REPORT FHWA/NY/SR-95/121

PB99-100166

Fluorescent Strong Yellow-Green Signs For Pedestrian/School/Bicycle Crossings: Results of a New York State Study

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SPECIAL REPORT 121
TRANSPORTATION RESEARCH AND DEVELOPMENT BUREAU
NEW YORK STATE DEPARTMENT OF TRANSPORTATION
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FLUORESCENT STRONG YELLOW-GREEN SIGNS FOR PEDESTRIAN/SCHOOL/BICYCLE CROSSINGS: RESULTS OF A NEW YORK STATE STUDY

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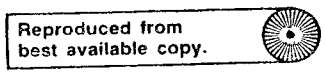
Report on a Study
Conducted In Cooperation With
The U.S. Department of Transportation
Federal Highway Administration

Special Report 121
June 1995



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ABSTRACT

This investigation was conducted as part of FHWA's nationwide study to evaluate a new sign color known as "fluorescent strong yellow-green" (SYG) for use at pedestrian, school, and bicycle crossings. The new color is highly visible and is proposed as more effective than standard yellow signs. This report presents results of SYG sign tests at three sites in New York State. At each site a single "before" and "after" study was designed -- the "before" study was conducted with standard yellow signs and the "after" with fluorescent SYG signs. The studies concerned traffic volume, driver behavior, and vehicle speed. An "impression" survey of persons viewing the signs was also conducted. Results of these studies and responses from the survey provided encouraging evidence of the benefits of using SYG signs over standard signs, although the short duration of this study and limited number of sites do not allow strong recommendations. It is anticipated that when FHWA combines results of this study with those in other jurisdictions, more definitive conclusions will be drawn regarding effectiveness of SYG color in improving driver behavior and reducing vehicle speed.

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BACKGROUND

The Federal Highway Administration (FHWA) is conducting a nationwide study to evaluate a new sign color known as "fluorescent strong yellow-green" (SYG) for use on pedestrian, school, and bicycle crossing signs. This is one of four colors reserved for future use under Section 2A-11 of Manual on Uniform Traffic Control Devices (1). SYG has high "conspicuity" -- a term for how readily a sign is noticed by motorists. An FHWA pilot study had indicated a beneficial effect of improved conspicuity provided by SYG signs. Those included in the evaluation are "Warning Signs" for bicycle crossings (W11-1), pedestrian crossings (W11A-2), pedestrian advance crossings (W11-2), school advance crossings (S1-1), and school crossings (S2-1).

Currently 52 jurisdictions -- 13 state agencies, 9 counties, 25 cities, and 5 locals (village, town, district, university) -- are experimenting with SYG signs. FHWA plans to terminate the evaluation by May 31, 1995. Other scheduled FHWA implementation plans include an "Advance Notice (Rulemaking)" by late 1995, a "Final Rule" in 1996, and an "Implementation Period" in 1998.

The New York State Department of Transportation (NYSDOT) volunteered to participate in the SYG evaluation in 1993. Various NYSDOT regions were asked to provide candidate sites. Three were identified and a preliminary evaluation performed based on the site selection criteria described in FHWA's "Guidelines for Evaluating Fluorescent Strong Yellow Green Crossing Signs" (2). Table 1 lists site characteristics, and the three sites are shown in Figure 1. NYSDOT applied to FHWA to experiment with the SYG signs at the three identified sites on August 2, 1994. FHWA approved this application on September 28, 1994.

A list of activities was prepared for the evaluation. Appendix A lists them along with their scheduled and actual dates.

