MICHIGAN ROADSIDE LITTER COMPOSITION STUDY

FINAL REPORT
DECEMBER 1979
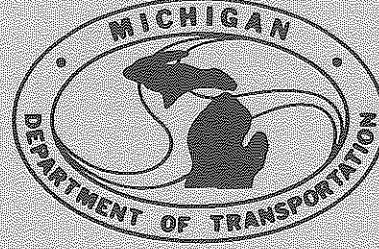
MICHIGAN DEPARTMENT OF TRANSPORTATION
MAINTENANCE DIVISION
M.L. O'Toole, Asst. Engineer of Maintenance

TABLE OF CONTENTS

SCOPE

It was determined that a total of 36 plots (see Figure 1) would be necessary to adequately sample the litter along the state highways.

The locations of the plots were selected by central office personnel and selections were made to meet the following conditions.

Four plots were selected in each of the nine highway districts, so the workload would be evenly spread among available permanent crews. The headquarters of the District Roadside Landscape crew was the beginning point for locating the plots. This was done to minimize travel time so all plots could be measured on the specified dates.

This system of plot selection, while not a true random method, did provide samples from all parts of the state and all types of highways were adequately represented.

The study divides the litter into five categories, the same categories used in the 1968 Highway Research Board litter study. While the methodology of the two studies differs slightly, some comparisons can be drawn between the two.

Figure I

LOCATION OF PERMANENT LITTER PLOTS
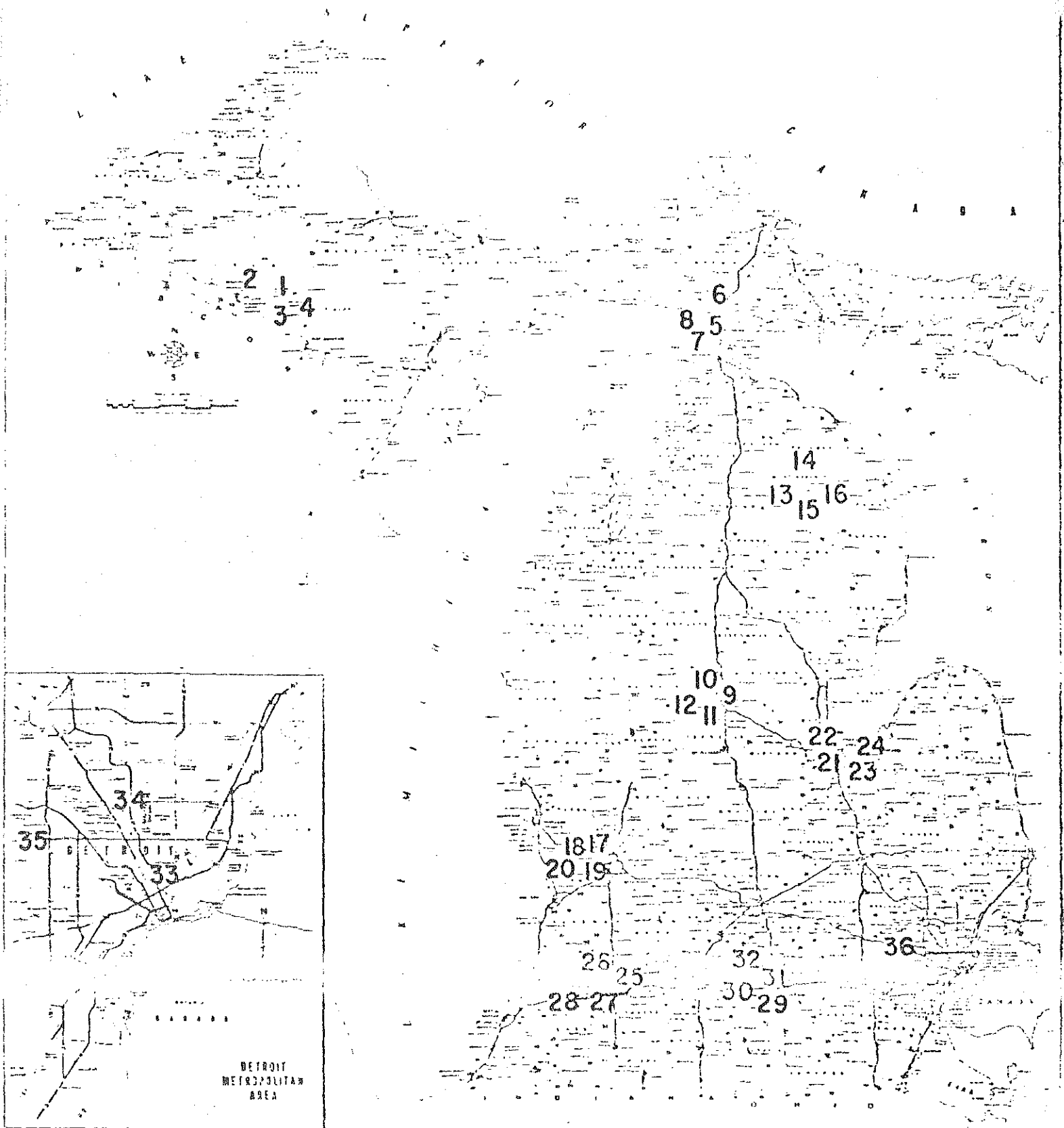
STUDY METHODOLOGY

The survey crews in each of the nine districts were sent directions to locate the four plots in their district. They were instructed to locate the point of beginning of each plot with the vehicle odometer and to accurately measure the 1,000-foot length of each plot (see instructions in Appendix). Each plot was permanently marked so the same exact location would be measured each year.

Each plot included the entire width of the right of way; so, in addition to picking up the litter on both sides of the highway, the litter was also picked up from the median of the divided highways. The entire right of way was included because, while the heavy litter items pretty much stay where they land, the lighter items sometimes blow back and forth across the highway.

The study did not take into consideration that some highway-oriented litter might have blown completely off the right of way or, for that matter, no allowance was made for urban-oriented litter which may have blown onto the right of way.

The survey period decided upon was in general, the last three weeks of August and the first week of September. This period covered Labor Day, one of the three major summer holidays - all three of which generate a high volume of tourist traffic.

MICHIGAN DEPARTMENT OF
TRANSPORTATION LIBRARY
LANSING   48909

The Michigan Department of Transportation's litter study included only items larger than a cigarette package. The decision to limit the tally to items this size excluded items such as gum wrappers and beverage can pull tabs; it was believed these items are not particularly significant along a high-speed highway. Small items do make a significant impact along sidewalks, in parks or on beaches.

