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FLASHER BRIGHTNESS AT SELECTED INTERSECTIONS

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On August 5, 1959, the Research Laboratory Division received a request from H. G. Bauerle, Director of the Traffic Division, to determine whether diminishing brightness of flashers might be a factor in the rising accident trend at 24 flasher-protected intersections in Districts 5 through 10. These intersections were selected by the Traffic Division because at least four more accidents had occurred at each location in 1958 than in 1957. According to Mr. Bauerle, flashers are more effective as safety devices during their first year of operation than during the second year, and he thought that diminishing brightness of the flasher might be a factor in this loss of effectiveness.

Test Description

Between September 15 and October 1, 1959, flasher brightness was measured at the 24 intersections. These measurements included recording voltage to the flasher, diagramming the location, and making various related observations.

Brightness of a surface is usually measured in footlamberts (fL), with visual-comparison or photoelectric instruments. In this case, the measurements were made with a Spectra Spot Brightness Meter, a photoelectric instrument corrected to produce a brightness response similar to that of the human eye. The brightness of a uniformly illuminated object is generally considered to be independent of viewing distance, providing the object subtends at least 5 min of angle to the eye at the viewing distance.

It could not be assumed that a traffic signal lens had a uniform surface brightness, because of the prismatic configuration of the inside surface which directs the light into a definite pattern. Also, the lamp filament is shaped like a horseshoe, which causes a dark spot at the open end. Therefore, simply measuring the brightness from a random selected point in the intersection would have been unsatisfactory, and a reproducible point of measurement had to be established. Furthermore, geometric limitations in the optical system of the brightness meter prevented measurements at distances greater than 80 ft. In practice, it was found that a meter distance of 60 ft gave best reproducibility of brightness readings.

The necessity of making measurements at this short distance precluded the possibility of relating any values obtained to a reasonable situation of a driver's eye while approaching a flasher-protected intersection. Since driver-eye conditions could not be duplicated, it was decided to obtain the brightness measurement at a point which would cause least interference with normal traffic movement. Such a point was established 10 ft to the right or left of the flasher beam center at 60 ft. Comparing the brightness of a new flasher and the 24 installed intersection flashers appeared to be the only method of determining performance, since the brightness of the installed flashers had not been measured previously.

Field Test

A panel truck was outfitted with brightness measuring equipment, inclinometers, and other related equipment (Fig. 1). Brightness readings were obtained with the meter on the tripod mounting as shown.

Data at the flasher intersections were obtained as follows:

1. Height of the signal bottom was measured from the pavement.

2. The equipment was set up so that the brightness meter was situated 10 ft right or left of a point 60 ft from beneath the flasher, using the flasher beam center for orientation.

3. Flasher brightness was measured with the flasher lamp burning constantly. Then a blank reading was obtained with the flasher lamp off.

4. The angle of the truck bed was recorded, and also the angle of the brightness meter.

5. Voltage to the flasher was measured at the controller box.

6. The intersection was diagrammed, and at some locations pictures were taken.

The bottom-height measurement, the truck bed angle, and the brightness meter angle were recorded because these data permitted at least two different calculations of the height of the flasher above the brightness meter at the point of measurement. Calculation of this height was necessary because the intersection areas were not level, and therefore the bottom-height measurement alone would not give the height of the flasher above the meter at the point of measurement. These data also permitted calculation of the true distance from the flasher to the brightness meter.

Figure 1. Brightness measuring equipment.

Voltage at the flashers was recorded because it was known that voltage variation would affect flasher brightness--voltage values are recorded in Table 1.

Laboratory Test

The minimum brightness of the new or "reference" flasher was determined in the photometric laboratory to establish a basis for evaluating the brightness of the flashers installed at the 24 intersections. It was assumed that an installed flasher with brightness equaling or exceeding the minimum brightness of the reference flasher was performing satisfactorily, and one with brightness less than this minimum had diminished while in service.

Signal heads from two different manufacturers, red and yellow lenses from two different manufacturers, and two 67-watt incandescent lamps were tested in all possible combinations for each lens color to determine the minimum brightness which could be expected from the reference flasher. In determining the minimum, the signal lamp was operated at 115 v, the signal head tilted in 1^{o} increments through the range of 8^{o} to

16^o, and the brightness meter set at a distance of 62.5 ft. This distance was found to be the average of the actual distances from flashers to the brightness meter in the field. Brightness measurements at the various angles permitted plotting brightness against various calculated mounting heights of flashers (Fig. 2). Using these plotted data, it was then possible to compare the brightness of the reference flasher with the brightnesses of the installed flashers. For example, according to Fig. 2, a new red flasher operating at 115 v, mounted at a height of 19 ft, should have a brightness of 240 fL, and a new yellow flasher under similar conditions should have a brightness of 2700 fL.

