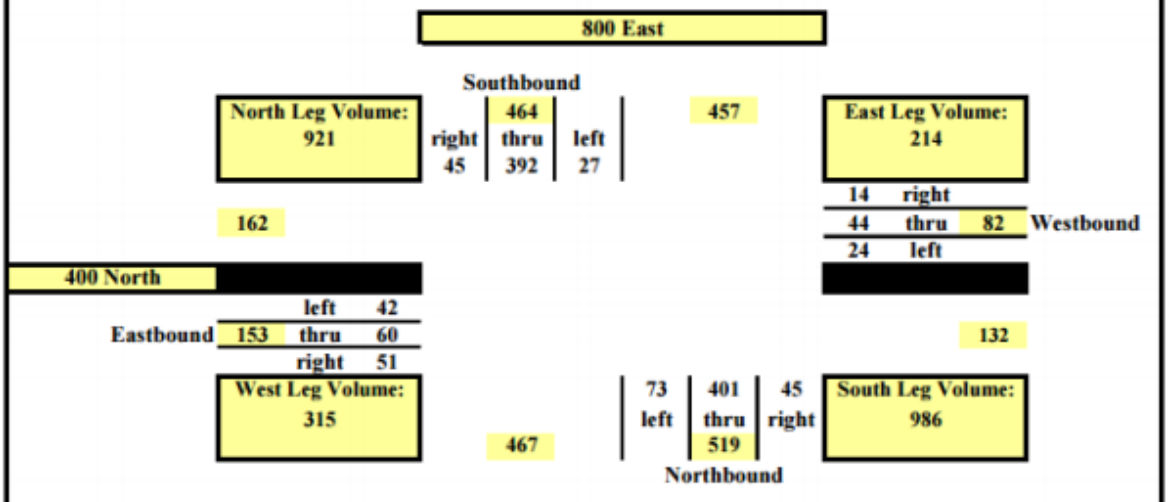
400 North & 800 East
Vehicle Page
Wednesday, June 18, 2014

4:30 - 6:00: PM Count

TIME PERIOD		EASTBOUND			SOUTHBOUND			WESTBOUND			NORTHBOUND			TOTAL	
BEGIN	END	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	15 MIN	SUM
4:30	4:45	6	11	5	3	76	12	7	13	3	9	76	6	227	227
4:45	5:00	12	13	18	7	89	9	3	10	4	16	85	11	277	504
5:00	5:15	8	13	9	4	95	15	5	10	4	21	103	14	301	805
5:15	5:30	5	13	12	6	100	10	10	12	5	21	112	11	317	1122
5:30	5:45	17	21	12	10	108	11	6	12	1	15	101	9	323	1445
5:45	6:00	5	9	15	2	101	12	9	14	3	9	81	14	274	1719

SUM	53	80	71	32	569	69	40	71	20	91	558	65
PERCENT	26%	39%	35%	5%	85%	10%	31%	54%	15%	13%	78%	9%
TOTAL	204			670			131			714		

Peak Hour Volume Statistics



PEAK TRAFFIC VOLUME												
EASTBOUND			SOUTHBOUND			WESTBOUND			NORTHBOUND			
LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	
42	60	51	27	392	45	24	44	14	73	401	45	
153			464			82			519			
Peak Hour:	4:45 - 5:45		Peak Volume:	1218		Peak Hour Factor:	0.94					

Figure A-1. Intersection turning movements at 400 North 800 East (Haskell, 2016).

