COMPARISON OF ROAD USER COSTS
INCURRED FROM DELAYS AT
VARIOUS TYPES OF RURAL INTERSECTIONS

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Prepared by the

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COMPARISONS OF ROAD USER COSTS INCURRED FROM DELAYS AT VARIOUS TYPES OF RURAL INTERSECTIONS

Traffic stops and slow downs cost the road user money. In stopping or slowing and then accelerating to his original speed, the driver expends money for wear on brakes and tires and for more fuel and oil than consumed in continuous, uniform speed driving. When considering intersections where turning movements necessitating slow downs are heavy or where a large traffic volume is stopped by traffic control devices, the cost to the motoring public is quite substantial. By incorporating certain features in intersection design such as special left-turn lanes or grade separated roadways the road user will realize savings due to the elimination of certain costly stops and slow downs.

In many cases it is advisable to investigate the costs to the road user at an intersection where a change in design or signing is contemplated in order to determine if this change would be economically desirable. It is necessary to determine the costs to the vehicles entering the intersection from each direction because of the large range of circumstances effecting the total road user costs. The average running speed of traffic on an average rural roadway is assumed to be 50 mph. The costs of slow downs from 50 mph to slower speeds and then back to the original 50 mph speed are shown in Table I. These costs were obtained by the Committee of Planning and Design Policies of the American Association of State Highway Officials.

TABLE I

Passenger Veh. Speed Reduced from 50 mph to	Cost per Passenger Vehicle
40 mph	$.0076
30 mph	.0127
20 mph	.0166
10 mph	.0187
0 mph (no standing delay)	.0205
Each second of delay	.0005

These costs may seem small; however, they are very substantial when put on an annual basis. For instance, if 1500 vehicles per day were stopped due to a stop sign condition, and not delayed by cross traffic, the annual road user cost due to this required stop would amount to $11,224.

The cost to any one motorist entering an at-grade intersection is dependent on other vehicles also entering the intersection. For example, if a motorist wishes to turn left, he must have an adequate gap between the vehicles entering the intersection from the opposite direction. If the gap is too short, he will be forced to stop and wait for an adequate gap. Graph I in the Appendix shows the percent of left-turning vehicles which are blocked due to insufficient length gap. In Graph II the average delay to a left-turning vehicle which is blocked is shown. In performing the left turn, costs for slowing for the turn or for stopping and waiting for an adequate gap in the opposing traffic stream will be realized. The average cost to one left-turning vehicle is shown on Graph III. A motorist turning right will also need to slow down in order to negotiate his turn. Motorists following a turning vehicle will be required to either stop or slow their vehicles in order to avoid colliding into the turning vehicle from the rear. This slowing or stopping will result in extra cost to the road user. Costs to these vehicles are shown in Graphs IV and V of the Appendix.

As can be expected, the erection of a stop sign will impose an additional cost on all motorists who are compelled to obey it. The average delay to the first vehicle stopped at the stop sign should be constant when waiting for a gap in a given cross volume. However, as the number of stopped vehicles increases, additional delay will be incurred by vehicles waiting for the stopped vehicles ahead to proceed. Graphs VI and VII in the appendix were obtained by the Wisconsin Highway Department from delay studies conducted at nineteen rural intersections. These graphs show the relationship of average delay to stopped volume and to the cross-volume. These graphs are combined to form Graph VIII which is used to determine the average delay to all stopped vehicles at a specified stopped volume and cross-volume. Extra costs will also accrue to all vehicles who stop for a red light at a signalized intersection. The number of vehicles who are required to stop for a fixed time signal will depend on the setting of the signal. Graph IX shows the number of vehicles stopped for different lengths of red time while Graph X shows their average delay. The number of vehicles stopped for a traffic actuated signal depends on the demands put on the signal from all legs. The number of vehicles who need stop, as observed at an Iowa intersection, at different opposing volumes is shown in Graph X. The average delay to these stopped vehicles is shown in Graph XI.

The costs to all vehicles entering an intersection is equal to the sum of the costs to the vehicles entering on each leg. The cost of each leg can be found by using the accompanying charts. Charts I, II, and III are used to determine the costs of slowing and stopping to vehicles entering a two-way stop intersection on a leg having no stop sign. This cost is the sum of the slowing costs of right-turning vehicles, slowing or stopping costs of left-turning vehicles, and slowing costs to vehicles following turning vehicles. On a two-lane leg (Chart I), straight through vehicles will be slowed by both right and left-turning vehicles, while on a four-lane leg (Chart II), it is assumed that a motorist wishing to travel along a straight path will take the lane with the least number of turning vehicles. Therefore, he will only be slowed by the turning vehicles in this lane. When a special right or left-turn lane is provided on a two-lane leg, the costs are assumed to be the same as those on a four-lane leg. When a right or left-turn lane is provided on a two-lane leg, the costs are assumed to be the same as those on a four-lane leg. When a right or left-turn lane is provided on a four-lane leg (Chart III), it is assumed that the vehicles wishing to continue straight through will not be detained by turning vehicles.

The charts are used in the following manner. Enter the abscissa of the chart at the average daily volume entering the intersection on a particular leg during an average day. Proceed vertically upward to the nearest percentage of these approaching vehicles turning left. From this point continue horizontally to line A. Join the intersection point of line A with a straight line to the 0 point on line C. This line will intersect line B at some point (d). Next enter the abscissa at the same point and proceed vertically downward to the nearest percentage of approaching vehicles turning right. From this point continue horizontally to line A. From this point on line A draw a straight line to line C intersecting line B at point (d). The intersection of this line with line C will denote the annual cost of stopping and slowing of all traffic entering on this leg of the intersection.

The cost to vehicles entering an intersection on a leg having a stop sign is found by using Chart IV. The cost to these vehicles will be dependent on the volume of cross traffic which would detain their movement after coming to a stop. When they are approaching a 2-way stop intersection they will need to have an adequate gap in both traffic streams approaching on the perpendicular legs. If they are approaching a four-way stop intersection, it is assumed that a stopped vehicle would only need an adequate gap in the traffic stream approaching on the leg to his right in that this traffic has the right to proceed through the intersection before him. To use the chart enter the abscissa at the average daily volume approaching the stop sign on the leg in question. Proceed vertically to the opposing volume. In the case of a 2-way stop intersection this opposing volume is the sum of volume A and C as shown on the diagram on the chart. For a four-way stop, as explained above, the opposing volume will only be the traffic approaching on the leg to his right, or volume C. From this point proceed horizontally to the ordinate where the annual cost to the vehicles approaching on one leg having a stop sign is shown.

When the intersection is signalized, vehicles entering on a leg will either incur costs for stopping for a red light or for turning if a stop is not necessary. Charts V and VI are used to determine the costs of vehicles entering on a leg for stopping and turning.

To use these charts enter the abscissa at the average daily volume entering on the leg in question and proceed vertically downward to the G/C ratio when using Chart V or the opposing volume when using Chart VI. The G/C ratio in most cases will equal the volume entering in the phase containing the leg in question divided by the total volume entering the intersection. The opposing volume in Chart VI will equal volumes C plus D. Next proceed horizontally to line E. From the intersection at line E draw a straight line through point e to line C. This intersection of line C (or point f) denotes the cost to vehicles who are stopped for the red light.

Next enter the abscissa at the same volume and proceed vertically upward to the G/C ratio when using Chart V or to the opposing volume when using Chart VI. From this point proceed horizontally to line D. From the intersection point at line D proceed vertically upwards to the percentage of vehicles turning left and the percentage of vehicles turning right. From the percentage of left-turning vehicles proceed horizontally to line A. From the intersection at line A draw a straight line to point (f) intersecting line B at some point (e). From the percentage of right-turning vehicles proceed horizontally to line A. From this intersection of line A draw a straight line through point e to line C. The intersection of this line with line C will denote the annual cost to all vehicles entering on the leg.

As illustrated above, the total annual cost of slowing and stopping at any at-grade intersection can be determined by adding the costs of traffic entering on each leg, but it should be kept in mind that these costs are for rural intersections only.

The annual costs of slowing and stopping will vary greatly for grade-separated interchanges, depending upon the design of the interchange. Using a typical diamond interchange as an example, it is noted that motorists wishing to turn right will save distance by using a more direct route while motorists wishing to turn left will find their designated route further than if they were on an at-grade intersection. On the typical diamond interchange chosen, a left-turning vehicle will drive approximately .25 mile further while right-turning vehicles will save .09 mile. The costs pertaining to these length differentials are incorporated into charts VII and VIII. All right-turning vehicles are assumed to slow to 48 mph and merge with the traffic stream with no delay by using acceleration lanes. Left-turning vehicles on the minor route need only slow to turn and can then proceed when an adequate gap exists in the opposing traffic stream. These vehicles must then make a merging movement with the traffic on the major route. Vehicles turning left from the major route will need to stop for a stop sign before merging with the minor traffic. In using Charts VII and VIII the same procedures, as previously explained for the use of the first three charts, are followed in determining the annual road user cost of vehicles entering on one leg of the interchange. The total cost will then be equal to the sum of the costs of traffic entering on the two minor legs and on the two major legs.

A synopsis indicating the charts that should be employed in determining the road user costs of traffic on legs having various types of controls and designs is shown below.

Type of Control on Leg	Number of Lanes	Chart Number
None	Two	I
None	Two plus special turning lane	II
None	Four	II
None	Four plus special turning lane	III
Stop Sign	Two or Four	IV
Fixed Time Signal	Two or Four	V
Traffic Actuated Signal	Two or Four	VI
Diamond Interchange	Major approach	VII
Diamond Interchange	Minor approach	VIII

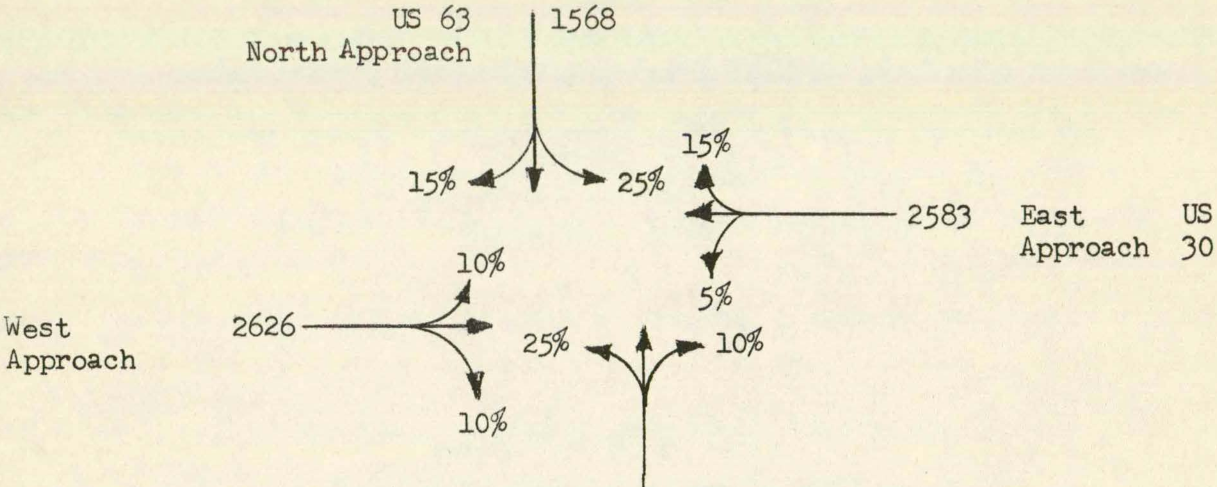
An example of the use of these charts is shown where an average of 2500 vehicles are entering on one intersection leg per day. It is assumed that 10% of these will turn left and 15% right. The annual road user costs on this leg are as follows:

Design of Leg		Annual Road User Costs
2-Lane	No Stop Sign	$ 5,250
4-Lane	" " "	4,600
4-Lane (Channelized)	" " "	4,000
2 or 4 Lane	Stop Sign	21,500
4-Lane	Fixed Time Signal	17,500
4-Lane	Traffic Actuated Signal	13,100
Diamond Interchange	Minor Leg	3,850
	Major Leg	3,450

As can be seen, features such as 4 lanes, special turning lanes, and grade separated interchanges mean a savings to the road user. A Stop sign, however, increases costs greatly.