DESIGN OF THE EVALUATION

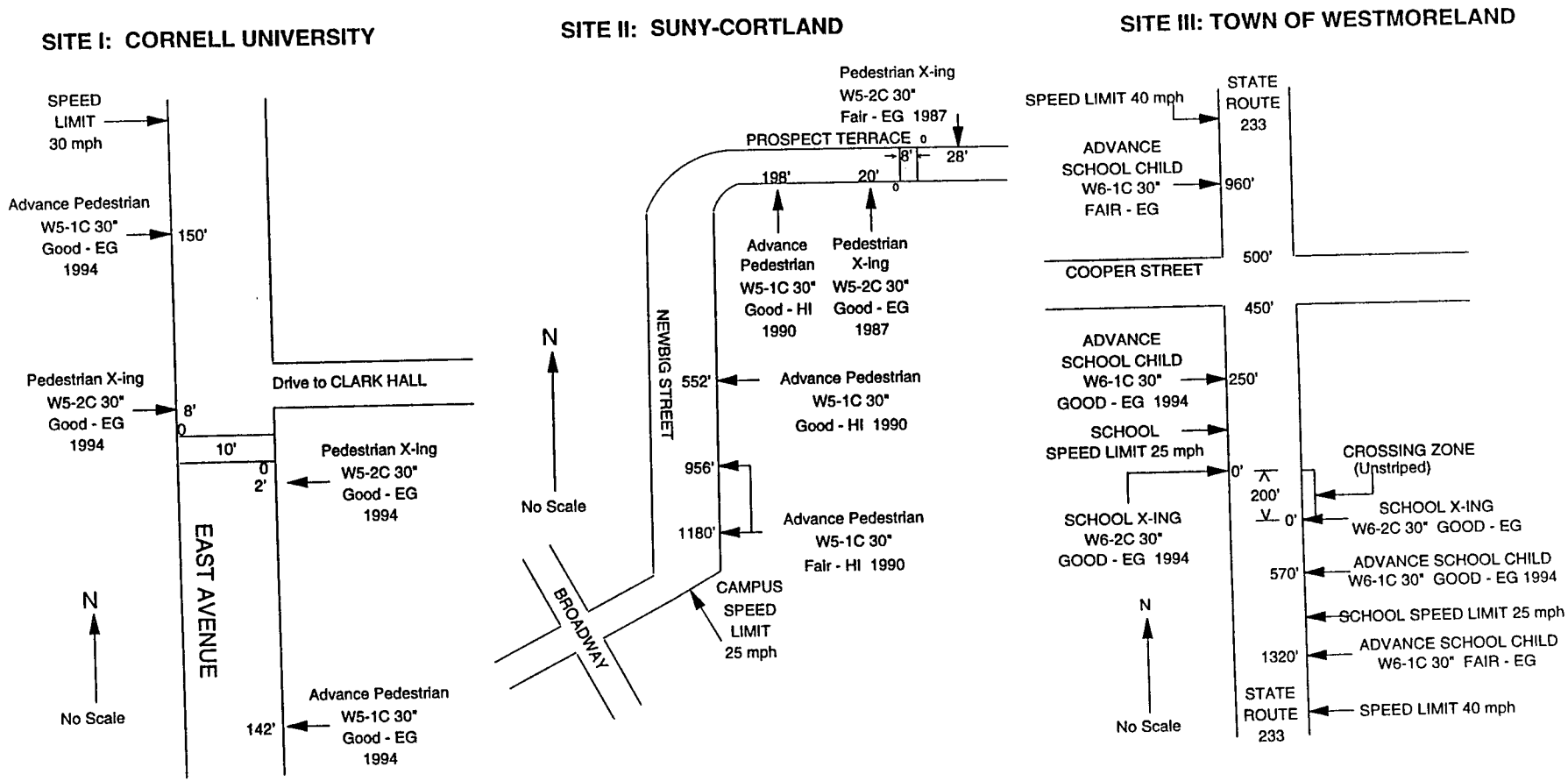
Due to time and resource constraints, a single study before and after the change of signage was designed to provide an estimate of short-term effects of the SYG sign. The "before" study was done with standard yellow signs which were then replaced by fluorescent SYG signs. A 30-day waiting period was observed between installation of the SYG signs and start of the "after" study, to avoid any "novelty" effects of the new SYG signs on driver and pedestrian behavior.

Table 1. Crossing characteristics before installing SYG signs.

Site	Location	Crossing Type	Predominant Use	Roadway Type	Avg Hourly Traffic*		
					Vehicles	Peds	Bikes
I	East Avenue, Ithaca (Cornell University)	Business	Pedestrian	Two-lane, two-way traffic, two bike lanes on East Ave	424	396	67
II	Newbig St & Prospect Terrace, Cortland (SUNY Cortland)	Business	Pedestrian	Two-lane, two-way traffic on each street	334	624	10
III	Rte 233, Westmoreland (midblock near Westmoreland Central School)	School	Pedestrian	Two-lane, two-way traffic on Rte 233	469	112	0

*Based on manual traffic counts at Sites I and II from 10:45 a.m. to 1 p.m. on 5/2/94, and at Site III from 11:45 a.m. to 1:30 p.m. on 6/6/94.

Figure 1. Signage at test sites before installing SYG signs.



East Avenue has two vehicle lanes and two bicycle lanes. Peak times are 9:30 a.m. to 3:30 p.m. when University is in session (Sept-May).

