

THE EXCLUSIVE BUS LANE ON THE NEW JERSEY APPROACH TO THE LINCOLN TUNNEL

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The planning, design, and operation of the reverse-flow exclusive bus lane on New Jersey Route I-495 are described. Multi-agency participation is discussed, and a brief history of events leading to the bus lane implementation is given. Elements of the extensive public information program are described, and costs, benefits, and first-year operating statistics are presented for the ongoing bus lane project. The results of an extensive series of evaluation surveys—both traffic and attitude—document the success and widespread support of the project. Elements of the plan for permanent operation of the project are discussed.

•THE I-495 exclusive bus lane on the New Jersey approach to the Lincoln Tunnel, opened on December 18, 1970, has completed a successful first year of operations. The regular operation of this bus rapid transit system has become an accepted part of the regional transportation system, enabling up to 35,000 daily commuters to reach their Manhattan jobs more reliably, some 10 to 25 minutes quicker than before. In this age of the "commuter revolution", it is quite a contrast to hear reports of bus passengers applauding and cheering as they arrived at the Port Authority Bus Terminal in New York City. This initial enthusiastic public response has been followed by numerous letters of praise and favorable press reports.

Buses use the bus lane on the 2½-mile section of the Interstate 495 approach to the tunnel during the morning peak period of each workday. The additional eastbound lane, for buses only, is one of the three lanes that ordinarily carry traffic in the westbound direction. These lanes have light use during the period on weekday mornings when the exclusive bus lane is in operation. This change provides four lanes for New York-bound traffic.

To evaluate the exclusive bus lane's effect on traffic operations and transportation users, a comprehensive before-and-after survey program was developed. Surveys of traffic operations included traffic volumes, travel times and speeds, bus and auto occupancies, and bus-terminal operations. To determine the effects on the people involved, various attitude surveys were also conducted.

Recognizing the satisfactory operating record, the favorable public response, and positive evaluation surveys, it has been determined that the one-year "experimental" project should be continued on a permanent basis. Part II of the project—installation of a permanent traffic control device system—is being considered for extension beyond the already completed preliminary engineering plans and cost estimates.

MULTI-AGENCY PARTICIPATION

Many agencies have worked together on the bus lane project to show how advanced traffic operation techniques can help to increase the capacity of highways for mass transit. The U. S. Department of Transportation financed installation of the necessary traffic controls for the bus lane, its first obligation of federal funds under the Urban Corridor program. (The bus lane is part of the North Jersey/Mid-Manhattan Urban Corridor Demonstration Project.) The New Jersey Turnpike Authority provided at its own expense a bus access roadway from Turnpike Interchanges 16 and 17 in Secaucus to I-495 (Figs. 1 and 2).

The New Jersey Department of Transportation, the Port of New York Authority, and the Turnpike Authority are participants in the project, which is being administered by

the Tri-State Regional Planning Commission. At Tri-State's request, project direction is handled by Port Authority staff. The overall traffic control plan for operation of the bus lane was prepared by a technical committee representing the participating agencies and the Hudson County Police Department. The Port Authority, which is operating the bus lane, has consulted with police from the four municipalities through which the lane extends—Secaucus, North Bergen, Union City, and Weehawken. Operating costs for the first year have been shared between the Port Authority and the New Jersey Department of Transportation, with the Turnpike Authority providing direct policing and maintenance assistance in the bus access roadway areas.

BACKGROUND OF PROJECT

Although installation of the I-495 bus lane "hardware" was achieved in only 2½ months, studies of an exclusive bus lane on the New Jersey approaches to the Lincoln Tunnel date back to 1963. In December of that year, the Port of New York Authority prepared a report evaluating several bus lane schemes and recommending in essence the plan implemented. The report also suggested a series of field tests to determine the feasibility of the concept.

Field tests were conducted in 1964 and 1965. The first 4-day experiment, in September 1964, simply closed the "exclusive lane" to westbound traffic and determined that the remaining westbound lanes had sufficient capacity to function with the median lane closed. The second and most critical phase of testing, in December 1965, involved a 3-day test of actual roadway operations, using maintenance trucks as "buses". It was concluded that the eastbound movement of the trucks in the "reversed" lane did not adversely affect westbound traffic. The findings were presented in a December 1965 report on both phases of the tests prepared by the Port Authority for the participating agencies.

