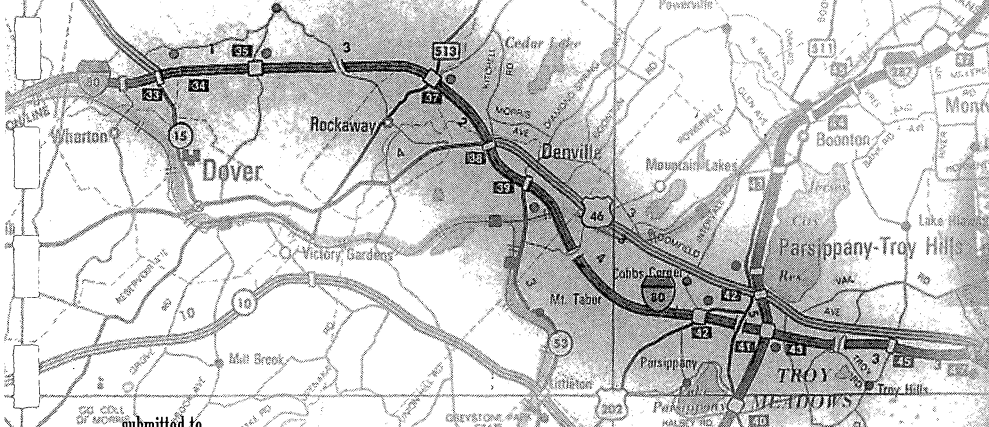
I-80 HOV Lane Evaluation Study



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16. Abstract

This report presents the results of the I-80 High Occupancy Vehicle (HOV) lane evaluation study. The purpose of the study is to determine the effectiveness of the I-80 HOV lanes between Route 15 and I-287 in Morris County, New Jersey. Study tasks included review of available traffic count data, data collection and analyses, and air quality benefit quantification.

The goal of the I-80 HOV lanes is to increase the persons per hour throughput of I-80 during peak periods. Achievement of the goal will result in overall corridor traffic congestion relief and reduction in vehicle emissions due to the reduction in vehicle miles traveled.

The objectives for the HOV lane are to move more people in HOVs, move more persons per vehicle, reduce travel times for HOV travelers, attain low HOV lane violation rates, have minimal negative impact on safety, sustain public support, improve air quality and reduce fuel consumption, enhance bus service, and be cost effective.

The data collection program included traffic volumes, vehicle classifications, vehicle occupancies, travel times, accident records, park and ride lot usage, and HOV lane enforcement data and costs.

Analyses and comparisons of the data were made for before construction and after HOV lane implementation. These comparisons found increases in the percentage of HOVs in the traffic stream and the percentage of people in HOVs after implementation, and an HOV lane violation rate below 10 percent. Travel time savings of about 3 minutes on average were observed. Accident numbers were higher during the peak periods, but stayed the same in daily trends, based on limited after implementation data. The air quality analysis showed reductions in vehicle emissions, vehicle miles traveled, and fuel consumption over a hypothetical I-80 with all general purpose lanes. Bus operators perceived significant travel time savings and schedule adherence. Park and ride lot usage remained flat. Public perception of the HOV lanes was not clear because of the lack of data available.

The net result of the findings of this study suggest that the I-80 HOV lane facility enjoys a modest success. However, longer term monitoring should occur, especially in light of the recent and planned implementation of HOV facilities on I-287 and the New Jersey Turnpike. As more HOV lanes are implemented in New Jersey, systemwide benefits may encourage a greater amount of carpooling and vanpooling.

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INTRODUCTION

This report presents the results of the I-80 High Occupancy Vehicle (HOV) lane evaluation study. The purpose of the study is to determine the effectiveness of the eastbound and westbound I-80 HOV lanes between Route 15 and I-287 in Morris County. The evaluation study included defining the goal and objectives for operation of the HOV lanes and measures of effectiveness to determine if objectives are met. The following tasks were performed as part of this study:

1. Review of available traffic count data
2. Data collection
3. Data analyses
4. Air quality benefit quantification

The evaluation study was performed for a two-year period from March 1994 to March 1996.

I-80 HOV LANES

The I-80 HOV lanes extend from the vicinity of Route 15 (M.P. 34.3) to approximately one mile east of I-287 (M.P. 45.0). The lanes cover a distance of 10.6 miles eastbound and 10.2 miles westbound. The HOV lanes operate in the left travel lane eastbound from 6:00 A.M. to 9:00 A.M. and westbound from 3:00 P.M. to 7:00 P.M., Monday through Friday, for buses and carpools/vanpools with two or more people. When not operating as an HOV facility, the lanes are open to general purpose traffic. There are no buffers to separate the eastbound and westbound left travel lanes from the adjacent travel lanes. HOV traffic may enter and exit the HOV lanes from the adjacent travel lanes along their entire length. The HOV lane pavement is marked with the standard diamond symbol. Signing alerts motorists to the HOV designation, vehicle occupancy requirements, and operating periods.

The inside shoulder adjacent to the HOV lane is typically 9 feet wide. At intervals of 3 to 4 miles the inside shoulder is widened to provide enforcement areas. At these locations, state troopers observe traffic in the HOV lane and pull over violators.

GOAL AND OBJECTIVES

The goal of the I-80 HOV lanes is to increase the person-per-hour throughput of I-80 during peak periods. This increase can be accomplished by providing a time advantage in the HOV lanes for those willing to carpool or take bus transit in contrast to the HOV lanes being redesignated for general purpose traffic and primarily serving single occupant vehicles.

Achievement of the goal will generate the following benefits resulting primarily from the reduction in vehicle miles traveled:

1. Overall corridor traffic congestion relief
2. Reduction in vehicle emissions.

The objectives for the I-80 HOV lane define what must be accomplished to achieve the goal and realize the desired benefits. A list of the objectives is provided below.

1. Move more people in HOVs (vehicles having two or more occupants)
2. Move more people per vehicle

3. Reduce travel times for HOV travelers
4. Attain low HOV lane violation rates
5. Have minimal negative impact on safety
6. Sustain public support
7. Improve air quality and reduce fuel consumption
8. Enhance bus service
9. Be cost effective

CONCLUSIONS

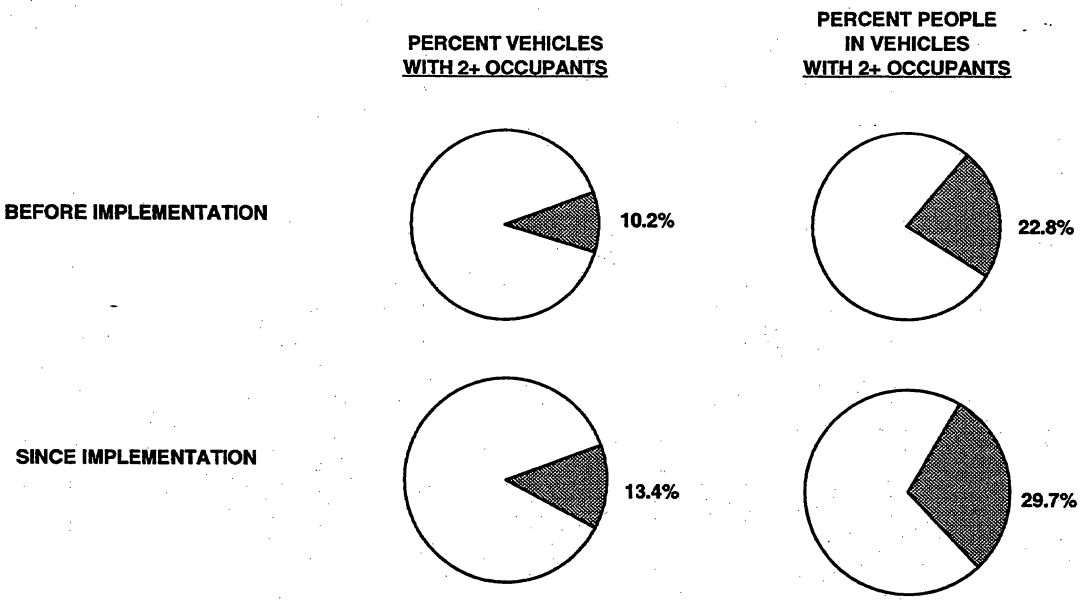
On the basis of the two-year evaluation study, the project goal of increasing the person-per-hour throughput of I-80 during peak periods by moving more people in fewer vehicles than if the left lanes had been opened to general purpose traffic appears to have been achieved with implementation of HOV lanes on I-80. As an example, a comparison of I-80 "before" versus "since" HOV lane implementation (see Figure S-1 on page S-3) shows that the peak period percentages of HOVs and people in HOVs have increased on I-80 after HOV lane implementation. This trend exhibited on I-80 appears to run counter to the latest available trends in carpooling in both New Jersey and across the nation. Based on the latest data available, carpooling percentages have dropped from 19.7 percent in 1980 to 13.4 percent in 1990 nationally, and from 18.3 percent to 12.4 percent in New Jersey. The negative trend in carpooling appears to extend into the 1990s.

Some of the other objectives identified above, such as the low HOV lane violation rate, and improving air quality and reducing fuel consumption appear to have been met. Other objectives, such as sustaining public support and having minimal negative impact on safety, do not have sufficient data to make a judgment based on the first two years of operation. Further, while travel times for HOV lane travelers are less than those for general purpose lane motorists, these travel time differences are not generally substantial.

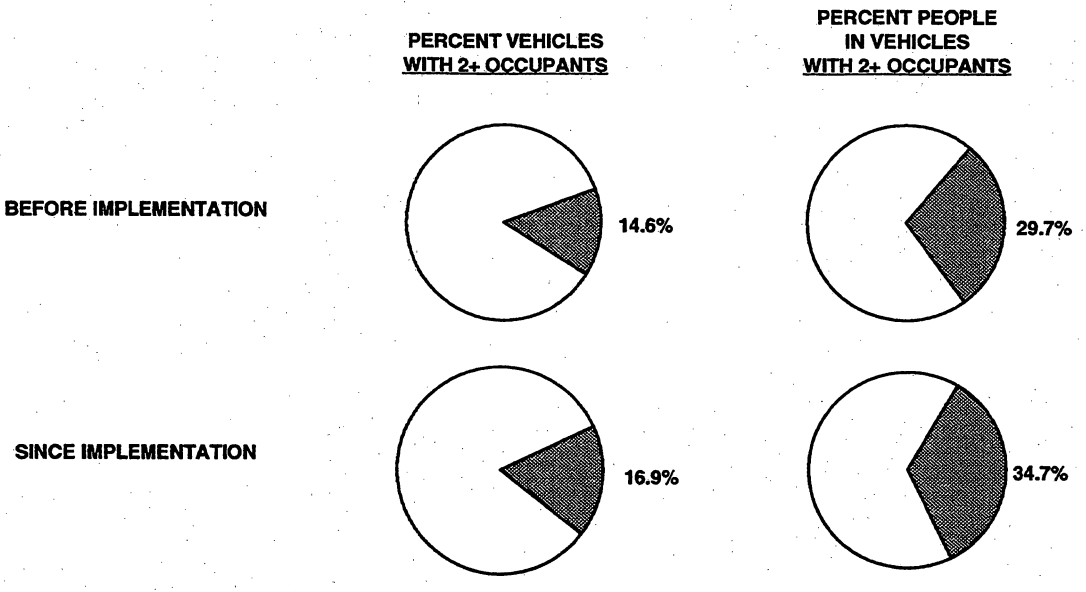
The impact of the HOV lane on safety, measured by accident records, indicated that same direction rear end accidents have increased in number since the opening of the I-80 HOV lane. Post-implementation accident data was only available through the end of 1994, not a sufficient time to determine longer term impacts of the HOV lanes on safety or to validate the observed peak period increase. Further, specific reasons for this increase could not be determined based on the available data. Accident records should continue to be reviewed as they become available before any conclusion regarding safety can be made.

The net result of the findings of this study suggest that the I-80 HOV lane facility enjoys a modest success. However, longer term monitoring should occur, especially in light of the recent and planned implementation of HOV facilities on I-287 and the New Jersey Turnpike. As more HOV lanes are implemented in New Jersey, systemwide benefits may encourage a greater amount of carpooling and vanpooling.

I-80 EASTBOUND



I-80 WESTBOUND



NOTES:
1. I-80 HOV Lane operation began in March 1994.
2. Before Implementation data is the average of data collected in October and November, 1993.
3. Since Implementation data is the average of data collected between April, 1994 and March, 1996.

