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16. Abstract

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Information regarding the availability of the program, named PASSER II, user's manual and coding forms may be obtained by writing:

Mr. A. J. Sherrod
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Attention: D-18T

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A REPORT ON THE USER'S MANUAL FOR PROGRESSION ANALYSIS AND SIGNAL SYSTEM EVALUATION ROUTINE-PASSER II

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Development of Urban Traffic Management and Control Systems

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Texas A&M University
College Station, Texas

August 1974

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DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification or regulation.

SUMMARY

The technology of traffic signal analysis and control has advanced considerably in recent years. Much of this technology has been developed within research projects having digital computers as their primary control mode. As a consequence, the need existed to convert this new traffic signal computer control technology into engineering orientated programs that can be applied to more typical signal problems that may involve pretimed controllers.

This report describes a step toward the implementation of the new technology in the form of a practical and efficient computer program, named PASSER-II, which has been programmed on the Texas Highway Department's computer system, located within the Division of Automation, in Austin. This report contains the developed user's manual, an illustrative example problem, optimal solution, optional time-space diagrams and coding forms.

The program is designed to calculate all the signal timing information needed for plan development and field implementation. The program can calculate the optimal demand to capacity ratio green times for simple two-phase signal sequences through complex, variable sequence, eight-phase signal sequences.

The progression optimization section of the program can analyze one or more of these phase sequences for each intersection and will select, from those available, the one at each intersection that provides the best arterial progression. After the optimal phase sequence is selected for each intersection, phase interval lengths and offsets are calculated. Resulting demand to signal capacity ratios are calculated for each movement

which may be used to objectively evaluate the resulting level of service. Optimal progression time-space diagrams are provided if requested.

Implementation

The results of this research have been directly implemented on the Department's computer system in Austin through the Division of Automation. The program will be available statewide to Texas Highway Department engineers and may be accessed at the District remote terminal units. The results of the program should prove most helpful in preparing traffic signal plans for arterial streets and evaluating existing systems.

TRAFFIC ENGINEERING COMPUTER PROGRAMS

PASSER II

(Multi-phase Arterial Progression Program)

Texas Highway Department

Division of Automation

1974

REPORT NOTE: Information regarding the availability of this program may be obtained by writing:

Mr. A. J. Sherrod
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11th and Brazos
Austin, Texas 78701

Attention: D-18T

PASSER II

Introduction

PASSER is an acronym for Progression Analysis and Signal System Evaluation Routine. It is a unique, general purpose, computer program developed to assist the traffic engineer in determining optimal traffic signal timings for an arterial street where progression is desired through signals having more than one arterial signal phase.

The basic theory of the program was developed and tested by the Texas Transportation Institute in the Dallas Corridor Project sponsored by the Federal Highway Administration and described in HRB Record 445 of 1973. PASSER was adapted for off line processing and analysis purposes in HPR Project 165 sponsored by the Texas Highway Department.

Features

The program is designed to calculate all the signal timing information needed for plan development and field implementation. The program can calculate the optimal demand to capacity ratio green times from a simple two-phase signal sequence through complex, variable sequence, eight-phase signal sequences. The progression optimization section of the program can analyze one or more of these phase sequences for each intersection and will select, from those available, the one at each intersection that provides the best arterial progression. After the optimal phase sequence is selected for each intersection, phase interval lengths and offsets are calculated. Resulting demand to capacity ratios are calculated for each movement which may be used to objectively evaluate the level of service that would result. Optimal progression time-space diagrams are provided if requested.

Scope

Much of the input data required by the program is similar to that needed by current Highway Department signal timing programs. Intersection distances, progression speeds, allowable cycle lengths, turning movement volumes and saturation capacity flow rates, etc., are used. In addition, the traffic engineer can specify a particular arterial phase sequence at an intersection or a set of allowable arterial phase sequences, each one analyzed for the intersection to determine which sequence gives the best progression. Sample input sheets are shown in Figures 1 and 2 and a sample program is shown in Figures 3-9.

The results generated by this program may not necessarily represent the optimum solution for a particular artery. However, the user can approach the optimum solution by supplying the most accurate values for the average speed, the queue clearances, the intersection traffic volumes, the saturation capacity flow and suitable minimum green times. If the "floating car" study or other similar studies as well as traffic and pedestrian counts are used as the basis for determining the values supplied, the probability of approaching an optimum solution for an arterial will be greatly increased.

Coding

Two input card forms (Figures 1 and 2) are coded by the user to get the necessary data to the program. These are as follows:

1. ARTERIAL HEADER (one line per arterial) and INTERSECTION HEADER (one line per intersection).
2. INTERSECTION DETAIL (three lines per intersection).

The sections following will describe in detail the procedure for coding these forms.

Arterial Header and Intersection Card Form

Arterial Header Card - This card identifies the traffic signal system and defines some general analysis parameters and options.

Columns 1-12. Enter the name of the city beginning in column 1.

Columns 13-24. Enter the name of the arterial beginning in column 13.

Columns 25-26. End the district number in column 26.

Columns 27-32. Enter the date.

Columns 33-34. Enter an arbitrary number to aid in identifying different sets of input data.

Columns 35-36. Code the number of signalized intersections in the arterial progression system ending in column 36. Maximum number is 20.

Columns 37-39. Code the smallest cycle length (in seconds) the program may consider in finding an optimal progression solution. It must be at least as large as sum of minimum conflicting greens and should be at least four seconds greater than sum of minimum conflicting greens to permit program flexibility.

The smallest permissible cycle length should be determined beforehand by using the Webster method, the Poisson method, or some other suitable method for optimal cycle length determination at individual intersections. A review of the Webster method is given in Appendix "A".