The significance of this type of study can best be shown by analyzing the costs to the road user at several rural intersections in the state. It is realized that some major changes such as signal systems have been made at some of these intersections but the road user comparisons will still be helpful.

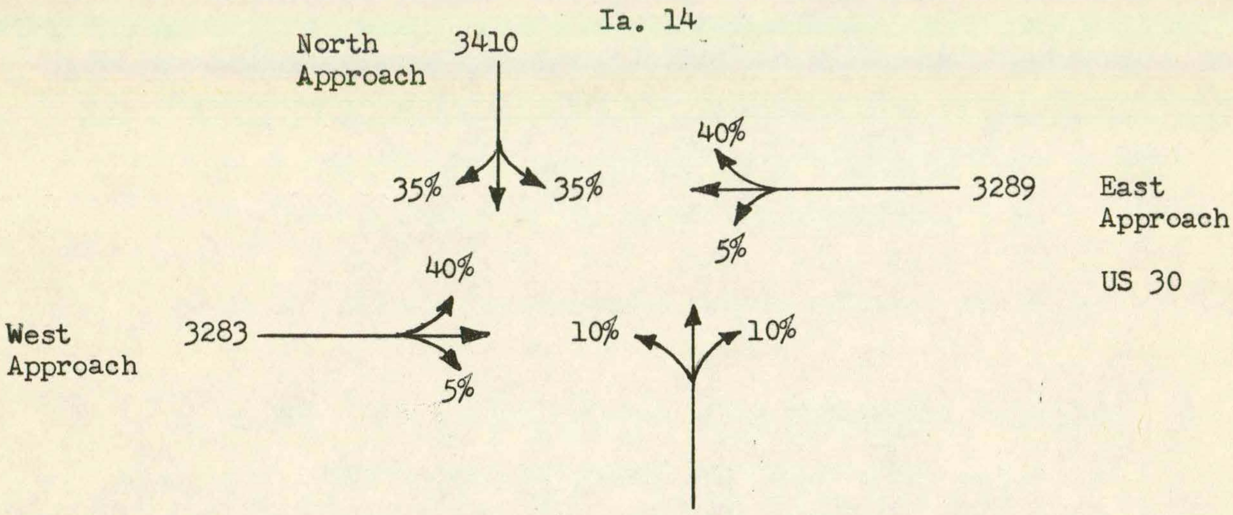
The first intersection to be examined is the junction of U.S. 63 and U.S. 30 in Tama County. The 1959 approach traffic and turning movements are shown below.



The annual road user costs are shown below.

Type of Control		Number of Lanes	Annual Road User Costs: West Approach	East Approach	North Approach	South Approach	Total
2-Way Stop	North-South Stop	All Approaches 2-Lane	4,500	4,400	13,700	11,300	33,900
	East-West Stop	All Approaches 2-Lane	22,100	21,700	4,850	3,400	52,050
	North-South Stop	All Approaches 4-Lane	3,700	3,600	13,700	11,300	32,300
	East-West Stop	All Approaches 4-Lane	22,100	21,700	4,200	3,000	51,000
	North-South Stop	All Approaches 4-Lane with special Turning Lane	3,600	3,500	13,700	11,300	32,100
	East-West Stop	All Approaches 4-Lane with special Turning Lane	22,100	21,700	4,200	3,000	51,000
4-Way Stop	All Stop	All Approaches 4-Lane	20,900	20,700	13,000	10,800	65,400
Fixed Time Signal		All Approaches 4-Lane	12,700	12,400	14,500	12,100	51,700
Traffic Actuated Signal		All Approaches 4-Lane	11,800	11,850	10,100	8,600	42,350
Diamond Interchange	North-South Major	All Approaches 4-Lane	4,100	1,800	5,700	4,800	16,400
	East-West Major	All Approaches 4-Lane	3,800	1,800	5,800	4,900	16,300

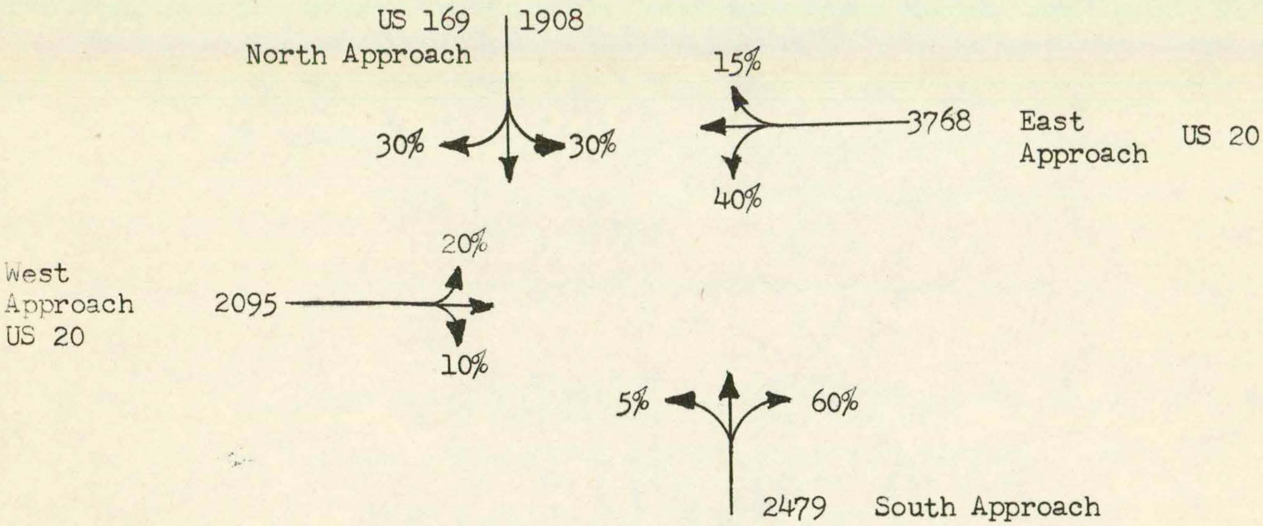
Another example is the junction of US 30 and Ia. 14 in Marshall County south of Marshalltown. The approach traffic and turning movements are shown below.



The annual road user costs are shown below.

Type of Control		Number of Lanes	Annual Road User Costs				
			West Approach	East Approach	North Approach	South Approach	Total
2-Way Stop	North-South Stop	All Approaches 4-Lane Exception South	10,200	11,400	31,200	11,700	64,500
	East-West Stop	All Approaches 4-Lane Exception South	29,300	29,400	17,100	1,900	77,700
	North-South Stop	All Approaches 4-Lane with special Turning Lane	10,100	9,600	31,200	11,700	62,600
	East-West Stop	All Approaches 4-Lane with special Turning Lane	29,300	29,400	16,000	1,700	76,400
4-Way Stop	All Stop	All Approaches 4-Lane	26,500	28,000	29,100	11,000	94,600
Fixed Time Signal		All Approaches 4-Lane	24,700	24,700	27,850	8,500	85,750
Traffic Actuated Signal		All Approaches 4-Lane	20,000	20,100	24,200	8,700	73,000
Diamond Interchange	North-South Major	All Approaches 4-Lane	20,700	2,050	15,500	1,900	40,150
	East-West Major	All Approaches 4-Lane	19,200	1,800	18,750	2,000	41,750

The last intersection to be examined in this report is Jct. US 169 and US 20 southwest of Fort Dodge. The 1961 approach traffic and turning movements are shown below.



The annual road user costs are shown below.

Type of Control		Number of Lanes	Annual Road User Costs: West Approach	East Approach	North Approach	South Approach	Total
2-Way Stop	North-South Stop	All Approaches 4-Lane	4,200	14,500	16,800	22,000	57,500
	East-West Stop	All Approaches 4-Lane	18,100	33,100	7,700	10,800	69,700
	North-South Stop	All Approaches 4-Lane with special Turning Lane	4,150	14,260	16,800	22,000	57,210
	East-West Stop	All Approaches 4-Lane with special Turning Lane	18,100	33,100	7,600	10,550	69,350
4-Way Stop	All Stop	All Approaches 4-Lane	17,450	31,100	15,800	21,100	85,450
Fixed Time Signal		All Approaches 4-Lane	14,500	29,400	14,500	19,400	77,800
Traffic Actuated Signal		All Approaches 4-Lane	11,400	23,900	13,600	17,700	66,600
Diamond Interchange	North-South Major	All Approaches 4-Lane	6,350	22,800	8,100	900	38,150
	East-West Major	All Approaches 4-Lane	7,600	18,900	8,500	1,100	36,100

This method can be used to analyze road user costs on other rural intersections throughout the state when the need arises. With road user cost comparisons, savings realized as a result of future intersection improvements can be determined. However, road user savings are only one criterion which can be used to justify future improvements. Other criteria, such as accident reduction and increased intersection capacity, may dictate future improvements and added controls even though the economic savings does not justify these improvements.

REFERENCES

1. American Association of State Highway Officials, Road User Benefit Analysis for Highway Improvements.

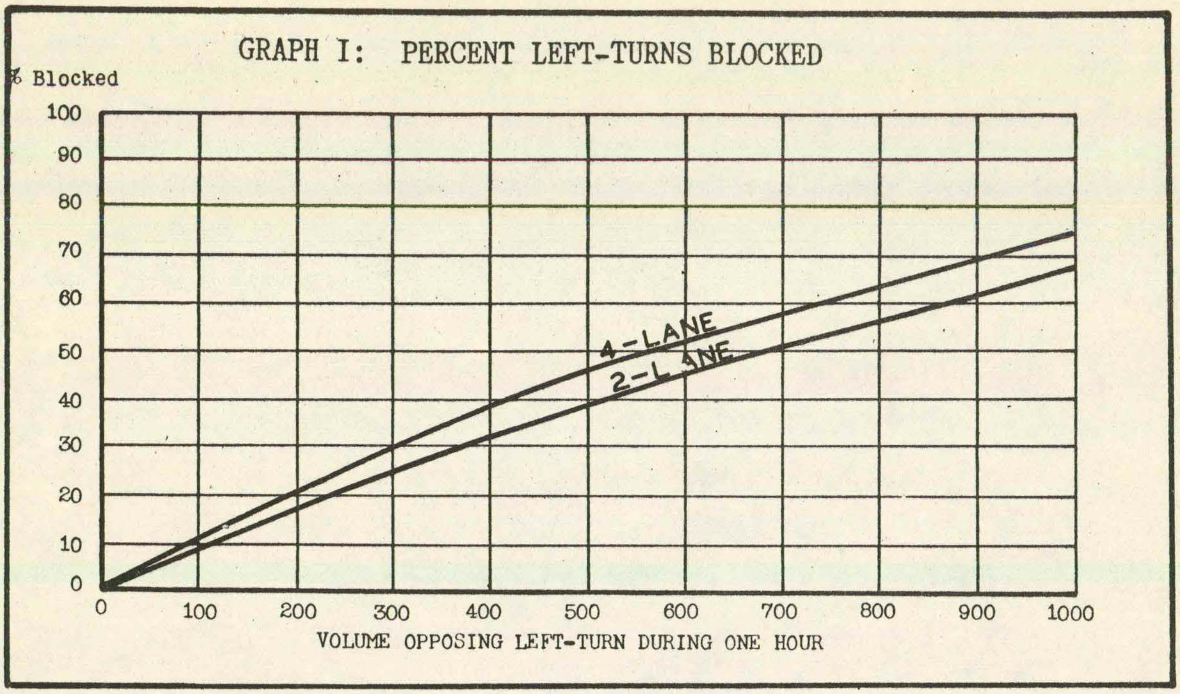
2. Iowa State Highway Commission, "Hourly Percentages of Week-day Traffic as Derived from the Hourly Percentage Distribution of Automatic Traffic Recorder Data at 26 Stations on the Primary Road System", 1959.

