NOACA
Technical Memorandum

Signal Warrant Analysis
City of Medina
Wadsworth Road & Sturbridge Drive

September 2017

1) Title & Subtitle Signal Warrant Analysis: City of Medina, Wadsworth Road & Sturbridge Road	2) NOACA Report No.
3) Author(s) Lawrence Hall, Melissa Thompson, Michael Kubek	4) Report Date September 2017
5) Performing Organization Name & Address Northeast Ohio Areawide Coordinating Agency 1299 Superior Avenue, Cleveland, OH 44114-3204 Phone: (216) 241-2414 FAX: (216) 621-3024 Website: www.noaca.org	6) Project Task No. 6251-3 7) NOACA Contract/Grant No. ODOT/FHWA
8) Sponsoring Agency Name & Address Ohio Department of Transportation 1980 W. Broad St., Box 899 Columbus, OH 43216-0899	9) Type of Report & Period Covered 2017 10) Sponsoring Agency Code
11) Supplementary Notes Federal funding for this project was provided by the Federal Highway Administration and administered by the Ohio Department of Transportation.	
12) Abstracts This memorandum contains a signal warrant analysis at the intersection of Wadsworth Road and Sturbridge Drive. Existing traffic control at the intersection consists of a two-way stop on Sturbridge Drive. The analysis will determine if conditions are present to justify installation of a traffic signal.	
13) Key Words & Document Analysis A. Descriptors B. Identifiers/Open Ended Terms	
14) Availability Statement NOACA	15) No. Pages 16) Price

Signal Warrant Analysis
Technical Memorandum

City of Medina
Wadsworth Road & Sturbridge Drive

September 2017

NORTHEAST OHIO AREAWIDE COORDINATING AGENCY

Adam Frederick
BOARD PRESIDENT

Grace Gallucci
EXECUTIVE DIRECTOR

Preparation of this publication was financed by appropriations from the counties of and municipalities within Cuyahoga, Geauga, Lake, Lorain and Medina; the U.S. Environmental Protection Agency; and the U.S. Department of Transportation, Federal Transit Administration and Federal Highway Administration, in conjunction with the Ohio Department of Transportation.

Table of Contents

Executive Summary

The Northeast Ohio Areawide Coordinating Agency (NOACA) conducted a signal warrant analysis as part of its Traffic Safety & Operations Technical Assistance program for the City of Medina. The analysis was done to examine if the need for a traffic control signal at the intersection of Wadsworth Road and Sturbridge Drive is justified.

NOACA followed the signal warrant guidelines presented in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) and used the Highway Capacity Software (HCS) to analyze traffic counts to determine the need for a traffic control signal. Nine different warrants exist and were examined for this Technical Memo. Based on the existing traffic volumes and conditions, none of the nine warrants in the OMUTCD are met. A traffic control signal is therefore not justified for recommendation at this intersection.

Warrant	Result	Note
Warrant 1: Eight-Hour Vehicular Volume	**No**	Insufficient traffic volumes
Warrant 2: Four-Hour Vehicular Volume	**No**	Insufficient traffic volumes
Warrant 3: Peak Hour	**No**	The minor street is not an unusual case of facilities that attract or discharge large numbers of vehicles over a short time
Warrant 4: Pedestrian Volume	**No**	Insufficient pedestrian volume
Warrant 5: School Crossing	**No**	Insufficient school crossing volume; Wadsworth Road, the major road, has a signalized intersection closer to the school
Warrant 6: Coordinated Signal System	**No**	The intersection is not within the limits of a coordinated signal system.
Warrant 7: Crash Experience	**No**	Insufficient traffic and pedestrian volumes
Warrant 8: Roadway Network	**No**	Sturbridge Drive is not a major route
Warrant 9: Intersection near a Grade Crossing	**No**	No nearby at-grade railroad crossing