The first measurement of the plots was in August/September of 1977. The plots, including a 100' buffer strip at each end of the plot were completely cleared of litter. The fresh litter accumulated in the plot was picked up at the end of the thirty-day period and each item was tallied in the appropriate category. Forms and complete instructions were provided to the survey crews. (A complete set of forms and instructions are included in the appendix of this report.)

The plots were measured again in 1978 and in 1979. The third measurement in August/September of 1979 was the first measurement after the effective date of the "Bottle Law" which was December 3, 1978. A summary of the three field measurements is in Table 4.

DATA ANALYSIS

The litter collected on the roadside plots was divided into five general categories; paper, plastic, cans, miscellaneous and bottles. Two of the five general categories were more closely examined. These were the categories of cans and bottles, which were the two categories directly affected

-4-

by the "Bottle Bill."

The data shown in Table 4 represents a 30-day accumulation of litter on each of the 36 plots for each year of the study. The instructions for each year's measurement specified the dates for the measurement. The example in the appendix was for the 1977 measurement.

For the purpose of this study, the general premise that roadside litter accumulations are in direct proportion to the traffic volume was accepted. The 9,300-mile state highway system was then separated into four traffic volume levels according to the ADT[1].

The categories used and the number of miles of highway in each category are as follows.

ADT	Miles in ADT Categories	Plots Assigned to each Category
0 - 2,500	2,400	1, 2, 3, 4, 12, 13, 14, 15, 16
2500 - 10,000	4,800	5, 6, 7, 8, 9,10, 11, 19, 20, 23,24, 27, 28, 31, 32
10,000+	1,900	17, 18, 21, 22,25, 26, 29, 30
Metro[2]	200	33, 34, 35, 36
TOTAL	9,300	36 plots

(1) ADT (Average Daily Traffic) the average number of vehicles using a section of highway each day computed on a yearly basis.

(2) The Metro category includes highways in metropolitan areas with very high ADT's.

After the 9,300 miles were divided into ADT groups, the ADT of each plot was determined and the plot assigned to one of the four categories. The aforementioned chart shows which plots were assigned to each ADT category.

The plots were separated in this manner to minimize bias in the results from extreme traffic volumes. For example, in 1977, Plot 1 had one newspaper item while Plot 34 had 265. The average would have been 133 items/plot which was not indicative of actual volumes on either plot. ADT grouping corrected these differences and provided a prorated average.

The data from 36 litter plots (Table 4) was analyzed in the above groups and it was within these groups that data was tested for reliability and outliers [1] eliminated.

The values in Table 1 (number of items per mile) were computed by weighting the item categories according to the ADT categories and comparison mileage in each category. The formula used to calculate the values in Tables 1, 2 and 3 is in Appendix 23.

RELIABILITY

Confidence limits of 95% were used to measure reliability of the data. Outliers, values that did not fall within the "t" distribution of ± 1.96 [2] (95% confidence), were suspect

(1) Outliers are unusually high or low values, they are determined statistically. See Appendix

(2) Blalock, Jr., Hubert M., 1972 <u>Social</u> <u>Statistics</u>, New York, McGraw Hill, P. 559

since their chances of occurring were less than one in twenty.
A test for outliers was used to determine reliability (See
Appendix 24). Plots were grouped according to ADT to
minimize the effects of sheer traffic volume in determining
mean values ($\bar{x}$). Means for each ADT group were calculated
then averaged to determine per mile and percentage figures.

The outlier test was used for totals in each category
(paper, plastic etc.) and for sub-categories in cans and
bottles (returnable soft drink, non-returnable bottles, etc.).
Outliers are marked with an "x" and totals affected by
outliers are marked with a "+." These values were not used
in statistical computations since they were calculated as
non-representative items.

FACTORS INFLUENCING ROADSIDE LITTER

While the litter study was set up primarily to document
changes brought about by the beverage container law, it should
be kept in mind that other factors could have an influence
on litter trends. Since litter is a "people problem", roadside
litter to a large extent is influenced not only by the number
of people (vehicles) using the highways, but by what is
available to the people at the market place. For example,
if there are "fast food" outlets in an area, it may be
expected that the packaging used in the fast food industry
will be represented in the roadside litter composition and
volume data.

Highways which are used to transport refuse from metro-
politan areas to "landfills" usually have a particularly high
volume of litter which is blown or falls from uncovered or
inadequately covered refuse-hauling vehicles.

Another item to be considered is a report released in
December 1979 by the Michigan Liquor Control Commission
which states that beer sales have declined in 1979. The
report does not identify the specific packaging that is
affected, but the overall sales in the two months which could
influence the roadside litter study were down. Sales to
wholesalers were down 13.1% in July 1979 and 5% in August 1979
over the 1978 volumes.

The factor which has the most direct effect on roadside
litter is the traffic volume. In general, the Michigan
traffic volumes for the month of August in 1978, were higher
than in 1977 (Figure 2) but in 1979, the volumes decreased
substantially. While the statewide average for August 1979
was only 4.1% below August 1978, the tourist areas of the
state showed a much larger decrease. For example, the Upper
Peninsula of Michigan was down 13.1% for the western portion
and 15.3% for the eastern portion.

No attempt has been made to adjust the plot data for any
of these factors but for those who are studying the litter
trends, it should be kept in mind that these and other
factors may have an influence on the results.

FIGURE 2

MICHIGAN DEPARTMENT OF TRANSPORTATION

TRAFFIC VOLUME TRENDS
Travel On Main Rural Roads Statewide
COMPARING MONTH OF AUGUST
1977 - 1978 - 1979

