

# UC Berkeley

## Working Papers

### Title

Analysis Of Arterial Street Data From The ATSAC System

### Permalink

<https://escholarship.org/uc/item/4946w42b>

### Authors

Bacon, Jr., Vinton W.  
May, Adolf D.

### Publication Date

1993

**This paper has been mechanically scanned. Some errors may have been inadvertently introduced.**

CALIFORNIA PATH PROGRAM  
INSTITUTE OF TRANSPORTATION STUDIES  
UNIVERSITY OF CALIFORNIA, BERKELEY

## **Analysis of Arterial Street Data from the ATSAC System**

**Vinton W. Bacon, Jr.**  
**Adolf D. May**

**UCB-ITS-PWP-93-11**

This work was performed **as** part **of** the California PATH Program of the University of California, in cooperation with the State of California Business, Transportation, and Housing Agency, Department of Transportation; and the United States Department of Transportation, Federal Highway Administration.

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 State of California. This report **does** not constitute a standard, specification, or regulation.

AUGUST 1993

ISSN 1055-1417

## **Acknowledgements**

This work was made performed as part of the California PATH Program, in cooperation with the State of California, Business, Transportation and Housing Agency, Department of Transportation; and the United States Department of Transportation, Federal Highway Administration.

The authors wish to thank the officials at ATSAC for providing the tapes that make up the backbone of this study. In particular, Sean Skehan was very helpful in sending us the tapes and provided much assistance in understanding the organization of the tapes and the ATSAC system itself.

The authors also wish to thank the many people at ITS who assisted throughout the project. Randall Cayford demonstrated how to get the magnetic tapes downloaded from the magnetic tapes to a PC. Dave Lovell and Loren Bloomberg were both of much help with advice pertaining to the writing of the computer programs that were written.

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 State of California. This report does not constitute a standard, specification, or regulation.

This report is part of an effort to simulate various IVHS strategies on the Santa Monica Freeway Corridor (I-10) in Los Angeles. This corridor is also known as the "Smart Corridor" because of the Santa Monica Freeway Smart Corridor Demonstration Project that is currently underway in Los Angeles. While much of the data used for this report was obtained from the agencies involved in the Smart Corridor Project, it should be made clear that this research was conducted at the University of California at Berkeley and is not a part of the Smart Corridor Project itself. The results arrived at in this report do not necessarily reflect the views of any of the agencies involved in the Smart Corridor Project nor should they be interpreted as an evaluation of the Smart Corridor Project.

## Table of Contents

Section 1:	Executive Summary	Page 1
Section 2:	Purpose of the Data Collection Efforts	Page 3
Section 3:	Description of the Tapes Received	Page 4
Section 4:	The Signal Timing Portion of the Data Tape	Page 8
Section 5:	The Second Portion of the Data Tape and <b>ATSAC.CPP</b>	Page 10
Section 6:	The <b>SLICE.CPP</b> Program and Results	Page 14
Section 7:	The <b>COMBINE.CPP</b> Program and Results	Page 26
Section 8:	Plans for Continued Work	Page 46
Appendix A:	The <b>ATSAC.CPP</b> Program	Page 47
Appendix B:	The <b>SLICE.CPP</b> Program	Page 50
Appendix C:	The <b>COMBINE.CPP</b> Program	Page 53
Appendix D:	Maps of the Intersections and their Detectors	Page 56

## List of Tables and Figures

Figure	Title	Page
1	The Data Extraction Process	2
2	Map of Corridor to be Simulated	5
3	Map of the Nine Intersections Analyzed	5
4	Map of the Detectors at Olympic & Figueroa	6
5	Map of the Detectors at Olympic & Main	7
6	Sample of the Signal Timing Data	8
7	Sample of Output File <b>789</b>	11
8	Flow by Signal Cycle - Detector <b>718</b>	12
9	Flow by Signal Cycle - Detector <b>725</b>	13
10	Complete Output File <b>718.TXT</b>	15
11	Speed Flow Curve - Detector <b>718</b>	16
12	Speed Flow Curve - Detector <b>773</b>	17
13	Speed Flow Curve - Detector <b>789</b>	18
14	Flow on Olympic@Figueroa - Westbound	20
15	Occupancy on Olympic@Figueroa - Westbound	21
16	Flow on Olympic@Main - Westbound	22
17	Occupancy on Olympic@Main - Westbound	23
18	Flow on Olympic@Figueroa - Eastbound	24
19	Occupancy on Olympic@Figueroa - Eastbound	25
20	Complete Output File <b>OLY@FIG.E</b>	27
21	Flow Data for Olympic Eastbound	28
22	Occupancy Data for Olympic Eastbound	29
23	Flow Data for Olympic Westbound	30
24	Occupancy Data for Olympic Westbound	31
25	Contour Graph of Flow on Olympic Eastbound	32
26	Contour Graph of Occupancy on Olympic Eastbound	33

## List of Tables and Figures (cont.)

Figure	Title	Page
27	Flow on Olympic Eastbound - Part 1	34
28	Flow on Olympic Eastbound - Part 2	35
29	Flow on Olympic Eastbound - Part 3	36
30	Occupancy on Olympic Eastbound - Part 1	37
31	Occupancy on Olympic Eastbound - Part 2	38
32	Occupancy on Olympic Eastbound - Part 3	39
33	Contour Graph of Flow on Olympic Westbound	40
34	Contour Graph of Occupancy on Olympic Westbound	41
35	Flow on Olympic Westbound - Part 1	42
36	Flow on Olympic Westbound - Part 2	43
37	Occupancy on Olympic Westbound - Part 1	44
38	Occupancy on Olympic Westbound - Part 2	45
39	Map of the Detectors at Olympic & Flower	56
40	Map of the Detectors at Olympic & Hope	57
41	Map of the Detectors at Olympic & Grand	58
42	Map of the Detectors at Olympic & Olive	59
43	Map of the Detectors at Olympic & Hill	60
44	Map of the Detectors at Olympic & Broadway	61
45	Map of the Detectors at Olympic & Los Angeles	62

Table	Title	Page
1	Summary of Signal Timing Portion of Tape	9

## Section 1: Executive Summary

A data tape was requested and received from the ATSAC system in Los Angeles. The tape contained data for 75 detectors from nine intersections along Olympic Boulevard from Figueroa Street to Los Angeles Street. This tape was analyzed to determine the possibility of using this data for a simulation study of the Santa Monica Freeway Corridor using the INTEGRATION model. The goal of the research was to develop efficient methods of data extraction to be used for future use and to test the integrity of the data itself. Computer programs were developed which can be applied to the raw data from the tapes that allow for relatively fast analysis and extraction of the data. Overall, the data appeared to be very good. Of the 75 detectors on the tape, 45 were analyzed in detail. Only 1 of these 45 detectors produced results that indicated a possible detector malfunction.

Three programs were written to extract the data. The first **ATSAC.CPP** takes the data from the raw data file, puts it in a format that is importable to spreadsheets, and divides the data into files for each detector. **SLICE.CPP** takes the files for each detector and aggregates the data into half hour time slices. The final program **COMBINE.CPP** takes the half hour time slice data for flow and occupancy and combines the data from various detectors together. This is used to get data for a specific link or group of detectors. The end result is that the approximately 8 megabytes of data from the tapes is condensed into files that occupy only a few hundred kilobytes of space. The data extraction process is summarized in Figure 1.

The data was analyzed at both the level of individual detectors and groups of detectors or links. A few individual detectors were analyzed using speed flow curves. For each group of detectors along Olympic Boulevard the flow and occupancy data was graphed to check for reasonable flow patterns. The cumulative data for each link was used to chart the eastbound and westbound flow along Olympic. With few exceptions, the data appeared quite reasonable. It should be emphasized that the possible detector malfunction found could be explained by a more thorough knowledge of the physical features of the roadway or the ATSAC system itself.

The work was considered a success on two accounts. First, the data can be extracted into a format that is compatible with the INTEGRATION model. Secondly, the data appear to be reliable. It is hoped that data for the entire corridor to be studied can be collected in the near future. This will be a critical element in creating an accurate simulation of the Santa Monica Freeway Corridor.



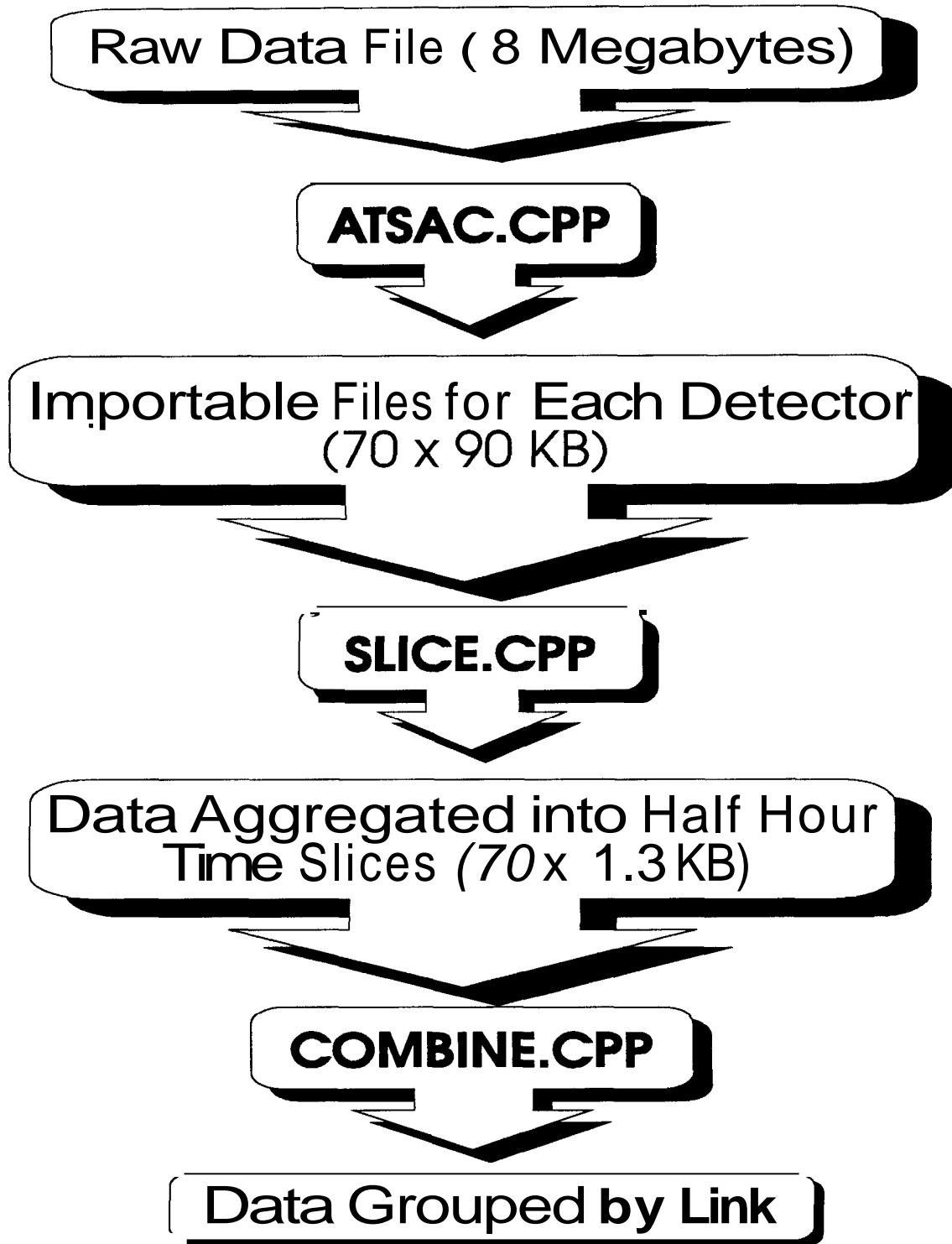


Figure 1

The Data Extraction Process

## **Section 2: Purpose of the Data Collection Efforts**

This study is part of an effort to simulate the Santa Monica Freeway Corridor (Rte. 10) in Los Angeles using the INTEGRATION model. The model will be used to determine the potential benefits of various types of route guidance systems, Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems (ATIS), and combinations of these three under a number of different traffic scenarios. The selection of an actual traffic system as opposed to a hypothetical model was desired to make the results more applicable to the real world and to avoid subjectivity.

The boundaries of the area to be simulated will be Centinela Street on the West and Soto Street on the East. The entire length of this section is about **14** miles long. The corridor will also include the five parallel arterial streets: Olympic, Washington, Jefferson, Adams, and Pico. The number of nodes and links required for a simulation of a network this size will be quite large. It is estimated that up to 2000 links and 1000 nodes may be required to simulate the corridor. Efforts are underway to obtain the x-y coordinates for the nodes in the corridor using Geographical Information Systems (GIS) software. Data concerning the geometry of the roadway, number of lanes, etc. will also be needed. In addition to the supply data, extensive demand data will also be required. Accurate demand data will be critical to establish the original base run and determining the effects of various ATIS, ATMS and routing strategies based on varying levels of traffic and incident scenarios.

The INTEGRATION model will generate a synthetic origin/destination pairing using a supporting module named QUEENSOD. QUEENSOD requires individual link flows to create these pairs. Efforts are underway to collect data from Caltrans for the freeway portion of the corridor. Data for the arterial streets will be equally necessary.

The purpose of this report is first to develop an efficient process whereby the extensive arterial street data that the ATSAC system collects can be used to generate link flows that can be used by the QUEENSOD module. Secondly, an attempt was made to analyze the data that is available from the ATSAC system and determine if the quality of the data is of sufficient quality to be used by the simulation project. Current efforts at ATSAC are being undertaken that will provide extensive data for the corridor in the near future. Given the large amount of data involved, it will be necessary to have a method of processing this data in a timely manner. It is hoped that the methodology detailed in this report will be sufficient to meet these needs.

### **Section 3: Description of the Tapes Received**

The researchers at UC-Berkeley requested data from the officials at ATSAC and the City of Los Angeles preferably from the corridor to be simulated. In the middle of February 1993 a magnetic tape was received from ATSAC. The magnetic tape was then taken to the Computing Services on the UC-Berkeley campus. From here it was transferred onto a PC via the campus computer network (Ethernet). Doing this resulted in a file approximately 8.1 megabytes in size. Officials at ATSAC also sent along a packet of literature that included samples of the data on both parts of the tape that described what each column of data represents. Also included were detailed maps that show the geometry of each intersection included on the tape and where each detector is located within the intersection.

There was an initial difficulty analyzing the second portion of the data file using typical text editors. It appeared that there was no data on this portion of the tape or that the data was flawed. Using a commercially available disk editor the source of the problem was discovered. The tapes use 4 or 5 null characters (ASCII code 0) to delimit new lines as opposed to the carriage return and newline characters used by text editors. With the disk editor it was possible to look at the data on the tape and determine what the tape contained. However, at this point the data could not be extracted to a spreadsheet because of the lack of newline characters.

With the disk editor and the materials provided by ATSAC, the contents of the tapes could be discovered. The tape is composed of two parts, which are discussed in detail in subsequent sections of this report. The location of the corridor to be studied and the locations of the detectors included on the tape are shown in Figure 2. Data is included for nine intersections along Olympic Avenue from Figueroa Avenue westward to Los Angeles Street. These are shown in Figure 3. Figures 4 and 5 show the intersections of Olympic and Figueroa and Olympic and Main respectively and the location of the detectors within these intersections. Similar maps of the seven other intersections are shown in Appendix D. The tape includes all of the detectors on Olympic that are indicated by the ATSAC maps for all nine intersections in both directions. Data for the upstream cross street detectors is present for all but one of the intersections. Downstream cross street detectors are generally not included. All of the included detectors contain data for February 11, 1993 from 6 am to 7 pm.

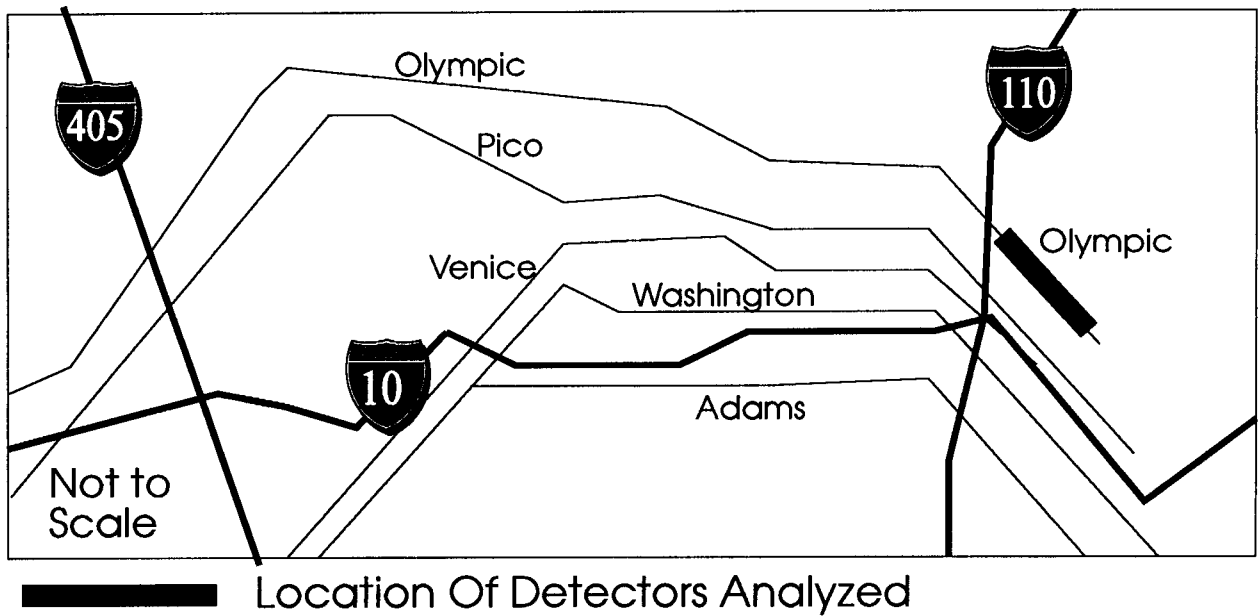


Figure 2  
Location of Corridor to be Simulated

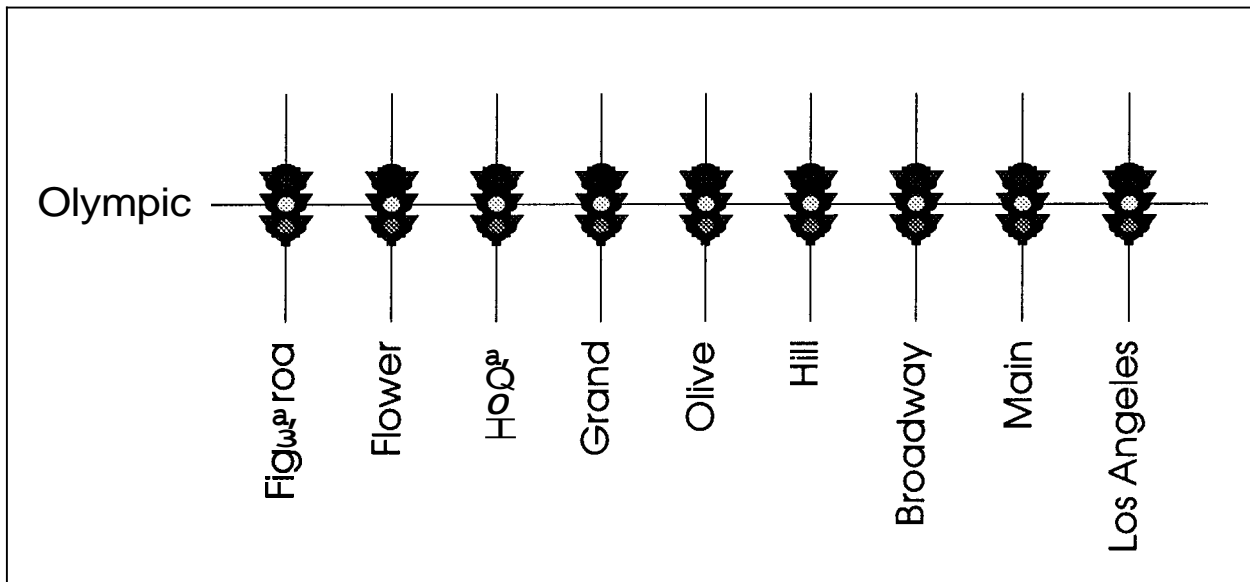
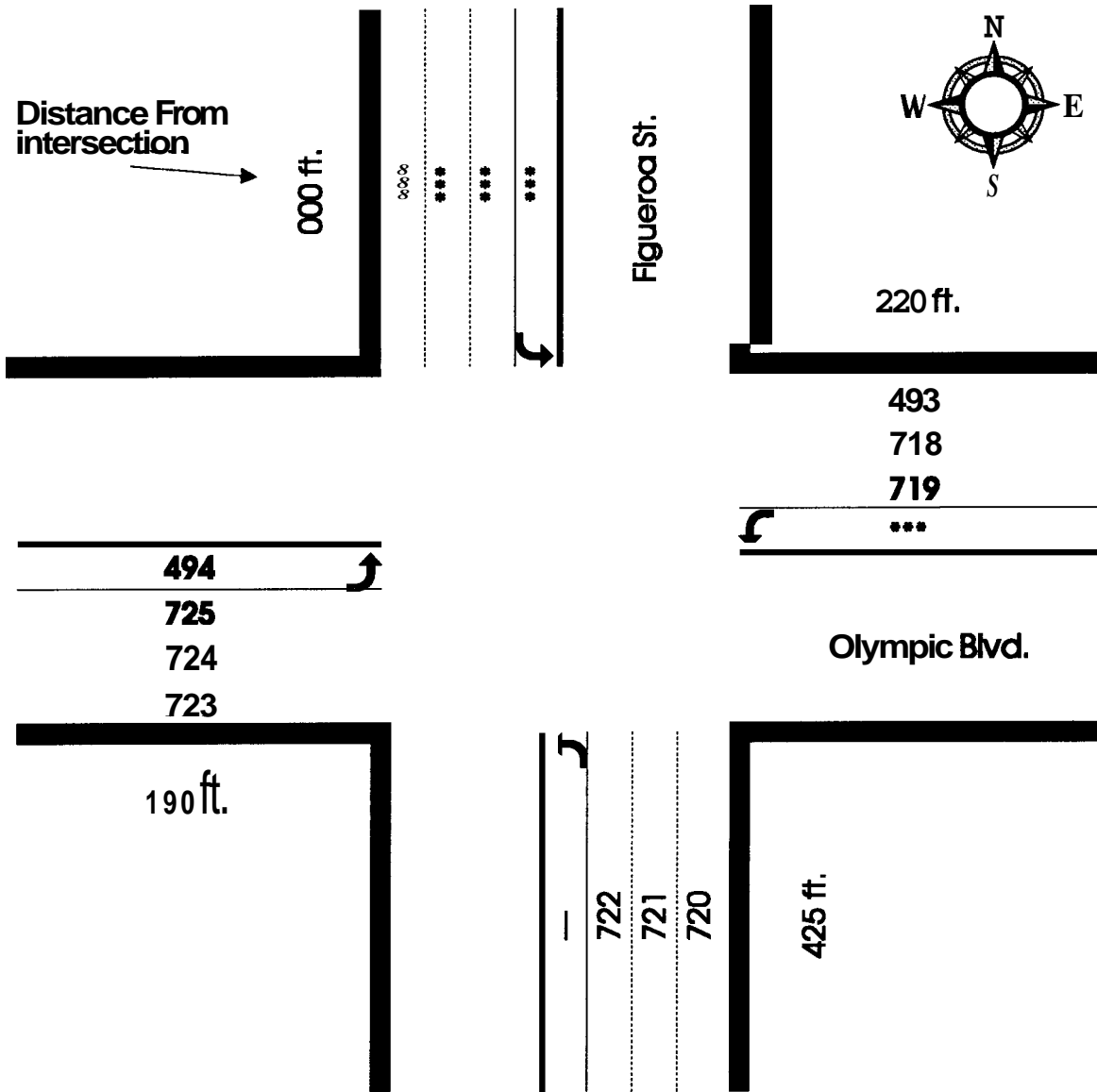