Each intersection in an arterial system will generally have a different optimal cycle length from the other intersections. The smallest permissible cycle length for the arterial should not be less than .85 times the largest individual optimal cycle length, nor be normally greater than 1.25 times the smallest optimal cycle length for an intersection. For example, assume an arterial has four intersections whose optimal cycle lengths based on the Webster formula are 45, 50, and 55 seconds. The smallest permissible cycle lengths of the arterial should not be less than (0.85 x 55) = 47 seconds or greater than (1.25 x 45) = 56 seconds.

Columns 40-42.	Code the largest cycle length (in seconds) the program may consider, ending in column 42. This upper bound on the cycle length is usually no more than 10 seconds greater than the lower bound value. If a progression solution for only one cycle length is desired, the same cycle length should be entered for the lower and upper cycle limits.
Columns 43-44.	Code the number of seconds the program will increment and use between the lower and upper cycle length limits, ending in column 43. A 5-second increment is recommended for pretimed signal systems, but a different increment could be used for digital or analog traffic responsive systems.
Columns 45-46.	Option 1. The user may specify the percent of the total progression bandwidth to be provided in the "B" direction. This will establish a minimum value and a larger B direction band may be provided, if possible, resulting in different band splits than those input. Code the B percent ending in column 45. If no percentage is entered, the A and B direction bands will be split generally in proportion to the traffic volume distribution in the A and B directions.
Column 47.	Option 2. If a one (1) is coded in this column, the program will search for an optimum solution by varying all link speeds within ± 2 MPH in 1 MPH increments of the link speeds coded in columns 19-20 and 25-26 of the intersection header cards. If column 47 is left blank, no variation is permitted.
Column 48.	Enter a one (1) if it is desired to have the optimum time space progression diagram printed on the district terminal plotter.
Column 49.	Enter a one (1) if it is desired to have the optimum time-space progression diagram plotted by a D-19 line plotter.
Columns 50-51.	If a D-19 line plot is requested, code the number of seconds that are to equal one inch for scaling the plot.
Columns 52-55.	If a D-19 line plot is requested, code the number of feet that are to equal one inch for scaling the plot.

Intersection Header Card - The Intersection Header Card provides signal phasing information for each signalized intersection. One card (one line of information per intersection to be input) is required for each signalized intersection in the progression system. Other descriptive information about the link to the next signal along the arterial is also to be provided.

Columns 1-12. Enter the name of the cross street at this signal beginning in column 1.

Columns 13-14. Enter the intersection sequence number in the "A" direction for this intersection ending in column 14. Maximum number is 20. As noted in the figure of the Arterial Header Card, the "A" direction can be selected to be either direction along the arterial. However, all signal progression offsets will be calculated with respect to the first signal in the "A" direction.

Columns 15-18. Code the distance in feet from this signal to the next signal in the "A" direction, ending in column 18. See the figure of the Arterial Header Card for illustration.

Columns 19-20. Code the desired average progression speed in miles per hour for the link whose distance was just coded in columns 15-18.

The average speed (in MPH) between intersections should be based on the average speeds obtained from the "floating car" study or other similar studies in each direction of travel during peak and off-peak volume conditions. The "floating car" study is based on the average speed found to exist between two points by traveling within or following platoons of vehicles. This average speed is figured from five to ten trial runs during the off-peak traffic volume conditions and five to ten trial runs during each of the AM peak period and the PM peak period conditions. The speeds obtained should be free flowing speeds of platoons between stop signs and stops at traffic signals. Trial runs during both off-peak and peak periods should be made to determine if different average speeds occur. If they do, two or three time-space diagrams should be prepared. If the average speeds change along an arterial, the change in average speed may be inserted in the proper Intersection Header Card. For example - if the "A" direction average speed between Intersections 1 and 2 is 30 MPH and the "A" direction average speed between Intersections 2 and 3 is 26 MPH, columns 19-20 for Intersection 2 could show "30" and columns 19-20 for Intersection 3 could show "26". An alternate to this could be to show "28" in columns 19-20 for both Intersections 2 and 3.

Columns 21-24. Code the distance in feet in the "B" direction from the next signal back to this one and as illustrated in the figure of the Arterial Header Card, ending in column 24. Usually, this distance is the same as that coded in columns 15-18.

Columns 25-26. Code the "B" direction desired progression speed in miles per hour for the link just coded in columns 19-20.

The first intersection along the arterial will not have an upstream link to code. In this case, the first Intersection Header Card would have columns 15-26 blank, the link distance and speed information.

Columns 27-28. If it is desired to insure that the progression band will lag the start of the "A" direction progressive green at a signal by a certain amount, not to exceed 10 seconds, code the amount of the lag time (queue clearance time) for the intersection in seconds, ending in column 28. Otherwise, code a zero. PASSER tries to balance out "slack" time and, as a consequence, some progression lag time may occur at a signal even if no assured time is provided. Hand adjustments of the offsets from the time-space diagram normally can also provide some progression lagging for a given optimum progression solution.

Columns 29-30. Code the "B" direction progression band lag in seconds (queue clearance time), for this signal, if desired, ending in column 30 and not to exceed 10 seconds. Otherwise, code zero. Normally, columns 27-28 and 29-30 will be coded zero.

Columns 31, 32, 33, 34. The arterial phase sequences that may be evaluated by the program to find the best progression solution are defined in these four columns, one column for each of the four phase sequences shown in the figure of the Intersection Header Card. Each multi-phase intersection must have at least one arterial sequence possible and may have all four.