Figure S-1
Peak Period Comparisons of
Percent Vehicles With 2+ Occupants and
Percent People in Vehicles With 2+ Occupants
Before vs. Since HOV Lane Implementation

I. INTRODUCTION

This report presents the results of the I-80 High Occupancy Vehicle (HOV) lane evaluation study. The purpose of the study is to determine the effectiveness of the eastbound and westbound I-80 HOV lanes between Route 15 and I-287 in Morris County. The evaluation study included defining the goal and objectives for operation of the HOV lanes and measures of effectiveness to determine if objectives are met. The following tasks were performed as part of this study:

1. Review of available traffic count data
2. Data collection
3. Data analyses
4. Air quality benefit quantification

The evaluation study was performed for a two-year period from March 1994 to March 1996.

BACKGROUND

Need to Evaluate the I-80 HOV Lanes

Evaluation of the I-80 HOV lanes was necessary to determine if the lanes are providing the desired benefits and if the expenditure of public funds was justified. The evaluation also was necessary to determine if the lanes are operating safely and efficiently. Information on usage, violation rates, and accidents were used to identify if operational changes, such as operating hours, vehicle occupancy requirements, or levels of enforcement, are necessary to obtain or maintain the desired benefits. Finally, the evaluation results can serve to calibrate demand estimation procedures for feasibility studies of future HOV facilities in New Jersey. The success of future projects can be enhanced by the experience gained in evaluating the I-80 HOV lanes.

Development of the I-80 HOV Lanes

In February 1991, the New Jersey Department of Transportation (NJDOT) initiated a study to determine the feasibility of placing HOV lanes on I-80 in Morris County. Prior to the study, construction had begun on a fourth lane in each direction within the existing median of I-80 from Route 15 to I-287. The construction of the new lanes offered an opportunity for considering HOV use of the lanes before they were opened to traffic. The feasibility study was structured to include analyses of technical data (traffic patterns, nature of congestion, roadway characteristics) and public attitudes via telephone surveys and executive interviews. This information provided decision-makers with a clear impression of how feasible and successful HOV lanes would be along I-80.

The study process involved all affected agencies in the decision-making process. To accomplish this, a multi-disciplinary project steering committee was formed to review findings, offer suggestions, reach consensus, and recommend particular courses of action to NJDOT's Commissioner. The Steering Committee included representatives from NJDOT, New Jersey State Police, NJ TRANSIT, New Jersey Turnpike Authority, Morris County DOT, Somerset County Planning Board, North Jersey Transportation Coordinating Council, MC RIDES, Inc., and the Federal Highway Administration. The results of the study were presented in the "Route I-80 High

Occupancy Vehicle Lane Feasibility Study," dated January 1992, by Parsons Brinckerhoff Quade & Douglas, Inc. and Pacific Rim Resources.

In January 1992, the Steering Committee agreed that HOV lanes can operate successfully on I-80, based on their findings that:

1. HOV lanes are geometrically and operationally viable, and
2. HOV lanes are needed due to traffic congestion and to foster the State's compliance with the 1990 Clean Air Act Amendments as part of its Strategic Implementation Plan (SIP).

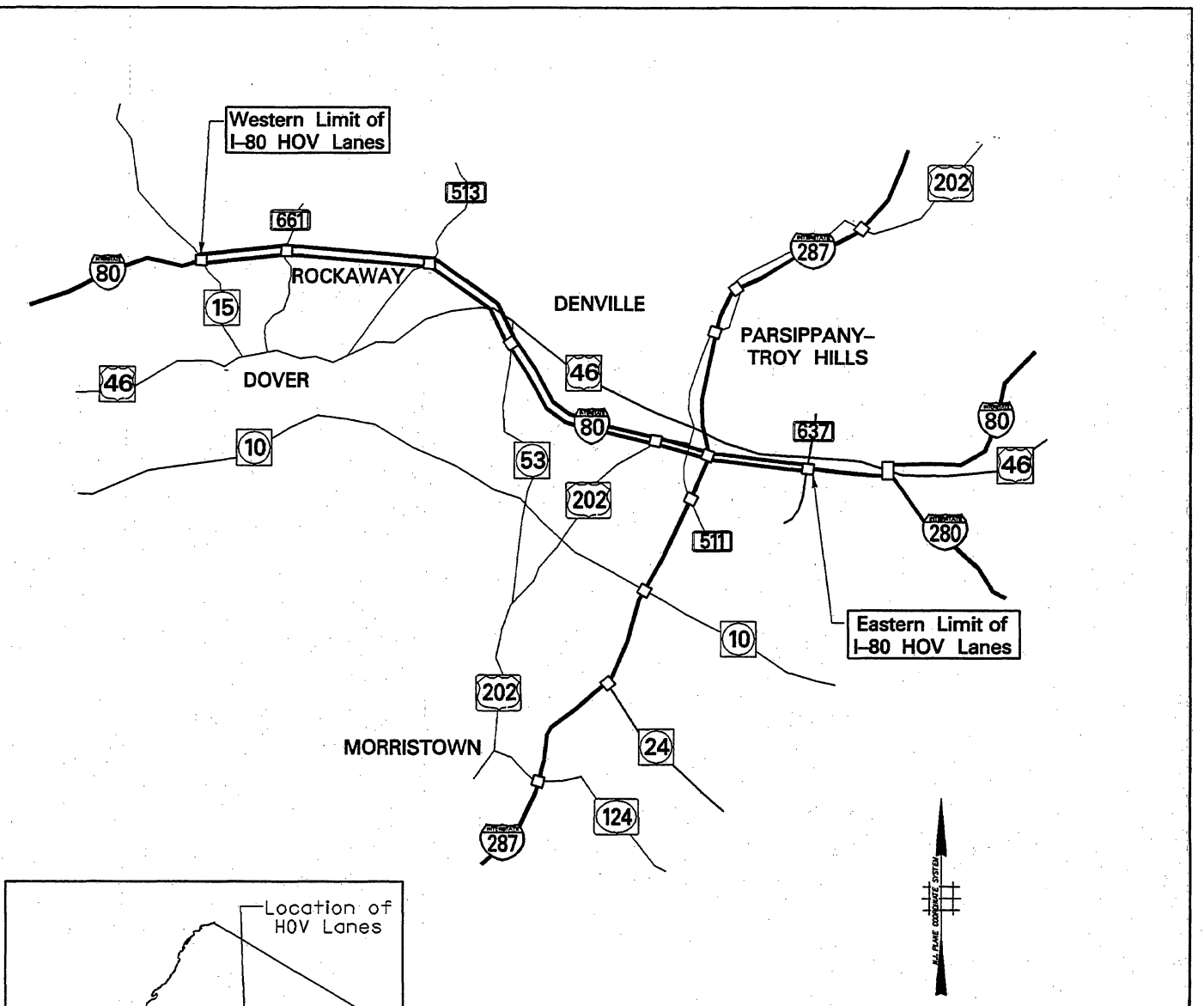
Changes were required in the on-going construction contracts to incorporate HOV lane elements (signing, pavement markings, and HOV lane enforcement areas). All work was completed in early 1994 and the I-80 HOV lanes were opened to traffic on March 7, 1994.

The I-80 HOV lanes extend from the vicinity of Route 15 (M.P. 34.3) to approximately one mile east of I-287 (M.P. 45.0), see Figure 1 (page 3). The lanes extend for 10.6 miles eastbound and 10.2 miles westbound. The HOV lanes operate in the left travel lane eastbound from 6:00 A.M. to 9:00 A.M. and westbound from 3:00 P.M. to 7:00 P.M., Monday through Friday, for buses and carpools/vanpools with two or more people. When not operating as an HOV facility, the lanes are open to general purpose traffic. There are no buffers to separate the eastbound and westbound HOV lanes from the adjacent travel lanes. HOV traffic may enter and exit the HOV lanes from the adjacent travel lanes along their entire length. The HOV lane pavement is marked with the standard diamond symbol. Ground-mounted and overhead signing alert motorists to the HOV designation, vehicle occupancy requirements, and operating periods.

The inside shoulder adjacent to the HOV lane is typically 9 feet wide. At intervals of 3 to 4 miles the inside shoulder is widened to provide enforcement areas. At these locations, state troopers can observe traffic in the HOV lane and pull over violators.

Reference Document

The evaluation study was based on the "I-80 HOV Lane Evaluation Plan," Revised Draft, March 21, 1994, prepared by the NJDOT Office of Region II Design. This reference was used as a guide. The evaluation plan was tailored to reflect information obtained and experience gained during the evaluations.



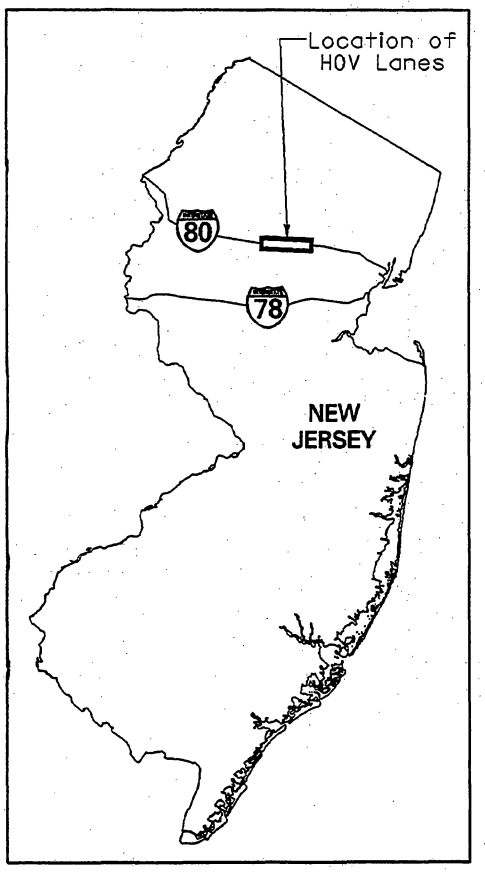


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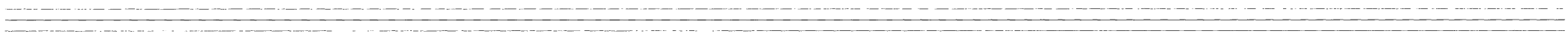
Figure 1

Location of I–80 HOV Lanes



II. GOAL AND OBJECTIVES

The development of the goal, objectives, and measures of effectiveness of the I-80 HOV lanes is predicated upon the ability to determine whether impacts on I-80 can be attributed directly to the implementation of the HOV lanes or to other external factors. While the evaluation of the I-80 HOV lanes required monitoring changes to travel characteristics on the general purpose lanes and the HOV lanes of I-80, not all of the changes in the travel characteristics are attributable to implementation of the HOV lanes. For example, the influence of the Employer Trip Reduction Program and trends in the economic health of the region also affected commuting behavior. To improve the ability to distinguish which changes were attributable to the HOV lanes, I-78 was selected and monitored during the same time period as the I-80 monitoring period. I-78 was chosen by the NJDOT because both I-80 and I-78 are east-west interstate highways serving similar corridor land uses in north-central New Jersey and also serving the New York metropolitan area, and I-78 does not have HOV lanes. Moreover, carpool usage on I-78 would not likely be influenced by the HOV lanes on I-80. However, I-78 is not considered a control freeway because the levels of traffic congestion and densities of developments differ along the I-80 and I-78 corridors. Similar data to that collected on I-80 was collected on I-78 with the intention of comparing trends in travel behavior on the two routes and accounting for external influences on travel behavior on I-80 in the assessment of the effectiveness of the I-80 HOV lanes.

GOAL

The goal of the I-80 HOV lanes is to increase the person-per-hour throughput of I-80 during peak periods by moving more people in fewer vehicles than if the left lanes had been opened to general purpose traffic.

Achievement of the goal was expected to generate the following benefits resulting primarily from the reduction in vehicle miles traveled:

1. Overall corridor traffic congestion relief
2. Reduction in vehicle emissions.

OBJECTIVES OF THE HOV LANE

The objectives for the I-80 HOV lane define what had to be accomplished to achieve this goal and realize the desired benefits. A list of the objectives is provided below:

1. Move more people in HOVs (vehicles have two or more occupants)
2. Move more people per vehicle
3. Reduce travel times for HOV travelers
4. Attain low HOV lane violation rates
5. Have minimal negative impact on safety
6. Sustain public support
7. Improve air quality and reduce fuel consumption
8. Enhance bus service
9. Be cost effective

Each of these objectives is discussed below along with the definition of measures of effectiveness adopted for achieving the objectives.