Based on the significant success of the field tests, a January 1967 report outlined and strongly recommended the exclusive bus lane plan. It was not immediately implemented at that time although studies of this and alternate bus lane plans were continued. In late 1970, New Jersey Transportation Commissioner John Kohl determined that, based on a July 1970 report by his Bureau of Research and Evaluation, the exclusive bus lane should be implemented as soon as practicable. To accomplish this, it was decided to implement the reversible bus lane scheme now in operation (essentially the plan presented in the January 1967 report).

PUBLIC INFORMATION PROGRAM

A comprehensive public information program was developed and carried out as a joint effort of the participating agencies. News releases were issued at various times within the 2½-month period preceding the bus lane opening. These releases generated considerable coverage in newspapers, radio, and television. Climaxing these efforts, a preview of bus lane operations for press and public officials was conducted on the day before opening day. Supplementing the general press releases, bus lane advisory material was distributed to specific interest groups—i.e., motorists, bus drivers, and bus passengers.

Two separate handouts were distributed to motorists at the Lincoln Tunnel and Turnpike plazas to inform them of the upcoming operation and to encourage switching to bus transit for their commuting trip. The first handout was distributed about 2 weeks prior to the beginning of operations on December 18; the second handout was timed several days in advance of the bus lane opening. The multicolored, 4- by 11-inch cards were distributed at toll booths of the Lincoln Tunnel and New Jersey Turnpike.

Special efforts went into the bus driver information program, since much of the success of the bus lane depended on their positive participation. This was part of an intensive bus driver-bus company orientation. Distributed through the bus companies several weeks before operations, the bus driver handout explained the project, told what special guide signs to look for, and indicated the bus lane "rules". A map of the project was included on the reverse side of the card. In addition, a large version of

the bus lane map was posted in each bus garage. On this map, the approach roads to the bus lane were shown with bold red lines and arrows.

The bus passengers were extremely well-informed about the upcoming bus lane operation through extensive advance press coverage. In addition, the Port Authority Bus Terminal devoted an issue of its "Terminal Topics" bulletin to the lane. The issue was distributed in the Terminal the night before opening day for maximum interest. It achieved this goal, and copies were exhausted almost immediately.

PROJECT COSTS AND BENEFITS

Costs

The exclusive bus lane project was financed under a \$500,000 allocation from the U. S. Department of Transportation. This allocation provided for development and implementation of bus lane traffic control devices under the Part I plan, the survey program and evaluation, preliminary engineering for Part II, administration, and project direction and coordination. In addition, the New Jersey Turnpike provided a \$134,000 bus access roadway from Turnpike Interchanges 16 and 17 in Secaucus to I-495.

Total operating and maintenance expenses for the first full year were approximately \$176,000. Operating costs during this first year were shared by the New Jersey Department of Transportation and the Port of New York Authority.

Benefits

Significant benefits are being realized by bus commuters. The I-495 bus lane is literally "making time" for road users, particularly bus passengers. The 10-minute time-saving during the peak period amounts to more than 1½ days (37½ hours) of time for each bus commuter during the average 225-day working year. Equally important is the newly created reliability of bus service in the entire corridor.

And what is the value of this travel-time saving? Typical of many studies, the Stanford Research Institute recently developed a value of time for a commuter of approximately \$2.82 per hour per person. In the case of the exclusive bus lane, an average commuter would theoretically value the 10-minute time-saving at almost 50¢. From these figures, which are certainly conservative for the higher income New York area, the exclusive bus lane is now returning in a year more than \$100 worth of "time" to each peak-period bus commuter. Thus, the 35,000 daily commuters who use the lane benefit to the tune of roughly \$3.9 million annually.

Along with environmental and social factors, engineers use calculations of project benefits such as these to evaluate the desirability and economic feasibility of projects. As the so-called benefit-cost ratio gets higher, the public receives a greater return on the investment. With the approximate exclusive bus lane project total cost for the first year of \$810,000 (including capital and first-year operation and maintenance) and the bus passenger benefits of about \$3.9 million, the benefit-cost ratio, even if the project only operates for the 1-year contract period, is 4.8. However, based on its enthusiastic public acceptance, the bus lane operation is continuing and has become a regular part of the regional transportation system. Assuming a 5-year amortization period (at 6 percent interest), which would be appropriate for a project of this type, the estimated annual cost (assuming \$200,000 annual operation and maintenance) is reduced to \$350,000. Therefore, the benefit-cost ratio increases to a resounding 11.2.

