

9400 S 500 W Intersection Study

A four-way stop and traffic control signal warrant analysis using MUTCD, 2009 edition

MUTCD text is shown in italics

Completed by: Britney Ward, PE
Sandy City Transportation Engineer

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Warrant Summary, Traffic Count Data

A multi-way STOP application is warranted based on MUTCD criteria. However, due to the volume of vehicles on 500 West in comparison to 9400 S, it is advised to not stop the northbound/southbound vehicles or excessive delay will occur. Currently, eastbound/westbound vehicles are stop controlled. *Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.* Traffic volumes on 500 W are significantly higher than on 9400 S. A four-way stop will not be installed at this time.

All applicable traffic signal warrants are met for this intersection. A traffic control signal should be considered for installation at this intersection.

The proceeding pages discuss multi-way stop applications and traffic signal warrant criteria's used in this assessment.

Multi-Way Stop Application	4-way Stop Warranted	Signal Warrant	Warrant Type	Signal Warranted
Paragraph 04.A	Yes	1	8-hr Vol.	Yes
Paragraph 04.B	Yes, Barely	2	4-hr Vol.	Yes, Barely
Paragraph 04.C.1	Yes	3	Peak Hour	N/A
Paragraph 04.C.2	No	4	Pedestrian Vol.	N/A
Paragraph 04.C.3	Yes	5	School Crossing	N/A
Paragraph 04.D	Yes	6	Signal System	N/A
		7	Crashes	Yes
		8	Road Network	Yes
		9	RR Crossing	N/A

Vehicle Volume	Avg. Speed (mph)	Speed Limit (mph)	Mode	85 th Percentile (mph)	Study Date	Direction	Location
1,346	16	30	16	19	11/29/2017	EB	9400 S @ Sandy Pkwy (west leg)
1,719	20	30	20	23	11/29/2017	WB	9400 S @ Sandy Pkwy (west leg)
7,289	36	35	37	42	11/30/2017	NB	Sandy Pkwy @ 9400 S (north leg)
6,400	36	35	38	42	11/30/2017	SB	Sandy Pkwy @ 9400 S (north leg)
458	23	35	26	25	11/30/2017	SBL	Sandy Pkwy @ 9400 S (north leg)
914	23	30	17	26	12/1/2017	EB	9400 S @ Sandy Pkwy (east leg)
878	25	30	29	28	12/1/2017	WB	9400 S @ Sandy Pkwy (east leg)
8,761	39	35	39	44	12/5/2017	NB	Sandy Pkwy @ 9400 S (south leg)
7,230	39	35	38	43	12/5/2017	SB	Sandy Pkwy @ 9400 S (south leg)

Section 2B.07 Multi-Way Stop Applications

Paragraph 04: *The following criteria should be considered in the engineering study for a multi-way STOP sign installation:*

- A.** *Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.*

All of the three applicable traffic signal warrants are met. Installation of a traffic control signal should be discussed. Each applicable warrant is addressed later in this document.

Traffic Signal Warrants:

- Warrant 1, Eight-Hour Vehicular Volume (warrant met)
- Warrant 2, Four-Hour Vehicular Volume (warrant met)
- Warrant 3, Peak Hour (not applicable)
- Warrant 4, Pedestrian Volume (not applicable)
- Warrant 5, School Crossing (not applicable)
- Warrant 6, Coordinated Signal System (not applicable)
- Warrant 7, Crash Experience (not applicable)
- Warrant 8, Roadway Network (warrant met)
- Warrant 9, Intersection Near a Grade Crossing (not applicable)

- B.** *Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions.*

Year	# Accidents	# Correctable With 4-Way Stop
2013	5	1+
2014	4	0+
2015	1	0
2016	2	1
2017	2	2
2018	7	4
2019	8	5

- C.** *Minimum volumes:*

- 1.** *The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and*

Vehicle volume entering the intersection from 500 West was recorded at 15,619 vehicles per day. Vehicle volume entering the intersection from 500 West was 9,217 between 10:00am and 6:00pm. Vehicle volume entering the intersection from 500 West was 7,301 between 7:00am and 3:00pm. At an average of 1,152 and 913 vehicles per hour for each of

the windows of time used, this is greater than the minimum 300 vehicles per hour for any 8 hours.