1978 + 4.1 % over 1977
1979 - 13.1 % over 1978

WESTERN UPPER
PENINSULA

EASTERN UPPER
PENINSULA

1978 + 2.9 % over 1977
1979 - 15.3 % over 1978

NORTHERN
LOWER PENINSULA

1978 + 3.6 % over 1977
1979 - 5.4 % over 1978

SOUTH CENTRAL
& THUMB AREA

1978 + 7.2 % over 1977
1979 - 5.8 % over 1978

SOUTH
WESTERN

SOUTH
EASTERN

1978 + 7.6 % over 1977
1979 - 3.2 % over 1978

1978 + 3.9 % over 1977
1979 - 1.4 % over 1978
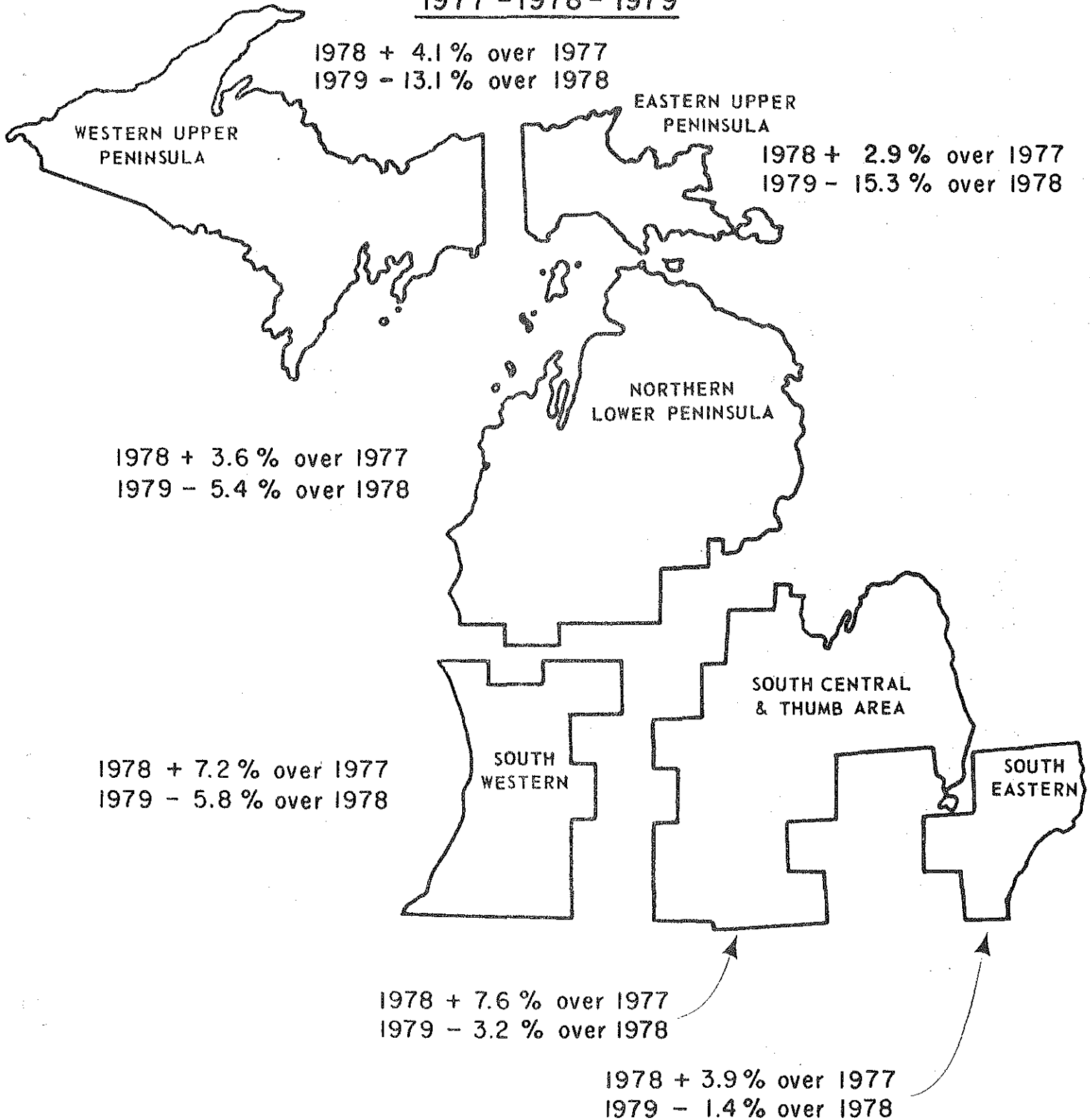
RESULTS OF STUDY

The total litter items in 1979 showed a reduction of 41% over 1978 and 29% over 1977.

The results of the study indicate a reduction in roadside litter in 1979 in four of the five major litter categories and,while paper items decreased in 1979 from the 1978 total, it was still higher than the 1977 value.

The plastic items showed a small decrease in 1978 over 1977 figures and a little larger decrease (approximately 22%) in 1979 over 1978.

There were reductions of 38% and 35% in 1978 and 1979 over the previous year for the miscellaneous items.

The major impact of the beverage container law was on the can and bottle categories which are discussed in more detail below.

CAN CATEGORY

The totals for the can category (See Table 2) show a 79% reduction in 1979 over 1977 and an 81% reduction over 1978. Beverage cans including both returnable and non-returnable cans for the same years showed an 82% and 84% reduction respectively. It is interesting to note that even with a 10¢ deposit on beverage cans, a fair number of them showed up along the roadsides.

Of perhaps even more significance, there were still a number of non-returnable cans deposited along the highway system.

BOTTLE CATEGORY

There was a reduction of 76% in total bottles (See Table 3) in 1979 over 1977 and 77% over 1978. When just the beverage bottles were examined, the percentages were a minus 84% and 86% respectively for the same years.

Although the non-returnable beverage bottles were still represented in the roadside litter, the reduction for 1979 was 92% over 1977 and 94% over 1978.

TABLE 1

NUMBER OF ITEMS PER MILE BY CATEGORY OF LITTER

ACCUMULATED ALONG STATE HIGHWAYS IN MICHIGAN

IN AN AUGUST – SEPTEMBER [1] 30 DAY PERIOD

	1968 [2]	1977	1978	1979
Paper Items				
Newspapers, packages & containers	392	506	795	519
Cans				
Beer, soft drink and food	74	162	180	34
Plastic				
Packages, containers	75	159	156	122
Miscellaneous				
Auto parts, tires, lumber etc.	159	201	123	80
Bottles				
Beer, soft drink, food and liquor	49	47	48	11
TOTAL	749	1075	1302	766

(1) Study conducted last three weeks of August and first week of September

(2) Michigan figures taken from a Highway Research Board Study conducted in 1968

TABLE 2

AVERAGE NUMBER OF CANS ACCUMULATED PER MILE

ALONG MICHIGAN ROADSIDES IN A 30 DAY
AUGUST - SEPTEMBER (1) PERIOD

	1968 (2)	1977	1978	1979
Returnable beer cans	-0-	-0-	-0-	5.0
Non-returnable beer cans	53	116.6	127.1	13.5
Returnable soft drink cans	-0-	-0-	-0-	3.2
Non-returnable soft drink cans	16	34.6	49.4	6.2
Food cans	-0-	4.6	2.0	2.3
Other cans	5	5.7	1.5	4.0
TOTAL	74	161.5	180.0	34.2

(1) Study conducted last three weeks of August and first week of September

(2) Michigan figures taken from a nationwide Highway Research Board Study conducted in 1968