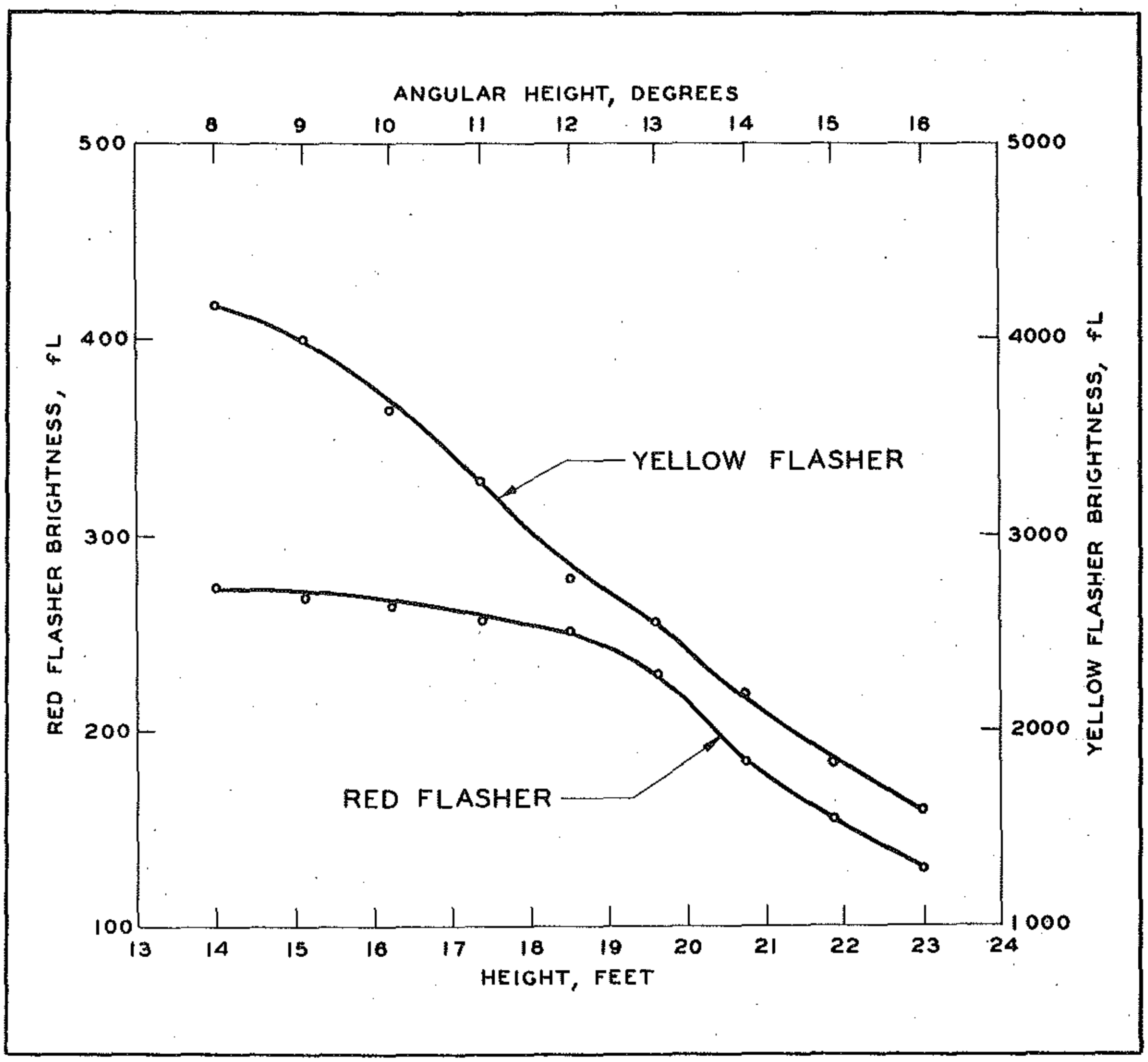

Figure 2. Minimum brightness values of Yellow and Red signals vs angular height and height in feet.

