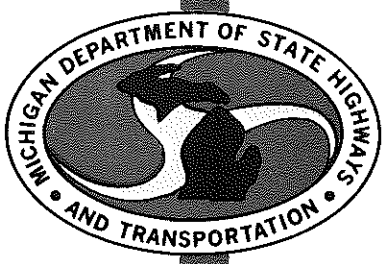
AN ACCIDENT FREQUENCY PREDICTION MODEL FOR SELECTED STATE TRUNKLINE CLASSIFICATIONS



TESTING AND RESEARCH DIVISION
RESEARCH LABORATORY SECTION

AN ACCIDENT FREQUENCY PREDICTION MODEL FOR SELECTED STATE TRUNKLINE CLASSIFICATIONS

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A Report Prepared by the Testing and Research Division
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I
INTRODUCTION

Improper driving, the roadway and its environment, as well as conflicts among vehicles are the primary causes of highway accidents. Some accidents can be prevented either by providing motorists with sufficient and effective road guidance information[1], or by improving roadways through reconstruction in conformance with current design standards. Since safety program funding is limited, it is neither practical nor possible for program administrators to fully examine and improve every segment of the highway system. Thus, a selection procedure is needed to identify segments of roadway which are considered hazardous and, therefore, may require some treatment.

In the following steps, the techniques of quality control are used to develop a high-hazard identification program.

1) Categorize every segment of roadway in terms of "controllable" variables; for example, those described in Section II.

2) Describe the accident behavior of each roadway segment in each category in terms of accident probability distributions.

3) Set the upper control limit for accidents that could occur on a roadway segment in each category, based on the probability distributions described above. Any roadway segment that has accidents beyond the upper control limit is considered abnormal and, therefore, should be examined for assignable causes.

4) Rank the roadway segments which exceed the upper control limit according to the hazard criterion.

5) Determine what actions can be performed on each roadway segment. Also, determine what costs and benefits correspond to each contemplated action. This information is needed in the next step.

6) Use mathematical programming techniques to find the "best" improvement strategy for these roadway segments with available funding.

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[1] A User's Guide to Positive Guidance; U. S. Department of Transportation, Federal Highway Administration, Office of Traffic Operation, June 1977.

It is the purpose of this study to provide techniques for establishing Steps 2 and 3, and also some information needed in Step 6.

The data for this study are the accident statistics and ADT figures for every 0.2 mile segment of roadway in the Michigan trunkline system (excluding Interstate) of Highway Districts 1 through 4 for the years 1971 to 1975, inclusive. Since 86 percent of the 0.2 mile segments in this data set are classified as rural, two-way, two-lane roadways, we shall devote our primary effort to this category of roadway segments.

Each 0.2 mile segment of roadway is classified according to variables described in Section II. Non-linear curve fitting techniques are used to estimate parameters of accident probability distributions describing accident behavior on the 0.2 mile roadway segment. Stein's estimation procedures are also used to simultaneously estimate accident parameters. These techniques are presented in Sections IV through VIII. The procedure for setting up the upper control limit for each category is outlined in Section IX.

Throughout this report, the term 'accident' refers only to those incidents involving death or personal injury. No property damage accidents are included.

II
MIDBLOCK CLASSIFICATION

Every 0.2 mile segment of roadway in the trunkline system (excluding Interstate) will be termed a 'midblock.' There are 17,446 midblocks in Districts 1 through 4. Each midblock is categorized according to the following midblock characteristics:

M_1) urban, fringe-strip, or rural (U, F, R),

M_2) one-way, two-way, or divided highway,

M_3) number of lanes,

M_4) intersected or non-intersected midblock (I, NI),

M_5) tangent or curve (T, C),

M_6) no passing or passing (NP, P),

M_7) lane width (10 ft, 11 ft, 12 ft),

M_8) curb and shoulder width (0-4 ft, 4-8 ft, 8-10 ft, 10-12 ft).

The number of midblocks in each group categorized according to the first three midblock characteristics are shown in Figure 1. Note that 86 percent of the midblocks are in the category of rural, two-way, two-lane midblocks. As mentioned before, this is the only category that will be fully examined. The further breakdown of this category is shown in Figure 2.

There are 4,545 intersections in the category of rural, two-way, two-lane midblocks. The frequency distribution of intersections per midblock in this category is presented in Table 1. Each intersection is categorized according to the following characteristics:

I_1) located on tangent or curve midblock,

I_2) intersecting road is tangent or curve,

I_3) no signal, flasher, or signal,

I_4) no turn, right turn, left turn, or both turn lanes,

I_5) left turn phase, left turn prohibit or none,

I_6) all red or none.

TABLE 1
THE FREQUENCY DISTRIBUTION OF INTERSECTIONS PER RURAL, TWO-WAY, TWO-LANE MIDBLOCK IN DISTRICTS 1 THROUGH 4

Number of Intersections Per Midblock	Number of Midblocks
0	11,020
1	3,538
2	384
3	58
4	11
5	3
6	1

The number of intersections in each group categorized according to the above characteristics are shown in Figure 3.

The above data were provided by the Engineering Development Unit, Traffic and Safety Division, Michigan Department of State Highways and Transportation.

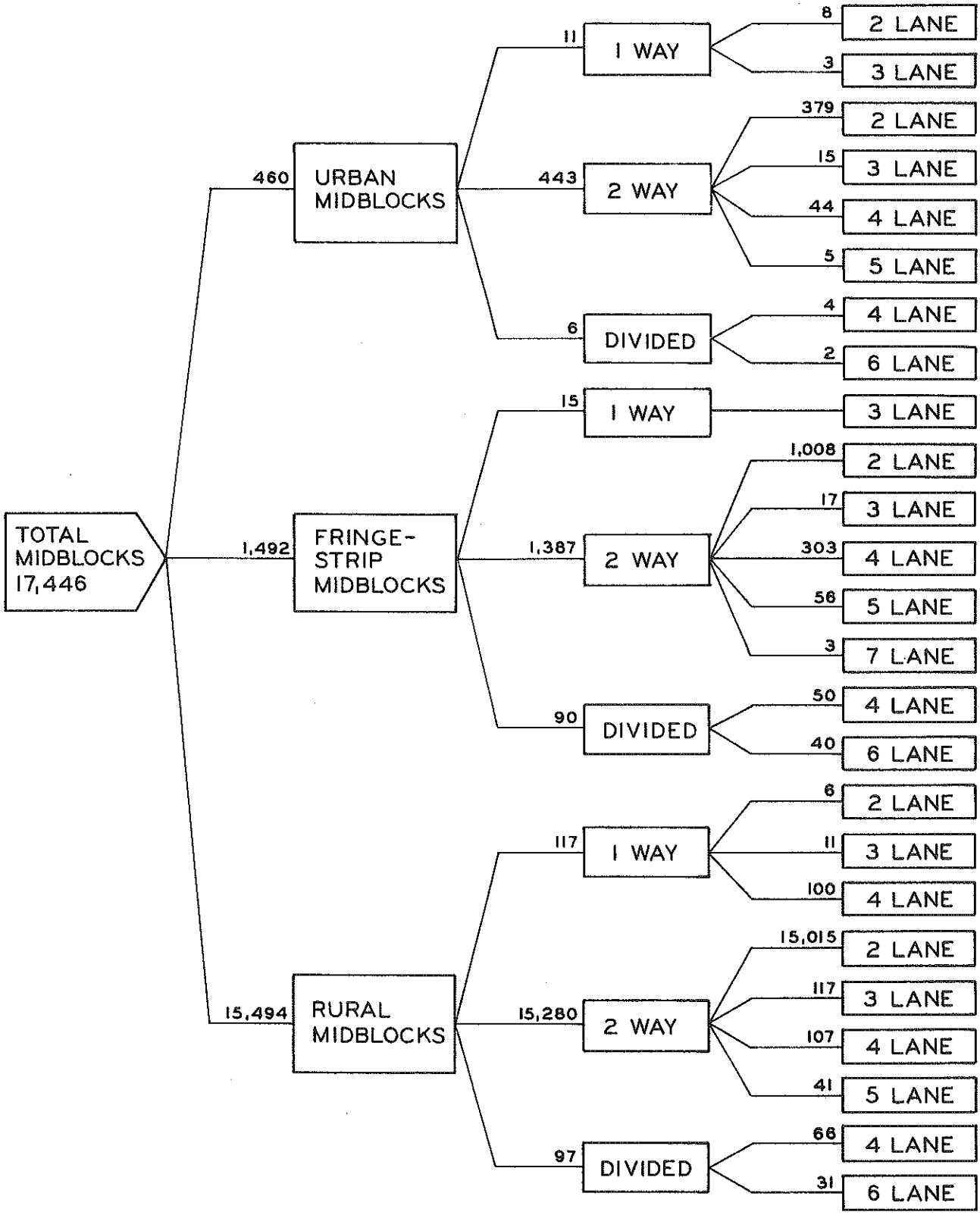
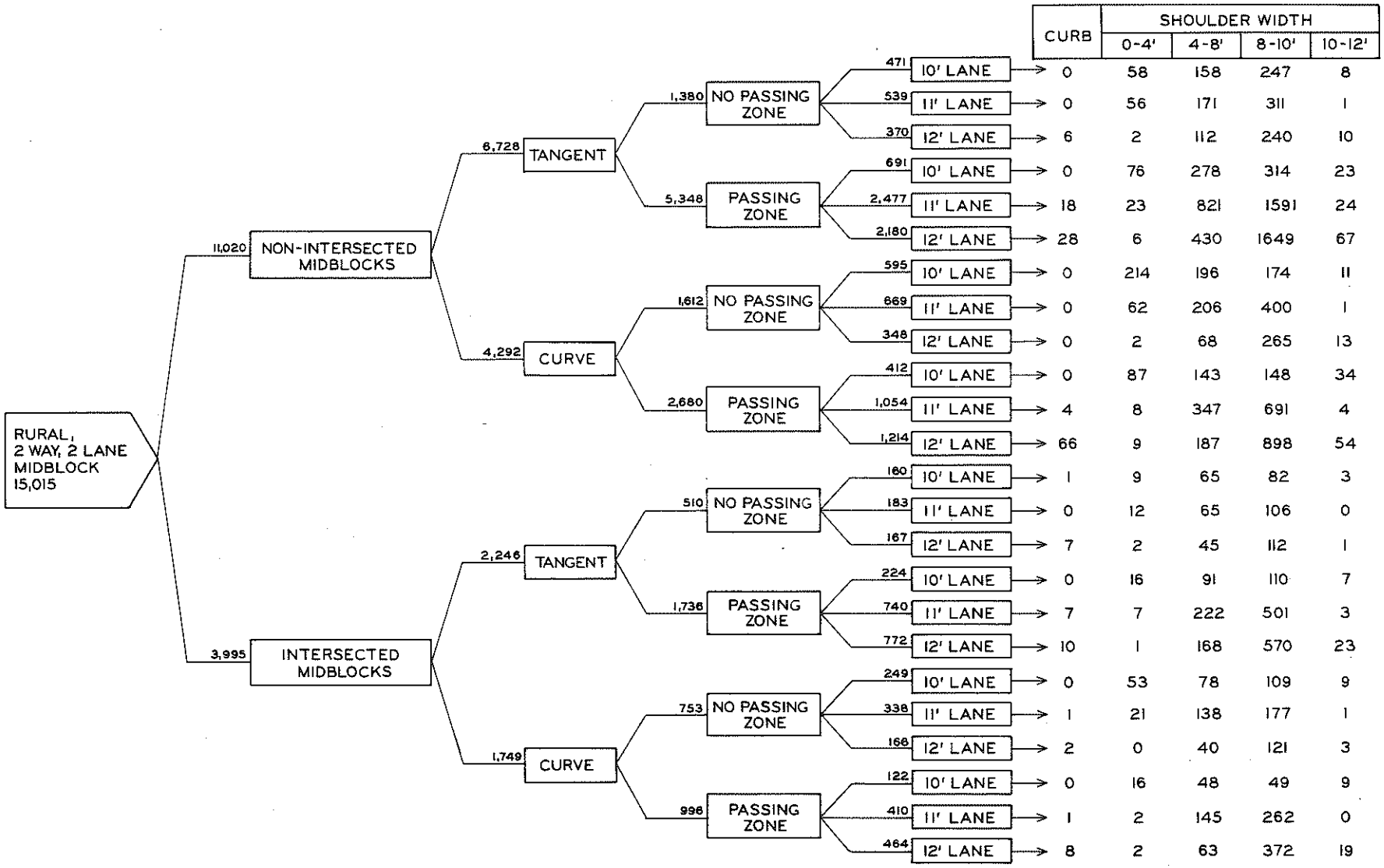


Figure 1. Number of midblocks in each group categorized according to the first three midblock characteristics (Districts 1 through 4).



CURB	SHOULDER WIDTH			
	0-4'	4-8'	8-10'	10-12'
0	58	158	247	8
0	56	171	311	1
6	2	112	240	10
0	76	278	314	23
18	23	821	1591	24
28	6	430	1649	67
0	214	196	174	11
0	62	206	400	1
0	2	68	265	13
0	87	143	148	34
4	8	347	691	4
66	9	187	898	54
1	9	65	82	3
0	12	65	106	0
7	2	45	112	1
0	16	91	110	7
7	7	222	501	3
10	1	168	570	23
0	53	78	109	9
1	21	138	177	1
2	0	40	121	3
0	16	48	49	9
1	2	145	262	0
8	2	63	372	19

Figure 2. Number of midblocks in each category of rural, two-way, two-lane midblocks (Districts 1 through 4).

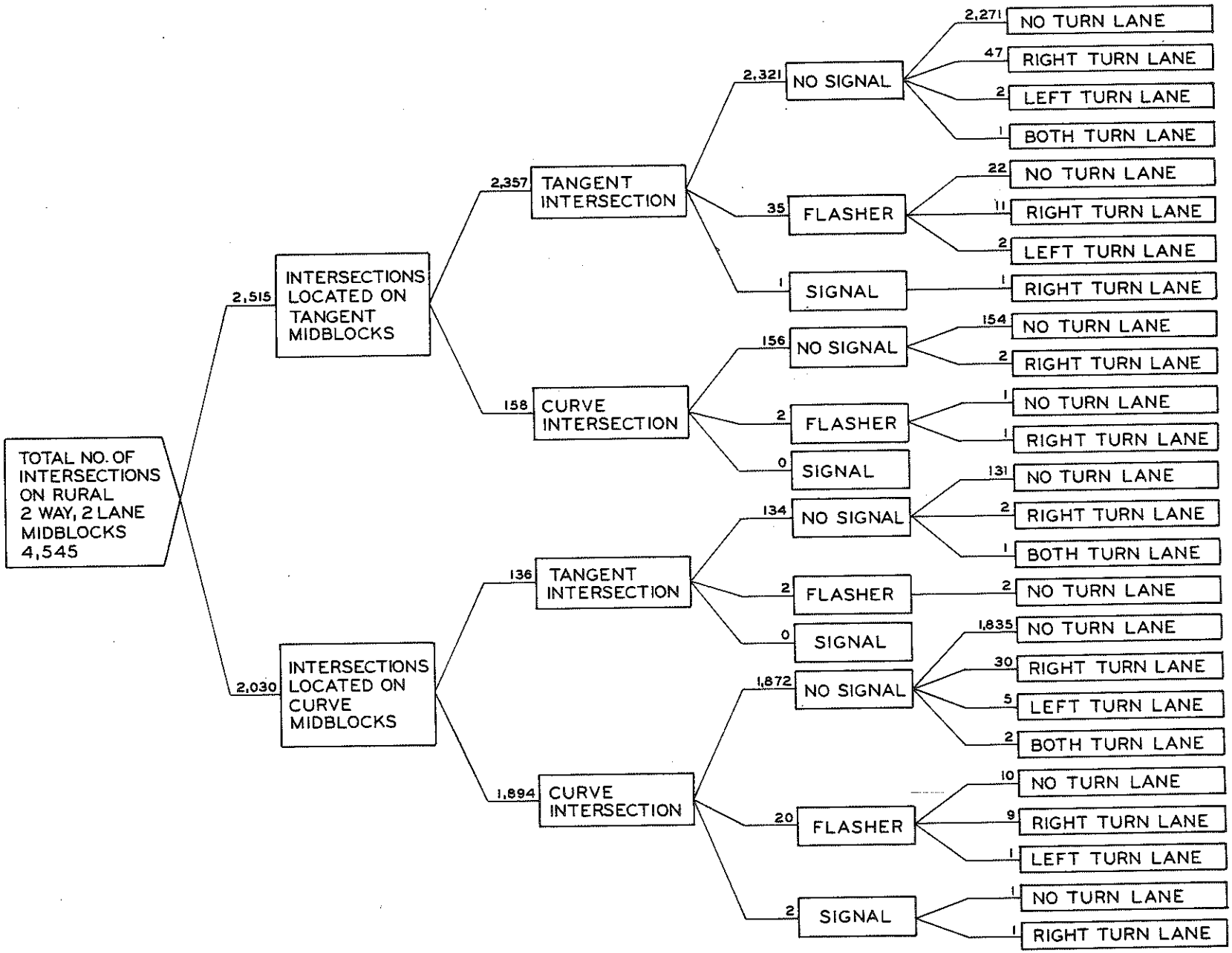


Figure 3. Number of intersections in each category (Districts 1 through 4).

III
ACCIDENT DATA

The total number of accidents that occurred in each midblock in Districts 1 through 4 from 1971 through 1975 are recorded. Each accident that occurred on a midblock is coded as 'intersection-related' if the occurrence of that accident was judged to be a consequence of the intersection. Any non-intersection related accident is then coded simply as a midblock accident. Thus, every accident that occurs on a non-intersected midblock is a midblock accident. Hence, the total number of accidents occurring on a midblock is the sum of the number of midblock and intersection-related accidents.

Each accident is also coded according to the following accident characteristics:

A_1) right angle,

A_2) rear end,

A_3) left turn,

A_4) right turn,

A_5) head-on,

A_6) ran off roadway,

A_7) ran off roadway, hit guardrail,

A_8) ran off roadway, hit sign,

A_9) ran off roadway, hit pole,

A_{10}) ran off roadway, hit culvert or ditch,

A_{11}) ran off roadway, hit abutment

A_{12}) ran off roadway, hit tree,

A_{13}) parking,

A_{14}) pedestrian,

A_{15}) dry surface,

A_{16}) wet surface,

A_{17}) icy surface,

A_{18}) light,

A_{19}) non-light.

These accident statistics for every midblock in Districts 1 through 4 were provided by the Engineering Development Unit, Traffic and Safety Division, Michigan Department of State Highways and Transportation.

IV
AVERAGE DAILY TRAFFIC DATA

It is well known that the average daily traffic volume (ADT) is a significant variable affecting accident statistics. In order to incorporate this variable into the accident statistics for each midblock, we must assign an ADT value to each midblock.

The Engineering Development Unit, Traffic and Safety Division, provided the actual ADT survey at various spots in Districts 1 through 4. Based on this set of ADT data, we can assign an ADT value to each midblock in two ways. The simplest way is to use linear interpolation to assign an ADT to each midblock situated between two ADT survey spots. The disadvantage of this method is that intersections are not taken into consideration for the ADT assignment. To remedy this defect, a second method of ADT allocation is presented as follows.

Case 1 - Intersections Existing Between Two ADT Survey Spots

As an example, let us say that there are N midblocks and three intersections between two ADT survey spots. We further assume that two intersections are located on the I^{th} midblock and one intersection is located on the J^{th} midblock ($I<J$). Let T_K be the ADT value of the K^{th} midblock, $K=1,\ldots,N$. In this example, T_1, and T_N are known (survey of ADT). We would like to estimate $T_K, K=2,\ldots,N-1$, based on these data. This situation is presented in Figure 4.

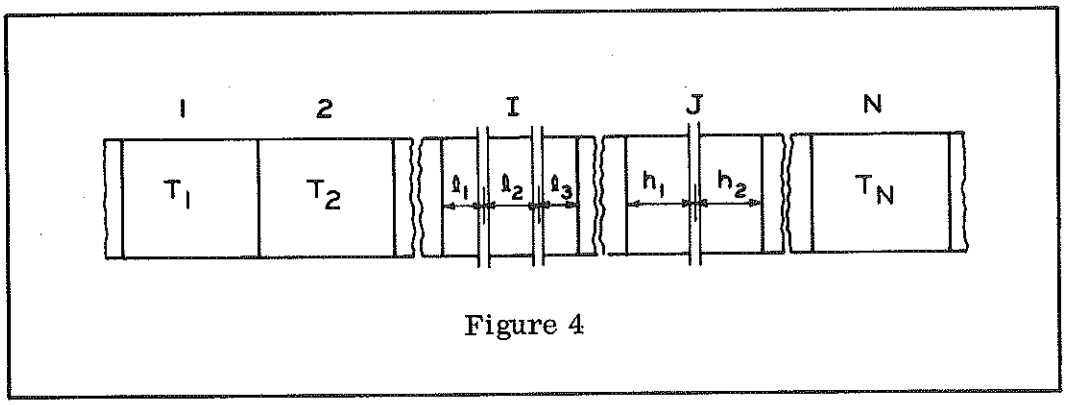


Figure 4

We see from Figure 4 that the I^{th} and J^{th} midblock are broken down into three and two subsections, respectively. The length of each subsection is specified in Figure 4. Since there are no other roadways in between the first midblock and the first subsection of the I^{th} midblock, it is reasonable to assume that $T_k=T_1, k=2,\ldots,I-1$, and T_{I1}, the ADT of the first subsection of the I^{th} midblock, is also equal to T_1. Similarly, $T_k=T_N, k=J+1,\ldots,N-1$ and $T_{J2}=T_N$. The difference between T_1 and T_N resulted from the traffic flow input from the three intersections. With no other information about three intersections, we must assume that the influence of each intersection on the traffic volume is the same. That is, each intersection is either introducing or absorbing $(T_1-T_N)/3$ traffic volume. Under this assumption, we obtain the following estimates:

$$\bar{T}_{I2} = \bar{T}_1 - (\bar{T}_1 - \bar{T}_N)/3 \tag{1}$$

$$\bar{T}_{I3} = \bar{T}_1 - 2(\bar{T}_1 - \bar{T}_N)/3 \tag{2}$$

$$\bar{T}_k = \bar{T}_1 - 2(\bar{T}_1 - \bar{T}_N)/3, \; k = I+1, \ldots, J-1 \tag{3}$$

and

$$\bar{T}_{J1} = \bar{T}_1 - 2(\bar{T}_1 - \bar{T}_N)/3 \tag{4}$$

The ADT values of the I^{th} and J^{th} midblocks remain to be determined. We shall use the weighted average of subsection ADT values as the estimate of midblock ADT. That is,

$$\bar{T}_I = \sum_{k=1}^{3} \ell_k \bar{T}_{Ik} / \sum_{k=1}^{3} \ell_k \tag{5}$$

and

$$\bar{T}_J = \sum_{k=1}^{2} h_k \bar{T}_{Jk} / \sum_{k=1}^{2} h_k \tag{6}$$

Case 2 - No Intersections Between Two ADT Survey Spots

This situation does not often occur, but when it does, unless other information is available, the average of the two given ADT's is used as the ADT estimate of every midblock between two ADT survey spots.

