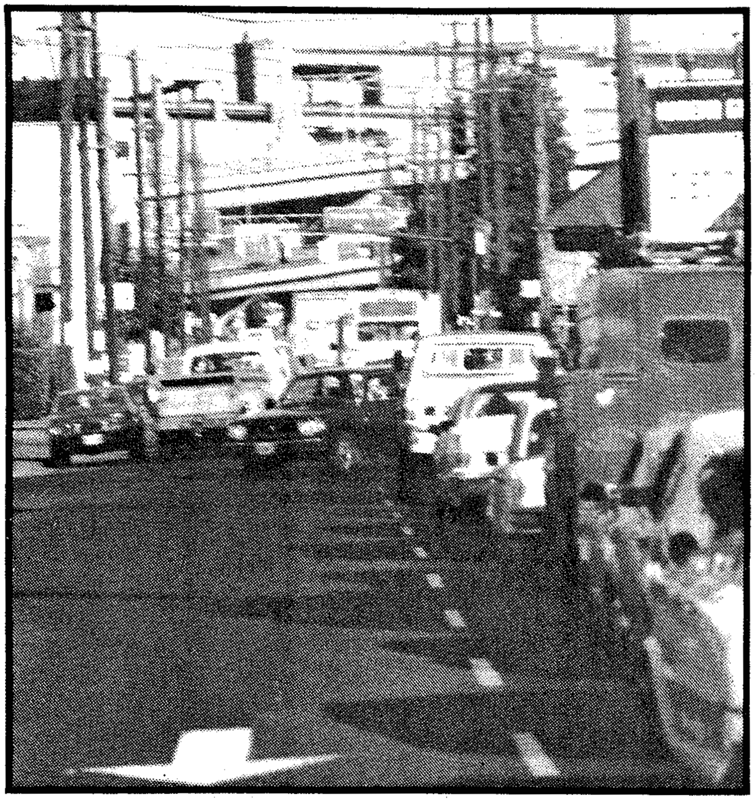
Technical Memorandum No.3

CURRENT PERFORMANCE of the HIGHWAY SYSTEM in the CRAG REGION

April, 1978



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TECHNICAL MEMORANDUM NO. 3

CURRENT PERFORMANCE OF THE HIGHWAY SYSTEM IN THE CRAG REGION

APRIL, 1978

Columbia Region Association of Governments
527 SW Hall Street
Portland, Oregon 97201

PUBLISHED BY

COLUMBIA REGION ASSOCIATION OF GOVERNMENTS
527 SW Hall Street
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STAFF PRINCIPALLY RESPONSIBLE FOR THIS REPORT

C. William Ockert	Director, CRAG Transportation Division

Research Team

Steven Siegel	Project Manager
Craig Ferris	Planning Technician
James Gieseking, Jr.	Planner
T. Keith Lawton	Principal Planner
Darrel Clark	ODOT

Report Production

Karen Thackston	Administrative Aide
Ginger Haskins	Word Processing
Alan Holsted	Graphics
Navaho	Graphics
Bill Jordan	Technical Editor

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Preface

This report is part of a series of technical memoranda prepared by CRAG to document the current conditions of the region's transportation system and its related impacts. The objectives of this specific report are to analyze highway performance from the viewpoint of the user and to indicate the magnitude and location of regional traffic congestion. The base data used in this report was updated to conform with current (1977) assumptions and was prepared by CRAG for use by local and regional transportation planning and traffic engineering staff. While this particular report does not examine the comprehensive impacts of the regional highway network, auto-related air quality impacts are documented in CRAG Technical Memorandum No. 2: Current Transportation Related Air Quality Conditions in the CRAG Region.

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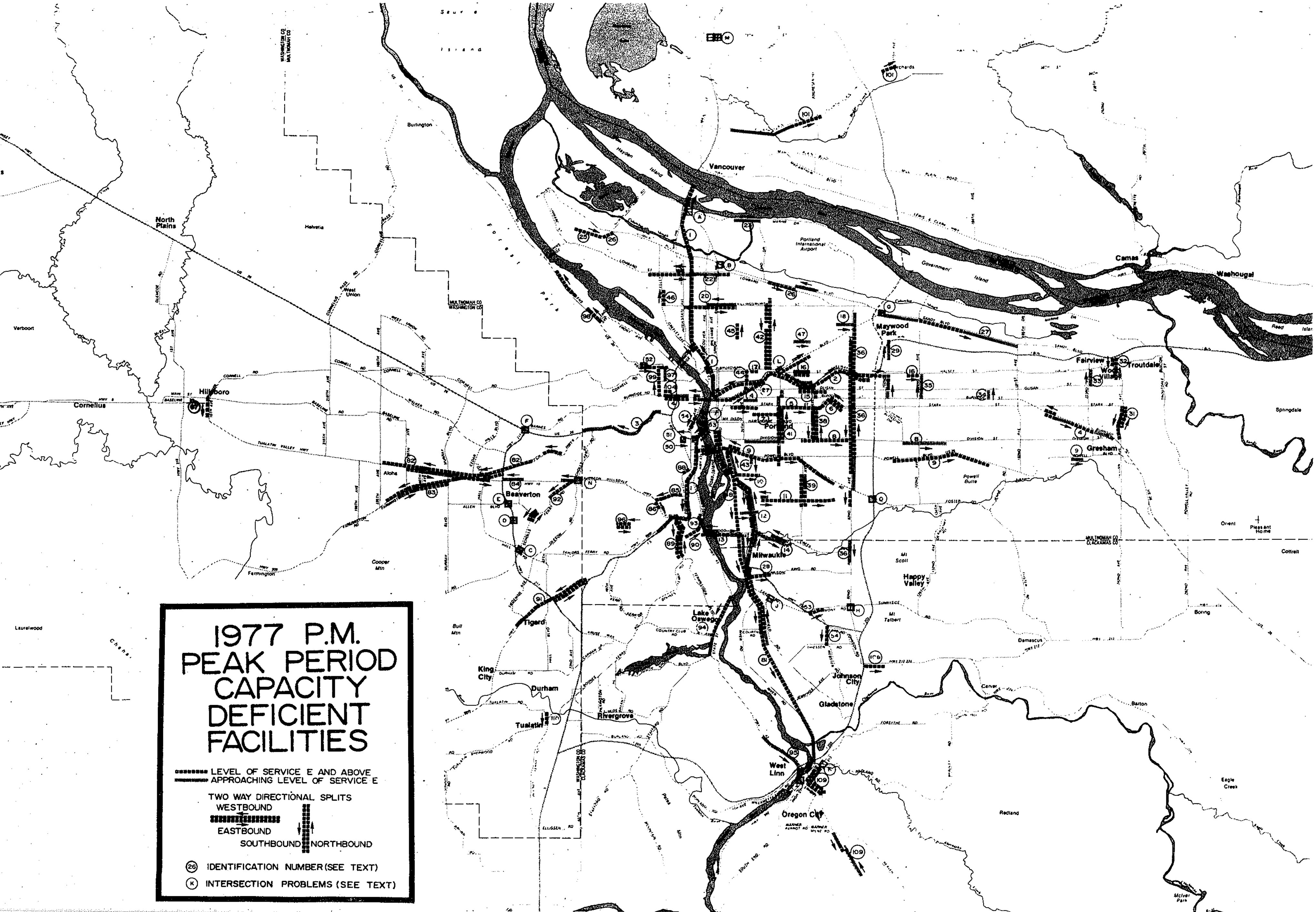
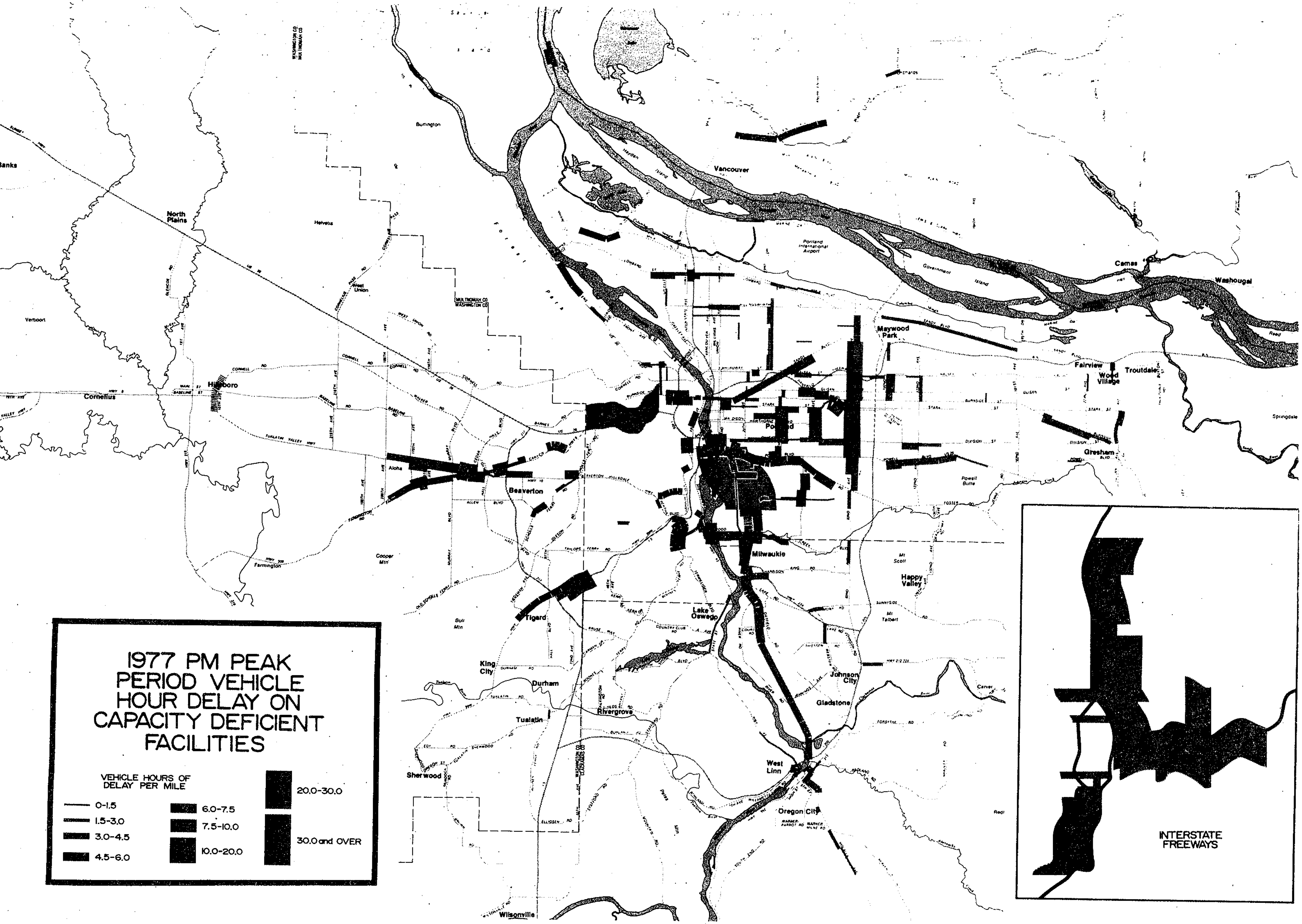
SUMMARY OF FINDINGS

This report investigates the current PM peak-hour congestion problems which occur on the Federal Aid Urban (FAU) highway system. Approximately 267 lane-miles of roadway and 15 major intersections were found to have a capacity deficiency problem. The congestion on these facilities causes over 1,000 vehicle-hours of delay. The Interstate System accounts for only 15 percent (41 lane-miles) of the region's capacity deficient roadways, but comprises almost 50 percent (472 vehicle-hours) of the delay experienced during the PM peak hour. The specific location of capacity deficient facilities and the relative amount of delay they exhibit are illustrated in the illustrations which follow.


1977 P.M.
PEAK PERIOD
CAPACITY
DEFICIENT
FACILITIES
LEVEL OF SERVICE E AND ABOVE
APPROACHING LEVEL OF SERVICE E
TWO WAY DIRECTIONAL SPLITS
WESTBOUND
EASTBOUND
SOUTHBOUND
NORTHBOUND
IDENTIFICATION NUMBER (SEE TEXT)
INTERSECTION PROBLEMS (SEE TEXT)
Vancouver
Camas
Washougal
Portland International Airport
Government Island
Hayden Island
Maywood Park
Fairview
Troutdale
Gresham
Powell Butte
Portland
Milwaukie
Happy Valley
Lake Oswego
Johnson City
Gladstone
West Linn
Oregon City
Beaverton
Aloha
Tigard
King City
Durham
Tualatin
Rivergrove
Hillsboro
Cornelius
North Plains
Helvetia
West Union
Burlington
Verboort
Laurelwood
Cooper Mtn
Bull Mtn
Farmington
Damascus
Boring
Carver
Barton
Redland
Eagle Creek
Springdale
Orient
Pleasant Home
Cottrell
Mt Scott
Mt Talbert
Orchards
Forest Park
Sauvie Island


1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES
VEHICLE HOURS OF DELAY PER MILE
0-1.5
1.5-3.0
3.0-4.5
4.5-6.0
6.0-7.5
7.5-10.0
10.0-20.0
20.0-30.0
30.0 and OVER
INTERSTATE FREEWAYS
Vancouver
Portland International Airport
Camas
Washougal
Maywood Park
Fairview
Wood Village
Troutdale
Gresham
Powell Butte
Portland
Milwaukie
Happy Valley
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A. Background

Each auto-user has a unique perception of the "quality of service" (or "performance") afforded by each highway facility he or she uses. The major factors included in this perception of highway performance seem to be:

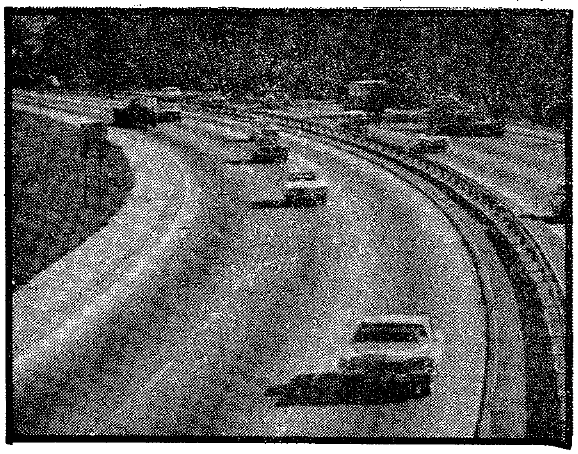
a. speed and travel time,
b. traffic interruptions and restrictions,
c. freedom to maneuver,
d. safety,
e. driving comfort and convenience, and
f. economy.

Ideally, a planner's evaluation of highway service should measure each of these factors and relate these measures to an overall performance scale. In practice, most of these factors can seldom be explicitly and quantitatively accounted for. The <u>Highway Capacity Manual</u> describes a traffic engineering approach to this problem which can be adapted to conform with the data, manpower and time requirements of a regionwide study.

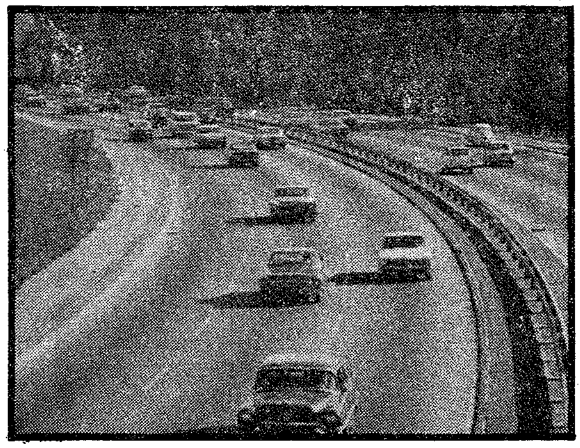
The evaluation of highway performance at the traffic engineering level of detail is a complex, and expensive process which measures the operating conditions associated with the use of each section of a roadway by a given number of vehicles. These operating conditions result from the interaction of a variety of factors, including (a) the physical attributes of the roadway (i.e., lane width, alignment, etc.), (b) the capabilities of the vehicles using the roadway (i.e., braking power, acceleration, etc.), and (c) driver skill and awareness (reaction times, etc.). The traffic engineering procedure described in the <u>Highway Capacity Manual</u> requires a detailed accounting of these factors on a section by section basis for each facility to be evaluated and equates them to a predefined <u>level of service</u> scale. Level of service is a qualititative measure of the freedom of traffic flow from constraints, interruptions or other inconveniences, relative to the best possible conditions for a given type of highway facility. The <u>Highway Capacity Manual</u> defines six alphabetically designated level of service categories in terms of speed and volume-to-capacity (V/C) ratios for each facility type, ranging from level A, free flow, to level F, forced flow (Figure 1). As volume increases and speeds decrease, the <u>level of service</u> gets progressively worse on a step-by-step basis (Figure 2).