TABLE 3

AVERAGE NUMBER OF GLASS ITEMS ACCUMULATED PER MILE

ALONG MICHIGAN ROADSIDES IN A 30 DAY
(1)
AUGUST – SEPTEMBER PERIOD

	1968 (2)	1977	1978	1979
Returnable beer bottles	8	3.0	2.1	2.6
Non-returnable beer bottles	27	24.5	29.0	1.5
Returnable soft drink bottles	5	4.2	2.6	1.0
Non-returnable soft drink bottles	2	6.8	10.0	1.0
Wine or liquor bottles	5	5.0	3.3	2.2
Food bottles or jars	3	1.9	1.0	.5
Other bottles or jars	0	1.4	.4	2.2
TOTAL	50	46.8	48.4	11.0

(1) Study conducted last three weeks of August and
     first week of September

(2) Michigan figures taken from a nationwide Highway
     Research Board study conducted in 1968

SUMMARY

The analysis of the litter data collected over the past three years indicates that roadside litter was substantially reduced in 1979. The data also confirms that the beverage container legislation was a primary factor responsible for the litter decrease. In addition, decreased traffic volumes and increased public concern have figured prominently in reducing total litter.

Highway roadside litter decreased 41% during the 30 day August/September survey period in 1979 over the same period in 1978. In 1978, however, beverage containers affected by the law made up only 16% of the roadside litter total and while there was an 84% reduction in beverage containers in 1979, that reduction only accounts for a little over one-third of the 41% reduction in total litter.

While decreased August traffic volumes in 1979 have had an impact on roadside litter, especially in tourist areas, a large portion of the reduction can be attributed to an indirect benefit of the "Bottle Bill." It is quite possible that, with all the publicity and public awareness the "Bottle Bill" has generated, our society has become more litter conscious.

APPENDIX

TABLE 4

ROADSIDE LITTER DATA
RAW DATA FOR AUG-SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT #	1			2			3			4			5			6		
	YEAR	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.		1	0	0	0	4	0	13	0	0	7	0	0	0	0	0	0	0	0
Paper Packages, etc.		1	0	7	6	7	0	5	7	0	8	8	0	26	42	24	16	14	10
Other Paper Items		0	3	7	1	6	15	22	9	15	0	25	6	146	57	55	85	19	71
TOTAL PAPER ITEMS		2	3	14	7	17	15	40	16	15	15	33	6	172	99	79	101	33	81
Returnable Beer Cans		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2
Non-Ret. Beer Cans		7	8	1	7	3	0	7	9	0	8	10	0	30	10	1	7	14	0
Return. Soft Drink Cans		0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Non-Ret. Soft Drink Cans		2	2	0	3	1	1	2	4	0	0	2	0	9	4	2	14	10	3
Food Cans		0	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1
Other Cans		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL CAN ITEMS		9	11	2	10	4	1	10	13	0	8	12	0	39	14	6	21	24	6
Plastic Containers		2	1	4	3	0	0	17	1	0	6	0	0	1	4	3	0	2	3
Other Plastic Items		4	0	1	1	1	2	6(x)	0	2	2	5	0	19	10	7	4	6	10
TOTAL PLASTIC ITEMS		6	1	5	4	1	2	23(x)	1	2	8	5	0	20	14	10	4	8	13
Auto Parts & Acces.		0	1	0	8	2	0	0	0	0	0	0	0	1	3	4	0	0	2
Tires or Tire Pieces		0	0	0	0	0	0	0	0	0	0	0	1	37	3	1	9	5	11
Lumber & Construction Items		0	1	1	4	0	0	0	0	0	1	0	0	0	0	3	1	0	0
Unclassified Items		0	1	0	0	0	0	5	1	12	0	0	0	48	0	0	15	0	0
Special Interest Items		0	0	0	0	0	0	0	0	0(x)	0	0	0	1	2	0	0	4	0
TOTAL MISCELLANEOUS ITEMS		0	3	1	12	2	0	5	1	12(x)	1	0	1	87(x)	8	8	25	9	13
Returnable Beer Bottles		0	0	0	0	0	0	1	0	0	0	0	0	1	5	0	0	0	0
Non-Ret. Beer Bottles		1	1	0	2	0	0	2	0	0	0	2	0	6	0	0	4	2	0
Return. Soft Drink Bottles		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Non-Ret. Soft Drink Bottles		0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0
Wine or Liquor Bottles		0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Food Bottles or Jars		0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
Other Bottles or Jars		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL BOTTLE & JAR ITEMS		1	1	0	3	0	0	3	1	2	0	3	0	10	6	0	4	2	0
TOTAL ITEMS ON PLOT		18	19	22	36	25	18	81(+)	32	31	32	53	7	328(+)	141	103	155	76	113

(x) - Outliers deleted   (+) - Outlier affected totals deleted

TABLE 4 (CONT.)

ROADSIDE LITTER DATA
RAW DATA FOR AUG – SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT #	7			8			9			10			11			12		
	YEAR	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.		2	1	1	0	1	1	0	0	0	0	0	4	4	3	0	2	0	0
Paper Packages, etc.		114	34	32	4	19	11	16	45	53	28	65	118	15	175	48	5	30	10
Other Paper Items		0	77	74	116	33	37	13	30	55	16	52	45	12	30	20	3	11	7
TOTAL PAPER ITEMS		116	112	107	120	53	49	29	75	108	44	117	167	31	208	68	10	41	17
Returnable Beer Cans		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Non-Ret. Beer Cans		16	15	0	13	4	0	14	26	4	14	20	12	23	150	8	13	31	2
Return. Soft Drink Cans		0	0	2	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0
Non-Ret. Soft Drink Cans		5	11	2	3	7	1	3	4	0	2	11	3	6	49	1	1	9	0
Food Cans		0	0	0	0	0	0	1	0	0	1	0	2	2	6	0	0	0	0
Other Cans		1	1	1	0	0	0	0	1	0	0	0	1 (x)	0	2 (x)	0	0	0 (x)	0
TOTAL CAN ITEMS		22	27	5	16	11	1	18	31	4	17	31	24 (x)	31	207 (x)	9	14	40 (x)	2
Plastic Containers		1	6	9	2	2	2	0	0	0	0	10	12	6	23	8	1	4	3
Other Plastic Items		5	6	6	10	8	4	3	4	9	0	13	3	3	24	3	2	7	1
TOTAL PLASTIC ITEMS		6	12	15	12	10	6	3	4	9	0	23	15	9	47	11	3	11	4
Auto Parts & Acces.		0	4	4	1	1	1	2	5	16	0	5	7	0	27	2	0	4	2
Tires or Tire Pieces		2	5	4	8	1	2	3	15	5	1	25	13	2	8	5	2	2	3
Lumber & Construction Items		0	1	2	0	1	0	1	5	4	0	15	2	4	6	1	0	1	2
Unclassified Items		9	0	0	0	0	0	0	3	6	0	0	1	0	6	4	0	0	1
Special Interest Items		3	0	0	1	0	0	1	0	0 (x)	0	1	0	0	13 (x)	0	0	3 (x)	0
TOTAL MISCELLANEOUS ITEMS		14	10	10	10	3	3	7	28	31 (x)	1	46	23	6	60 (x)	12	2	10 (x)	8
Returnable Beer Bottles		0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0
Non-Ret. Beer Bottles		1	5	0	1	2	0	3	4	0	3	2	1	4	29	1	8	5	0
Return. Soft Drink Bottles		0	0	0	0	0	0	1	1	1	0	0	0	2	1	1	1	1	0
Non-Ret. Soft Drink Bottles		2	0	0	0	0	0	1	0	0	1	0	1	1	16	0	0	3	0
Wine or Liquor Bottles		1	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0
Food Bottles or Jars		0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Other Bottles or Jars		1	0	0	0	0	0	0	0	0	0	0	0	0	0 (x)	0	0	0 (x)	0
TOTAL BOTTLE & JAR ITEMS		5	5	1	1	2	1	4	6	1	4	3	2	8	48 (x)	2	9	11 (x)	0
TOTAL ITEMS ON PLOT		163	166	138	159	79	60	60	144	153 (+)	66	220	233 (+)	85	570 (+)	102	38	113 (+)	31