We note that, for each category, the average ADT's obtained by the above two methods are comparable. As will become obvious in later sections, the parameter estimation procedures are most sensitive to average ADT of the category considered. That is, either method would give "equivalent" estimates of accident parameters. In this study, we shall use midblock ADTs generated by the second method.

V
ACCIDENT PREDICTION MODEL

For a midblock in a given category, let τ be the ADT of the midblock and define $X(\tau)$ to be the number of accidents occurring on this midblock during a given year. We denote $p_i(\tau)$ to be the probability that there are exactly i accidents occurring in the midblock during a year. That is,

$$p_i(\tau) = P_r[X(\tau) = i], \; i = 0, 1, \ldots \tag{7}$$

Then, the expected number of accidents per year, $\mu(\tau)$, of this midblock is equal to,

$$\mu(\tau) = EX(\tau) = \sum_i i p_i(\tau) \tag{8}$$

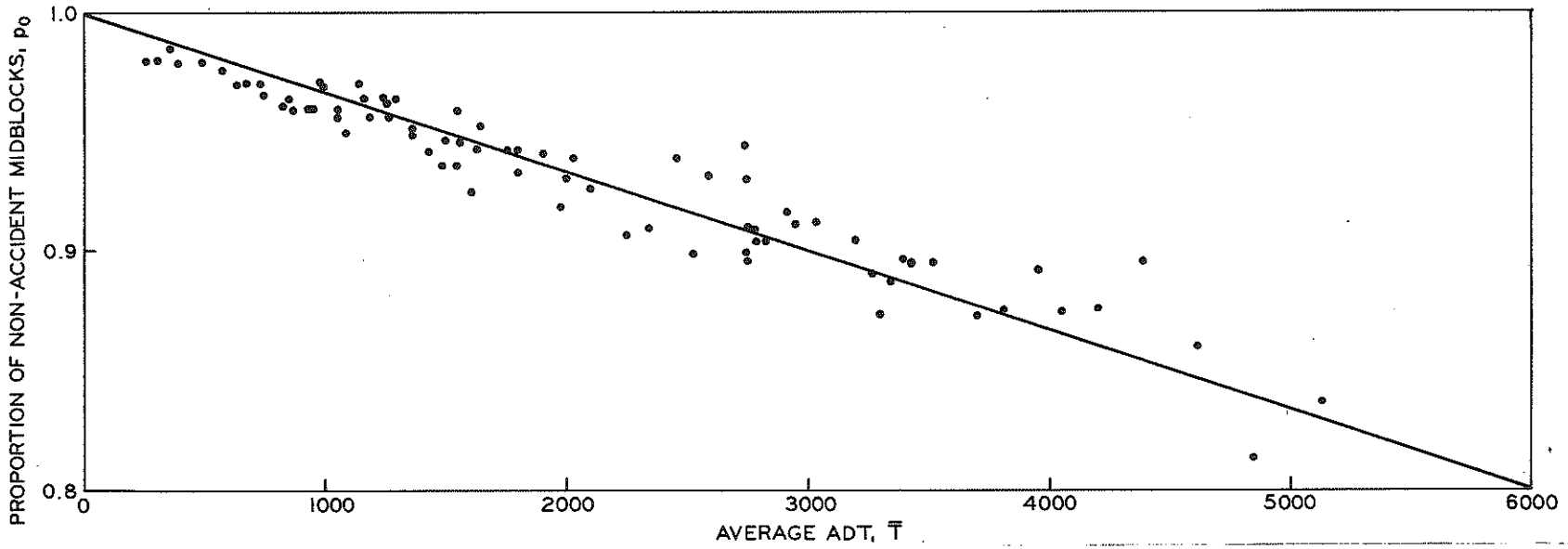


Figure 5. Relationship between proportion of non-accident midblocks and average ADT in the category of rural, two-way, two-lane, non-intersected tangent midblocks.

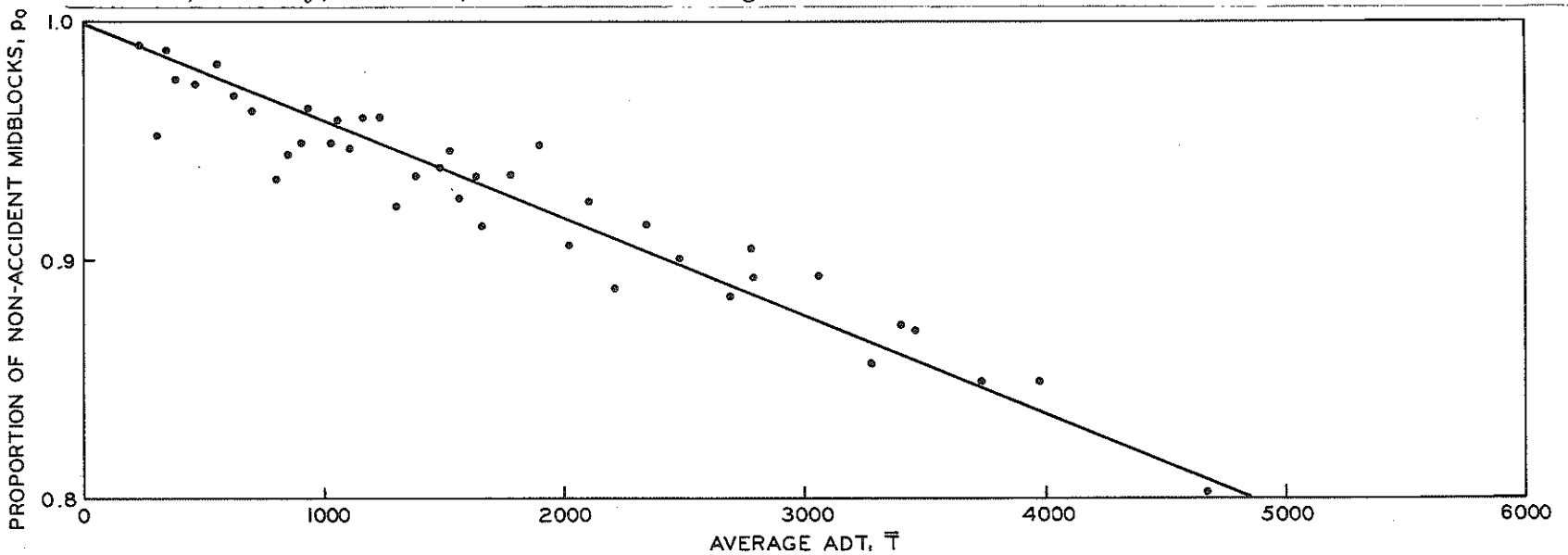


Figure 6. Relationship between proportion of non-accident midblocks and average ADT in the category of rural, two-way, two-lane, non-intersected curve midblocks.

In order to set up the upper control limit for accidents that could occur on a roadway segment in each category, we must know the variance of the defined random variable $[x(\tau)]$. Furthermore, if some improvement effort has been performed on this midblock, the expected accident change due to this action is therefore equal to $\mu(\tau)-\mu^*(\tau^*)$, where τ^* and $\mu^*(\tau^*)$ are the ADT value and the expected number of accidents per year of the new category to which this midblock belongs, respectively (resulting from the improvement action). Thus, a major goal of this study will be accomplished if the $p_i(\tau)$ for each category of midblocks can be expressed in computable form. This can be accomplished as follows.

It is reasonable to assume that the number of accidents occurring on a midblock during a given year are statistically independent. Hence, we may postulate that,

$$p_i(\tau)=[p_1(\tau)]^i, \quad i\geq 1 \tag{9}$$

It is clear that,

$$p_0(\tau)=1-\sum_{i=1}^{M(\tau)} p_i(\tau) \tag{10}$$

where $M(\tau)$ is the maximal number of accidents that could occur on a midblock during a year.

If τ is large enough, $p_0(\tau)$ can be approximated by the following equation:

$$p_0(\tau)=1-\sum_{i=1}^{\infty} p_i(\tau)=\frac{1-2p_1(\tau)}{1-p_1(\tau)} \tag{11}$$

From Eq. (11), we obtain the following fundamental equation,

$$p_1(\tau)=\frac{1-p_0(\tau)}{2-p_0(\tau)} \tag{12}$$

Thus, the accident prediction model will be completed once the functional form of $p_0(\tau)$ for each category of midblocks is specified. To study the functional form of $p_0(\tau)$, we rank 6,728 rural, two-way, two-lane, non-intersected tangent midblocks according to ADT value. Then, every 100 sequential midblocks are formed as a group to compute p_0, the proportion of midblocks that have no accidents during a year, and to also compute $\bar{\tau}$, the average of midblock ADT's. The results are plotted in Figure 5. The same procedures are also repeated for the category of 4,292 rural, two-way, two-lane, non-intersected curve midblocks. The results are plotted in Figure 6. The correlation coefficient between p_0 and average ADT for both categories is -0.96. Thus, p_0 is a linear function of $\bar{\tau}$ for the range of ADT values in these two categories. More precisely, p_0 can be expressed as the following equation,

$$p_0 = 1 - a\bar{T} \tag{13}$$

where 'a' is a non-negative parameter to be determined.

The above equation suggests that

$$p_0(T) = 1 - aT \tag{14}$$

Substituting Eq. (14) into Eq. (12) and then combining with Eq. (9), we obtain the following equation:

$$p_i(T) = \left[\frac{aT}{1+aT}\right]^i, \quad i \geq 1 \tag{15}$$

Equations (14) and (15) completely specify the accident prediction model. Note that the accident behavior of each midblock category is categorized by only one parameter (a).

It can be shown under this model specification that the expected value, $\mu(T)$, and the variance, $\sigma^2_{X(T)}$, of the random variable $X(T)$ are respectively,

$$\mu(T) = EX(T) = \frac{p_1(T)}{[1-p_1(T)]^2} = aT(1+aT) \tag{16}$$

and

$$\sigma^2_{X(T)} = \sum_i [i - \mu(T)]^2 p_i(T) = aT(1+aT)(1+2aT) \tag{17}$$

VI
PARAMETER ESTIMATION PROCEDURES

Based on the model specified in Eqs. (14) and (15), we would like to estimate the parameter 'a' for each category of midblocks. The estimation procedures are described as follows:

For a category of N midblocks, let T_i be the ADT of the i^{th} midblock, $i=1,\ldots,N$. Denote P_k to be the proportion of midblocks that have k accidents during a year. That is,

$$P_k = \frac{M_k}{N} \tag{18}$$

where M_k is the number of midblocks that have k accidents during a year. Then, based on the model specified in Eqs. (14) and (15), P_k can be estimated by the following equations:

$$\hat{P}_0 = 1 - a\bar{T} \tag{19}$$

and

$$\hat{P}_k = \frac{1}{N}\sum_{i=1}^{N}\left[\frac{aT_i}{1+aT_i}\right]^k, \quad k \geq 1 \tag{20}$$

where $\bar{T} = \sum_{i=1}^{N} T_i/N$

Equations (19) and (20) shall be used to fit the empirical probability distribution defined in Eq. (18) for every category of midblocks. That is, the parameter 'a' for each category is determined such that the sum of square of residuals, SSR, defined as,

$$SSR = (1 - a\bar{T} - p_0)^2 + \sum_{k=1}\left\{\frac{1}{N}\sum_{i=1}^{N}\left[\frac{aT_i}{1+aT_i}\right]^k - P_k\right\}^2 \tag{21}$$

is minimized.

The above estimation is carried out by a non-linear curve fitting computer program written according to the least square criterion. The fitted results for each category of midblocks are presented in the next section.

VII
PRELIMINARY PARAMETER ESTIMATIONS (BASED ON PROBABILITY DISTRIBUTIONS)

As mentioned before, we shall only examine the category of rural, two-way, two-lane midblocks. The empirical and estimated probability distributions of this category and its subcategories are presented in the Appendix. Although no statistical analyses were performed to evaluate how well the model specified in Eqs. (14) and (15) fits the data, one can see from the Appendix that the estimated probabilities are close to the actual probabilities.

The estimated parameters are presented in Tables 2 through 5. Notation used in Tables 2 and 3 and the Appendix are defined below.

R22M - the category of rural, two-way, two-lane midblocks,

NIM - the category of non-intersected midblocks

TABLE 2
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTION OF MIDBLOCK ACCIDENTS IN THE CATEGORY OF RURAL, TWO-WAY, TWO-LANE AND NON-INTERSECTED MIDBLOCKS AND ITS SUBCATEGORIES

Category	Number of Midblocks	Average ADT	Estimated Parameter, (a)
R22NITM	6,728	1909.85	0.0000335853
R22NICM	4,292	1973.32	0.0000413502
R22NITNPM	1,380	1799.19	0.0000381798
R22NITPM	5,348	1938.41	0.0000324820
R22NICNPM	1,612	1644.40	0.0000503277
R22NICPM	2,680	2171.17	0.0000372580
R22NITNP10M	471	1420.97	0.0000458595
R22NITNP11M	539	1605.43	0.0000378772
R22NITNP12M	370	2562.92	0.0000330335
R22NITP10M	691	1439.33	0.0000361370
R22NITP11M	2,477	1611.50	0.0000347477
R22NITP12M	2,180	2468.06	0.0000300812
R22NICNP10M	595	1182.83	0.0000525492
R22NICNP11M	669	1595.71	0.0000518326
R22NICNP12M	348	2527.18	0.0000465523
R22NICP10M	412	1462.57	0.0000395753
R22NICP11M	1,054	1891.70	0.0000384400
R22NICP12M	1,214	2654.28	0.0000360596

TABLE 3
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTION OF MIDBLOCK ACCIDENTS IN THE CATEGORY OF RURAL, TWO-WAY, TWO-LANE AND INTERSECTED MIDBLOCKS AND ITS SUBCATEGORIES

Category	Number of Midblocks	Average ADT	Estimated Parameter, (a)
R22ITM	2,246	2117.16	0.0000368247
R22ICM	1,749	2222.80	0.0000438422
R22ITNPM	510	2178.54	0.0000407067
R22ITPM	1,736	2099.14	0.0000356598
R22ICNPM	753	2006.74	0.0000534315
R22ICPM	996	2386.14	0.0000377856
R22ITNP10M	160	1511.23	0.0000394972
R22ITNP11M	183	2167.14	0.0000423508
R22ITNP12M	167	2830.36	0.0000402352
R22ITP10M	224	1601.36	0.0000414096
R22ITP11M	740	1798.27	0.0000386996
R22ITP12M	772	2531.98	0.0000325219
R22ICNP10M	249	1408.66	0.0000747207
R22ICNP11M	338	2028.42	0.0000519572
R22ICNP12M	166	2859.70	0.0000397595
R22ICP10M	122	1601.42	0.0000561624
R22ICP11M	410	1930.16	0.0000400131
R22ICP12M	464	2995.37	0.0000339127

TABLE 4
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTION OF INTERSECTION-RELATED ACCIDENTS PER INTERSECTION IN THE CATEGORY OF RURAL, TWO-WAY, TWO-LANE, INTERSECTED TANGENT MIDBLOCKS (R22ITM)

Category	Number of Intersections	Average ADT	Estimated Parameter, (q)
Intersection	2,515	2147.11	0.0000353437
Tangent Intersection	2,357	2138.50	0.0000356741
Curve Intersection	158	2275.51	0.0000310700
Tangent Intersection and No Signal	2,321	2119.11	0.0000335143
Tangent Intersection and Flasher	35	3079.43	0.0001564650
Tangent Intersection and Signal	1	11291.67	----
Curve Intersection and No Signal	156	2273.66	0.0000309016
Curve Intersection and Flasher	2	2419.92	----
Curve Intersection and Signal	0	---	----

TABLE 5
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTION OF INTERSECTION-RELATED ACCIDENTS PER INTERSECTION IN THE CATEGORY OF RURAL, TWO-WAY, TWO-LANE, INTERSECTED CURVE MIDBLOCKS (R22ICM)

Category	Number of Intersections	Average ADT	Estimated Parameter, (q)
Intersection	2,030	2258.51	0.0000377549
Tangent Intersection	136	1952.38	0.0000492923
Curve Intersection	1,894	2280.49	0.0000370033
Tangent Intersection and No Signal	134	1956.42	0.0000455906
Tangent Intersection and Flasher	2	1681.40	----
Tangent Intersection and Signal	0	---	----
Curve Intersection and No Signal	1,872	2268.98	0.0000356424
Curve Intersection and Flasher	20	3325.81	0.0001477810
Curve Intersection and Signal	2	2598.78	----

IM - the category of intersected midblocks,

TM - the category of tangent midblocks,

CM - the category of curve midblocks,

NPM - the category of midblocks that have no passing zones,

PM - the category of midblocks that have passing zones,

10, 11, 12M - the category of midblocks for which the width of each lane is 10, 11, or 12 ft.

Combinations of the above categories can be interpreted in a similar manner. For example, R22NITNPM represents the category of rural, two-way, two-lane, non-intersected, tangent midblocks that have no passing zones; and, R22ITP12M is the category of rural, two-way, two-lane, intersected tangent midblocks that have passing zones and lane widths of 12 ft.

The estimated parameter would be close to the true parameter if the empirical probability distribution is reliable. Since sample sizes (total number of midblocks and intersections) of categories that are smaller than those presented in Tables 2 through 5 are not large enough to obtain reliable distributions, we did not estimate parameters for these categories based on probability distributions.

Unless there are unknown factors affecting accident behavior, intuitively, the parameters of CM and NPM should be larger than those of TM and PM, respectively. Moreover, the parameters of 10M, 11M, and 12M should be in descending order. If the above conjecture is true, the order of parameter magnitude in Table 2 is correct. But, the parameters of R22ITNP10M and R22ITNP12M in Table 3 are too small and too large, respectively. This could be due to unreliable probability distributions that are obtained based on sample sizes of only 160 and 167, respectively.

We would like to point out that the probability distribution tail of midblock accidents would be affected the most if $p_i \geq p_j$ for $i \geq j$ and the sample size is not large. That is, p_0 in our case is more reliable than p_i, $i \geq 1$. In this case the parameter of each category can be estimated by using Eq. (19) only. However, using Eq. (19) alone to estimate the parameter means that we would have to discard a substantial amount of available information. In general, this is not a preferred estimation procedure. To remedy this defect, we shall use Stein's techniques which would combine p_0 and results

obtained from fitting the probability distribution to estimate parameters of every category. The major advantage of this method is to utilize all the available information to simultaneously estimate category parameters. Stein's techniques and the estimated parameters based on this new method are presented in the next section.

VIII
THE ESTIMATED PARAMETERS

The estimation method presented in this section was first presented by James and Stein[2] and, later, revised by Efron and Morris[3]. This method, which will be called Stein's estimator throughout this report, is better than the usual maximum likelihood estimator from the standpoint of square error loss.

Suppose that for given θ_i (parameter to be estimated), $X_i|\theta_i, i=1,\ldots,N\ (N\geq 3)$, are independent and normally distributed with mean $E\,X_i|\theta_i=\theta_i$ and variance $Var(X_i|\theta_i)=D_i$. Furthermore, we assume that the prior distribution of $U_i, i=1,\ldots,N$ are also independent and normally distributed with mean $E\theta_i=U_i$ and variance $Var(\theta_i)=A$. Then, the preferred estimate of θ_i, based on the observation X_i, is

$$\hat{\theta}_i = B_i U_i + (1-B_i)X_i \tag{22}$$

where

$$B_i = C_i D_i/(\hat{A}_i + D_i) \tag{23}$$

with

$$C_i = Max\left[(K_i-2)/(K_i+2), 0\right] \tag{24}$$

and

$$K_i = \sum_{j=1}^{N} (\hat{A}_i + D_i)^2/(\hat{A}_i + D_j)^2 \tag{25}$$

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[2] James, W., and Stein, C., "Estimation with Quadratic Loss," Berkeley Symposium on Mathematical Statistics and Probability, Proceeding No. 4, 361-379.

[3] Efron, B., and Morris, C., "Data Analysis - Using Stein's Estimator and Its Generalizations," R-1394-OEO, March 1974.

The estimate $\hat{A}_i$ of A, which is allowed to depend on i, is the solution to,

$$A_i = \sum_{j=1}^{N} a_j I_j(A_i) \Big/ \sum_{j=1}^{N} I_j(A_i) \tag{26}$$

with

$$\begin{aligned} a_j &= S_j - D_j \quad \text{if} \quad j \neq i \\ a_i &= (S_i - 3D_i)/3 \quad j = i \end{aligned} \tag{27}$$

and

$$S_j = (X_j - U_j)^2 \ , \ j = 1, \ldots, N \tag{28}$$

The functions $\{I_j\}$ in Eq. (26) are Fisher informations which are defined as

$$\begin{aligned} I_j(A) &= 1/[2(A+D_j)^2] \quad j \neq i \\ I_j(A) &= 3/[2(A+D_i)^2] \quad j = i \end{aligned} \tag{29}$$

We permit solution A_i of Eq. (26) to be negative, but were A_i so negative that $B_i > 1$ or $B_i < 0$, we could use $B_i = 1$ or $B_i = 0$, instead.

Before applying the above equations to our problems, let us numerically recategorize those subcategories presented in Tables 2 and 3 in Table 6.

TABLE 6
DESCRIPTION OF MIDBLOCK CATEGORIES

Category Number	Description of Category	
	Non-Intersected Midblocks	Intersected Midblocks
1	R22NITNP10M	R22ITNP10M
2	R22NITNP11M	R22ITNP11M
3	R22NITNP12M	R22ITNP12M
4	R22NITP10M	R22ITP10M
5	R22NITP11M	R22ITP11M
6	R22NITP12M	R22ITP12M
7	R22NICNP10M	R22ICNP10M
8	R22NICNP11M	R22ICNP11M
9	R22NICNP12M	R22ICNP12M
10	R22NICP10M	R22ICP10M
11	R22NICP11M	R22ICP11M
12	R22NICP12M	R22ICP12M

Case 1 - Rural, Two-Way, Two-Lane, Non-Intersected Midblock Category

We shall simultaneously estimate the parameters of the probability distributions of midblock accidents in 12 subcategories of R22NIM presented in Table 6. That is, $N=12$. Let N_i and $\bar{T}_i$ be the total number of midblocks and average ADT of the i^{th} category, respectively. Define X_i to be the proportion of midblocks in the i^{th} category that have accidents in a year. Then, X_i is (approximately) a normally distributed random variable if N_i is fairly large, and based on the model specified in Eqs. (14) and (15),

$$\theta_i = EX_i = \alpha_i \bar{T}_i \tag{30}$$

where α_i is the parameter of the i^{th} category, requiring estimation.

