EFFECTIVENESS OF **TRAFFIC CALMING MEASURES** IN SALT LAKE CITY

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INTRODUCTION & BACKGROUND

Traffic calming was a hot topic at meetings of the Institute of Transportation Engineers (ITE) and the American Society of Civil Engineers (ASCE) in the late 1990s and early 2000s but has received much less attention in recent years. Has traffic calming fallen out of favor due to unintended consequences such as slower emergency response times, or has traffic calming just become a standard part of city transportation departments' functions and therefore not worthy of professional attention? We cannot be sure, but the most recent national survey, published in the ITE Journal, suggests the latter (Ewing et al., 2005). Many of the nation's most livable cities were found to have made traffic calming a routine part of their traffic operations (see accompanying table). Perhaps traffic calming has already proved its utility in addressing citizen complaints about speeding and cut-through traffic, and therefore doesn't require additional documentation.

	Surveyed in mid-1990s	Surveyed in 2004	Program Start Date
Albuquerque, NM		X	1991
Austin, TX	X	X	1986
Bellevue, WA	X	X	1985
Berkeley, CA	X		NA
Boulder, CO	X		1983
Broward County, FL	X	X	2000
Charlotte, NC	X	X	1978
Charlottesville, VA		X	1996
Colorado Springs, CO		X	1998
Dayton, OH	X		1990
Eugene, OR	X	X	1974
Ft. Lauderdale, FL	X		NA
Gainesville, FL	X		1984
Gwinnett County, GA	X	X	1992
Howard County, MD	X	X	NA
Los Angeles County, CA		X	NA
Minneapolis, MN		X	1994
Montgomery County, MD	X	X	1978
Phoenix, AZ	X		1986
Pima County, AZ		X	NA
Portland, OR	X	X	1977
Riverside, CA		X	1996
Sacramento, CA		X	1996
San Diego, CA	X		NA
San Jose, CA	X		1978
Sarasota, FL	X		1989
Seattle, WA	X	X	1971
Tallahassee, FL	X		NA
Vancouver, WA		X	1999
Walnut Creek, CA		X	NA
West Palm Beach, FL	X		NA

Table 1 Traffic Calming Programs Surveyed. Source: Ewing et al., 2005

OF TRAFFIC CALMING IMPACTS

There are two national reports on traffic calming, ITE's Traffic Calming State-of-the Practice and ASCE's U.S. Traffic Calming Manual. They define traffic calming the same way, as 'changes in street alignment, installation of barriers, and other physical measures to reduce traffic speeds and cut-through volumes, in the interest of street safety, liveability, and other public purposes' (Ewing, 1999; Ewing and Brown, 2009). Two things bare note in connection with this definition. First, nonphysical measures such as radar speed trailers and street lane restriping were excluded from the definition due to their limited proven effectiveness in reducing speeds. Second, the installation of barriers has been largely replaced by changes in vertical or horizontal alignment of streets (with humps and circles, for example) as a more effective way of achieving public purposes (specifically not diverting traffic to alternate routes). The emphasis in recent years has been on reducing 85th percentile speeds to the level, or near the level, of posted speeds, not in diverting traffic from one street to the next. New full closures, half closures, diagonal diverters, and other volume control measures have become a rarety since publication of SOP, while new speed humps, speed lumps, traffic circles, chokers, and other speed control measures have reportedly become a standard part of the toolbox in cities with traffic calming programs.

Physical traffic calming measures have that ability to reduce speeds between traffic calming devices like speed humps by an average of up to 7 or 8 mph (Ewing, 1999; Ewing and Brown, 2009). The accompanying table shows that vertical devices such as short speed humps (12 feet in the direction of travel), longer speed tables (flat-topped speed humps that 22 feet in the direction of travel), and speed lumps (like speed humps but with wheel cut outs for emergency vehicles} are more effective in reducing speeds than are horizontal devices like circles, and horizontal devices are more effective than narrowing devices like chokers. These measurements are taken at the midpoints between a series of speed control measures. The speed reductions at these measures themselves are much greater than these numbers imply. At a standard speed hump (12 feet in the direction of travel), speeds drop to 15 to 20 mph, depending on the height of the hump, while midpoint speeds are closer to 25 mph. At a standard speed table (22 feet in the direction of travel), speeds drop to 25 mph at the devices themselves while midpoint speeds are closer to 30 mph.

	Sample Size	Average Speed After Traffic Calming	Average Change in Speed with Traffic Calming	Average % Change in Speed with Traffic Calming
12' Humps	184	27.3 mph (4.0 mph)	−7.8 mph (3.7 mph)	−22 (9)
14' Humps	15	25.6 (2.1)	−7.7 (2.1)	−23 (6)
Lumps	49	27.0 (3.4)	−8.9 (5.3)	−24 (12)
22' Tables	78	29.2 (3.1)	−7.3 (3.4)	−20 (8)
Longer Tables	11	31.3 (2.9)	−3.6 (2.6)	−10 (7)
Raised Intersections	3	34.3 (6.0)	−0.3 (3.8)	−1 (10)
Minicircles	45	30.3 (4.4)	−3.9 (3.2)	−11 (10)
Narrowings	7	32.3 (2.8)	−2.6 (5.5)	−4 (22)
One-lane Slow Points	5	28.6 (3.1)	−4.8 (1.3)	−14 (4)
Half Closures	16	26.3 (5.2)	−6.0 (3.6)	−19 (11)
Diagonal Diverters	7	27.9 (5.2)	−1.4 (4.7)	−4 (17)

*Table 2. Speed Impacts of Traffic Calming Measures**

* Values in parantheses are standardd deviations from the average. Source: Ewing and Brown 2009

RESEARCH QUESTIONS

These facts raise two interesting questions that warrant further study. From the two national reports, we know only midpoint speed reductions. The ITE report, in particular, finds that speeds at considerable distances from speed control measures are considerably below speeds on the same streets before traffic calming. It is possible that speed control measures may have impacts on speeds far upstream and downstream of devices, not just at and near devices themselves, making repeated and closely spaced series of slow points unnecessary.

The second fact is that speed control measures with higher design speeds such as 22-foot speed tables vs. 12-foot humps may result in more constant (less highly fluctuating) speed profiles along the length of street segments. This is important because it is changes and differences in speed rather than speed itself that result in most crashes and the most troublesome noise impacts (of decelerating and accelerating vehicles). This study, funded by the Salt Lake City Transportation Division, seeks to explore these possibilities.

OTHER PUBLISHED STUDIES ASSESSING EFFECTIVENESS

The foremost goal of traffic calming is speed reduction. Evans (1994) saw a reduction of 25.6-28.9% between hump speeds in a survey conducted in Oxfordshire, England. Chadda and Cross (1985) measured a 22.4% between speed hump reduction in Brea, California, and Stephens (1986) reported a 26.8% decline in between hump speed in Corio, Australia, and 29.7% fall in various UK sites. In a study conducted in Denmark, N. Agerholm et al. (2017) observed a mean speed reduction from 53.5 km/h to 49.4 km/h before and after the installation of speed humps. Cottrell et al. (2006) studied some of the traffic calming measures [specifically speed humps and speed tables] in Salt Lake City. This study concluded that of the total sample, 78% of the locations experienced a reduction in speed after installation.

The other main impetus behind traffic calming is a reduction in crash rates caused by speeding. Vertical traffic calming measures (e.g., speed humps, speed tables, raised crosswalks) have been shown useful in this regard. Ewing (1999) studied multiple traffic calming devices in various US cities with respect to crash frequencies and found that for all types of traffic calming devices, crashes and speeds declined after traffic calming was installed. Traffic circles reduced crashes by 73% which is the highest among all traffic safety countermeasures. Ewing et al. (2013) studied safety countermeasures of speed humps, implemented in New York City and found that fatal and injury accidents decreased by 33% on treated streets versus streets without traffic calming measures. Elvik (2009) found a reduction of 41% in injury accidents on streets with speed humps. A study by Laura Jateikiene et al. (2016) in Lithuania observed a fall of 60% in fatal and injury accidents, 63% in the number of people injured and 82% in the number of people killed on-road sections with vertical traffic calming measures. Evans (1994) reported a decline in fatal and serious-injury crashes from 26% to 10% after traffic calming was installed. After a set of streets (54 sites) were treated with speed humps, it saw a decline of 14% in collisions. A 47% decline in collisions occurred after another 51 sites were treated by speed tables (Ewing, 2001).

BACKGROUND - STUDY AREA

The Salt Lake City 'Traffic Calming Program' was initiated in 1997, later named as the Salt Lake City Traffic Management Program (TMP). It had the overarching goals of improving quality of life, promoting active living, and ensuring that collector and arterial streets are used for their intended purpose so that traffic doesn't divert onto local streets. Particular objectives mentioned in the TMP were speed reduction on residential streets, diversion of non-local commuters to commuter streets, and safer streets for pedestrians and bikers.

Eligibility for traffic management was a function of traffic volume, 85th percentile speeds, pedestrian trip generators, sidewalk availability, and designation of the street as bicycle route and bus route. As of August 2003, 32 completed and 13 active traffic management projects were found throughout the city (Cottrell et al. 2006). There were officially 64 speed humps or tables, one traffic circle, one entry-way, and one curb extension.

The speed hump used by Salt Lake City is 14-ft long in the direction of travel and 3.5-inches at their highest point. The speed table is a variant of speed hump with the same height but longer at 22-ft with a flat section on top. Salt Lake City uses speed tables as raised crosswalks. According to the National Association of City Transportation Officials' (NACTO) Urban Street Design Guide, when a speed table coincides with a crossing or crosswalk, it should be designed as a raised crosswalk. A raised crosswalk is a ramped speed table spanning the entire width of the roadway and often placed at midblock crossings and demarcated with paint and/or special paving materials (Federal Highway Administration).

Around 2003, the traffic calming program was discontinued due to various social and political issues mainly related to emergency vehicle response times. Another major reason was dissatisfied residents who viewed traffic calming devices as more of a nuisance than a solution to speeding problems. Since then, the former director of the Salt Lake City Transportation Division told the Transportation Advisory Board that she received more complaints about speeding traffic than anything else. Yet, she had few tools to respond to these complaints. So, the problem hasn't gone away just because the traffic calming program has gone away.

TRAFFIC CALMING INVENTORY

To visually represent the spatial distribution of various traffic calming device type throughout the city for different neighborhoods/ council districts and schools, we prepared a couple of maps. The Salt Lake City Transportation Division provided the initial list of in-place devices. We expanded the list. Figure 1 represents all the traffic calming devices present to date, and the accompanying table provides a complete tally of both those in the city's list and those we found with Google Street View and field inspection.

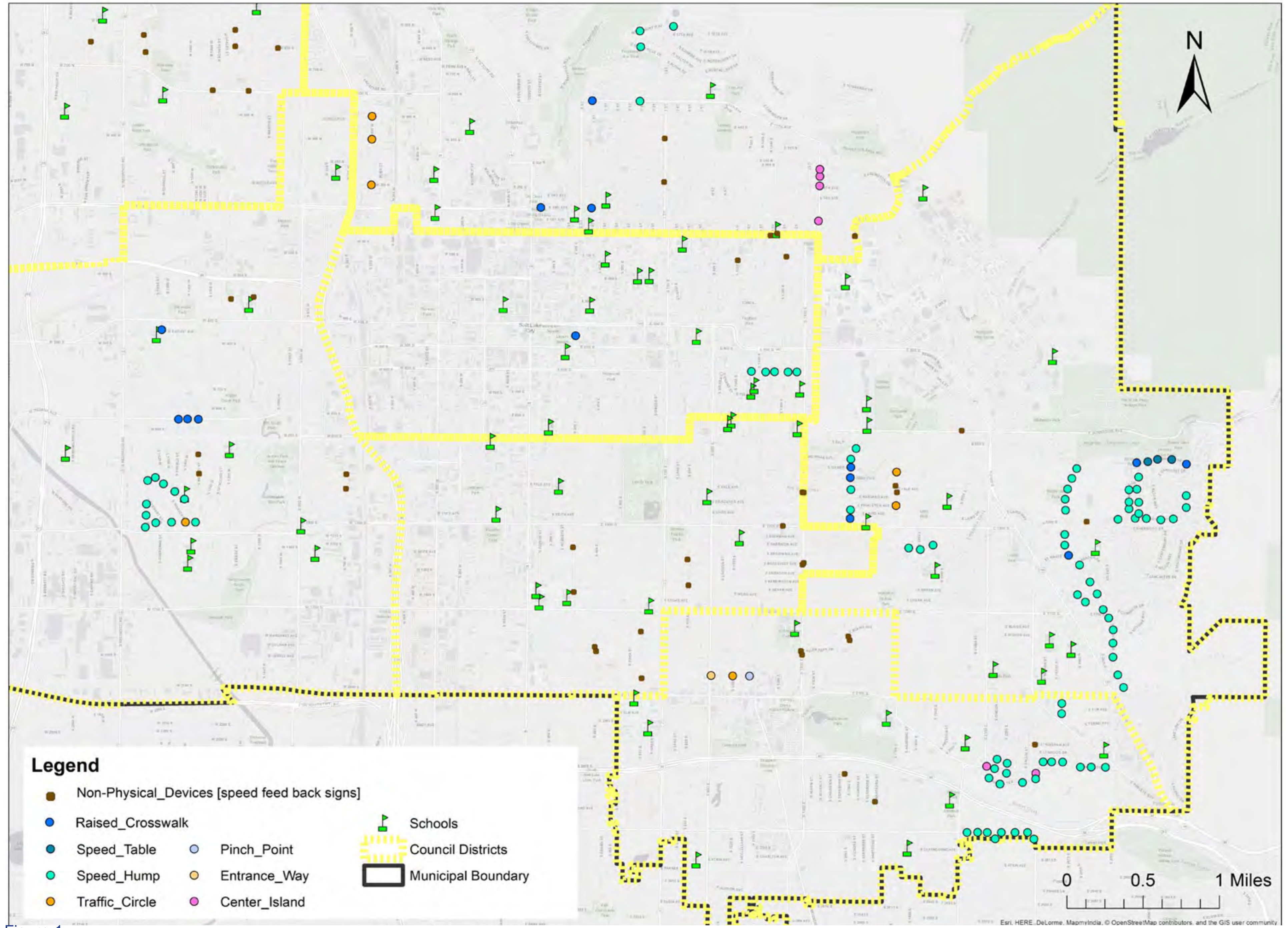


Figure 1
Map Showing all Traffic Calming device types, Salt Lake City, UtahTable 1 List of existing and new traffic calming devices

Existing list	New devices
Speed feedback signs [44]	Speed feedback signs [1]
Speed Hump [81]	Speed Hump [3]
Speed Table [2]	Speed Table [1]
Raised Crosswalk [8]	Raised Crosswalk [3]
Traffic Circle [3]	Traffic Circle [4]
Pinch-point [1]	Center Island [6]
Entranceway [1]	
Total: 140	**Total [18]**

Table 3. List of existing and new traffic calming devices in Salt Lake City

Figure 2 highlights the specific devices that are included in this study and their corresponding control streets or streets with no traffic calming devices but similar traffic volume and surrounding land uses.