(x) - Outliers deleted   (+) - Outlier affected totals deleted

-18-

TABLE 4 (CONT.)

ROADSIDE LITTER DATA
RAW DATA FOR AUG – SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT # 13			14			15			16			17			18		
YEAR	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.	0	2	0	0	3	0	1	0	0	4	1	1	2	5	5	2	4	4
Paper Packages, etc.	33	8	4	23	7	10	15	2	4	16	6	9	128	31	37	33	21	29
Other Paper Items	50	11	15	0	10	20	0	13	12	7	2	12	58	128	71	44	22	57
TOTAL PAPER ITEMS	83	21	19	23	20	30	16	15	16	27	9	22	188	164	113	79	47	90
Returnable Beer Cans	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	8
Non-Ret. Beer Cans	14	18	0	7	10	0	10	9	2	19	13	0	74	33	6	19	22	5
Return. Soft Drink Cans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
Non-Ret. Soft Drink Cans	9	6	0	5	5	0	3	0	1	4	3	0	27	13	0	6	6	1
Food Cans	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0
Other Cans	0	0	0	1	0	1	0	0	0	0	1	1	2	1	1	0	0	0
TOTAL CAN ITEMS	23	25	0	13	15	1	13	9	3	23	17	2	103	49	13	25	29	14
Plastic Containers	11	3	0	4	9	5	10	2	3	5	3	1	39	15	25	16	13	24
Other Plastic Items	1	4	1	0	4	10	0	4	0	0	2	0	25	29	20	18	8	18
TOTAL PLASTIC ITEMS	12	7	1	4	13	15(x)	10	6	3	5	5	1	64	44	45	34	21	42
Auto Parts & Acces.	0	0	0	2	0	0	1	0	0	0	0	0	14	16	11	7	4	10
Tires or Tire Pieces	0	0	0	1	0	0	1	0	1	0	0	1	8	23	15	19	5	11
Lumber & Construction Items	22	0	0	5	0	0	0	0	2	0	0	1	18	39	29	9	2	21
Unclassified Items	43	2	1	0	3	4	1	0	1	0	0	0	23	14	6	2	3	6
Special Interest Items	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0
TOTAL MISCELLANEOUS ITEMS	65(x)	2	2	8	3	4	3	1	4	0	0	3	64	92	61	37	14	48
Returnable Beer Bottles	0	0	0	0	1	2	0	0	0	1	0	0	0	1	0	0	0	1
Non-Ret. Beer Bottles	43	4	0	0	0	0	1	0	0	0	1	1	18	17	1	4	7	0
Return. Soft Drink Bottles	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	1	0
Non-Ret. Soft Drink Bottles	1	2	0	3	1	1	0	1	0	2	1	0	4	0	0	0	1	0
Wine or Liquor Bottles	1	0	0	1	1	0	0	0	0	0	0	0	0	2	0	2	1	0
Food Bottles or Jars	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
Other Bottles or Jars	0(x)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
TOTAL BOTTLE & JAR ITEMS	45(x)	6	0	4	3	3	3	1	0	4	2	1	23	21	1	7	10	2
TOTAL ITEMS ON PLOT	228	61	22	52	54	52(+)	45	32	26	59	33	29	442	370	233	182	121	196

(x) – Outliers deleted   (+) – Outliers affected totals deleted

TABLE 4 (CONT.)

ROADSIDE LITTER DATA
RAW DATA FOR AUG – SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT #	19			20			21			22			23			24		
	YEAR	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.		6	5	7	5	0	7	3	18	0	0	3	0	19	20	3	4	46	1
Paper Packages, etc.		14	51	15	14	46	31	55	550	69	105	555	154	53	150	43	31	130	36
Other Paper Items		13	23	31	16	37	52	73	150	137	146	90	159	28	20	67	23	14	29
TOTAL PAPER ITEMS		33	79	53	35	83	90	131	718	206	251	648	313	100	190	113	58	190	66
Returnable Beer Cans		0	0	0	0	0	1	0	0	3	0	0	8	0	0	0	0	0	0
Non-Ret. Beer Cans		18	7	2	13	40	10	34	48	6	116	76	20	27	40	1	42	32	1
Return. Soft Drink Cans		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Non-Ret. Soft Drink Cans		1	7	0	4	18	2	7	16	3	23	25	7	1	17	1	8	12	0
Food Cans		0	0	0	1	0	0	2	0	1	4	0	0	0	1	0	0	0	0
Other Cans		0	0	0	0	1	0	1	0	1	4	0	4	2	0	0	0	0	0
TOTAL CAN ITEMS		19	14	2	18	59	13	44	64	14	$147^{(x)}$	101	$40^{(x)}$	30	58	2	$50^{(x)}$	44	1
Plastic Containers		3	7	12	7	13	17	14	0	5	47	0	6	6	0	3	10	3	0
Other Plastic Items		2	9	8	8	18	5	21	5	0	41	4	10	18	1	0	0	1	2
TOTAL PLASTIC ITEMS		5	16	20	15	31	22	35	5	5	88	4	16	24	1	3	10	4	2
Auto Parts & Acces.		3	3	1	2	4	2	12	11	3	10	20	19	3	0	1	6	6	0
Tires or Tire Pieces		1	3	0	16	5	3	37	22	50	74	34	109	0	7	0	17	0	2
Lumber & Construction Items		10	5	4	3	2	4	10	3	20	28	5	10	17	4	1	11	1	0
Unclassified Items		2	3	0	1	4	3	0	3	9	0	13	43	1	2	9	0	0	1
Special Interest Items		0	0	2	0	0	0	0	1	0	0	0	0	1	1	0	2	0	0
TOTAL MISCELLANEOUS ITEMS		16	14	7	22	15	12	59	40	82	112	72	$181^{(x)}$	22	14	11	36	7	3
Returnable Beer Bottles		0	0	0	0	0	1	0	4	0	1	0	3	1	1	1	0	1	0
Non-Ret. Beer Bottles		2	0	0	1	13	0	4	17	0	23	29	8	12	11	0	5	11	2
Return. Soft Drink Bottles		0	1	0	0	0	0	2	1	-2	5	0	1	0	4	0	1	0	0
Non-Ret. Soft Drink Bottles		1	0	0	0	4	0	0	4	0	2	6	4	6	7	2	0	1	0
Wine or Liquor Bottles		0	0	0	0	1	0	1	1	2	1	1	3	0	3	0	0	0	0
Food Bottles or Jars		0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Other Bottles or Jars		0	0	1	0	0	5	0	0	0	0	0	0	1	0	1	0	0	0
TOTAL BOTTLE & JAR ITEMS		3	1	1	1	18	6	7	27	4	32	36	19	$21^{(x)}$	26	4	6	13	2
TOTAL ITEMS ON PLOT		76	124	83	91	206	143	276	853	211	$630^{(+)}$	861	$579^{(+)}$	$197^{(+)}$	289	133	160	258	74