As explained before, the estimated parameter α_i, based on the appropriate probability distribution, is a reliable estimate of the true parameter if the empirical distribution is reliable. Since the total number of midblocks of R22NITNPM, R22NITPM, R22NCNPM, and R22NICPM are quite large, the estimated parameters of these categories based on probability distributions are quite reliable. Thus, we shall use this information as prior estimates of θ_i. That is, from Eq. (30) and Table 2, we obtain

$$U_i = \begin{cases} 1799.19 \times 0.0000381798 = 0.068692\,, & i = 1,2,3 \\ 1938.41 \times 0.0000324820 = 0.062963\,, & i = 4,5,6 \\ 1644.40 \times 0.0000503277 = 0.082759\,, & i = 7,8,9 \\ 2171.17 \times 0.0000372580 = 0.080893\,, & i = 10,11,12 \end{cases} \tag{31}$$

Substituting prior information presented in Eq. (31) and the data X_i into Eqs. (22) through (29), we obtain Stein's estimate of each θ_i which, in turn gives the estimate of α_i by dividing by the average ADT. The results are presented in Table 7.

We see from Tables 2 and 7 that the estimated parameters based on the probability distributions and Stein's techniques are very close. This is not surprising since the sample size in each of the 12 categories is large enough to obtain a reliable empirical probability distribution.

We shall take the parameters' values presented in Table 7 as the final estimates of true parameters of the 12 categories. Then, the expected number of midblock accidents per year per midblock in each of 12 categories is equal to $\mu_i(T)$,

$$\mu_i(T) = \alpha_i T(1 + \alpha_i T) \tag{32}$$

These equations are plotted in Figures 7 through 10.

TABLE 7

ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS, BASED ON STEIN'S TECHNIQUES

Category	Prior Estimate	Proportion of Defective Midblocks, Xi	$\hat{\theta}_i$	Estimated Parameter, $\hat{a}_i = \hat{\theta}_i / \bar{T}_i$
R22NITNP10M	0.068692	0.065817	0.066090	0.0000465104
R22NITNP11M	0.068692	0.060111	0.060773	0.0000378543
R22NITNP12M	0.068692	0.085405	0.082950	0.0000323656
R22NITP10M	0.062963	0.051809	0.052401	0.0000364068
R22NITP11M	0.062963	0.056036	0.056148	0.0000348423
R22NITP12M	0.062963	0.074495	0.074218	0.0000300715
R22NICNP10M	0.082759	0.062857	0.064310	0.0000543695
R22NICNP11M	0.082759	0.080718	0.080883	0.0000506881
R22NICNP12M	0.082759	0.117816	0.110868	0.0000438702
R22NICP10M	0.080893	0.057767	0.059983	0.0000410117
R22NICP11M	0.080893	0.072865	0.073251	0.0000387222
R22NICP12M	0.080893	0.095387	0.094618	0.0000356472

TABLE 8

ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS, BASED ON STEIN'S TECHNIQUES

Category	Prior Estimate	Proportion of Defective Midblocks, Xi	$\hat{\theta}_i$	Estimated Parameter, $\hat{a}_i = \hat{\theta}_i / T_i$
R22ITNP10M	0.088681	0.060000	0.071643	0.0000474067
R22ITNP11M	0.088681	0.090710	0.089748	0.0000414133
R22ITNP12M	0.088681	0.112575	0.099378	0.0000351113
R22ITP10M	0.074855	0.066071	0.069058	0.0000431244
R22ITP11M	0.074855	0.068649	0.069344	0.0000385616
R22ITP12M	0.074855	0.082643	0.081636	0.0000322420
R22CNP10M	0.107223	0.102008	0.104186	0.0000739613
R22CNP11M	0.107223	0.104142	0.105191	0.0000518585
R22CNP12M	0.107223	0.113253	0.109904	0.0000384321
R22CP10M	0.090162	0.090164	0.090163	0.0000563017
R22CP11M	0.090162	0.077561	0.080476	0.0000416938
R22CP12M	0.090162	0.100862	0.098120	0.0000327572

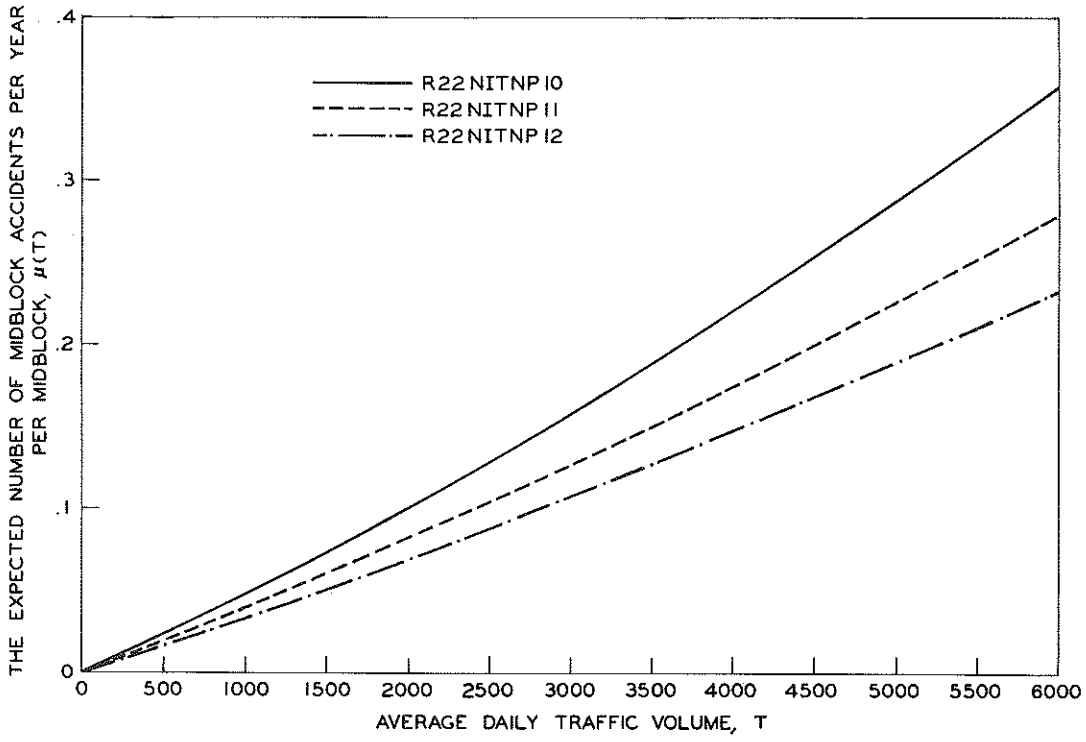

Figure 7. Expected number of midblock accidents per year per midblock in R22NITNPM.

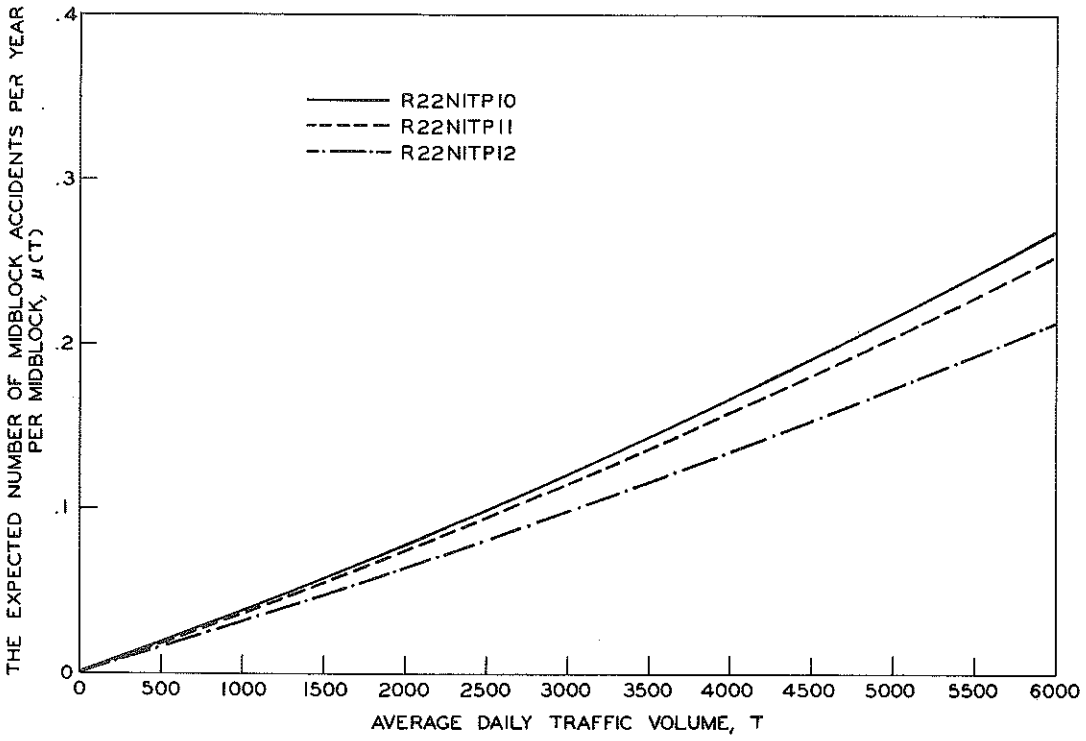

Figure 8. Expected number of midblock accidents per year per midblock in R22NITPM.

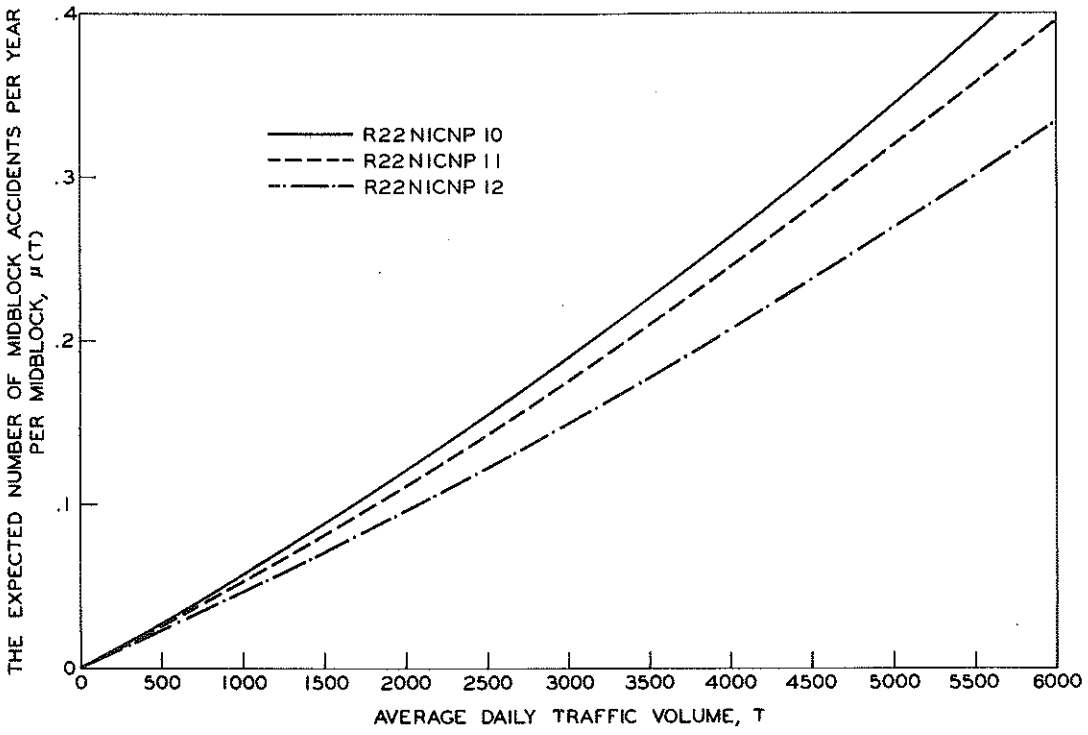

Figure 9. Expected number of midblock accidents per year per midblock in R22NICNPM.

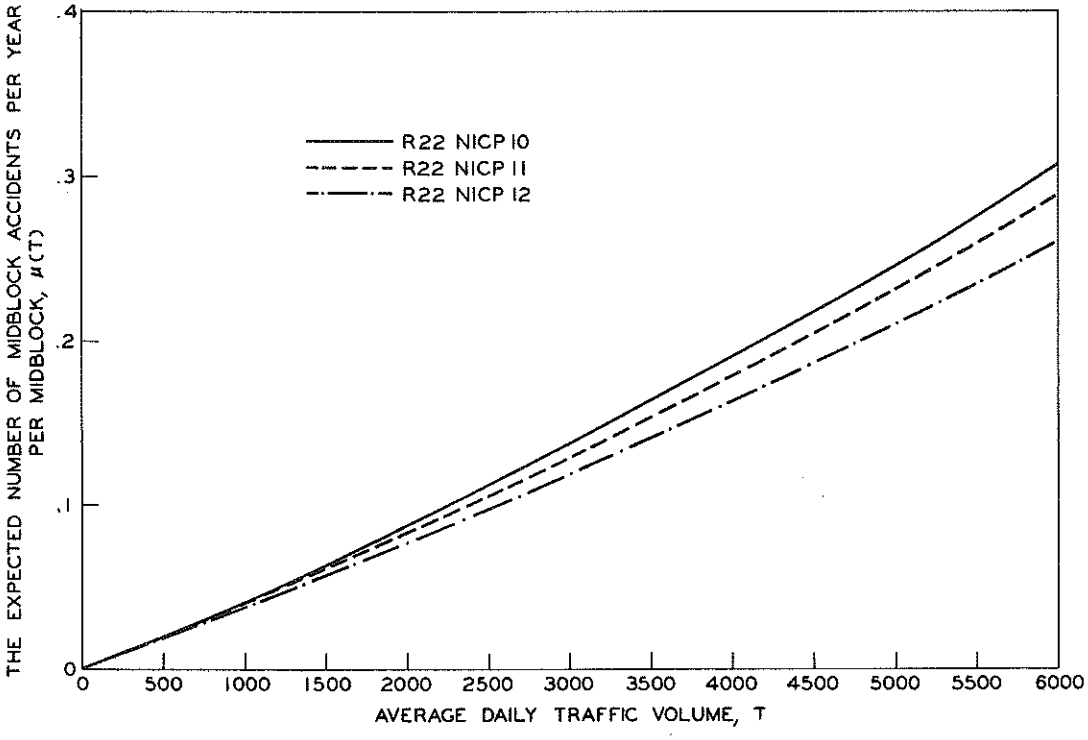

Figure 10. Expected number of midblock accidents per year per midblock in R22NICPM.

Case 2 - Rural, Two-Way, Two-Lane, Intersected Midblock Category

In this case, we shall simultaneously estimate the parameters of the probability distributions of midblock accidents in 12 subcategories of R22IM. The prior estimates of θ_i's, based on the probability distribution, are as follows:

$$U_i = \begin{cases} 2178.54 \times 0.0000407067 = 0.088081 \\ 2099.14 \times 0.0000356598 = 0.074855 \\ 2006.74 \times 0.0000534315 = 0.107223 \\ 2386.14 \times 0.0000377856 = 0.090162 \end{cases} \quad (33)$$

The same procedures used in Case 1 are repeated to obtain the results given in Table 8.

Comparing Table 8 with Table 3, we see that the estimated parameters of R22ITNP10M and R22ITNP12M, based on corresponding probability distributions, have been substantially adjusted by Stein's techniques. The expected number of midblock accidents per year per midblock in each of the 12 categories are plotted in Figures 11 through 14.

Case 3 - Intersections Located in Rural, Two-Way, Two-Lane, Intersected Midblock (R22IM) Category

In this case, we shall simultaneously estimate the parameters of the probability distributions of intersection-related accidents per intersection located in the category of rural, two-way, two-lane, intersected midblocks. Define x_i to be the proportion of intersections in the i^{th} category that have accidents in a year.

Due to the limitation of sample size (see Table 5), we shall only examine the categories, outlined in Table 9.

We shall use the estimated parameters, based on probability distributions of categories of intersections located in R22ITM and R22ICM as the prior estimates of $\theta_i, i=1,\ldots,6$, in Stein's estimation procedures. That is

$$U_i = \begin{cases} 2138.58 \times 0.0000356741 = 0.0758869, & i = 1,2,3 \\ 2258.51 \times 0.0000377549 = 0.0852697, & i = 4,5,6 \end{cases} \quad (34)$$

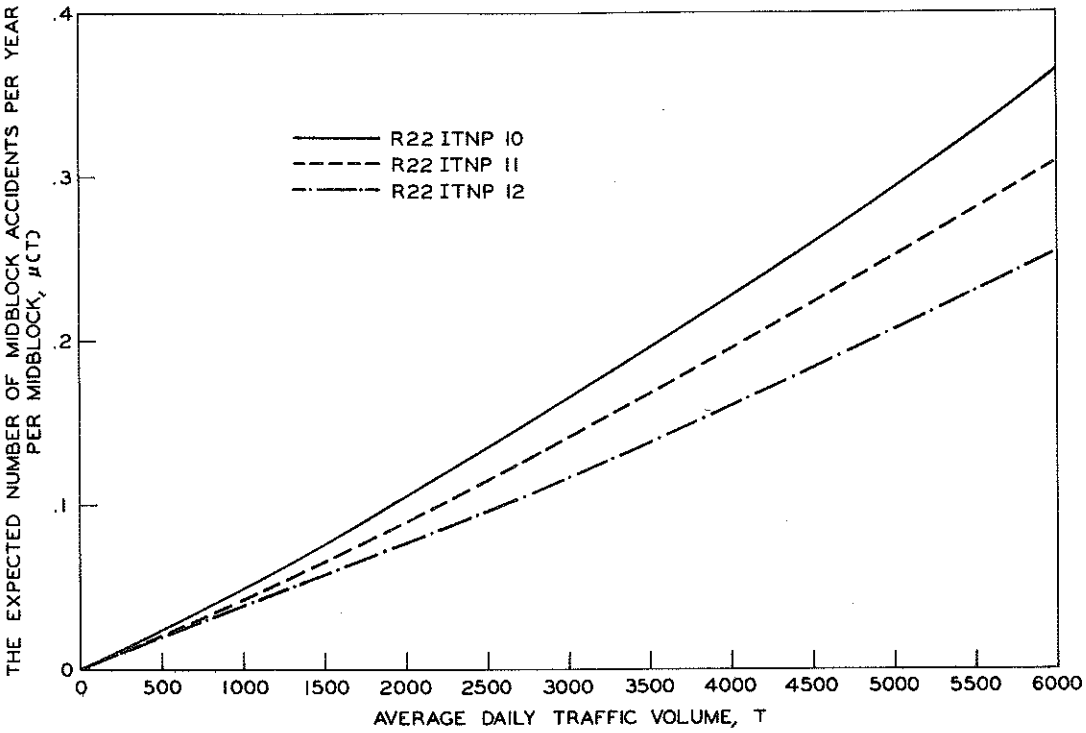

Figure 11. Expected number of midblock accidents per year per midblock in R22ITNPM.

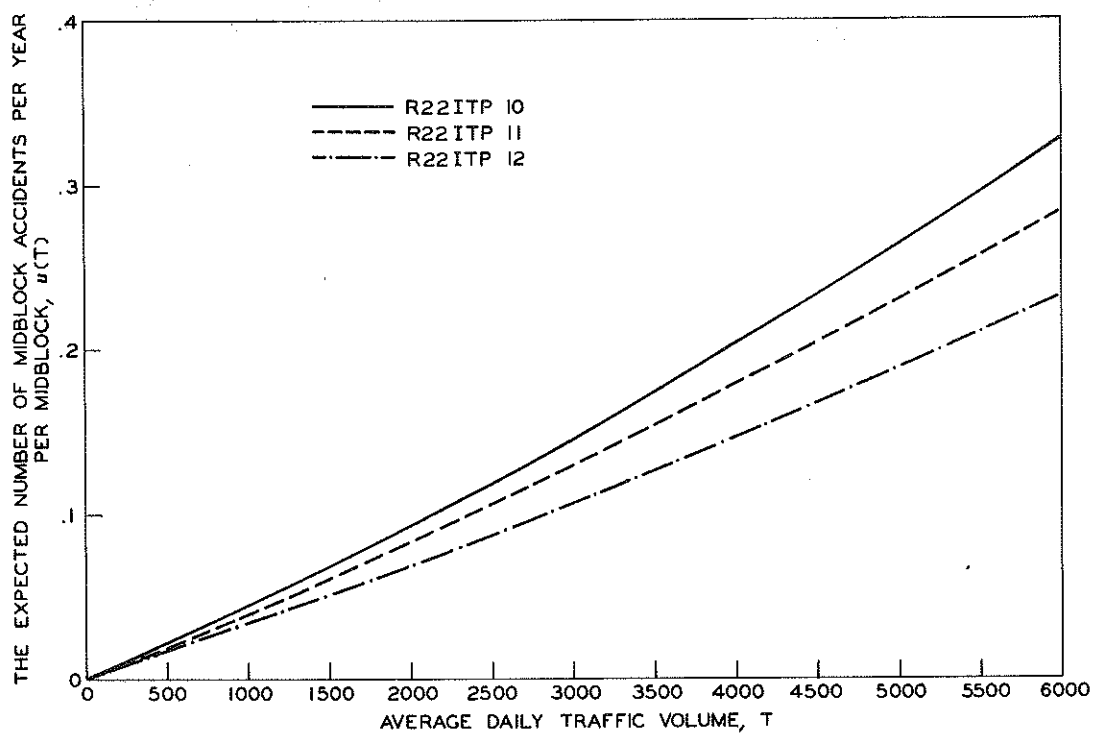

Figure 12. Expected number of midblock accidents per year per midblock in R22ITPM.