Aside from these exercises in arithmetic, the exclusive bus lane has had a tremendous psychological impact on 35,000 bus commuters. It is hard to measure the effects of travel-time reliability, the elimination of insecurity, the better planning of time, and the exhilarating feeling of bypassing the frustrating delays so ingrained in the daily journey to work.

The community also benefits considerably from the increased mass transportation use that bus rapid transit will encourage. Possible reduced auto use can lead to improved air quality and reduced requirements for highway expansion, with consequent reduced transportation costs and right-of-way acquisition. Another by-product of the bus lane's operation is improved movement of emergency vehicles through the corridor.

PROJECT OPERATIONS

Traffic Operations and Controls

Detailed operating plans provide for lane changeover to and from the exclusive bus lane operation, police surveillance, and assistance to disabled vehicles. The lane is being operated on weekday mornings except when weather and traffic conditions make its use impracticable or unnecessary.

Under Part I of the project, approximately 80 lane directional signals were installed on overpasses and sign bridges along the westbound side of I-495 (Fig. 3). Placed over the center of each lane, these signals show either a green arrow pointing downward when the lane is open for traffic, or a red X to indicate that the lane is closed. The signals, which inform westbound motorists and eastbound buses of the prevailing operations, were activated as they became available in order to give motorists an opportunity to familiarize themselves with the new traffic control devices in advance of the actual bus lane operations.

In addition to the overhead lane signals, manually changeable signs and traffic posts are a vital part of the traffic control plan for the bus lane. Inconspicuous holes were drilled in the pavement for more than 350 cylindrical 1½-foot-high, bright yellow plastic traffic posts, which are placed at 40-foot intervals for the entire 2½-mile length of the bus lane when it is in operation. The traffic posts, which separate the eastbound bus lane from westbound traffic, are manually placed before the lane is activated for buses and then removed at the conclusion of the morning peak-period operation (Fig. 4). The Port Authority Police activate about 50 traffic signs, most of which are hinged and manually changeable to display different messages depending on whether the lane is operating or not (Fig. 5). New Jersey State Police assigned to the Turnpike are assisting in operating the lane along Turnpike access roadways.

Bus Passenger Flows

During 1971 some 206,050 buses, carrying about 8,654,000 passengers, used the exclusive bus lane. The average flow in the peak period (approximately 7:30 to 9:30 a.m.) was 818 buses, transporting 34,350 passengers, while the average flow in the 8 to 9 a.m. hour was 480 buses, carrying 21,100 passengers. Bus passenger flows are rounded estimates based on typical observed bus occupancies of 42 for the peak period and 44 for the 8 to 9 a.m. hour.

Railroad Strike

The I-495 exclusive bus lane performed perfectly during the May 17-18, 1971, railroad strike, handling the added loads easily and further demonstrating its present and future function as a high-capacity bus rapid transit link in the New Jersey-New York regional transportation system. Record numbers of buses and bus passengers were accommodated with remarkable ease and no delays, as noted by field observers and the news media. Following are some highlights of the bus lane operation during the strike:

1. Bus volumes surpassed by far all prior use, reaching an average of 573 buses during the 8 to 9 a.m. peak hour and 1,038 buses during an extended peak period. Record flows were achieved on May 18 with 597 peak-hour and 1,096 peak-period buses.

2. Bus passengers were estimated to have increased significantly during both the peak hour and peak period. Compared to an average day, during the rail strike the lane carried about 25,800 peak-hour passengers (versus 21,100 normal) and 47,800 in the peak period (versus an average 34,350).

3. Operations were very smooth, with not a single bus lane stoppage during the strike. Due to heavy flows of buses, the bus lane operation was extended each day an additional hour beyond normal shut-down time to about 10:30 a.m. Buses moved freely through the lane at all times, although bus volumes did drop off somewhat toward the end of the period. Even with this lower flow, Lincoln Tunnel police report that the bus lane was operated later because there was extremely heavy eastbound traffic con-

Figure 1. Exclusive bus lane on New Jersey approach to Lincoln Tunnel.

