

HOV Compliance Monitoring and the Evaluation of the Hero Hotline Program

WA-RD 205.1

Final Summary Report
February 1990



Washington State Department of Transportation
Planning, Research and Public Transportation Division

in cooperation with the
United States Department of Transportation
Federal Highway Administration

**WASHINGTON STATE DEPARTMENT OF TRANSPORTATION
TECHNICAL REPORT STANDARD TITLE PAGE**

1. REPORT NO. WA-RD 205.1	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.	
4. TITLE AND SUBTITLE HOV COMPLIANCE MONITORING AND THE EVALUATION OF THE HERO HOTLINE PROGRAM		5. REPORT DATE February 1990	
		6. PERFORMING ORGANIZATION CODE	
7. AUTHOR(S) Ruth Kinchen, Mark Hallenbeck, G. Scott Rutherford, Leslie N. Jacobson, and Amy O'Brien		8. PERFORMING ORGANIZATION REPORT NO.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington State Transportation Center (TRAC) University of Washington, JE-10 The Corbet Building, Suite 204; 4507 University Way N.E. Seattle, Washington 98105		10. WORK UNIT NO.	
		11. CONTRACT OR GRANT NO. GC8286, Task 28	
		13. TYPE OF REPORT AND PERIOD COVERED Final Summary Report	
12. SPONSORING AGENCY NAME AND ADDRESS Washington State Department of Transportation Transportation Building, KF-10 Olympia, Washington 98504		14. SPONSORING AGENCY CODE	
15. SUPPLEMENTARY NOTES This study was conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.			
16. ABSTRACT This report discusses the development of recommended and alternative systems for monitoring the use of HOV lanes and compliance with HOV occupancy regulations in the Seattle metropolitan area. The report includes a state-of-the-art review of techniques for monitoring HOV lane use and the results of tests of the most promising of these techniques. In addition, the report presents a review of the existing HERO (HOV violation reporting hotline) program, including the results of a 500-person telephone survey on the public's awareness of and attitude toward the HERO program and HOV facilities in general. Finally, the report describes software written to ease the storage of HERO data and improve the reporting of HERO statistics.			
17. KEY WORDS HOV, HOV lanes, HOV compliance, HOV violations, traffic data collection		18. DISTRIBUTION STATEMENT No restrictions. This document is available to the public through the National Technical Information Service, Springfield, VA 22616	
19. SECURITY CLASSIF. (of this report) None	20. SECURITY CLASSIF. (of this page) None	21. NO. OF PAGES 49	22. PRICE

Final Summary Report

**Research Project GC 8286, Task 28
HOV Compliance Monitoring**

**HOV COMPLIANCE MONITORING
AND THE EVALUATION OF THE
HERO HOTLINE PROGRAM**

by

**G. Scott Rutherford
TRAC Director**

**Ruth Karla Kinchen
Research Assistant**

**Leslie N. Jacobson
FAME Project Manager**

**Mark E. Hallenbeck
Research Engineer**

**Amy O'Brien
TRAC Editor**

**Washington State Transportation Center (TRAC)
University of Washington, JE-10
The Corbet Building, Suite 204
4507 University Way N.E.
Seattle, Washington 98105**

**Washington State Department of Transportation
Technical Monitor
Leslie N. Jacobson
FAME Project Engineer**

Prepared for

**Washington State Transportation Commission
Department of Transportation
and in cooperation with
U.S. Department of Transportation
Federal Highway Administration**

February 1990

DISCLAIMER

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

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Summary of Principal Findings	vii
Public Awareness Survey	vii
Data Collection	viii
The HOV Violations Monitoring System	viii
The HERO Hotline Program	ix
Structure of the Report	x
Recommendations	xi
An HOV Violation Rate Monitoring System	xi
The HERO Hotline Program	xii
Chapter One. Background	1
Chapter Two. Literature Review	3
Washington	3
Virginia	4
California	5
Texas	5
Oregon	5
New Jersey	5
Other Monitoring Programs	6
Photographic Monitoring	6
Chapter Three. Research Approach	7
Survey Development	7
HOV Monitoring Effort	10
Chapter Four. Results	13
Public Awareness Survey	13
The HOV System	13
The HERO Program	21
HOV Violation Monitoring	25
Key Results	25
Violation and Compliance Rates	27
The Relationship Between HERO and Other Parameters	29
Development of an HOV Violation Rate Database	31
The HERO Hotline Program	32
Data Collected through the HERO Hotline	33
The Public's Opinion of the HERO Hotline	35
References	37

LIST OF FIGURES

Figure		Page
3.1	HOV Lanes.....	8
3.2	Study Area.....	9
3.3	Observer Locations for HOV Lane Monitoring.....	11
4.1	Type of Vehicle Used in HOV Lane (by facility).....	15
4.2	How often do you use the carpool lanes? (by mode).....	16
4.3	Do you think HERO is a good idea?.....	22
4.4	How much does HERO reduce the illegal use of HOV lanes?.....	22
4.5	Is HERO a good idea? (by vehicle used in the HOV lane).....	24

LIST OF TABLES

Table		Page
4.1	People's Attitudes Towards HOV Lanes Cross Tabulated with Their Perceptions of HOV Lane Violations (N=55)	19
4.2	Responses to Questions 12A through 12F	20
4.3	Minimum and Maximum Violation Rates at Each Monitoring Location.....	28
4.4	Completeness of Violation Data Received on the Answering Machine During Non-Work Hours	34

SUMMARY OF PRINCIPAL FINDINGS

The primary purposes of this project were to determine the public's attitude toward both the HOV system and the HERO hotline program, to develop a method of monitoring the violation rates on Seattle area HOV lanes on a continuing basis, and to evaluate the effectiveness of the HERO program. This summary covers the following topics:

- the results of a survey that details the public's awareness of and attitude toward the HOV system and HERO hotline program,
- the results of a three-week HOV violation rate data collection effort,
- a statistically valid method of monitoring HOV lane violations and a system to house an HOV violation rate database, and
- an analysis of the continuing effectiveness of the HERO program and recommendations regarding the continued operation of the HERO program.

PUBLIC AWARENESS SURVEY

The results of the public awareness survey were very positive. Most people sampled were both aware of and in favor of the HOV system and the HERO hotline program. The principal findings are outlined below.

- About 85 percent of those surveyed (i.e., persons living near a corridor that contains an HOV facility) had traveled on an HOV lane at least once, and 67 percent of those who had used the lanes said they did so most frequently as part of a carpool.
- Most people knew the minimum occupancy requirements for the HOV facilities nearest them. People who lived near both SR-520 (3+ HOV lane) and I-405 (2+ HOV lanes) were most likely to know that the occupancy requirements vary by facility.

- Almost 85 percent of those surveyed thought having HOV lanes in the Seattle area is a good idea. Another four percent thought HOV lanes are basically a good idea but qualified their answers.
- Approximately 80 percent of those sampled knew about the HERO hotline.
- Of those who knew of the hotline, 71 percent thought it was a good idea.
- Half of those who knew about HERO felt the hotline helps reduce HOV violations, but only 6 percent felt HERO reduces violations a great deal.
- Approximately 6 percent of the people who knew about HERO said they had used the hotline.

DATA COLLECTION

HOV violation data were collected each morning during the peak hour (i.e., 6:45-7:45 a.m.) for three weeks at three sites: on westbound SR-520 at 92nd Avenue, on southbound I-5 at N.E. 175th Street in Seattle, and at N.E. 145th Street. The number of peak hour violations counted each day at each site was compared to the number of HOV violations reported through the HERO hotline to determine whether the two parameters were related. If the number of violations reported through the HERO hotline had been found to be related to the number of HOV violations that had been measured during the monitoring effort, data from the HERO program might have been a means of monitoring HOV violation rates. However, other means of monitoring the violation rate will have to be used because no relationship was found between the two parameters.

THE HOV VIOLATIONS MONITORING SYSTEM

Because the HERO system did not provide sufficient data to accurately measure HOV violation rates, a statistically valid method of determining quarterly a.m. peak period violation rates was developed that will use data from an auto occupancy project that began in November 1989. The auto occupancy data are being collected during 20

half-hour monitoring sessions a quarter from three HOV lane sites. These HOV lanes include both directions of I-405 near Kennydale, both directions of I-5 near 145th N.E., and the HOV lane on westbound SR-520 near 92nd Ave. HOV lane violation rates for these facilities can easily be determined from the auto occupancy data, and the use of these data will greatly reduce data collection costs.

A prototype of an HOV violation rate database was developed with the help of a Lotus 1-2-3 spreadsheet. The spreadsheet program calculates the HOV violation rate obtained from each individual monitoring session, as well as quarterly and annual violation rates. The only information required from the user is the number of SOVs and two-person carpools in the HOV lane, the total volume in the HOV lane, and the number of persons traveling in the HOV lane. This information can be extracted from data collected during each auto occupancy monitoring session. The spreadsheet program developed to house the HOV violations database is both extremely easy to use and is able to graph the HOV violation rate results.

THE HERO HOTLINE PROGRAM

The project team evaluated the HERO program by using both the results of the HOV violations data collection effort and the results of the public awareness survey. Although this project could not demonstrate that the HERO program has kept the violation rate lower than it might otherwise have been, the violation rate was below pre-HERO levels despite a substantial increase in traffic demand. Furthermore, the program is viewed quite favorably by the public. The public's favorable opinion of the program apparently does not stem exclusively from a perception that the HERO hotline significantly reduces HOV violations. Although 50 percent of those who knew about the hotline felt it reduced HOV lane violations, only 6 percent felt it reduced violations a great deal.