An intersection having simple two-phase operation would have only one arterial phase and one cross steeet phase. The appropriate phase sequence to select would be the through movements first sequence without the overlap phase interval. The following left turn phase interval in the sequence is essentially deleted in the program by coding no left turn movement volumes or minimum green times.

The middle phase interval, the overlap phase, of these sequences may be added if desired. This might be desirable since overlapping normally adds some to the signal capacity of the intersection. When using standard pre-timed controllers, care must be exercised to insure that the final progression designs do not switch the order of the phase intervals at an intersection.

Code a 0 (zero) if the respective phase sequence is not permitted. Code a 1 if the phase sequence is permitted without the overlap phase. Code a 2 if the phase sequence is permitted and if the overlap phase is allowed.

Column 31. Left turns first sequence
Column 32. Through movements first sequence
Column 33. Leading green in "A" direction sequence
Column 34. Lagging green in "A" direction sequence

Columns 35, 36, 37, 38. Code the one cross street signal phase sequence to be used. Select from the four basic phasing sequences used previously with or without overlap. Leading green is the right side approach of the cross street with respect to the "A" direction along the arterial. Select only one sequence for the cross street signal phase sequence.

Code a 0 (zero) if the respective phase sequence is not used. Code a 1 if the phase sequence is to be used but no overlap is permitted. Code a 2 if the phase sequence is to be used and if overlap phasing is allowed.

Column 35. Left turns first on cross street
Column 36. Through movements first on cross street
Column 37. Right approach from "A" direction leading green
Column 38. Right approach from "A" direction lagging green

Intersection Detail Cards Form

There are three intersection detail cards, or three lines of information, to be coded per signalized intersection. All relate to the vehicle movements shown in the figure of the Intersection Header Cards. All data entered must be right justified, i.e., ended in the right most field column. Only card descriptions will be given.

Card 1. Movement volumes may be in vehicles per hour, vehicles per 15 minutes or vehicles per 5 minutes. Volumes for movements 2, 4, 6 and 8 are total volumes for through plus right turning vehicles. Tee intersections would have zero volumes for the missing approach leg. Left turning movements (1, 3, 5, 7) not protected by left-turn signal phasing have zero coded volumes. Add these counted left turn volumes to the approaches' through plus right turn volumes.

Card 2. Saturation capacity flow rates serve the respective movement volumes above. Reasonably accurate values should be established since the movement green time is calculated based on the movement's volume to saturation capacity flow ratio. Thus, saturation flow rate units (e.g., vehicles per hour green) must be the same interval of time as the movement volume units. The saturation capacity flow rate in vehicles per hour green could be obtained for each movement from the Highway Capacity Manual using a load factor of 1.0 and a P.H.F. of 1.00.

An alternate approach to determining the movement's saturation capacity flow is to assume that it is "n" times the saturation flow rate for one lane, where "n" is the number of lanes used by the movement. Approximate saturation flow rates per lane can be obtained from Table 1.

Table 1

Saturation Capacity Flow

(Vehicles per hour green per lane)

	Percent Trucks in Movement		
Traffic Conditions	0-5%	5-10%	Over 10%
Class A	1600	1400	1300
Class B	1400	1300	1100
Class C	1300	1100	1000

Traffic Conditions

Class A:

1. Protected Left Turn with Adequate Bay Length, or
2. Protected Through Movements with θ-5% Left Turns on Same Approach

Class B:

1. Protected Left Turn with Inadequate Bay Length, or
2. Protected Through Movement with 5-15% Left Turns on Same Approach

Class C:

1. All Other Through Movements

Card 3. The minimum green time in seconds for each movement is in effect the minimum time for the green, yellow and all-red time, if any, for the movement. For example, if the desired minimum green interval was 10 seconds followed by a 3-second yellow interval and a 1 second all-red interval, the coded minimum green time would be 14 seconds. The minimum phase green times for movements 2, 4, 6 and 8 must be long enough to insure adequate walk and pedestrian clearance time for pedestrians crossing the other street.

NOTE: The minimum cycle length coded in columns 37-39 of Arterial Header Card must exceed the sum of the phase minimum green times of the conflicting greens.

Applications

PASSER was primarily designed to calculate green timings, phase sequence and offsets for signalized intersections along an arterial that would minimize delay and provide good arterial progression for a given set of traffic flow conditions. The program only calculates - it does not engineer. Several program runs may be needed before the final progression solution is calculated.

The program does not, as yet, directly recommend what range of cycle lengths to consider. Since all intersections are assumed to be operating on the same cycle (no double cycling is permitted) all are likely to have different "minimum delay" cycle lengths if they were operated isolated from the others. After a run, however, the calculated demand to capacity ratios indicate whether there may be a need to increase the system cycle length to provide better green splits and increase the general capacity of the system. Excessively long cycle lengths are more proned to overload left turn bays, which could promote through lane blockages and reduce capacity. Cycle lengths above 80 seconds in length should be avoided if at all possible. If the cycle length for the system is determined to be in excess of 80 seconds, every attempt should be made to find a way to increase the intersection capacity (i.e., add lane(s), restrict parking, or restripe pavement).

Phase sequence selection is also an engineering judgment. Many factors must be considered including 1) the type of equipment, 2) volume levels and directional loadings, 3) storage length of left turn bays and left turn volume levels, 4) effects of progression, 5) pedestrian signal timing, etc. It is suggested that program runs first be made for AM, PM and off-peak traffic conditions with all phase sequences possible to determine what phase sequence(s) would provide the best progression under the three different traffic conditions. If the same phase sequence resulted at an intersection for all three traffic conditions, then it would be the logical choice to use, from a progression viewpoint, in the final AM, PM and off-peak program runs where only one phase sequence choice at each intersection would normally be permitted. In addition, the unlimited sequence analysis, which will obviously give the best possible progression, can be used to determine the actual drop in progression efficiency that might occur from using only one sequence at an intersection in the final analysis runs.