1. Objective: Move More People in HOVs

The percentage of people traveling in HOVs on I-80 since implementation of the HOV lanes compared to that prior to implementation gives an indication as to the attractiveness of the HOV lanes to carpoolers and vanpoolers. It is the ability to use the HOV lanes that attracts carpoolers and vanpoolers; however, it is not necessary that the HOVs travel in the HOV lanes, especially at times when the general purpose lanes do not experience the customary recurring congestion.

Measure of Effectiveness:

1. Percentage of people traveling in HOVs on I-80 since implementation of the HOV lanes compared to before implementation.

2. Objective: Move More People Per Vehicle

Average vehicle occupancy (AVO) is a measure of the extent of carpooling and vanpooling on a highway. The AVO is calculated by dividing the number of people passing a point on a highway by the number of vehicles passing that same point. Comparing the AVO on I-80 after HOV lane implementation to the AVO before implementation indicates if carpooling and vanpooling have increased as a result of HOV lane implementation. The before implementation AVO can be used to approximate the vehicle occupancy composition of I-80 if the left lanes were to be opened to general purpose traffic. This perspective will identify whether the implementation of the HOV lanes fulfills the goal of moving more people in fewer vehicles than a comparable four-lane non-HOV facility. This comparison would not, however, discern increases or decreases due to other factors that may affect carpooling and vanpooling on a statewide or regional basis, such as the Employer Trip Reduction Program and the state of the economy, from increases due to the implementation of the HOV lanes.

Improving the AVO in the I-80 corridor is also important in light of the voluntary Employer Trip Reduction Program. The goal of this voluntary program is to increase the average vehicle occupancy by at least 25 percent above the existing average vehicle occupancy at work locations with over 100 employees. The I-80 HOV lane is one tool to support achievement of this goal.

Measure of Effectiveness:

1. Average vehicle occupancy on I-80 since HOV lane implementation compared to AVO prior to implementation.

3. Objective: Reduce Travel Times for HOV Travelers (As Compared To General Purpose Traffic)

Travel time savings and more reliable trip times are two of the primary incentives for commuters to change their mode of travel from single occupant vehicles to carpools, vanpools, and buses. In general, travel times for motorists using the HOV lane should be less than corresponding travel times for motorists in the general purpose traffic lanes, and travel time reliability should be better for motorists using the HOV lanes. Suggested guidelines regarding travel time savings on a line haul HOV facility such as I-80 are that a minimum savings of 5 minutes and a desirable savings of 8 minutes should be achieved for a facility to be successful.[2]

In January 1994, a service patrol began operating on I-80 within the limits of the HOV lane. The patrol serves to detect and report traffic incidents to improve incident response time and

minimize traffic delays. As a result of the service patrol, travel time reliability for all motorists (HOVs and general purpose traffic) is improved.

Measures of Effectiveness:

1. Travel time savings for motorists using the HOV lane compared to motorists in the adjacent general purpose traffic lanes of at least 5 minutes.
2. Range of travel speeds in the HOV lane compared to the corresponding range of travel speeds in the general purpose lanes.

4. Objective: Attain Low HOV Lane Violation Rates

Effective enforcement of the I-80 HOV lanes is critical to the success of the lanes because it is a focus of the public's perception of the integrity of the operation of the lanes. Maintaining a low violation rate (i.e., percentage of vehicles using the HOV lane that do not have at least two occupants) is important in fostering public support for the HOV lanes by optimizing the availability of the lanes for HOVs, and reinforcing the perception that the lanes are used properly. Charles Fuhs, in his HOV manual, states that, "In general, violation rates should be capable of being managed to no more than 10 to 20 percent of the observed traffic stream in the HOV facility."[(2)] Strict enforcement may reduce speeds and encourage rubber-necking in the short term. However, in the longer term, strict enforcement allows HOVs to gain optimum travel time savings by keeping the violators out of the HOV lane.

Measure of Effectiveness:

1. HOV lane violation rate (percentage of vehicles using the HOV lane who do not have at least two occupants), compared to a maximum violation rate of 10 percent as identified through engineering judgment.

5. Objective: Have Minimal Negative Impact on Safety

Measuring the impact of the HOV lane with regard to highway safety requires two types of accident analysis -- a "before" and "after" comparison of accident totals and a similar comparison of accident types. The "before" condition represents the time period prior to the start of fourth lane (HOV) construction which began in 1989. The "after" condition represents the time period since the opening of the HOV lanes in March 1994. For both the before and after conditions, the information is grouped to include accidents that occurred only during current HOV lane operations and accidents that occurred throughout the day. Current HOV lane operations are defined as eastbound between 6:00 A.M. and 9:00 A.M., and westbound between 3:00 P.M. and 7:00 P.M., Monday through Friday.

Before and after comparisons of accident types for peak periods and for daily periods allow for identification of an increase or decrease in a specific type of accident after widening of I-80 and implementation of HOV lane operation. Such comparisons may also determine if any correlation exists between the change in the occurrence of a given accident type and the widening of I-80 or the implementation of HOV lane operation.

Peak period and daily comparisons of accident trends serve to identify whether the HOV lanes may have had an impact on the safety of I-80 at the most critical times of the day; i.e., when traffic volumes are at their heaviest.

Accident records for the years during construction (1990-1993) will also be included to provide a continuous period of time for review of accident trends.

Measures of Effectiveness:

1. Before construction and after HOV lane implementation comparison of peak period and daily accident totals.
2. Before construction and after HOV lane implementation comparison of peak period and daily accident types.
3. Comparison of peak period to daily total accident characteristics.

6. Objective: Sustain Public Support

Support for the I-80 HOV lane should exist among users, non-users, the general public, and policy makers. Public support is important because the I-80 HOV lane is the precursor of a much larger HOV network for New Jersey. Public understanding, acceptance, and endorsement of the HOV concept as a viable transportation improvement will facilitate development and public acceptance of additional HOV facilities in New Jersey.

Measures of Effectiveness:

1. Public support of the HOV lane as measured by media coverage and correspondence to the NJDOT.
2. Demonstrated acceptance of the HOV lane by maintenance of a low violation rate (see Objective 4).

7. Objective: Improve Air Quality and Reduce Fuel Consumption

The impact on air quality realized by implementation of the HOV lane can be measured by comparing total emissions, vehicle miles of travel, and fuel consumption for I-80 with the HOV lane in place with a hypothetical scenario assuming the fourth lane was opened to general purpose traffic. To be an effective facility, each of the three measures should decrease over a four general purpose lane scenario.

Use of HOV lanes can result in lower air pollution emissions in two ways -- reduction in running emissions, and reduction in trip end emissions. HOV lanes achieve reductions in running emissions because of the increased use of carpools, vanpools and buses, resulting in fewer vehicle miles traveled, and because of higher and more consistent speeds associated with uncongested operations in the HOV lane. HOV lanes also reduce trip end emissions. However, it is necessary to take into account that many users of HOV lanes drive to meet their carpool or bus, thereby impacting overall effectiveness in reducing emissions. In contrast, HOV lanes are most effective in reducing emissions when carpoolers and vanpoolers are picked up at or within walking distance of their homes.

Air quality impacts due to the existence of the HOV lane are not limited to the operational limits of the HOV lane. Carpool formation and spatial shift can and does originate in areas upstream of the area of HOV lane operations. Therefore, air quality impacts must be measured in two components -- on-system and off-system impacts.

Measures of Effectiveness:

Comparisons of the following for I-80 with an HOV lane to I-80 with four general purpose lanes:

1. Vehicular emissions.
2. Vehicle miles of travel.
3. Total fuel consumption.

The above parameters are measured for both on-system and off-system impacts.

8. Objective: Enhance Bus Service

Bus travel along I-80 during peak commuting periods was recorded in the 1992 Feasibility Study. Eastbound A.M. peak hour bus volumes varied from 17 buses west of Route 15 to 26 buses east of Beverwyck Road. Westbound P.M. peak hour volumes were higher, averaging 40 buses at Beverwyck Road and 19 buses at Mt. Hope Avenue. In conjunction with the opening of the HOV lanes, two new bus routes were introduced in the corridor by NJ TRANSIT. The routes were designed to connect park-and-ride lots in the western end of the corridor to corporate office parks in the eastern end, with the buses using the HOV lanes on I-80 to speed their trip.

Measures of Effectiveness:

1. Comparison of bus volumes before and since implementation of the HOV lane.
2. Comparison of bus patronage and utilization, before and since implementation.
3. Bus schedule adherence, measured by on-time performance.

9. Objective: Be Cost Effective

The cost-effectiveness of an HOV facility is measured by the value of benefits to the cost of the facility. For an HOV facility to be cost effective, the benefits should outweigh the costs.

Benefits are determined on the basis of reductions in person travel times, savings in fuel consumption and vehicle miles of travel, and reductions in vehicle emissions. HOV facility costs include initial capital costs for construction and annual costs for operation and maintenance.

Construction costs for the widening had been authorized when the additional lane was to be a general purpose lane. It was only after construction had begun that consideration was given to making the lane an HOV lane. Therefore, the cost to construct the lane would not be considered in determining cost-effectiveness. The costs of changes necessary to make the lane an HOV lane were minor.

Measure of Effectiveness:

1. Comparison of annual operating costs to the derived benefits of carpooling and vanpooling.

III. STUDY PROCEDURES

DATA COLLECTION PROGRAM

The previous section defined the measures of effectiveness for each of the objectives in the I-80 HOV lane evaluation study. Evaluation of each of the measures of effectiveness required data collection and analysis to determine if the objectives were met. The following information was obtained as part of the data collection program:

1. Peak period traffic counts on I-80, I-78, and U.S. 46. The counts included vehicle volumes, classifications, and occupancies for the three highways on a per lane basis.
2. Peak period travel time measurements on I-80 for the HOV lanes and the general purpose traffic lanes.
3. HOV lane violation data.
4. Accident data. The data included number and type of accidents.
5. Public attitudinal data.
6. Bus volumes and ridership data.
7. Park and ride lot usage.
8. HOV lane operating (enforcement) costs.

The field data collection program included traffic counts and travel time measurements. The program began in March 1994 and ended in March 1996. Traffic count data was collected daily during the first week of HOV lane operation, March 7 through 11, 1994, and weekly for the remainder of March. One set of counts was performed each month during the first year of HOV lane operation from April 1994 to March 1995. Travel time measurements were performed monthly from July 1994 to March 1995. Subsequently, one set of counts and travel time measurements was performed approximately every three months until March 1996. The NJDOT collected traffic count data through June 1994. PB and New Jersey Institute of Technology took over the data collection effort beginning in July 1994.

The field counts taken on I-80 were used to derive vehicle occupancy, person movement, and HOV lane violation rates. Travel time measurements were taken on I-80 to assess differences in speeds and travel times between HOV lane and general purpose lane motorists. I-78 field counts provided information on vehicle occupancy and person movement on a non-HOV facility. This information was collected with the intention of comparing trends on I-80 with HOV lanes to a facility without HOV lanes. However, I-78 is not considered a control freeway due to differences in traffic congestion levels and density of developments along the I-80 and I-78 corridors.

Field counts on U.S. 46 were collected to obtain information on traffic diversions of HOVs from U.S. 46 to I-80 after implementation of the HOV lanes. U.S. 46 closely parallels I-80 within a large part of the HOV lane operating area. Data, however, was not available for the before implementation period at the location surveyed.