People may also be in favor of the HERO hotline because it allows them the opportunity to vent their frustration at having to wait in traffic while HOV lane violators drive by at 55 mph, usually without being caught by the State Patrol. This hypothesis seems borne out by the fact that, at least during the three-week monitoring effort, the number of violations reported through the hotline was found to be related to the speed, lane occupancy, and traffic volume in the general lanes. People were more likely to report HOV lane violators when traffic became congested, and not necessarily when the number of HOV violations increased. However, additional studies on the reasons people use the HERO hotline need to be conducted before it can be definitively shown that people use the hotline as a means of reducing frustration.

STRUCTURE OF THE REPORT

A series of recommendations are presented next. These recommendations concern both the development of an HOV violation rate monitoring system and improvements that may increase the effectiveness of the HERO program.

Chapter One outlines the problem addressed and the study's objectives.

Chapter Two discusses the literature review and conversations with transportation personnel.

Chapter Three discusses the procedures for the survey of King and Snohomish County residents, which was conducted to determine the public's awareness of and attitude toward both the HOV system and the HERO hotline program, and the procedures of the three-week monitoring effort.

Chapter Four outlines the results of monitoring effort, the need and requirements for an HOV violation rate database, and an evaluation of the HERO hotline program.

RECOMMENDATIONS

AN HOV VIOLATION RATE MONITORING SYSTEM

First, the researchers recommended that HOV violation data be obtained from the auto occupancy project that began in November 1989. Because the same information that is collected to determine auto occupancy can also be used to determine HOV violation rates, the cost of collecting data for violation rates is substantially less if data from the auto occupancy project are used than the cost would be if the data were collected independently.

Data for the auto occupancy project are being collected 20 times a quarter on the HOV lane sites. These HOV lanes include both directions of I-405 near Kenndale, both directions of I-5 near 145th N.E., and the HOV lane on westbound SR-520 near 92nd Ave. The data obtained from the auto occupancy project will yield the quarterly a.m. peak period HOV violation rate for each of these five HOV facilities. The violation rates derived will be statistically valid (i.e., at the 95 percent confidence level) with an accuracy of between 1 and 2 percentage points.

Second, a simple HOV violation database was developed with a Lotus 1-2-3 spreadsheet. A system similar to this spreadsheet program (or the auto occupancy monitoring database modified to calculate violation rates) should be used to store HOV violation data because such a program is extremely easy to use and allows users to graph individual and quarterly violation rates.

In response to prompts from the spreadsheet, users could enter the monitoring time and date, the number of SOVs, the number of two-person carpools (not necessary if the monitored lane has 2+ carpool definition), the total volume in the HOV lane, and the total number of persons traveling in the HOV lane. The spreadsheet program could automatically calculate the violation rate of each individual monitoring session, as well as the quarterly and annual violation rates.

Third, the database should be stored at WSDOT's headquarters in Olympia within either the Transportation Data Office or the Transportation Planning Office. Both of these offices will be involved with the auto occupancy project and thus will have ready access to the data. In addition, locating the database within WSDOT's headquarters would allow the database to be expanded to include information about violation rates on HOV facilities outside the Seattle area, as such facilities were constructed.

THE HERO HOTLINE PROGRAM

Because the HERO hotline seems to be an effective tool for relieving the public's frustration over often unpenalized HOV lane violators, the project team recommends that the hotline be continued. The team also recommends that WSDOT and/or Metro take the following actions to increase the effectiveness of the HERO hotline program:

- implement a marketing and education campaign about the HERO hotline;
- encourage people with cellular phones to use the hotline by allowing them to call in at no cost to themselves;
- explore ways to obtain more complete information from callers, particularly from people who report HOV violations during non-work hours (i.e., before 8 a.m. and after 5 p.m.); and
- give additional effort to better coordinate the information gathered by Metro, WSDOT, and WSP.

A marketing and public education campaign should be implemented to increase the public's awareness of the hotline and to encourage more people to use the hotline, since the study conducted after HERO was first implemented showed the hotline had a significant effect on the violation rate. Alternatively, more modest marketing of the program could be implemented at more frequent intervals (e.g., every two years) to ensure that the public does not "forget" about the program and that people who move into the Seattle area are informed about the program.

It is unclear who should fund and direct such a marketing campaign. Encouragement of HOV use is a function of both WSDOT and the various transit authorities. Thus the logical candidates for this function are either WSDOT or Seattle Metro, although a joint project might be the most equitable solution.

More attention should be focused on encouraging people with car phones to report HOV violations. People with car phones may be more likely to report HOV violations than people without them because people with phones in their vehicles do not have to write down the license numbers of violators and remember to call the hotline after they've reached their destinations. To encourage more car phone users to use HERO, Metro and/or WSDOT should consider paying for calls made from cellular phones on a trial basis to determine if this action significantly increases the number of violations reported.

Metro and/or WSDOT should also explore ways to obtain more complete information from people who call during non-work hours and who therefore must leave pertinent information about HOV violations on an answering machine. Currently, a large percentage of the calls that are recorded on the answering machine contain incomplete information, even though the recorded message gives a list of the information that should be reported (i.e., the time, date, and location of the violation, the auto's occupancy, a description of the vehicle, and the license plate number).

One way in which additional information could be obtained would be to install an answering machine that can prompt callers through a series of questions. Callers could respond to each question by pressing the appropriate keys on a touch-tone phone. Another way to obtain the necessary information would be to hire part-time personnel to answer the hotline when Metro staff was not available (e.g., from 6 to 8 a.m. and from 5 to 7 p.m.). This option offers the advantage of not alienating people who do not like speaking to answering machines and who hang up if the phone is answered by a machine.

Finally, Metro, WSP, and WSDOT should give additional effort to coordinating information obtained from the HERO program (e.g., number of peak period calls) with

other sources of information, such as traffic speed, lane occupancy, the violation rate, and HOV enforcement activity. The three-week monitoring effort undertaken as part of this project did not provide enough data to establish a relationship between the violation rate and the number of violations reported through the HERO hotline. If such a relationship were found to exist, the HERO hotline could be used to monitor the violation rate on the area's HOV facilities.

The HERO database developed as part of this project makes extraction of HERO data much easier than it was when HERO data were stored on the Perkin-Elmer computer housed at WSDOT. In addition, HOV violation data will be much easier to obtain from data collected by the AVO monitoring project. Far more information will be more readily available than has been the case in the past, and efforts should be made to use this information as much as possible.

CHAPTER ONE

BACKGROUND

Continuing geographic, economic, and population growth in Washington state's urban areas has resulted in increased traffic congestion on roads, especially in the Seattle metropolitan area. At the same time, the public has become increasingly resistant to the construction of new roads. The development and use of high occupancy vehicle (HOV) facilities has provided a cost effective way to increase the efficiency of the existing transportation network with relatively few environmental and/or social impacts. (1) However, the long-term effectiveness of these facilities cannot be determined unless the facilities are monitored on a continuing basis. It is especially important to monitor violation or compliance rates, since high violation rates are frustrating to motorists and compromise their incentives for taking the bus or car/vanpool.

In 1984, the Washington State Department of Transportation (WSDOT) developed a public telephone hotline (HERO) for reporting HOV facility violators in the Seattle area. A study done at that time showed that the HERO hotline reduced violation rates on the region's HOV facilities by 33 percent. (2) However, WSDOT did not know whether the hotline continued to deter violators because no one had evaluated the HERO program since then. In addition, no study had ever sought to determine whether a correlation existed between compliance or violation rates and the number of calls received on the hotline. Finally, the state had not yet developed techniques to monitor HOV lane violation rates on a continuing basis, even though continuous monitoring would provide useful information to WSDOT and other agencies. HOV lane violation data could be used, along with other data, to evaluate the continuing effectiveness of the HOV lanes and to determine whether particular HOV facilities need more enforcement. In addition, HOV violation rates might be used in programs aimed at educating the public about the HOV system.

This study was a response to those concerns. The primary objectives of project were as follows:

- to conduct a state-of-the-art literature review to investigate techniques used in other states to monitor HOV compliance,
- to develop and test methods of monitoring HOV compliance and/or violation rates,
- to develop a system to house an HOV compliance database,
- to determine the public's attitudes toward both the HERO program and the HOV system through a survey,
- to analyze the effectiveness of the HERO program, and
- to establish methods of improving the effectiveness of the HERO program.

CHAPTER TWO

LITERATURE REVIEW

The project team was primarily interested in reviewing projects that studied compliance rates over long periods of time. However, a review of the literature revealed that compliance rates are rarely examined. Most attempts to monitor HOV lanes have used violation rates as their means of measurement. Because of the dearth of literature on HOV compliance monitoring, this study concentrated on methods of monitoring violation rates. Furthermore, there are few references in the literature to ongoing HOV violation monitoring programs. This probably reflects the fact that such programs are relatively expensive and may have no immediate impacts on traffic congestion. On the other hand, short-term monitoring of violation rates on HOV facilities is fairly common and is often used to determine the effectiveness of recently constructed HOV lanes. Therefore, short-term studies of HOV compliance rates were also reviewed.

Most states that currently have or have had HOV lanes have monitored those lanes for at least a short period of time just after the lanes have been constructed. However, not all states have examined violation rates as part of this initial study, and of those that have, not all of them have included methodology information in their reports. For this reason, the project team solicited states operating HOV lanes for information regarding HOV compliance monitoring methodology. Therefore, the methodology information came from sources other than published literature, including unpublished literature, written responses to a letter, and telephone conversations with knowledgeable professionals in the states' transportation departments.

WASHINGTON

The Washington State Department of Transportation (WSDOT) has not monitored violation rates on the state's HOV facilities on a continuing basis. (However, the new auto occupancy monitoring project begun in November 1989 provides WSDOT with an

opportunity to do so.) It has conducted several short-term monitoring projects since the inception of various HOV lanes in Seattle to evaluate their overall performance. However, little effort has been expended on monitoring HOV violation rates over the long term.