Final AM, PM and off-peak program runs would be made after a thorough study of all results. During these final analysis runs, only one phase sequence would normally be permitted for each intersection.

While PASSER was developed to calculate movement green times from volume data and then develop an optimum progression solution, PASSER may also be used to develop a progression solution when the green times and cycle lengths are already known. The given cycle length is entered by setting the upper and lower cycle limits the same as the given cycle length. The given green times for the movements, green plus yellow and all-red, are coded as the minimum greens. All volumes are left blank (zero). The program will use the minimum green as the actual green. Phase selection is made as appropriate.

Computer Printout

Figures 3-5 are a printout of the principal data that were coded and read into the program. The user should satisfy himself by referencing this printout that no mistake was made in coding and reading in the data.

Figures 6-7 are a printout of the "Best Solution" for timing the signals at the intersections as computed by the program from the User Input Data.

The output first presents information describing the progression for the arterial followed by intersection signal timing and evaluation results. The progression values include the optimum cycle length, widths of the progression bands in seconds for the A and B directions, the average band speeds, and two other descriptors of the quality of the progression solution. These two descriptors are bandwidth efficiency and attainability. Efficiency is the average fraction of the cycle for progression. Attainability is the average fraction of the arterial minimum through greens used for progression.

The initial result given for an intersection is the progression offset of the start of the first arterial phase with respect to the start of the first arterial phase of the first intersection in the A direction. Also shown is the arterial phase sequence selected by the program for this intersection.

Signal timing information is then presented for the intersection beginning with the arterial phases followed by the cross street phases. Each phase is defined by the movement combination forming the phase. The green time shown for each phase includes the yellow clearance time.

Volume to signal capacity ratios are calculated for all movements and can be used to make an objective evaluation of expected traffic conditions. Check for general balance of all ratios and the level of each. A movement having a ratio exceeding 0.85 is likely to experience both large delays and numerous failures of the stopped queues to clear during the green.

Figure 8 is a simulated printer plotted time-space diagram which is available by coding a one (1) in Col. 48 of the Arterial Header Card Form; "***" indicate a dual left phase, "===" indicate a straight thru phase, "+++" indicate a leading green phase, and "---" indicate a lagging green phase.

The "..." show the location of the progression bands.

The simulated printer plot can be used to determine the most logical solution for a problem. Several sets of input cards can be coded and the best solution for each set of data plotted by the printer. Once the most logical solution is determined the corresponding data can then be rerun and the digital line plot requested from File D-19 by coding a one (1) in column 49 of the Arterial Header Card.

Figure 9 is a digital line plot of the time-space diagram of the best solution for a set of data which is available by coding a one (1) in column 49 of the Arterial Header Card. A straight line represents the arterial green split while another straight line on either side of this first straight line represent the protected left turn green times. The lines below the first mentioned line represent the leading greens. Those above it represent the lagging greens in the "A" direction.

TEXAS HIGHWAY DEPARTMENT

MULTIPHASE SIGNAL PROGRESSION PROGRAM - "PASSER II"

ARTERIAL & INTERSECTION HEADER CODING CARD FORMS

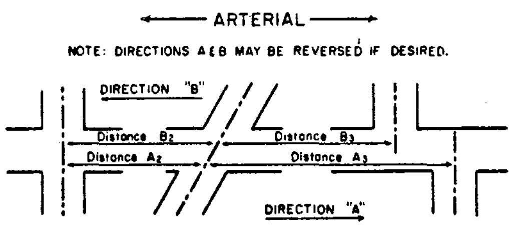
ARTERIAL HEADER CARD FORM (One card per Arterial)

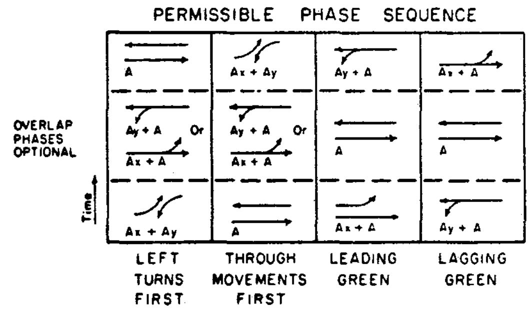
NAME OF CITY	NAME OF ARTERIAL	DIST.	DATE MO.	DATE DAY	DATE YR.	RUN NO.
1 – 12	– 24	26	28	29	31	34

CONTINUED

NUMBER OF INTERSECTIONS	LOWER CYCLE LENGTH (In Seconds)	UPPER CYCLE LENGTH (In Seconds)	CYCLE LENGTH INCREMENTS (Secs.)	OPTION 1	OPTION 2	PRINTER PLOT	LINE PLOT	X-SCALE 1" = ___ SECS.	Y-SCALE 1" = ___ FEET
35	37	40	43	45		48		50	52

INTERSECTION HEADER CARD FORM (One card per Intersection)





CODE: 0 - PHASE SEQ. NOT PERMITTED
1 - PHASE SEQ. PERMITTED NO OVERLAP
2 - PHASE SEQ. PERMITTED WITH OVERLAP

STREET NAME	INTERSECTION NUMBER	DISTANCE "A" (Feet)	DIRECTION "A" AVG. SPEED M.P.H.	DISTANCE "B" (Feet)	DIRECTION "B" AVG. SPEED M.P.H.	QUEUE CL. "A" SIDE (Secs.)	QUEUE CL. "B" SIDE (Secs.)	PERMISSIBLE PHASE SEQS. — ARTERIAL: LEFT TURNS FIRST	THROUGH MOVEMENTS FIRST	LEADING GREEN	LAGGING GREEN	PERMISSIBLE PHASE SEQS. — CROSS STREET: LEFT TURNS FIRST	THROUGH MOVEMENTS FIRST	LEADING GREEN	LAGGING GREEN
1	13	15	19	21	25	27	29	31				35			38