INTERSECTION TURNING MOVEMENTS

200 N & 800 E

Thursday, February 23, 2017
5:40 - 6:40: PM Count

TIME PERIOD		NORTHBOUND	SOUTHBOUND	EASTBOUND	WESTBOUND	TOTAL
BEGIN	END	THRU	THRU	RIGHT	LEFT	SUM
5:40	6:40	216	180	22	3	421

600 N & 800 E

Thursday, February 23, 2017
4:00 - 5:00: PM Count

TIME PERIOD		NORTH-BOUND			SOUTH-BOUND			EAST-BOUND			WEST-BOUND			TOTAL
BEGIN	END	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	LEFT	THRU	RIGHT	SUM
4:00	5:00	16	74	12	8	96	24	4	4	20	8	4	28	298

Appendix B

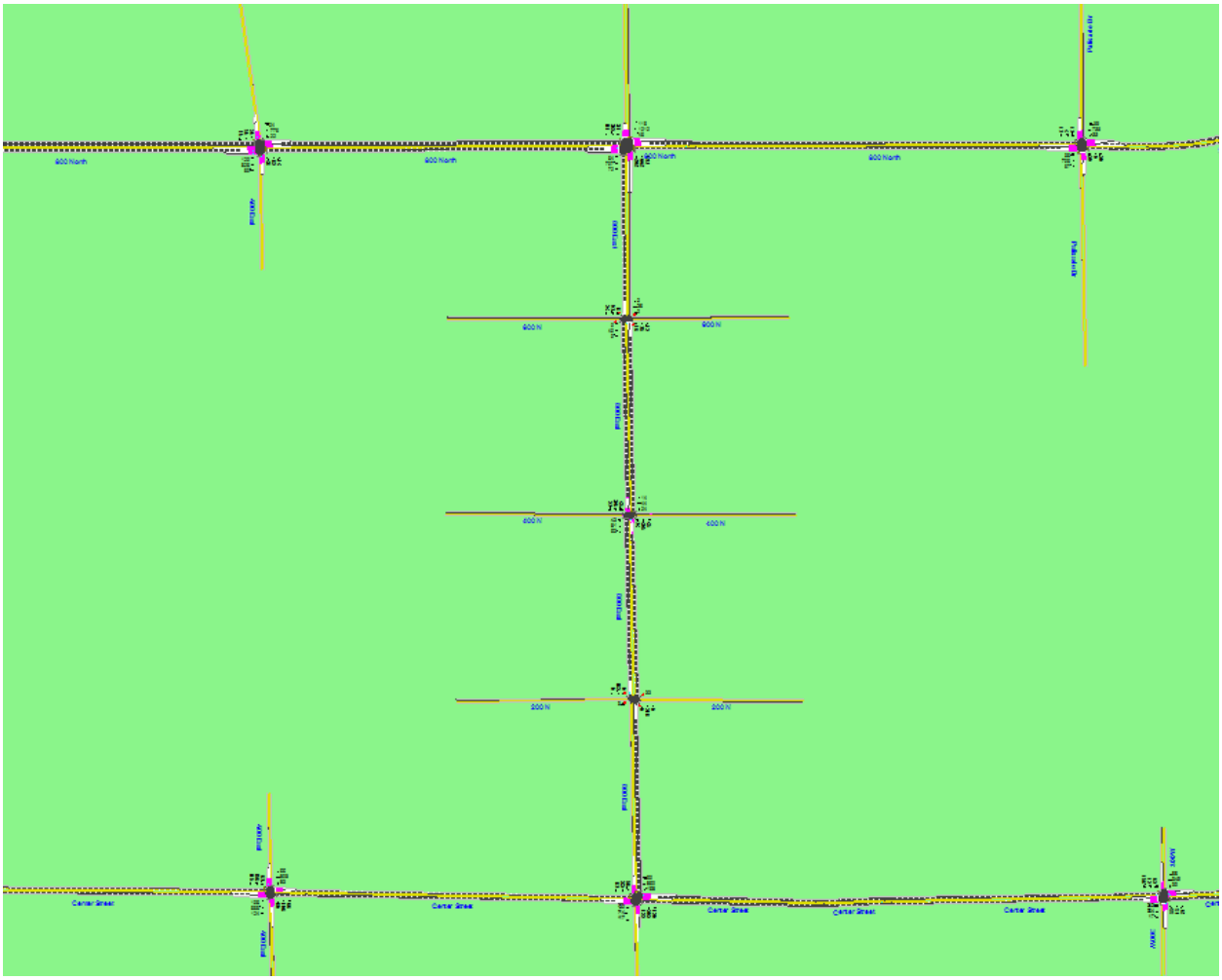


Figure B-1. Model of 800 East Corridor.