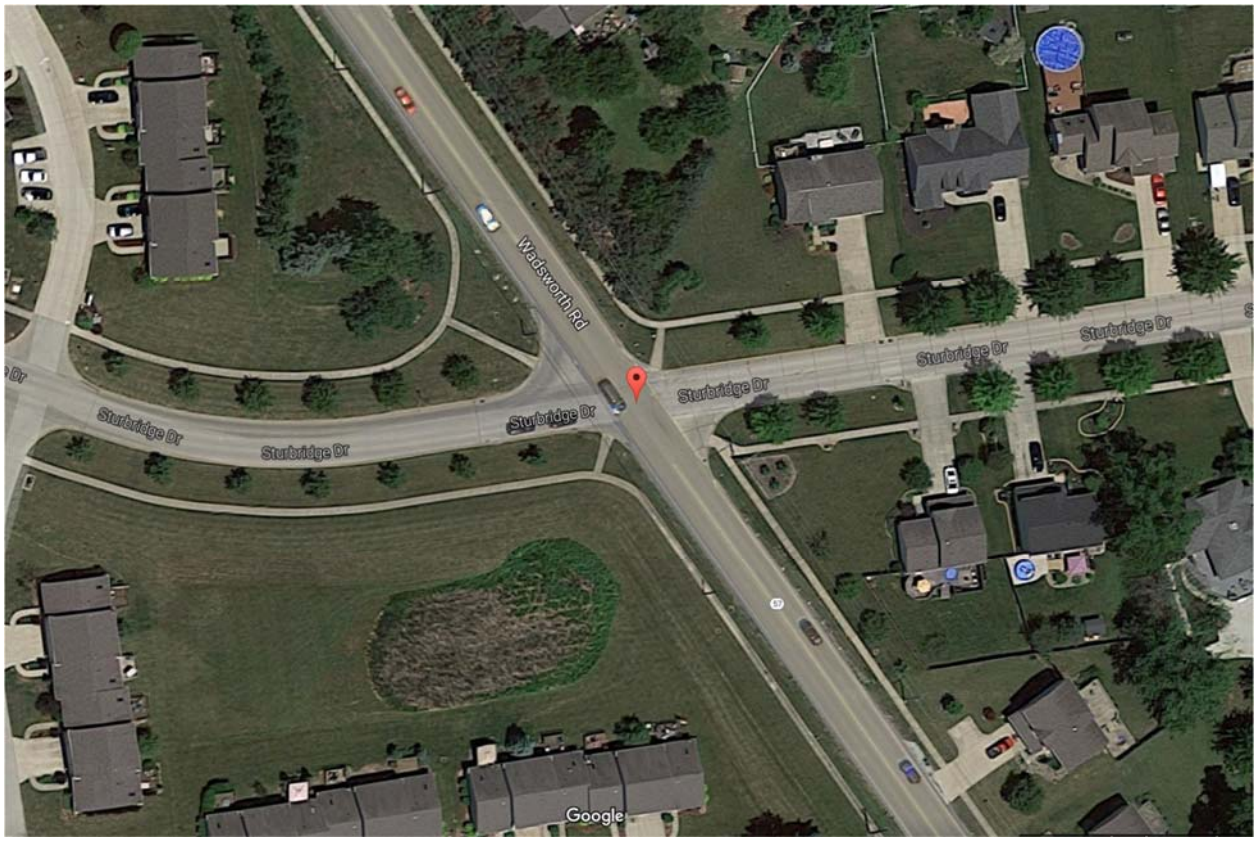
Introduction

The City of Medina requested that NOACA conduct a signal warrant analysis to evaluate the necessity of installing a traffic control signal at the intersection of Wadsworth Road (State Route 57) and Sturbridge Drive. The intersection is currently controlled by stop signs on Sturbridge Road, the minor road in the analysis. To conduct this analysis, traffic counts were collected by NOACA staff on Thursday, March 23, 2017. Counts were collected for the eight hours of highest traffic. These hours were selected based on 24-hour traffic counts on Wadsworth Road obtained in 2014, which were the hours of 7:00-9:00 a.m. and 1:00-7:00 p.m. By using these periods, NOACA was able to evaluate how the intersection operates during the busiest times of day. Once the data was collected, NOACA staff analyzed it using the criteria set forth in the Ohio Manual of Uniform Traffic Control Devices (OMUTCD) in Chapter 4, Section C.[1]

Image 1: Project Location Map

[1] [1] Ohio Department of Transportation (ODOT) Office of Traffic Engineering, Ohio Manual of Uniform Traffic Control Devices (OMUTCD), 2012, http://www.dot.state.oh.us/Divisions/Engineering/Roadway/DesignStandards/traffic/OhioMUTCD/Documents/2012_Part04_Final_bookmarked_011712_added_bookmarks_forFiguresandTables.pdf (accessed April 5, 2017).

Image 2: Aerial View of Project Location



Wadsworth Road, which travels roughly north-south through the study area, is considered the "major" road in the analysis due to its higher functional classification as a minor arterial (FC4) and higher traffic volumes. The posted speed limit is 35 mph with one lane in each direction. Sturbridge Drive is classified as a major collector (FC5) to the east of Wadsworth Road and a local road (FC7) to the west. The posted speed limit is 25 mph with one lane in each direction east-west. Because Wadsworth Road is the major road, it is not controlled by any traffic control device, while Sturbridge Drive has stop signs at the intersection.

Image 3: Southwest corner of Wadsworth Road and Sturbridge Road, looking east

Crash History, 2012-2016

The crash history indicates a low number of crashes per year with no obvious trend. Seven angle and six rear-end crashes were the only types reported. Angle crashes are typically reduced following the installation of a traffic control signal, while rear-end crashes may be made worse. The City of Medina may continue to monitor the intersection for an increase in crashes or crash severity.

Table 1: Crash History, 2012-2016

Year	Type of Crash		Crash Severity		Total
	Angle	Rear-End	Injury	Property Damage	
2012	2	2	0	4	4
2013	2	0	1	1	2
2014	1	1	0	2	2
2015	1	3	1	3	4
2016	1	0	0	1	1
5-Year Average			0.4	2.2	2.6

Methodology

The Ohio Manual of Uniform Traffic Control Devices provides nine possible justifications for a traffic signal. Chapter 4C of the Manual notes that meeting one or more is the minimum necessary to justify a traffic signal but that meeting this standard "shall not in itself require the installation of a traffic control signal."