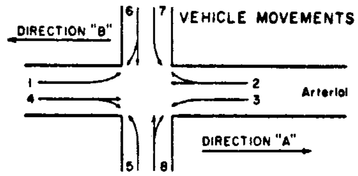
File 18.249-1

Figure 1

TEXAS HIGHWAY DEPARTMENT

MULTIPHASE SIGNAL PROGRESSION PROGRAM - "PASSER II"

INTERSECTION DETAIL CARD FORMS (Three cards per Intersection)



	INTERSECTION NUMBER	VEHICLE MOVEMENTS							
		MAJOR ST. (Arterial)				MINOR ST.			
		1	2	3	4	5	6	7	8
	1	3 6	10	14	18	22	26	30	34
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
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MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									
VOLUMES									
SAT. CAP. FLOW									
MIN. GREEN (Secs.)									

File 18.249-2

Figure 2

COLLEGE STAT SH 6 DIST 17 6/27/74 RUN NO. 1
OPTIONS IN EFFECT ARE # 2

INPUT DATA

NUMBER OF INTERSECTIONS	LOWER CYCLE LENGTH	UPPER CYCLE LENGTH	CYCLE INCREMENT
5	55	65	5

****

***** INTERSECTION 1 N ROSEMARY

DISTANCE 0 TO 1 0. FT SPEED 0. MPH DISTANCE 1 TO 0 0. FT SPEED 0. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE 0 SEC B SIDE QUEUE CLEARANCE 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE CROSS ST PHASE SEQUENCE IS THROUGH MOVEMENTS FIRST WITH OVERLAP
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH OVERLAP
LEADING GREEN WITH CVERLAP
LAGGING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	35	159	0	179	0	14	0	0
SAT. CAPACITY	1700	3400	0	3400	0	2000	0	0
MINIMUM GREEN	12	16	0	16	0	14	14	0

****

***** INTERSECTION 2 FM 6C

DISTANCE 1 TO 2 2065. FT SPEED 40. MPH DISTANCE 2 TO 1 2065. FT SPEED 40. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE 0 SEC B SIDE QUEUE CLEARANCE 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE CROSS ST PHASE SEQUENCE IS LEFT TURNS FIRST WITH OVERLAP
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH CVERLAP
LEADING GREEN WITH OVERLAP
LAGGING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	34	547	202	589	235	238	88	398
SAT. CAPACITY	17C0	3400	1700	4200	1700	3500	1700	3400
MINIMUM GREEN	12	16	12	16	12	14	12	14

Figure 3

COLLEGE STAT SH 6 DIST 17 6/27/74 RUN NO. 1
OPTIONS IN EFFECT ARE # 2

INPUT DATA

NUMBER OF INTERSECTIONS	LOWER CYCLE LENGTH	UPPER CYCLE LENGTH	CYCLE INCREMENT
5	55	65	5

****

***** INTERSECTION 1 N ROSEMARY

DISTANCE 0 TO 1 SPEED DISTANCE 1 TO 0 SPEED
0. FT 0. MPH 0. FT 0. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE B SIDE QUEUE CLEARANCE
0 SEC 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE CROSS ST PHASE SEQUENCE IS THROUGH MOVEMENTS FIRST WITH OVERLAP
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH OVERLAP
LEADING GREEN WITH CVERLAP
LAGGING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	35	159	0	179	0	14	0	0
SAT. CAPACITY	1700	3400	0	3400	0	2000	0	0
MINIMUM GREEN	12	16	0	16	0	14	14	0

****

***** INTERSECTION 2 FM 6C

DISTANCE 1 TO 2 SPEED DISTANCE 2 TO 1 SPEED
2065. FT 40. MPH 2065. FT 40. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE B SIDE QUEUE CLEARANCE
0 SEC 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE CROSS ST PHASE SEQUENCE IS LEFT TURNS FIRST WITH OVERLAP
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH CVERLAP
LEADING GREEN WITH OVERLAP
LAGGING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	34	547	202	589	235	238	88	398
SAT. CAPACITY	17C0	3400	1700	4200	1700	3500	1700	3400
MINIMUM GREEN	12	16	12	16	12	14	12	14

Figure 3

INPUT DATA

****

***** INTERSECTION 3 WALTCN DR

DISTANCE 2 TO 3 SPEED
2300. FT 40. MPH

DISTANCE 3 TO 2 SPEED
2300. FT 40. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE B SIDE QUEUE CLEARANCE
0 SEC 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH OVERLAP
LEADING GREEN WITH OVERLAP
LAGGING GREEN WITH OVERLAP

CROSS ST PHASE SEQUENCE IS LEADING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	16	492	107	621	147	120	21	175
SAT. CAPACITY	1700	3400	1700	3400	2200	3500	1700	2200
MINIMUM GREEN	12	16	12	16	12	12	12	12

****

***** INTERSECTION 4 JERSEY ST

DISTANCE 3 TO 4 SPEED
2610. FT 40. MPH

DISTANCE 4 TO 3 SPEED
2610. FT 40. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE B SIDE QUEUE CLEARANCE
0 SEC 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH CVERLAP
LEADING GREEN WITH OVERLAP
LAGGING GREEN WITH OVERLAP