Generally, human observers with traffic counter boards have collected HOV violation data for studies that examined violation rates. However, small, portable computers have also been used to collect vehicle occupancy data. (3)

VIRGINIA (4)

The Virginia Department of Transportation uses human observers to collect data on HOV violation rates and usage on Interstates 66, 95, and 395 annually. One person observes each lane, recording up to six occupants per vehicle on traffic counter boards. Vehicles are classified as cars, public buses, and private buses. Bus companies furnish occupancy data on the buses. Since no trucks are allowed in the HOV lanes, trucks are not counted.

CALIFORNIA (5)

Only the HOV lanes in the southern half of the state are monitored on a regular basis. To obtain HOV occupancy rates, data are collected in 1/2-hour segments by a team of two counters for each location. One person counts the number of persons in each vehicle. The second person records data on vehicle type. The information collected from both people is then combined to determine the number and type of vehicles and the number of persons using the HOV facility. Violation rates can be extracted from these data.

Caltrans also uses a video camera to monitor roads in southern California but does not use the camera to determine vehicle occupancy, since the camera is unable to "see" into the back seats of vehicles.

TEXAS

The Texas Transportation Institute (TTI) collects a wide range of data on the utilization of the HOV facilities in Texas. Data collected monthly on the transitways include person and vehicle volumes and vehicle occupancy. Additional transitway data on travel times and speeds are collected quarterly. (6) Human observers are used to collect occupancy data over the 3-1/2-hour peak periods. One person observes each lane and records the occupancy of each vehicle by speaking into a tape recorder.

TTI does not monitor violation rates. However, the Metropolitan Transit Authority of Harris County (METRO) police (in the Houston area) enforce all transitways during most hours of operation. Most violators are cited. Therefore, the number of violators using the HOV lane is very close to the number of citations issued. (7)

OREGON (8,9)

Before the HOV lanes on the Banfield Freeway, near Portland, were closed in 1982, the Oregon Department of Transportation conducted an extensive monitoring program to determine the lanes' effectiveness. Violation rates were also determined as part of this study.

Occupancy counts were conducted by two people, each of whom used a four-column traffic counter board on three consecutive days per month. Vehicles were not classified by type. The average number of one, two, and three or more occupant vehicles was found by taking the average of each over the three days. These figures were then used to determine both occupancy and violation rates.

NEW JERSEY (10,11)

In 1983 the New Jersey Department of Transportation conducted an extensive monitoring program of the George Washington Bridge into New York City. Violation

rates were examined as part of this study. Counts were done once a month during the midweek. Recorders manually recorded data with a five-button traffic counter.

OTHER MONITORING PROGRAMS

Other states that have monitored HOV violation rates include Colorado, Florida, Hawaii, Massachusetts, and Minnesota. However, none of these states have monitored their HOV lanes on a regular basis, usually because of staff shortages or safety concerns. It was not easy to determine specifics of the methods these states used to collect data on occupancy and violation rates. However, in all cases human observers were used.

PHOTOGRAPHIC MONITORING

Although much interest has been expressed in the use of photographic or video equipment to monitor HOV violations, the review of the literature revealed that no state has used photography for this purpose. Recent work with a set of three cameras and sophisticated VCR playback equipment was demonstrated at the annual TRB Meeting in January 1990. This new design reduces much of the error but at increased equipment and staff costs.

CHAPTER THREE

RESEARCH APPROACH

The section outlines the research approach that was used to develop the public awareness survey and to monitor HOV lane compliance.

SURVEY DEVELOPMENT

The chief objectives of the public awareness survey were to determine

- the public's awareness of the HERO program and the HOV system,
- whether the public believes the two systems are successful, and
- whether the public agrees with the concept of the HERO program and the HOV system.

The questions used in the survey were constructed through a joint effort by personnel from WSDOT, Metro, and the Washington State Transportation Center (TRAC). A private market research firm hired to conduct the survey, Gilmore Research Group, also suggested the wording of specific survey questions. A private firm was contracted to help write and conduct the survey because of such firms' abilities to quickly survey a random sample of the target population and their experience in writing and performing surveys.

The project team was most interested in the opinions and attitudes of people who had at least seen, if not used, the area's HOV facilities (Figure 3.1). To maximize the number of these respondents, the communities surveyed were located either close to routes with HOV facilities or where their residents could reasonably be expected to use these routes fairly frequently (Figure 3.2).

Following the selection of the areas to be surveyed, the market research firm constructed a list of telephone prefixes from those areas. It then used a computer-generated list of random numbers to obtain the last four digits of the telephone numbers. This procedure assured that all households within the study area, including those households