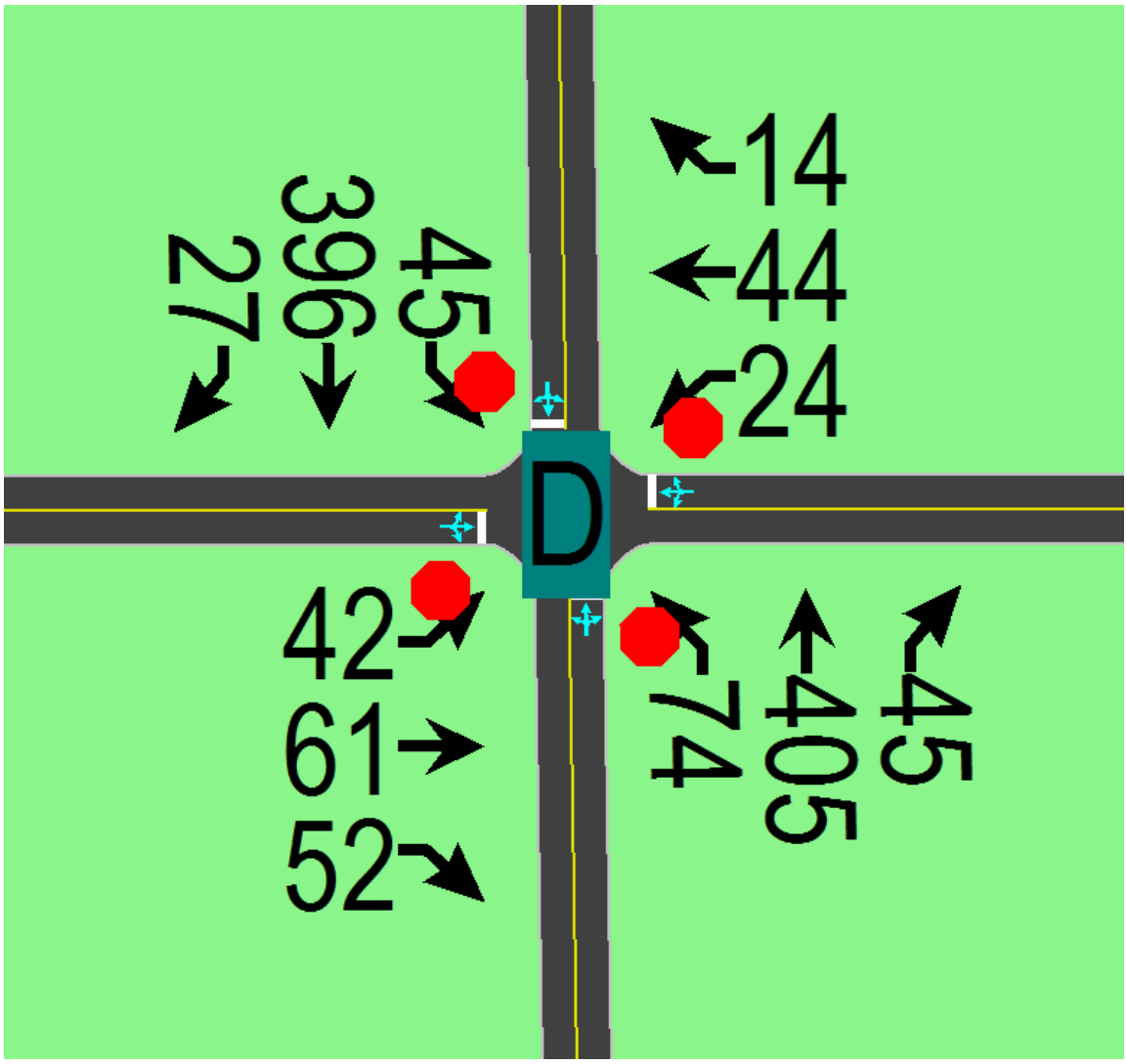


Figure B-2. Model of Four-Way Stop.