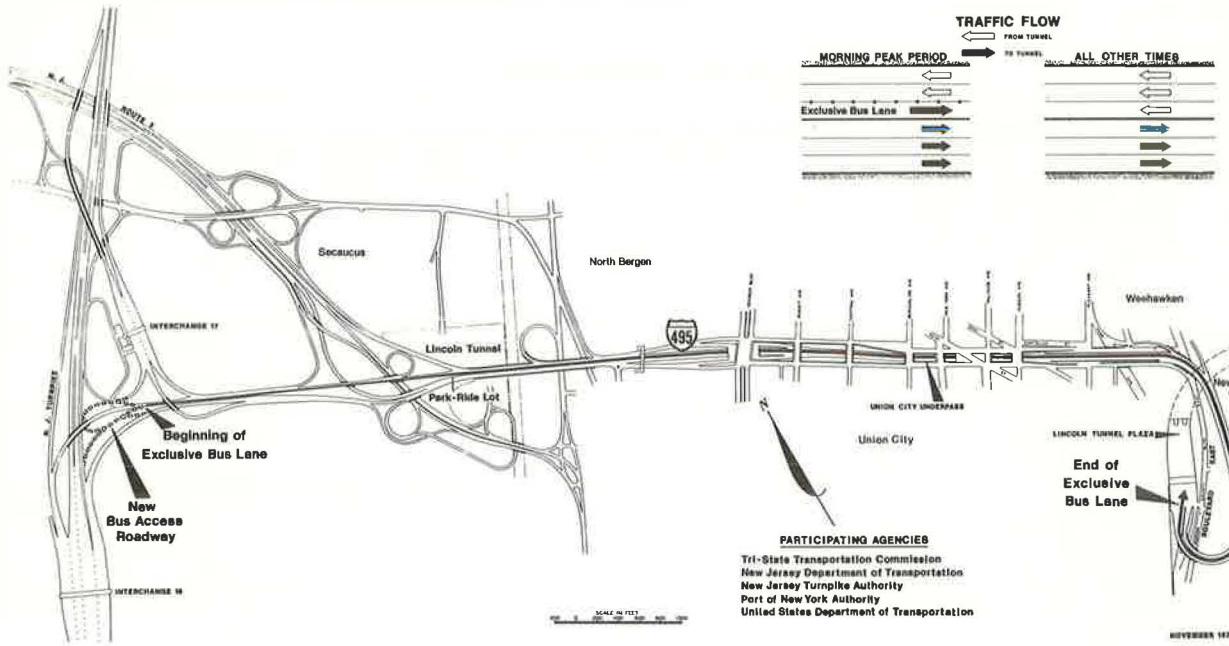


Figure 2. Bus access roadway at New Jersey Turnpike interchange; exclusive bus lane entrance at lower right. "Escape hatch" roadway at center allows off-route vehicles to enter regular eastbound flow.



Figure 3. Overhead lane directional signals and plastic traffic posts to separate exclusive bus lane from westbound flow.



Figure 4. Port Authority personnel in specially equipped vehicle inserting plastic traffic posts into pavement holes.



Figure 5. Police officer activating hinged, changeable bus lane guide sign.



gestion all morning, with delays of approximately $\frac{1}{2}$ hour in the normal eastbound roadway.

4. Media coverage of the bus lane was generous and favorable. A highlight of the coverage was the local Channel 7 "Eyewitness News" on May 18 showing movies of morning peak traffic approaching the Lincoln Tunnel plaza, which included the bus lane, with commentary to the effect that, "The only thing moving into New York this morning was the express bus lane into the Lincoln Tunnel."

Bus Lane Stoppages

Exclusive bus lane stoppages caused by flat tires, brake problems, engine problems, and other factors occurred at the rate of less than three a month through 1971. This is an average, with three months (April, September, and October) having no recorded stoppages. Stoppage-handling procedures are working satisfactorily, with the typical incident lasting about 7 minutes.

This delay experience is certainly not unsatisfactory, particularly when compared with other mass-transit operations in the Tri-State Region. However, the Lincoln Tunnel operations staff is continuing to work with the bus companies to get their maintenance procedures improved.

