

I-95 HOV Feasibility Study



FINAL REPORT

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I-95 HOV FEASIBILITY STUDY

Final Report

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I-95 HOV FEASIBILITY STUDY REPORT EXECUTIVE SUMMARY

BACKGROUND

The objective of this study, which was initiated by the Virginia Department of Transportation (VDOT) in April 2000, was to determine if an extension of the existing Interstate 95 (I-95) High Occupancy Vehicle (HOV 3+) lanes would be an effective strategy to accommodate future peak commuter demands in the I-95 corridor.

Substantial population and employment growth is projected for the Fredericksburg Area Metropolitan Planning Organization (FAMPO) area by 2025, which will result in a significant amount of growth in traffic demand on I-95. In addition, a substantial number of workers commute to Northern Virginia and the Washington, D.C. metropolitan areas. As evidenced by 1990 Census data, approximately 38 percent of the region's combined workforce commutes northward, using I-95 as their primary commuting route. Individually, 50 percent of Stafford County's work force, 28 percent of Spotsylvania County's work force and 19 percent of Fredericksburg's work force commutes north along the I-95 corridor. In light of this commuting pattern, which has continued to grow over the past decade, the FAMPO 2020 Constrained Long Range Transportation Plan (CLRP) calls for extension of HOV lanes or widening of I-95 to four lanes in each direction from the Prince William/Stafford County Line to VA Route 3. However, due to funding constraints in the FAMPO 2025 Interim CLRP, the constrained project was shortened and the southern terminus became the VA Route 610 corridor. The remainder of the project is identified in the 2025 Interim CLRP in the unconstrained project list. The results of this study are intended to provide valuable input to determining the nature of improvements required to maintain an acceptable level of service along the mainline of I-95 and the extent of the improvement that should ultimately be implemented.

Projections of person travel by mode (i.e., low occupant vehicles, high occupant vehicles, bus and Virginia Railway Express) were developed for a typical weekday PM peak hour to examine:

1. Potential demand for HOV travel, and
2. Potential effects the extension of HOV lanes may have on the usage of other modes.

Additional considerations that were examined included the following:

1. Extent of the HOV lanes, i.e., should they be extended all the way to VA Route 3 or some point north of there, such as VA Route 610?
2. Should the HOV lanes be provided as a barrier-separated two-lane facility or as single concurrent lanes?



3. How should access to the HOV lanes be provided?
4. What are potential alternative uses of the HOV lanes during off-peak periods?

ANALYSIS RESULTS

The findings of this study are summarized below in terms of the goals, objectives and measures of effectiveness (MOE's) that were established for this study in consultation with VDOT and the FAMPO Technical Committee. The FAMPO Technical Committee served as the advisory committee for this study. Two build alternatives were evaluated, in addition to a baseline, or no build, alternative. The baseline alternative assumed three general use lanes in each direction on I-95 in the FAMPO region, one build alternative assumed the existing three general use lanes plus a HOV facility (i.e., either a reversible separate facility or concurrent flow lanes), while the second build alternative assumed one additional general use lane in each direction.

Goal: Improve Multimodal Person Trip Mobility Within the Corridor Study Area.

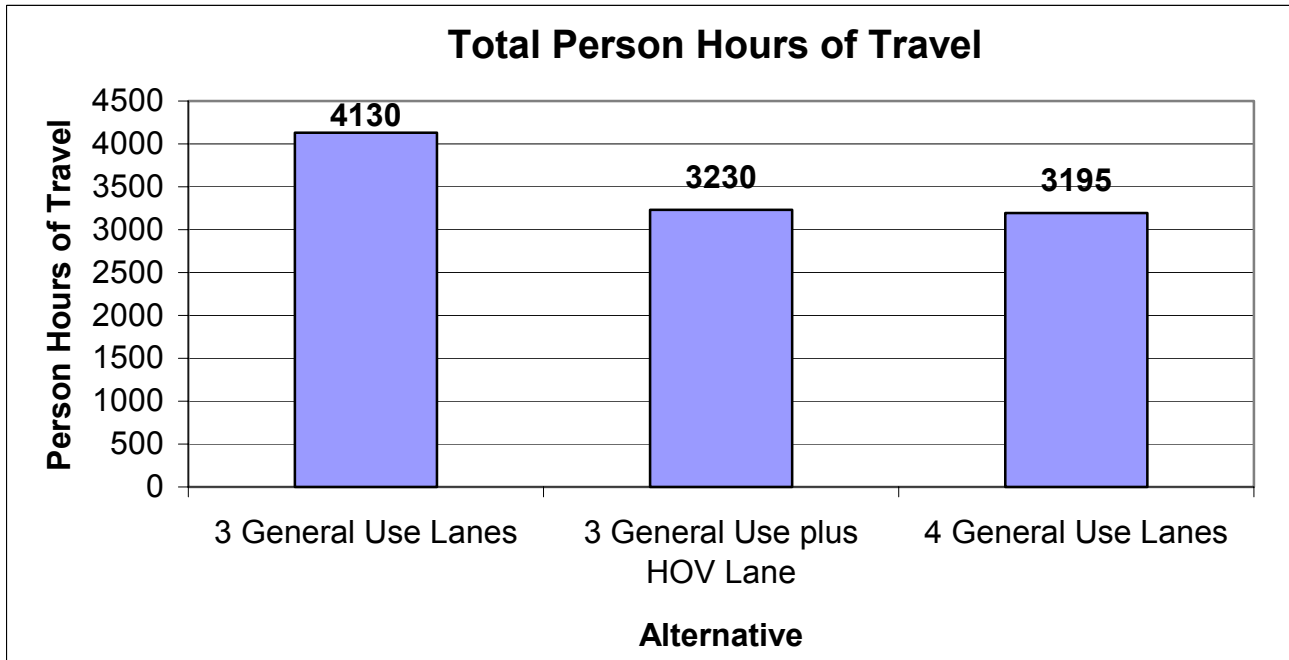
Objective: Decrease person trip travel times.