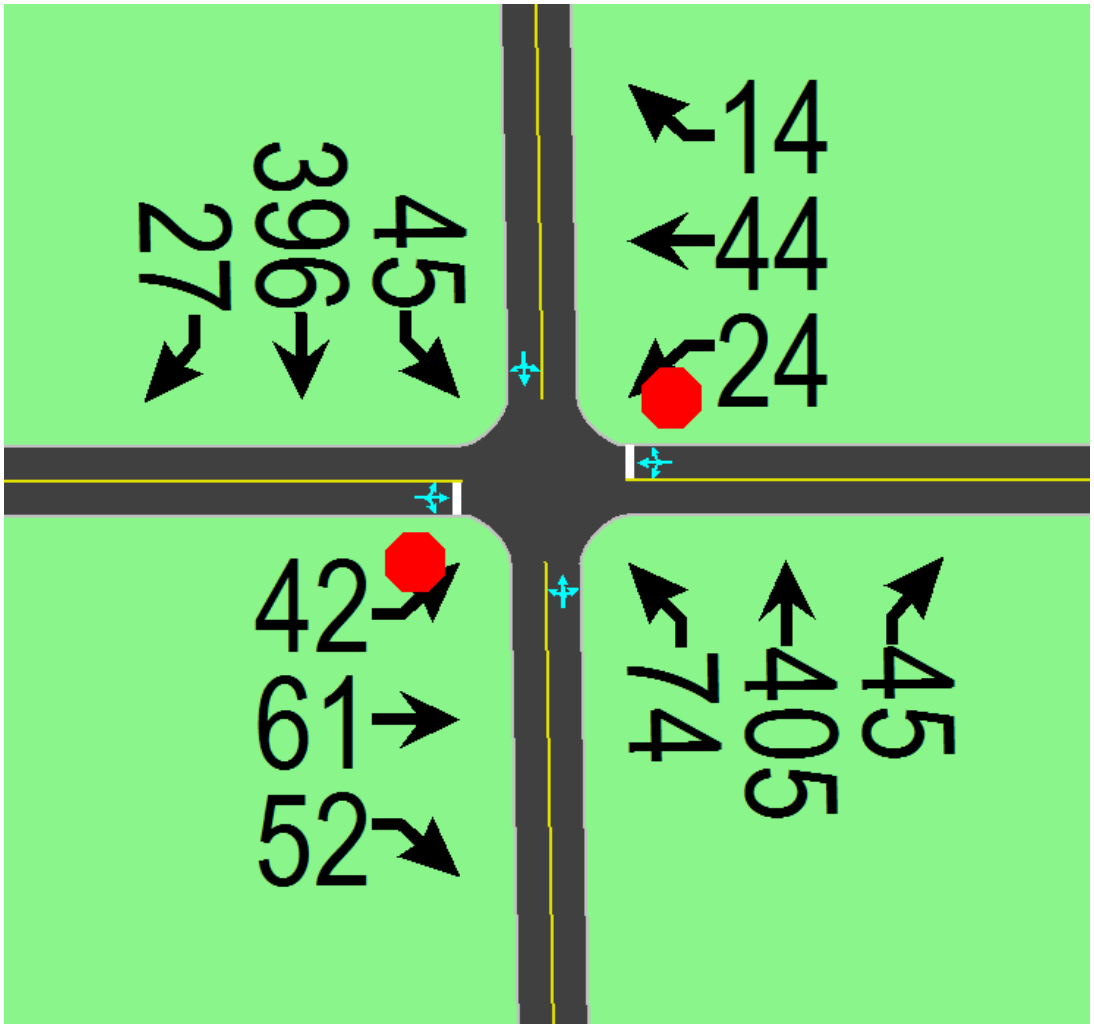


Figure B-3. Model of Two-Way Stop.