Warrant 1: Eight-Hour Vehicular Volume
Warrant 2: Four-Hour Vehicular Volume
Warrant 3: Peak Hour
Warrant 4: Pedestrian Volume
Warrant 5: School Crossing
Warrant 6: Coordinated Signal System
Warrant 7: Crash Experience
Warrant 8: Roadway Network
Warrant 9: Intersection Near a Grade Crossing

Warrant 1: Eight-Hour Vehicular Volume

Condition A: Applied at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Condition B: Applied at locations where condition A is not satisfied and the minor road traffic experiences high delays and conflict in entering or crossing the major road.

At the 100 percent level, either Condition A or B must be met for eight hours. If neither condition is met, then the 80 percent level is analyzed. Both Conditions A and B must be met for the same eight hours at the 80 percent level. For each of any eight hours of an average day, the total volume in vehicles per hour (VPH) of the major road and the higher VPH of the two approaches of the minor road should exceed the minimum threshold traffic volumes defined in the OMUTCD.

NOACA used the eight hours of highest traffic volumes for this location. The thresholds are shown in the worksheet found in Table 4 (Appendix B). At the 100 percent level, no hours were met for Condition A and only two hours were met for Condition B. There was only one hour when all minimum values were met for both Conditions A and B at the 80 percent level.

The 100 percent traffic volume thresholds can be decreased to the 70 percent level if the posted speed limit exceeds 40 mph, or the intersection is in a community with a population under 10,000. The posted speed limit at the subject intersection is 35mph and the population of the City of Medina exceeds 10,000. Therefore, the option for 70 percent level analysis is not applicable.

Warrant 1 is not satisfied due to low traffic volumes.

Warrant 2: Four-Hour Vehicular Volume

This warrant is applied where the volume of intersecting traffic is the main reason to consider installing a traffic control signal. The volume of at least four hours should exceed the minimum threshold outlined in the OMUTCD to justify this warrant. 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 must fall above the applicable curve from the OMUTCD.

None of the hourly volumes for the subject intersection exceed the minimum threshold as shown in Table 6 (Appendix C). As previously stated in Warrant 1, the option for 70 percent level analysis is not applicable.

Warrant 2 is not satisfied due to low traffic volumes.

Warrant 3: Peak Hour

This warrant is applied where traffic conditions are such that for at least one hour, the minor road traffic suffers undue delay. This signal warrant is 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. The need for a traffic control signal would be considered if either of the following two categories are met:

- **Category A:** If all three of the following conditions exist for the same 1 hour:
    1. The total stopped time delay experienced by traffic on the minor street approach equals or exceeds OMUTCD thresholds; and
    2. The volume on the same minor street approach equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and
    3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.
- **Category B:** The point representing the VPH (in both directions) on the major street and the corresponding VPH on the higher-volume minor street approach (one direction only) for any one hour of an average day should fall above the applicable OMUTCD thresholds.

Warrant 3 is not satisfied as the minor street is not an unusual case of facilities that attract or discharge large numbers of vehicles over a short time.

Warrant 4: Pedestrian Volume

The pedestrian volume warrant is intended for situations where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. Bicyclists may be counted as pedestrians in cases where they are using bicycle or pedestrian crossings rather than sharing the lane with vehicular traffic. The need for a traffic control signal at an intersection or midblock crossing would be considered if both of the following criteria are met:

- Pedestrian volume crossing the major road meets minimum thresholds for either four-hour or peak-hour volumes based on the number of vehicles on the major road; and

- There is no existing traffic control signal or stop sign on the major street within 300 feet of the intersection under study, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

For the four-hour and peak-hour warrants, the number of pedestrian crossings needed to satisfy the warrant is inversely proportional to the number of vehicles per hour. In other words, the number of pedestrians necessary decreases as the number of vehicles increases. Note, however, that for the four-hour criteria, at least 107 pedestrian crossings are needed per hour, and for the peak-hour criteria, at least 133 pedestrian crossings are needed, regardless of traffic volumes.

The highest number of pedestrians per hour crossing the major street at the subject intersection was two (Table 3, Appendix A), which is well below these minimum values. The graphs for pedestrian values are shown in Appendix D. As previously stated in Warrant 1, the option for 70 percent level analysis is not applicable.

Warrant 4 is not satisfied due to low pedestrian volumes.

Warrant 5: School Crossing

The school crossing warrant is intended for cases where the principal reason to consider installing a traffic control signal is schoolchildren crossing the major street. For purposes of this warrant, "schoolchildren" includes elementary through high school students. A signal may be considered if the number of adequate gaps in the vehicular traffic stream during the period when children are using an established school crossing is less than the number of minutes in the same period and there are a minimum of 20 students during the highest crossing hour. As with the pedestrian volume warrant, the school crossing warrant is only to be applied if there is no existing traffic control signal or stop sign on the major street within 300 feet of the intersection under study, unless the proposed traffic control signal will not restrict the progressive movement of traffic.