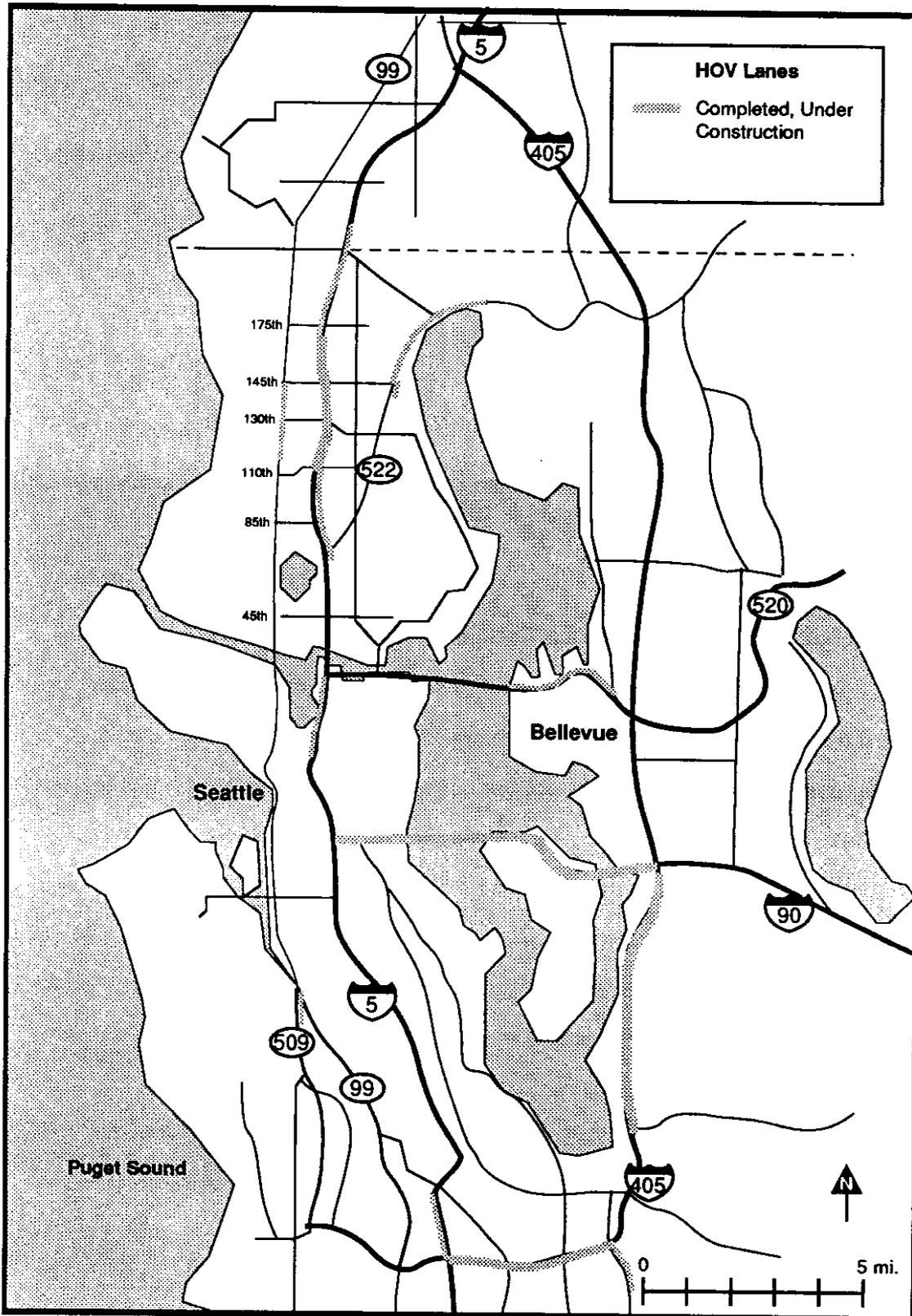


Figure 3.1. HOV Lanes

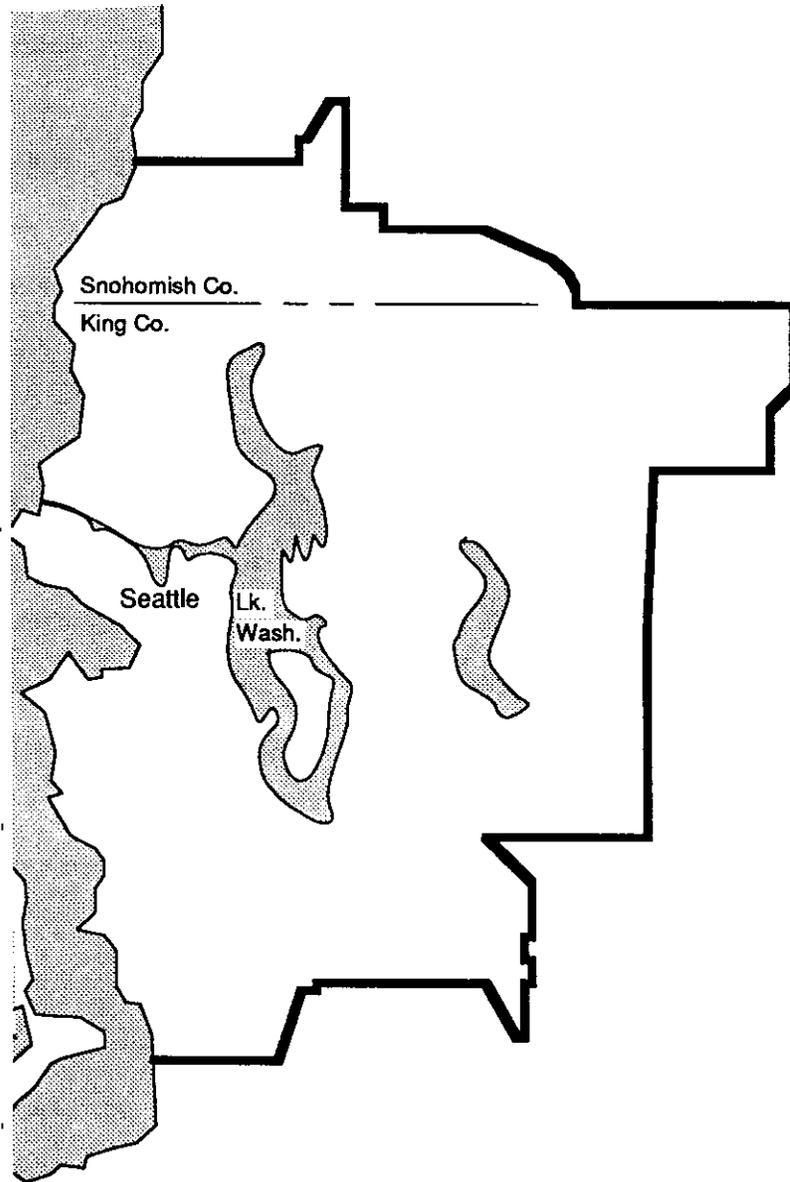


Figure 3.2. Study Area

that had recently moved or that had unlisted telephone numbers, had a nearly equal opportunity of being included in the sample.

The surveyors made calls weekday afternoons and evenings and all day Saturdays. They called households up to five times at different times of the day to ensure that busy people were not underrepresented. The total sample size was 551 households. The Washington State Transportation Center (TRAC) analyzed the survey results.

HOV MONITORING EFFORT

HOV violation data were collected at three locations on two of the area's major HOV facilities. Some facilities were not monitored because of personnel limitations. The two routes monitored, SR-520 and I-5, were selected because of the availability of possible monitoring locations and because an examination of the calls received on the HERO hotline revealed that more calls were received regarding violations on SR-520 and I-5 than on the other facilities. I-5 was monitored at two sites because the HOV lane on that facility is fairly long (i.e., 5 miles in the southbound direction). In addition, the project team wanted to compare the violation rate at the two sites.

The three selected sites were monitored on weekday mornings during the peak period (6:45-7:45) every day for three consecutive weeks in late March and early April 1989. Mondays and Fridays, days on which traffic conditions are often atypical, were included in the monitoring because the project team wanted to compare the violation rate with the number of HERO calls received over a range of traffic conditions.

The violation data were collected by one person at each location. Figure 3.3 shows their locations. The collectors used small, portable computers. A BASIC program written for the study allowed the data collector to classify each vehicle simply by pressing a single key. Vehicles were classified as SOVs, 2-person carpools, 3-or-more-person carpools, vanpools, buses, motorcycles, or "misses." Vehicles were classified as "misses" if the observer could not ascertain the number of occupants. When the observer pressed the

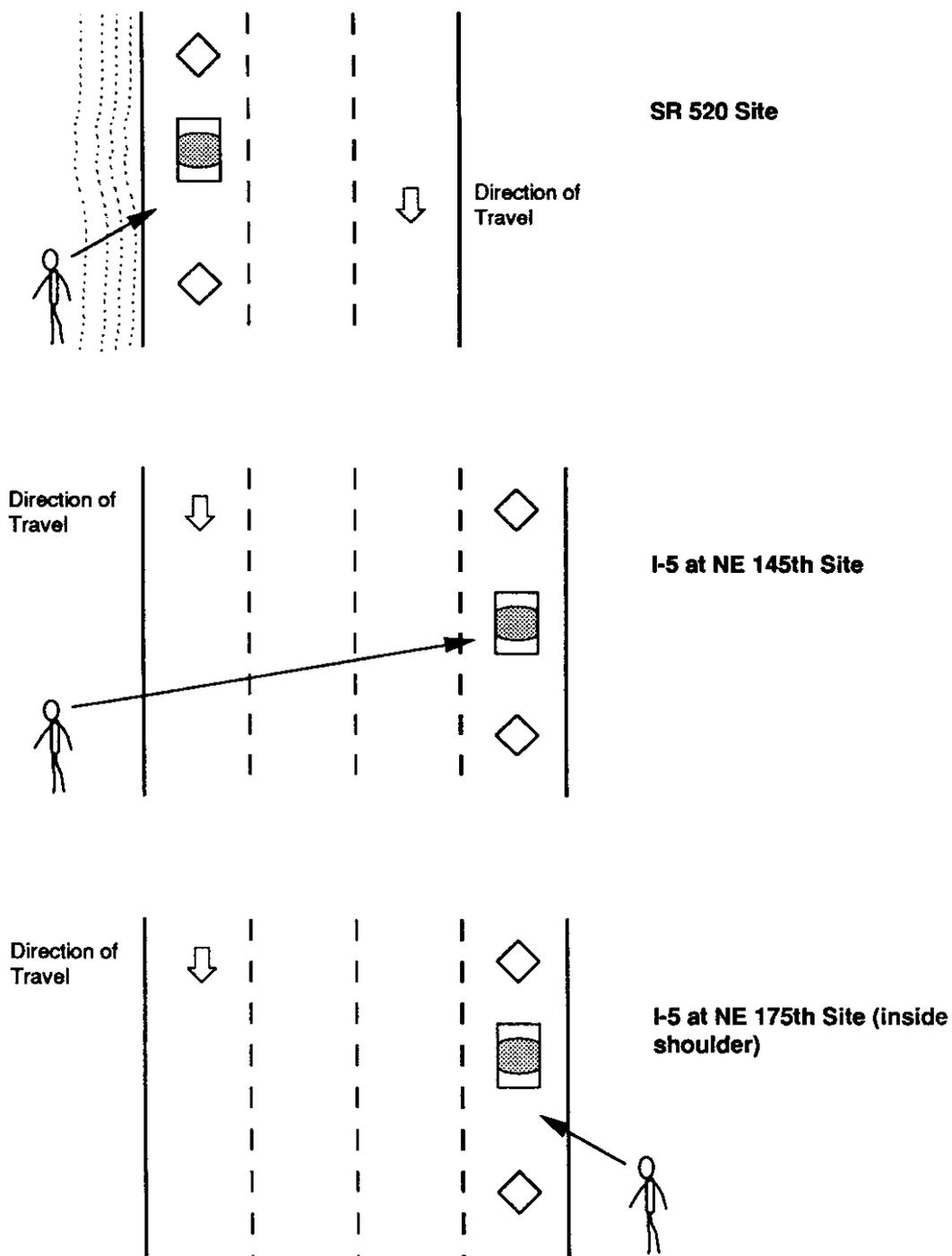


Figure 3.3. Observer Locations for HOV Lane Monitoring

appropriate key (e.g., "1" for SOV, "2" for 2-person carpool, etc.), the computer recorded the time of the observation.

The portable computers were selected to help collect data because they offered several advantages over more conventional recording devices, such as traffic counter boards.

1. The computers were able to record the time of each observation. This ability largely eliminated the need to supervise the data collectors once these personnel had learned how to use the computers because the data collected could be checked by examining the recording times.
2. The data collected could be easily transferred to a microcomputer for further analysis.
3. The third advantage of using the computers is that the computer program allowed the observers to make corrections on past observations.

CHAPTER FOUR

RESULTS

This section outlines the results of the public awareness survey about the HOV system and the HERO program and the HOV violation monitoring effort.

PUBLIC AWARENESS SURVEY

Residents of areas served by HOV lanes were surveyed to determine the following:

- how aware the public is of the HOV lane and HERO programs,
- whether the public feels the programs are successful, and
- whether the public agrees with the concept of each program.

The telephone survey of 551 King and Snohomish county residents in February 1989 led to the following conclusions regarding the public's awareness of and attitude toward the HOV system and the HERO hotline program.

The HOV System

Almost 85 percent of those surveyed had traveled on an HOV lane at least once. Much of this travel took place in carpools: 67 percent of the respondents used HOV lanes most frequently as part of a carpool. While most people reported traveling on HOV lanes, they do so infrequently. Approximately 38 percent of the people who had used HOV lanes said they used HOV lanes less than once a month, and another 31 percent of these people said they used the lanes at least once a month but less than once a week. Only about 14 percent of the HOV lane users said they used the lanes three to five days a week, the same percentage who said they used the lanes once or twice a week.

Slightly more than half of those who had used HOV lanes at least once knew that either two or three persons were necessary to travel in the lanes. More importantly, stratification of the results by residential areas showed that most people knew the minimum occupancy requirements for the HOV facilities nearest them. The majority (80 percent) of

those who lived near both SR-520 (3 person carpools) and I-405 (2-person carpools) knew that the minimum occupancy requirements vary by facility.

Almost 85 percent of those surveyed thought having HOV lanes in the Seattle area is a good idea. Another four percent of the sample thought HOV lanes are basically a good idea, but qualified their responses with statements such as "only if the lanes are operational just during rush hour." Overall, only about 9 percent of the sample didn't like the idea of HOV lanes.