Both streets have one lane in each direction. Peak times are 9:30 a.m. to 2:00 p.m. when College is in session (Sept-May).

EG = Engineering Grade
HI = High-Intensity

STUDIES PERFORMED

The before studies were completed during the last week of September 1994, and the after studies during mid-November 1994. Steps were taken to ensure that both before and after data collection was carried out under similar traffic and weather conditions. The studies performed were as follows:

Traffic Volume Study

Volume counts for both before and after periods were done from 10:45 a.m. to 1 p.m. for Sites I and II, and from 11:45 a.m. to 1:30 p.m. for Site III. Average numbers of vehicles per hour for the three sites for periods before and after the change of signage were as follows:

Site I	331.3 (before) and 303.0 (after)
Site II	268.3 (before) and 290.6 (after)
Site III	508.5 (before) and 517.7 (after)

The average numbers of pedestrians per hour for three sites in the before and after periods were as follows:

Site I	453.4 (before) and 480.9 (after)
Site II	513.4 (before) and 550.7 (after)
Site III	128.0 (before) and 101.7 (after)

The average number of bikes per hour were as follows (bike traffic was not recorded at Site III):

Site I	74.6 (before) and 50.1 (after)
Site II	5.6 (before) and 5.6 (after)

These volume counts indicate similar vehicle, pedestrian, and bike conditions for the before and after periods.

Behavioral Study

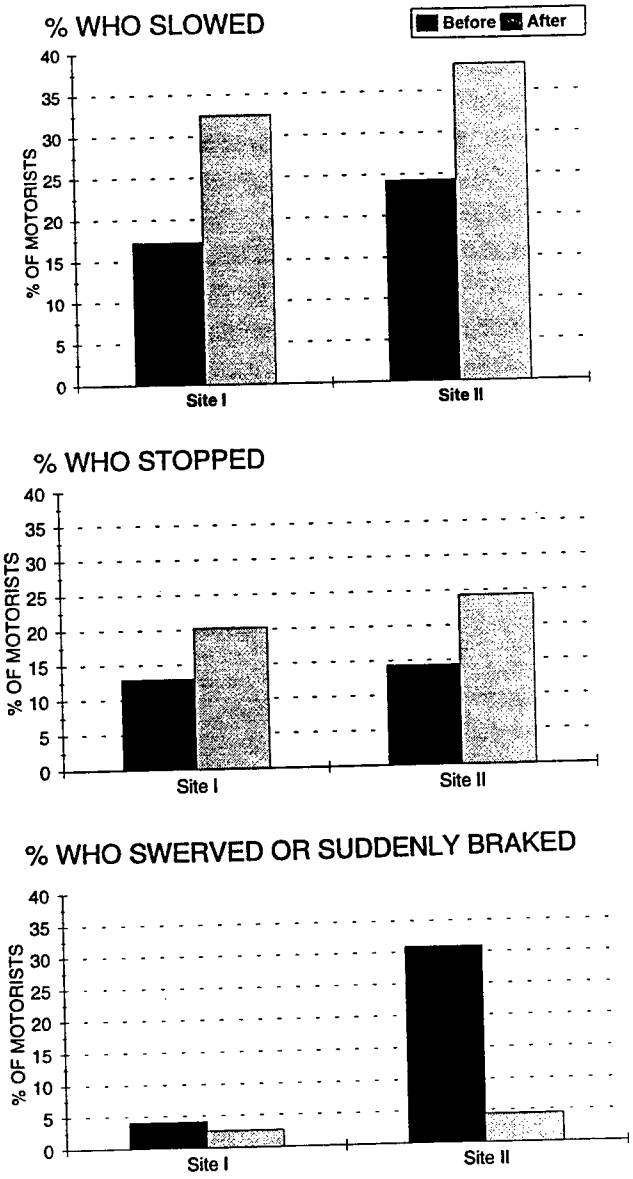
The volume counts for Sites I and II were further classified according to number of vehicles that slowed or came to a full stop when pedestrians were crossing. Pedestrian-vehicle "conflicts" were also recorded for both sites, defined as swerving or sudden braking. Behavioral and conflict data were not recorded at Site III. Table 2 lists before and after behavioral and conflict data at Sites I and II. These data were also plotted in Figure 2. It is observed from these graphs that after SYG signs were installed percentages increased at both sites for motorists who slowed or stopped for peds/bikes, and decreased for those who swerved or suddenly braked.

Table 2. Behavioral data before and after change of signage.