The measure of effectiveness that was quantified for each alternative to evaluate their performance related to this objective is person hours of travel (PHT). This measure is reflective of person trips by mode (i.e. low occupant vehicle (LOV), high occupant vehicle (HOV), bus and VRE commuter rail) and the travel times associated with each mode. It is calculated by multiplying the number of person trips using each mode by the travel time for each mode. For example, if 1,000 persons are traveling in a particular mode and each trip takes 2 hours, then there are 1,000 persons times 2 hours equals 2000 person hours of travel. PHT values by mode are summed for all modes to quantify a corridor-level PHT value for each alternative. The lower the PHT value, the better the alternative serves to decrease total person trip travel times.

Figure ES-1 shows the total corridor-level person hours of travel during the PM peak hour under each alternative. As shown, the HOV lane and four general use lane alternatives both reduce PHT, as compared to the baseline alternative, by approximately 22 percent. Both build alternatives are equally effective in decreasing person trip travel times on I-95. Travel time savings of seven minutes in the study area are projected for LOV and HOV modes under either build alternative.



Figure ES-1. 2025 PM Peak Hour Person Hours of Travel (PHT) for Baseline and Build Alternatives



Objective: Improve traffic operations on I-95 general use lanes.

As congestion on I-95 increases in future years, the existing six-lane mainline section is projected to be over capacity, particularly in the northern portion of the FAMPO region, under baseline conditions. Level of service (LOS) on the I-95 section just south of the Stafford County/Prince William County Line was calculated for conditions under the baseline and two alternatives.

I-95 is projected to be operating at LOS F during the PM peak hour in 2025 under baseline conditions. LOS F is indicative of forced or breakdown traffic flow, such as can be found upstream of bottlenecks. LOS F conditions are found where a freeway segment’s volume exceeds its capacity. Both alternatives are expected to improve level of service conditions along the same section to LOS E. LOS E describes a freeway segment that is operating at capacity, with resulting unstable flow characteristics that are susceptible to disruptions and incidents. Either of the two build alternatives can be expected to improve traffic operations on I-95, as compared to the baseline.

Goal: Enhance Efficiency of Total Transportation System.

Objective: Increase person movement capacity of I-95 in the study area.

Addition of an HOV facility with either one HOV lane in each direction or two barrier-separated HOV lanes on I-95 will result in a higher person movement capacity for I-95 than will the

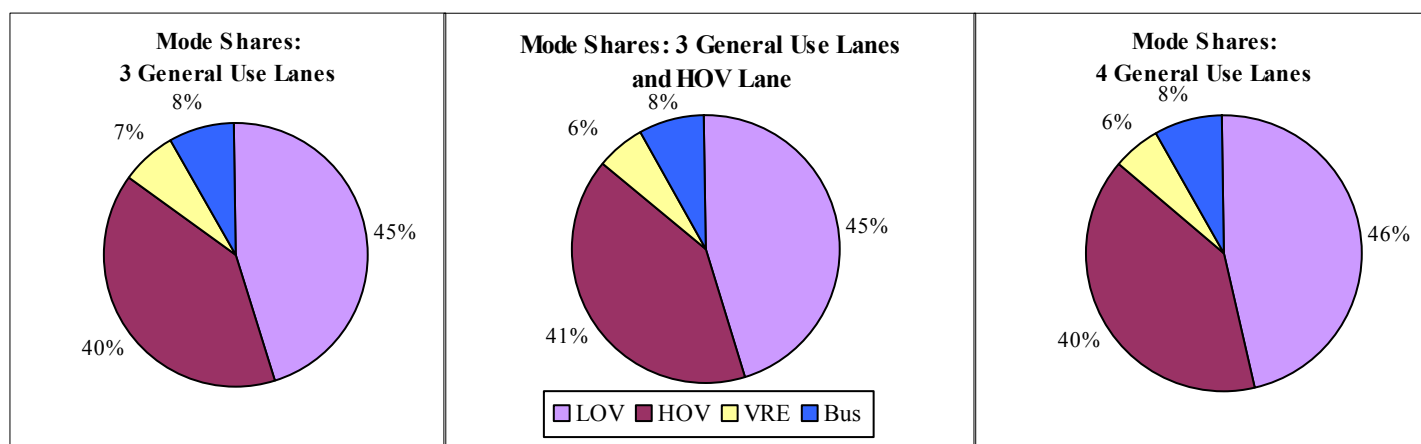


addition of a fourth general use lane in each direction, assuming prevailing and projected automobile occupancy rates. The increased person movement capacity will be as much as 25 to 50 percent depending on the number of new HOV lanes.

Objective: Increase HOV and transit mode shares.

Average vehicle ridership (AVR) is a measure used to quantify relative levels of high occupant vehicle usage, including buses and rail modes, between alternatives. AVR is calculated by dividing the total number of person trips by the total number of private non-transit vehicles, excluding vanpools. As such, as AVR increases, less vehicles are being used to transport the same number of persons. The analysis for this study found that AVR is projected to remain relatively constant across the baseline and two build alternatives, thus indicating that provision of HOV lanes would not lead to a significant shift in modal use, with little or no impact on transit ridership. Figure ES-2 shows projected mode shares under the baseline and two build alternatives.

Figure ES-2. Mode Shares for the Baseline and Build Alternatives.