Safety

There were four accidents involving exclusive bus lane operations in 1971, two of which involved minor personal injury. Accident statistics are not available yet from the Turnpike and state sections of I-495. The Port Authority has reported that during the first 6 months of 1971 there was no significant change in the overall accident records on the Lincoln Tunnel and its New York and New Jersey approaches.

SURVEYS

To evaluate the exclusive bus lane impact on traffic operations and transportation users, a comprehensive before-and-after survey program was developed, coordinated with the overall North Jersey/Mid-Manhattan Urban Corridor Study. This section summarizes the results of the survey program, highlighting the major findings and detailing the individual traffic and attitude surveys. Traffic surveys included volumes on I-495, Lincoln Tunnel, Lincoln Tunnel Park-Ride lot, and the exclusive bus lane; travel times on the exclusive bus lane, autos, buses, and trucks; vehicle occupancies for autos and buses; and terminal operation at the Port Authority Bus Terminal. Attitude surveys were conducted among bus passengers, bus drivers, bus company management, I-495 motorists both eastbound and westbound, and police. These surveys were supplemented with data from other sources, primarily regularly collected Port Authority data on use of the Lincoln Tunnel, the Port Authority Bus Terminal, and the Lincoln Tunnel Park-Ride lot.

Capacity

A comprehensive series of detailed traffic surveys conducted in April 1971 measured the impact of the exclusive bus lane on I-495 travel characteristics.

The presence of the exclusive bus lane has dramatically increased the traffic-carrying capacity of the substandard six-lane Union City Underpass section of I-495. Removal of eastbound buses to their own exclusive lane has increased morning peak-hour eastbound flow by 40 percent, from 3,287 vehicles (in three lanes) to 4,529 vehicles (in four lanes). Concurrent with this tremendous eastbound increase, the exclusive bus lane has had no adverse impact on westbound flow, as the same number of westbound vehicles was being handled before and after the lane became operational.

The peak-hour traffic composition of eastbound I-495 traffic has changed substantially, with the gaps caused by the removal of eastbound buses to their own lane filled primarily by passenger cars (2,324 before versus 3,227 after), with a doubling in the number of trucks (248 before versus 494 after).

The eastbound I-495 lane-by-lane classification also changed substantially due to the exclusive bus lane. Prior to the bus lane almost half the eastbound vehicles were carried in the single left median lane of the eastbound roadway. The creation of the bus lane has caused this lane's share of eastbound vehicles to drop sharply to 36 percent of its former load, although the lane is now actually carrying additional vehicles (1,523 versus 1,630). Even the right "truck lane", under the burden of about 50 percent trucks and tractor-trailers, has increased its peak-hour flow by about 70 percent (from 521 vehicles before to 884 vehicles after), due mainly to the influx of autos to that lane. While the bus lane has enabled the regular eastbound lanes to increase their vehicle-carrying ability, the bus lane still carries more than ten times the number of people carried in any of the three other eastbound lanes, at a much higher level of service.

Bus Volumes

Numerous exclusive bus lane traffic operating characteristics were obtained. The daily average lane volume has varied during 9 months of operation, ranging from a low of 724 buses per day in January to a peak in May of 852. Exclusive bus lane volumes have exhibited daily variation because of differing passenger demands on various weekdays, local traffic conditions, seasonal variations, and other reasons.

Data collected on bus volumes by 5-minute intervals at two exclusive bus lane locations yield the lane's hourly flow rates. The highest 5-minute counts at these two key points were 62 and 68 buses, which translate to hourly rates of 745 and 817 buses per hour respectively. Another survey examined bus flow in platoon groups; it indicates the lane's capacity to be substantially higher than 800 buses per hour.

The peaking characteristics of the bus lane traffic were also investigated, as given by the peak-hour factor (PHF). This is the ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour, usually a 5-minute period. The bus lane PHF is 0.70 to 0.76, reflecting moderate peaking. This can be contrasted with a PHF approaching 1.0 for the Lincoln Tunnel, where there is heavy, sustained flow and very little peaking during the morning peak hour.

It appears that the exclusive bus lane project has significantly altered the time distribution of morning eastbound Lincoln Tunnel traffic to an earlier peak while the total traffic has remained essentially unchanged. The total eastbound volume was essentially unchanged in the before-and-after periods (total traffic of 12,792 before versus 12,843 after), indicating that the exclusive bus lane project has not attracted increased traffic volumes to the Lincoln Tunnel during the morning peak.