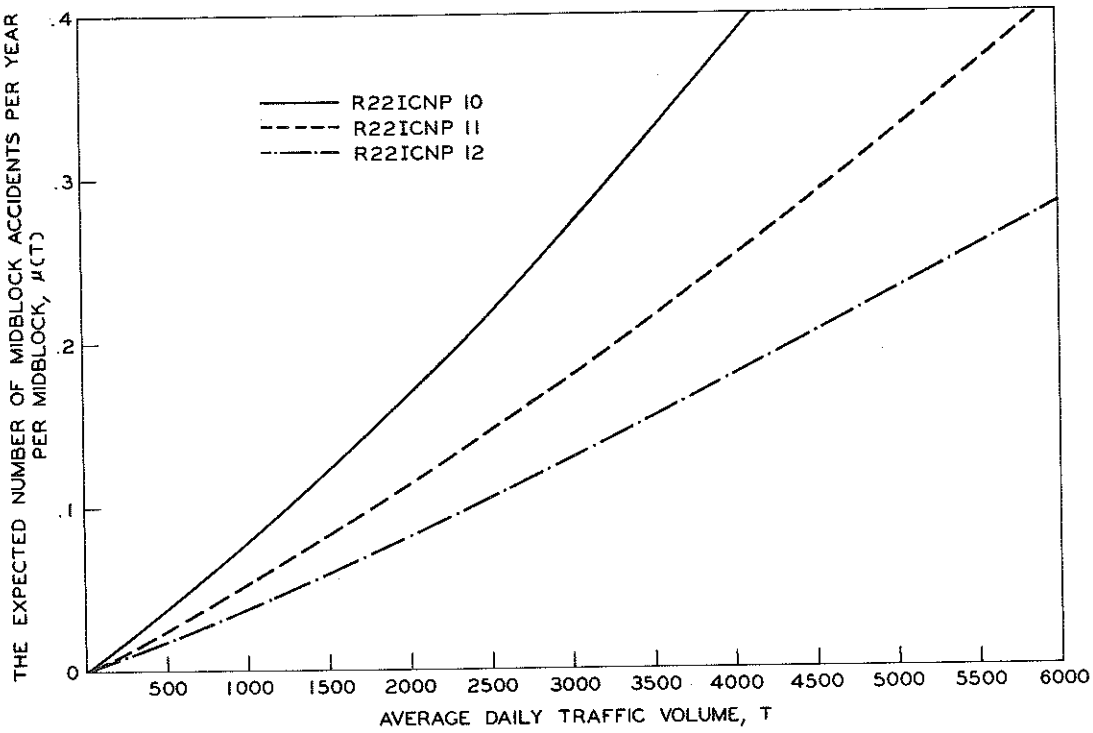

Figure 13. Expected number of midblock accidents per year per midblock in R22ICNPM.

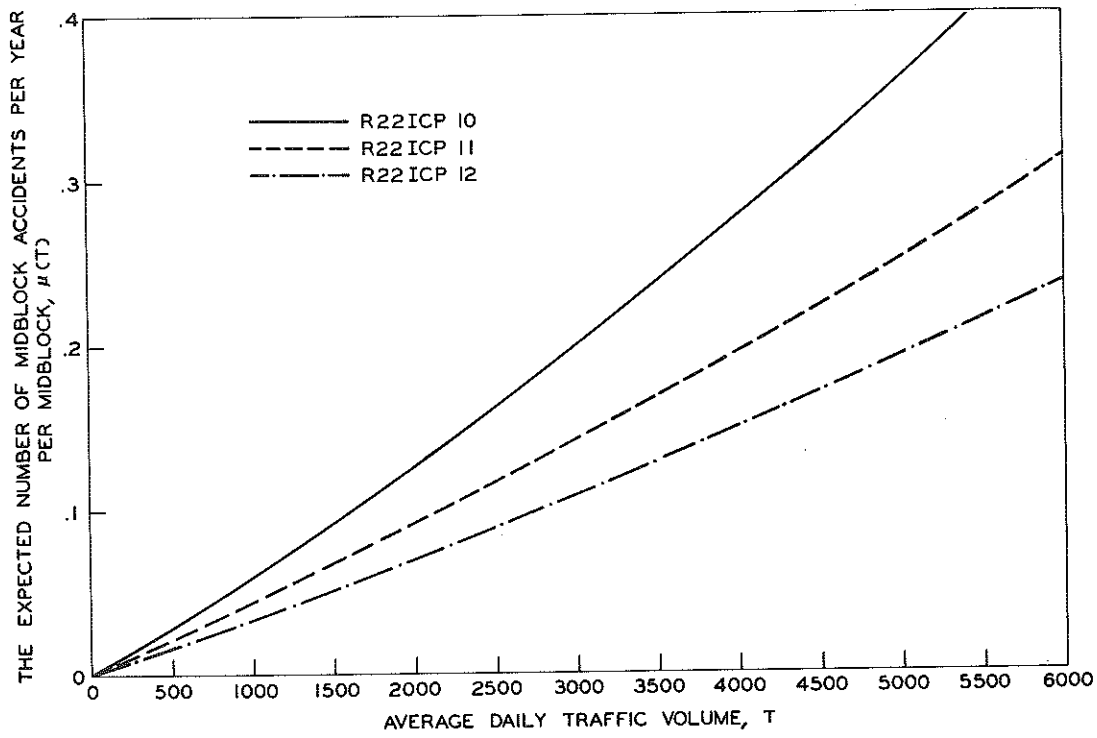

Figure 14. Expected number of midblock accidents per year per midblock in R22ICPM.

TABLE 9
DESCRIPTIONS OF INTERSECTION CATEGORIES

Category	Description
1	Tangent intersections that have no signals and are located in R22ITM
2	Tangent intersections equipped with flasher and located in R22ITM
3	Curve intersections that have no signals and are located in R22ITM
4	Tangent intersections that have no signal and are located in R22ICM
5	Curve intersections that have no signal and are located in R22ICM
6	Curve intersections equipped with flasher and are located in R22ICM

TABLE 10
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTIONS OF INTERSECTION-RELATED ACCIDENTS PER INTERSECTION LOCATED IN R22IM, BASED ON STEIN'S ESTIMATION PROCEDURES

Category[1]	Prior Estimate	X_i	$\hat{\theta}_i$	Estimated Parameters
1	0.0758869	0.071693	0.071694	0.000033832
2	0.0758869	0.445714	0.438114	0.000142271
3	0.0758869	0.069231	0.069256	0.000030460
4	0.0852697	0.094030	0.093990	0.000048042
5	0.0852697	0.079594	0.079596	0.000035080
6	0.0852697	0.400000	0.388736	0.000116885

[1] Descriptions of each category are presented in Table 9.

Since sample sizes (number of intersections in each category) in this case are not all large enough to assure that the x_i's are normally distributed, we transformed each x_i through the following equation,

$$y_i = \sin^{-1}(\sqrt{x_i}) \tag{35}$$

to satisfy the normality requirement in Stein's estimation procedure. Now, we apply Stein's procedure to the transformed data y_i to obtain the results given in Table 10.

The expected number of intersection-related accidents per year per intersection in R22ITM and R22ICM are plotted in Figures 15 and 16.

We have obtained the estimates of parameters of the probability distributions of midblock accidents in the 24 subcategories of R22M. We have also obtained the estimates of parameters of probability distributions of intersection-related accidents per intersection located in R22TM and R22CM. The sample sizes for categories that are finer than those categories presented in this section are not all large enough to support reliable distributions. However, we shall make an effort to also estimate parameters for these categories in Section X. We shall also present the estimates of parameters for some categories of urban and fringe-strip midblocks.

The expected number of accidents per midblock is the sum of the midblock accidents and the intersection-related accidents per intersection located in this midblock. Note that we only estimate the parameters of probability distributions of intersection-related accidents per intersection located in the category of rural, two-way, two-lane, tangent and curve midblocks because of the limitation of sample size. In this circumstance, we would not be able to estimate, for example, the expected number of accidents per midblock in R22ITNP10M because we do not have the estimate of the expected number of intersection-related accidents per intersection located in this category. However, if we are willing to use the expected number of intersection-related accidents per intersection located in R22ITM as the estimate in R22ITNP10M, we can then estimate the expected number of accidents per midblock in R22ITNP10M.

IX
APPLICATION OF THE ACCIDENT PREDICTION MODEL

In this section, we shall demonstrate and discuss how to use the accident prediction model presented in this study.

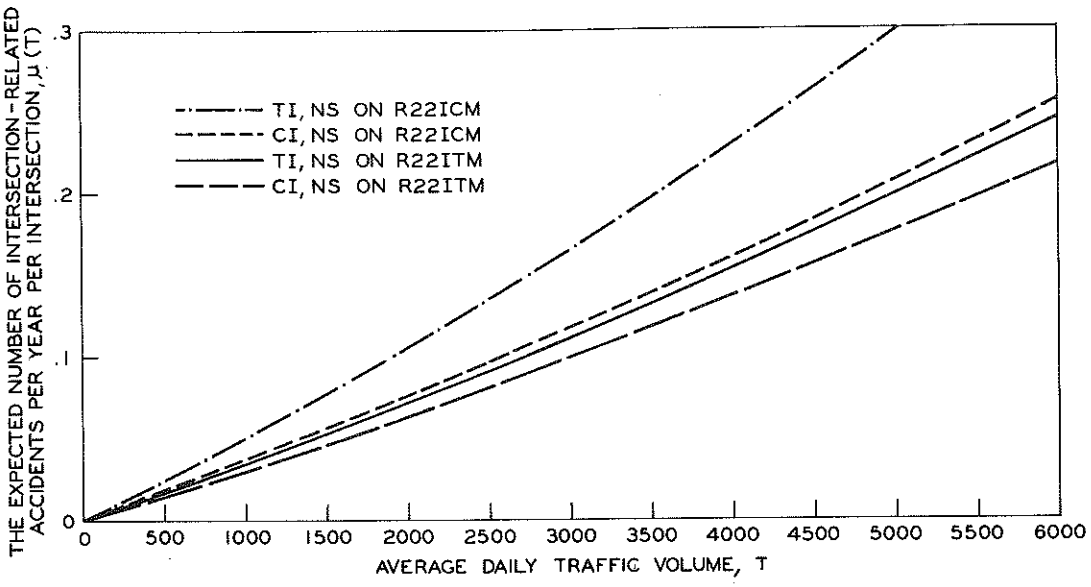

Figure 15. Expected number of intersection-related accidents per year per intersection located in R22ITM and R22ICM.

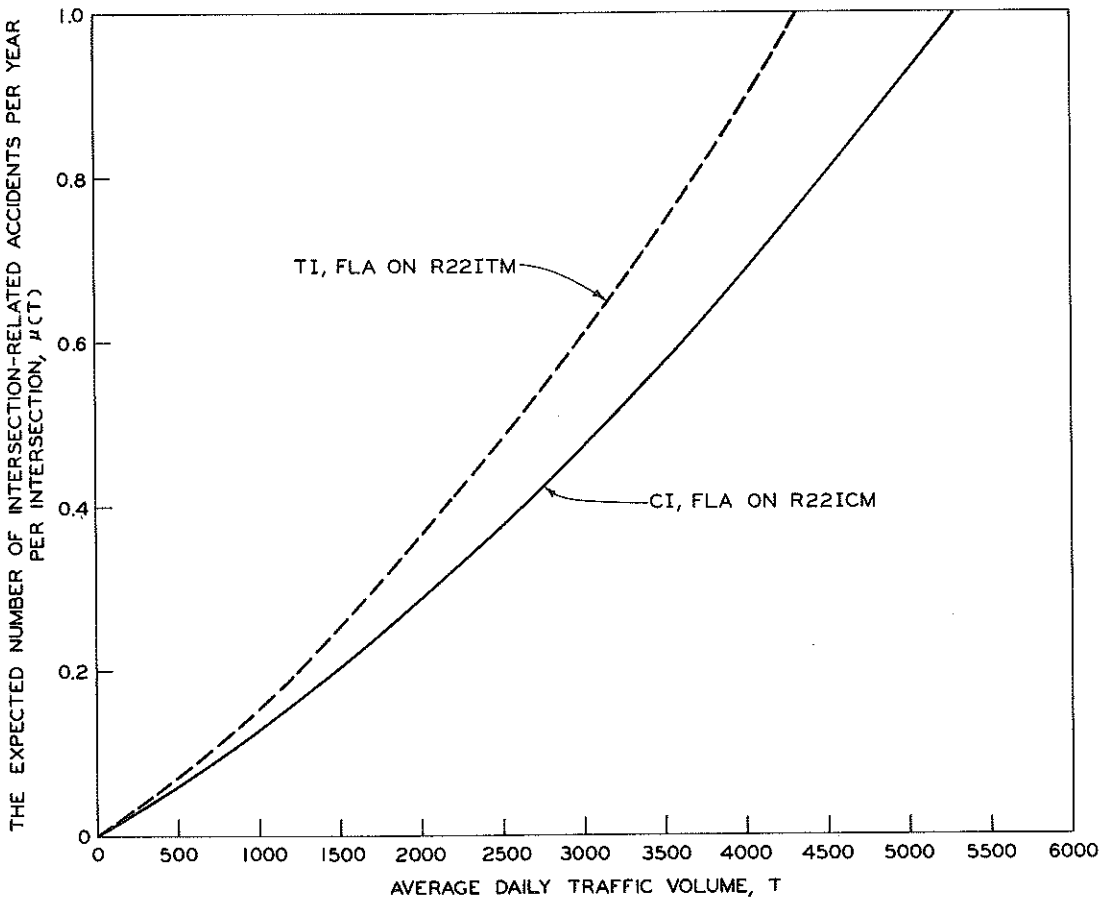

Figure 16. Expected number of intersection-related accidents per year per intersection located in R22ITM and R22ICM.

1) The model can be used to design a control chart for controlling the proportion of 'defective' midblocks in each category. For a given category of midblocks, let 'a' be the parameter of the probability distribution of accidents per year per midblock. Let T_i be the ADT of the i^{th} midblock, $i = 1,\ldots,N$. Define $Z_i(T_i) = 1$, if there is an accident occurring in the i^{th} midblock during a year, and 0 otherwise. Then q, defined in the following equation,

$$q = \frac{1}{N} \sum_{i=1}^{N} Z_i(T_i) \tag{36}$$

is the proportion of defective midblocks in the given category. It is easy to confirm that the expected value, μ_q , and the variance, σ_q^2, of the random variable q are,

$$\mu_q = Eq = \frac{1}{N} \sum_{i=1}^{N} EZ_i(T_i) = a\bar{T} \tag{37}$$

and

$$\sigma_q^2 = \frac{1}{N^2} \sum_{i=1}^{N} Var\left[Z_i(T_i)\right] = \frac{1}{N}\left[a\bar{T} - a^2 \sum_{i=1}^{N} T_i^2/N\right] \tag{38}$$

where

$$\bar{T} = \sum_{i=1}^{N} T_i/N \tag{39}$$

Moreover, q is approximately normally distributed if N is fairly large.

Now, for a given future year, let q be the (sample) proportion of defective midblocks in that category. Based on the sample proportion of defective midblocks, we would like to make a decision about whether q is high enough to hunt for an assignable accident cause associated with this category of midblocks. This can be facilitated by using quality control charts which set an upper control limit (UCL) as the criterion for judging whether q is excessive. The upper control limit is determined so that if chance variation alone were at work, the probability of a (sample) proportion falling above UCL is the prescribed risk α. Since a hunt will be made for an assignable accident cause only if the sample proportion of defective midblocks falls above the UCL, α then, is the risk of making the hunt when there was no assignable cause of the observed deviation.

The upper control limit for q is determined in the following equation,

$$UCL = \mu_q + z_\alpha \sigma_q \tag{40}$$

where μ_q was defined in Eq. (37), σ_q is the square root of σ_q^2 defined in Eq. (38), and z_α is the upper 100α percentage point of the standard normal distribution.

2) The model can be used to design a control chart for controlling the expected number of accidents in each category. For a given category of N midblocks with parameter 'a,' we define $x_i(\tau_i)$ to be the number of yearly accidents of the i^{th} midblock in which the average daily traffic volume is τ_i. Then, $\bar{x}$, defined in the following equation,

$$\bar{x} = \frac{1}{N} \sum_{i=1}^{N} x_i(\tau_i) \tag{41}$$

is the average number of yearly accidents per midblock in this category. It can be confirmed that the expected value, $\mu_{\bar{x}}$, and the variance, $\sigma_{\bar{x}}^2$, of the random variable $\bar{x}$ are,

$$\mu_{\bar{x}} = E\bar{X} = \frac{1}{N}\left[a\bar{\tau} + a^2 \sum_{i=1}^{N} \tau_i^2/N\right] \tag{42}$$

and

$$\sigma_{\bar{x}}^2 = Var(\bar{X}) = \frac{1}{N^2} \sum_{i=1}^{N} a\tau_i (1+a\tau_i)(1+2a\tau_i) \tag{43}$$

Thus, the upper control limit for $\bar{x}$ is,

$$UCL = \mu_{\bar{x}} + z_\alpha \sigma_{\bar{x}} \tag{44}$$

where $\mu_{\bar{x}}$ was defined in Eq. (42), $\sigma_{\bar{x}}$ is the square root of $\sigma_{\bar{x}}^2$ defined in Eq. (43), and z_α is the 100α upper percentage point of the standard normal distribution.

In Cases (1) and (2), we treated the overall quality control for a category of midblocks. Sometimes, even if $\bar{q}$ or $\bar{x}$ are under control, there could be cases where a few midblocks have exceedingly high accidents. It might be beneficial to conduct a case study on these high accident midblocks to identify assignable accident causes. Thus, we need a control chart to identify extraordinarily high accident midblocks. The control chart for this purpose is presented below.

3) The model can be used to identify high accident midblocks. For a given midblock with parameter 'a,' let τ and $x(\tau)$ be the ADT and the number of yearly accidents of that midblock. Then, the midblock would be considered as a high-accident midblock if the number of accidents in this midblock is higher than c, where c is the least integer such that,

$$Pr\left[x(\tau) > c\right] = \alpha \tag{45}$$

where the probability distribution of $x(\tau)$ was specified in Section IV.

4) The model can be used as a reference for designing new roadways. Various segments of a roadway can be constructed in many ways according to those midblock and intersection variables that classify midblock categories. Costs of each construction method vary and each results in a different expected number of accidents, as shown in this study. Since the construction cost and the expected number of accidents can be estimated in advance, this information could be converted into a set of suitable cost-and-accident-related criteria for designing a minimal accident roadway.

It is beyond the scope of this study to investigate how to convert the construction cost information and expected number of accidents into a set of cost-benefit criteria. But, we would point out that the estimated number of accidents for each roadway design should be taken into consideration in making the final choice.

5) The model can be used as a reference to provide information needed for optimally allocating limited funds into various safety improvement programs. As mentioned before, mathematical programming techniques can be applied using cost and benefit information resulting from each improvement action to optimally allocate limited funds to various improvement programs. To do so, it is essential to have a reliable estimate of the benefit (e. g., the expected accident reduction) resulting from improvement action. This estimate can be obtained by using the accident prediction model, because the expected reduction due to an improvement action is simply the difference between the expected number of accidents before and after the improvement was applied to a section of roadway. For example, an h-mile section of roadway in the category R22NITNP10M can be widened into the category R22NITNP12M. If the average traffic volume, τ, on this roadway remains the same, the expected accident reduction, EAR, resulting from this action is equal to,

$$\begin{aligned} EAR &= \frac{h}{0.2}\left[a_1\tau(1+a_1\tau) - a_2\tau(1+a_2\tau)\right] \\ &= \frac{h}{0.2}(a_1-a_2)\tau\left[1+(a_1+a_2)\tau\right] \end{aligned} \qquad (46)$$

where a_1=0.0000465104, a_2=0.0000323656 (see Table 7) and h/0.2 is the number of midblocks, in this section of roadway.

From the above example, we see that the expected accident reduction resulting from improving a midblock is equal to EAR,

$$EAR = (a_1-a_2)\bar{\tau}\left[1+(a_1+a_2)\bar{\tau}\right] \qquad (47)$$

where a_1 and a_2 are the parameters of the probability distributions of accidents of this midblock before and after improvement, respectively, and $\bar{\tau}$ is the expected ADT of the midblock before improvement in the following year.

The parameters for each category obtained in the previous section should be used and interpreted carefully. For example, we see from Tables 7 and 8 that the no-passing midblock has a higher accident rate than the passing midblock. This could be due to the fact that roadways allowing traffic to pass have better driving conditions than no-passing roadways. Thus, the process of removing a 'no-passing' restriction from a no-passing roadway should not be considered as a potential improvement. Thus, one would not use Eq. (47) in this situation.

X
URBAN AND FRINGE-STRIP MIDBLOCKS

We have demonstrated in detail the estimation procedures in the category of rural midblocks. In this section, we shall repeat the same procedures to estimate parameters in the categories of urban and fringe-strip midblocks. Due to the limitation of sample size, we shall only estimate the parameters of the probability distributions per year per midblock in categories of urban, two-way, two-lane, non-intersected and intersected midblocks (U22NIM and U22IM), and fringe-strip, two-way, two-lane, non-intersected and intersected midblocks (F22NIM and F22IM). The results are presented in Items 1 through 4 below. In Item 5 we present the estimated results in the categories of midblocks which are finer than those presented in the previous sections.

1) There are 379 urban, two-way, two-lane (U22M) midblocks in Districts 1 through 4 as shown in Figure 1. These 379 midblocks are further broken down into non-intersected and intersected midblocks as shown in Figure 17.

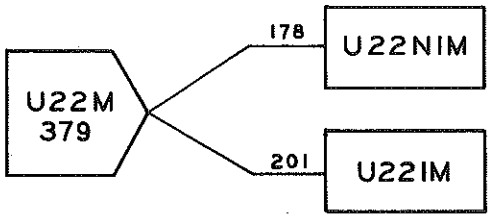

Figure 17. Number of midblocks in each category of urban, two-way, two-lane midblocks.

The estimated parameters of midblock accident distributions of U22NIM and U22IM, based on their respective probability distributions, are 0.0000517582 and 0.0000633827. The fitted results are presented in Tables 11 and 12.

2) There are 387 intersections located in U22M. The estimated parameter of this probability distribution of intersection-related accidents per intersection located in U22M is 0.0000417107. The fitted results are presented in Table 13.

3) There are 1,008 fringe-strip, two-way, two-lane (F22M) midblocks in Districts 1 through 4 as shown in Figure 1. These 1,008 midblocks are further broken down into non-intersected and intersected midblocks as shown in Figure 18.

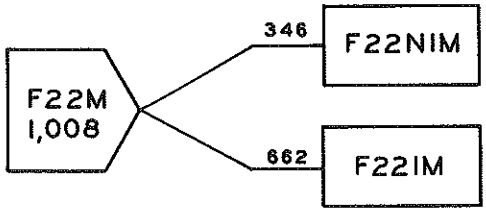

Figure 18. Number of midblocks in each category of fringe-strip, two-way, two-lane midblocks.

The estimated parameters of midblock accident distributions of F22NIM and F22IM, based on their respective probability distributions, are 0.0000626857 and 0.0000474802. The fitted results are presented in Tables 14 and 15.

4) There are 1,221 intersections located in F22M. The estimated parameter of the probability distribution of intersection-related accidents per intersection located in F22M is 0.0000425162. The fitted results are presented in Table 16.

5) We have obtained the estimates of parameters of the probability distributions of midblock accidents per midblock in each of the 24 categories of R22M. As one can see from Figure 2, each category can be further broken down into five more subcategories according to curb and shoulder width. Since most of the midblocks in each of the 24 categories have 4 to 8 ft or 8 to 10 ft shoulders, we shall repeat Stein's estimation procedures presented in Section VIII to estimate parameters of these 48 categories. The estimated results are presented in Tables 17 and 18.