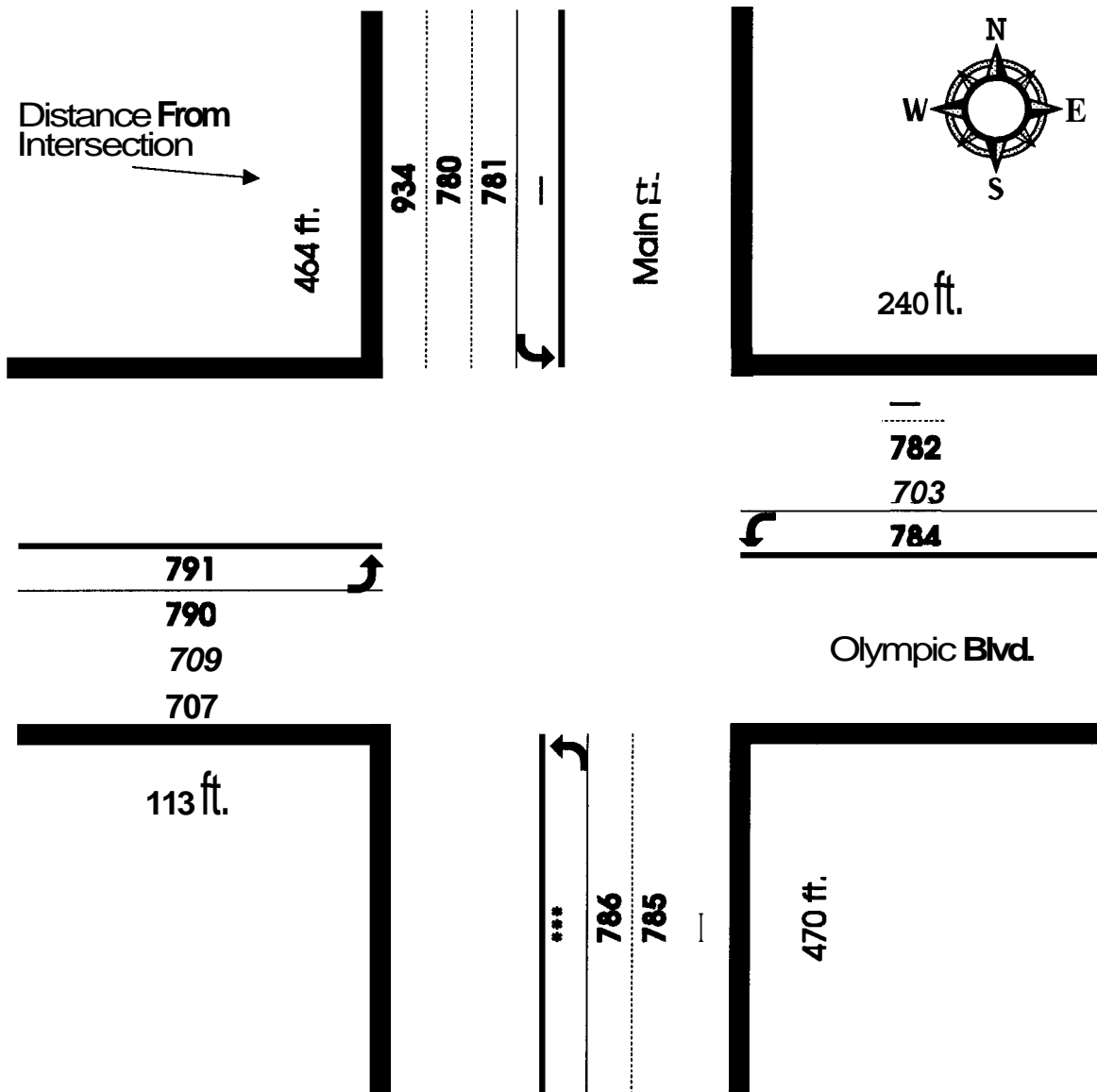
Figure 3  
The Nine Intersections Studied



# Olympic and Figueroa

--- No Detector  
 \*\*\* No Lane  
 Bold - Data Included

Figure 4



**Olympic  
and  
Main**

--- No Detector  
 \*\*\* No Lane  
 Bold - Data Included

**Figure 5**

## Section 4: The Signal Timing Portion of the Data Tape

The first portion of the tapes contains the signal lengths and splits for all nine intersections for the entire time period. A sample of this output is given in Figure 2.

```

CONTR. NO.    123
FLOWER ST & OLYMPIC BL
CYCLE LENGTH 60    DESIRED OFFSET 56
START TIME 06:19    END TIME 19:00    PLAN 1
CYCLE   STATUS   TIME    ACTUAL    MOVEMENT (SEC)
NO.     OFFSET
1       NORM     06:19    59        1  2  3  4  5  6  7  8
2       NORM     06:20    59        0  32 0  23 0  32 0  23
3       NORM     06:21    59        0  41 0  23 0  41 0  23
4       NORM     06:22    59        0  41 0  23 0  41 0  23
5       NORM     06:23    59        0  41 0  23 0  41 0  23
6       NORM     06:24    59        0  41 0  23 0  41 0  23
7       NORM     06:26    59        0  41 0  23 0  41 0  23
8       NORM     06:27    59        0  41 0  23 0  41 0  23
9       NORM     06:28    59        0  41 0  23 0  41 0  23
10      NORM     06:29    59        0  41 0  23 0  41 0  23
  
```

Figure 6  
Sample Output from First Portion of Data Tape

The first line in the figure gives the controller number for this intersection. The third line gives the starting signal length and initial offset for the intersection. There is no specific intersection where the offset is set to zero. Also, the offset changes throughout the day with the current offset shown under "ACTUAL OFFSET". The plan number shows the initial signal timing plan for the intersection. There are four plans that are used throughout the day for all of the intersections in the system. The first is in effect from 6 am to 10 am, the second from 10 am to 3 pm, the third from 3 pm to 7 pm and plan number four is in effect from 7 pm to 6 am. Status is "NORM" for the majority of the day and changes to "TRANS" when a cycle is altered during a change in plans. This is often needed to get all of the signals synchronized for the next plan. Movement numbers 2 and 6 are westbound and eastbound respectively and movements 4 and 8 represent southbound and northbound respectively. This is shown in Figure 4 which represents a typical intersection. None of the intersections included had any additional signal phases. The numbers below the movement number indicate the green time for each movement in seconds.

The data for all of the nine intersections follows the same pattern on the tape and conforms with what was expected after conversations with officials at ATSAC. With only minor exceptions, the cycle length for all of the intersections is 70 seconds from 6 am to

3 pm (plans 1 and 2) and 90 seconds from 3 pm to 7 pm (plan 3). The signals for the most part have the same splits from 6 am to 10 am. Most switch to a different pattern from 10 am to 3 pm. The offsets also change with each change in signal plan. Table 1 summarizes these results.

The current version of the INTEGRATION model can only optimize individual intersections based on flow and occupancy encountered during the running of the model. It does this while preserving the original cycle length and any offsets that were entered. This optimization feature can be turned off or set to work at any user-defined frequency. The user may also specify any number of plans to be followed throughout the day. Thus, the INTEGRATION model is capable of simulating the ATSAC system whether the various signal timing plans are fixed or vary from day to day. It would be interesting to compare the optimized plans for both the ATSAC system and the INTEGRATION model. More needs to be learned about how both of these systems optimize. The model would also allow one to test the results of various optimization strategies. Incidentally, the creators of the INTEGRATION model are in the process of developing a SCOOT-like system of system-wide signal optimization. This project could provide a test of this feature by comparing its performance to the actual ATSAC data.

Intersection	Initial Offset	PLAN 1 (70 Sec.)			PLAN 2 (70 Sec.)			PIAN 3 (70 Sec.)		
		6 am to 10 am			10 am to 3 pm			3 pm to 7 pm		
Olympic and..		E/W	N/S	Offset	E/W	N/S	Offset	E/W	N/S	Offset
<b>Figueroa</b>	85	37	26	50	32	28	6	51	32	87
<b>Flower</b>	56	41	23	59	30	34	55	49	35	77
<b>Hope</b>	33	47	17	61	47	17	51	60	24	77
<b>Grand</b>	75	28	36	23	45	19	44	49	35	77
<b>Olive</b>	19	33	31	33	32	31	0	47	36	76
<b>Hill</b>	9	38	26	47	42	22	28	57	27	77
<b>Broadway</b>	70	31	33	55	37	27	30	42	42	72
<b>Main</b>	18	33	30	60	35	29	31	38	46	62
<b>Los Angeles</b>	59	27	37	8	33	31	40	42	42	47

Table 1

Summary of Signal Timing Data



## Section 5: The Second Portion of the Data Tape and AT SAC.CPP

The second portion of the tape comprises about 85% of the entire tape. It consists of data for all of the 75 detectors for each signal cycle throughout the entire 13 hour period. The data included is exact time of the cycle, flow per cycle converted to vehicles per hour, percent occupancy, speed in miles per hour, delay in seconds per vehicle per cycle, queue, stops and demand, the last three being measured in vehicles per cycle. The length of the signal cycle is also reported in this section, but not the green time for that movement.

Flow and occupancy are the only parameters that are actually measured. The other measures of performance are derived from these figures, the location of the detector, the cycle length and the signal status. Queue represents the number of vehicles that will have to stop at the signal. It is calculated using the distance between the detector and the signal, the speed of the vehicle, and the status of the signal. With this data, it can be determined which vehicles will have to stop and which won't. Stops is the same as queue unless the queue from one cycle is not cleared. Delay is calculated by determining how long an approaching vehicle will have to wait before clearing the signal. This can be done since the system knows precisely when the signal changes and hence when a vehicle will arrive at the signal and when it will be able to leave. Demand is simply the number of vehicles that passed the detector in the cycle.

Data on the tape is arranged by time slice. All of the data for a certain half hour period is grouped together. The detectors always appear in the same order for each half hour slice. Interspersed among the data are page headers that give the date for the data and explain what each column of data represents.

As mentioned, the data cannot be imported to a spreadsheet or word processor at this stage. A computer program, **ATSAC.CPP**, was written to make the data importable to a spreadsheet. The source code for this program is included in Appendix A. This and the other programs discussed below were all written in C++ and compiled using the Borland C++ 3.1 compiler. It was decided that some processing of the data could also be done in this initial program. The goal was to divide the huge data file into smaller subfiles as well as making the data importable to a spreadsheet. It was felt that the data should be grouped by detector so that data for groups of detectors can be dealt with together.

The program reads the data file, eliminates the header lines that do not contain data, and detects when the data file switches from one detector to another. It also removes all of the null characters and inserts newline characters where appropriate. When it encounters a change in the detector number it creates or appends a file having the name of the

detector number (i.e. **757**) and puts the next batch of data into that file until it encounters another change in detector number. The end result is a file for each detector that consists of only data lines and has data for the entire time period for this detector. These files are roughly 90 kilobytes in size and contain nearly 600 lines of data, each line representing a signal cycle.

A sample portion of one of these files is shown in Figure 7. The headings given in this figure are shown for clarity but are not a part of the actual output file.

Time	Vol	Occ	Speed	Queue	Stops	Delay	Demand	Cycle
15:53:02	280	5	14	3	3	43	7	90 (C)
15:54:32	320	37	2	3	3	42	8	90 (C)
15:56:02	360	39	3	3	3	41	9	90 (C)
15:57:33	356	9	11	2	2	41	9	91 (C)
15:59:02	566	32	5	4	4	40	14	89 (C)
16:00:32	400	39	3	3	3	39	10	90 (C)
16:02:02	240	15	4	3	3	30	6	90 (C)
16:03:32	320	39	2	3	3	41	8	90 (C)
16:05:03	395	9	12	2	2	36	10	91 (C)

Figure 7

#### Sample of Output File **789** Generated by **ATSAC.CPP**

Descriptions of each measure of performance are given above. This file is essentially identical to the output on the tapes except that the data is now grouped by detector instead of by half hour time slice. A file exists for each detector that contains the entire day's data for that detector. One should note the large variance in flow and occupancy between individual cycles. This is seen in all of the detectors and is to be expected. The variance is quite evident in figures 8 and 9 that show the flow values for an entire day graphed for two detectors, 718 and 725. Detector 718 is located on Olympic Boulevard upstream of Figueroa in the second lane from the median (not including the left turn lane). Detector 725 is located in the second lane upstream of Figueroa but in the Eastbound direction. Despite the large variance seen the general pattern of demand is evident in these graphs and conforms to what would be expected given the location of the detectors. One should also note that the evening eastbound peak is more pronounced than the morning westbound peak. This trend was prevalent in most of the detectors along Olympic.

# Flow vs. Time (By Signal Cycle)

Det 718 - Olympic@Figueroa - Westbound

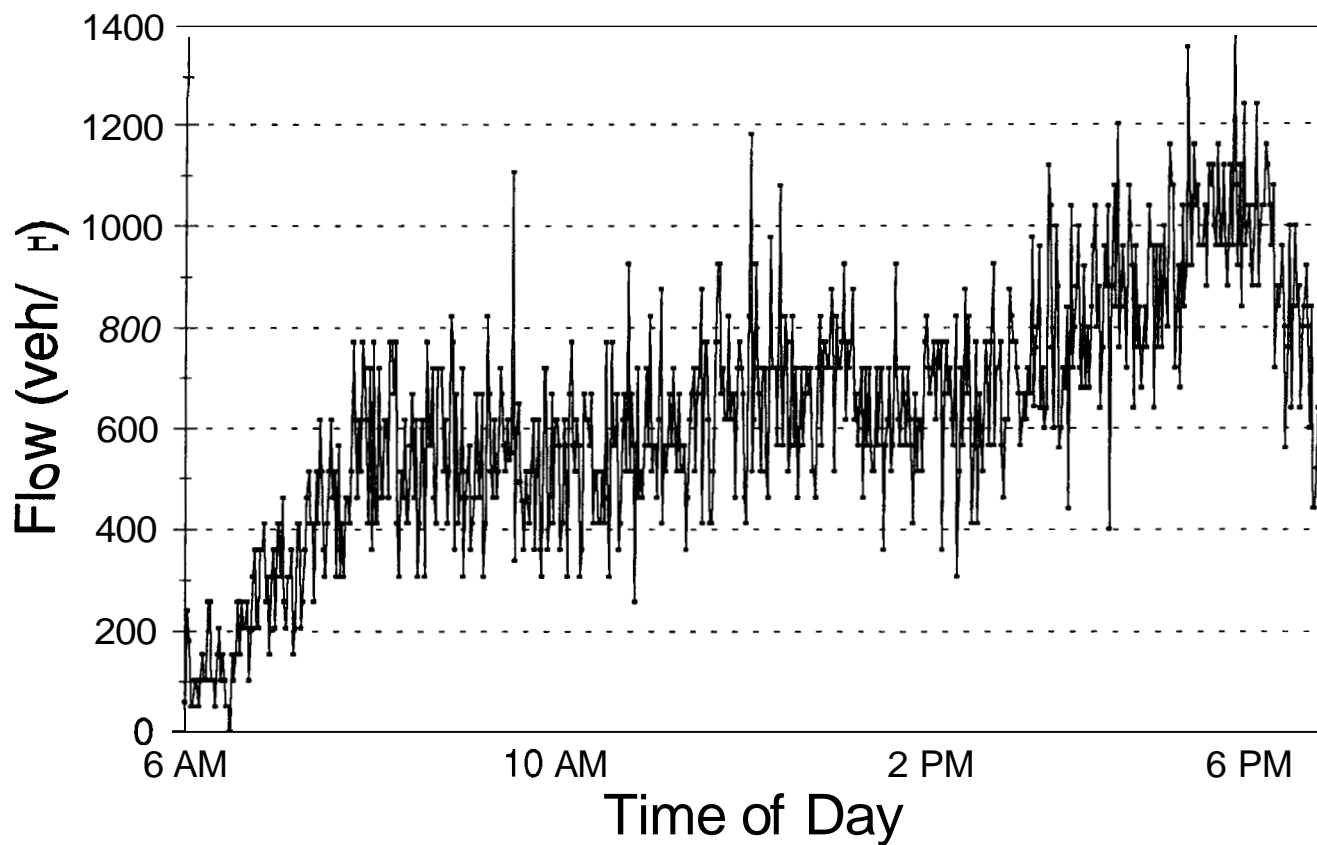


Figure 8

Flow by Signal Cycle - Detector 718

## Flow vs. Time (By Signal Cycle)

Det 725 - Olympic@Figueroa - Eastbound

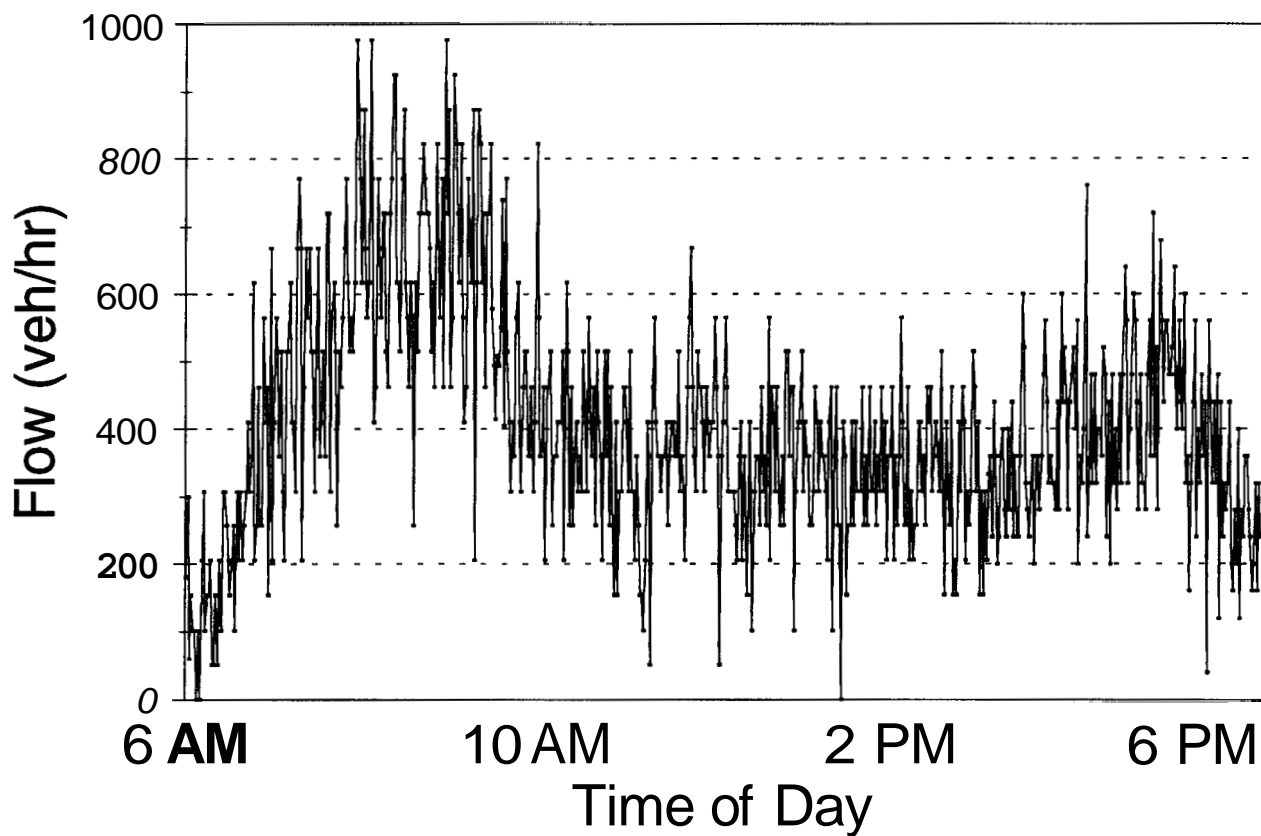


Figure 9

Flow by Signal Cycle - Detector 725

## Section 6: The SLICE.CPP Program and Analysis of Results

The current plan for the simulation is to divide the origin/destination data into half hour periods. This gives 28 time periods for the entire 14 hour simulation period. Another program, **SLICE.CPP** was written to aggregate the data into half hour blocks. The source code for this program is included in Appendix B. Since flow is given in vehicles per hour and occupancy is given in percent occupancy, flow and percent occupancy for each cycle may be simply averaged to produce an aggregate figure for the time period. This is precisely what the program does.

Because of the difficulty associated with reading time values, the program takes the inefficient but easy method of first creating a file named **CONVERT**, where the colons in the time values are replaced by spaces. Each line from this file is read as a stream consisting of hour, minute, second, flow, occupancy, etc. The program works by reading the minute value and checking to see if it is less than 30 or if it is greater than or equal to 30. While this condition is the same it sums up the flow and occupancy figures. Once this condition changes it determines the averages for that half hour block and outputs these values. Then it starts summing up the values for the next time period.

The output file is given the same name as the detector plus the extension **.TXT** to produce a file name such as **757.TXT**. In these files the colons are restored to the time values to produce more readable results. The complete file for detector 718, **718.TXT**, is shown in Figure 10 on the next page. The number of cycles is the number of signal cycles for that particular half hour time slice.

Initial analysis of this data consisted of creating speed-flow curves as a test of the integrity of the data and to assess the capacity characteristics of the roadway. Three of these are shown in Figures 11-13 for detectors 718, 773 and 789. These detectors were chosen since they have occupancies that rose above 15%. Detectors 773 and 789 show the usual shape of a speed-flow curve although the higher flow values (i.e. 1000 vph) are not present. Detector 718 reaches these high flow values but does not contain occupancies above 20%. It appears that the capacity of the roadway at detector 718 is significantly higher than at the other two detectors.

These output files were also used to compare the flows and occupancies of parallel detectors within the same intersection. Flow and occupancy from the detectors at all of the eastbound and westbound approaches along Olympic were graphed. The convention used here was to associate the upstream detectors of an intersection with that intersection. Actually, at the majority of intersections the downstream detectors are closer to the intersection. From these graphs one could determine patterns of flow and occupancy for the various lanes. This was done as a general test of the integrity of the

data. The scheme used in this report is that a left turn lane is labelled as such (L T) and lane 1 (L 1) is the lane closest to the median or left turn lane of the roadway. Lanes increase in number as they approach the curb.