CROSS ST PHASE SEQUENCE IS LAGGING GREEN WITH OVERLAP

MOVEMENTS

	1	2	3	4	5	6	7	8
VOLUMES	7	412	162	581	0	58	0	384
SAT. CAPACITY	1500	3400	1500	3400	0	3400	0	3600
MINIMUM GREEN	12	16	12	16	0	22	0	22

Figure 4

INPUT DATA

****

***** INTERSECTION 5 SH 30

DISTANCE 4 TO 5 SPEED
1925. FT 40. MPH

DISTANCE 5 TO 4 SPEED
1925. FT 40. MPH

MAJOR ST. MINOR ST.
A SIDE QUEUE CLEARANCE B SIDE QUEUE CLEARANCE
0 SEC 0 SEC

ARTERIAL PERMISSIBLE PHASE SEQUENCE
LEFT TURNS FIRST WITH OVERLAP
THROUGH MOVEMENTS FIRST WITH CVERLAP
LEADING GREEN WITH OVERLAP
LAGGING GREEN WITH OVERLAP

CROSS ST PHASE SEQUENCE IS THROUGH MOVEMENTS FIRST WITH OVERLAP

	MOVEMENTS							
	1	2	3	4	5	6	7	8
VOLUMES	137	276	0	288	0	349	23	0
SAT. CAPACITY	1700	3400	0	3400	0	2200	1700	0
MINIMUM GREEN	12	16	0	16	0	24	24	0

Figure 5

MULTIPHASE ARTERIAL PROGRESSION PROGRAM - PASSER II

COLLEGE STAT SH 6 DIST 17 6/27/74 RUN NO. 1

***** BEST SOLUTION *****

55 SECOND CYCLE , BAND A = 16 SECONDS , BAND B = 15 SECONDS 0.29 EFFICIENCY 0.98 ATTAIN
AVERAGE SPEED THRU SYSTEM BAND A SPEED = 41. BAND B SPEED = 41.

**** INTERSECTION 1 0.0 SECONDS OFFSET ARTERIAL PHASE SEQUENCE IS LEFT TURNS FIRST
N ROSEMARY

	ARTERIAL				CROSS STREET				
MOVEMENTS	2 + 4	1 + 4	1 + 3	TOTAL MAJOR ST	5+7	5+8	6+7	6+8	TOTAL MINOR ST
GREEN TIME SECS	27.2	13.8	0.0	41.0	0.0	0.0	14.0	0.0	14.0

MOVEMENTS	1	2	3	4	5	6	7	8
VOLUME TO CAPACITY RATIO	0.126	0.112	0.0	0.078	0.0	0.038	0.0	0.0

**** INTERSECTION 2 34.3 SECONDS OFFSET ARTERIAL PHASE SEQUENCE IS LEADING GREEN
FM 60

	ARTERIAL				CROSS STREET				
MOVEMENTS	1 + 4	2 + 4	2 + 3	TOTAL MAJOR ST	5+7	5+8	6+7	6+8	TOTAL MINOR ST
GREEN TIME SECS	12.0	4.0	13.0	29.0	12.0	0.0	0.0	14.0	26.0

MOVEMENTS	1	2	3	4	5	6	7	8
VOLUME TO CAPACITY RATIO	0.137	0.681	0.726	0.643	0.950	0.374	0.356	0.644

**** INTERSECTION 3 5.5 SECONDS OFFSET ARTERIAL PHASE SEQUENCE IS LAGGING GREEN
WALTON DR

	ARTERIAL				CROSS STREET				
MOVEMENTS	2 + 3	2 + 4	1 + 4	TOTAL MAJOR ST	5+7	5+8	6+7	6+8	TOTAL MINOR ST
GREEN TIME SECS	12.0	7.0	12.0	31.0	0.0	12.0	12.0	0.0	24.0

MOVEMENTS	1	2	3	4	5	6	7	8
VOLUME TO CAPACITY RATIO	0.065	0.531	0.433	0.670	0.459	0.236	0.085	0.547

Figure 6

BEST SOLUTION CONTINUED

**** INTERSECTION 4 5.9 SECONDS OFFSET ARTERIAL PHASE SEQUENCE IS LEADING GREEN
JERSEY ST

	ARTERIAL				CROSS STREET				
MOVEMENTS	1 + 4	2 + 4	2 + 3	TOTAL MAJOR ST	5+7	5+8	6+7	6+8	TOTAL MINOR ST
GREEN TIME SECS	12.0	7.3	13.6	32.9	0.0	0.0	0.0	22.1	22.1

MOVEMENTS	1	2	3	4	5	6	7	8
VOLUME TO CAPACITY RATIO	0.032	0.417	0.660	0.627	0.0	0.052	0.0	0.326

**** INTERSECTION 5 28.9 SECONDS OFFSET ARTERIAL PHASE SEQUENCE IS LEFT TURNS FIRST
SH 30

	ARTERIAL				CROSS STREET				
MOVEMENTS	2 + 4	1 + 4	1 + 3	TOTAL MAJOR ST	5+7	5+8	6+7	6+8	TOTAL MINOR ST
GREEN TIME SECS	16.0	13.8	0.0	29.8	0.0	0.0	25.2	0.0	25.2