(x) – Outliers deleted   (+) – Outlier affected totals deleted

TABLE 4 (CONT.)

ROADSIDE LITTER DATA
RAW DATA FOR AUG – SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT #	25			26			27			28			29			30	
	YEAR	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.		5	0	50	0	0	0	3	2	3	14	0	7	8	0	4	5	1	0
Paper Packages, etc.		76	94	76	57	122	86	58	91	65	40	78	29	48	61	28	31	46	10
Other Paper Items		121	168	0	115	118	115	112	241	116	33	71	124	152	120	18	47	22	15
TOTAL PAPER ITEMS		202	262	126	172	240	201	173	334(x)	184	87	149	160	208	181	50	83	69	25
Returnable Beer Cans		0	0	1	0	0	0	0	0	0	0	0	1	0	0	5	0	0	0
Non-Ret. Beer Cans		56	26	11	43	20	8	31	22	0	18	15	2	20	17	4	11	23	0
Return. Soft Drink Cans		0	0	0	0	0	0	0	0	1	0	0	3	0	0	5	0	0	1
Non-Ret. Soft Drink Cans		18	10	2	12	6	4	10	7	0	7	4	0	10	10	1	10	15	7
Food Cans		4	0	0	2	0	0	1	3	0	1	0	0	5	0	9	0	0	0
Other Cans		0	0	0	0	0	0	2	0	0	1	0	0	3	0	7	1	0	0
TOTAL CAN ITEMS		78	36	14	57	26	12	44	32	1	27	19	6	38	27	31	22	38	8
Plastic Containers		10	33	21	9	14	5	17	78	12	3	25	13	13	33	35	4	5	9
Other Plastic Items		29	70	41	40	121	76	24	86	59	21	15	17	55	45	23	16	5	4
TOTAL PLASTIC ITEMS		39	103	62	49	135	81	41(x)	164(x)	71(x)	24	40	30	68	78	58	20	10	13
Auto Parts & Acces.		18	6	8	16	9	11	11	12	4	4	9	2	23	4	15	9	5	3
Tires or Tire Pieces		14	7	9	51	52	24	3	4	4	3	0	8	73	30	12	85	16	41
Lumber & Construction Items		15	3	12	31	11	3	12	14	3	2	2	4	24	39	8	5	1	2
Unclassified Items		12	14	6	14	14	8	12	0	3	2	4	4	28	11	10	10	9	1
Special Interest Items		1	0	0	2	0	0	9	8	0	0	0	0	2	0	0	0	0	0
TOTAL MISCELLANEOUS ITEMS		60	30	35	114	86	46	47	38	14	11	15	18	150	84	43	109	31	47
Returnable Beer Bottles		3	0	3	0	0	3	6	0	1	0	0	4	0	0	2	1	0	0
Non-Ret. Beer Bottles		7	7	1	8	5	0	3	0	0	6	2	2	0	0	6	2	0	0
Return. Soft Drink Bottles		4	0	1	1	1	0	1	2	0	3	0	2	3	0	6	0	3	0
Non-Ret. Soft Drink Bottles		3	4	2	3	1	0	3	0	0	0	0	0	0	1	5	2	1	0
Wine or Liquor Bottles		7	1	1	4	0	0	0	3	1	1	0	0	1	0	2	1	0	2
Food Bottles or Jars		5	0	0	3	0	1	0	4	0	0	0	0	0	0	7	0	0	0
Other Bottles or Jars		0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
TOTAL BOTTLE & JAR ITEMS		29	13	7	19	7	4	13	9	2	10	2	8(x)	4	1	32(x)	6	4	2
TOTAL ITEMS ON PLOT		408	444	243	411	494	344	318(+)	577(+)	274(+)	159	225	222(+)	468	371	214(+)	240	152	95

(x) – Outliers Deleted   (+) – Outlier affected totals deleted

TABLE 4 (CONT.)