FIGURE 1
LEVEL OF SERVICE CONCEPT

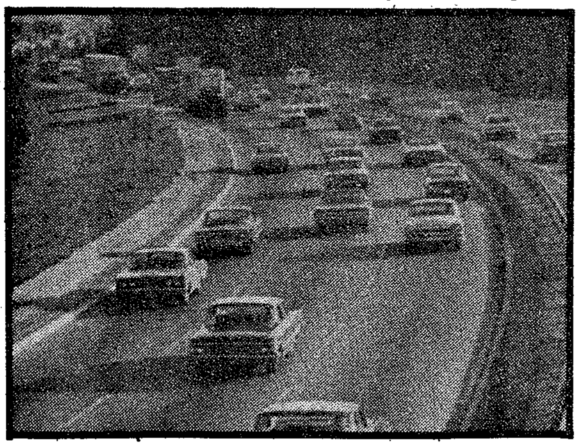
LEVEL OF SERVICE A



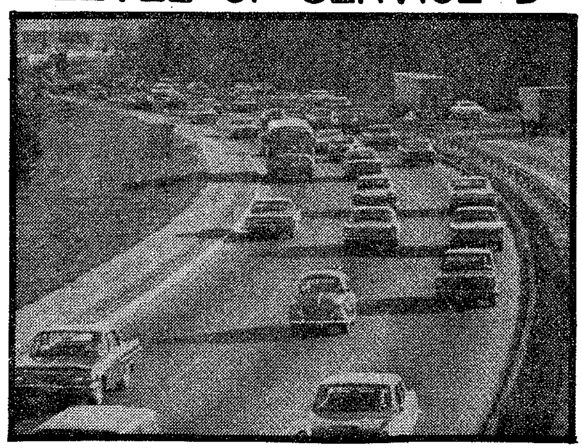
LEVEL OF SERVICE B



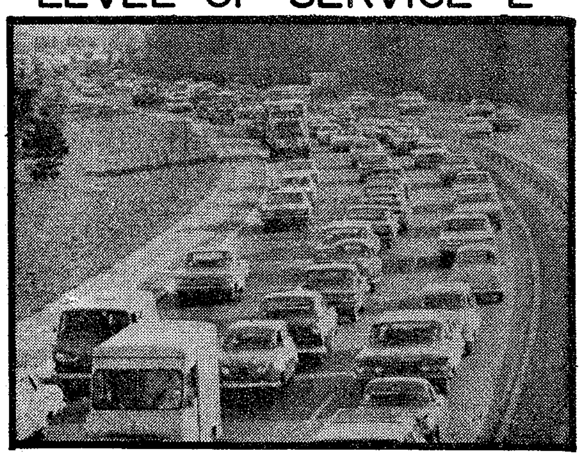
LEVEL OF SERVICE C



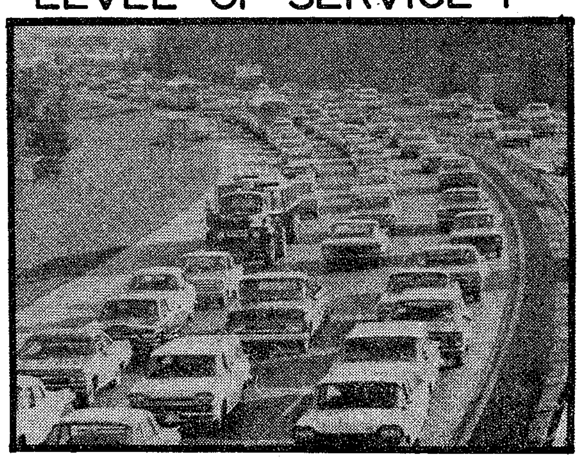
LEVEL OF SERVICE D



LEVEL OF SERVICE E

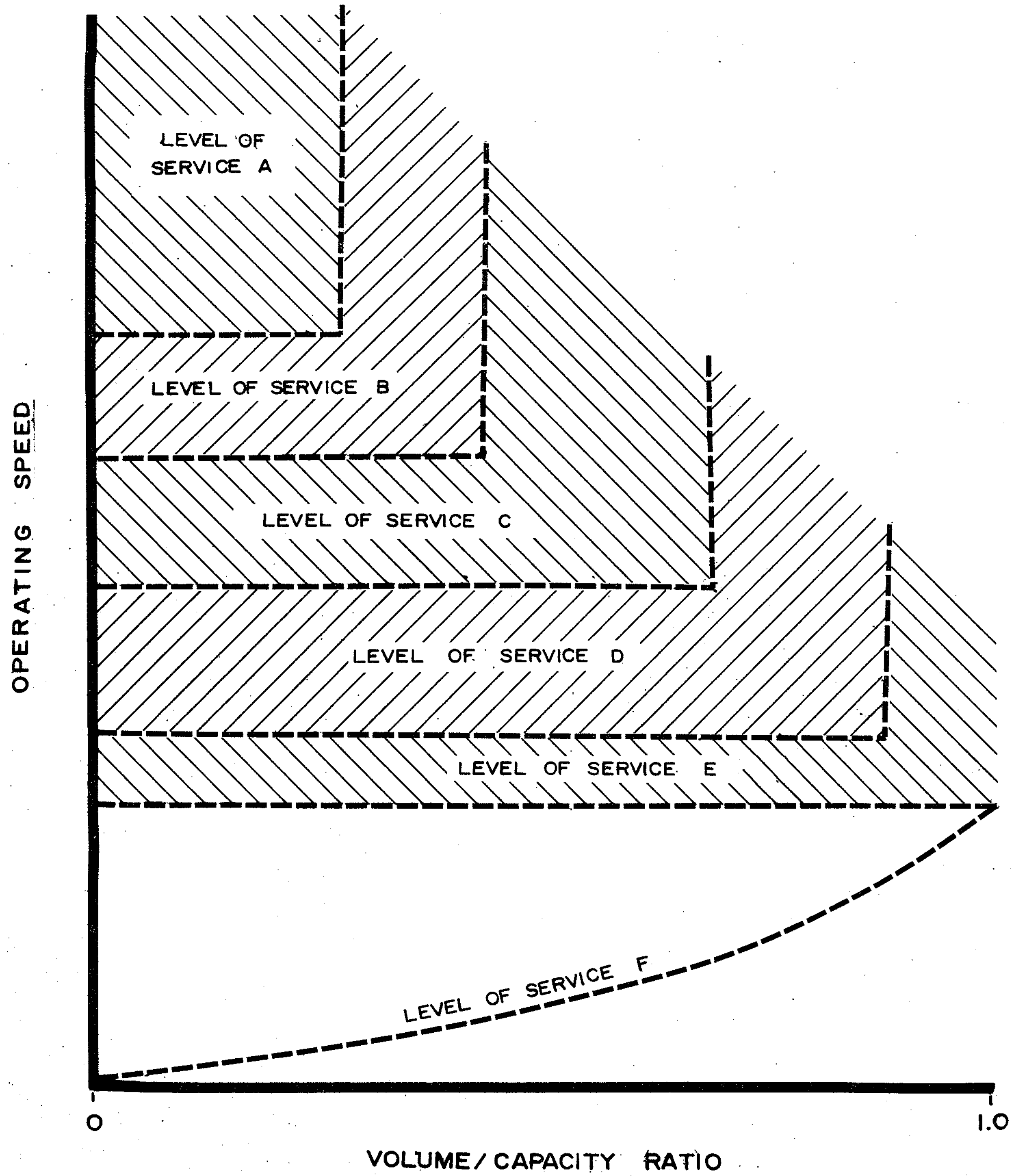


LEVEL OF SERVICE F



SOURCE: HRB; HIGHWAY CAPACITY MANUAL; SPECIAL REPORT 87, 1965

FIGURE 2 RELATIONSHIP OF LEVELS OF SERVICE TO SPEED AND VOLUME/CAPACITY RATIO



(Not to scale)

The traffic engineering approach to performance evaluation has a number of characteristics associated with it that makes its usefulness at the regional analysis scale somewhat limited. Foremost are the practical concerns for data, manpower and, thus, planning funds; the engineering procedures tend to be slow, cumbersome and expensive when investigating one facility--not to mention an entire urban network. Secondly, level of service is not a scale which is sensitive to regional considerations. Differences in the designated level of service can represent both very small or significantly large changes in speed or V/C ratios. As defined, level of service is also independent of the absolute number of users being subjected to a particular performance level.

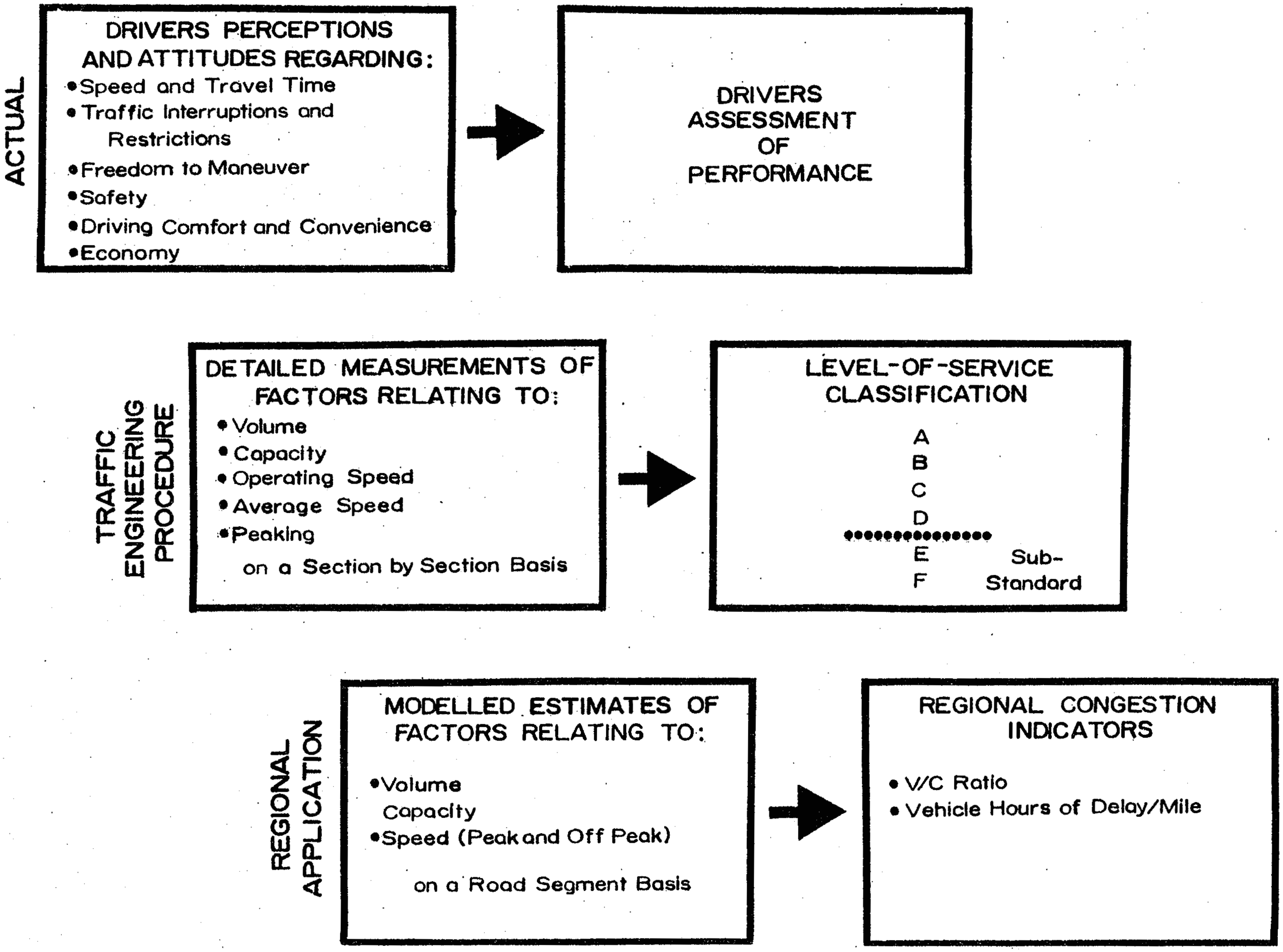
To respond to these concerns, a regional approach (Figure 3) was developed based on the traffic engineering procedures described in the Highway Capacity Manual. The fundamental units of this approach are two quantitative indicators: (a) the Volume-to-Capacity (V/C) ratio, which inversely relates to comfort, convenience, maneuverability, interruptions and safety factors; and (b) the Vehicle Hours of Delay per Mile, which relates directly to lost time and user-costs associated with congestion. The methodology requires four basic pieces of information for each segment of a facility: volume, capacity, peak-period (restricted) speed and off-peak period (free-flow) speed. Values for capacity, volume and peak-period speed are based on quantifiable measurements for certain influencing factors and reasonable assumptions concerning the effects of others. To insure that the results from the analysis are properly interpreted, this methodology is explained in detail in Sections II, III and IV.

B. Purpose

This analysis was completed as part of the Current Conditions project of the CRAG System Planning Program. In this context, the results will form a portion of the baseline evaluation of regional transportation system needs and related impacts. These needs will be the focus of the revised long-range transportation planning effort. This does not imply that the revised plan will solve, or even attempt to address, each of the problem areas identified in this report. Traffic congestion per se is neither a necessary nor sufficient condition to justify additional public expenditures. Rather, the results herein can assist CRAG and the jurisdictions in their efforts: (a) to identify the underlying causes of priority problems (b) to develop a set of detailed objectives for the regional plan regarding the priority problems and their causes and (c) to test project or program alternatives which are expected to meet these objectives.

FIGURE 3

HIGHWAY PERFORMANCE FROM THE USERS PERSPECTIVE: DIFFERENT SCALES OF ANALYSIS



The results of this study may also be useful to the jurisdictions in developing their proposed annual element for the Transportation Improvement Program (TIP). Additionally, the TIP Subcommittee, together with CRAG staff, can employ these results to assess the potential effectiveness of the TIP and TSME in meeting regional traffic congestion concerns.

Regardless of their use, the results must be understood for what they are. While the methodology used was fairly elaborate, it does represent a generalized engineering procedure which may not be sensitive to a highly localized condition of overriding importance. The results are, however, the best of their kind available to the region and appear to be fairly reliable. Eight roadways, for which hourly directional traffic counts exist, were selected to test the validity of study results. In seven cases the estimates were within 10-15 percent of the observed values. For uses in which this degree of accuracy is not sufficient, a detailed traffic engineering analysis will have to be performed. The <u>1965 Highway Capacity Manual</u> is the best single reference for these cases.

C. Organization of the Report

The proceeding sections describe the specifics of the regional highway performance evaluation procedure, its derivation from the traffic engineering approach, and the results that ensued from its application. The report is organized as follows:

Section II:	describes the methodology for determining the generalized road segment capacities on the basis of roadway features and traffic characteristics.
Section III:	describes how peak hour directional lane volumes were computed from Average Daily Traffic (ADT) counts obtained from local jurisdictions and ODOT.
Section IV:	describes the process for computing peak-hour speeds on the basis of off-peak speeds and V/C ratios.
Section V:	documents the results of the analysis broken out by jurisdiction.

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II. DETERMINATION OF ROAD SEGMENT CAPACITY

A. Overview

Capacity is the maximum number of vehicles which has a reasonable expectation of passing over a given section of roadway during a given time period under prevailing roadway and traffic conditions. The variables and assumptions employed in determining capacity are described in this section. In expressing capacity, it is essential to state the prevailing conditions under which the capacity is applicable. The capacity would not normally be exceeded without changing one or more of the conditions that prevail. These prevailing conditions can be grouped into three categories of factors:

(a) those factors that are established by the physical features of the roadway;
(b) those factors that are dependent on the nature of the traffic using the roadway; and,
(c) those factors that are dependent on the ambient conditions of the roadway.

The following subsections explain how the detailed traffic engineering procedure accounts for these factors and the simplifications required for regional application.

B. Roadway Factors

1. Traffic Engineering Procedures: Roadway factors are the restrictive physical features incorporated into the design of a roadway section and do not change unless reconstruction is performed. There are a number of roadway factors accounted for in the *Highway Capacity Manual*'s procedure for estimating capacity including:

   (a) Number and Types of Lanes - In a detailed analysis, it is important to note that the number of lanes formed by moving traffic can change, either due to regulation or simply because striped lanes are not respected. It is this actual number of lanes of moving traffic that is the determinant of capacity. The types of lanes composing a road segment are also a major capacity determinant. Generally, additional capacity is created by combinations of auxiliary lanes, which are the portions of a roadway adjoining the through lane and are used for parking, speed changes, weaving and turning purposes.

   (b) Lane Width and Lateral Clearance - Narrower lanes have a lower capacity under uninterrupted flow conditions than standard 12-foot lanes. On both two-lane and multi-lane facilities, more vehicles encroach on adjacent lanes when the lanes are narrow than when they are wide, in effect occupying two lanes at such times. Lateral obstructions (such as retaining walls, abutments, signposts, light poles and parked cars) located closer than six feet from the edge of a traffic lane reduce its effective width. Adequate shoulders are essential to maintain capacity continuously. In facilities without shoulders, disabled vehicles can reduce highway capacity by an amount greater than the capacity of one lane.

(c) Alignment and Grades - The alignment profile and grades of a highway are important factors in its traffic carrying capability. For detailed analyses, information which reflects the nature of curves on the route and the speed changes necessary to negotiate them safely is required. This information would include (a) the geometrics of each horizontal and vertical curve, including curvature and length; (b) distance between curves; and (c) the design speed for each curve. The effects of grades on sight distance, vehicle braking distance, and speed maintenance must also be considered.

(d) Surface Condition - A deteriorated, poorly maintained pavement adversely affects the capacity of a road segment.

2. Regional Application: The methodology employed for determining capacity is sensitive to the following roadway variables on a road segment basis (i.e., groupings of smaller, more detailed highway sections):

(a) Facility Type - This variable accounts for the basic cross-sectional components and egress/ingress factors of a roadway. Each highway element in the Federal Aid Urban System was categorized into one of three groupings:

(1) Arterial--major streets and highways outside the central business district having either (1) speed limits of 40 mph or less, or (2) average signal spacing of one mile or less.

(2) Expressway (signalized)--divided arterial highways for through traffic with partial control of access and with signals at major intersections.

(3) Freeways--expressways with full control of access and grade separations at major intersections.

When calculating the capacity of a roadway segment, facility type is employed to determine the importance and influence of other factors to be considered.

(b) Number of Lanes - This is the variable which accounts for the number of traffic streams occurring on a road segment. For freeways and expressways, capacity is assumed to increase at the same rate as the number of lanes. For urban arterials each additional lane adds less additional capacity. The analysis assumes 12 foot lanes and added (15 percent) capacity to roadways having left turn lanes.

(c) Directional Use - This variable accounts for whether the road segment is a one-way or two-way facility. It is assumed to be irrelevant to freeways and expressways, but it has a marked effect on the capacity of arterials.

(d) Terrain - The effects of grades and curves were collected in a composite indicator called "terrain." The effect of terrain on the capacity of arterials and signalized expressways is considered negligible in comparison to the effect of at-grade intersections. Each freeway segment was classified as having either level or rolling terrain.

C. Traffic Factors

1. Traffic Engineering Procedures: Highways of identical roadway features may nevertheless have different capacities. This is true because the capacity of a highway is influenced by the composition, habits and desires of the traffic which uses it, as well as the controls which must be exercised over that traffic. Considerations of this nature are termed "traffic factors." Essential traffic factors, as described in the Highway Capacity Manual, include:

(a) Traffic Composition - Variability in the percentage of different types of vehicles constituting the traffic stream has a significant effect on highway capacity. In effect, each truck or bus displaces several passenger cars in the flow. Most grades would not appreciably affect capacity if it were not for trucks. Conversely, the effect of trucks on capacity is much greater on long, steep upgrades than on level sections of the roadway. Thus, the relative proportion of trucks and buses using a facility (applied as a vehicle mix percentage) is an important factor in capacity determinations, especially when considered in relation to roadway conditions.

(b) Traffic Interruptions - At-grade intersections constitute the most common type of traffic interruption. Their influence on capacity is so great that they govern the capacity determination. In addition to factors discussed elsewhere in this report, the amount of vehicular traffic which can approach and pass through an intersection depends on the type and operation of its traffic control measures. The main influence of a signal on approach capacity is the degree to which it stops moving vehicles. This is measured in terms of vehicles per hour of green. For example, if all approaching vehicles were stopped on the approach before entering, then traffic would rarely move away at a rate greater than 1,500 VPH of green per lane. However, if traffic were never stopped, a capacity flow rate of 2,000 VPH of green per lane might be achieved. In addition to at-grade intersections, the effects of other interruptions such as drawbridges, railroad and pedestrian crossings, etc., must be accounted for.

(c) Character of Traffic - Highway capacity is greatly influenced by the inherent characteristics of the traffic flow being accommodated. Some important localized factors affecting capacity include (a) frequency of vehicles stopping to load or unload passengers, (b) types and frequencies of right and left turns, (c) curb parking turnover and (d) pedestrian influences.

(d) Weaving - The basic components of the capacity potential of a highway are: (a) the highway proper, characterized by generally uninterrupted flow; (b) the intersection at grade; and (c) the interchange, characterized by diverging or merging maneuvers. Sometimes these combine to form another component referred to as a "weaving section." Weaving sections are prevalent on urban freeways because of the need for frequent egress and ingress. Many factors affect the operational characteristics of weaving sections; each must be considered in a detailed capacity analysis. However, it has been shown that the length of the section is the critical factor in weaving. Its importance is evidenced by the fact that the fundamental weaving volume chart in the Highway Capacity Manual incorporates length as the basic variable.

2. Regional Application: To account for the effects of traffic composition, the analysis assumed a constant percentage of truck traffic for each facility type. The capacities are sensitive to three traffic variables:

   (a) Location: To account for the basic character of traffic flow on a facility in a particular area, each road segment was categorized by its location as follows:

      (1) Central Business District - That portion of the region in which the dominant land use is for intense business activity. This district is characterized by large numbers of pedestrians, commercial vehicle loadings of goods and people, a heavy demand for parking space, and high parking turnover.

      (2) Fringe Area - That portion of a the region immediately outside the central business district in which there is a wide range in type of business activity, generally including small business, light industry, warehousing, automobile service activities, and intermediate strip development, as well as some concentrated residential areas. Most of the traffic in this area involves trips that do not have an origin or a destination within the area. This area is characterized by moderate pedestrian traffic and a lower parking turnover than is found in the central business district, but it may include large parking areas serving that district.

      (3) Suburban Area - That portion of the region within the influence of a municipality, in which the dominant land use is residential development, but where small business areas may be included. This area is characterized by few pedestrians and a low parking turnover.

(4) Rural Area - That portion of the region outside the suburban fringe, in which low density residential development is dominant.

(b) Weaving Section: The effect of weaving was considered to be a significant capacity determinant for freeways only. The presence of a weaving section reduces the capacity of a freeway segment.

(c) G/C Ratio: On signalized facilities, the interruptions caused by at-grade intersections dominates the determination of capacity. Each signalized expressway and arterial was classified as having either free flow, three-phase or two-phase signal control and assigned its green time-to-cycle time (G/C) ratio.

D. Ambient Factors

1. Traffic Engineering Procedure: Ambient conditions relate primarily to weather and include measures such as clear, cold, dry, rain, smog, wet or icy pavement. Visibility during different hours of the day, particularly daylight as compared to dark, also is an ambient condition. There is limited data available to quantify the effect of ambient conditions on capacity, and they are not generally included in the actual determination of the capacity of a specific roadway.

2. Regional Application: Ambient conditions were not expressly accounted for in the current analysis.

E. Summary

The relationship between the Highway Capacity Manual's recommended procedure for determining capacity and its regional application is shown in Figure 4. Table 1 documents the capacity (at level-of-service E) by location, facility type and facility characteristics. Each link on CRAG's detailed (6000 link) highway network was categorized by these factors and assigned a level-of-service D service volume. The link description file documents these service volumes for each link. These capacities were factored to service level E capacities using a 1.15 adjustment factor for freeways and a 1.10 factor for arterials. Capacities for road segments were determined by averaging the capacities of the component links. Care was taken to insure that road segments did not include links with significantly different capacities.