Additional field traffic counts were performed during June 1995 on a majority of the ramps within the limits of HOV lane operation. The counts provided vehicle occupancy and classification information. Major ramps were counted for the full peak period, while the remaining ramps were counted for a 15-minute sample period. The 15-minute sample counts provided a basis for comparison to previous count data collected in 1991 as part of the Feasibility Study. Mainline counts performed as part of this evaluation study, the peak period and sample ramp counts, and the previous data from the Feasibility Study served as volume inputs to the air quality assessment. Appendix A provides a summary of the June 1995 ramp counts. The ramps chosen as major were determined based on the peak direction of travel and whether an

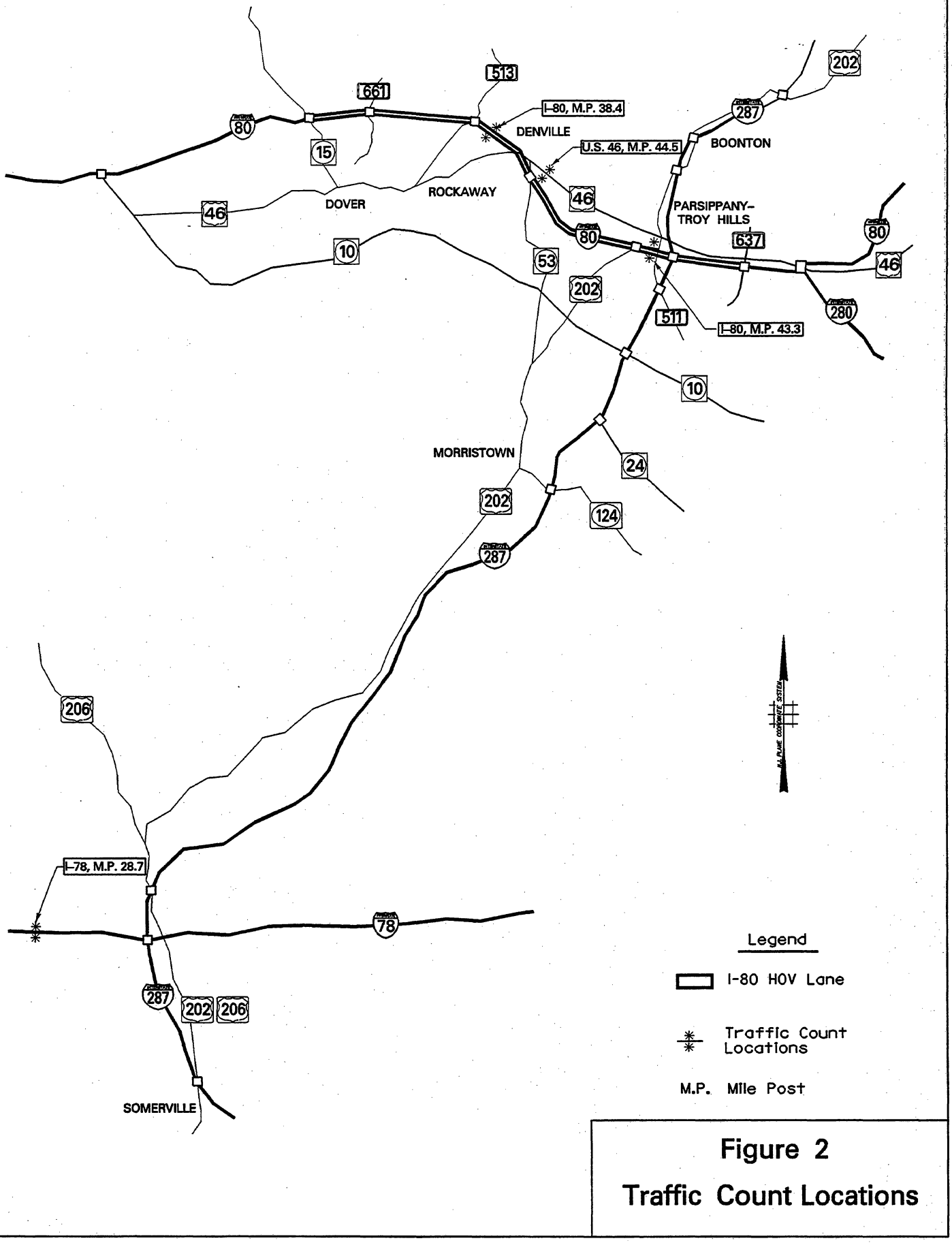
interchange is a major traffic generator or attraction during the peak periods. For instance, the Route 15, U.S. 202 and I-287 interchanges were chosen as major generators or attractions for traffic. During the A.M. peak period, the Route 15 on-ramp was counted as a major generator, while the U.S. 202 and I-287 off-ramp were counted as major attractions. The opposite was true for westbound ramps during the P.M. peak period. In one case, a full peak period count was performed for the westbound local-to-express crossover near Beverwyck Road because no previous data was available for this new ramp.

The vehicle classification counts measured the number of cars, light trucks, heavy trucks, transit buses, and school buses in the traffic stream. The vehicle occupancy counts measured the number of occupants per passenger car and van (single-occupant, two-occupant, and three-or-more-occupant cars and one-to-three-occupant and four-or-more occupant vans). The NJDOT data collection procedure assigned an occupancy of 30 passengers per bus and 1.1 occupants per truck. These values were used throughout the data collection program to maintain consistency in data reporting.

Field counts were performed manually during the A.M. and P.M. peak periods -- 6:00 A.M. to 9:00 A.M. in the eastbound direction and 3:00 P.M. to 7:00 P.M. in the westbound direction. Count data was obtained at two locations on I-80 (mileposts 38.4 and 43.3), one location on I-78 (milepost 28.7), and one location on U.S. 46 (milepost 44.5), see Figure 2 (page 11). The count locations are the same as were used by the NJDOT to collect "before" data in October and November 1993, except for the U.S. 46 location, for which "before" data was not collected. Summaries of the field counts are found in Appendix A.

Peak period travel times and speeds were measured along the length of the I-80 HOV facility both for the HOV lane and the adjacent general purpose traffic lanes. Travel time data was collected using the "floating car" method wherein test vehicles float with the traffic (i.e., keep up with traffic in the HOV lane, and pass as many vehicles as pass the test vehicle in the general purpose traffic lanes). Two "floating cars", one traveling in the HOV lane, the other in the general purpose lanes, started at the same time to collect travel time data, allowing for direct comparisons of speeds and travel time savings. Generally, four runs were performed during the A.M. peak period and five runs during the P.M. peak period. These runs served to help identify when during the HOV lane operating periods and at which locations along I-80 congestion occurs. Travel time and speed measurements are summarized in Appendix A.

Accident data, park and ride lot usage, and HOV lane enforcement costs were obtained from the NJDOT. HOV lane enforcement data was obtained from the State Police. Information on bus schedules and patronage was obtained from NJ TRANSIT and through telephone interviews with the private bus operators. Much of the information provided by the bus operators was in the form of order-of-magnitude estimates which did not represent hard data. Public attitudinal trends were obtained from monitoring press coverage, letters to the editor, and letters and telephone calls to the NJDOT.



PARSONS BRINCKERHOFF CAUD DATA

OPERATOR	cunk
PLOT DATE	25-JUN-1997 12:33
PENTABLE	pentable-heh.tbl
DESIGN FILE	n:\100246\mopl.dgn

Figure 2

Traffic Count Locations

DATA ANALYSIS

Statistical and non-statistical analyses were performed for the data obtained from the data collection program. Traffic volume, vehicle classification, vehicle occupancy, HOV lane violation, and lane 3 truck percentage data could be easily categorized by measure of effectiveness and by time period such that statistical analyses could be made and trends could be discerned. Other data sets such as accident data, travel times/travel speeds, and air quality analysis data, for which this categorization was not possible or meaningful, required other, non-statistical analysis procedures to derive meaningful conclusions. Statistical and non-statistical techniques are described below.

Statistical Data Analysis

I-80 traffic volume, classification and occupancy data were categorized by the measures of effectiveness derived in the previous chapter and time periods corresponding to before and after implementation of the I-80 HOV lanes for the statistical analyses. Four time periods were considered, as shown below.

Time Periods for Statistical Analysis

Time Period	Description
Prior to March 1994	Before Implementation
March 1994	Day One HOV Lane Operation
April 1994 through March 1995	One Year Startup Period (Year One HOV Lane Operation)
April 1995 through March 1996	Second Year Short Term Operation (Year Two HOV Lane Operation)

Exceptions to this categorization were the HOV lane violation data, which were organized by enforcement profile, and the lane 3 truck percentage, for which before and after truck ban categories were used. However, the statistical procedures discussed in this section were applied to these parameters as well.

The duration of one year for the startup period was chosen based on the anticipated timeframe for changes in travel behavior resulting from implementation of the HOV lane. Diversion into an HOV lane would be expected to occur within approximately six weeks after opening of the HOV lanes, while mode shifts would occur over a year or longer following opening. Day One Operation, usually referring to the first few days of the operation of an HOV lane facility, comprised the entire month of March 1994 to allow for the transition to the new traffic pattern. The Before Implementation category allows for comparison between post-implementation data and data collected by the NJDOT in October and November 1993.

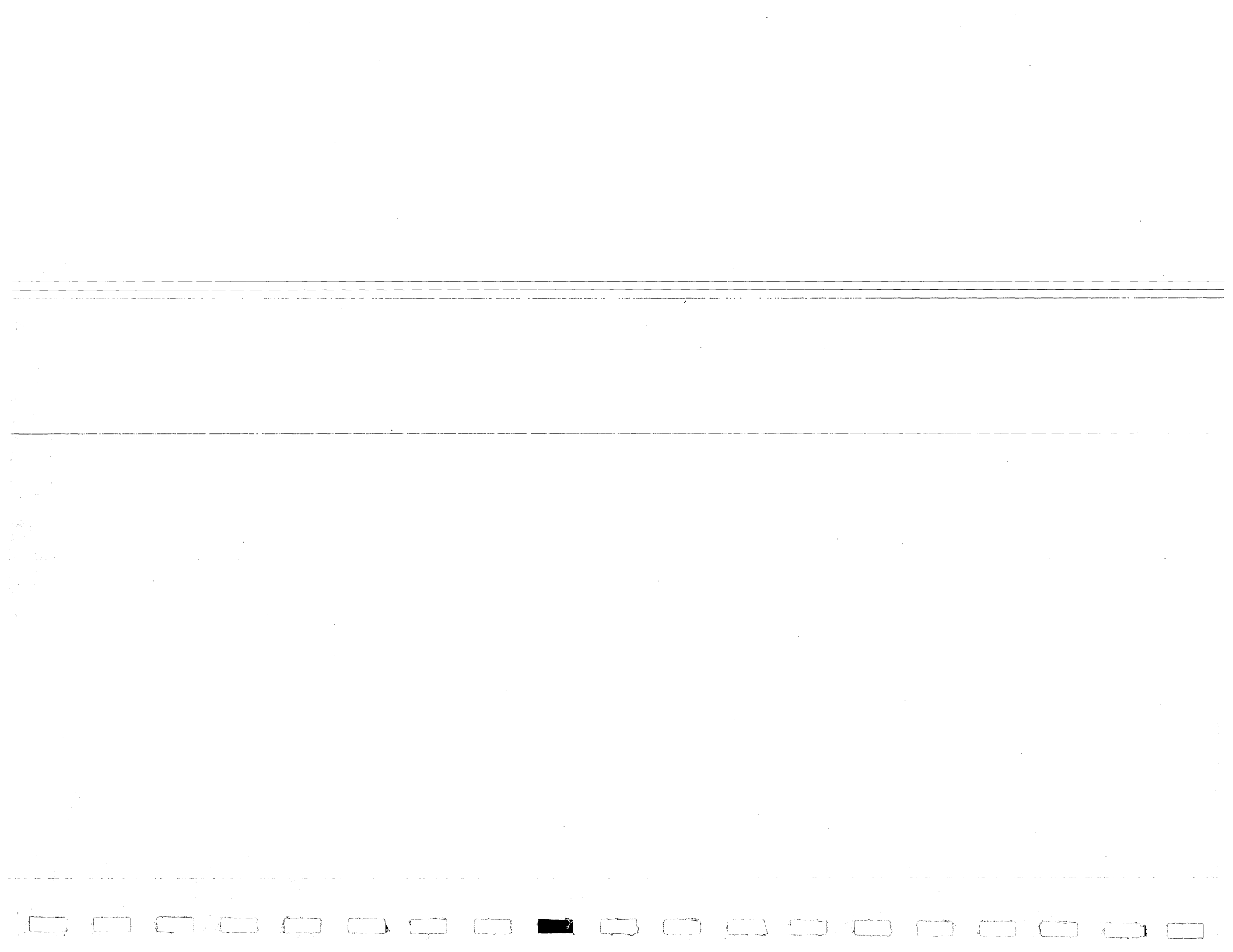
Statistical analyses were performed for measures of effectiveness based on these time periods. Sample means, standard deviations and confidence intervals were calculated to facilitate the reporting of the data and the comparisons between time periods. Various statistical distributions were employed to determine whether the difference between the sample means of various time periods were meaningful. A statistically meaningful or not significant finding suggests that based on the available data, a difference can be reported to a high degree of confidence. A not statistically meaningful or not significant difference is one that is within the range of normal variation. A discussion of the statistical distributions used and their formulas can be found in

Appendix B. The comparisons focused on Year One Operation vs. Before Implementation and Year Two Operation vs. Year One Operation. Comparisons to Day One Operation do not provide reasonable insights into trends because of the high variability of traffic conditions associated with the newness of the facility. Year Two vs. Year One Operation comparisons serve to identify whether the Year One levels are being maintained. Summaries of the results of these statistical analyses are found in Appendix C.