CONCLUSIONS

The objective of this study was to determine if an extension of the existing HOV lanes would be an effective strategy to accommodate future peak commuter demands in the I-95 corridor in the FAMPO region. Two build alternatives were evaluated; the first assumed addition of an HOV facility and the second assumed addition of a fourth general use lane in each direction. The additional lanes, whether HOV or general use, would extend from the Stafford County/Prince William County line as far as VA Route 3 to the south.

The analysis results described above demonstrate a need to add capacity to this section of I-95; however, they are less definitive with respect to the question of whether added capacity should be in the form of HOV or general use lanes. With respect to the goal of improving multimodal trip mobility within the corridor, both build alternatives have the same effects on person hours of



travel and level of service on I-95, although both are shown to provide improvement over baseline conditions.

In terms of increasing efficiency of the total transportation system, it can be argued that addition of an HOV facility will provide an opportunity to increase the person movement capacity of I-95, as compared to adding a fourth general use lane. This is assuming prevailing and projected automobile occupancy rates and vehicle demand on the general use lanes approaching capacity. However, the analysis also shows that projected 2025 vehicle demand on the general use lanes will not reach such high levels, which is why large shifts of person trips to HOV and transit modes from low occupant vehicles are not being projected. Provision of a HOV facility can be expected to induce such shifts only after the general use lanes reach high levels of congestion, which could occur beyond the target year for this study of 2025.

Generally accepted guidelines for assessing the performance and value of HOV lanes include the following (*An Evaluation of HOV Lanes in Texas*, 1996, Texas Transportation Institute.):

1. Daily HOV lane person trips should be in the range of 10,000 to 15,000 or greater.
2. The HOV lane should move a greater percentage of persons during the peak hour than the percentage of total directional capacity the HOV lane represents. For example, in this case, a new HOV lane would represent 25 percent of directional lane capacity and should therefore carry more than 25 percent of the total directional person trips.
3. The HOV lane should increase average vehicle occupancy by at least 10 percent to 15 percent.
4. More than 25 percent of the total carpools using the HOV lane should be new carpools created because of the HOV lane.
5. More than 25 percent of the total bus riders using the HOV lane should be new bus riders created because of the HOV lane.

The results of this analysis show that addition of an HOV facility from VA Route 3 northward would satisfy these first two criteria, but not the final three.

If it were to be determined that a HOV facility should be provided, there would be several considerations that would need to be addressed:

1. *How far south should the HOV lanes extend?*

HOV person volumes increase in the northern portion of the corridor from 4,150 south of VA 610 to 5,700 north of VA 610 in the PM peak hour; however, projected HOV person volumes are still relatively high at 3,500 north of VA 3. A significant amount of the person hour of travel time savings on the HOV and general use lanes found under the HOV alternative is a result of HOV persons bypassing congestion on the general use lanes between VA 3 and the proposed Route 627 interchange. This section of the I-95 general use lanes is projected to be congested



with reduced speeds due to the high volumes between US Route 17 and VA Route 3, which is where US Route 17 and I-95 overlap. These results would indicate that an HOV facility should be extended to VA Route 3.

2. *Should the HOV facility consist of one concurrent flow lane in each direction or a continuation of the barrier-separated reversible two-lane facility currently in place in Northern Virginia?*

Each type of facility has its advantages and disadvantages:

- The total projected HOV vehicle volumes at their highest point in the corridor do not necessarily warrant two freeway lanes of capacity, but they will be approaching a level where free-flow speed conditions would not be as reliable on one concurrent flow lane as they would be with two barrier-separated lanes.
- National experience shows that concurrent flow lanes, unless they are separated by physical barriers or a striped buffer zone, tend to be less safe and can reduce HOV lane speeds.
- Extension of the existing barrier-separated facility would provide continuity of design.
- A review of HOV facility cost experience indicates that a separated facility would be five to six times more costly than construction of concurrent flow lanes.
- Construction of concurrent flow lanes would allow for continuous access along the corridor, while access to a barrier-separated facility would have to be via slip/flyover ramps or direct connections at interchanges.
- Provision of direct HOV ramp connections from a barrier-separated facility at Routes 610 and VA Route 3 would divert as many as 350 peak hour vehicle trips at each location from the general use lanes and interchange ramps.

3. *What are potential alternative uses of the HOV lanes during off-peak periods?*

A barrier-separated reversible facility would add two additional lanes of capacity in one direction while concurrent flow lanes would add one additional lane in each direction. Separated lanes provide the opportunity for provision of express lanes in one direction for heavy seasonal volumes and additional capacity in case of an incident on the general use lanes.



I. INTRODUCTION

Background

The I-95 HOV Feasibility Study, which was initiated by the Virginia Department of Transportation (VDOT) in April 2000, was undertaken to determine if an extension of the existing Interstate 95 (I-95) High Occupancy Vehicles (HOV 3+) lanes into the Fredericksburg Area Metropolitan Planning Organization (FAMPO) region would be an effective and feasible strategy to accommodate future peak commuter demands in the I-95 corridor. The project study area, which is shown in Figure 1, extends from the Prince William/Stafford County Line south to VA Route 3 in Fredericksburg.

Close coordination with the FAMPO Technical Committee, which was the advisory committee for this study, was maintained throughout this study, which also included a public workshop at which citizens were able to review the scope of the study and provide comment. The results of this study were intended to provide input to determining the nature of improvements in the I-95 corridor that will best accommodate future person travel demand. It is important to note that implementation of a HOV facility extension will require additional and more detailed preliminary engineering analyses.