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FIGURE 4
CALCULATION OF CAPACITY

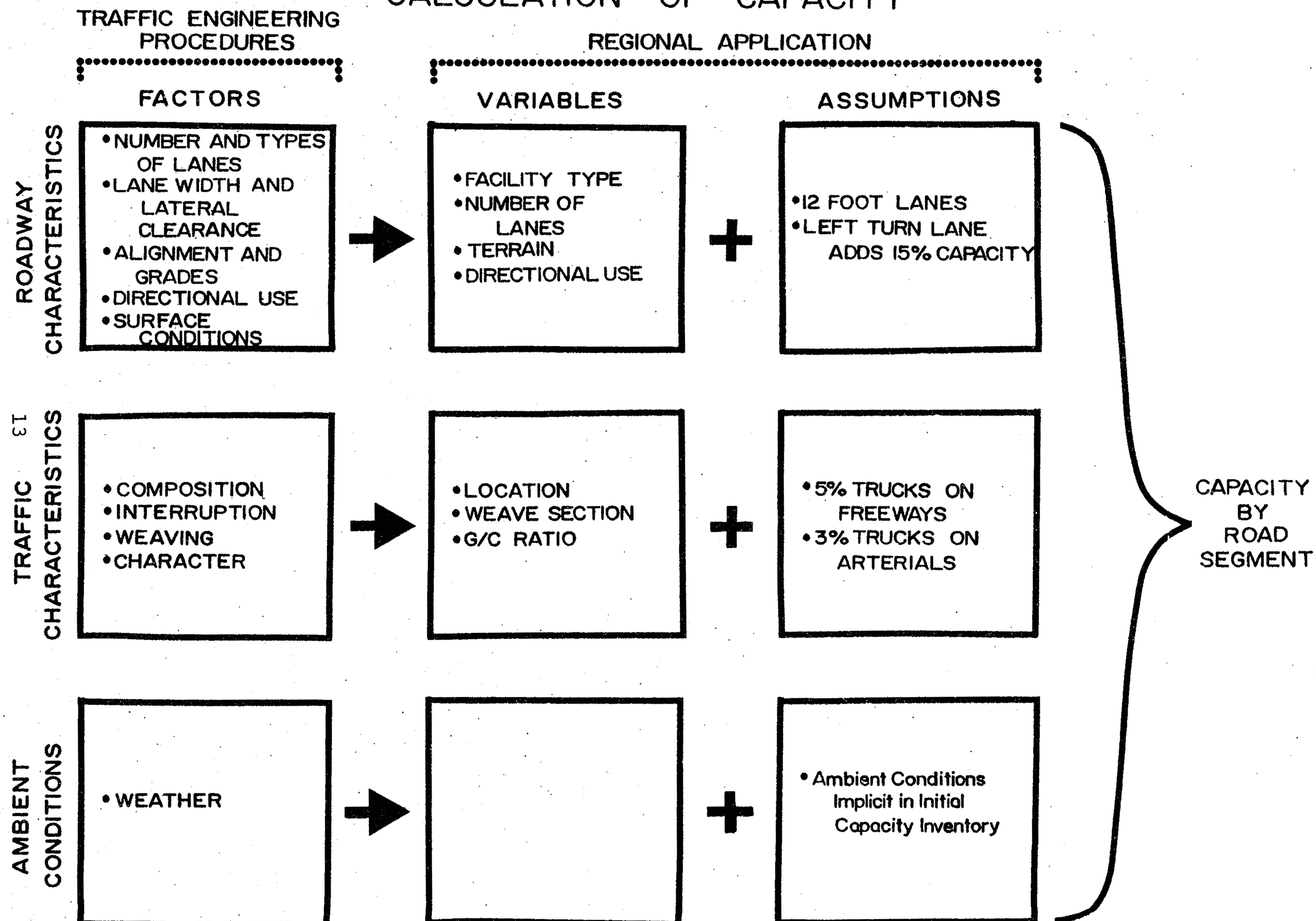

Table 1 : GENERALIZED CORRIDOR CAPACITY BY FACILITY TYPE, LOCATION AND FLOW CHARACTERISTICS

TYPE OF FACILITY	CHARACTERISTICS	LOCATION: CBD	FRINGE	SUBURBAN	RURAL
A. FREEWAY (Vehicles-per-hour)	1 Non-weave section				
	a level terrain	1820	1820	1820	1650
	b rolling terrain	1650	1650	1650	1490
	2 Weave section 1000'				
	a level terrain	1600	1600	1600	1430
	b rolling terrain	1430	1600	1600	1270
B. SIGNALIZED EXPRESSWAY (Vehicles-per-hour of green)	1 Freeflow	1650	1650	1650	1490
	2 $g/c=0.60$ (2 phase)	1100	1100	1100	990
	3 $g/c=0.45$ (3 phase)	825	825	825	770
C. ARTERIAL (Vehicles-per-hour of green)	1 One way 2 lanes				
	a $g/c=0.45$ (2 phase)	1265	1380	1540	n/a
	b $g/c=0.60$ (freeflow)	1710	1870	2090	n/a
	2 One way 3 lanes				
	a $g/c=0.45$	1980	2200	2310	n/a
	b $g/c=0.60$	2640	2860	3080	n/a
	3 One way 4 lanes				
	a $g/c=0.45$	2640	2860	3190	n/a
	b $g/c=0.60$	3520	3850	4290	n/a
	4 Two way 2 lanes				
	a $g/c=0.35$ (3 phase)	440	500	500	390
	b $g/c=0.45$ (2 phase)	500	660	660	500
	c $g/c=0.60$ (freeflow)	720	880	880	610
	5 Two way 4 lanes				
	a $g/c=0.35$	860	1050	1050	770
	b $g/c=0.45$	1050	1380	1380	990
	c $g/c=0.60$	1430	1870	1870	1270
	6 Two way 6 lanes				
	a $g/c=0.35$	1320	1600	1600	n/a
	b $g/c=0.45$	1650	2040	2040	n/a

Source: ODOT

III. DETERMINATION OF PEAK HOUR DIRECTIONAL VOLUMES

A. Overview

Currently, there is no regional counting program which provides reliable peak hour directional traffic volumes --they must be estimated. The following paragraphs describe how these volumes were estimated for 1977 using 24-hour, 2-way traffic counts obtained from local jurisdictions and ODOT.

Experience indicates that normal traffic patterns develop peaking characteristics with respect to time and location. Because these variations in traffic flow represent patterns of travel desire, the performance of a highway cannot be judged by its ability to carry the average volume. Rather, it must be evaluated in terms of its ability to function properly under specified peak loads. General performance analysis dictates that traffic volumes be expressed in terms of vehicles per hour (VPH). In the CRAG region, the only information available regarding traffic volumes consists of scattered counts (over a variety of years) of average daily traffic (ADT) and average weekday traffic (AWT). Thus a method for adjusting the available data to determine the hourly directional volumes is of paramount importance. These volume adjustments can be classified into two groups:

(a) temporal variations, and
(b) spatial variations.

B. Temporal Variations

1. Traffic Engineering Procedure: Within the annual increase in motor vehicle travel, there exist certain cyclical variations with respect to time. The major variations may be expressed as seasonal, weekly and daily time patterns of traffic flow. Peaking characteristics within peak hours should also be considered, although data rarely exists. The following paragraphs elaborate on these points:

   (a) Annual, Seasonal and Weekly Variations - Over the years, as population, disposable income, auto ownership and other travel generating factors have grown, the total vehicle miles of travel have demonstrated a consistent annual increase. Within a region, the annual increase will vary by subarea in relation to relative amounts of population and employment growth. The seasonal pattern of traffic volume on any highway is closely related to seasonal variations in the public's economic and social demands. In general, volumes observed in May and October are close to the annual average. Within a particular season, traffic is observed to vary by day of the week. On urban streets and highways the Monday through Friday traffic volume is fairly stable (Wednesday usually exhibiting the weekly average) and the Sunday volume relatively low.

(b) Daily Variations - Many characteristics related to trip generation--such as geographic and time concentrations of trips, facility type and character (i.e., radial freeway, circumferential freeway, radial arterial etc.), and population area served--have marked effects on peaking characteristics. Traffic variations become less pronounced as the traffic composition (i.e., trip purposes) become more varied. Thus, the extent of development in the area traversed by the facility is a factor. Although hourly volumes are normally used in performance evaluation, the ability of the facility to accommodate an hourly volume depends on the magnitude and duration of a sequence of short period volume fluctuations. At some time, capacity limitations of the facility may limit the amount of traffic carried during the peak period. This condition can cause a lengthening of the peak period on that facility.

2. Regional Application

a. ADT Counts - The most recent counts available were obtained from ODOT (1976 counts) and local jurisdictions (various years between 1974 and 1976). Annual growth factors supplied by ODOT (five percent per annum for Oregon) and WDOT (eight percent per annum for Clark County) were applied to the base counts to bring all volumes to expected 1977 levels. Some counts were computed on an Average Daily Traffic (ADT) basis and some on an Average Weekday Traffic (AWT) basis--the difference being that the ADT totals include the effect of weekends while the AWT totals do not. AWT counts were reduced by seven percent to bring them in line with an ADT base and peaking factors were developed on an ADT basis.

b. Peaking Factor - The peaking factor is defined as the ratio of the highest one-hour volume to the ADT, or in other words, it is the percent of ADT occurring during the peak hour period. The peaking factors by facility type and location employed in this study were developed by ODOT as part of the 1971 Portland-

Vancouver Metropolitan Area Transportation Study (Table 2). Using these factors, the estimated 1977 ADT was multiplied by the appropriate peaking factor to obtain 1977 two-way peak period volumes.

C. Spatial Variations

1. Traffic Engineering Procedure: The specific location of traffic varies throughout the day. Factors to be considered include:

   (a) Directional Distribution - On most two-way highways the annual average daily traffic has been found to be approximately the same in each direction. This is also the case for most 24-hour volumes, but holiday and weekend travel can cause imbalances in the total flow on specific days. However, the volume during a given hour, especially the peak hour, may be a great deal heavier in one direction than in the other. The peak-hour directional distribution of traffic on a facility is a function of the specific land-uses associated with the roadway. Therefore, there can be significant directional differences in volume between roadways--even those that are in close proximity to each other.

   (b) Lane Distribution - Where two or more lanes are available for travel in one direction, the number of vehicles in each lane may vary widely. The distribution of traffic between lanes going in the same direction depends on several factors including traffic volume, the proportion of slow-moving vehicles (trucks and buses), and the number and location of access (ingress and egress) points. The origin and destination desires of the individual users are principal determinants of lane distribution for lanes near entrance or exit points. Also, turbulence in the form of merging, weaving and turning movements associated with previously mentioned roadway components often creates imbalances in lane distribution and lane speed which greatly affect roadway capacity.

2. Regional Application

   (a) Directional Distribution - In order to compute meaningful V/C ratios, the two-way volumes had to be broken down into their component directions. The directional split variable represents the percent of two-way traffic moving in each direction. Directional distributions by subarea and facility type were obtained from ODOT and WDOT. The assumed

Table 2 : PEAKING FACTOR BY FACILITY TYPE AND AREA TYPE

TYPE OF FACILITY	LOCATION			
	CBD	FRINGE	SUBURBAN	RURAL
A. FREEWAY	9%	9.5%	10%	10%
B. EXPRESSWAY (Signalized)	9%	9.5%	10%	10%
C. ARTERIAL	9%	10%	10%	10%

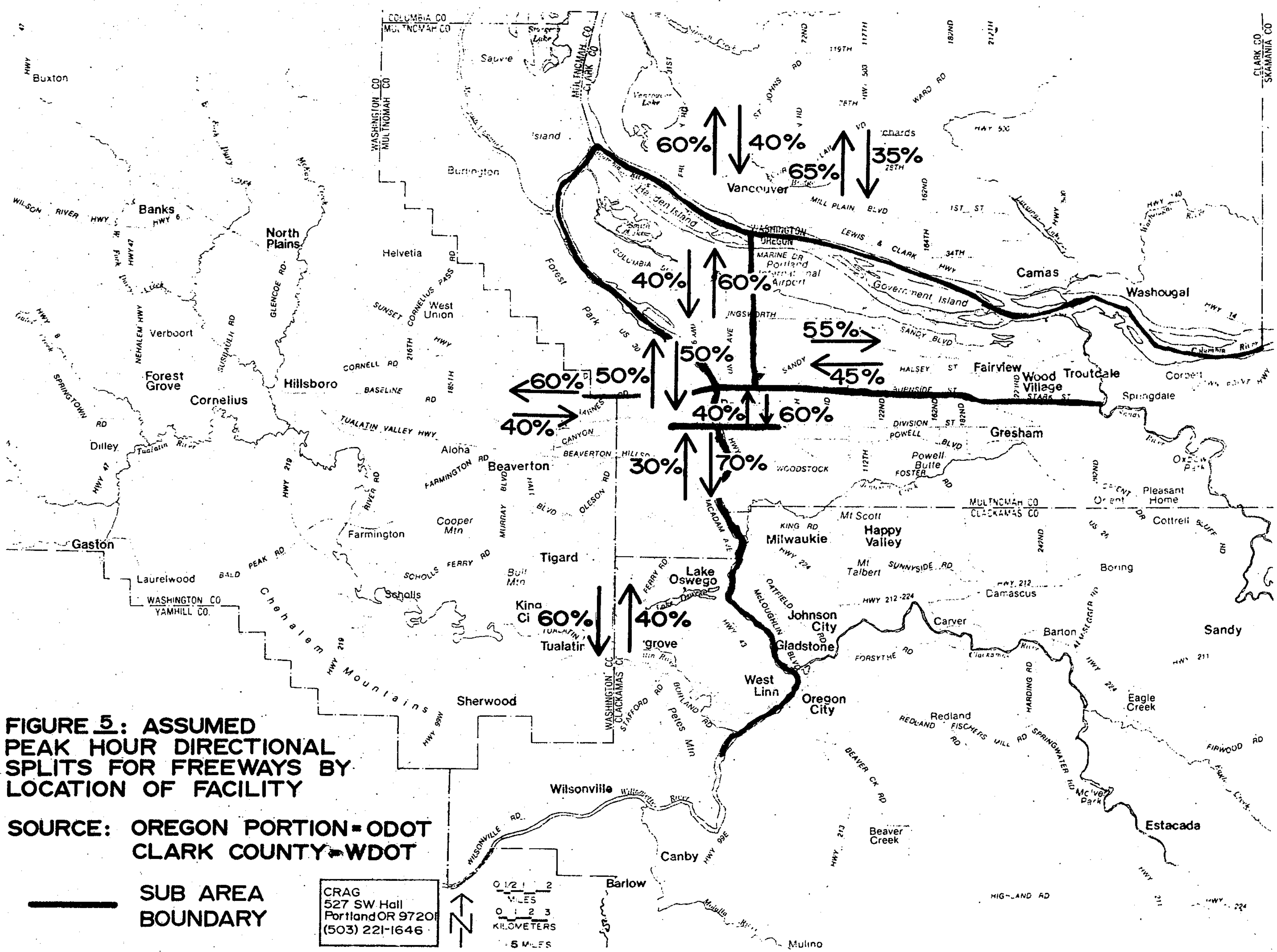

FIGURE 5: ASSUMED PEAK HOUR DIRECTIONAL SPLITS FOR FREEWAYS BY LOCATION OF FACILITY

SOURCE: OREGON PORTION = ODOT
CLARK COUNTY = WDOT

SUB AREA BOUNDARY

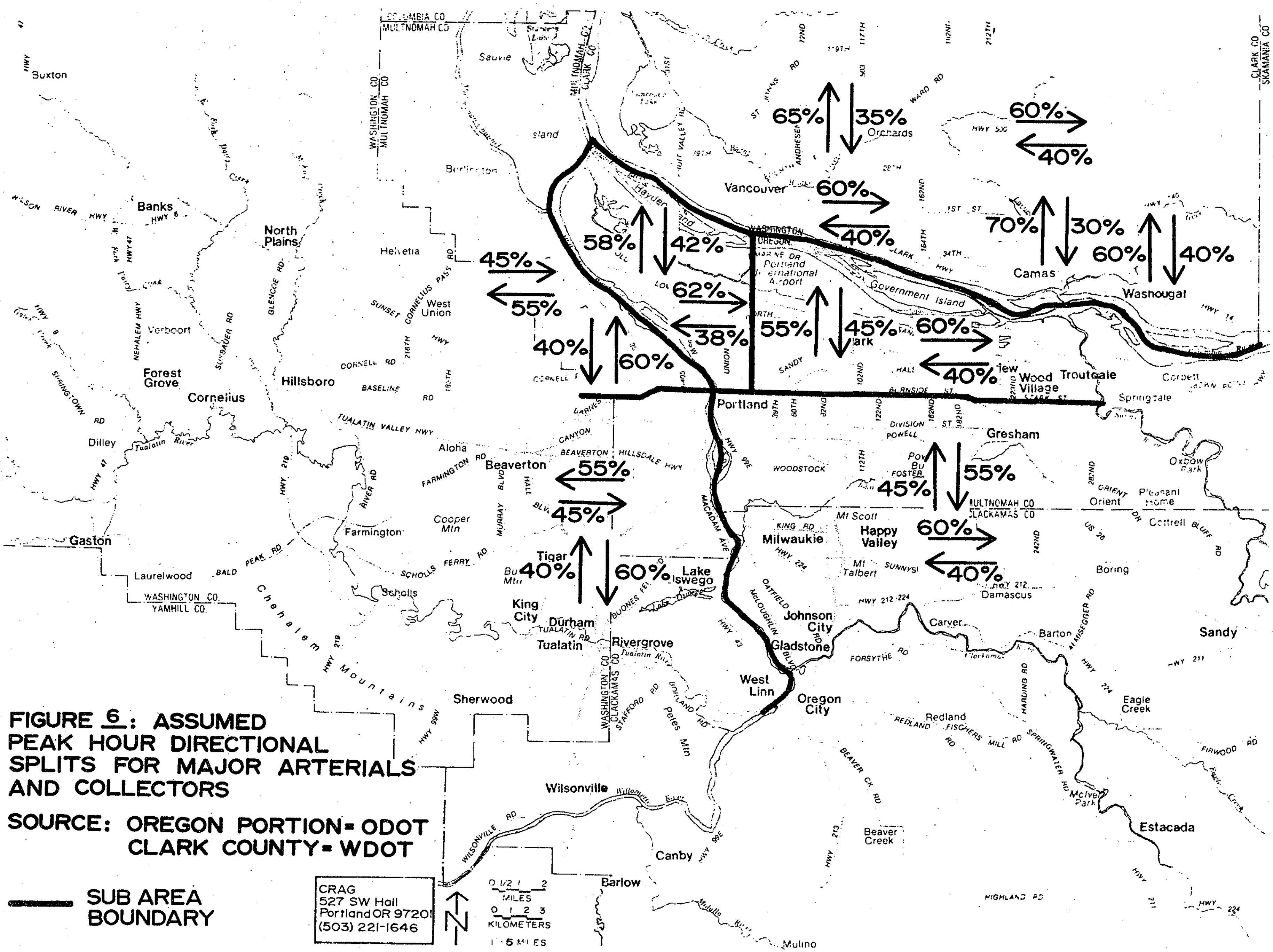

FIGURE 6: ASSUMED PEAK HOUR DIRECTIONAL SPLITS FOR MAJOR ARTERIALS AND COLLECTORS

SOURCE: OREGON PORTION = ODOT
CLARK COUNTY = WDOT

SUB AREA BOUNDARY

values are illustrated in Figure 5 and Figure 6. These factors were applied to the estimated 1977 two-way peak hour volumes to get peak-hour directional volumes.

(b) Lane Distribution - For multi-lane facilities, the lane distribution of peak hour directional volumes was assumed to be uniform.

D. Summary

The relationship between the *Highway Capacity Manual*'s recommended peak hour directional volume procedure and its application on a regional scale is depicted in Figure 7. The most recent traffic counts were obtained from all possible sources. Those counts that were compiled on an Average Weekday Traffic ((AWT) basis were factored to Average Daily Traffic (ADT) levels to conform with the peaking factor baseline. ADT counts were factored into peak hour directional volumes on the basis of the facility type and location of the roadway segment.

