Michigan Department of TRANSPORTATION

MILLER-LINDEN AREA CORRIDOR ANALYSIS TECHNICAL REPORT FOR THE FLINT URBAN AREA

AUGUST, 1985

TRAVEL DEMAND
ANALYSIS
PERMANENT FILES

BUREAU OF TRANSPORTATION PLANNING
Urban Transportation Planning Division

MICHIGAN DEPARTMENT

OF

TRANSPORTATION

MILLER-LINDEN AREA CORRIDOR ANALYSIS TECHNICAL REPORT FOR THE FLINT URBAN AREA

AUGUST, 1985

This report represents the findings and/or professional opinions of the Michigan Department of Transportation and not an official opinion of the State Transportation Commission.

Prepared By:

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SYSTEMS DEVELOPMENT AND ANALYSIS SECTION

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In Cooperation With:

U.S. Department of Transportation
Federal Highway Administration

OFFICE MEMORANDUM

DATE: August, 1985

TO: G. Robert Adams, Deputy Director
Bureau of Transportation Planning

FROM: Louis H. Lambert, Administrator
Urban Transportation Planning Division

SUBJECT: Miller-Linden Area Corridor Analysis - Technical Report

The Systems Development and Analysis Section of the Urban Transportation Planning Division is pleased to present the Miller-Linden Area Corridor Analysis - Technical Report. This report is a result of technical planning analysis used to evaluate the present and projected future travel conditions on Miller and Linden Roads within the study area. The report identifies the problem areas within the corridor and analyzes possible short term solutions to existing problems.

This analysis is a product of the TSM special project portion in the FY 84 Unified Work Program, and serves as the technical support document for the Miller-Linden-Bristol Roads Area Corridor Study Report prepared by the Genesee County Metropolitan Planning Commission (GCMPC) staff.

Section staff were responsible for the development of this document. Inventory data was provided by MDOT, the City of Flint, Genesee County Road Commission, and GCMPC.

This report was prepared by Scott Wheeler, Transportation Planner, under the supervision of Paul Hershkowitz, Unit Supervisor.

Administrator

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF EXHIBITS

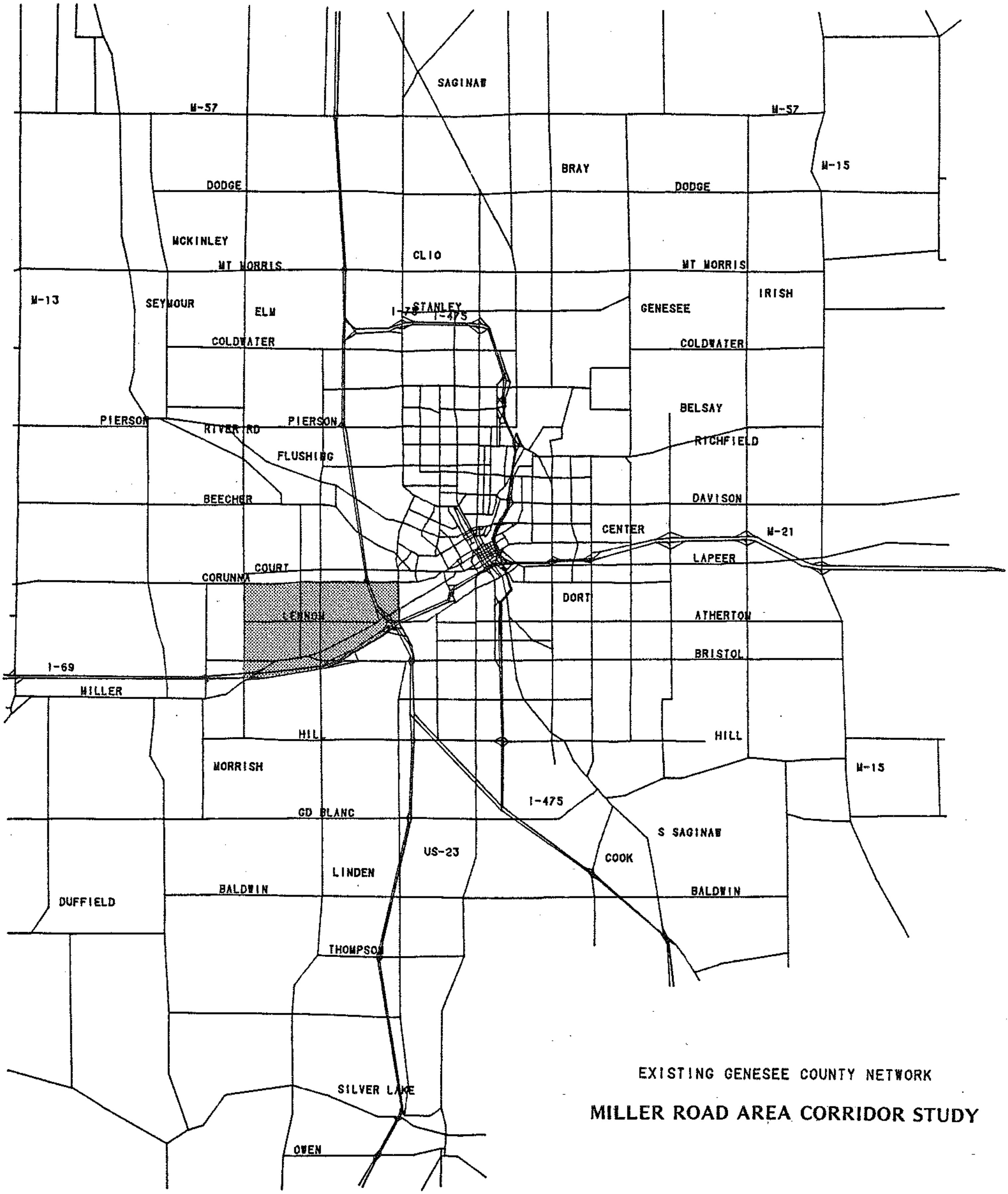
LIST OF TABLES

INTRODUCTION

This study was conducted jointly by the staffs of the Genesee County Metropolitan Planning Commission (GCMPC), Genesee-Lapeer-Shiawassee (GLS) Region V and the Michigan Department of Transportation's (MDOT) Urban Transportation Planning Division. A Miller Road area corridor study ad hoc subcommittee, composed of transportation planners, businessmen, educators, neighborhood leaders and concerned citizens, was formed to add local input and review to the study. This committee discussed and reviewed the identified corridor problems and potential improvements that could be implemented to help solve these problems.

This report is intended as a technical support document for the Miller Road Area Corridor Study conducted through the Flint-Genesee County 3C Urban Transportation Planning Process. This report conpletes MDOT's technical analyses portion of the study. The analysis report consists of the various traffic data items, modeling techniques and analysis tools utilized by MDOT in identifying and analyzing corridor problem areas and their alternatives. Those analysis items not covered in this report were completed by other members of the subcommittee.

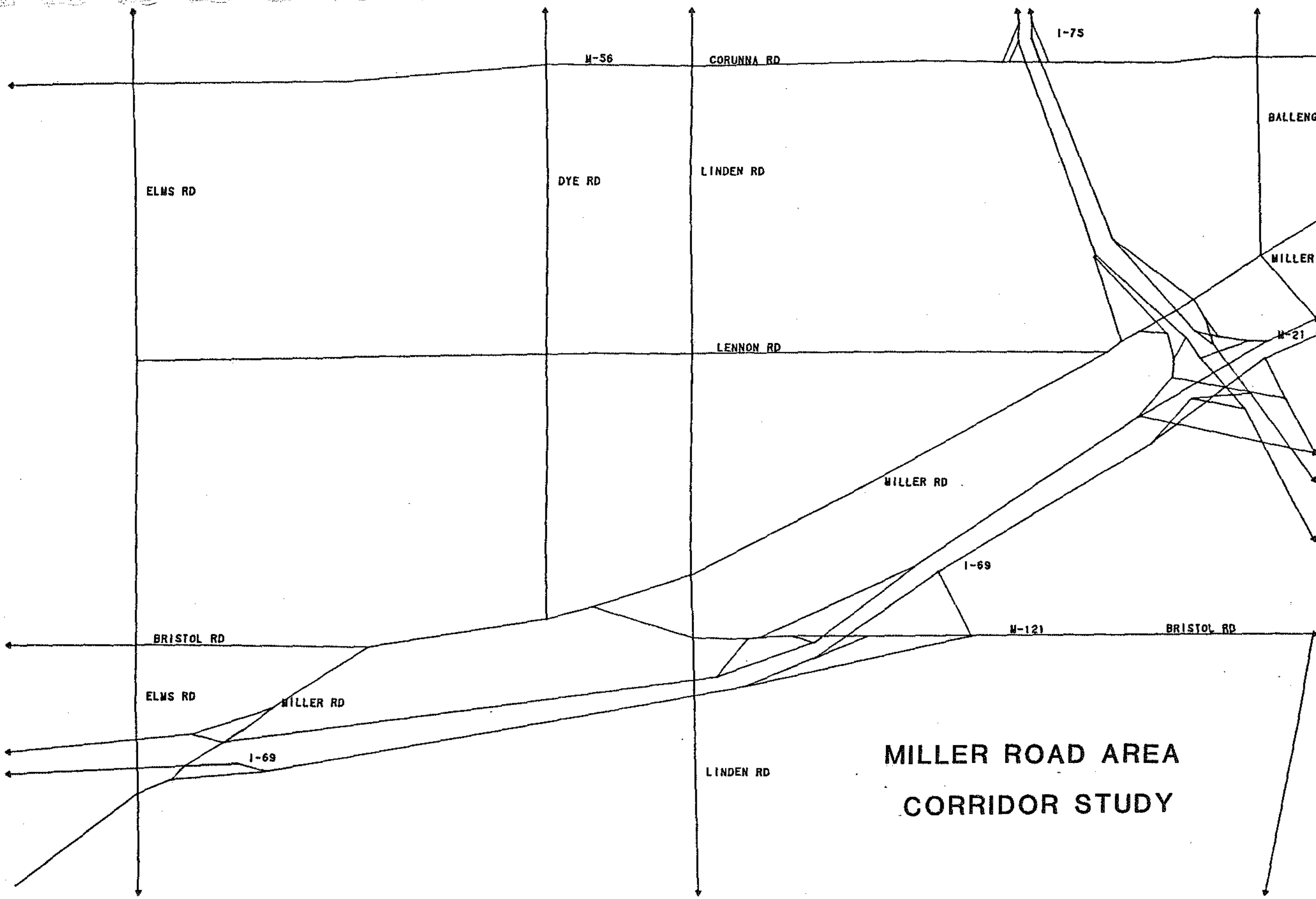
The corridor as defined includes the area bounded by Ballenger Highway on the east, I-69 to the south, Elms Road to the west, and M-56 Corunna Road to the north. The maps on the following pages (Figures I-1&2) show the corridor location. This area includes major portions of Miller and Linden Roads, both of which are presently prime commercial development areas. Miller Road runs basically east and west with road widths varying from four to six lanes. Linden Road is a five lane roadway running north and south and intersects Miller Road.



EXISTING GENESEE COUNTY NETWORK

MILLER ROAD AREA CORRIDOR STUDY

FIGURE I-1



MILLER ROAD AREA CORRIDOR STUDY

FIGURE I-2

As a result of recent commercial and professional land-use development in the area, traffic volumes have increased dramatically in the last few years placing a further burden on the heavily traveled corridor. Local residents and businessmen, as well as individuals using the corridor on a regular basis, have expressed concern over a number of problem areas. This study was undertaken in hopes of identifying the problems (both existing and future) and developing realistic relief solutions for congestion and safety problems within the area.

In response to recent and anticipated future development, zonal socio-economic data needed to be updated within the corridor for the year 2005 time period. This task needed to be completed before traffic modeling and analysis could be initiated. Due to time constraints placed on this study, it was decided by GCMPC and MDOT to modify the existing 2005 trip table for traffic analysis zones within the corridor study boundaries (zones 279, 280, 283, 286 and 288) to reflect recent and anticipated future growth. (See the Genesee County zone map on page). This was accomplished through the seven step process outlined below.

PROCESS TO MODIFY THE 2005 TRIP TABLE
FOR ZONES WITHIN THE MILLER ROAD
COORIDOR STUDY AREA

1. Determine zones of potential development.
2. Determine what type of development will occur in each zone (future land use maps, Master Plans, etc.)
    a. Port and Terminal (commercial airports, truck terminals)
    b. Industrial/Agricultural
    c. Residential
    d. Lodging
    e. Recreational
    f. Institution
    g. Medical
    h. Office
    i. Retail
    j. Service (banks, insurance, etc.)

3. Estimate future data for each category in 2 above.

   a. Number of Employees
   b. Square Footage
   c Acreage
   d. Dwelling Units (for apartments, condominiums, etc.)
   e. Number of Rooms (motels, hotels)
   f. Parking Spaces

4. Calculate number of trips into and out of each zone.

   a. Trip Generation Manual Rates

5. Compare new 2005 zonal trips to present 2005 trips and determine percent increase (factor) for each zone.

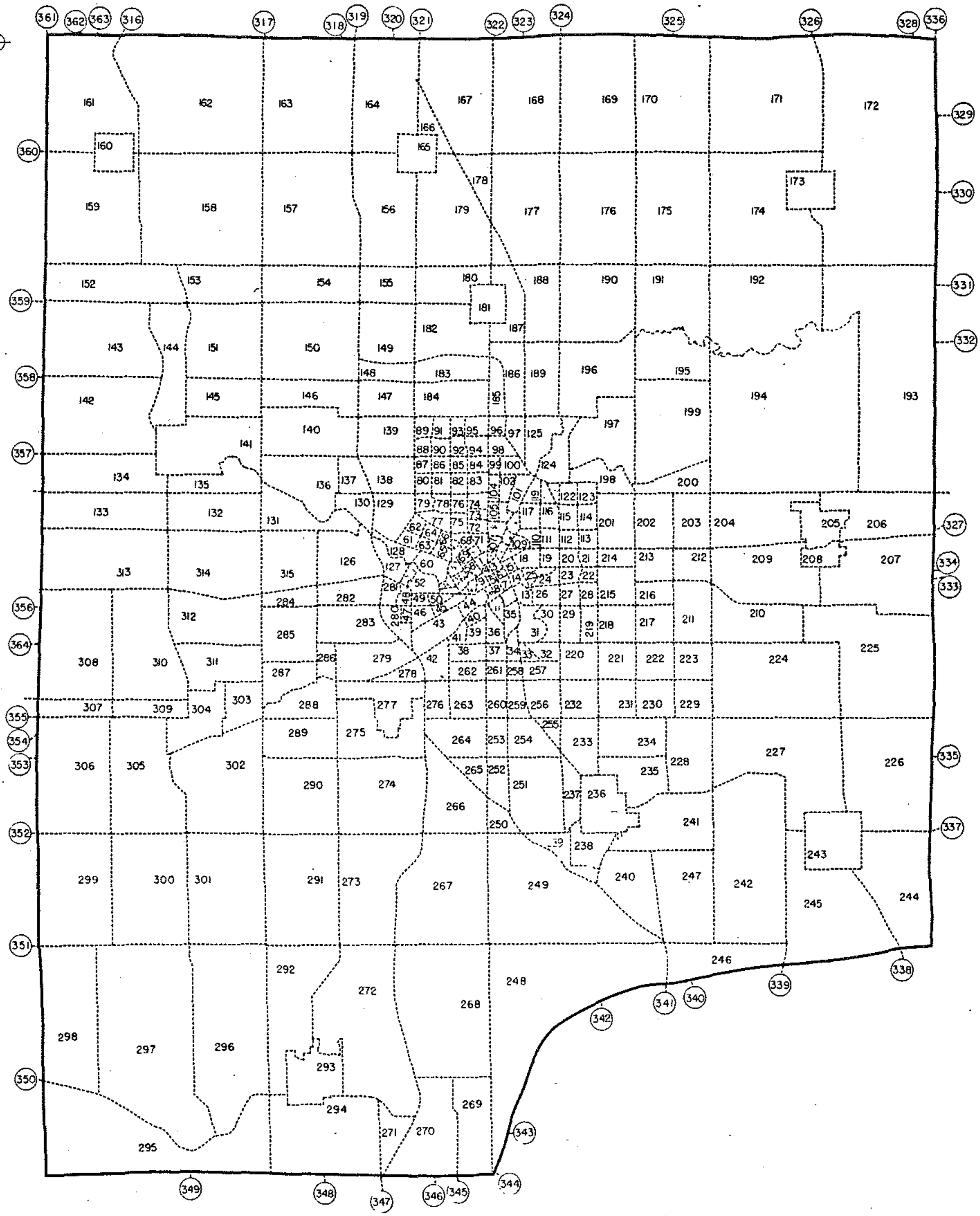
6. Modify trip table for each zone based on factor determined in 5 above.

7. Run new traffic assignment with old 2005 trees.

The GCMPC and GLS Region V staff's prepared the items included in steps 2 & 3. The Systems Development and Analysis Section within MDOT's Urban Transportation Planning Division completed steps 4-7. This process resulted in a total increase of over 48,000 (46%) trips into and out of the corridor zones for the year 2005. Zone 279 vehicle trips were increased by 25%, zone 280 by 43%, zone 283 by 14%, zone 286 by 182% and zone 288 by 93%. The new trip table provides a more realistic projection of future travel within the corridor. It reflects not only the increased travel resulting from development that has occurred since 1980 (the last trip table update) but also that which is expected to occur by the year 2005. The updated socio-economic figures developed here will also be used for updating the Genesee County 2005 Long-Range Transportation Plan in the near future.

ZONE MAP

GENESEE COUNTY



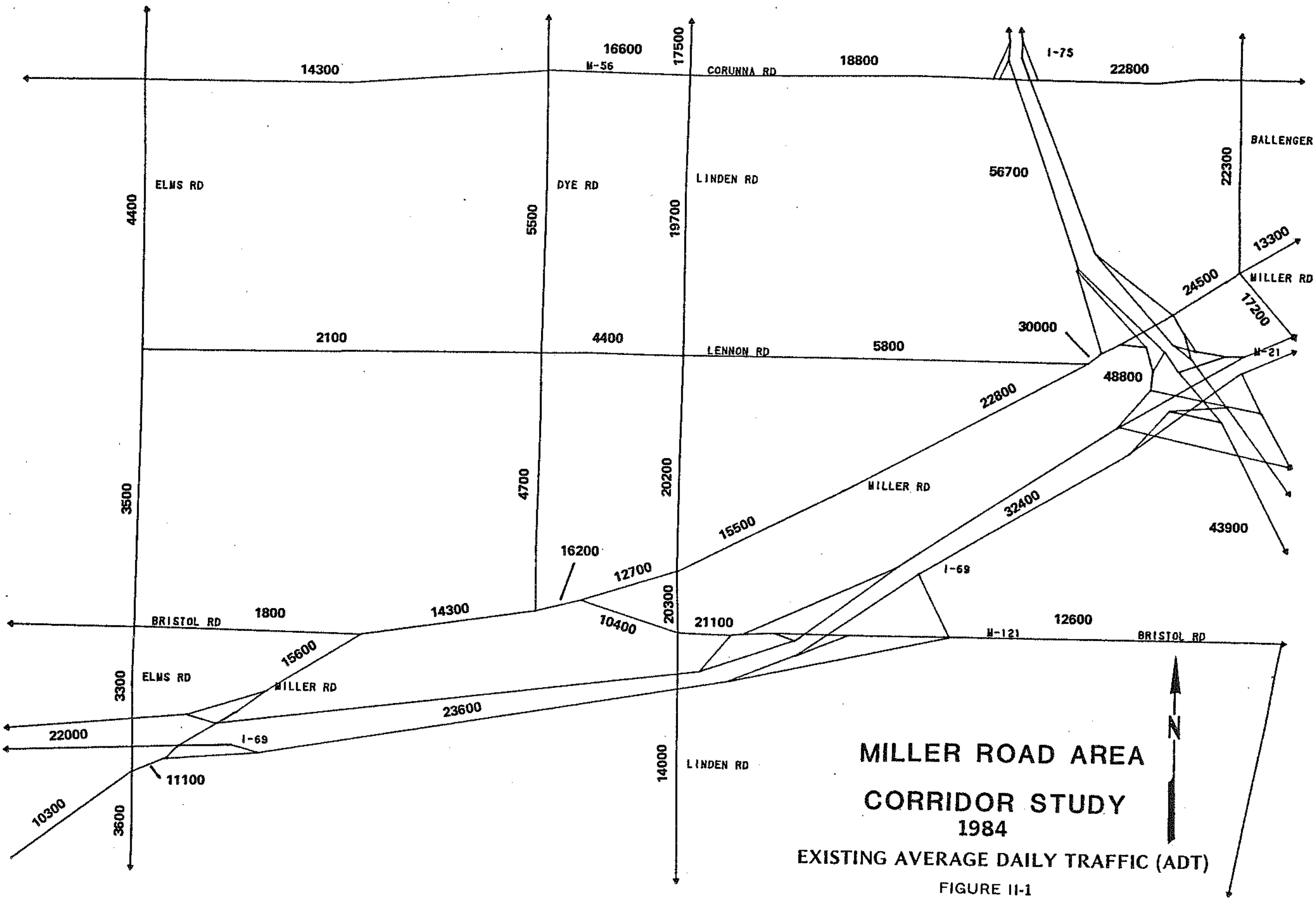
TRAFFIC VOLUME ANALYSIS

AVERAGE DAILY TRAFFIC VOLUMES

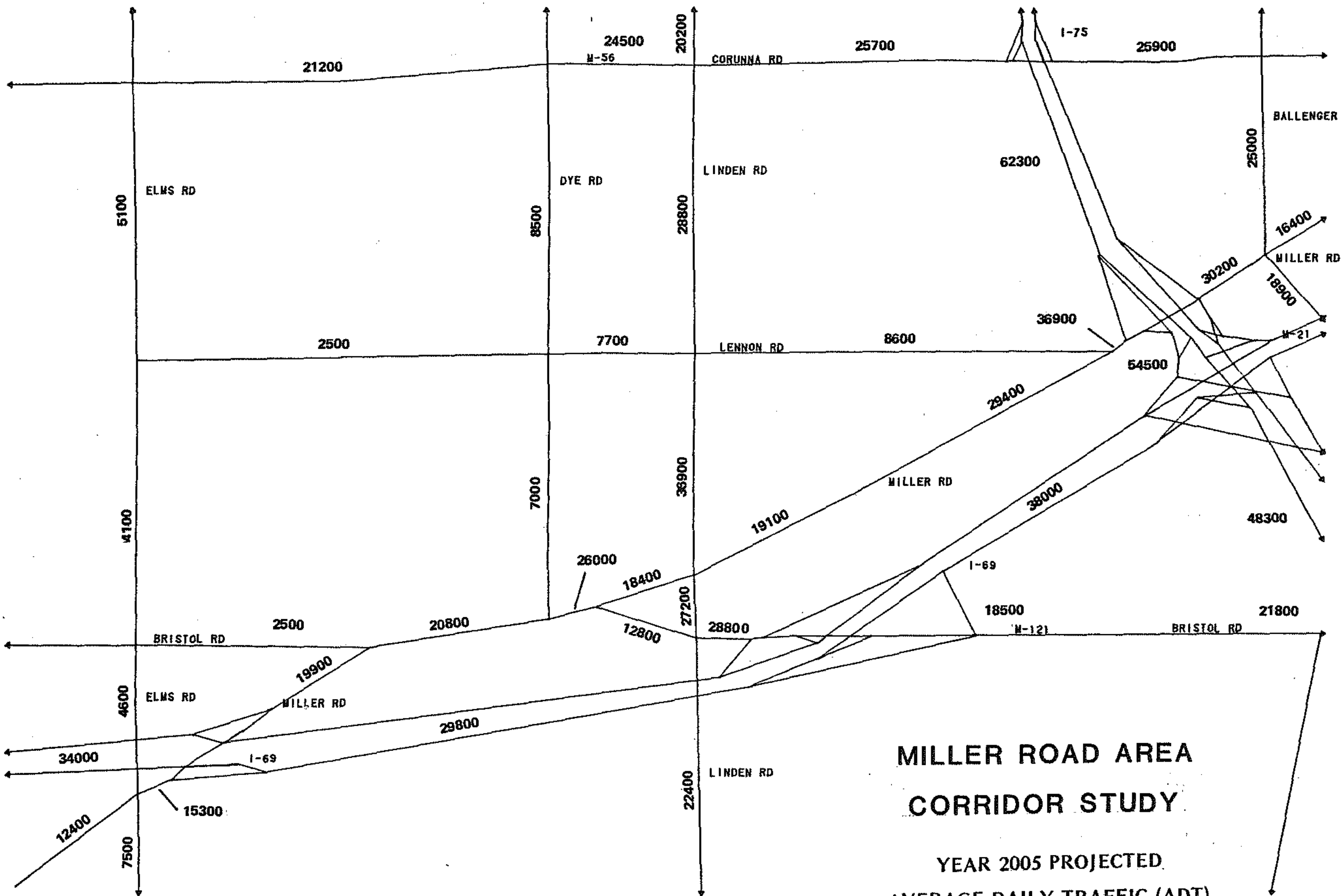
Within the Miller Road Corridor study area, 1984 average daily traffic volumes (ADT's) on the major roadways (excluding the freeways) range from 1,800 to 30,000 vehicles per day. The higher volumes occur on Miller, Linden, Ballenger, Bristol and Corrunna Roads where ADT's are between 11,100 and 30,000. The segment of roadway with the highest volumes (30,000) is on Miller Road between Lennon Road and the I-75 interchange. These figures were determined from 24 hour machine counts taken by the Michigan Department of Transportation (MDOT) during the month of April, 1984.

Traffic volumes within the corridor have increased about 18% over 1980 levels. Volumes on Miller and Linden Roads averaged 23% and 28%, respectively above the 1980 figures. This increase is due primarily to the large amount of trips made to new or expanded commercial, shopping or professional establishments in the area. Figure II-1 shows the existing 1984 average daily traffic volumes for the major roads within the study area. It should be noted that these figures do not reflect the additional volumes that will be added to the roadway network with the opening of the new Oakbrook Mall. Traffic counts should be taken at key locations, after the new mall has been opened for a period of time, to study the full impacts.

Volumes by the year 2005 are projected to be about 15% higher within the corridor than present volumes. Miller Road will average about a 29% increase and Linden Road about a 55% increase within this time frame. The 2005 projected ADT's are shown in Figure II-2. These figures include traffic generated by Oakbrook Mall and other anticipated development within, or close to, the corridor boundaries.



MILLER ROAD AREA CORRIDOR STUDY
1984
EXISTING AVERAGE DAILY TRAFFIC (ADT)
FIGURE II-1



MILLER ROAD AREA CORRIDOR STUDY

YEAR 2005 PROJECTED
AVERAGE DAILY TRAFFIC (ADT)

FIGURE II-2

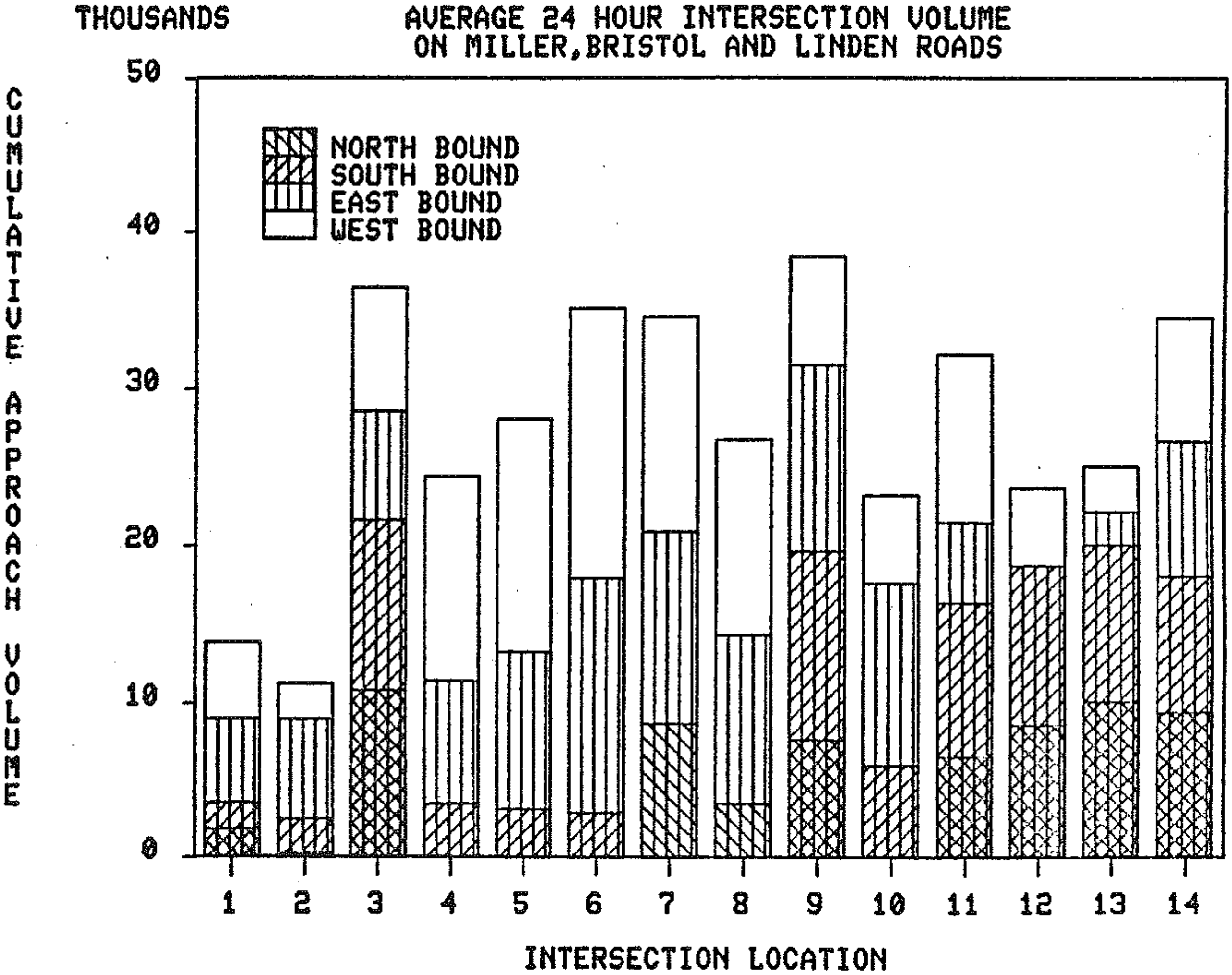
INTERSECTION VOLUMES

Average daily intersection volumes were calculated at all of the signalized intersections on Miller and Linden Roads. These volumes were determined by summing the adjusted 24 hour machine counts taken on each intersection approach. Figure II-3 illustrates the cumulative approach volumes for each of the 14 signalized intersections.

The intersection with the highest volume is Miller Road at Ballenger Highway (38,400), while the lowest volume occurs at Miller Road and Dye Road (11,300). The intersections of Miller at Linden, SB I-75 ramp, NB I-75 ramp, Ballenger and Linden at Bristol, M-56 Corunna all experience average daily intersection volumes greater than 30,000 vehicles. The remaining intersections have volumes ranging from 13,900 to 28,100 vehicles per day. As would be expected, the larger volumes occur on east and west bound Miller and north and south bound Linden.

The predominate direction of travel on Miller Road west of Linden is east bound, and east of Linden is west bound. On Linden Road the direction of travel is fairly well balanced at the intersection of Miller Road. At the intersections of Linden/Bristol and Linden/Genesee Valley Mall the predominate flow is south bound. For those intersections north of the mall, the major flow is north bound. A few conclusions can be drawn from these travel patterns:

1. A large number of trips that are originating to the west of Linden Road and using Miller Road to access the mall area, are returning by a different route, possibly I-69.
2. Some trips using Miller Road to get to the mall from the east are using a different route on the return trip, again possibly I-69.



1. MILLER @ ELMS
2. MILLER @ DYE
3. MILLER @ LINDEN
4. MILLER @ GENESEE VALLEY MALL
5. MILLER @ LENNON
6. MILLER @ SB I-75 RAMPS
7. MILLER @ NB I-75 RAMPS
8. MILLER @ K-MART
9. MILLER @ BALLENGER
10. BRISTOL @ I-69
11. LINDEN @ BRISTOL
12. LINDEN @ GENESEE VALLEY MALL
13. LINDEN @ LENNON
14. LINDEN @ M-56 CORUNNA

FIGURE II-3

3. This would partially account for the heavy south bound flow on Linden Road between Miller and Bristol.

Further study in the select link analysis portion of this report will address travel patterns in more detail.

Average hourly intersection volumes for each of the signalized intersections within the Miller-Linden Study area are shown in Figures II-4A thru II-4N. Each of these graphs indicate the average hourly approach volume by direction. Most travel within the corridor occurs weekdays between the hours of 8:00 am and 8:00 pm. Peak hours for each approach, and the intersection as a whole, can readily be determined from the graphs.

PEAK HOUR TRAFFIC ANALYSIS

Peak hour traffic flow is the hour within a 24 hour period which experiences the largest volume of traffic on a particular roadway. In an urban area, such as Flint, the peak occurs sometime between the hours of 7:00 am and 9:00 am or between 3:00 pm and 6:00 pm on a typical weekday. This is due largely to the fact that these periods generally contain the greatest number of work trips. A knowledge of peak hour taffic flow contributes to a good understanding of how efficiently a roadway operates under heavily traveled conditions.

Figures II-4A - II-4N illustrates the hourly flow for each intersection and also provide the basis for determining peak hours. Several generalizations can be made from analyzing these graphs. First, the majority of intersections do not exhibit a defined peak hour "point", but rather one or more peak "humps" consisting of two, three or more hours. Within these humps, volumes rarely vary by more than 100 vehicles for any one direction of travel. This pattern is particularly noticeable on the east and west Miller Road approaches and the north and south Linden Road approaches to intersections.

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT BALLENGER ROAD

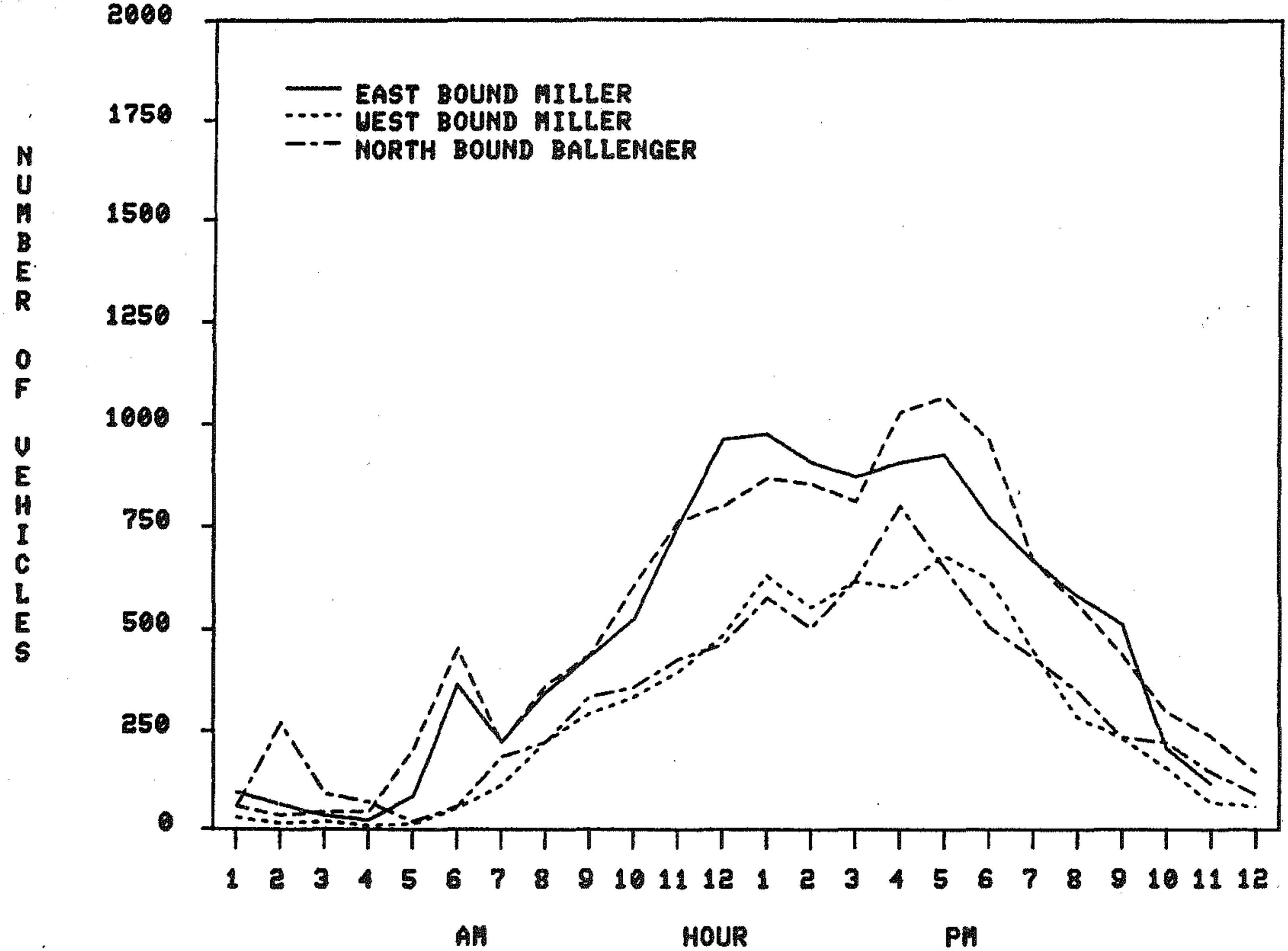


FIGURE II-4A

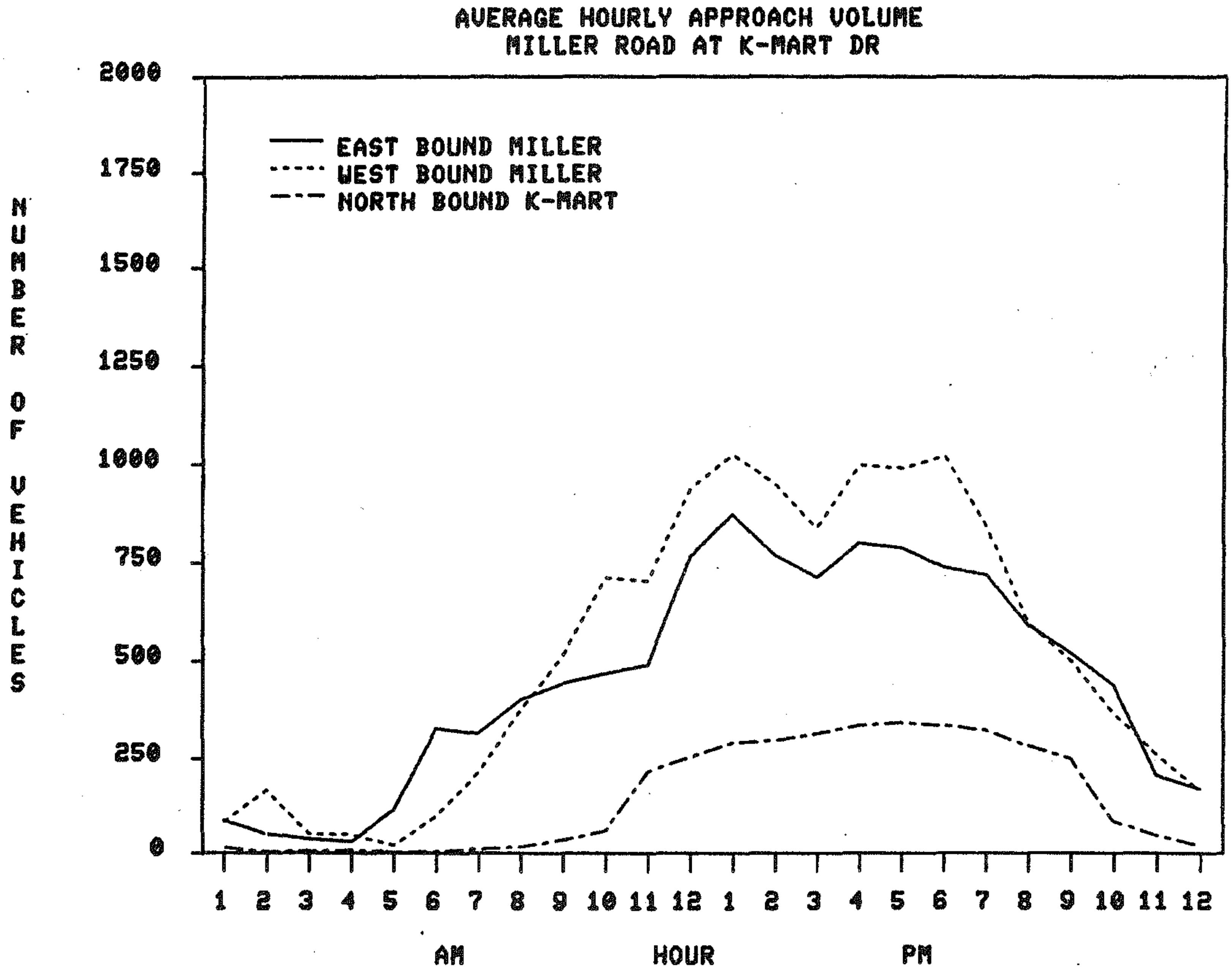

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT K-MART DR
EAST BOUND MILLER
WEST BOUND MILLER
NORTH BOUND K-MART
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4B