Substantial population and employment growth is projected for the Fredericksburg Area Metropolitan Planning Organization (FAMPO) area by 2025, which will result in significant growth in traffic demand on I-95. In addition, a substantial number of workers commute to the Northern Virginia and Washington, D.C. metropolitan areas. As evidenced by 1990 Census data, approximately 38 percent of the region's combined workforce commutes northward (i.e., inbound in the AM), using I-95 as their primary commuting route. Individually, 50 percent of Stafford County's work force, 28 percent of Spotsylvania County's work force and 19 percent of the City of Fredericksburg's work force commutes north along the I-95 corridor. In light of this commuting pattern, which has continued to grow over the past decade, the FAMPO 2020 Constrained Long Range Transportation Plan (CLRP) called for the extension of HOV lanes or the widening of I-95 to four lanes in each direction from the Prince William/Stafford County Line to VA Route 3. The 2020 CLRP was in effect when this study was initiated. In the new plan, due to funding constraints in the FAMPO 2025 Interim CLRP, the project was shortened making the southern terminus Route 610. The remainder of the project is identified in the 2025 Interim CLRP as part of the unconstrained project list.

Projections of person travel by mode (i.e., low occupant vehicles (LOV), high occupant vehicles (HOV), commuter bus and Virginia Railway Express (VRE) commuter rail) were developed for a typical weekday PM peak hour to examine:

1. Potential demand for HOV travel, and
2. Potential effects of an extension of the HOV lanes on usage of other modes.

Additional considerations that were examined as part of this study included the following:

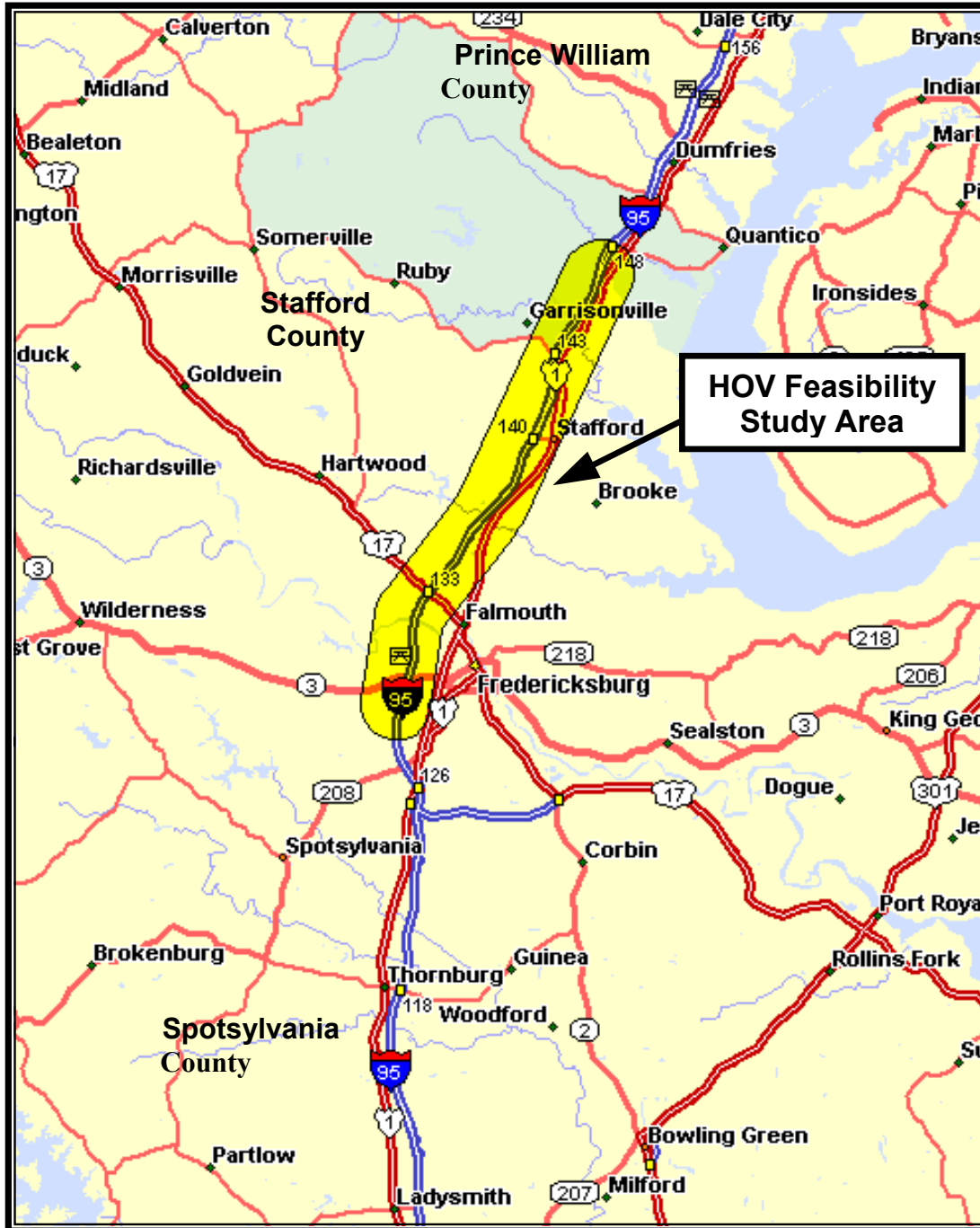


Figure 1. Project Study Area



1. Extent of the HOV lanes, i.e., should they be extended all the way to VA Route 3 or some point north of there in the FAMPO region?
2. Should the HOV lanes be provided as a barrier-separated two-lane facility or as single concurrent lanes?
3. How should access to the HOV lanes be provided?
4. What are potential alternative uses of the HOV lanes during off-peak periods?
5. How would an extension of the I-95 HOV lanes affect the need for new or expanded park and ride lots and other transit and ridesharing support?