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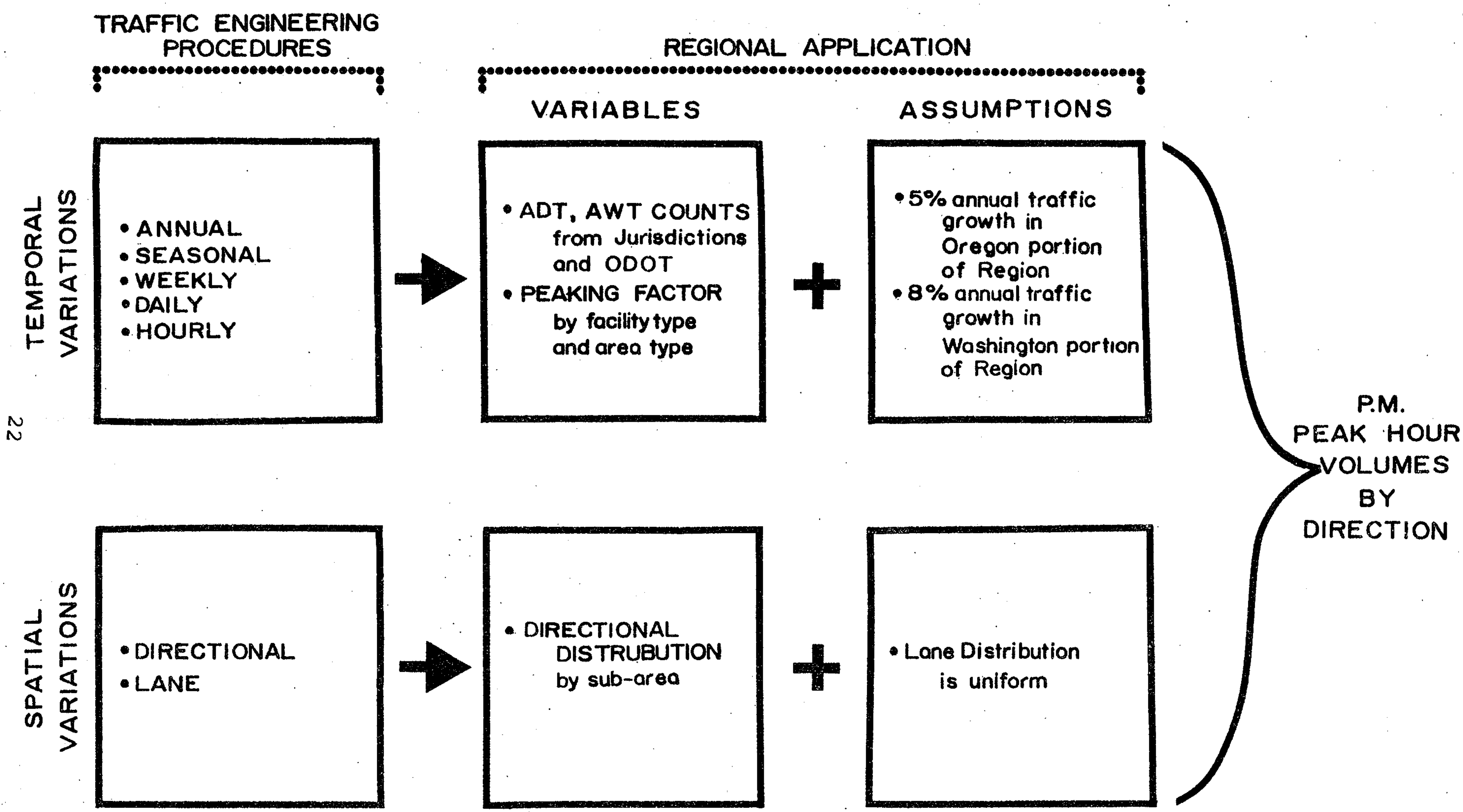
FIGURE 7

CALCULATION OF PEAK-HOUR DIRECTIONAL VOLUMES



IV. DETERMINATION OF PEAK PERIOD DELAYS

A. Overview

No discussion of highway performance would be complete without some consideration of peak period speeds and their relation to off-peak conditions. Much of the users' perspective of highway conditions depends on the speed at which he/she can operate. Speed distributions and averages vary by hours of the day as the result of such influences as driver characteristics, trip purposes, visibility, and volume-capacity relationships. These factors can be grouped into the following classifications:

(a) Ambient Speed Characteristics
(b) Traffic Flow Relationships

B. Ambient Speed Characteristics

1. Traffic Engineering Procedure: There are varying degrees of uninterrupted (continuous) flow. Although there may be congestion, uninterrupted flow implies the absence of traffic signals, stop signs and other traffic control interruptions. At one extreme the movement may be irregular due to traffic frictions such as strip commercial development. At the other extreme, vehicular movement may be quite smooth in the absence of such factors. This suggests that different facilities have different speed-flow relationships depending on the character of the traffic, the weather, the accident record and other factors. The speed-flow relationship is difficult to isolate under interrupted flow conditions. For example, on urban arterials with signalized intersections, maximum speed is frequently determined by external influences such as signal progression, timing and speed limits, rather than driver desires.

2. Regional Application: Off-peak travel time (speed) by area type and location were derived from the CRAG 1977 Speed and Delay Survey. In that study, several different facility types and area types were identified. The survey routes were selected so that each facility type passed through a portion of each area type. Using the data that was collected, it was possible to identify a representative off-peak speed for a given facility type and area type. In this manner, each link was assigned its ambient speed characteristic.

C. Traffic Flow Relationships

1. Traffic Engineering Procedure: The fundamental speed-flow relationship for a given population of drivers can be simply stated as follows: as traffic flow on a road segment increases, the average speed in that road segment decreases.

This relationship holds true throughout the range of free flow and impending congestion, up to the point of critical density at the maximum flow. At this point and beyond, however, it no longer applies; both traffic flow and average speed both decrease with an increase in density. This relationship holds over a reasonably significant length of roadway--it may not hold true across very short sections.

2. Regional Application: Peak period speeds were derived from the speed-flow relationship assumed in the UMTA-UTPS computer package. Speeds on a network link are computed by dividing the travel time required to tranverse the link by its length. This relationship (called the "BPR Model") is defined as follows:

$$T_p = T_{op} + .15 \times T_{op} \times (V/C)^4$$

where:

T_p is the travel time on a link during peak period

T_{op} is the off-peak travel time on the link

V is the peak period volume on the link

C is the practical capacity of the link

The validity of this formula was confirmed by comparing its results to those from the speed and delay survey. While incongruities can exist on a link basis, these can be eliminated by averaging links into road segments.

D. Summary

The relationship between the *Highway Capacity Manual*'s recommended procedure for determining peak-period speed and its regional application is shown in Figure 8. Based on its facility type and location, each link in CRAG's detailed (6000 link) highway network was assigned an off-peak speed from Table 3. Link speeds are available in the link description file. Peak-period speeds were derived from UMTA's UTPS computer package (UROAD subroutine) which employs the BPR model. Because of limitations in the model, link speeds were averaged into road segment speeds to eliminate minor incongruities. For all capacity deficient sections, the difference between peak and off-peak time was calculated. This difference represents the delay-per mile-per vehicle which is caused by the congested condition. This figure was multiplied by the peak-hour volume to determine the vehicle-hours-of-delay per mile.

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FIGURE 8
CALCULATION OF USER DELAY

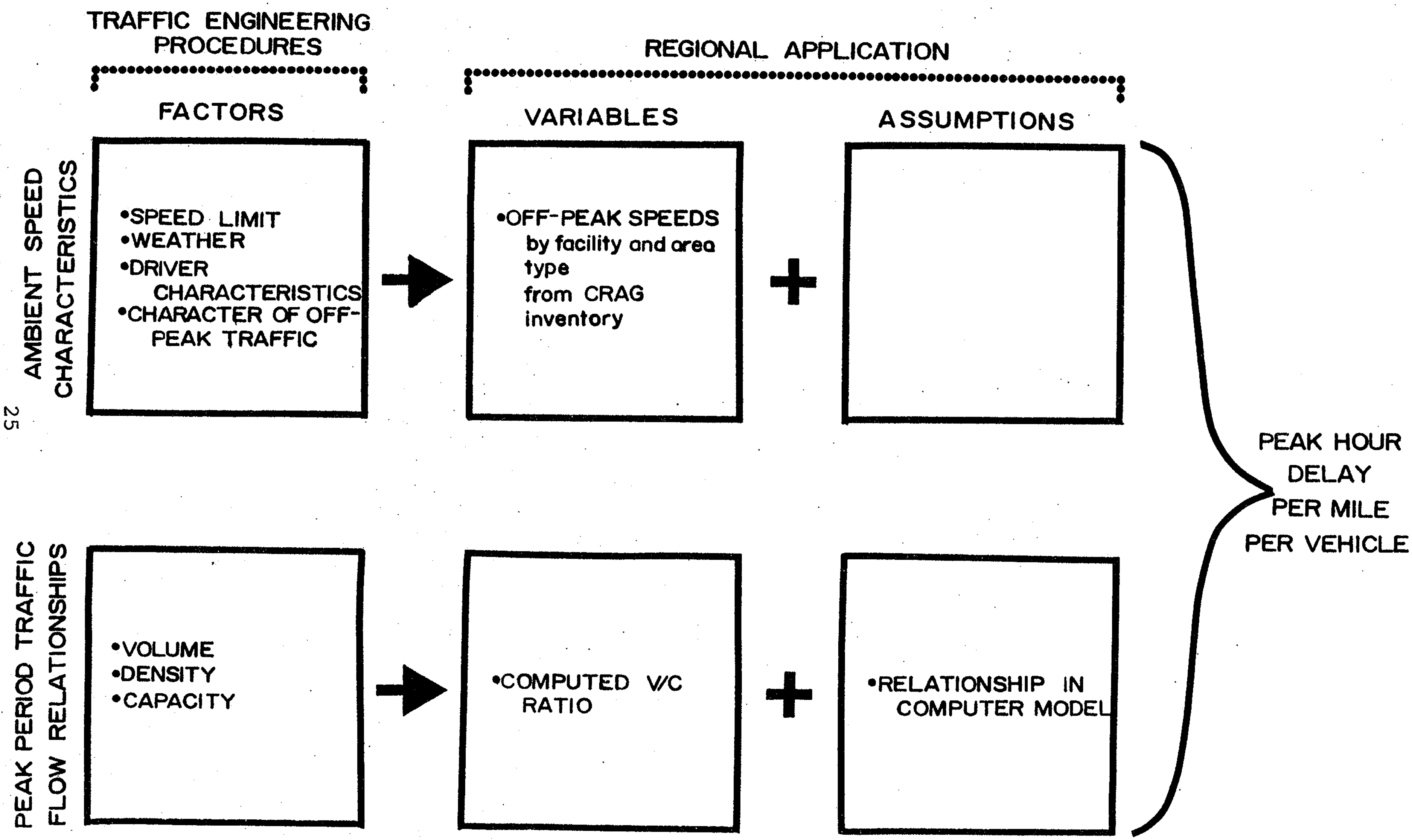

TABLE NO 3: ESTIMATED FREEFLOW SPEEDS (IN MPH) BY FACILITY TYPE, AREA TYPE, AND NUMBER OF LANES

		FACILITY TYPE				
AREA TYPE	# OF LANES	FREEWAY	EXPSWAY	2 WAY w/ PARKING	1 WAY w/ PARKING	2 WAY NO PARKING
CBD	1	30	30	15	12	22
	2	45	40	15	12	25
	3+	50	40	15	12	30
Outer CBD	1	30	30	30	15	22
	2	45	40	20	15	25
	3+	50	40	20	15	30
Fringe	1	30	30	28	30	30
	2	50	45	32	32	34
	3+	50	45	35	35	38
Resi-dental	1	30	30	30	30	32
	2	53	45	32	32	25
	3+	53	50	35	35	40
Rural	1	30	30	30	30	35
	2	56	45	32	32	40
	3	56	50	35	35	45

Source: CRAG, 1977 Speed & Delay Survey

V. RESULTS

A. Background: The Indicators and Their Meaning

The previous three sections have explained the process used to calculate: (a) capacity, (b) peak-hour directional volumes, (c) off-peak-period speeds, and (d) peak period speeds. These factors serve as the basis for the following two performance indicators documented in the results in subsections V.B through V.G:

1. V/C Ratio: represents the relationship of the expected peak hour directional volume to the generalized capacity (defined at level-of-service E) expressed as a fraction. A V/C ratio equal to 1.0 implies that the volume equals the capacity, and, therefore, is indicative of operating conditions similiar to those illustrated for level-of- service E in Figure 1. It is important to note that level-of-service E conditions can occur at lower V/C ratios if operating speeds are significantly reduced by factors other than the speed-volume relationship. In this analysis, a V/C ratio greater than 1.0 is indicative of a capacity deficient road segment. In addition, road segments having V/C ratios between .90 and 1.0 are considered to be approaching capacity deficiency in the near term, given an annual regional traffic growth rate of at least five percent.

   The existence of a high V/C ratio at a given point on the highway network does not necessarily imply that congestion is occurring at that specific point. Congestion at a point on a roadway is governed by the volume-to-capacity relationship of the roadway at:
   1. the point of observation
   2. a point upstream
   3. a point downstream

   When the flow is limited by item 1, traffic will generally be flowing freely at the point of observation, but a backlog may occur on the section immediately upstream. When the flow is limited by item 2, traffic will generally be flowing freely at the point of observation, because it has been metered at the point upstream. When flow is limited by item 3, a backlog will occur on the section under observation.

   Conversely, a low V/C ratio at a given point is not necessarily indicative of the absence of congestion at that point. This problem is particularly acute in areas around major regional intersections and interchanges where turning and weaving movements can cause queuing on the roadway itself. Technically, these cases can be accounted for only by the most detailed traffic engineering procedures. For the analysis in this report, major intersection problem areas were identified by observation and consultation with local jurisdictions.

In the maps and tables contained in the results that follow, capacity deficient roadway segments are referenced by an identifying number and major intersection problems are referenced by an identifying letter.

2. Vehicle Hours of Delay per Mile: is employed as an indicator of the relative degree of impact caused by congestion. It can be viewed as a surrogate measure for increases in the operating and travel time costs and the frustration level perceived by users of the facility. As described in the previous section, this measure is calculated by multiplying the difference between peak and off-peak travel time per mile by the expected volume on the road segment. Thus, roadways which have large delays per individual user but low volumes may not exhibit high total vehicle hours of delay per mile. In the results which follow, the width of the band represents the level of delay per mile at that point. Comparison of overall delay among road segments is possible by examining the delay band width in conjunction with the length of the roadway segment. This process would approximate the following relationship: total delay on a road segment = (vehicle hours of delay per mile) X (miles of delay).

B. Results: Regional Overview

Approximately 267 lane-miles of roadway and 15 major intersections in the CRAG region were identified as being capacity deficient during the PM peak hour period. A map of these deficiencies (Figure 9) indicates that nearly 202 lane-miles (75 percent) are currently capacity deficient and an additional 64 lane-miles are approaching capacity deficiency. A total of approximately 1,006 vehicle hours of delay (Figure 10) occurs on these facilities during an average PM peak hour period.

The Interstate System accounts for only 15.3 percent (41 lane-miles) of the region's capacity deficient roadway, but comprises 47 percent (472 vehicle hours) of the regional delay total.

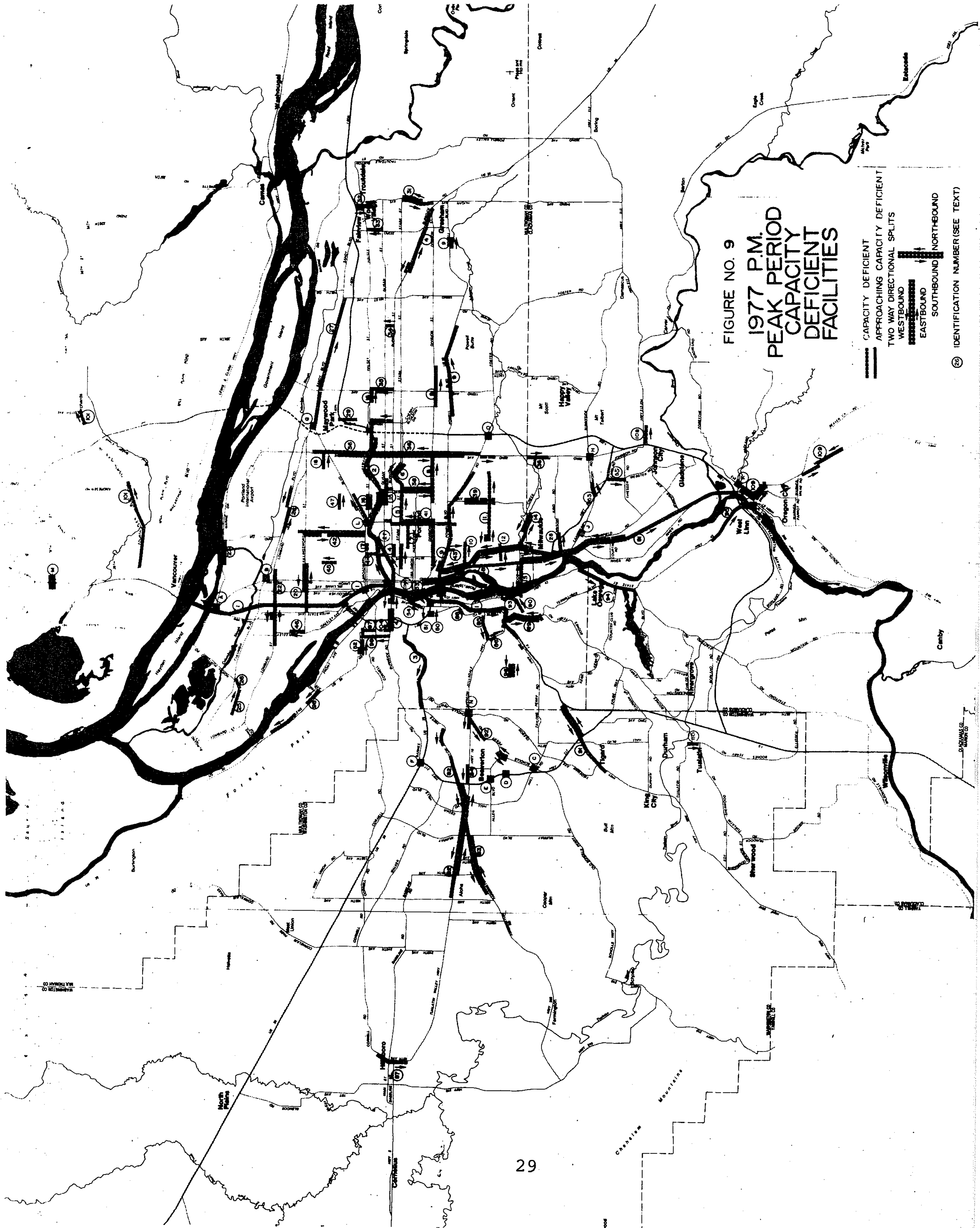
FIGURE NO. 9
1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES
CAPACITY DEFICIENT
APPROACHING CAPACITY DEFICIENT
TWO WAY DIRECTIONAL SPLITS
WESTBOUND
EASTBOUND
SOUTHBOUND
NORTHBOUND
26 IDENTIFICATION NUMBER (SEE TEXT)
Vancouver
Camas
Troutdale
Gresham
Portland International Airport
Milwaukie
Lake Oswego
Gladstone
Oregon City
West Linn
Beaverton
Tigard
Durham
King City
Tualatin
Sherwood
Wilsonville
Canby
Hillsboro
Happy Valley
Forest Park

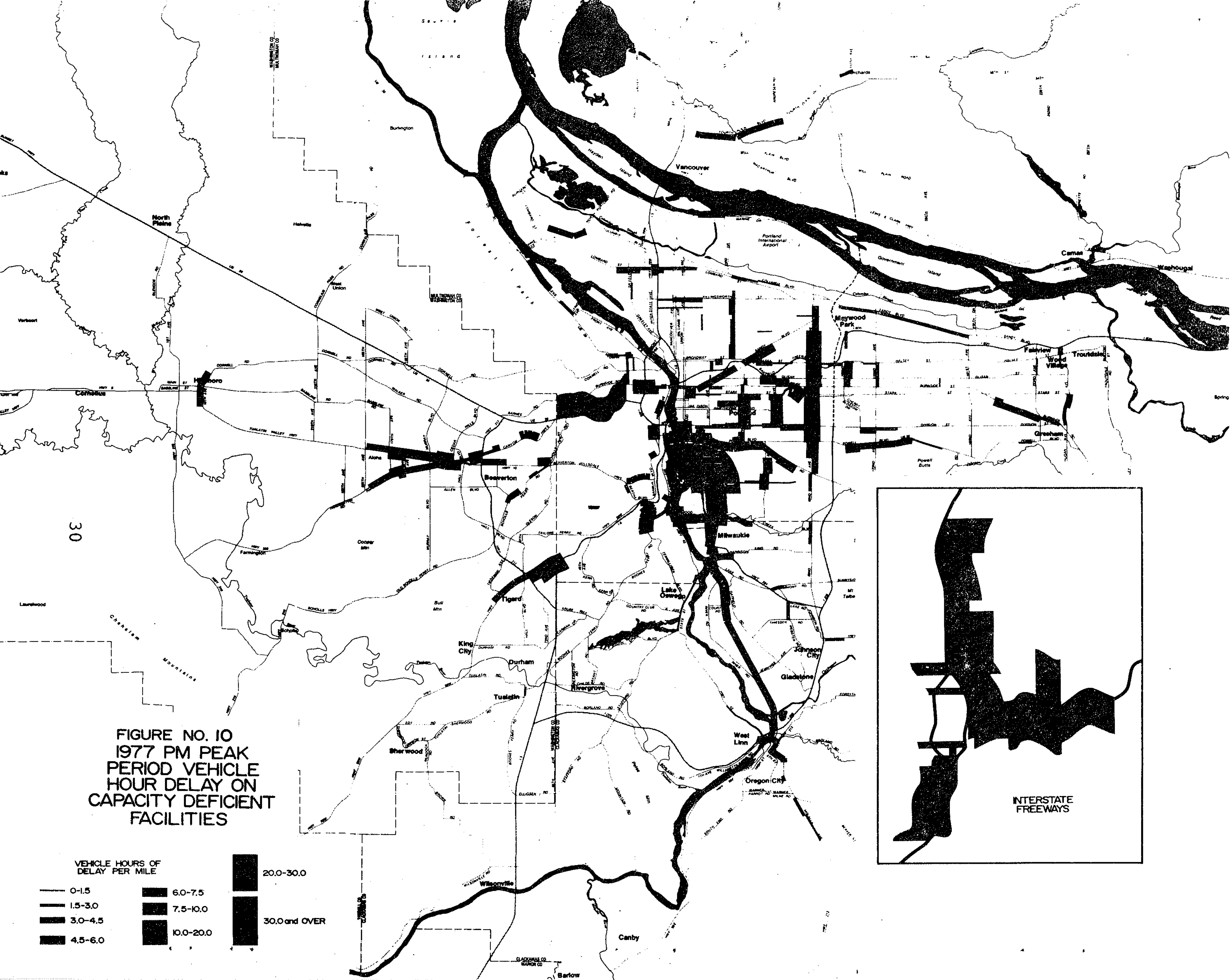

FIGURE NO. 10
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES

CITY of PORTLAND

C. Results: City of Portland

There are an estimated 177 lane-miles of capacity deficient roadway within the City of Portland (Figure 11). This represents 66 percent of the regional total and includes approximately 97 percent (39.5 lane-miles) of the deficiencies identified on the Interstate System. In addition, four significant intersection deficiencies were identified (Table 4).