Of a total of 140 existing devices, 44 are non-physical (i.e., speed feedback signs) and the rest are speed humps followed by raised crosswalks. Other devices, like speed tables and traffic circles, are very few in number. Figure 4 illustrates the streets where before construction speeds were measured. Most of the traffic calming devices were constructed during 2002-03, and the before speed were measured between the year 1999 and 2001.

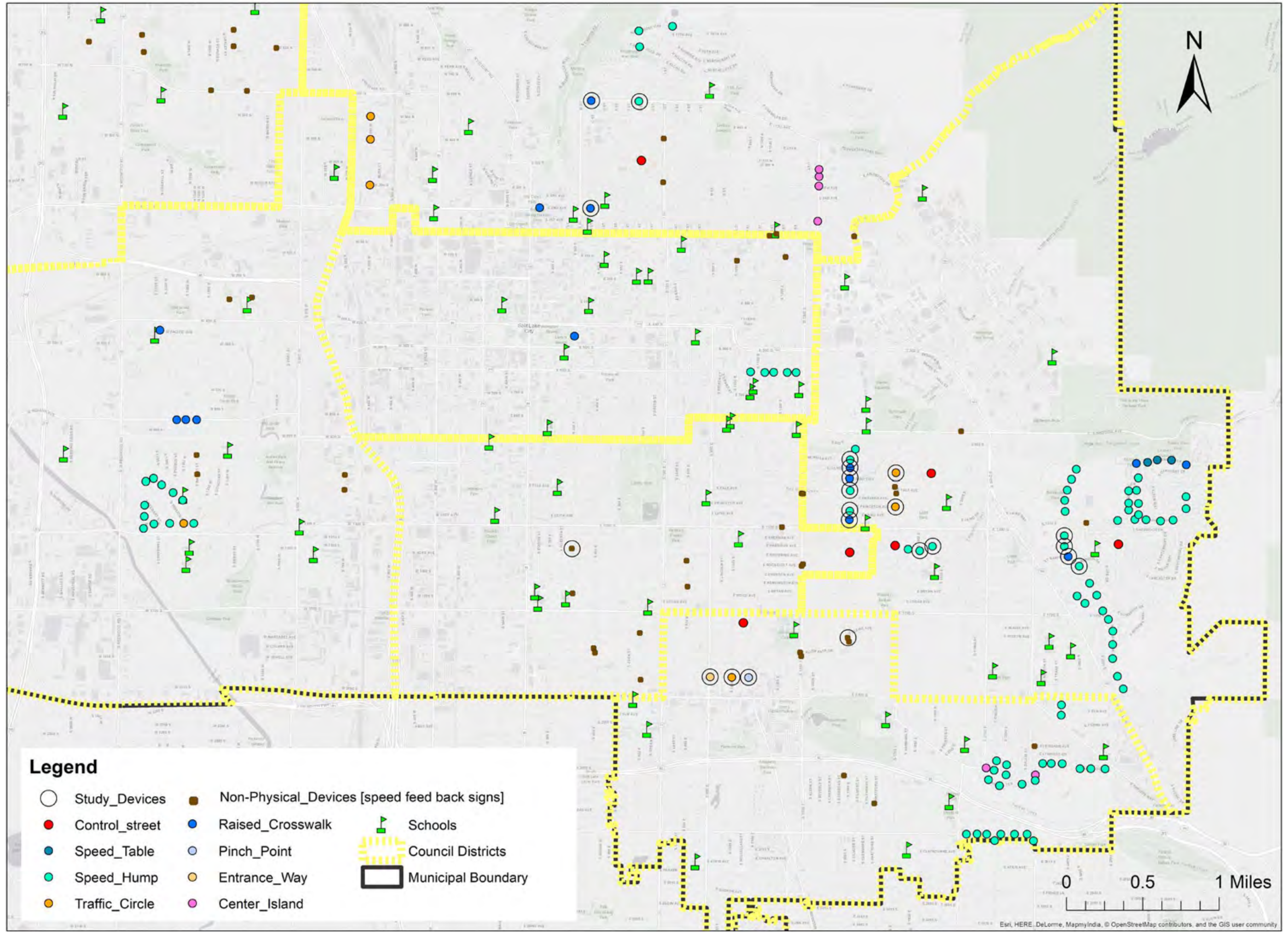


Figure 2 Map Showing Study and Control sites

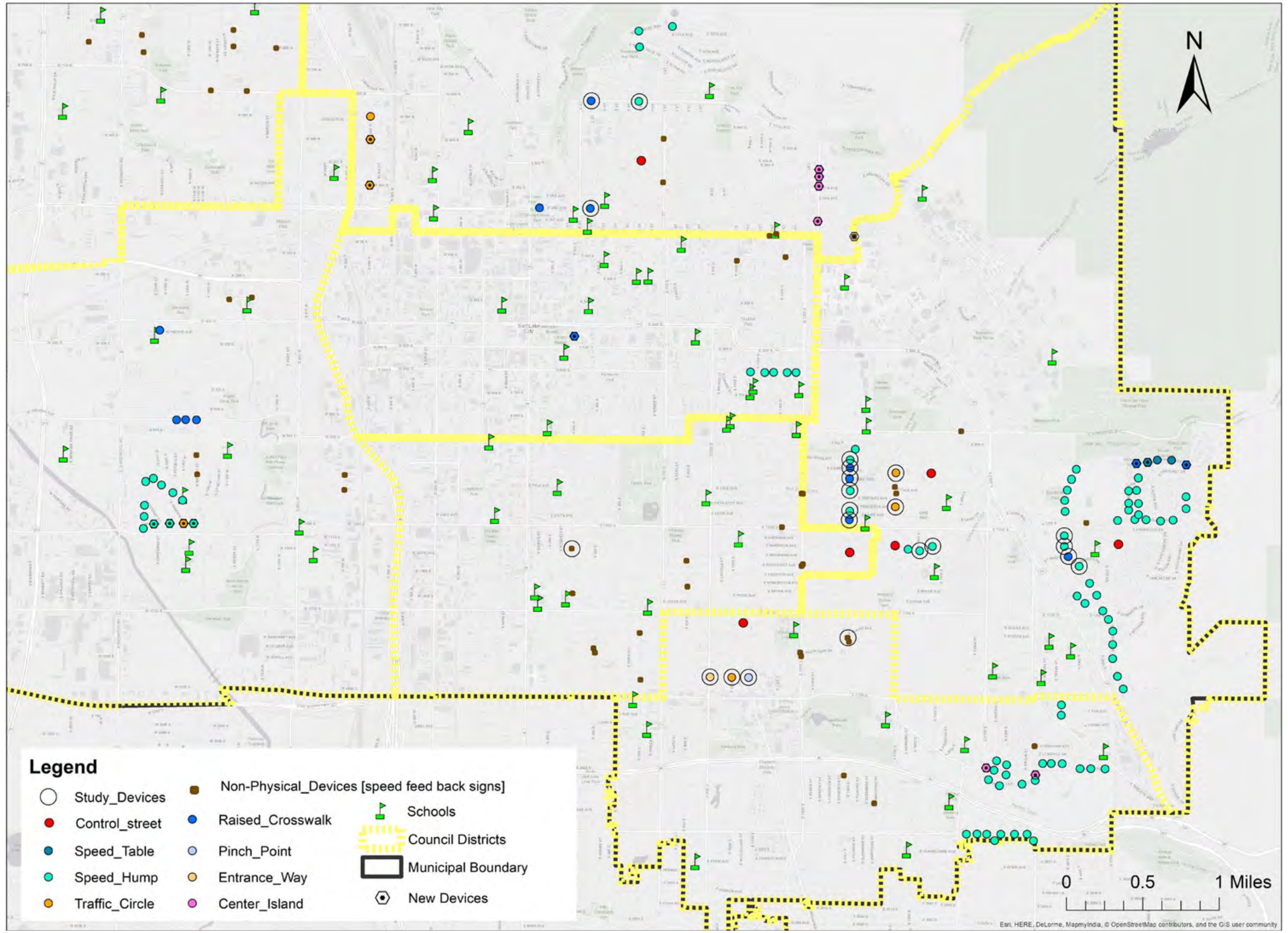


Figure 3 Map Showing new traffic calming devices, Salt Lake City

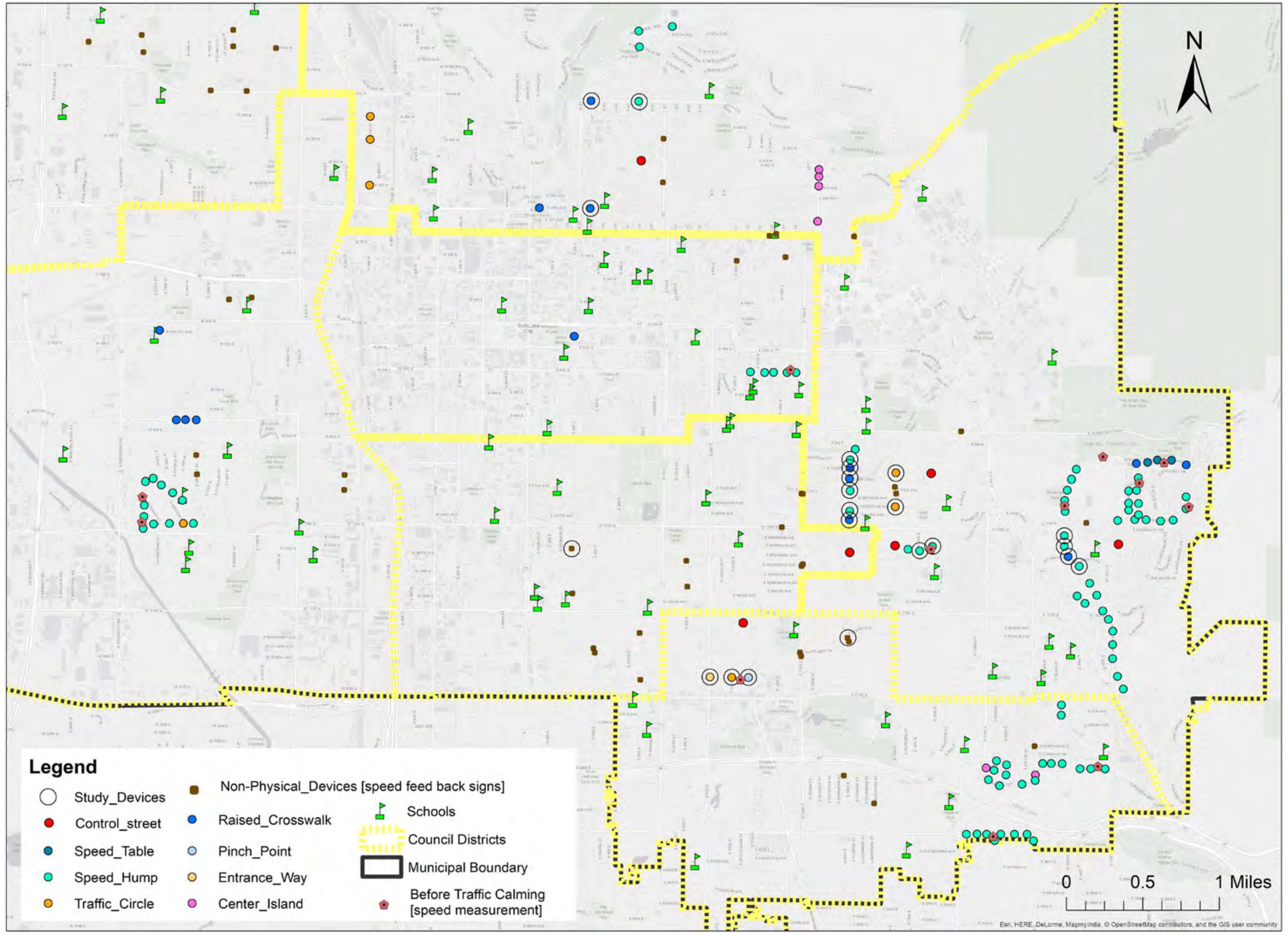


Figure 4 Map showing the location of before speed measurement

METHODS

We first created a complete inventory of traffic calming measures, for both physical and non-physical devices within Salt Lake City. This was done by using Google Street View to survey the entire city. The city had already supplied a partial list of measures and locations. However, we found that this list was incomplete. For example, the two raised crosswalks on 2nd Avenue were not included in the inventory, nor were the traffic circles on 600 West.

After identifying the complete list of traffic calming devices in Salt Lake City, we selected a sample of traffic calming devices for speed studies based on (1) the widest possible variety of measures (traffic circles, raised crosswalks, center island narrowing, etc.), and (2) the presence of valid control streets to which we could compare the treated streets.