Auto occupancy in the eastbound Lincoln Tunnel during the 7:30 to 9:30 a.m. period declined about 4 percent from 1.60 to 1.54 occupants per auto. During the 8 to 9 a.m. period, the time period of greatest bus lane benefits, the decrease in occupancy was almost 10 percent. This might indicate a shift of some auto riders in car pools to exclusive bus lane buses.

Figures for the first 7 months of 1971 indicate a marked increase in use of the Lincoln Tunnel park-ride lot. Reflecting increased use of the park-ride lot, a "before 9:00 a.m." category has shown a substantial 11.1 percent growth through the first 7 months of 1971. This increase in park-ride lot use is probably largely attributable to the exclusive bus lane, which has considerably improved operations in the shuttle-bus service from the lot to the Port Authority Bus Terminal.

Bus Patronage and Occupancy

A bus occupancy survey taken in April 1971 did not reveal clear-cut ridership changes due to the bus lane when compared with surveys in April and October 1970. However, a time-series analysis of data from past Port Authority bus passenger surveys shows a marked effect on patronage trends. It appears from this analysis that the exclusive bus lane had induced an additional 2,300 daily peak-period bus riders, representing a 6 percent increase in ridership, on the lane's bus runs.

Based on comparable spring survey data from 1968 through 1971, the bus lane has arrested a mild downward trend in the short-haul category of ridership on close-in

bus companies while it has also spurred medium-haul patronage. Peak-period ridership on short-haul routes had been declining by 800 to 900 passengers per year until 1971, when it increased by 800, largely representing the exclusive bus lane's apparent inducement of 1,600 bus riders. Meanwhile, middle-range bus routes had been rising at an increasing rate in the past several years. With an expected increase during 1970-1971 of about 500 bus riders, there was in fact an increase of 1,200, indicating that about 700 were attracted by the exclusive bus lane.

Bus volumes on the short-haul routes increased less than their passenger volumes while medium-haul bus and passenger increases were about equal. This indicates that the medium-haul carriers reacted to the increase with increased schedules, whereas the short-haul increase was accomplished through higher loadings on existing scheduled buses.

Observed bus occupancy for routes using the bus lane was 42.2 passengers per bus during the 7 to 10 a.m. peak-period arrivals at the Port Authority Bus Terminal, while 44.1 passengers per bus traveled during the 8 to 9 a.m. peak hour.

Bus Travel Times

Eastbound bus travel times were obtained from two separate methods—ground observations and spot checks of bus riders. The ground observers scrutinized the average bus time savings in the immediate vicinity of the exclusive bus lane and the Lincoln Tunnel approaches; the rider survey recorded the effect of the bus lane on the overall journey to work.

Results from the ground observation surveys indicate that the exclusive bus lane saved the average bus about $7\frac{3}{4}$ minutes during the morning peak period, from the point where the bus approached the vicinity of the exclusive bus lane to the Lincoln Tunnel Plaza. During the 8:15 to 9:15 a.m. hour of peak congestion, the bus lane saved each bus an average of more than 10 minutes of travel time. These average time savings do not reflect larger traffic delays during shorter-term peaks or those occurring with some regularity on the normal inbound tunnel approach due to stoppages of various types. Savings by exclusive bus lane buses on these days can easily be on the order of a $\frac{1}{2}$ hour or more.

Interestingly, there is actually a time loss using the initial section of the bus lane from several approaches for several of the earlier time periods, because of the substantial "back-tracking" required from these approaches to gain access to the exclusive bus lane. However, in every time period from every approach, the time lost in gaining access to the exclusive bus lane was more than offset by the time saved on the total trip to the Tunnel Plaza, and thus there is always a positive overall time saving by buses using the exclusive bus lane.

The bus rider survey focused mainly on components of the total trip from home to the Port Authority Bus Terminal. Travel time data, before and after the bus lane, showed no perceptible changes on sections between home and the exclusive bus lane entrance and from Lincoln Tunnel Plaza to the bus terminal. The data did verify the significant travel time improvements produced in the exclusive bus lane section, resulting in a reduction in overall trip time.