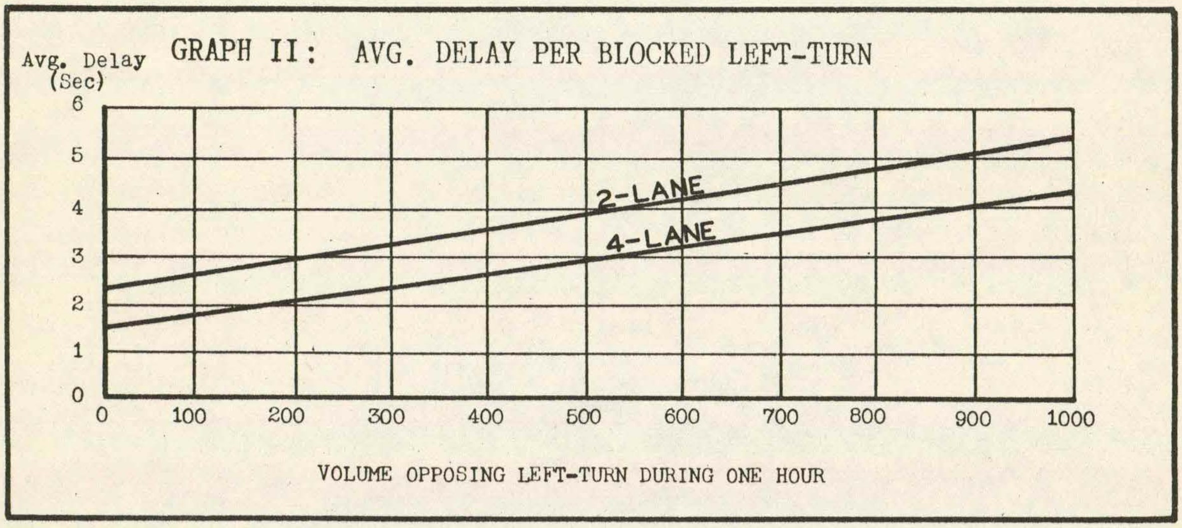
3. Madson, Smith, and Hurd, Traffic Engineering, McGraw-Hill Book Company, Inc.

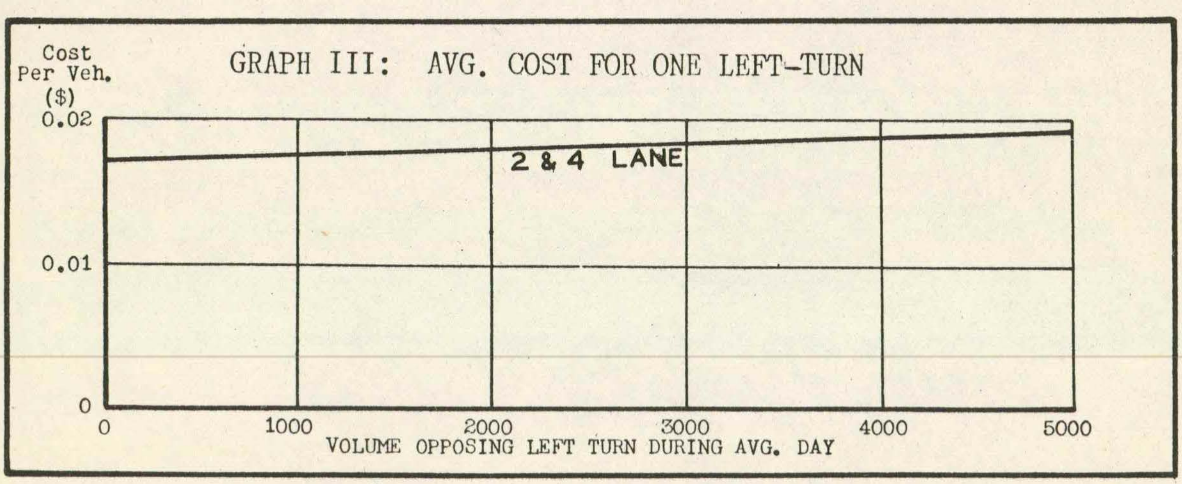
4. United States Department of Commerce, Highway Capacity Manual, United States Government Printing Office.

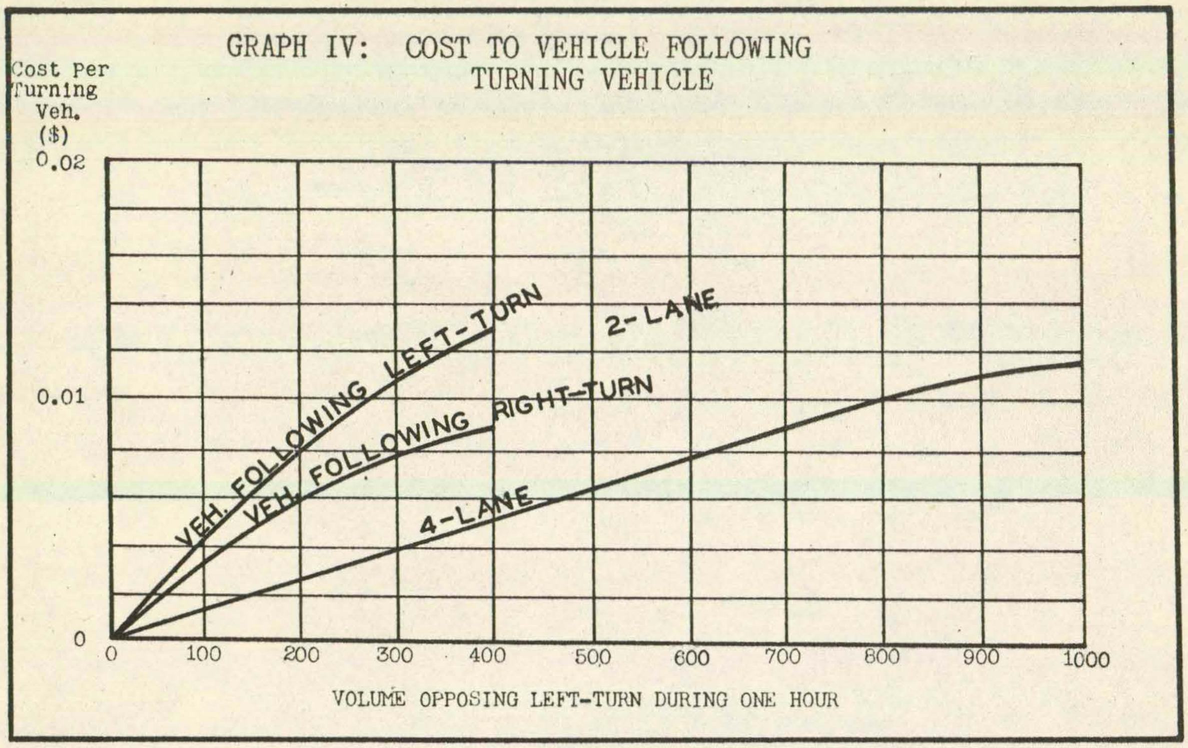
5. Volk, Wayne N., "Effect of Type of Control on Intersection Delay", Highway Research Board Proceedings, 1956.

APPENDIX

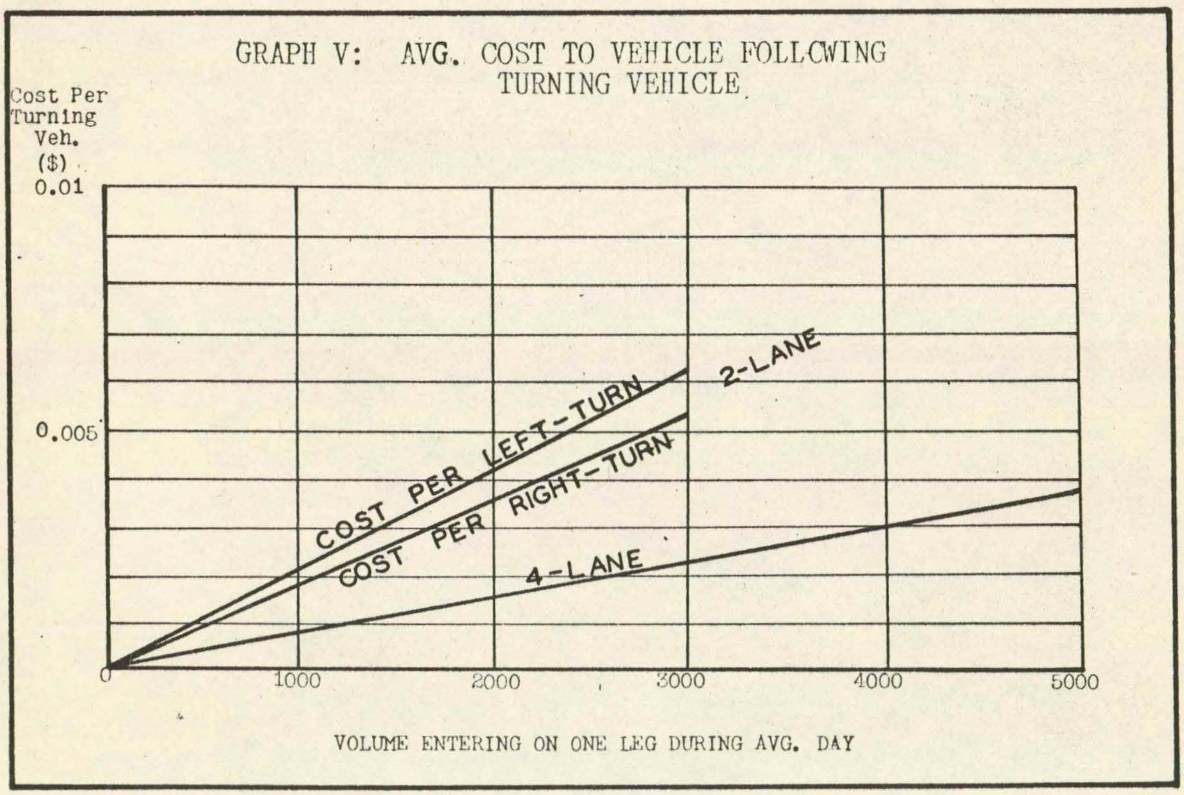

GRAPH I: PERCENT LEFT-TURNS BLOCKED
% Blocked
100
90
80
70
60
50
40
30
20
10
0
0
100
200
300
400
500
600
700
800
900
1000
VOLUME OPPOSING LEFT-TURN DURING ONE HOUR
4-LANE
2-LANE


GRAPH II: AVG. DELAY PER BLOCKED LEFT-TURN
Avg. Delay (Sec)
6
5
4
3
2
1
0
0
100
200
300
400
500
600
700
800
900
1000
VOLUME OPPOSING LEFT-TURN DURING ONE HOUR
2-LANE
4-LANE