No school children were observed crossing Wadsworth Road at Sturbridge Drive. The intersection of Wadsworth Road and Smokerise Drive is four-tenths of a mile from the study intersection and is a signalized intersection with a four-way crosswalk, indicating pedestrian and schoolchild crossings may safely occur there.

Warrant 5 is not satisfied due to low crossing volumes.

Warrant 6: Coordinated Signal System

This analysis determines if a signal is warranted to maintain proper platooning through a series of coordinated signals. A signal may be warranted if the adjacent traffic control signals do not provide the necessary degree of platooning and the addition of a new signal will provide a progressive operation in conjunction with existing signals; however, this warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.

The closest signal to the north is 1,930 feet away and the closest to the south is more than one mile away. This meets the 1,000 feet minimum spacing, but is also indicative that a coordinated system may not exist on the corridor.

Warrant 6 is not satisfied as the intersection is not within the limits of coordinated signal system.

Warrant 7: Crash Experience

The crash experience warrant is intended for application where the frequency and severity of crashes are the principal reasons to consider installing a traffic control signal. A signal is considered warranted if all three criteria are met:

- An adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce crash frequency; and

- Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period. Crashes susceptible to correction by a traffic control signal typically include angle and left-turn crashes. Engineering judgment is used to determine if other crash types could be prevented by a signal at the location in question (e.g., pedestrian and failure-to-yield crashes). Rear-end crashes are typically expected to increase after installation of a traffic control signal.

- For each of any eight hours of an average day, the traffic volume given in both of the 80 percent columns of Warrant 1 Condition A must be met as defined in the OMUTCD; or the traffic volume given in both of the 80 percent columns for Condition B must be met; or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume Warrant 4.

The highest number of angle crashes between the years 2012 and 2016 was two per year, which is less than the minimum threshold of five or more. Also, the 80 percent traffic volumes of Warrant 1 only meet one hour in Condition A and only meet six hours for Condition B (Table 4, Appendix B). The highest number of pedestrians per hour at the subject intersection was two (Table 3, Appendix A), which is well below 80 percent of the minimum values of Warrant 4.

The 80 percent traffic volume thresholds can be decreased to the 56 percent level if the posted speed limit exceeds 40 mph, or the intersection is in a community with a population under 10,000. The posted speed limit at the subject intersection is 35mph and the population of the City of Medina exceeds 10,000. Therefore, the option for 56 percent level analysis is not applicable.

Warrant 7 is not satisfied because all three criteria are not met due to low traffic and pedestrian volumes and yearly crashes are below the minimum threshold.

Warrant 8: Roadway Network

A traffic control signal may be justified to encourage concentration and organization of traffic flow on a roadway network. The common intersection of two or more major routes must meet at least one of the following criteria:

- The intersection has an existing or immediately projected entering volume of at least 1,000 VPH during the peak hour of a typical weekday and has five-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

- The intersection has an existing or immediately projected entering volume of at least 1,000 VPH for each of any five hours of a non-normal business day.

Note that for this warrant, a “major route” is defined as having at least one of the following conditions:

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

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

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

Warrant 8 is not satisfied because Sturbridge Drive is classified as a local road to the west and does not meet the definition of a “major route.”

Warrant 9: Intersection Near a Grade Crossing

This warrant is intended for use at a location where none of the other eight warrants are met but the proximity to the intersection of a grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a signal.

Warrant 9 is not satisfied due to no at-grade railroad crossings near the intersection.

Warrant Analysis Summary

Warrants #1 and #2 are not satisfied due to low traffic volumes (see Appendix B and Appendix C). Warrant 3 is also not satisfied as the minor street is not an unusual case of facilities that attract or discharge large numbers of vehicles over a short time. Pedestrian volume is insufficient to satisfy Warrant #4 (see Appendix D for details).

Warrant #5 is not satisfied due to a low volume of pedestrian schoolchildren. The nearest school is one-half mile from the intersection; the intersection of Wadsworth Road and Smokerise Drive is four-tenths of a mile from the study intersection and is a signalized intersection with a four-way crosswalk, indicating pedestrian and schoolchild crossings may safely occur here.

Warrant 6 is not satisfied as the intersection is not within the limits of coordinated signal system. The closest signal to the north is 1,930 feet away and the closest to the south is more than one mile away. This meets the 1,000 feet minimum spacing, but is also indicative that a coordinated system may not exist on the corridor. Also, per section 402-3.5 of the Ohio Department of Transportation (ODOT) Traffic Engineering Manual (TEM), Warrant #6 is not used as the sole warrant in an ODOT signal warrant analysis.

Warrant #7 is not satisfied because only 1.4 crashes per year occur at the intersection that are of the type that may be preventable by a signal. Furthermore, traffic and pedestrian volume is too low to meet the criteria.