Non-Statistical Data Analysis

Other, non-statistical analyses were performed for data sets where statistical analyses were not appropriate. These analyses are described below:

1. **Travel Times & Average Travel Speeds:** Travel times were evaluated based on the peak hour travel time savings of HOV lane motorists compared to general purpose lane motorists. The data highlights the variability of travel time savings to indicate the dependence upon levels of congestion in the general purpose lanes. In a similar fashion, average travel speeds were evaluated. Additionally, ranges of peak hour and peak period speeds of the HOV lane and general purpose lanes were evaluated for reliability of overall travel times.
2. **Accident Analysis:** The accident analysis included data from a three-year period (1987-1989) prior to construction on I-80 and the four-year construction period (1990-1993). The data for both groups was averaged to represent a typical annual accident profile for the I-80 three-lane roadways prior to HOV lane implementation. The construction period was included to look at trends over the three-lane section. These profiles were compared to an after profile which was determined using available accident records after implementation of the HOV lane. These records were also annualized to provide a consistent basis for comparison.
3. **Park and Ride Lot Usage:** The park and ride lot analysis comprised a direct comparison of facility utilization prior to implementation of the I-80 HOV lane to utilization since implementation. Data used in this analysis can be found in Appendix E.
4. **Public Attitudes:** Public acceptance of the HOV lane was assessed based on the contents of letters from the motoring public to the NJDOT and the monitoring of newspaper articles. Also included is a brief summary of the public opinion survey performed during the Feasibility Study, prior to implementation of the HOV lane.
5. **Air Quality Benefits:** The assessment of air quality impacts focused on the estimation of emissions, vehicle miles of travel and fuel consumption for the existing I-80 lane use -- four lanes with the left lane as an HOV lane in the peak direction during the peak periods -- and the alternate lane use where the left lane is open to general purpose traffic at all times (as was the original intent of the widening). No actual measurements of emissions or fuel consumption were made during this study. This assessment required a summary of peak period traffic volumes for mainline and ramp sections within the limits of HOV lane operation, along with occupancy, classification, and origin-destination information for both the existing I-80 profile and the I-80 four general purpose lane profile. The existing profile used the June 1995 supplemental ramp counts and information from previous data collected for the Feasibility Study. The four general purpose lane alternate was derived by using the existing I-80 profile ramp and mainline volumes, I-80 before implementation average vehicle occupancy, and trends in average vehicle occupancy on I-78 to estimate the number of vehicles to carry the same number of people as in the existing profile. The I-78 AVO data, available through counts done as part of this study, was used as a sample of trends in AVO for a non-HOV interstate facility. The procedure for the derivation of the volume profiles is contained in Appendix D. The volume profiles were input to the FREQ11PL simulation model



to predict the existing and alternate lane use scenarios. The model simulation for the existing profile was calibrated to the field observed conditions based on using the travel time measurements, traffic volumes, and occupancy and classification distributions. Model output such as travel speeds, volumes, and link distances were extracted from the FREQ11PL results to estimate vehicle emissions using 1996 vehicle emission rate tables from the MOBILE 5A modeling software for the I-80 HOV lane limits. The methodology developed for the 1992 NJDOT Strategic Improvement Plan by Raytheon Infrastructure (and approved by the NJDOT for the study) was used to estimate emissions for areas outside of the I-80 HOV lane limits. A description of the estimation of emissions can also be found in Appendix D. The final assessment was made as a direct comparison between existing lane use emissions and alternate lane use emissions. Similar comparisons were made for vehicle miles of travel and fuel consumption.

6. **Bus Service:** The evaluation of the bus service on I-80 relied on bus counts taken during the field data collection program and telephone interviews with NJ TRANSIT and private bus operators to derive conclusions about the services.

IV. RESULTS

The information obtained in the field data collection program has been summarized in the following tabulations:

1. I-80 Peak Hour and Peak Period Traffic Volumes
2. I-80 HOV Lane Traffic Volumes
3. I-80 Total Vehicles with 2+ Occupants
4. I-80 Total People in All Lanes
5. I-80 People in Vehicles with 2+ Occupants
6. I-80 Average Vehicle Occupancy
7. I-80 Peak Hour Travel Time Savings of HOV Lane Users vs. General Purpose Lane Users
8. I-80 Peak Hour Average Travel Speeds
9. I-80 Lane 3 Heavy Truck Percentage
10. HOV Lane Violations
11. I-80 Peak Period Accident Totals
12. I-80 Total Accidents
13. I-80 Peak Period Accidents by Lane After HOV Lane Implementation
14. Park and Ride Lots Serving I-80
15. Park and Ride Lot Usage
16. Reductions in Air Quality Parameters, I-80 with HOV Lanes vs. I-80 without HOV lanes

In addition to the above tabulations, information was also summarized for bus transit usage, public attitudes, and HOV lane enforcement costs.

TRAFFIC VOLUMES

Total peak period and peak hour traffic volumes on I-80 are shown in Table 1 (page 16). The opening of the HOV lanes in March 1994 coincided with the completion of most construction activities along I-80. Although three lanes of traffic were maintained during construction of the fourth lane, some traffic may have diverted from I-80 during construction. I-80 traffic volumes appear to have been stable during the P.M. peak period. During the A.M. peak period, however, a meaningful increase in volume from the Before Implementation period to Year One is evident, based on statistical hypothesis testing. This increase may have been the result of a number of factors, including traffic returning to I-80 after completion of construction. The construction may have had a greater impact on morning commuters than on evening commuters.

Table 1
I-80 Peak Hour and Peak Period Traffic Volumes

A.M.	Peak Hour	Peak Period
Before Implementation (Before March 1994)	5,470	15,000
Day One Operation (March 1994)	6,330	17,000
Year One Operation (April 1994 - March 1995)	6,290	17,000
Year Two Operation (April 1995 - March 1996)	6,430	17,800
P.M.		
Before Implementation (Before March 1994)	5,670	20,100
Day One Operation (March 1994)	6,200	21,600
Year One Operation (April 1994 - March 1995)	6,010	21,200
Year Two Operation (April 1995 - March 1996)	6,210	22,000

Note: Traffic volumes represent averages of the traffic count data taken during the indicated time periods.

I-80 HOV LANE VOLUME

Peak hour and peak period HOV lane volumes are summarized in Table 2 (page 17). The volumes are shown both with and without violators (single-occupant vehicles in the HOV lane). The post-implementation numbers suggest that the HOV lanes are attracting a substantial number of 2+ vehicles to be a viable facility. The values without violators appear to be well within the accepted range of 400 to 800 vehicles per hour for HOV lane viability.[2] Further, these values remained stable during the two-year study period and are not statistically different from the number of HOV lane-eligible vehicles identified from the before implementation data.

HOV lane volumes do not include 2+ occupant vehicles not in the HOV lane. A major factor in HOV lane use is the degree of traffic congestion in the general purpose traffic lanes. If the general purpose lanes operate at a reasonable level of service with high travel speeds, then HOV motorists do not need to use the HOV lane to attain travel time savings. If the general purpose lanes are congested, then there is a travel time savings inducement for HOV motorists to use the HOV lane. The number of violators in the HOV lane does not appear to affect the attractability of the lane to carpools and vanpools because, based on a theoretical capacity of 1,500 to 1,700 vph [2], there appears to be adequate reserve capacity to accommodate all HOV motorists using I-80.

TOTAL VEHICLES WITH 2+ OCCUPANTS

Table 3 (page 17) shows the total number of vehicles with 2+ occupants on all lanes of I-80 during the peak hours and peak periods. The total number of 2+ occupant vehicles is greater than the 2+ occupant vehicle volume in the HOV lane since this measure includes 2+ occupant vehicles in the general purpose lanes.

Data for both peak hours and peak periods show increases in 2+ occupant vehicles on I-80 after HOV lane implementation. Based on statistical comparisons, the increases are meaningful for the A.M. periods but not the P.M. periods. The increase in 2+ occupant vehicles may be due to carpool diversions from parallel routes (e.g., U.S. 46) and to some new carpool formation. The significant increase only during the A.M. periods implies a greater diversion of traffic to I-80 from parallel routes, perhaps a reflection that fourth lane construction caused a greater diversion of A.M. peak period motorists from I-80 than of P.M. peak period motorists.

Table 2
I-80 HOV Lane Traffic Volumes

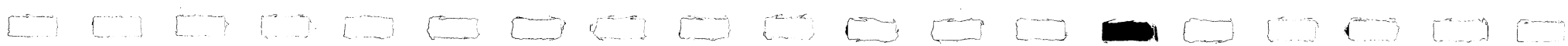
	Peak Hour		Peak Period	
A.M.	**w/out Violators**	**w/Violators**	**w/out Violators**	**w/Violators**
Before March 1994 [1]	600 (11.0%)	600 (11.0%)	1,530 (10.2%)	1,530 (10.2%)
Day One Operation (March 1994)	920 (14.5%)	960 (15.2%)	2,380 (14.0%)	2,500 (14.7%)
Year One Operation (April 1994 - March 1995)	750 (11.9%)	810 (12.9%)	1,870 (11.0%)	2,040 (12.0%)
Year Two Operation (April 1995 - March 1996)	700 (10.9%)	750 (11.7%)	1,900 (10.7%)	2,150 (12.1%)
P.M.				
Before March 1994 [1]	810 (14.3%)	810 (14.3%)	2,930 (14.6%)	2,930 (14.6%)
Day One Operation (March 1994)	820 (13.2%)	870 (14.0%)	2,870 (13.3%)	3,060 (14.2%)
Year One Operation (April 1994 - March 1995)	720 (12.0%)	780 (13.0%)	2,440 (11.5%)	2,670 (12.6%)
Year Two Operation (April 1995 - March 1996)	830 (13.4%)	890 (14.3%)	2,600 (11.8%)	2,800 (12.7%)

Notes:
1. Before March 1994 volumes are HOV lane eligible vehicles.
2. Traffic volumes represent averages of the traffic count data taken during the indicated time periods.
3. Percentages are of total traffic volumes.

Table 3
I-80 Total Vehicles with 2+ Occupants

A.M.	**Peak Hour**	**Peak Period**
Before Implementation (Before March 1994)	600 (11.0%)	1,530 (10.2%)
Day One Operation (March 1994)	1,030 (16.3%)	2,710 (15.9%)
Year One Operation (April 1994 - March 1995)	890 (14.1%)	2,300 (13.5%)
Year Two Operation (April 1995 - March 1996)	830 (12.9%)	2,340 (13.1%)
P.M.		
Before Implementation (Before March 1994)	810 (14.3%)	2,930 (14.6%)
Day One Operation (March 1994)	1,140 (18.4%)	4,110 (19.0%)
Year One Operation (April 1994 - March 1995)	1,000 (16.6%)	3,540 (16.7%)
Year Two Operation (April 1995 - March 1996)	1,090 (17.6%)	3,740 (17.0%)

Notes:
1. Traffic volumes represent averages of the traffic count data taken during the indicated time periods.
2. Percentages are of total traffic volumes.



TOTAL PEOPLE IN ALL LANES

Total peak period and peak hour people on I-80 are shown in Table 4 below. The increase in I-80 A.M. and P.M. peak period people from Before Implementation to Year One is meaningful, while a peak hour increase in total people appears to be within the ranges of normal variation. This may indicate that modal shifts to HOVs and spatial shifts of HOVs from parallel routes occurred outside of the A.M. and P.M. peak hours, but within the two peak periods. The increase in I-80 A.M. peak period people from Year One to Year Two was also found to be statistically significant, continuing the upward trend.