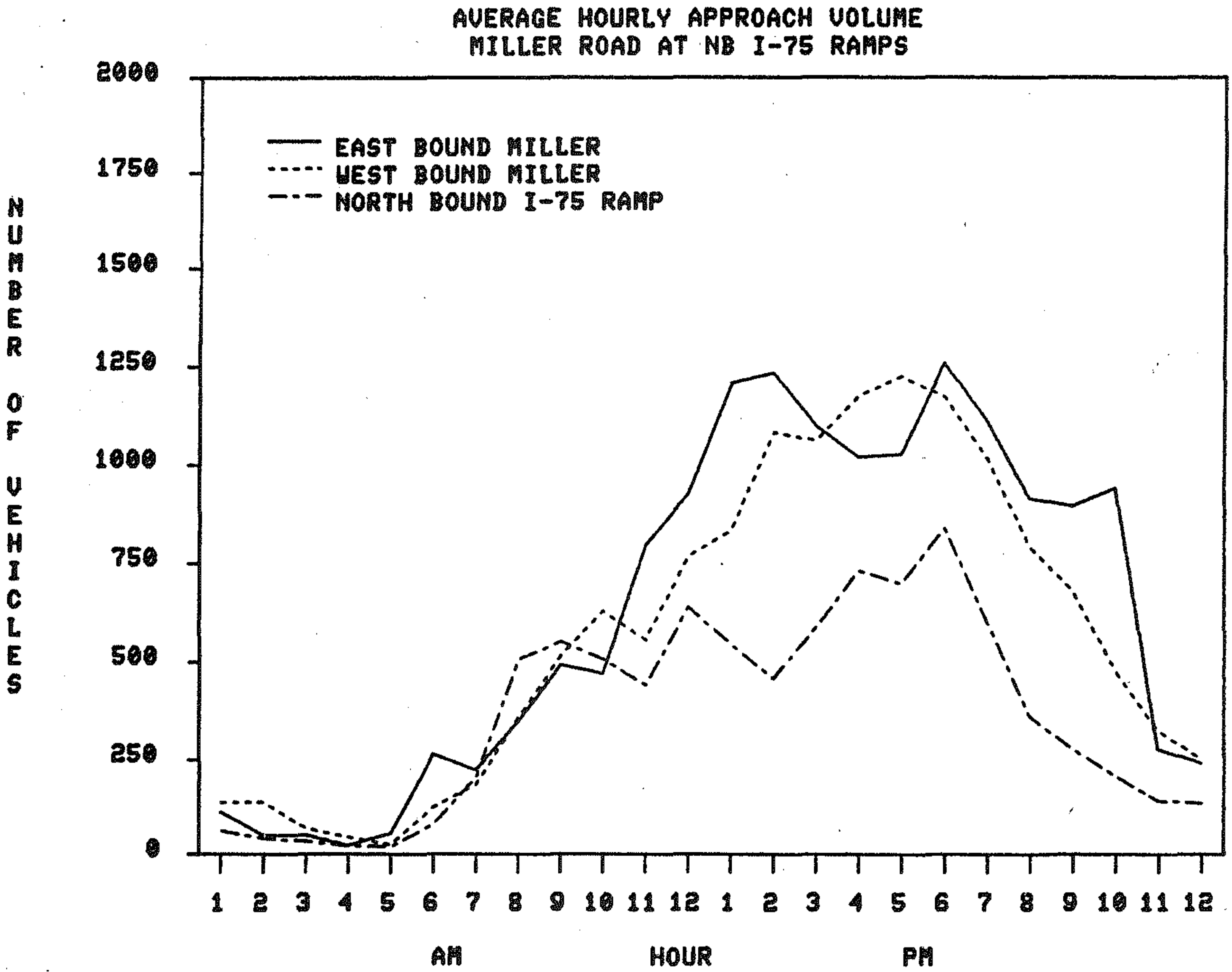

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT NB I-75 RAMPS
EAST BOUND MILLER
WEST BOUND MILLER
NORTH BOUND I-75 RAMP
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4C

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT SB I-75 RAMPS

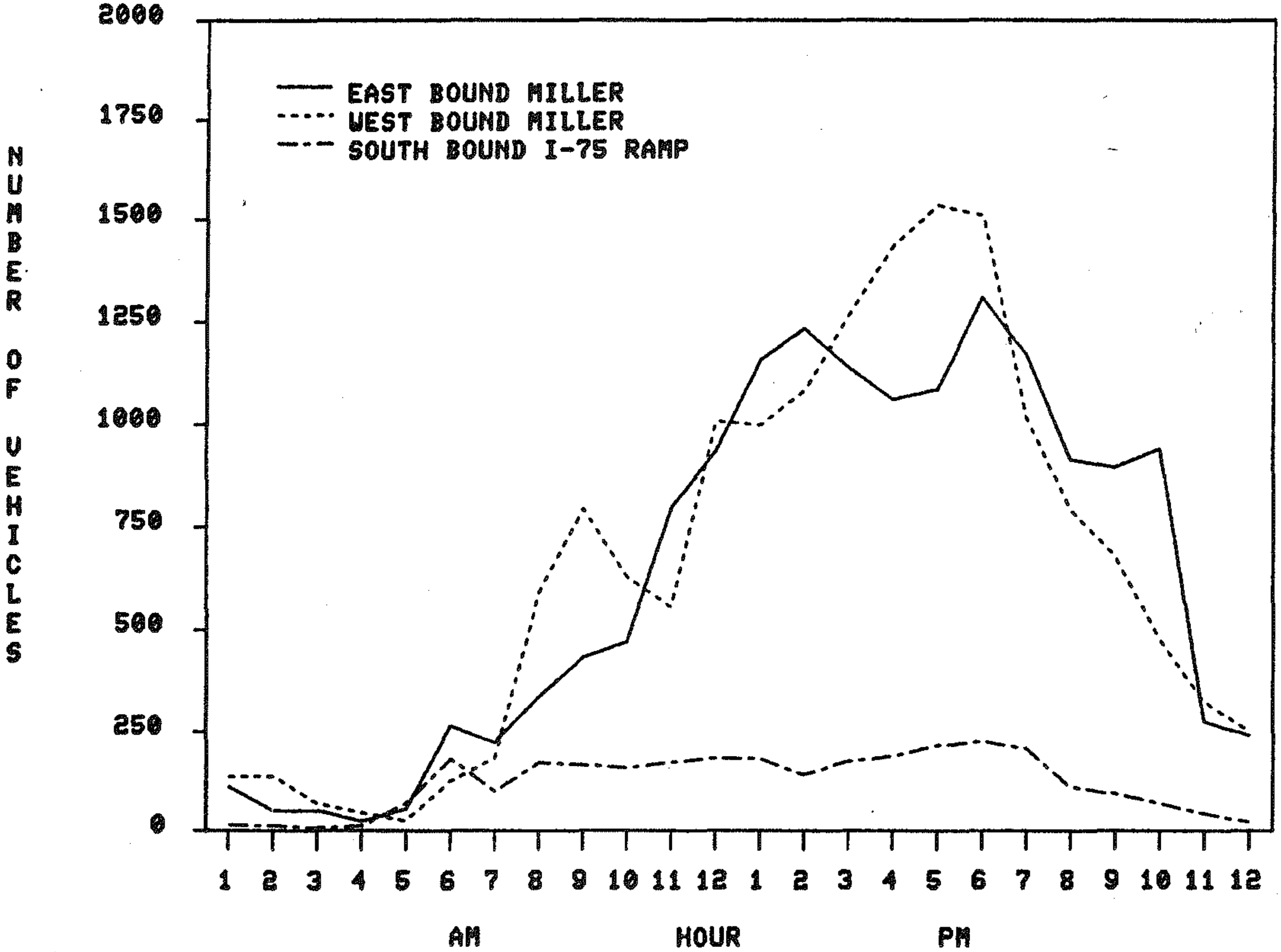


FIGURE II-4D

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT LENNON ROAD

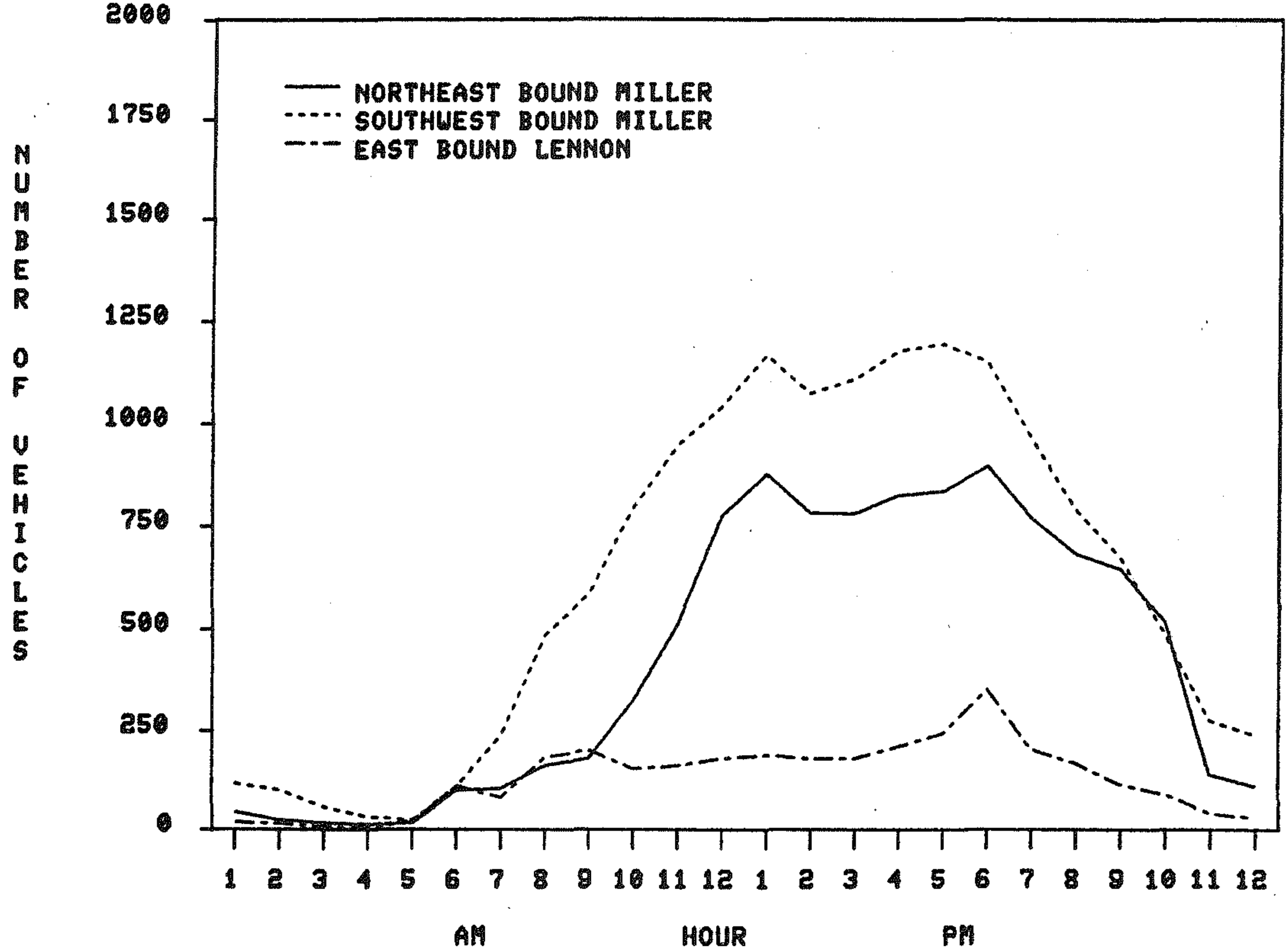


FIGURE II-4E

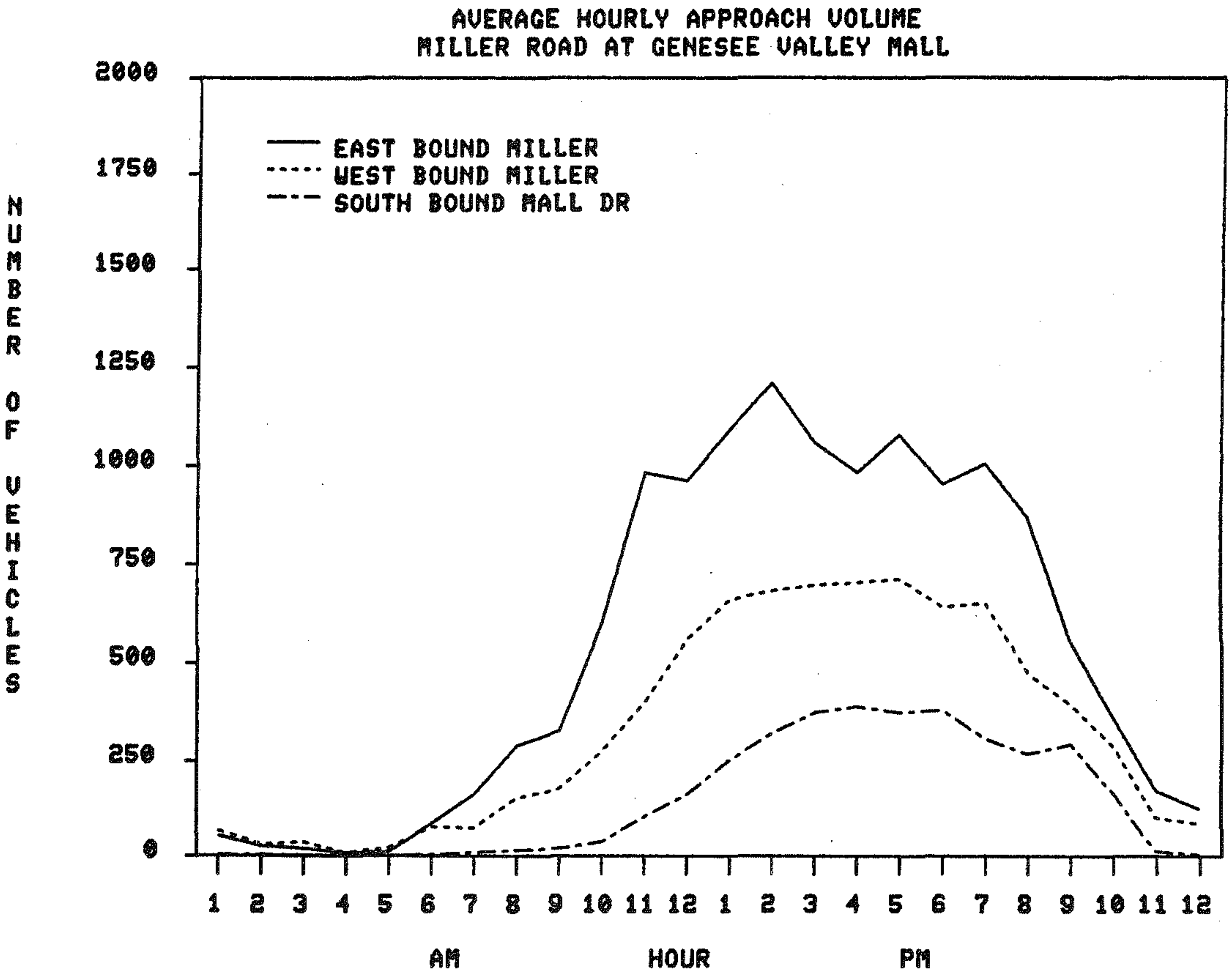

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT GENESEE VALLEY MALL
EAST BOUND MILLER
WEST BOUND MILLER
SOUTH BOUND MALL DR
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4F

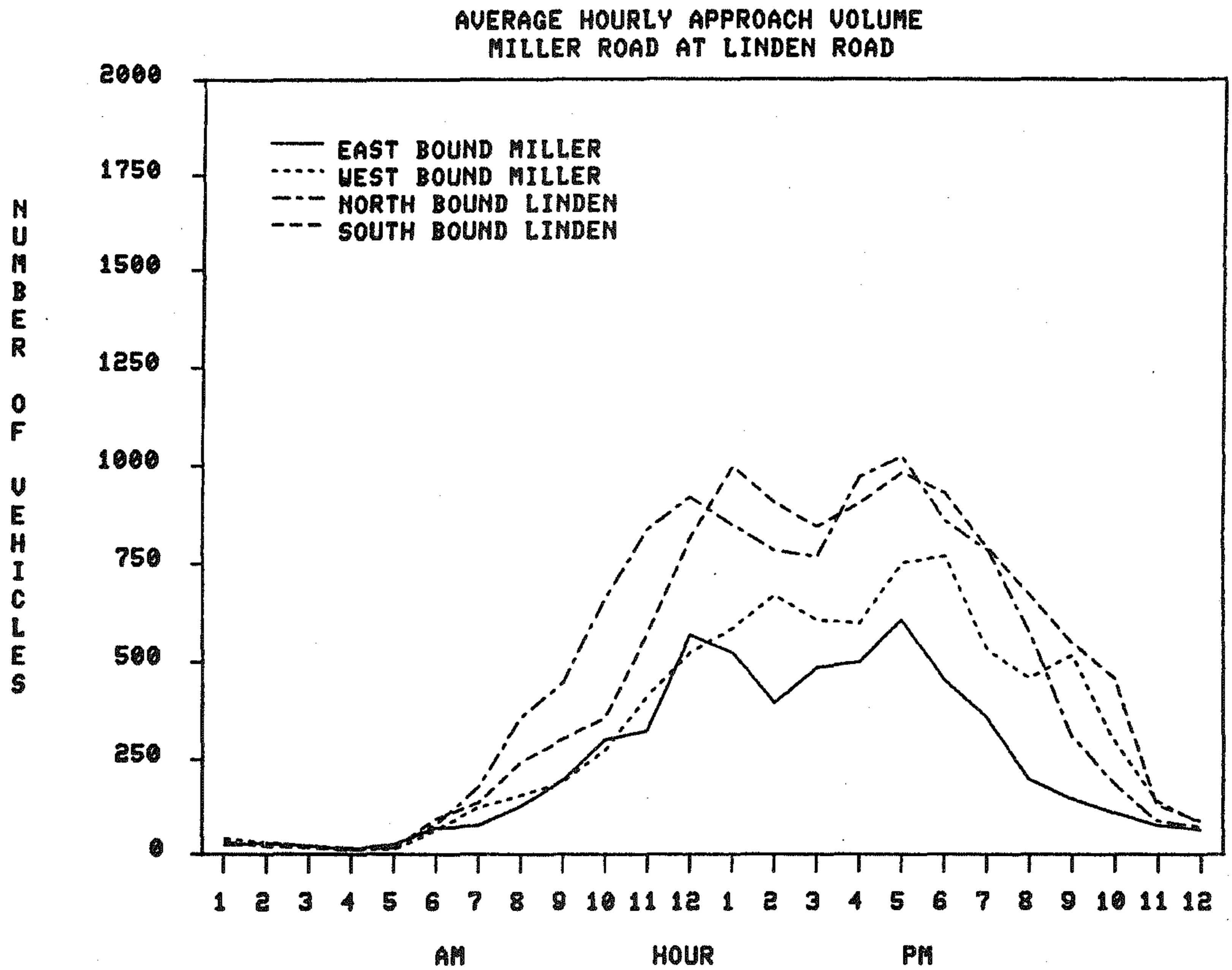

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT LINDEN ROAD
EAST BOUND MILLER
WEST BOUND MILLER
NORTH BOUND LINDEN
SOUTH BOUND LINDEN
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4G

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT DYE ROAD

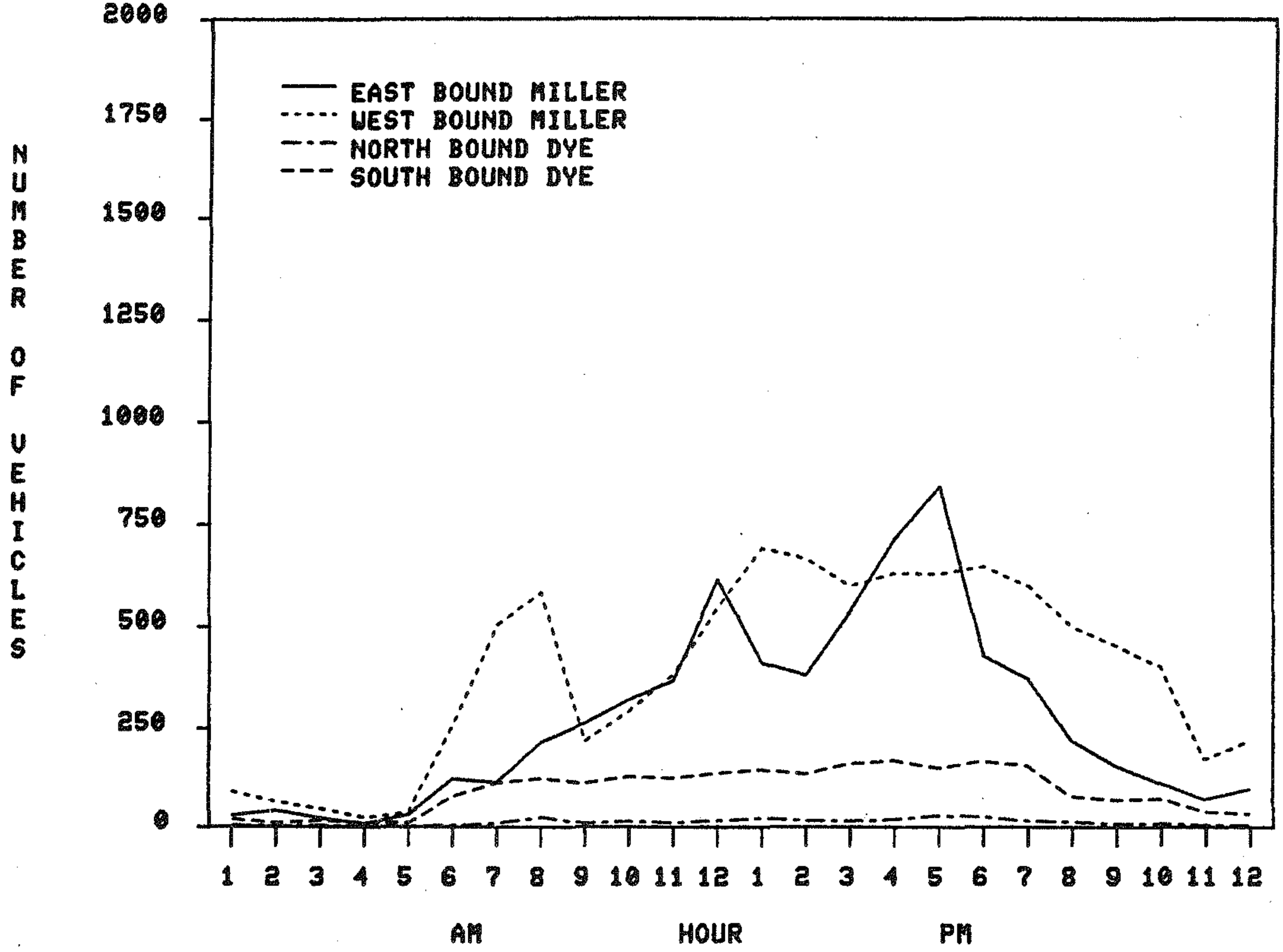


FIGURE II-4H

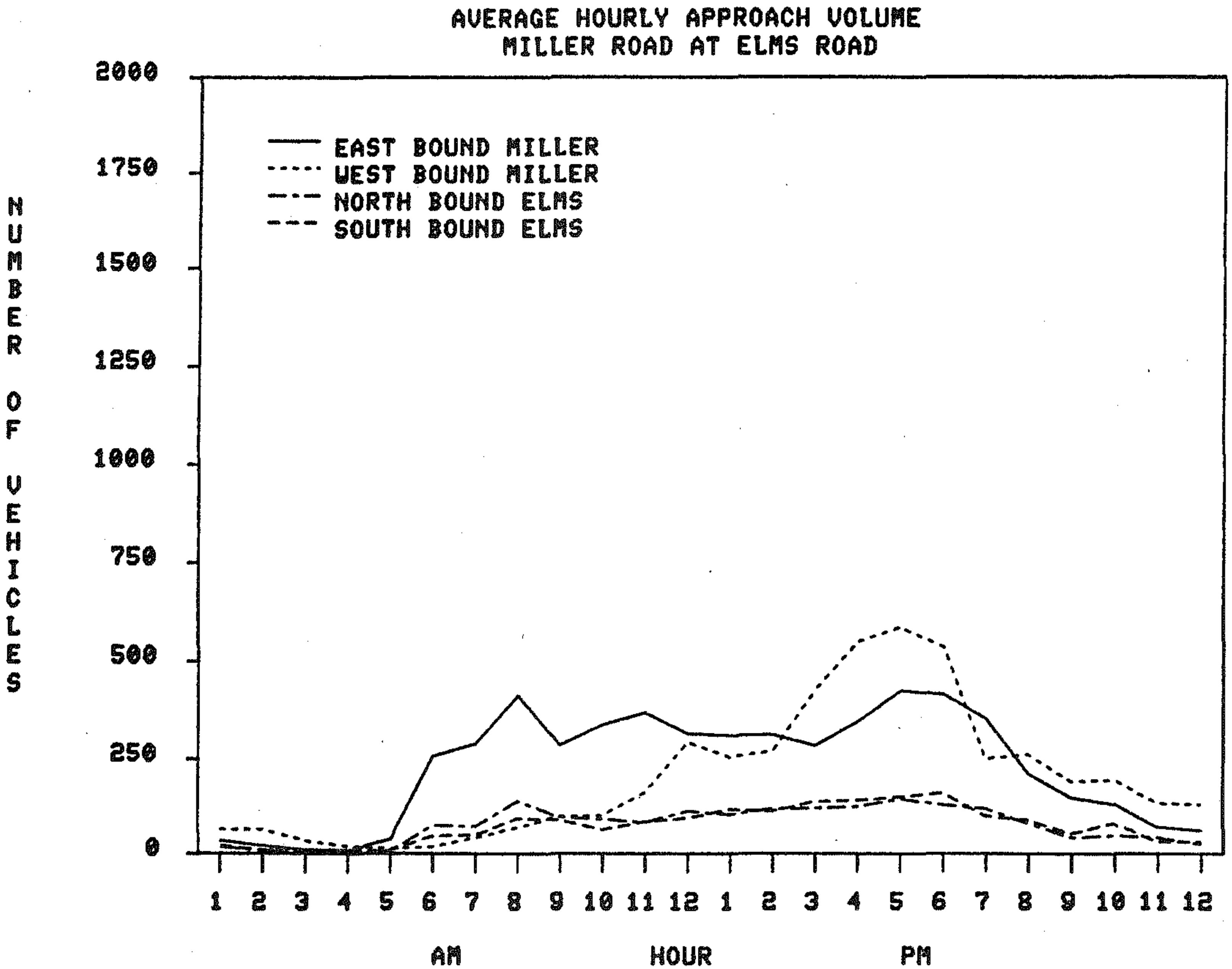

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT ELMS ROAD
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
EAST BOUND MILLER
WEST BOUND MILLER
NORTH BOUND ELMS
SOUTH BOUND ELMS
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-41

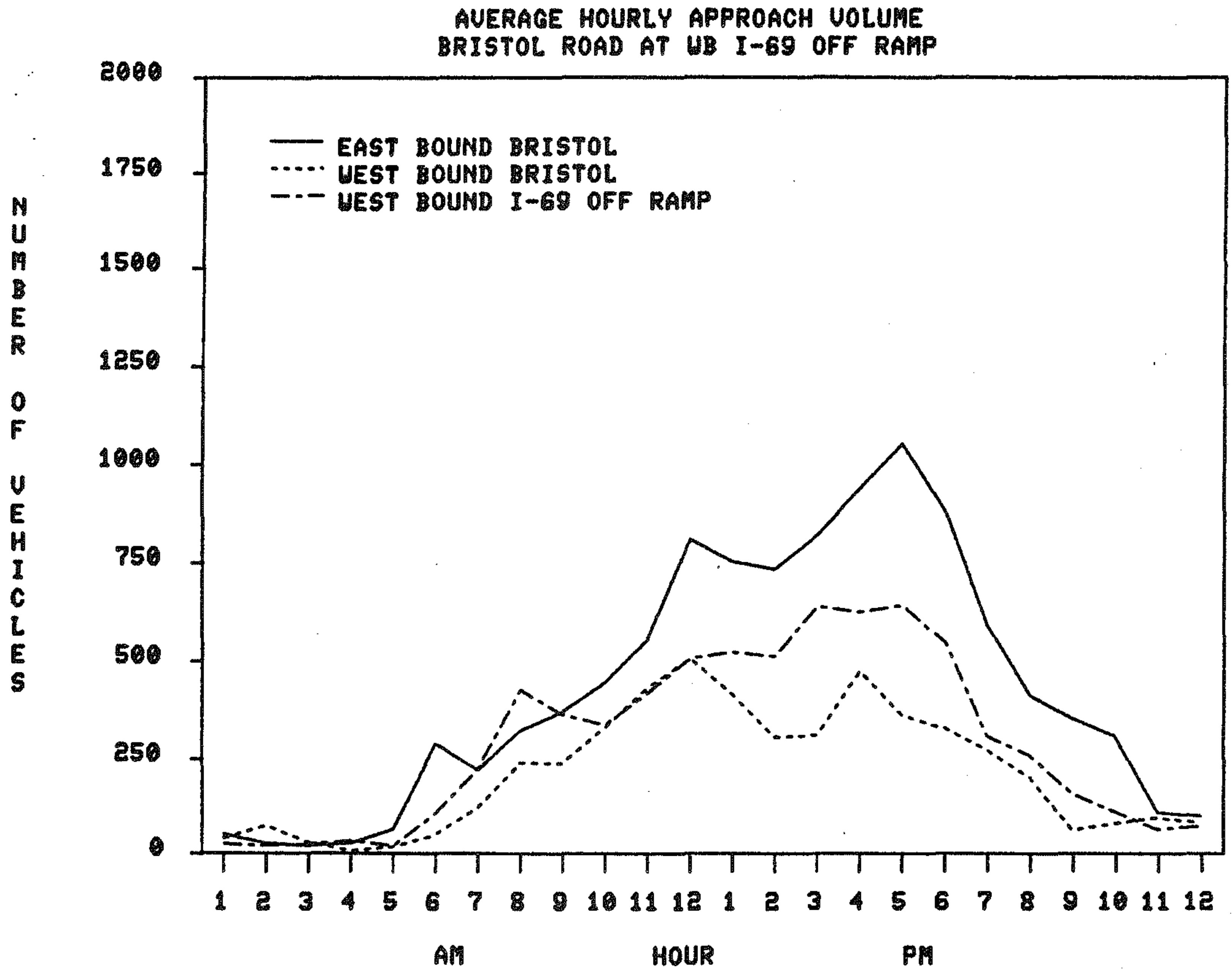

AVERAGE HOURLY APPROACH VOLUME
BRISTOL ROAD AT WB I-69 OFF RAMP
EAST BOUND BRISTOL
WEST BOUND BRISTOL
WEST BOUND I-69 OFF RAMP
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4J

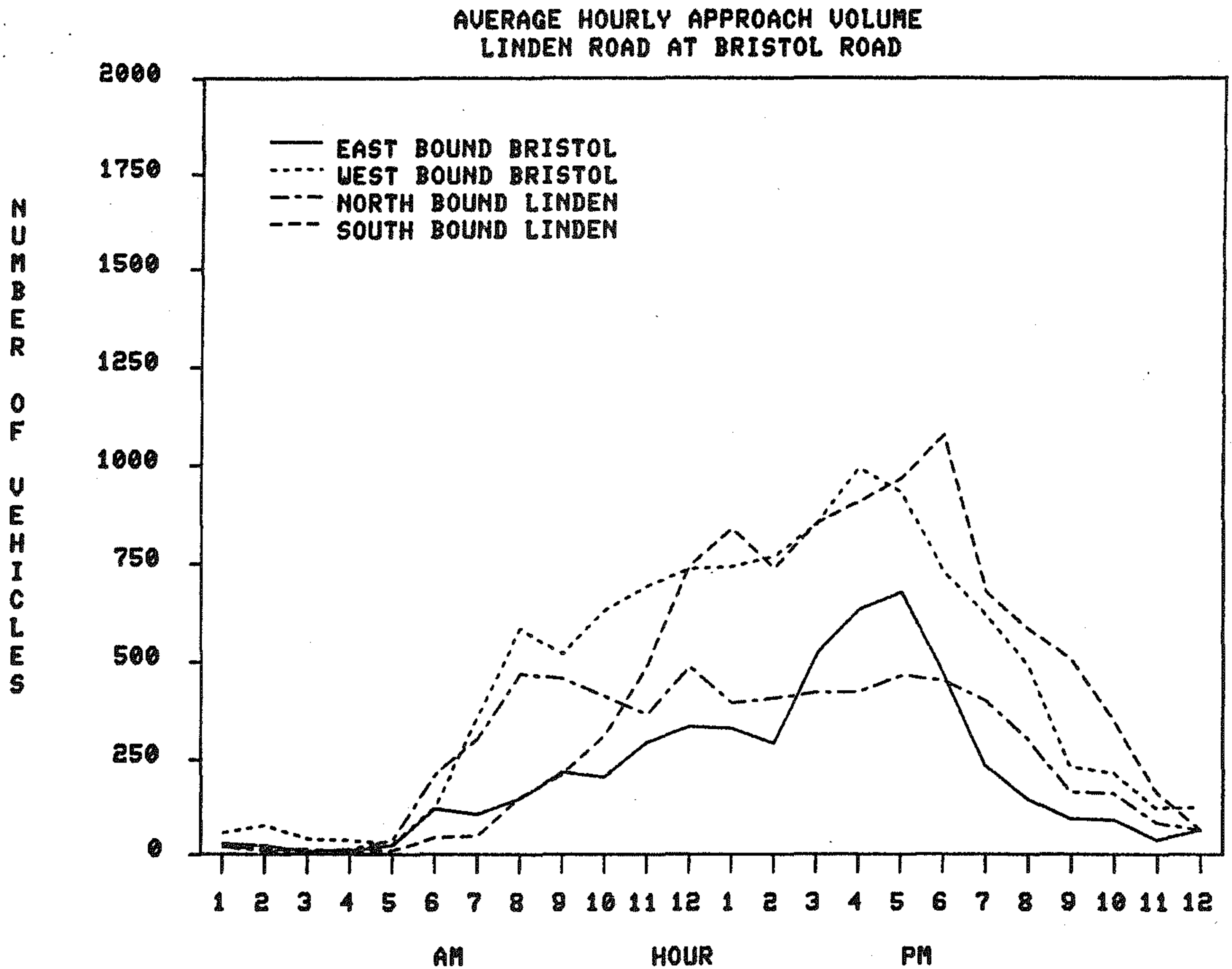

AVERAGE HOURLY APPROACH VOLUME
LINDEN ROAD AT BRISTOL ROAD
EAST BOUND BRISTOL
WEST BOUND BRISTOL
NORTH BOUND LINDEN
SOUTH BOUND LINDEN
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4K

AVERAGE HOURLY APPROACH VOLUME
LINDEN ROAD AT GENESEE VALLEY MALL

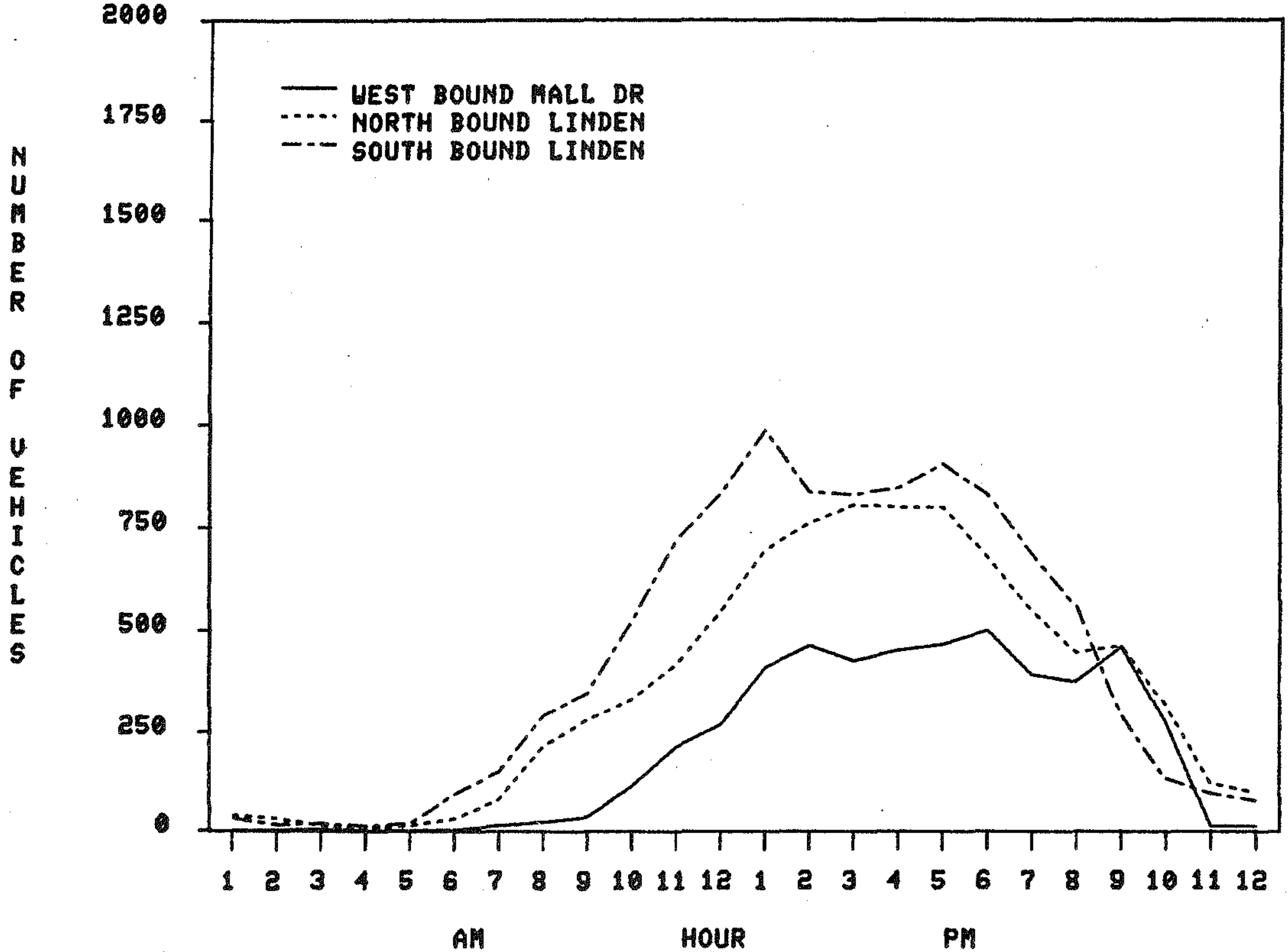


FIGURE II-4L

AVERAGE HOURLY APPROACH VOLUME
LINDEN ROAD AT LENNON ROAD

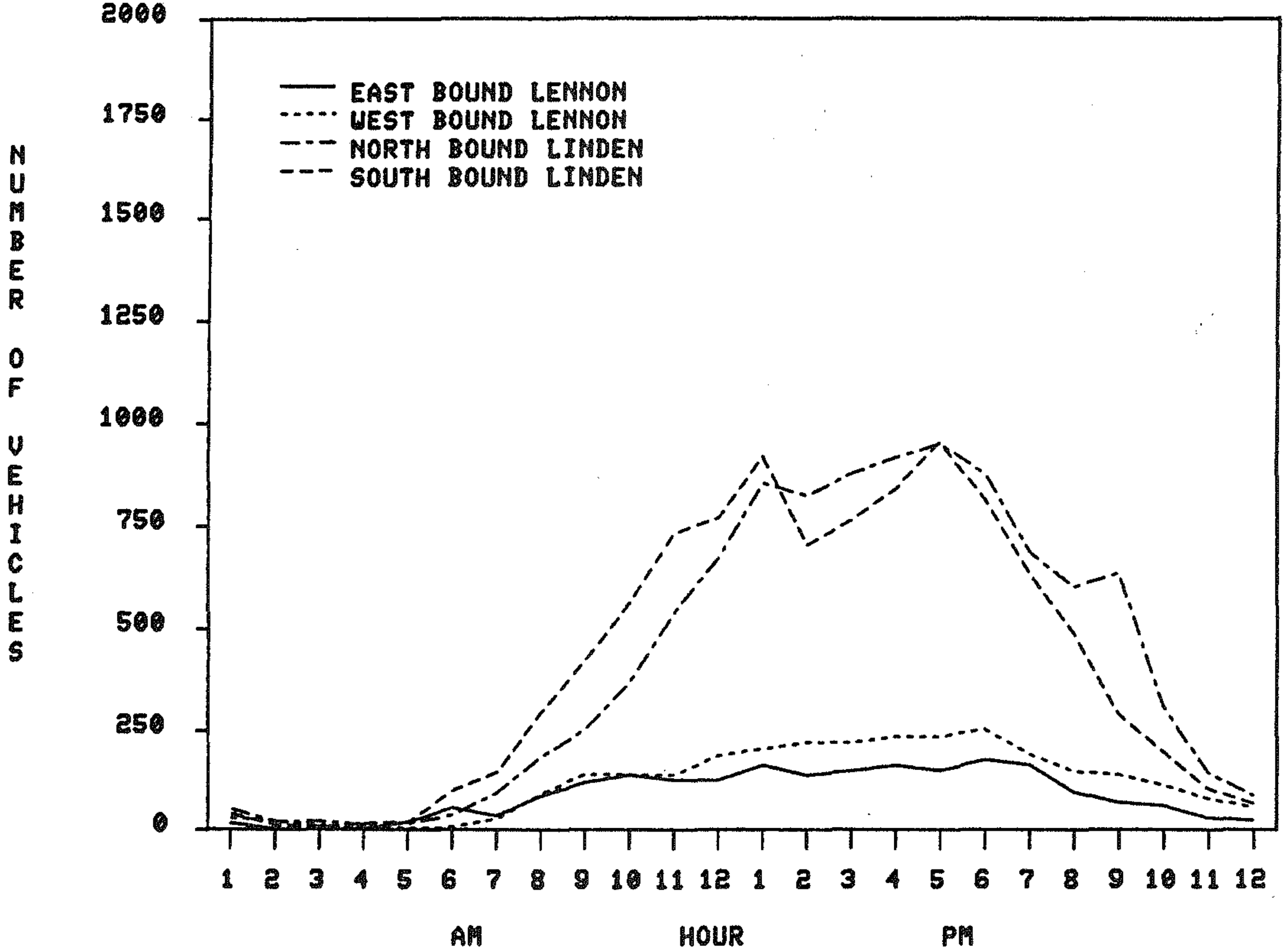


FIGURE II-4M

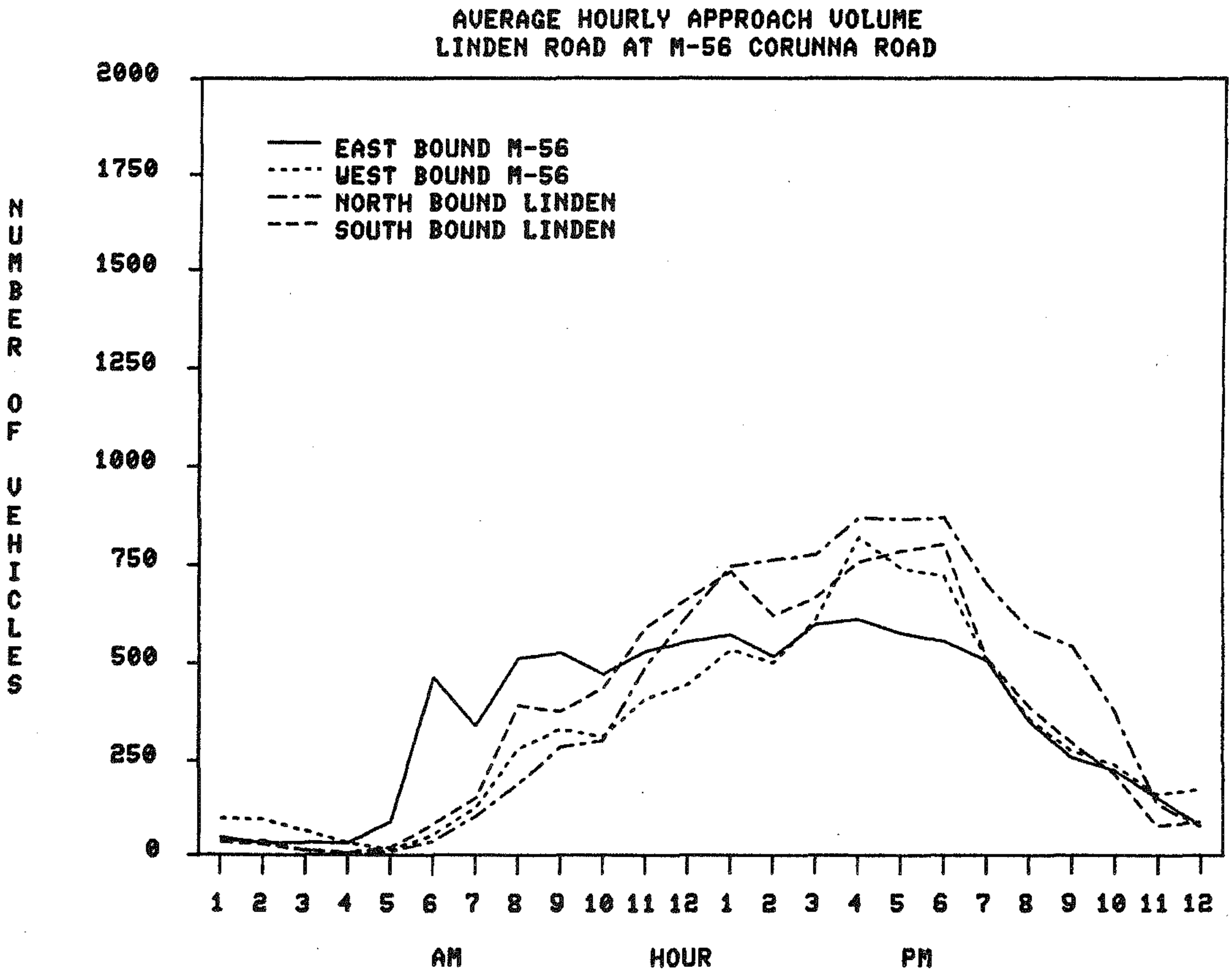

AVERAGE HOURLY APPROACH VOLUME
LINDEN ROAD AT M-56 CORUNNA ROAD
EAST BOUND M-56
WEST BOUND M-56
NORTH BOUND LINDEN
SOUTH BOUND LINDEN
NUMBER OF VEHICLES
2000
1750
1500
1250
1000
750
500
250
0
1 2 3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10 11 12
AM
HOUR
PM

FIGURE II-4N

Another observation is that the directional volumes on both Miller and Linden Roads seem to have the same peak humps. This condition might be an indication that these roads are used less for work trip purposes and more for shopping/personal business. Trip purpose is addressed in detail within the corridor travel patterns section of this report.