Motorist Data	Site I Signs		Site II Signs	
	Std	SYG	Std	SYG
Number with peds/bikes present	169	114	181	136
Number slowing for peds/bikes	29	37	44	52
% slowing for peds/bikes	17.2	32.5	24.3	38.2
Number stopping for peds/bikes	22	23	26	33
% stopping for peds/bikes	13.0	20.2	14.4	24.3
Number swerving/suddenly braking	7	3	56	6
% swerving/suddenly braking	4.1	2.6	30.9	4.4

Data collected at Site I only for NB vehicles, at Site II only for EB vehicles.

Figure 2. Motorist behavior before and after change of signage.



Vehicle Speed Study

Speed data for Sites I and II were recorded with automated equipment for a continuous 72-hour period both before and after change of signage. Speed data at Site III were collected manually for 1-hour periods both before and after the change of signage (due to malfunctioning of the automated unit during data collection). At Site III, data were recorded within the school zone and 1000 ft from it for northbound traffic; data for southbound traffic were collected only within the school zone. Presence of an intersection 500 ft from the school zone (Fig. 1), restricted data collection beyond that zone (at some point 500 to 1000 ft) in the southbound direction.

ANALYSIS

Behavioral Study

Non-parametric Mann-Whitney tests for small samples (3) were used to find any significant difference between before and after behavioral observations for Sites I and II. The usual parametric tests (Z- or t-test) were not used because there were only seven observations for each period. The following three cases were evaluated at the 95-percent confidence level, with the results given in Table 3 (in the test hypothesis, Ho is rejected if the p-values are less then 0.05):

Case A.
- Ho: Proportions of motorists who slowed for pedestrians-bicycles (peds/bikes) are the same for both the before and after periods
- Ha: Proportions of motorists who slowed for peds/bikes in the after period are higher than the before period

There was a significant increase in proportion of motorists slowing for peds/bikes in the after period, compared to the before period at both Sites I and II.

Case B.
- Ho: Proportions of motorists who stopped for peds/bikes are the same for both the before and after periods
- Ha: Proportions of motorists who stopped for peds/bikes in the after period are higher than the before period

There was no significant increase in proportion of motorists stopping for peds/bikes in the after period, compared to the before period for both Sites I and II.

Case C.
- Ho: Proportions of conflicts (swerving/suddenly braking) with peds/bikes are the same for both before and after periods
- Ha: Proportions of conflicts with peds/bikes in the after period are lower than the before period

Table 3. Non-parametric test of behavioral data.

Motorist Data	p-Values Site I	Site II
Case A: % slowing for peds/bikes	0.0035*	0.0160*
Case B: % stopping for peds/bikes	0.4024	0.2675
Case C: % swerving or suddenly braking	0.3326	0.0160*

*Statistically significant changes.

There was a significant reduction in proportion of conflicts with peds/bikes in the after period compared to the before period for Site II, but no significant reduction in proportion of conflicts was observed for Site I.

Vehicle Speed Study

The average speed, 85th-percentile speed, and "percent exceeding speed limit by" for the three sites for both before and after periods are summarized in Table 4. Speed results for Sites I and II were obtained from the first 24 hours of speed data. The category "percent exceeding speed limit by" was classified into four subcategories -- 0, 5, 10, and 15 mph. Average speed and 85th-percentile speed were less in the after period than in the before period for most cases.

Speed data for the first 24 hours for Sites I and II were classified according to time of day -- Night (6 p.m. to 5 a.m.), Morning (5 to 9 a.m.), Day (9 a.m. to 3 p.m.), and Evening (3 to 6 p.m.) for both before and after periods. Average and the 85th-percentile speeds were also computed using the first 48 hours of speed data for Sites I and II. The data showed no significant difference between before and after speeds for any of these categories for any of the three sites.

Table 4. Speeds before and after change of signage.

Site and Traffic Direction	Speed Limit, mph	Avg Speed, mph		85th-Percentile Speed, mph		% Exceeding Speed Limit by 0 mph		5 mph		10 mph		15 mph	
		Std	SYG	Std	SYG	Std	SYG	Std	SYG	Std	SYG	Std	SYG
I NB	30	31.1	31.8	37.6	38.0	63.7	67.1	26.2	28.2	5.0	6.3	0.7	0.8
I SB	30	30.6	29.6	36.2	34.9	57.1	49.4	18.9	14.2	2.5	2.3	0.2	0.2
II NB	25	25.5	25.3	32.5	32.6	55.6	53.4	24.9	25.7	4.9	4.9	0.5	0.5
II SB	25	26.5	26.0	32.6	32.1	61.0	55.4	26.5	22.4	4.7	4.7	0.5	0.9
III NB*	55*	49.3	47.2	53.0	52.0	4.7	5.4	0.9	0.9	Vehicles not observed			
III NB**	25**	36.8	34.2	44.0	42.0	96.3	95.2	16.7	21.9	38.9	47.2	71.3	80.0
III SB	25	33.1	32.8	39.0	38.0	91.0	90.2	27.9	31.3	59.5	59.8	87.4	87.5