Results and Discussion

Brightness values of the reference and installed flashers, in foot-lamberts, may be compared in Table 1. Values are divided in columns for red and for yellow flashers, and listed according to the direction of traffic flow.

The only flasher found operating at less than 115 v was at the M 15 - M 81 intersection. Most flashers were operating at voltages of 118 or greater. The effect of voltage variation on brightness is shown in Fig. 3, where the percentage of flasher brightness at 115 v is plotted against voltage.

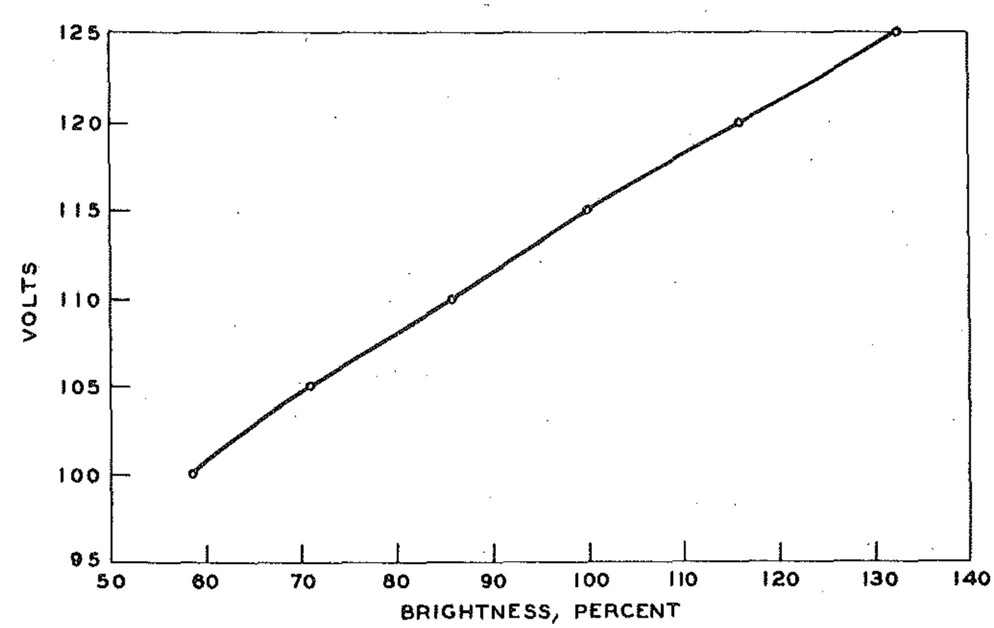

Figure 3. Effect of voltage on brightness.

The results obtained for the US 31 - Giles Rd, the M 46 - M 83, and the US 31 - M 43 intersections should have been omitted in this study because these flashers are less than 2 years old. The last of these had been in use for about five weeks, and the high brightness values obtained indicate the wide range of brightness values possible for new flashers. Measuring the flashers at US 31 - M 43 annually for the next 2 or 3 years would provide one set of data covering flasher brightness versus age.

Flasher installation dates available at the MSHD Signal Shop showed that half the tested flashers had been in service from 5 to 13 years. The varying ages of the flashers were an important consideration in evaluating the results. Since no previous brightness data were available, it was assumed that the older installations would most likely have substandard brightness values. Of the 47 red flashers measured, 20 had less than the reference brightness, and of the 48 yellow flashers measured, 20 had less.

It appears, then, that a significant number of flashers have substandard brightness. However, there is no apparent correlation between substandard brightness and length of service. For example, two of four flashers at the US 23 - M 59 intersection, and three of four at M 15 - Lapeer Rd, had substandard brightness--both installations are over 7 years old. On the other hand, none of four at M 59 - Milford Rd, and none of three at the US 25 - Little Mack Ave intersection were substandard--both installations are also over 7 years old.

A further comparison can be made by noting that three of the four flashers at the M 46 - M 83 intersection, and two of four at US 31 - Giles Rd are substandard--both are less than 2 years old. From these examples and others among the 24 intersections, it was concluded that substandard brightness could not be correlated with an increase in accidents at the 24 flasher-protected intersections, but that lack of such a correlation does not indicate that flashers perform satisfactorily at a substandard brightness.