Based on total intersection volume, peak hours and periods can be summarized on a road segment basis as follows:

Miller Road between Ballenger and K-Mart

Peak Period	12-5 pm
Highest Peak Hour	4-5 pm

Miller Road between NBD I-75 ramps and Lennon

Peak Period	1-6 pm
Highest Peak Hour	5-6 pm

Miller Road between Genesee Valley Mall and Linden

Peak Period	12-7 pm
Highest Peak Hour	4-5 pm

Miller Road between Dye and Elms

Peak Period	3-6 pm
Highest Peak Hour	4-5 pm

M-121 Bristol at I-69

Peak Period	2-6 pm
Highest Peak Hour	4-5 pm

Linden Road between Bristol and Genesee Valley Mall

Peak Period	12-6 pm
Highest Peak Hour	4-5 pm

Linden at Lennon

Peak Period	12-6 pm
Highest Peak Hour	5-6 pm

Linden at M-56 Corunna

Peak Period	2-6 pm
Highest Peak Hour	3-4 pm

VEHICLE MILES OF TRAVEL ANALYSIS

The State of Michigan, and Genesee County both have historically shown a pattern of travel growth from year to year with few exceptions over the past several decades. The projection of future travel volumes on all major streets and roads within Genesee county is possible by utilizing areawide demand estimation modeling techniques. For Genesee County, MDOT has developed a county-wide transportation systems model. Future travel volumes are based on population, employment and other socio-economic projections developed by the Genesee County Metrpolitan Planning Commission (GCMPC). Increases (or decreases) in travel over a period of time are measured in terms of "vehicle miles of travel" (VMT). This VMT measurement is an estimate of the collective sum of all the daily travel in an area multiplied by the total distance over which it travels. VMT provides a realistic, weighted measure of travel. Use of the systems model provides simulation of both the existing and future VMT.

In analyzing the Miller-Linden corridor, it is important to compare the existing and projected VMT for the corridor study area with that of the entire county. This will provide an indication as to whether travel will continue to increase within the corridor at the same or greater rate as that of the county as a whole. This comparison provides the means by which to evaluate and anticipate traffic problems and formulate workable solutions.

COMPARISON OF MILLER ROAD AREA TO GENESEE CO. SYSTEM

The following table summarizes the existing and projected VMT for the years 1980, 1984 and 2005. The future figures were derived from the transportation modelling process and are based on the extension of past and present travel patterns, growth patterns, and personal mobility trends within Genesee County.

Area	1980 VMT	% of TOTAL	1984 VMT	% of TOTAL	2005 VMT	% of TOTAL	% 1980/ 1984	% 1980/ 2005
Total System	7,940,105	100%	8,257,709	100%	9,839,886	100%	+ 4.0%	+24.0%
Corridor	386,677	4.9%	455,626	5.5%	523,381	5.3%	+17.8%	+35.4%
Miller Road	74,695	.9%	91,818	1.1%	118,457	1.2%	+23.0%	+58.6%
Linden Road	40,999	.5%	52,480	.6%	81,365	.8%	+28.0%	+98.5%

These figures indicate a 24% increase in travel within Genesee County as a whole by the year 2005. The corridor, on the other hand, shows a much faster (35%) rate of growth for the same period. The VMT figures also show that the corridor's share of the total VMT will increase from 4.9% to approximately 5.3% by the year 2005.

Within the corridor boundaries both Miller and Linden Roads show substantial increases in VMT by the year 2005. Miller Road's VMT is expected to grow by 58% (23% of which has occurred since 1980) and Linden by 98% (28% of which has occurred since 1980). Figure II-5 illustrates the VMT growth rates. These rates of increase will impose further pressure on portions of the corridor which are presently experiencing travel congestion and delays.

CUTLINE ANALYSIS

Cutline* analysis is used to study the impacts that projected increase in travel will have on a corridor. Cutlines were established on the corridor boundary roads and were used to determine the direction from which the greatest amount of VMT was entering the corridor. This provides an

*an imaginary line(s) placed across a corridor to intercept all traffic on roadway segments in the corridor. The imaginary line "cuts" across the corridor and VMT are then summed and compared with the other perimeter cutlines.

VEHICLE MILES OF TRAVEL (VMT) GROWTH COMPARISON
MILLER/LINDEN CORRIDOR VS GENESEE COUNTY

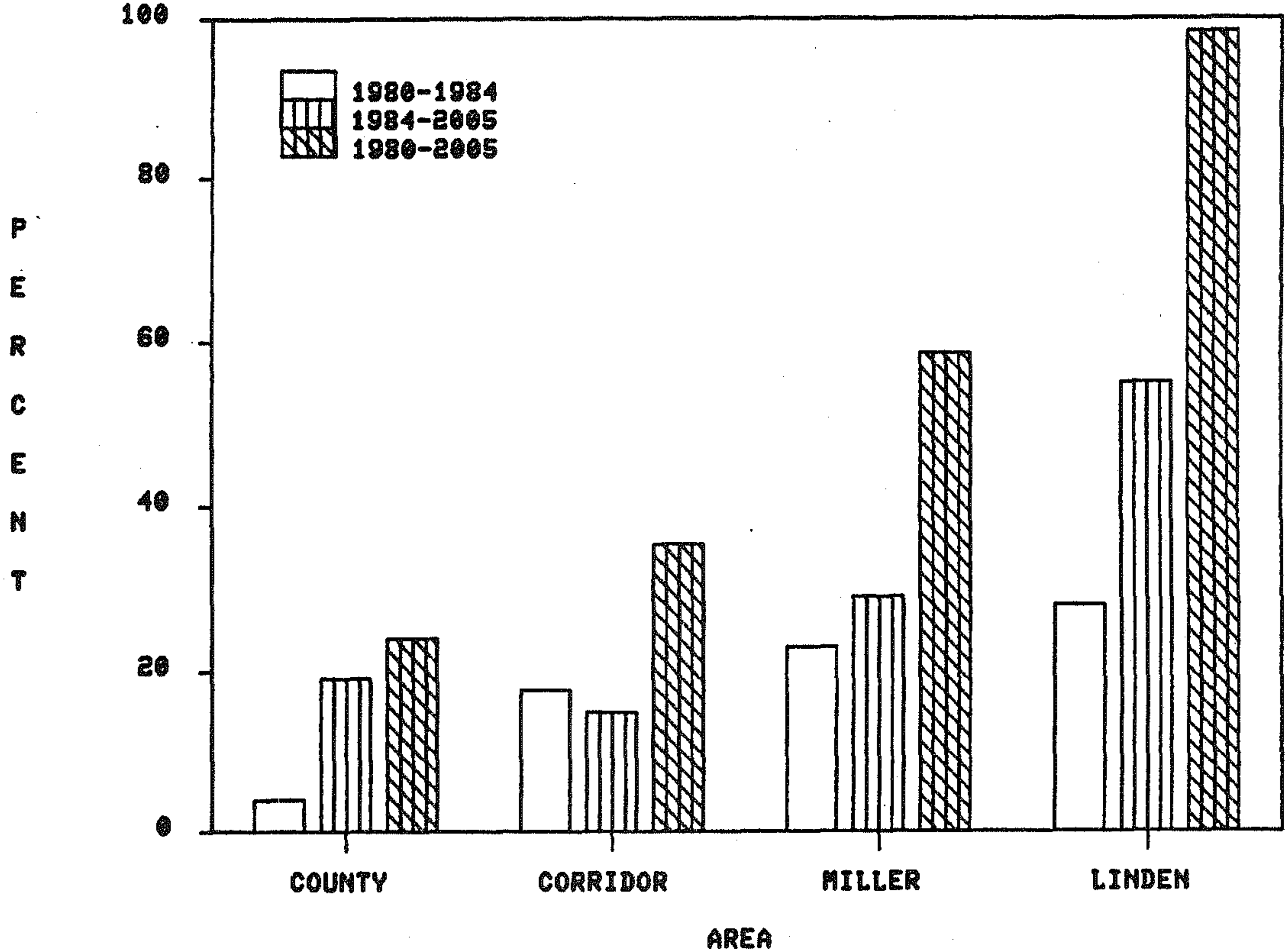


FIGURE II-5

indication of external growth areas which will impact the corridor. A comparison of the 1984 and 2005 VMT entering the corridor indicates that the greatest percent increase that will be from the south (66%) and west (44%). VMT entering the corridor from the north and east show smaller increases (23% and 25% respectively) over the 21 year period. Figure II-6 illustrates the percent increase in VMT entering the corridor from all four directions.

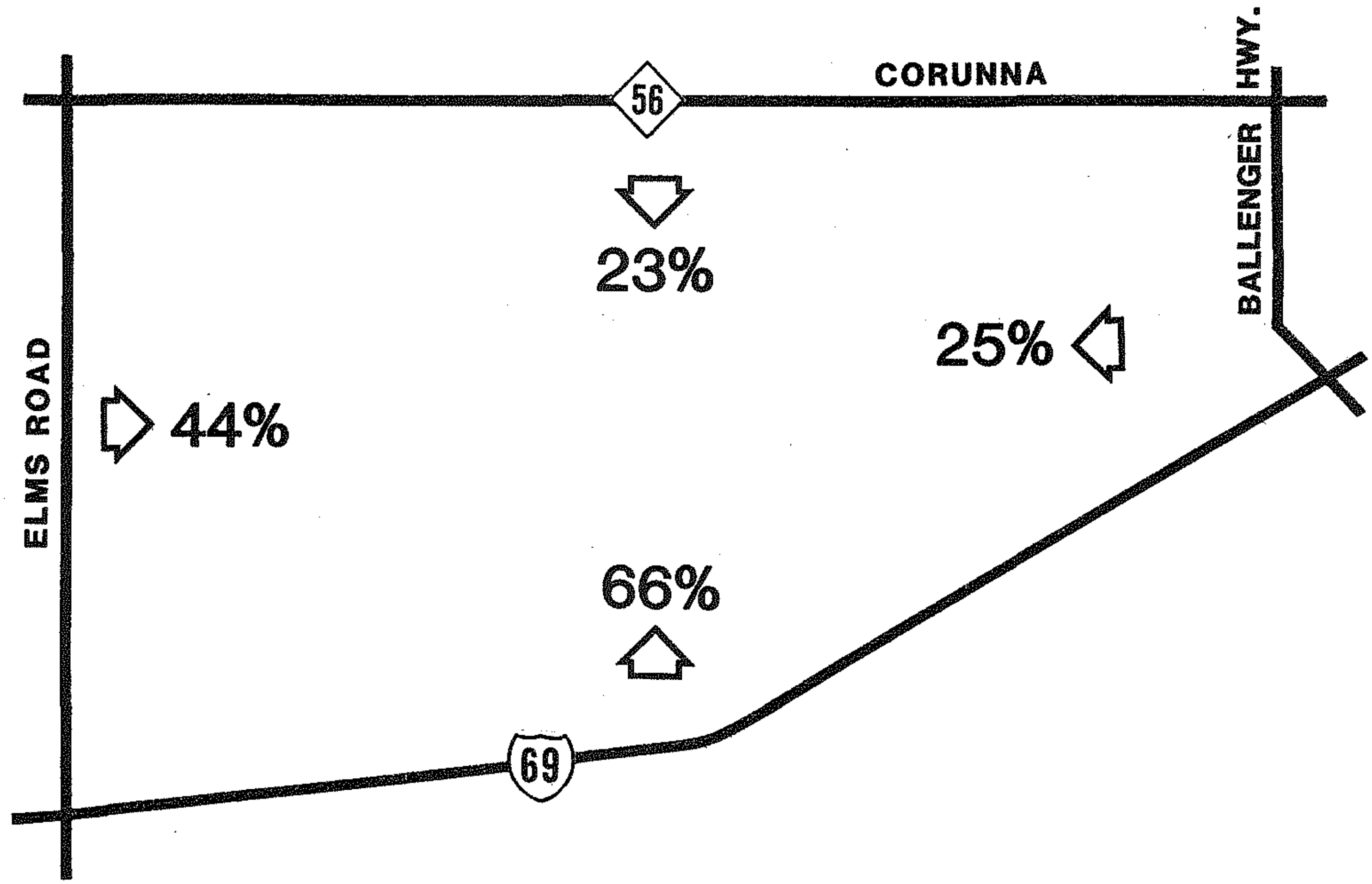
This comparison shows that as development occurs to the south and west of the corridor a tremendous increase in VMT into the study area will occur. Even though areas to the north and east are for the most part developed, substantial VMT growth will still occur because of the retail attractiveness within the corridor. As more retail development occurs within the corridor, it is reasonable to assume that more shopping/recreational trips will be diverted or shifted from other locations within the Flint Metropolitan Area.

SUMMARY

The Miller Road Study Area should continue to grow in traffic volumes and gradually expand its share (4.9% to 5.3%) of the total VMT generated within Genesee County.

Realizing that future fluctuations in the local, state and national economies could impact the above VMT numbers, it is expected that daily travel will fall near these figures by the year 2005.

A thorough analysis of existing and future capacities for both roadway and intersections is necessary to understand the impacts the additional VMT will have within the corridor.



PERCENT INCREASE IN VMT
ENTERING THE CORRIDOR STUDY AREA
(1984-2005)

FIGURE II-6

ANALYSIS OF
CORRIDOR TRAVEL PATTERNS

ANALYSIS OF CORRIDOR TRAVEL PATTERNS

INTRODUCTION

To fully understand how the transportation network within the Miller-Linden Corridor serves the area, a knowledge of several travel characteristics is necessary. Analysis of the type of travel, trip origins and destinations and the average trip length are essential. This information is often difficult to ascertain because of the vast system of streets and roads over which travel is dispersed. Adding further complexity is the fact that any particular day represents a unique collection of individual trips throughout this system. Some trips are routine and quite predictable, such as work-trips, while others are more spontaneous and constantly changing from day to day.

MDOT's Genesee County Transportation Systems Model was used to generate most of the analysis data used in this section. The model simulates average weekday travel for major roads within the county. By focusing on the roadway segments (or links) within the corridor, travel paths (select links), travel times (average trip length) and origins/destinations (trip end summary) of trips using the corridor can be analyzed. This section discusses these three elements.

SELECT LINK ANALYSIS

Select link analysis is a valuable tool for illustrating the service area of a particular roadway. The process determines which trips in the system use "selected" network links and highlights areas which contribute to traffic on a segment of road. The process is also useful in estimating average trip length and trip ends which use the select links. The following four links along Miller and Linden Roads were chosen to reflect the travel patterns within the corridor:

1. Miller Road West of Lennon Road

2. Miller Road East of Dye Road

3. Linden Road North of Miller Road

4. Linden Road South of Lennon Road

Computer generated band width plots were developed for the four select links showing the amount of trips and the travel patterns using each selected link. Exhibits III-1, III-2, III-3 and III-4, graphically illustrate these patterns (the wider the band, the greater the volume). A brief synopsis of travel over each respective select link is provided below.

SELECT LINK 1 - MILLER ROAD EAST OF GENESEE VALLEY MAIL

The major access of trips to this portion of roadway is by means of both north and south bound I-75. A fair amount of travel is coming from outside the county; Livingston to the south and Saginaw to the north via this route. Other roads contributing directly to travel on this link are Miller Road to the east of I-75 and Ballenger Road north of Miller. Overall trips using this link are predominantl coming from the city of Flint to the east and I-75 to the north and south. Few, if any, through trips are using this link.

SELECT LINK 2 - MILLER ROAD EAST OF DYE ROAD

This plot shows that practically all areas whithin the county and a few outside contribute to travel on this link. Roads providing the greatest share of trips are I-69, M-121 (Bristol Road), and Linden Road. Again, trips are coming from outside the county, mainly from the west, south and east. Some through trips are utilizing the link, however the majority are going to or coming from areas around the Genesee Valley Mall.

SELECT LINK 3 - LINDEN ROAD NORTH OF MILLER ROAD

Trips on this link originating from outside the corridor access Linden mainly by way of Miller, I-69, M-121 (Bristol), Corunna, Beecher, Flushing and Pierson Roads. A small amount of trips originate or end with neighboring counties (Shiawassee, Saginaw, Tuscola, Lapeer, Oakland and Livingston). The bulk of the travel using this link occurs between Beecher Road to the north and I-69 on the south end. Although most of the trips would appear to be local there is a greater percentage of through trips on this link than on Miller Road.

SELECT LINK 4 - LINDEN ROAD SOUTH OF LENNON ROAD

Travel patterns on this link are similar to those discussed above. The main difference is that the area east of I-75 and south of I-69/ M-21 does not contribute to travel on this link. The north-west and south-west portions of the county are the major service areas. Again a substantial amount of total trips on the link are local in nature with most travel occurring between I-69 and Flushing Road. This link also has a greater percentage of through trips than the Miller Road select links.

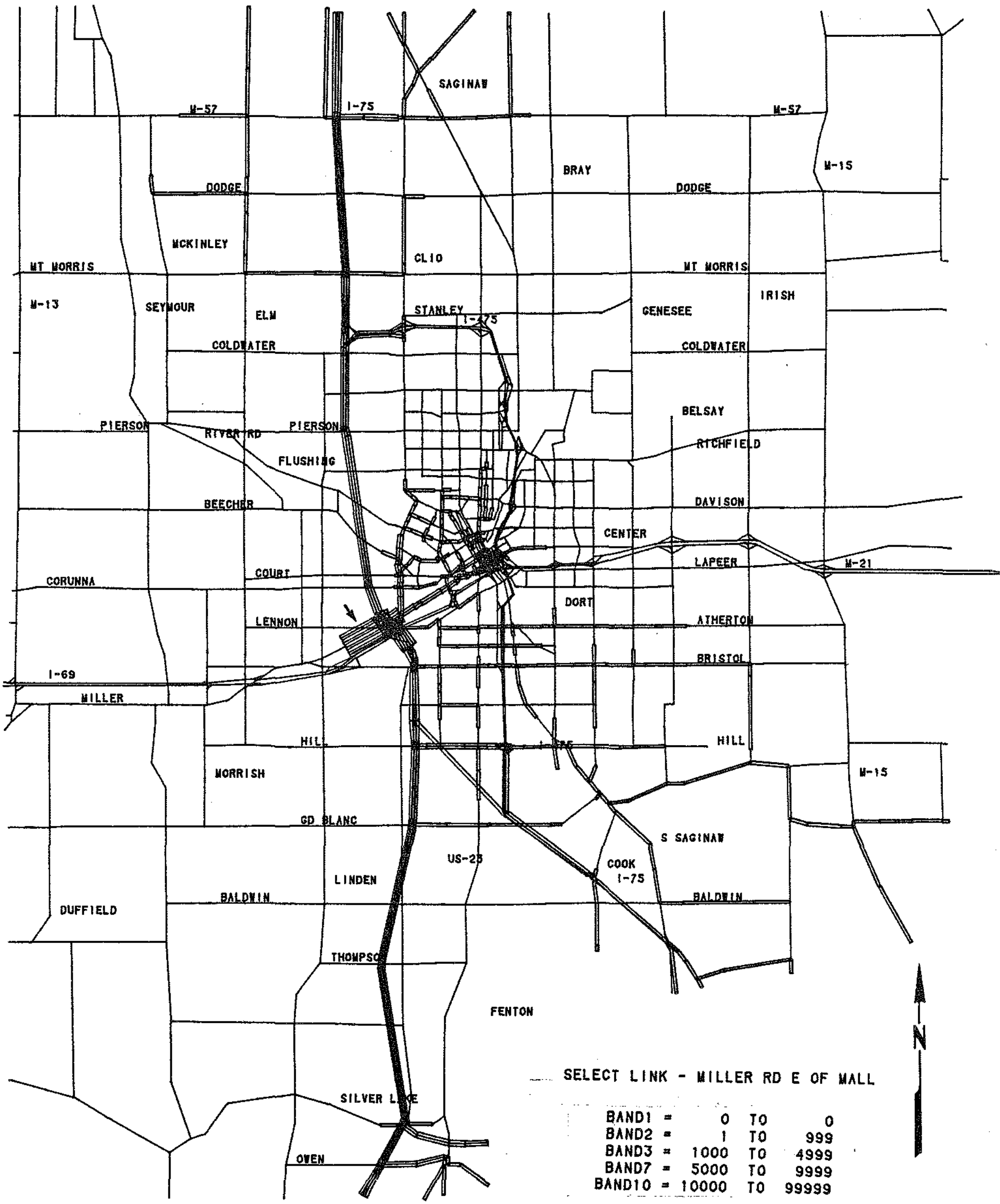


EXHIBIT III-1

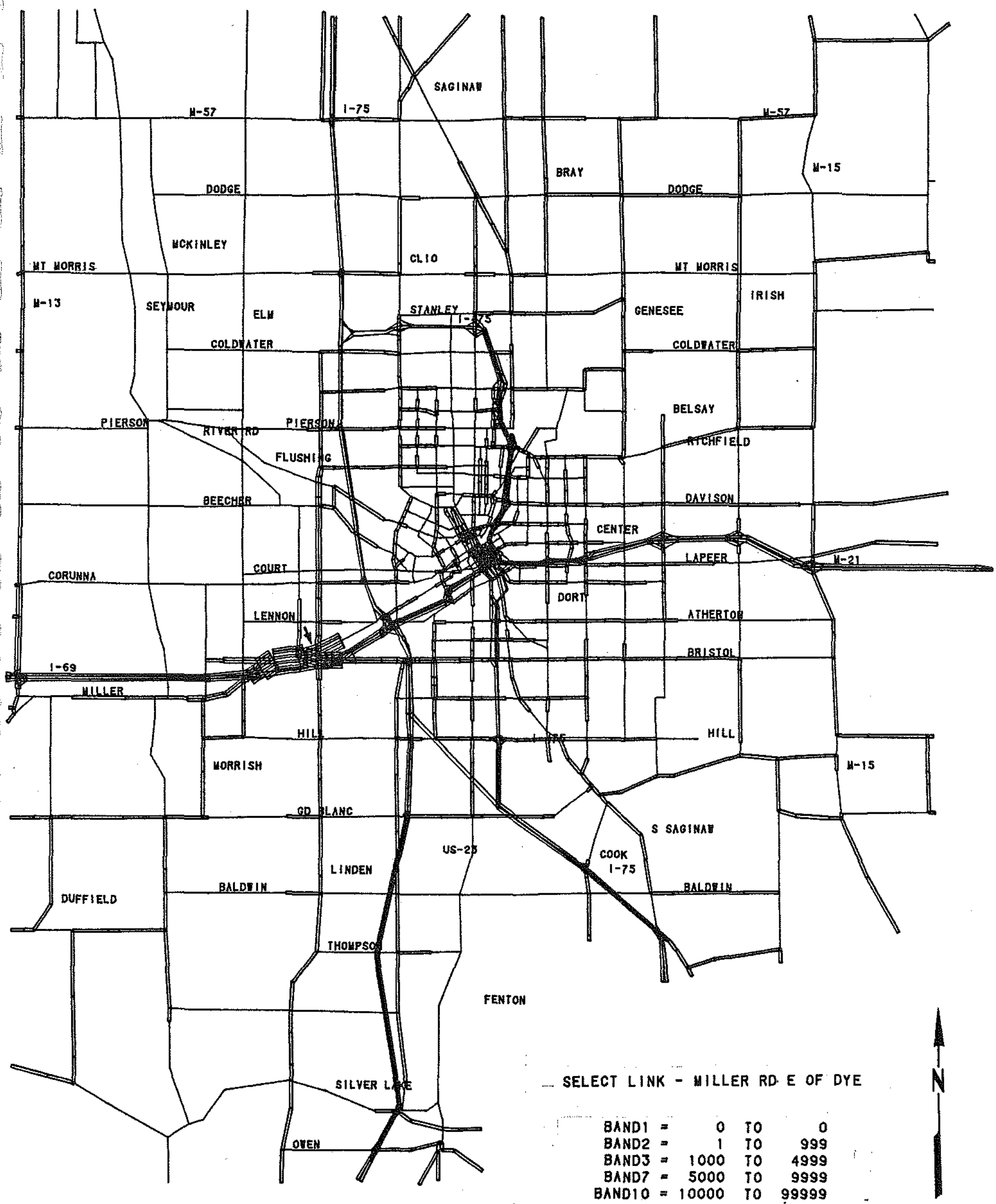
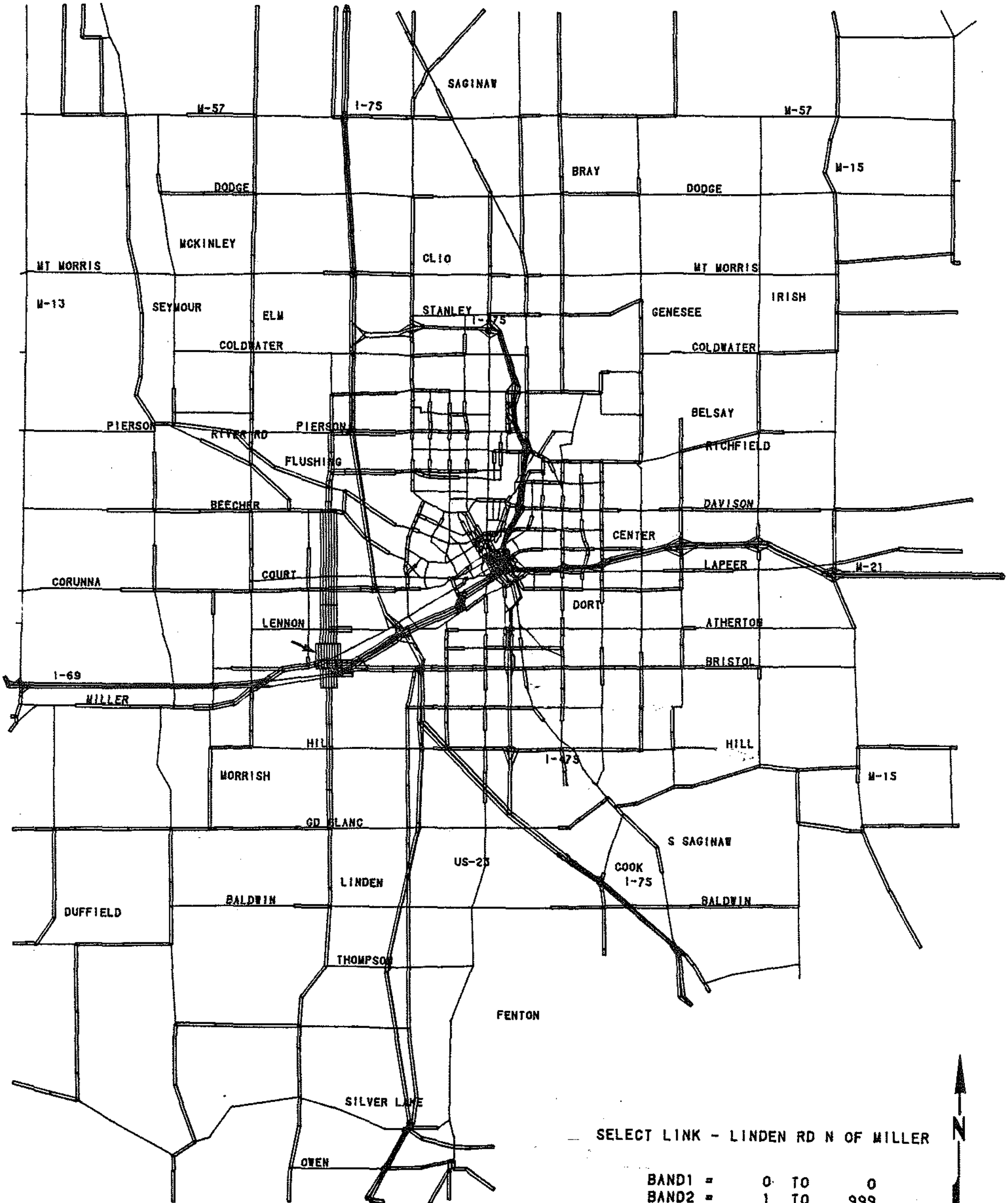


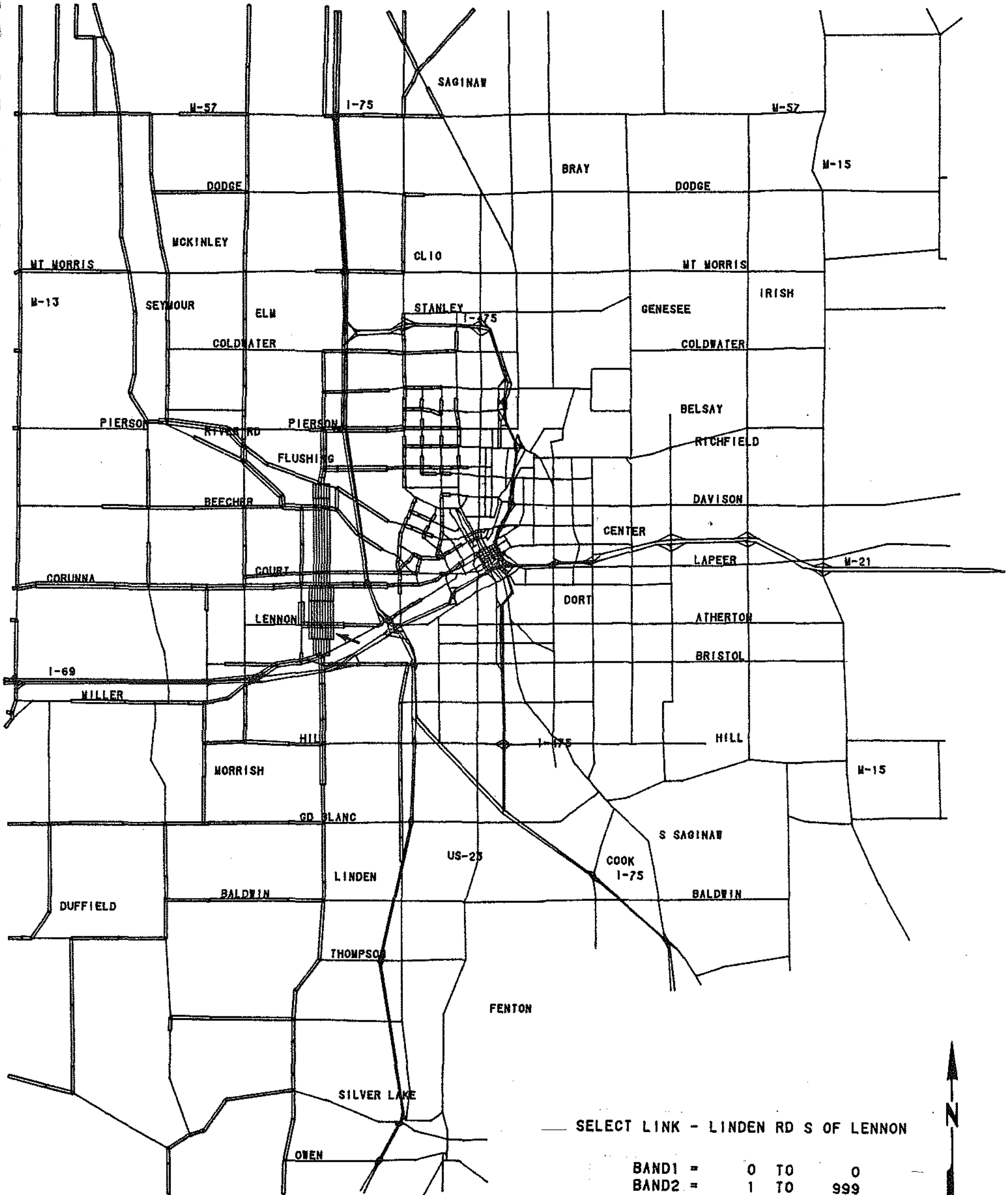
EXHIBIT III-2



SELECT LINK - LINDEN RD N OF MILLER

BAND1	=	0	TO	0
BAND2	=	1	TO	999
BAND3	=	1000	TO	4999
BAND7	=	5000	TO	9999
BAND10	=	10000	TO	99999

EXHIBIT III-3



SELECT LINK - LINDEN RD S OF LENNON

BAND1 =	0	TO	0
BAND2 =	1	TO	999
BAND3 =	1000	TO	4999
BAND7 =	5000	TO	9999
BAND10 =	10000	TO	99999

EXHIBIT III-4

AVERAGE TRIP LENGTH

In conjunction with the select link analysis portion of the study, a knowledge of the average travel times for trips using various portions of the corridor is extremely important. The average trip length, or trip length distribution (TLD) is derived from the model by accumulating all trips which pass over a selected link by the actual travel time in minutes and then displays them in a frequency distribution. The statistical tests of mean, standard deviation and variance are then calculated. Along with select link band width plots, the TLD provides an indication of what type of travel (local, shopping, through trips, etc.) is using the corridor.

This process was applied to the four select links and the results are summarized below:

1. Miller Road west of Lennon Road		
Total Trips	18,754	
Average Travel Time	34.48	minutes
Standard Deviation of Travel Time	15.15	minutes
2. Miller Road east of Dye Road		
Total Trips	18,369	
Average Travel Time	28.86	minutes
Standard Deviation of Travel Time	11.09	minutes
3. Linden Road north of Miller Road		
Total Trips	9,031	
Average Travel Time	24.85	minutes
Standard Deviation of Travel Time	11.61	minutes
4. Linden Road south of Lennon Road		
Total Trips	18,649	
Average Travel Time	22.45	minutes

Standard Deviation of Travel Time 12.647 minutes

From the figures shown above it can be seen that the average travel time ranges between 22 and 34 minutes to and from the corridor. Because this range is fairly high, the first assumption is that there is a high percentage of through trips using the corridor. However, a closer look at the nature of development along the corridor indicates that a good portion of the trips could be shopping or non-work in nature. These types of trips are typically of shorter duration than work trips.

In order to identify the predominate trip purpose within the corridor, an analysis of where the trips are coming from and going to is essential. This was accomplished by utilizing a trip end summary report.

TRIP END SUMMARY

Trips are usually classified into three general travel categories. These are:

LOCAL OR INTERNAL TRIPS - Trips which begin and end within a defined metropolitan area including any work, shopping, personal business, social-recreation and other trip-purpose categories (i.e. a work trip from Grand Blanc to Genesee Valley Mall).

THRU TRIPS - Trips with neither the beginning nor end within the defined metropolitan area, but passing through (utilizing) the transportation system. (i.e. a trip from Lapeer to Lansing).

CORDON TRIPS - Trips which either begin or end outside the defined metropolitan area, but with one end of the trip within the metropolitan area. (i.e. a shopping trip from Durand to Genesee Valley Mall).

By evaluating the types of trips and where they are going to or coming from helps provide information explaining average travel time and the role the corridor has to surrounding areas.

Trip ends are literally the ends of a trip. Each trip has two ends, an origin and a destination. Summing the zonal trip ends of all trips using a particular roadway segment, within a 24 hour period, gives an indication of the area(s) being served and the type of travel. A trip end summary (TESM) report is a computer program which totals both beginning and ending trip ends in each zone and displays them by zone. The TESM is a summary matrix derived from a trip table (zone-to-zone travel) which for this study are the four select link trip tables.

The zones listed in the following tables are those which contain the greatest number of trip ends from trips passing through the selected links. From the tables one can see that an average between 32% and 52% of all trips using the select links have at least one end within the corridor boundaries. These percentages indicate that most of the trips are local in nature with very little through type travel. It should be noted that between 18% to 25% of all trip ends using Miller Road originate or end outside of the county and are thus cordon in nature. About 6% of all trips using Linden Road north of Miller Road would be considered cordon trips. This amount is not surprising considering the corridor contains a regional shopping center as well as numerous individual retail, recreational, eating and other service oriented establishments.

This helps to explain why the average trip length is longer than might be expected. Because a fair amount of trips are coming from outside the county (cordon trips) the average travel times are increased significantly.

SUMMARY

It can be seen from this analysis that the corridor services both the immediate area (local trips) as well as providing access to shopping facilities from areas outside of Genesee County (cordon trips). This travel mix provides for slightly higher than expected average travel times. If the corridor continues to develop and attract additional trips, travel times will be lengthened even more. With this in mind it is important to look at the impacts of both existing and future travel within the corridor to help analyze and alleviate delays and congestion.

MILLER ROAD WEST OF LENNON — TOTAL TRIP ENDS = 37,508

	ZONE	TOTAL TRIP ENDS	PERCENT OF TOTAL TRIP ENDS
*	46	414	1.1 %
*	279	18,754	50 %
*	280	496	1.3 %
	319	2,224	6 %
	320	326	.9 %
	321	450	1.2 %
Zones	341	708	1.9
Outside	343	1,085	2.9
Genesee	344	659	1.8
County	345	448	1.2
	347	3,333	8.9
	TOTAL	28,897	77 %

- 52% of total trip ends within study area
- 25% of total trip ends from out side the county

* Zones within or adjacent to Miller Road Study Area

MILLER ROAD EAST OF DYE

TOTAL TRIP ENDS = 36,738

	ZONE	TOTAL TRIP ENDS	PERCENT OF TOTAL TRIP ENDS
	42	1,005	2.7 %
	138	531	1.4
	261	424	1.2
*	279	6,901	18.8
*	283	606	1.6
*	286	865	2.4
*	287	3,947	10.7
*	288	508	1.4
*	303	1,821	5
	304	2,420	6.6
	308	682	1.9
Outside	353	867	2.4
Genesee	355	5,064	13.8
County	356	856	2.3
	Total	26,497	72 %

- 40% of total trip ends within study area
- 18.5% of total trip ends from outside the county

* Zones within or adjacent to Miller Road Study Area

LINDEN ROAD NORTH OF MILLER   TOTAL TRIP ENDS = 18,062

	ZONE	TOTAL TRIP ENDS	PERCENT OF TOTAL TRIP ENDS
	138	643	3.6 %
	274	345	1.9 %
	275	552	3.0
	278	304	1.7
*	283	1,397	7.7
*	285	309	1.7
*	286	2,654	14.7
*	288	1,403	7.8
	290	347	1.9
	304	744	4.1
Outside Genesee County	355	1,108	6.1
	Total	9,806	54 %

- 34% of total trip ends within study area
- 6% of total trip ends from outside the county

* Zones within or adjacent to Miller Road Study Area

LINDEN ROAD SOUTH OF LENNON

TOTAL TRIP ENDS = 37,298

	ZONE	TOTAL TRIP ENDS	PERCENT OF TOTAL TRIP ENDS
	126	571	1.5 %
	131	509	1.4
	138	801	2.1
	141	553	1.5
	275	452	1.2
*	279	8,910	23.9
	282	979	2.6
*	283	3,573	9.6
*	285	1,132	3.0
*	286	3,362	9.0
*	288	1,167	3.1
	304	744	2.0
	315	865	2.3
Outside	355	1,108	3.0
Genesee	356	779	2.1
County	360	419	1.1
	Total	25,924	69.5 %

- 48.6% of total trip ends within study area
- 6 % of total trip ends from outside the county

*Zones within or adjacent to Miller Road Study Area

CAPACITY ANALYSIS

CAPACITY ANALYSIS

INTRODUCTION

The present Genesee County "2005 Long Range Transportation Plan, Vols. 1 & 2"[1/] identifies portions of Miller Road (from Lennon to Ballenger), Ballenger (from Miller north), Bristol (from I-69 east) and Corunna (from Linden east) as existing problem segments within the corridor area. In addition, the intersection of Miller and Linden Road was highlighted as a problem area. Volume two of the transportation plan, which deals with the year 2005 projected conditions, identifies Miller Road from Ballenger to I-69 as being a "Major Corridor Problem Area".