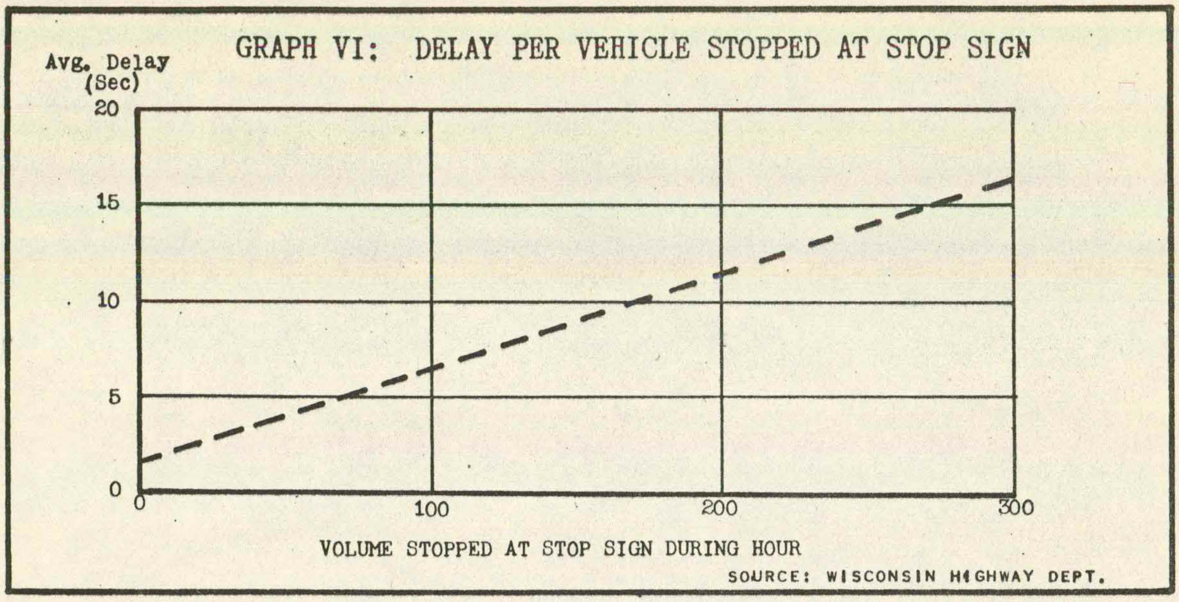

GRAPH III: AVG. COST FOR ONE LEFT-TURN
Cost Per Veh. ($)
0.02
0.01
0
0
1000
2000
3000
4000
5000
VOLUME OPPOSING LEFT TURN DURING AVG. DAY
2 & 4 LANE

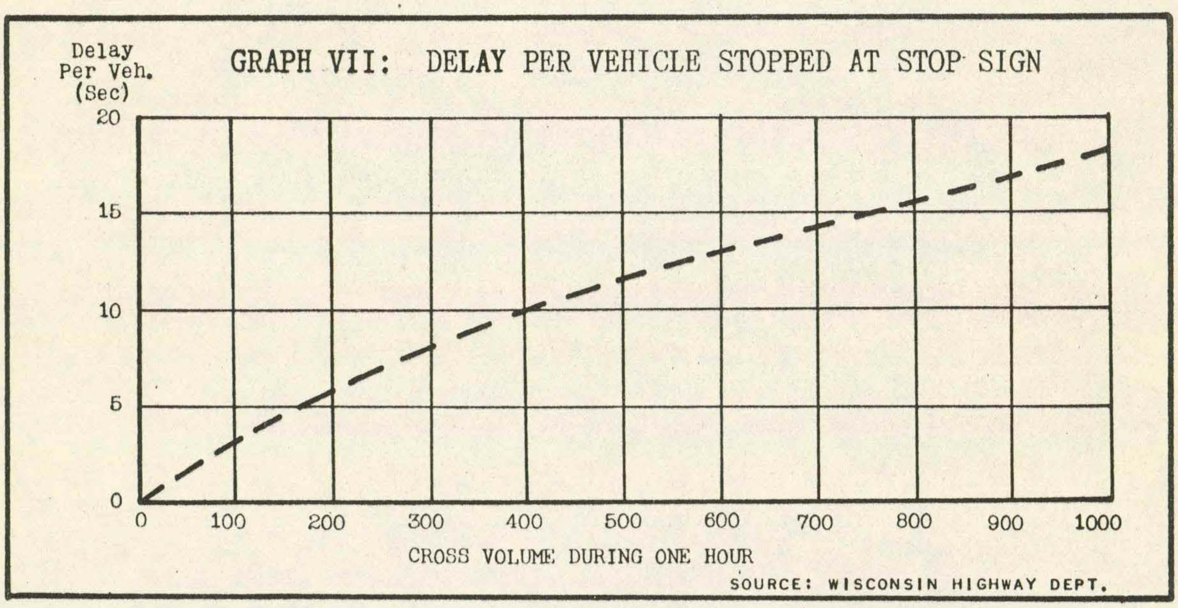


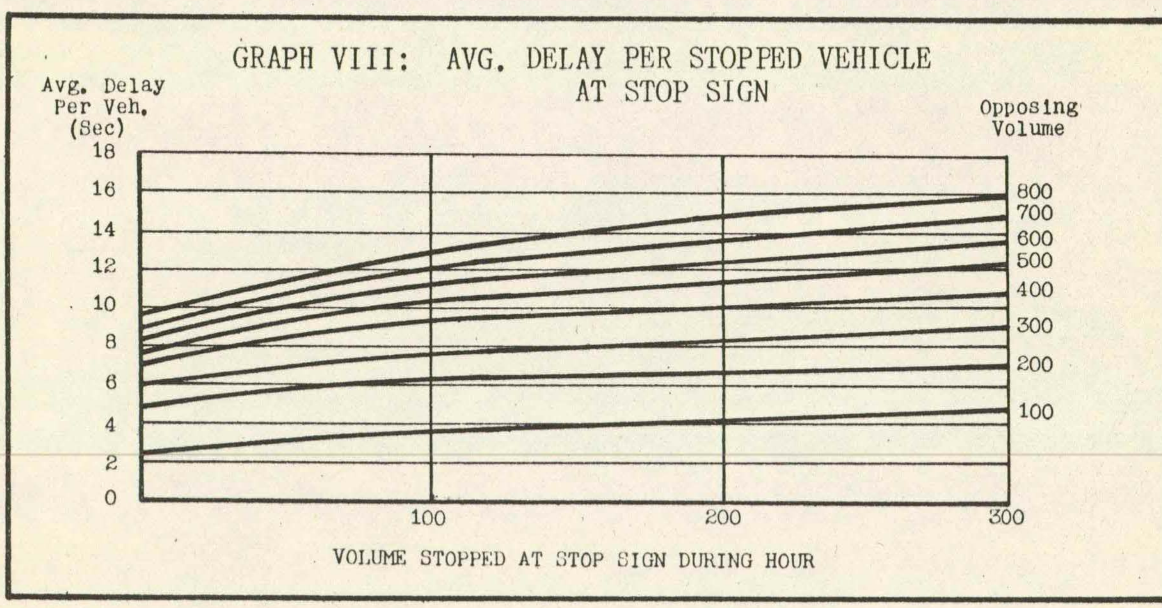
GRAPH IV: COST TO VEHICLE FOLLOWING TURNING VEHICLE
Cost Per Turning Veh. ($)
0.02
0.01
0
0
100
200
300
400
500
600
700
800
900
1000
VEH. FOLLOWING LEFT-TURN
VEH. FOLLOWING RIGHT-TURN
2-LANE
4-LANE
VOLUME OPPOSING LEFT-TURN DURING ONE HOUR

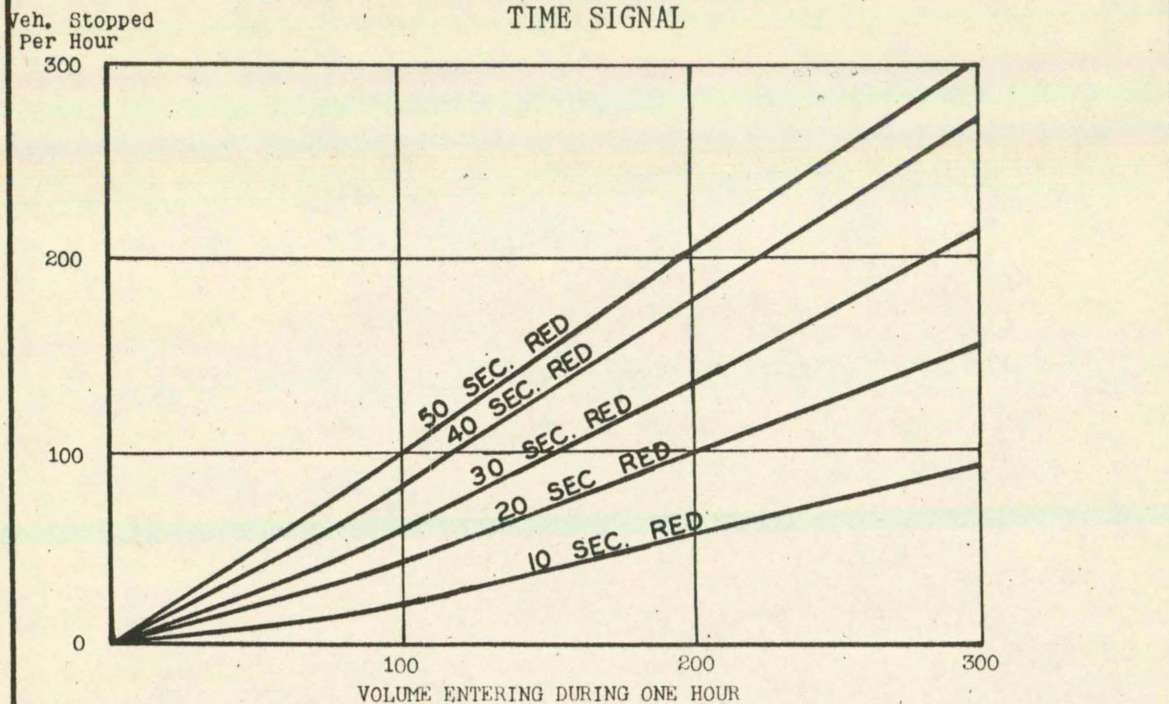


GRAPH V: AVG. COST TO VEHICLE FOLLOWING TURNING VEHICLE
Cost Per Turning Veh. ($)
0.01
0.005
0
1000
2000
3000
4000
5000
COST PER LEFT-TURN
COST PER RIGHT-TURN
2-LANE
4-LANE
VOLUME ENTERING ON ONE LEG DURING AVG. DAY