Over 780 vehicle hours of delay, representing 78 percent of the regional total, occur on City roadways during the PM peak hour period (Figure 12). The Interstate System comprises 60 percent of this delay in contrast to only 22 percent of the City's lane-miles of deficiency.

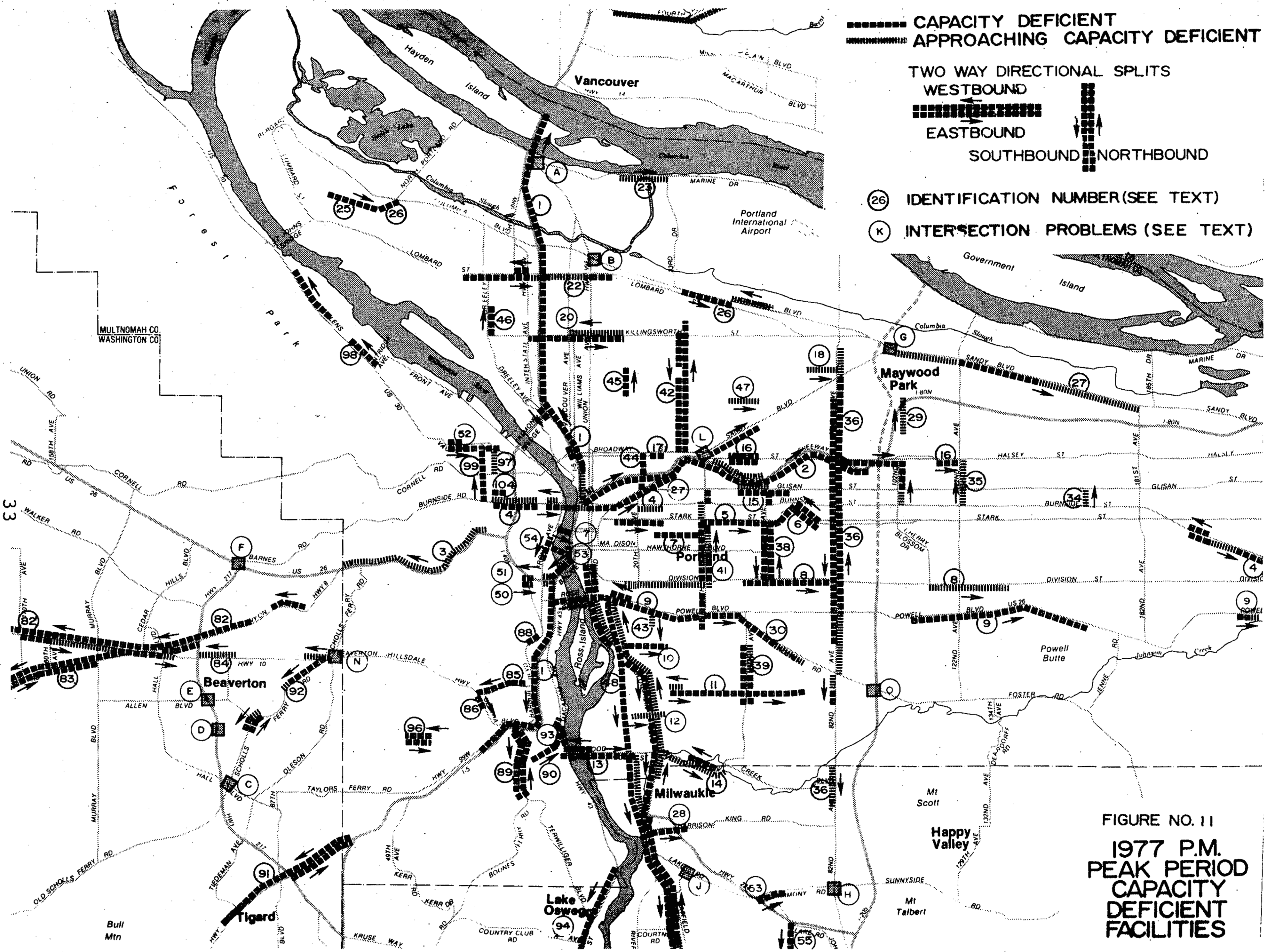

FIGURE NO. 11

1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES

CITY OF PORTLAND

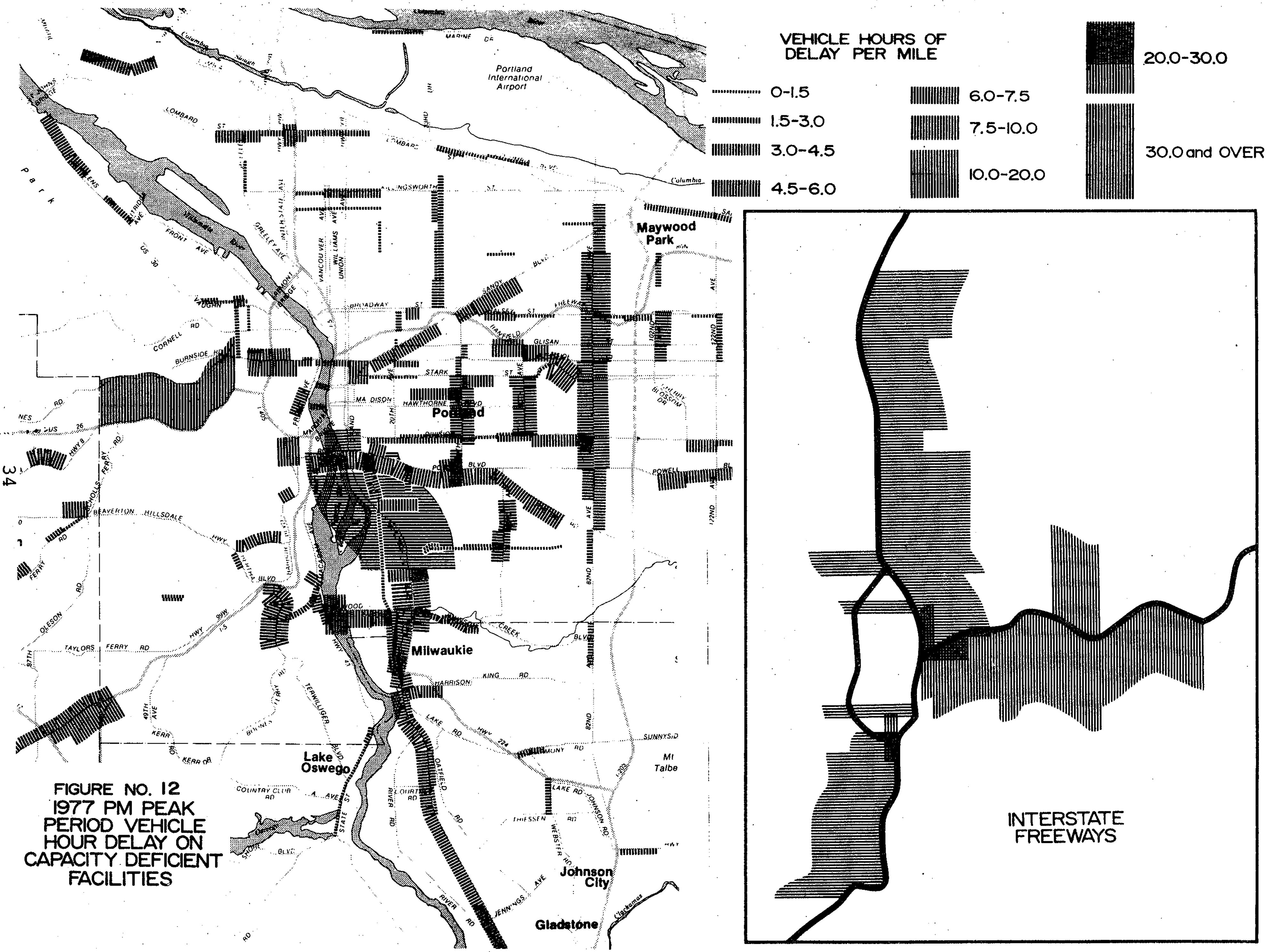

FIGURE NO. 12
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES

CITY OF PORTLAND

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	INTERSTATE					
1	Interstate 5	Burnside Bridge to NE Holladay St.	North	3,458	3,800	1
1	Interstate 5	NE Holladay St. to NE Weidler St.	North	6,035	5,000	1
1	Interstate 5	NE Weidler St. to Fremont entrance	North	6,035	3,800	1
1	Interstate 5	Fremont entrance to Fremont exit	North	5,978	3,800	1
1	Interstate 5	NE Fremont St. to NE Dekum St.	North	6,009	4,740	1
1	Interstate 5	NE Dekum St. to Lombard St.	North	5,147	3,800	1
1	Interstate 5	Lombard St. to 99W entrance	North	4,000	3,570	1
1	Interstate 5	99W entrance to Interstate Bridge	North	5,966	5,000	1
1	Interstate 5	Fremont Br. exit to Fremont Br. entr.	South	3,985	3,800	1
1	Interstate 5	Broadway Br. exit to NE Weidler St.	South	4,023	3,800	1
1	Interstate 5	SE Hawthorne St. to Marquam Bridge	South	4,983	5,120	1
1	Interstate 5	Marquam Bridge	South	5,090	5,120	1
1	Interstate 5	Marquam Br. to I-405 Jct.	South	5,174	3,800	1
1	Interstate 5	Interstate 405 Jct. to Multnomah Blvd.	South	5,473	4,740	1
1	Interstate 5	Stadium Freeway to Marquam Bridge	East	3,696	3,800	1
1	Interstate 5	Marquam Bridge to Stadium Freeway	West	3,696	3,800	1
2	Banfield I-80N	Interstate 5 Ramp to Grand Ave.	East	5,506	3,800	1
2	Banfield I-80N	Grand Ave. to Holladay exit	East	5,506	4,660	1
2	Banfield I-80N	NE Holladay to 33rd Ave.	East	6,180	5,270	1
2	Banfield I-80N	NE 33rd to NE 42nd Ave.	East	5,613	5,270	1
2	Banfield I-80N	NE 42nd to NE 58th Ave.	East	5,065	3,540	1
2	Banfield I-80N	NE 58th to Portland City Limits	East	4,819	3,540	1
2	Banfield I-80N	NE 58th Ave. to 42nd Ave.	West	3,376	3,540	1
2	Banfield I-80N	NE Grand Ave. to Interstate 5	West	3,670	3,800	1

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TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
3	Sunset Hwy. 26	Vista Ridge Tunnel to Canyon Hwy. 8	West	4,855	4,950	1
9	Powell Blvd. Hwy. 26	I-5 to (Ross Island Br.) SE Milwaukie	East	2,356	1,980	1
9	Powell Blvd. Hwy. 26	Milwaukie Ave. to SE 17th St.	East	2,035	1,240	1
9	Powell Blvd. Hwy. 26	SE 17th Ave. to SE 39th Ave.	East	1,772	1,580	1
9	Powell Blvd. Hwy. 26	SE 39th Ave. to SE 45th Ave.	East	1,701	1,580	1
9	Powell Blvd. Hwy. 26	SE 45th Ave. to SE Foster Road	East	1,890	1,580	1
9	Powell Blvd. Hwy. 26	SE 17th Ave. to Milwaukie Ave.	West	1,356	1,240	1
22	N Lombard St.	N Wabash to N Greeley	East	1,406	1,380	1
22	N Lombard St.	N Greeley to N Delaware	East	1,191	1,100	1
22	N Lombard St.	N Delaware to N Denver	East	1,296	1,100	1
22	N Lombard St.	N Denver to N Interstate	East	1,823	1,270	1
22	N Lombard St.	N Interstate Ave. to I-5	East	1,367	1,380	1
22	N Lombard St.	I-5 to N Albina St.	East	1,335	1,100	1
22	N Lombard St.	N Albina to NE Union	East	1,050	1,100	1
22	N Lombard St.	NE Union to NE 11th Ave.	East	1,191	1,100	1
26	N Columbia Blvd. (Hwy. 30 By)	N Gilbert Ave. to N Olympia St.	East	628	550	2
26	NE Columbia Blvd. (Hwy. 30 By)	NE 33rd Ave. to NE 47th Ave.	East	693	440	1
26	NE Columbia Blvd. (Hwy. 30 By)	NE 60th Ave. to NE 47th Ave.	West	424	440	1

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TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
27	Sandy Blvd. (Hwy 30)	E Burnside St. to NE 20th	East	1,344	1,240	2
27	Sandy Blvd. (Hwy 30)	NE 20th to NE 28th	East	1,285	1,240	1
27	Sandy Blvd. (Hwy 30)	NE 38th to NE 42nd	East	1,512	1,100	1
27	Sandy Blvd. (Hwy 30)	NE 42nd to NE 57th	East	1,273	1,240	1
36	82nd (Hwy. 213)	SE Foster Rd. to SE Powell Blvd.	North	1,289	1,350	1
36	82nd (Hwy. 213)	SE Powell Blvd. to SE Washington St.	North	1,549	1,210	1
36	82nd (Hwy. 213)	SE Washington St. to E Burnside St.	North	1,413	1,380	1
36	82nd (Hwy. 213)	E Burnside St. to NE Fremont St.	North	1,602	1,240	1
36	82nd (Hwy. 213)	NE Fremont St. to NE Sandy Blvd.	North	1,201	1,100	1
36	82nd (Hwy. 213)	NE Sandy Blvd. to NE Alberta St.	North	1,145	1,180	1
36	82nd (Hwy. 213)	NE Fremont St. to E Burnside St.	South	1,311	1,240	1
36	82nd (Hwy. 213)	E Burnside St. to SE Washington St.	South	1,726	1,380	1
36	82nd (Hwy. 213)	SE Washington St. to SE Powell Blvd.	South	1,894	1,400	1
36	82nd (Hwy. 213)	SE Powell Blvd. to SE Holgate Blvd.	South	1,709	1,430	1
36	82nd (Hwy. 213)	SE Foster Rd. to SE Woodstock Ave.	South	1,134	1,430	1
36	82nd (Hwy. 213)	SE Woodstock Ave. to SE Duke Ave.	South	1,369	1,380	1
36	82nd (Hwy. 213)	SE Cornwall Ave. to SE Otty Rd.	South	1,195	1,240	1
81	McLoughlin Blvd. (Hwy. 99E)	SE Ochoco St. to SE Powell Blvd.	North	2,004	2,130	1
81	McLoughlin Blvd. (Hwy. 99E)	SE Powell Blvd. to NE Union Ave.	North	2,032	1,870	1
81	McLoughlin Blvd. (Hwy. 99E)	NE Union Ave. to SE Powell Blvd.	South	2,483	1,870	1
81	McLoughlin Blvd. (Hwy. 99E)	SE Powell Blvd to SE 17th	South	2,769	2,390	1

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TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
81	McLoughlin Blvd. (Hwy. 99E)	SE 17th to SE 19th	South	2,281	2,040	1
81	McLoughlin Blvd. (Hwy. 99E)	SE 19th to SE Ochoco	South	2,299	1,410	1
85	Beaverton-Hills-dale-Hwy. 10	SW Terwilliger to SW Capitol Hwy.	West	1,290	1,240	1
88	Barbur Blvd. (Hwy 99W)	SW Hamilton St. to SW Seymour St.	South	1,953	1,870	1
93	Macadam Ave. (Hwy. 43)	SW Terwilliger Blvd. to Sellwood Br.	South		*	
94	Macadam Ave. (Hwy. 43)	SW Greenwood Rd. to Clackamas Cty. Line	South	1,008	1,580	1
98	St. Helens Rd. (Hwy. 30)	NW 63rd Ave. to S St. Johns Br. Ramp	North	1,297	1,100	1
98	St. Helens Rd. (Hwy. 30)	NW Kittridge Ave. to NW Dodge Ave.	North	1,184	1,100	1
	ARTERIALS					
4	W Burnside St.	W 21st to W 18th	East	1,164	1,100	2
4	W Burnside St.	W 18th to W 14th	East	1,221	1,100	2
4	W Burnside St.	W 14th to Park	East	1,342	1,230	2
4	W Burnside St.	NE Broadway to NW 4th	East	1,749	1,600	2
4	W Burnside St.	NW 4th to NW 3rd	East	1,919	1,600	2
4	W Burnside St.	NW 3rd to NW 2nd	East	1,919	1,870	2
4	W to E Burnside St.	NW 2nd to NE Grand	East	1,919	1,910	2

* Backlogged Area

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TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
4	E Burnside St.	NE Grand to Sandy Blvd.	East	1,919	1,280	2
4	E Burnside St.	SE 28th to SE 20th	East	999	1,100	2
4	W Burnside St.	NW 3rd to NW 5th	West	1,501	1,630	2
4	W Burnside St.	Park to SW 21st	West	1,015	1,166	2
5	Stark St.	SE 12th to SE 28th	East	559	590	2
5	Stark St.	SE 39th to SE 49th	East	592	590	2
5	Stark St.	SE 49th to SE 60th	East	559	590	2
5	Stark St.	SE 60th to SE 64th and Thorburn	East	578	440	2
5	Stark St.	SE 64th to SE Gilham Ave.	East	463	440	2
6	Thorburn St.	SE Gilham Ave. to SE 76th	East	1,083	880	2
6	Thorburn St.	SE 76th to SE Gilham Ave.	West	719	440	2
7	Belmont St.	Morrison Bridge	East	2,044	2,200	2
7	Belmont St.	SE 25th to SE 30th	East	852	660	2
7	Belmont St.	SE 30th to SE 39th	East	664	660	2
8	Division St.	SE 12th to SE 39th	East	719	590	2
8	Division St.	SE 50th to SE 60th	East	875	590	2
8	Division St.	SE 60th to SE 76th	East	1,390	1,430	2
8	Division St.	SE 76th to SE 82nd	East	1,360	1,430	2
10	Holgate	Milwaukie Ave. (Hwy 99E) to SE 17th	East	1,004	1,100	2
10	Holgate	SE 17th Ave. to SE 28th Ave.	East	1,203	1,100	2
11	Woodstock	SE 28th Ave. to SE 32nd Ave.	East	706	660	2
11	Woodstock	SE 32nd Ave. to SE 39th Ave.	East	562	510	2
11	Woodstock	SE 39th Ave. to SE 47th Ave.	East	866	660	2