Our primary research approach was a post-installation only design with a comparison group since we did not have pre-installation speed data for most traffic-calmed streets. Ewing et al. (2013) explained the necessity of considering control streets when studying treated streets to eliminate bias. For this study, we identified comparison streets based on similar traffic volumes, the same number of lanes and direction, surrounding land uses, and similar slope and topography. To ensure that the main difference between study and control streets is the presence of traffic calming devices, we tried to select the control sites on the same streets, but a few blocks away. Also, we made sure that there was no stop sign, traffic signal, or other traffic control device 300-400 feet before or after the data collection point for the control street.

The Salt Lake City Transportation Division provided with eight pneumatic tube counters (TimeMark Delta III) to measure speeds at existing devices. We first proposed to collect vehicle speed at three locations per traffic calming devices: 100 feet before, at, and 100 feet after, by using one tube per counter. After doing a pilot study and further research, we revised our method as followed. In order to record speed more accurately, we decided to install two tubes per counter 10 feet apart. Moreover, to render a more accurate and smooth speed profile, we increased the number of counters for each traffic calming device from three to seven. For each device, we installed three counters recording “upstream” speeds 50 feet apart, one counter “at” the device, and three counters “downstream” of the devices 50 feet apart. Also, for consecutive devices, we installed one counter spaced equally between two devices to record the “midpoint” speed.

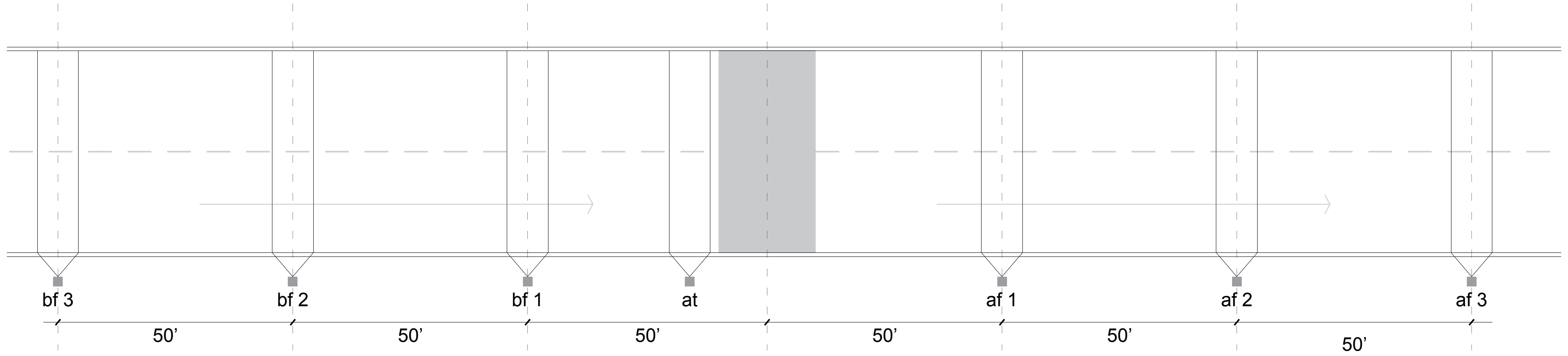


Figure 5 Example of counter spacing. bf= before, af=after

Depending on the location of the traffic calming devices, in some cases, we had to install counters up to 20 feet before or after designated location. For instance, if there was a driveway or an intersection with another street, we had to find a proper location concerning vehicle movement. To install counters, we first marked streets using a measuring wheel to indicate the exact location of each tube on each side of the street. After installing counters, recording data (i.e., date, time, location, type of device, latitude, longitude, spacing between tubes, and device dimension) we waited for minimum of 50 cars to pass in each direction.

Figure 5 Wasatch Dr. Counter locations for consecutive devices

DATA COLLECTION

Data collection took place from August to October 2018 in 8 different locations. However, after extracting data from the counters, we noticed the error at some of the locations. We had to wait during the winter and early spring to redo data collection under the same weather conditions. The second round of data collection for locations with errors occurred from April to June 2019.

	Locations	Data*
Speed Hump	8	16
Raised Crosswalk	7	11
Traffic Circle	3	6
Entry Way	1	2
Pinch point	1	2
Speed Feedback Sign	1	2
Total	**22**	**39**

Table 4. Types of traffic calming devices studied for this study

* For most of the locations, streets were two-way, and we recorded data for both locations. It means that although we recorded data of one location, we have data for two traffic calming devices.

Data were only collected on weekdays to eliminate the possible difference between weekend and weekday traffic patterns. We avoided collecting data under rainy condition to ensure that the speed was not affected by the weather. Data collected at each detector included vehicle frequency, speed, GPS locations, start/end time, the distance between the tubes, and an indication to whether or not stop signs or other traffic control devices were present. We collected data for a total of 22 traffic calming devices. For most of the two-way streets, data were collected in both directions. This gave us data for 39 traffic calming devices.

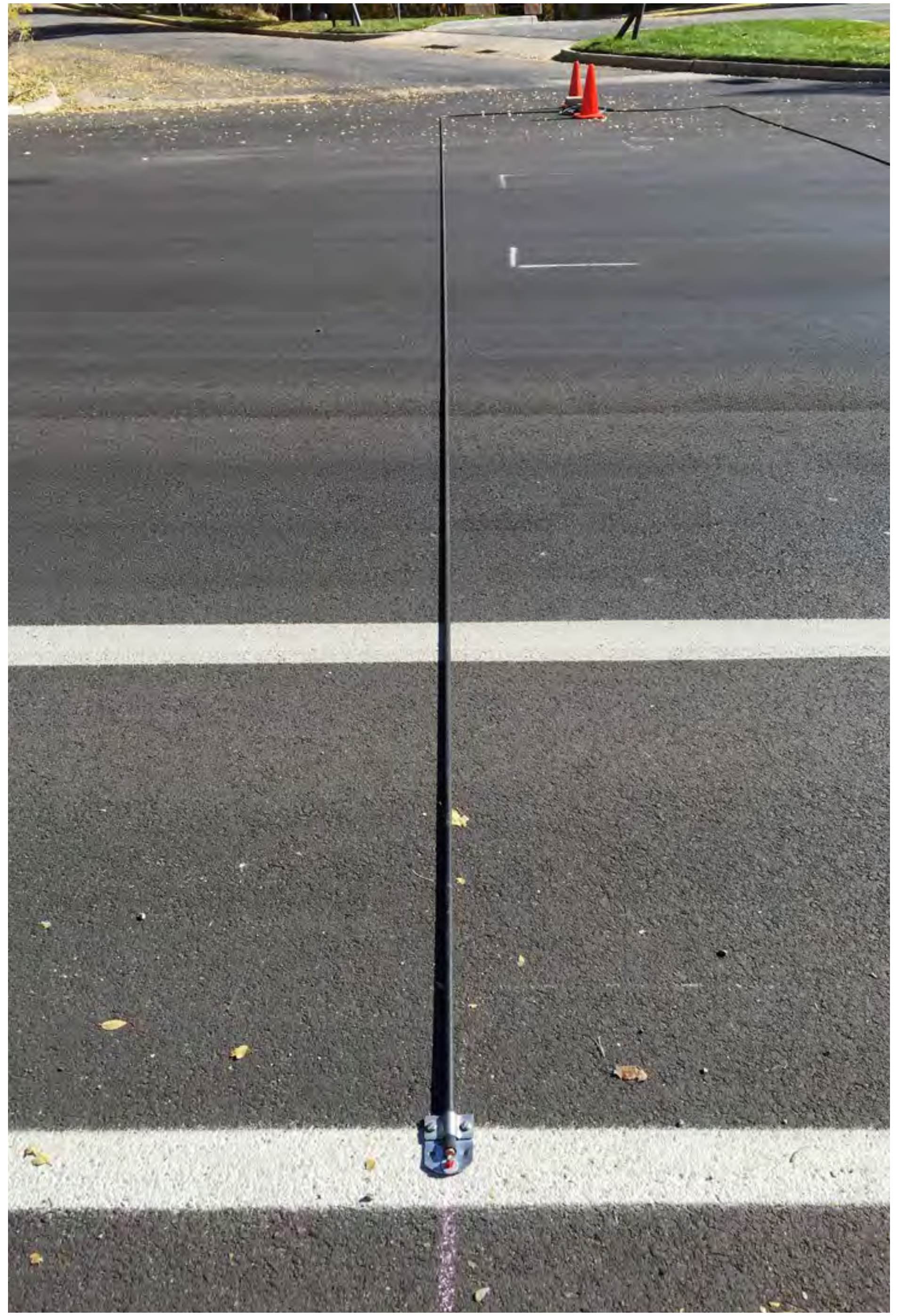


Figure 6-10 Counter installation process

Street		Type	Direction*	Counters	Midpoint
S Hollywood Ave	1	Entry Way	2	7	2
		Traffic Circle	2	7	
		Pinch point	2	7	
1700 E	1	Traffic Circle	2	7	1
		Traffic Circle	2	7	
1500 E	1	Speed Hump	2	7	5
		Raised Crosswalk	2	7	
		Raised Crosswalk	2	7	
		Speed Hump	2	7	
		Speed Hump	2	7	
		Raised Crosswalk	2	7	
		Speed Feedback Sign	1	7	
Wasatch Dr.	1	Speed Hump	2	7	3
		Speed Hump	2	7	
		Raised Crosswalk	2	7	
		Speed Hump	2	7	
Harrison Ave	1	Speed Hump	2	7	1
		Speed Hump	2	7	
2nd Ave	1	Raised Crosswalk	1	7	0
11th Ave		Raised	1	7	

* Direction equals to 2 means the street was two-way and we collected data for both directions

Table 5. Number of counters installed at each location

To accomplish collecting data for 22 locations (or 39 traffic calming devices differentiating between two directions of a device on the two-way streets), we installed a total of 170 speed counters, 370 pneumatic tubes. These numbers do not include repeated data collection for points with errors in the first round. This was a very arduous and labor intensive project.

For data collection, the most challenging traffic calming devices were traffic circles. For “upstream” and “downstream” counters, we had to install counters farther than 50 feet to ensure the cars’ two front wheels hit the first tube at the same time. Besides, for the “at” point in traffic circles, our assumption was that diagonal placement of tubes 10 feet apart would be a reasonable option. After extracting data, we realized that the speed was unreasonably high. We then installed counters with one tube. Finally, we found the best approach. We installed two parallel tubes, two feet apart, and the result became consistent with upstream and downstream speeds.

Figure 11 Examples of installing counters at intersections (300 E)

Figure 12 Issue with front wheel at “before1” tube at Traffic Circle.

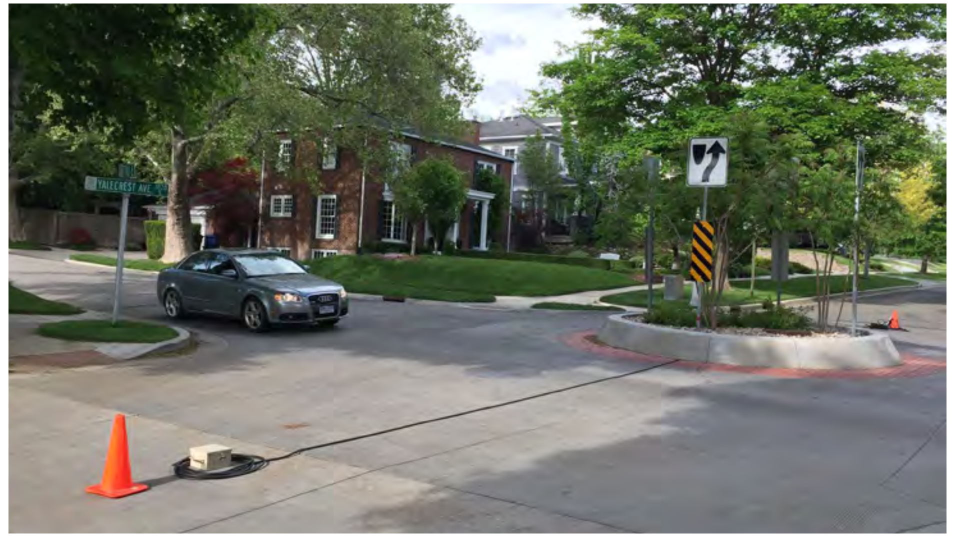


Figure 13-16 Different tube layout at Traffic Circles: Parallel 10 ft apart, Diagonal 10 ft apart, Single tube, Parallel 2 ft apart

Figure 17 Best tube layout at Traffic Circles: Parallel 2 ft apart (1500 E)