The time the sampling of riders left their homes before and after the exclusive bus lane was also compared to determine if the bus travel-time saving allowed commuters to leave later. Of the 15 checked, 8 riders showed a tendency to leave home later whereas 7 riders either left home at the same time or slightly earlier. For those who did leave later, they were apparently satisfied that the reliability and time saving of the buses using the exclusive bus lane allow a 4- to 10-minute later start from their homes. Those leaving home at the same or slightly earlier times, perhaps constrained by limited bus schedules, also benefited from the exclusive bus lane and arrived consistently earlier at the Port Authority Bus Terminal.

Eastbound Auto and Truck Speeds

The exclusive bus lane, by removing a large volume of buses from the regular I-495 eastbound roadway, has significantly increased eastbound peak-period auto and truck

speeds on the I-495 approach section through the New Jersey Turnpike-Route 3 merge and over the North Bergen Viaduct. However, this operating improvement abruptly ends for eastbound cars and buses beginning at the exit ramp for Kennedy Boulevard through the remaining 1.5-mile roadway to the Lincoln Tunnel Plaza, where slow-but-moving speeds are no different from speeds before the exclusive bus lane.

The Turnpike-Route 3 area, carrying slow (5-10 mph), heavily congested merging traffic prior to the institution of the bus lane, has been substantially freed of daily peak-period congestion with vehicular speeds now in the 30- to 40-mph range. Auto speeds from Route 3, at a 4-mph crawl into the merge area before the exclusive bus lane, have jumped to 40 mph. Motorists from both New Jersey Turnpike approaches have tripled their eastbound speed from about 10 mph to 30 mph. The combination of this merging traffic flowing over the $\frac{1}{2}$ -mile-long North Bergen Viaduct also shows a sizable increase from 10 up to 20 mph, with truck speeds slightly slower. These operating improvements over the I-495 approaches west of Kennedy Boulevard represent substantial savings in travel time for auto and truck traffic, especially for locally destined traffic using exits to US-1, US-9, and Kennedy Boulevard. The travel time improvements for eastbound autos and trucks end at the exit ramp to Kennedy Boulevard; thereafter, over the remaining approach to the tunnel, speeds remain essentially unchanged in the 10- to 20-mph range.

Westbound Vehicular Speed

In all I-495 sections surveyed, westbound traffic flowed with no congestion caused by the exclusive bus lane as indicated by speeds generally varying in the 30- to 40-mph range through the morning peak period. (There is a 35-mph speed limit along westbound I-495 when the left median lane is closed for the eastbound exclusive bus lane.) Although westbound speeds were undoubtedly substantially higher before the exclusive bus lane began (but were not recorded), the exclusive bus lane has resulted in westbound speeds that are only of minor time inconvenience in such a short roadway section.

Port Authority Bus Terminal Operations

The exclusive bus lane itself has had no perceptible effect on bus terminal operation. However, a modest change in bus unloading procedures, instituted concurrently with the bus lane implementation, has improved operations on the two commuter bus levels during the peak period. The new procedure, utilizing additional "load" berths for unloading, has appreciably lessened bus delay on the bus terminal approach ramps where, prior to the new procedure, there were 19 minutes of ramp delay during which 6 or more buses were observed queued on the ramps. After the new unload procedures were instituted, delay minutes were reduced about 85 percent from the 19 minutes of ramp delay to only 3 minutes, representing a substantial increase in the commuter unloading efficiency of the bus terminal during the morning peak period.

Attitude Surveys

A series of attitude surveys, undertaken as part of the I-495 exclusive bus lane project evaluation, obtained reactions and experiences of various groups involved in bus lane, Lincoln Tunnel, and Port Authority Bus Terminal operations. Groups surveyed (in May and June 1971) were the bus patrons, bus drivers, eastbound and westbound motorists, bus company management, and police.

Overall Reaction—The vast majority of all groups polled was extremely favorable toward the implementation and operation of the exclusive bus lane. Only a rather small number of westbound motorists, who gain least from the lane, expressed some reservations.

Bus Priority on Highways—All groups favored generally the introduction of special provisions for buses on highways, although eastbound and westbound motorists were far less inclined to this concept than the other groups surveyed.

Frequency of Trips—The proportion of bus patrons traveling four or more times a week increased substantially—from 82 percent to 92 percent—after the introduction of

the exclusive lane. By contrast, the change in trip frequencies of westbound and eastbound motorists was less significant.