Brightness Measurement Limitations

The measurements obtained depended upon several variables which had to be disregarded because measurement of the variables was either impossible or impractical. It was assumed that all the installed flashers were hanging vertically and that their lenses were correctly mounted. The color and transmission factor of these lenses were assumed equal to those of the reference flasher lens. Calculations were based on the assumption that a uniform grade existed throughout each intersection.

Supplemental Observations

While field brightness was measured, supplemental observations were recorded. These included appraisals of the intersection situations by local police, residents, Michigan State Police, and Research personnel, and are included for what interest they may have.

Vehicle speeds 10 to 20 mph over posted limits were mentioned by police as an average condition through more than half the intersections. It was noted that without exception vehicles driving through a yellow flasher indicator did not reduce speed, avoid passing, or return to an open traffic lane after passing.

Poor visibility conditions were also observed at more than half the intersections. Drivers making a required stop apparently could not see intersecting traffic at a distance sufficient to make a safe crossing or turn. Highway signing, buildings, brush and small trees, utility poles, and intersection geometry were responsible for most of the poor visibility conditions. Poor visibility of the flashers was also noted because of improper mounting alignment or intersection geometry.

Insufficient median storage space for vehicles making left turns into four-lane divided highways was also observed. One, two, and sometimes three vehicles at once were observed to proceed into left turns after making initial stops, and then stop in the median before completing the turns. When the median was not wide enough to accommodate the length of one car, then two or three vehicles crowding that region created a hazardous condition.

The US 24 - M 17 N Jct (Ames Hwy) intersection had many of these features (Fig. 4). The yellow flasher was not aligned for US 24 traffic, and the red flasher was not well aligned for M 17. Traffic on US 24 proceeds at high speeds, and the volume is apparently high enough to force truckers headed for the northbound lane to pull away from the stop sign on M 17 and then stop in the narrow median, blocking southbound traffic. Visibility to the south on US 24 from the M 17 stop sign appeared insufficient because of signs, utility poles, and an overpass. It was also noted that delivery trucks and customers from northbound US 24 for the establishment on the southwest corner, use the traffic-blocked driveway which opens on M 17 just west of the Ames Hwy sign, resulting in vehicles stopping across southbound US 24.

At the M 58 - Pontiac Lake Rd, vehicle speeds were reported to be 10 to 15 mph above the limit (Fig. 5). Turning traffic from Pontiac Lake Rd has insufficient visibility to the south. It was also noted that northbound vehicles making left turns from M 58 often stopped in the passing lane, creating maneuvering problems for passing northbound vehicles.

The US 10 - Hatchery Rd intersection in Drayton Plains also illustrates these problems (Fig. 6). Vehicle speeds on US 10 were reported