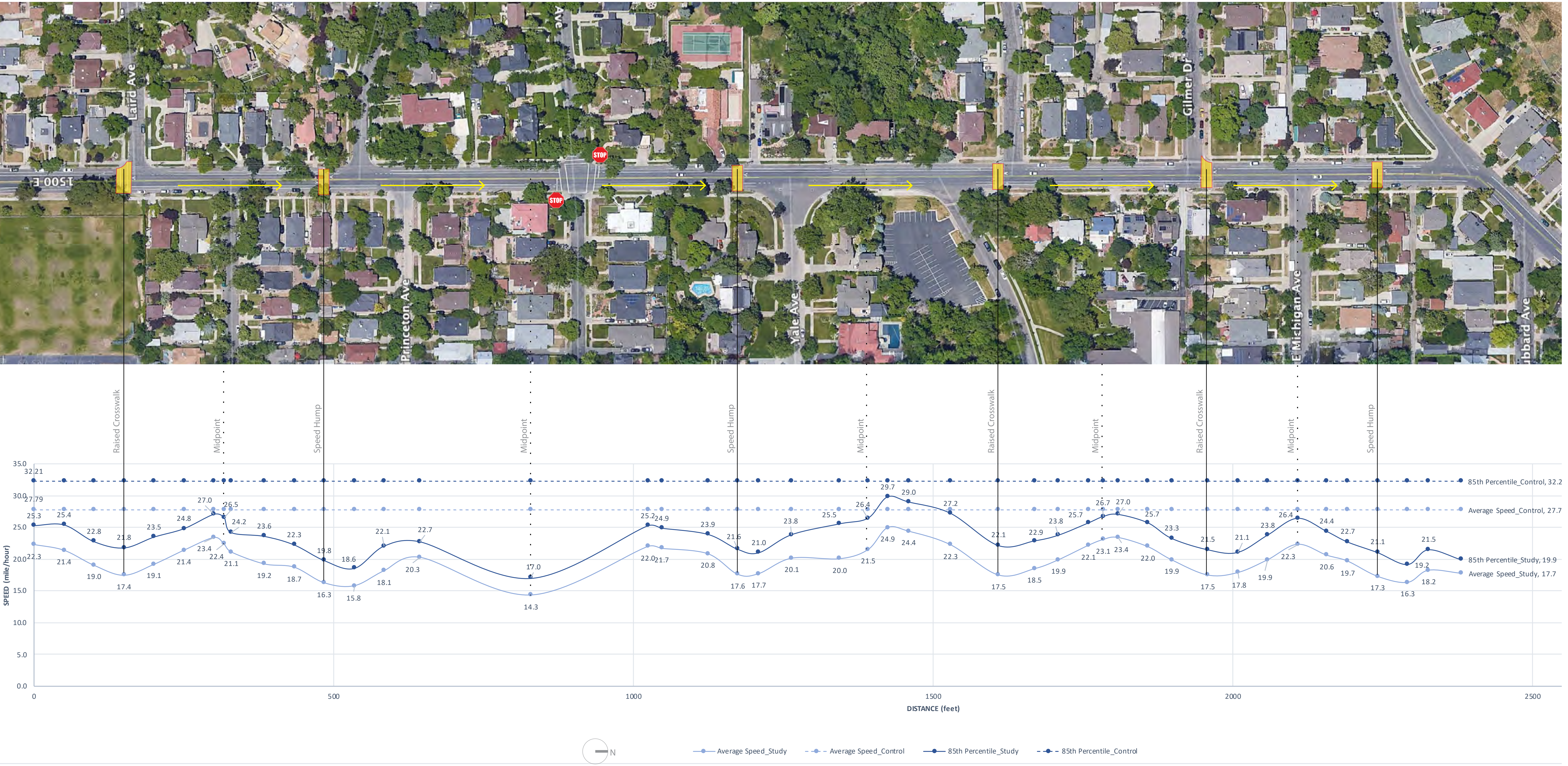
RESULTS

SPEED PROFILE

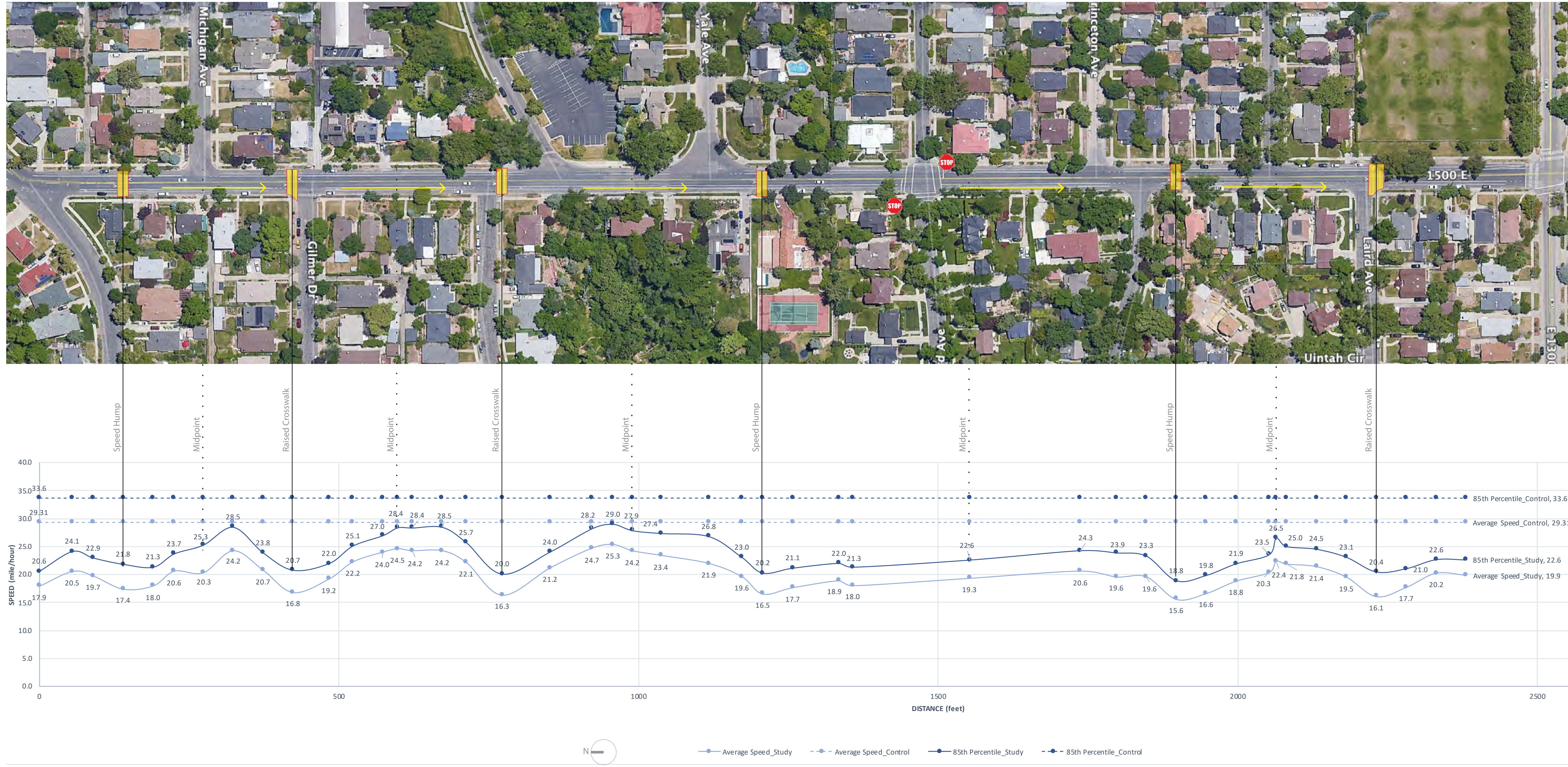
After data collection, speed data was extracted from each counter showing vehicles' speed and time per vehicle. In most of the cases, final speed profiles are as expected based on the context. One of the unexpected results was at a raised crosswalk, located immediately after a stop-sign before an intersection. In this case, the lowest speed is not "at" the device, but "upstream" of the device (50 feet before the device). This was due to the fact that cars decelerate at the stop-sign close to "upstream" location and accelerate after the stop-sign as they pass the raised crosswalk.

Figure 18 Wasatch Dr. Raised Crosswalk and stop signs

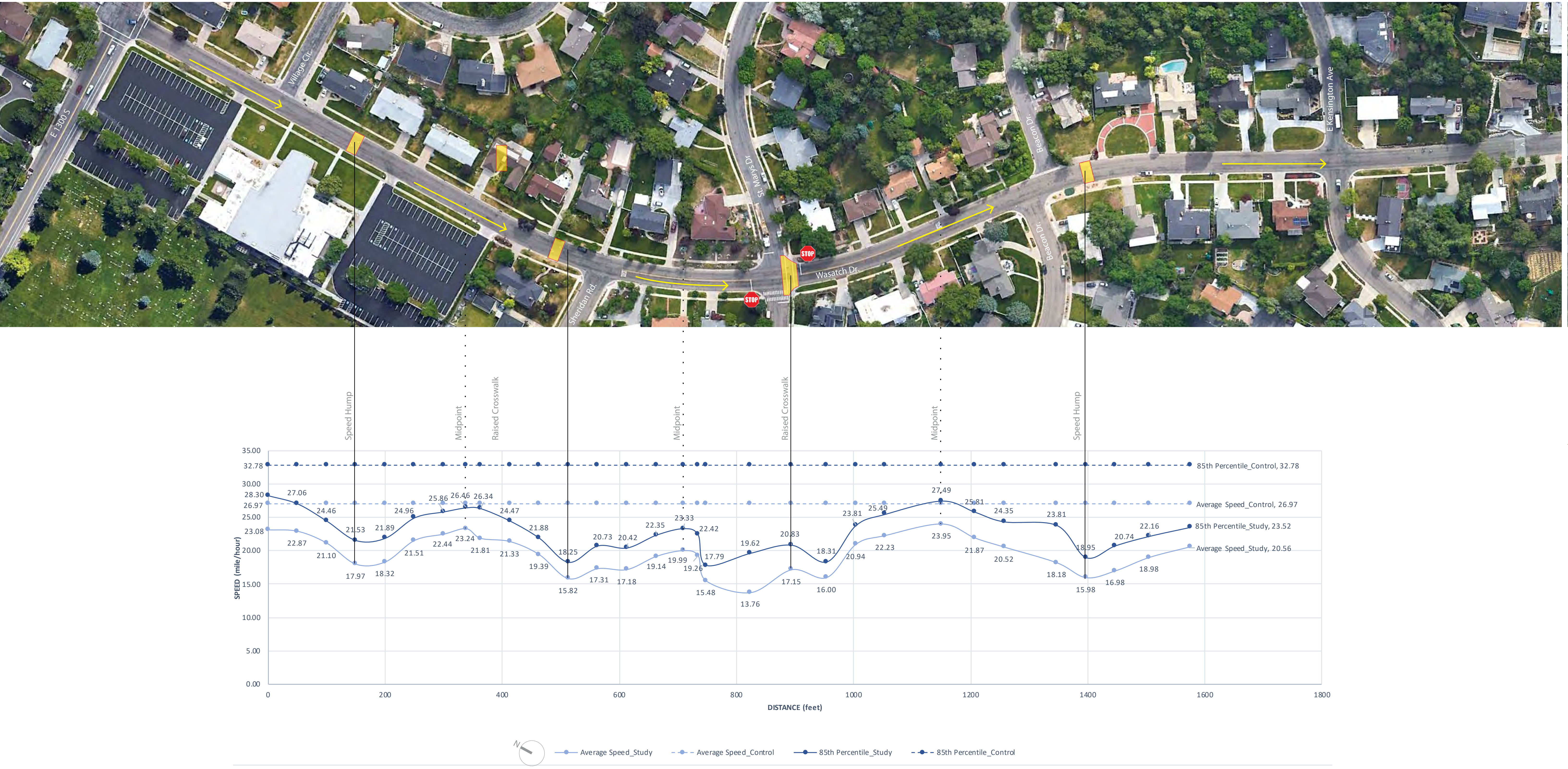
Figure 5 Illustrates the speed profile for 1500 East where there are six consecutive devices. We realized the lowest speed in both directions is close to the midpoint between the second and third devices in the northbound direction. This was a surprise. We expected the highest speed to be exactly at the midpoint between the devices. The reason is because there is a stop sign at the intersection of 1500 E and Harvard Avenue. This is the same for other locations such as the intersection of South Hollywood Avenue eastbound and 1000 East.



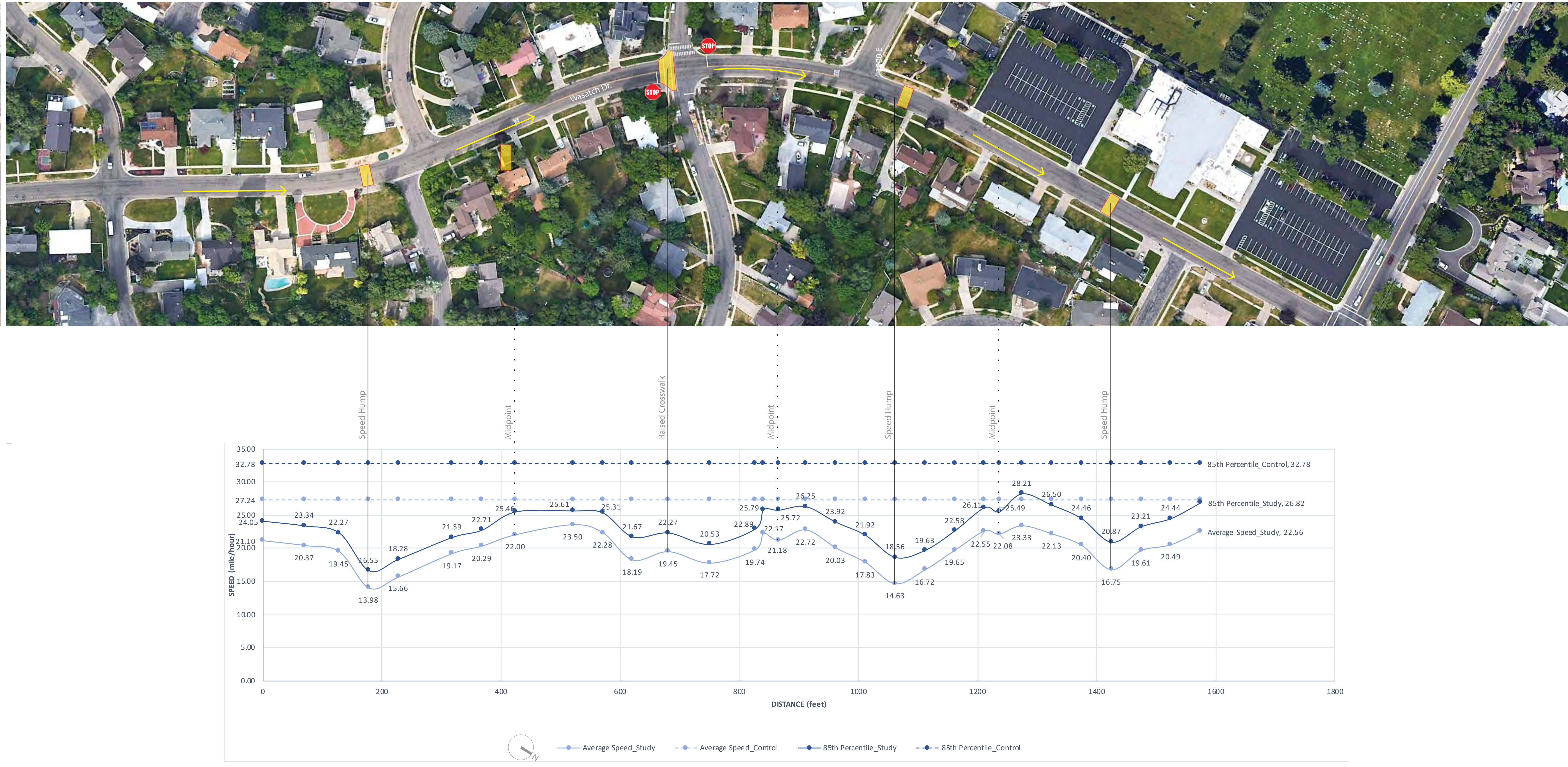
1500 East _ North Bound Speed Profile
Consecutive Traffic Calming Devices