Over 75 percent of the respondents felt HOV lane violations are a problem. However, over 50 percent of the respondents felt violations are a minor problem, while only one-quarter of the sample felt they are a serious problem. In addition, about 17 percent of those sampled felt these violations are not a problem at all. However, the interpretation of this result is difficult; either people do not think enough violations are occurring to warrant labeling the problem as "serious," or many people do not view HOV lane violations as being serious infractions of the law.

Usage by Mode. The survey asked respondents whether they had ever used the carpool lanes while traveling in a bus, carpool, vanpool, motorcycle, by themselves, even for a short period of time, by themselves for exiting or turning right, or had never used the lanes at all.

Almost 85 percent (84.5 percent) of the sample had traveled on an HOV lane at least once. The most frequently chosen answer was carpool (77 percent). The second most commonly selected choice was the bus, which only 22 percent of those surveyed had ever used. When the survey was analyzed to determine which one mode was used most often by each respondent when he or she traveled on an HOV lane, the outcome was similar: 67 percent used the lanes most frequently as part of a carpool, whereas only 10 percent of those sampled most often used an HOV lane while on a bus.

The percentage of people who used HOV lanes as part of carpools or while in buses varied significantly among the different HOV facilities (Figure 4.1). For example,

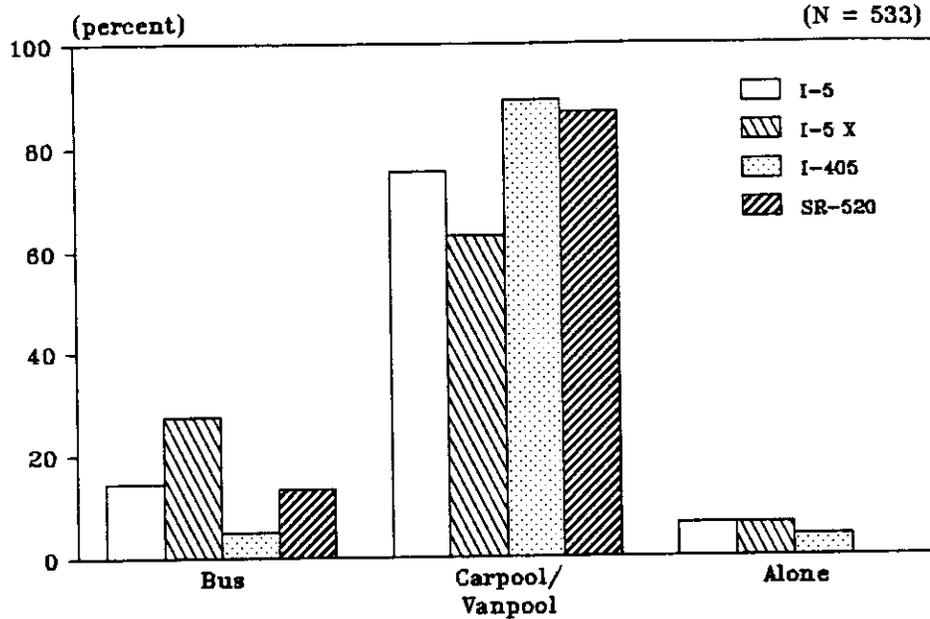


Figure 4.1. Type of vehicle used in HOV lane (by facility)

88 percent of those who reported using the HOV lanes on I-405 did so as part of carpools, whereas approximately 74 percent of the people who traveled on I-5 traveled in carpools. The fact that the definition of "carpool" is three people per vehicle on I-5 but only two people on I-405, combined with the fact that far more buses travel along I-5 than along I-405, is probably responsible for this difference.

Frequency of Use. When people who said they had used the HOV lanes at least once in the past were asked how often they used the lane, the most commonly selected answer was "less than once a month" (38.4 percent). The second most popular answer was "at least once a month" (31.1 percent). Only 13.6 percent of these respondents said they used the lanes between three and five days a week. The same percentage (13.6) traveled on HOV lanes only once or twice a week.

These results differed slightly by mode choice (Figure 4.2). Thirty-one percent of the bus riders stated they used HOV lanes between three and five days a week, whereas only 11 percent of the carpools used HOV lanes that frequently. On the other hand,

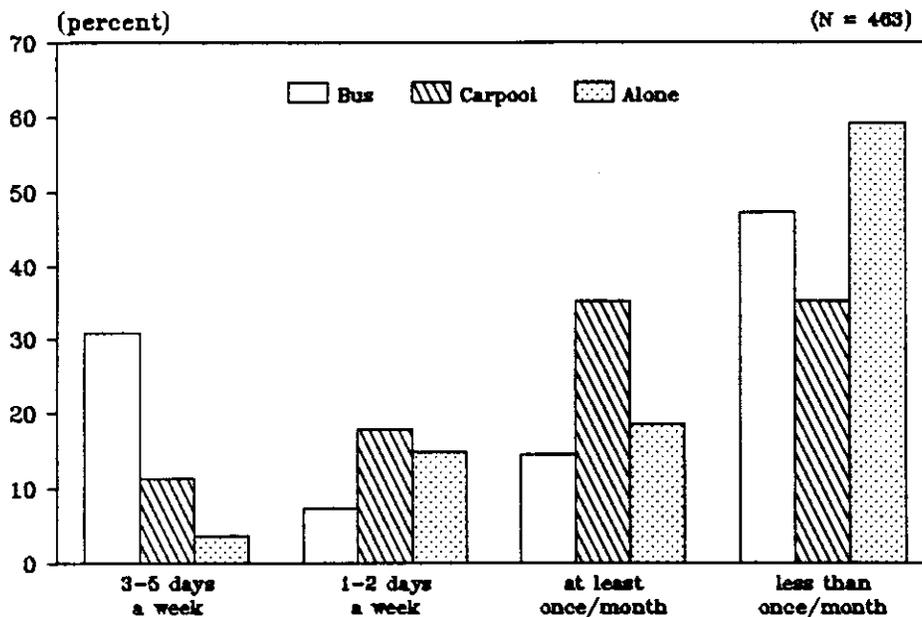


Figure 4.2. How often do you use the carpool lanes?
(by mode)

47 percent of the bus riders said they used HOV lanes less than once a month, while only 35 percent of the carpoolers used the lanes that infrequently.

Frequency of HOV lane use was also cross-tabulated with area of residence and with HOV facility used. While no statistically significant difference in frequency of HOV lane use was found among different areas, the facility used did appear to influence HOV lane usage. People who reported using the HOV lanes on the I-5 express lanes were more likely to travel on the HOV lanes between three and five days a week than were people who traveled on the other major HOV lanes (SR-520, I-5 mainline, and I-405), probably because of the large number of bus routes that utilize the I-5 express lanes. Nonetheless, only 23 percent of the people who used the I-5 express lanes HOV facility used the lanes this frequently. More importantly, the most common answer for users of every major HOV facility when asked how often they used HOV lanes was "less than once a month." This pattern of answers indicates that while most people have used HOV lanes at least

once, the majority of people only travel on the lanes infrequently, and relatively few people use the lanes daily.

Non-Usage of HOV Lanes When Qualified. When respondents were asked whether they ever chose not to use the HOV lanes at times when they had enough people in the car to use them, 46.6 percent of them said "yes." However, when these people were asked why they sometimes failed to use HOV lanes when they were qualified to use them, almost two-thirds (65.4 percent) replied that traffic was not heavy enough at those times. These people might have been qualified to use the HOV lanes during the evening or on a weekend, when congestion is usually not present. The second most frequently stated response was, "it takes too much trouble to change lanes" (11.7 percent).

Knowledge of Regulations. One way of determining the public's awareness of the HOV system is to assess the public's knowledge of the regulations regarding the use of the area's HOV facilities. Two regulations of particular interest pertaining to the HOV system are those governing the hours of operation and the minimum occupancy requirements.

The survey results showed that the majority of those sampled (79 percent) knew that HOV lanes are in effect at all times. Residents of the northeastern part of the study area were slightly more likely to know this fact (84.7 percent) than were residents in other areas, but the differences between the groups were not statistically significant.

However, the public was not nearly as knowledgeable about the minimum occupancy necessary to use the area's HOV lanes. Slightly more than half of those who had used the lanes at least once knew that either two or three persons were necessary to travel in the lanes (53 percent). This result is not surprising, given that many people have not been exposed to all the area's HOV lanes and thus only know the occupancy requirements for those lanes that they have seen or used.

A majority of those living on the east side of Lake Washington (81.6 percent), where HOV lanes with each of the two occupancy requirements are represented, knew that

minimum occupancy is either two or three persons. In contrast, only 24.7 percent of those living on the west side of the lake, where the occupancy requirement for all major HOV facilities is three persons, knew that the occupancy requirement varies between facilities. More importantly, however, 71.7 percent of this group said three people were necessary to qualify as a carpool, indicating that residents of this area did know the occupancy requirements for the HOV lane nearest them.

Attitudes Toward HOV Lanes. A number of questions were designed to assess the respondents' attitude toward the HOV system. When asked whether they thought having carpool lanes in the Seattle area is a good idea, 84.6 of the respondents said "yes." Another 4.5 percent felt that the lanes were a good idea, but qualified their answers with statements such as "only if the lane restrictions are enforced," or "if the lanes are for buses only." Only 9.1 percent of those surveyed responded to the question with a "no." This pattern did not differ significantly by area of residence or by travel mode. Over 75 percent of every mode group, including people who admitted using HOV lanes while alone in a vehicle, felt that HOV lanes are a good idea. However, the percentage of women who felt HOV lanes are a good idea was higher than the percentage of men who felt that way (90 percent versus 80 percent). Younger people were also more likely to be in favor of HOV lanes.