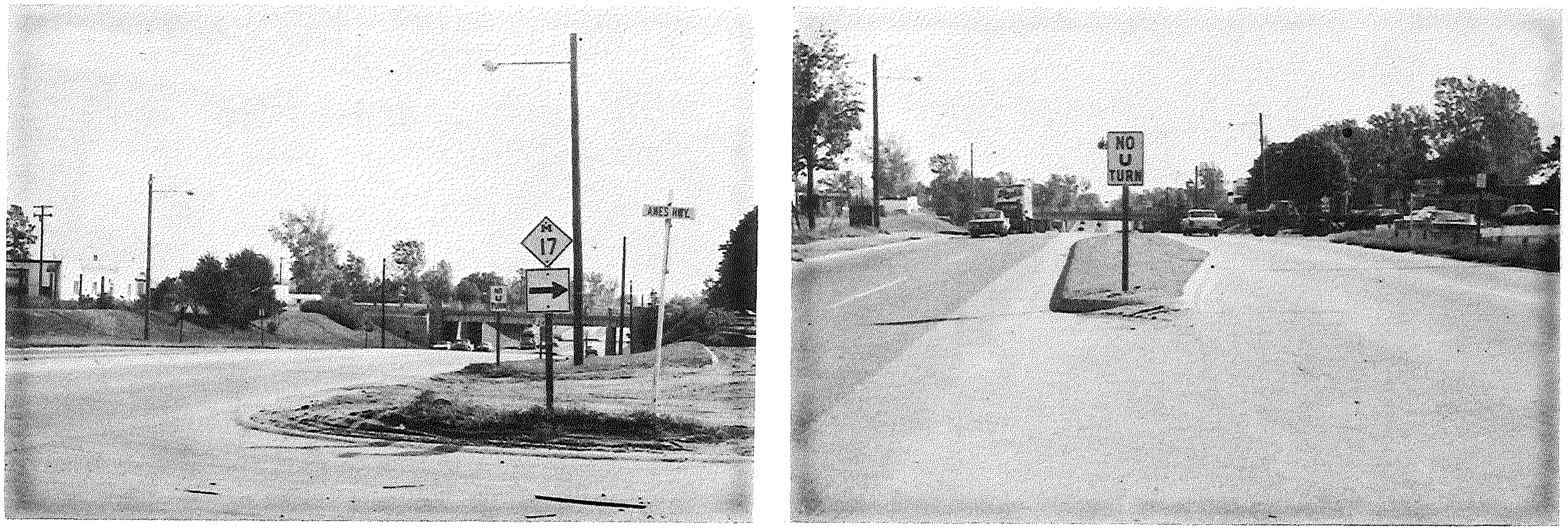

Figure 4. Looking south on US 24 at the intersection with M 17 N Jct (Ames Hwy) (left), signs and utility poles interfere with visibility. At the US 24 centerline directly north of the Ames Highway intersection (right), the truck turning from M 17 at right blocked southbound traffic.

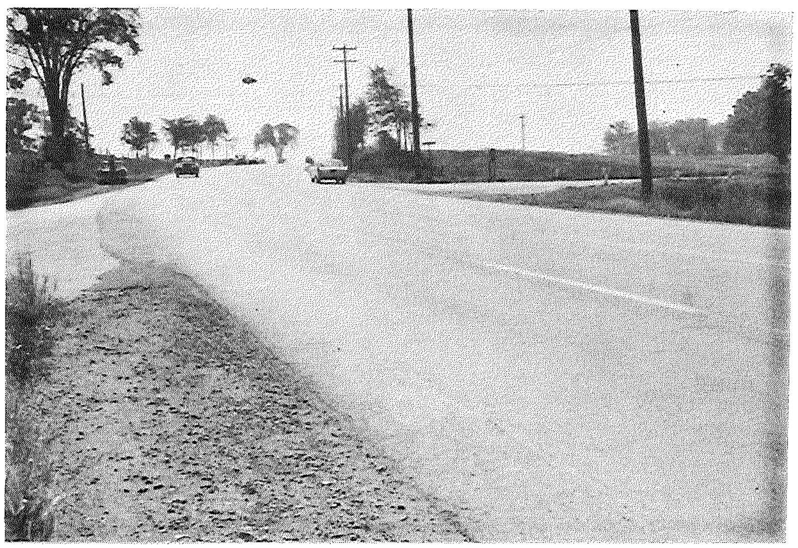

Figure 5. Looking south on M58, with Pontiac Lake Rd intersecting at right.

Figure 6. Looking south on US 10, with Hatchery Rd intersecting at right.

to be at least 15 to 20 mph over the posted limit. Visibility to the south is very limited because of utility poles, parked vehicles, and the curve.

Conclusion

Approximately 40 percent of the flashers measured had a substandard brightness. However, since no correlation was apparent between flasher brightness and length of service within the scope of this investigation it cannot be concluded that diminishing brightness has been a factor in the rising trend of accidents at the 24 intersections studied.

TABLE 1
FLASHER VOLTAGE AND RELATIVE BRIGHTNESS

District	County	Township	Intersection	Voltage	Flasher	Traffic Lane	Brightness, footlamberts: Red Lens, Installed Flasher	Red Lens, Reference Flasher	Yellow Lens, Installed Flasher	Yellow Lens, Reference Flasher
5	Kent	Courtland	US 131 - M 57	122.0		WB	260	255		
						NB			**2490**	2655
						SB			4405	3645
5	Kent	Plainfield	US 131 - US 131 BR	118.8	US 131 SB	EB	**150**	245		
						SB			**715**	2340
					US 131 NB	EB	**180**	250		
						NB			**875**	3015
5	Kent	Plainfield	US 131 - M 44	121.2	US 131 SB	EB	270	250		
						WB	**250**	255		
						SB			4210	3330
					US 131 NB	EB	**220**	250		
						WB	395	255		
						NB			4120	3195
5	Montcalm	Bushnell	M 57 - M 66	122.5		EB	230	225		
						WB	205	180		
						NB			**1710**	2430
						SB			**1900**	2160
5	Muskegon	Casnovia	M 37 - M 46	121.8		NB	**180**	235		
						SB	345	190		
						EB			3875	3645
						WB			2200	2160
5*	Muskegon	Muskegon	US 31 - Giles Rd	122.4		EB	**240**	250		
						WB	330	235		
						NB			**1800**	3015
						SB			5950	3015

*Flasher installed less than 2 years old.