Evaluation Goals and Objectives

The potential effectiveness of extending the I-95 HOV lanes into the FAMPO area was evaluated in terms of a set of goals, objectives and measures of effectiveness (MOEs) that were established through consultation with the FAMPO Technical Committee. These goals, objectives and MOE’s are presented in Table 1.

Table 1. Goals, Objectives, and Measures of Effectiveness (MOEs).

Goal 1:	Improve multimodal person trip mobility within the corridor study area.
<i>Objective:</i>	<ul style="list-style-type: none"> • Decrease person trip travel times.
MOE:	Person hours of travel (PHT).
<i>Objective:</i>	<ul style="list-style-type: none"> • Improve traffic operations on I-95 general use lanes.
MOE:	Peak hour level of service on general use lanes.
Goal 2:	Enhance efficiency of total transportation system.
<i>Objective:</i>	<ul style="list-style-type: none"> • Increase person movement capacity of I-95 in the study area.
MOE:	Person movement capacity.
<i>Objective:</i>	<ul style="list-style-type: none"> • Increase HOV and transit mode shares.
MOE:	Average vehicle ridership and mode shares.

The potential HOV facility extension was also assessed in terms of generally accepted guidelines and performance measures that have been used elsewhere in the United States, such as:

- Utilization,
- Person throughput,
- Effects on mode shift, and
- Automobile occupancy.



II. CURRENT CONDITIONS

Highway

The focus of the HOV extension feasibility study is on the I-95 corridor from north of VA 3 to the Stafford County/Prince William County Line. This section of I-95 is currently three lanes in each direction, with interchanges at VA 3, US 17, Route 630 and Route 610.

Figure 2 shows year 2000 LOV and HOV person trips in the I-95/I-395 corridor. As shown, HOV person trips outnumber LOV person trips in the northern portion of the corridor. As congestion increases in the southern portion of the corridor in future years, the proportion of HOV travel is also expected to increase.

A summary of person movement by mode at the Stafford County/Prince William County Line at the northern end of this corridor during the PM peak hour is provided in Table 2. A typical weekday PM peak hour was chosen as the analysis period for this study in order to coincide with the analysis period being used for the I-95 Access/Collector-Distributor Study that was performed in concert with this study. During weekdays, in this corridor, PM peak hour traffic conditions represent a worst case situation in terms of traffic volumes and level of service. As shown in Table 2, approximately 44 percent of the total person trips destined into the FAMPO area during the PM peak hour are currently in a HOV mode (i.e., either carpools of three or more people, vanpools or buses). This relatively high proportion of HOV usage is due to time savings gained on the existing HOV lanes north of the study area. The LOV mode reflects persons in one or two occupant vehicles.

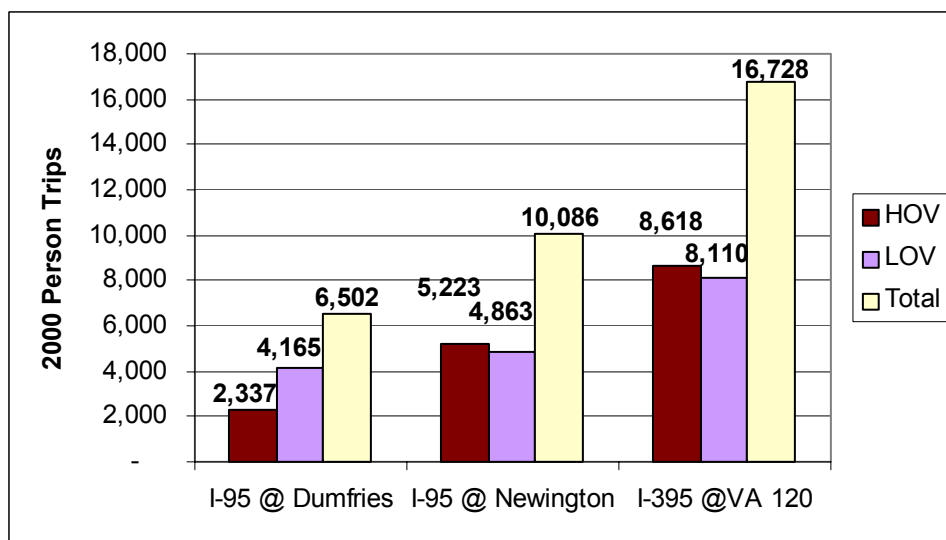


Figure 2. 2000 HOV and LOV Person Trips in the I-95/I-395 Corridor.



Table 2. Year 2000 PM Peak Hour Person Trips at the Stafford County/Prince William County Line.

Mode	Total Persons
LOV*	3,070 (51%)
HOV*	2,275 (38%)
VRE**	310 (5%)
Bus**	380 (6%)
Total Persons	6,035 (100%)

*Based on Fall 2000 Metropolitan Washington Council of Governments (MWCOG) data

**Data collected by SG Associates(2000).

HOV usage has been growing significantly in recent years in this corridor due to a number of factors, most notably increasing congestion and slower LOV travel times on I-95 and I-395 to the north. Table 3 demonstrates the growth that has occurred since 1997 in HOV usage in the I-95 corridor. The HOV person volumes shown in the table do not include bus passengers. This data shows an 8 percent increase in total southbound person trips on I-95 during the PM peak hour from 1997 to 2000. This is an annual growth rate of approximately 2.7 percent. However, during this same time period, LOV trips decreased by 1 percent while HOV trips increased by 30 percent. Additionally, in the year 2000, HOV trips are 36 percent of the total person trips as compared to 30 percent of the person trips in 1997. There are several factors that may account for these trends: 1) construction activities at the Springfield interchange have adversely affected LOV operations and speeds, making HOV travel more attractive, 2) dynamic ridesharing activities, known as slugging, in the FAMPO region have increased over the past 3 years, leading to a higher HOV use, 3) a general worsening of traffic conditions in Northern Virginia on I-95/395 and I-495 has made HOV travel more appealing, and 4) the recently-implemented Federal Commuter Choice Benefit Program, which provides subsidies to Federal government employees who use ridesharing and transit modes, has served to decrease LOV trips.