Warrant #8 is not satisfied because Sturbridge Drive is a local road and not considered a major route.

Finally, Warrant #9 is not satisfied because there is no rail crossing on Sturbridge Drive.

Conclusion

Based on Chapter 4, Traffic Control Signal Needs Studies, of the OMUTCD and using traffic counts performed on Thursday, March 23, 2017, a traffic signal is not currently justified at the intersection of Wadsworth Road and Sturbridge Drive. None of the nine warrants is satisfied.

Appendix A

Traffic Counts

Table 3: Traffic Counts

	STURBRIDGE Eastbound					STURBRIDGE Westbound					WADSWORTH Northbound					WADSWORTH Southbound				
Start Time	Right	Thru	Left	Total	Peds	Right	Thru	Left	Total	Peds	Right	Thru	Left	Total	Peds	Right	Thru	Left	Total	Peds
7am	36	67	20	123	0	31	33	12	76	0	20	425	15	460	0	20	219	6	245	0
8am	23	47	30	100	0	21	42	10	73	0	17	356	16	389	0	18	177	11	206	0
1pm	19	30	12	61	0	10	24	4	38	0	32	248	11	291	0	5	240	17	262	0
2pm	20	44	19	83	0	16	29	17	62	0	34	312	20	366	0	18	271	21	310	0
3pm	21	50	27	98	0	118	22	13	53	0	36	376	23	438	0	15	293	26	334	0
4pm	14	39	19	72	3	14	41	16	71	0	15	327	30	372	0	51	412	33	496	1
5pm	16	43	16	75	1	19	45	12	76	0	22	387	41	450	0	59	381	31	471	2
6pm	14	34	17	65	1	27	36	13	76	1	14	277	28	319	0	40	296	30	366	0

Appendix B

Signal Warrant Evaluation Output

Table 4: Signal Warrant Analysis Summary

SIGNAL WARRANTS EVALUATION

Intersection: Wadsworth Road and Sturbridge Drive
Location : Medina
Number of Lanes per approach: N= 1 S= 1 E= 1 W= 1
Does 70% warrant apply? No
Major Street speed limit: 35

Analysis By : NOACA
Traffic count date : 3/24/2017

Condition	No. of Lanes	Hourly volumes: Major St. 2-way	Hourly volumes: Minor St. 1-way	Hourly volumes: Minor St. 1-way	WARRANT #1 Condition A 100% Major	100% Minor	80% Major	80% Minor	Condition B 100% Major	100% Minor	80% Major	80% Minor	WARRANT #2 FOUR HOUR	WARRANT #3 PEAK HOUR
Normal	1				500	150	400	120	750	75	600	60		
	2+				600	200	480	160	900	100	720	80		
70%*	1				350	105	280	84	525	53	420	42		
	2+				420	140	336	112	630	70	504	56		
MID to 1 AM														
1 AM to 2 AM														
2 AM to 3 AM														
3 AM to 4 AM														
4 AM to 5 AM														
5 AM to 6 AM														
6 AM to 7 AM														
7 AM to 8 AM		705	123	76	*		*	*		*	*	*		
8 AM to 9 AM		595	100	73	*		*			*		*		
9 AM to 10 AM														
10 AM to 11 AM														
11 AM to 12 Noon														
12 Noon to 1 PM														
1 PM to 2 PM		553	61	38	*		*					*		
2 PM to 3 PM		676	83	62	*		*			*	*	*		
3 PM to 4 PM		772	98	53	*		*		*	*	*	*		
4 PM to 5 PM		868	72	71	*		*		*		*	*		
5 PM to 6 PM		921	75	76	*		*		*	*	*	*		
6 PM to 7 PM		685	65	76	*		*			*	*	*		
7 PM to 8 PM														
8 PM to 9 PM														
9 PM to 10 PM														
10 PM to 11 PM														
11 PM to MID														
Hours Met					0		1		2		6		0	0
WARRANT SATISFIED					No		No		No		No		No	No

* Condition is determined by envirnoment: Use 70% values if the speed limit exceeds 40 mph on the major road or if the location is in a build up area of an isolated community with a population of less than 10,000.

WARRANT #1 (Combination)
Conditions A & B are each met at the 80% level: No

WARRANT #4 (Pedestrian Volume)
Hours with 107 or more pedestrians: 0
Hours with 133 or more pedestrians: 0
Distance to nearest traffic control on major street: 1930'
Warrant Satisfied? No

WARRANT #5 (School Crossing)
At least 20 children crossing during highest volume hour: No
Gap analysis made during period: N/A
Pedestrian crossing time (t): N/A
Number of gaps greater than (t) during period: N/A
Distance to nearest traffic control on major street: 1930'
Warrant Satisfied? No

WARRANT #6 (COORDINATED SIGNAL SYSTEM)
Distance to nearest signal in each direction on major street: 1930, 5990
Time space diagram (attached) shows that this location can be implemented into a system: N/A
Warrant Satisfied? No