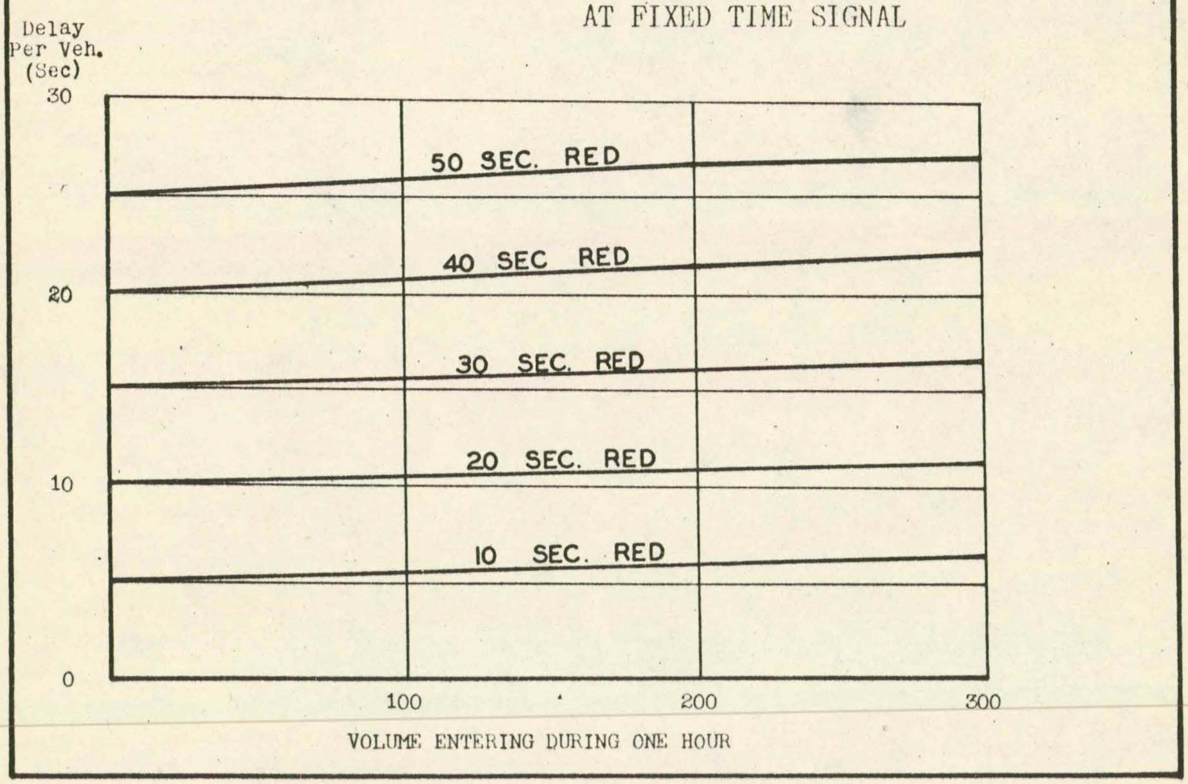

GRAPH VI: DELAY PER VEHICLE STOPPED AT STOP SIGN
Avg. Delay (Sec)
20
15
10
5
0
0
100
200
300
VOLUME STOPPED AT STOP SIGN DURING HOUR
SOURCE: WISCONSIN HIGHWAY DEPT.


GRAPH VII: DELAY PER VEHICLE STOPPED AT STOP SIGN
Delay Per Veh. (Sec)
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
1000
CROSS VOLUME DURING ONE HOUR
SOURCE: WISCONSIN HIGHWAY DEPT.

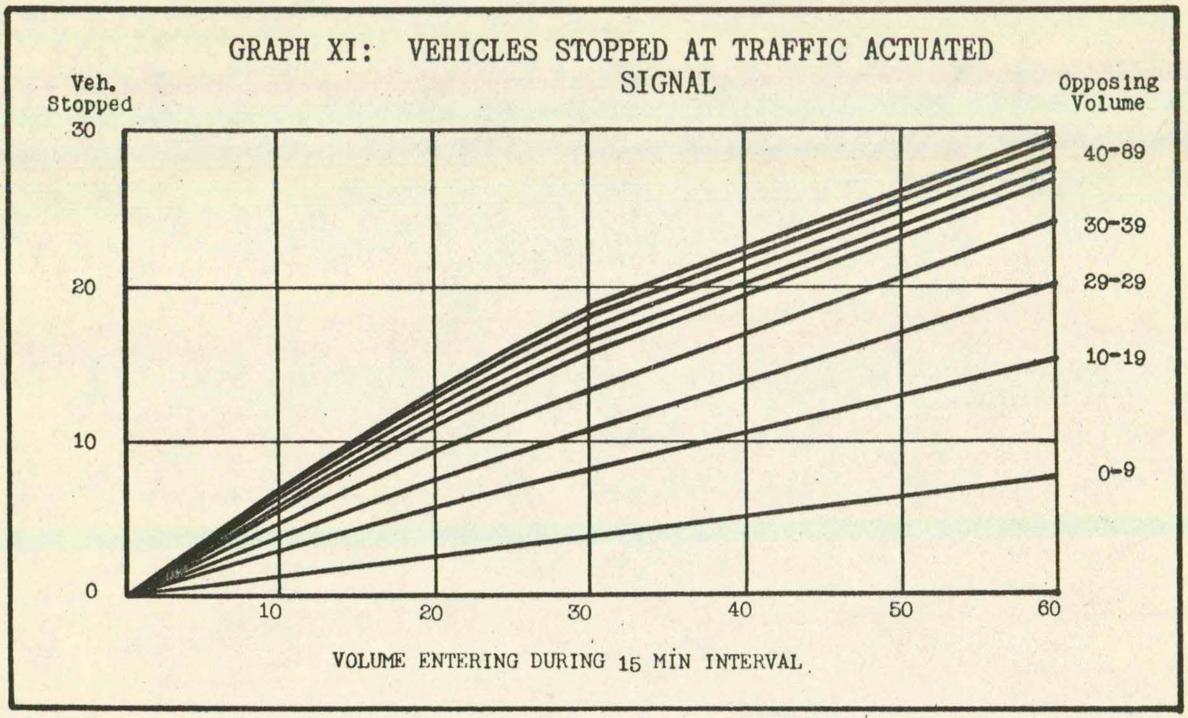

GRAPH VIII: AVG. DELAY PER STOPPED VEHICLE AT STOP SIGN
Avg. Delay Per Veh. (Sec)
18
16
14
12
10
8
6
4
2
0
Opposing Volume
800
700
600
500
400
300
200
100
100
200
300
VOLUME STOPPED AT STOP SIGN DURING HOUR

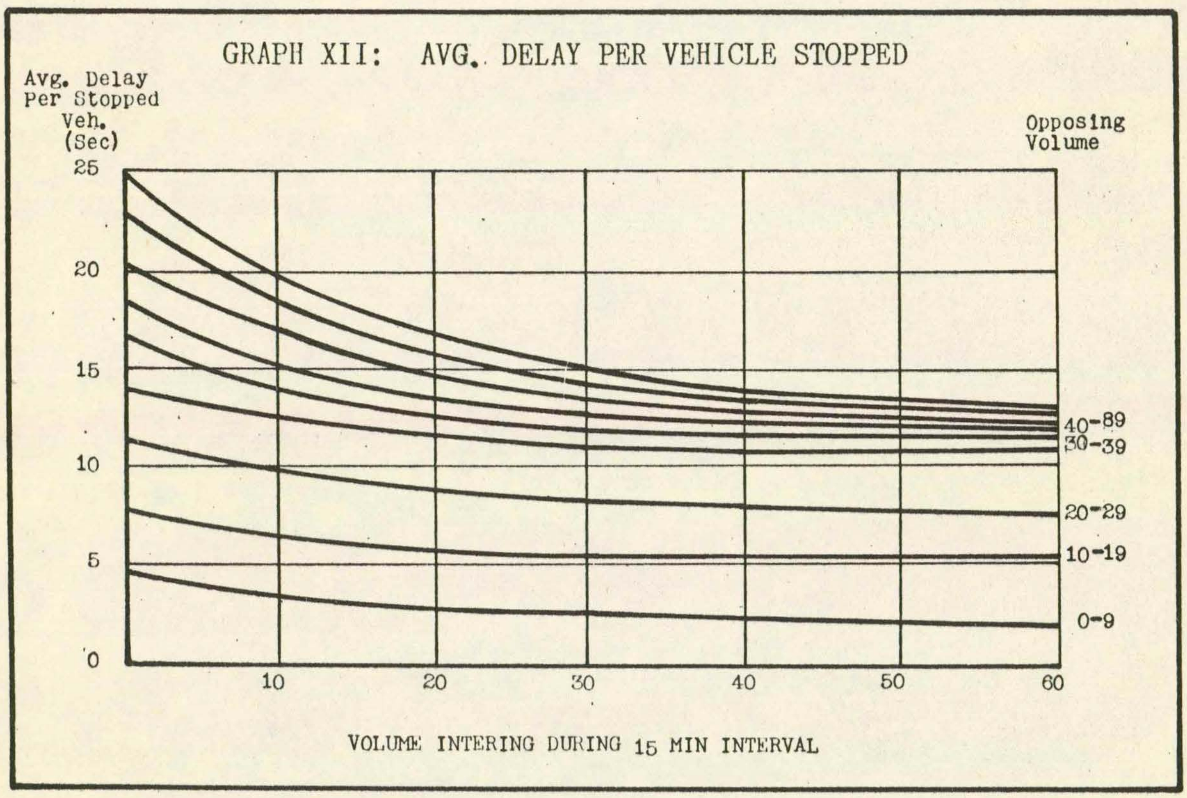


GRAPH IX: VEHICLES STOPPED AT FIXED TIME SIGNAL



GRAPH X: AVG. DELAY PER VEHICLE STOPPED AT FIXED TIME SIGNAL


GRAPH XI: VEHICLES STOPPED AT TRAFFIC ACTUATED SIGNAL
Veh. Stopped
Opposing Volume
30
20
10
0
40-89
30-39
29-29
10-19
0-9
10
20
30
40
50
60
VOLUME ENTERING DURING 15 MIN INTERVAL


GRAPH XII: AVG. DELAY PER VEHICLE STOPPED
Avg. Delay Per Stopped Veh. (Sec)
Opposing Volume
25
20
15
10
5
0
40-89
30-39
20-29
10-19
0-9
10
20
30
40
50
60
VOLUME INTERING DURING 15 MIN INTERVAL