NOTE: Sites I and II speed data recorded for 72 hr with automatic counter; data shown here are from first 24 hr. Site III data recorded with radar gun for 1 hr.
*1000 ft from school zone.
**Within school zone.

"IMPRESSION" SURVEY AND RESULTS

An "impression" survey was also conducted, using questions modelled on those in a survey by the Oregon Department of Transportation during their initial test of the SYG sign color. A sample NYSDOT survey form is shown in Appendix B. A total of 210 survey forms were distributed (70 at each location) with 54 returned. The survey forms were distributed randomly by DOT staff to pedestrians, nearby residents, and passing motorists beyond the evaluation zone at each site. Survey respondents (more than one category per person was allowed) were classified as follows:

Student	36
Interested Citizen	25
Nearby Resident	17
Passing Motorist	18
Civic Organization	1

Respondents were asked to rate both the standard yellow and fluorescent SYG signs on a scale of 1 to 5 against four criteria. The response scale was as follows:

1 = Strongly Agree
2 = Agree
3 = Neutral
4 = Disagree
5 = Strongly Disagree

The four criteria were as follows:

1 = It gets my attention
2 = It stands out against the background
3 = The symbol on the sign is easy to recognize
4 = It will improve safety.

Survey responses for each of these four criteria were classified as coming from persons who 1)"favored standard sign over SYG sign," 2) were "neutral," or 3) "favored SYG sign over the standard sign." Their responses are summarized in Table 5. The SYG sign was favored over the standard sign for all four criteria. A non-parametric sign test (4) was used to find any significant difference among survey responses. Results indicate that the SYG sign was significantly favored over the standard sign for the first, second, and fourth criteria. No significant difference was observed between the two signs for the third criterion. Results of this sign test are also given in Table 5.

Respondents were also asked to provide overall recommendations for changing sign color from standard yellow to fluorescent SYG. Fifty-two persons provided overall recommendations, with

Table 5. Classification of "impression" survey responses.

Criterion	Responses: Favored Std Sign	Neutral	Favored SYG Sign	Binomial Probabilities at p = 0.5
Gets my attention	1	9	30	0.00111 for n = 40 and r = 10*
Stands out against background	1	7	31	0.00015 for n = 39 and r = 8*
Symbol is easily recognized	1	20	19	0.43731 for n = 40 and r = 21
Will improve safety	1	11	27	0.01185 for n = 39 and r = 12*

NOTE: The following hypothesis was evaluated: Ho: $p \leq 0.5$ and Ha: $p > 0.5$ where p indicates probability of favoring the SYG sign over the standard sign. The null hypothesis Ho means that the SYG sign is less or equally favored compared to the standard sign, and is rejected if the critical number obtained from the binomial table is less than 0.05. It can then be concluded that the SYG sign is significantly favored over the standard sign.
*SYG sign significantly favored over the standard sign (n = sample size, r = respondents who were neutral or favored the standard sign over the SYG sign).

more than half recommending change to the SYG color. The breakdown of the various recommendations was as follows:

Strongly Recommend Change	23 (44%)
Recommend Change	15 (29%)
Neutral	11 (21%)
Recommend Against Change	2 (4%)
Strongly Recommend Against Change	1 (2%)

The 38 respondents favoring change to the SYG sign had viewed the signs at various times of day -- 16 (42%) during "complete daylight," 9 (24%) during "complete darkness," and 13 (34%) during "daylight/darkness" conditions.

Some respondents also provided additional comments. Most mentioned that the new SYG sign color attracts attention. A few expressed concern about the cost of changing the sign color, and that the novelty effect might wear off if the SYG color were used on a regular basis. One respondent viewed the new sign as "ugly" and another expressed doubts as to whether the new color would be effective in changing driver behavior. Another respondent also recommended replacing "signs with long sentences by signs with symbols."