WARRANT #7 (CRASH EXPERIENCE)
Adequate trial of less restrictive measures: No
Number of crashes per year which could be prevented: 1.4
80% of warrant #1 or #2 satisfied: No
Warrant Satisfied? No

WARRANT #8 (ROADWAY NETWORK)
Both streets are considered major routes: No
At least 1000 V.P.H. during weekday peak hour: No
5-Year projection meets Warrant 1, 2, or 3: N/A
At least 1000 V.P.H. for any 5 hours on a Saturday or Sunday: N/A
Meets Characteristic requirements? N/A
Warrant Satisfied? No

Warrant # 9 (Intersection Near a Grade Crossing)
Distance to nearest crossing on street with existing control: N/A
Warrant Satisfied? No

Appendix C

Highway Capacity Software (HCS) Output

Table 5: HCS Output – Warrants Summary

Warrants Summary

Information			
Analyst	Lawrence Hall	Intersection	
Agency/Co	NOACA	Jurisdiction	City of Medina
Date Performed	4/5/2017	Units	U.S. Customary
Project ID		Time Period Analyzed	March 24, 2017
East/West Street	Sturbridge Road	North/South Street	Wadsworth Road
File Name	Medina_Warrants.xhy	Major Street	North-South
Project Description			

General				Roadway Network	
Major Street Speed (mph)	35	☐	Population < 10,000	Two Major Routes	☐
Nearest Signal (ft)	1930	☐	Coordinated Signal System	Weekend Count	☐
Crashes (per year)	1.4	☐	Adequate Trials of Alternatives	5-yr Growth Factor	0

Geometry and Traffic	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Number of lanes, N	0	1	0	0	1	0	0	1	0	0	1	0
Lane usage		T			T			T			T	
Vehicle Volume Averages (vph)	0	55	0	0	43	0	0	257	0	0	224	0
Peds (ped/h) / Gaps (gaps/h)	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--
Delay (s/veh) / (veh-hr)	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--	--	0 / 0	--

Warrant 1: Eight-Hour Vehicular Volume	☐
1 A. Minimum Vehicular Volumes (Both major approaches --and-- higher minor approach) --or--	☐
1 B. Interruption of Continuous Traffic (Both major approaches --and-- higher minor approach) --or--	☐
1 80% Vehicular --and-- Interruption Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 2: Four-Hour Vehicular Volume	☐
2 A. Four-Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 3: Peak Hour	☐
3 A. Peak-Hour Conditions (Minor delay --and-- minor volume --and-- total volume) --or--	☐
3 B. Peak- Hour Vehicular Volumes (Both major approaches --and-- higher minor approach)	☐
Warrant 4: Pedestrian Volume	☐
4 A. Pedestrian Volumes (Four hours --or-- one hour) --and--	☐
4 B. Gaps Same Period (Four hours --or-- one hour)	☐
Warrant 5: School Crossing	☐
5. Student Volumes --and--	☐
5. Gaps Same Period	☐
Warrant 6: Coordinated Signal System	☐
6. Degree of Platooning (Predominant direction or both directions)	☐
Warrant 7: Crash Experience	☐
7 A. Adequate trials of alternatives, observance and enforcement failed --and--	☐
7 B. Reported crashes susceptible to correction by signal (12-month period) --and--	☐
7 C. 80% Volumes for Warrants 1A, 1B --or-- 4 are satisfied	☐
Warrant 8: Roadway Network	☐
8 A. Weekday Volume (Peak hour total --and-- projected warrants 1, 2 or 3) --or--	☐
8 B. Weekend Volume (Five hours total)	☐

 HCS+™ Version 5.5 Generated: 4/13/2017 10:17 AM

Table 6: HCS Output – Warrants Volume

Warrants Volume

Information			
Analyst	Lawrence Hall	Intersection	
Agency/Co	NOACA	Jurisdiction	City of Medina
Date Performed	4/5/2017	Units	U.S. Customary
Project ID		Time Period Analyzed	March 24, 2017
East/West Street	Sturbridge Road	North/South Street	Wadsworth Road
File Name	Medina_Warrants.xhy	Major Street	North-South
Project Description			

Warrant 1

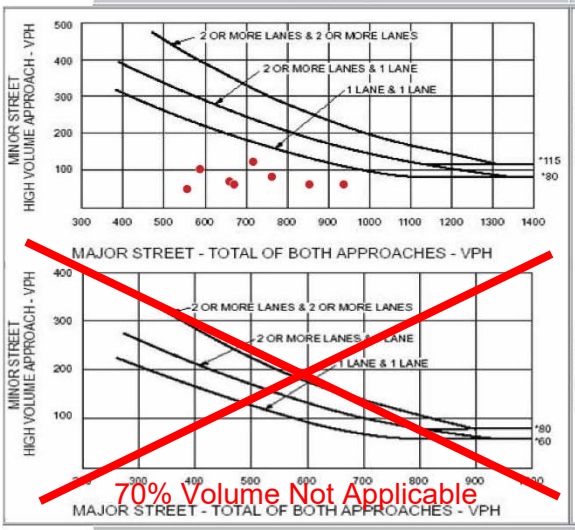
Condition A - Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approach (one direction only)		
Major Street	Minor Street	100%*	80%*	70%*	100%*	80%*	70%*
1	1	500	400	350	150	120	105
2 or more	1	600	480	420	150	120	105
2 or more	2 or more	600	480	420	200	160	140
1	2 or more	500	400	350	200	160	140