Table 4
I-80 Total People in All Lanes

A.M.	**Peak Hour**	**Peak Period**
Before Implementation (Before March 1994)	6,580	17,600
Day One Operation (March 1994)	8,080	21,100
Year One Operation (April 1994 - March 1995)	7,810	20,700
Year Two Operation (April 1995 - March 1996)	8,230	22,300
P.M.		
Before Implementation (Before March 1994)	6,880	24,500
Day One Operation (March 1994)	7,880	27,700
Year One Operation (April 1994 - March 1995)	7,620	27,100
Year Two Operation (April 1995 - March 1996)	8,000	28,400

Note: Figures represent averages of data derived from traffic counts taken during the indicated time periods.

PEOPLE IN VEHICLES WITH 2+ OCCUPANTS

People in 2+ vehicles (carpools, vanpools, and buses) on I-80 is shown in Table 5 (page 19). The number of people in HOVs on I-80 appears to have increased after implementation of the HOV lanes. The statistical comparisons show that these increases are meaningful for the A.M. peak hour and peak period consistent with the significant increases in number and percentage of vehicles with 2+ occupants exhibited in Table 3. The percentage increase appears to be of the same magnitude as the increase in vehicles, suggesting a greater spatial shift than modal shift.

AVERAGE VEHICLE OCCUPANCY

Average vehicle occupancy (AVO) was calculated by dividing the total people by the total vehicles for all lanes of I-80. AVOs are given for both peak hour and peak period (Table 6, page 21). The average vehicle occupancy appears to have increased on I-80 after HOV lane implementation. The increase from Before Implementation to Year One operation is meaningful only for the P.M. peak period because of the high variation in AVO and few samples for the Before Implementation data. The ranges in AVO are from 1.127 to 1.264 for the A.M. periods and 1.185 to 1.246 in the P.M. periods. A meaningful increase in I-80 AVO also occurs from Year One to Year Two for the A.M. peak hour and peak period.

Table 5
I-80 People in Vehicles with 2+ Occupants

A.M.	**Peak Hour**	**Peak Period**
Before Implementation (Before March 1994)	1,680 (25.5%)	4,010 (22.8%)
Day One Operation (March 1994)	2,730 (33.8%)	6,770 (32.1%)
Year One Operation (April 1994 - March 1995)	2,350 (30.1%)	6,070 (29.3%)
Year Two Operation (April 1995 - March 1996)	2,560 (31.1%)	6,760 (30.3%)
P.M.		
Before Implementation (Before March 1994)	2,000 (29.1%)	7,270 (29.7%)
Day One Operation (March 1994)	2,750 (34.9%)	10,060 (36.3%)
Year One Operation (April 1994 - March 1995)	2,530 (33.2%)	9,310 (34.4%)
Year Two Operation (April 1995 - March 1996)	2,810 (35.1%)	10,070 (35.5%)

Note: 1. Figures represent averages of data derived from traffic counts taken during the indicated time periods.
2. Percentages are of total people in all lanes.

Table 6
I-80 Average Vehicle Occupancy

	Peak Hour	**Peak Period**
A.M.		
Before Implementation (Before March 1994)	1.203	1.170
Day One Operation (March 1994)	1.276	1.244
Year One Operation (April 1994 - March 1995)	1.242	1.219
Year Two Operation (April 1995 - March 1996)	1.280	1.256
P.M.		
Before Implementation (Before March 1994)	1.213	1.222
Day One Operation (March 1994)	1.271	1.279
Year One Operation (April 1994 - March 1995)	1.268	1.280
Year Two Operation (April 1995 - March 1996)	1.288	1.293

Note: Figures represent weighted averages (over total volume) of values derived from traffic counts taken during the indicated time periods.

PEAK HOUR TRAVEL TIME SAVINGS & AVERAGE TRAVEL SPEEDS

Tables 7 and 8 (pages 20 and 21) show the travel time savings and average speeds for vehicles in the HOV lanes compared to vehicles in the general purpose traffic lanes. Travel time savings are achieved by using the HOV lanes, where travel speeds are higher as compared to speeds in the general purpose lanes. Additionally, the range of speeds is considerably smaller in the HOV lanes compared to the general purpose lanes because of the varying levels of congestion which occur in the general purpose lanes.

The travel time savings data shown in Table 7 suggest that many of the measured peak hour time differentials do not meet the suggested minimum 5-minute travel time savings threshold,

averaging about 3 minutes in both the A.M. and the P.M. peak hours. However, informal interviews were conducted with vanpool drivers and bus operators to supplement the measured travel time savings. These people were asked to quantify their time savings. Three bus operators with routes on I-80 and two vanpool operators were contacted. They reported travel time savings of 15 minutes in both the A.M. and P.M. peak hours. One bus operator suggested that time savings of up to 20 minutes are realized during the A.M. and P.M. peak hours. These perceptions are apparently overstated when compared to the actual data or may represent actual occurrences, especially considering the actual data reflected observations only during one day per month. However, there is often a substantial difference between perceived and actual time savings. Nevertheless, the experience of the bus and vanpool operators seems to substantiate an appreciable savings in travel time and reliability benefits of using the HOV lanes.

Table 7
I-80 Peak Hour Travel Time Savings of HOV Lane Users vs. General Purpose Lane Users

		Travel Time Savings (Min.)	
Month		**A.M.**	**P.M.**
July	**1994**	1.5	14.0
August		4.0	0.0
September		6.0	9.5
October		3.3	1.0
November		2.0	3.0
December		4.0	3.7
January	**1995**	1.0	5.0
February		1.0	1.5
March		3.5	2.0
April		1.7	1.0
June		3.3	3.7
October		2.0	3.0
December		2.5	3.0
March	**1996**	5.1	15.7

Notes:

1. Travel time savings are for the 10.5-mile length of the HOV lane (travel times in the HOV lane compared to travel times in the adjacent general purpose lanes).
2. Travel time savings are based on the "floating car" method wherein test vehicles float with the traffic (i.e., keep up with traffic in the HOV lane, and pass as many vehicles as pass the test vehicle in the general purpose lanes).
3. The July 1994 and March 1996 P.M. values are inconsistent with other data collected. They may be the result of unrecorded incidents.

Table 8
I-80 Peak Hour Average Travel Speeds

Month		A.M. PEAK HOUR HOV Lane Speed (mph)	A.M. PEAK HOUR G.P. Lane Speed (mph)	P.M. PEAK HOUR HOV Lane Speed (mph)	P.M. PEAK HOUR G.P. Lane Speed (mph)
July	**1994**	64	55	58	26
August		60	43	64	64
September		55	35	50	29
October		58	44	65	58
November		59	49	61	47
December		57	42	57	43
January	**1995**	66	59	63	43
February		63	57	62	54
March		60	45	67	56
April		64	54	67	61
June		60	46	64	47
October		58	49	61	47
December		57	46	61	48
March	**1996**	61	40	48	23

Peak Period Range in Observed Speeds

	A.M. Peak Period HOV Lane	A.M. Peak Period G.P. Lane	P.M. Peak Period HOV Lane	P.M. Peak Period G.P. Lane
Highest Speed (mph)	72	65	72	64
Lowest Speed (mph)	54	21	47	23

Notes:

1. Speeds indicated are average speeds over the entire 10.5 mile length of the HOV lane and the adjacent general purpose lanes.
2. The July 1994 and March 1996 P.M. values are inconsistent with other data collected. They may be the result of unrecorded incidents.

LANE 3 HEAVY TRUCK PERCENTAGE

Table 9 (page 23) shows the lane 3 truck volume for I-80 for the A.M. and P.M. peak periods as a percentage of the total volume of traffic. Lane 3 is the lane adjacent to the HOV lane. Letters to the NJDOT included complaints about trucks in lane 3. Allowing slow moving trucks in lane 3 adjacent to the higher speed HOV lane may negatively impact safety and may encourage some SOV motorists to use the HOV lane as a passing lane. During the first year of HOV lane operation, the NJDOT had discussions with trucking associations concerning a voluntary ban of trucks from the third general purpose lane during HOV operating periods. A ban of lane 3 trucks allows the third lane to operate as a passing or higher speed lane for general purpose traffic. In May 1995, the Department erected signs along I-80 prohibiting trucks in the third general purpose lane during HOV lane operation. These signs state NO TRUCKS OVER 5 TONS IN LEFT 2 LANES, 6:00-9:00 A.M. (or 3:00-7:00 P.M.) MON-FRI. As shown in the table, the lane 3 truck percentage decreased significantly during both peak periods after the signs were posted. While this change has occurred, it is difficult to assess whether this change has had a positive or negative impact on traffic speed, accessibility to and from the HOV lane, or the frequency of accidents. General purpose lane and HOV lane speeds did not appear to change significantly, based on the data shown in Table 8 (page 23). Available accident records did not provide a clear indication of the impact of this ban on the safety of the facility, particularly of Lane 3 and the HOV lane.

I-80 HOV LANE VIOLATION RATES

The number of HOV lane violations and violation rates are shown in Table 10 (page 23). A violation was determined during the field counts as a single occupant vehicle (SOV) in the HOV lane. However, the difficulty in discerning small children and reclining or sleeping passengers brought into question the accuracy of the SOV counts. Therefore, the counts were adjusted based on summons information provided by the New Jersey State Police. State Police data included monthly figures for the number of summons issued to HOV lane violators (i.e., SOV motorists) and the total number of vehicles pulled over from the HOV lane (i.e., SOV motorists along with carpools where officers were unable to see small or slumping passengers). A summary of the data obtained from the State Police can be found in Appendix G.

State Police enforcement activities commenced immediately upon implementation of HOV lane operations in March 1994 with coverage during the A.M. and P.M. peak periods, Monday through Friday. Enforcement operations consisted of State Police troopers cruising I-80 in police vehicles. HOV lane violators were pulled over to enforcement areas (widened inside shoulders) along the eastbound and westbound HOV lanes. During the first two weeks of HOV lane operation, HOV lane violators received warnings. After the two-week grace period, violators received $60 traffic tickets and two infraction points on their records. This level of activity continued until September 1994. In October 1994, coverage was reduced to three days per week for both the A.M. and P.M. periods. In February 1995, State Police enforcement was modified to include three random A.M. peak periods and three random P.M. peak periods (i.e., A.M. enforcement periods independent of P.M. enforcement periods) with four patrols cars. In July 1995, enforcement was further modified to include four random A.M. peak periods and four random P.M. peak periods using three patrol cars.

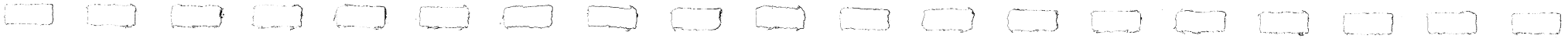


Table 9
I-80 Lane 3 Heavy Truck Percentage

	A.M. Peak Period	P.M. Peak Period
Before Third Lane Truck Ban	0.7%	0.6%
After Third Lane Truck Ban	0.3%	0.3%

Notes:

1. Lane 3 is the leftmost general purpose lane and is adjacent to the HOV lane.
2. The third lane truck ban prohibits trucks over 5 tons from the leftmost general purpose lane during HOV lane operation. The ban took effect in May 1995.
3. Percentages expressed based on total peak period volume.

Table 10
HOV Lane Violations

	Average Number of Violators	
Weekday Enforcement	**A.M. Peak Period**	**P.M. Peak Period**
Five Days per Week	165 (6.9%)	190 (6.0%)
Three Days per Week	210 (9.7%)	525 (21.5%)
Six Random Peaks per Week	80 (4.7%)	125 (5.6%)
Eight Random Peaks per Week	175 (7.5%)	205 (6.9%)

Notes: 1. State Police activities are described by the following Weekday Enforcement Profiles:

a. Five Day Enforcement occurred between March and September 1994.
b. Three Day Enforcement occurred between October 1994, and January 1995. During each of the three days, both a.m. and p.m. peaks were enforced.
c. Six Peak Period Enforcement occurred between February and June 1995. During each week, three random a.m. peaks and three random p.m. peaks were enforced using 4 patrol cars.
d. Eight Peak Period Enforcement occurred after June 1995. During each week, four random a.m. peaks and four random p.m. peaks were enforced using 3 patrol cars.