ROADSIDE LITTER DATA
RAW DATA FOR AUG - SEPT
30 DAY PERIOD

ROADSIDE LITTER ITEM	PLOT # YEAR	31			32			33			34			35			36		
		77	78	79	77	78	79	77	78	79	77	78	79	77	78	79	77	78	79
Newspapers, etc.		0	4	1	0	1	0	175	80	527	265	234	143	17	41	30	12	38	34
Paper Packages, etc.		20	30	7	14	28	7	280	194	250	575	1421	516	137	260	122	136	327	220
Other Paper Items		14	11	15	11	4	6	534	268	649	1035	2194	401	118	433	100	95	363	484
TOTAL PAPER ITEMS		34	45	23	25	33	13	989	542	426	1875	3849	1060	272	734	252	243	728	738
Returnable Beer Cans		0	0	0	0	0	0	0	0	13	0	0	13	0	0	2	0	0	2
Non-Ret. Beer Cans		29	23	0	20	19	0	45	25	6	452	372	25	51	24	1	40	56	0
Return. Soft Drink Cans		0	0	0	0	0	0	0	0	2	0	0	13	0	0	3	0	0	1
Non-Ret. Soft Drink Cans		7	3	0	5	7	0	6	14	5	76	141	22	20	23	1	22	23	3
Food Cans		0	0	0	0	0	0	1	0	2	20	11	3	6	15	1	0	4	0
Other Cans		0	0	0	0	1	0	1	2	7	120	4	3	0	2	3	1	0	0
TOTAL CAN ITEMS		36	26	0	25	27	0	53	41	35	668	528	79	77	64	11	63	83	6
Plastic Containers		3	4	13	1	6	0	375	105	293	778	726	264	74	295	124	85	197	122
Other Plastic Items		14	7	4	8	0	0	22	14	220	685	319	143	30	33	65	378	3	9
TOTAL PLASTIC ITEMS		17	11	17	9	6	0	397	119	513	1463	1045	507	104	328	189	463	200	131
Auto Parts & Acces.		2	0	0	1	1	1	45	8	60	198	116	57	27	7	22	22	2	8
Tires or Tire Pieces		0	2	0	0	0	0	46	21	45	262	111	79	3	4	14	7	5	1
Lumber & Construction Items		2	5	0	0	0	0	150	16	209	548	285	194	24	19	75	25	24	20
Unclassified Items		0	0	3	1	0	0	87	12	39	425	91	20	7	11	0	2	45	3
Special Interest Items		0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	14	0	0
TOTAL MISCELLANEOUS ITEMS		4	7	3	2	1	1	328	57	353	1433	603	351	61	41	111	70	76	32
Returnable Beer Bottles		2	0	0	0	0	0	0	0	0	4	0	7	0	0	0	0	0	2
Non-Ret. Beer Bottles		5	1	0	0	1	0	8	9	0	120	144	8	40	39	0	2	13	0
Return. Soft Drink Bottles		0	0	0	0	0	0	1	0	0	4	1	5	1	0	3	1	2	0
Non-Ret. Soft Drink Bottles		2	0	0	3	0	0	1	32	1	65	54	0	13	11	0	3	8	0
Wine or Liquor Bottles		1	0	0	0	0	0	2	7	9	17	25	16	1	6	5	3	5	11
Food Bottles or Jars		0	0	0	0	0	0	2	1	0	10	5	1	0	2	0	0	0	1
Other Bottles or Jars		0	0	3	0	0	0	3	0	0	40	1	0	0	0	2	0	2	3
TOTAL BOTTLE & JAR ITEMS		10	1	3	3	1	0	17	49	10	260	230	37	55	58	10	9	30	17
TOTAL ITEMS ON PLOT		101	90	46	64	68	14	1782	808	2337	5699	6255	2034	569	1225	573	848	1117	924

(x) - Outliers Deleted   (+) - Outlier affected totals deleted

FORMULA FOR PRORATING ROADSIDE LITTER VALUES

$$\frac{A + B + C + D}{9,300 \text{ (total miles)}} \quad x \quad 5.28^{(1)} = \text{Prorated average number of items per mile}$$

As an example: When figuring bottles per mile on a prorated basis, A, B, C and D in the above mentioned formula would have the following values:

A = Average number of bottles in 0 - 2,500 ADT category times mileage in category.

B = Average number of bottles in 2,500 - 10,000 ADT category times mileage in category.

C = Average number of bottles in 10,000+ ADT category times mileage in category.

D = Average number of bottles assigned to the Metro category times mileage in category.

(1) Conversion factor from per plot to per mile

TEST FOR OUTLIERS

Outliers (designated by "x" on Table 5) are values exceeding 95% confidence limits of $\pm$ 1.96$^{(1)}$ for a normal distribution curve. Plots were grouped by average daily travel volume (ADT) and outlier items in each grouping were deleted totals affected by outlier effects are marked by "+".

DETERMINATION OF OUTLIERS

The 36 plots divided by ADT were then tested for outliers using a "Z" test.

Example:

$$Z = \frac{x_i - \bar{x}}{\text{St. Dev.}}$$

x_i = Number

$\bar{x}$ = Mean of ADT category

St. Dev. = Standard Deviation of ADT category

1977 paper ADT 2,500 $\bar{x}$ = 24.77 St. Dev. = 24.636

Plot 13 total paper x_i = 83

$$Z = \frac{83 - 24.77}{24.636} = 2.364$$

Z = 2.364 is larger than the 1.96 limit, therefore the 83 value was deleted from further computation as a non-representative value with a less than one in twenty chance of occurring.

(1)   Blalock, Jr., Hubert M., 1972 _Social Statistics_, New York, McGraw Hill, P. 559

PROCEDURES FOR SETTING UP AND COLLECTING DATA FOR THE LITTER RESEARCH

I. Location of Plots

    A. Locate plots with odometer on car.

    B. On limited access if plot falls in an interchange, relocate the
        plot by proceeding .5 miles past the interchange. (Use bridge as
        starting point to begin .5 of mile).

    C. Mark beginning point of plot and continue 1,000 feet to end of the
        plot (measure the 1,000 feet, do not use odometer).

    D. Mark plots permanently, same plots will be used for two years. Use
        stakes that will remain in place and that can be easily found.

    E. Plots include entire width of right of way. Both sides and median
        on limited access. Mark plot extremities on both sides.