SS:gh:02
S/308/5

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
11	Woodstock	SE 47th Ave. to SE 52nd Ave.	East	817	660	2
11	Woodstock	SE 52nd Ave. to SE 72nd Ave.	East	550	550	2
11	Woodstock	SE 32nd Ave. to SE 28th Ave.	West	471	500	2
12	Bybee Blvd.	SE 17th Ave. to SE Tolman St.	East	767	840	2
13	Tacoma St.	Sellwood Bridge	East	1,464	990	2
13	Tacoma St.	Sellwood Bridge to SE 13th Ave.	East	1,093	990	2
13	Tacoma St.	SE 13th Ave. to SE 17th Ave.	East	1,037	1,100	2
13	Tacoma St.	Sellwood Bridge	West	976	990	2
14	Johnson Creek Blvd.	McLoughlin Blvd. to Brookside Dr.	East	658	750	2
14	Johnson Creek Blvd.	SE 42nd Ave. to SE 32nd Ave.	West	433	400	2
15	Glisan St.	NE 49th Ave. to NE 60th Ave.	East	1,449	1,100	2
15	Glisan St.	NE 60th Ave. to NE 67th Ave.	East	1,194	1,100	2
15	Glisan St.	NE 60th Ave. to NE 49th Ave.	West	965	1,100	2
16	Halsey St.	NE 47th Ave. to NE 57th Ave.	East	893	590	2
16	Halsey St.	I-80N Overpass	East	1,384	880	2
16	Halsey St.	I-80N to NE 92nd Ave.	East	1,160	660	2
16	Halsey St.	NE 92nd Ave. to NE 102nd Ave.	East	1,412	1,200	2
16	Halsey St.	NE 113th Ave. to NE 118th Ave.	East	1,821	1,580	1
16	Halsey St.	NE 118th Ave. to NE 122nd Ave.	East	1,670	1,580	1
16	Halsey St.	NE 57th Ave. to NE 47th Ave.	West	595	590	2

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S/308/6

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
17	Broadway St.	NE 24th Ave. to NE 28th Ave.	East	1,114	1,100	2
18	Prescott St.	NE 72nd Ave. to NE 82nd Ave.	East	528	590	2
20	N Killingsworth St.	Interstate 5 to Vancouver Ave.	East	680	590	2
20	N Killingsworth St.	Vancouver to NE 15th Ave.	East	850	590	2
20	N Killingsworth St.	NE 15th Ave. to Vancouver Ave.	West	521	590	2
23	NE Marine Dr.	NE Gertz Rd. to NE 33rd Ave.	East	777	880	2
25	N Fessenden	N Oswego Ave. to N Gilbert Ave.	East	593	550	2
30	Foster Rd.	SE Powell Blvd. to SE 52nd	East	1,332	1,100	2
30	Foster Rd.	SE 52nd to SE Holgate	East	1,145	1,100	2
30	Foster Rd.	SE Holgate Blvd. to SE 72nd	East	1,230	1,380	2
38	60th Ave.	SE Division St. to SE Belmont St.	North	579	530	2
38	60th Ave.	SE Belmont St. to SE Stark St.	North	483	530	2
38	60th Ave.	E Burnside St. to NE Glisan St.	North	599	660	2
38	60th Ave.	SE Stark St. to SE Belmont St.	South	591	530	2
38	60th Ave.	SE Belmont St. to SE Division St.	South	709	530	2
39	52nd Ave.	SE Duke St. to SE Harold St.	North	598	530	2
39	52nd Ave.	SE Harold St. to SE Holgate Blvd.	North	602	660	2

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S/308/7

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
39	52nd Ave.	SE Holgate Blvd. to SE Harold St.	South	736	590	2
39	52nd Ave.	SE Harold St. to SE Duke St.	South	731	530	2
41	39th Ave.	SE Clinton St. to SE Division St.	North	971	1,100	2
41	39th Ave.	SE Division St. to SE Hawthorne Blvd.	North	1,125	1,100	2
41	39th Ave.	SE Hawthorne Blvd. to SE Belmont St.	North	1,125	1,270	2
41	39th Ave.	SE Belmont St. to SE Stark St.	North	1,121	1,100	2
41	39th Ave.	E Burnside St. to NE Glisan St.	North	1,108	1,100	2
41	39th Ave.	E Burnside St. to SE Stark St.	South	1,271	1,380	2
41	39th Ave.	SE Stark St. to SE Hawthorne Blvd.	South	1,373	1,100	2
41	39th Ave.	SE Hawthorne Blvd. to SE Division St.	South	1,375	1,100	2
41	39th Ave.	SE Woodward St. to SE Gladstone St.	South	1,136	1,100	2
42	33rd Ave.	NE Broadway to NE Knott St.	North	1,066	680	2
42	33rd Ave.	NE Knott St. to NE Mason St.	North	795	590	2
42	33rd Ave.	NE Mason St. to NE Killingsworth St.	North	748	590	2
42	33rd Ave.	NE Killingsworth to NE Ainsworth St.	North	571	590	2
42	33rd Ave.	NE Killingsworth to NE Prescott St.	South	607	590	2
42	33rd Ave.	NE Mason St. to NE Knott St.	South	651	590	2
42	33rd Ave.	NE Knott St. to NE Broadway	South	872	590	2
43	26th Ave.	SE Powell Blvd. to SE Gladstone St.	South	435	500	2
44	20th Ave.	NE Sandy Blvd. to NE Irving St.	North	526	500	2
44	20th Ave.	I-80N to NE Weidler St.	North	767	650	2
45	15th Ave.	NE Fremont St. to NE Prescott St.	North	409	440	2
46	Greeley Ave.	N Killingsworth to N Ainsworth	North	649	660	2
46	Greeley Ave.	N Ainsworth to N Portland Blvd.	North	629	660	2

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S/308/8

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
47	NE Fremont St.	NE 42nd Ave. to NE 47th Ave.	East	543	650	2
48	Milwaukie Ave.	SE Holgate Blvd. to SE Powell Blvd.	North	589	660	2
48	17th Ave.	SE Ochoco St. to SE Tacoma St.	North	612	680	2
48	Milwaukie Ave.	SE Powell Blvd. to SE Holgate Blvd.	South	720	760	2
48	Milwaukie Ave.	SE Holgate Blvd. to SE Bybee Blvd.	South	630	660	2
48	Milwaukie Ave.	SE Bybee Blvd. to SE Tacoma St.	South	618	540	2
48	17th Ave.	SE Tacoma St to SE Ochoco St.	South	748	680	2
50	Sheridan St.	SW 5th to SW 4th	East	2,052	1,380	2
50	Sheridan St.	SW 4th to SW 3rd	East	1,305	1,380	2
51	Carruthers	SW 3rd to SW 4th	West	1,417	1,650	2
51	Carruthers	SW 5th to SW 6th	West	1,422	1,650	2
52	NW Vaughn St.	SW 29th to SW 27th	East	805	440	2
52	NW Vaughn St.	SW 27th to SW 23rd	East	755	660	2
52	NW Vaughn St.	SW 23rd to SW 21st	East	643	660	2
52	NW Vaughn St.	SW 27th to SW 29th	West	785	500	2
53	Hawthorne Blvd.	Hawthorne Bridge	East	1,620	1,530	2
54	Front Ave.	SW Salmon St. to SW Market St.	South	1,638	1,540	1
86	Bertha Blvd.	SW Vermont St. to SW Capitol Hwy.	South	460	400	2
89	Terwilliger Blvd.	SW Boones Ferry Rd. to SW Canby St.	North	753	670	2
89	Terwilliger Blvd.	SW Canby St. to SW Barbur Blvd.	North	822	700	2

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S/308/9

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
89	Terwilliger Blvd.	SW Barbur Blvd. to SW Canby St.	South	1,205	1,020	2
89	Terwilliger Blvd.	SW Canby St. to SW Boones Ferry Rd.	South	1,112	610	2
90	Taylors Ferry Rd.	SW Boones Ferry Rd. to SW Macadam Ave.	East	653	400	2
90	Taylors Ferry Rd.	SW Macadam Ave. to SW Corbett St.	West	799	400	2
96	SW Multnomah Blvd.	SW 45th Ave. to SW Capitol Hwy.	East	555	590	2
96	SW Multnomah Blvd.	SW Capitol Hwy. to SW 45th Ave.	West	658	500	2
97	NW 21st Ave.	NW Thurman to NW Lovejoy St.	North	537	330	2
99	NW 23rd Ave.	W Burnside to NW Thurman	North	567	590	2
99	NW 23rd Ave.	NW Thurman to NW Vaughn	North	560	440	2

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S/308/10

TABLE 4 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN THE CITY OF PORTLAND (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	MAJOR INTER-SECTIONS AND INTERCHANGES					
A	Intersection	NE Union Ave. (Hwy 99E) and I-5	The generalized facility capacity is significantly reduced by the merging and weaving manuevers at the interchange. Cueing is experienced on Union, interruptions occur on I-5.			1b
B	Intersection	NE Union Ave. (Hwy 99E) and Columbia Blvd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Columbia Blvd. on to Union Ave.			1b
L	Intersection	NE Sandy Blvd. (Hwy 30) and NE 39th Ave.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Sandy Blvd. to 39th St.			2b
O	Intersection	SE Foster Rd. and SE 92nd Ave.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from SE Foster Rd. to SE 92nd.			1b

SS:gh:02
S/308/11

EAST MULTNOMAH COUNTY

D. Results: East Multnomah County

There are approximately 25.6 lane-miles of capacity deficient roadway in Multnomah County outside the Portland city limits (Figure 13)*. This represents 9.6 percent of the regional total and includes the remainder (1.5 lane-miles) of the Interstate System deficiency. Slightly over 99 vehicle hours of delay (9.9 percent of the region's total) are experienced on Multnomah County roadways during the PM Peak hour period (Figure 14). There was one major intersection deficiency identified in Multnomah County (Table 5). The Interstate System accounts for 5.8 percent of the County's lane-miles of capacity deficiency, but 34 percent (34 vehicle hours) of the County's total vehicle hours of delay.

*To maintain continuity in the tables, some portions of Mutlnomah County outside the city limits are included in the city of Portland maps (Figures 11 and 12)

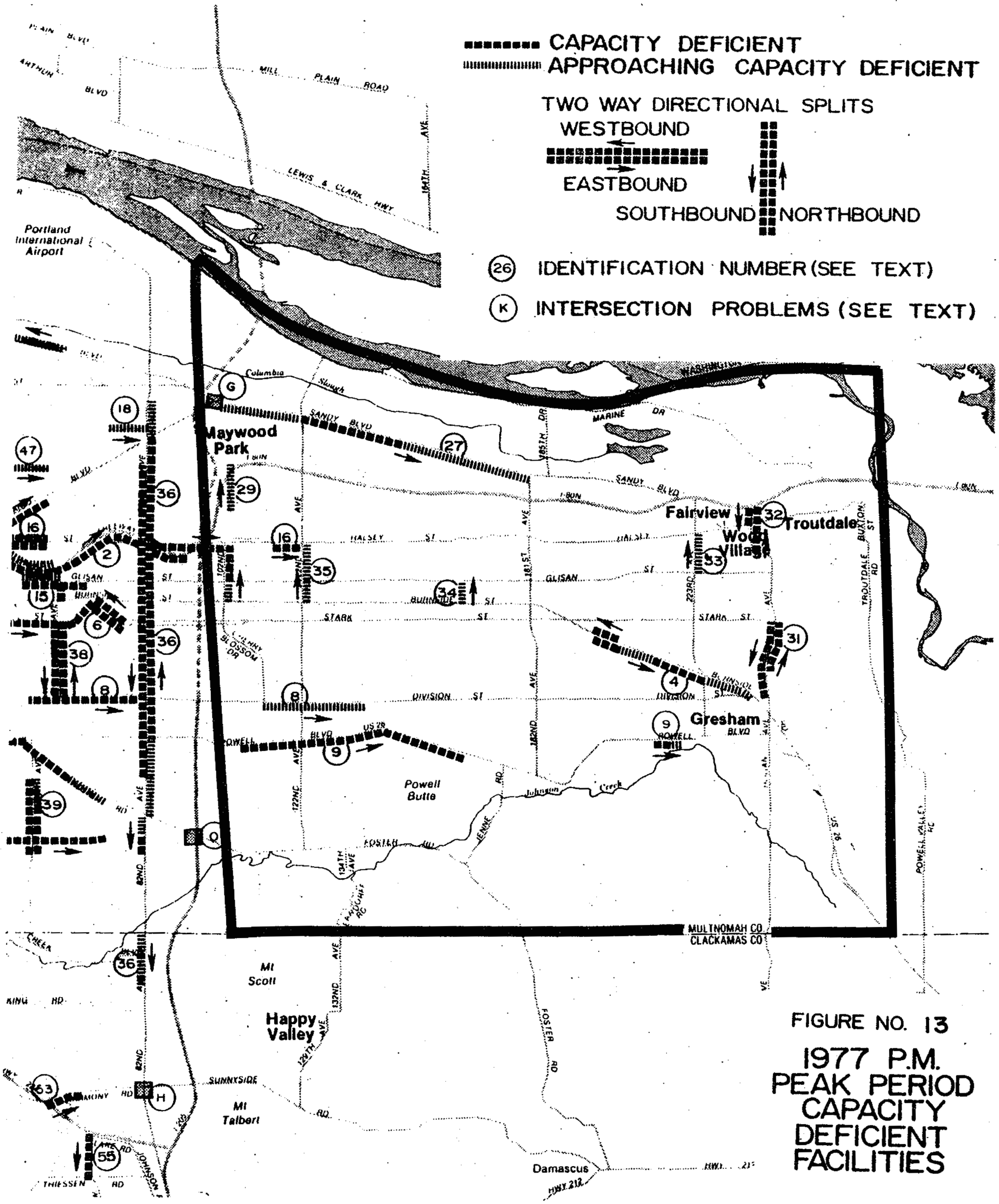

FIGURE NO. 13

1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES

EAST MULTNOMAH CO.

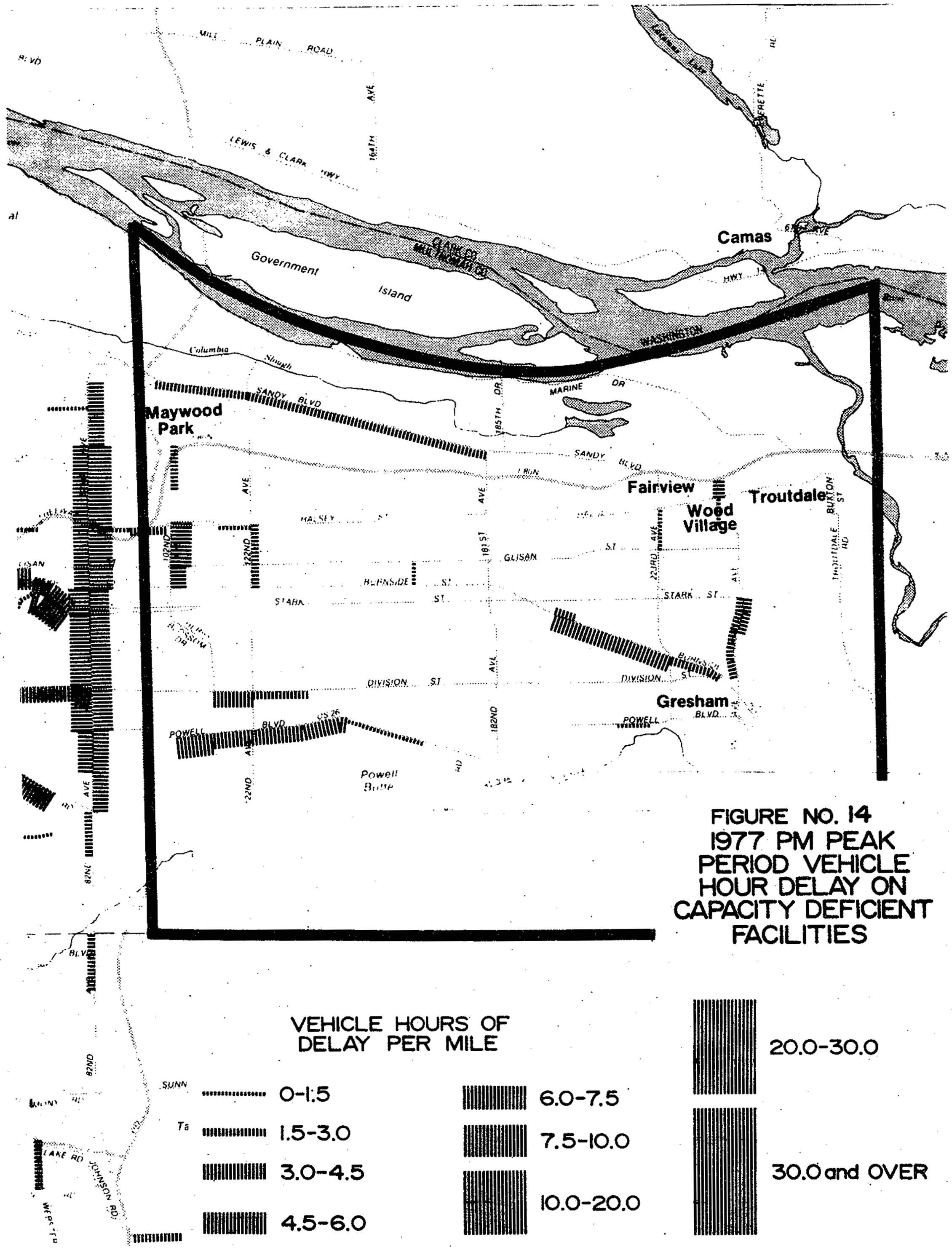

FIGURE NO. 14
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES

EAST MULTNOMAH CO.

TABLE 5 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN MULTNOMAH COUNTY

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
3	Sunset Hwy. 26	Vista Ridge Tunnel to Canyon Hwy. 8	West	4,855	4,950	1
9	Powell Blvd. (Hwy. 26)	SE 104th Ave. to SE 112th Ave.	East	730	660	1
9	Powell Blvd. (Hwy. 26)	SE 112th Ave. to SE 119th Ave.	East	781	660	1
9	Powell Blvd. (Hwy. 26)	SE 119th Ave. to SE 122nd Ave.	East	725	660	1
9	Powell Blvd. (Hwy. 26)	SE 122nd Ave. to SE 136th Ave.	East	832	660	1
9	Powell Blvd. (Hwy. 26)	SE 136th Ave. to SE 144th Ave.	East	754	660	1
9	Powell Blvd. (Hwy. 26)	SE 144th Ave. to SE 145th Ave.	East	731	660	1
9	Powell Blvd. (Hwy. 26)	SE 145th Ave. to SE 164th Ave.	East	693	660	1
9	Powell Blvd. (Hwy. 26)	NW Wallula Ave. to NW Wilson Ave.	East	712	660	4
9	Powell Blvd. (Hwy. 26)	NW Wilson Ave. to NW Ava Ave.	East	643	660	4
27	Sandy Blvd. (Hwy. 30)	NE 99th to NE 122nd Ave.	East	1,197	1,230	1
27	Sandy Blvd. (Hwy. 30)	NE 122nd Ave. to NE 147th Ave.	East	1,058	970	1
27	Sandy Blvd. (Hwy. 30)	NE 147th Ave. to NE 181st Ave.	East	740	740	1
91	Barbur Blvd. (Hwy. 99W)	Clackamas County Line to I-5	East	1,559	1,380	1
91	Barbur Blvd. (Hwy. 99W)	I-5 to Clackamas County Line	West	1,906	1,380	1

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S/308/13

TABLE 5 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN MULTNOMAH COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
4	E Burnside	SE Yamhill to SE 202nd (Gresham)	East	1,008	880	1
4	E Burnside	SE 202nd to 212th	East	838	880	1
4	E Burnside	SE 212th to Main St.	East	907	760	1
4	E Burnside	Main St. to Division St.	East	724	760	1
4	E Burnside	SE 202nd to Yamhill (Gresham)	West	672	660	1
8	Division St.	SE 112th Ave. to SE 122nd Ave.	East	1,802	1,580	1
8	Division St.	SE 122nd Ave. to SE 139th Ave.	East	1,508	1,580	1
16	Halsey St.	NE 92nd Ave. to NE 102nd Ave.	East	1,412	1,390	2
16	Halsey St.	NE 113th Ave. to NE 118th Ave.	East	1,821	1,580	1
16	Halsey St.	NE 118th Ave. to NE 122nd Ave.	East	1,670	1,580	1
29	102nd Ave.	E Burnside St. to NE Glisan St.	North	1,375	1,430	1
29	102nd Ave.	NE Glisan St. to NE Weidler St.	North	1,386	1,380	1
29	102nd Ave.	NE Sacramento St. to NE Fremont St.	North	1,311	1,400	1
31	242nd Ave.	NE 18th ST. to SE Stark St. (Gresham)	North	849	760	1
31	242nd Ave.	SE Stark St. to 18th Ave.	South	695	660	1
31	242nd Ave.	NE 18th to NE Division (Gresham)	South	682	730	1
32	238th Ave.	NE Shannon St. to NE Halsey St.	North	520	500	1
32	238th Ave.	NE Halsey St. to I-80N	North	599	500	4
32	238th Ave.	I-80N to NE Halsey St.	South	542	500	4
33	223rd Ave.	NE Glisan St. to NE Halsey St.	North	471	500	1
34	162nd Ave.	E Burnside St. to NE Glisan St.	North	502	530	1
35	122nd Ave.	E Burnside St. to NE Halsey St.	North	1,526	1,580	1

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S/308/14

TABLE 5 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN MULTNOMAH COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	MAJOR INTER-SECTIONS AND INTERCHANGES					
G	Intersection	NE Sandy Blvd. (Hwy. 30) and NE Columbia Blvd. (Hwy. 30 Bypass)	The generalized facility capacity is significantly reduced by the at grade intersection with signal control Significant traffic interruption and cueing results from turning movements on to Sandy Blvd. from Columbia Blvd.			1b

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S/308/15

CLACKAMAS COUNTY

E. Results: Clackamas County

There are approximately 34 lane-miles of capacity deficient roadway located in Clackamas County (Figure 15). This represents 12.8 percent of the regional total. Three major routes, Highway 99E (17.3 lane-miles), Highway 213 (6.9 lane-miles) and Highway 43 (5.1 lane-miles) account for roughly 86 percent of the deficient roadway in the County. Four major intersection deficiencies were also identified (Table 6). Roughly 54 vehicle hours of delay are experienced on capacity deficient Clackamas County facilities in the PM peak hour period (Figure 16). This represents 5.4 percent of the regional total, and occurs primarily on the same three roadways previously mentioned.