2. Percentages are violation rates of total HOV lane volumes.

Comparisons were made among the various enforcement procedures to determine if enforcement activities carried out less than five days per week would result in an increase in HOV lane violations. When the I-80 HOV lanes were enforced three days per week instead of five days per week, HOV lane violations increased significantly during the P.M. peak period. SOV motorists were likely emboldened to use the westbound HOV lane during the P.M. peak period after having observed no enforcement of the eastbound HOV lane during the A.M. peak period. As soon as the procedure was modified to three random A.M. and three random P.M. peaks using the same resources (i.e., four patrol cars per peak period), the number of violations significantly decreased. Under this random procedure, motorists could never be sure when the lanes were being patrolled. In July 1995, the procedure was modified again to spread the same resources over more days by using three patrol cars, instead of four, over four random A.M. and four random P.M. peaks. This modification in police enforcement has not significantly changed the percentages of violators in the HOV lanes.

I-80 ACCIDENT EXPERIENCE

Accident records were collected to review trends before fourth lane (HOV) construction (January 1, 1987 to December 31, 1989), during construction (January 1, 1990 to March 6, 1994), and after HOV lane implementation (March 7, 1994 to December 31, 1994). Records for 1995 and 1996 were not available for this analysis. Computerized summaries of accident data were obtained for I-80 between mileposts 32.0 and 48.0 to account for all areas potentially influenced by HOV lane operation. These records were available for 1987 through 1994, except for 1990. Police reports were used to develop the accident profile for 1990. Police reports for 1994 were also used to provide further details concerning specific accident locations. The information was summarized as to accident types, weather and pavement conditions, and lighting conditions for two different time periods -- HOV lane hours of operation, and all times of the day. This information is contained in Appendix F. To provide a comparison of accident histories, the before construction, during construction, and after implementation data were annualized to a 12-month base (Tables 11 and 12, page 25). Annualization of the data consisted of averaging the 1987-1989 data to a single "before construction" year, averaging the 1990-1993 data to a single "during construction" year, and extrapolating the 10-month data (March to December 1994) to represent a 12-month "after implementation" period. The accident records from January 1 to March 6, 1994 were not included in the annualized "during construction" figures due to the atypical data as a result of extreme winter weather.

Addition of a lane to an expressway will result in an increase in lane merging movements. This increase in merging movements may result in an increase in the potential for same direction rear end and sideswipe accidents. When the additional lane is an HOV lane, the potential increase in accidents may be even greater due to the speed differential between the fast moving HOV lane and the slower moving adjacent general purpose lane.

The accident record summaries in Table 11 show an increase in peak period total accidents during both peak periods from before construction to after implementation, while the summaries in Table 12 show a small decrease in daily total accidents for the same before and after comparison. The comparison of peak period to daily total accidents suggests that HOV lane operations may have been a factor in the increase in peak period accidents. To gain insight as to the impact of HOV lane operations on safety, a breakdown of accidents by lane was developed (Table 13, page 25). As shown in Table 13, very few accidents occurred in the HOV lane or between the HOV lane and adjacent lane 3. This suggests that safety was not compromised as a direct result of HOV lane operations.

Data on same direction accidents were also reviewed. Rear end accidents increased after HOV lane implementation in both peak periods and also in daily total accidents. The percent increases were greater for the peak period during times of HOV lane operations. However, sideswipe accidents decreased in both peak periods and in daily total accidents. The percent decreases were also greater during the peak periods compared to the daily totals. Insufficient data was available to determine if the results are statistically significant, and why sideswipe accidents decrease rather than increase in number after HOV lane implementation.

Table 11
I-80 Peak Period Accident Totals

	Before HOV Lane Construction [1]	During HOV Lane Construction [2]	After HOV Lane Implementation [3]
Total Accidents			
I-80 Eastbound, A.M. Peak Period (6:00-9:00)	124	112	157
I-80 Westbound, P.M. Peak Period (3:00-7:00)	120	119	170
Same Direction - Rear End Accidents			
I-80 Eastbound, A.M. Peak Period (6:00-9:00)	78	80	120
I-80 Westbound, P.M. Peak Period (3:00-7:00)	70	75	141
Same Direction - Side Swipe Accidents			
I-80 Eastbound, A.M. Peak Period (6:00-9:00)	38	23	27
I-80 Westbound, P.M. Peak Period (3:00-7:00)	37	31	19

Notes:
1. Annualized averages of 1987-1989 data.
2. Annualized averages of 1990-1993 data.
3. Extrapolation of March through December 1994 data to a 12-month base.

Table 12
I-80 Total Accidents

	Before HOV Lane Construction [1]	During HOV Lane Construction [2]	After HOV Lane Implementation [3]
Total Accidents			
I-80 Eastbound	357	351	352
I-80 Westbound	356	337	331
Same Direction - Rear End Accidents			
I-80 Eastbound	142	163	183
I-80 Westbound	135	150	190
Same Direction - Side Swipe Accidents			
I-80 Eastbound	103	80	79
I-80 Westbound	98	90	60

Notes:
1. Annualized averages of 1987-1989 data.
2. Annualized averages of 1990-1993 data.
3. Extrapolation of March through December 1994 data to a 12-month base.

Table 13
I-80 Peak Period Accidents By Lane After HOV Lane Implementation

	Lanes 1 & 2 [1]	Lane 3 [2]	Lane 4 (HOV Lane) [3]
I-80 Eastbound, A.M. Peak Period (6:00-9:00)	57	63	9
I-80 Westbound, P.M. Peak Period (3:00-7:00)	51	81	8

Notes:
1. Includes interaction with auxiliary lanes and shoulders.
2. Includes interaction with lane 2.
3. Includes interaction with lane 3.
4. Data shown covers the period from March 7 to December 31, 1994.

In addition to the widening of I-80 and HOV lane operation, there are other potential contributing factors to the after implementation accident totals. These other factors are:

1. The fourth lane opened as an HOV lane, creating a new traffic pattern for motorists accustomed to construction activities and three lanes of peak period congestion.
2. Motorists diverting from U.S. 46 or other routes were unaccustomed to the new traffic pattern and HOV lane operation.
3. Minor construction activities were still occurring along I-80 for as long as six months after HOV lane implementation.
4. Construction activities along southbound I-287 at the I-80/I-287 interchange during 1994 resulted in traffic backups onto eastbound I-80 from the I-80 EB/I-287 SB ramp during A.M. peak periods.

Until data after 1994 is available, it is not clear if the magnitude of after implementation accident totals continued or decreased as construction activities ceased and motorists acclimated to the new traffic patterns.

PARK AND RIDE LOT USAGE

Park and ride lot locations and utilization data are summarized in Table 14 below and Table 15 (page 27). This information was collected by the NJDOT's Bureau of Suburban Mobility at eleven park and ride facilities which could be impacted by the increase in carpooling expected by the opening of the I-80 HOV lanes. These lots are located in Morris, Sussex, and Warren Counties and are easily accessible from I-80 or from major arterials connecting to I-80 such as Route 15, U.S. 46, and U.S. 206. Table 14 indicates the locations of the park and ride facilities and the routes providing access to I-80.

Utilization counts were taken during the midday period (Table 15). One count was taken at the beginning of March 1994 just prior to HOV lane implementation. Counts were then taken monthly from March 1994 after HOV lane implementation to June 1995, and then bi-monthly from August 1995 to April 1996. Overall usage increased slightly -- some lots experienced increases in usage while other lots experienced decreases in usage. No clear trend is evident from the data.

Table 14
Park and Ride Lots Serving I-80

Park and Ride Facility	County	Nearby Major Route
Blue Heron	Sussex	Route 15
Byram	Sussex	U.S. 206
Denville	Morris	U.S. 46, I-80
Hope	Warren	I-80
Netcong	Morris	U.S. 46, I-80
Rockaway Borough	Morris	U.S. 46, I-80
Sparta Municipal Building	Sussex	Route 15
Rockaway Townsquare Mall	Morris	I-80, Route 15
Sterli Court	Morris	I-80
Washington Twp.	Morris	U.S. 46
Newton	Sussex	U.S. 206

Table 15
Park and Ride Lot Usage

Park and Ride Facility	Capacity (veh.)	Occupancy (veh.) Before Impl.	Year One Operation	Year Two Operation
Blue Heron	50	33	48	52
Byram	40	29	30	26
Denville	130	37	33	37
Hope	46	27	31	36
Netcong	246	157	158	160
Rockaway Borough	90	31	26	26
Sparta Municipal Building	95	37	22	18
Rockaway Townsquare Mall	200	63	73	82
Sterli Court*	50	--	--	30
Washington Twp.	94	13	22	20
Newton	200	56	56	53
Total Utilization	**1,241**	**483**	**499**	**540**
Percent Utilization	**--**	**40.6%**	**41.9%**	**43.5%**

* Sterli Court opened in November 1994.

PUBLIC ATTITUDES TOWARD THE HOV LANE

Public attitudes toward HOV lanes prior to the implementation of HOV lanes on I-80 were determined through in-depth executive interviews with 23 business leaders and community representatives, and a telephone survey of 1,201 adults living in Somerset and Morris Counties. This public outreach program was performed during May and June 1991 during preparation of the feasibility studies for HOV lanes on I-80 and I-287. Highlights of the findings from the outreach program specific to I-80 include:

1. Sixty-one percent of the Morris County residents polled called the I-80 study section "extremely congested" during peak hours.
2. In general, 67 percent in Morris County said they thought HOV lanes could be "very effective" or "fairly effective" in reducing congestion.
3. When asked specifically about implementing an HOV lane on I-80, 58 percent of the Morris County residents "favor strongly" or "favor somewhat" building special lanes for carpools and buses.

Prior to opening of the I-80 HOV lanes, a public information campaign was initiated to further the public's understanding and awareness of the benefits of HOV lanes, provide information on support facilities, and foster support for the I-80 HOV lanes. The campaign continued through the early weeks of HOV lane operation.

Public attitudinal data was collected for the first two years of I-80 HOV lane operation. This has been accomplished through monitoring of press coverage, letters to the editor, and letters and telephone calls to the NJDOT.

Press coverage has generally presented the positive side of HOV lane operation highlighting the travel time savings for carpoolers and bus riders. The two main complaints covered by the press include trucks traveling in the third lane adjacent to the HOV lane, and the lane changing required between the HOV lane and interchange ramps.

Letters to the editor and communications with the Department were negative in tone and were generally written by motorists that drive alone. Most of the letter writers stated that the HOV lane should be opened up to all motorists for the following reasons:

1. The HOV lane is underutilized.
2. The HOV lane creates congestion in the other three lanes.
3. Tax dollars from "all motorists" paid for the HOV lane.

Letter writers also questioned specific design and operation features, including:

1. Eastbound and westbound HOV lane termini
2. Trucks traveling in the third lane adjacent to the HOV lane
3. Lane changing between the HOV lane on the left and the interchange ramps on the right side of I-80.

The NJDOT responded to the letter writers with clarifications of the above issues and preliminary count data.

AIR QUALITY IMPACTS ASSESSMENT

The air quality benefit analysis included estimates of vehicular emissions, vehicle miles of travel, and fuel consumption for the existing condition (one HOV lane and three general purpose traffic lanes in each direction) versus an alternate scenario wherein all four lanes in each direction would be operated as general purpose traffic lanes. These estimates were developed using the FREQ11PL assignment model and MOBILE 5A emission rate tables as provided by the NJDOT. Inputs to the FREQ11PL model simulations were based on field counts and travel time measurements. The estimated reductions in 1995 vehicular emissions due to operation of the I-80 HOV lanes are shown in Table 16 below. As suggested by the positive values for all of the parameters listed, representing decreases from the four general purpose lane scenario, the implementation of the HOV lanes was beneficial in terms of air quality.

Table 16
Reductions in Air Quality Parameters
I-80 with HOV Lanes vs. I-80 without HOV Lanes

	Reduction
Vehicular Emissions	
Carbon Monoxide (CO)	0.444 tons per day
Nitrogen Oxides (NO_x)	0.144 tons per day
Hydrocarbons (HC)	0.050 tons per day
Vehicle Miles of Travel	68,000 miles per day
Fuel Consumption	3,200 gallons per day

Notes:
1. The reductions represent estimated decreases for existing HOV lane operations compared to a four general purpose lane alternate. They are represented above as the sum of eastbound, A.M. peak period and westbound, P.M. peak period benefits for 1995 volumes.
2. Hydrocarbons are also referred to as volatile organic compounds (VOCs).
3. Figures above represent estimates of reductions in vehicular emissions, vehicle miles of travel and fuel consumption derived from the FREQ11PL model simulations and MOBILE 5A emission rate tables provided by NJDOT. No actual measurements were made for this analysis.