TABLE 11

THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER YEAR PER MIDBLOCK IN U22NIM

Year	Number of Accidents	Number of Midblocks With i Accidents	Actual Probability	Estimated Probability	Residual
1971	0	151	0.84831	0.82879	0.01952
1971	1	19	0.10674	0.13850	-0.03176
1971	2	6	0.03371	0.02547	0.00824
1971	3	2	0.01124	0.00548	0.00576
1972	0	147	0.82584	0.83102	-0.00518
1972	1	26	0.14607	0.13710	0.00897
1972	2	2	0.01124	0.02492	-0.01368
1972	3	3	0.01685	0.00529	0.01156
1973	0	142	0.79775	0.83117	-0.03342
1973	1	31	0.17416	0.13684	0.03732
1973	2	1	0.00562	0.02498	-0.01936
1973	3	4	0.02247	0.00532	0.01715
1974	0	148	0.83146	0.83523	-0.00378
1974	1	27	0.15169	0.13419	0.01750
1974	2	3	0.01685	0.02410	-0.00725
1975	0	151	0.84831	0.82633	0.02198
1975	1	21	0.11798	0.14064	-0.02266
1975	2	4	0.02247	0.02603	-0.00356
1975	3	2	0.01124	0.00543	0.00582

TABLE 12

THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER YEAR PER MIDBLOCK IN U22IM

Year	Number of Accidents	Number of Midblocks With i Accidents	Actual Probability	Estimated Probability	Residual
1971	0	154	0.76617	0.77008	-0.00391
1971	1	33	0.16418	0.17102	-0.00684
1971	2	12	0.05970	0.04222	0.01748
1971	3	1	0.00498	0.01164	-0.00666
1971	5	1	0.00498	0.00107	0.00391
1972	0	159	0.79104	0.77681	0.01423
1972	1	33	0.16418	0.16738	-0.00320
1972	2	8	0.03980	0.04038	-0.00058
1972	4	1	0.00498	0.00315	0.00183
1973	0	157	0.78109	0.76924	0.01185
1973	1	34	0.16915	0.17142	-0.00227
1973	2	7	0.03483	0.04246	-0.00763
1973	3	3	0.01493	0.01175	0.00318
1974	0	159	0.79104	0.77803	0.01301
1974	1	32	0.15920	0.16566	-0.00646
1974	2	8	0.03980	0.04058	-0.00078
1974	3	2	0.00995	0.01105	-0.00110
1975	0	149	0.74129	0.77295	-0.03166
1975	1	37	0.18408	0.16852	0.01556
1975	2	10	0.04975	0.04205	0.00770
1975	3	4	0.01990	0.01156	0.00834

TABLE 13

THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF INTERSECTION-RELATED ACCIDENTS PER YEAR PER INTERSECTION LOCATED IN U22IM

Year	Number of Accidents	Number of Intersections	Actual Probability	Estimated Probability	Residual
1971	0	290	0.74935	0.76344	-0.01409
1971	1	65	0.16796	0.17221	-0.00425
1971	2	19	0.04910	0.04499	0.00411
1971	3	7	0.01809	0.01316	0.00493
1971	4	4	0.01034	0.00413	0.00621
1971	5	1	0.00258	0.00136	0.00122
1971	8	1	0.00258	0.00006	0.00252
1972	0	295	0.76227	0.77086	-0.00859
1972	1	61	0.15762	0.16824	-0.01062
1972	2	22	0.05685	0.04296	0.01389
1972	3	5	0.01292	0.01230	0.00062
1972	4	3	0.00775	0.00379	0.00396
1972	15	1	0.00258	0.00000	0.00258
1973	0	287	0.74160	0.76196	-0.02036
1973	1	77	0.19897	0.17289	0.02608
1973	2	14	0.03618	0.04540	-0.00922
1973	3	6	0.01550	0.01337	0.00214
1973	4	1	0.00258	0.00423	-0.00165
1973	5	2	0.00517	0.00141	0.00376
1974	0	312	0.80620	0.77368	0.03252
1974	1	57	0.14729	0.16541	-0.01812
1974	2	7	0.01809	0.04280	-0.02471
1974	3	4	0.01034	0.01237	-0.00203
1974	4	6	0.01550	0.00384	0.01166
1974	5	1	0.00258	0.00125	0.00133
1975	0	301	0.77778	0.77387	0.00391
1975	1	64	0.16537	0.16488	0.00049
1975	2	13	0.03359	0.04303	-0.00944
1975	3	4	0.01034	0.01246	-0.00212
1975	4	2	0.00517	0.00386	0.00131
1975	5	1	0.00258	0.00125	0.00133
1975	7	1	0.00258	0.00015	0.00243
1975	12	1	0.00258	0.00000	0.00258

TABLE 14
THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER YEAR PER MIDBLOCK IN F22NIM

Year	Number of Accidents	Number of Intersection	Actual Probability	Estimated Probability	Residual
1971	0	280	0.80925	0.79789	0.01136
1971	1	56	0.16185	0.15916	0.00269
1971	2	9	0.02601	0.03265	-0.00664
1971	3	1	0.00289	0.00764	-0.00475
1972	0	270	0.78035	0.80869	-0.02834
1972	1	64	0.18497	0.15218	0.03279
1972	2	10	0.02890	0.03004	-0.00114
1972	3	2	0.00578	0.00680	-0.00102
1973	0	277	0.80058	0.79922	0.00136
1973	1	54	0.15607	0.15842	-0.00235
1973	2	12	0.03468	0.03226	0.00242
1973	3	3	0.00867	0.00749	0.00118
1974	0	282	0.81503	0.79400	0.02103
1974	1	55	0.15896	0.16172	-0.00276
1974	2	9	0.02601	0.03357	-0.00756
1975	0	272	0.78613	0.77787	0.00826
1975	1	62	0.17919	0.17153	0.00766
1975	2	9	0.02601	0.03763	-0.01162
1975	3	3	0.00867	0.00938	-0.00072

TABLE 15
THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER YEAR PER MIDBLOCK IN F22IM

Year	Number of Accidents	Number of Intersection	Actual Probability	Estimated Probability	Residual
1971	0	560	0.84592	0.84522	0.00070
1971	1	82	0.12387	0.12904	-0.00517
1971	2	16	0.02417	0.02082	0.00335
1971	3	3	0.00453	0.00388	0.00065
1971	4	1	0.00151	0.00080	0.00071
1972	0	541	0.81722	0.85323	-0.03601
1972	1	105	0.15861	0.12322	0.03540
1972	2	15	0.02266	0.01918	0.00348
1972	3	1	0.00151	0.00347	-0.00196
1973	0	557	0.84139	0.84114	0.00025
1973	1	84	0.12689	0.13184	-0.00495
1973	2	15	0.02266	0.02176	0.00091
1973	3	5	0.00755	0.00413	0.00342
1973	4	1	0.00151	0.00087	0.00064
1974	0	578	0.87311	0.83753	0.03558
1974	1	77	0.11631	0.13438	-0.01807
1974	2	7	0.01057	0.02257	-0.01200
1975	0	551	0.83233	0.82932	0.00302
1975	1	99	0.14955	0.14000	0.00955
1975	2	11	0.01662	0.02445	-0.00783
1975	3	1	0.00151	0.00486	-0.00335

TABLE 16
THE EMPIRICAL AND ESTIMATED PROBABILITY DISTRIBUTIONS OF INTERSECTION-RELATED ACCIDENTS PER YEAR PER INTERSECTION LOCATED IN F22IM

Year	Number of Accidents	Number of Intersection	Actual Probability	Estimated Probability	Residual
1971	0	1,034	0.84685	0.86414	-0.01729
1971	1	146	0.11957	0.11562	0.00395
1971	2	31	0.02539	0.01675	0.00864
1971	3	4	0.00328	0.00282	0.00046
1971	4	4	0.00328	0.00053	0.00275
1971	6	1	0.00082	0.00002	0.00080
1971	7	1	0.00082	0.00000	0.00082
1972	0	1,047	0.85749	0.87140	-0.01391
1972	1	136	0.11138	0.11016	0.00122
1972	2	28	0.02293	0.01535	0.00758
1972	3	7	0.00573	0.00251	0.00322
1972	4	2	0.00164	0.00046	0.00118
1972	6	1	0.00082	0.00002	0.00080
1973	0	1,049	0.85913	0.85870	0.00043
1973	1	132	0.10811	0.11949	-0.01139
1973	2	26	0.02129	0.01793	0.00336
1973	3	11	0.00901	0.00311	0.00590
1973	4	3	0.00246	0.00060	0.00186
1974	0	1,056	0.86486	0.85449	0.01037
1974	1	138	0.11302	0.12253	-0.00951
1974	2	20	0.01638	0.01882	-0.00244
1974	3	4	0.00328	0.00333	-0.00005
1974	4	2	0.00164	0.00065	0.00099
1974	5	1	0.00082	0.00014	0.00068
1975	0	1,041	0.85258	0.84918	0.00340
1975	1	143	0.11171	0.12636	-0.00924
1975	2	24	0.01966	0.01995	-0.00029
1975	3	9	0.00737	0.00360	0.00377
1975	5	2	0.00164	0.00015	0.00149
1975	6	1	0.00082	0.00003	0.00079
1975	7	1	0.00082	0.00000	0.00082

TABLE 17
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER MIDBLOCK IN R22NIM, BASED ON STEIN'S ESTIMATION PROCEDURES

Category[1]					Prior Estimate	Proportion of Defective Midblocks X_i	$\hat{\theta}_i$	Estimated Parameter
R22NI	T	NP	10 ft	S1M	0.068692	0.0531646	0.0563642	0.0000460823
				S2M	0.068692	0.0825911	0.0798146	0.0000484048
			11 ft	S1M	0.068692	0.0561404	0.0586689	0.0000418086
				S2M	0.068692	0.0643087	0.0648995	0.0000346849
			12 ft	S1M	0.068692	0.0660714	0.0668923	0.0000271993
				S2M	0.068692	0.0950000	0.0890426	0.0000340163
		P	10 ft	S1M	0.062963	0.0539568	0.0551155	0.0000407113
				S2M	0.062963	0.0496815	0.0511091	0.0000322216
			11 ft	S1M	0.062963	0.0479903	0.0486211	0.0000368706
				S2M	0.062963	0.0599623	0.0600438	0.0000338588
			12 ft	S1M	0.062963	0.0748837	0.0735198	0.0000332058
				S2M	0.062963	0.0750758	0.0746865	0.0000292069
	C	NP	10 ft	S1M	0.082759	0.0581633	0.0627121	0.0000478352
				S2M	0.082759	0.0954023	0.0917314	0.0000593951
			11 ft	S1M	0.082759	0.0825243	0.0825785	0.0000673330
				S2M	0.082759	0.0820000	0.0820998	0.0000426522
			12 ft	S1M	0.082759	0.1029410	0.0921243	0.0000374332
				S2M	0.082759	0.1207550	0.1113610	0.0000443909
		P	10 ft	S1M	0.080893	0.0601399	0.0652174	0.0000440859
				S2M	0.080893	0.0635135	0.0678208	0.0000416738
			11 ft	S1M	0.080893	0.0512968	0.0542822	0.0000364571
				S2M	0.080893	0.0836469	0.0834233	0.0000395084
			12 ft	S1M	0.080893	0.1058820	0.0985177	0.0000409830
				S2M	0.080893	0.0946548	0.0936842	0.0000347433

[1] S1M (S2M) means that the midblock was 4 to 8 (8 to 10) ft shoulder.

TABLE 18
ESTIMATED PARAMETERS OF THE PROBABILITY DISTRIBUTIONS OF MIDBLOCK ACCIDENTS PER MIDBLOCK IN R22IM, BASED ON STEIN'S ESTIMATION PROCEDURES

Category[1]					Prior Estimate	Proportion of Defective Midblocks X_i	$\hat{\theta}_i$	Estimated Parameter
R22I	T	NP	10 ft	S1M	0.088681	0.0676923	0.0776307	0.0000513577
				S2M	0.088681	0.0560976	0.0680839	0.0000448494
			11 ft	S1M	0.088681	0.0830769	0.0860104	0.0000405516
				S2M	0.088681	0.0981132	0.0940231	0.0000407187
			12 ft	S1M	0.088681	0.1200000	0.0982204	0.0000369127
				S2M	0.088681	0.1160710	0.1035240	0.0000357597
		P	10 ft	S1M	0.074855	0.0791209	0.0773176	0.0000499213
				S2M	0.074855	0.0600000	0.0646424	0.0000381346
			11 ft	S1M	0.074855	0.0612613	0.0637015	0.0000436558
				S2M	0.074855	0.0706587	0.0710612	0.0000363922
			12 ft	S1M	0.074855	0.0607143	0.0639116	0.0000294539
				S2M	0.074855	0.0873684	0.0860913	0.0000329848
	C	NP	10 ft	S1M	0.107223	0.0948718	0.1011320	0.0000720974
				S2M	0.107223	0.1192660	0.1135870	0.0000679148
			11 ft	S1M	0.107223	0.0898551	0.0958777	0.0000630455
				S2M	0.107223	0.0120904	0.1161160	0.0000454443
			12 ft	S1M	0.107223	0.0750000	0.0951196	0.0000393137
				S2M	0.107223	0.1256200	0.1172360	0.0000394389
		P	10 ft	S1M	0.090162	0.0958333	0.0922362	0.0000620688
				S2M	0.090162	0.0979592	0.0930158	0.0000542033
			11 ft	S1M	0.090162	0.0510345	0.0597633	0.0000380477
				S2M	0.090162	0.0931298	0.0924869	0.0000431618
			12 ft	S1M	0.090162	0.0857143	0.0881122	0.0000328103
				S2M	0.090162	0.1005380	0.0987765	0.0000319183

[1] S1M (S2M) means that the midblock was 4 to 8 (8 to 10) ft shoulder.

XI
REMARKS

During the course of this investigation, certain matters arose that are worthy of comment. These are discussed in the following remarks.

1) The Poisson distribution was also used to fit the empirical probability distribution of midblock accidents per midblock. That is, the probability distribution of $X(T)$ is,

$$P_i(T) = P_r\left[X(T) = i\right] = e^{-\lambda(T)}\frac{\left[\lambda(T)\right]}{i!} \tag{48}$$

where $\lambda(T) = aT^b$ or $\lambda(T) = aT + bT^2$.

Fitting these specifications to the data indicates that the model presented in Section V is better than the Poisson model in the least squares sense.

2) The model presented in Section V assumes the following relation,

$$P_i(T) = \left[P_1(T)\right]^i \qquad , i \geq 1 \tag{49}$$

To make the above assumption more general, we assume that $\left\{P_i(T) \ , i=1,\ldots.\right\}$ is a geometric series with rate $r(T)$. We then have the following model,

$$\begin{aligned} P_0(T) &= 1 - aT \\ P_i(T) &= \left[1 - r(T)\right]\left[r(T)\right]^{i-1} aT, \ i \geq 1 \end{aligned} \tag{50}$$

Note that if $r(T) = P_1(T)$, the above model becomes the one presented in Section V. The above model with $r(T) = b$ (independent of T) was used to fit empirical probability distributions. In most cases, this model is slightly better than the one presented in Section V. However, we felt that the reduction in the sum of square residuals by using this model is not enough to justify the extra parameter introduced.

3) In Section IX, the upper control limits were set to identify high-accident locations. We also mentioned that the procedures for optimally allocating available funds to various safety improvement programs at various locations can be designed so that the accident reduction per dollar investment is maximal. The number of accidents is the unit used in both cases to set the desired goal. However, in some situations, the number of accidents might not be the best unit for decision making. For example, Location 1 has more accidents than Location 2; but, each accident occurring at Location 1 is much less severe than each one at Location 2. Under this circumstance, it might be better to pay more attention to Location 2 than Location 1. That is, accident severity could be the more suitable unit for decision making.

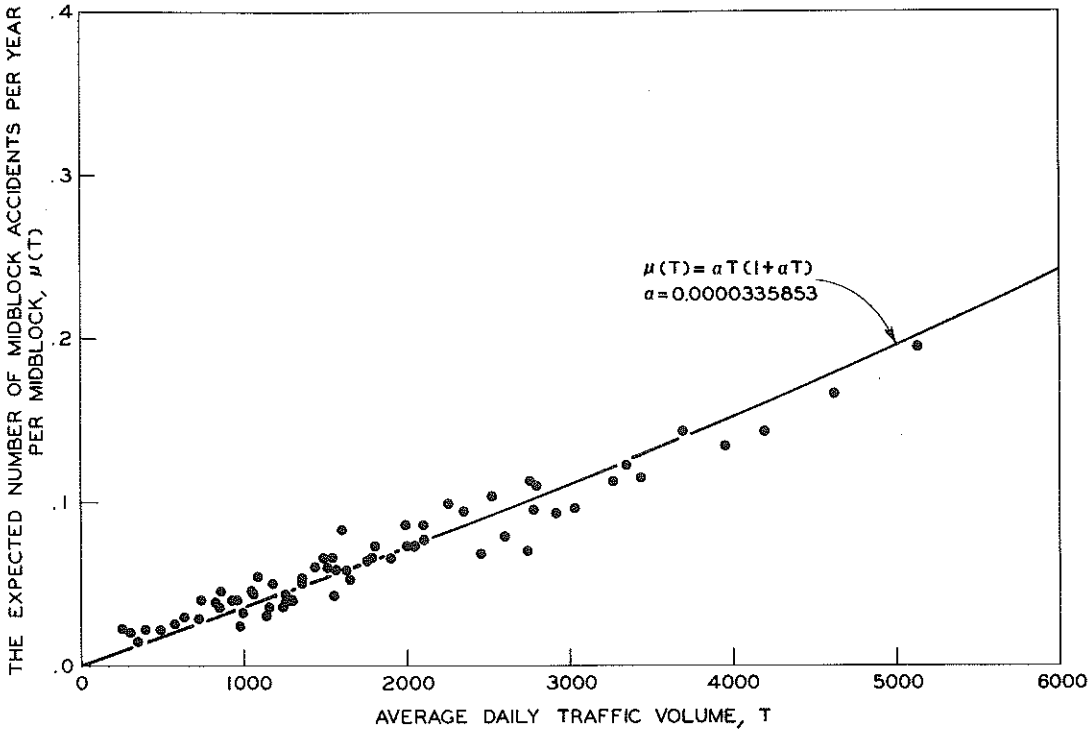

Figure 19. Actual and predicted expected number of accidents per year per midblock in R22NITM. (The point (8057.39, 0.255) is not plotted in the figure due to scale.)

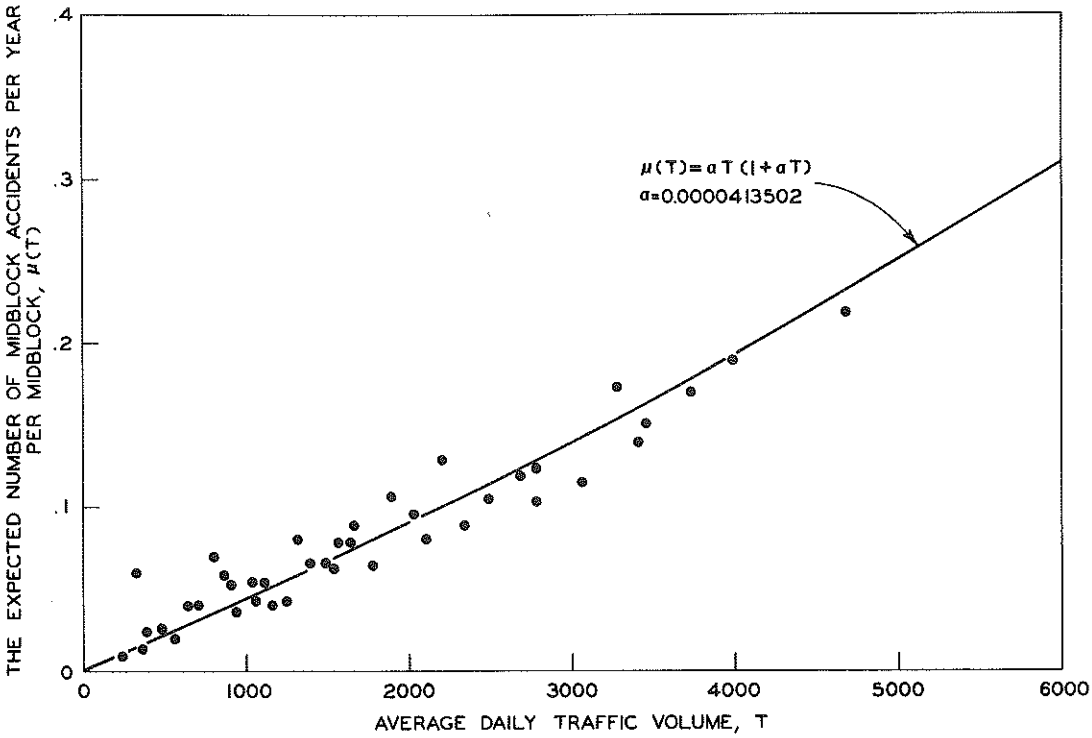

Figure 20. Actual and predicted expected number of accidents per year per midblock in R22NICM. (The point (8057.39, 0.255) is not plotted in the figure due to scale.)

Each accident in our data set was coded according to those accident types (1 through 19) mentioned in Section III. The severity index of each accident type can be estimated from past accident statistics. Thus, if one can compute the probability that a given accident occurring on a midblock is the i^{th} type accident, the expected accident severity of a midblock in each category can be computed. Due to the accident sample sizes and the time limitation, we did not investigate this subject.

4) There are other variables provided in the data that were not taken into consideration due to the time limitation. However, a similar approach to that presented in this report could be used to study the effect of these variables on accident behavior.

5) In Section V, we used the categories R22NITM and R22NICM to investigate the functional form of P_o (Figs. 5 and 6). One hundred midblocks, grouped according to the order of the ADT value (to compute P_o), are also used to compute the average number of accidents, $\bar{x}$, per year per midblock. If the model presented in Section V is good, the estimated value $\mu(\tau)$ defined in Eq. (16) should reasonably 'agree' with the actual value $\bar{x}$.

The parameters in $\mu(\tau)$ for these two categories were presented in Table 2. The results are plotted in Figures 19 and 20. One can see from these two figures that the estimated values are reasonably close to the actual values except for one extreme point in each category. These two extreme points are due to extremely high ADT's of a few midblocks. This raises a question concerning the accuracy of the ADT values of these few midblocks. Nevertheless, the model gives reasonable estimates of the expected number of accidents per year per midblock.