Table 3. LOV and HOV Person Trip Summary at Dumfries (VA 234) during PM Peak Hour

Person Trips	1997 MWCOG Data	2000 MWCOG Data
LOV Persons	4,214 (70%)	4,165 (64%)
HOV Persons	1,795 (30%)	2,337 (36%)
Total	6,009	6,502 (8%)

A general trend of increasing congestion for LOV person trips is expected to continue in to the future, although not necessarily at the rapid growth rate seen recently. This trend will encourage more persons to take advantage of the travel time savings and superior reliability of travel on the HOV lanes.



Transit

Extending the HOV lanes may impact several public transit operators, private transit operators and ridesharing programs. Current service areas, operating times and daily ridership, as well as possible future service patterns, of the potentially affected operators/programs are discussed below.

Bus Services

Greyhound

Greyhound provides commuter service from Richmond to Washington. Greyhound operates 15 runs to Washington and 12 runs from Washington in the I-95 study corridor. The operator has direct trips from Richmond to Washington, as well as trips which serve local stops. Fredericksburg, Triangle, Woodbridge, Springfield and Arlington are local points served by Greyhound. The operator provides service 24 hours a day. Greyhound buses average 30 daily riders per run, approximately 800 total daily riders.

Private Commuter Buses

Lee Coaches, Inc.

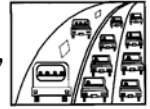
Lee Coaches is located in Fredericksburg, VA and operates two routes along the study corridor. Both routes serve the commuter park and ride lots at VA 208, US 17, and Route 630. The first commuter route operates entirely on I-95 providing service to the Pentagon. The inbound run begins at 5:30 AM and the outbound run begins at 4:40 PM. The second commuter route operates along I-95/ Route 1 and provides service to Fort Belvoir. The inbound run begins at 4:50 AM and the outbound run begins at 3:30 PM.

National Coach

National Coach is located in Fredericksburg, VA and operates 17 inbound and 17 outbound runs along I-95. Passengers can board National Coach buses at park and ride lots along VA 3, US 17, VA 208, and Route 610. National Coach provides service to Army/Navy Drive, the Pentagon, and Washington from 5:00 AM to 7:40 PM.

Quick's Commuter and Charter Service

Quick's is located in Falmouth, VA and operates nine inbound and nine outbound runs along I-95. Riders can board a Quick's bus at park and ride lots along VA 3, US 17, VA 208 and Route 630 and various points in Fredericksburg. Service is provided to Washington, the Pentagon, Crystal City, National Airport, Rosslyn, Army/Navy Drive and Baileys Crossroads from 4:55 AM to 5:50 PM.



Fredericksburg Regional Transit (FRED)

FRED is located in the City of Fredericksburg and provides service in northern Spotsylvania County, Fredericksburg, and has recently expanded service to southern Stafford County. FRED serves VRE and is currently not operating along the I-95 corridor.

The Potomac and Rappahannock Transportation Commission (PRTC)

PRTC is located in Woodbridge, VA and operates 10 inbound and 10 outbound runs along I-95. Commuter service is provided from Triangle, Dumfries, Woodbridge, US Route 1, and Montclair to the Pentagon and Washington. PRTC operates from 5:00 AM to 7:00 PM.

Rail Services

Amtrak

Amtrak currently provides nine round trips through the Richmond to Washington corridor, two originate in Richmond, two originate in Newport News, one originates in Charlotte, NC, and three long distance trains originate in Florida. The last train runs non-stop from Lorton, VA to Florida. The Virginia Department of Rail and Public Transportation has concept plans to make significant improvements to intercity rail in the Richmond to Washington corridor by 2025. These plans include having intercity trains stop at Fredericksburg, increasing service frequency to hourly, increasing maximum speed to 110 mph, and reducing travel time from Richmond to Washington by 40 minutes (2 hour and 10 minute trip to 1 hour and 30 minute trip). Half of the time savings, 20 minutes, will be between Fredericksburg and Washington. The plan also calls for adding a third track within the existing right of way, purchasing new high-speed train sets, and other spot improvements. Corridor rail ridership is currently approximately 700,000 per year. As a result of the improvements, VDRPT projects that ridership will increase to 2.2 million by 2015. A daily average of 320 persons use VRE tickets to ride Amtrak trains.

The Virginia Railway Express (VRE)

The VRE has an administrative office located in Alexandria, VA. The VRE has two lines providing commuter service from Fredericksburg and Manassas to Alexandria, Crystal City, and Washington. Only the Fredericksburg line will be impacted by HOV changes in the I-95 corridor. The Fredericksburg line currently has 12 stations and operates 12 runs (6 inbound and 6 outbound). Service is provided from 5:15 AM to 8:04 PM. The VRE currently carries a daily average of 4,200 passengers on the Fredericksburg line. An additional daily average of 320 persons using VRE tickets ride Amtrak trains.

VRE has plans under discussion to build two new stations on the Fredericksburg line, Cherry Hill (located between Rippon and Quantico) and Widewater (located between Quantico and Brook). HOV extensions may affect these stations as well as the rest of the line. In addition, full double (or even triple) tracking of the CSX rail line from



Fredericksburg to DC would permit more VRE service (more frequent trains) and faster service (skip/stop express), which may also affect demand on this line.