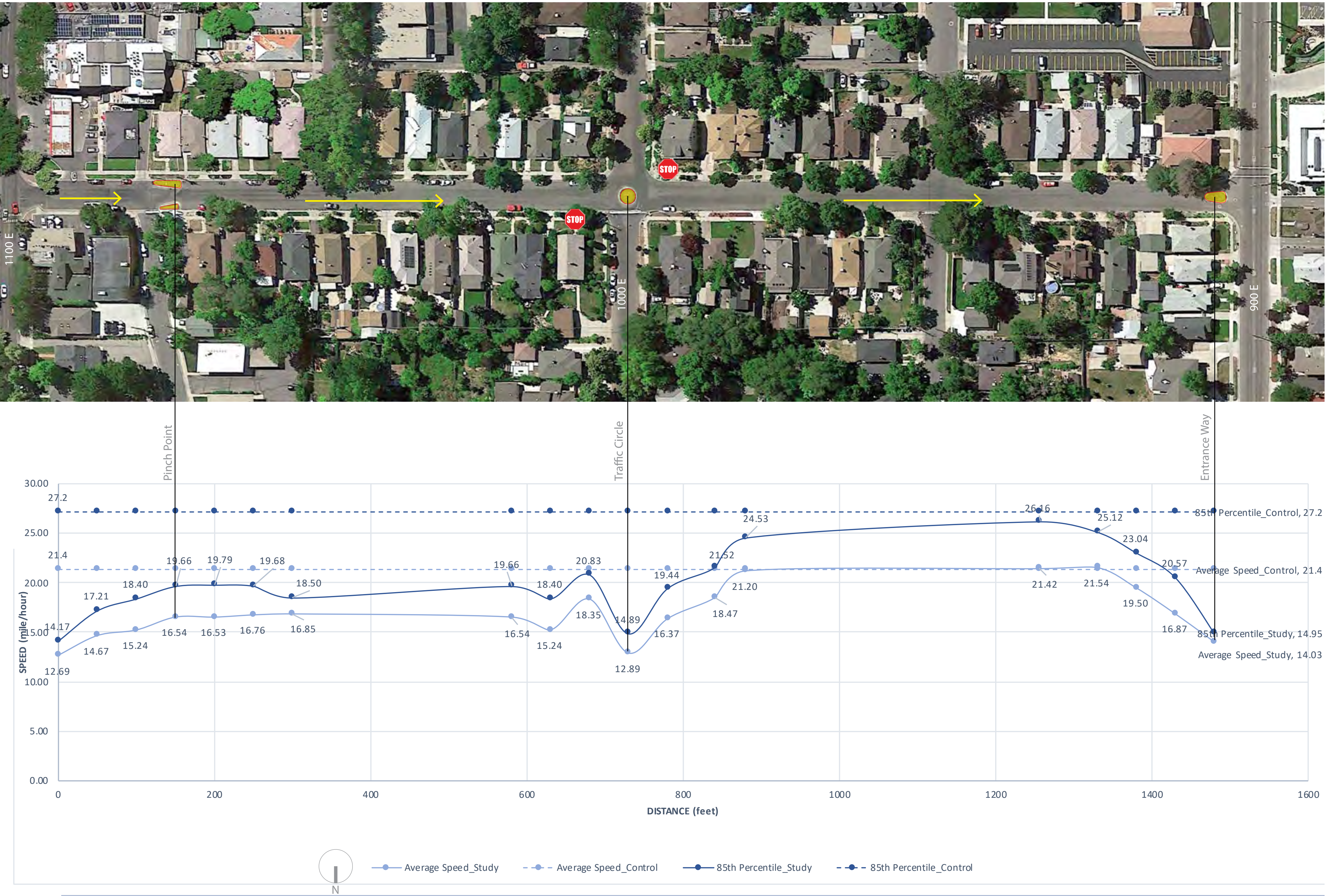
1500 East _ South Bound Speed Profile
Consecutive Traffic Calming Devices



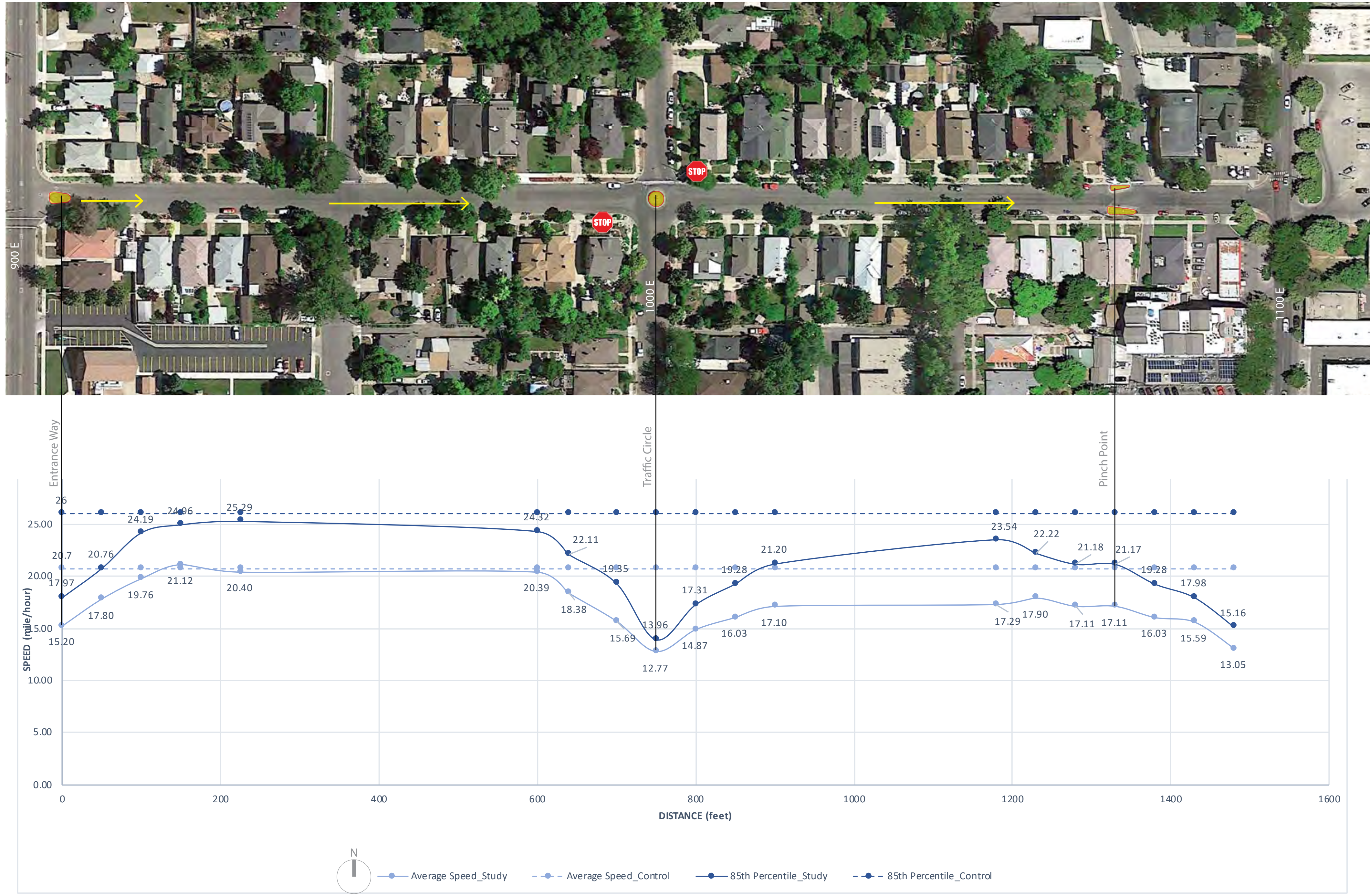
Wasatch Dr. _ South Bound Speed Profile
Consecutive Traffic Calming Devices



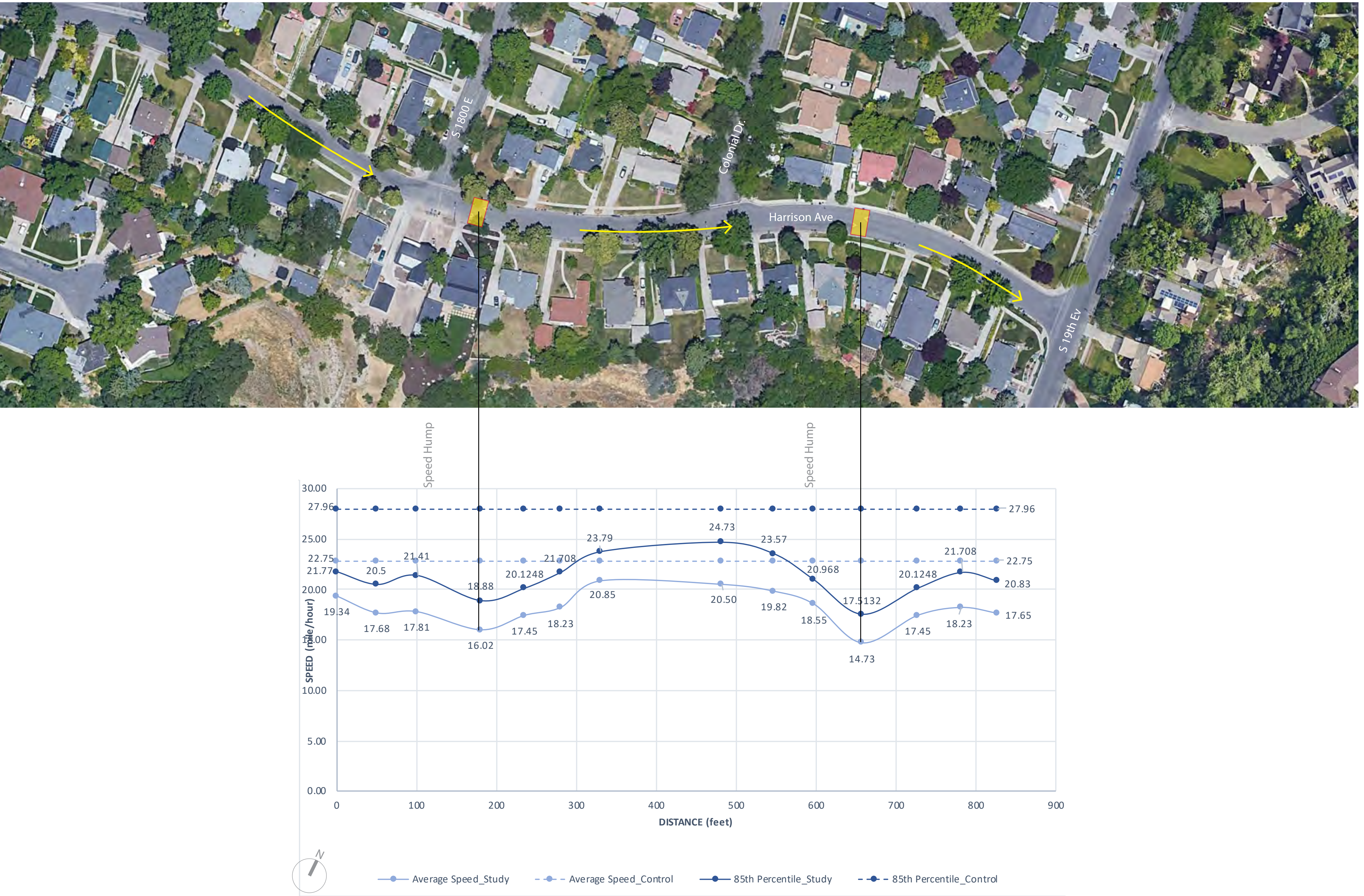
Wasatch Dr. _ North Bound Speed Profile
Consecutive Traffic Calming Devices