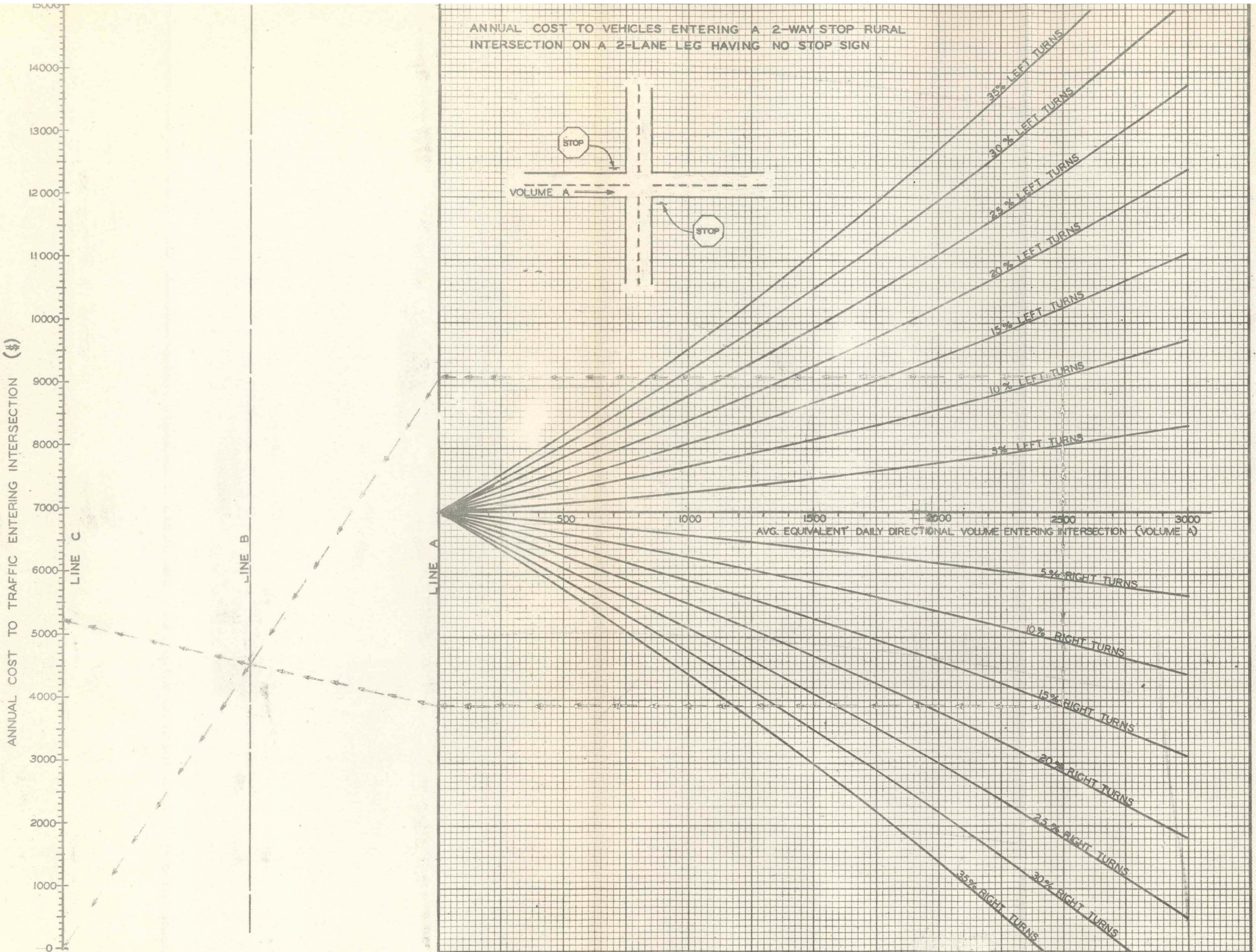

ANNUAL COST TO VEHICLES ENTERING A 2-WAY STOP RURAL INTERSECTION ON A 2-LANE LEG HAVING NO STOP SIGN
STOP
STOP
VOLUME A
35% LEFT TURNS
30% LEFT TURNS
25% LEFT TURNS
20% LEFT TURNS
15% LEFT TURNS
10% LEFT TURNS
5% LEFT TURNS
5% RIGHT TURNS
10% RIGHT TURNS
15% RIGHT TURNS
20% RIGHT TURNS
25% RIGHT TURNS
30% RIGHT TURNS
35% RIGHT TURNS
500
1000
1500
2000
2500
3000
AVG. EQUIVALENT DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION (VOLUME A)
LINE A
LINE B
LINE C
ANNUAL COST TO TRAFFIC ENTERING INTERSECTION ($)
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000
11000
12000
13000
14000

CHART I

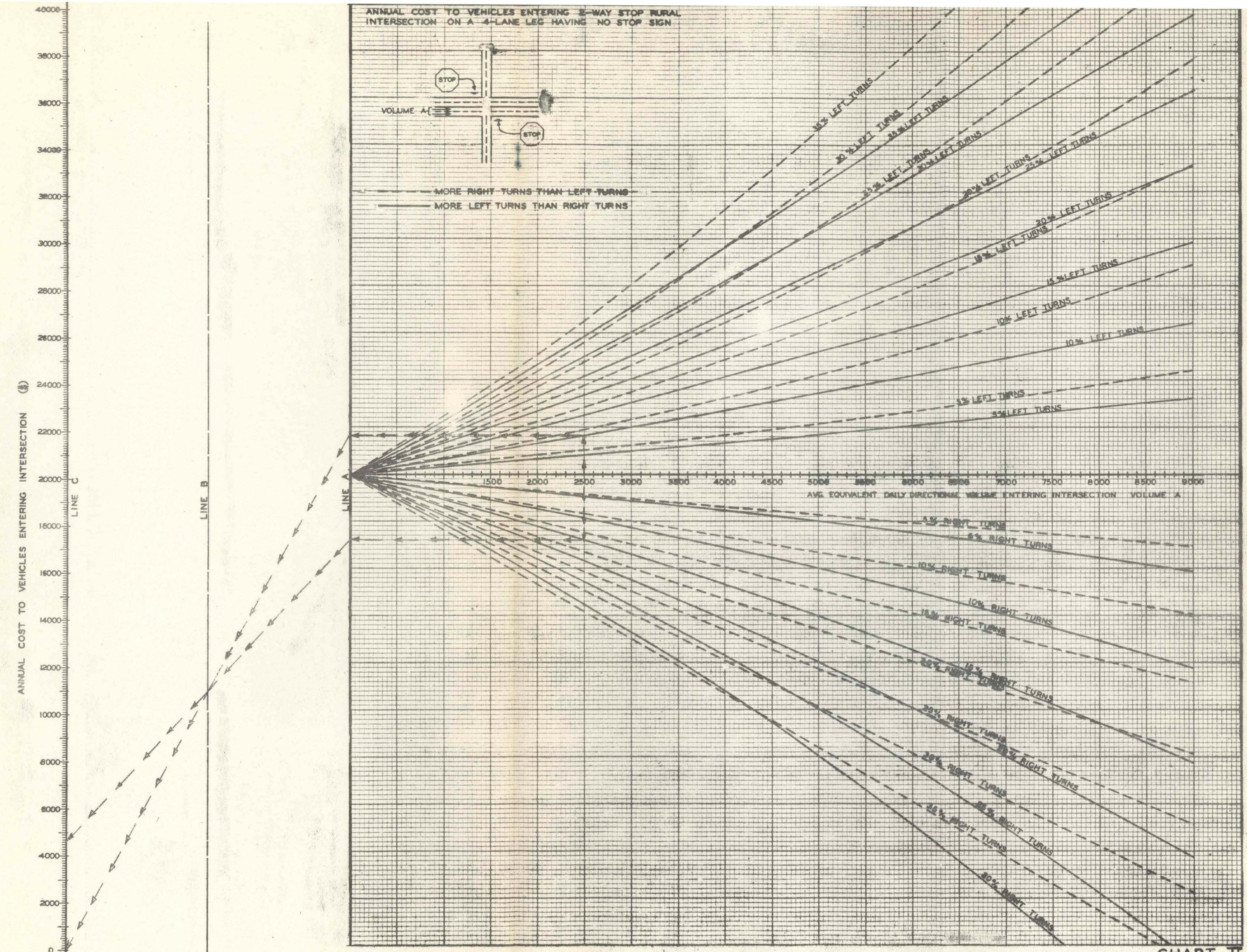

ANNUAL COST TO VEHICLES ENTERING 2-WAY STOP RURAL INTERSECTION ON A 4-LANE LEG HAVING NO STOP SIGN
STOP
STOP
VOLUME A
MORE RIGHT TURNS THAN LEFT TURNS
MORE LEFT TURNS THAN RIGHT TURNS
35% LEFT TURNS
30% LEFT TURNS
35% LEFT TURNS
25% LEFT TURNS
30% LEFT TURNS
20% LEFT TURNS
25% LEFT TURNS
20% LEFT TURNS
15% LEFT TURNS
15% LEFT TURNS
10% LEFT TURNS
10% LEFT TURNS
5% LEFT TURNS
5% LEFT TURNS
5% RIGHT TURNS
5% RIGHT TURNS
10% RIGHT TURNS
10% RIGHT TURNS
15% RIGHT TURNS
20% RIGHT TURNS
15% RIGHT TURNS
25% RIGHT TURNS
20% RIGHT TURNS
25% RIGHT TURNS
35% RIGHT TURNS
30% RIGHT TURNS
35% RIGHT TURNS
30% RIGHT TURNS
AVG. EQUIVALENT DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION VOLUME A
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
ANNUAL COST TO VEHICLES ENTERING INTERSECTION ($)
LINE C
LINE B
LINE
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0