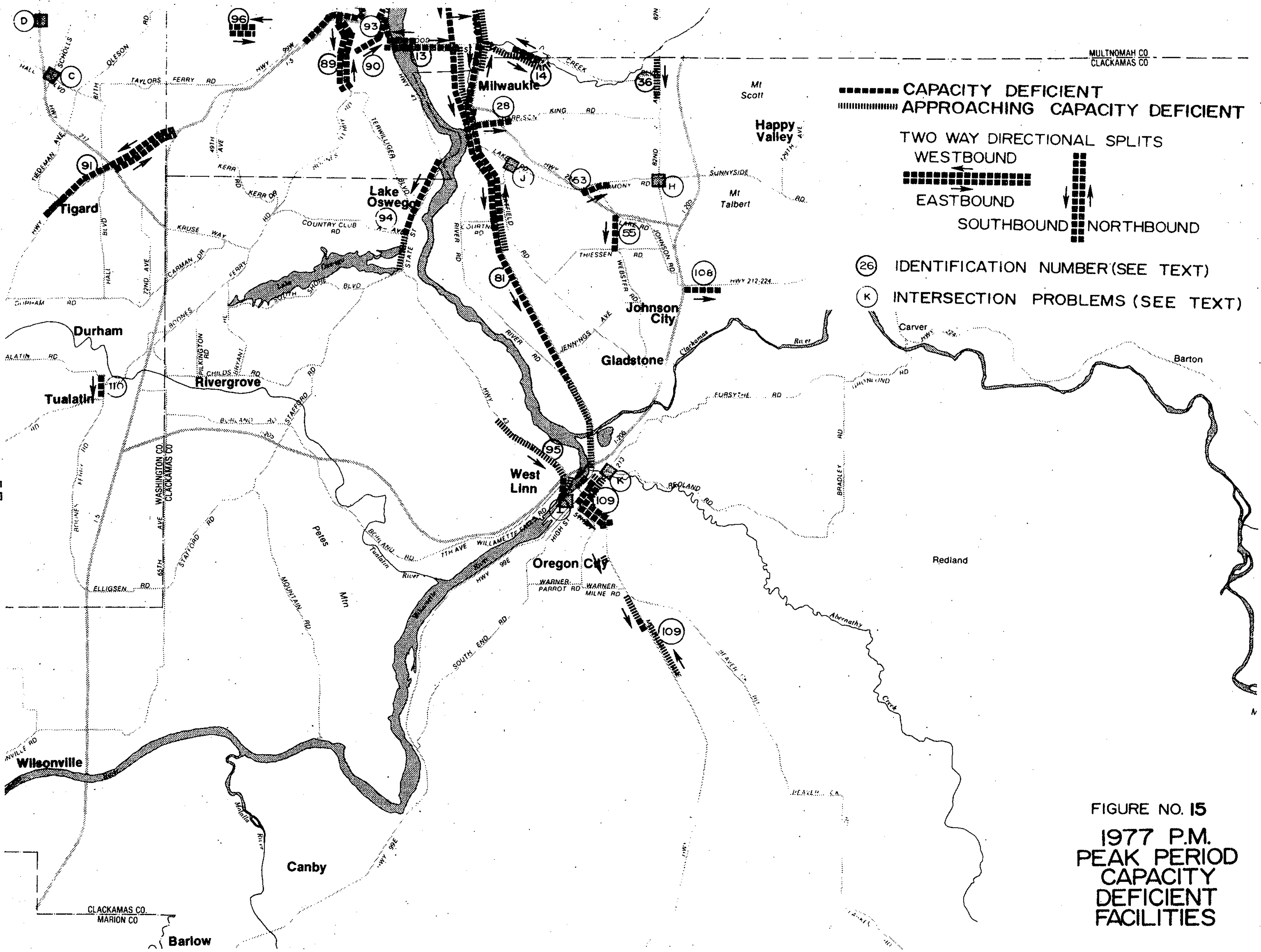
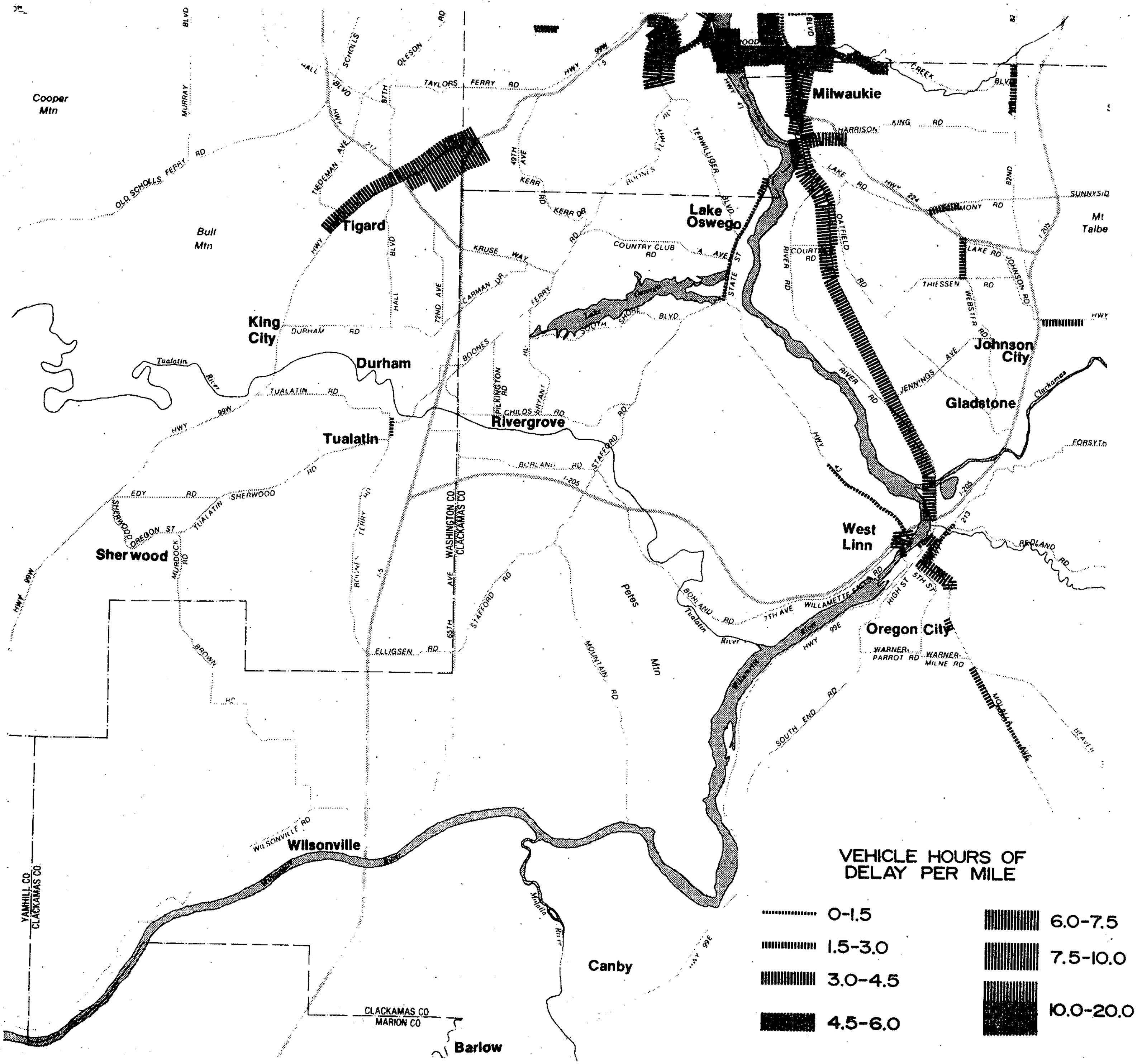


FIGURE NO. 15

1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES

CLACKAMAS CO.

FIGURE NO. 16
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES



VEHICLE HOURS OF DELAY PER MILE

0-1.5	6.0-7.5
1.5-3.0	7.5-10.0
3.0-4.5	10.0-20.0
4.5-6.0	20.0-30.0
	30.0 and OVER

CLACKAMAS CO.

TABLE 6 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLACKAMAS COUNTY

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
36	82nd Ave. (Hwy. 213)	Clackamas County Line to Otty Rd.	South	1,199	1,240	1
81	McLoughlin Blvd. (Hwy. 99E)	Concord Rd. to Courtney Ave.	North	1,371	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	Courtney Ave. to Harrison Ave.	North	1,543	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	Harrison Ave. to Hwy. 224	North	1,578	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	SE Ochoco St. to Clackamas Co. Line	North	2,281	1,980	1
81	McLoughlin Blvd. (Hwy. 99E)	Ochoco St. to Hwy. 224	South	1,952	1,980	1
81	McLoughlin Blvd. (Hwy. 99E)	Hwy. 224 to Harrison Ave.	South	1,929	1,650	1
81	McLoughlin Blvd. (Hwy. 99E)	Harrison Ave. to Courtney Ave.	South	1,886	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	Courtney Ave. to Jennings Ave.	South	1,636	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	Jennings Ave. to Gladstone City Limits	South	1,539	1,430	1
81	McLoughlin Blvd. (Hwy. 99E)	Gladstone City Limits to I-205	South	1,548	1,650	1
81	McLoughlin Blvd. (Hwy. 99E)	14th St. (Oregon City) to 10th St.	South	1,190	1,240	1
94	Riverside Dr. (Hwy. 43)	County Line to G Ave. (Oswego)	South	1,008	990	1
94	State St. (Hwy. 43)	(Oswego) G Ave. to A Ave.	South	1,165	990	1

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S/308/16

TABLE 6 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLACKAMAS COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
94	State St. (Hwy. 43)	(Oswego) A Ave. to McVey	South	1,315	1,140	1
95	Pacific Hwy. 43	Broadway St. to I-205	North	470	500	1
95	Pacific Hwy. 43	I-205 to Broadway St.	South	706	660	1
95	Pacific Hwy. 43	Broadway St. to E Side Willamette Falls Bridge	South	617	530	1
108	Clackamas (Hwy. 212/224)	I-205 to Evelyn St.	East	1,207	970	1
109	Hwy. 213 (Oregon City on 14th St.)	Hwy. 99 to Main St.	East	643	500	1
109	Hwy. 213 (Oregon City on 14th St.)	Main St. to Washington St.	East	693	590	1
109	Hwy. 213 (Oregon City, Washington St.)	14th St. to 12th St.	South	753	590	1
109	Hwy. 213 (Oregon City, Washington St.)	12th St. to 7th St.	South	725	680	1
109	Hwy. 213 (Molalla Ave.)	Polk St. to Division St.	South	1,004	660	1
109	Hwy. 213 (Cascade Hwy.)	Mt. Hood Ave. to Holmes Lane	South	1,184	1,240	1
109	Hwy. 213 (Cascade Hwy.)	Beaver Creek Rd. to Gaffney Lane	South	693	700	1
109	Hwy. 213 (Cascade Hwy.)	Gaffney Lane to Fir St.	South	693	530	1

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S/308/17

TABLE 6 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLACKAMAS COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
109	Hwy. 213 (Cascade Hwy.)	Caufield Dr. to Fir St.	North	520	530	1
109	Hwy. 213 (Oregon City 7th St.)	Polk St. to Monroe St.	West	713	680	1
109	Hwy. 213 (Oregon City 7th St.)	Monroe St. to Washington St.	West	1,320	680	1
109	Hwy. 213 (Oregon City 7th St.)	Washington St. to Main St.	West	484	500	1
109	Hwy. 213 (Oregon City, Washington St.)	7th St. to 12th St.	North	614	590	1
	ARTERIALS					
14	Johnson Creek Blvd.	McLoughlin Blvd. to Brookside Dr.	East	658	1,190	2
14	Johnson Creek Blvd.	42nd Ave. to 32nd Ave.	West	433	400	2
28	Harrison St.	McLoughlin Blvd. to Miller Dr.	East	560	510	1
28	Harrison St.	Miller Dr. to SE 32nd Ave.	East	850	620	1
48	River Rd. (17th Ave.)	Cascade Hwy. 224 to SE Tacoma St.	North	612	680	2
48	River Rd. (17th Ave.)	SE Tacoma St. to Cascade Hwy. 224	South	749	680	2

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S/308/18

TABLE 6 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLACKAMAS COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	ARTERIALS					
53	Harmony Rd.	Lake Rd to Linwood Ave.	East	683	530	5
55	Webster Rd.	Hwy. 224 to Theissen Rd.	South	660	600	6
	MAJOR INTERSECTIONS AND INTERCHANGES					
H	Intersection	SE 82nd (Hwy. 213) and Sunnyside Rd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Sunnyside Rd. to 82nd Ave.			6
I	Intersection	Main St. (Hwy. 212) and 7th Ave.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from 7th Ave. to Main St.			6

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S/308/19

TABLE 6 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLACKAMAS COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	<u>MAJOR INTER-SECTIONS AND INTERCHANGES</u>					
J	Intersection	Oatfield Road and Lake Road	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Lake Road to Oatfield Road.			6
K	Intersection	Washington St. and Redland Rd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Washington St. to Redland Rd.			6

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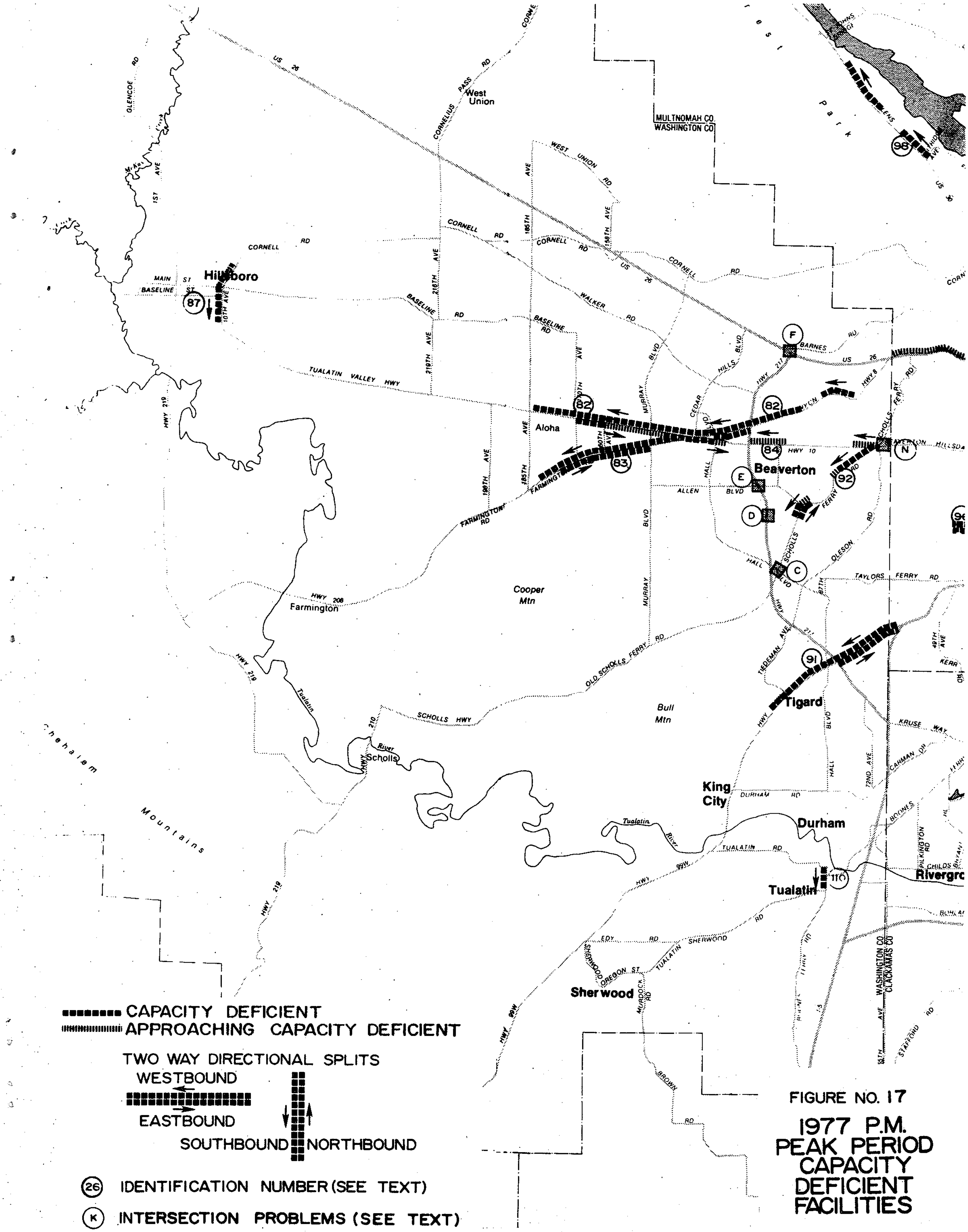
S/308/20

WASHINGTON COUNTY

F. <u>Results: Washington County</u>

Nine percent (24.6 lane-miles) of the region's capacity deficient roadway is located in Washington County (Figure 17). Highway 8 is the major single deficiency, making up 43 percent (10.7 land-miles) of the County total. Significant intersection problems were identified at five locations in Washington County (Table 7). Nearly 63 vehicle hours of delay (slightly over 6.0 percent of the regional total) occur during the PM peak hour period on Washington County roadways. Highway 8, Highway 99W and Farmington Road compose approximately 90 percent of the County total in terms of delay (Figure 18).



CAPACITY DEFICIENT
APPROACHING CAPACITY DEFICIENT

TWO WAY DIRECTIONAL SPLITS
WESTBOUND
EASTBOUND
SOUTHBOUND NORTHBOUND

(26) IDENTIFICATION NUMBER (SEE TEXT)

(K) INTERSECTION PROBLEMS (SEE TEXT)

FIGURE NO. 17

1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES

WASHINGTON CO.