The Long-Range Plan was based on data which existed in 1978-1979 and does not reflect current conditions. Because substantial development has occurred within and adjacent to the corridor in recent years, traffic counts were taken in April of 1984 to update the base travel data. These counts consisted of 24-hour machine counts and 8 hour turning movement counts at all of the signalized intersections. This provides detailed information on existing traffic volumes and travel patterns.

The capacity analysis in this section is based on the updated traffic data.

The amount of traffic, number of turning movements, pavement width, number of lanes and numerous other factors influence the capacity a roadway is able to provide. To effectively identify and analyze capacity problems within the study area, two levels of analysis are used. The first level examines the

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[1/] Gensee County 2005 Long Range Transportation Plan, Vol. 1 & 2, Genesee County Metropolitan Planning Commission, Flint, Michigan (February 1981) PP. V-13-V-19, V-70 & VIII-3.

24-hour volume-to-capacity (v/c) ratios of the overall roadway. The second level looks specifically at the signalized intersections and determines how well each operates during the peak hour of a typical week day.

ROADWAY CAPACITY ANALYSIS

Before this analysis could be initiated the 24-hour traffic volume counts within the corridor study area had to be updated to include 1983 and 1984 volumes. Updates were also made to the areawide network to include roadway widenings or other geometric changes that increased or decreased capacity since the last update. The following v/c ranges and corresponding level of services (LOS) were used to determine 24 hour capacity problems for this study. Within these ranges, a v/c ratio of greater than 1.25 is considered to be the point at which capacity problems become evident (LOS E).

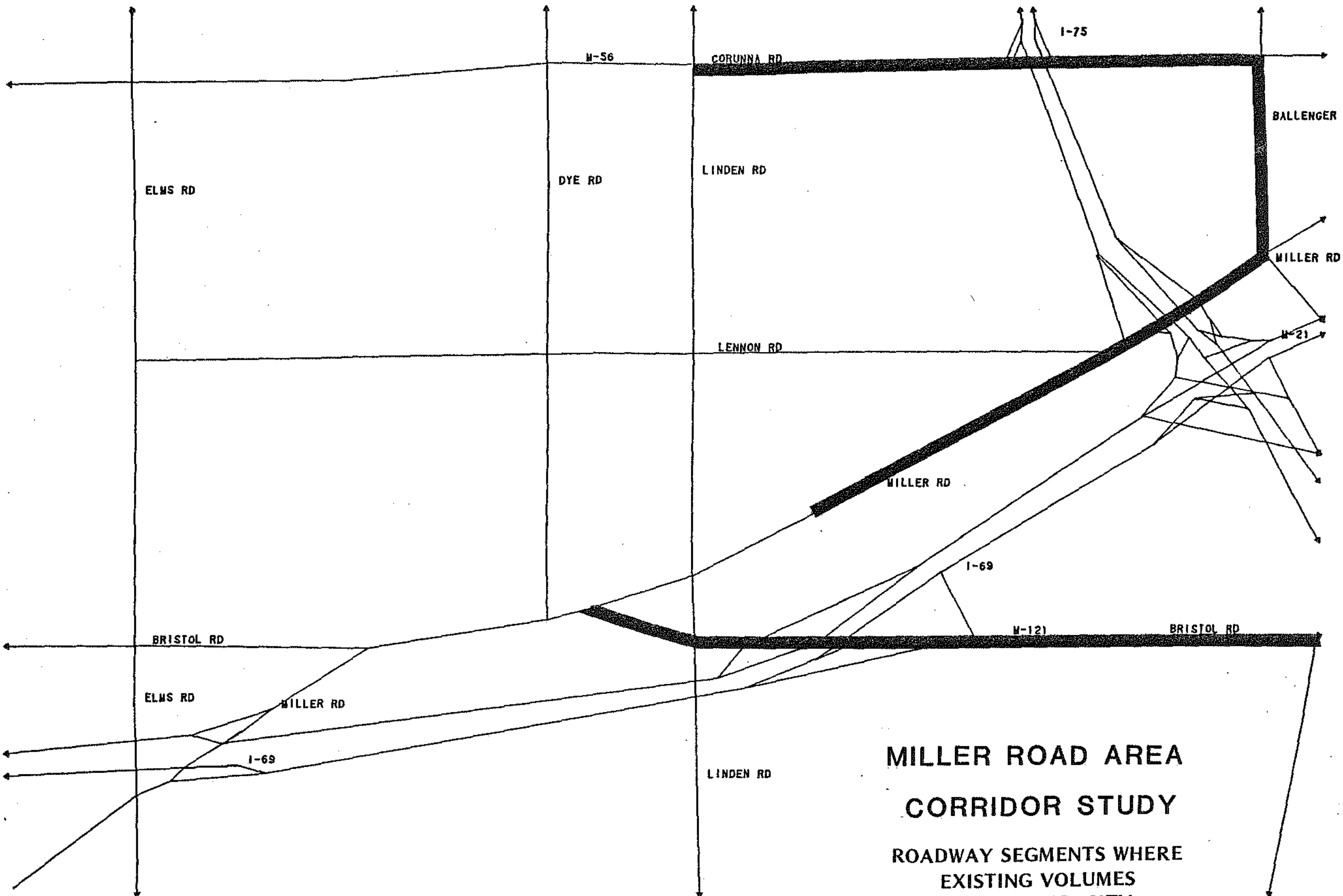
LOS	V/C RANGE
A-C	0.00-1.00
D	1.00-1.25
E	1.26-1.50
F	1.51-9.99

LOS	DESCRIPTION
A	Free flow condition where there is little or no restriction in speed or maneuverability.
B	Stable flow condition where operating speed is beginning to be restricted by other traffic.
C	Stable flow condition in which speed and maneuverability are becoming restricted. Typically represents design capacity.
D	Approaching unstable flow where average operating speeds are maintained but subject to considerable and sudden change. Usually considered an unsatisfactory level.
E	Unstable flow where speeds fluctuate and maneuverability is severely restricted. Frequent stoppages occur raising the accident potential.
F	Forced flow condition with low speeds and many stoppages. Roadway is not able to function as designed.

A close examitation of the 24 hour v/c ratios for roadway segments within the corridor reveals locations where actual capacity problems are occurring. At the present time about 21.5% (6.83 miles) of the total network miles within the corridor are at LOS "D", "E" or "F". Twenty four percent (1.64 miles) of this amount occurs on Miller Road. These segments correspond, for the most part, to those identified in the Long Range Plan. The only additional segment is on Miller Road between Lennon and the Genesee Valley Mall. Segments where existing volumes exceed capacity (LOS D, E or F) are shown in Figure IV-1.

Future LOS conditions within the corridor were analyzed using the existing network with projected 2005 volumes assigned to the system. This condition shows how future volumes would operate on the existing system assuming no improvements are made. By the year 2005, LOS projections indicate that 15.92 miles (50%) of corridor roadways will have a capacity problem. In addition to the segments currently identified as having capacity problems, six more would be added. These include Miller Road (Genesee Valley Mall west to I-69), Lennon Road (Miller to Linden), Dye Road (Corunna to Lennon), Corunna Road (Elms to Dye), Linden Road (Corunna to south of I-69) and Ballenger Highway (south of Miller). Segments where 2005 projected volumes exceed capacity are shown in Figure IV-2.

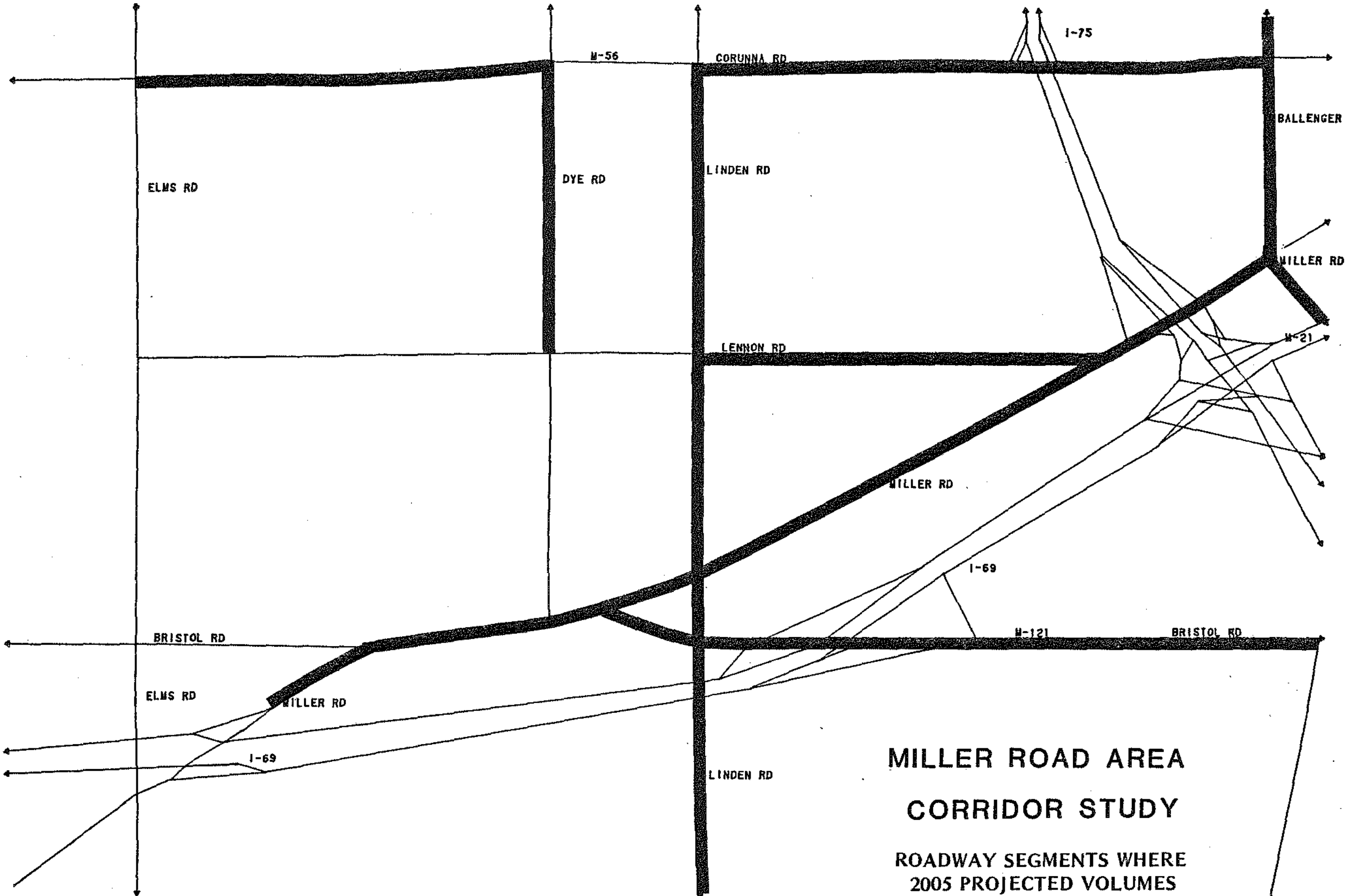
Rarely are traffic volumes on a roadway spread equally over a 24 hour period. Usually the greatest percentage of daily travel occurs within an eight to ten hour span as discussed in the peak hour traffic analysis portion of this report. For this reason a study of 24 hour capacity is useful in defining areas where, for a large portion of the day, hourly volumes are at or greater than the hourly capacities. Figure IV-3 illustrates a portion of Miller Road where this condition exists. Here both east bound Miller and south bound Ballenger hourly traffic exceed the hourly capacity for about 6 hours of the



MILLER ROAD AREA CORRIDOR STUDY

ROADWAY SEGMENTS WHERE EXISTING VOLUMES EXCEED CAPACITY

FIGURE IV-1



MILLER ROAD AREA

CORRIDOR STUDY

ROADWAY SEGMENTS WHERE 2005 PROJECTED VOLUMES EXCEED CAPACITY (ASSUMING NO IMPROVEMENTS)

FIGURE IV-2

day. Similar conditions are found on other portions of Miller and Linden Roads.

This analysis reinforces the problems identified through the Long Range Planning Process. With recent development in the area and more anticipated, a grim picture is painted if no provisions are made to deal with the increased traffic volumes. A more detailed look at specific capacity problems can be made by examining the peak hour capacity at the signalized intersections within the study area. This provides a clear operational picture of individual approach lanes during the hour with the largest volume of traffic.

SIGNALIZED INTERSECTION CAPACITY

With general 24 hour problems identified on the corridor, a more detailed analysis of specific problems and possible solutions was required. This study attempts to identify individual capacity related problems leading to alternatives that will improve existing and future conditions. Because intersections have a major influence on roadway capacity and safety, a major part of the study centers around this element.

A. Background Information

In an urban area like Flint, the traffic flow on a roadway is controlled by the stop-and-go action of the traffic signals, and this interrupted flow characteristic has the greatest effect on capacity. Several elements related to traffic signals affect the capacity of an intersection and hence the capacity of the roadway. These are listed below:

1. Green time/cycle length (G/C) ratio and cycle split are prime determinants of intersection capacity. The G/C ratio is the fraction of cycle time that a specific through movement has the green signal light. If for example, Miller at Ballenger received 45 seconds of

AVERAGE HOURLY APPROACH VOLUME
MILLER ROAD AT BALLENGER ROAD

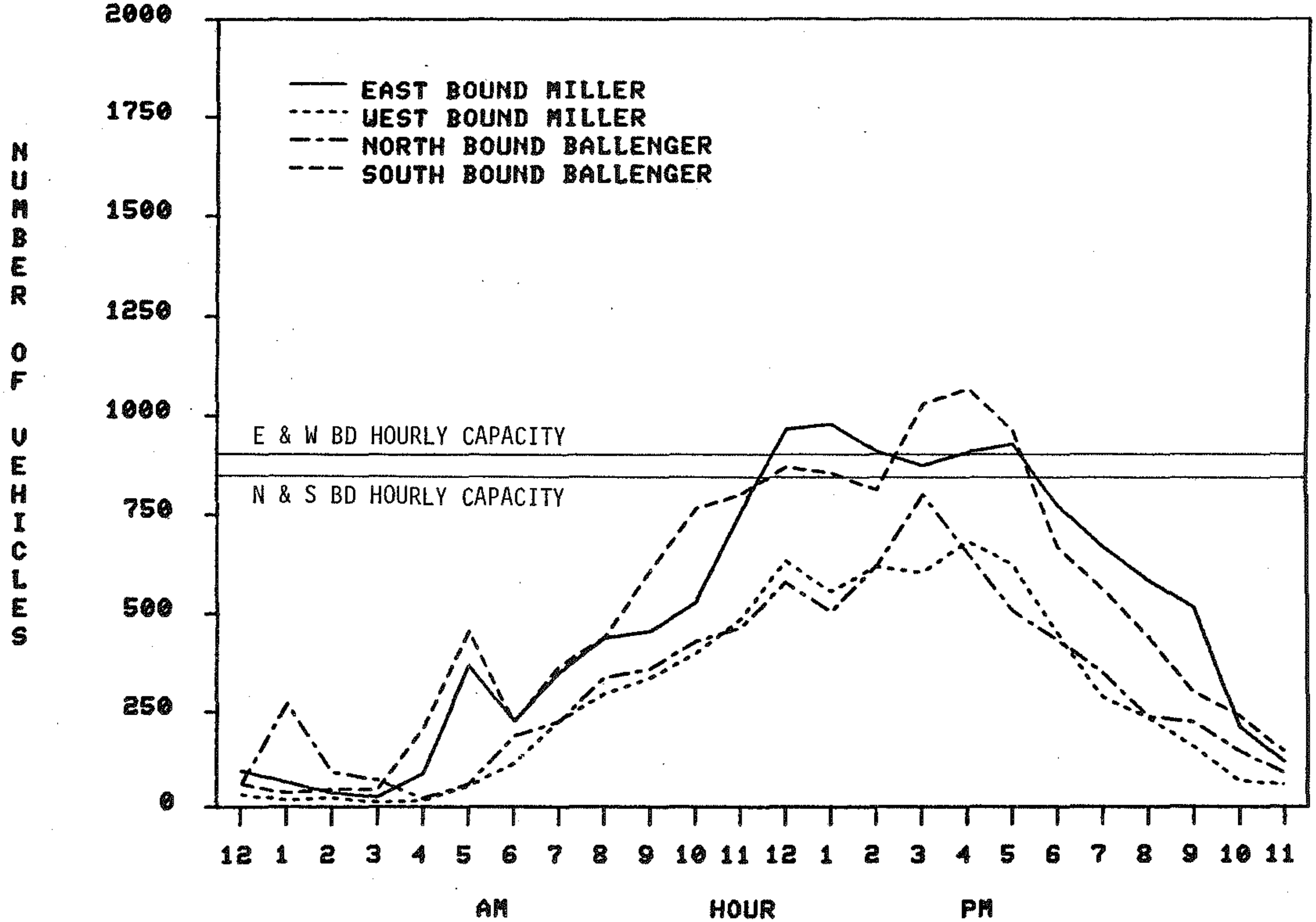


FIGURE IV-3

green time and the total cycle length was 90 seconds, the G/C ratio would be expressed as 45/90, 1/2, .50 or 50 percent. Cicle split refers to the amount of signal time portioned to each roadway at an intersection. It is generally expressed as a ratio, i.e., 60/40, meaning that one roadway gets 60 percent of the cycle time and the other, 40 percent.

If both roadways have about equal traffic volumes a 50/50 split could be used. Splits at intersections within the corridor range from 77/23 to 60/40 depending on the cross-street traffic.

2. The signal cycle length plays an important role in moving vehicles through an intersection. As an example, the cycle length of the signal at the Miller/Lennon intersection is 70 seconds, that is, it takes the signal 70 seconds to go from a green indication on Miller, through yellow and red and back to green on Miller.

   Cycle lengths usually range from 60 to 120 seconds. Within the corridor they range from 60 to 80 seconds. Studies in the United States have shown that longer cycle lengths will generally accommodate more vehicles per hour if demand is constant throughout the green period. If not, the vehicles will experience higher average delays with the longer cycle. Two different cycle lengths at one intersection are sometimes employed, a longer one during peak demand periods and a shorter one during the "slack" or off-peak times such as late evening or early morning.

3. Phasing or phases determine which lanes will be allowed to move during a cycle at a particular intersection. The typical intersection operates with two phases. An example is the signal at Miller/Dye. During Phase 1 the

eastbound and westbound Miller Road traffic is allowed to move with left turns being made during breaks in the opposing traffic flow. During Phase 2 the north and southbound Dye Road traffic is allowed to move. Again left turns are made when opposing traffic clears the intersection. Some signals may have as many as 8 phases depending on demand or special intersection configuration, but most in the urban area operate on two or four phases.

4. A progressive signal system allows a vehicle or group of vehicles to travel from signal to signal at a pre-set speed (speed limit or lower) without having to stop at each signal. When a vehicle leaves an intersection as the signal turns green, progression would allow that vehicle to travel through successive intersections on the green light. However, it should be emphasized that if the vehicle or group of vehicles travels much faster or slower than the preset speed, it will be forced to stop at a red light at the next intersection.

   There are various progressive timing systems used, simultaneous, alternate, limited, and flexible, but all attempt to move traffic from one signal to another at a safe, efficient speed without stopping. Progression, however, only works well when the signals are of the same cycle length or 50 percent longer or shorter. Five advantages of progression include:

   A. A higher level of service in terms of reduced number of stops,

   B. Smoother flow with an improvement in capacity,

   C. More uniform vehicle speeds because there is less incentive to travel at excessively high speeds to reach a signal that is out of step.

D. Fewer rear-end accidents and red signal violations because the groups of vehicles will arrive at each signal when it is green rather than red, and

E. Fuel consumption and some types of air pollutants are reduced.

Portions of Miller Road, from K-Mart to Lennon, and Linden Road, from Bristol to north of the corridor limits, currently operate with progressive signal systems. Each functions independently of the other.

5. Various turn movements can impact the operation of an intersection. Heavy left turn demand of an approach leg that has no provision for left turn lanes or phases can seriously delay and back-up traffic approaching from behind. Right turning vehicles have some effect on intersection capacity because typically, the short turn radius requires slowing to considerably below through traffic speeds. The presence of pedestrians can affect headways and performance as the vehicles attempt to turn.1/

B. Intersection Capacity

The following intersection capacity analysis was initiated for all signalized intersections within the Miller-Linden corridor study area. The purpose of the analysis was to determine how well the existing intersection geometrics and signal timing handle present and projected approach volumes. From initial analysis, specific problems were identified and various methods of improving the deficiencies were tested for their effectiveness.

1/ Ballenger Highway Corridor Study, Genesee County Metropolitan Planning Commission, Flint, Michigan (December 1981) pp 44-45.

Present approach volumes were based on peak hour conditions. Peak hours within the corridor were determined from 24 hour machine counts and 8 hour turning movement counts taken in April of 1984. A discussion of peak hour traffic is included under the traffic volume analysis portion of this report. These counts are graphically summarized in Appendix A.

Future approach volumes were obtained by assigning 2005 traffic onto the existing model network. For instances where an approach was not represented in the network, manual calculations were made to model future volumes. Individual turning movement percentages for the year 2005 were based on the existing left, thru, and right turn percentages with adjustments made where professional judgement was deemed necessary.

With the existing and projected approach volume data and the necessary intersection inventory data provided by MDOT's Traffic and Safety Division (T&S), City of Flint traffic engineering and the Genesee County Road Commission, the intersection capacity analysis process was initiated.

C. Intersection Capacity Analysis Methodolody

Utilizing a computerized program developed by the T&S Division of MDOT in 1974, the capacity of each intersection approach lane was computed.2/ The program determines the capacity for each approach lane based on the lane type, lane width, percent commercial traffic, cycle length and the amount of green time allotted each approach. When the approach volumes are applied, the program calculates the volume/capacity (V/C) ratio

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2/. Mercer, Donald J., and Maleck, Thomas L., Operating Manual for Intersection Capacity Analysis Computer Program, TSD-254-74, Michigan Department of State Highways and Transportation, (Oct. 1974) for each approach lane. By adjusting the cycle length and green time/ cycle length (G/C) ratio, level of service improvements are achieved.

This program is designed to handle a two-phase signal, but multiphase signals can be analyzed by setting up successive runs of the program. The input data includes lane type (i.e., through, right or left turn options), cycle length, signal split, percent amber, lane width, percent trucks and traffic volumes by direction and movement. The equations used to compute capacity were developed by T&S, using a headway approach technique, based on the theory that headway decreases with each successive vehicle in a cycle.[3/] This model has been in continuous use by MDOT since its development, and has been extensively tested and validated since that time. Evaluation of both the present and future traffic at the signalized intersections within the corridor was completed by the MDOT's, Safety Programs Unit of the Traffic & Safety Division.

D. Level of Service Analysis

Intersections control to a large extent the capability of major and secondary arterial streets to accommodate the flow of vehicles and pedestrians. Because many factors influence interrupted flow through intersections, it is not feasible to define "ideal conditions" as is done in the case of uninterrupted flow. Rarely are all approaches to an intersection simultaneously burdened to their full capacities. Therefore, intersection capacity is defined in terms of the separate

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3/ Maleck, Thomas L., Vehicular Starting Headways as a Function of Lane Operation and Green Time, Masters Degree Thesis, M.S.U., East Lansing, Michigan (1972).

capacities of each individual approach. The term "loaded cycle" or "loaded phase" is used in describing the degree of utilization of an individual intersection approach. A "loaded phase" is a phase in which all vehicles on the approach fail to clear the intersection during the allotted green time. The vehicles must wait until the next green phase. This condition usually occurs during the peak hour.

The load factor is the ratio of loaded cycles to the total number of cycles, ranging from 0.0 to 1.0. The approach capacity is calcuated at a load factor of 1.0. The corresponding approach V/C ratio results in the approach level of services (LOS). The following table illustrates the relationship between the V/C ratio and LOS.

LOS	V/C RATIO
A	0.00-0.60
B	0.61-0.70
C	0.71-0.80
D	0.81-0.90
E	0.91-1.00
F	---

A general description of traffic flow for each LOS is shown in Figure IV-4 on the following page. As a general rule, approaches with a LOS of "A", "B", "C" are acceptable in an urban situation and operate well the majority of the time, while ones with a LOS of "D", "E", or "F" do not. For the purpose of this study this rule was followed.

LOS	Description	
A	Free Flow	Approach appears quite open; turns are easily made; nearly everyone has freedom of movement, no vehicle waits more than one red indication.
B	Stable Flow	Occasionally an approach is fully utilized, others are approaching full. Drivers feel somewhat restricted within platoons of vehicles. About 10% of the cycles are loaded.
C	Stable Flow	Occasionally waiting through more than one red signal. Back-ups may develop behind turning vehicle. Drivers somewhat restricted but not objectionally so. About 30% or 20 minutes out of the peak hour has loaded cycles.
D	Approaching Unstable Flow	Delays may be substantial during short peaks with some vehicles waiting two or more cycles. Enough cycles with low demand occur to permit clearance of queues preventing excessive back-ups. Beginning to tax capabilities of street. Up to 70% or 45 minutes of peak hour has loaded cycles.
E	Unstable Flow	This represents theoretical capacity. Every bit of green time is being fully utilized. Continuous backups at intersection approaches. Delays may be several signal cycles.
F	Forced Flow	Jammed conditions. Backups on other intersections ahead prevent movement.

INTERSECTION LEVEL-OF-SERVICE

FIGURE IV-4

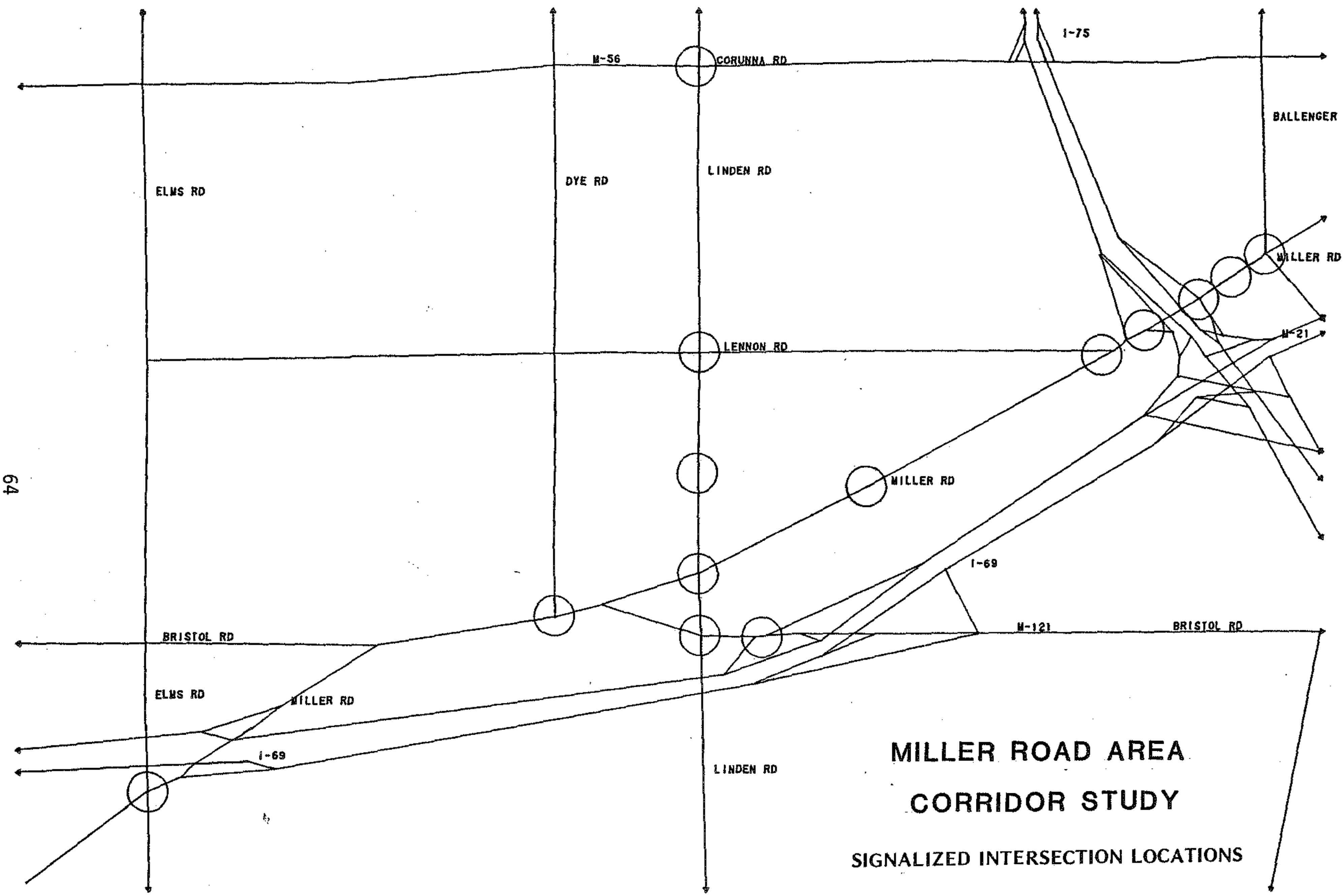

M-56
CORUNNA RD
I-75
BALLENGER
ELMS RD
DYE RD
LINDEN RD
MILLER RD
LENNON RD
M-21
MILLER RD
I-69
BRISTOL RD
M-121
BRISTOL RD
ELMS RD
MILLER RD
I-69
LINDEN RD
MILLER ROAD AREA
CORRIDOR STUDY
SIGNALIZED INTERSECTION LOCATIONS

FIGURE IV-5

MILLER ROAD AREA CORRIDOR STUDY
SIGNALIZED INTERSECTION LOS

SIGNALIZED INTERSECTION	Year	APPROACH																			
		NB					SB					EB					WB				
		Left	Left Thru	Thru	Right Thru	Right	Left	Left Thru	Thru	Right Thru	Right	Left	Left Thru	Thru	Right Thru	Right	Left	Left Thru	Thru	Right Thru	Right
MILLER @ BALLENGER	1984	F		A	A		A		F	F		F		D	D		A		B	B	
	2005	F		A	A		A		F	F		F		F	F		A		D	D	
MILLER @ K-MART	1984		A		A			A		A		A		A	A		A		A	A	
	2005		A		A			A		A		A		A	A		A		A	A	
MILLER @ NB I-75 RAMPS	1984	F				D							C	C					A	A	
	2005 (1)	F				F						F		A*					C	C	
MILLER @ SB I-75 RAMPS	1984						A				B	F		A*					A*		A
	2005 (1)						A				B	F		A*					E*		A
MILLER @ LENNON	1984						A*				A	A		A*					A*	A	
	2005						A*				A	A		B*					A*	A	
MILLER @ GENESEE VALLEY	1984						A				A			A*					A*	A	
	2005						B				B			A*					A*	B	
MILLER @ LINDEN	1984	C		D	D		F		D	D			F	C		C		F	D		D
	2005	F		F	F		F		F	F			F	F		F		F	F		F
MILLER @ DYE	1984		A		A			A		A			C		B			A	A		A
	2005		A		A			A		A			D		C			A	A		A
MILLER @ ELMS	1984		A			A		B			A	A		A	A		A		A	A	
	2005		E			A		F			A	A		A	A		A		A	A	
BRISTOL @ I-69	1984						A				E*			A	A				A*		
	2005						A				F*			B	B				A*		
LINDEN @ BRISTOL	1984	A		A	A		D		A	A			E		E		A		A		D
	2005	A		A	A		F		A	A			E		E		B		B		F
LINDEN @ GENESEE VALLEY	1984			B	B		C		A*								A				D
	2005 (2)	F		C	C		F		A*		C	D			D		B			E	
LINDEN @ LENNON	1984	A		A	A		A		A	A			A		A			A		A	
	2005	F		C	C		F		A	A			A		A			A		A	
LINDEN @ M-56	1984	A		B	B		A		A	A		A		A*		A	A		A*		A
	2005	D		D	D		A		B	B		A		A*		A	D		A*		A

(1) Includes 5th lane added on Miller Road Bridge over I-75 and signal adjustments.

(2) Includes new approach from Oakbrook Mall.

* Two lanes operating with this LOS.

TABLE IV-6

Figure IV-5 indicates the location of all the signalized intersections within the corridor study area. Table IV-6 summarizes the LOS under present and projected future volumes for each approach lane of the 14 intersections analyzed. The overall approach LOS was determined by the approach lane with the lowest (poorest) LOS. Future LOS was based on the assumption that no intersection improvements had been made, except at Miller and the north and south bound I-75 on/off ramps. Analysis at this location includes a fifth lane on the Miller Road bridge which is scheduled for completion by Septmber, 1984.

Intersections experiencing a LOS of "D", "E", or "F" for one or more of their approaches at the present time are shown in Figure IV-7. At this time seven intersections, or 50 percent of all the signalized intersections, have at least one approach operating at LOS "D"-"F". By the year 2005 eleven intersections, or 70 percent of the signalized ones are projected to be operating at LOS "D"-"F". Figure IV-8 shows those intersections operating at LOS"D"-"F" by the year 2005.

The following list summarizes the capacity problems at each of the signalized intersections within the corridor. Appendix B includes LOS diagrams for each intersection graphically illustrating which lanes or movements are experiencing problems for the existing and future conditions.

Miller at Ballenger

PROBLEM: The intersection currently operates with a LOS "F" on the northbound (NB) left turn (LT) lane, the southbound (SB) Thru

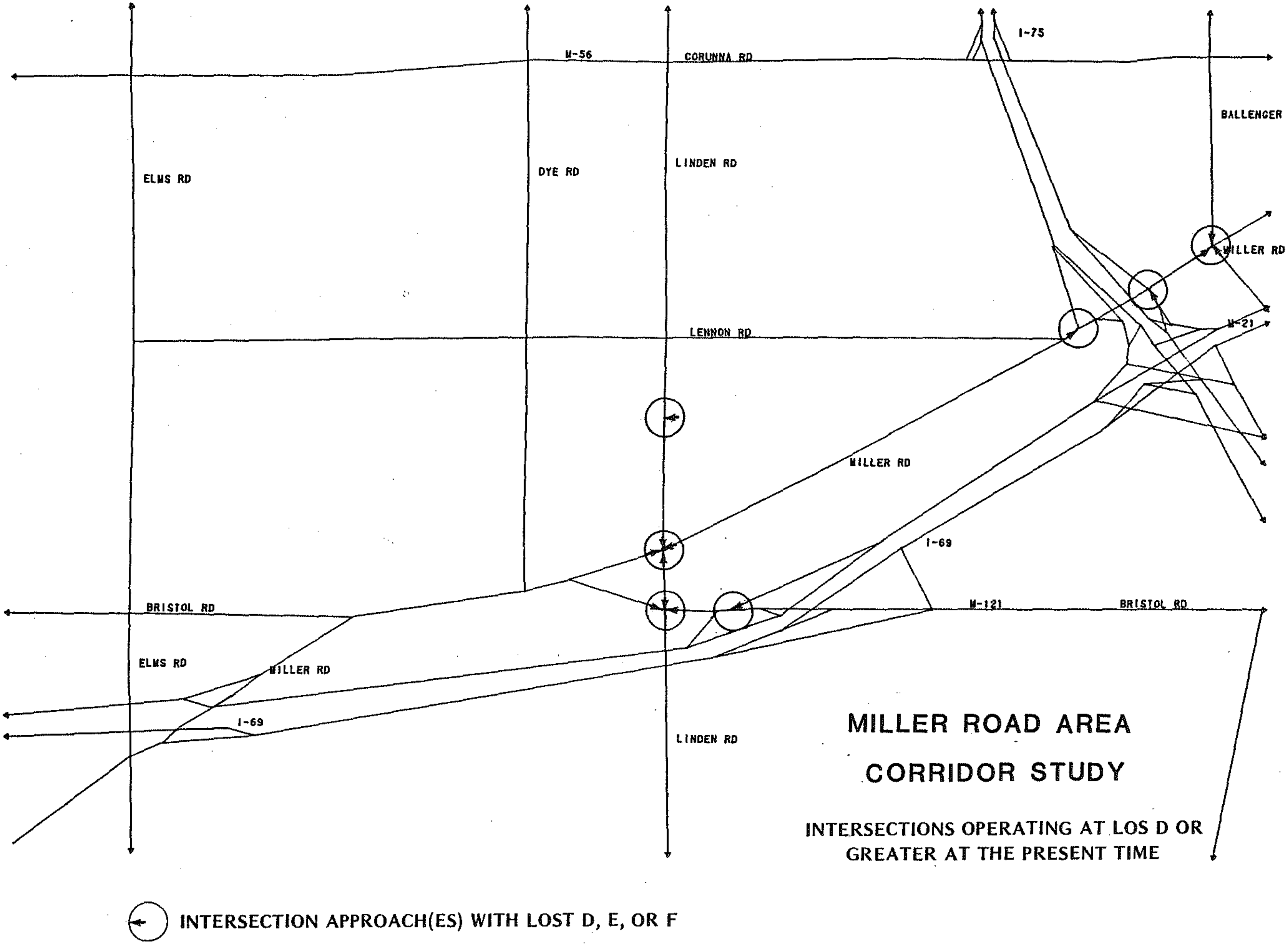
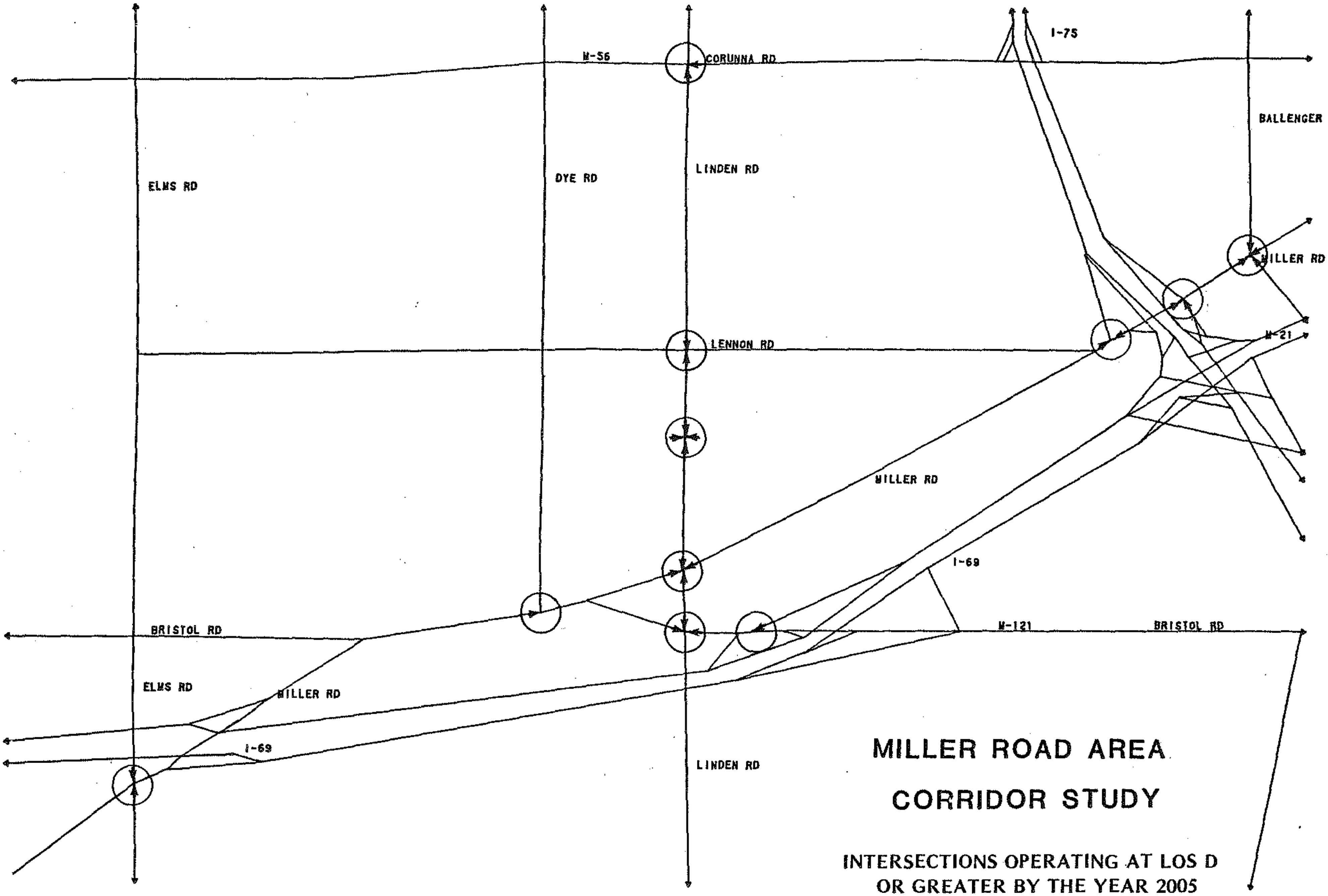

I-75
M-56
CORUNNA RD
BALLENGER
ELMS RD
DYE RD
LINDEN RD
MILLER RD
LENNON RD
M-21
MILLER RD
I-69
BRISTOL RD
M-121
BRISTOL RD
ELMS RD
MILLER RD
I-69
LINDEN RD
MILLER ROAD AREA
CORRIDOR STUDY
INTERSECTIONS OPERATING AT LOS D OR
GREATER AT THE PRESENT TIME
INTERSECTION APPROACH(ES) WITH LOST D, E, OR F

FIGURE IV-7



MILLER ROAD AREA

CORRIDOR STUDY

INTERSECTIONS OPERATING AT LOS D
OR GREATER BY THE YEAR 2005

(←) INTERSECTION APPROACH(ES) WITH LOS D, E, OR F

FIGURE IV-8

and Right/ thru (RT Thru) lanes and eastbound (EB) LT lane. The EB Thru and RT Thru lanes also operate at LOS "D". By the year 2005 the EB and west bound (WB) Thru and RT Thru lanes drop to LOS "F" and "D" respectively.