Boldface figures used where brightness of flasher is substandard compared to reference flasher.

TABLE 1 (continued)
FLASHER VOLTAGE AND RELATIVE BRIGHTNESS

District	County	Township	Intersection	Voltage	Flasher Traffic Lane		Brightness, footlamberts			
							Red Lens		Yellow Lens	
							Installed Flasher	Reference Flasher	Installed Flasher	Reference Flasher
6	Genessee	Davison	M 15 - Lapeer Rd	120.5		EB	**70**	250		
						WB	**200**	245		
						NB			**1450**	3285
						SB			3140	2655
6*	Saginaw	Blumfield	M 15 - M 81	114.0	M 15 SB	EB	260	250		
						WB	**150**	255		
						SB			**3210**	3375
					M 15 NB	EB	500	260		
						WB	480	255		
						NB			3740	3645
6	Saginaw	Blumfield	M 46 - M 83	117.5		EB	250	245		
						WB	**200**	235		
						NB			**2260**	2790
						SB			**2250**	2655
6	Saginaw	Bridgeport	US 10 (US 23 BR) - US 23	123.8		SB	460	245		
						EB			5650	2700
						WB			**1920**	3060
6	Saginaw	Buena Vista	US 23 - M 81	120.0		EB	**170**	240		
						NB			**2270**	2340
						SB			3760	2430
7	St. Joseph	Mottville	US 112 - US 131	119.0		NB	290	250		
						SB	**190**	250		
						EB			4200	3240
						WB			**2230**	3015
7*	Van Buren	South Haven	US 31 - M 43	122.0		EB	640	250		
						WB	690	250		
						NB			9300	3150
						SB			13650	3510
8	Livingston	Hartland	US 23 - M 59	117.5		EB	**100**	245		
						WB	**200**	240		
						NB			3400	2700
						SB			3990	2610
8	Washtenaw	Sylvan	US 12 - M 92	122.0		NB	350	250		
						SB	**260**	265		
					Traffic Lane	EB			8945	1755
					Passing Lane	EB			4000	1845
						WB			**1900**	3465

*Flasher installed less than 2 years old.

Boldface figures used where brightness of flasher is substandard compared to reference flasher.

TABLE 1 (continued)
FLASHER VOLTAGE AND RELATIVE BRIGHTNESS

District	County	Township	Intersection	Voltage	Flasher Traffic Lane		Brightness, footlamberts			
							Red Lens		Yellow Lens	
							Installed Flasher	Reference Flasher	Installed Flasher	Reference Flasher
9	Macomb	Clinton	M 97 - Elizabeth Rd	120.1	-	NB	340	250		
						SB	**180**	240		
						EB			**1525**	3015
						WB			**1800**	3150
9	Macomb	Erin	US 25 - Little Mack Ave	121.0	US 25 NEB	NB	660	245		
						SB	370	250		
						NEB			3680	3015
9	Macomb	Macomb	M 59 - Romeo Plank Rd	121.0		NB	320	190		
						SB	370	190		
						EB			3330	2430
						WB			2700	2430
9	Oakland	Avon	M 150 - Avon Rd	118.0		EB	**230**	260		
						WB	230	225		
						NB			4845	3420
						SB			3850	3510
9	Oakland	Highland	M 59 - Milford Rd	177.5		NB	270	255		
						SB	350	260		
						EB			8540	3915
						WB			5640	2520
9	Oakland	Waterford	M 58 - Pontiac Lake Rd	115.5		EB	320	155		
						SB	**90**	110		
						NB			4070	2565
						SB			5100	1600
9	Oakland	Waterford	US 10 - Hatchery Rd	117.0		EB	**230**	270		
						SB			**2300**	2925
						NB			**3800**	3870
9	St. Clair	Mussey	M 21 - Capac Rd	120.5		NB	**240**	250		
						SB	470	250		
						EB			7200	3285
						WB			3710	2970
10	Wayne	Taylor	US 24 - M 17 N. Jct (Ames Hwy)	122.5		EB	560	260		
						NB			**2800**	3240
						SB			6450	3690

*Flasher installed less than 2 years old.

Boldface figures used where brightness of flasher is substandard compared to reference flasher.