START	END	AVG FLOW	AVG OCC.	No. Cycles
6:00:00	6:30:00	116.88	1.73	26
6:30:00	7:00:00	262.65	3.23	26
7:00:00	7:30:00	369.50	4.73	26
7:30:00	8:00:00	524.16	7.92	25
8:00:00	8:30:00	543.50	7.38	26
8:30:00	9:00:00	555.42	12.12	26
9:00:00	9:30:00	551.57	7.67	21
9:30:00	10:00:00	525.16	7.84	25
10:00:00	10:30:00	527.77	7.88	26
10:30:00	11:00:00	561.12	7.84	25
11:00:00	11:30:00	581.08	8.85	26
11:30:00	12:00:00	674.12	10.85	26
12:00:00	12:30:00	697.00	14.00	25
12:30:00	13:00:00	668.12	10.96	26
13:00:00	13:30:00	664.31	11.35	26
13:30:00	14:00:00	642.50	10.85	26
14:00:00	14:30:00	643.48	10.96	25
14:30:00	15:00:00	678.04	12.04	26
15:00:00	15:30:00	770.40	11.35	20
15:30:00	16:00:00	802.00	10.85	20
16:00:00	16:30:00	878.00	11.85	20
16:30:00	17:00:00	882.00	13.05	20
17:00:00	17:30:00	998.00	18.95	20
17:30:00	18:00:00	1032.00	16.70	20
18:00:00	18:30:00	952.00	14.50	20
18:30:00	19:00:00	736.00	10.00	20

Figure 10

Complete Output File **718.TXT**

# Flow vs. Occupancy

Det 718 - Oly @ Fig - WB

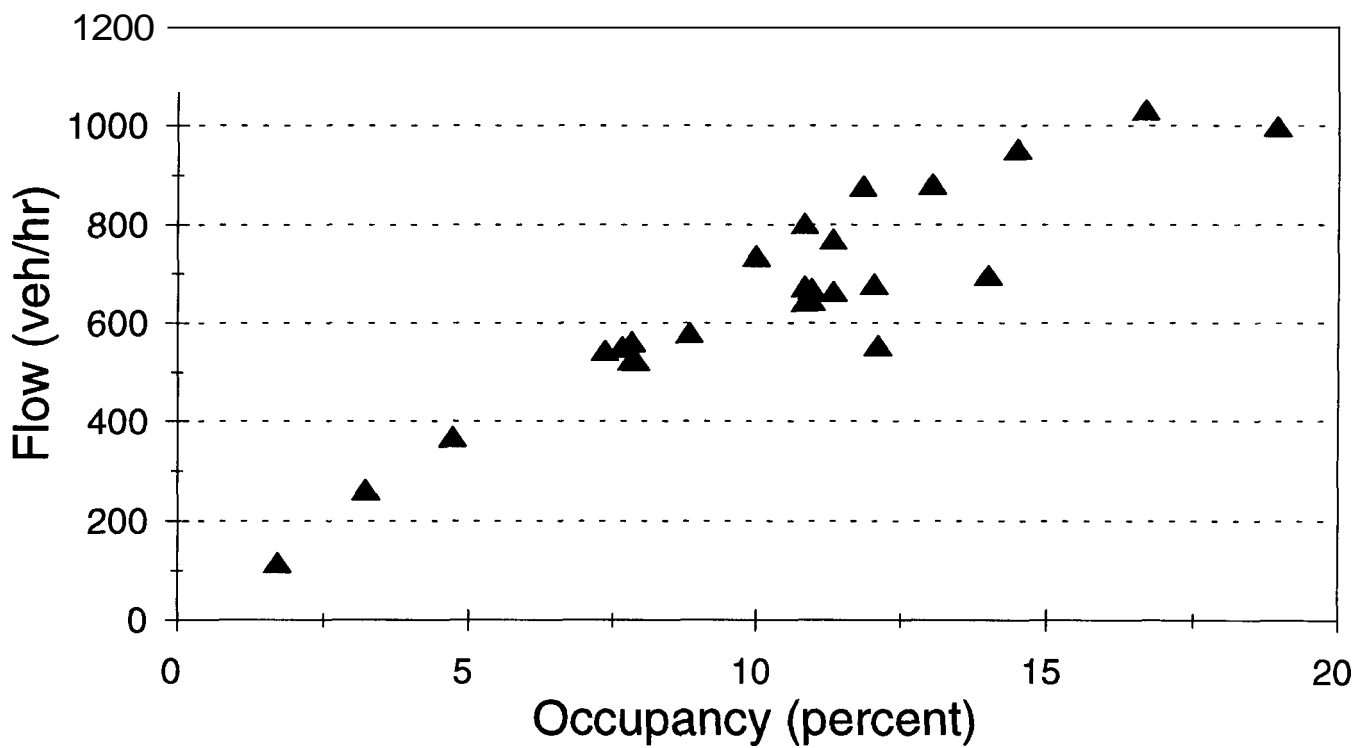


Figure 11

Speed Flow Curve - Detector 718

# Flow vs. Occupancy

Det 773 - Oly @ Broad - WB

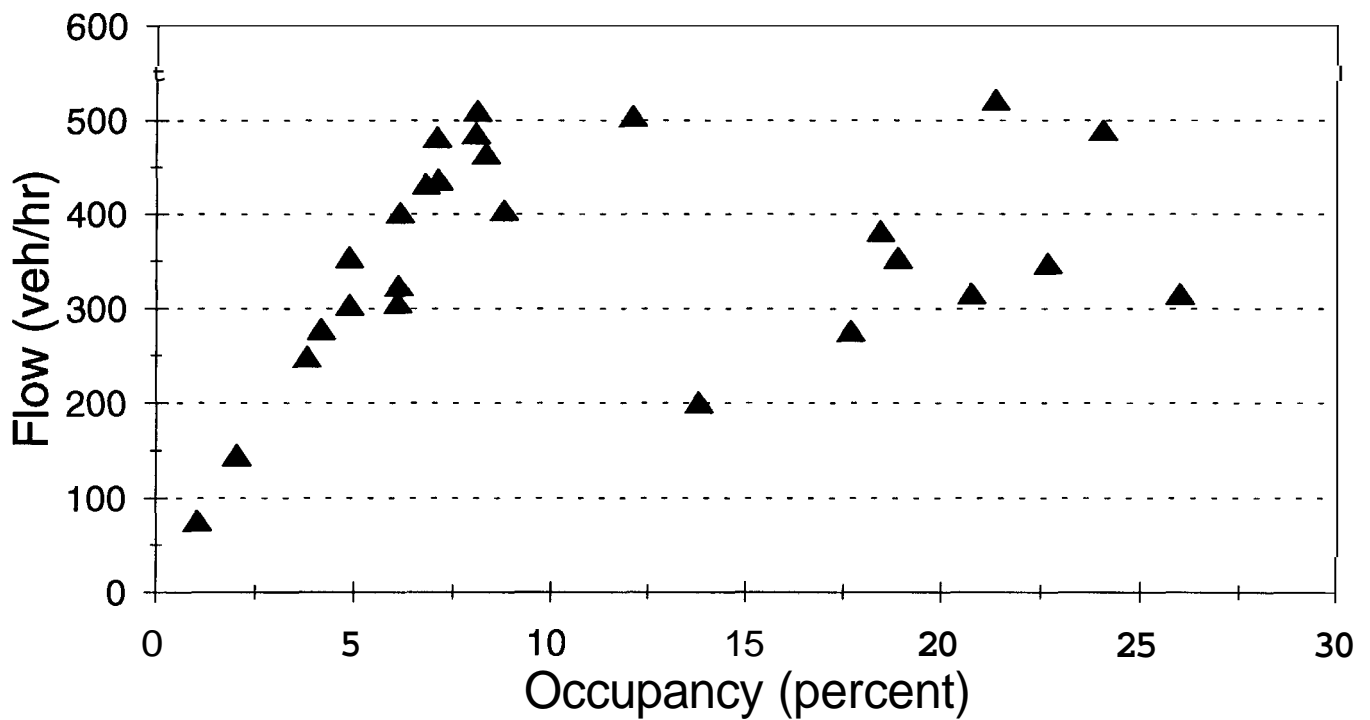


Figure 12

Speed Flow Curve - Detector 773



# Flow vs. Occupancy

Det 789 - Oly @ Main - EB

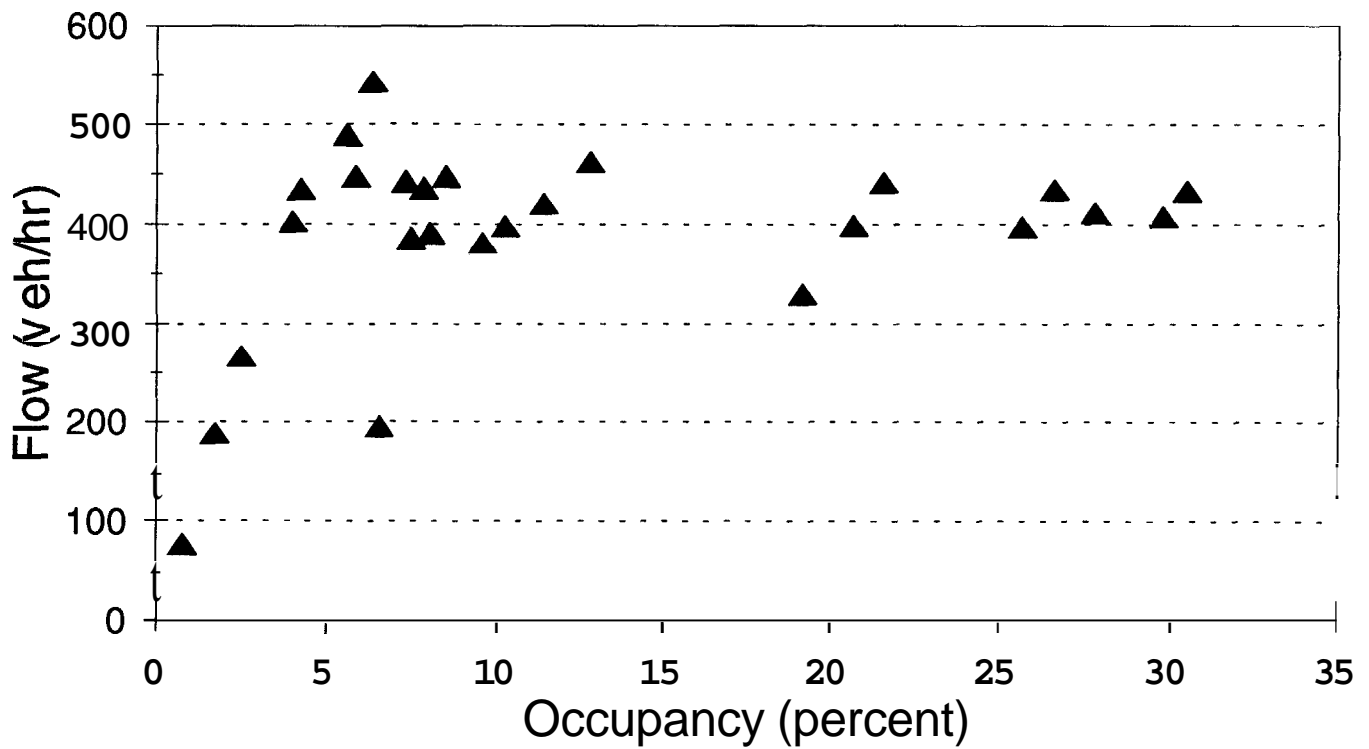


Figure 13

Speed Flow Curve - Detector 789

Figures 14 and 15 give an example of the graphs that were used to test the integrity of the data. These figures show the flow and occupancy vs. time for Olympic at Figueroa, westbound. Figure 14 is the same as Figure 8 except that the data in Figure 14 is aggregated into half hour time slices. Comparing the two reveals that the general pattern is indeed the same. It should be noted that there is a left turn lane at this intersection but the map indicates that there is no detector in this lane. Considering this, the data looks quite reasonable. The left turn lane will create some "friction" that will decrease the flow in lane 1. The data indicates that the curb lane is not well used. In most of the other intersections, lane 2 had significantly higher flow than lane 1 and the flow in lane 3 was usually quite low.

Figures 16 and 17 show the flow and occupancy vs. time for Olympic at Main, westbound. For this intersection there is excellent correlation between the two lanes of through traffic for both flow and occupancy. The left turn lane shows much lower flows and occupancies. The one location where a possible detector malfunction was found is Olympic at Figueroa, eastbound. Figures 18 and 19 show the figures for this intersection. In Figure 18, the flow for lane 2, detector 724, has the general flow pattern of the other lanes but appears to be too low. Looking at the occupancy figures for this detector in Figure 19 show that the occupancy is quite erratic. The speed flow curve of this detector also looked irregular. This could be explained by some physical feature of the intersection, by the detectors being mislabelled or by a malfunction of the detector. Another possibility is that lanes 2 and 3 are switched. Lane 3 has abnormally high flow figures.

In summary, the data appear to be very good. Graphs such as those in figures 14 through 19 were used to test all of the detectors along Olympic. Of the 45 detectors analyzed in this manner only one (# 724) was found with questionable results. As mentioned, it is quite possible that the cause of this is explainable. There were three westbound groups where the data looks reasonable but the lane numbers assigned to each detector do not seem accurate. For example, at Olympic@Hope - westbound lane 1 is significantly higher than lane 2 which is the reverse of the typical situation which is seen at adjacent intersections.

Since there was a need to access these files for further analysis a similar program **SLICE2.CPP** was created. This program is identical to **SLICE.CPP** except for the output that is produced. **SLICE2.CPP** creates a file with the extension **.TBA** (To Be Accessed) instead of **.TXT** and does not put a colon between the components of the time values. Only the files with the extension **.TBA** are accepted by the program discussed in the next section. Thus, the data can be accessed in the same manner as this program does.