Another question designed to determine the public's attitude toward HOV lane violations was, "Do you feel that the use of carpool lanes by cars without the proper number of people is a serious problem, minor problem, or not a problem?" The results of this question were fairly positive. While 76.2 percent of the sample felt violations are a problem, only 25 percent of the sample felt the problem was serious. Over 50 percent of the respondents (51.2 percent) felt HOV violations were a minor problem, while 17.4 percent felt these violations were not a problem at all. Apparently, many people surveyed either felt that HOV violations are not serious infractions of the law or that not enough violations are occurring to label the situation a "serious problem."

TABLE 4.1 - People's Attitudes Towards HOV Lanes Cross Tabulated with Their Perceptions of HOV Lane Violations (N = 551)

**ARE HOV LANES IN SEATTLE A GOOD IDEA?
(READ ACROSS)**

HOW SERIOUS ARE HOV VIOLATIONS?	YES; A GOOD IDEA	QUALIFIED YES	NOT A GOOD IDEA	DON'T KNOW
A serious problem	120 ^a (25.8) ^b	8 (32.0)	10 (20.0)	0 (0.0)
A minor problem	247 (53.0)	12 (48.0)	19 (38.0)	4 (40.0)
Not a problem	70 (15.0)	3 (12.0)	20 (40.0)	3 (30.0)
Don't know	29 (6.2)	2 (8.0)	0 (0.0)	3 (30.0)
Refused to answer	0 (0.0)	0 (0.0)	1 (2.0)	0 (0.0)
Total	466 (100.0)	25 (100.0)	50 (100.0)	10 (100.0)

^a number of respondents

^b percent of respondents

A statistically significant difference was found between people who felt HOV lanes are a good idea and those who felt they are not a good idea (Table 4.1). People who did not think HOV lanes are a good idea were more likely to feel HOV lane violations are either a minor problem or not a problem than were those who thought HOV lanes are a good idea.

Finally, the people surveyed were asked to agree or disagree with a series of statements about HOV lanes and their effects. The results of these questions are shown in Table 4.2. Most of those sampled agreed with the statement that HOV lanes save time for people who use the lane (96 percent agreed strongly or somewhat with this statement). The majority of those sampled also felt that HOV lanes do not worsen traffic in other lanes, are not unfair to drivers who cannot use them, and do not increase the number of accidents. However, the results of two other questions were less positive. Only 39 percent of the sample felt HOV lanes reduce traffic congestion in all lanes, approximately the same percentage that disagreed with the statement that HOV lanes reduce air pollution.

Table 4.2 - Responses to Questions 12A through 12F^b

QUESTIONS	DISAGREE STRONGLY	DISAGREE SOMEWHAT	DON'T KNOW	AGREE SOMEWHAT	AGREE STRONGLY	REFUSED
HOV lanes save time for people who use them	0.90 ^a	2.50	0.50	15.40	80.60	0.00
HOV lanes worsen traffic in other lanes	44.60	28.30	3.10	10.90	13.10	0.00
HOV lanes are unfair to those who don't use them	53.70	26.70	3.10	7.80	8.70	0.00
HOV lanes reduce congestion in all lanes	20.50	18.10	5.40	31.80	24.00	0.20
HOV lanes increase the number of accidents	51.40	26.50	10.70	6.50	4.00	0.90
HOV lanes reduce air pollution	23.00	16.50	14.50	26.10	19.10	0.40

^aNumbers shown are percentages

^bRows total to 100%

The HERO Program

Most people sampled (81 percent) knew about the HERO program. This result is encouraging, since no marketing of the program has taken place since 1984, when the program was first begun. Although only 6.3 percent of the respondents who knew about the hotline said they had actually used it to report an HOV violation, the majority (71 percent) nonetheless thought the program was a good idea.

About half of those who knew about the HERO program felt that HERO helps reduce HOV violations (Figure 4.3), but only 6 percent of these people thought HERO reduces HOV violations a great deal (Figure 4.4). Most of those sampled generally approve of the HERO program in spite of the fact that they do not think the program reduces the violation rate a great deal. Perhaps they feel that even a modest decrease in the violation rate is worthwhile, or perhaps the general acceptance of HERO stems from another source. Many people may be in favor of HERO because it gives them the chance to vent their frustration at being delayed by traffic congestion while violators apparently get rewarded for breaking the law by being able to drive by at 55 mph in the HOV lane.

Awareness of the HERO Program. Knowledge of the hotline's existence was fairly high; 81 percent of the sample knew about the HERO program. Carpoolers were more likely to know about the program than were people who used other modes while in the HOV lanes. Of the carpoolers, 87 percent knew about HERO, whereas about 82 percent of the bus-riders in the sample had heard of HERO. Approximately 65 percent of those who had never used the lanes knew about the program.

Knowledge of the HERO program also differed among residential areas. People who lived on the east side of Lake Washington were most likely to know about the HERO program (89.9 percent), followed by residents of the northeastern part of the study area (81.8 percent), and residents of North Seattle (77.9 percent). Residents of Renton and south Seattle were least likely to know about HERO (72.1 percent). The high percentage of people who lived on the east side of the lake who knew about the HERO program is not

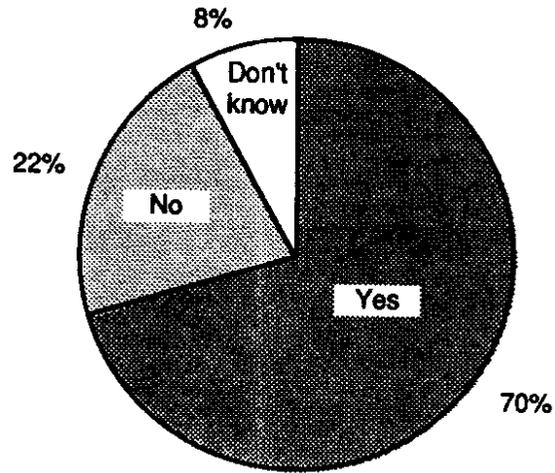


Figure 4.3. Do You Think HERO is a Good Idea

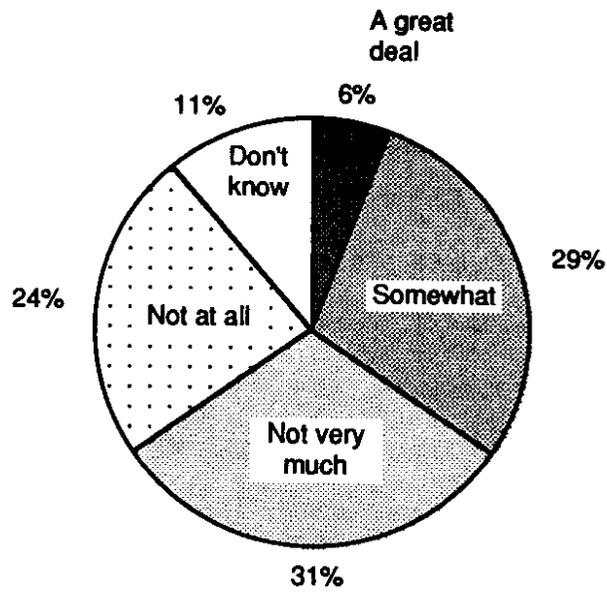


Figure 4.4. How Much Does HERO Reduce the Illegal Use of HOV Lanes?

surprising, since two of the major freeways on that side of Lake Washington have HOV lanes (SR-520 and I-405).

Signs that ask motorists to report HOV lane violators and provide the hotline telephone number are extensively posted next to HOV facilities. Most of the people who knew about the HERO program had seen signs about the hotline next to the freeway (96.7 percent).

Usage of the Hotline. Of those who knew about HERO, only 6.3 percent, or 5.1 percent of the total sample, had actually used the hotline to report an HOV violation. This result was expected, since only 67 percent of those surveyed said they traveled on roads with HOV lanes during the peak periods. Another reason for the low report rate may be the difficulty motorists have in seeing and writing down the license plate numbers of the violating vehicles, which are typically moving much faster than vehicles in the general lanes. Given the fact that Metro and WSDOT have not marketed the program since 1984, the percentage sampled who said they have used the hotline is not unreasonably low.

Attitudes Toward the HERO Program. When people who knew about HERO were asked whether they thought the program was a good idea, the majority (71 percent) thought the program was a good idea. The percentage of people who liked the idea of the HERO program differed only slightly among users of different modes. Interestingly, 75 percent of those who said they had never used the HOV lanes thought HERO was a good idea (only 22 percent thought HERO was actually a bad idea). In contrast, approximately 59 percent of those who admitted using an HOV lane while alone in a vehicle were in favor of the HERO program (Figure 4.5).

The percentages of people who thought HERO is a good idea also differed among residential areas, although not significantly. People from east King county and from north Seattle and southwest Snohomish county were more likely to think HERO is a good idea

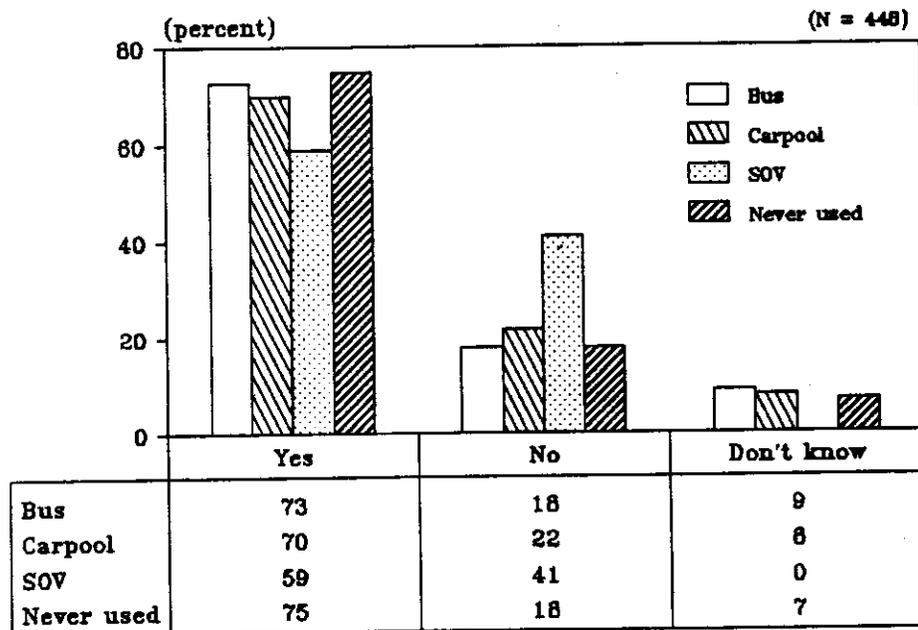


Figure 4.5. Is HERO a good idea?
(by vehicle used in the HOV lane)

than were people from other areas, perhaps because they were more familiar with the program.