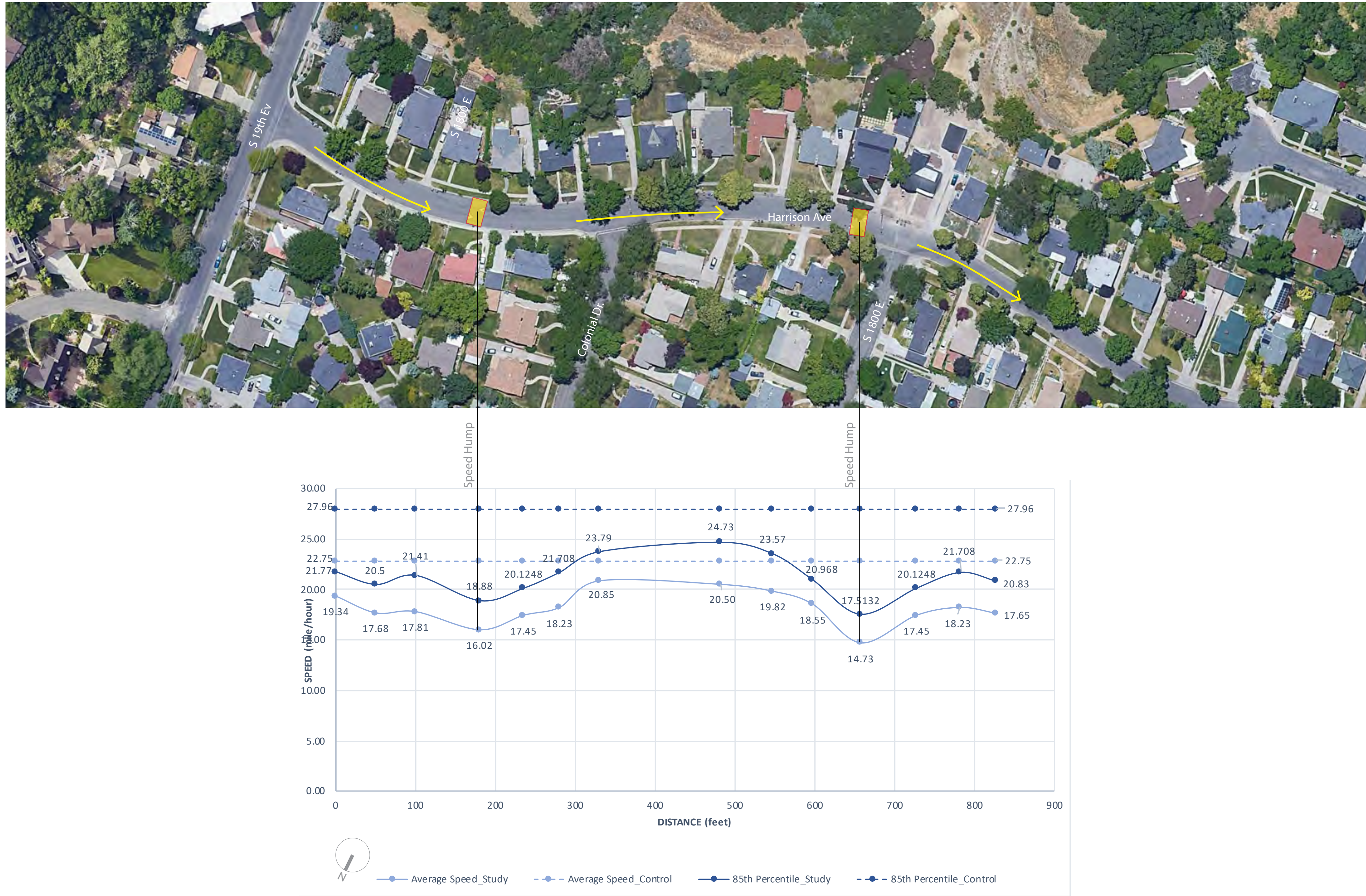
South Hollywood Ave _ West Bound Speed Profile
Consecutive Traffic Calming Devices



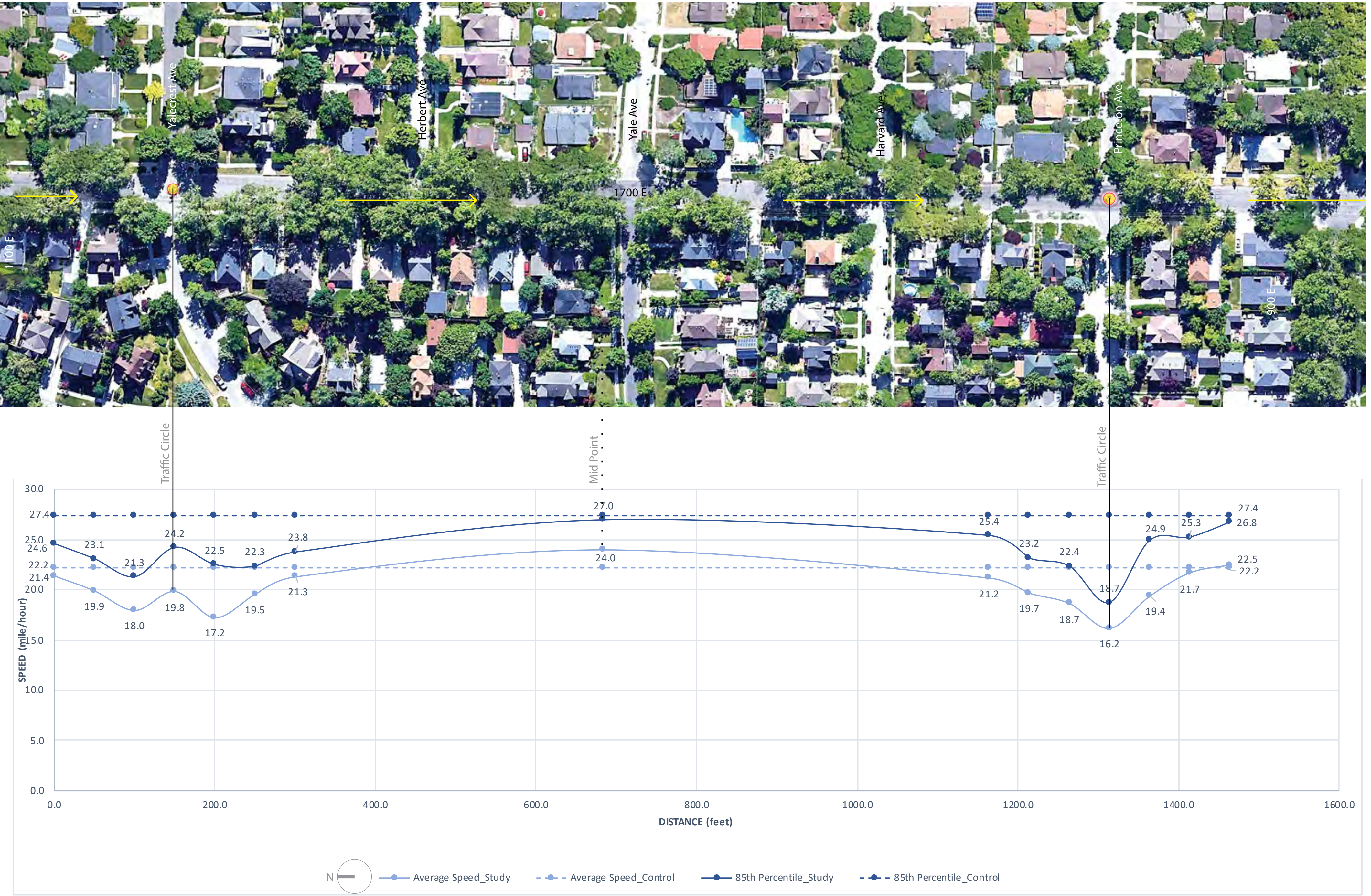
South Hollywood Ave _ East Bound Speed Profile
Consecutive Traffic Calming Devices



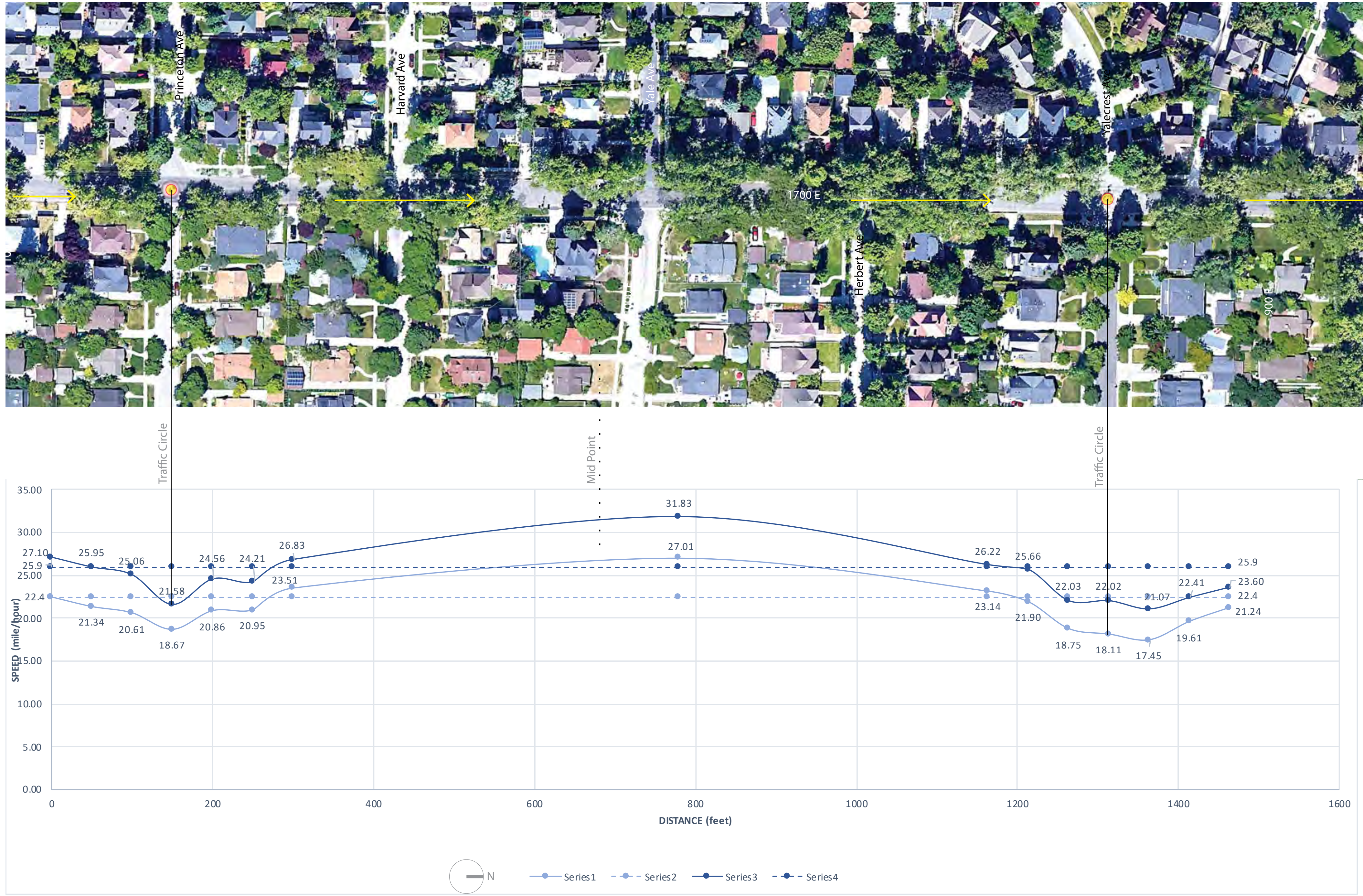
Harrison Ave _ East Bound Speed Profile
Consecutive Traffic Calming Devices



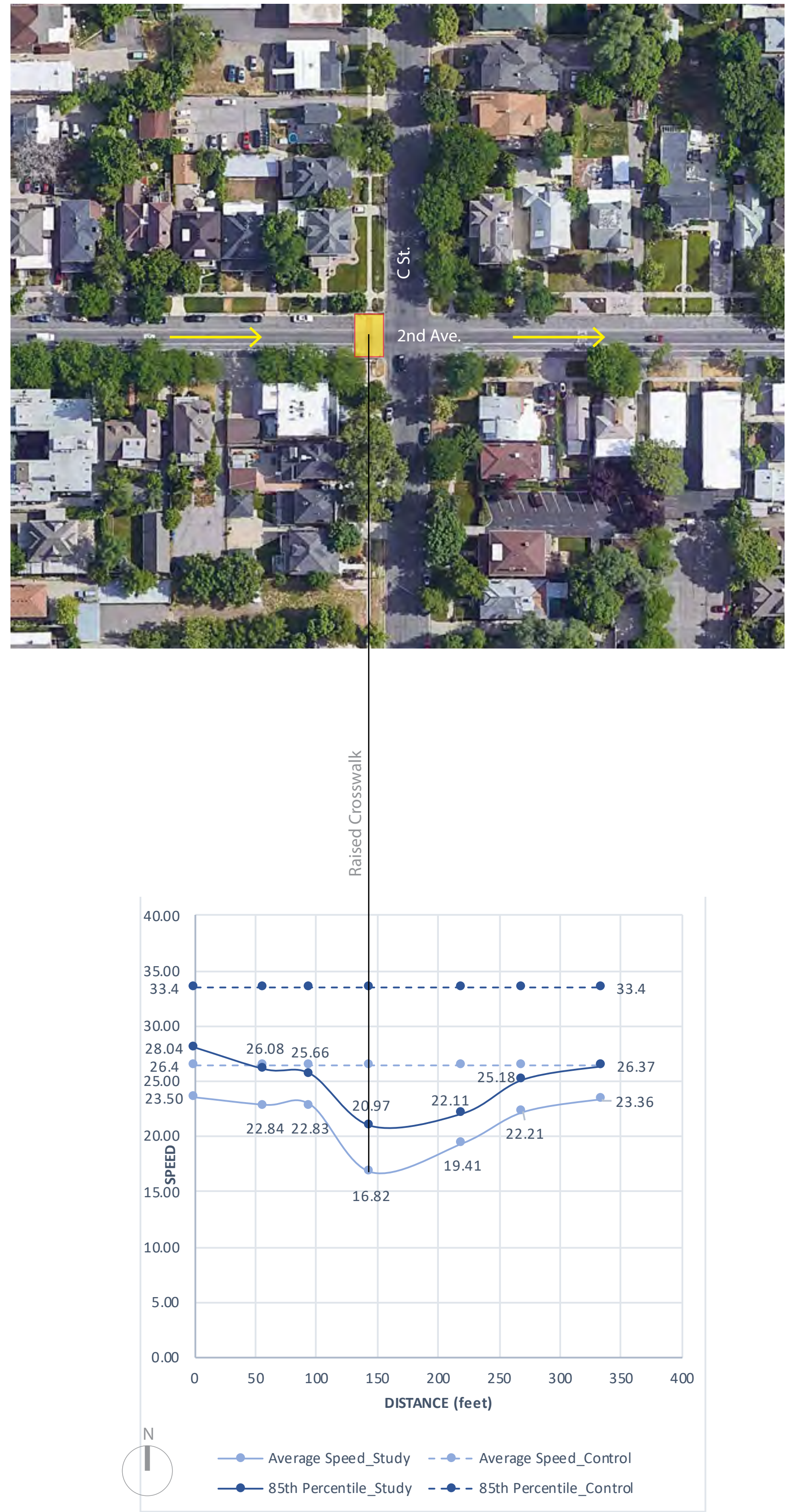
Harrison Ave _ West Bound Speed Profile
Consecutive Traffic Calming Devices