# Flow vs. Time

## Olympic@ Figueroa - Westbound

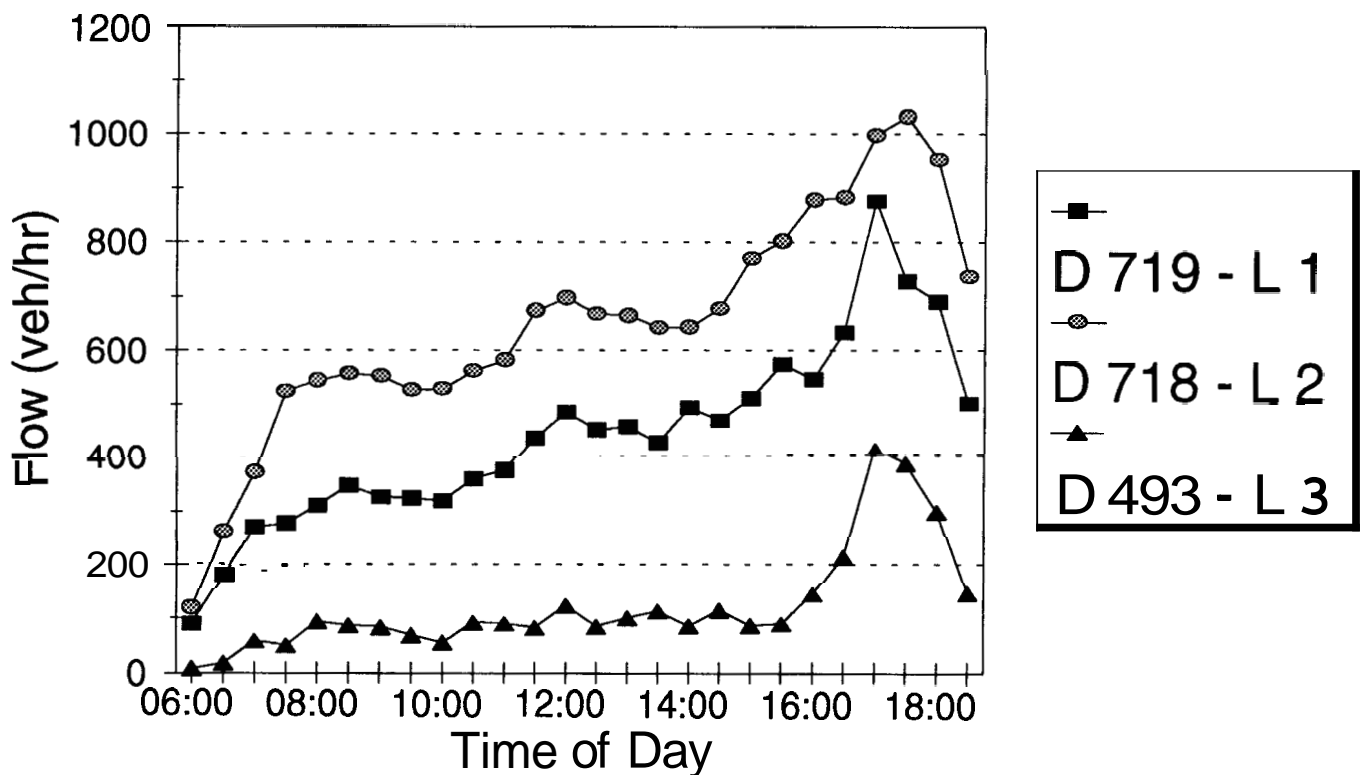


Figure 14

Flow on Olympic@Figueroa - Westbound

# Occupancy vs. Time

## Olympic@Figueroa - Westbound

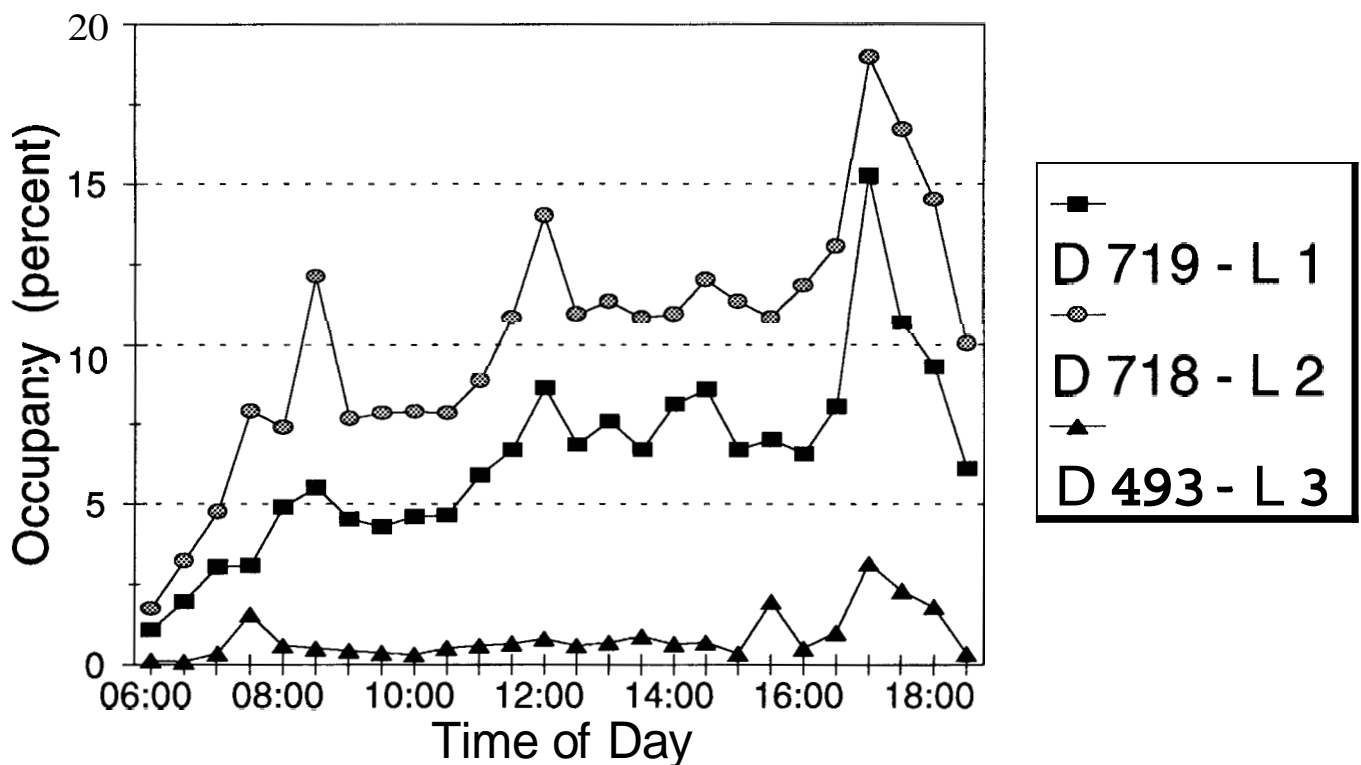


Figure 15

Occupancy on Olympic@Figueroa - Westbound

# Flow vs. Time

## Olympic@Main - Westbound

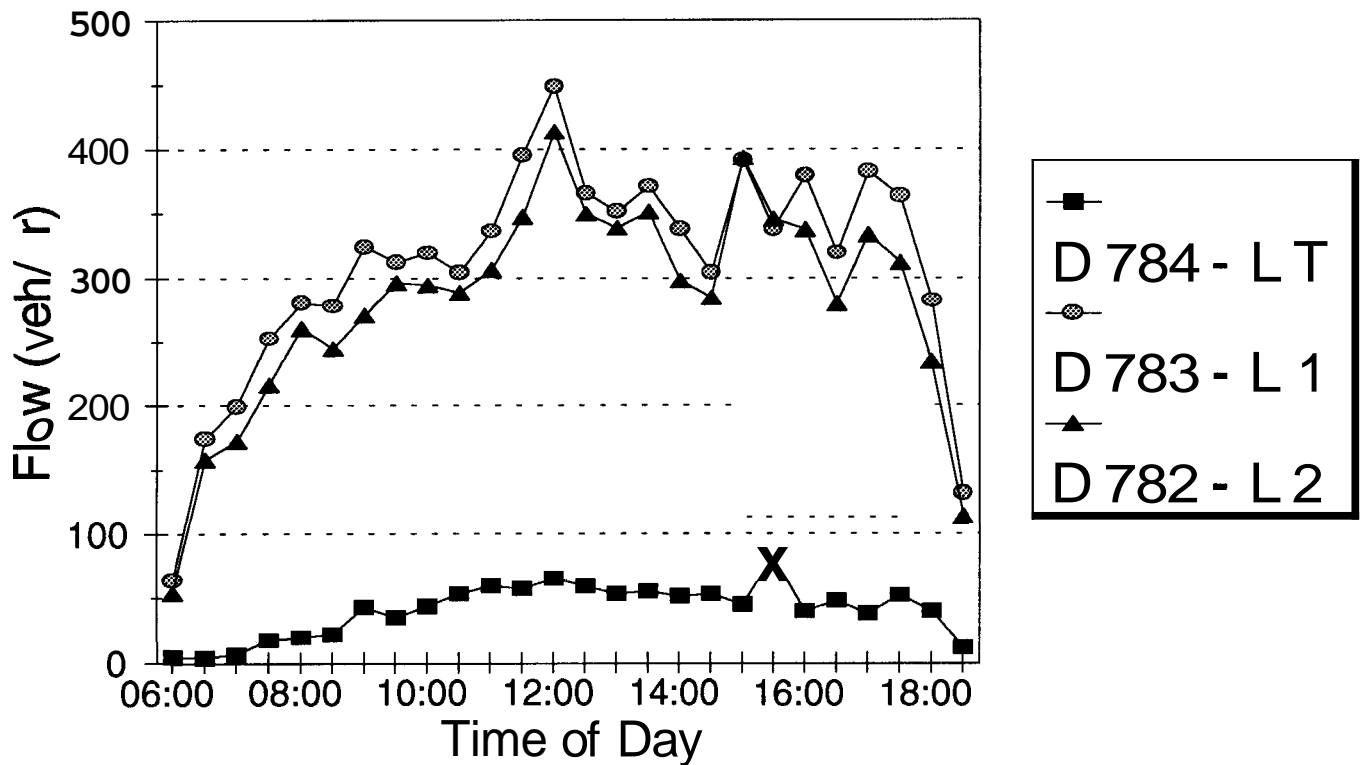


Figure 16

Flow on Olympic@Main - Westbound

# Occupancy vs. Time

Olympic@Main - Westbound

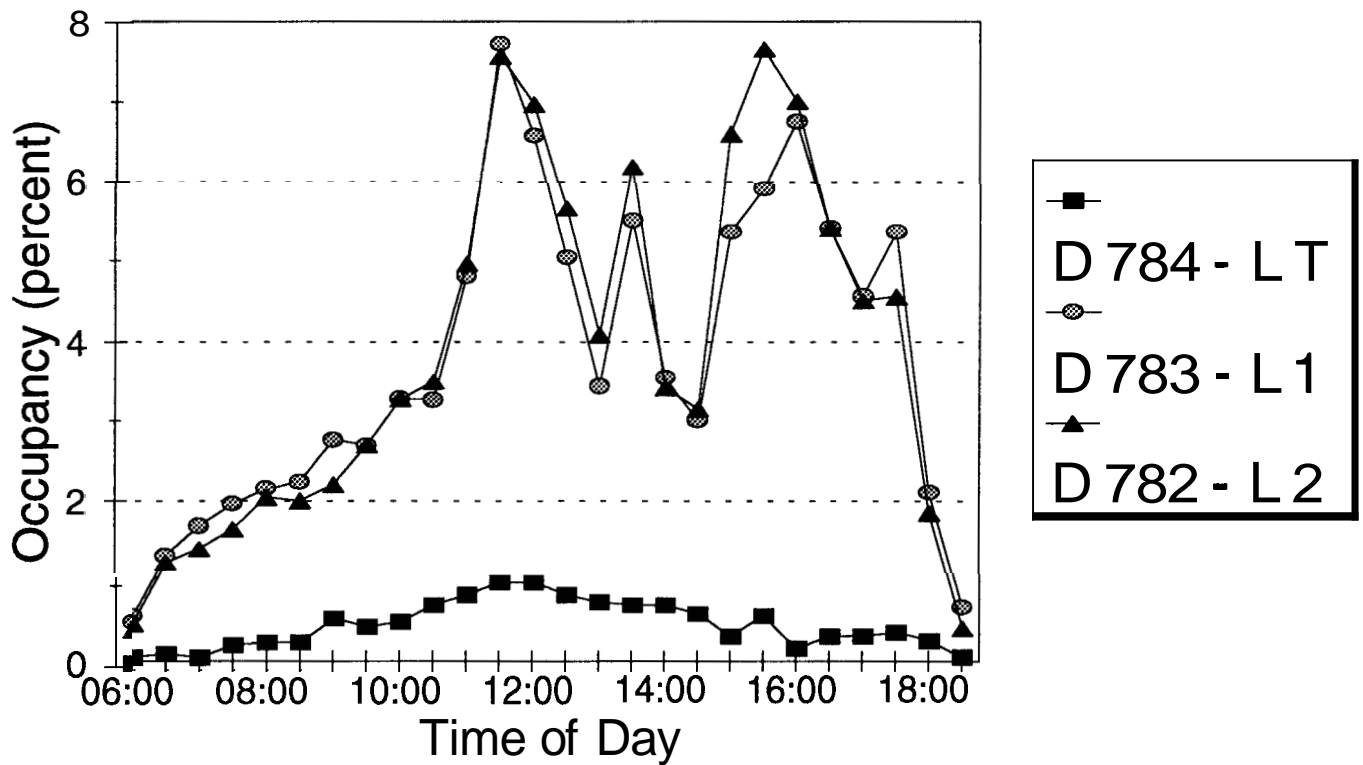


Figure 17

Occupancy on Olympic@Main - Westbound

# Flow vs. Time

## Olympic@Figueroa - Eastbound

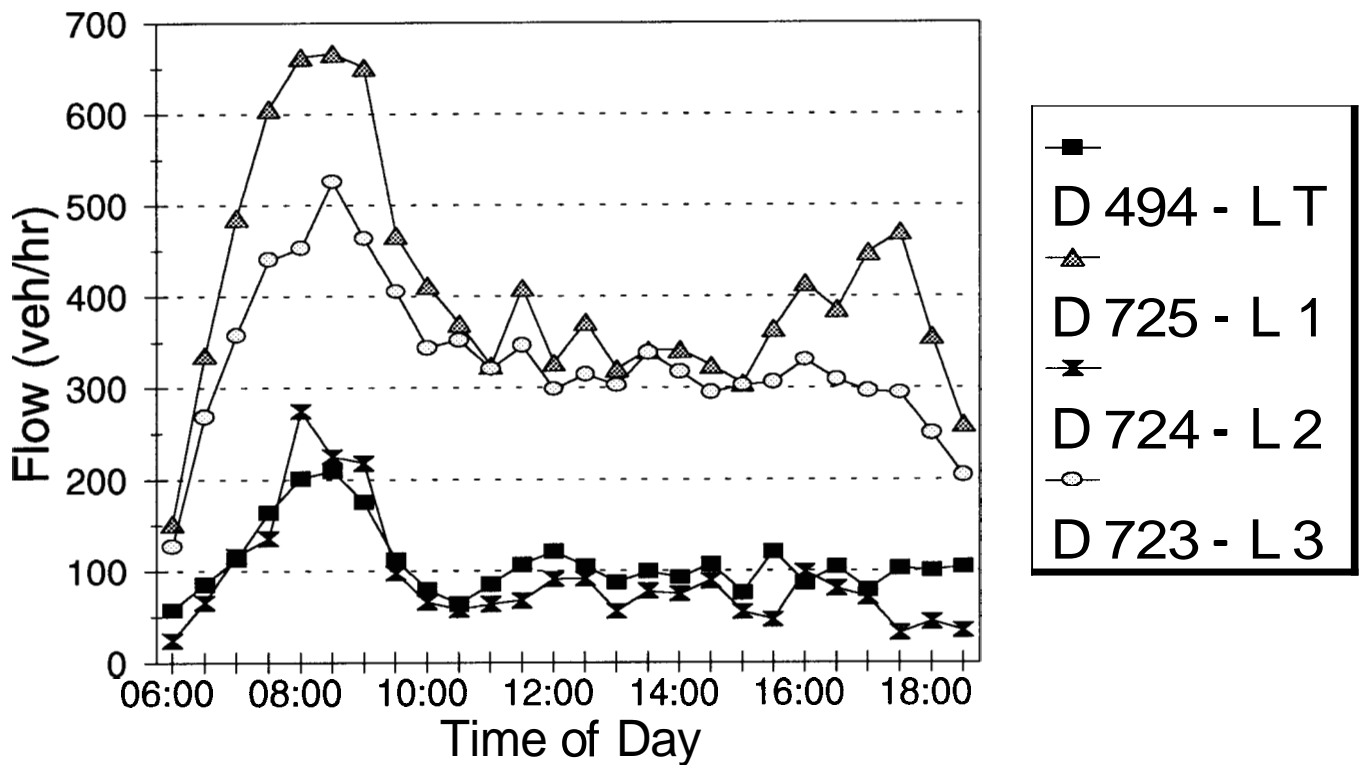


Figure 18

Flow on Olympic@Figueroa - Eastbound

# Occupancy vs. Time

Olympic@Figueroa - Eastbound

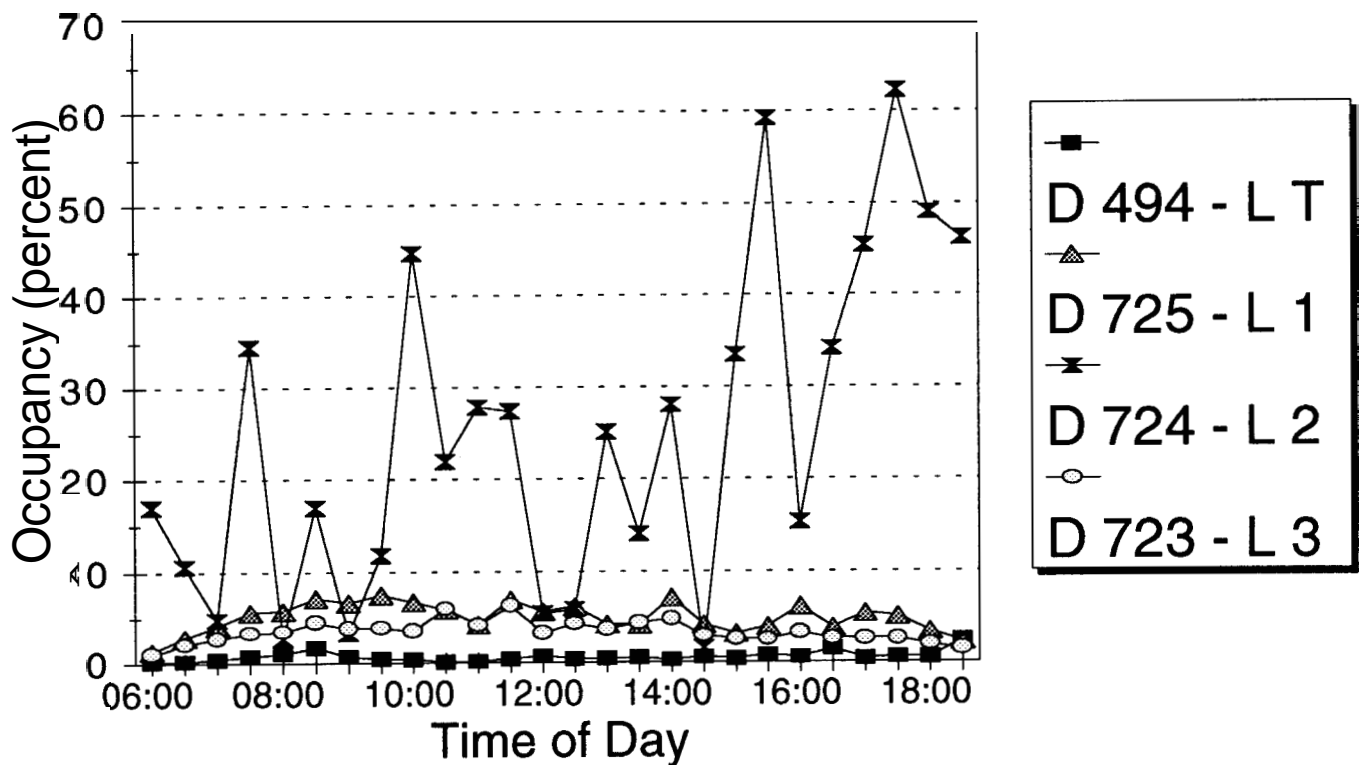


Figure 19

Occupancy on Olympic@Figueroa - Eastbound



## Section 7: The COMBINE.CPP Program and Analysis of Results

The final program that was written, **COMBINE.CPP** allows the user to combine the values of 2-4 detectors to produce a single set of figures for the group of detectors. All of the flow and occupancy values in each half hour period will be added up to produce a total flow and average occupancy figure for the group. The source code for this program is included in Appendix C. It is imagined that in processing a large amount of this data only the link flow data will be desired. Data analysis of individual detectors will not be needed for the simulation. This program allows one to create the files that will be needed to analyze data link by link.

The content of the program is very simple. The user enters the street, cross street, direction and detector numbers. The flow and occupancy values for a specific time period are summed (flow) or averaged (occupancy) for all of the detectors considered. The file created is given a name based on the information entered. The file name consists of the following: the first three letters of the street with the detectors, then the "at" (@) sign, followed by the first three letters of the cross street. The extension is the first letter of the direction. For example, entering Olympic at Main, westbound, will produce the output file **OLY@MAI.W**. One has to avoid using streets with the same first three letters. Also, street names with two words may not be used in this program. The convention used is that the detectors upstream of the intersection constitute the detectors for this intersection. Clarification is necessary since the maps show the detectors before and after the intersection. ATSAC detectors usually are positioned after the intersection in question. An example of the output file created by this file is shown in Figure 20.

This program was run for all of the eastbound and westbound approaches along Olympic. The data for the eastbound approaches is tabulated in Figures 20 and 21 and the westbound data is shown in Figures 22 and 23. This data is also shown in a couple of graphical formats. Figures 25 and 26 are a contour graph of the flow and occupancy data for the eastbound approaches. Figures 27, 28 and 29 show the same data in two dimensions. Figures 30 - 32 show the occupancy in two dimensions. It is interesting to note that the correlation between flow and occupancy does not appear to be very strong. A period of heavy flow is seen in the morning peak period near Figueroa. In contrast, a period of high occupancy is seen in the afternoon peak period near Main. Figures 33 - 38 contain the same graphs for the westbound approaches. The two-dimensional graphs of flow show excellent consistency along Olympic in both directions. The corresponding occupancy graphs are not as consistent but this is to be expected. Overall, these figures are further confirmation that the data are reasonable.

Olympic@Figueroa  
 Eastbound  
 Detectors 494, 725, 724, 723

Start	End	Flow	Avg Occ
06:00:00	06:30:00	359.93	4.86
06:30:00	07:00:00	753.82	3.91
07:00:00	07:30:00	1072.38	2.97
07:30:00	08:00:00	1345.76	11.01
08:00:00	08:30:00	1590.77	3.19
08:30:00	09:00:00	1626.14	7.54
09:00:00	09:30:00	1508.33	3.57
09:30:00	10:00:00	1080.04	5.89
10:00:00	10:30:00	898.93	13.82
10:30:00	11:00:00	841.68	8.45
11:00:00	11:30:00	791.62	9.08
11:30:00	12:00:00	927.70	10.22
12:00:00	12:30:00	835.60	3.72
12:30:00	13:00:00	880.27	4.14
13:00:00	13:30:00	764.16	8.35
13:30:00	14:00:00	853.01	5.74
14:00:00	14:30:00	823.32	10.04
14:30:00	15:00:00	813.19	2.28
15:00:00	15:30:00	736.00	9.88
15:30:00	16:00:00	836.00	16.60
16:00:00	16:30:00	928.00	6.31
16:30:00	17:00:00	878.00	10.50
17:00:00	17:30:00	892.00	13.44
17:30:00	18:00:00	898.00	17.60
18:00:00	18:30:00	750.00	13.70
18:30:00	19:00:00	602.00	13.05

Figure 20

Complete Output File **OLY@FIG.E**

## Eastbound Flow on Olympic (veh/hr)

Time	Figueroa	Flower	Hope	Grand	Olive	Hill	Broadway	Main	Los Angeles
06:00	359.93	282.40	399.50	257.92	277.31	213.58	212.69	214.42	162.26
06:30	753.82	624.27	851.73	581.44	611.57	509.34	477.77	547.85	439.46
07:00	1072.38	873.35	1157.32	758.77	720.77	628.12	614.38	689.24	537.44
07:30	1345.76	1114.16	1395.65	924.77	962.34	811.80	832.32	934.61	775.69
08:00	1590.77	1193.88	1534.11	959.84	1033.48	855.62	863.69	1067.65	900.31
08:30	1626.14	1233.42	1589.50	1011.88	1065.15	1000.08	960.50	1205.20	1039.24
09:00	1508.33	1097.72	1480.24	1021.80	1033.12	972.39	955.80	1211.60	1052.99
09:30	1080.04	948.69	1239.42	877.39	877.12	838.48	857.62	1012.27	860.65
10:00	898.93	836.19	1001.42	784.44	834.20	840.24	826.56	929.56	804.36
10:30	841.68	800.35	952.38	744.88	803.68	788.39	818.12	915.16	805.58
11:00	791.62	721.12	933.04	688.28	713.61	774.54	742.85	884.77	790.68
11:30	927.70	772.54	1009.96	774.54	839.39	840.48	861.04	943.56	835.16
12:00	835.60	661.88	843.85	667.69	745.20	796.35	756.66	943.81	833.19
12:30	880.27	733.44	926.88	727.15	790.66	750.69	756.81	842.77	784.08
13:00	764.16	604.54	855.50	673.76	689.77	675.50	711.04	798.72	792.68
13:30	853.01	663.81	861.46	657.96	696.73	758.20	758.84	945.46	825.58
14:00	823.32	677.58	826.00	681.61	727.68	725.19	723.16	798.96	780.12
14:30	813.19	589.68	760.36	614.20	673.97	631.96	669.70	754.73	749.32
15:00	736.00	644.19	841.43	615.85	680.45	713.05	738.55	813.30	791.05
15:30	836.00	700.00	960.00	694.00	731.35	754.00	756.00	815.65	786.00
16:00	928.00	782.00	1058.00	742.00	831.35	822.00	824.00	941.65	880.00
16:30	878.00	778.00	1050.00	724.00	744.15	830.00	802.00	897.30	934.00
17:00	892.00	796.00	1120.00	756.00	759.30	770.00	804.00	999.60	980.00
17:30	898.00	788.00	1052.00	736.00	775.35	786.00	778.00	930.35	990.00
18:00	750.00	638.00	870.00	610.00	649.85	620.00	684.00	777.00	712.00
18:30	602.00	480.00	652.00	438.00	435.35	430.00	474.00	521.40	414.00

Figure 21

Flow Data for Olympic Eastbound

## Eastbound Occupancy on Olympic (percent)

Time	Figueroa	Flower	Hope	Grand	Olive	Hill	Broadway	Main	Los Angeles
06:00	4.86	1.22	1.92	1.33	1.69	1.17	1.15	0.63	0.38
06:30	3.91	2.56	4.02	3.14	3.98	3.00	2.73	2.61	1.08
07:00	2.97	3.79	5.82	4.35	4.75	3.38	3.44	2.52	1.34
07:30	11.01	5.06	7.59	6.44	6.61	4.30	4.54	2.93	2.02
08:00	3.19	5.19	8.17	7.14	8.80	4.68	4.79	4.93	2.45
08:30	7.54	5.75	9.32	8.73	10.09	6.00	7.72	4.81	5.79
09:00	3.57	5.20	8.04	7.67	8.50	5.58	6.52	5.36	3.81
09:30	5.89	4.96	6.73	6.61	8.62	5.44	5.06	6.70	4.73
10:00	13.82	7.65	6.19	4.28	5.31	6.84	5.00	7.90	2.81
10:30	8.45	8.47	6.31	3.88	5.50	6.18	6.19	6.22	4.20
11:00	9.08	6.22	6.10	3.58	4.44	5.52	5.40	7.69	3.36
11:30	10.22	8.89	6.78	4.17	6.48	7.60	8.04	13.57	9.95
12:00	3.72	5.60	5.90	3.58	5.38	7.72	6.03	6.72	7.56
12:30	4.14	6.90	6.82	3.92	4.81	5.40	5.18	4.37	4.59
13:00	8.35	4.11	6.29	3.38	4.21	5.50	4.92	5.96	2.76
13:30	5.74	5.36	6.07	3.40	4.77	6.46	4.89	4.60	2.70
14:00	10.04	6.39	6.69	3.60	4.32	6.24	4.98	4.08	2.35
14:30	2.28	3.98	5.62	3.16	4.02	4.50	4.25	3.40	4.68
15:00	9.88	3.03	4.67	2.84	4.75	3.92	7.90	14.84	5.28
15:30	16.60	3.38	5.97	3.28	6.60	3.78	4.75	14.66	5.31
16:00	6.31	3.72	6.43	3.60	5.32	4.43	9.48	18.60	3.88
16:30	10.50	3.75	6.60	3.12	3.97	4.12	6.10	19.88	3.80
17:00	13.44	3.75	6.12	3.60	4.97	3.72	9.55	21.15	3.36
17:30	17.60	4.53	8.20	3.58	6.02	4.00	9.65	27.71	2.67
18:00	13.70	2.90	4.85	2.75	3.43	2.90	3.88	16.16	3.76
18:30	13.05	2.03	7.72	2.08	1.92	1.75	2.28	4.11	1.49

Figure 22

Occupancy Data for Olympic Eastbound

## Westbound Flow on Olympic (veh/hr)

Time	Figueroa	Hope	Olive	Hill	Broadway	Main	Los Angeles
06:00	213.34	123.89	155.62	183.97	175.76	121.70	111.11
06:30	459.84	311.46	334.93	350.92	360.65	335.49	301.28
07:00	697.04	474.20	489.70	582.27	540.92	377.28	518.92
07:30	850.56	564.81	592.66	659.00	570.96	485.46	657.19
08:00	946.11	655.73	650.92	770.23	673.65	560.47	834.96
08:30	985.66	758.73	715.19	817.65	772.07	544.58	907.68
09:00	958.19	680.08	705.16	770.15	749.64	637.84	921.92
09:30	916.20	622.11	626.20	690.20	631.92	643.15	805.38
10:00	900.65	647.34	726.50	723.28	770.96	657.64	878.96
10:30	1008.76	750.81	776.52	770.15	817.77	645.73	825.38
11:00	1043.04	807.56	753.23	778.35	754.27	701.80	947.24
11:30	1191.55	905.04	784.34	790.96	723.08	799.40	868.92
12:00	1302.88	950.50	946.00	877.42	922.61	926.69	906.54
12:30	1203.39	914.52	989.96	897.11	967.97	774.47	1015.31
13:00	1221.35	869.43	879.46	936.62	926.72	743.24	957.28
13:30	1181.54	927.04	861.11	889.80	900.85	777.35	902.66
14:00	1220.60	913.04	916.92	869.46	881.04	686.93	1027.34
14:30	1260.62	902.24	872.11	914.92	926.61	641.89	924.48
15:00	1366.90	1040.95	960.20	929.20	806.00	829.45	984.30
15:30	1464.00	1070.00	977.65	972.00	860.00	765.45	1036.00
16:00	1566.00	1086.00	950.00	984.00	892.00	757.15	1098.00
16:30	1728.00	1212.00	1141.35	1158.00	1102.00	647.45	1092.00
17:00	2288.00	1490.00	1319.30	1398.00	1154.00	753.55	1224.00
17:30	2146.00	1342.00	1317.90	1458.00	1168.00	727.55	1334.00
18:00	1940.00	1348.00	1207.55	1260.00	872.00	555.55	820.00
18:30	1382.00	924.00	857.60	778.00	656.00	257.35	432.00

Figure 23

Flow Data for Olympic Westbound

## Westbound Occupancy on Olympic (percent)

Time	Figueroa	Hope	Olive	Hill	Broadway	Main	Los Angeles
06:00	0.98	0.69	0.88	0.64	0.98	0.35	0.06
06:30	1.76	1.79	2.04	1.29	1.77	0.87	0.20
07:00	2.71	2.60	2.83	2.12	3.21	1.04	0.67
07:30	4.19	3.10	3.50	2.39	6.65	1.27	0.78
08:00	4.28	4.28	4.58	2.76	4.56	1.47	1.99
08:30	6.04	4.56	4.54	3.27	5.25	1.49	2.49
09:00	4.21	3.98	4.60	2.81	4.33	1.83	2.12
09:30	4.16	4.52	4.64	3.28	8.86	1.93	1.43
10:00	4.26	3.56	5.73	2.72	4.03	2.35	2.61
10:30	4.33	4.00	6.00	3.94	4.99	2.49	6.64
11:00	5.10	4.44	6.11	3.96	10.31	3.53	4.93
11:30	6.06	4.85	6.31	7.20	9.73	5.41	8.02
12:00	7.81	5.36	9.58	6.87	5.95	4.83	5.23
12:30	6.13	5.06	9.09	4.51	6.17	3.83	3.74
13:00	6.54	4.69	7.82	12.36	6.57	2.75	7.69
13:30	6.14	5.11	8.02	5.29	6.19	4.13	6.16
14:00	6.57	5.06	8.82	9.98	5.40	2.55	4.04
14:30	7.10	4.76	8.78	3.52	5.37	2.24	2.91
15:00	6.13	5.09	6.45	5.42	9.52	4.08	3.64
15:30	6.60	5.20	5.30	3.75	10.60	4.70	4.20
16:00	6.30	5.30	5.35	3.42	7.40	4.63	3.47
16:30	7.37	6.35	7.25	4.75	10.47	3.70	3.80
17:00	12.45	8.68	12.32	6.28	14.70	3.12	5.60
17:30	9.90	8.23	19.70	7.05	14.90	3.42	7.69
18:00	8.53	7.48	8.30	5.18	14.17	1.40	4.50
18:30	5.48	4.85	4.80	16.00	4.33	0.37	2.01