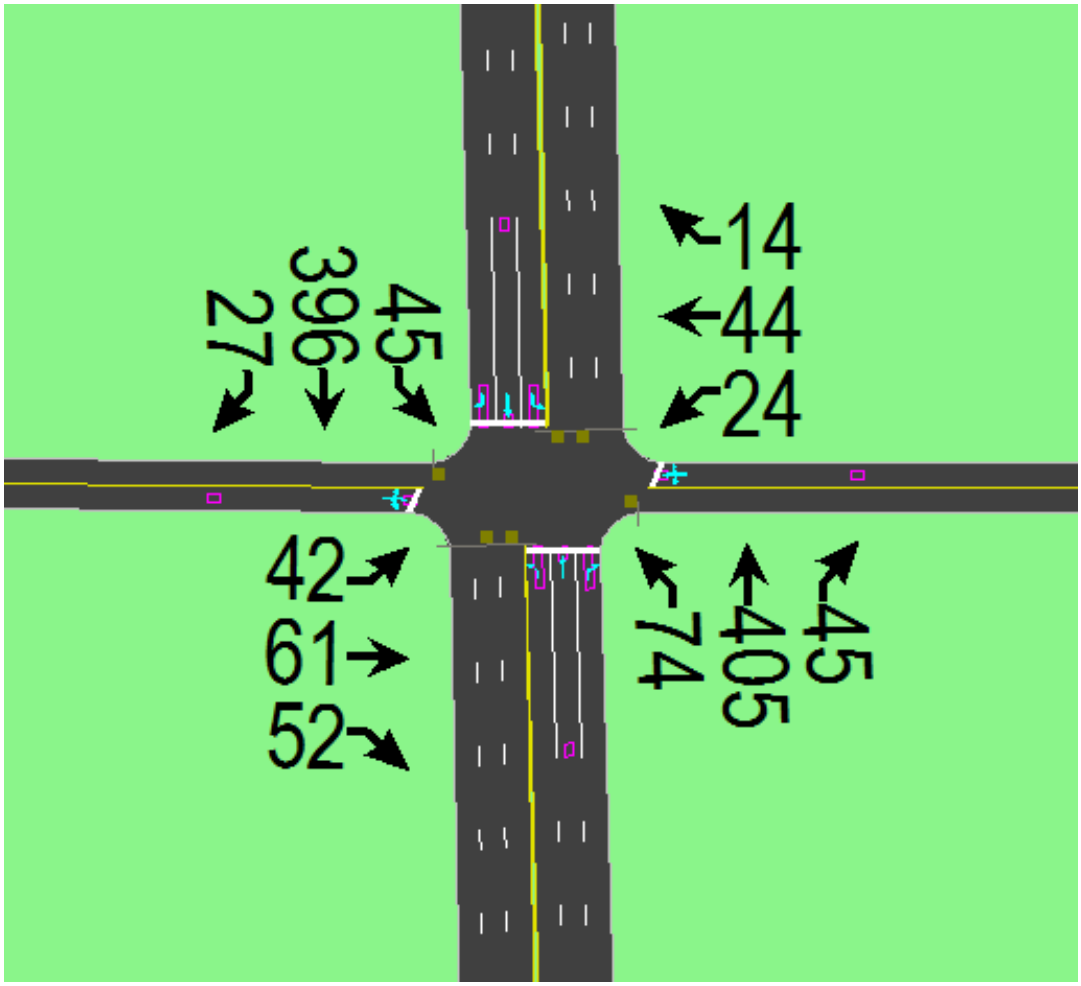


Figure B-4. Model of Signalized Intersection.