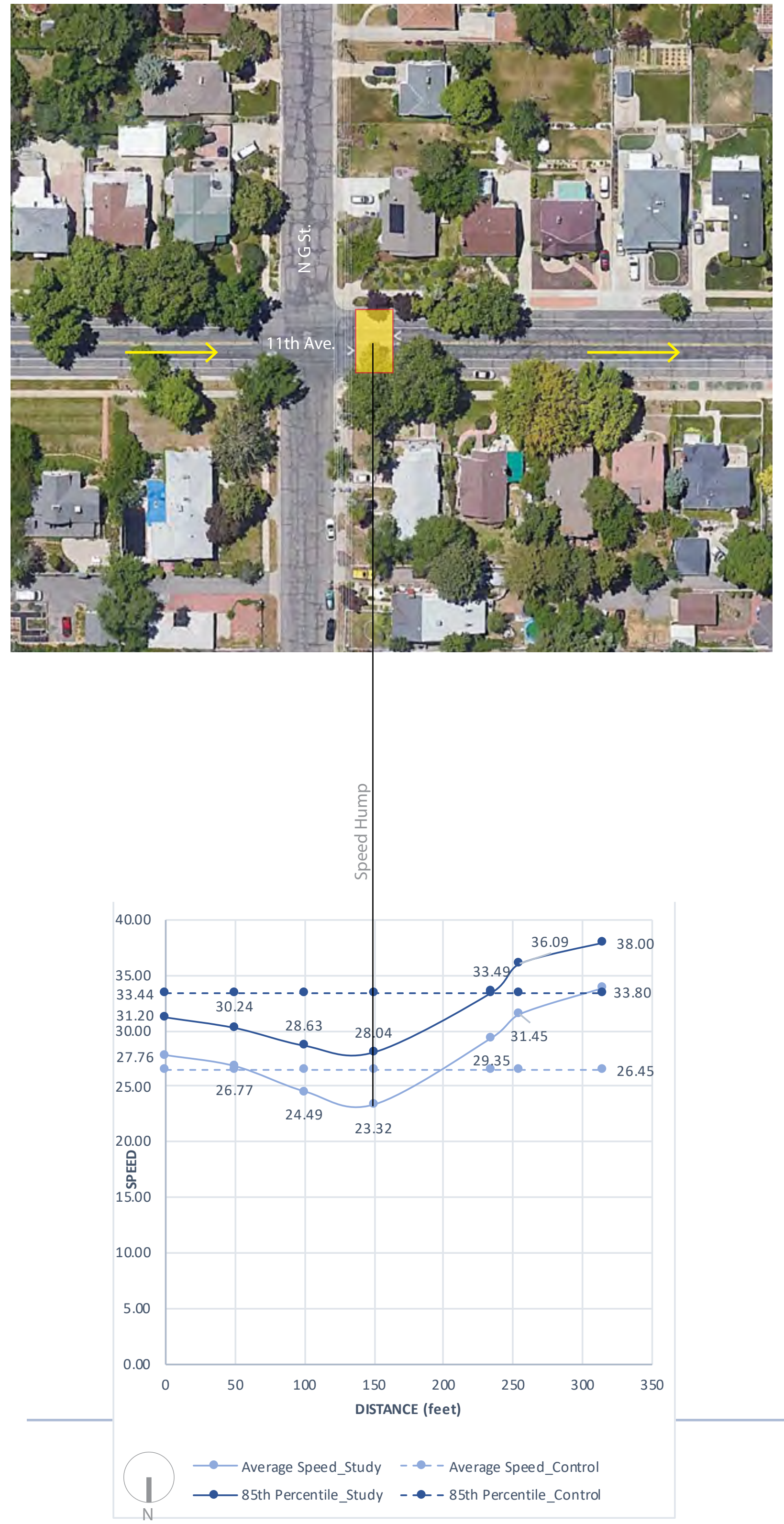
1700 E _ South Bound Speed Profile
Consecutive Traffic Calming Devices



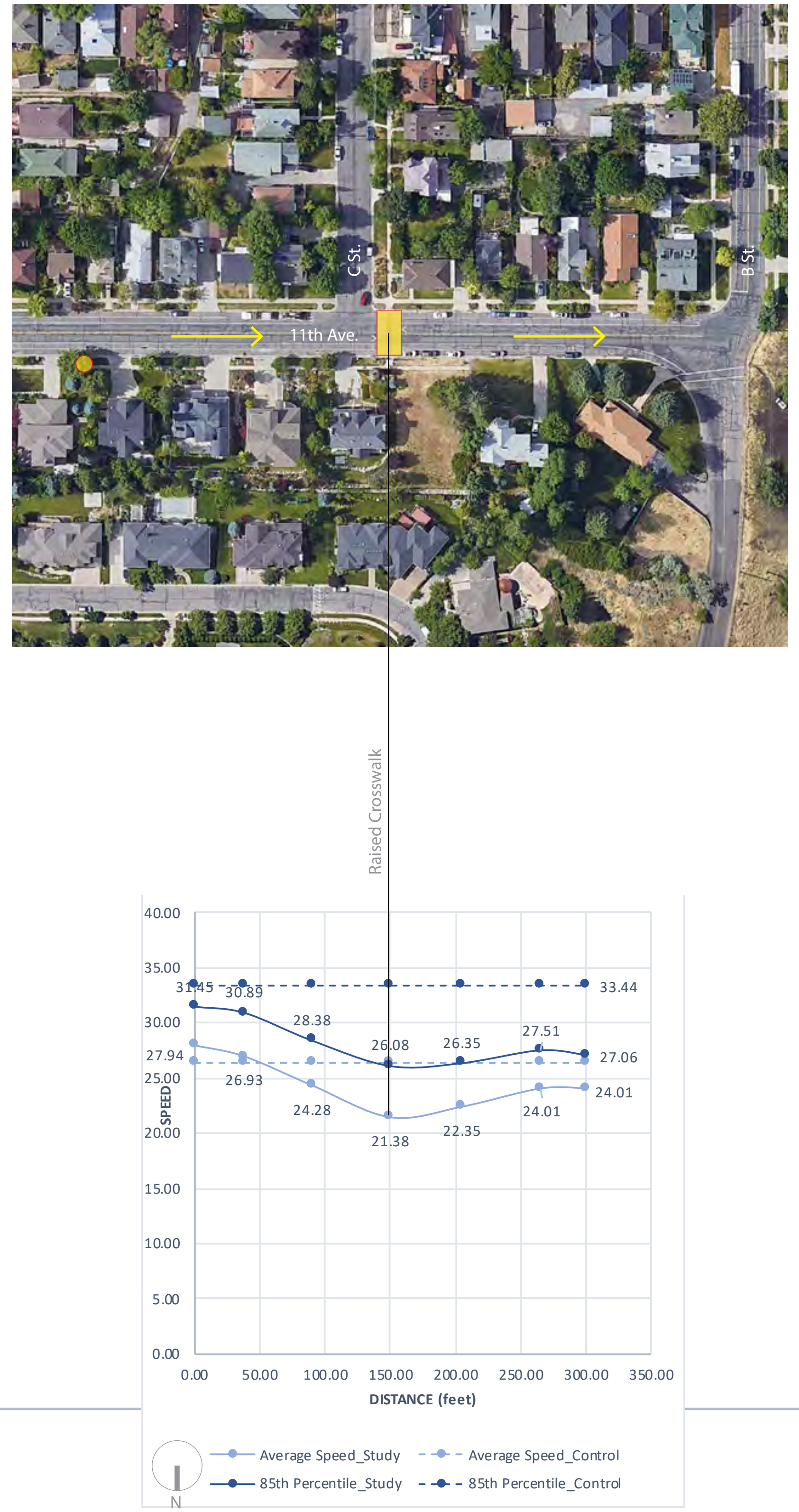
1700 E _ North Bound Speed Profile
Consecutive Traffic Calming Devices



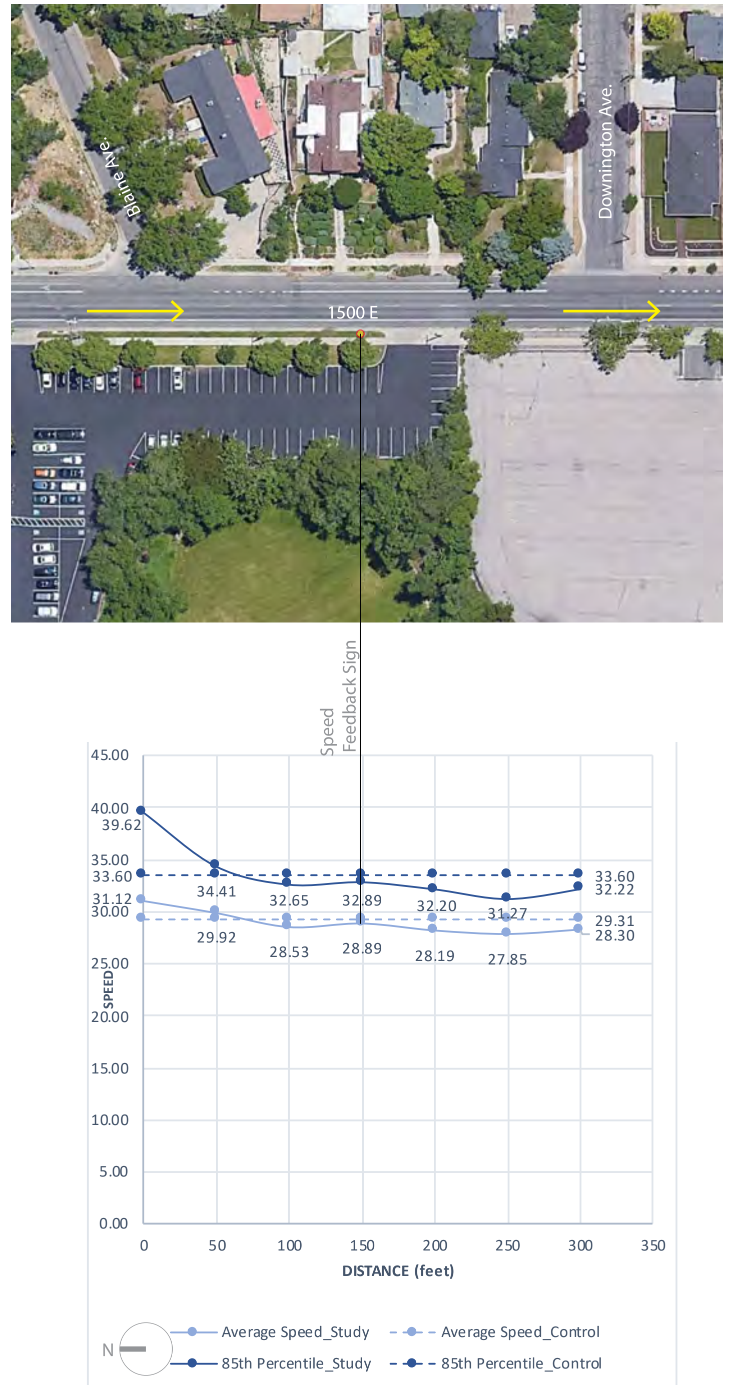
2nd Ave. C St. Speed Profile
Traffic Calming Device



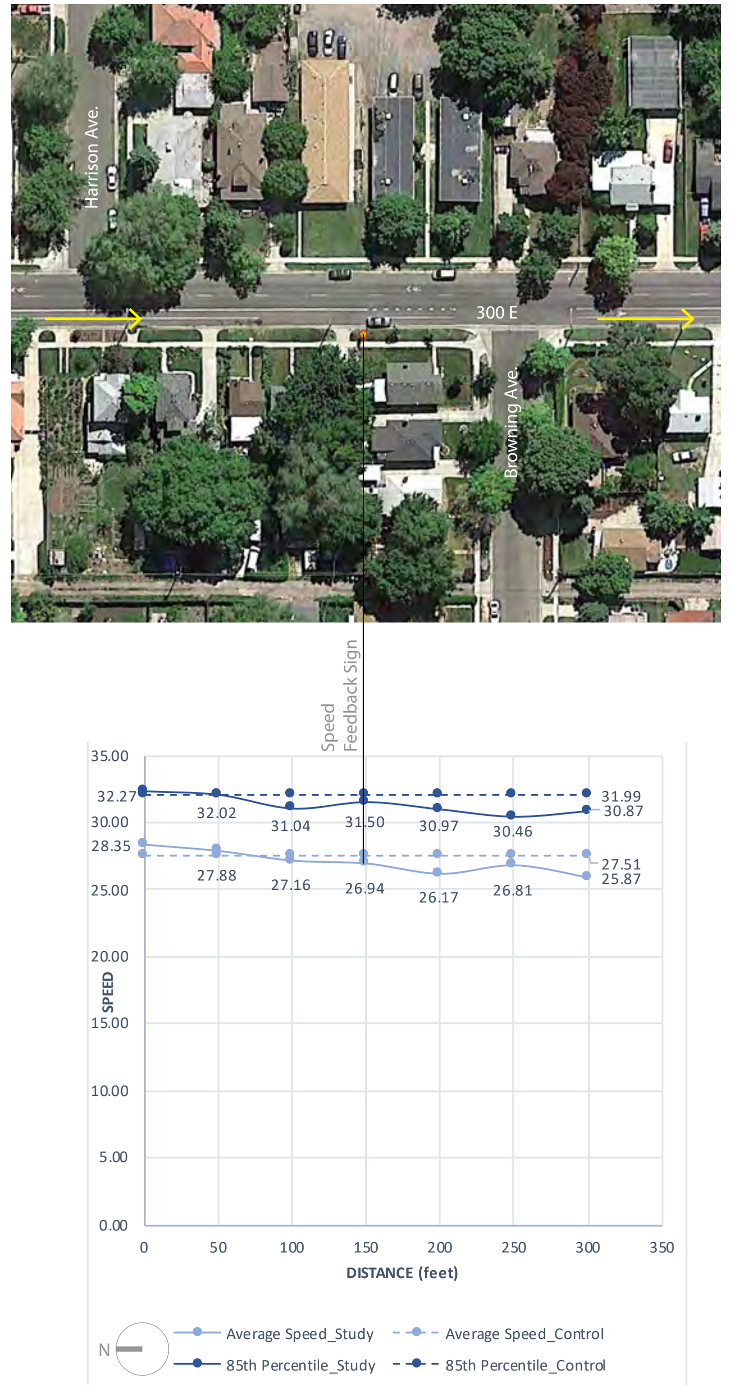
11th Ave. N. G St. _ West Bound Speed Profile
Traffic Calming Device



11th Ave. C St. _West BoundSpeed Profile
Traffic Calming Device



1500 E _ South Bound Speed Profile
Non-Physical Traffic Calming Device



300 E _ South Bound Speed Profile
Non-Physical Traffic Calming Device

IMPACT OF TRAFFIC CALMING DEVICES ON SPEED

Table 6 summarizes the mean speed measured at the devices, mean speed on control streets and standard deviation of mean speeds. A total of nine speed humps, six raised crosswalks, three traffic circles, two speed feedback signs, one entranceway, and one pinch point located at various neighborhoods in the city were included in this study. As shown in Table 2, speeds on all the control streets are much higher than speed measured on streets with traffic calming devices. The highest speed reductions [more than 40%] between treatment and control streets can be observed on streets with speed humps and raised crosswalks and lowest speed reduction on streets with non-physical or speed feedback signs [less than 10% speed reduction]. There seems to be a certain amount of variability in the mean speed data, as is shown by the standard deviation measures.