Figure 24

Occupancy Data for Olympic Westbound

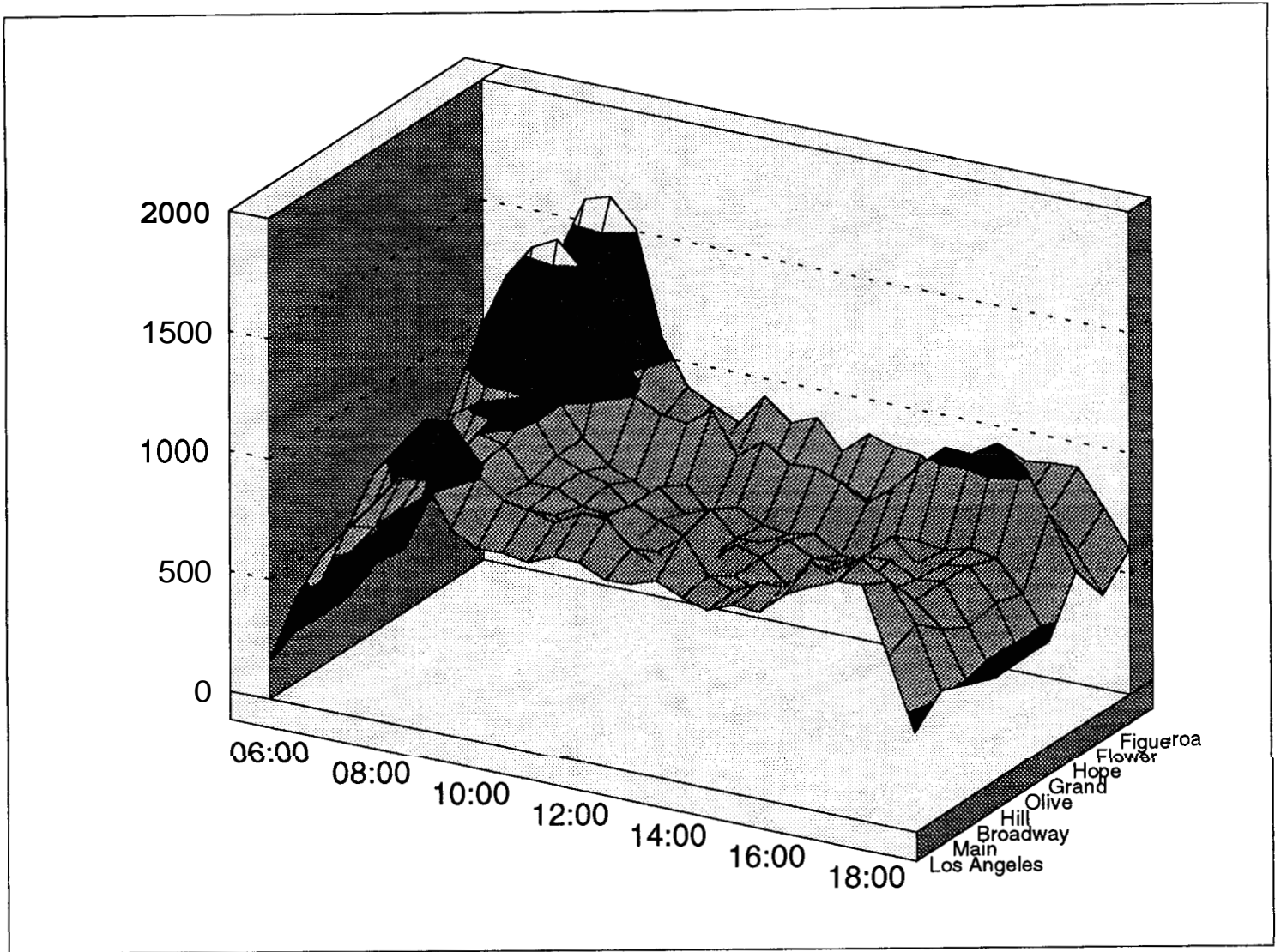


Figure 25

Contour Graph for Flow on Olympic Eastbound

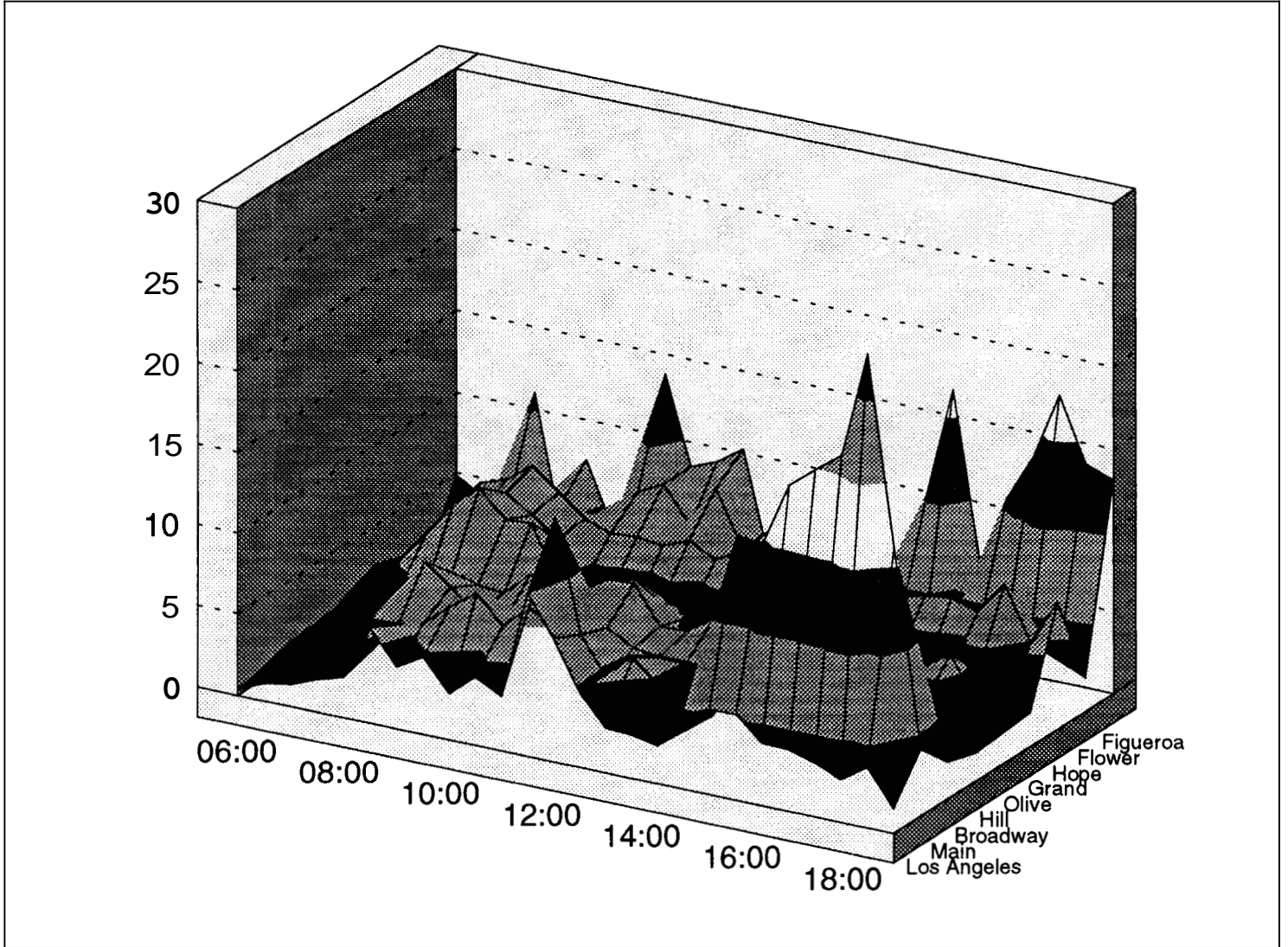


Figure 26

Contour Graph for Occupancy on Olympic Eastbound



# Olympic Eastbound - Flow vs. Time

## Figueroa to Hope

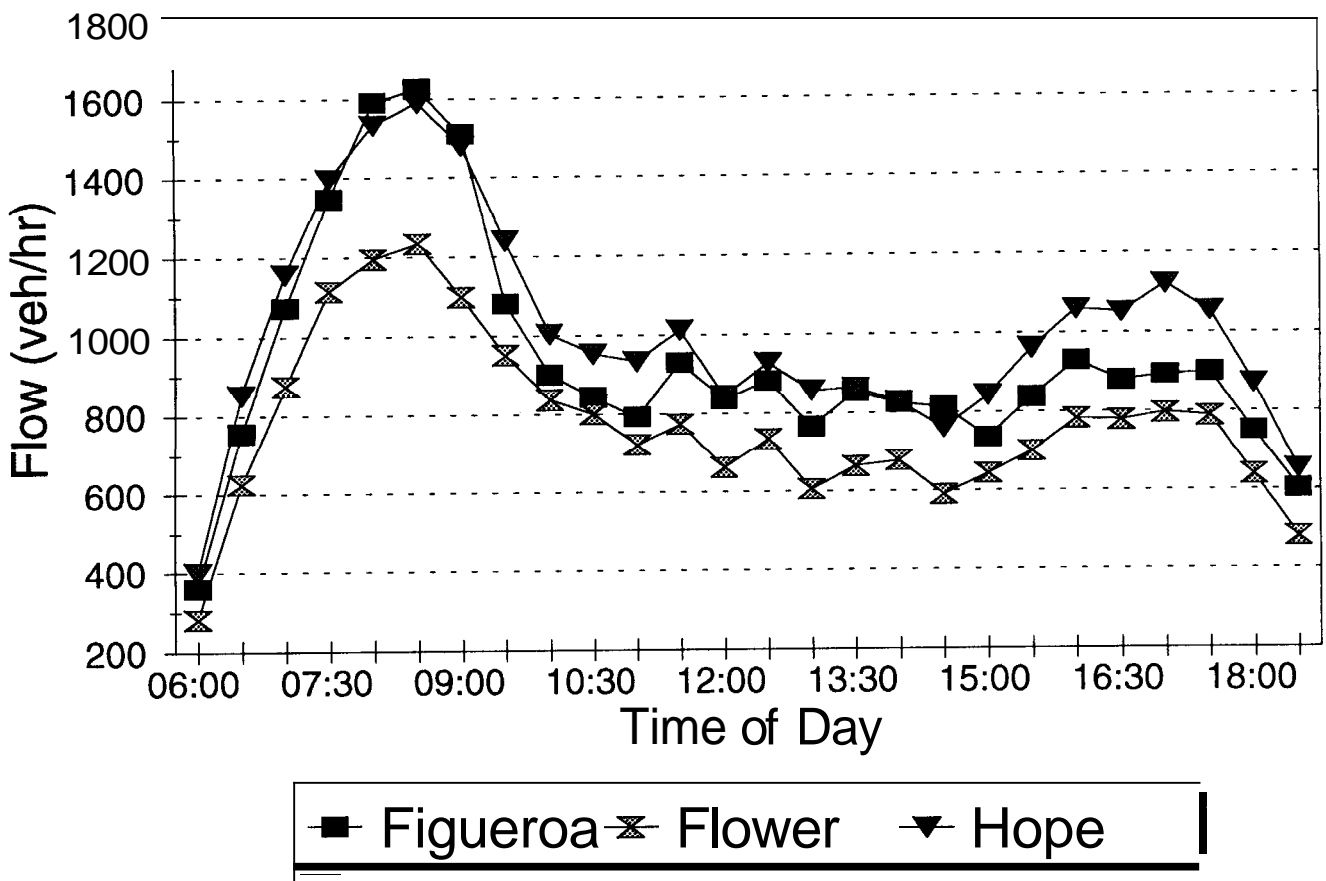


Figure 27

Flow on Olympic Eastbound - Part 1

# Olympic Eastbound - Flow vs. Time

## Grand to Hill

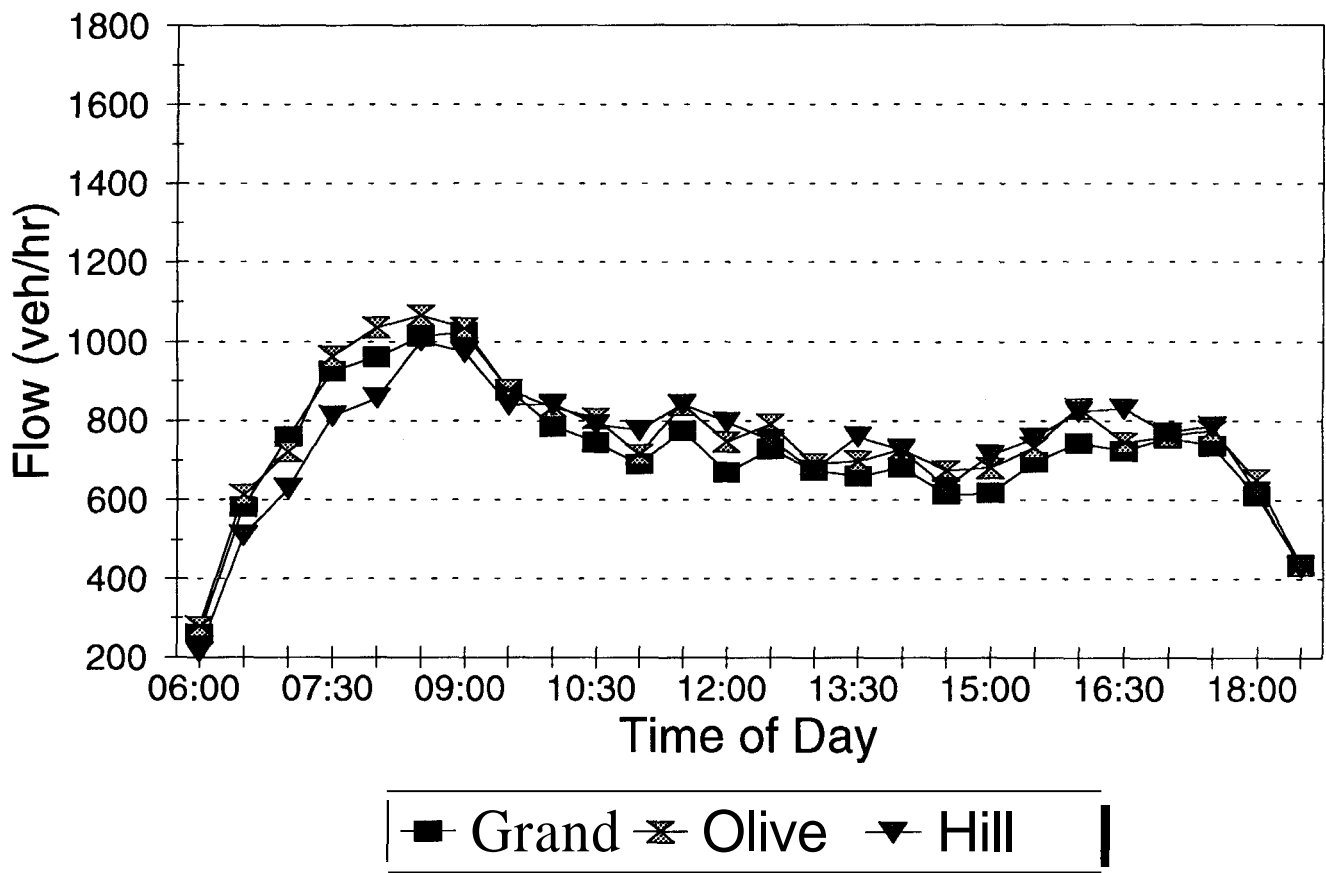


Figure 28

Flow on Olympic Eastbound - Part 2

# Olympic Eastbound - Flow vs. Time

## Broadway to Los Angeles

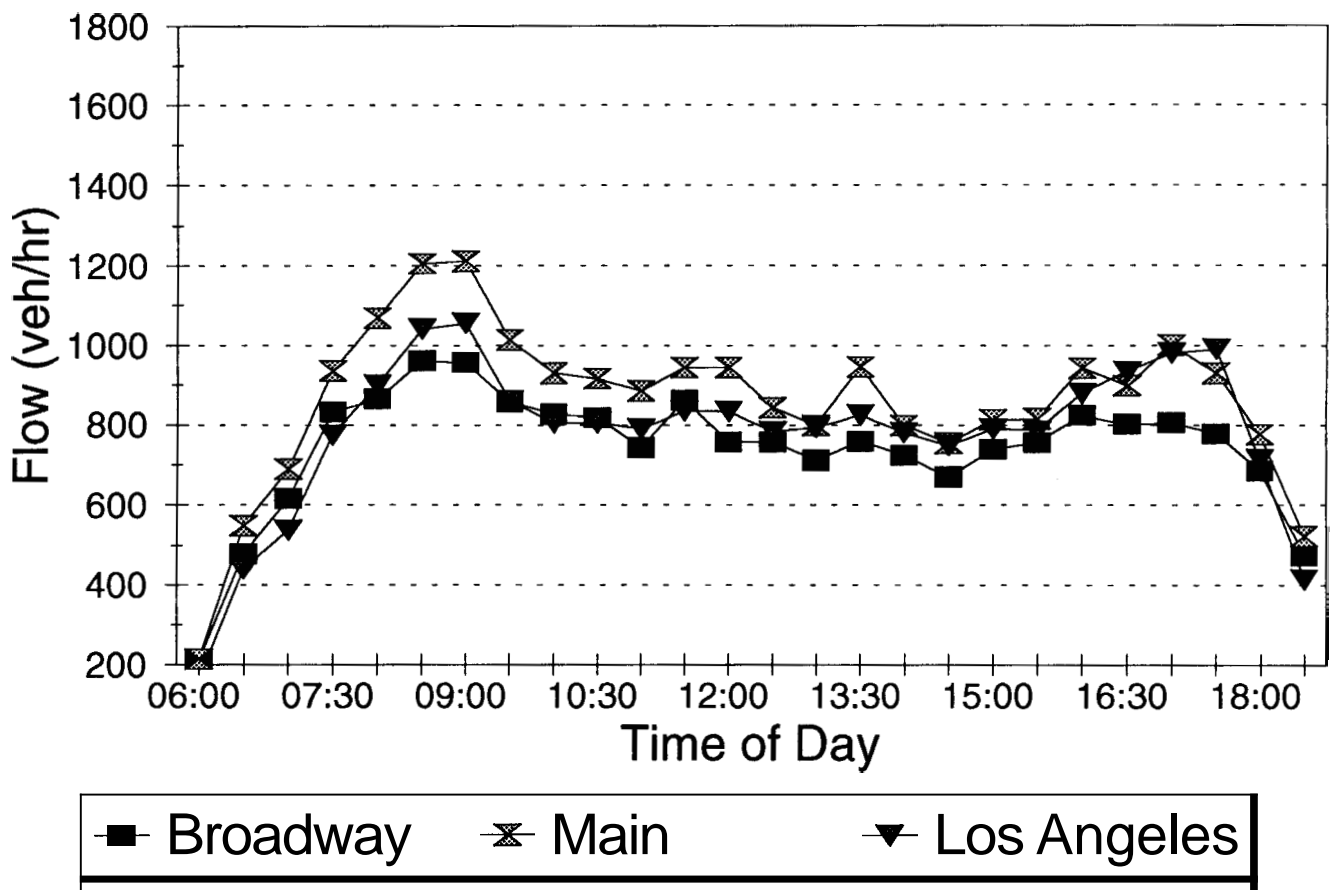


Figure 29

Flow on Olympic Eastbound- Part 3

## Olympic Eastbound - Occupancy vs. Time Figueroa to Hope

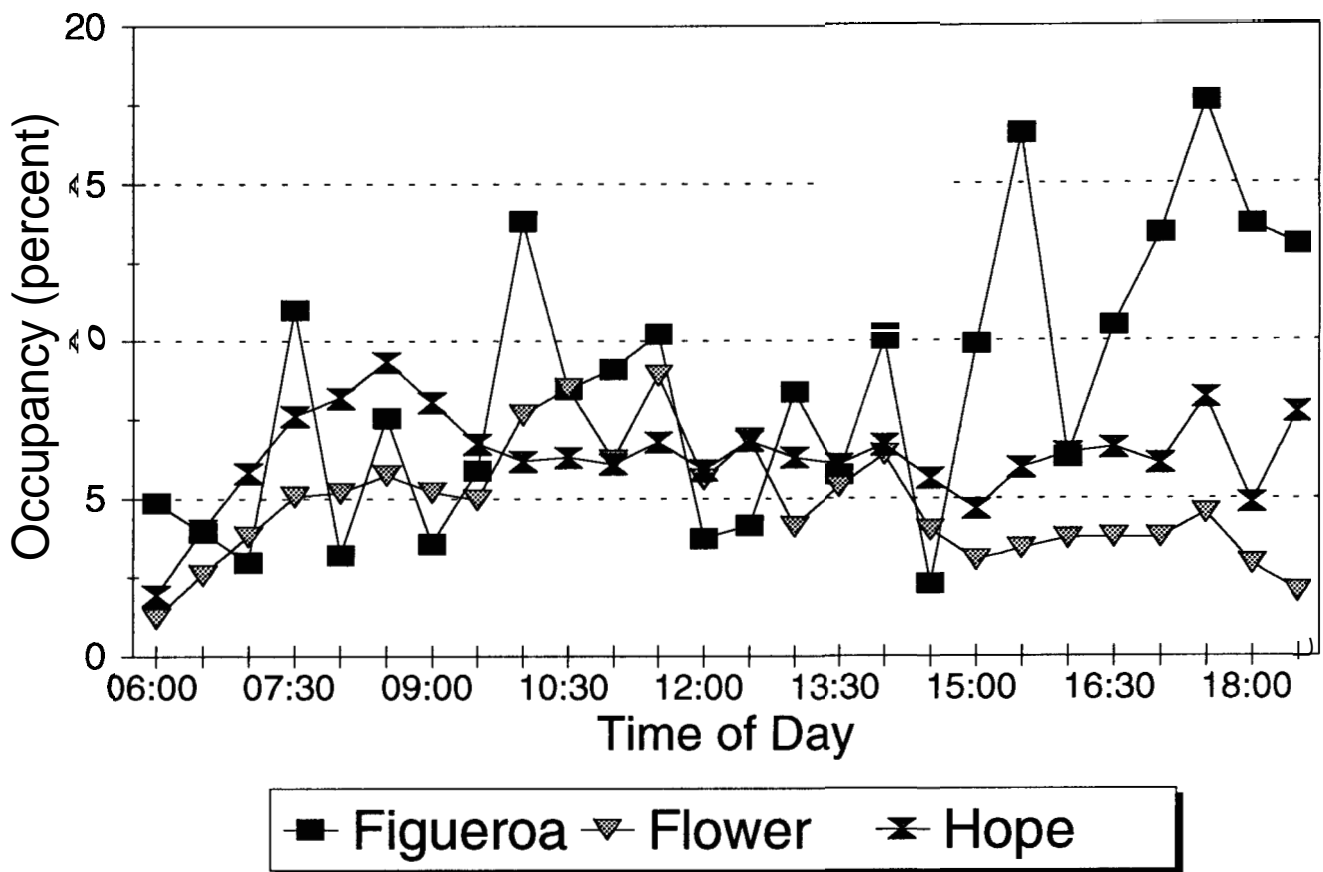


Figure 30

Occupancy on Olympic Eastbound - Part 1

## Olympic Eastbound - Occupancy vs. Time Grand to Hill

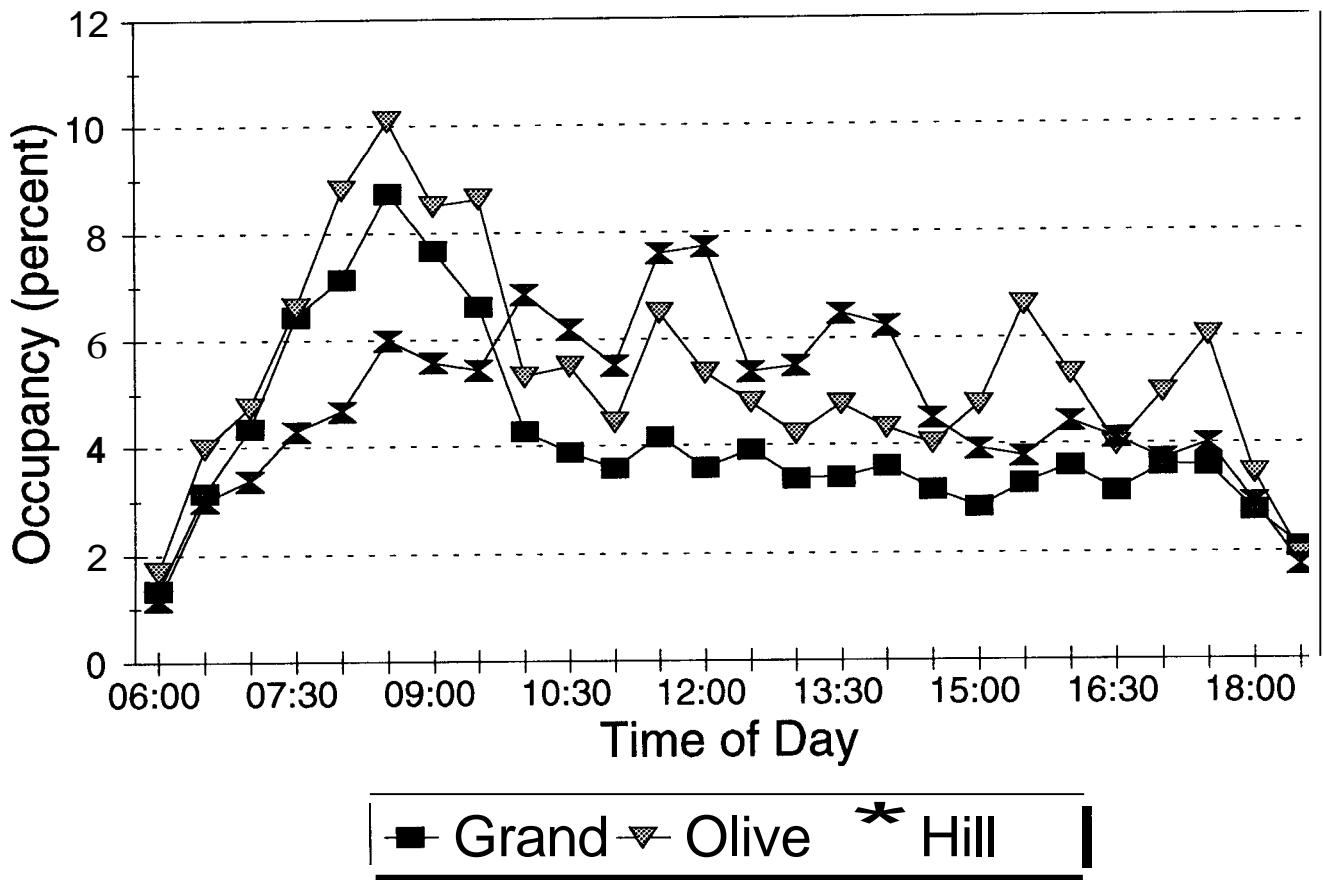