2. *The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but*

Vehicle volume entering the intersection from 9400 South was 2,224 per day. Vehicle volume entering the intersection from 9400 South was 1,214 between 10:00am and 6:00pm. Vehicle volume entering the intersection from 9400 South was 1,022 between 7:00am and 3:00pm. At an average of 152 and 128 vehicles per hour for each of the windows of time used, this is less than the minimum 200 units (pedestrians, bicycles, vehicles, etc.) per hour for any 8 hours.

During the highest vehicle volume hour, 4:45pm-5:45pm, the approximate delay to westbound vehicles approaching the intersection is 3.3 minutes, and 3.4 minutes for eastbound approaching vehicles. This was calculated using the Highway Capacity Manual AWSC delay equation.

It should be noted that data was collected for the east leg on a Friday from 12:00am to 3:00pm. It is typical to see lighter traffic volumes on Fridays for both the major and minor streets. Having this in mind, it is likely that the hourly vehicle volumes are larger than what was recorded.

3. *If the 85th percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.*

The 85th percentile approach speed of 500 West for northbound vehicles is 44 mph, and 42 mph for southbound traffic. Item 1 is already satisfied to 100 percent of the minimum warrant value. 70 percent of the minimum unit average guidance for 9400 South is 140 units. Between 10:00am and 6:00pm, vehicle volume averages 152 vehicles per hour. Between 7:00am and 3:00pm, the vehicle volume averages 128 vehicles per hour. Due to expected higher traffic volumes on a typical weekday, it would be safe to assume that the hourly vehicle volume rate would be higher.

- D. *Where no single criterion is satisfied, but where criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.*

Criteria B: 80 percent of 5 accidents per year is 4 accidents per year.

Criteria C.1: Satisfied at 100 percent.

Criteria C.2: 80 percent of 200 units is 160 units. There are 152 units per average hour between 10:00am and 6:00pm entering the intersection from 9400 South. The average vehicle volume entering the intersection during the am and pm peak hours are 160 vehicles and 264 vehicles. However, due to lighter traffic volumes recorded on Friday, it is likely that the 160 unit average is met over the eight hour period.

Satisfied Criteria
B
C.1
C.2
C.3
D

Paragraph 05: *Other criteria that may be considered in an engineering study include:*

- A.** *The need to control left-turn conflicts*
- B.** *The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes*
- C.** *Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop*
- D.** *An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.*

Section 4C.02 Traffic Signal Warrant 1, Eight-Hour Vehicular Volume

Paragraph 04: *The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:*

- A.** *The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or*

Table 4C-1 Condition A in the 100% column states that the minimum vehicle volume on the major street (total of both approaches) should be 500 vehicles, and the minimum vehicle volume on the higher-volume minor-street approach (one direction only) should be 150 vehicles.

The number of vehicles entering the intersection between 7:00am and 3:00pm from 500 West is 7,301, and 692 from the west leg of the intersection. This equates to an average of 913 and 87 vehicles per hour. This condition is not met.

- B.** *The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.*

Table 4C-1 Condition B in the 100% column states that the minimum vehicle volume on the major street (total of both approaches) should be 750 vehicles, and the minimum vehicle volume on the higher volume minor-street approach (one direction only) should be 75 vehicles.

The number of vehicles entering the intersection between 7:00am and 3:00pm from 500 West is 7,301, and 692 from the west leg of the intersection. This equates to an average of 913 and 87 vehicles per hour. This condition is met.

As can be seen in the condition descriptions, Condition A is not met and Condition B is met. Per Warrant 1, a traffic control signal should be considered.

Section 4C.03 Traffic Signal Warrant 2, Four-Hour Vehicular Volume

Paragraph 02: *The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.*

The number of vehicles entering the intersection between 7:00am and 11:00am from 500 West is 4,359, and 419 from the west leg of the intersection. This equates to an average of 1,090 and 105 vehicles per hour.

Using the average number of vehicles per hour on the chart in Figure 4C-1, the point plots above the applicable curve. Thus, a traffic control signal should be considered per Warrant 2.