II. Initial Pickup of the Plots

    A. The initial litter pickup should be done on August 8, August 9 is
        the rain date.

    B. Do not tally the litter picked up.

    C. Plots are located so Youth Crew can be used to clean the plots on
        the initial pickup.

    D. Pick up all of the litter on the entire plot and for a distance of
        100 feet each side of the plot.

    E. Pick up all articles matchbook size or larger.

III. Second Pickup

    A. The second pickup will be done on September 8, September 9 will be
        the rain date.

    B. All litter picked up at this time will be tallied.

    C. Youth crews will not be available but the plots are located so
        the Forestry Crew can make the pickup.

    D. Pick up only the litter on the plot.

    E. Pickup and tally all articles matchbook size or larger.

DISTRICT _____

PLOT LOCATION _____   ROUTE   _____

SECTION OF PLOT N. OR E. SIDE _____   MEDIAN _____   S. OR W. SIDE _____

LITTER COMPOSITION	TALLY OF ITEMS	TOTAL ITEMS	EST. VOL. IN CU. FT.
NEWSPAPERS OR MAGAZINES			
PAPER PACKAGES OR CONTAINERS			
OTHER PAPER ITEMS			
TOTAL NUMBER OF PAPER ITEMS			
RETURNABLE BEER CANS			
NON-RETURNABLE BEER CANS			
RETURNABLE SOFT DRINK CANS			
NON-RETURNABLE SOFT DRINK CANS			
FOOD CANS			
OTHER CANS			
TOTAL NUMBER OF CANS			
PLASTIC PACKAGES OR CONTAINERS			
OTHER PLASTIC ITEMS			
TOTAL NUMBER OF PLASTIC ITEMS			
AUTO PARTS AND ACCESSORIES (NOT TIRES)			
TIRES (OR TIRE PIECES)			
LUMBER OR CONSTRUCTION ITEMS			
UNCLASSIFIED ITEMS			
TOTAL NUMBER OF MISCELLANEOUS ITEMS			
NUMBER OF SPECIAL INTEREST ITEMS			
RETURNABLE BEER BOTTLES			
NONRETURNABLE BEER BOTTLES			
RETURNABLE SOFT DRINK BOTTLES			
NONRETURNABLE SOFT DRINK BOTTLES			
WINE OR LIQUOR BOTTLES			
FOOD BOTTLES OR JARS			
OTHER BOTTLES OR JARS			
TOTAL NUMBER OF BOTTLES AND JARS			

LIST SPECIAL INTEREST ITEMS - _____

ROADSIDE LITTER SURVEY

INSTRUCTIONS FOR PICKUP AND TALLYING

Tally the litter on the north and east side, median and south and west side on three separate sheets (2 if there is no median). Indicate on each sheet which is being tallied, count only items cigarette package size or larger.

    (a) - Paper Litter - each newspaper, magazine or part thereof which is separate should be counted once. Each separate package should be counted once. For example, a paper sack full of beer cans should be counted as one paper package.

    (b) - Cans - self-explanatory

    (c) - Plastic Items - Instructions the same as for paper items.

    (d) - Special Interest Items - Count and list at bottom of page.

    (e) - Bottles or Jars - Self-explanatory

ROADSIDE LITTER SURVEY PLOT SUMMARY

(1) DISTRICT _____

(2) PLOT LOCATION _____ (3) ROUTE _____

(4) RIGHT OF WAY WIDTH   N. OR E. _____   MEDIAN _____   S. OR W. _____

(5) PAVEMENT TYPE _____ (6) NO. OF LANES _____ (7) ADT _____

(8) HIGHWAY USE _____

(9) ROADSIDE FEATURES _____

| Litter Composition | NO. OF ARTICLES | | | (13) Est. Vol. in Cu.Ft. |
	(10) N. or E. Side	(11) Median	(12) S. or W. Side	
NEWSPAPERS OR MAGAZINES				
PAPER PACKAGES OR CONTAINERS				
OTHER PAPER ITEMS				
TOTAL NUMBER OF PAPER ITEMS				
RETURNABLE BEER CANS				
NON-RETURNABLE BEER CANS				
RETURNABLE SOFT DRINK CANS				
NON-RETURNABLE SOFT DRINK CANS				
FOOD CANS				
OTHER CANS				
TOTAL NUMBER OF CANS				
PLASTIC PACKAGES OR CONTAINERS				
OTHER PLASTIC ITEMS				
TOTAL NUMBER OF PLASTIC ITEMS				
AUTO PARTS AND ACCESSORIES (NOT TIRES)				
TIRES (OR TIRE PIECES)				
LUMBER OR CONSTRUCTION ITEMS				
UNCLASSIFIED ITEMS				
TOTAL NUMBER OF MISCELLANEOUS ITEMS				
NUMBER OF SPECIAL INTEREST ITEMS				
RETURNABLE BEER BOTTLES				
NONRETURNABLE BEER BOTTLES				
RETURNABLE SOFT DRINK BOTTLES				
NONRETURNABLE SOFT DRINK BOTTLES				
WINE OR LIQUOR BOTTLES				
FOOD BOTTLES OR JARS				
OTHER BOTTLES OR JARS				
TOTAL NUMBER OF BOTTLES AND JARS				

(14) TOTAL ITEM COUNT PER SECTION _____ _____ _____
(15) TOTAL ITEM COUNT ALL SECTIONS _____ _____
(16) DATE OF 1ST PICKUP _____
(17) DATE OF THIS PICKUP _____
(18) NAME OF PERSON IN CHARGE _____

ROADSIDE LITTER SURVEY

GENERAL INSTRUCTIONS

(1) District - Your District number.

(2) Plot Location - Describe location of plot, circle the description
     if you have modified the assigned location.

(3) Route - Number of route plot located on.

(4) Right Of Way Width - Give width from shoulder edge to right of way
     line for both sides of highway and total width of median between
     shoulders if there is a median.

(5) Pavement Type - Concrete or blacktop.

(6) Number of Lanes - Total number of lanes both ways.

(7) ADT - Average Daily Traffic, get from traffic map.

(8) Highway Use - Indicate if its predominantly commuter, commercial
     or recreational.

(9) Roadside Features - Indicate close proximity of fast food store,
     rest area, open, wooded, residential or commercial.

(10) N. Or E. Side - From worksheet, enter the number of each article
     found on the North side of the East-West highways or the East
     side of North-South highways.

(11) Median - From worksheet, enter number of articles found in median.
     If there is no median, leave blank.

(12) S. or W. Side - South of West Side - See instructions on #10.

(13) Estimate Volume in Cubic Feet - Estimate volume, for group totals
     only, in cubic feet. In other words, enter total for both sides
     and the median for paper items, total cans, total plastics etc.

(14) Total Item Count each section. Add total paper, total cans, total
     plastics, etc., and enter on this line.

(15) Total Item Count and cubic feet for entire plot. One number giving
     total items on plot and one number showing total cubic feet of
     litter on the plot.

(16) Date of 1st pickup.

(17) Date of this pickup.

(18) Name of person in charge.

FOREWARD

On November 6, 1976, the voters of the State of Michigan passed the Michigan Bottle Bill referendum by a 64 percent margin. The law, which went into effect on December 3, 1978, required among other things, that all beer and soft drink beverage containers be of the returnable type and carry a refundable deposit.

There was little doubt that the law would have an impact on roadside litter, but the extent of the impact could not be determined without a comparative before and after study.

During the summer of 1977, the Maintenance Division of the Michigan Department of Transportation began a study of the litter on the 9,300-mile state highway system. The study, to some degree, was patterned after a 1968 Federal Highway Research Board litter study, which Michigan took part in, so that the present litter composition could be compared, at least in a general way, to the composition of the roadside litter in 1968.

The study was continued during the summer of 1978 to develop a two-year base litter prior to the implementation of the law. The August 1979 measurement was eight months after the December 3, 1978 effective date for the "Bottle Law" which should reflect the complete changeover of the industry to meet the requirements of the law.