Miller at K-Mart

PROBLEM: Intersection operates at satisfactory levels for both existing and future volumes.

Miller at NB I-75 Ramps

PROBLEM: At the present time the left and right lanes on the NB off ramp function at LOS "F" and "D". By 2005 the right lane drops to LOS "F" along with the EB LT lane even with the additional lane on Miller over I-75.

Miller at SB I-75 Ramps

PROBLEM: The EB LT lane operates at LOS "F". With 2005 volumes the WB Thru lanes deteriorate to LOS "D" even with the fifth lane added to Miller Road over I-75.

Miller at Lennon

PROBLEM: Intersection operates at satisfactory levels for both existing and future volumes.

Miller at Genesee Valley Mall

PROBLEM: Intersection operates at satisfactory levels for both existing and future volumes.

Miller at Linden

PROBLEM: At this time the NB Thru and RT Thru lanes are at LOS "D", the SB LT lane at "F" and Thru and RT Thru lanes at "D", the EB Left at "F" and the WB Left, Thru and RT Thru lanes at LOS "F", "D" and "D" respectively. By the year 2005 all approach lanes will deteriorate to LOS "F".

Miller at Dye

PROBLEM: All approach lanes currently function with an acceptable LOS. With 2005 volumes the EB LT Thru lane will operate at LOS "D".

Miller at Elms

PROBLEMS: No LOS problems at the present tiem. By 2005 the NB and SB LT Thru lanes are expected to operate at LOS "E" and "F" respectively.

M-121 Bristol at I-69 WB off Ramp

PROBLEM: The SB I-69 ramp approach operates at LOS "E" for the RT lanes. These drop to LOS "F" by the year 2005.

Linden at Bristol

PROBLEM: The SB LT and WB RT lanes currently function at LOS "D". The EB LT thru and RT thru lanes are at LOS "E". By 2005 the SB LT and WB RT lanes deteriorate to LOS "F".

Linden at Lennon

PROBLEM: No LOS problems at the present time. By the year 2005 both the NB and SB LT lanes will operate at LOS "F". No other LOS problems are anticipated.

Linden at M-56 Corruna

PROBLEM: No LOS problems at the present time. With 2005 traffic volumes, all NB lanes and the WB LT Lane will be at LOS "D".

E. Summary

Only one of the signalized intersections within the corridor has capacity problems on all approaches at the present time. Three intersections, however, will have problems on all approaches by the year 2005. Of the indentified LOS problems, the majority involve left turning movements. Most of the approaches that are, or will be, experiencing left turn difficulties already have exclusive left turn lanes. Other capacity problems are more random involving thru as well as right turning movements, depending upon the turn demands and approach volumes.

Accurate modelling of right turning movements is complicated by permissive right-turn-on-red conditions at most intersections. Because the opportunities to complete right turns on red is dependent upon numerous factors (volumes, gaps, time of day, etc.) it is virtually impossible to predict. For this reason, the modelled LOS for right turning movements is probably somewhat better than indicated.

Over 70% of the present intersection capacity problems occur on either the Miller or Linden road approaches. The remaining 30% occur on the approaches of cross streets. Although capacity problems on these streets do not number as many as those on the major roads within the corridor, they are still areas of concern. Cross streets contibute to traffic flow interruptions and raise the accident potential at intersections. For these reasons capacity improvements on the cross streets should be considered as equally important as those on Miller and Linden Roads.

This analysis paints a grim picture if provisions are not made to cope with existing and projected future traffic volumes. Three improvement projects are planned, however, within the corridor area in the near future and will relieve some of the congestion. These include the widening of (1) M-56 Corunna Road between Linden and Ballenger to five lanes, (2) M-121 Bristol Road between I-69 and I-475 to five lanes and (3) Miller Road I-75 overpass to five lanes. While these projects will help alleviate congestion problems in the near future, they will have little impact if volumes reach the projected 2005 levels.

ALTERNATIVE ANALYSIS

ALTERNATIVE ANALYSIS

Numerous alternative solutions were examined to relieve identified existing, as well as future, level of service problems. This section summarizes those improvements from which the greatest benefit can be realized. In most cases they are improvements which can be made in a relatively short period of time without major capital expenditures (such as those associated with the construction of a new road). Specific improvements examined consisted of adjusting existing signal timings, signal optimization, and adding turning lanes or additional through lanes where warranted. This analysis was conducted jointly by MDOT's Traffic and Safety and Urban Transportation Planning Divisions. The following dicusssion lists those improvements for each signalized intersection that were found to have the greatest impact.

Miller @ Ballenger

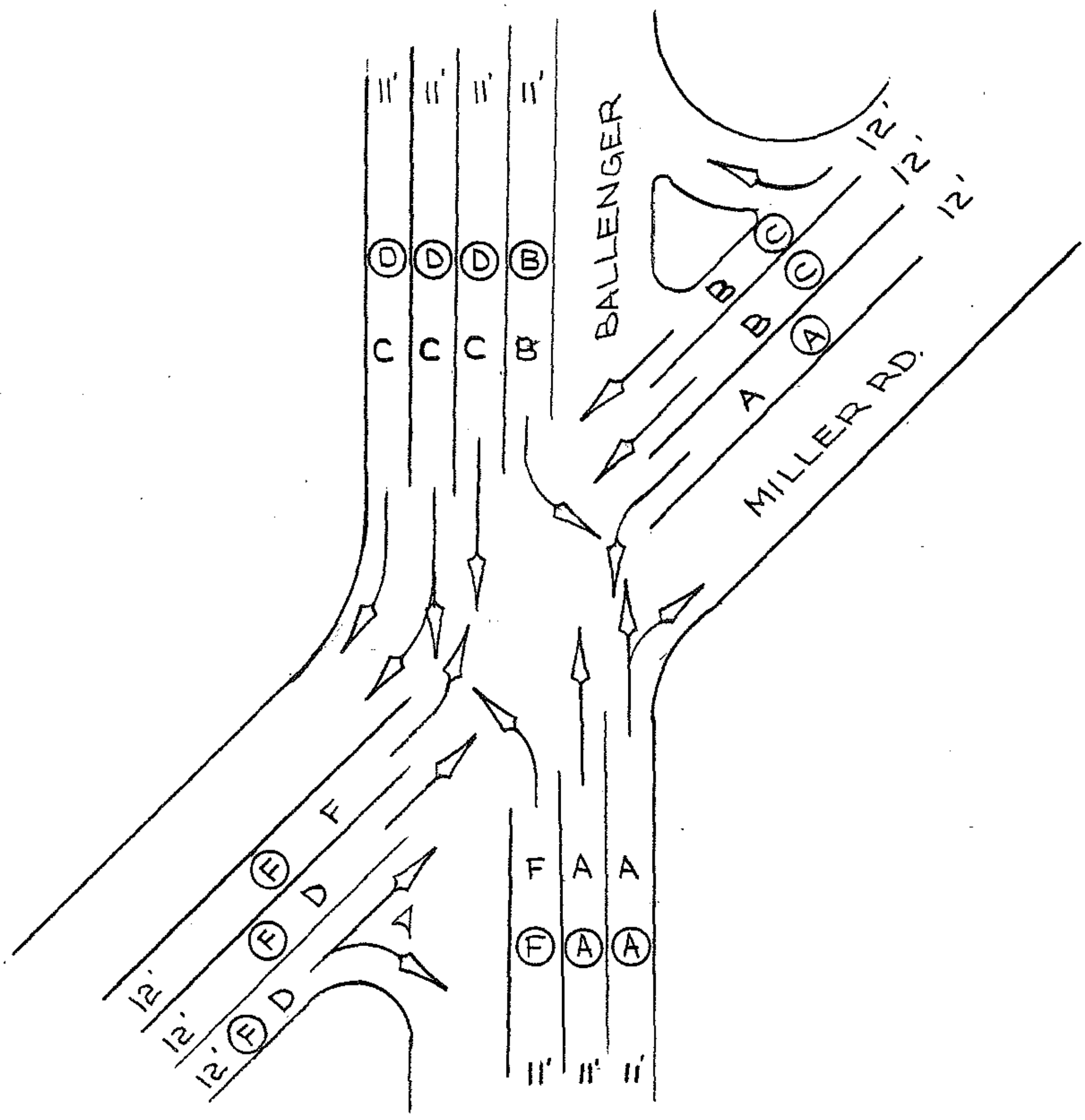
Changing the signal splits to 33% Miller, 33% Ballenger for the thru and right turning movements and 18% Miller, 16% Ballenger for the left turn phase, has a minimum impact on the LOS by itself. By providing a right turn only lane on the southbound (SBD) approach, in addition to the existing right/thru, thru and left turn lanes, the LOS improves from "F" to "D" for the thru and right movements under present conditions. By the year 2005 the LOS would be at "D" for these lanes. Some improvement is also realized by the year 2005 on the westbound (WBD) approach with the signal timing change. The thru and right/thru movements improve from LOS "D" to "C". The left turning movement problems can be lessened, to a degree, with a flashing red indication provided on all approaches following the green arrow. Figure V-1 illustrates LOS improvements with these modifications.

Note: Diagrams are included for those intersections where geometric changes would be benefical in improving the LOS.

KEY

A EXISTING LOS

Ⓐ YEAR 2005 LOS



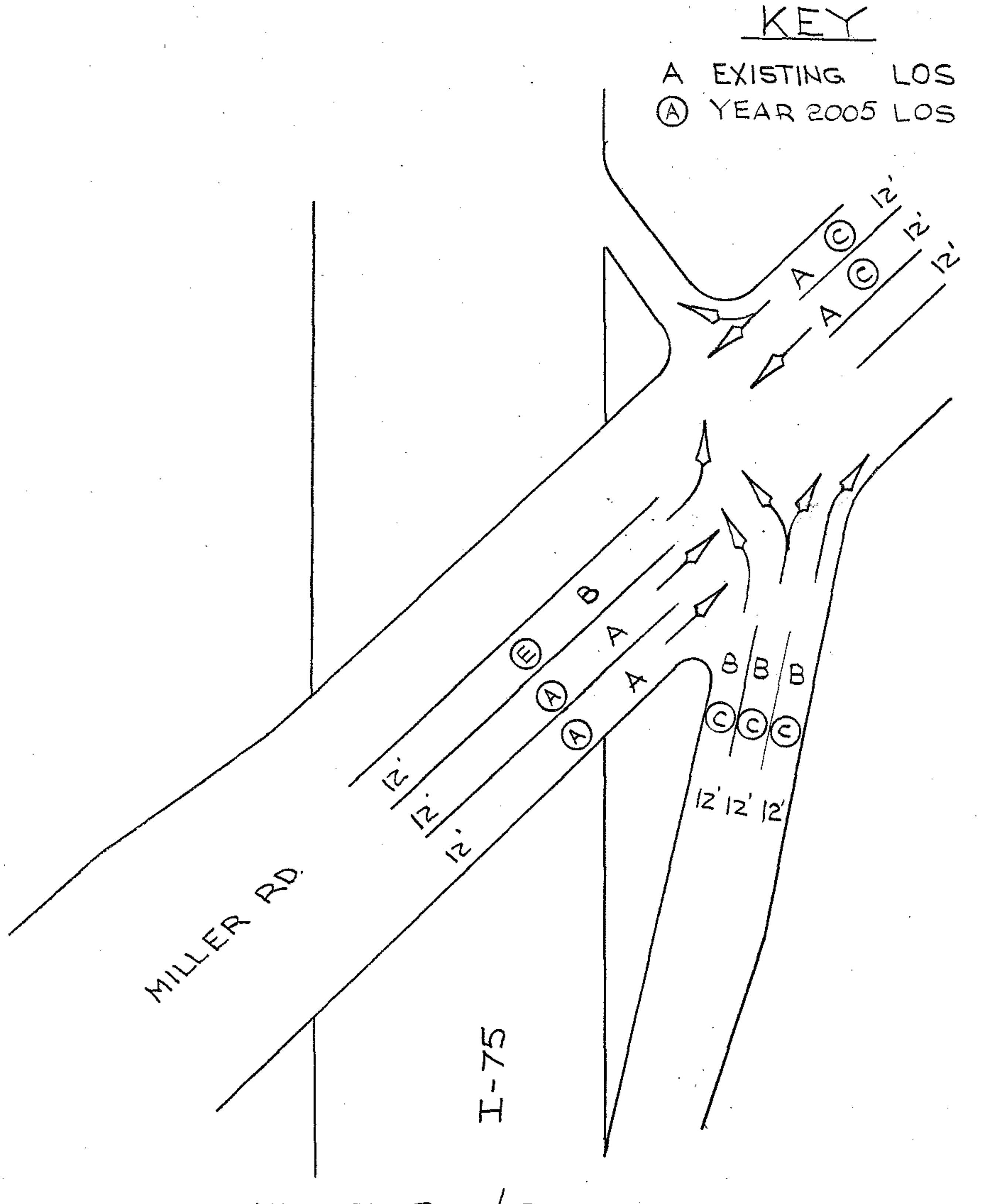
MILLER RD. / BALLENGER

WITH SBD RIGHT ONLY LANE ADDED

AND SIGNAL TIMING ADJUSTED

NO SCALE

FIGURE V-1



MILLER RD / I-75 NBD
WITH LANE ADDED ON RAMP AND
SIGNAL TIMING ADJUSTED

FIGURE V -2

Miller @ K-Mart

Although there are no LOS problems at the present time, or projected for the future, some benefit can be derived by adjusting the signal splits to allow more green time on the Miller Road approaches. Adjusting the amount of green time ratio from 65/35 to 77/23 (Miller/K-Mart) provides for a smoother traffic flow on Miller with less stopping and idling time without forcing unacceptable conditions on the K-Mart approach.

Miller @ NB I-75 Ramps

Considerable improvement will result on the east bound (EBD) approach with the widening of the Miller Road bridge over I-75. The EBD LOS changes overall from "C" under present conditions to "A" on the thru lanes and "B" on the left only. Problems will still be apparant on the NBD off ramp. With the addition of a third lane (left/right option) on the NBD off ramp the LOS improves from "F" on the left lane and "D" on the right lane to LOS "B" for all three lanes on the approach. With some minor signal timing adjustments and the establishment of progression on Miller Road, traffic flow as a whole should improve through this intersection. See Figure V-2 for LOS improvements with these modifications.

Miller @ SB I-75 Ramps

Traffic flow in this area as a whole should improve with the widening of the Miller Road bridge over I-75. With the addition of a left-turn phase on the east bound approach the LOS will change from "F" to "D" for this movement. The west bound thru lanes will drop from LOS "A" to "C" by incorporating the left-turn phase but should cause no major problems.

Miller @ Lennon

This intersection currently operates at LOS "A" on all approaches and no major problems are projected in the future. No improvements are presently needed or planned.

Miller @ Genesee Valley Mall

At the present time EBD left turns are prohibited at this signal. As a result no specific problems are identified now or by the year 2005. Conditions could change at this location with the addition of a center left turn lane and allowing EBD left turns. Signal progression in the mall vicinity should help facilitate mid block turning movements occurring between this signal and the one at Linden Road.

Miller @ Linden

All approaches currently have one or more lanes operating at LOS "D" or worse with all lanes projected to be at LOS "F" by the year 2005. Little or no LOS improvement can be made without the addition of north (NBD) and south bound (SBD) right turn lanes. With these lanes plus minor signal split adjustments the LOS would improve on three of the four approaches for the thru and right movements. The NBD and SBD right lanes would operate at LOS "A" along with the EBD and SBD thru lanes. The NBD thru improves to LOS "B". Figure V-3 illustrates the resulting LOS improvement. No substantial improvement is made, however, on any of the left turning movements. With the heavy traffic volumes projected at this location in the future, a number of LOS problems will exist by the year 2005 if not before. This intersection should be reanalyzed when additional traffic generated from the new Oak Brook Mall stabilizes.

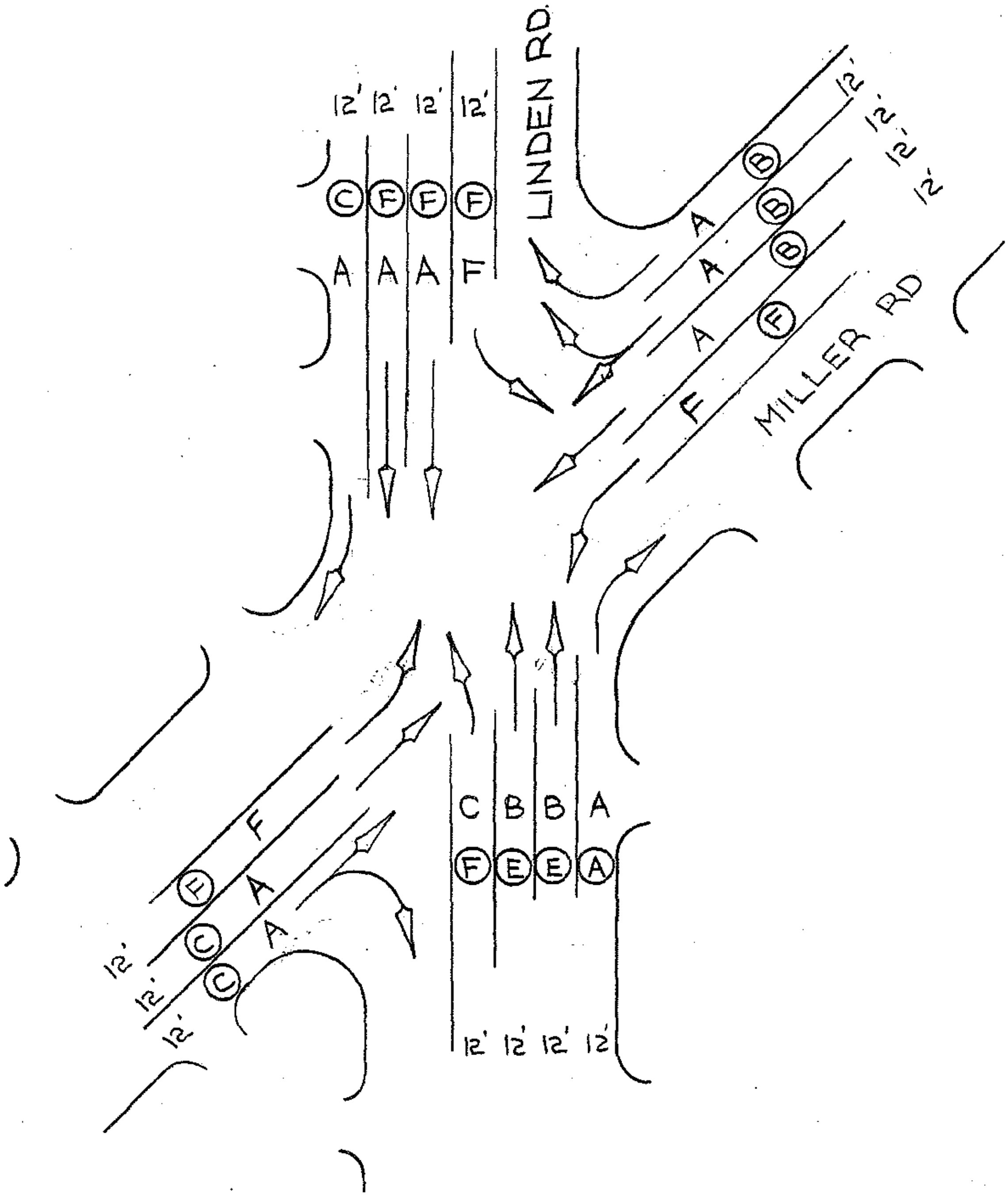
Miller @ Dye

Presently all approaches are operating with an acceptable LOS. A potential LOS problem on the EBD approach can be rectified by changing the signal

KEY

A EXISTING LOS

(A) YEAR 2005 LOS



MILLER RD / LINDEN RD

ALTERNATIVE WITH RIGHT TURN LANES AND LEFT TURN PHASES

NO SCALE

FIGURE V-3

splits to allow for additional green time on the EBD and WBD approaches and with the establishment of signal progression on Miller Road. These adjustments would improve the EBD left/thru and right/thru LOS from "C" and "B" respectively to LOS "A" on both.

Miller @ Elms

No LOS problems exist at the present time at this location. By the year 2005 the NBD and SBD left/thru lanes will drop to LOS "E" and "F" respectively with the existing signal timings. By changing the signal split from the present 30/70 (Elms/Miller) to 35/65, or even 40/60, these problems would be eliminated without adversely affecting the LOS on Miller Road. This, however, would not be necessary until the traffic volumes on Elms Road warrant it.

Bristol @ I-69

The two right only lanes on the SBD approach are currently at LOS "E" and projected to deteriorate even further by 2005. By increasing the amount of green time for the SBD off ramp from 33% to 40% the LOS improves substantially without hindering the EBD or WBD Bristol Road flow. With the proposed signal splits the LOS improves to "C" under existing conditions and LOS "D" with projected future traffic voluems. Traffic flow would greatly improve at this intersection as well as at Linden/Bristol and Linden/Miller if this signal was included in the Linden Road progression system (See Appendix C).

Linden @ Bristol

The EBD left/thru, right/thru and WBD right turn lanes are operating at LOS "E" and "D" at the present time and the SBD left turn lane falls to LOS "F" by the year 2005. With the addition of another right turn only lane on the WBD approach, the LOS improves to "B". By widening the EBD approach to provide for a right/thru, thru and left turn lanes the LOS would improve to acceptable conditions for both existing and future traffic volumes. The SBD approach would also show LOS improvement by redesignating the three existing lanes as two exlcusive left turn lanes and a right/thru lane. Signal timing adjustments are also required to accommodate the large WBD right turn and SBD left turn demands. Figure V-4 shows the resulting LOS improvements with these changes.

Linden @ Genesee Valley Mall

The intersection is experiencing a LOS problem only on the WBD right turn lane at the present time. This lane is at LOS "D" and is projected to be at LOS "F" by the year 2005. With the opening of the Oak Brook Mall, however, turning movement volumes will increase substantially on all approaches. The planned left-turn phases followed by a flashing red on the Linden approaches will help substantially for the left turning movements. The additon of an exclusive right turn lane on the south bound approach will also help facilitate vehicles turning into the Oak Brook Mall. Until the new mall is open for a period of time and traffic stabilizes, it is difficult to anticipate specific problems and solutions.

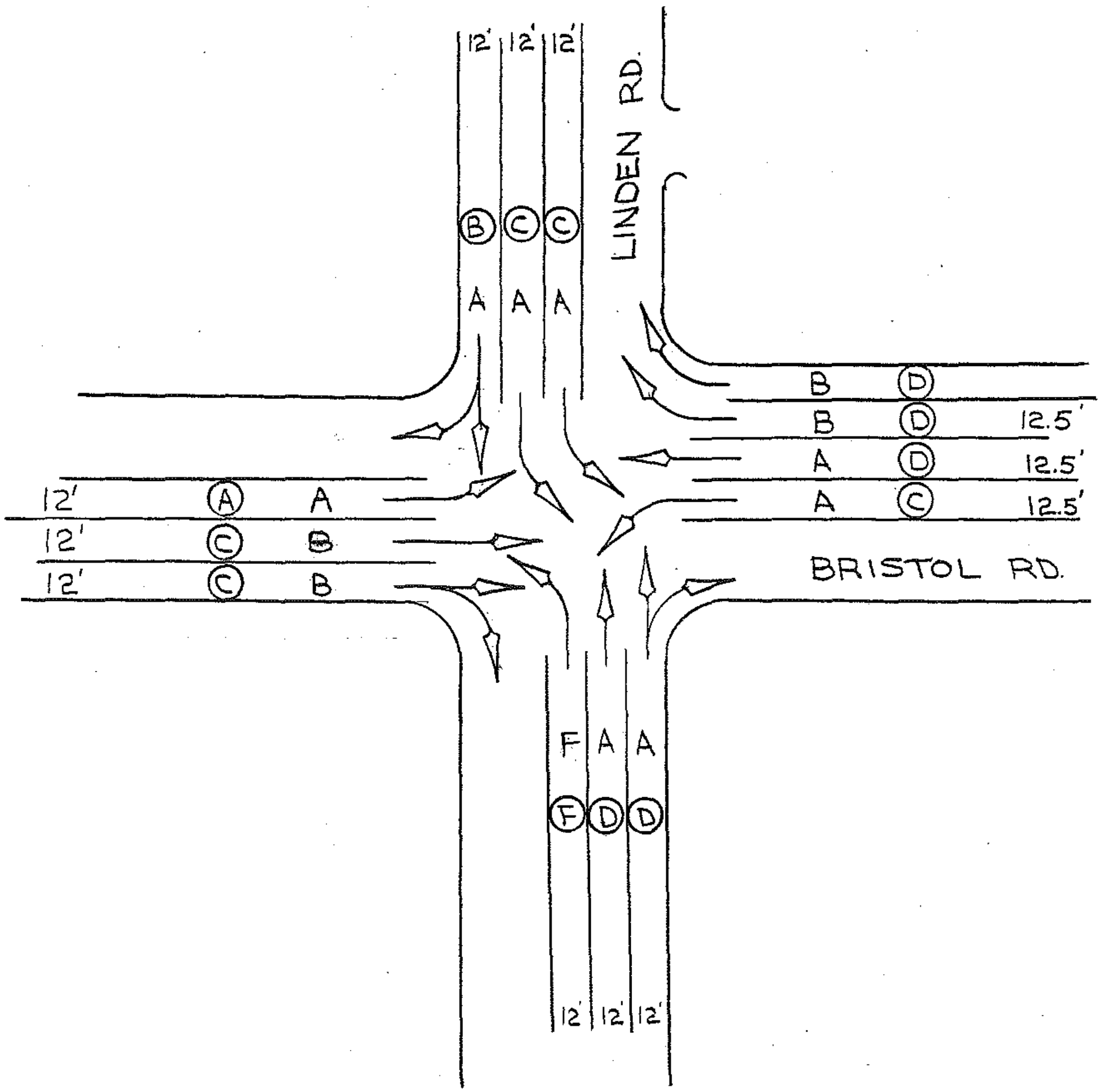
Linden @ Lennon

Although there are presently no LOS problems at this intersection, left-turns from Linden onto Lennon are projected to be hampered with increased traffic volumes. By changing the existing splits from 65/35 (Linden/Lennon) to 68/28 with a 2% all red phase following each green, some LOS improvements can be

KEY

A EXISTING LOS

(A) YEAR 2005 LOS



LINDEN RD / BRISTOL RD

WITH EBD AND WBD APPROACHES WIDENED, SBD LANES REDESIGNATED AND NBD & SBD LEFT TURN PHASES

NO SCALE

FIGURE V-4

attained. If these signal timing changes do not help the north and south bound left turning movements then the feasibility of adding left-turn phases should be studied.

Linden @ M-56 Corruna

No LOS problems exist at the present time at this location. With projected volumes by the year 2005 all lanes on the north bound approach and the west bound left turn lane will be at LOS "D". Changing the existing signal split from 53/43 (M-56/Linden) to 48/48, with two 2% all red phases, would improve the LOS to "C" for the NBD thru and right thru movements. This adjustment, however, would cause the WBD left turn movement to decline to LOS "E". When the volumes warrant, left-turn phases should be considered at this intersection.

Beside the improvements described at each of the locations above, travel in general would be enhanced throughout the corridor by implementing some broader range alternatives. Two of those that were tested were establishing progression on both Miller and Linden Roads and widening Miller Road to six lanes on those segments between Linden and Lennon that presently are not.

With the establishment of progression, the vehicle delay time, fuel consumption and the incentive to travel faster than the set speed limit, would all be reduced.

The proposed progression would interconnect the traffic signals on Miller Road into one system and those on Linden Road into another. The Miller Road system would interconnect the signals from Dye Road to Genesee Valley Mall

Drive and from Lennon to Ballenger. The Linden Road system currently is interconnected from M-56 south to Bristol Road. The proposed system would also incorporate the Bristol Road/I-69 interchange. Both systems would operate on an 80-second cycle and work independent of one another. See Appendix C for recommended timing splits and proposed time - space diagrams for each system. This analysis and resulting recommendations were done in conjunction with MDOT's Safety Programs Unit, Traffic and Safety Division.

The second alternative studied was the widening of Miller Road, between Linden and Lennon Roads, to six lanes on portions that are currently four or five lanes. This configuration would provide for a continuous left-turn lane, three west bound lanes, and two east bound lanes. The center left-turn lane would allow through traffic in both directions to flow smoothly with the least amount of interruptions between signals. Some of the benefits derived from this concept are a reduction in accidents and improved progression.

With the continuous left-turn lane a significant reduction in left turn and rear-end accidents would be realized. By eliminating left turns from the through travel lanes, rear-end accidents would be reduced. Vehicles making left turns onto Miller from the commercial drives would also be able to use the center turn lane for transition into the traffic flow, thus reducing angle type accidents.

Another alternative that was examined is the concept of consolidating commercial driveways within the corridor. A number of driveways are in close proximity to major intersections, and hence interfere with normal traffic movement through the intersection. In some cases, access and egress to and from these business establishments is also hampered. Limiting future and consolidating existing access points would facilitate traffic flow between signalized intersections.

Although this access control concept is usually very difficult to implement "after the fact", it should be required whenever possible. The construction of service drives, such as the one parallel to Linden on the west side just north of Miller, that accesses cross streets or limited locations on Miller or Linden roads would reduce the number of conflicting traffic movements and related accident potential. The concept of consolidating access points in areas with high commercial development is one that needs to be studied and analyzed in more detail so that specific recommendations can be made.

Summary

As discussed in the capacity analysis section, 50% (or seven) of the signalized intersections within the corridor currently have some type of capacity problem. With the Transportation Systems Management (TSM) type of improvements outlined above, the level of service could be improved on at least one approach, if not all, of the identified problem intersections. These improvements include signal optimization, signal progression, redesignating existing lanes and construction of turn lanes or additional through lanes. All are considered to be short term in nature and implemented with relatively low costs.

These improvements will help alleviate some of the projected year 2005 problems. It is difficult at this time to pinpoint specific LOS improvements because of the extensive amount of new development occurring within and adjacent to the corridor. If current trends continue, however, the proposed

TSM improvements will not solve all of the future traffic problems. Instead longer range alternatives will need to be developed to facilitate the larger volumes of traffic. Further analysis and testing must be done to formulate feasible solutions for these problems if they do indeed occur.

GLOSSARY

GLOSSARY

Approach Volume-Total number of vehicles entering an intersection from a given direction usually counted on a one hour, peak hour, 8 hour or 24 hour basis.

Average Daily Traffic (ADT)-The average number of vehicles passing a specified point during a 24 hour period.

Band Width Plot-Graphically summarizes the number of trips passing over a specific roadway segment in a 24 hour period.

Capacity-The maximum number of vehicles that can pass over a given section of a lane or roadway in one direction (or in both directions for a 2-lane highway) during a given time period under prevailing roadway and traffic conditions.

GCMPC-Genesee County Metropolitan Planning Commission.

Computer Modeling-A computer process which uses a mathematical formula that expresses the actions and interactions of the elements of a system so that the system may be evaluated under any given set of conditions: Land-use, economic, socio-economic, travel characteristics, etc.

Corridor-A geographical study area containing a major roadway and the related area of influence. (Defined here as used within this report).

Count-A traffic volume counted at a specified point on a roadway, either manually or by machine. The count may be directional or total two-way, peak hour - morning and/or afternoon - and/or a 24 hour value.

Green Time/Cycle Length (G/C) Ratio-The fraction of cycle time that a specific through traffic movement has a green signal light. It is generally expressed as a ratio of the percent green time allowed adjacent approaches (e.g., 60/40).

Headway-The distance or time that separates vehicles moving in the same direction measured from head to head as they pass a given point.

Level of Service (LOS)-The quality of service at which a facility operates. It is determined by the volume/capacity ratio and expressed by a series of letter grades from A (high V/C ratio) and F (jammed conditions).

Link-A segment of roadway in a transportation network.

Michigan Accident Location Index (MALI)-A central computer file of all reported traffic accidents within the state that is maintained by the Michigan State Police. Outputs include accidents on individual county and street basis, at intersections by month and day or as otherwise requested.

MDOT-Michigan Department of Transportation.

Network-A system of links describing a transportation system for analysis.

Peak Hour-The hour during which the largest amount of traffic is using a particular roadway.

Segment-Portion of roadway identified by common characteristics that can be analyzed in finer detail (consists of one or more connecting links).

Select Link Analysis-Process which utilizes computer programs to identify and analyze all trips by origin and destination which use a particular segment of roadway in a 24 hour period.

Signal Cycle Length-Amount of time (in seconds) that it takes a traffic signal to go from a green indication through the yellow and red periods and back to green.

Signal Phase-The interval of cycle time allocated to any traffic movement(s) receiving the right-of-way.

Signal Progression-A signal system in which the signals controlling a given street are set to permit as nearly as possible continuous operations at a planned rate of speed.

Traffic Analysis Zone (TAZ)-The smallest geographical area for transportation analysis.

Trip-A one-direction movement which begins at the origin, ends at the destination, and is conducted for a specific purpose.

Trip End-The origins or destinations of trips. The total number of trip ends in an area equals twice the number of trips to or from it.

Trip Length-The length of a trip measured in miles.

Trip Purpose-The reason for making a trip: Normally for one of ten identified purposes. Each trip may have a purpose at each end; for example, home to work.

Trip Table-A matrix of the number of trips from each zone to all other zones.

TSM-Transportation Systems Management. An element of TIP (Transportation Improvement Program) that proposes non-capital-intensive steps toward the improvement of a transportation system.

Urbanized Area-An area that contains a city (or twin cities) of 50,000 or more population (central city) plus the surrounding, closely settled incorporated area which meets certain criteria of population size or density.

Vehicle miles of travel (VMT)-Is generally used as an areawide measure. It is calculated by summing the total amount of travel in a defined area and multiplying by the total distance over which it travels.

Volume-The amount of traffic passing over a given point for a specified period of time (usually 24 hours).

Volume/Capacity (V/C) Ratio-Is the volume traveling on a particular roadway segment divided by the capacity the segment can handle. It is expressed as a fraction of one.

APPENDIX A

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY #083

1763 (4/80)

DATE 4-9/10-84 DAY MON-TUE COUNTY GENESEE

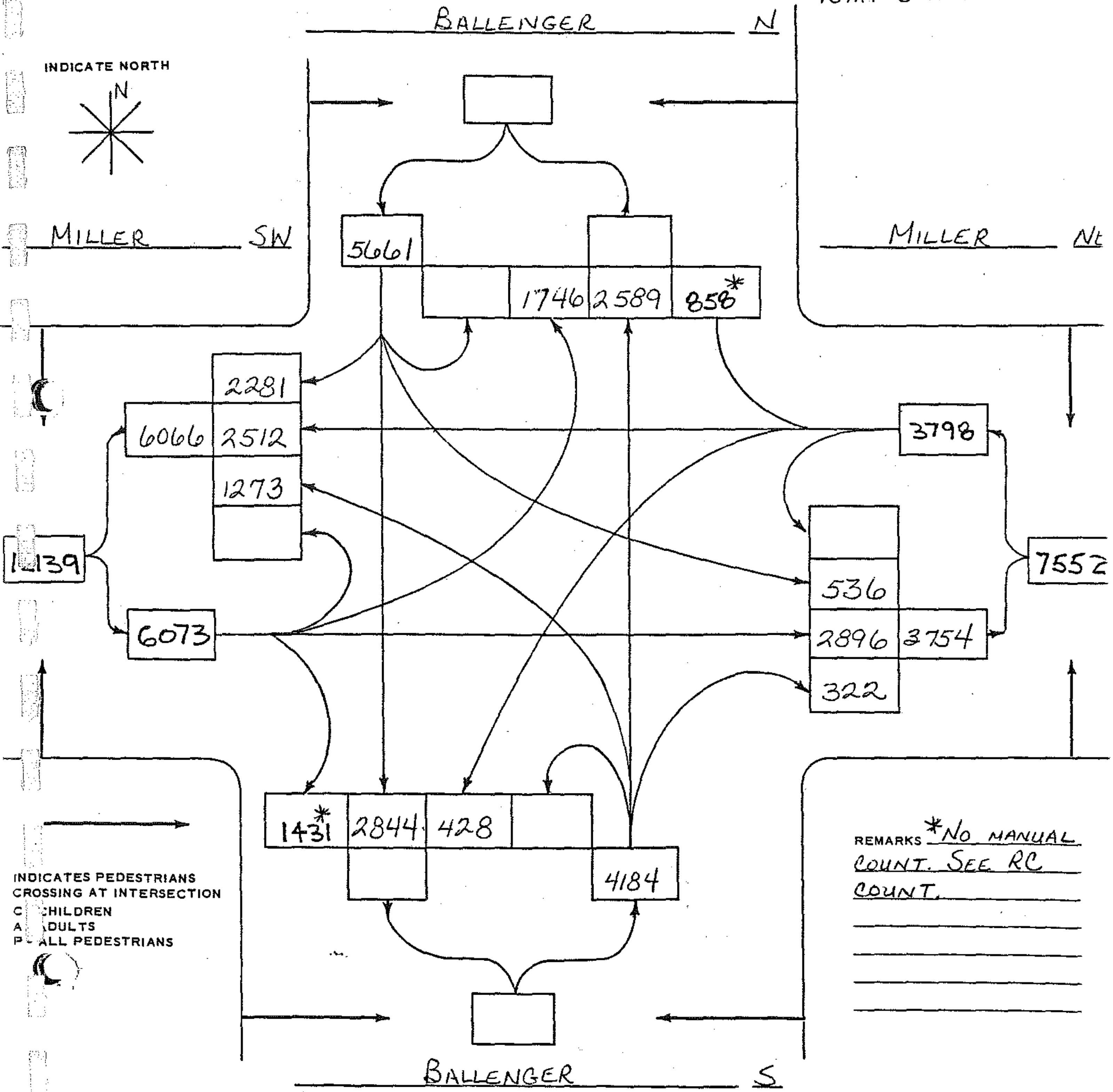
TWP., VILLAGE OR CITY FLINT WEATHER CLEAR

INTERSECTION OF MILLER RD @ BALLENGER

TIME: 11A TO 1P; 2P TO 6P; 7A TO 9A

Total 8 HRS

INDICATE NORTH



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS *NO MANUAL COUNT. SEE RC COUNT.

MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

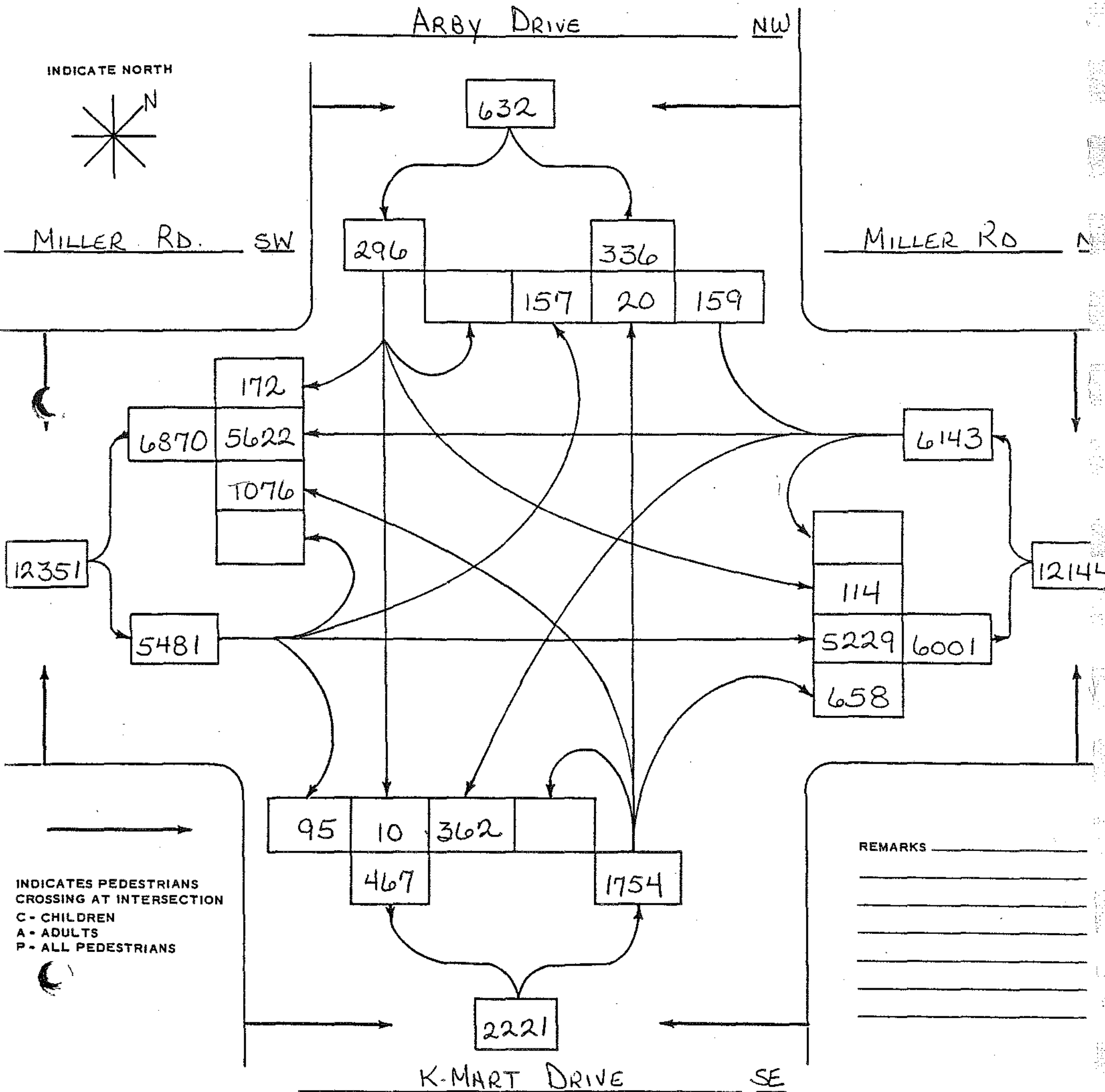
STUDY # 82

DATE 4-10/11-84 DAY TUE-WED COUNTY GENESEE TIME

TWP., VILLAGE OR CITY FLINT WEATHER CLEAR

INTERSECTION OF MILLER RD @ KMART AND ARBY DRIVES

TIME		
11A	TO	1P
2P	TO	6P
7A	TO	9A



VEHICLE VOLUME COUNT

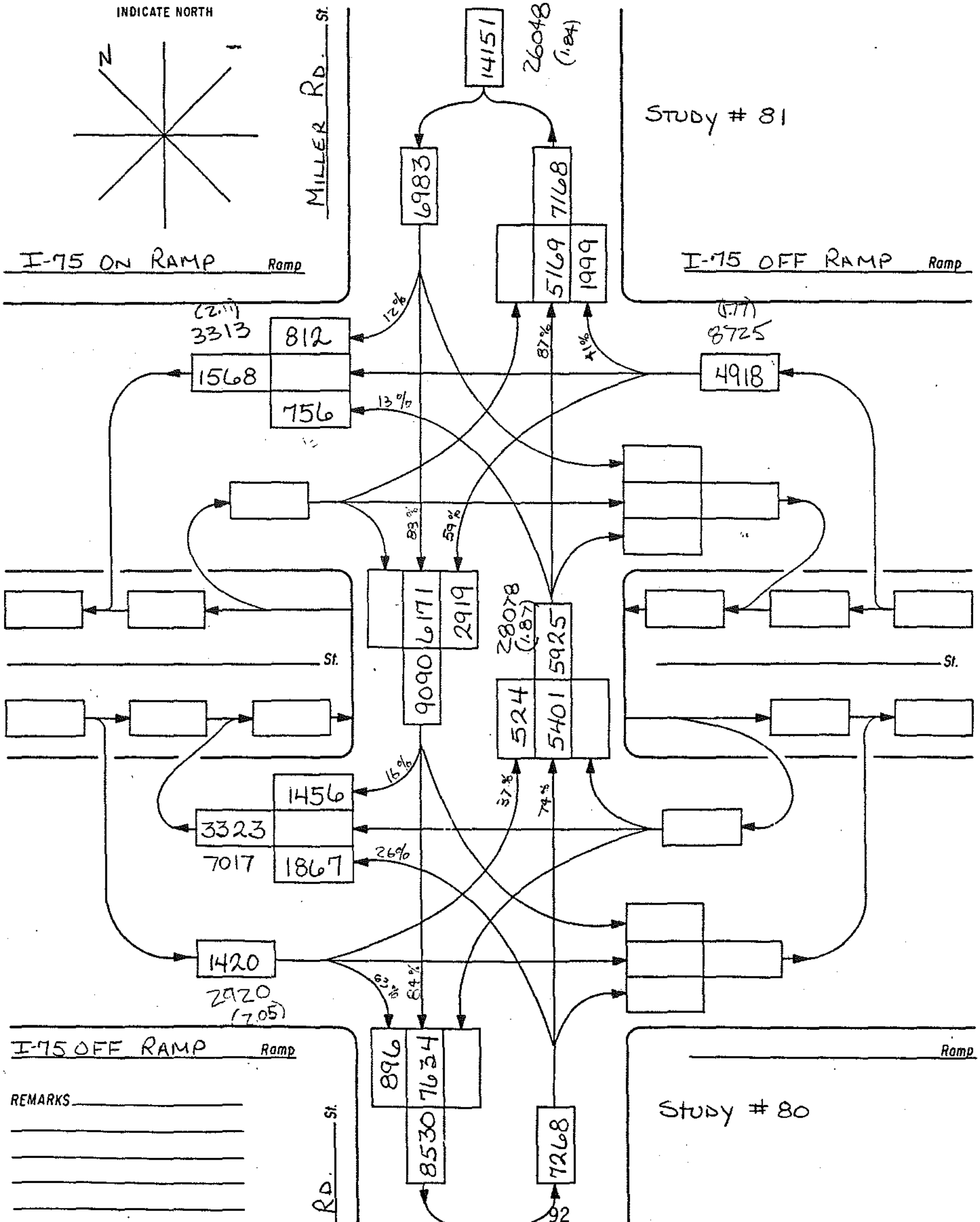
GRAPHIC SUMMMARY SHEET
STUDY # 80 & 81

MICHIGAN DEPARTMENT OF TRANSPORTATION
1763A (7/79)

DATE 4-11/12-84 DAY WED-Thur WEATHER Clear TIME 2P-6P, 7A-9A, 11A-1P

COUNTY GENESEE TWP., VILLAGE OR CITY FLINT

INTERSECTION OF I-75 RAMPS @ MILLER RD.



REMARKS

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY #079

MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

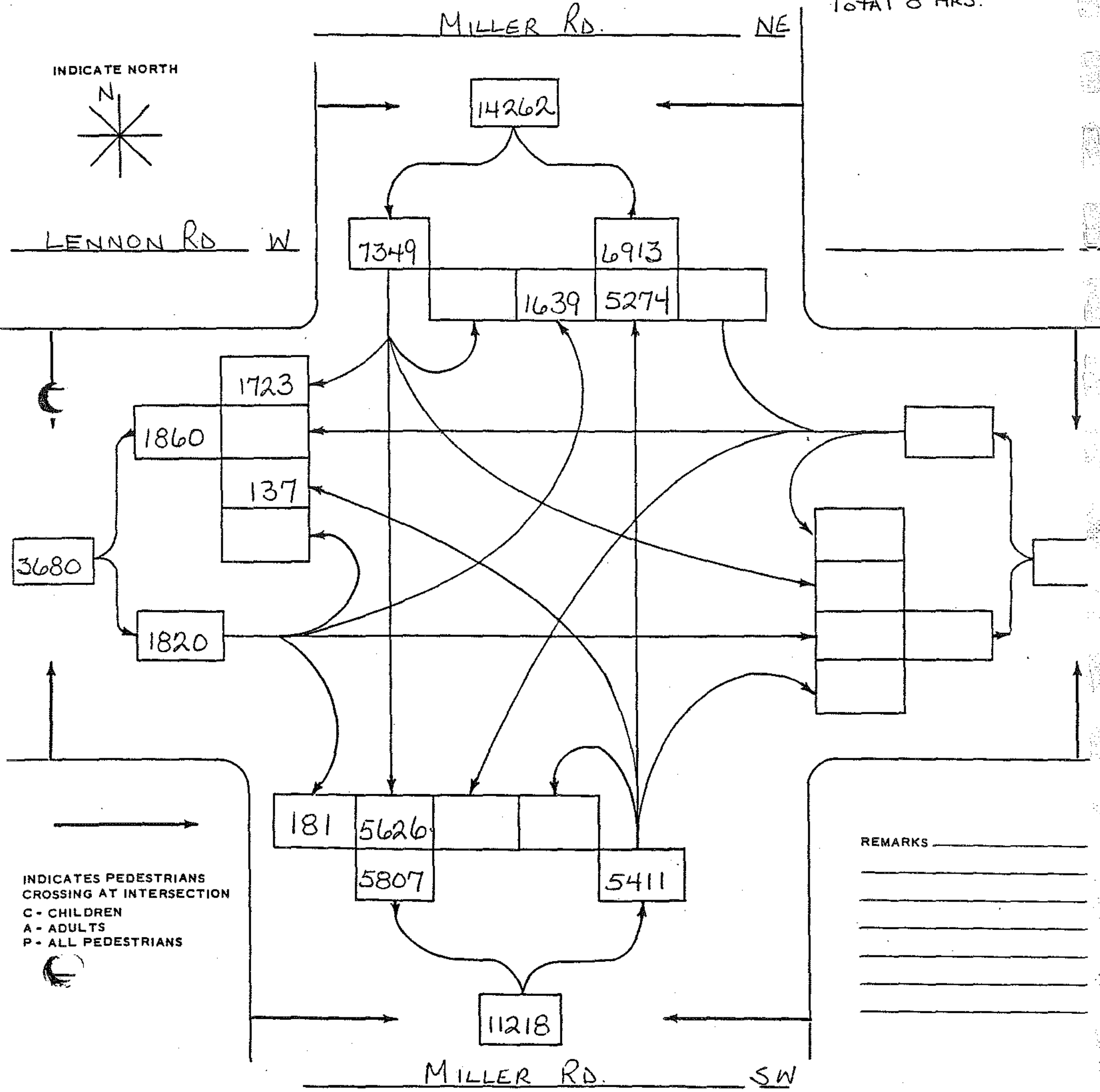
DATE 4-11/12-84 DAY Wed-Thur COUNTY GENESEE TIME

TWP., VILLAGE OR CITY Flint WEATHER Clear 2P TO 6P

INTERSECTION OF MILLER RD @ LENNON RD. 7A TO 9A

11A TO 1P

Total 8 HRS.



VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY #078

MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

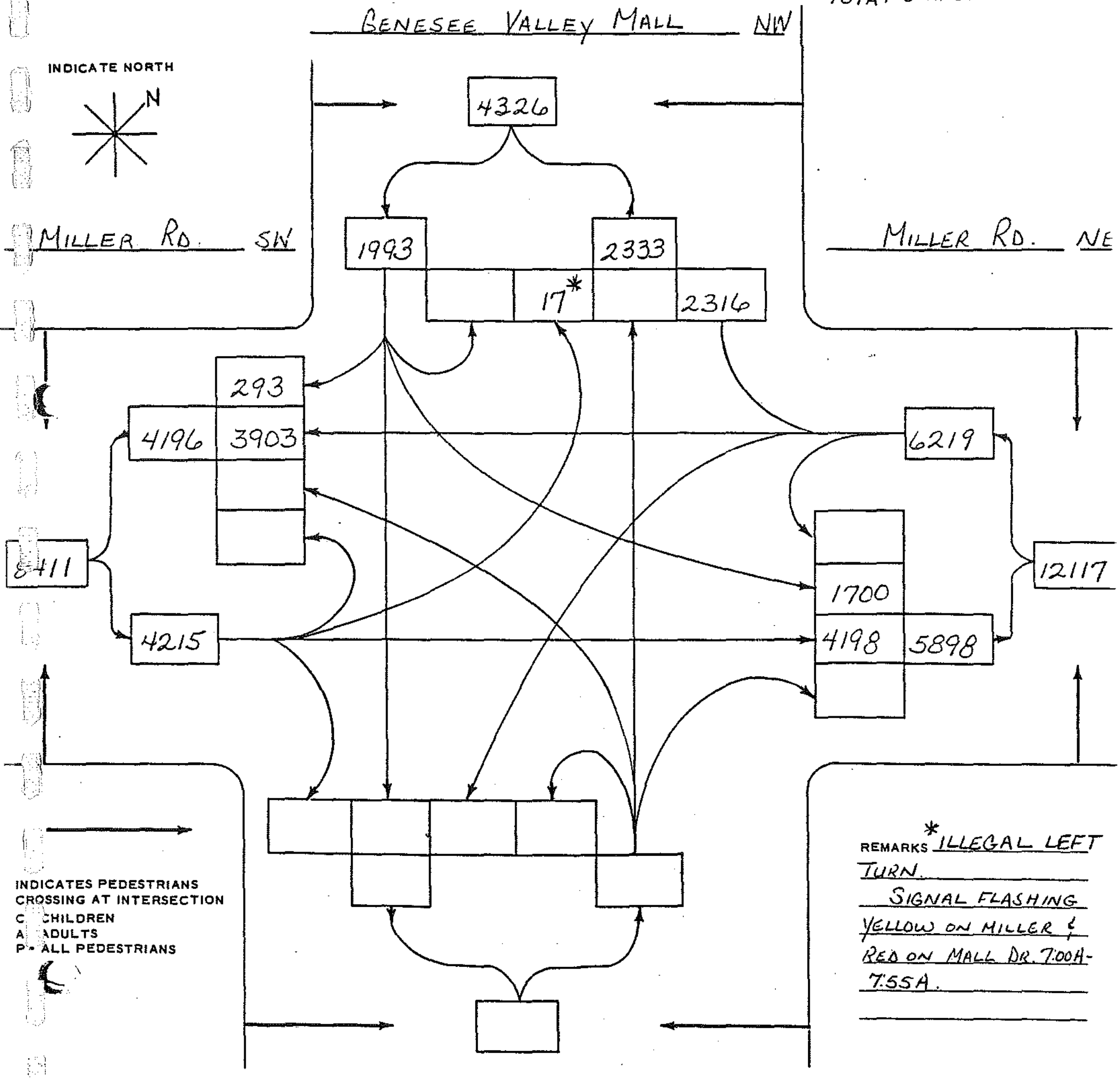
DATE 4-16/17-84 DAY MON-TUE COUNTY GENESEE

TWP., VILLAGE OR CITY FLINT WEATHER CLOUDY

INTERSECTION OF MILLER RD @ GENESEE VALLEY MALL DR.

TIME		
11A	TO	1P
2P	TO	6P
7A	TO	9A

Total 8 HRS.



REMARKS *ILLEGAL LEFT TURN.
SIGNAL FLASHING YELLOW ON MILLER & RED ON MALL DR. 7:00A-7:55A.

MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY # 84

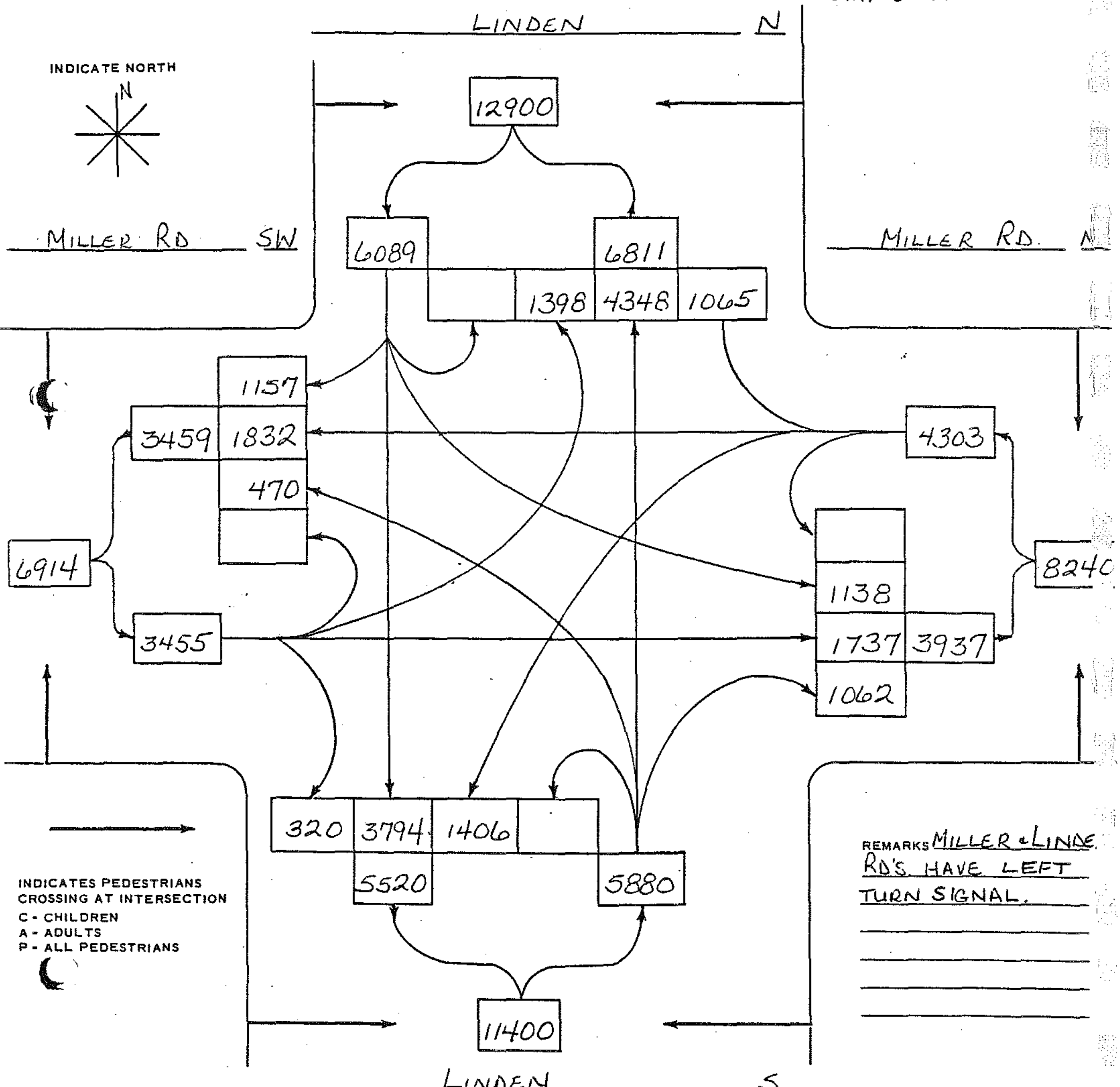
DATE 4-9/10-84 DAY MON-TUE COUNTY GENESEE

TWP., VILLAGE OR CITY FLINT WEATHER CLEAR

INTERSECTION OF MILLER RD @ LINDEN RD

TIME		
11A	TO	1P
2P	TO	6P
7A	TO	9A

TOTAL 8 HRS.



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS MILLER & LINDE. RD'S. HAVE LEFT TURN SIGNAL.

1763 (4/80)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY # 77

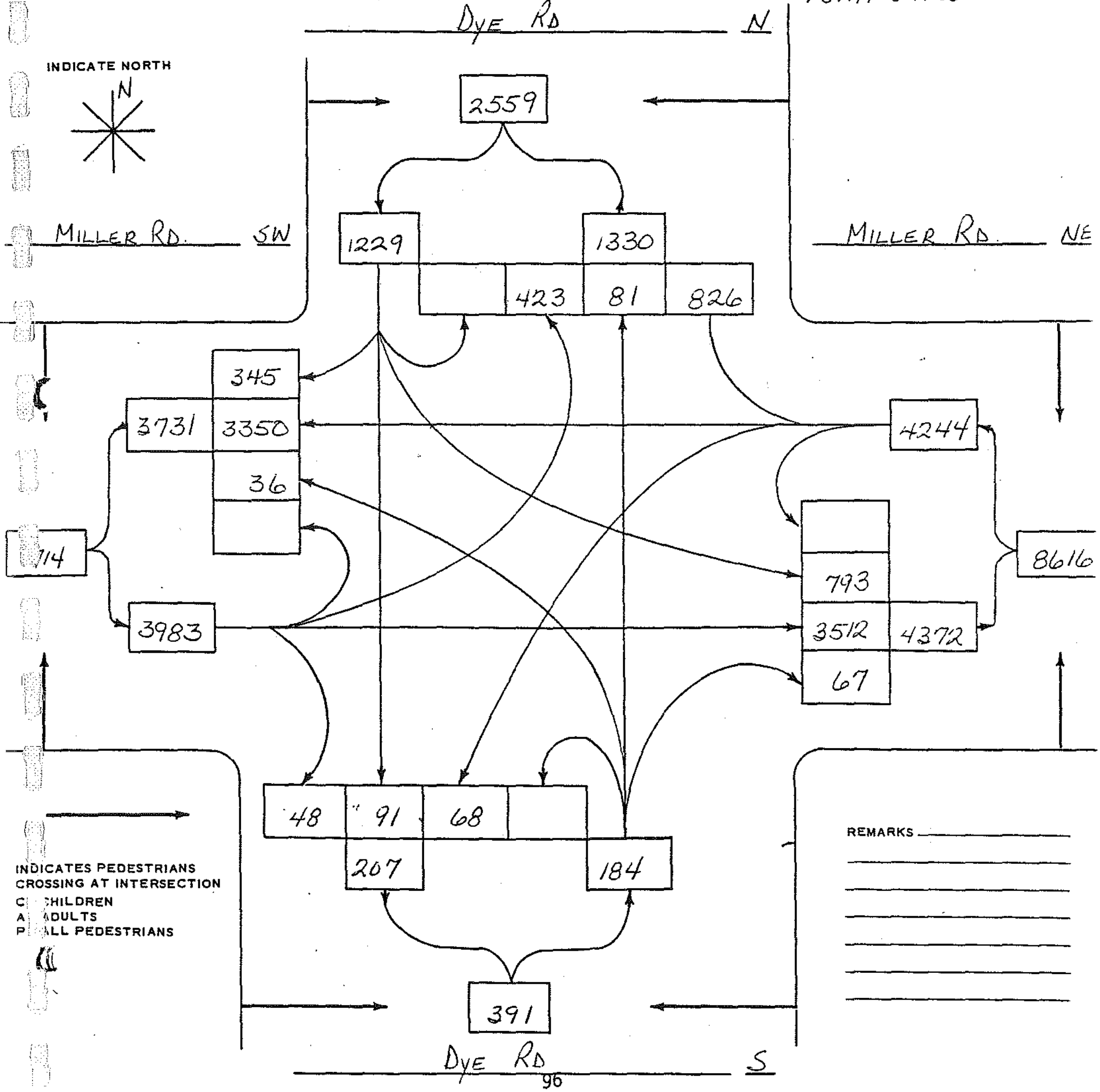
DATE 4-18/19-84 DAY WED-Thur COUNTY GENESEE

TWP., VILLAGE OR CITY FLINT WEATHER RAIN

INTERSECTION OF MILLER RD @ DYE RD.

TIME		
2P	TO	6P
7A	TO	9A
11A	TO	1P

Total 8 HRS.

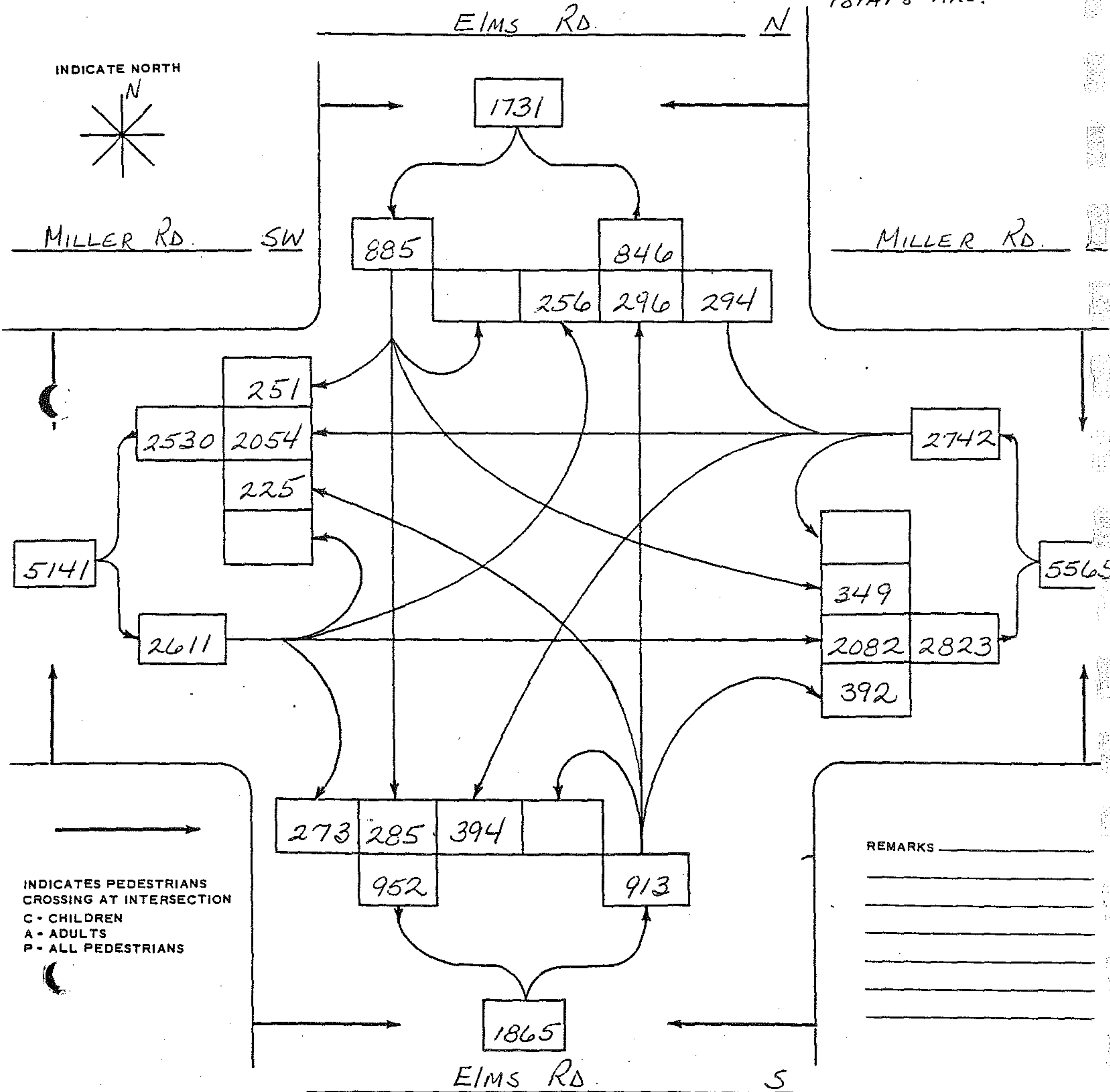


VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET
STUDY # 76

MICHIGAN DEPARTMENT OF TRANSPORTATION
1763 (4/80)

DATE 4-18/19-84 DAY WED-Thur COUNTY GENESEE
TWP., VILLAGE OR CITY FLINT WEATHER RAIN
INTERSECTION OF MILLER RD @ ELMS RD

TIME
2P TO 6P
7A TO 9A
11A TO 1P
Total 8 HRS.



1763A (7/79)

VEHICLE VOLUME COUNT

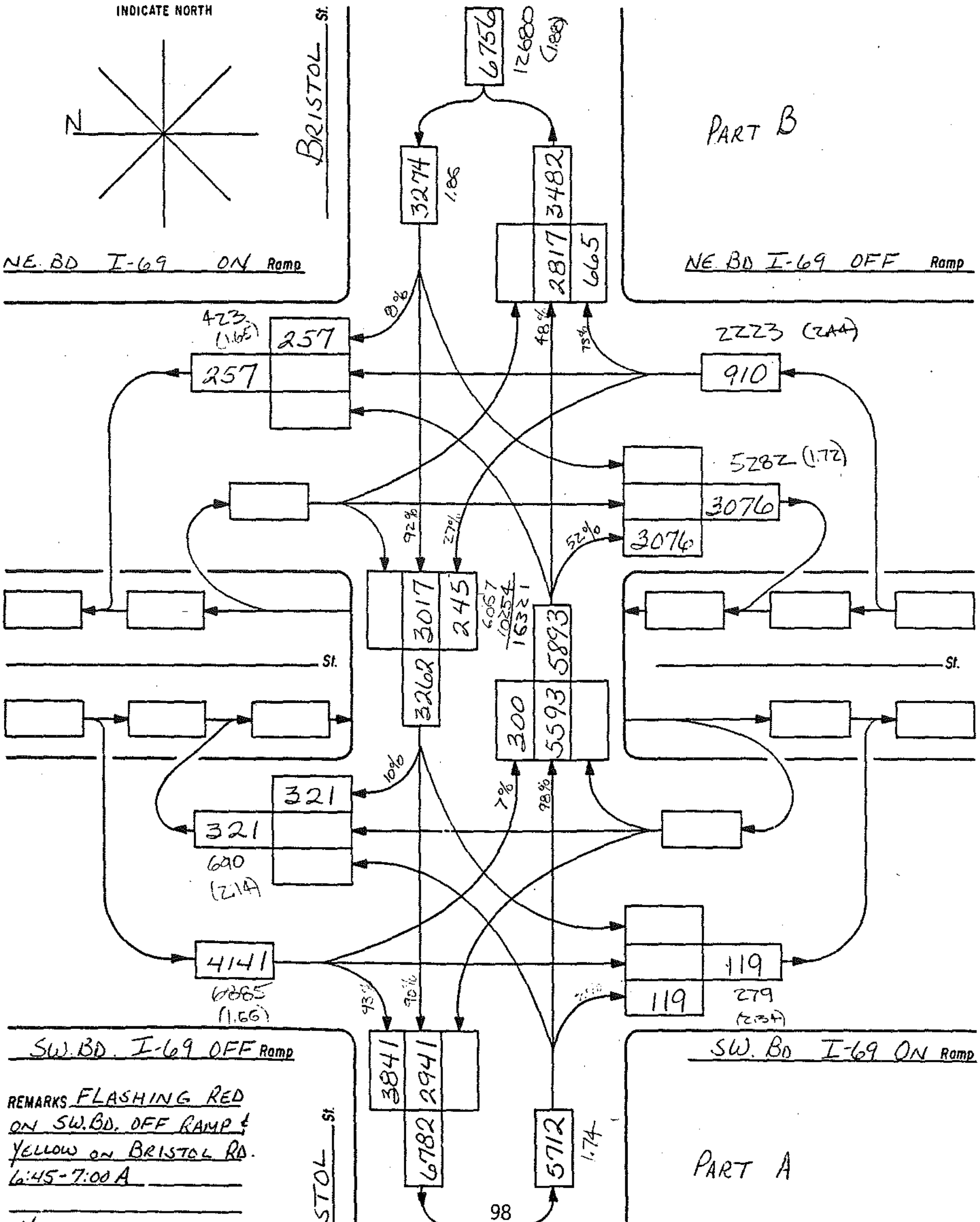
GRAPHIC SUMMMARY SHEET

STUDY # 73

DATE 4-17/18-84 DAY TUE-WED WEATHER RAIN/SNOW TIME 11A-1P, 2P-6P, 7A-9A

COUNTY GENESEE TWP., VILLAGE OR CITY FLINT

INTERSECTION OF I-69 @ BRISTOL ROAD



REMARKS FLASHING RED ON SW. BD. OFF RAMP & YELLOW ON BRISTOL RD. 6:45-7:00 A

NO EXTENDED

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY #085

MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

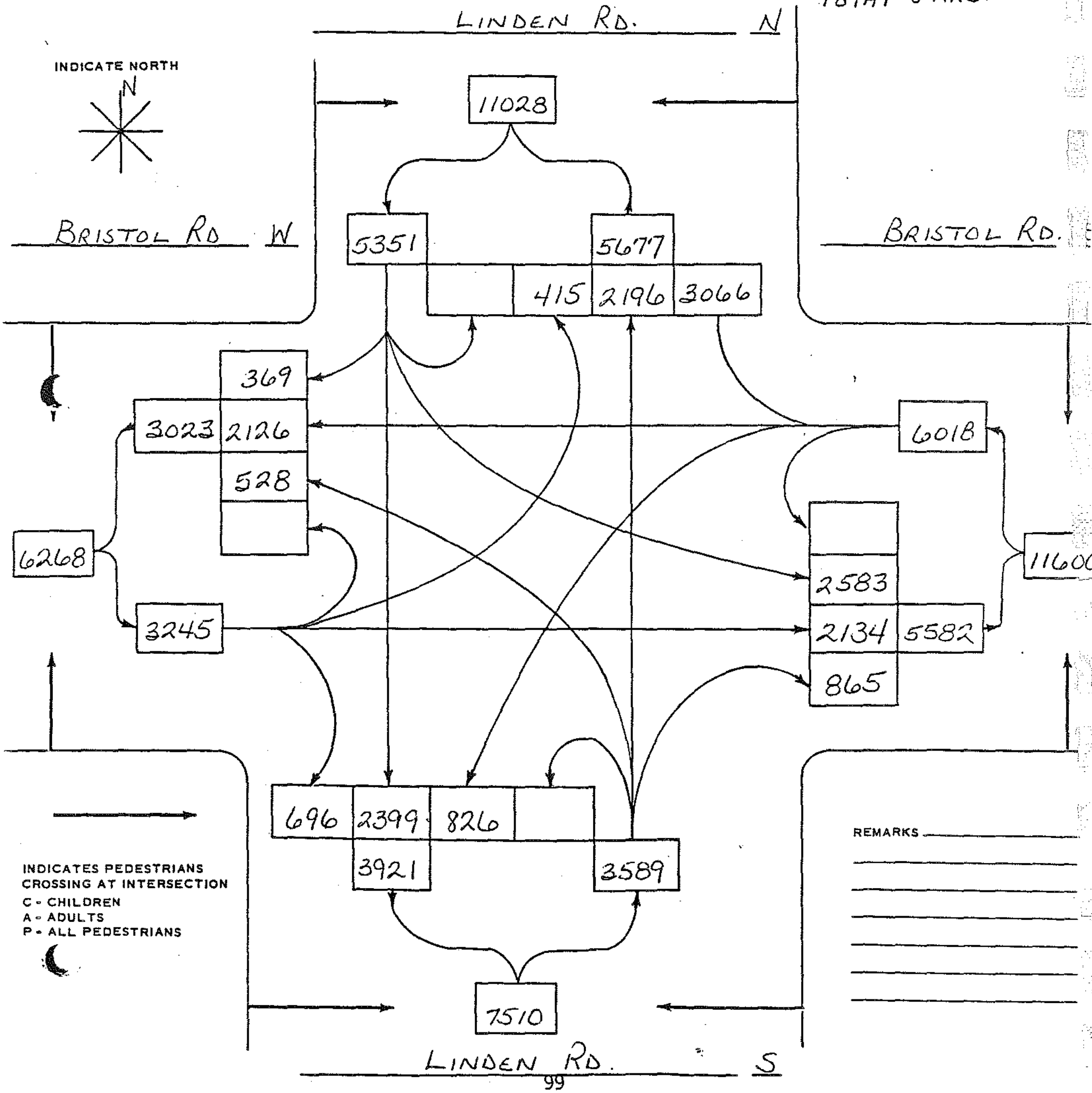
DATE 4-10/11-84 DAY TUE-WED COUNTY GENESEE

TWP., VILLAGE OR CITY FLINT WEATHER CLEAR

INTERSECTION OF LINDEN RD @ BRISTOL RD

TIME	
11A TO 1P	
2P TO 6P	
7A TO 9A	

Total 8 HRS.



REMARKS

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY #075

1763 (4/80)

MICHIGAN DEPARTMENT OF TRANSPORTATION

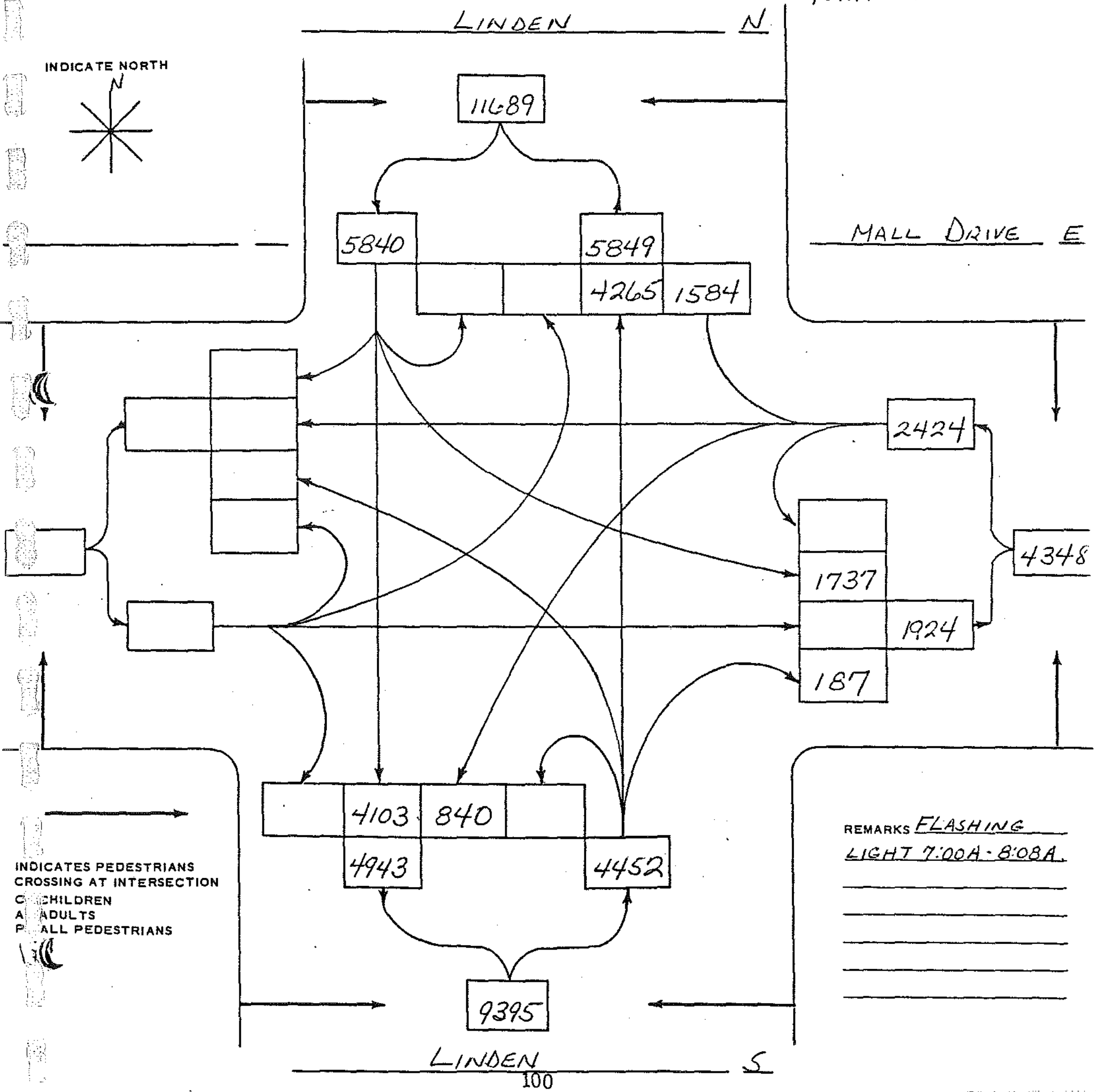
DATE 4-17/18-84 DAY TUE-WED COUNTY GENESEE TIME

TWP., VILLAGE OR CITY FLINT WEATHER DRIZZLE 11A TO 1P

INTERSECTION OF LINDEN @ GENESEE VALLEY MALL 2P TO 6P

7A TO 9A

TOTAL 8 HRS



MICHIGAN DEPARTMENT OF TRANSPORTATION

1763 (4/80)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

STUDY # 074

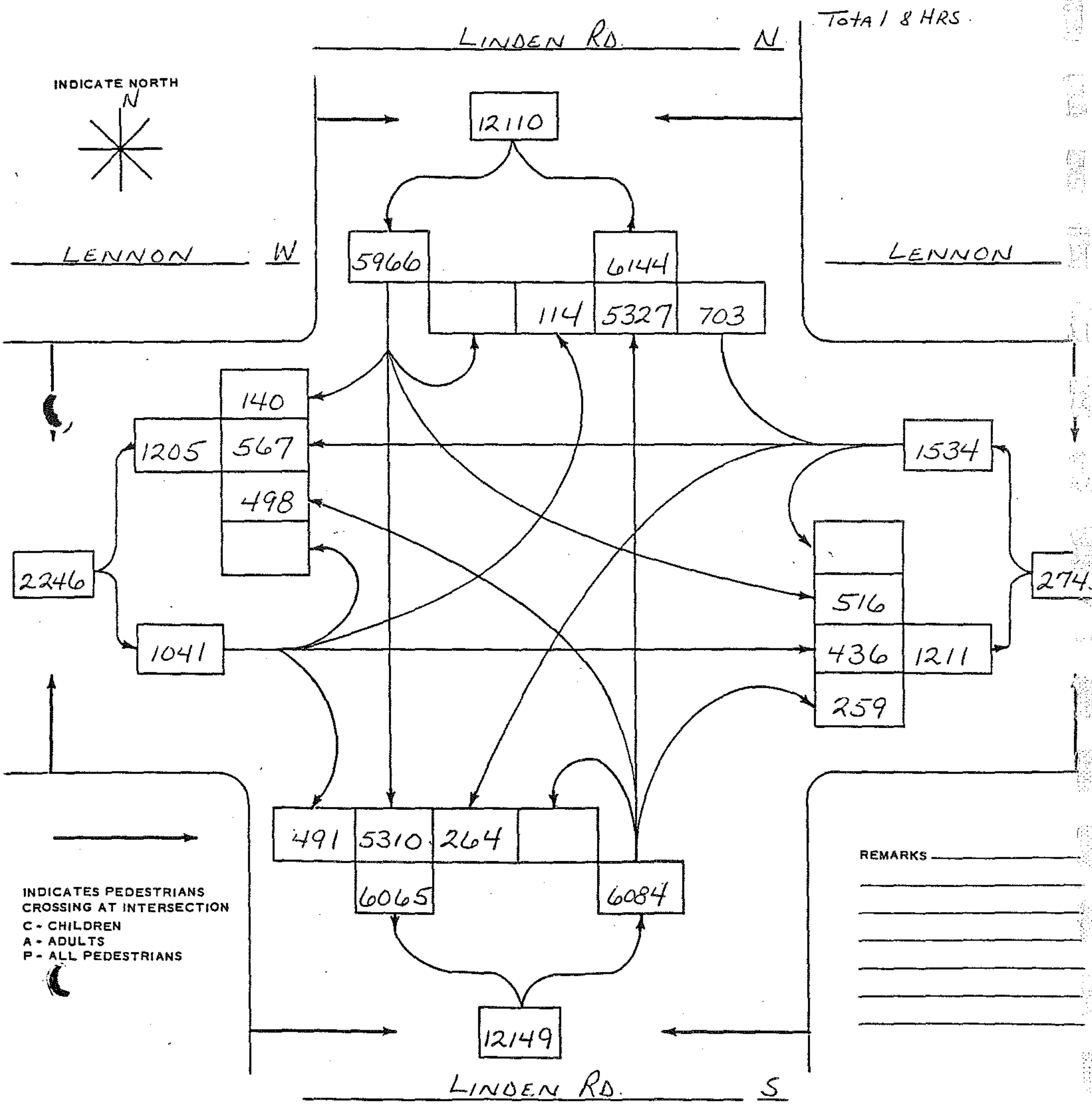
DATE 4-16/17-84 DAY MON-TUE COUNTY GENESEE TIME

TWP., VILLAGE OR CITY FLINT WEATHER Cloudy 11A TO 1P

INTERSECTION OF LINDEN RD @ LENNON RD. 2P TO 6P

7A TO 9A

Total 8 HRS



INDICATES PEDESTRIANS CROSSING AT INTERSECTION

C - CHILDREN

A - ADULTS

P - ALL PEDESTRIANS

REMARKS

1763 (4/80)

VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

STUDY # 23

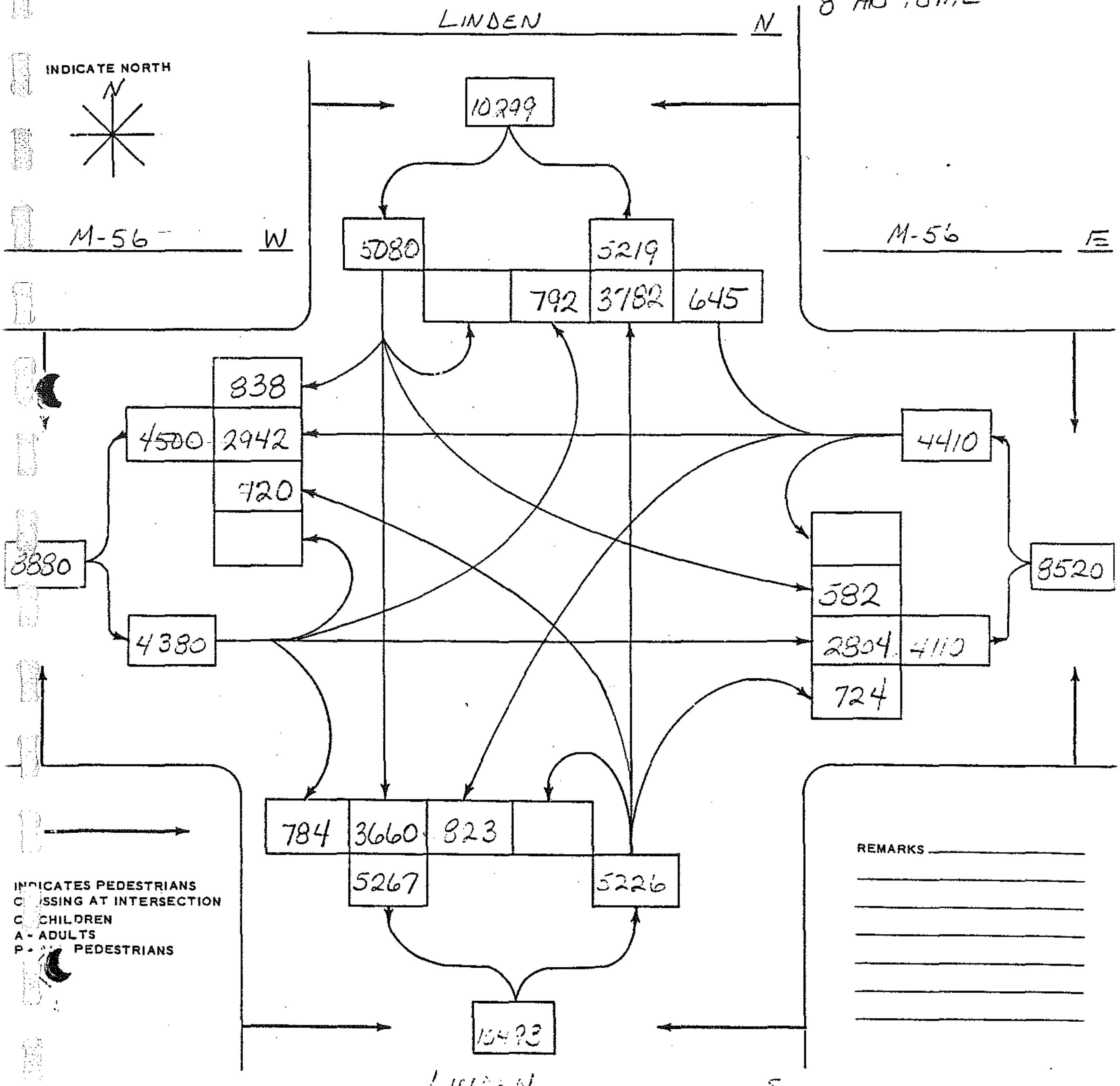
DATE 3/29-30/83 DAY Tues/Wed COUNTY GENESEE

TWP., VILLAGE OR CITY FLINT TWP WEATHER CLEAR

INTERSECTION OF M-56 (Corunna Rd) @ Linden Rd

TIME	
11A	TO 1P
2P	TO 6P
7A	TO 9A

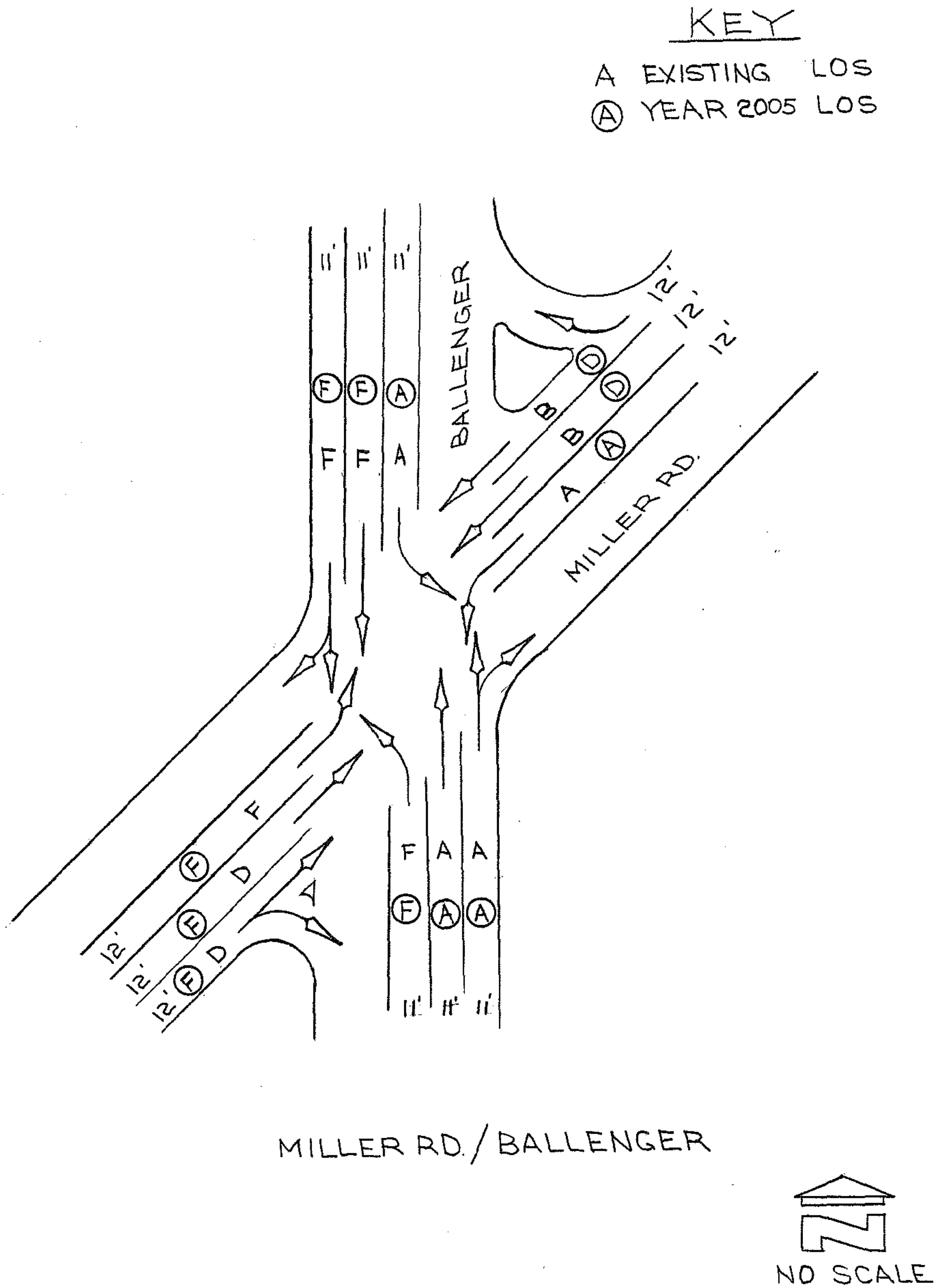
8 HR TOTAL



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS

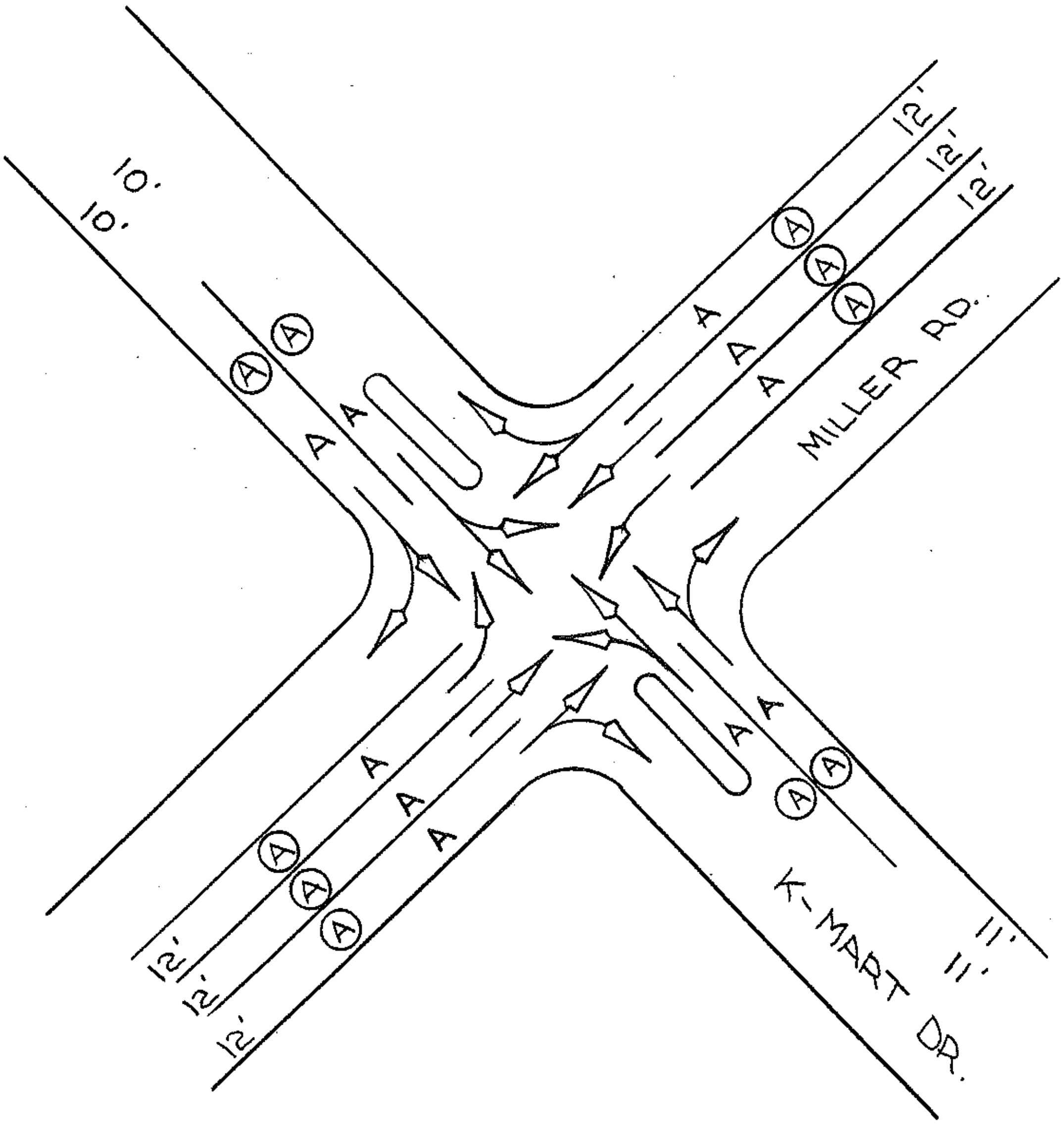
APPENDIX B



MILLER RD. / BALLENGER

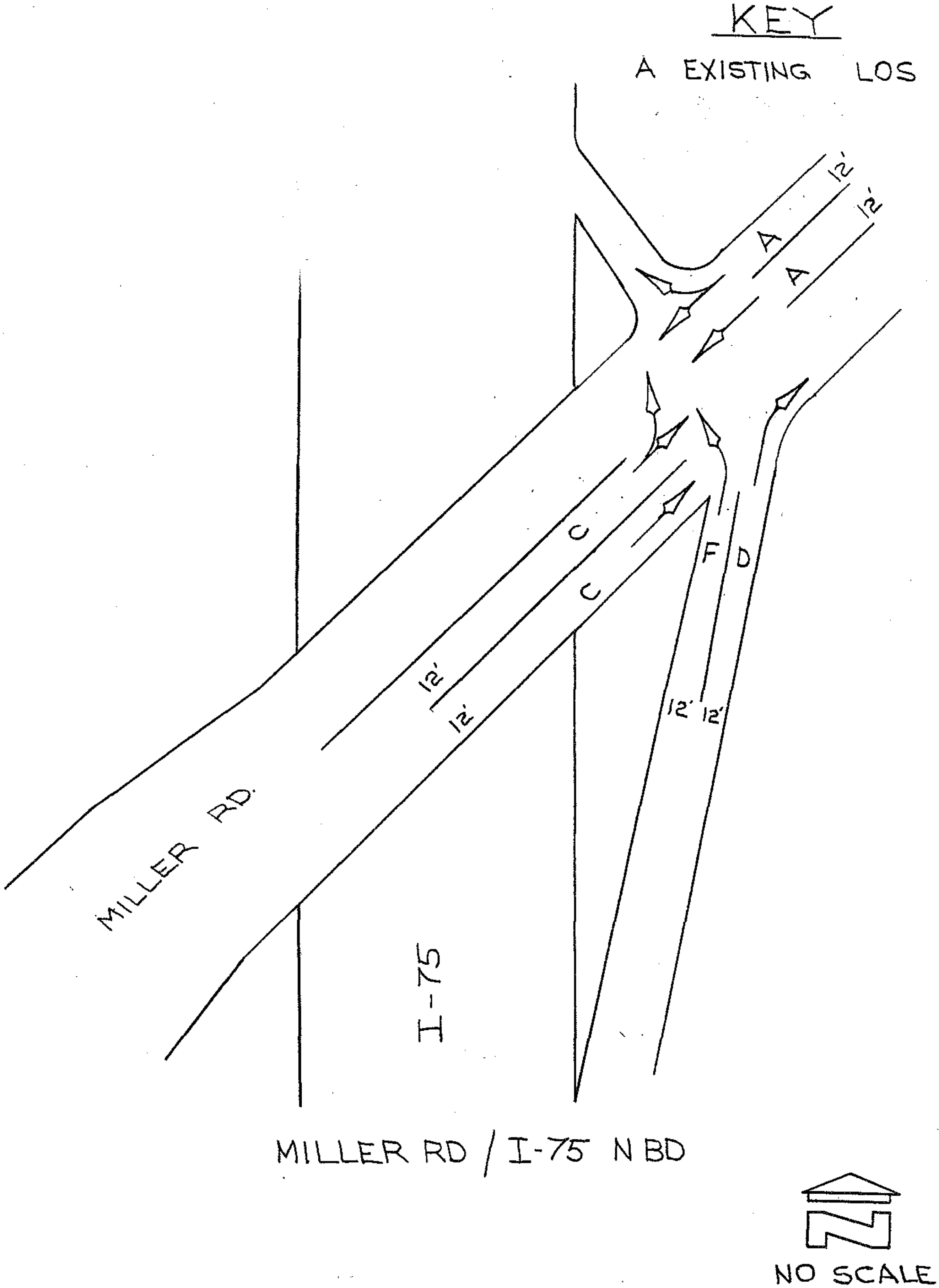
KEY

A EXISTING LOS
Ⓐ YEAR 2005 LOS

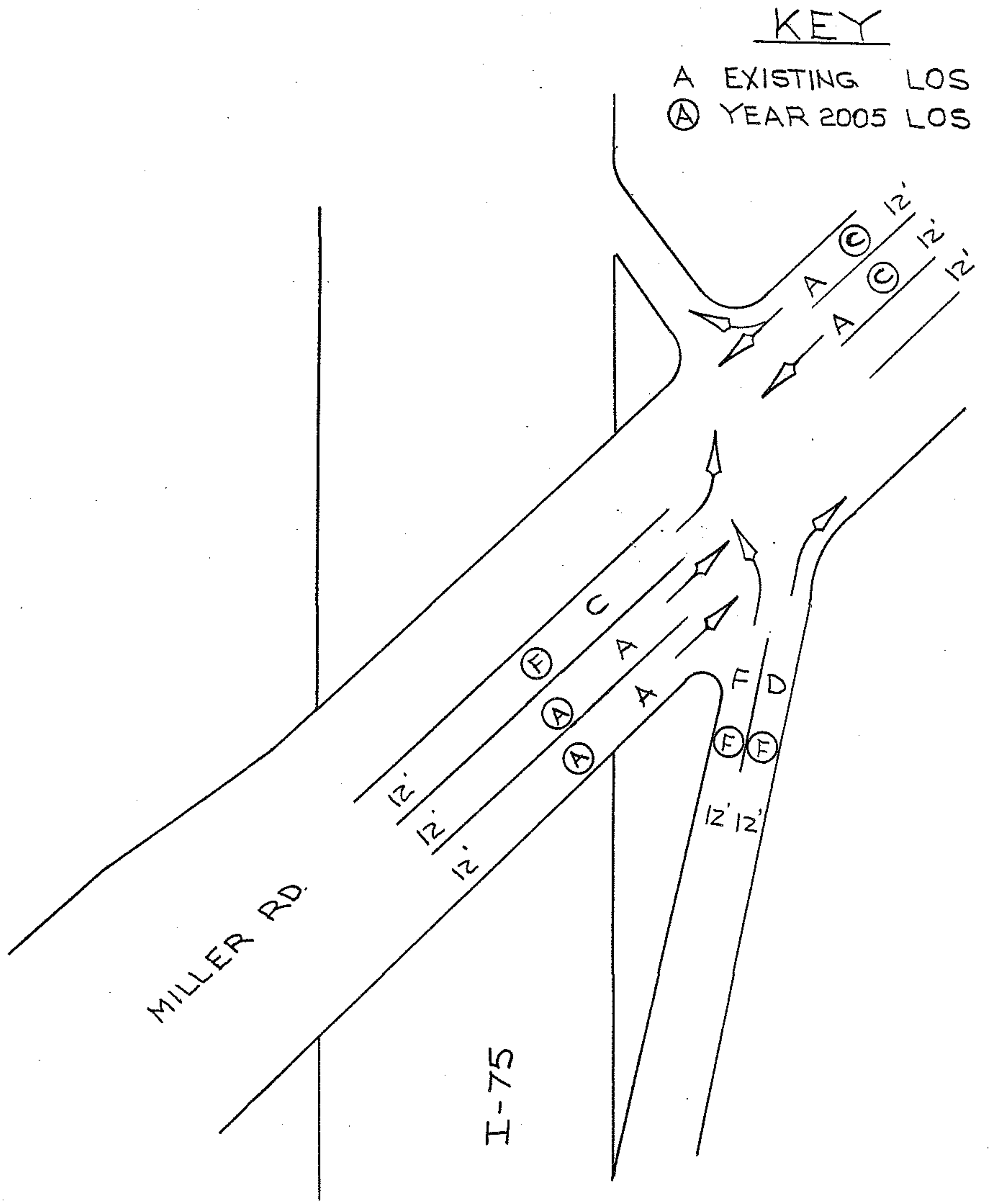


MILLER RD. / K-MART DR.

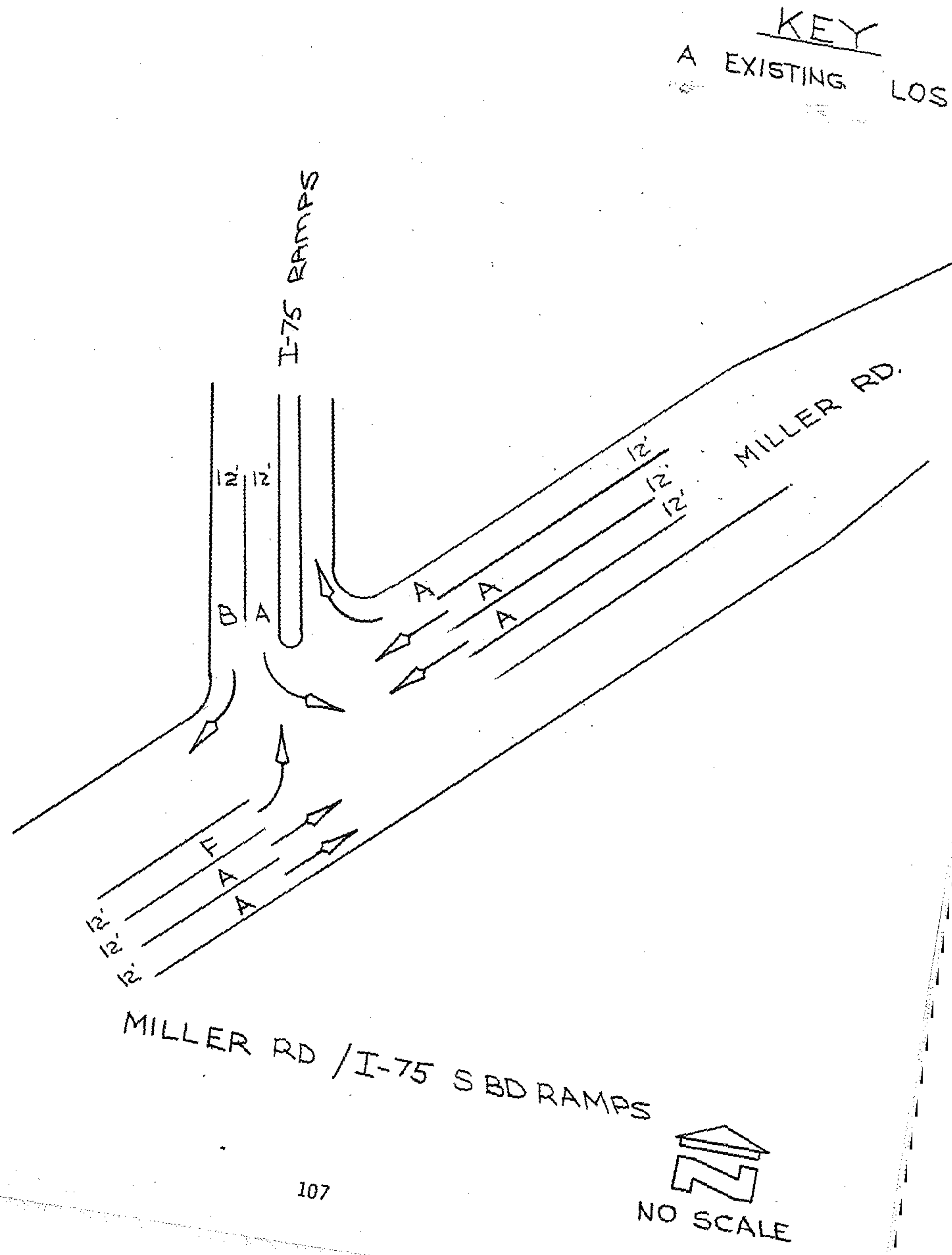
NO SCALE

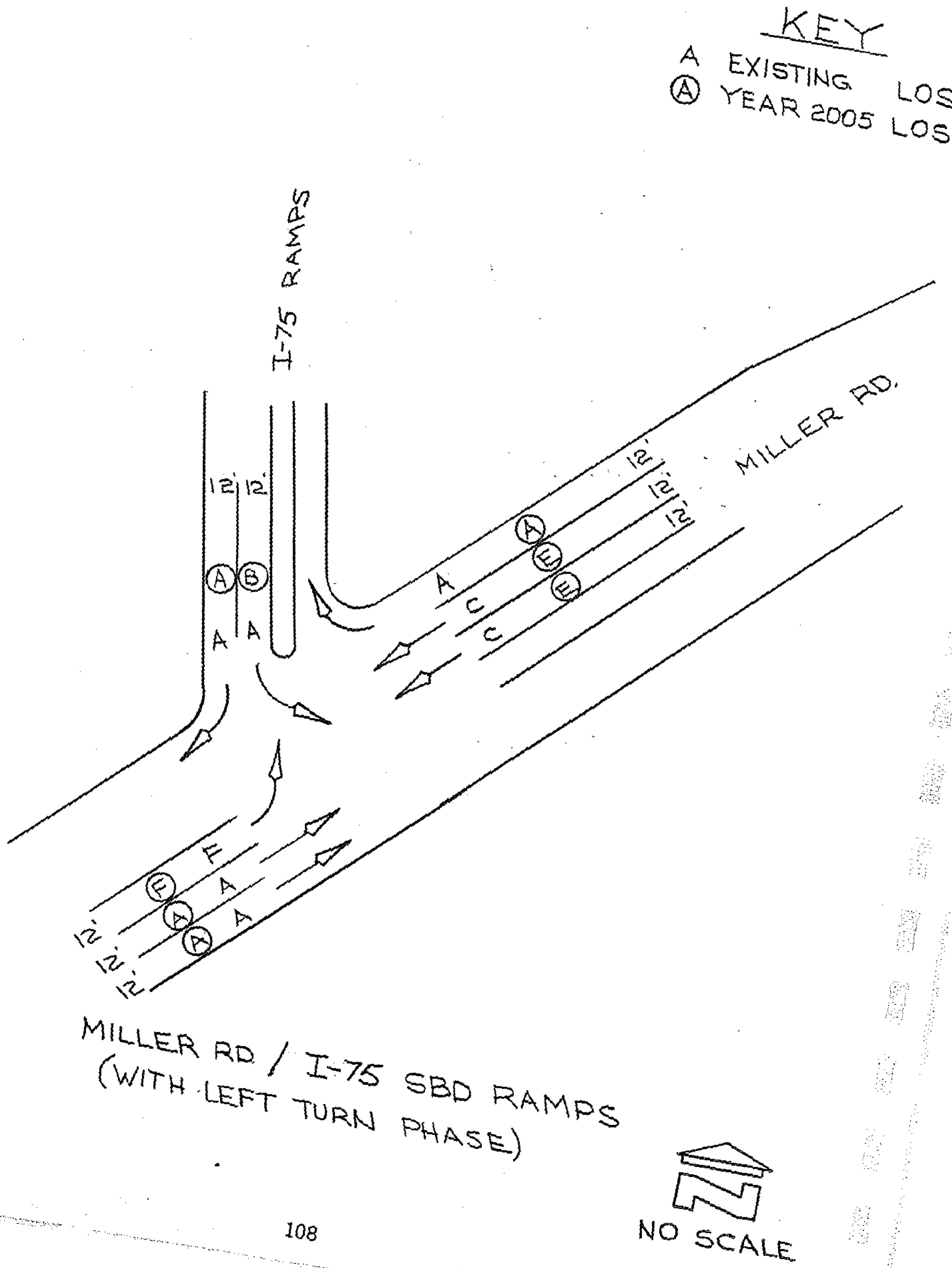


MILLER RD / I-75 N BD

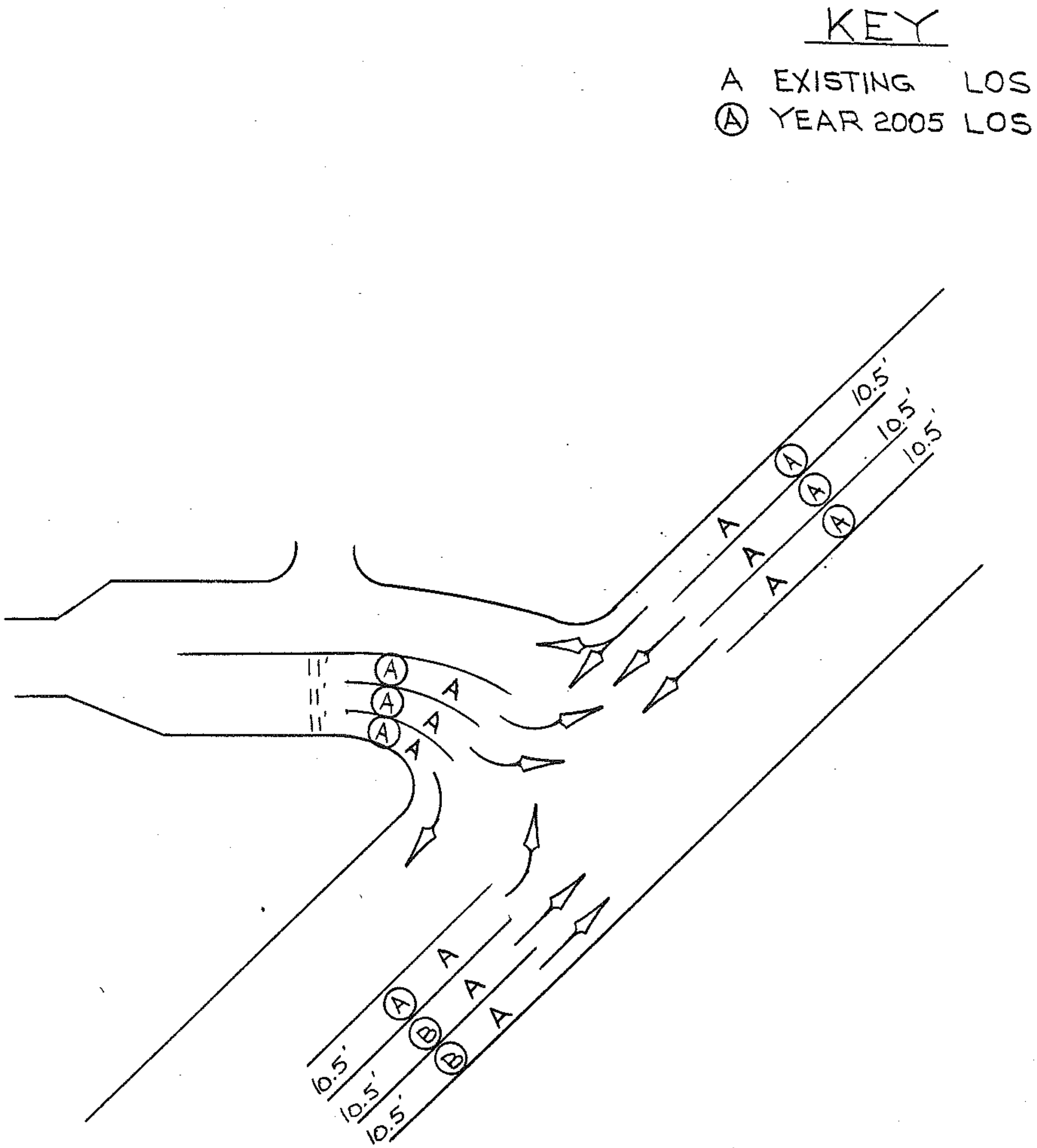


MILLER RD / I-75 NBD
(WITH FIFTH LANE)


KEY
A EXISTING LOS
I-75 RAMPS
MILLER RD.
12'
12'
12'
12' 12'
B A
A
A
A
F
A
A
12'
12'
12'
MILLER RD / I-75 S BD RAMPS
NO SCALE

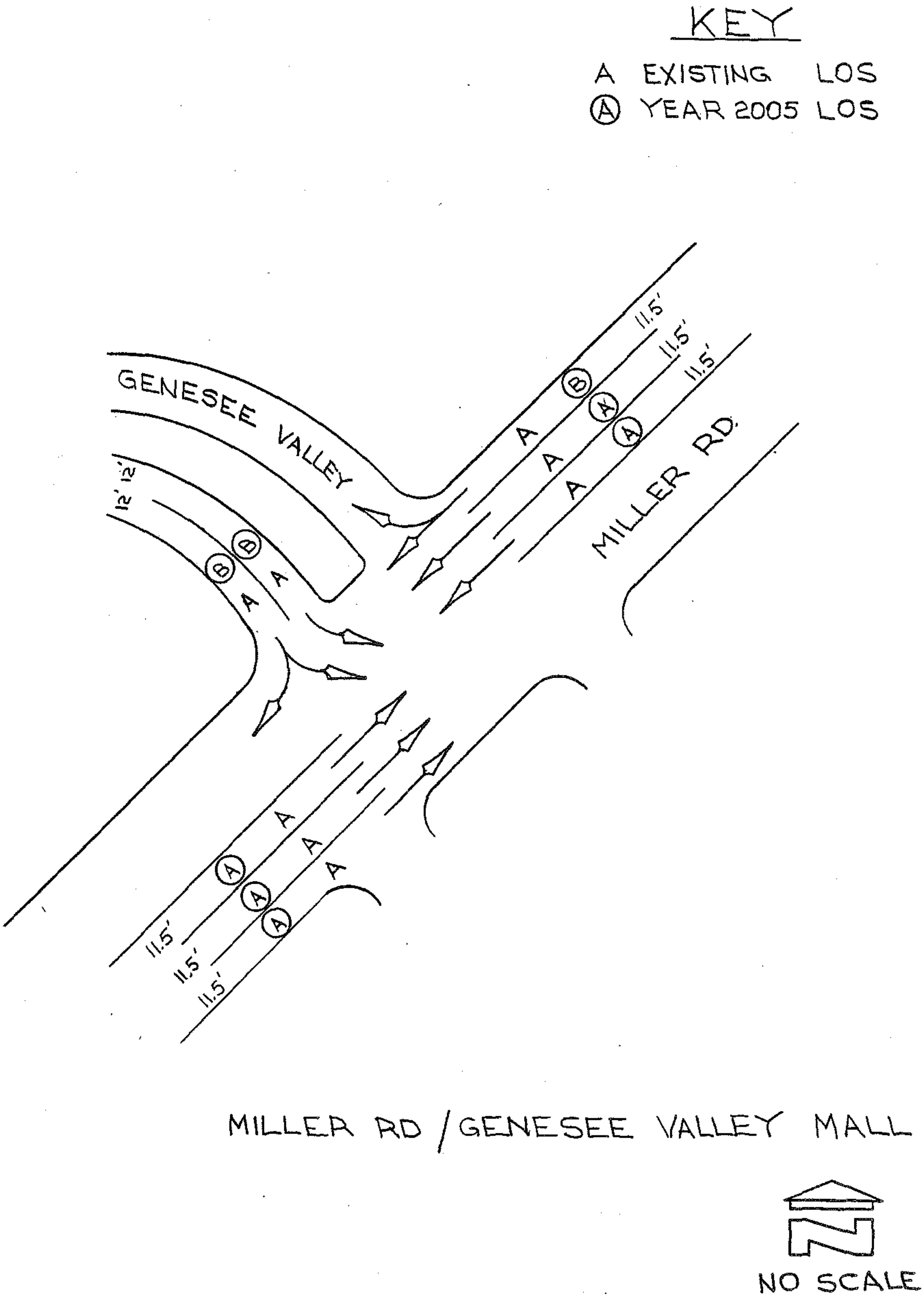


MILLER RD / I-75 SBD RAMPS
(WITH LEFT TURN PHASE)

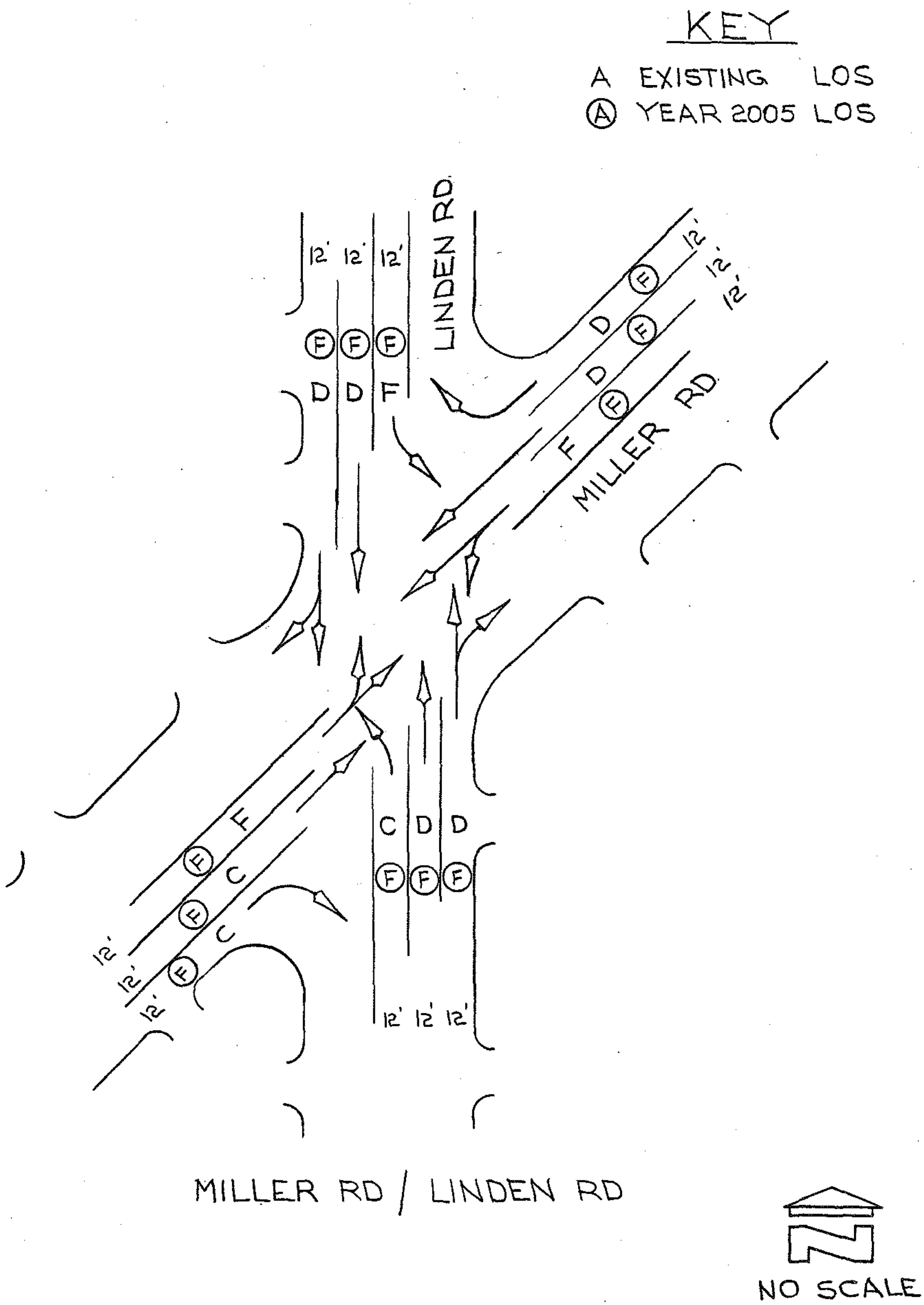


MILLER RD / LENNON RD.