Section 4C.08 Traffic Signal Warrant 7, Crash Experience

Paragraph 02: *The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:*

- A.** *Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and*

In the summer of 2000, a temporary signal was installed at the subject intersection for a trial. It was found that the crash rate was higher while the traffic signal was up than in 2002 and 2003 without the signal.

Currently, the intersection has a two-way stop for eastbound and westbound vehicles. The intersection has operated this way since it was paved between 1988 and 1997.

No other alternatives have been tested.

- B.** *Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and*

Year	# Accidents	# Correctable With Signal
2013	5	1+
2014	4	0+
2015	1	0
2016	2	1
2017	2	2
2018	7	4
2019	8	5

The above table shows an increase in yearly accidents that may be correctable with the installation of a traffic signal. In 2019, there were 5 crashes that may not have occurred had a traffic signal been installed. Criteria B is met.

- C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vhp in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.*

Table 4C-1 Condition A in the 80 % column states that the minimum vehicle volume on the major street (total of both approaches) should be 400 vehicles, and the minimum vehicle volume on the higher volume minor-street approach (one direction only) should be 120 vehicles.

Table 4C-1 Condition B in the 80% column states that the minimum vehicle volume on the major street (total of both approaches) should be 600 vehicles, and the minimum vehicle volume on the higher volume minor-street approach (one direction only) should be 60 vehicles.

The number of vehicles entering the intersection between 7:00am and 3:00pm from 500 West is 7,301, and 692 from the west leg of the intersection. This equates to an average of 913 and 87 vehicles per hour. As can be seen in the condition descriptions, Condition A is not satisfied and Condition B is satisfied. Criteria C is met.

Per Warrant 8, a traffic control signal should be considered.

Section 4C.09 Traffic Signal Warrant 8, Roadway Network

Paragraph 02: *The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:*

Both Sandy Parkway (500 W) and 9400 S are classified as major collector roads.

- A.** *The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has a 5-year projected traffic*

volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or

Vehicle volumes currently entering the intersection are 1,083 during the morning peak hour (average per hour from 7:00 am to 9:00 am) and 1,556 during the evening peak hour (5:00 pm to 6:00 pm). Existing conditions already meet Warrants 1 and 2. Thus, per Traffic Signal Warrant 8, a traffic control signal should be considered.

- B.** *The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).*

Traffic counts were not recorded on a Saturday or Sunday.

Paragraph 03: *A major route as used in this signal warrant shall have at least one of the following characteristics:*

- A.** *It is part of the street or highway system that serves as the principal roadway network for through traffic flow.*

500 West and 9400 South are both major collector roads. 500 West, serves as the principal roadway through this intersection. 500 West connects 9000 South to 10000 South and 10600 South. 500 West serves, and is signed as, the I-15 frontage road. 9400 South is the only east/west collector road between I-15, Jordan River, 9000 South, and 1000 South. However, 9400 S does not currently cross I-15.

- B.** *It includes rural or suburban highways outside, entering, or traversing a city.*

500 West and 9400 South are both major collector roads. In addition to 500 West acting as the through road, both roads serve both industrial and residential developments in the area. 500 West acts as the I-15 frontage road, connecting to South Jordan to the south. Also, 500 West is used to gain access to the 9000 S I-15 interchange.

- C.** *It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.*

500 West and 9400 South are both shown as major collector roads on the Sandy City Master Transportation Plan.

All three characteristics are met. Thus, Traffic Signal Warrant 8 should be considered for a traffic control signal.

Section 4C.10 Traffic Signal Warrant 9, Intersection Near a Grade Crossing

The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a grade crossing on an intersection approach controlled to a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Paragraph 03: *The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:*

- A.** *A grade crossing exists on an approach controlled by a SOTP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and*

The center of the track nearest the STOP bar is 400 feet away. Criteria A is not satisfied. Therefore, Traffic Signal Warrant 9 is not met. However, because other signal warrants are met, Warrant 9 does not need to be evaluated.

Non-Applicable Traffic Signal Warrants

Warrant 3: Peak Hour.

This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.

Warrant 4: Pedestrian Volume

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Warrant 5: School Crossing

The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal.

Warrant 6: Coordinated Signal System

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.