Based on the above discussions, it seems that the parameter 'a' for the probability distribution of accidents per year per midblock can be estimated by using the (non-linear) regression analysis on the following model specification,

$$X(\bar{\tau}_i) = a\bar{\tau}_i + a^2 \sum_{j=1}^{N_i} \tau_{ij}^2 / N_i + \epsilon(\tau_i) \qquad (51)$$

where τ_{ij} is the ADT value of the j^{th} midblock of the i^{th} group, N_i is the number of midblocks in the i^{th} group, $\bar{\tau}_i = \sum_{j=1}^{N_i} \tau_{ij} / N_i$ and $\epsilon(\bar{\tau}_i)$ is the random variable with $E\epsilon(\bar{\tau}_i) = 0$ and $\sigma^2_{\epsilon(\bar{\tau}_i)} = \left[a \sum_{j=1}^{N_i} \tau_{ij} + 3a^2 \sum_{j=1}^{N_i} \tau_{ij}^2 + 2a^3 \sum_{j=1}^{N_i} \tau_{ij}^3\right] / N_i^2$. Using the above method to estimate the parameter 'a' is simpler than the method presented in Sections V to VII. We do not, however, recommend this method since the estimated results depend upon the grouping method used to compute $\bar{\tau}_i$ and $X(\bar{\tau}_i)$.

APPENDIX

THE ACTUAL AND ESTIMATED PROBABILITY DISTRIBUTION OF MIDBLOCK AND INTERSECTION-RELATED ACCIDENTS PER YEAR PER MIDBLOCK AND INTERSECTION, RESPECTIVELY, IN EACH CATEGORY

APPENDIX

Tables A1 to A18 are the actual and estimated probability distributions of midblock accidents per year per midblock in each category of rural, two-way, two-lane, non-intersected midblocks presented in Table 2 in the text.

Tables A19 to A36 are the actual and estimated probability distributions of midblock accidents per year per midblock in each category of rural, two-way, two-lane, intersected midblocks presented in Table 3 in the text.

Tables A37 to A48 are the actual and estimated probability distributions of intersection-related accidents per year per intersection in each category of intersections located in R22ITM and R22ICM. Symbols in Tables A37 to A48 are explained as follows:

I - the category of intersections.

TI(CI) - the category of intersecting roadways are tangent (curved). In short, the category of tangent (curved) intersections.

NS - the category of intersections that have no signal.

FLR - the category of intersections equipped with a flasher.

Any combination of the above variables can be interpreted in a similar way. For example, TI, NS in R22ITM means the category of tangent intersections that have no signal and are located in R22ITM.

TABLE A1

CATEGORY : R22NITM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	6276	.932818E+00	.936993E+00	-.417479E-02
1971	1	419	.622771E-01	.576018E-01	.467520E-02
1971	2	29	.431034E-02	.473890E-02	-.428557E-03
1971	3	3	.445898E-03	.548747E-03	-.102849E-03
1971	4	1	.148633E-03	.900143E-04	.586182E-04
1972	0	6235	.926724E+00	.940765E+00	-.140413E-01
1972	1	454	.674792E-01	.543119E-01	.131673E-01
1972	2	32	.475624E-02	.431834E-02	.437903E-03
1972	3	4	.594530E-03	.496345E-03	.981853E-04
1972	4	3	.445898E-03	.823265E-04	.363571E-03
1973	0	6310	.937872E+00	.937083E+00	.788302E-03
1973	1	384	.570749E-01	.575293E-01	-.454402E-03
1973	2	31	.460761E-02	.472142E-02	-.113806E-03
1973	3	3	.445898E-03	.547562E-03	-.101664E-03
1974	0	6345	.943074E+00	.934789E+00	.828443E-02
1974	1	355	.527646E-01	.594677E-01	-.670317E-02
1974	2	23	.341855E-02	.501765E-02	-.159910E-02
1974	3	4	.594530E-03	.594280E-03	.249970E-06
1974	5	1	.148633E-03	.224926E-04	.126140E-03
1975	0	6314	.938466E+00	.929653E+00	.881291E-02
1975	1	386	.573722E-01	.636468E-01	-.627459E-02
1975	2	24	.356718E-02	.579131E-02	-.222413E-02
1975	3	4	.594530E-03	.736028E-03	-.141498E-03

TABLE A2

CATEGORY : R22NICM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	3946	.919385E+00	.919758E+00	-.372779E-03
1971	1	315	.733924E-01	.714338E-01	.195851E-02
1971	2	28	.652377E-02	.752000E-02	-.996235E-03
1971	3	2	.465983E-03	.104818E-02	-.582194E-03
1971	4	1	.232992E-03	.184846E-03	.481451E-04
1972	0	3920	.913327E+00	.924279E+00	-.109519E-01
1972	1	331	.771202E-01	.676731E-01	.944714E-02
1972	2	36	.838770E-02	.688323E-02	.150447E-02
1972	3	4	.931966E-03	.946105E-03	-.141387E-04
1972	4	1	.232992E-03	.167492E-03	.654991E-04
1973	0	3925	.914492E+00	.920286E+00	-.579380E-02
1973	1	326	.759553E-01	.710847E-01	.487054E-02
1973	2	35	.815471E-02	.737702E-02	.777688E-03
1973	3	4	.931966E-03	.101802E-02	-.860558E-04
1973	4	2	.465983E-03	.179755E-03	.286229E-03
1974	0	3980	.927307E+00	.917431E+00	.987514E-02
1974	1	296	.689655E-01	.733858E-01	-.442031E-02
1974	2	15	.349487E-02	.782088E-02	-.432601E-02
1974	3	1	.232992E-03	.110262E-02	-.869628E-03
1975	0	3945	.919152E+00	.910260E+00	.889189E-02
1975	1	319	.743243E-01	.788742E-01	-.454992E-02
1975	2	22	.512582E-02	.911335E-02	-.398754E-02
1975	3	4	.931966E-03	.139291E-02	-.460942E-03
1975	4	1	.232992E-03	.268966E-03	-.359746E-04
1975	6	1	.232992E-03	.178919E-04	.215100E-03

TABLEA3

CATEGORY : R22NITNPM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1278	.926087E+00	.933721E+00	-.763430E-02
1971	1	91	.659420E-01	.604635E-01	.547853E-02
1971	2	8	.579710E-02	.514149E-02	.655616E-03
1971	3	2	.144928E-02	.573022E-03	.876254E-03
1971	4	1	.724638E-03	.815011E-04	.643137E-03
1972	0	1274	.923188E+00	.936565E+00	-.133765E-01
1972	1	99	.717391E-01	.580124E-01	.137267E-01
1972	2	6	.434783E-02	.480147E-02	-.453649E-03
1972	3	1	.724638E-03	.528041E-03	.196597E-03
1973	0	1293	.936957E+00	.932350E+00	.460655E-02
1973	1	80	.579710E-01	.616601E-01	-.368913E-02
1973	2	7	.507246E-02	.529345E-02	-.220986E-03
1974	0	1299	.941304E+00	.930002E+00	.113024E-01
1974	1	77	.557971E-01	.636235E-01	-.782638E-02
1974	2	3	.217391E-02	.561524E-02	-.344133E-02
1974	5	1	.724638E-03	.169370E-04	.707701E-03
1975	0	1281	.928261E+00	.923898E+00	.436300E-02
1975	1	89	.644928E-01	.685417E-01	-.404896E-02
1975	2	8	.579710E-02	.656857E-02	-.771467E-03
1975	3	2	.144928E-02	.820079E-03	.625196E-03

TABLE A4

CATEGORY : R22NIT PM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	4998	.934555E+00	.937889E+00	-.333370E-02
1971	1	328	.613313E-01	.568301E-01	.450124E-02
1971	2	21	.392670E-02	.462597E-02	-.699269E-03
1971	3	1	.186986E-03	.537587E-03	-.350601E-03
1972	0	4961	.927636E+00	.941855E+00	-.142181E-01
1972	1	355	.663800E-01	.533598E-01	.130202E-01
1972	2	26	.486163E-02	.419309E-02	.668542E-03
1972	3	3	.560957E-03	.484694E-03	.762635E-04
1972	4	3	.560957E-03	.819720E-04	.478985E-03
1973	0	5017	.938108E+00	.938300E+00	-.192021E-03
1973	1	304	.568437E-01	.564734E-01	.370312E-03
1973	2	24	.448766E-02	.457580E-02	-.881370E-04
1973	3	3	.560957E-03	.532972E-03	.279856E-04
1974	0	5046	.943530E+00	.936024E+00	.750623E-02
1974	1	278	.519820E-01	.584020E-01	-.641991E-02
1974	2	20	.373972E-02	.486496E-02	-.112525E-02
1974	3	4	.747943E-03	.578350E-03	.169593E-03
1975	0	5033	.941099E+00	.931115E+00	.998452E-02
1975	1	297	.555348E-01	.624059E-01	-.687113E-02
1975	2	16	.299177E-02	.559783E-02	-.260606E-02
1975	3	2	.373972E-03	.711529E-03	-.337557E-03

TABLE A5

CATEGORY : R22NICNPM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1485	.921216E+00	.919191E+00	.202509E-02
1971	1	116	.719603E-01	.714414E-01	.518887E-03
1971	2	9	.558313E-02	.796389E-02	-.238076E-02
1971	3	1	.620347E-03	.115828E-02	-.537935E-03
1971	4	1	.620347E-03	.197915E-03	.422433E-03
1972	0	1485	.921216E+00	.923250E+00	-.203450E-02
1972	1	109	.676179E-01	.681518E-01	-.533937E-03
1972	2	15	.930521E-02	.734093E-02	.196428E-02
1972	3	3	.186104E-02	.104066E-02	.820381E-03
1973	0	1475	.915012E+00	.919117E+00	-.410500E-02
1973	1	123	.763027E-01	.715828E-01	.471996E-02
1973	2	12	.744417E-02	.791147E-02	-.467298E-03
1973	3	2	.124069E-02	.114383E-02	.968671E-04
1974	0	1489	.923697E+00	.916222E+00	.747480E-02
1974	1	114	.707196E-01	.738761E-01	-.315651E-02
1974	2	8	.496278E-02	.838598E-02	-.342320E-02
1974	3	1	.620347E-03	.124213E-02	-.621783E-03
1975	0	1464	.908189E+00	.908425E+00	-.236395E-03
1975	1	136	.843672E-01	.798138E-01	.455348E-02
1975	2	9	.558313E-02	.981289E-02	-.422977E-02
1975	3	3	.186104E-02	.157007E-02	.290971E-03

TABLE A6

CATEGORY : R22NIC PM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2461	.918284E+00	.920194E+00	-.191013E-02
1971	1	199	.742537E-01	.713987E-01	.285506E-02
1971	2	19	.708955E-02	.721673E-02	-.127180E-03
1971	3	1	.373134E-03	.970769E-03	-.597634E-03
1972	0	2435	.908582E+00	.924910E+00	-.163282E-01
1972	1	222	.828358E-01	.674201E-01	.154158E-01
1972	2	21	.783582E-02	.658903E-02	.124679E-02
1972	3	1	.373134E-03	.878564E-03	-.505429E-03
1972	4	1	.373134E-03	.154668E-03	.218467E-03
1973	0	2450	.914179E+00	.920989E+00	-.680947E-02
1973	1	203	.757463E-01	.708176E-01	.492867E-02
1973	2	23	.858209E-02	.704273E-02	.153936E-02
1973	3	2	.746269E-03	.937434E-03	-.191166E-03
1973	4	2	.746269E-03	.163735E-03	.582534E-03
1974	0	2491	.929478E+00	.918159E+00	.113189E-01
1974	1	182	.679104E-01	.731235E-01	-.521304E-02
1974	2	7	.261194E-02	.746749E-02	-.485555E-02
1975	0	2481	.925746E+00	.911282E+00	.144638E-01
1975	1	183	.682836E-01	.784126E-01	-.101290E-01
1975	2	13	.485075E-02	.869323E-02	-.384248E-02
1975	3	1	.373134E-03	.128360E-02	-.910465E-03
1975	4	1	.373134E-03	.245215E-03	.127919E-03
1975	6	1	.373134E-03	.164789E-04	.356655E-03

TABLE A7

CATEGORY : R22NITNP10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	432	.917197E+00	.936852E+00	-.196544E-01
1971	1	36	.764331E-01	.581487E-01	.182844E-01
1971	2	3	.636943E-02	.451251E-02	.185692E-02
1972	0	436	.925690E+00	.938435E+00	-.127449E-01
1972	1	29	.615711E-01	.567756E-01	.479557E-02
1972	2	5	.106157E-01	.433089E-02	.628482E-02
1972	3	1	.212314E-02	.407350E-03	.171579E-02
1973	0	444	.942675E+00	.936614E+00	.606071E-02
1973	1	26	.552017E-01	.583677E-01	-.316603E-02
1973	2	1	.212314E-02	.452787E-02	-.240472E-02
1974	0	446	.946921E+00	.934595E+00	.123261E-01
1974	1	24	.509554E-01	.600877E-01	-.913227E-02
1974	2	1	.212314E-02	.478442E-02	-.266128E-02
1975	0	442	.938429E+00	.927679E+00	.107498E-01
1975	1	26	.552017E-01	.659083E-01	-.107066E-01
1975	2	3	.636943E-02	.571963E-02	.649800E-03

TABLE A8

CATEGORY : R22NITNP11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	509	.944341E+00	.941423E+00	.291804E-02
1971	1	28	.519481E-01	.535557E-01	-.160764E-02
1971	2	1	.185529E-02	.437652E-02	-.252123E-02
1971	3	1	.185529E-02	.525089E-03	.133020E-02
1972	0	507	.940631E+00	.944336E+00	-.370548E-02
1972	1	32	.593692E-01	.509717E-01	.839753E-02
1973	0	511	.948052E+00	.939780E+00	.827206E-02
1973	1	27	.500928E-01	.550590E-01	-.496625E-02
1973	2	1	.185529E-02	.450646E-02	-.265118E-02
1974	0	506	.938776E+00	.937622E+00	.115384E-02
1974	1	30	.556586E-01	.568909E-01	-.123222E-02
1974	2	2	.371058E-02	.477814E-02	-.106757E-02
1974	5	1	.185529E-02	.227550E-04	.183253E-02
1975	0	500	.927644E+00	.932792E+00	-.514836E-02
1975	1	35	.649351E-01	.606774E-01	.425770E-02
1975	2	3	.556586E-02	.558308E-02	-.172210E-04
1975	3	1	.185529E-02	.750288E-03	.110500E-02

TABLE A9

CATEGORY : R22NITNP12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	337	.910811E+00	.918442E+00	-.763135E-02
1971	1	27	.729730E-01	.741145E-01	-.114154E-02
1971	2	4	.108108E-01	.664838E-02	.416243E-02
1971	3	1	.270270E-02	.698933E-03	.200377E-02
1971	4	1	.270270E-02	.832992E-04	.261940E-02
1972	0	331	.894595E+00	.922466E+00	-.278715E-01
1972	1	38	.102703E+00	.706925E-01	.320102E-01
1972	2	1	.270270E-02	.612509E-02	-.342239E-02
1973	0	338	.913514E+00	.916323E+00	-.280912E-02
1973	1	27	.729730E-01	.759072E-01	-.293422E-02
1973	2	5	.135135E-01	.692986E-02	.658366E-02
1974	0	347	.937838E+00	.913339E+00	.244988E-01
1974	1	23	.621622E-01	.783680E-01	-.162058E-01
1975	0	339	.916216E+00	.906119E+00	.100975E-01
1975	1	28	.756757E-01	.841323E-01	-.845662E-02
1975	2	2	.540541E-02	.855989E-02	-.315449E-02
1975	3	1	.270270E-02	.102424E-02	.167846E-02

TABLE A10

CATEGORY : R22NIT P10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	656	.949349E+00	.948302E+00	.104726E-02
1971	1	32	.463097E-01	.478795E-01	-.156983E-02
1971	2	2	.289436E-02	.344979E-02	-.555429E-03
1971	3	1	.144718E-02	.326817E-03	.112036E-02
1972	0	653	.945007E+00	.951205E+00	-.619814E-02
1972	1	36	.520984E-01	.454074E-01	.669100E-02
1972	2	2	.289436E-02	.308509E-02	-.190736E-03
1973	0	652	.943560E+00	.949571E+00	-.601131E-02
1973	1	38	.549928E-01	.468812E-01	.811152E-02
1973	3	1	.144718E-02	.284343E-03	.116284E-02
1974	0	666	.963821E+00	.947777E+00	.160437E-01
1974	1	23	.332851E-01	.484333E-01	-.151482E-01
1974	2	2	.289436E-02	.344011E-02	-.545751E-03
1975	0	649	.939219E+00	.943079E+00	-.386048E-02
1975	1	39	.564399E-01	.524240E-01	.401595E-02
1975	2	2	.289436E-02	.404470E-02	-.115034E-02
1975	3	1	.144718E-02	.399472E-03	.104771E-02

TABLE A11

CATEGORY : R22NIT P11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2333	.941865E+00	.943995E+00	-.213025E-02
1971	1	140	.565200E-01	.519769E-01	.454311E-02
1971	2	4	.161486E-02	.365919E-02	-.204434E-02
1972	0	2311	.932983E+00	.948551E+00	-.155680E-01
1972	1	158	.637868E-01	.479444E-01	.158424E-01
1972	2	6	.242229E-02	.319309E-02	-.770809E-03
1972	3	2	.807428E-03	.276880E-03	.530548E-03
1973	0	2348	.947921E+00	.945211E+00	.271000E-02
1973	1	118	.476383E-01	.509011E-01	-.326278E-02
1973	2	10	.403714E-02	.353212E-02	.505021E-03
1973	3	1	.403714E-03	.315884E-03	.878303E-04
1974	0	2350	.948728E+00	.943060E+00	.566865E-02
1974	1	115	.464271E-01	.527692E-01	-.634207E-02
1974	2	10	.403714E-02	.377849E-02	.258648E-03
1974	3	2	.807428E-03	.347324E-03	.460104E-03
1975	0	2349	.948325E+00	.939203E+00	.912198E-02
1975	1	123	.496568E-01	.560061E-01	-.634927E-02
1975	2	5	.201857E-02	.430438E-02	-.228581E-02

TABLE A12

CATEGORY : R22NIT P12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2009	.921560E+00	.927619E+00	-.605980E-02
1971	1	156	.715596E-01	.654909E-01	.606868E-02
1971	2	15	.688073E-02	.592825E-02	.952485E-03
1972	0	1997	.916055E+00	.931382E+00	-.153268E-01
1972	1	161	.738532E-01	.622313E-01	.116219E-01
1972	2	18	.825688E-02	.549393E-02	.276295E-02
1972	3	1	.458716E-03	.715665E-03	-.256950E-03
1972	4	3	.137615E-02	.133494E-03	.124265E-02
1973	0	2017	.925229E+00	.927023E+00	-.179331E-02
1973	1	148	.678899E-01	.660207E-01	.186923E-02
1973	2	14	.642202E-02	.598370E-02	.438322E-03
1973	3	1	.458716E-03	.780278E-03	-.321562E-03
1974	0	2030	.931193E+00	.924442E+00	.675052E-02
1974	1	140	.642202E-01	.681616E-01	-.394145E-02
1974	2	8	.366972E-02	.634106E-02	-.267134E-02
1974	3	2	.917431E-03	.842744E-03	.746870E-04
1975	0	2035	.933486E+00	.918323E+00	.151635E-01
1975	1	135	.619266E-01	.730477E-01	-.111210E-01
1975	2	9	.412844E-02	.731947E-02	-.319103E-02
1975	3	1	.458716E-03	.103557E-02	-.576856E-03

TABLE A13

CATEGORY : R22NICNP10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	554	.931092E+00	.939368E+00	-.827570E-02
1971	1	34	.571429E-01	.556444E-01	.149842E-02
1971	2	5	.840336E-02	.446687E-02	.393649E-02
1971	3	1	.168067E-02	.457205E-03	.122347E-02
1971	4	1	.168067E-02	.548330E-04	.162584E-02
1972	0	566	.951261E+00	.942021E+00	.923994E-02
1972	1	22	.369748E-01	.533787E-01	-.164039E-01
1972	2	6	.100840E-01	.413842E-02	.594561E-02
1972	3	1	.168067E-02	.407983E-03	.127269E-02
1973	0	553	.929412E+00	.939525E+00	-.101134E-01
1973	1	39	.655462E-01	.555634E-01	.998284E-02
1973	2	2	.336134E-02	.440357E-02	-.104222E-02
1973	3	1	.168067E-02	.446035E-03	.123464E-02
1974	0	557	.936134E+00	.937291E+00	-.115612E-02
1974	1	37	.621849E-01	.574644E-01	.472050E-02
1974	2	1	.168067E-02	.468748E-02	-.300681E-02
1975	0	558	.937815E+00	.931013E+00	.680230E-02
1975	1	35	.588235E-01	.626614E-01	-.383784E-02
1975	2	1	.168067E-02	.559429E-02	-.391362E-02
1975	3	1	.168067E-02	.632643E-03	.104803E-02

TABLE A14

CATEGORY : R22NICNP11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	622	.929744E+00	.919647E+00	.100992E-01
1971	1	46	.687593E-01	.709846E-01	-.222530E-02
1971	2	1	.149477E-02	.796994E-02	-.647517E-02
1972	0	615	.919283E+00	.923461E+00	-.417850E-02
1972	1	52	.777280E-01	.678423E-01	.988563E-02
1972	2	2	.298954E-02	.742363E-02	-.443410E-02
1973	0	615	.919283E+00	.918778E+00	.504859E-03
1973	1	48	.717489E-01	.717490E-01	-.108395E-06
1973	2	6	.896861E-02	.805497E-02	.913643E-03
1974	0	626	.935725E+00	.915918E+00	.198073E-01
1974	1	40	.597907E-01	.740034E-01	-.142127E-01
1974	2	2	.298954E-02	.853047E-02	-.554093E-02
1974	3	1	.149477E-02	.127334E-02	.221426E-03
1975	0	597	.892377E+00	.908648E+00	-.162716E-01
1975	1	67	.100149E+00	.795120E-01	.206375E-01
1975	2	5	.747384E-02	.989252E-02	-.241868E-02

TABLE A15

CATEGORY : R22NICNP12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	309	.887931E+00	.884329E+00	.360180E-02
1971	1	36	.103448E+00	.996463E-01	.380193E-02
1971	2	3	.862069E-02	.133940E-01	-.477336E-02
1972	0	304	.873563E+00	.891120E+00	-.175569E-01
1972	1	35	.100575E+00	.943613E-01	.621344E-02
1972	2	7	.201149E-01	.121896E-01	.792539E-02
1972	3	2	.574713E-02	.190669E-02	.384043E-02
1973	0	307	.882184E+00	.885277E+00	-.309357E-02
1973	1	36	.103448E+00	.990339E-01	.441442E-02
1973	2	4	.114943E-01	.131296E-01	-.163532E-02
1973	3	1	.287356E-02	.208590E-02	.787666E-03
1974	0	306	.879310E+00	.881196E+00	-.188580E-02
1974	1	37	.106322E+00	.102108E+00	.421393E-02
1974	2	5	.143678E-01	.139058E-01	.462005E-03
1975	0	309	.887931E+00	.869846E+00	.180851E-01
1975	1	34	.977011E-01	.110228E+00	-.125270E-01
1975	2	3	.862069E-02	.162860E-01	-.766530E-02
1975	3	2	.574713E-02	.288884E-02	.285829E-02