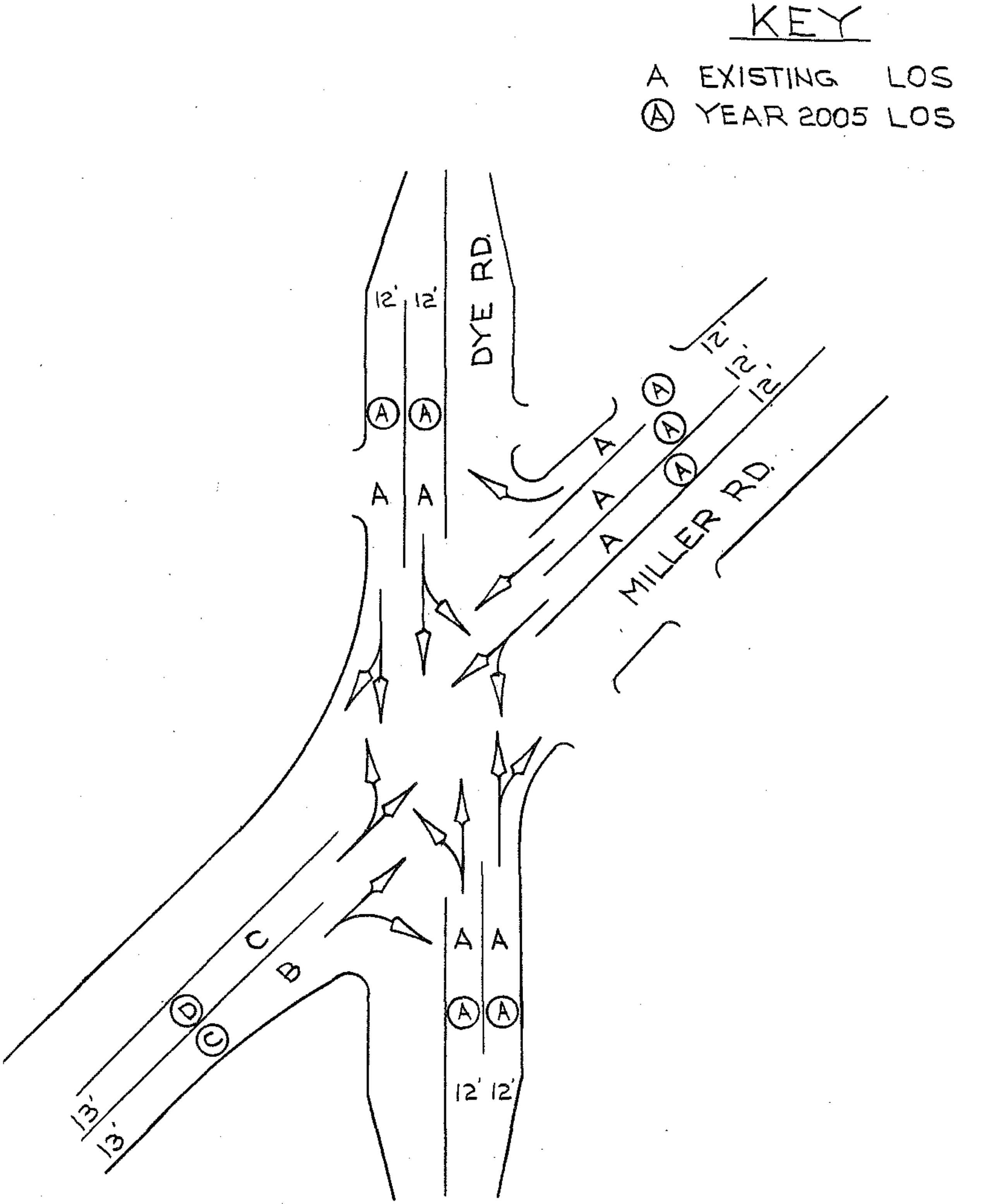
NO SCALE



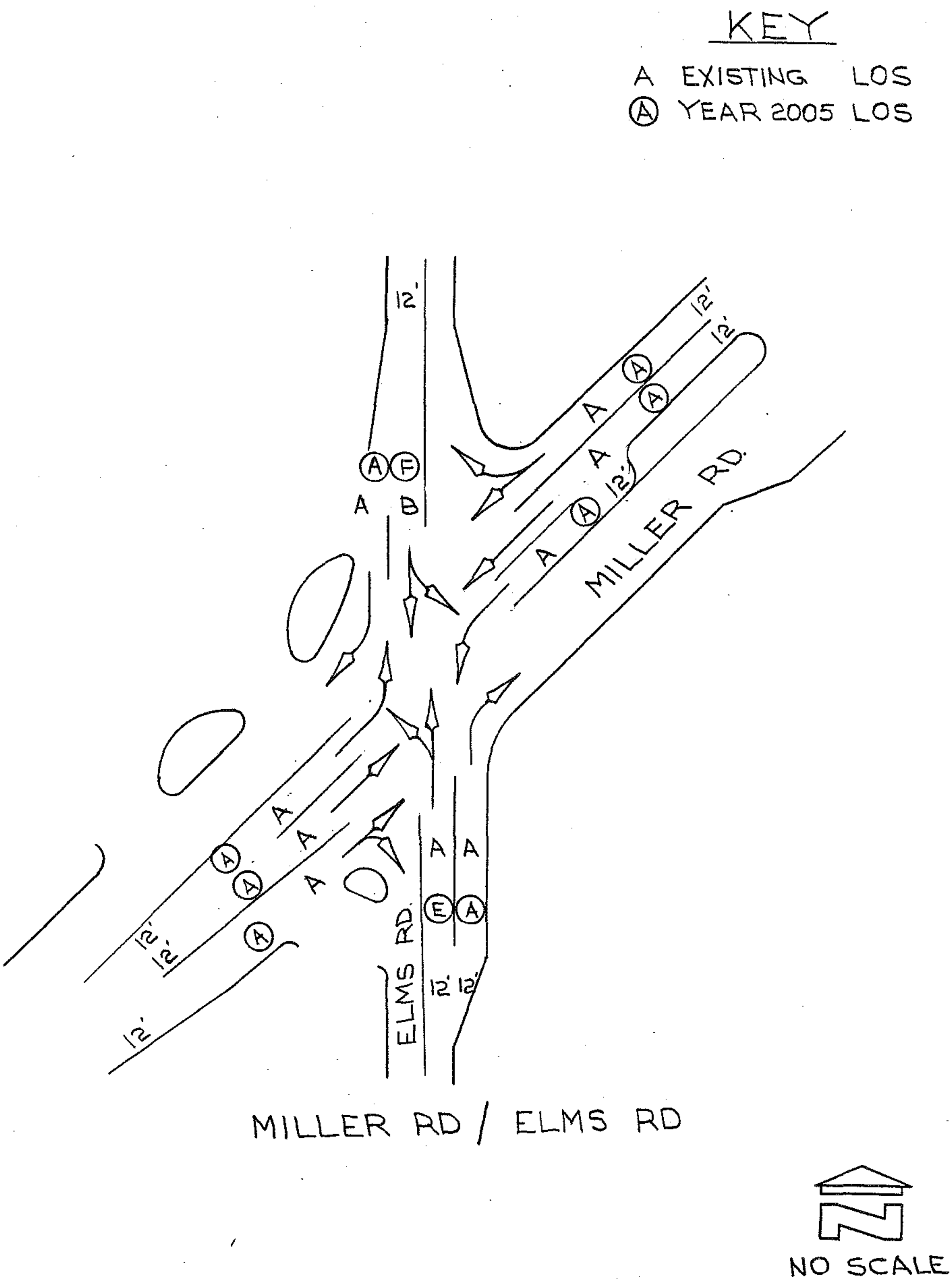
MILLER RD / GENESEE VALLEY MALL



MILLER RD / LINDEN RD



MILLER RD / DYE RD

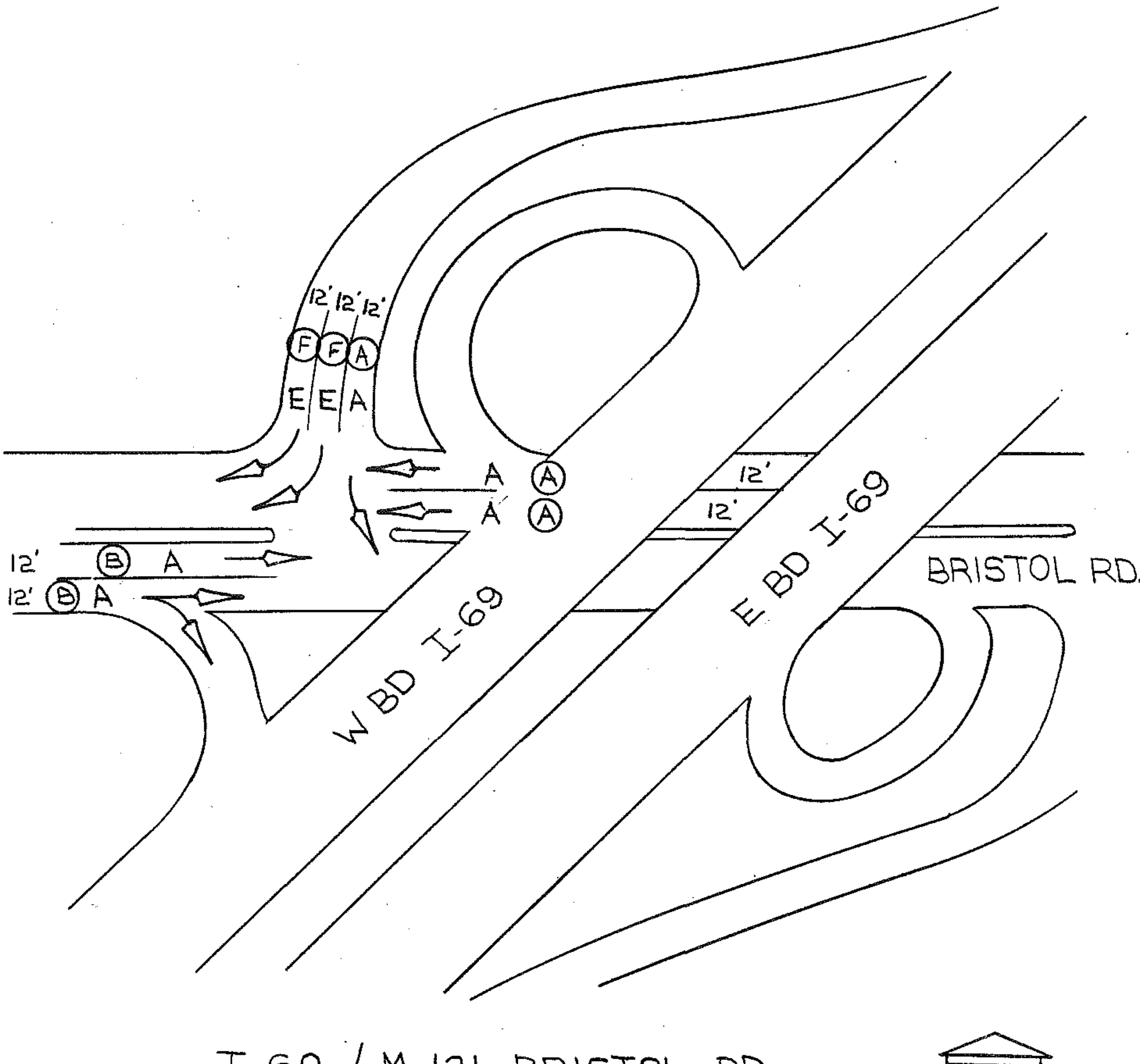


MILLER RD / ELMS RD

KEY

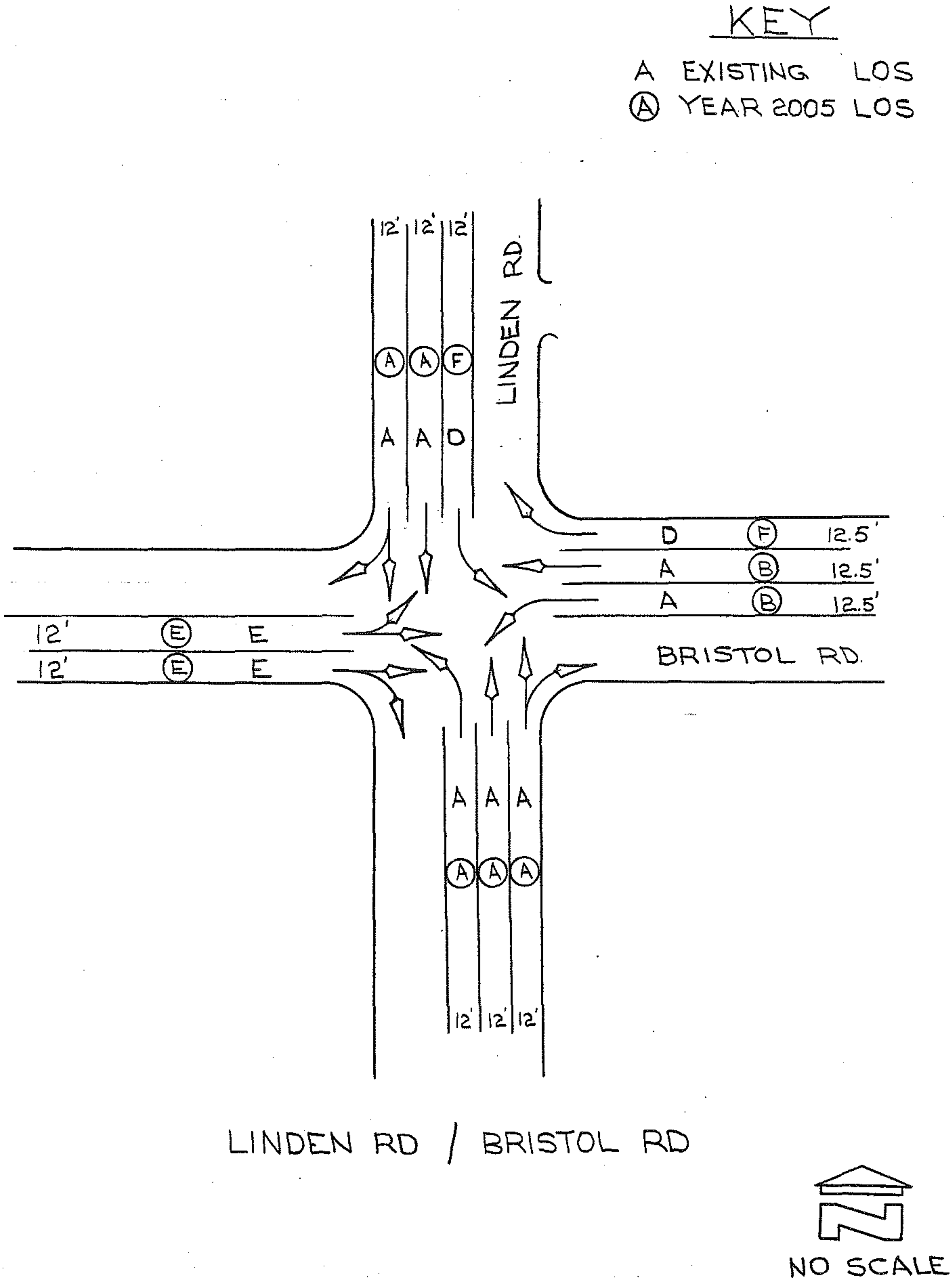
A EXISTING LOS

(A) YEAR 2005 LOS



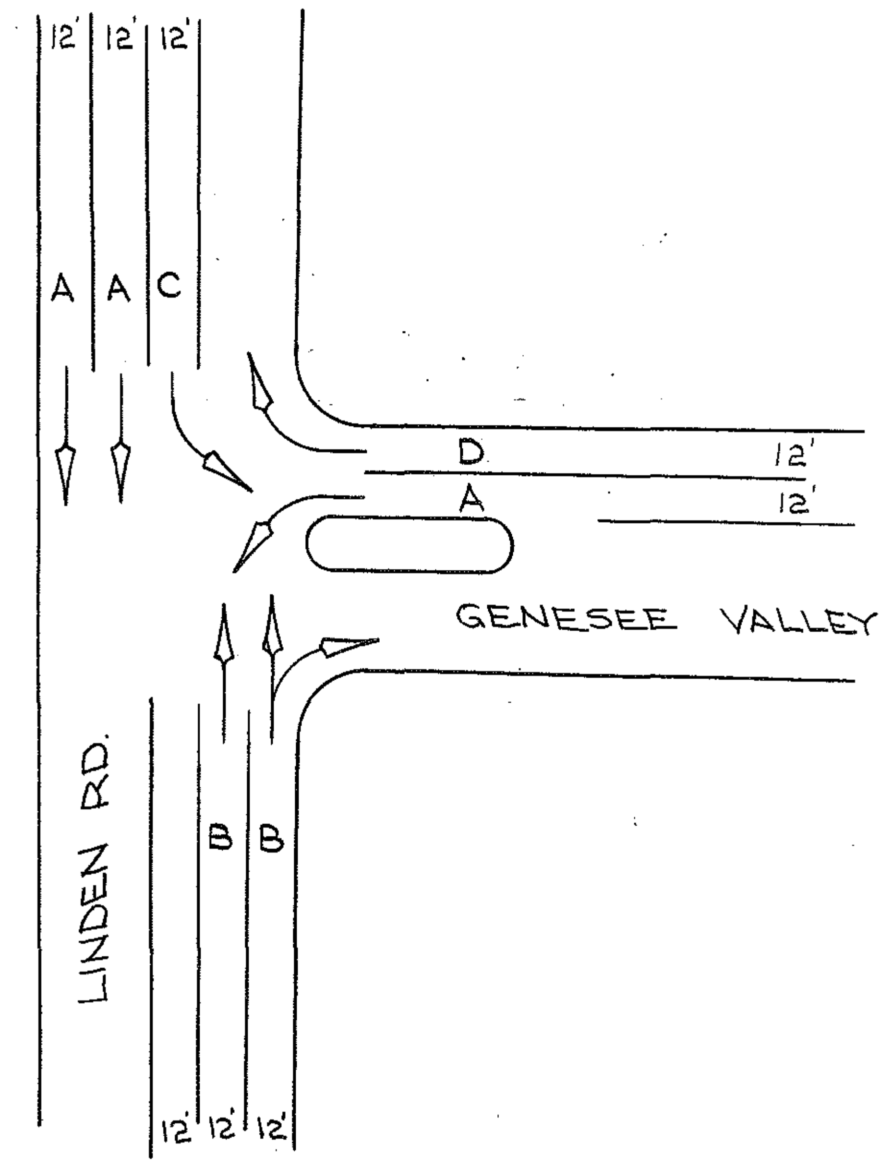
I-69 / M-121 BRISTOL RD.

NO SCALE


KEY
A EXISTING LOS
Ⓐ YEAR 2005 LOS
12' 12' 12'
LINDEN RD.
Ⓐ Ⓐ Ⓕ
A A D
D Ⓕ 12.5'
A Ⓑ 12.5'
A Ⓑ 12.5'
12' Ⓔ E
12' Ⓔ E
BRISTOL RD.
A A A
Ⓐ Ⓐ Ⓐ
12' 12' 12'
LINDEN RD / BRISTOL RD
NO SCALE

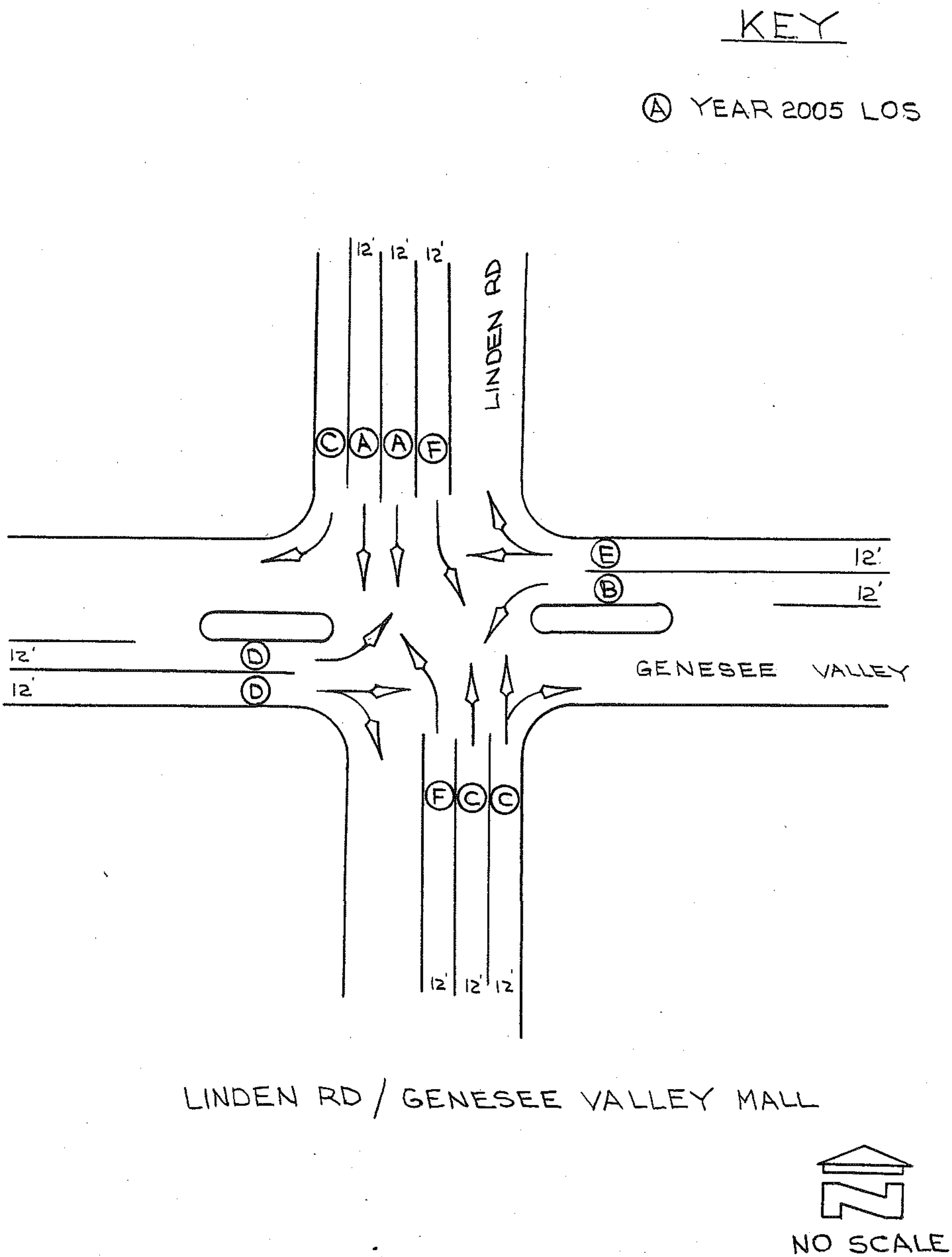
KEY

A EXISTING LOS

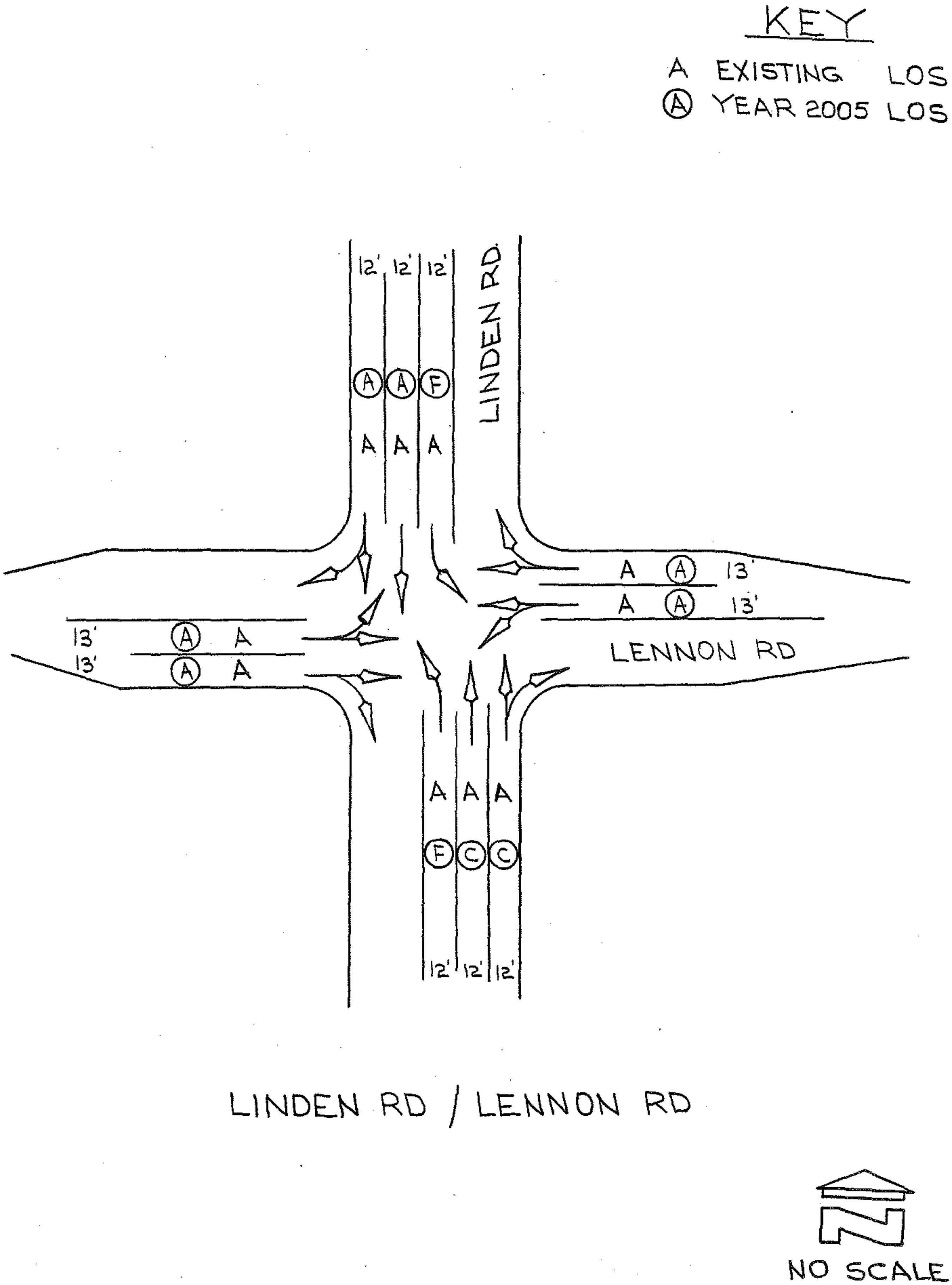


LINDEN RD./ GENESEE VALLEY MALL

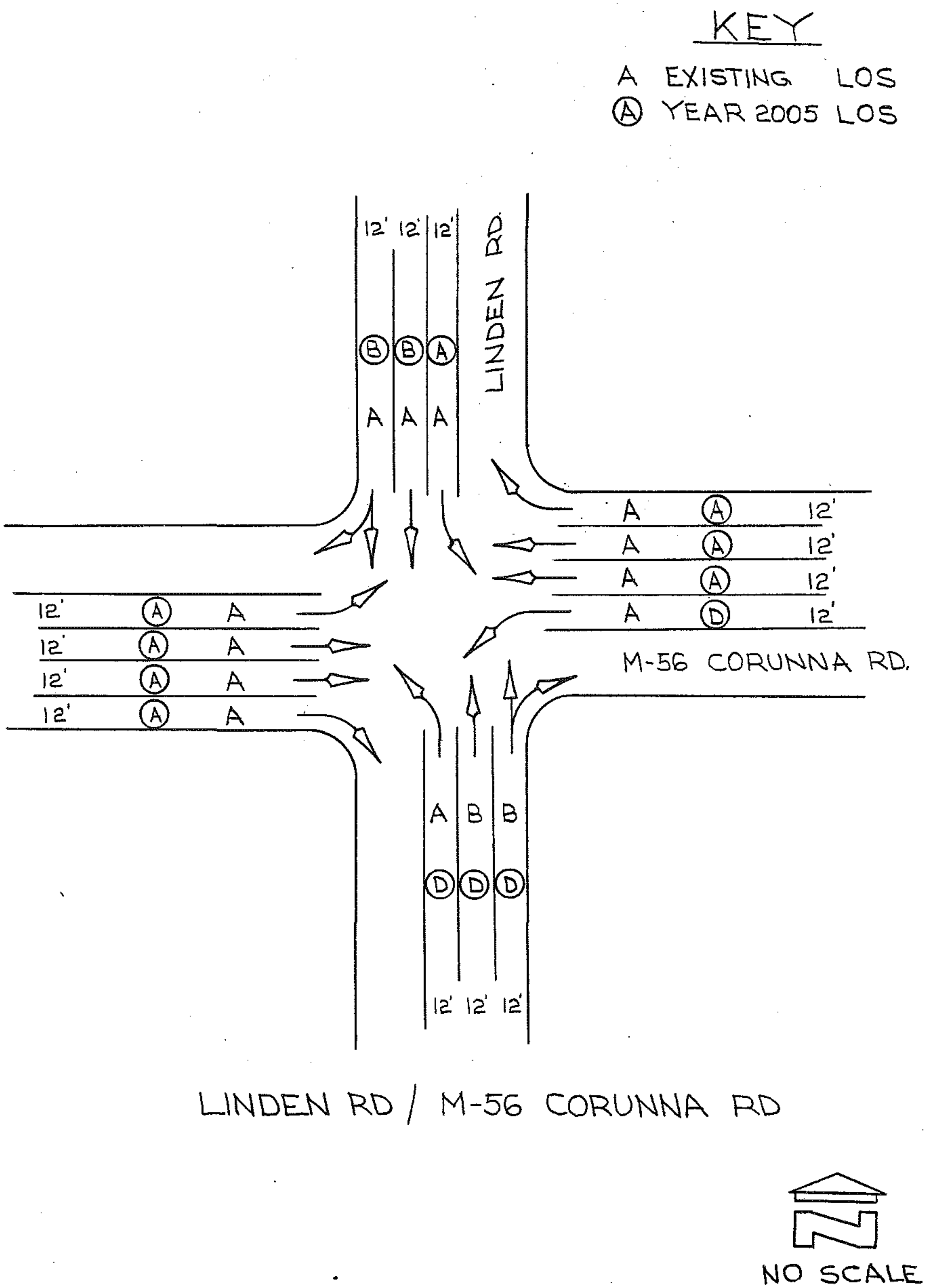
NO SCALE



KEY
A YEAR 2005 LOS
LINDEN RD
12' 12' 12'
C A A F
E
B
12'
12'
D
D
12'
12'
GENESEE VALLEY
F C C
12' 12' 12'
LINDEN RD / GENESEE VALLEY MALL
N
NO SCALE



LINDEN RD / LENNON RD


KEY
A EXISTING LOS
Ⓐ YEAR 2005 LOS
LINDEN RD.
12' 12' 12'
Ⓑ Ⓑ Ⓐ
A A A
A Ⓐ 12'
A Ⓐ 12'
A Ⓐ 12'
A Ⓓ 12'
M-56 CORUNNA RD.
12' Ⓐ A
12' Ⓐ A
12' Ⓐ A
12' Ⓐ A
A B B
Ⓓ Ⓓ Ⓓ
12' 12' 12'
LINDEN RD / M-56 CORUNNA RD
NO SCALE

APPENDIX C

Signal Optimization and Corridor Study
Linden Road (M-56 to Bristol)

This five-lane section of roadway runs from M-56 on the north to Bristol Road on the south. The five signals along this section are all interconnected and operate on an 80-second cycle. Figure 3 shows the proposed time-space diagram for an 80-second cycle.

Recommendations

1. The signal at the Linden/Bristol intersection is operating very inefficiently. Southbound traffic is required to stop for a short time period (two percent or 1.6 seconds) during the southbound phase to allow northbound left-turners to make a safe maneuver.

   To increase both opertional efficiency and safety, a split phase operation is recommended along Linden. It would include a concurrent northbound left and thru phase, followed by a northbound and southbound thru phase (with southbound left-turns permitted), followed by a concurrent southbound left and thru phase. This operation will provide protected left-turn movements as well as coordinated traffic progression with the next signal to the north at Miller.

2. Also at the Linden/Bristol intersection, pedestrian signals should be

considered in conjunction with the proposed signal changes. Pedestrian signals will help to clarify when the "safe" walk periods are provided.

3. To increase capacity along Bristol at Linden, headed-up left-turn lanes should be provided on the Bristol approaches. This could be accomplished by widening Bristol Road on the south side by 12 feet.

4. In order to prevent "fencing" (or queuing) of vehicles along the northbound Linden Road approach to Miller Road, a No-Turn-on-Red operation could be used on the westbound Bristol approach to Linden. This would prevent a steady stream of westbound Bristol to northbound Linden traffic. However, the right-turn green arrow (for westbound Bristol traffic) could come on shortly before the westbound green ball. This would help accommodate the large demand of right-turning vehicles.

5. To provide signal coordination between the Bristol/Linden and Bristol/I-69 intersections, signal interconnection could be provided. This would allow the existing I-69 ramp traffic to progress through both signals (see the proposed time-space diagram in Figure 4). At present, the two signals are operating on different cycle lengths.

6. To help increase capacity at the Linden/Miller intersection, right-turn lanes should be constructed on the northbound and southbound approaches.

7. At the Linden/Miller intersection, the installation of pedestrian signals should be considered.

8. The timing splits and resets shown in the appendix should be implemented.

interconnect the signals between Genesee Valley Mall and Lennon - a distance of 6,380 feet. However, interconnection will be desirable if a signal is ever installed at the proposed "Mansour Development" driveway (about 2400 feet west of Lennon Road).

2. In the 6-lane sections along Miller Road, an exclusive left-turn lane should be considered. This could be accomplished by providing three westbound lanes, the left-turn lane, and two eastbound lanes. This alignment is proposed because of the heavier westbound traffic flow and should align nicely with the bridge widening over I-75. In addition, an exclusive left-turn lane could serve as a buffer zone for left-turning traffic coming out of commercial drives.

3. At the Miller/Linden intersection, the existing split phase operation along Miller should be revised in accordance with the proposed left-turn lane. The proposed phasing on Miller would include a leading left-turn phase followed by the thru phase.

4. To help increase capacity at the Miller/Linden intersection, right-turn lanes should be constructed on the northbound and southbound approaches.

5. Also at the Miller/Linden intersection, the installation of pedestrian signals should be considered. At present, it is very confusing for pedestrians to know when they should cross.

6. When the Miller Road bridge widening over I-75 is completed, a left-turn phase will be installed for eastbound Miller to the southbound I-75 on-ramp. The extremely heavy eastbound to northbound left-turn movement (311 left turns during the peak hour) is now made opposite 1,000 westbound vehicles. This signal work will be coordinated by the Michigan Department of Transportation.

7. The southbound Ballenger approach to Miller Road should be widened to include a right-turn lane. The addition of a right-turn lane would greatly increase the capacity of the intersection since about 40 percent of the approach traffic turns right.

8. Also at the Miller/Ballenger intersection, the installation of pedestrian signals should be considered.

9. The cycle length at Miller and Ballenger should be increased from 70 to 80 seconds. By using a common 80-second cycle length along Miller, interconnection may be accomplished.

10. The timing splits and resets shown in the appendix should be implemented.

8-7-84
WHO:nkg(SP-4-65)-7
Safety Programs Unit

Signal Optimization and Corridor Study
Miller Road (Elms to Ballenger)

This section of roadway runs basically east and west from Elms Road on the west to Ballenger Road on the east. The road width varies from four to six lanes as shown in Figure 1.

Figure 1 also shows the signals along Miller and identifies those that are presently interconnected. The signals at Dye, Genesee Valley Mall, and Ballenger operate on a 70-second cycle, while most of the others operate on 80-second cycles.

Figure 2 shows the proposed time-space diagram for an 80-second cycle. The signal at Elms was not included as part of the proposed system because of its isolated location (about 1 mile from the signal at the west junction of Bristol Road). The signals at the west junction of Bristol Road and at the G.M. Parts Division parking lot drive were not included because they are both semi-actuated.

Recommendations

1. The signals from Dye Road to Genesee Valley Mall Drive and from Lennon to Ballenger should be interconnected. The interconnection could be accomplished with time-based coordinators, hard wire interconnect, or telephone lease lines. It probably is not necessary at this time to

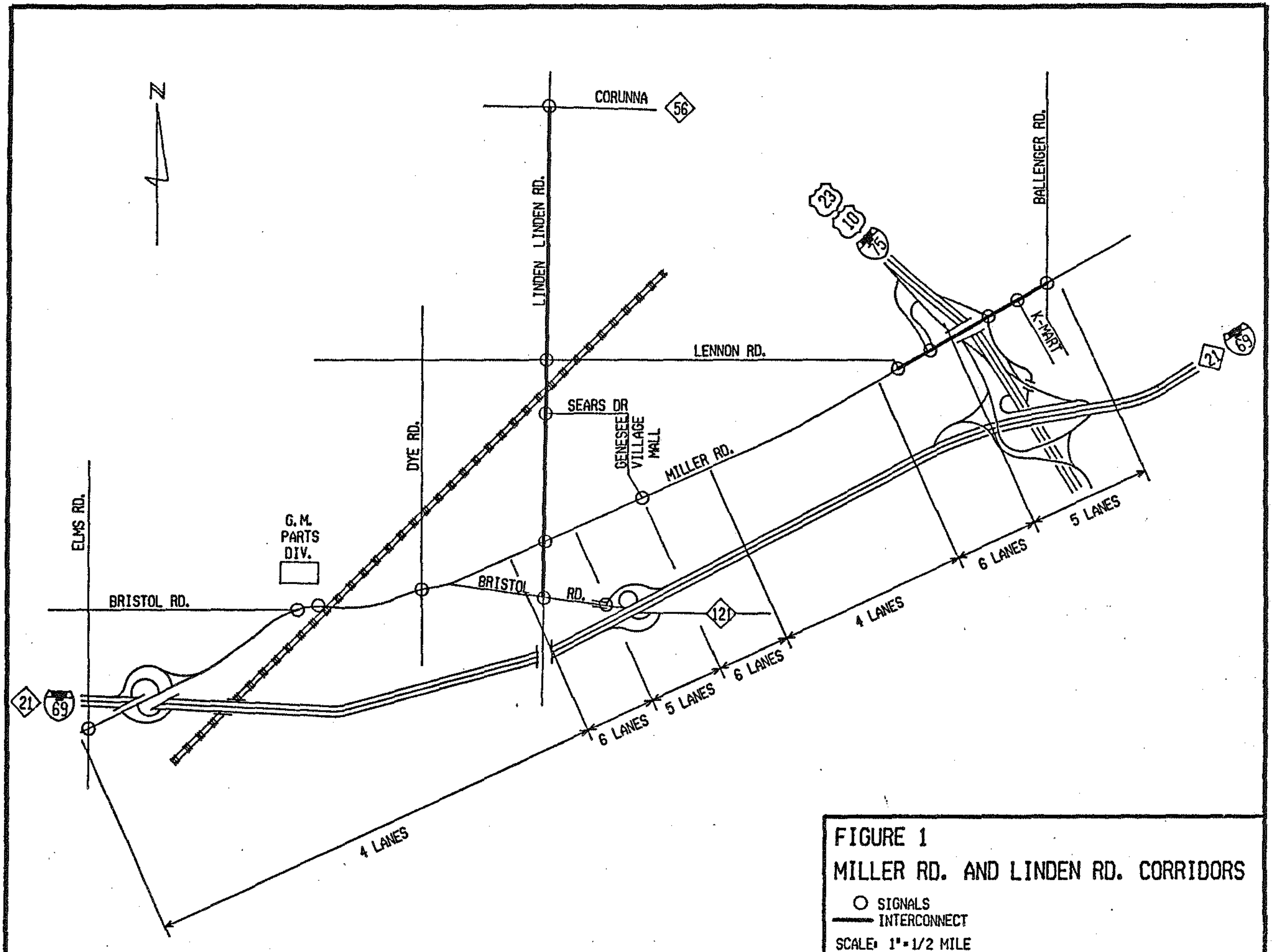


FIGURE 1
MILLER RD. AND LINDEN RD. CORRIDORS

Proposed Signal Timing Splits for
Miller Road (Elms to Ballenger) - Genesee County
(80 - Second Cycles)

1. <u>Miller at Elms</u>

Miller	G-69%	55.2 sec.
Miller	Y- 6%	4.8 sec.
Elms	G-19%	~~16.2~~ sec.
Elms	Y- 6%	4.8 sec.

2. <u>Miller at Bristol (W. Jct.)</u>

Miller	G-64%	51.2 sec.
Miller	Y- 6%	4.8 sec.
Bristol	G-24%	19.2 sec.
Bristol	Y- 6%	4.8 sec.

Semi-actuated

3. <u>Miller at Dye</u>

Miller	G-64%	51.2 sec.
Miller	Y- 6%	4.8 sec.
Dye	G-24%	19.2 sec.
Dye	Y- 6%	4.8 sec.

Reset to Miller - 80%

4. <u>Miller at Linden</u>

Miller L.T.	G-16%	12.8 sec.
Miller L.T.	Y- 5%	4.0 sec.
Miller	G-21%	16.8 sec.
Miller	Y- 6%	4.8 sec.
Linden L.T.	G-10%	8.0 sec.
Linden L.T.	Y- 5%	4.0 sec.
Linden	G-31%	24.8 sec.
Linden	Y- 6%	4.8 sec.

Reset to Miller - 12%

5. <u>Miller at Genesee Valley Mall</u>

Miller	G-64%	51.2 sec.
Miller	Y- 6%	4.8 sec.
G.V. Mall	G-24%	19.2 sec.
G.V. Mall	Y- 6%	4.8 sec.

Reset to Miller - 75%

6. <u>Miller at Lennon</u>

Miller	G-59%	47.2 sec.
Miller	Y- 6%	4.8 sec.
Lennon	G-29%	23.2 sec.
Lennon	Y- 6%	4.8 sec.

Reset to Miller - 60%

7. <u>Miller at S.B. I-75 Ramp</u>

Miller L.T.	G-18%	14.4 sec.
Miller L.T.	Y- 5%	4.0 sec.
Miller	G-45%	36.0 sec.
Miller	Y- 6%	4.8 sec.
S.B. I-75	G-20%	16.0 sec.
S.B. I-75	Y- 6%	4.8 sec.

Reset to Miller thru - 4%

8. <u>Miller at N.B. I-75 Ramp</u>

Miller	G-56%	44.8 sec.
Miller	Y- 6%	4.8 sec.
N.B. I-75	G-32%	25.6 sec.
N.B. I-75	Y- 6%	4.8 sec.

Reset to Miller - 10%

9. <u>Miller at K-Mart</u>

Miller	G-71%	56.8 sec.
Miller	Y- 6%	4.8 sec.
K-Mart	G-17%	13.6 sec.
K-Mart	Y- 6%	4.8 sec.

Reset to Miller - 60%

10. <u>Miller at Ballenger</u>

Miller L.T.	G-13%	10.4 sec.
Miller L.T.	Y- 5%	4.0 sec.
Miller	G-27%	21.6 sec.
Miller	Y- 6%	4.8 sec.
Ballenger L.T	G-11%	8.8 sec.
Ballenger L.T.	Y- 5%	4.0 sec.
Ballenger	G-27%	21.6 sec.
Ballenger	Y- 6%	4.8 sec.

Reset to Miller thru - 46%

Proposed Signal Timing Splits for
Linden Road (M-56 to Bristol) Genesee County
(80 - Second Cycles)

1. Linden at M-56

Linden	G-42%	33.6 sec.
Linden	Y- 6%	4.8 sec.
Linden	R- 2%	1.6 sec.
M-56	G-42%	33.6 sec.
M-56	Y- 6%	4.8 sec.
M-56	R- 2%	1.6 sec.

Reset to Linden - 65%

2. Linden at Lennon

Linden	G-62%	49.6 sec.
Linden	Y- 6%	4.8 sec.
Linden	R- 2%	1.6 sec.
Lennon	G-22%	17.6 sec.
Lennon	Y- 6%	4.8 sec.
Lennon	R- 2%	1.6 sec.

Reset to Linden - 95%

3. Linden at Sears Drive

Linden L.T.	G-18%	14.4 sec.
Linden L.T.	Y- 5%	4.0 sec.
Linden	G-44%	35.2 sec.
Linden	Y- 6%	4.8 sec.
Sears Drive	G-21%	16.8 sec.
Sears Drive	Y- 6%	4.8 sec.

Reset to Linden Thru - 32%

4. Linden at Miller

Linden L.T.	G-10%	8.0 sec.
Linden L.T.	Y- 5%	4.0 sec.
Linden	G-31%	24.8 sec.
Linden	Y- 6%	4.8 sec.
Miller L.T.	G-16%	12.8 sec.
Miller L.T.	Y- 5%	4.0 sec.
Miller	G-21%	16.8 sec.
Miller	Y- 6%	4.8 sec.

Reset to Linden thru - 70%

5. Linden (N-S) at Bristol (E-W)

N.B./L.T. & Thru	G- 5%	4.0 sec.
N.B./L.T. Yellow	Y- 5%	4.0 sec.
N.B. & S.B. Thru	G-14%	11.2 sec.
N.B. Yellow	Y- 6%	4.8 sec.
S.B./L.T. & Thru	G-29%	23.2 sec.
S.B./L.T. & Thru	Y- 6%	4.8 sec.
Bristol	G-29%	23.2 sec.
Bristol	Y- 6%	4.8 sec.

Reset to N.B./L.T. & Thru - 84%

6. Bristol at WB I-69 Off-Ramp

Bristol	G-61%	48.8 sec.
Bristol	Y- 6%	4.8 sec.
W.B. I-69	G-28%	22.4 sec.
W.B. I-69	Y- 5%	4.0 sec.

Reset to Bristol - 16%

8-08-84
WHO:mrs(016516-139)-3
Safety Programs Unit

FIGURE 2. MILLER RD. 80-SEC. CYCLE PROPOSED

FIGURE 3. LINDEN RD. 80-SEC. CYCLE PROPOSED

G.4. BRISTOL RD. 80-SEC. CYCLE PROPOSED