IMPACT TO I-80 CORRIDOR BUS SERVICE

A measure of the effectiveness of implementation of the I-80 HOV lanes to attract mass transit users is to evaluate the facility's impact on bus service in the area, primarily long-distance commuter bus operations. This evaluation was accomplished by two methods -- bus counts performed during the field data collection program, and telephone interviews of bus operators to obtain information not apparent by the counts.

Bus counts (transit buses and school buses) indicated a change in bus volume on I-80 from 33 before HOV lane implementation to 57 after implementation during the A.M. peak period, and from 42 to 66 during the P.M. peak period. Buses were counted in all lanes of I-80 for both the before implementation and after implementation cases. These counts suggest significant increases in bus service in the I-80 corridor with the implementation of the HOV lane. For the telephone interviews, five private bus carriers and NJ TRANSIT were identified as potential users of the I-80 HOV lanes. These carriers are listed below.

Bus Operators in the I-80 Corridor

Operator	Headquarters
Lakeland Bus Lines	Dover, N.J.
Martz Trailways	Stroudsburg, PA
Evergreen Lines/Pocono Mountain Trails	Blairstown, N.J.
Community Coach	Passaic, N.J.
Trans-Bridge Lines	Bethlehem, PA
NJ TRANSIT	Newark, N.J.

Items discussed during the interviews included the number of buses on the route, impact on schedules and schedule adherence, perceived travel time savings, bus capacity and ridership, and bus stop locations. They were also asked for their comments about the operation of the HOV lanes.

Private Bus Carrier Service

Three private carriers (Lakeland Bus Lines, Martz Trailways, and Evergreen Lines) indicated that they operate a total of between 46 and 51 buses on I-80 between Route 15 and I-287 during the peak commuter periods (6:00 to 9:00 a.m. and 3:00 to 7:00 p.m., Monday through Friday). All of these carriers stated that their commuter buses use the eastbound and westbound HOV lanes during the peak periods. The other two private bus carriers, Trans-Bridge Lines and Community Coach, indicated that they do not operate commuter buses in the I-80 HOV lane corridor. They did, however, state that their charter buses use the HOV lane if they are required to travel in the corridor.

The bus operators were asked if their bus schedules or routes had changed since the implementation of the HOV lane. One operator indicated that their bus schedules had not changed. Another operator has changed their schedules to reflect the travel time savings their buses have achieved since implementation of the HOV lane. The other operator has been updating their schedules regularly based on ridership demand. There was no indication from any of the operators that their routes have changed.

All of the carriers indicated that their buses run on schedule more often now than prior to HOV lane implementation as a result of using the HOV lane. The operators felt that their drivers saved at least 15 minutes of travel time for both the A.M. and P.M. peak periods. One carrier suggested a savings of up to 20 minutes during both the A.M. and P.M. peak periods.

Increases in ridership since the implementation of the HOV lane have been observed by all of the carriers though none specified the magnitude of the increase. Two of the carriers noted, however, that their ridership has started to decrease due to the opening of NJ TRANSIT's Midtown Direct Rail Service. This service, which began June 10, 1996, provides a direct rail connection between NJ TRANSIT's Morris & Essex Lines and Amtrak's Northeast Corridor to access New York's Penn Station without having to change trains in Hoboken. This connection may result in rail travel time savings of approximately 20 minutes. Commuter bus capacity cited by the private bus operators surveyed ranged from 47 to 49 passengers. Bus utilization was typically in the 90 percent range, although one operator reported a 50 percent utilization rate for the two buses they operate along the I-80 corridor during the peak periods. The buses typically pick-up and discharge passengers at park-and-ride lots and bus stops along local roads.

The carriers were asked if any of their buses travel I-80 eastbound to access I-287 during the A.M. peak period and if their drivers have experienced problems in crossing the three lanes of general purpose traffic from the HOV lane to the ramp. One of the carriers cited reports by their drivers concerning the difficulty in accessing I-287 from the HOV lane.

General comments and observations made by the operators about the HOV lanes were positive. The operators felt that the HOV lanes have been beneficial to their operations and are working effectively. Some carriers suggested that they would like to see the HOV lanes extended. One carrier suggested that the tolls should be raised at the Hudson River crossings into New York City to encourage greater use of public transportation and realize the full benefits of the HOV lane.

The telephone interviews appear to confirm observations and bus counts that the HOV lanes have enhanced bus service in terms of bus volumes, ridership, and schedule adherence.

NJ TRANSIT Service

In June 1994, NJ TRANSIT initiated two experimental minibus routes to serve business centers in Parsippany from residential communities in Sparta and Hackettstown. The two routes, called Diamond Express WHEELS, were designed to use the I-80 HOV lanes. Marketing efforts for the routes were meant to build upon the NJDOT's marketing program for the HOV lanes.

Each route began operating three round trips per day. This was reduced to two round trips per day due to low ridership levels. The Hackettstown route was dropped in December 1996, while the Sparta route has seen increases in ridership and continues to operate.

I-80 HOV LANE ENFORCEMENT COSTS

The major cost associated with operation of the HOV lanes is the cost of enforcement activities. The Department's contract with the State Police requires the NJDOT to pay for labor and mileage. Annual costs for the State Police were:

1994	$ 264,000
1995	$ 188,000

Costs were higher in 1994 due to police coverage five days per week. After September 1994, enforcement costs were reduced as coverage was reduced.

V. CONCLUSIONS

On the basis of the two-year I-80 HOV lane evaluation study, the project goal of increasing the person-per-hour throughput of I-80 during peak periods by moving more people in fewer vehicles than if the left lanes had been opened to general purpose traffic has been achieved. A discussion on how the project objectives have been accomplished to achieve the goal is presented below.

PROJECT OBJECTIVES

1. Move More People in HOVs

The peak period percentages of HOVs (2+ occupants per vehicle) and of people traveling in HOVs on I-80 are summarized in Table 17 below. A review of the table shows that the peak period percentages of HOVs and people in HOVs on I-80 have increased since implementation of the HOV lanes.

Table 17
I-80 Peak Period Percentages of 2+ Occupant Vehicles and People in 2+ Occupant Vehicles

	Percentage 2+ Occupant Vehicles	Percentage People in 2+ Occupant Vehicles
I-80 Eastbound (A.M. Peak Period)		
Before Implementation	10.2%	22.8%
Since Implementation	13.4%	29.7%
I-80 Westbound (P.M. Peak Period)		
Before Implementation	14.6%	29.7%
Since Implementation	16.9%	34.7%

Notes:

1. I-80 HOV Lane operation began in March 1994.
2. Before Implementation data is the average of data collected in October and November 1993.
3. Since Implementation data is the average of data collected between April 1994 and March 1996.

National and state trends in carpooling indicate a decrease in HOV use -- the percentage of all commuters who carpool dropped nationally from 19.7 percent in 1980 to 13.4 percent in 1990, and in New Jersey dropped from 18.3 percent of all commuters in 1980 to 12.4 percent in 1990. The negative trend in carpooling appears to extend into the 1990s. However, the I-80 HOV facility, with its increase in HOVs and people in HOVs, contradicts this trend.

2. Move More People Per Vehicle

The AVO on I-80 appears to have increased since HOV lane implementation. Table 6 (page 19) indicates changes in AVO from 1.203 to 1.280 in the A.M. peak hour and from 1.213 to 1.288 in the P.M. peak hour.

3. Reduce Travel Times for HOV Travelers

The data in Tables 7 and 8 (pages 20 and 21) show that travel time savings are achieved and travel speeds are higher for travelers in the HOV lanes as compared to travelers in the general purpose lanes. These travel time savings, however, have generally fallen below the accepted minimum savings of 5 minutes. Travel times on the HOV lane were generally between 1.0 and 6.0 minutes less than general purpose lane travel times for motorists traveling the entire length of the HOV lanes. Peak hour speeds on the HOV lane ranged between 50 and 67 mph while general purpose lane speeds ranged from 29 to 64 mph. Additionally, the range of speeds is smaller in the HOV lanes compared to the general purpose lanes, resulting in more reliable travel times for carpoolers in the HOV lanes. Private bus carriers and vanpool operators have perceived travel time savings of 15 to 20 minutes, which would make the HOV lane an attractive route for them.

4. Attain Low HOV Lane Violation Rates

Low violation rates (i.e., less than 10 percent) have been achieved consistently (Table 10, page 23) despite the changing State Police enforcement patterns. The violation rates have ranged from 4.7 percent to 9.7 percent during the A.M. peak period and 5.6 percent to 21.5 percent during the P.M. peak period. The high violation rate during the P.M. peak period occurred during the three day per week police enforcement period because commuters could anticipate non-enforcement days based on police presence during the A.M. peak period. This trend of low violation rates should continue provided that a random enforcement pattern is maintained for the HOV lanes, such as the current four random A.M. peak, four random P.M. peak enforcement pattern.

5. Have Minimal Negative Impact on Safety

The accident analysis resulting in the comparisons portrayed in Tables 11 and 12 (page 25) suggests that peak period accidents have increased in the months following the initiation of HOV lane operations, while daily accident totals have remained stable. With only a small data sample (10 months) available for "after implementation", which covers the time period of transition and motorist acclimation to a new traffic pattern, and the seemingly contradictory trend in rear end and side swipe accidents, this increase in peak period accidents may not be representative. As more accident records become available, they should be reviewed to determine if peak period accident totals have returned to "before construction" characteristics indicating that motorists have acclimated to the new traffic pattern and traffic backups on I-80 due to construction activities in the corridor have been eliminated.

6. Sustain Public Support

The public acceptance of the HOV lanes since their implementation appears to have been demonstrated by the finite measures of increasing the number of HOVs and people in HOVs.

Support of the HOV lanes have been exhibited by a low HOV lane violation rate (less than 10 percent). The qualitative assessment of public support based on letters to the NJDOT and press coverage is less clear because the information available represents only a small portion of the motoring public.

7. Improve Air Quality and Reduce Fuel Consumption

As evidenced by the data contained in Table 16 (page 28), the I-80 HOV lanes achieved air quality objectives of reduced emissions and fuel consumption. Implementation of the HOV lanes results in approximately 68,000 fewer vehicle miles traveled per day, 3,200 gallons of fuel saved per day, and about 0.6 tons fewer emissions (CO, NO_x and HC) per day than if the fourth lanes had been open to all traffic.

8. Enhance Bus Service

Based on the bus counts and interviews with the private bus operators, the HOV lane has enhanced bus service in the corridor because of perceived and actual travel time savings, schedule reliability, and near capacity ridership during the two year evaluation period.

9. Be Cost Effective

HOV lane enforcement costs ranged between $180,000 and $270,000 annually. These costs are offset by the savings in fuel consumption, estimated at 800,000 gallons per year. Assigning a cost of $1.25 per gallon results in an annual fuel savings of $1.0 M, which outweighs enforcement costs. Additionally, savings in person travel times and vehicle miles of travel have been identified in the air quality analysis. However, these savings are difficult to quantify in terms of monetary value.

CONCLUSIONS

Analysis of the data as they relate to the objectives of the I-80 HOV lane evaluation study indicates mixed results. While the implementation of HOV lanes on I-80 appears to have been successful in attracting carpools and vanpools to I-80 and generating new carpools and vanpools, the level of congestion in the general purpose lanes has not been substantial (according to the measured data) to generate appreciable travel time savings to allow carpools and vanpools to take full advantage of the HOV lane. While some carpools and vanpools do not use the HOV lane because of the nature of their trips, other carpools and vanpools may elect to use the general purpose lanes at times when I-80 is not experiencing heavy congestion. Public acceptance of the I-80 HOV lanes has been demonstrated by the low violation rate on the facility, but support for the concept of HOV lanes is unclear based on the limited information available. The implementation of the HOV lanes has resulted in reductions in emissions, fuel consumption and vehicle miles traveled, but available accident data does not suggest clearly the impact on the safety of the facility.

The net result of the findings of this study suggest that the I-80 HOV lane facility enjoys a modest success. However, longer term monitoring should occur, especially in light of the recent and planned implementation of HOV facilities on I-287 and the New Jersey Turnpike. As more HOV lanes are implemented in New Jersey, systemwide benefits may encourage a greater amount of carpooling and vanpooling.

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