Gender also appeared to have a significant effect on people's attitudes toward the HERO program. Women were more likely to be in favor of the hotline than were men. About three-fourths of the women (74 percent) who knew about the HERO program thought that HERO is a good idea, while only 68 percent of the men felt that way.

Attitudes Toward HERO's Effectiveness in Reducing the Violation Rate. Two of the survey's questions were designed to determine whether people feel that HERO reduces the illegal use of HOV facilities. Half of the people who knew about the HERO program felt that the hotline does help reduce violations. However, when asked *how much* they thought HERO reduces HOV violations, only 6 percent of those sampled felt the hotline reduces HOV violations a great deal. Almost 25 percent (23.7) of those asked thought HERO does not reduce HOV violations at all. These results are interesting, given that 70 percent of those asked felt that HERO is a good idea. Apparently, even

though many people feel the HERO hotline does not significantly reduce the illegal use of HOV lanes by unqualified vehicles, the majority of people are nonetheless in favor of the HERO program. Perhaps many people are in favor of the program because it gives them the ability to "do something" about HOV lane violators, even though most of them don't often make use of that capability.

HOV VIOLATION MONITORING

The results of a three-week HOV lane violation/compliance monitoring effort on I-5 and SR-520 are presented in this section. However, the objective of the monitoring effort was not merely to determine the violation rates on these two facilities. The primary purpose of the monitoring was to test possible monitoring locations and to find out whether HOV lane violations are related to the calls received on the HERO hotline. The monitoring results were also used to evaluate HERO's effectiveness. The research team compared the violation rates with previously measured violation rates on the two facilities to determine whether the violation rate remained at the same level after the HERO program had been implemented.

Key Results

HOV violation rates were monitored daily over three weeks. This effort led to a number of conclusions:

1. The best vantage point from which to determine occupancy in the HOV lane on SR-520, which is located on the outside lane, is from a position slightly above and in front of the vehicles, at an angle of about 45° measured from the long axis of the vehicle. On I-5, a better view of the interiors of vehicles in the HOV lanes, which are located on the inside of the freeway, can be obtained from the inside shoulder. The I-5 HOV lanes can also be viewed from a position on a raised outside shoulder, but the view into passing HOV vehicles can be blocked by passing trucks, buses and other large vehicles.

2. Violation rates were lowest on the SR-520 HOV lane. The highest violation rates were found at the 175th Street site on I-5.
3. The number of violations observed at the SR-520 monitoring site was negatively related to the speed in the adjacent general purpose lanes. In other words, violations increased when speeds decreased. When speeds higher than 45 mph were excluded, a similar relationship was found to exist between speed and violations on I-5. In addition, HOV violations on I-5 were positively related to the lane occupancy in the general purpose lanes: as lane occupancy increased, the number of violations also increased.
4. On I-5, the number of violations reported through the HERO hotline was related to traffic volume, lane occupancy, and speed in the general purpose lanes. The number of calls received through HERO increased as traffic volume and lane occupancy increased and speeds decreased. This finding could not be duplicated for SR-520 because of the low number of violations reported through HERO for that facility.
5. The number of violations reported through HERO was not significantly associated with the violation rate on I-5. Perhaps the lack of severe congestion on most days that violations were monitored along southbound I-5 (as evidenced by the generally high speeds measured by the data station at NE 175th Street) may have been responsible for the lack of correspondence. In contrast, SR-520 was congested to some degree on most days, but no relationship was found between actual violations and those reported through HERO because of a lack of a sufficient number of HERO calls during the study period. A relationship may in fact exist between actual and reported (i.e., through HERO) violations, but there were not enough violations reported through HERO during the monitoring period to statistically prove the relationship.

Violation and Compliance Rates

The collectors gathered data at the three monitoring locations with portable computers. After being down-loaded into IBM compatible microcomputers, the data were aggregated into 15-minute time periods. The violation rate was determined for each 15-minute interval and for each hour-long monitoring period. The minimum and maximum violation rates for each interval and monitoring period were also calculated.

Table 4.3 shows the minimum and maximum violation rates for each of the monitoring sites. The highest violation rate at each site occurred between 7:30 and 7:45 a.m. This result seems intuitively correct because one would expect people to be more likely to violate the HOV lanes as congestion, measured by decreased speed and increased lane occupancy, increased.

The fact that the second highest violation rate at all three sites occurred between 6:45 and 7:00 a.m. is more surprising. However, an examination of the number of violations that occurred during each interval revealed that the mean number of violations remained almost constant during the peak hour. Variations in HOV lane volumes during the four intervals were almost solely responsible for the fluctuations in the violation rate.

Violation rates were lowest at the SR-520 site during all four intervals. The difference in the configurations of the HOV lanes may be responsible for the difference in the violation rates. Another factor that may account for the lower violation rates along SR-520 is that motorists using SR-520 can more easily associate the Washington State Patrol's (WSP's) enforcement with HOV lane violations. Troopers enforcing SR-520 are able to cite violators in refuge areas adjacent to the HOV lane, whereas troopers on I-5, where the HOV lane is located on the inside lane, often must escort violators across several lanes of traffic in order to write up tickets. Once the violator is parked on the outside shoulder, other motorists may not be able to determine why the violator was pulled over.

A statistically significant difference in the minimum violation rates was also found between the two monitoring sites on I-5 ($\alpha = .05$). The minimum violation rates were

Table 4.3 - Minimum & Maximum Violation Rates at Each Monitoring Location

MONITORING LOCATION	6:45-7:00	7:00-7:15	7:15-7:30	7:30-7:45	ENTIRE PERIOD
WB SR-520	7.06 ^a	3.80	4.40	5.32	5.01
	10.51 ^b	9.56	9.63	12.44	10.69
I-5 / 145TH	6.71	6.37	6.93	9.19	7.26
	14.89	12.74	13.38	15.28	14.33
I-5 / 175TH	13.00	12.23	11.19	16.23	13.01
	16.44	14.29	13.46	18.14	15.29

^a minimum

^b maximum

lower on average at the 145th Street site than at the 175th Street location. This difference was probably caused by the higher levels of congestion typically found at the northern I-5 site (i.e., at 175th). Much of this congestion was due to the construction of a new Metro bus storage facility south of the 175th Street site and north of the 145th Street site. Traffic speeds in the general lanes were generally higher at the 145th Street location, so motorists had less incentive to violate the HOV lane at this site. However, the measurement of the violation rate at the 145th Street site was less precise than that at the 175th Street location because of variability in the data at 145th. This variability was possibly larger for the 145th Street monitoring site as a result of the observer's vantage point at that location (i.e., across three lanes of general purpose traffic). Thus there may have been no significant difference between the violation rates at the two sites.

The Relationship Between HERO and Other Parameters

One of the primary purposes of the monitoring effort was to determine the parameters that influence the number of violations reported through the HERO hotline program. In particular, it was hoped that a correlation could be established between the number of violations recorded at a specific site and the number of violations reported through the hotline for that site during a specified time period. However, it was felt that other factors, such as the speed, volume, and occupancy in the general purpose lanes, might also influence the violations reported through the HERO program.

Simple linear regression methods were used to test for the existence of any relationships between the number of HERO calls received and the other four parameters. Data on HERO violations reported during the monitoring period were obtained from Metro staff, who operate the hotline program.

An analysis of the phone calls regarding violations that occurred at the same time that I-5 and SR-520 were being monitored revealed that very few violations were reported for the exact times and dates of the monitoring period (i.e., March 22 through April 11, 1989, between 6:45 and 7:45 a.m.). In fact, only six violations were reported on

southbound I-5 and only three were reported for westbound SR-520. Because so few violations were reported between 6:45 and 7:45 a.m. during the monitoring period, the statistical tests for correlation were unreliable. Consequently, all reported HOV violations that occurred on southbound I-5 and westbound SR-520 between 5:30 and 9:30 a.m. were examined.

Significantly more I-5 HOV violations were reported for the longer time period than for the times the lane was actually monitored. However, only four HOV violations were reported for SR-520 during the longer time period. Therefore, the relationship between HERO calls and other parameters could only be examined for I-5.

The number of HOV violations reported on southbound I-5 was fairly strongly related to both the speed and the occupancy in the general purpose lanes. In fact, congestion in the general purpose lanes, indicated by speed, explained approximately 55 percent (i.e., the adjusted R^2 s for speed and occupancy) of the variation in the number of a.m. HERO calls received. This finding indicates that motorists became more inclined to report HOV violations as traffic congestion in the mixed-flow lanes increased.

The relationship between HOV violations reported and the volume in the general purpose lanes was less strong. This result seems intuitively correct, since traffic volume is not linearly related to congestion (as measured by speed or lane occupancy).