MOVEMENTS	1	2	3	4	5	6	7	8
VOLUME TO CAPACITY RATIO	0.492	0.372	0.0	0.186	0.0	0.415	0.035	0.0

Figure 7

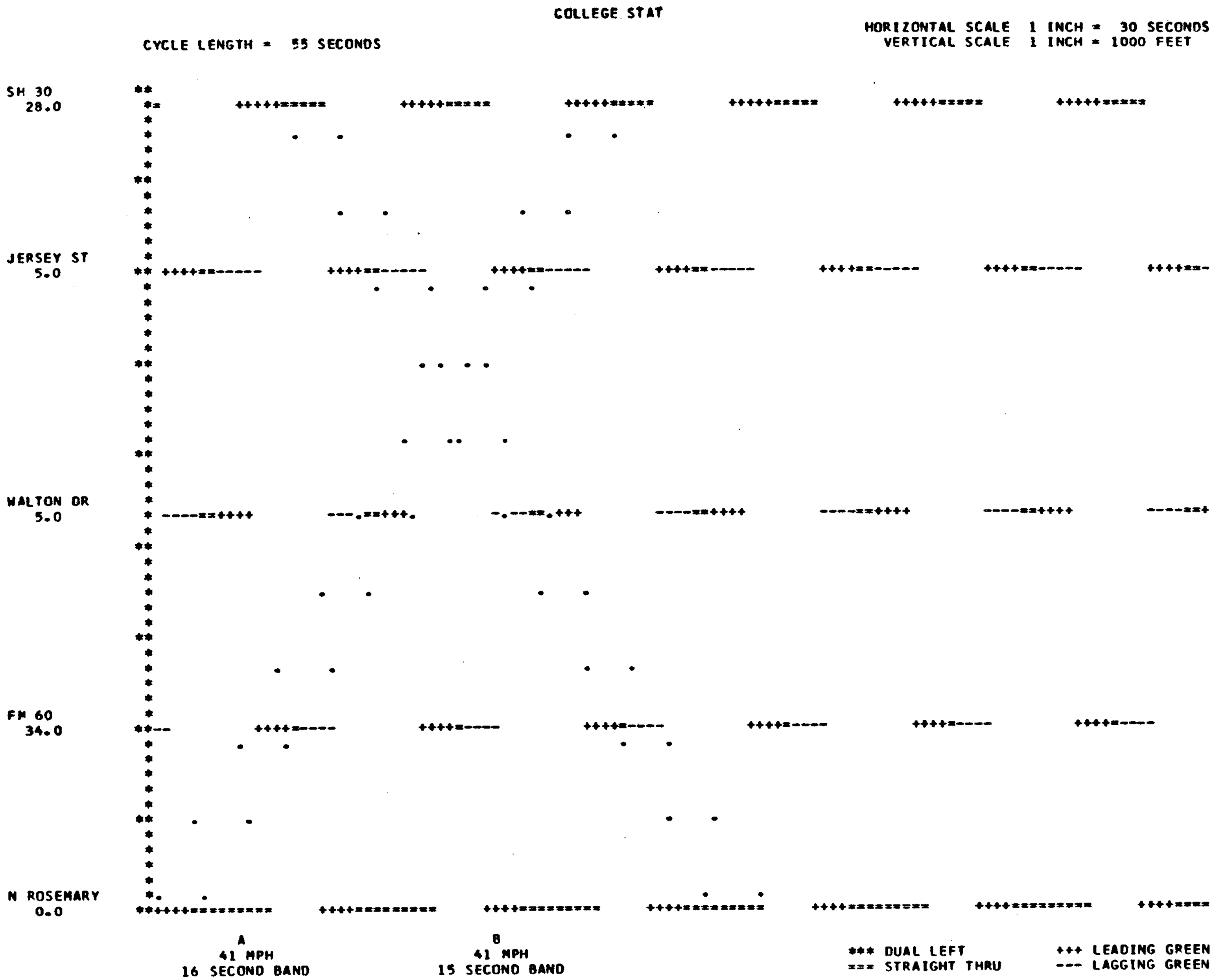
COLLEGE STAT
CYCLE LENGTH = 55 SECONDS
HORIZONTAL SCALE 1 INCH = 30 SECONDS
VERTICAL SCALE 1 INCH = 1000 FEET
SH 30
28.0
JERSEY ST
5.0
WALTON DR
5.0
FM 60
34.0
N ROSEMARY
0.0
A
41 MPH
16 SECOND BAND
B
41 MPH
15 SECOND BAND
*** DUAL LEFT
=== STRAIGHT THRU
+++ LEADING GREEN
--- LAGGING GREEN