Figure 31

Occupancy on Olympic Eastbound - Part 2

## Olympic Eastbound - Occupancy vs. Time Broadway to Los Angeles

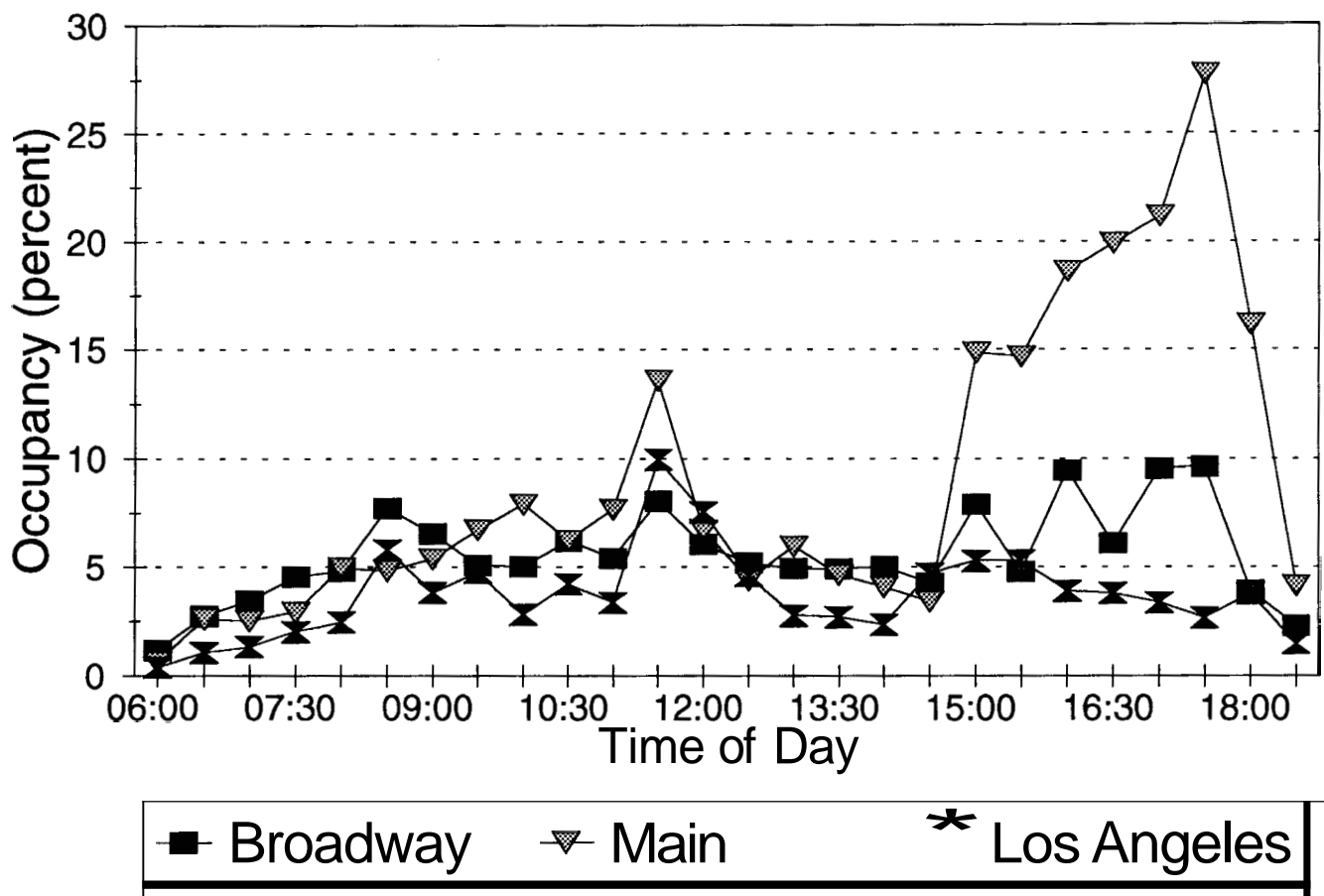


Figure 32

Occupancy on Olympic Eastbound - Part 3

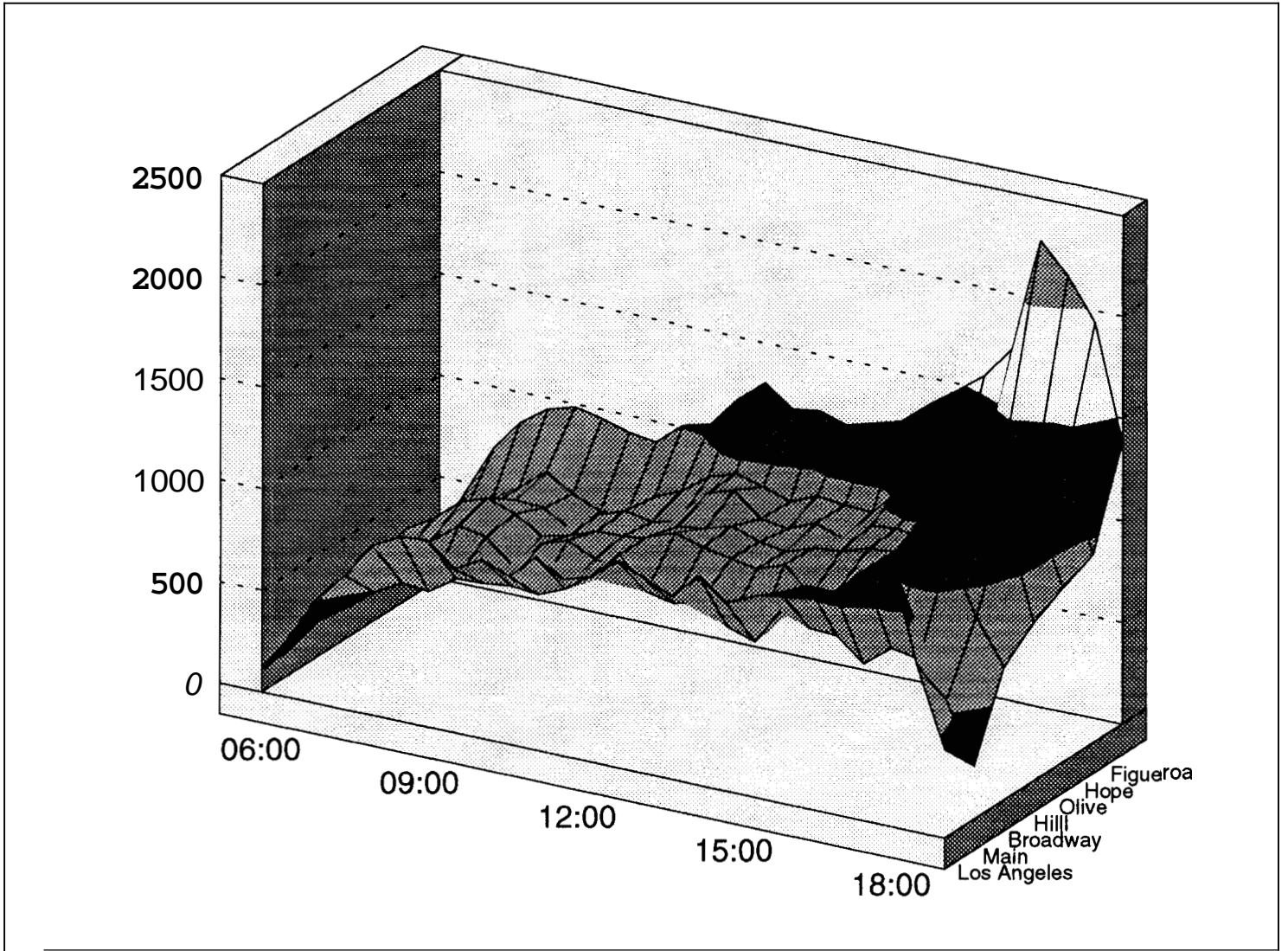


Figure 33

Contour Graph of Flow on Olympic Westbound

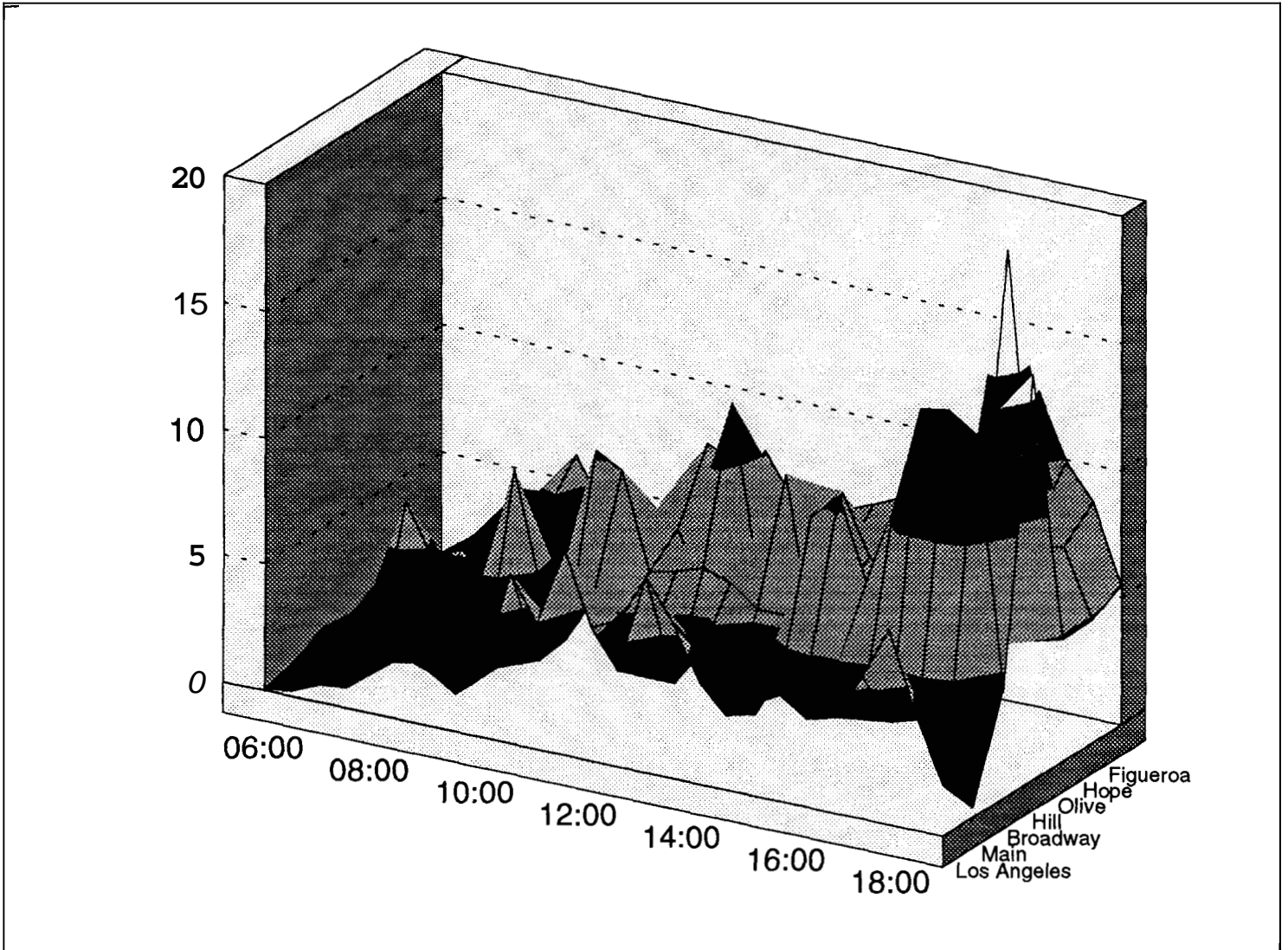


Figure 34

Contour Graph of Occupancy on Olympic Westbound



# Olympic Westbound - Flow vs. Time

## Los Angeles to Hill

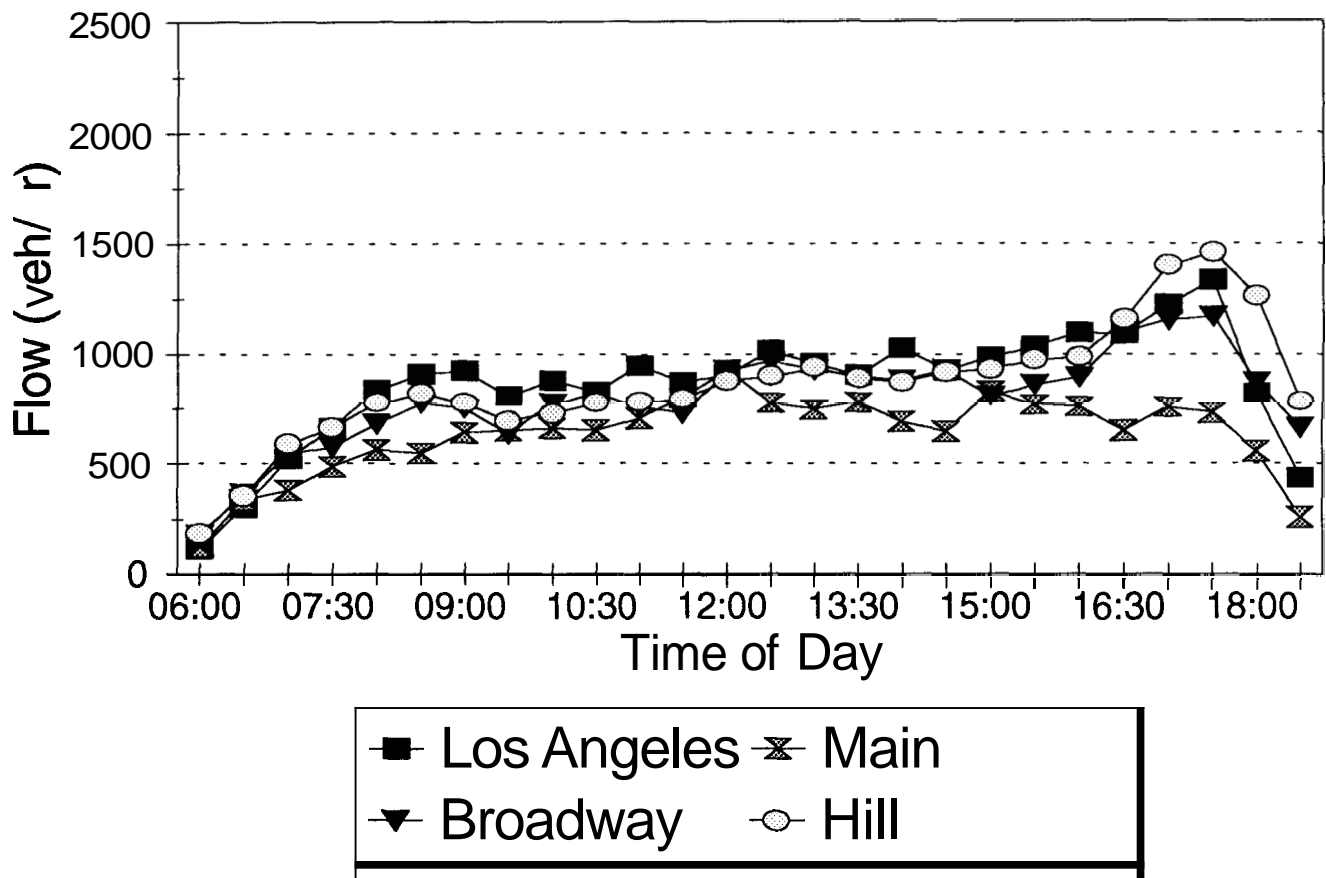


Figure 35

Flow on Olympic Westbound - Part 1

# Olympic Westbound - Flow vs. Time

## Olive to Figueroa

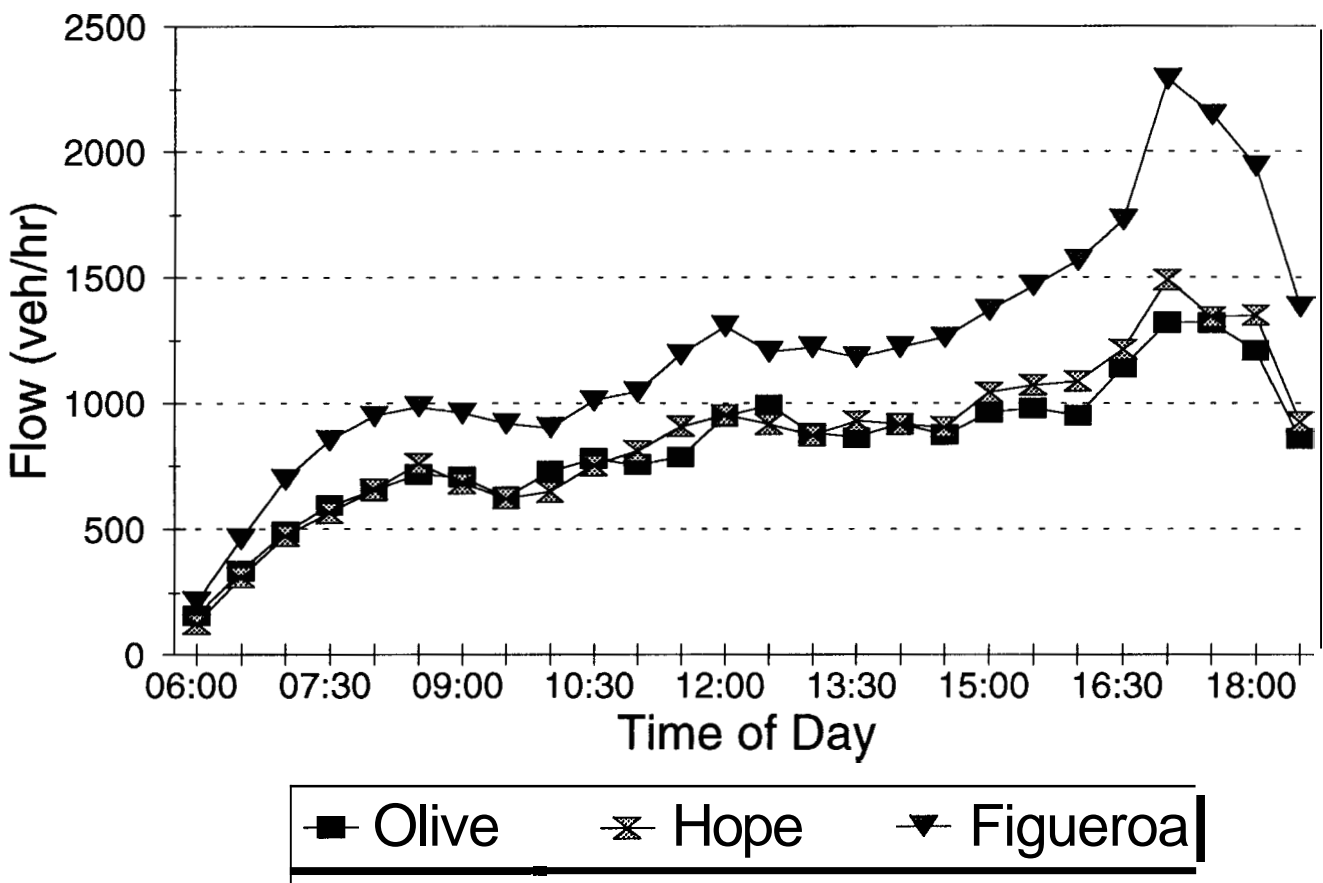


Figure 36

Flow on Olympic Westbound - Part 2

# Olympic Westbound - Occupancy vs. Time

Los Angeles to Hill

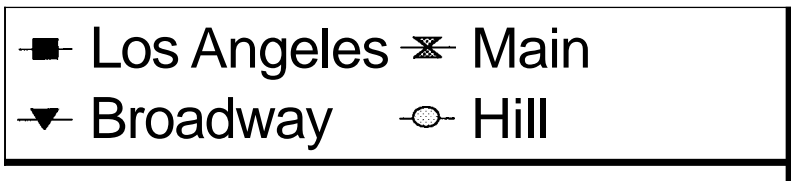
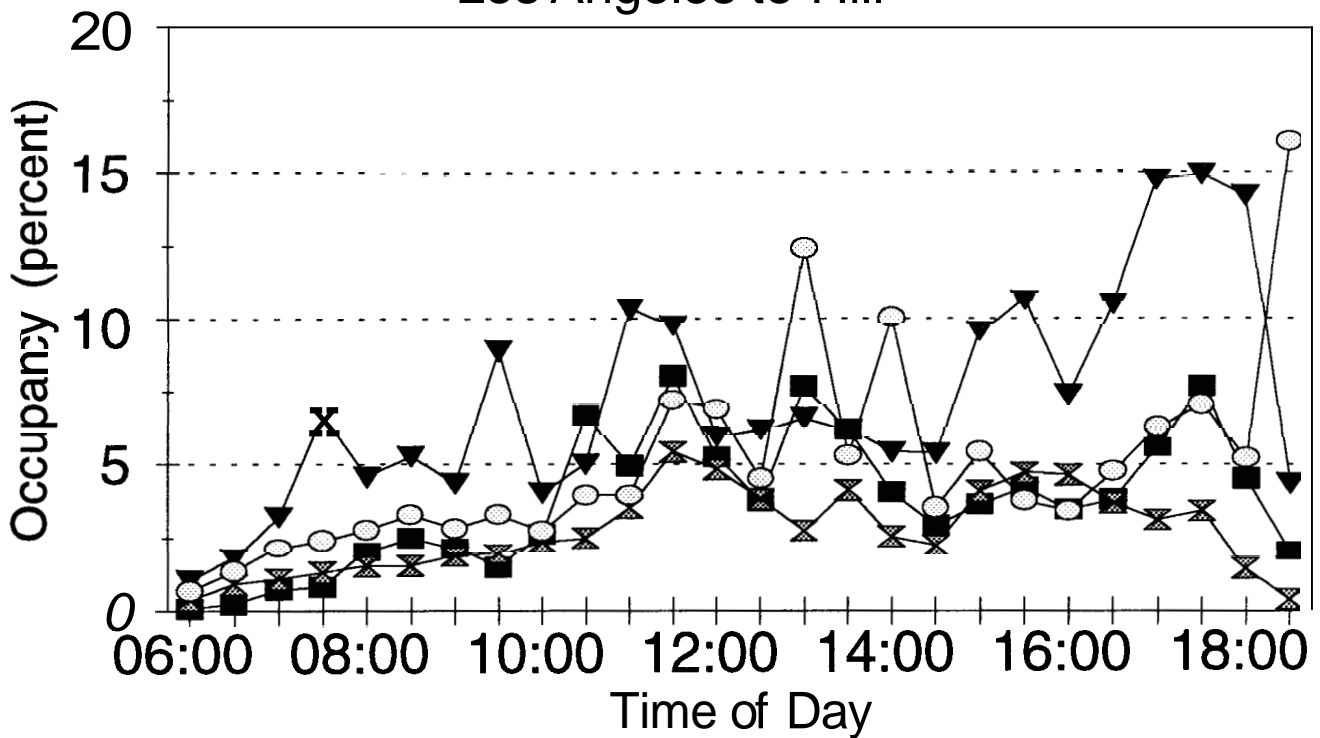