TABLE A16

CATEGORY : R22NIC P10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	395	.958738E+00	.942155E+00	.165833E-01
1971	1	16	.388350E-01	.531421E-01	-.143071E-01
1971	2	1	.242718E-02	.421105E-02	-.178387E-02
1972	0	397	.963592E+00	.945954E+00	.176385E-01
1972	1	15	.364078E-01	.499193E-01	-.135116E-01
1973	0	380	.922330E+00	.943707E+00	-.213766E-01
1973	1	31	.752427E-01	.519415E-01	.233012E-01
1973	2	1	.242718E-02	.391992E-02	-.149274E-02
1974	0	385	.934466E+00	.941664E+00	-.719819E-02
1974	1	26	.631068E-01	.536835E-01	.942331E-02
1974	2	1	.24271AE-02	.417725E-02	-.175007E-02
1975	0	384	.932039E+00	.937113E+00	-.507440E-02
1975	1	21	.509709E-01	.574357E-01	-.646486E-02
1975	2	6	.145631E-01	.484501E-02	.971810E-02
1975	3	1	.242718E-02	.527084E-03	.190010E-02

TABLE A17

CATEGORY : R22NI CP11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	976	.925996E+00	.928317E+00	-.232089E-02
1971	1	71	.673624E-01	.644690E-01	.289340E-02
1971	2	7	.664137E-02	.619814E-02	.443224E-03
1972	0	964	.914611E+00	.932539E+00	-.179285E-01
1972	1	79	.749526E-01	.608183E-01	.141343E-01
1972	2	11	.104364E-01	.570482E-02	.473161E-02
1973	0	974	.924099E+00	.928824E+00	-.472494E-02
1973	1	71	.673624E-01	.640561E-01	.330635E-02
1973	2	7	.664137E-02	.612193E-02	.519437E-03
1973	3	1	.948767E-03	.813785E-03	.134981E-03
1973	4	1	.948767E-03	.142181E-03	.806585E-03
1974	0	988	.937381E+00	.926260E+00	.111215E-01
1974	1	62	.588235E-01	.661686E-01	-.734508E-02
1974	2	4	.379507E-02	.648842E-02	-.269335E-02
1975	0	984	.933586E+00	.920475E+00	.131112E-01
1975	1	66	.626186E-01	.706263E-01	-.800773E-02
1975	2	2	.189753E-02	.750057E-02	-.560303E-02
1975	4	1	.948767E-03	.214959E-03	.733808E-03
1975	6	1	.948767E-03	.151331E-04	.933633E-03

TABLE A18

CATEGORY : R22NIC P12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1090	.897858E+00	.905757E+00	-.789857E-02
1971	1	112	.922570E-01	.836755E-01	.858153E-02
1971	2	11	.906096E-02	.902987E-02	.310846E-04
1971	3	1	.823723E-03	.124862E-02	-.424899E-03
1972	0	1074	.884679E+00	.911221E+00	-.265418E-01
1972	1	128	.105437E+00	.791402E-01	.262963E-01
1972	2	10	.823723E-02	.824518E-02	-.794682E-05
1972	3	1	.823723E-03	.112906E-02	-.305338E-03
1972	4	1	.823723E-03	.202261E-03	.621462E-03
1973	0	1096	.902801E+00	.906563E+00	-.376204E-02
1973	1	101	.831960E-01	.831415E-01	.545416E-04
1973	2	15	.123558E-01	.880976E-02	.354609E-02
1973	3	1	.823723E-03	.120456E-02	-.380839E-03
1973	4	1	.823723E-03	.214617E-03	.609106E-03
1974	0	1118	.920923E+00	.903236E+00	.176864E-01
1974	1	94	.774300E-01	.858125E-01	-.838254E-02
1974	2	2	.164745E-02	.933772E-02	-.769028E-02
1975	0	1113	.916804E+00	.894663E+00	.221408E-01
1975	1	96	.790774E-01	.923367E-01	-.132592E-01
1975	2	5	.411862E-02	.109194E-01	-.680083E-02

TABLE A19

CATEGORY : R22ITM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2083	.927427E+00	.924231E+00	.319586E-02
1971	1	147	.654497E-01	.683632E-01	-.291350E-02
1971	2	13	.578807E-02	.643532E-02	-.647252E-03
1971	3	3	.133571E-02	.803459E-03	.532249E-03
1972	0	2044	.910062E+00	.928237E+00	-.181749E-01
1972	1	184	.819234E-01	.649643E-01	.169591E-01
1972	2	13	.578807E-02	.591796E-02	-.129890E-03
1972	3	5	.222618E-02	.728082E-03	.149810E-02
1973	0	2072	.922529E+00	.923241E+00	-.711946E-03
1973	1	161	.716830E-01	.691343E-01	.254871E-02
1973	2	12	.534283E-02	.660869E-02	-.126586E-02
1973	3	1	.445236E-03	.839280E-03	-.394044E-03
1974	0	2077	.924755E+00	.920481E+00	.427436E-02
1974	1	161	.716830E-01	.713897E-01	.293265E-03
1974	2	8	.356189E-02	.701944E-02	-.345755E-02
1975	0	2082	.926981E+00	.913990E+00	.129916E-01
1975	1	154	.685663E-01	.765212E-01	-.795488E-02
1975	2	10	.445236E-02	.809024E-02	-.363788E-02

TABLE A20

CATEGORY : R22ICM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1578	.902230E+00	.905035E+00	-.280515E-02
1971	1	161	.920526E-01	.827100E-01	.934263E-02
1971	2	8	.457404E-02	.101083E-01	-.553428E-02
1971	3	2	.114351E-02	.166599E-02	-.522480E-03
1972	0	1558	.890795E+00	.909357E+00	-.185618E-01
1972	1	167	.954831E-01	.792258E-01	.162574E-01
1972	2	19	.108634E-01	.943105E-02	.143230E-02
1972	3	3	.171527E-02	.153930E-02	.175964E-03
1972	4	1	.571755E-03	.324986E-03	.246770E-03
1972	6	1	.571755E-03	.252484E-04	.546507E-03
1973	0	1592	.910234E+00	.904532E+00	.570250E-02
1973	1	140	.800457E-01	.831167E-01	-.307097E-02
1973	2	15	.857633E-02	.101860E-01	-.160967E-02
1973	3	2	.114351E-02	.168101E-02	-.537500E-03
1974	0	1594	.911378E+00	.901234E+00	.101442E-01
1974	1	143	.817610E-01	.856553E-01	-.389431E-02
1974	2	10	.571755E-02	.107648E-01	-.504724E-02
1974	3	2	.114351E-02	.181288E-02	-.669370E-03
1975	0	1578	.902230E+00	.892583E+00	.964704E-02
1975	1	152	.869068E-01	.920024E-01	-.509560E-02
1975	2	17	.971984E-02	.124280E-01	-.270816E-02
1975	3	1	.571755E-03	.225084E-02	-.167908E-02
1975	6	1	.571755E-03	.465930E-04	.525162E-03

TABLE A21

CATEGORY : R22ITNPM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	477	.935294E+00	.915015E+00	.202788E-01
1971	1	27	.529412E-01	.755238E-01	-.225827E-01
1971	2	5	.980392E-02	.808013E-02	.172379E-02
1971	3	1	.196078E-02	.112743E-02	.833359E-03
1972	0	454	.890196E+00	.919160E+00	-.289643E-01
1972	1	51	.100000E+00	.721518E-01	.278482E-01
1972	2	4	.784314E-02	.744659E-02	.396545E-03
1972	3	1	.196078E-02	.101451E-02	.946277E-03
1973	0	461	.903922E+00	.912080E+00	-.815810E-02
1973	1	47	.921569E-01	.777785E-01	.143784E-01
1973	2	2	.392157E-02	.860933E-02	-.468777E-02
1974	0	465	.911765E+00	.908885E+00	.287997E-02
1974	1	44	.862745E-01	.802866E-01	.5987796E-02
1974	2	1	.196078E-02	.914800E-02	-.718721E-02
1975	0	468	.917647E+00	.901455E+00	.161919E-01
1975	1	37	.725490E-01	.860174E-01	-.134684E-01
1975	2	5	.980392E-02	.104453E-01	-.641339E-03

TABLE A22

CATEGORY : R22IT PM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1606	.925115E+00	.926944E+00	-.182833E-02
1971	1	120	.691244E-01	.620662E-01	.291827E-02
1971	2	8	.460829E-02	.598281E-02	-.137452E-02
1971	3	2	.115207E-02	.720787E-03	.431286E-03
1972	0	1590	.915899E+00	.930896E+00	-.149978E-01
1972	1	133	.766129E-01	.628157E-01	.137972E-01
1972	2	9	.518453E-02	.549868E-02	-.314345E-03
1972	3	4	.230415E-02	.654803E-03	.164934E-02
1973	0	1611	.927995E+00	.926459E+00	.153641E-02
1973	1	114	.656682E-01	.665815E-01	-.913321E-03
1973	2	10	.576037E-02	.606976E-02	-.309393E-03
1973	3	1	.576037E-03	.738439E-03	-.162402E-03
1974	0	1612	.928571E+00	.923823E+00	.474824E-02
1974	1	117	.673963E-01	.687605E-01	-.136421E-02
1974	2	7	.403226E-02	.644575E-02	-.241350E-02
1975	0	1614	.929724E+00	.917603E+00	.121206E-01
1975	1	117	.673963E-01	.737148E-01	-.631847E-02
1975	2	5	.288018E-02	.745219E-02	-.457200E-02

TABLE A23

CATEGORY : R22ICNPM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	677	.899070E+00	.895975E+00	.309521E-02
1971	1	69	.916335E-01	.887783E-01	.285514E-02
1971	2	6	.796813E-02	.121893E-01	-.422114E-02
1971	3	1	.132802E-02	.228446E-02	-.956439E-03
1972	0	664	.881806E+00	.900090E+00	-.182842E-01
1972	1	80	.106242E+00	.855791E-01	.206626E-01
1972	2	7	.929615E-02	.114784E-01	-.218221E-02
1972	3	1	.132802E-02	.212786E-02	-.799842E-03
1972	6	1	.132802E-02	.473899E-04	.128063E-02
1973	0	679	.901726E+00	.895208E+00	.651800E-02
1973	1	68	.903054E-01	.893285E-01	.976922E-03
1973	2	5	.664011E-02	.123511E-01	-.571102E-02
1973	3	1	.132802E-02	.232663E-02	-.998614E-03
1974	0	681	.904382E+00	.891646E+00	.127361E-01
1974	1	66	.876494E-01	.919642E-01	-.431481E-02
1974	2	5	.664011E-02	.130248E-01	-.638473E-02
1974	3	1	.132802E-02	.250220E-02	-.117418E-02
1975	0	667	.885790E+00	.880965E+00	.482482E-02
1975	1	76	.100930E+00	.995215E-01	.140815E-02
1975	2	9	.119522E-01	.151659E-01	-.321371E-02
1975	6	1	.132802E-02	.898137E-04	.123821E-02

TABLE A24

CATEGORY : R22IC PM

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	901	.904618E+00	.911893E+00	-.727417E-02
1971	1	92	.923695E-01	.778536E-01	.145159E-01
1971	2	2	.200803E-02	.863912E-02	-.663108E-02
1971	3	1	.100402E-02	.128567E-02	-.281649E-03
1972	0	894	.897590E+00	.916233E+00	-.186425E-01
1972	1	87	.873494E-01	.742645E-01	.130849E-01
1972	2	12	.120482E-01	.801542E-02	.403277E-02
1972	3	2	.200803E-02	.118238E-02	.825657E-03
1972	4	1	.100402E-02	.227959E-03	.776058E-03
1973	0	913	.916667E+00	.911541E+00	.512546E-02
1973	1	72	.722892E-01	.781643E-01	-.587511E-02
1973	2	10	.100402E-01	.867444E-02	.136572E-02
1973	3	1	.100402E-02	.129001E-02	-.285989E-03
1974	0	913	.916667E+00	.908454E+00	.821268E-02
1974	1	77	.773092E-01	.806078E-01	-.329857E-02
1974	2	5	.502008E-02	.918033E-02	-.416025E-02
1974	3	1	.100402E-02	.139374E-02	-.389723E-03
1975	0	911	.914659E+00	.901072E+00	.135867E-01
1975	1	76	.763052E-01	.861670E-01	-.986183E-02
1975	2	8	.803213E-02	.105453E-01	-.251312E-02
1975	3	1	.100402E-02	.172160E-02	-.717585E-03

TABLE A25

CATEGORY : R22ITNP10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	151	.943750E+00	.942562E+00	.118826E-02
1971	1	9	.562500E-01	.533554E-01	.289460E-02
1972	0	149	.931250E+00	.944531E+00	-.132813E-01
1972	1	11	.687500E-01	.516596E-01	.170904E-01
1973	0	148	.925000E+00	.941501E+00	-.165012E-01
1973	1	10	.625000E-01	.542426E-01	.825739E-02
1973	2	2	.125000E-01	.387689E-02	.862311E-02
1974	0	151	.943750E+00	.939464E+00	.428582E-02
1974	1	9	.562500E-01	.559939E-01	.256129E-03
1975	0	153	.956250E+00	.933495E+00	.227552E-01
1975	1	6	.375000E-01	.611346E-01	-.236346E-01
1975	2	1	.625000E-02	.484730E-02	.140270E-02

TABLE A26

CATEGORY : R22ITNP11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	174	.950820E+00	.912086E+00	.387334E-01
1971	1	7	.382514E-01	.770797E-01	-.388283E-01
1971	2	1	.546448E-02	.897019E-02	-.350571E-02
1971	3	1	.546448E-02	.144162E-02	.402286E-02
1972	0	165	.901639E+00	.916514E+00	-.148751E-01
1972	1	16	.874317E-01	.734388E-01	.139929E-01
1972	2	2	.109290E-01	.832049E-02	.260847E-02
1973	0	165	.901639E+00	.908910E+00	-.727057E-02
1973	1	18	.983607E-01	.795307E-01	.188300E-01
1974	0	159	.868852E+00	.905611E+00	-.367583E-01
1974	1	23	.125683E+00	.820779E-01	.436052E-01
1974	2	1	.546448E-02	.101176E-01	-.465307E-02
1975	0	169	.923497E+00	.897980E+00	.255178E-01
1975	1	11	.601093E-01	.876661E-01	-.275568E-01
1975	2	3	.163934E-01	.115633E-01	.483015E-02

TABLE A27

CATEGORY : R22ITNP12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	152	.910180E+00	.891055E+00	.191244E-01
1971	1	11	.658683E-01	.955314E-01	-.296631E-01
1971	2	4	.239521E-01	.114733E-01	.12478AE-01
1972	0	140	.838323E+00	.897035E+00	-.587114E-01
1972	1	24	.143713E+00	.908058E-01	.52906AE-01
1972	2	2	.119760E-01	.104626E-01	.151344E-02
1972	3	1	.598802E-02	.143114E-02	.455688E-02
1973	0	148	.886228E+00	.886536E+00	-.308182E-03
1973	1	19	.113772E+00	.989108E-01	.148617E-01
1974	0	155	.928144E+00	.882315E+00	.458292E-01
1974	1	12	.718563E-01	.102113E+00	-.302572E-01
1975	0	146	.874251E+00	.873659E+00	.592646E-03
1975	1	20	.119760E+00	.108560E+00	.112009E-01
1975	2	1	.598802E-02	.148297E-01	-.884172E-02

TABLE A28

CATEGORY : R22IT P10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	208	.928571E+00	.934888E+00	-.631626E-02
1971	1	14	.625000E-01	.597127E-01	.278735E-02
1971	2	1	.446429E-02	.484358E-02	-.379294E-03
1971	3	1	.446429E-02	.489996E-03	.397429E-02
1972	0	205	.915179E+00	.937714E+00	-.225352E-01
1972	1	17	.758929E-01	.573667E-01	.185261E-01
1972	2	2	.892857E-02	.444251E-02	.448606E-02
1973	0	214	.955357E+00	.935326E+00	.200308E-01
1973	1	10	.446429E-01	.594347E-01	-.147919E-01
1974	0	209	.933036E+00	.933119E+00	-.836925E-04
1974	1	14	.625000E-01	.612964E-01	.120365E-02
1974	2	1	.446429E-02	.501651E-02	-.552228E-03
1975	0	210	.937500E+00	.927395E+00	.101054E-01
1975	1	14	.625000E-01	.660724E-01	-.357238E-02

TABLE A29

CATEGORY : R22IT P11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	688	.929730E+00	.931457E+00	-.172679E-02
1971	1	49	.662162E-01	.625806E-01	.363562E-02
1971	2	3	.405405E-02	.529815E-02	-.124410E-02
1972	0	683	.922973E+00	.936198E+00	-.132249E-01
1972	1	55	.743243E-01	.584941E-01	.158302E-01
1972	2	1	.135135E-02	.473211E-02	-.338076E-02
1972	3	1	.135135E-02	.497562E-03	.853789E-03
1973	0	696	.940541E+00	.931553E+00	.898708E-02
1973	1	42	.567568E-01	.624216E-01	-.566485E-02
1973	2	2	.270270E-02	.533770E-02	-.263500E-02
1974	0	689	.931081E+00	.928944E+00	.213692E-02
1974	1	49	.662162E-01	.646045E-01	.161171E-02
1974	2	2	.270270E-02	.569454E-02	-.299183E-02
1975	0	690	.932432E+00	.923887E+00	.854543E-02
1975	1	48	.648649E-01	.686971E-01	-.383223E-02
1975	2	2	.270270E-02	.648278E-02	-.378008E-02

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CATEGORY : R22IT P12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	710	.959689E+00	.960226E+00	-.536449E-03
1971	1	57	.738342E-01	.719152E-01	.191899E-02
1971	2	4	.518135E-02	.681189E-02	-.163054E-02
1971	3	1	.129534E-02	.860703E-03	.434634E-03
1972	0	702	.909326E+00	.923869E+00	-.145425E-01
1972	1	61	.790155E-01	.687947E-01	.102209E-01
1972	2	6	.777202E-02	.636147E-02	.141055E-02
1972	3	3	.388601E-02	.800057E-03	.308595E-02
1973	0	701	.908031E+00	.919054E+00	-.110227E-01
1973	1	62	.803109E-01	.728932E-01	.741764E-02
1973	2	8	.103627E-01	.697412E-02	.338858E-02
1973	3	1	.129534E-02	.886568E-03	.408769E-03
1974	0	714	.924870E+00	.916253E+00	.861746E-02
1974	1	54	.699482E-01	.751863E-01	-.523811E-02
1974	2	4	.518135E-02	.738839E-02	-.220705E-02
1975	0	714	.924870E+00	.908875E+00	.159959E-01
1975	1	55	.712435E-01	.810015E-01	-.975801E-02
1975	2	3	.388601E-02	.861905E-02	-.473304E-02

TABLE A31

CATEGORY : R22ICNP10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	222	.891566E+00	.897712E+00	-.614559E-02
1971	1	27	.108434E+00	.898944E-01	.185394E-01
1972	0	222	.891566E+00	.900270E+00	-.870362E-02
1972	1	27	.108434E+00	.878087E-01	.206250E-01
1973	0	226	.907631E+00	.898112E+00	.951868E-02
1973	1	21	.843373E-01	.895326E-01	-.519522E-02
1973	2	2	.803213E-02	.105320E-01	-.249989E-02
1974	0	225	.903614E+00	.894845E+00	.876900E-02
1974	1	24	.963855E-01	.920813E-01	.430422E-02
1975	0	223	.895582E+00	.882782E+00	.128000E-01
1975	1	22	.883534E-01	.101195E+00	-.128421E-01
1975	2	4	.160643E-01	.133811E-01	.268315E-02

TABLE A32

CATEGORY : R22ICNP11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	309	.914201E+00	.897881E+00	.163206E-01
1971	1	26	.769231E-01	.868353E-01	-.991223E-02
1971	2	2	.591716E-02	.121415E-01	-.622437E-02
1971	3	1	.295858E-02	.232738E-02	.631200E-03
1972	0	294	.869822E+00	.902091E+00	-.322684E-01
1972	1	36	.106509E+00	.835052E-01	.230037E-01
1972	2	6	.177515E-01	.114528E-01	.629871E-02
1972	3	1	.295858E-02	.218073E-02	.777850E-03
1972	6	1	.295858E-02	.523368E-04	.290624E-02
1973	0	306	.905325E+00	.896712E+00	.861375E-02
1973	1	30	.887574E-01	.876764E-01	.108100E-02
1973	2	1	.295858E-02	.123897E-01	-.943117E-02
1973	3	1	.295858E-02	.239034E-02	.568241E-03
1974	0	306	.905325E+00	.893136E+00	.121895E-01
1974	1	29	.857988E-01	.903133E-01	-.451446E-02
1974	2	2	.591716E-02	.130683E-01	-.715109E-02
1974	3	1	.295858E-02	.256997E-02	.388610E-03
1975	0	299	.884615E+00	.883225E+00	.139051E-02
1975	1	36	.106509E+00	.972509E-01	.925800E-02
1975	2	2	.591716E-02	.150795E-01	-.916234E-02
1975	6	1	.295858E-02	.972456E-04	.286133E-02

TABLE A33

CATEGORY : R22ICNP12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	146	.879518E+00	.889628E+00	-.101102E-01
1971	1	16	.963855E-01	.947920E-01	.159356E-02
1971	2	4	.240964E-01	.127755E-01	.113209E-01
1972	0	148	.891566E+00	.894917E+00	-.335048E-02
1972	1	17	.102410E+00	.906178E-01	.117918E-01
1972	2	1	.602410E-02	.118752E-01	-.585106E-02
1973	0	147	.885542E+00	.888542E+00	-.300007E-02
1973	1	17	.102410E+00	.956959E-01	.671373E-02
1973	2	2	.120482E-01	.129245E-01	-.676279E-03
1974	0	150	.903614E+00	.884697E+00	.189172E-01
1974	1	13	.783133E-01	.985741E-01	-.202609E-01
1974	2	3	.180723E-01	.136536E-01	.441866E-02
1975	0	145	.873494E+00	.873715E+00	-.221256E-03
1975	1	18	.108434E+00	.106256E+00	.217813E-02
1975	2	3	.180723E-01	.159652E-01	.210709E-02

TABLE A34

CATEGORY : R22IC P10M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	111	.909836E+00	.910588E+00	-.752404E-03
1971	1	11	.901639E-01	.786881E-01	.114758E-01
1972	0	108	.885246E+00	.915365E+00	-.301193E-01
1972	1	10	.819672E-01	.749876E-01	.697963E-02
1972	2	4	.327869E-01	.819286E-02	.245940E-01
1973	0	113	.926230E+00	.912544E+00	.136853E-01
1973	1	8	.655738E-01	.773132E-01	-.117394E-01
1973	2	1	.819672E-02	.859607E-02	-.399352E-03
1974	0	112	.918033E+00	.909564E+00	.846871E-02
1974	1	9	.737705E-01	.796435E-01	-.587304E-02
1974	2	1	.819672E-02	.910107E-02	-.904344E-03
1975	0	111	.909836E+00	.902242E+00	.759391E-02
1975	1	10	.819672E-01	.851871E-01	-.321987E-02
1975	2	1	.819672E-02	.104617E-01	-.226497E-02