Carpool/Vanpool

Rappahannock Area Development Commission Organization (RADCO)

RADCO maintains a ridesharing program that assists commuters in the I-95 corridor to form vanpools and carpools. RADCO Rideshare currently has 247 registered vanpools. It should be noted; however, that the RADCO database is not inclusive of all carpooling or vanpooling activity in the FAMPO region.

Summary of Transit Ridership

Table 4 summarizes current daily commuter transit ridership in the I-95 FAMPO study area. Approximately 2,060 commuters use a bus service in this corridor on a daily basis. Furthermore, 4,780 commuters use either bus or rail service in the study area on a daily basis. Table 5 summarizes the information for southbound transit during the PM peak hour.

Table 4. Year 2000 Daily Bus and Rail Ridership in the I-95 Corridor Between VA 234 and VA 3.

Operator	Daily Ridership	Daily Runs	Operating Times
Private	1,260	56	4:50 AM to 7:40 PM
Greyhound	800	27	24 hour service
Total Bus	2,060	83	----
VRE	2,400	12	5:15 AM to 8:04 PM
VRE on Amtrak	320*	5	6:53 AM to 6:17 PM
Total Rail	2,720	17	----
Total Transit	4,780	100	----

*Ridership is based on available data for Amtrak Trains 84, 186, 94, 80, and 93 from March 2000.



**Table 5. Year 2000 PM Peak Hour Bus and Rail Ridership in the I-95 Corridor
Between VA 234 and VA 3**

Operator	Avg. PM Peak Hour Ridership*	Number of Southbound Runs
Private	350	12
Greyhound	30	1
Total Bus	380	13
VRE	310	2
Total Rail	310	2
Total Transit	690	15

*Ridership is for runs traveling through the study area between 4:15 and 5:15 PM, but is for entire bus route . (VRE is the exception with estimated ridership at Brooke, Leeland and Fredericksburg stations only.)



III. STUDY METHODOLOGY

Overview

The basic methodology that was used to forecast HOV demand included two steps: first, derivation of a Year 2025 baseline trip table and secondly, application of a pivot point model to project changes in person travel by mode given the extension of the I-95 HOV lanes or addition of a fourth general use lane in each direction. Figure 3 shows a schematic of the process. The procedures and assumptions that were used under each component are described in the following sections.

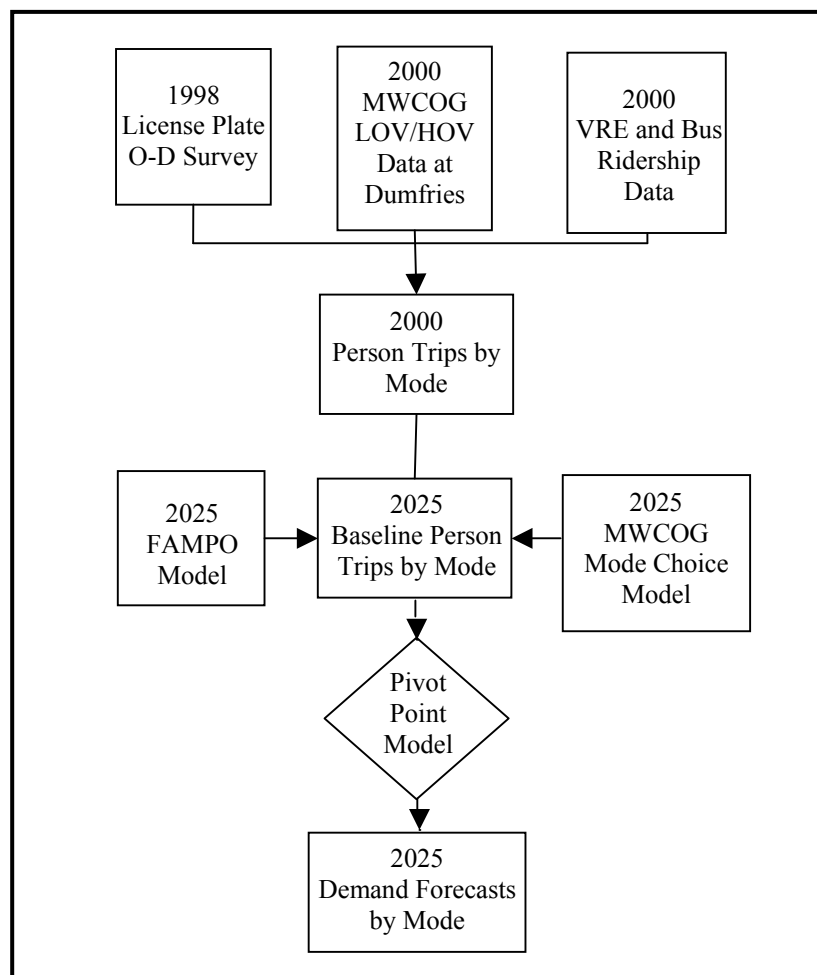


Figure 3. Methodology for HOV Study



Development of 2025 Baseline Trip Table

The 2025 baseline PM peak hour trip table, used as the input for the pivot model, represented Year 2025 person travel by mode for the current roadway network configuration in the FAMPO area (i.e., three general use lanes in each direction and no HOV lanes). Trip origins during the PM peak hour represented trips coming from the north heading southward into the FAMPO area. These were linked to destination pivot districts, which were groups of FAMPO traffic analysis zones that were within close proximity to one another and had similar growth factors between 1995 and 2025 according to the FAMPO model. It was this baseline PM peak hour trip table that was then “pivoted from” in order to project mode shares that would result from a change in the roadway network, such as the extension of the HOV lanes or addition of general use lanes. Development of the 2025 baseline PM peak hour trip table ultimately made use of five data sources including 1998 I-95 license plate origin – destination (O-D) survey data, MWCOG HOV and LOV count data, VRE and bus ridership data, the FAMPO model, and the MWCOG model. This process is further described in Figure 4.