Figure 37

Occupancy on Olympic Westbound - Part 1

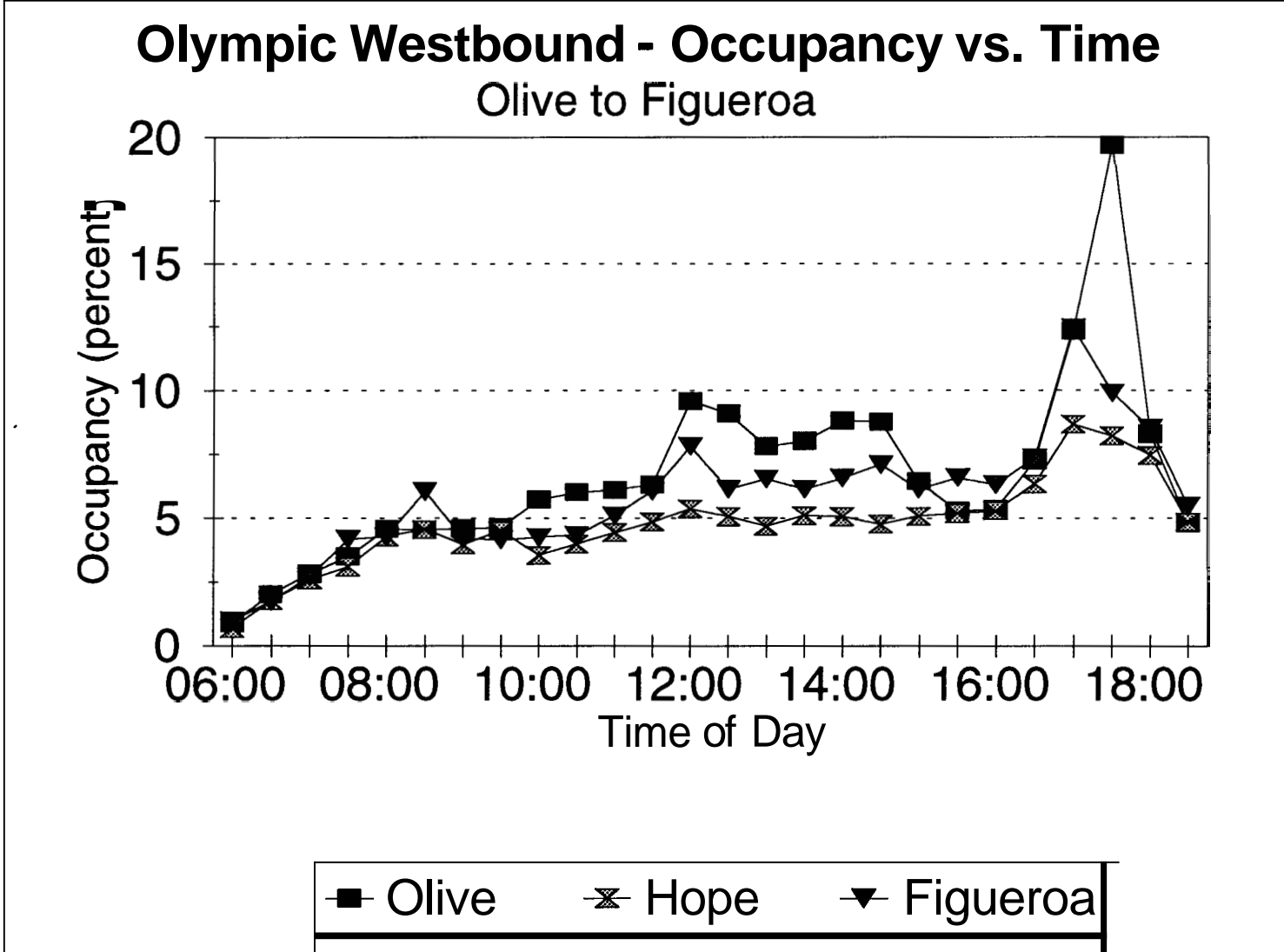


Figure 38

Occupancy on Olympic Westbound - Part 2

## Section 8: Plans for Future Work

The findings in this report indicate that the data from the ATSAC system are quite reliable and can be used rather easily in the simulation of the Santa Monica Freeway Corridor. Thus, it is recommended that this data be used to generate the arterial supply data that will be needed. More extensive data tapes will be needed from the officials at ATSAC to achieve this goal.

If the simulation is to be successful, the project will need to obtain data of this type for all of the major intersections within the corridor and performing the forementioned analysis many times over. In particular, the link flow data obtained from the **COMBINE.CPP** program will be used the most. Unfortunately, the target date for putting the entire corridor online is October of this year.

The programs worked well in analyzing the data that were received. Still, there remains much potential for modification and improvement of the programs. The possible changes include having the **ATSAC.CPP** program send more parameters, such as delay and stops, to the output files to allow for a more complete assessment of the data. This data could also be manipulated further within the program to produce other measures of performance. Another possible modification is to have the **SLICE.CPP** program produce time slices of 15 minutes or an hour as opposed to one half hour. 15 minute time slices would provide a more precise view of the traffic flow along a corridor. The disadvantages to this are that the INTEGRATION model will have to generate a more precise distribution of origin destination pairs. This could significantly slow the running of the program.

Another program that is being developed by the authors will provide a graphical display of the intersection flows throughout the day. The user will be able to move forward and backward in time and will be able to toggle between flow and occupancy values. This program would also be able to import flow data from the INTEGRATION model so that data obtained from the simulation model could also be displayed by the program. Another possibility along these lines is to display the flow and occupancy along a link to check the integrity of the data and to assess the general flow characteristics of an arterial.

## Appendix A: ATSAC.CPP Program

```
#include <stdio.h>
#include <stdlib.h>
#include <conio.h>
#include <string.h>
#include cdir.h>
#include <dos.h>

int drive;
int subcount = 0;
FILE *in, *out;
char ch;
char curdir[40];
char cr = 10;                \\Carriage return
char infile[40];
char directory[30];
char string [8] = "NONE YET";
char opench;
float count1 = 1;
long avail;

void openfile();
void checkdisk();

main()
{
checkdisk();
clrscr();
printf("\n\nAll output files will be put into the current directory.");
getcwd(curdir, 40);
printf("\n\nThe current directory is %s.", curdir);
printf("\n\nThe %c drive has %ld bytes available", 'A' + drive, avail);
printf("\n\nMake sure this directory has plenty of room.");
printf("\n\nFiles will be made for each detector and appended as needed.");
printf("\n\nPress q to quit or any other key to continue.");

opench = getch();
if (opench == 'q' || opench == 'Q') {
    exit(1);
}
```

```

clrscr();
printf("\n\n\n\nEnter name of input file to be modified: ");
scanf("%s", infile);
if ((in = fopen(infile, "rt")) == NULL) {
    printf ("Input file not opened!");
    return (0);
}

while (!feof(in)) {
    ch = fgetc(in);
    if (ch == 0) { // Check for new line (4 null characters)
        ch = fgetc(in);
        if (ch == 0); {
            ch = fgetc(in);
            if (ch == 0) {
                ch = fgetc(in);
                if (ch == 0) {
                    fgetc(in);
                    ch = fgetc(in);
                    if (ch == 'D') { // Check for new detector
                        openfile(); //If found, open new file
                    }
                    else if (ch == ' ' || ch == 'E') {
                        fgetc(in);
                        while (ch != 0)
                        {
                            ch = fgetc(in);
                        }
                        ungetc(ch, in);
                    }
                    else {
                        fputc(cr, out);
                        fputc(ch, out);
                    }
                }
            }
        }
    }
    else fputc(ch, out);
    countl = countl + 1;
    subcount = subcount + 1;
    if (subcount > 1000) {
        clrscr(); // Output screen during program
    }
}

```

```

        printf("\n\n\n\nMaking File %s\\%s", curdir, string);
        printf("\n\nApproximate Number of Bytes Read is %.0f",count1*1.1);
        subcount = 0;
    }
}
fclose(in);                // Clean up
fclose(out);
return(0);
}                // End of MAIN

void openfile()
{
fclose(out);
fgetc(in);
fgetc(in);
fgetc(in);
fscanf (in, "%s", string);
    if ((out = fopen(string, "a")) == NULL) {
        clrscr();
        printf("\n\n%s", string);
        printf("\n\nCannot Open File");
        getch();
    }
int counter = 0;
    while (counter < 50) {
        fgetc(in);
        counter ++;
    }
}

void checkdisk()
{
    // Check current disk space available
struct dfree free;
drive = getdisk();
getdfree(drive + 1, &free);
if (free.df_sclus == 0xFFFF) {
    clrscr();
    printf ("\n\nError in getdfree() call.");
    exit(1);
}
avail = (long) free.df_avail * (long) free.df_bsec * (long) free.df_sclus;
}

```



## Appendix B: SLICE.CPP Program

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include <strstream.h>
#include <fstream.h>
#include <string.h>

void convert();
void setflag();
void sumfirst();
void sumsecond();

int count = 0;
FILE *in, *out;
char infile[20];
char outfile[20];
char inpline[300];
char ch, flag;
char txt_ext[] = ".TXT";
float hour, minute, second;
float flow, occup, speed, cqueue;
float cycle = 0;
float totflow = 0;
float totocc = 0;
float avgflow, avgocc;

main()
{
convert();           // Creates file "CONVERT" with no colons
strcpy(outfile, infile);
strcat(outfile, txt_ext);
if ((out = fopen(outfile,"w")) == NULL) {
    printf("\n\nCan't open file.");
    exit(0);
}
fprintf(out, "START    END    AVG FLOW  AVG OCC.  No. Cycles\n\n");

ifstream in("convert", ios::in);
if (!in) {
```

```

printf("Could not open file.");
return(0);
}

while (in.getline(inpline, 300)) {
    istrstream cline(inpline, 300);
    cline >> hour >> minute >> second >> flow >> occup >> speed >> cqueue;

    if (hour != 0) {
        // Checks for blank line
        if (count == 0) setflag(); // Sets flag to start
        if (minute < 30) {
            if (flag != '1') sumsecond();
            totflow = totflow + flow;
            totocc = totocc + occup;
            cycle ++;
            flag = '1';
        }
        if (minute >= 30) {
            if (flag != '2') sumfirst();
            totflow = totflow + flow;
            totocc = totocc + occup;
            cycle ++;
            flag = '2';
        }
    }
}

if (flag == '1') sumfirst(); // Clears last time slice
if (flag == '2') {
    hour = hour + 1; // Correct hour
    sumsecond();
}
return (0);
} // End of MAIN

void convert()

char space = 32;
printf("\n\n\nEnter name of input file to be modified: ");
scanf("%s", infile);
if ((in = fopen(infile, "r")) == NULL) {
    printf("\n\nCannot Open File");
    exit(1);
}

```

```

if ((out = fopen("CONVERT", "w+")) == NULL) {
    printf("\n\nCannot Open Intermediate File");
    exit(1);
}
while (!feof(in)) {
    ch = getc(in);           // Changes colons to
    if (ch == 58) fputc(space, out);    // spaces
    else fputc(ch, out);
}
fclose(out);
}

```

```

void setflag()
{
if (minute < 30)    flag = '1';
if (minute >= 30)  flag = '2';
count = 1;
}

```

```

void sumfirst()
{
if (cycle != 0) {
    avgflow = totflow / cycle;
    avgocc = totocc / cycle;
}
else avgflow = avgocc = -1;
fprintf(out, "%2.0f:00:00 %2.0f:30:00 ", hour, hour);
fprintf(out, "%8.2f%8.2f%8.0f\n", avgflow, avgocc, cycle);
totflow = totocc = cycle = 0;
}

```

```

void sumsecond()
{
if (cycle != 0) {
    avgflow = totflow / cycle;
    avgocc = totocc / cycle;
}
else avgflow = avgocc = -1;
fprintf(out, "%2.0f:30:00 %2.0f:00:00 ", hour - 1, hour);
fprintf(out, "%8.2f%8.2f%8.0f\n", avgflow, avgocc, cycle);
totflow = totocc = cycle = 0;
}

```

## Appendix C: COMBINE.CPP Program

```
#include <stdio.h>
#include <conio.h>
#include <strstream.h>
#include <fstream.h>
#include <string.h>

int hour1[4], hour2[4];
int minute1[4], minute2[4];
int second1[4], second2[4];
FILE *in1, *in2, *in3, *in4, *out;
char street[12], cross[12], direction[12];
char *tba_ext = ".tba";
char *at_sign = "@";
char *dot = ".";
char outfile[20];
char inpline1[300], inpline2[300], inpline3[300], inpline4[300];
char ch;
char det1[9], det2[9], det3[9], det4[9];
float cycle = 0;
float avgflow[4], avgocc[4], flow, occup, flag;

main()

printf("\n\nEnter street that the detectors to be added are on: ");
scanf("%s", street);
printf("\n\nEnter cross street for the intersection: ");
scanf("%s", cross);
printf("\n\nEnter direction of travel for these detectors: ");
scanf("%s", direction);
strncpy(outfile, street, 3);
strcat(outfile, at-sign);
strncat(outfile, cross, 3);
strcat(outfile, dot);
strncat(outfile, direction, 1);

if ((out = fopen(outfile,"w")) == NULL) {
    printf("\n\nCan't open file. Sorry.");
    return (0);
}
```

```

printf("\n\nEnter number of detectors to be added (2 - 4): ");
scanf("%f", &flag);
printf("\n\nEnter number of first detector to be added: ");
scanf("%s", det1);
printf("\n\nEnter number of second detector to be added: ");
scanf("%s", det2);
if (flag > 2) {
    printf("\n\nEnter number of third detector to be added: ");
    scanf("%s", det3);
}
if (flag > 3) {
    printf("\n\nEnter number of fourth detector to be added: ");
    scanf("%s", det4);
}
fprintf(out, "%s@%s\n%s\n", street, cross, direction);
fprintf(out, "Detectors %s, %s", det1, det2);
if (flag > 2) fprintf(out, ", %s", det3);
if (flag > 3) fprintf(out, ", %s", det4);
fprintf(out, "\nStart \tEnd \tFlow \t Avg Occ\n");
strcat(det1, tba-ext);
strcat(det2, tba-ext);
if (flag > 2) strcat(det3, tba-ext);
if (flag > 3) strcat(det4, tba-ext);

ifstream in1(det1, ios::in);
if (!in1) {
    printf("Could not open first input file %s.", det1);
    return(0);
}
ifstream in2(det2, ios::in);
if (!in2) {
    printf("Could not open second input file %s.", det2);
    return(0);
}
ifstream in3(det3, ios::in);
if (!in3) {
    if (flag > 2) {
        printf("Could not open third input file %s", det3);
        return(0);
    }
}
ifstream in4(det4, ios::in);
if (!in4) {

```

```

    if (flag > 3) {
        printf("Could not open one of the input files.");
        return(0);
    }
}

while (in1.getline(inpline1, 300)) {
    istrstream cline1(inpline1, 300);
    cline1 >> hour1[0] >> minutel[0] >> secondl[0] >> hour2[0] >>\
        minute2[0] >> second2[0] >> avgflow[0] >> avgocc[0];

    in2.getline(inpline2, 300);
    istrstream cline2(inpline2, 300);
    cline2 >> hour1[1] >> minutel[1] >> secondl[1] >> hour2[1] >>\
        minute2[1] >> second2[1] >> avgflow[1] >> avgocc[1];

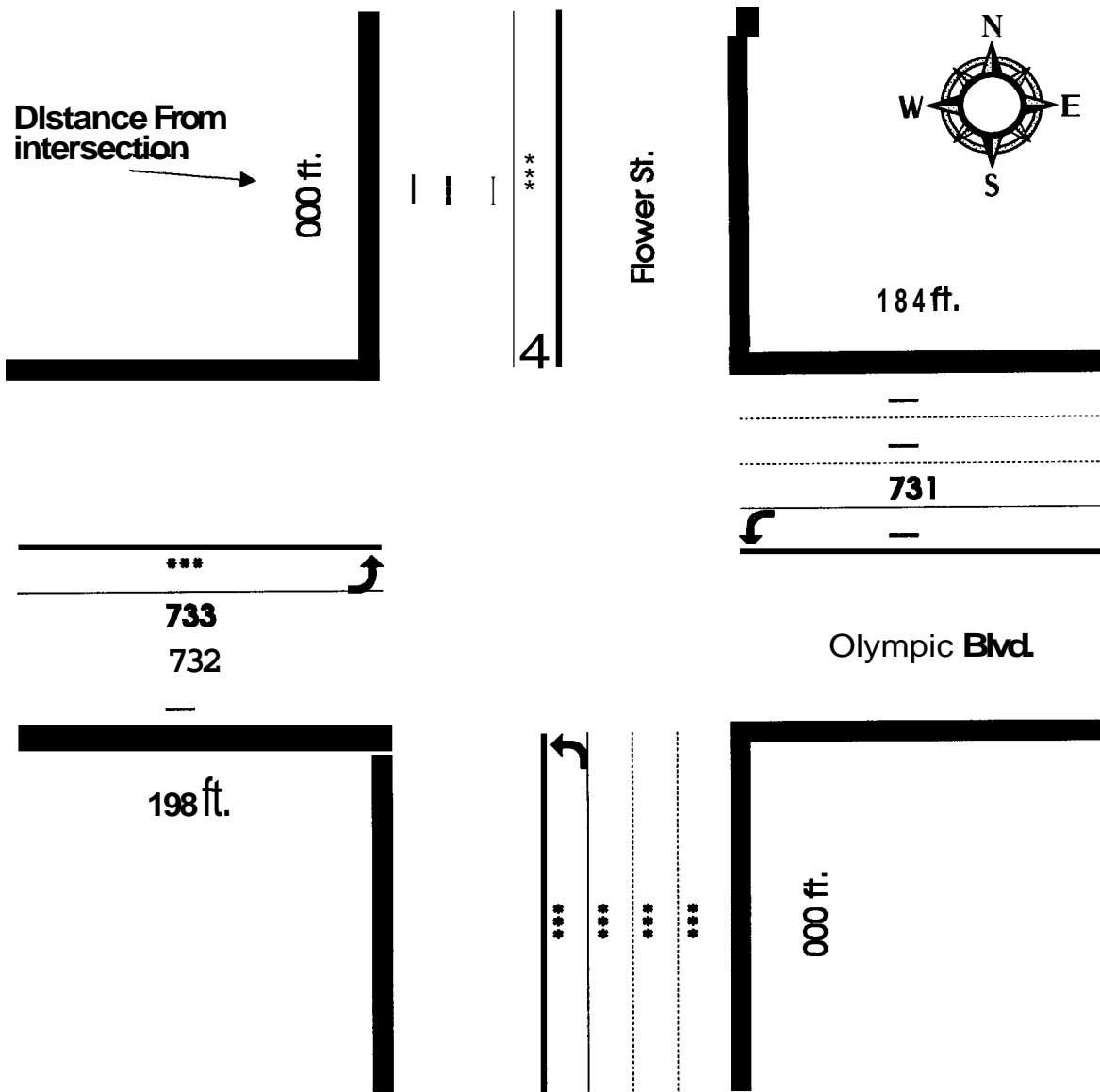
    if (flag > 2) {
        in3.getline(inpline3, 300);
        istrstream cline3(inpline3, 300);
        cline3 >> hour1[2] >> minutel[2] >> secondl[2] >> hour2[2] >>\
            minute2[2] >> second2[2] >> avgflow[2] >> avgocc[2];
    }
    else avgflow[2] = avgocc[2] = 0;

    if (flag > 3) {
        in4.getline(inpline4, 300);
        istrstream cline4(inpline4, 300);
        cline4 >> hour1[3] >> minutel[3] >> secondl[3] >> hour2[3] >>\
            minute2[3] >> second2[3] >> avgflow[3] >> avgocc[3];
    }
    else avgflow[3] = avgocc[3] = 0;