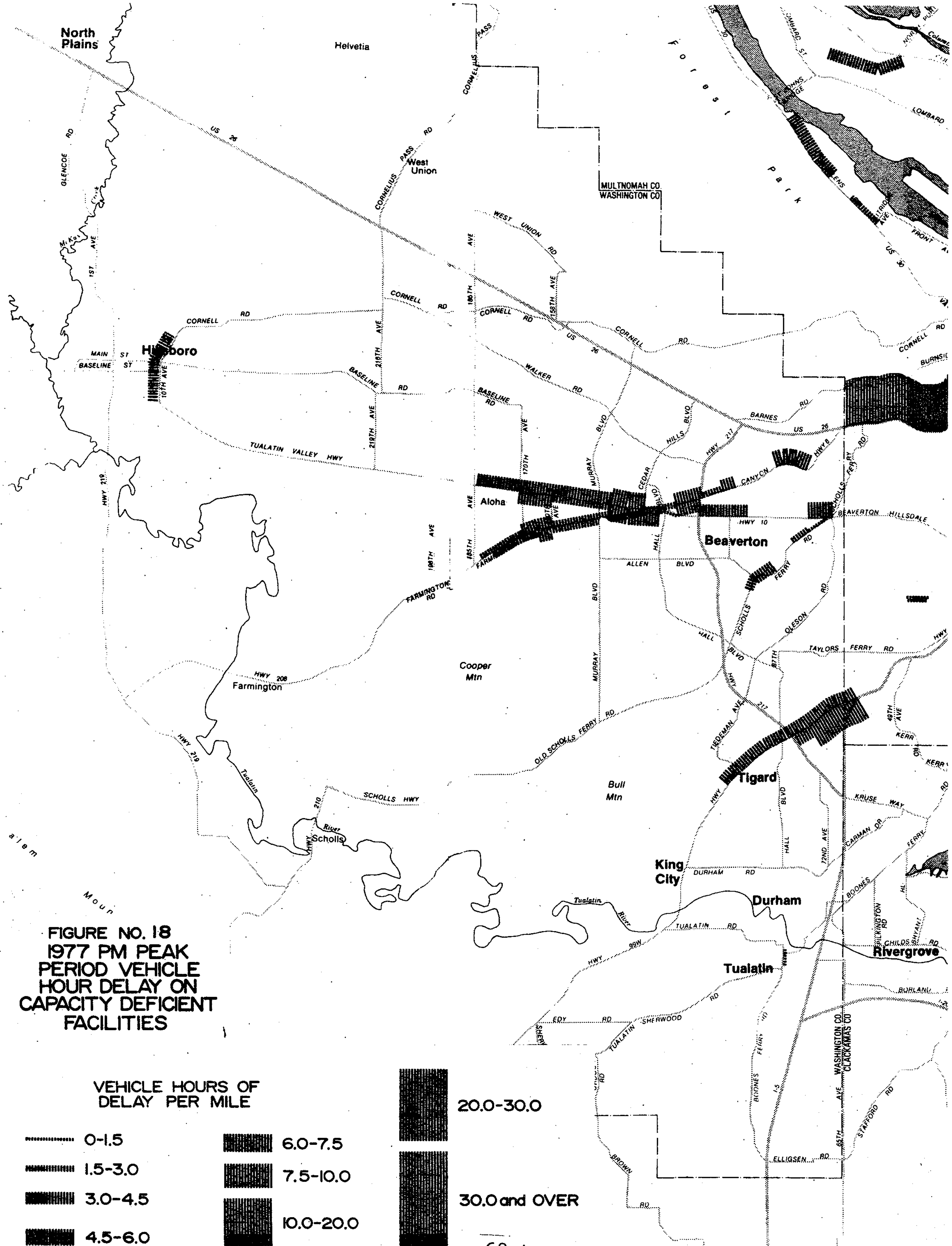


FIGURE NO. 18
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES

VEHICLE HOURS OF DELAY PER MILE

0-1.5
1.5-3.0
3.0-4.5
4.5-6.0
6.0-7.5
7.5-10.0
10.0-20.0
20.0-30.0
30.0 and OVER

WASHINGTON CO.

TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
82	Tualatin Valley (Hwy. 8)	SW 170th Ave. to SW 160th Ave.	East	1,309	1,270	1
82	Tualatin Valley (Hwy. 8)	SW 160th Ave. to SW 141st Ave.	East	1,342	1,380	1
82	Tualatin Valley (Hwy. 8)	SW 141st Ave. to SW Hall Blvd.	East	1,342	1,240	1
82	Canyon Rd. (Hwy. 8)	SW Hall Blvd. to SW Broadway St.	East	1,342	1,240	1
82	Canyon Rd. (Hwy. 8)	SW Broadway St. to SW Hwy. 217	East	1,384	1,240	1
82	Canyon Rd. (Hwy. 8)	SW Crestdale Rd. to SW 87th Ave.	West	1,253	1,240	1
82	Canyon Rd. (Hwy. 8)	SW 87th Ave. to SW 91st Ave.	West	1,310	1,240	1
82	Canyon Rd. (Hwy. 8)	SW 106th to SW Hwy. 217	West	1,432	1,380	1
82	Canyon Rd. (Hwy. 8)	SW Hwy. 217 to SW Broadway St.	West	1,692	1,240	1
82	Canyon Rd. (Hwy. 8)	SW Broadway St. to SW Hall Blvd.	West	1,640	1,240	1
82	Canyon Rd. (Hwy. 8)	SW Hall Blvd. to SW Cedar Hills Blvd.	West	1,601	1,380	1
82	Canyon Rd. (Hwy. 8)	SW Cedar Hills Blvd. to SW 141st Ave.	West	1,640	1,240	1
82	Canyon Rd. (Hwy. 8)	SW 141st Ave. to SW 145th Ave.	West	1,640	1,270	1
82	Canyon Rd. (Hwy. 8)	SW 145th Ave. to SW 160th Ave.	West	1,640	1,270	1
82	Tualatin Valley (Hwy. 8)	SW 160th Ave. to SW 170th Ave.	West	1,600	1,500	1

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S/308/21

TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
82	Tualatin Valley (Hwy. 8)	SW 170th Ave. to SW 178th Ave.	West	1,467	1,270	1
82	Tualatin Valley (Hwy. 8)	SW 178th Ave. to SW 185th Ave.	West	1,363	1,270	1
83	Farmington Rd. (Hwy. 208)	SW 174th Ave. to SW 165th Ave.	East	591	530	1
83	Farmington Rd. (Hwy. 208)	SW 165th Ave. to SW 160th Ave.	East	595	530	1
83	Farmington Rd. (Hwy. 208)	SW 160th Ave. to SW 148th Ave.	East	600	530	1
83	Farmington Rd. (Hwy. 208)	SW 148th Ave. to SW 145th Ave.	East	614	530	1
83	Farmington Rd. (Hwy. 208)	SW Watson Ave. to SW Cedar Hills Blvd.	West	647	530	1
83	Farmington Rd. (Hwy. 208)	SW Cedar Hills Blvd. to SW Erickson Ave.	West	664	530	1
83	Farmington Rd. (Hwy. 208)	SW Erickson Ave. to Menlow Dr.	West	635	530	1
83	Farmington Rd. (Hwy. 208)	SW Menlow Dr. to SW 148th Ave.	West	681	530	1
83	Farmington Rd. (Hwy. 208)	SW 148th Ave. to SW 160th Ave.	West	733	530	1
83	Farmington Rd. (Hwy. 208)	SW 160th Ave. to SW 165th Ave.	West	728	700	1
83	Farmington Rd. (Hwy. 208)	SW 165th Ave. to SW 174th Ave.	West	720	700	1

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TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
83	Farmington Rd. (Hwy. 208)	SW 174th to Kinnaman	West	716	700	1
84	Beaverton-Hillsdale (Hwy. 10)	SW East Ave. to SW Lombard Ave.	East	685	700	1
84	Beaverton Hillsdale (Hwy. 10)	SW Watson Ave. to SW Hall Blvd.	East	534	530	1
84	Beaverton Hillsdale (Hwy. 10)	SW Hall Blvd. to SW East Ave.	East	643	530	1
84	Beaverton Hillsdale (Hwy. 10)	SW Lombard Ave. to SW East Ave.	West	837	590	1
84	Beaverton Hillsdale (Hwy. 10)	SW East Ave. to SW Hall Blvd.	West	785	530	1
84	Beaverton Hillsdale (Hwy. 10)	SW Hall Blvd. to SW Watson	West	653	530	1
84	Beaverton Hillsdale (Hwy. 10)	SW Jamieson Rd. to Hwy. 217	West	1,328	1,380	1
84	Beaverton Hillsdale (Hwy. 10)	SW Scholls Ferry Rd. to 78th Ave.	West	1,339	1,380	1
91	Barbur Blvd. (Hwy. 99W)	Hwy. 217 to SW Pfaffel St.	East	1,576	1,380	1
91	Barbur Blvd. (Hwy. 99W)	SW Pfaffel St. to Multnomah Co. Line	East	1,559	1,380	1
91	Barbur Blvd. (Hwy. 99W)	Multnomah Co. Line to SW Pfaffel St.	West	1,906	1,240	1
91	Barbur Blvd. (Hwy. 99W)	SW Pfaffel St. to Hwy. 217	West	1,926	1,410	1
91	Barbur Blvd. (Hwy. 99W)	Hwy. 217 to Greenburg Rd.	West	1,600	1,580	1

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S/308/23

TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
91	Barbur Blvd. (Hwy. 99W)	SW Greenburg Rd. to SW Garrett St.	West	1,603	1,240	1
	ARTERIALS					
87	Cornell Rd. (City of Hillsboro)	SW Grant to SW Baseline St.	South	636	660	1
87	Tenth St. (City of Hillsboro)	SW Baseline St. to SW Oak St.	South	951	660	1
87	Tenth St. (City of Hillsboro)	SW Oak St. to SW Maple	South	1,292	660	1
92	Scholls Ferry Rd.	SW Denny Ave. to SW Allen Ave.	North	483	440	1
92	Scholls Ferry Rd.	SW Allen Ave. to SW 92nd St.	East	562	440	1
92	Scholls Ferry Rd.	Beaverton Hillsdale Hwy. 10 to SW Laurelwood Rd.	West	583	530	1
92	Scholls Ferry Rd.	SW Laurelwood Rd. to SW Jamieson Rd.	West	698	700	1
92	Scholls Ferry Rd.	SW 92nd Ave. to SW Allen Ave.	West	687	700	1
92	Scholls Ferry Rd.	SW Allen Ave. to Denny Rd.	South	725	700	1
110	Boones Ferry Rd.	SW Sherwood-Tualatin Rd. to SW 85th St.	South	605	550	1

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S/308/24

TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	<u>MAJOR INTER-SECTIONS AND INTERCHANGES</u>					
C	Intersection	SW Scholls Ferry Rd. and SW Hall Blvd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements to and from SW Hall Blvd. to SW Scholls Ferry Rd.			7
D	Intersection	Hwy. 217 and SW Denny Rd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant weaving maneuvering, traffic interruption and cueing result on Denny Rd. and Hwy. 217.			7
E	Intersection	Hwy. 217 and SW Allen Blvd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant weaving maneuvering, traffic interruption and cueing result on SW Allen Blvd. and Hwy. 217.			7

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TABLE 7 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN WASHINGTON COUNTY (cont.)

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	<u>MAJOR INTERSECTIONS AND INTERCHANGES</u>					
F	Intersection	Hwy. 217 and Sunset Hwy. 26 and SW Barnes Rd.	The generalized facility capacity is significantly reduced by the merging and weaving maneuvers at the interchange. Cueing is experienced on Barnes Rd. and Hwy. 217 and interruptions occur on Sunset Highway.			7
N	Intersection	Beaverton-Hillsdale Hwy. 10 and Scholls Ferry Rd.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from the Beaverton-Hillsdale Highway to Scholls Ferry Rd.			7

SS:gh:02
S/308/26

G. Results: Clark County

Approximately 6.4 lane-miles of roadway in Clark County are identified as capacity deficient (Figure 19). This represents less than three percent of the regional total and is located primarily on Highway 500. Three successive intersections on 78th Street --Hazel Dell Avenue, I-5 and Highway 99--were identified as significant problems (Table 8). Slightly over seven vehicle hours of delay occur on identified capacity deficient roadways in Clark County during the PM peak hour period (Figure 20). This represents less than one percent of the regional total.

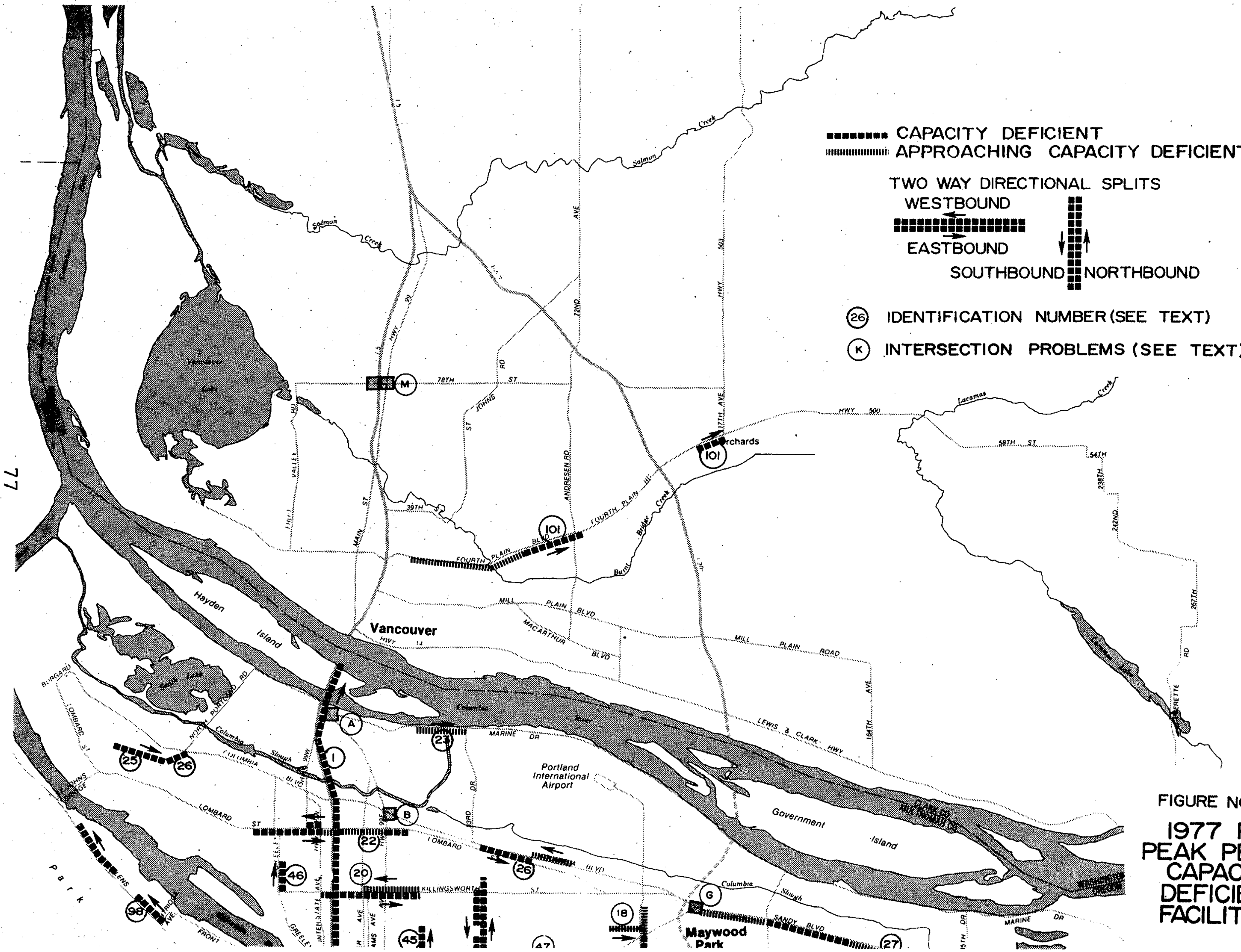

FIGURE NO. 19

1977 P.M. PEAK PERIOD CAPACITY DEFICIENT FACILITIES

CLARK CO.

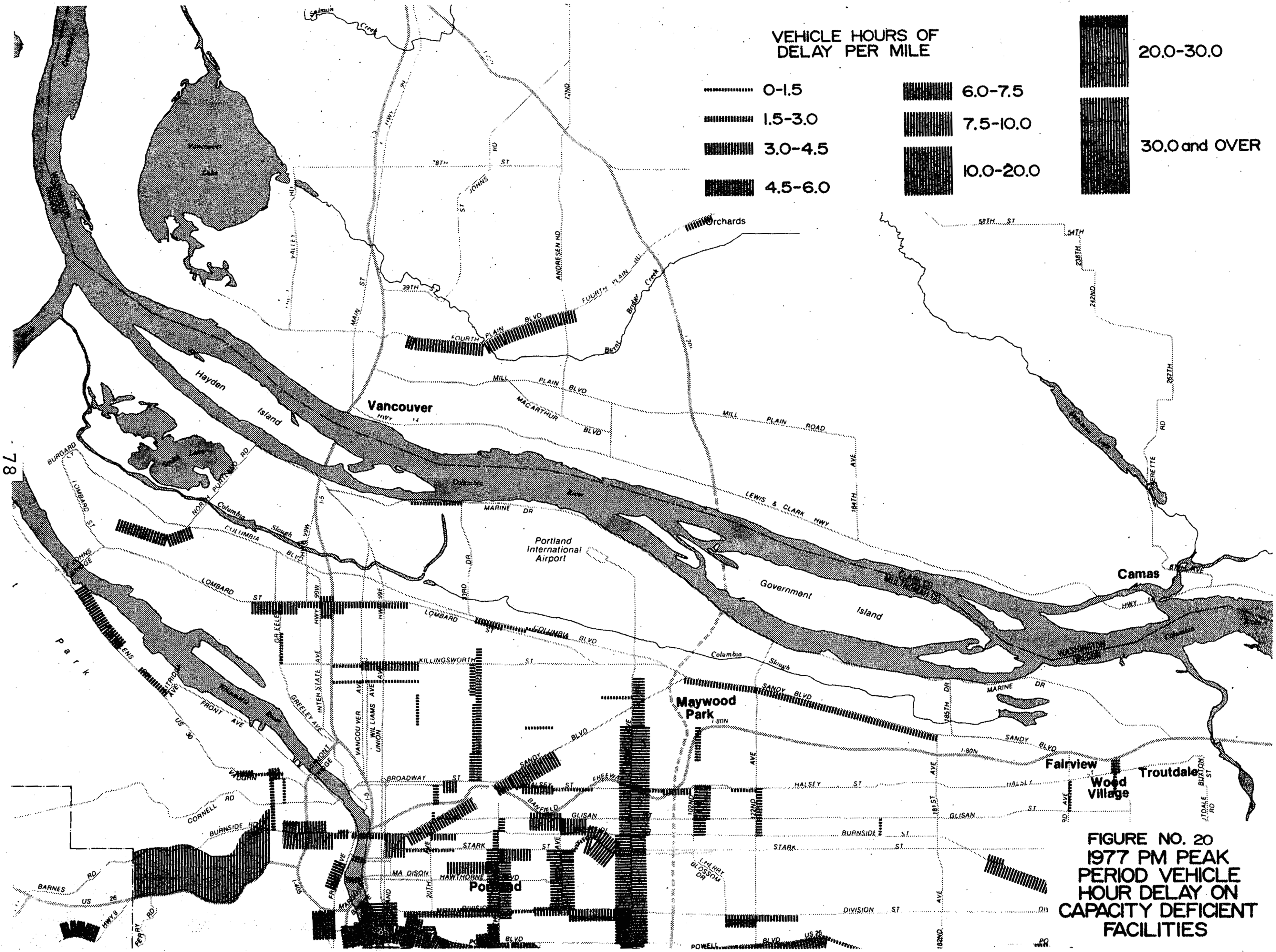

FIGURE NO. 20
1977 PM PEAK PERIOD VEHICLE HOUR DELAY ON CAPACITY DEFICIENT FACILITIES

CLARK CO.

TABLE 8 : 1977 PM PEAK PERIOD CAPACITY DEFICIENT FACILITIES IN CLARK COUNTY

MAP NO.	FACILITY	SECTION	DIRECTION	EXPECTED PEAK VOLUME	GENERALIZED CAPACITY	SOURCE
	STATE HIGHWAYS					
101	Fourth Plain Rd. (Hwy. 500)	Stapleton Rd. to Andresen Rd.	East	1,354	1,030	3a
101	Fourth Plain Rd. (Hwy. 500)	Andresen Rd. to Prop. Co. Rd.	East	1,089	870	3a
101	Fourth Plain Rd. (Hwy. 500)	109th To 112th	East	888	870	3a
101	Fourth Plain Rd. (Hwy. 500)	112th Ave. to 117th Ave.	East	888	630	3a
	MAJOR INTERSECTIONS AND INTERCHANGES					
M	Intersection	NE 78th St. and HazelDell Ave.	The generalized facility capacity is significantly reduced by the at grade intersection with signal control. Significant traffic interruption and cueing results from turning movements from Hwy. 99 and Hazel Dell Ave. to NE 78th St.			3b
M	Intersection	NE 78th St. and Hwy. 99				3b
M	Intersection	NE 78th St. and I-5 Overpass				3b

ss:gh:02
S/308/27

Appendix A: DATA SOURCES

1. Oregon State Highway Division, Official Publication No. 77-1, Traffic Volume Tables for 1976, June, 1977.

1b. Oregon Department of Transportation, Discussion with Traffic Engineering Section regarding 1977 Traffic Counts, April, 1978.

2. City of Portland, Traffic Flow Map, Bureau of Traffic Engineering, April, 1978.

2b. City of Portland, Discussion with Bureau of Traffic Engineering, April, 1978.

3. Washington State Highway Department, Rural Urban Inventory Work Listings, July, 1977.

3b. Clark County, Discussion with Bureau of Traffic Engineering regarding 1976 traffic counts, April, 1978.

4. Multnomah County, Discussion with Bureau of Planning regarding 1976 data, March, 1978.

5. City of Milwaukie, Discussion with Traffic Engineering regarding 1976 data, April, 1978.

6. Clackamas County, Discussion with Transportation Planners regarding 1977 information, March, 1978.

7. Washington County, Discussion with Bureau of Traffic Engineering, April, 1978.