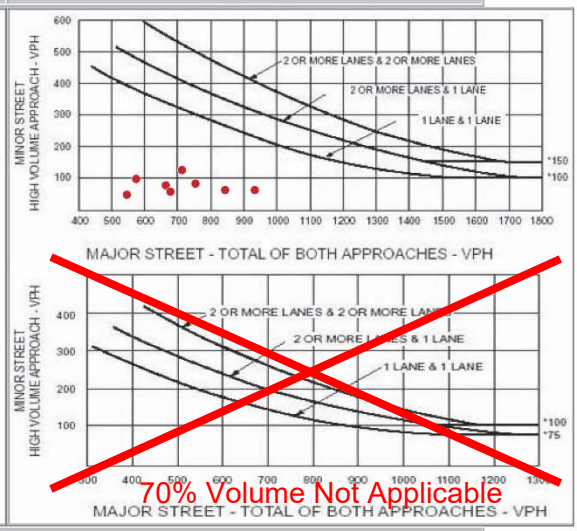
Condition B - Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)			Vehicles per hour on higher-volume minor-street approach (one direction only)		
Major Street	Minor Street	100%*	80%*	70%*	100%*	80%*	70%*
1	1	750	600	525	75	60	53
2 or more	1	900	720	630	75	60	53
2 or more	2 or more	900	720	630	100	80	70
1	2 or more	750	600	525	100	80	70

Warrant 2



Warrant 3



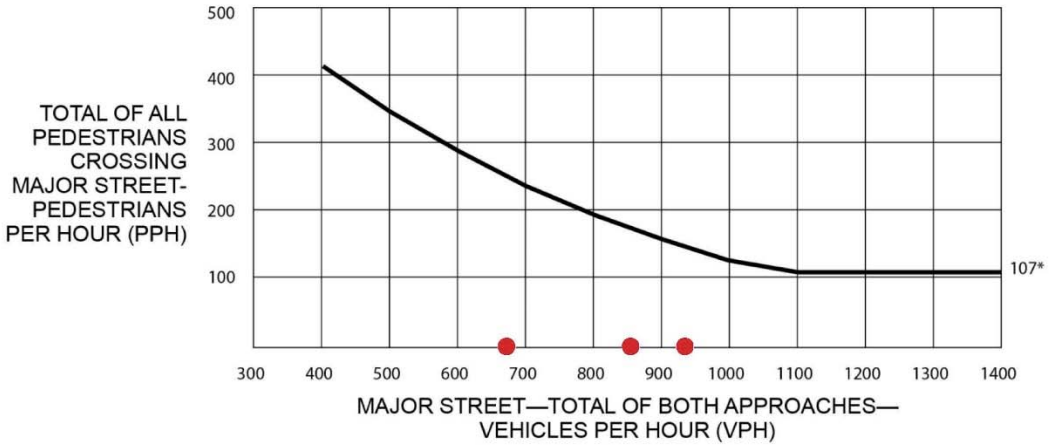
Volume Summary

Major Street Lanes 1			Minor Street Lanes 1		Speed		35	Population		10000+
Hours	Major Volume	Minor Volume	Total Volume	1A (100%)	1A (80%)	1B (100%)	1B (80%)	2 (100%)	3A (100%)	3B (100%)
07-08	705	123	904	No	Yes	No	Yes	No	No	No
08-09	595	100	768	No	No	No	No	No	No	No
09-10	0	0	0	No	No	No	No	No	No	No
10-11	0	0	0	No	No	No	No	No	No	No
11-12	0	0	0	No	No	No	No	No	No	No
12-13	0	0	0	No	No	No	No	No	No	No
13-14	553	61	652	No	No	No	No	No	No	No
14-15	676	83	821	No	No	No	Yes	No	No	No
15-16	772	92	917	No	No	Yes	Yes	No	No	No
16-17	868	71	1006	No	No	No	Yes	No	No	No
17-18	921	76	1072	No	No	Yes	Yes	No	No	No
18-19	685	76	823	No	No	No	Yes	No	No	No
Totals	5775	682	6963	0	1	2	6	0	0	0