CHART II

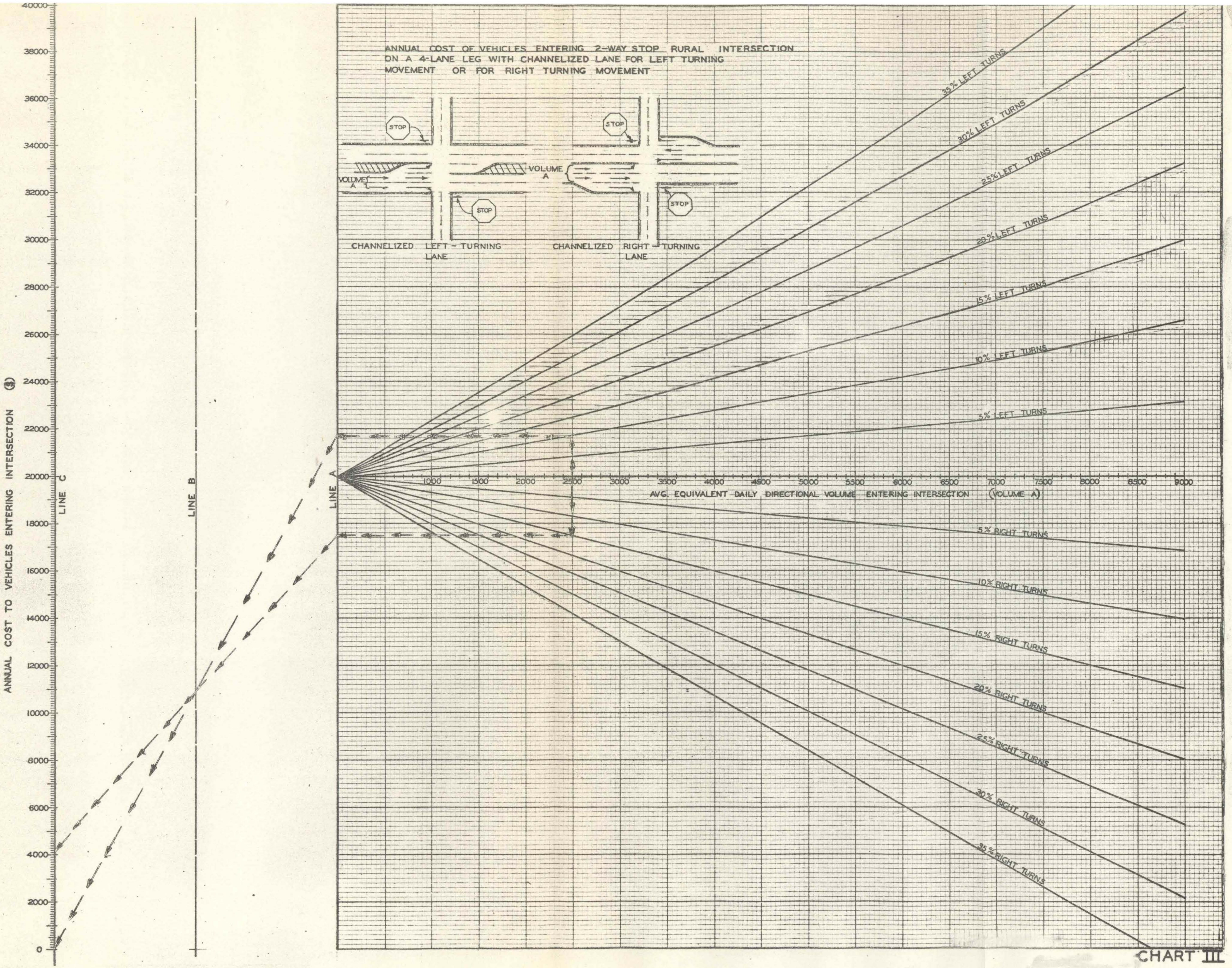
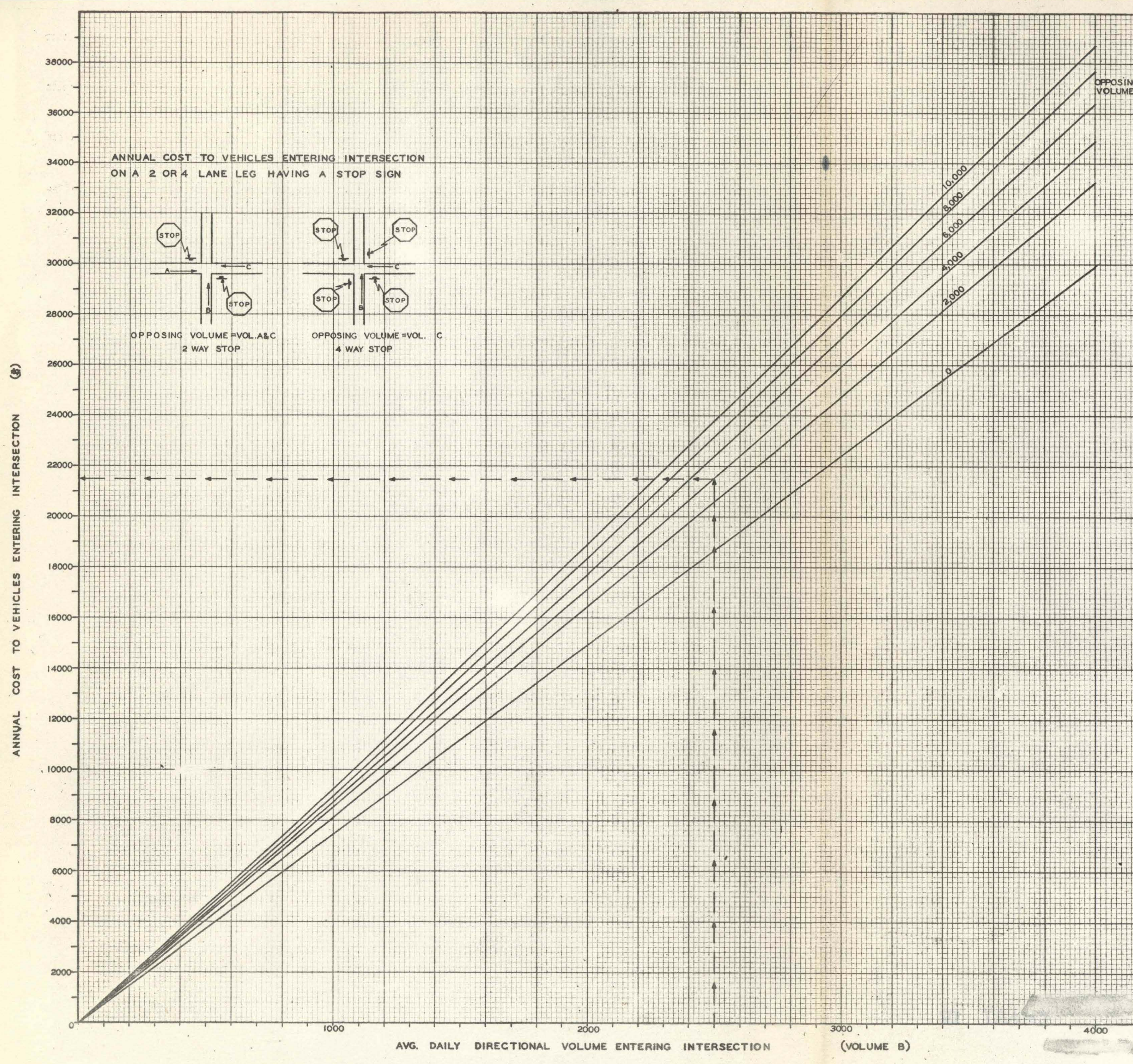
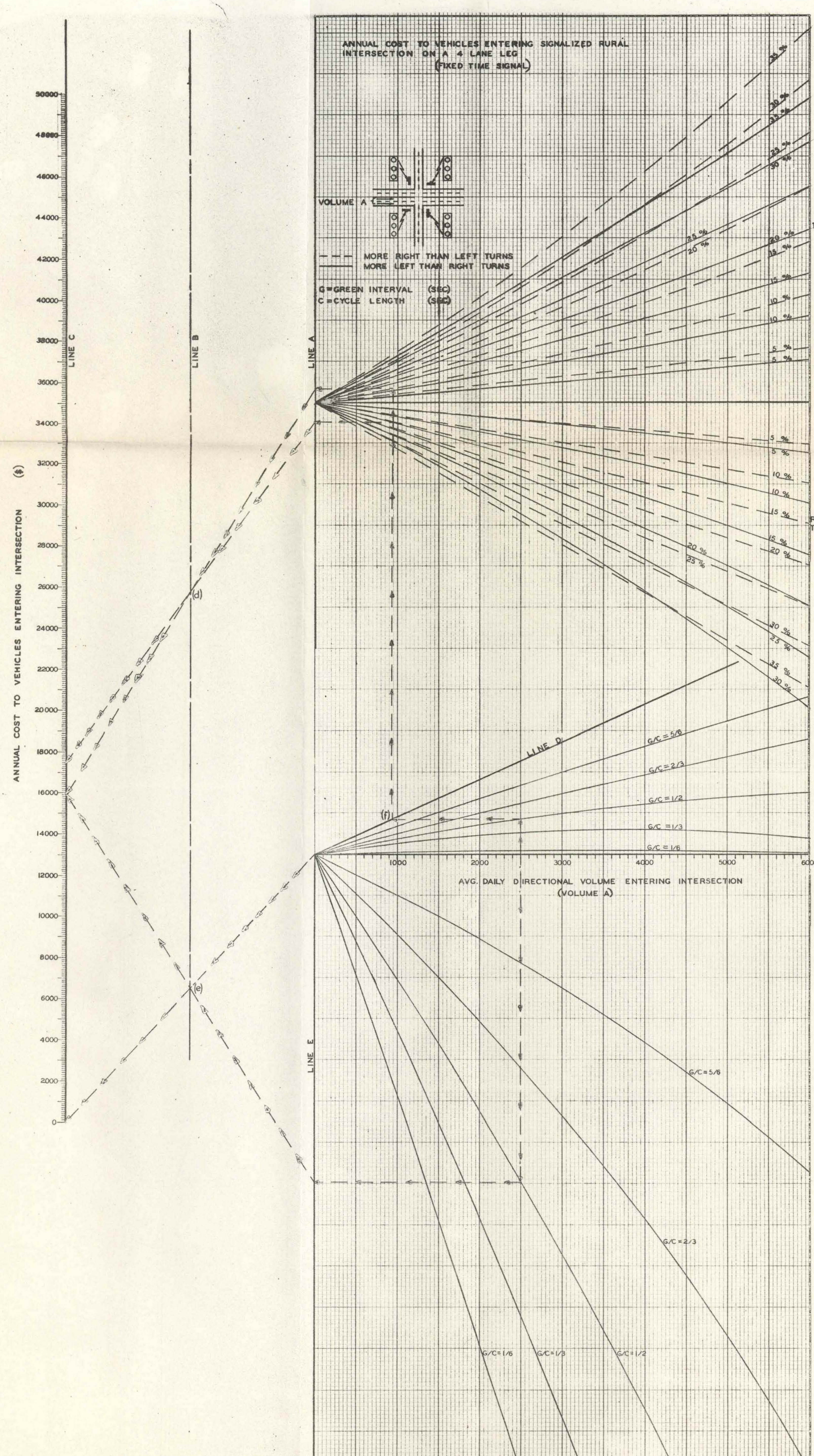

ANNUAL COST OF VEHICLES ENTERING 2-WAY STOP RURAL INTERSECTION
ON A 4-LANE LEG WITH CHANNELIZED LANE FOR LEFT TURNING
MOVEMENT OR FOR RIGHT TURNING MOVEMENT
STOP
VOLUME A
CHANNELIZED LEFT - TURNING LANE
CHANNELIZED RIGHT - TURNING LANE
35% LEFT TURNS
30% LEFT TURNS
25% LEFT TURNS
20% LEFT TURNS
15% LEFT TURNS
10% LEFT TURNS
5% LEFT TURNS
5% RIGHT TURNS
10% RIGHT TURNS
15% RIGHT TURNS
20% RIGHT TURNS
25% RIGHT TURNS
30% RIGHT TURNS
35% RIGHT TURNS
AVG. EQUIVALENT DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION (VOLUME A)
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
6500
7000
7500
8000
8500
9000
ANNUAL COST TO VEHICLES ENTERING INTERSECTION ($)
0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000
22000
24000
26000
28000
30000
32000
34000
36000
38000
40000
LINE C
LINE B
LINE

CHART III



ANNUAL COST TO VEHICLES ENTERING INTERSECTION
ON A 2 OR 4 LANE LEG HAVING A STOP SIGN
STOP
A
B
C
OPPOSING VOLUME = VOL. A&C
2 WAY STOP
OPPOSING VOLUME = VOL. C
4 WAY STOP
OPPOSING VOLUME
10,000
8,000
6,000
4,000
2,000
0
ANNUAL COST TO VEHICLES ENTERING INTERSECTION ($)
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1000
2000
3000
4000
AVG. DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION (VOLUME B)



ANNUAL COST TO VEHICLES ENTERING SIGNALIZED RURAL INTERSECTION ON A 4 LANE LEG
(FIXED TIME SIGNAL)
VOLUME A
MORE RIGHT THAN LEFT TURNS
MORE LEFT THAN RIGHT TURNS
G=GREEN INTERVAL (SEC)
C=CYCLE LENGTH (SEC)
LEFT TURNS
RIGHT TURNS
LINE A
LINE B
LINE C
LINE D
LINE E
ANNUAL COST TO VEHICLES ENTERING INTERSECTION ($)
AVG. DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION
(VOLUME A)
G/C=5/6
G/C=2/3
G/C=1/2
G/C=1/3
G/C=1/6
(d)
(e)
(f)