    if (hour1[0] == 0) continue;
    flow = avgflow[0] + avgflow[1] + avgflow[2] + avgflow[3];
    occup = (avgocc[0] + avgocc[1] + avgocc[2] + avgocc[3])/flag;
    fprintf(out, "%02d:%02d:00\t%02d:%02d:00\t", hour1[0], minutel[0],\
        hour2[0], minute2[0]);
    fprintf(out, "%7.2f\t%6.2f\n", flow, occup);
}
return (0);
}

```

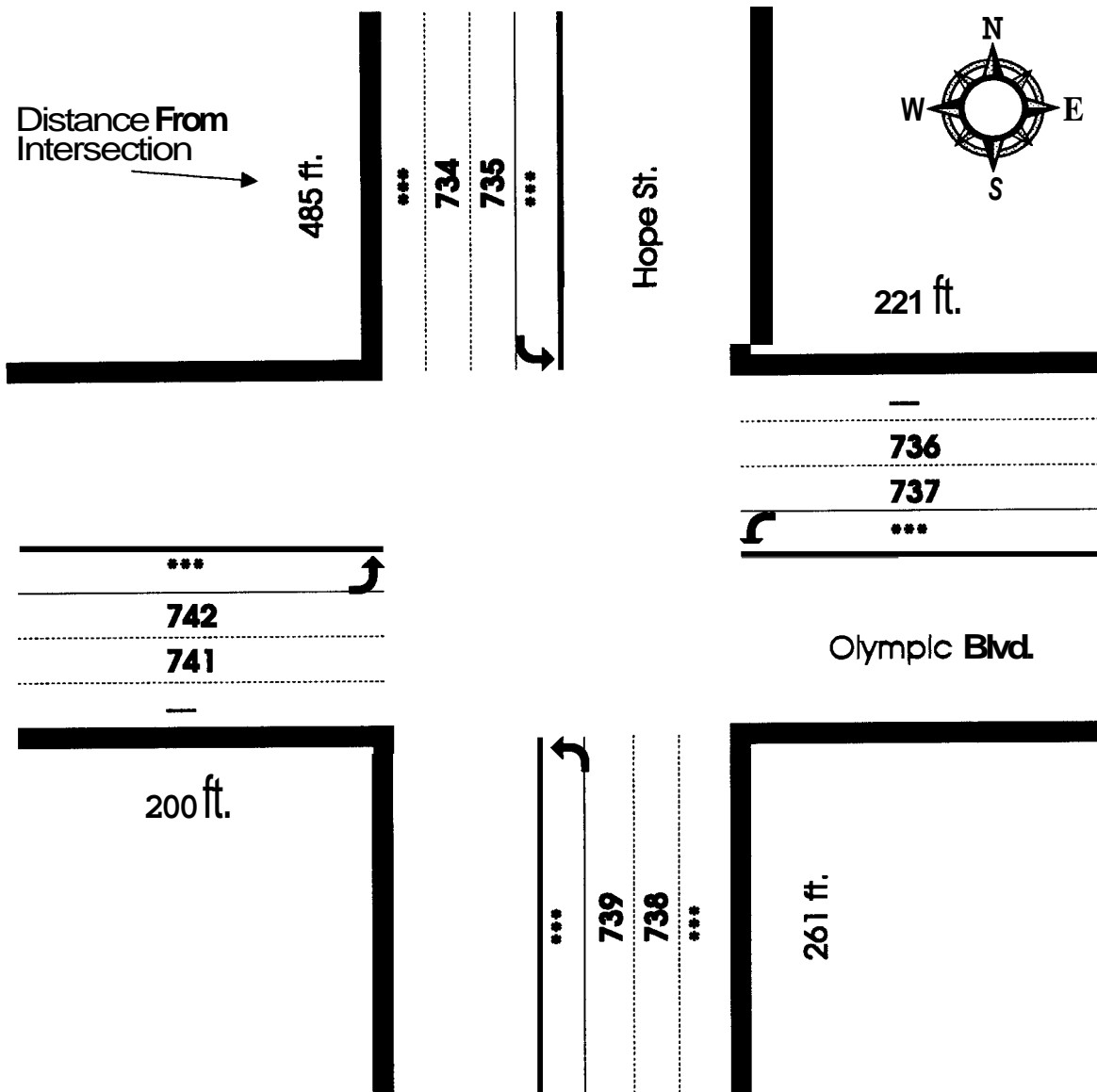
# Appendix D: Maps of Individual Intersections



**Olympic  
and  
Flower**

--- No Detector  
 \*\*\* No Lane  
 Bold - Data Included

**Figure 39**

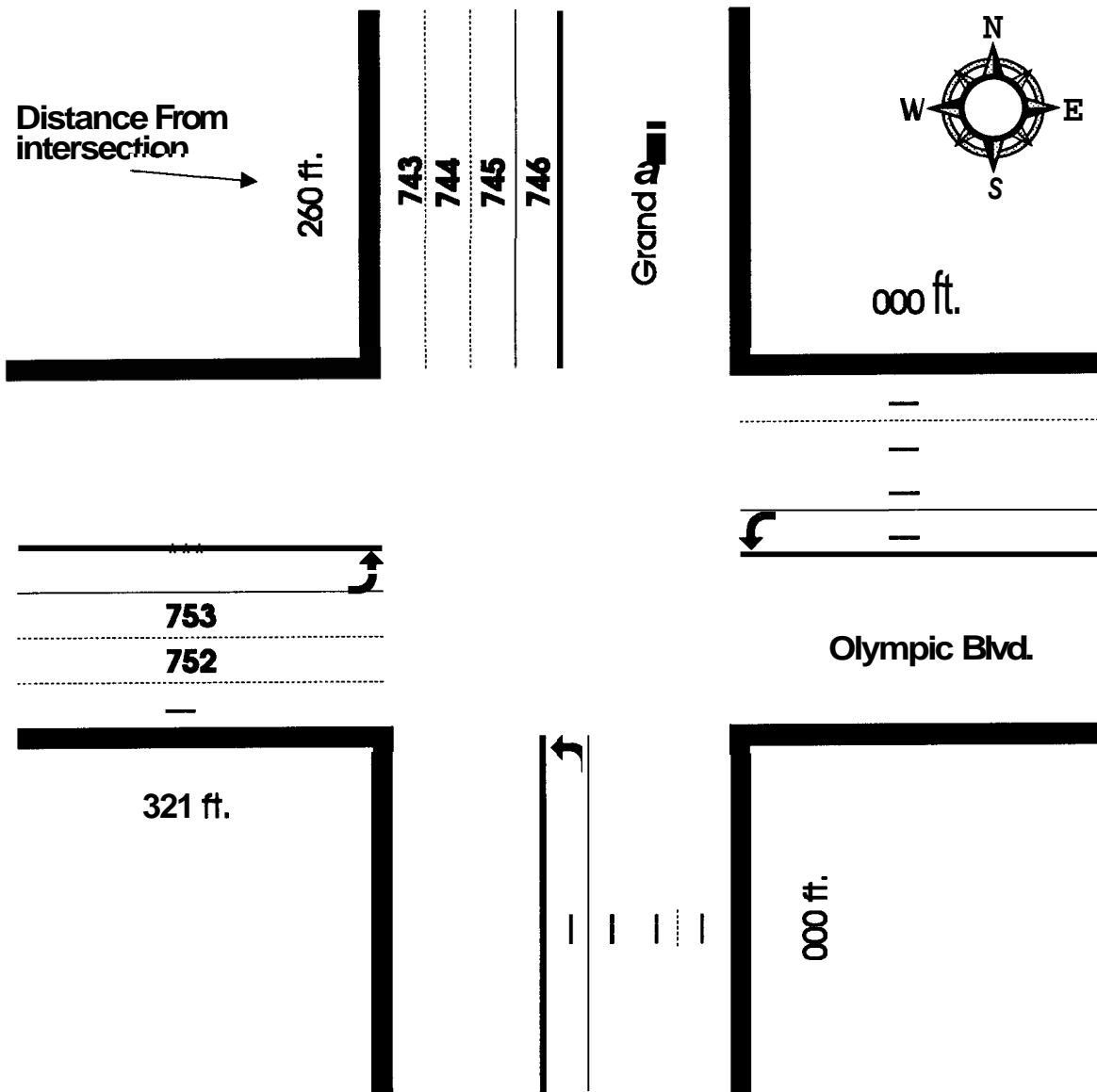


# Olympic and Hope

--- No Detector  
 \*\*\* No Lane  
**Bold - Data Included**

Figure 40

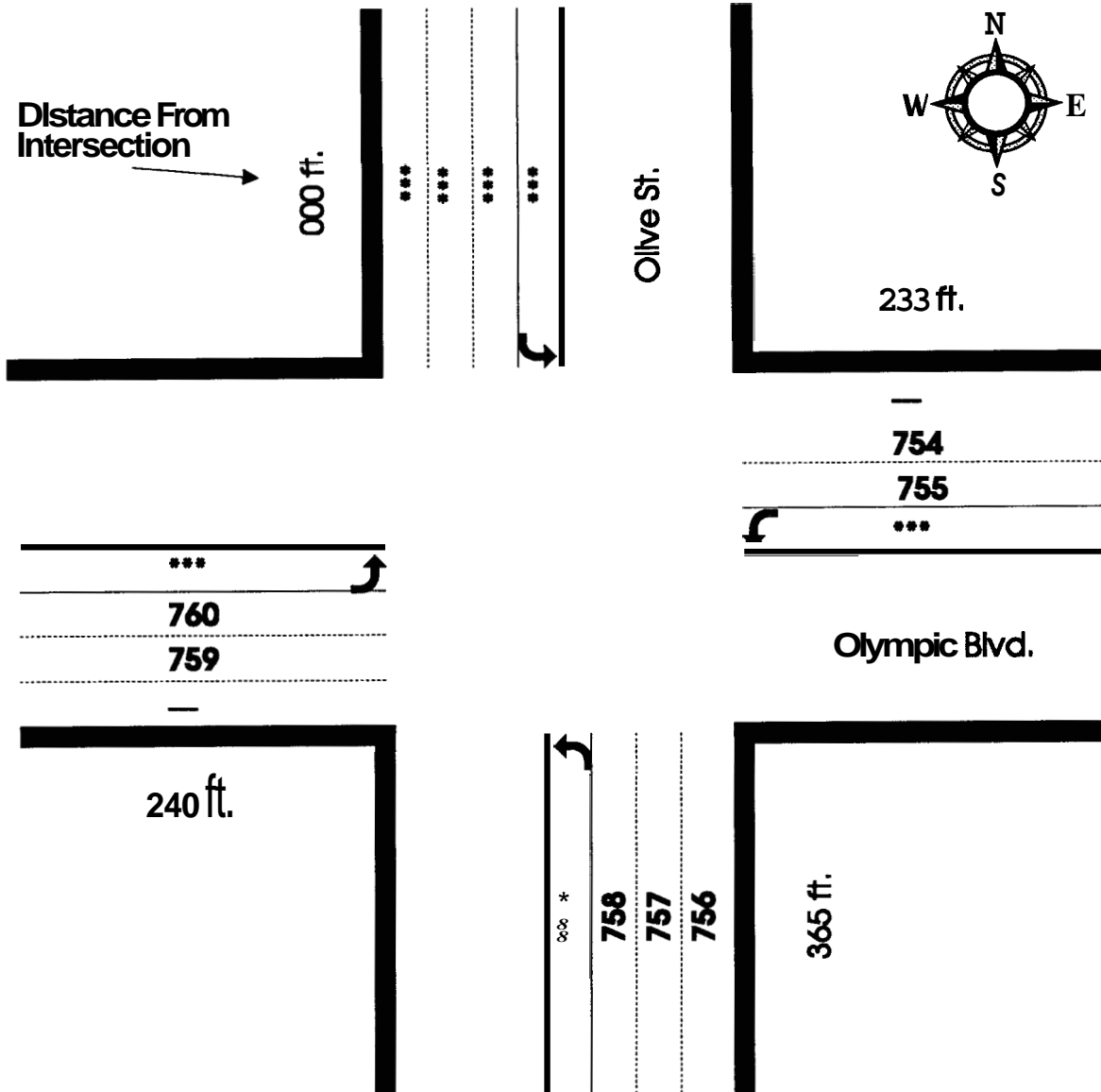




# Olympic and Grand

--- No **Detector**  
 \*\*\* No **Lane**  
**Bold - Data Included**

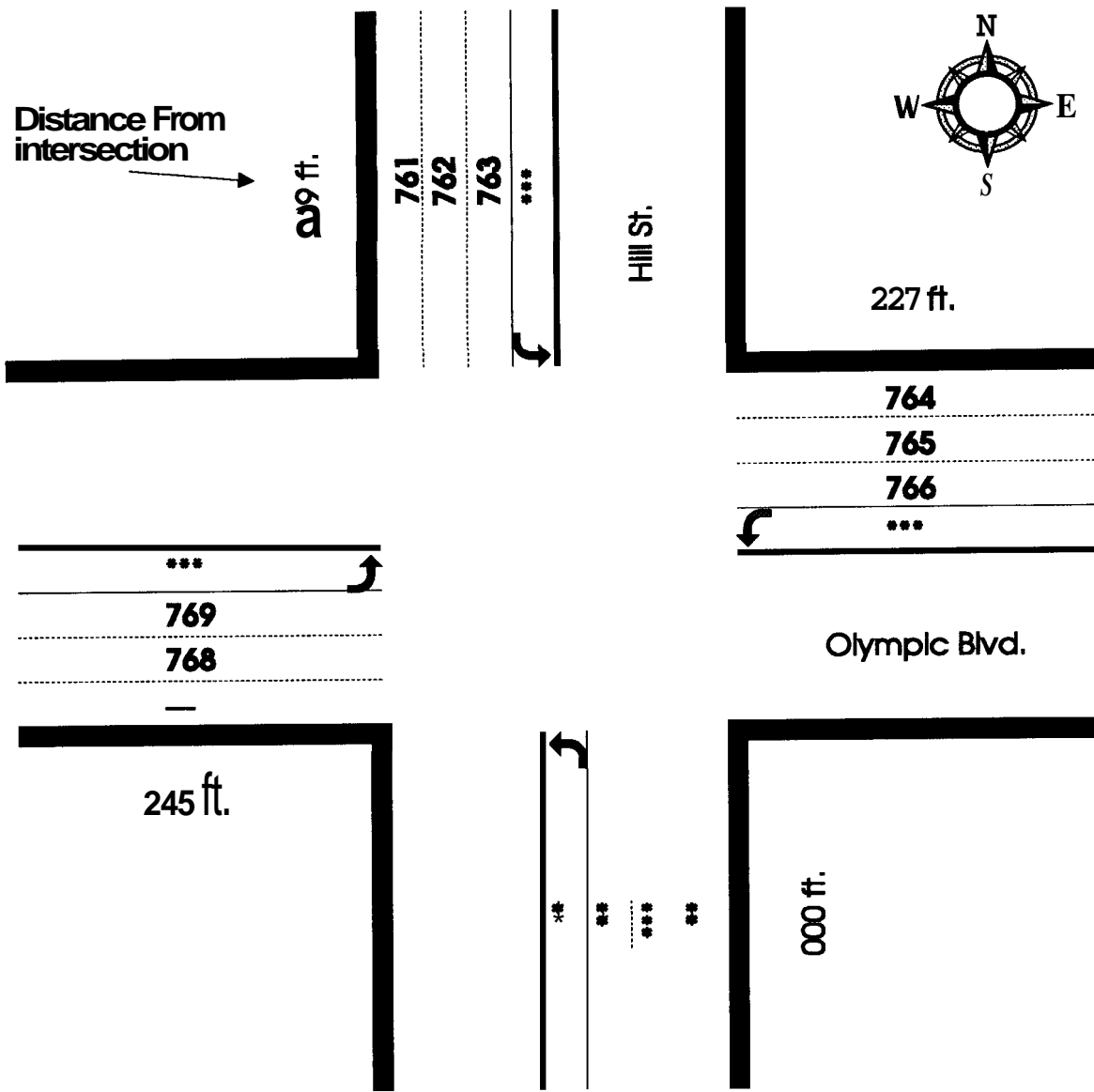
Figure 41



# Olympic and Olive

- No Detector
- \*\*\* No Lane
- Bold - Data Included**

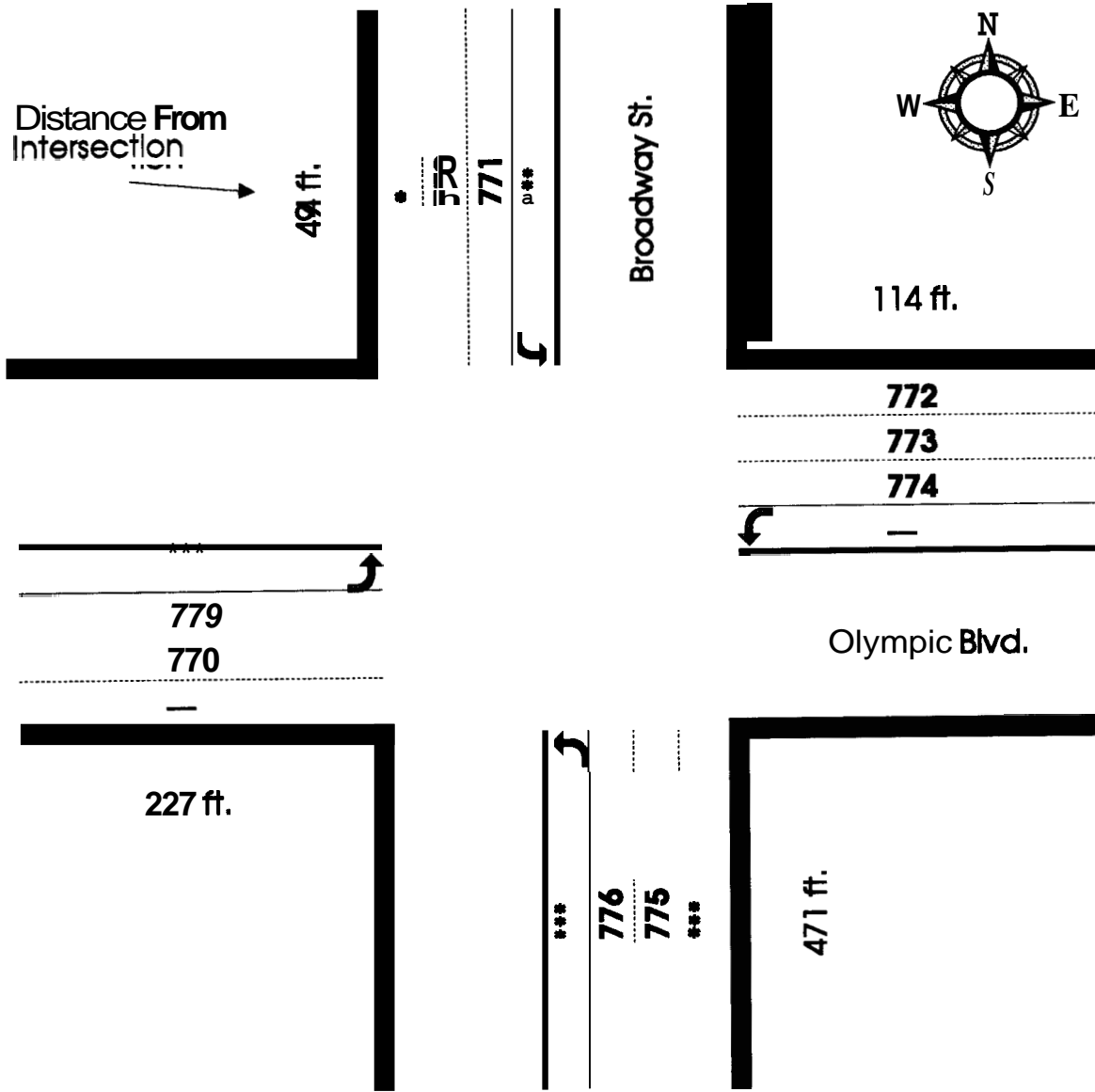
Figure 42



**Olympic  
and  
Hill**

--- No Detector  
 \*\*\* No Lane  
**Bold - Data Included**

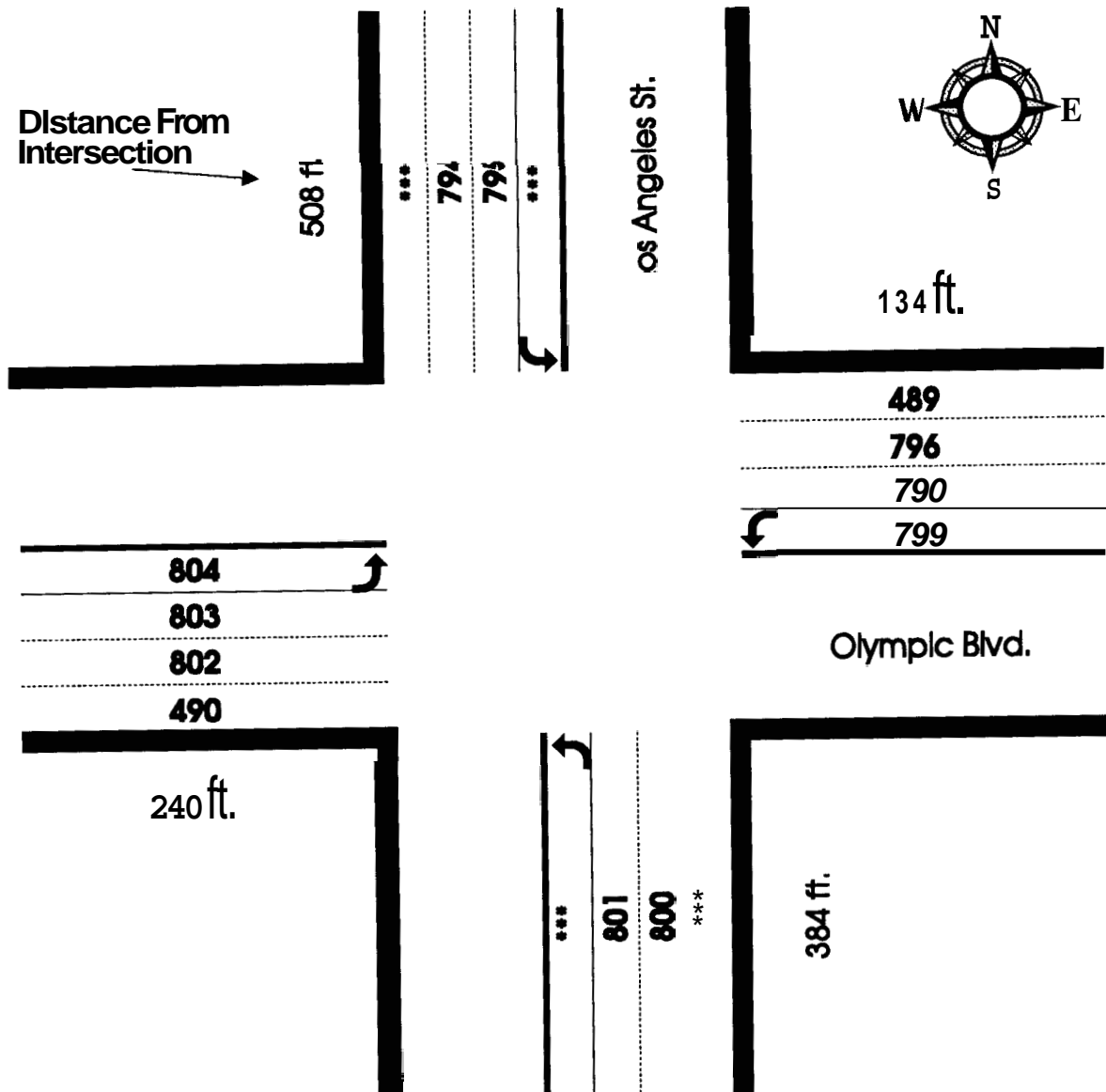
Figure 43



**Olympic  
and  
Broadway**

--- No Detector  
 \*\*\* No Lane  
 Bold - Data Included

Figure 44



# Olympic and Los Angeles

Figure 45