Location	Device Type	Mean Speed at Device [mph]	Mean Speed (Control Street) [mph]	Diff. Treated v/s. Control Speed [mph]	Percent Speed fall [treated street]	85th Percentile speed at device [mph]	Standard deviation from average speed [mph]
Wasatch Drive	SH1	16.54	26.2	-9.66	36.87	21.5	3.94
	SH2	14.72		-11.48	43.82	18.3	3.12
	SH3	15.14		-11.07	42.23	18.5	3.23
	RC1	18.06		-8.14	31.06	21.3	4.04
1500 East	SH1	18.43	30.91	-12.475	40.362	19.4	3.65
	SH2	19.37		-11.542	37.343	21	3.99
	SH3	19.78		-11.125	35.995	21.4	4.1
	RC1	19.86		-11.046	35.738	21.2	4.08
	RC2	19.47		-11.434	36.994	21.4	4.5
	RC3	20.11		-10.793	34.922	21.2	4.12
South Hollywood Avenue	EW	14.86	20.99	-6.13	29.22	17.4	5.07
	TC	12.94		-8.05	38.35	14.4	2.5
	PP	17.58		-3.41	16.27	20.7	3.71
1700 East	TC1	18.88	21.82	-2.94	13.47	27.6	6.03
	TC2	16.18		-5.63	25.82	18.7	3.13
Avenues	RC1	23.50	26.2	-2.7	10.31	28.2	4.51
	RC2	21.40		-4.8	18.32	26	4.55
	SH	23.00		-3.2	12.21	28	5.14
Non-physical Speed feedback signs	1500 E Speed feedback	29.13	29.43	-0.3	1.02	33.8	4.49
	300 E Speed feedback	28.87	31.35	-2.48	7.91	31.7	4.69
Harrison Avenue	SH1	15.64	22.13	-6.49	29.32	18.1	2.88
	SH2	17.15		-4.98	22.50	18.9	5.98

Table 6 speed impacts and descriptive statistics of Traffic Calming measures

Table 7 summarizes the before and after change in mean speed on traffic-calmed streets. This table covers all the 7 locations (Wasatch Drive, 1500 East, South Hollywood Avenue, 1700 East, Avenues, 300 East and Harrison Avenue) and 22 traffic calming devices. It also summarizes the speed limit compliance after traffic calming measures are installed.

			Mean Speed - at the device				**Standard deviation from average speed [mph]**	***Speed limit [25 mph] compliance % after Traffic calming***
Location	Traffic calming device type [serial number]		Before	After	Average change in speed with Traffic calming	Average % change in speed with Traffic Calming		
Wasatch Drive	Speed Hump 1	North	22.6	16.74	-5.86	-25.93	4.7	46.86
		South	23.0	18.00	-5.00	-21.74	3.62	48.12
	Speed Hump 2	North	22.6	14.63	-7.97	-35.27	3.4	49.93
		South	23.0	15.82	-7.18	-31.22	3.06	49.92
	Raised Crosswalk	North	22.6	19.45	-3.15	-13.94	2.84	48.34
		South	23.0	17.15	-5.85	-25.43	4.21	47.62
	Speed Hump 3	North	22.6	14.0	-8.60	-38.05	2.48	50.00
		South	23.0	16.0	-7.00	-30.43	3.39	49.75
Harrison Avenue	Speed Hump 1	East	25.3	14.73	-10.57	-41.78	2.82	49.99
		West	24.1	15.53	-8.57	-35.56	2.91	49.97
	Speed Hump 2	East	25.3	16.02	-9.28	-36.68	3.04	49.91
		West	24.1	17.21	-6.89	-28.59	8.39	33.89
1500 East	Raised Crosswalk 1	North	30.6	17.43	-13.17	-43.04	4.29	47.00
		South	25.2	16.09	-9.11	-36.15	3.47	49.66
	Speed Hump 1	North	30.6	16.25	-14.35	-46.90	3.47	49.62
		South	25.2	15.61	-9.59	-38.06	3.78	49.56
	Speed Hump 2	North	30.6	17.59	-13.01	-42.52	3.79	48.17
		South	25.2	16.55	-8.65	-34.33	4.06	48.61
	Raised Crosswalk 2	North	30.6	17.48	-13.12	-42.88	5.07	44.30
		South	25.2	16.35	-8.85	-35.12	3.93	49.01
	Raised Crosswalk 3	North	30.6	17.47	-13.13	-42.91	4.15	47.32
		South	25.2	16.81	-8.39	-33.29	4.09	48.30
	Speed Hump 3	North	30.6	17.27	-13.33	-43.56	3.92	48.21
		South	25.2	17.4	-7.80	-30.95	4.21	47.26

Table 7 Before-after mean speed on traffic calmed streets

For this study, we could find before speeds for only 3 out of the 7 locations where traffic calming was installed. This means we had before and after speeds for 12 devices (8 speed humps and 4 raised crosswalks)]. From Table 8, it is evident that after speeds for all the locations fell significantly. Mean speed reduction ranged from -5.00 mph to -13.33 mph on traffic-calmed streets, so a decline of about 22% to 43% in average speed occurred. Hence, broadly, there is a significant speed variation between treated and control streets.

			85th Percentile Speed - at the device			
Location	Traffic calming device type [serial number]		Before	After	Average change in speed with Traffic calming	Average % change in speed with Traffic Calming
Wasatch Drive	Speed Hump 1	North	27.8	20.87	-6.93	-24.93
		South	28.6	21.53	-7.07	-24.72
	Speed Hump 2	North	27.8	18.56	-9.24	-33.24
		South	28.6	18.25	-10.35	-36.19
	Raised Crosswalk	North	27.8	22.27	-5.53	-19.89
		South	28.6	20.83	-7.77	-27.17
	Speed Hump 3	North	27.8	16.55	-11.25	-40.47
		South	28.6	18.95	-9.65	-33.74
Harrison Avenue	Speed Hump 1	East	31.9	17.5	-14.40	-45.14
		West	29.7	18.8	-10.90	-36.70
	Speed Hump 2	East	31.9	18.88	-13.02	-40.82
		West	29.7	18.58	-11.12	-37.44
1500 East	Raised Crosswalk 1	North	36.3	21.77	-14.53	-40.03
		South	29.3	20.43	-8.87	-30.27
	Speed Hump 1	North	36.3	19.81	-16.49	-45.43
		South	29.3	18.85	-10.45	-35.67
	Speed Hump 2	North	36.3	21.57	-14.73	-40.58
		South	29.3	20.22	-9.08	-30.99
	Raised Crosswalk 2	North	36.3	17.48	-18.82	-51.85
		South	29.3	16.35	-12.95	-44.20
	Raised Crosswalk 3	North	36.3	21.5	-14.80	-40.77
		South	29.3	20.73	-8.57	-29.25
	Speed Hump 3	North	36.3	21.06	-15.24	-41.98
		South	29.3	21.8	-7.50	-25.60

Table 8 Before-after 85th percentile speed on traffic-calmed street

Table 8 also summarizes the speed limit compliance for the traffic-calmed streets. Speed compliance was calculated by measuring the probability that an 'after' speed was equal to or less than 25 mph, which was the posted speed limits for the streets studied in this report. This analysis indicates the effectiveness of traffic calming in increasing level of compliance for speed limits on roads. The probability was calculated based on standard normal density function, where:

$Z = (25.499 - \mu)/\sigma$,

Where Z is the standard normal variate, μ is the standard deviation of speed at a given site, and σ is the mean speed at a given site.

Compliance with 25 mph speed on traffic-calmed streets ranged from 33% to about 50% and out of the 12 sites, 9 of them have more than 45% compliance with the speed limit. Table 9 summarizes the result of the change in 85th percentile speed before and after installing traffic calming devices. The reduction in 85th percentile speed ranged from 5 to 18 mph, with a percentage decrease between 19% to 15%. Overall 85th percentile speeds fell significantly on streets with traffic calming devices on them.

CONCLUSION AND RECOMMENDATION

If the goal is speed reduction to a level closer to the posted speed limit, this study and the previous literature show that traffic calming works. The technical appendix shows speed profiles on the streets that were studied. These profiles, plus the tables in the main body of this report, illustrate that traffic calming measures in Salt Lake City, Utah, have experienced substantial speed reductions compared to before treatment speeds or control street speeds.

Traffic calming is not a panacea. Our data show that speeding continues to occur on traffic calmed streets. But whether measured in terms of average speed or 85th percentile speed, speeds are significantly reduced at traffic calming devices and at a distance upstream and downstream from devices (see speed profiles page 32-43).

Right now the city really has only one tool in its toolbox to deal with speeding. And that one tool, speed feedback signs, does not appear to be very effective from our study and earlier ones. The former director of the Transportation Division told the city's Transportation Advisory Board (TAB) that speeding was the number one complaint lodged by citizens. The current director said that speeding is one of the top two complaints. Our second recommendation is that the city, if it does reinstate the traffic calming program, do so with a full toolbox of traffic calming measures, not just speed feedback signs and 14-foot speed humps. If a relatively constant speed profile is desired, longer humps and standard speed tables may be a better option. And for other traffic problems, such as crashes at intersections, other devices such as traffic circles may be preferred.

At a TAB meeting, when the subject of traffic calming was discussed, the problem of diverted traffic came up. If we traffic calm one street, won't traffic simply move to another street? The answer is maybe, depending the availability of alternate routes and nature of the traffic calming devices deployed. Because of their low design speeds and rocking motion, speed humps lead to more diversion than other devices such as speed tables, raised crosswalks, and raised intersections. From our earlier work, traffic circles and chokers don't lead to any diversion. This both makes the case for a complete toolbox of traffic calming measures, and for neighborhood-wide treatments rather than spot treatments on individual problem streets. The U.S. Traffic Calming Manual lays out a model process for neighborhood-wide traffic calming based on our successful earlier work and the successful consulting practice of Fehr & Peers. It involves neighborhood residents starting with a traffic calming 101 short course, a design charrette, and a neighborhood mail-in ballot prior to implementation. If the city Transportation Division reinstates its traffic calming program, we recommend it follow this model process. Also, the process prioritizes projects based on objective measures of need, with factors such as traffic speeds and crash rates being weighted by factors agreed-upon by city policy makers, presumably including the TAB and City Council.

While we are not political strategists, the consultants on this project have considerable experience and would suggest other process measures if the Transportation Division decides to pursue a traffic calming program. They are:

(1) Act now. The city has new funds available from the quarter cent sales tax, the road bond, and the additional sales tax from the Inland Port Agreement. This would seem to be a perfect time to divert a moderate amount of funding to the pilot project recom-

mended below. Permanent dedicated funding would depend on the success of the pilot project.

(2) Conduct an analysis of crash experience on traffic calmed streets relative to control streets, using the same sample as in this speed study. The issue of safety is bound to come up if the Salt Lake City Transportation Division seeks to reinstate its traffic calming program.The Metropolitan Research Center would be glad to conduct this study.

(3) Confirm that the livable cities in Table 1 continue with their traffic calming programs. The fact that Portland, Seattle, Austin, and other cities known for their progressive policies have active programs is likely to be a selling point for the Salt Lake City Mayor and Council. The Metropolitan Research Center would be glad to conduct the survey.

(4) Conduct a survey of localities in Utah to see which ones currently operated traffic calming programs and how they judge their success. This can be done at no cost through Utah APA and Utah ITE.

(5) Start small with a pilot project following the model process in the U.S. Traffic Calming Manual. Use objective criteria to select the pilot neighborhood from among the neighborhoods that have generated the most speeding complaints in recent years.

(6) Continue to experiment with traffic calming devices on larger road improvement projects such as 2700 South. Conduct before and after studies of traffic speeds, traffic volumes, crashes, pedestrian and bicycle volumes, and after-surveys of citizen satisfaction with traffic calming devices and road improvement projects generally.

(7) Use the TAB as a sounding board for the approach suggested above, and have the TAB (if inclined) endorse the reinstatement of the city's traffic calming program in a letter to the Mayor and City Council.

(8) With the Mayor's approval, request a workshop with the City Council to present the results of this study, plus its recommendations. This workshop might be jointly run by the consultants on this project, the Director of the Transportation Division, and city staff such as Jeff Gulden who have expertise in traffic calming.

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