RECOMMENDATIONS

Analysis of the behavioral and conflict data showed that the SYG color performed better than the standard yellow. Survey respondents also rated SYG signs as better than the standard signs. Results of the speed study showed that vehicle speeds and percentage of vehicles exceeding the speed limit were essentially the same during the entire evaluation period. The findings of this study provide encouraging evidence about the benefits of using SYG signs to replace standard yellow signs. However, the study's short duration, absence of control sites, and limited number of sites used for testing prevent drawing a strong recommendation about using SYG signs. It is anticipated that when FHWA combines results of this study with those from other jurisdictions, more definitive conclusions will be drawn regarding effectiveness of the SYG sign color in improving driver behavior and vehicle speed.

ACKNOWLEDGMENTS

This research was initiated by Thomas C. Werner, Director, Traffic Engineering and Safety Division. Michael Clarke, Transportation Maintenance Division, helped in ordering and purchasing the signs required to conduct the field study. Traffic and Safety personnel in NYSDOT Regions 2 and 3 collected and summarized all data for this study. David Fifield, Head of the Traffic Monitoring Section at the Main Office in Albany, helped in downloading and summarizing speed data from traffic counters. Jennifer Opar, Engineering Intern in 1994 from Rensselaer Polytechnic Institute, also provided valuable assistance during the approval process for this study. Cooperation of the communities where studies were conducted is gratefully acknowledged.

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APPENDIX A. RESEARCH AND EVALUATION PLAN.

Activities	Scheduled Dates		Actual Dates	
	Begin	End	Begin	End
1. Select sites (three locations)	3/22	7/31	3/22	7/31
2. Review sites and inventory existing signs	5/1	6/29	5/1	6/29
3. Order and receive SYG signs	9/8	10/3	9/8	10/7
4. Conduct "before" studies	9/26	10/3	9/26	10/6
5. Install SYG signs	10/5	10/14	10/10	10/13
6. Conduct "after studies and distribute survey forms	11/15	11/30	11/14	11/17
7. Receive responses to survey forms	11/20	12/31	11/20	12/31
8. Reinstall standard yellow signs	12/10	12/31	12/1	12/15
9. Write and transmit final report	1/10*	3/31*	12/5	5/31*

*1995 activities; all other activities in 1994.

APPENDIX B. SAMPLE "IMPRESSION" SURVEY FORM

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Fluorescent Strong Yellow-Green Crossing Sign
Comparison Study

The New York State Department of Transportation is participating in a Federal study to evaluate a new sign material known as flourescent strong yellow green for warning signs. The new sign material is designed to improve motorist recognition of a crossing area. If successful, the change could help reduce some of the 8,200 traffic accident deaths that occur nationally among school children, pedestrians, and bicyclists each year. You can provide valuable feedback by completing and returning this survey by December 31, 1994.

Sign Locations: Please Circle the Appropriate Location

Route 233	Newbig Street & Prospect Terrace	East Ave.
Westmoreland C.S.	SUNY, College at Cortland	Cornell U.
Utica, NY	Cortland, NY	Ithaca, NY

The signs were observed on: _____ / _____ / 1994 [(month) (day)]

The time that you last saw the signs: ___:___ [ ] AM [ ] PM

Describe the light conditions at the time of viewing?

[ ] Complete Daylight
[ ] Complete Darkness
[ ] Daylight/Darkness (Dusk/Dawn)

Describe the weather conditions? (Check all that apply)

[ ] Clear
[ ] Light Cloud Cover
[ ] Heavy Cloud Cover
[ ] Rain
[ ] Other _____

Check all descriptions which apply to you:

[ ] Student
[ ] Interested Citizen
[ ] Nearby Resident
[ ] Passing Motorist
[ ] Civic Organization - (e.g., Lions Club, PTA, etc.)

Occupation: _____

Rate each of the two signs on a scale from 1 to 5 using the following criteria.

1 = Strongly Agree
2 = Agree
3 = Neutral
4 = Disagree
5 = Strongly Disagree

Place only one mark per question and sign type.

	Standard Yellow Signs					Flourescent Strong Yellow-Green Signs				
	1	2	3	4	5	1	2	3	4	5
It gets my attention										
It stands out against the background										
The symbol on the sign is easy to recognize										
It will improve safety										

Indicate your recommendation for changing the color of these warning signs from yellow to flourescent strong yellow-green.

[ ] Strongly Recommend Change
[ ] Recommend Change
[ ] Neutral
[ ] Recommend Against Change
[ ] Strongly Recommend Against Change

Other Comments:_____

_____

_____

_____

----------Fold Line----------

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