Appendix D

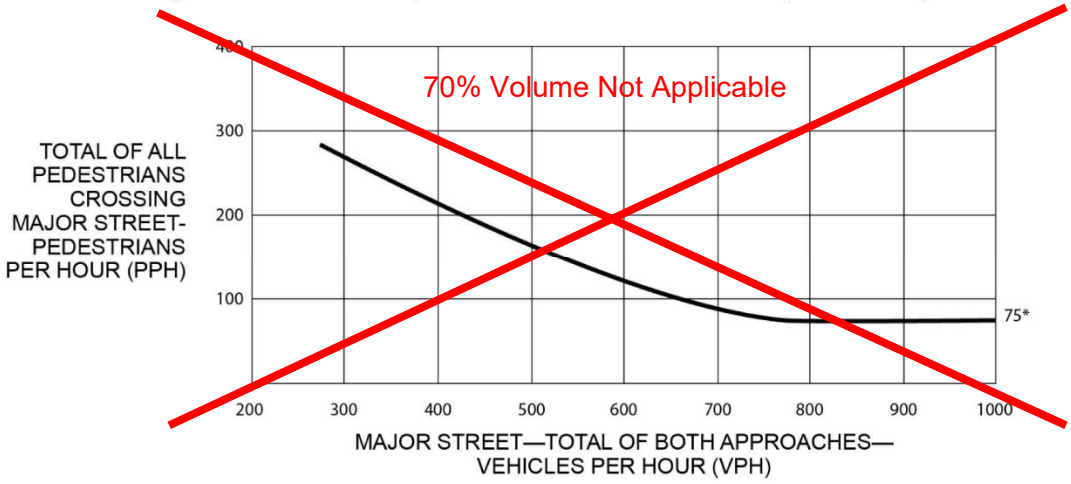
Warrant 4, Pedestrian Volume OMUTCD Thresholds

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



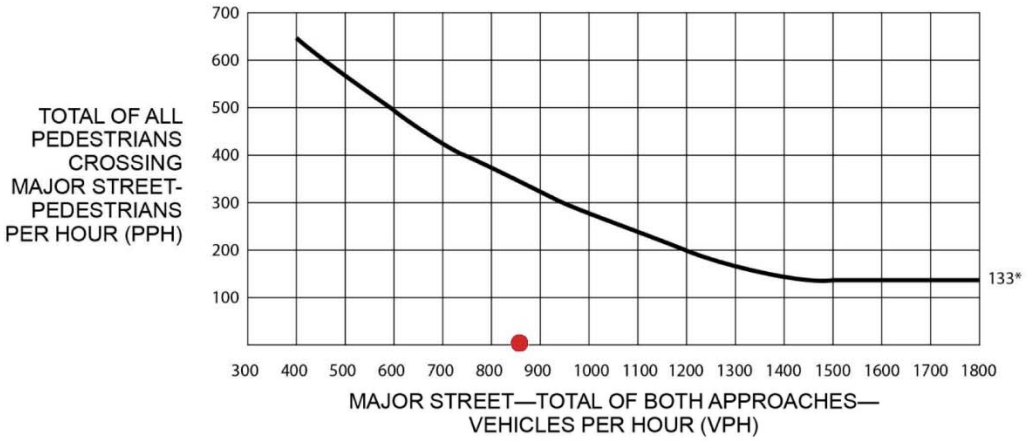
*Note: 107 pph applies as the lower threshold volume.

Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)



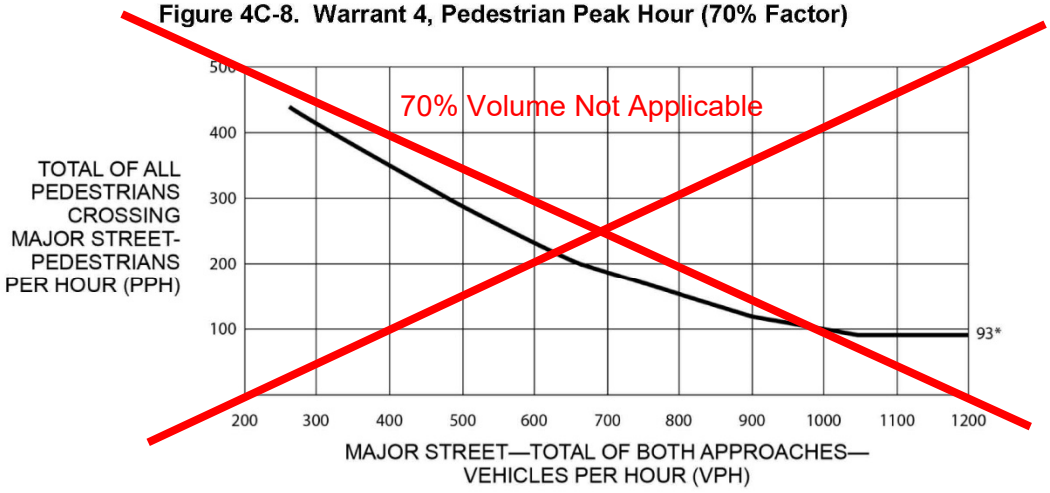
*Note: 75 pph applies as the lower threshold volume.

Figure 4C-7. Warrant 4, Pedestrian Peak Hour



*Note: 133 pph applies as the lower threshold volume.

Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)



*Note: 93 pph applies as the lower threshold volume.