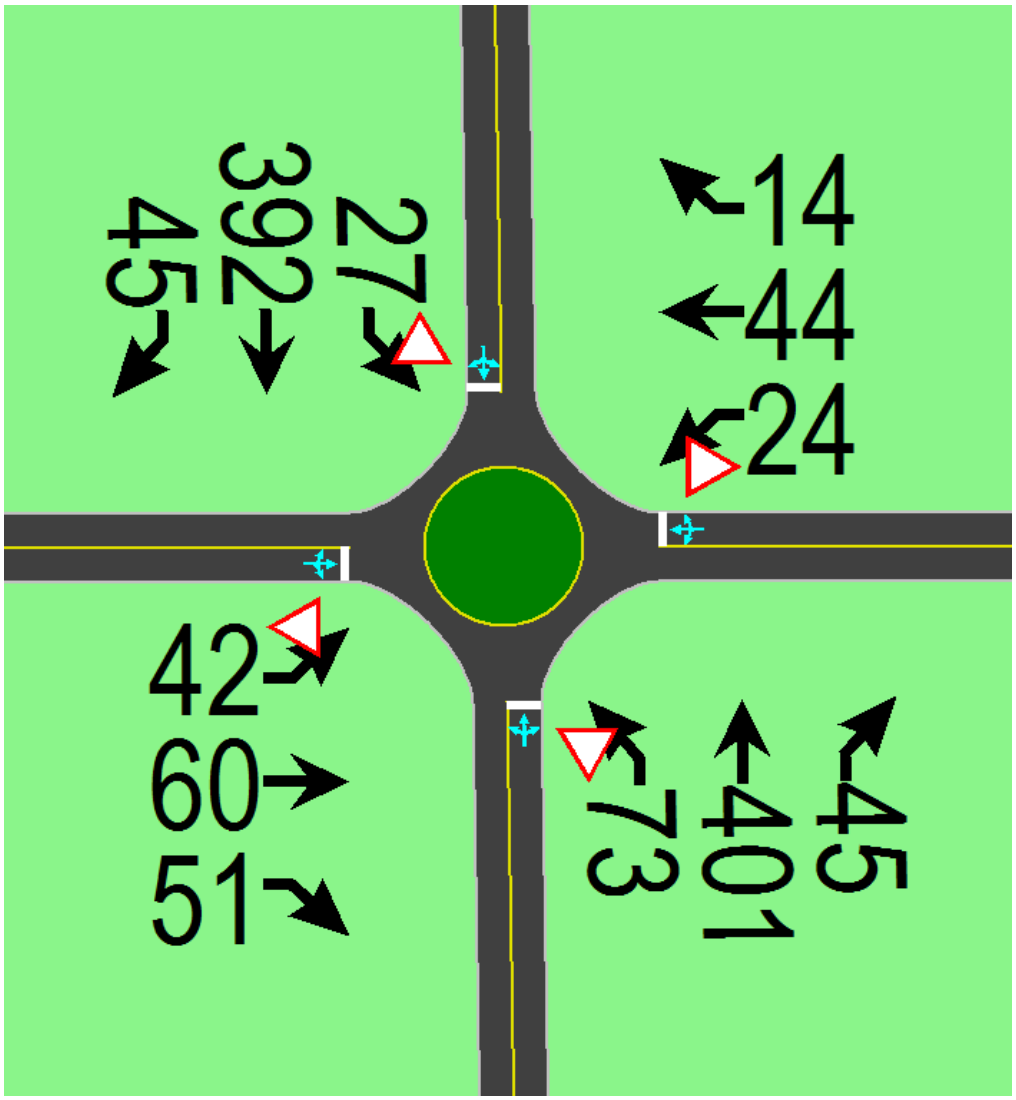


Figure B-5. Model of Roundabout.