Safety and Relaxation of Trip—Some 88 percent of the bus drivers felt more relaxed and 75 percent felt safer while driving to Manhattan than before the exclusive bus lane was implemented. A majority of the eastbound and, surprisingly, a good many westbound motorists also felt that driving conditions had been improved. Almost all operating police felt that bus lane safety was adequate. Furthermore, the suggestions given by several officers for possible safety improvements have spurred operational and enforcement changes since the survey was conducted. In addition, the police observed no major change in accidents and violations on I-495.

Travel Time—All patron groups surveyed felt they save a goodly amount of time on their trips. The majority of bus patrons and bus drivers—54 percent in each group—indicated the exclusive bus lane saved them 10 to 19 minutes. Some 75 percent of the eastbound motorists also saved substantial time per trip. Surprisingly, more than one-third of the westbound motorists claimed their travel times have been shortened by the exclusive bus lane (although some 19 percent of these drivers did experience longer travel times). Police noted substantially improved traffic flow on the I-495 Lincoln Tunnel approaches.

Trip Reliability and Pleasantness—Practically all bus patrons (95 percent) said they experienced more reliable travel times, and only 1 percent indicated less reliable time. Some 86 percent indicated that their trips were more enjoyable, and the remaining 14 percent said that there was no change.

Travel Mode Changes—About 81 percent of the bus patrons indicated that they rode on the same bus route before and after the bus lane began operating; 7 percent said that they used another bus route to the Port Authority Bus Terminal before the exclusive bus lane. In addition, some 2 percent were patrons who previously traveled by bus to the George Washington Bridge (178th Street) bus station. These two bus groups together constitute nearly half the patrons who indicated some change in their travel modes. The second largest single group, almost 3 percent, did not travel to Manhattan prior to the exclusive bus lane. As for auto commuters, including those in car pools, they also accounted for almost 4 percent of those who switched. The remaining 3 percent were split between railroad (2 percent) and the PATH transit system (1 percent). Of those changing travel modes, 59 percent of the patrons gave the exclusive bus lane as their reason for changing. The remaining patrons indicated changes in location of residences or employment.

Travel Schedule—In spite of the significant travel-time savings attributed to the exclusive lane, three-fifths of the bus patrons responding to the attitude survey still continue to leave home at the same time. However, there were a large number of bus patrons (38 percent) who stated that they can now leave home at a later time.

Bus Patronage—A majority of bus-company managements reported small increases in patronage due to the exclusive bus lane. None of the several companies offering routes to both the midtown bus terminal and the uptown George Washington Bridge bus station reported any noticeable shift to exclusive bus lane routes to the terminal.

Bus Company Operations—Reductions in driver overtime costs were reported by three-quarters of the bus company managements due to the travel-time saving. A majority of bus-company managements indicated generally improved utilization of their equipment and also that their bus patrons and drivers are more satisfied and cooperative since the lane began operating.

PLAN FOR PERMANENT OPERATION

Based on the success of the first year of operations, preliminary engineering plans and a cost estimate for the completion of the permanent exclusive bus lane traffic control system have been prepared by Port Authority engineering staff with the guidance of the project technical committee. This "Part II" program includes the following elements:

1. Several additional installations of overhead lane-control directional signals to provide coverage in areas presently covered only by sign and traffic-post control;
2. Interconnection of all lane-control directional signals;

3. Replacement of the present manually operated, locally controlled changeable signs with electrically operated remote-controlled changeable-message signs;
4. Installation of a television camera in the Secausus interchange area, with monitors at a central control location;
5. Installation of central remote control for all changeable-message signs and signals in the Lincoln Tunnel Administration Building;
6. Installation of an automatic gate at the bus lane entrance;
7. Additions and revisions to the system of fixed-message signs based on operating experience; and
8. Provision of a permanent police booth for use of the police officer on duty at the bus lane entrance.

Numerous safety, service, and economic benefits will be gained with completion of the exclusive bus lane permanent traffic control called for in the Part II plan. Although several components are essential traffic control features for any reversible roadway operation, others are specifically tailored for this bus lane based on extensive operational experience. As the operation enters its second year, the participating agencies are in the process of reviewing possible financing and implementation of the Part II permanent traffic control plan.