TABLE A35

CATEGORY : R22IC P11M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	374	.912195E+00	.924369E+00	-.121744E-01
1971	1	35	.853659E-01	.676713E-01	.176945E-01
1971	2	1	.243902E-02	.674434E-02	-.430532E-02
1972	0	375	.914634E+00	.928814E+00	-.141794E-01
1972	1	31	.756098E-01	.638997E-01	.117100E-01
1972	2	1	.243902E-02	.617230E-02	-.373328E-02
1972	3	2	.487805E-02	.872350E-03	.400570E-02
1972	4	1	.243902E-02	.174497E-03	.226453E-02
1973	0	378	.921951E+00	.923971E+00	-.202021E-02
1973	1	30	.731707E-01	.679832E-01	.518756E-02
1973	2	2	.487805E-02	.681666E-02	-.193861E-02
1974	0	380	.926829E+00	.921180E+00	.564900E-02
1974	1	27	.658537E-01	.702487E-01	-.439505E-02
1974	2	2	.487805E-02	.723617E-02	-.235812E-02
1974	3	1	.243902E-02	.104972E-02	.138931E-02
1975	0	384	.936585E+00	.915507E+00	.210780E-01
1975	1	21	.512195E-01	.745588E-01	-.233393E-01
1975	2	4	.975610E-02	.823362E-02	.152248E-02
1975	3	1	.243902E-02	.129424E-02	.114479E-02

TABLE A36

CATEGORY : R22IC P12M

ACCIDENT TYPE : MIDBLOCK ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF MIDBLOCK	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	416	.896552E+00	.901093E+00	-.454169E-02
1971	1	46	.991379E-01	.871568E-01	.119811E-01
1971	2	1	.215517E-02	.995076E-02	-.779558E-02
1971	3	1	.215517E-02	.145298E-02	.702193E-03
1972	0	411	.885776E+00	.905369E+00	-.195926E-01
1972	1	46	.991379E-01	.836526E-01	.154853E-01
1972	2	7	.150862E-01	.930999E-02	.577622E-02
1973	0	422	.909483E+00	.900464E+00	.907878E-02
1973	1	34	.732759E-01	.877680E-01	-.144921E-01
1973	2	7	.150862E-01	.100153E-01	.507094E-02
1973	3	1	.215517E-02	.146248E-02	.692690E-03
1974	0	421	.907328E+00	.897020E+00	.103078E-01
1974	1	41	.883621E-01	.904268E-01	-.206477E-02
1974	2	2	.431034E-02	.105874E-01	-.627702E-02
1975	0	416	.896552E+00	.888209E+00	.834283E-02
1975	1	45	.969828E-01	.970927E-01	-.109897E-03
1975	2	3	.646552E-02	.122263E-01	-.57607RE-02

TABLE A37

CATEGORY : I IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2319	.922068E+00	.926372E+00	-.430442E-02
1971	1	162	.644135E-01	.665929E-01	-.217942E-02
1971	2	23	.914513E-02	.813112E-02	.301401E-02
1971	3	5	.198807E-02	.751378E-03	.123669E-02
1971	4	3	.119284E-02	.119954E-03	.107289E-02
1971	5	2	.795229E-03	.242857E-04	.770943E-03
1971	6	1	.397614E-03	.593572E-05	.391679E-03
1972	0	2295	.912525E+00	.930261E+00	-.177360E-01
1972	1	178	.707753E-01	.632811E-01	.749425E-02
1972	2	34	.135189E-01	.563794E-02	.788095E-02
1972	3	6	.238569E-02	.681049E-03	.170464E-02
1972	4	1	.397614E-03	.108991E-03	.288623E-03
1972	5	1	.397614E-03	.223422E-04	.375272E-03
1973	0	2332	.927237E+00	.925185E+00	.205127E-02
1973	1	152	.604374E-01	.675246E-01	-.708726E-02
1973	2	17	.675944E-02	.633561E-02	.423834E-03
1973	3	8	.318091E-02	.791939E-03	.238898E-02
1973	4	3	.119284E-02	.127963E-03	.106488E-02
1973	5	2	.795229E-03	.258616E-04	.769367E-03
1973	6	1	.397614E-03	.623974E-05	.391375E-03
1974	0	2345	.932406E+00	.922488E+00	.991749E-02
1974	1	142	.564612E-01	.697365E-01	-.132753E-01
1974	2	24	.954274E-02	.673202E-02	.281073E-02
1974	3	3	.119284E-02	.862220E-03	.330623E-03
1974	4	1	.397614E-03	.142071E-03	.255543E-03
1975	0	2314	.920080E+00	.916260E+00	.381998E-02
1975	1	170	.675944E-01	.746820E-01	-.708756E-02
1975	2	23	.914513E-02	.774442E-02	.140071E-02
1975	3	5	.198807E-02	.106668E-02	.921393E-03
1975	4	3	.119284E-02	.189286E-03	.100356E-02

TABLE A38

CATEGORY : TI IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2166	.918965E+00	.925850E+00	-.688542E-02
1971	1	157	.666101E-01	.670263E-01	-.416201E-03
1971	2	23	.975817E-02	.619882E-02	.355934E-02
1971	3	5	.212134E-02	.765837E-03	.135550E-02
1971	4	3	.127280E-02	.124151E-03	.114865E-02
1971	5	2	.848536E-03	.256607E-04	.822876E-03
1971	6	1	.424268E-03	.640213E-05	.417866E-03
1972	0	2146	.910479E+00	.929758E+00	-.192782E-01
1972	1	170	.721256E-01	.636999E-01	.842573E-02
1972	2	33	.140008E-01	.570252E-02	.829833E-02
1972	3	6	.254561E-02	.694880E-03	.185073E-02
1972	4	1	.424268E-03	.113021E-03	.311247E-03
1972	5	1	.424268E-03	.236627E-04	.400605E-03
1973	0	2189	.928723E+00	.924894E+00	.382862E-02
1973	1	138	.585490E-01	.677658E-01	-.921682E-02
1973	2	16	.678829E-02	.637067E-02	.417616E-03
1973	3	8	.339415E-02	.801293E-03	.259285E-02
1973	4	3	.127280E-02	.131382E-03	.114142E-02
1973	5	2	.848536E-03	.271214E-04	.821415E-03
1973	6	1	.424268E-03	.668948E-05	.417579E-03
1974	0	2197	.932117E+00	.922204E+00	.991285E-02
1974	1	133	.564277E-01	.699708E-01	-.135431E-01
1974	2	23	.975817E-02	.676637E-02	.299180E-02
1974	3	3	.127280E-02	.871691E-03	.401113E-03
1974	4	1	.424268E-03	.145667E-03	.278601E-03
1975	0	2172	.921510E+00	.915848E+00	.566285E-02
1975	1	156	.661858E-01	.750088E-01	-.882392E-02
1975	2	21	.890963E-02	.780351E-02	.110612E-02
1975	3	5	.212134E-02	.108265E-02	.103869E-02
1975	4	3	.127280E-02	.194987E-03	.107782E-02

TABLE A39

CATEGORY : CI IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	153	.968354E+00	.933112E+00	.352424E-01
1971	1	5	.316456E-01	.609655E-01	-.293199E-01
1972	0	149	.943038E+00	.936761E+00	.627689E-02
1972	1	8	.506329E-01	.578404E-01	-.720751E-02
1972	2	1	.632911E-02	.481536E-02	.151375E-02
1973	0	143	.905063E+00	.928926E+00	-.238623E-01
1973	1	14	.886076E-01	.644529E-01	.241547E-01
1973	2	1	.632911E-02	.585574E-02	.473378E-03
1974	0	148	.936709E+00	.926134E+00	.105748E-01
1974	1	9	.569620E-01	.667622E-01	-.980015E-02
1974	2	1	.632911E-02	.625732E-02	.717893E-04
1975	0	142	.898734E+00	.921567E+00	-.228332E-01
1975	1	14	.886076E-01	.704656E-01	.181420E-01
1975	2	2	.126582E-01	.696442E-02	.569381E-02

TABLE A40

CATEGORY : TI, NS IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	2148	.925463E+00	.930987E+00	-.552413E-02
1971	1	147	.633348E-01	.628264E-01	.508338E-03
1971	2	20	.861698E-02	.543946E-02	.317752E-02
1971	3	3	.129255E-02	.627506E-03	.665040E-03
1971	4	1	.430849E-03	.949093E-04	.335939E-03
1971	5	1	.430849E-03	.183922E-04	.412457E-03
1971	6	1	.430849E-03	.434304E-05	.426506E-03
1972	0	2129	.917277E+00	.934651E+00	-.173742E-01
1972	1	160	.689358E-01	.596774E-01	.925844E-02
1972	2	28	.120638E-01	.499567E-02	.706810E-02
1972	3	3	.129255E-02	.567335E-03	.725211E-03
1972	4	1	.430849E-03	.859296E-04	.344919E-03
1973	0	2170	.934942E+00	.930044E+00	.489735E-02
1973	1	130	.560103E-01	.635690E-01	-.755863E-02
1973	2	13	.560103E-02	.560071E-02	.325527E-06
1973	3	5	.215424E-02	.658900E-03	.149534E-02
1973	4	2	.861698E-03	.101033E-03	.760665E-03
1973	5	1	.430849E-03	.195938E-04	.411255E-03
1974	0	2176	.937527E+00	.927532E+00	.999538E-02
1974	1	126	.542869E-01	.656555E-01	-.113685E-01
1974	2	18	.775528E-02	.595332E-02	.180195E-02
1974	3	1	.430849E-03	.717966E-03	-.287117E-03
1975	0	2150	.926325E+00	.921682E+00	.464250E-02
1975	1	151	.650582E-01	.703747E-01	-.531655E-02
1975	2	15	.646273E-02	.686071E-02	-.397974E-03
1975	3	3	.129255E-02	.889507E-03	.403039E-03
1975	4	2	.861698E-03	.149485E-03	.712212E-03

TABLE A41

CATEGORY : TI, FLR IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	18	.514286E+00	.526169E+00	-.118833E-01
1971	1	10	.285714E+00	.296820E+00	-.111056E-01
1971	2	3	.857143E-01	.103018E+00	-.173032E-01
1971	3	1	.285714E-01	.402124E-01	-.116410E-01
1971	4	2	.571429E-01	.172193E-01	.399236E-01
1971	5	1	.285714E-01	.795735E-02	.206141E-01
1972	0	17	.485714E+00	.545712E+00	-.599981E-01
1972	1	10	.285714E+00	.286872E+00	-.115738E-02
1972	2	4	.114286E+00	.975939E-01	.166918E-01
1972	3	3	.857143E-01	.378191E-01	.478952E-01
1972	5	1	.285714E-01	.753364E-02	.210378E-01
1973	0	19	.542857E+00	.535105E+00	.775225E-02
1973	1	8	.228571E+00	.291291E+00	-.627197E-01
1973	2	3	.857143E-01	.100484E+00	-.147698E-01
1973	3	3	.857143E-01	.394372E-01	.462771E-01
1973	4	1	.285714E-01	.170663E-01	.115051E-01
1973	5	1	.285714E-01	.796634E-02	.206051E-01
1974	0	21	.600000E+00	.520125E+00	.798746E-01
1974	1	7	.200000E+00	.297597E+00	-.975973E-01
1974	2	5	.142857E+00	.104438E+00	.384192E-01
1974	3	2	.571429E-01	.415641E-01	.155787E-01
1975	0	22	.628571E+00	.463775E+00	.164797E+00
1975	1	5	.142857E+00	.317750E+00	-.174893E+00
1975	2	6	.171429E+00	.118789E+00	.526400E-01
1975	3	1	.285714E-01	.502328E-01	-.216614E-01
1975	4	1	.285714E-01	.233065E-01	.526491E-02

TABLE A42

CATEGORY : CI, NS IN R22ITM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	151	.967949E+00	.933492E+00	.344572E-01
1971	1	5	.320513E-01	.606345E-01	-.285832E-01
1972	0	147	.942308E+00	.937081E+00	.522634E-02
1972	1	8	.512821E-01	.575586E-01	-.627656E-02
1972	2	1	.641026E-02	.478191E-02	.162834E-02
1973	0	142	.910256E+00	.929422E+00	-.191653E-01
1973	1	13	.833333E-01	.640256E-01	.193078E-01
1973	2	1	.641026E-02	.579644E-02	.613813E-03
1974	0	146	.935897E+00	.926659E+00	.923877E-02
1974	1	9	.576923E-01	.663130E-01	-.862066E-02
1974	2	1	.641026E-02	.619260E-02	.217654E-03
1975	0	140	.897436E+00	.922049E+00	-.246130E-01
1975	1	14	.897436E-01	.700554E-01	.196882E-01
1975	2	2	.128205E-01	.690379E-02	.591673E-02

TABLE A43

CATEGORY : I IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1880	.926108E+00	.917003E+00	.910583E-02
1971	1	117	.576355E-01	.734207E-01	-.157852E-01
1971	2	20	.985222E-02	.806893E-02	.178329E-02
1971	3	10	.492611E-02	.120451E-02	.372160E-02
1971	4	3	.147783E-02	.229561E-03	.124827E-02
1972	0	1842	.907389E+00	.920663E+00	-.132739E-01
1972	1	158	.778325E-01	.703914E-01	.744114E-02
1972	2	20	.985222E-02	.754579E-02	.230643E-02
1972	3	5	.246305E-02	.111673E-02	.134633E-02
1972	4	3	.147783E-02	.213615E-03	.126422E-02
1972	5	1	.492611E-03	.499503E-04	.442661E-03
1972	7	1	.492611E-03	.403327E-05	.488578E-03
1973	0	1841	.906897E+00	.916453E+00	-.955682E-02
1973	1	152	.748768E-01	.738721E-01	.100479E-02
1973	2	25	.123153E-01	.814901E-02	.416626E-02
1973	3	10	.492611E-02	.121902E-02	.370709E-02
1973	5	1	.492611E-03	.536694E-04	.438941E-03
1973	16	1	.492611E-03	.272075E-09	.492611E-03
1974	0	1873	.922660E+00	.913571E+00	.908938E-02
1974	1	128	.630542E-01	.761568E-01	-.131026E-01
1974	2	23	.113300E-01	.861797E-02	.271208E-02
1974	3	5	.246305E-02	.131632E-02	.114673E-02
1974	7	1	.492611E-03	.483408E-05	.487777E-03
1975	0	1855	.913793E+00	.905962E+00	.783101E-02
1975	1	150	.738916E-01	.819305E-01	-.803887E-02
1975	2	19	.935961E-02	.998810E-02	-.628492E-03
1975	3	4	.197044E-02	.164699E-02	.323457E-03
1975	4	2	.985222E-03	.345708E-03	.639514E-03

TABLE A44

CATEGORY : TI IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	118	.867647E+00	.908196E+00	-.405487E-01
1971	1	14	.102941E+00	.810346E-01	.219066E-01
1971	2	2	.147059E-01	.918961E-02	.551628E-02
1971	3	2	.147059E-01	.131248E-02	.133934E-01
1972	0	118	.867647E+00	.912650E+00	-.450029E-01
1972	1	13	.955882E-01	.774492E-01	.181391E-01
1972	2	5	.367647E-01	.848916E-02	.282755E-01
1973	0	126	.926471E+00	.904160E+00	.223103E-01
1973	1	8	.588235E-01	.842551E-01	-.254316E-01
1973	2	2	.147059E-01	.983946E-02	.486643E-02
1974	0	122	.897059E+00	.900599E+00	-.353995E-02
1974	1	11	.808824E-01	.870320E-01	-.614962E-02
1974	2	3	.220588E-01	.104549E-01	.116039E-01
1975	0	127	.933824E+00	.893209E+00	.406146E-01
1975	1	8	.588235E-01	.926685E-01	-.338449E-01
1975	2	1	.735294E-02	.118142E-01	-.446125E-02

TABLE A45

CATEGORY : CI IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1762	.930306E+00	.917762E+00	.125439E-01
1971	1	103	.543823E-01	.727992E-01	-.184170E-01
1971	2	18	.950370E-02	.795699E-02	.154671E-02
1971	3	8	.422386E-02	.118408E-02	.303978E-02
1971	4	3	.158395E-02	.225281E-03	.135867E-02
1972	0	1724	.910243E+00	.921368E+00	-.111247E-01
1972	1	145	.765576E-01	.698092E-01	.674835E-02
1972	2	15	.791975E-02	.744604E-02	.473706E-03
1972	3	5	.263992E-02	.109929E-02	.154062E-02
1972	4	3	.158395E-02	.210009E-03	.137394E-02
1972	5	1	.527983E-03	.489900E-04	.478993E-03
1972	7	1	.527983E-03	.390667E-05	.524076E-03
1973	0	1715	.905491E+00	.917403E+00	-.119120E-01
1973	1	144	.760296E-01	.730923E-01	.293730E-02
1973	2	23	.121436E-01	.801091E-02	.413270E-02
1973	3	10	.527983E-02	.119426E-02	.408557E-02
1973	5	1	.527983E-03	.523983E-04	.475585E-03
1973	16	1	.527983E-03	.236860E-09	.527983E-03
1974	0	1751	.924498E+00	.914567E+00	.993157E-02
1974	1	117	.617740E-01	.753437E-01	-.135697E-01
1974	2	20	.105597E-01	.846997E-02	.208969E-02
1974	3	5	.263992E-02	.128911E-02	.135081E-02
1974	7	1	.527983E-03	.467166E-05	.523311E-03
1975	0	1728	.912355E+00	.906973E+00	.538224E-02
1975	1	142	.749736E-01	.811145E-01	-.614085E-02
1975	2	18	.950370E-02	.983259E-02	-.328893E-03
1975	3	4	.211193E-02	.161733E-02	.494602E-03
1975	4	2	.105597E-02	.339234E-03	.716732E-03

TABLE A46

CATEGORY : TI, NS IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	118	.880597E+00	.914908E+00	-.343113E-01
1971	1	13	.970149E-01	.757255E-01	.212894E-01
1971	2	2	.149254E-01	.807243E-02	.685295E-02
1971	3	1	.746269E-02	.108721E-02	.637548E-02
1972	0	117	.873134E+00	.919059E+00	-.459246E-01
1972	1	13	.970149E-01	.723380E-01	.246770E-01
1972	2	4	.298507E-01	.744859E-02	.224022E-01
1973	0	125	.932836E+00	.911159E+00	.216765E-01
1973	1	7	.522388E-01	.787581E-01	-.265193E-01
1973	2	2	.149254E-01	.865172E-02	.627365E-02
1974	0	121	.902985E+00	.907853E+00	-.486778E-02
1974	1	10	.746269E-01	.813773E-01	-.675045E-02
1974	2	3	.223881E-01	.919898E-02	.131891E-01
1975	0	126	.940299E+00	.901048E+00	.392505E-01
1975	1	7	.522388E-01	.866607E-01	-.344219E-01
1975	2	1	.746269E-02	.103969E-01	-.293424E-02

TABLE A47

CATEGORY : CI, NS IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	1748	.933761E+00	.921178E+00	.125822E-01
1971	1	99	.528846E-01	.701208E-01	-.172362E-01
1971	2	17	.908120E-02	.738935E-02	.169185E-02
1971	3	7	.373932E-02	.105888E-02	.268044E-02
1971	4	1	.534188E-03	.193727E-03	.340461E-03
1972	0	1714	.915598E+00	.924643E+00	-.904429E-02
1972	1	139	.742521E-01	.672292E-01	.702299E-02
1972	2	10	.534188E-02	.691037E-02	-.156849E-02
1972	3	5	.267094E-02	.982036E-03	.168890E-02
1972	4	2	.106838E-02	.180439E-03	.887937E-03
1972	5	1	.534188E-03	.405220E-04	.493666E-03
1972	7	1	.534188E-03	.301818E-05	.531170E-03
1973	0	1705	.910791E+00	.920847E+00	-.100561E-01
1973	1	137	.731838E-01	.703942E-01	.278960E-02
1973	2	21	.112179E-01	.743743E-02	.378052E-02
1973	3	8	.427350E-02	.106758E-02	.320592E-02
1973	16	1	.534188E-03	.141053E-09	.534188E-03
1974	0	1735	.926816E+00	.918127E+00	.868896E-02
1974	1	115	.614316E-01	.725723E-01	-.111407E-01
1974	2	16	.854701E-02	.786669E-02	.680322E-03
1974	3	5	.267094E-02	.115322E-02	.151772E-02
1974	7	1	.534188E-03	.358504E-05	.530603E-03
1975	0	1713	.915064E+00	.910846E+00	.421839E-02
1975	1	139	.742521E-01	.781608E-01	-.390862E-02
1975	2	16	.854701E-02	.914418E-02	-.597167E-03
1975	3	2	.106838E-02	.145228E-02	-.383900E-03
1975	4	2	.106838E-02	.294356E-03	.774020E-03

TABLE A48

CATEGORY : CI, FLR IN R22ICM

ACCIDENT TYPE : INTERSECTION - RELATED ACCIDENTS

YEAR	NO. OF ACCIDENT	NO. OF INTERSECTION	PROBABILITY ACTUAL	ESTIMATE	RESIDUAL
1971	0	13	.650000E+00	.523900E+00	.126100E+00
1971	1	3	.150000E+00	.281425E+00	-.131425E+00
1971	2	1	.500000E-01	.992309E-01	-.492309E-01
1971	3	1	.500000E-01	.426929E-01	.730709E-02
1971	4	2	.100000E+00	.213389E-01	.786611E-01
1972	0	9	.450000E+00	.542763E+00	-.927631E-01
1972	1	6	.300000E+00	.270954E+00	.290456E-01
1972	2	4	.200000E+00	.946887E-01	.105311E+00
1972	4	1	.500000E-01	.205536E-01	.294464E-01
1973	0	9	.450000E+00	.516568E+00	-.665680E-01
1973	1	6	.300000E+00	.284501E+00	.154988E-01
1973	2	2	.100000E+00	.101358E+00	-.135846E-02
1973	3	2	.100000E+00	.437206E-01	.562794E-01
1973	5	1	.500000E-01	.120384E-01	.379616E-01
1974	0	15	.750000E+00	.500290E+00	.249710E+00
1974	1	2	.100000E+00	.291066E+00	-.191066E+00
1974	2	3	.150000E+00	.105274E+00	.447262E-01
1975	0	14	.700000E+00	.459023E+00	.240977E+00
1975	1	2	.100000E+00	.305542E+00	-.205542E+00
1975	2	2	.100000E+00	.115497E+00	-.154972E-01
1975	3	2	.100000E+00	.520563E-01	.479437E-01