Figure 8

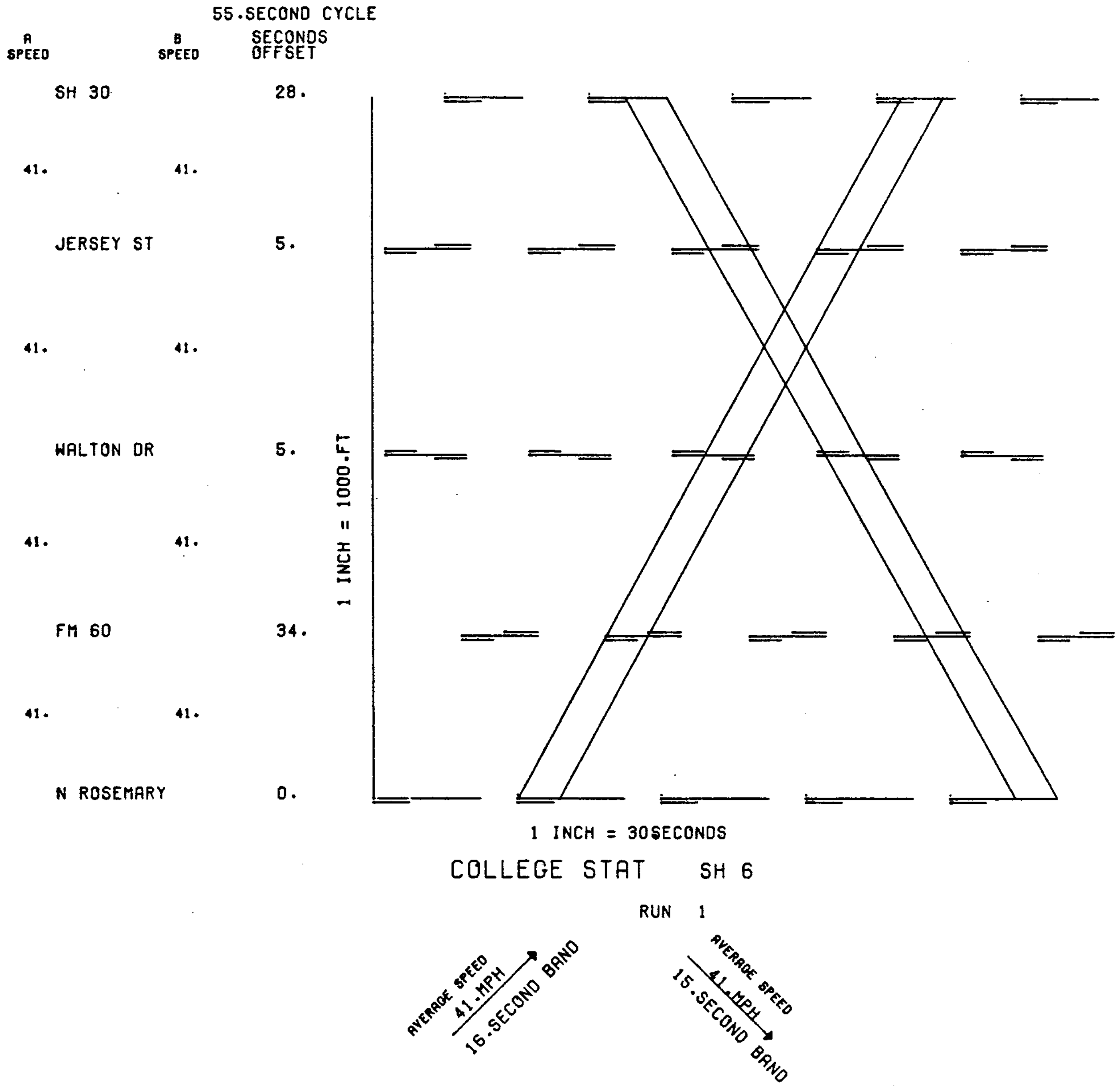
55.SECOND CYCLE
A SPEED
B SPEED
SECONDS OFFSET
SH 30
28.
41.
41.
JERSEY ST
5.
41.
41.
WALTON DR
5.
41.
41.
FM 60
34.
41.
41.
N ROSEMARY
0.
1 INCH = 1000.FT
1 INCH = 30SECONDS
COLLEGE STAT SH 6
RUN 1
AVERAGE SPEED 41.MPH
16.SECOND BAND
AVERAGE SPEED 41.MPH
15.SECOND BAND

Figure 9

APPENDIX A

WEBSTER'S METHOD FOR CALCULATING FIXED TIME CYCLE LENGTHS AND SPLITS

Variables:

SAT - Saturation flow interval (seconds per vehicle) time gap between vehicles - normally set at 2.0 seconds per vehicle in urban areas and 2.1 second/veh in suburban areas.

TIME - Time interval over which vehicle counts were made (in seconds).

Ni - Number of vehicles, for the highest volume approach, counted during the time interval "TIME" (veh per lane).

If the volumes in one lane for an approach during the phase green for that approach are expected to be considerably higher than the other lane volumes for that phase under the new traffic signal operation, then use the number of vehicles for this critical lane.

EFF - Effective or equivalent straight through passenger car factor for each phase (takes into account the extra time needed for trucks and turning movements). Suggest values of 1.07 for protected phase movements and 1.12 for unprotected phase movements unless data from the intersection are available.

STARTING DELAY TIME - (Recommend value of 4.0 seconds)

AMBER TAKEN AS LOST TIME - (Recommend value of "0" zero seconds)

AL - Lost time per phase =

STARTING DELAY TIME + ALL RED INTERVAL + AMBER TAKEN AS LOST TIME

TLOST - Total lost time per cycle = $\sum_{i=1}^{N} AL_i$, N = number of phases

TLOST for 3 phases = $AL_1 + AL_2 + AL_3$

Yi - The ratio between the actual volume and the saturation volume for the highest volume approach of a phase or the critical lane for a phase.

To calculate cycle lengths

$$Yi = [(Ni \times EFFi) / TIME] \div SAT$$

$$Y = \sum_{i=1}^{N} Yi, \quad n = \text{number of phases}$$

$$CYCLE = [(1.5 \times TLOST) + 5\ ] \ / \ (1-Y)$$

To calculate splits

$$Gi = [(Yi/Y) \ (CYCLE-TLOST)] + ALi$$

APPENDIX "B"

Instructions for Coding Diamond Interchanges

When a Diamond Interchange is part of the Arterial System and it is desired to have progression thru the Diamond in relation to the other intersections in the arterial, the following coding procedures should be followed:

1. Diamond Interchanges with four phase operation with overlaps.

   Code the permissible phase sequence for the first diamond intersection in the "A" direction as lagging green (a "1" in Col. 34) and the other intersection as leading green (a "1" in Col. 33).

2. Diamond Interchange Three Phase Lagging Green

   Code the permissible phase sequence for the first diamond intersection in the "A" direction as leading green (a "1" in Col. 33) and the other intersection as lagging green (a "1" in Col. 34).