CHART V

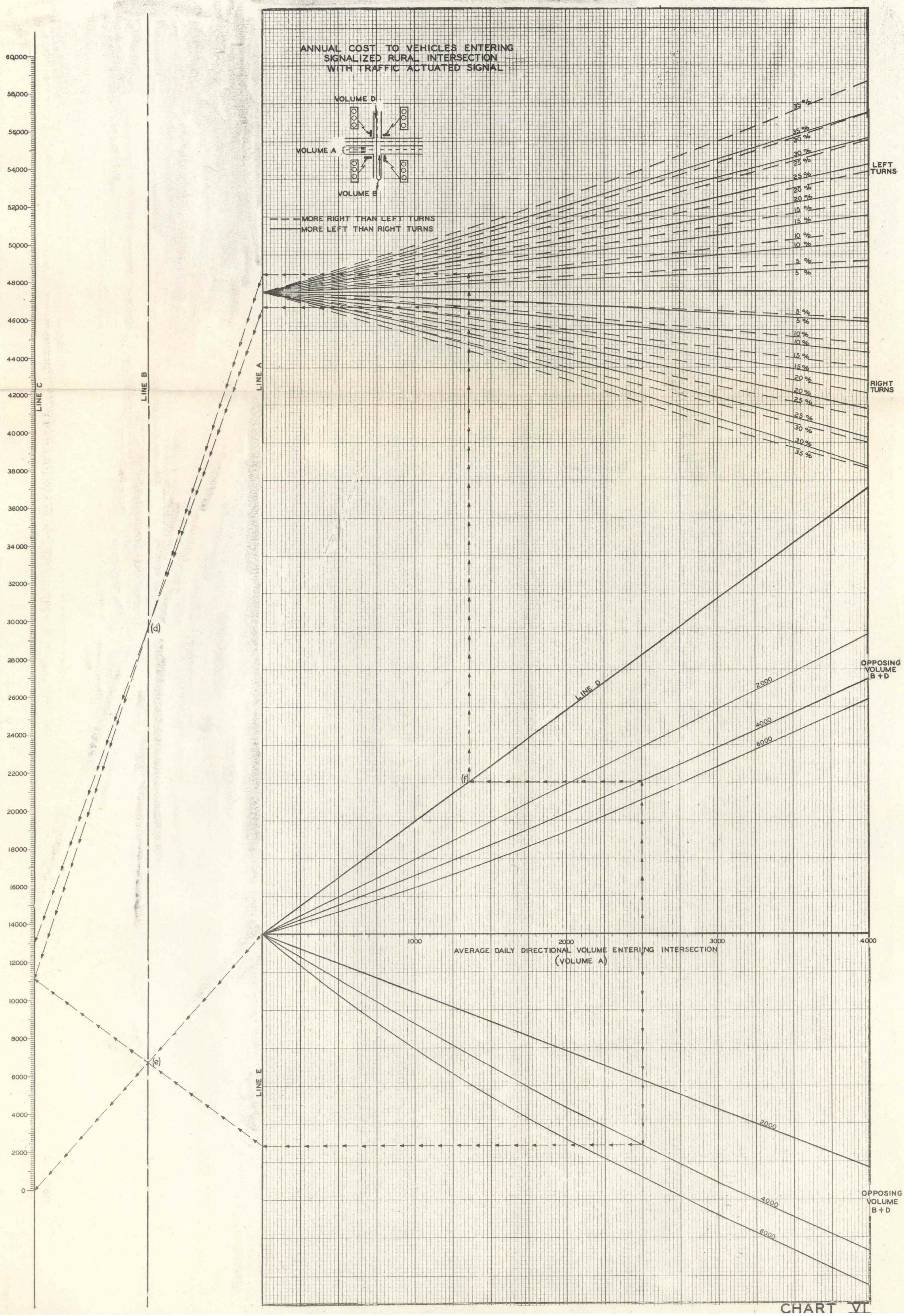
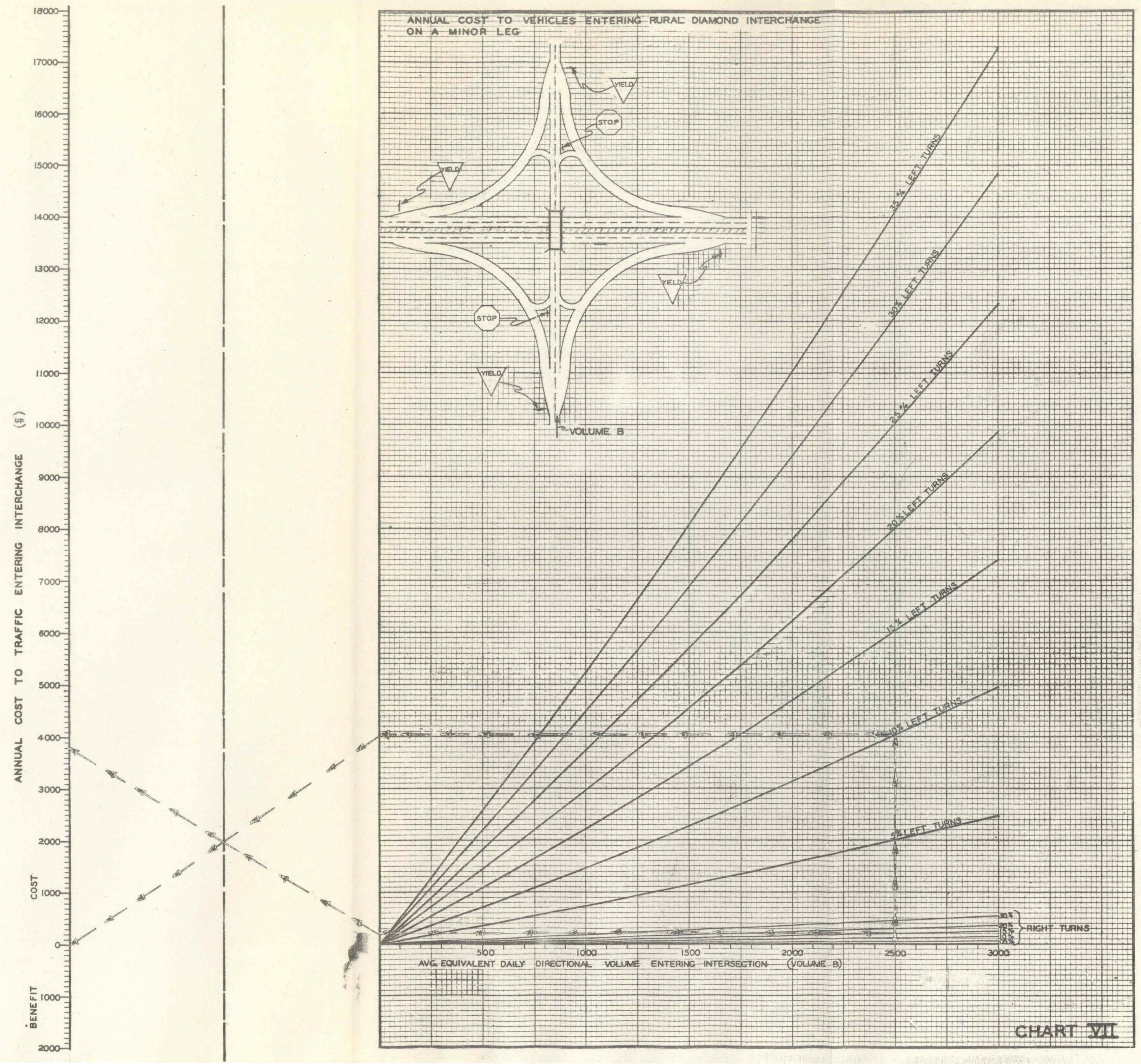
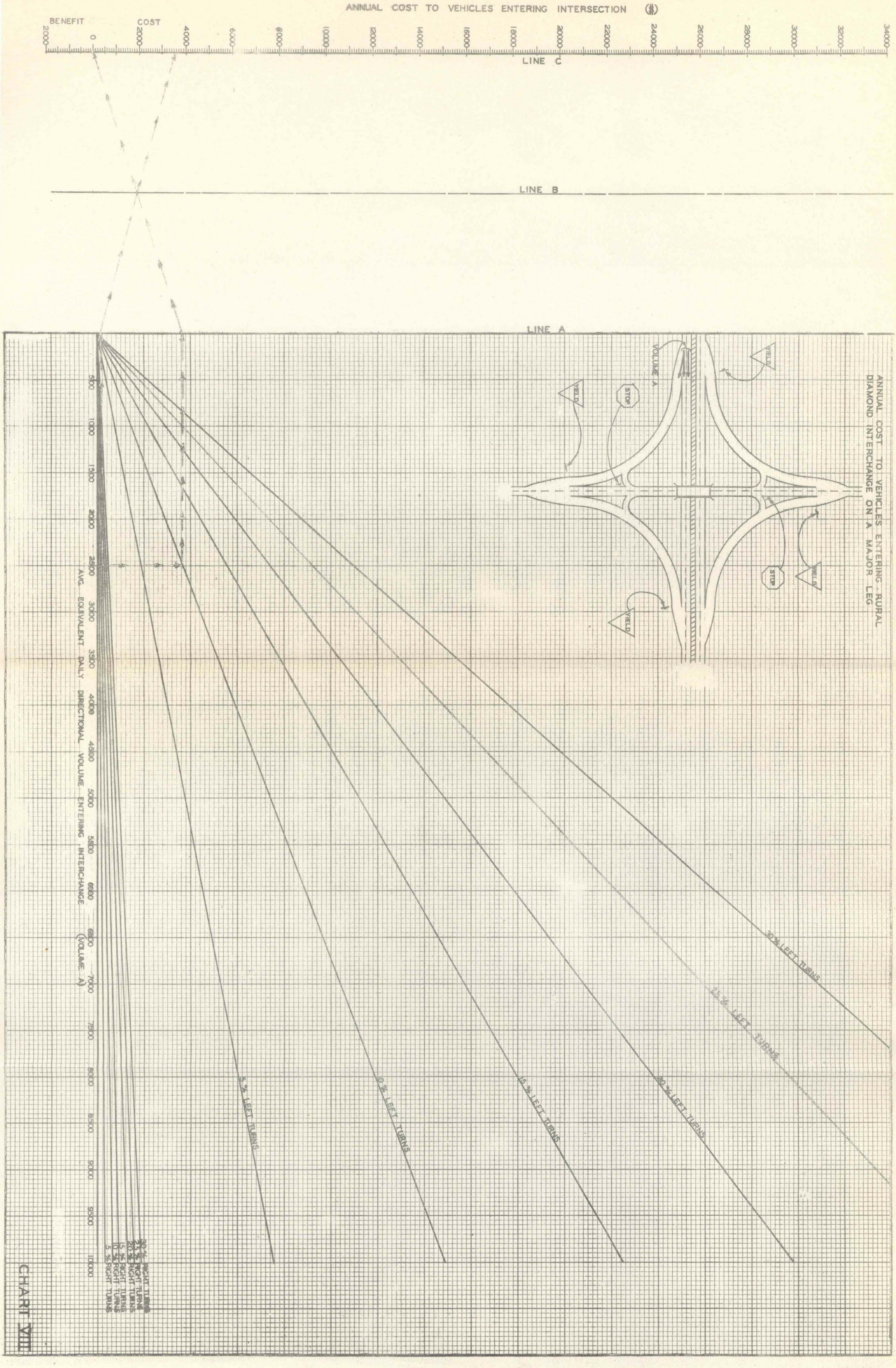

ANNUAL COST TO VEHICLES ENTERING
SIGNALIZED RURAL INTERSECTION
WITH TRAFFIC ACTUATED SIGNAL
VOLUME D
VOLUME A
VOLUME B
MORE RIGHT THAN LEFT TURNS
MORE LEFT THAN RIGHT TURNS
LEFT TURNS
RIGHT TURNS
LINE C
LINE B
LINE A
LINE D
LINE E
(d)
(e)
(f)
OPPOSING VOLUME B + D
2000
4000
6000
AVERAGE DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION
(VOLUME A)
1000
2000
3000
4000
60,000
58,000
56,000
54,000
52,000
50,000
48000
46000
44000
42000
40000
38000
36000
34000
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0

CHART VI


ANNUAL COST TO VEHICLES ENTERING RURAL DIAMOND INTERCHANGE
ON A MINOR LEG
ANNUAL COST TO TRAFFIC ENTERING INTERCHANGE ($)
COST
BENEFIT
18000
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1000
2000
YIELD
STOP
YIELD
STOP
YIELD
YIELD
VOLUME B
35% LEFT TURNS
30% LEFT TURNS
25% LEFT TURNS
20% LEFT TURNS
15% LEFT TURNS
10% LEFT TURNS
5% LEFT TURNS
RIGHT TURNS
500
1000
1500
2000
2500
3000
AVG. EQUIVALENT DAILY DIRECTIONAL VOLUME ENTERING INTERSECTION (VOLUME B)
CHART VII


ANNUAL COST TO VEHICLES ENTERING INTERSECTION ($)
BENEFIT
COST
2000 0 2000 4000 6000 8000 10000 12000 14000 16000 18000 20000 22000 24000 26000 28000 30000 32000 34000
LINE C
LINE B
LINE A
ANNUAL COST TO VEHICLES ENTERING - RURAL
DIAMOND INTERCHANGE ON A MAJOR LEG
VOLUME A
YIELD
STOP
500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000 7500 8000 8500 9000 9500 10000
AVG. EQUIVALENT DAILY DIRECTIONAL VOLUME ENTERING INTERCHANGE (VOLUME A)
5 % LEFT TURNS
10 % LEFT TURNS
15 % LEFT TURNS
20 % LEFT TURNS
25 % LEFT TURNS
30 % LEFT TURNS
30 % RIGHT TURNS
25 % RIGHT TURNS
20 % RIGHT TURNS
15 % RIGHT TURNS
10 % RIGHT TURNS
5 % RIGHT TURNS
CHART VIII