The most disappointing result was the lack of a relationship between the violations reported through HERO and the number of HOV violations at either I-5 site. Although the research team initially hoped that a relationship would exist between actual violations, as measured by observers, and reported violations, as obtained through HERO, this relationship could not be demonstrated by this project, primarily because of lack of data. However, the number of violations observed on SR-520 during the monitoring effort was negatively related to speed in the general purpose lanes. At the same time, speed on I-5 was negatively related to the number of violations reported through HERO. These two findings imply that a relationship may exist between actual and reported violations. Such a

relationship, if it exists, might be demonstrated if enough HOV violation data were collected.

DEVELOPMENT OF AN HOV VIOLATION RATE DATABASE

The current methods of collecting and storing HOV violation rate data have a number of shortcomings:

- the lack of both a regularly scheduled HOV violation rate monitoring program and a procedure to compile the collected violation data,
- the storage of collected data in several locations, and
- the collection of an insufficient number of data to determine statistically valid HOV violation rates.

To overcome these shortcomings, a system is needed to regularly collect and report HOV violation data and to store the data in a format that will allow long-term trends in HOV violation rates to be traced over time. Sufficient data is needed to establish statistically valid HOV violation rates on a quarterly basis. The determination of annual violation rates requires fewer data than the determination of monthly or quarterly rates, but without monthly or quarterly collection, changes in the violation rate within a given year could not be observed. Conversely, changes in the violation rate could be more closely monitored if sufficient data to determine monthly violation rates were collected, but the large number of data required to determine monthly violation rates would be difficult to collect.

The most cost-efficient means of obtaining the data needed to determine quarterly HOV violation rates would be to use data collected for another project designed to determine average vehicle occupancy. The auto occupancy project began collecting data in November 1989. The number of data that the auto occupancy project will collect (at least 20 one-half hour monitoring sessions per quarter at each HOV monitoring location) will be sufficient to guarantee statistically valid quarterly violation rates.

A Lotus 1-2-3 spreadsheet program was developed to calculate the violation rate for each monitoring session, as well as the quarterly and annual violation rates. The spreadsheet program is both easy to use and also allows users to graph individual and quarterly violation rates.

The HOV violation rate data and database should be stored where the information is accessible to all who may need it. The Transportation Planning Office, located at WSDOT's headquarters in Olympia, may be the best place to house the database, both because that office will also be responsible for compiling data for the auto occupancy project and because that office would be able to collect information on future HOV facilities that might be constructed outside the Seattle area.

THE HERO HOTLINE PROGRAM

The HERO hotline program, conceived as a method of reducing the HOV violation rate without resorting to expensive special enforcement efforts, was first implemented in February 1984 by WSDOT, WSP, and Metro. Studies of the HOV violation rate conducted before and after HERO's implementation showed that the violation rate on the I-5 HOV lanes decreased by 33 percent (from 28.3 to 19.1 percent averaged over four mainline I-5 locations) after the hotline program had begun. This decrease was attributed to the existence of the HERO program. Because the program's implementation had been coordinated with an extensive public information campaign, the public was well aware of the new program, and this awareness presumably discouraged people from violating the HOV lanes. Because of the reduction in violation rates, the HERO hotline program was judged to be successful.

The work described below was performed to reexamine HERO to determine whether it was still operating effectively and whether its benefits justified continued expenditure on the program.

Data Collected through the HERO Hotline

Several kinds of information obtained from the HERO database itself were used to help evaluate the HERO hotline program. These were the number of violations reported through the hotline and the completeness of the information obtained from the hotline.

A comparison was made between the number of weekly violations reported through HERO in 1984 and those reported in late 1988 and early 1989. This comparison was intended to determine whether usage of the hotline has declined since its introduction in 1984. While a large number of violations were reported by the public during the first few weeks after the hotline was introduced, the number of violations reported after about June 1984 was generally between 100 and 200 calls per week. The number of HERO calls received per week between November 1988 and April 1989 was also usually between 100 and 200 calls per week. Therefore, the number of violations reported through the hotline appears to have decreased after an initial startup flurry (i.e., until approximately June 1984) but to have remained fairly constant since that time.

However, several facts should be kept in mind. First, data on the violations reported through HERO for the years between 1984 and 1988 could not be obtained. The fact that the number of violations reported during late 1988 and early 1989 is approximately the same as the number of violations reported during the latter half of 1984 may be merely a coincidence. Second, traffic volumes have increased significantly on major roads (e.g., by 60 percent during the a.m. peak period on southbound I-5 since 1981), and additional HERO signs have been installed since 1984. Therefore, far more people are exposed to the HERO hotline signs. If the number of calls has remained constant while traffic volumes have increased, a smaller *percentage* of the people traveling along the area's roads are using the hotline to report violators than did so in 1984.

Violations reported through the hotline between March 1, 1989, and April 15, 1989, were analyzed to determine whether callers were giving incomplete information. In particular, the violations that were reported on the answering machine, which answers calls

before 8 a.m. and after 5 p.m., were compared with the violations reported directly to Metro staff. The results of this analysis are shown in Table 4.4.

More than half (55 percent) of the 1,304 violations that occurred within the time period analyzed were reported to the answering machine. Callers who left messages on the answering machine were more likely to leave incomplete information than were callers who reported violations directly to Metro staff. However, both categories of people were fairly likely to leave incomplete information. Over one-third (35 percent) of those who spoke to Metro staff left at least one incomplete item, and almost half (45 percent) of those who left messages on the machine did so.

These findings indicate that the usefulness of the data received through the hotline is substantially reduced by the incompleteness of the information received.

TABLE 4.4 - Completeness of Violation Data Received on the Answering Machine During Non-Work Hours

TYPE OF INFO NOT GIVEN	(N = 718) REPORTED TO ANS. MACH.		(N = 586) REPORTED TO METRO STAFF	
	#	%	#	%
no cross street	289	40	205	35
no route	23	3	0	0
no direction	37	5	0	0
no violation time	16	2	7	1
mainline or ramp not specified	59	8	20	3
vehicle occupancy not specified	41	6	5	1
at least one of the above left blank	320	45	207	35

The Public's Opinion of the HERO Hotline

As stated previously, detailed analysis of the public's opinion of the HERO program had never been conducted before this project to determine the public's perception of HERO, a factor that is almost as important as various agencies' opinion of the program. The key findings regarding the public's attitudes toward the HERO program are restated below.

- Eighty-one percent of the people sampled knew about the HERO program.
- Only 6.3 percent of the respondents said they had used the hotline to report an HOV violator.
- Over two thirds (71 percent) of those who knew about the hotline said they thought it was a good idea.
- Fifty percent of those who knew of the HERO program felt that the program reduced HOV violations.
- Only 6 percent of the people who knew about HERO thought the hotline reduced HOV violations a great deal.

The relative importance of the hotline's effect on the HOV lane violation rate and the public's attitude toward the hotline largely depends on the public's and various state agencies' (i.e., WSDOT, Metro, and WSP) perceptions of what the HERO program's primary objectives are. For example, if people generally feel that HERO is primarily a tool for reducing the violation rate on the HOV facilities, then clearly the most important criteria on which to judge HERO's success is the violation rate. On the other hand, if HERO is perceived to be a tool for relieving the public's frustration at seeing people violate the HOV lanes without getting cited, then the public's opinion of the program is the more important criteria with which to judge.

This project was not able to either prove or disprove that the existence of the HERO program has, in the long run, discouraged people from violating the HOV lanes and thus kept the violation rate lower than it would have been if HERO had not existed. While peak

period traffic volumes have increased significantly, the violation rate measured as part of this project was slightly lower than the violation rate measured before HERO's implementation. However, the significance of this difference could not be determined. Even if the difference between the two rates *were* significant, it would be difficult to prove that the existence of the HERO program, rather than other factors.

The public's attitude toward the program was quite favorable. The public's attitude is especially satisfactory because no educational programs regarding the program have been undertaken for over five years. In addition, most of the people who knew about HERO liked it in spite of the fact that they thought it didn't appreciably reduce HOV violations. Thus the results of the survey showed that HERO has provided the public with a system they believe to be valuable.

REFERENCES

1. Washington State Department of Transportation, "Transportation System Management (TSM) in Washington State," Washington State Department of Transportation (July 1985), 109 pp.
2. Hamm, J.T, and Lewis, R.J., "HOV Enforcement Project Final Report," Report No. TWA-1006(001), Washington State Department of Transportation, Municipality of Metropolitan Seattle, and Washington State Patrol (August 1985), 35 pp.
3. Ulberg, C., and McCormack, E., "Auto Occupancy Monitoring Study," Report No. WA-RD 157.1, Washington State Transportation Center (June 1988), 32 pp.
4. Nesselrodt, J., Virginia Department of Transportation, Richmond, VA; telephone conversation in September 1988.
5. Klusza, R., California Department of Transportation, HOV Operations, Los Angeles, CA; telephone conversation in September 1988.
6. JHK and Associates, "Interim Data Summary: The Effects of the Change in Restricted Hours on I-66," Virginia Department of Highways and Transportation (January 1985), 48 pp.
7. Christiansen, D.L., Texas Transportation Institute, Texas A & M University, College Station, TX; telephone conversations in September and October 1988.
8. Schwab, T., Transportation Analysis Manager, Oregon Department of Transportation, Highway Division, Region 1, Milwaukie, OR; telephone conversation in September 1988.
9. Oregon Department of Transportation, "Banfield High Occupancy Vehicle Lanes: Final Report," Report No. FHWA/RD-78/59, Oregon Department of Transportation (March 1978), 129 pp.
10. Powers, J.C., Garden State Parkway High Occupancy Vehicle Lane Final Report, New Jersey Department of Transportation (May 1982), 35 pp.
11. Powers, J.C., Project Engineer, Bureau of Transportation Systems Research, New Jersey Department of Transportation, Trenton, NJ; telephone conversations and correspondence, September and December 1988.