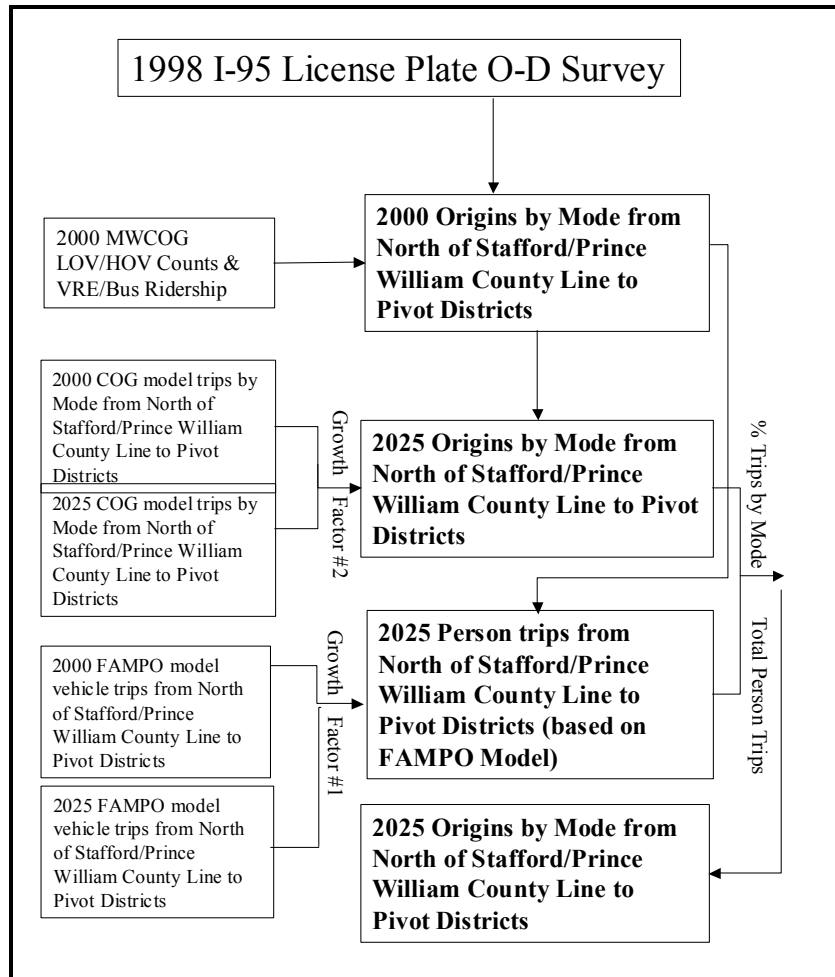


Figure 4. LOV/HOV Baseline Factoring Process.



1998 License Plate O-D Survey

In May of 1998, BMI conducted a license plate matching origin-destination survey of the I-95/I-395 corridor as part of a previous study. The southernmost survey station was at VA 234 in Dumfries, which is just north of the FAMPO region. The license plates of all Virginia-registered vehicles on the general use and HOV lanes during the PM peak hour recorded at this station were sent to the Virginia Department of Motor Vehicles to obtain vehicle registration addresses. This data was then geocoded to the FAMPO model's traffic analysis zone (TAZ) system to estimate the destinations of vehicle trips observed on I-95 at Dumfries coming into the FAMPO region during the PM peak hour. Figures 5 and 6 show the results of the geocoding effort for the general use and HOV lanes. These vehicle trips were then converted to person trips using MWCOG vehicle occupancy data at the Dumfries station. This process provided estimates of 1998 LOV (i.e., 1-2 person vehicles) and HOV (i.e., 3 or more person vehicles including vanpools) person-trip destinations from FAMPO zones to Dumfries.

2000 Origins by Mode from Dumfries to Pivot Districts

Initially, BMI had planned to use the 1998 O-D survey LOV and HOV volumes as a basis for deriving 2025 baseline conditions, which would be projected by factoring up 1998 volumes using FAMPO model outputs. However, as shown in Table 3 of the preceding section, Fall 2000 data collected by MWCOG showed a significant increase in HOV person travel at Dumfries, as compared to 1997 volume levels. Given this finding, it was determined that the Fall 2000 LOV and HOV person trip data would be used for this analysis, in conjunction with the 1998 O-D trip pattern data, in order to guard against an overly optimistic projection of HOV usage resulting from use of one data source.

Apart from Year 2000 LOV and HOV trips, Year 2000 commuter bus and rail trips were needed to quantify total PM peak hour person travel. SG Associates obtained this information from the various providers and compiled PM peak hour person movement in the transit modes at the Prince William/Stafford County line, which was shown in Table 5. Transit trip destinations were assigned to FAMPO pivot districts based on data from the MWCOG mode choice model for this area.

The product of the above was a PM peak hour person trip table by mode between the Prince William/Stafford County Line and pivot districts within the FAMPO area for the Year 2000.

In order to develop Year 2025 baseline PM peak hour demand forecasts, the Year 2000 trip table needed to be factored up to Year 2025 appropriately. There were two factoring elements required: 1) total number of 2025 peak hour person trips and 2) distribution of total person trips to each available mode. Since the FAMPO model did not explicitly estimate HOV or transit trips, and also did not account for highway, HOV and/or transit improvements north of the FAMPO region, it was necessary to utilize outputs of the MWCOG mode choice model in conjunction with zonal growth factors from the FAMPO model.

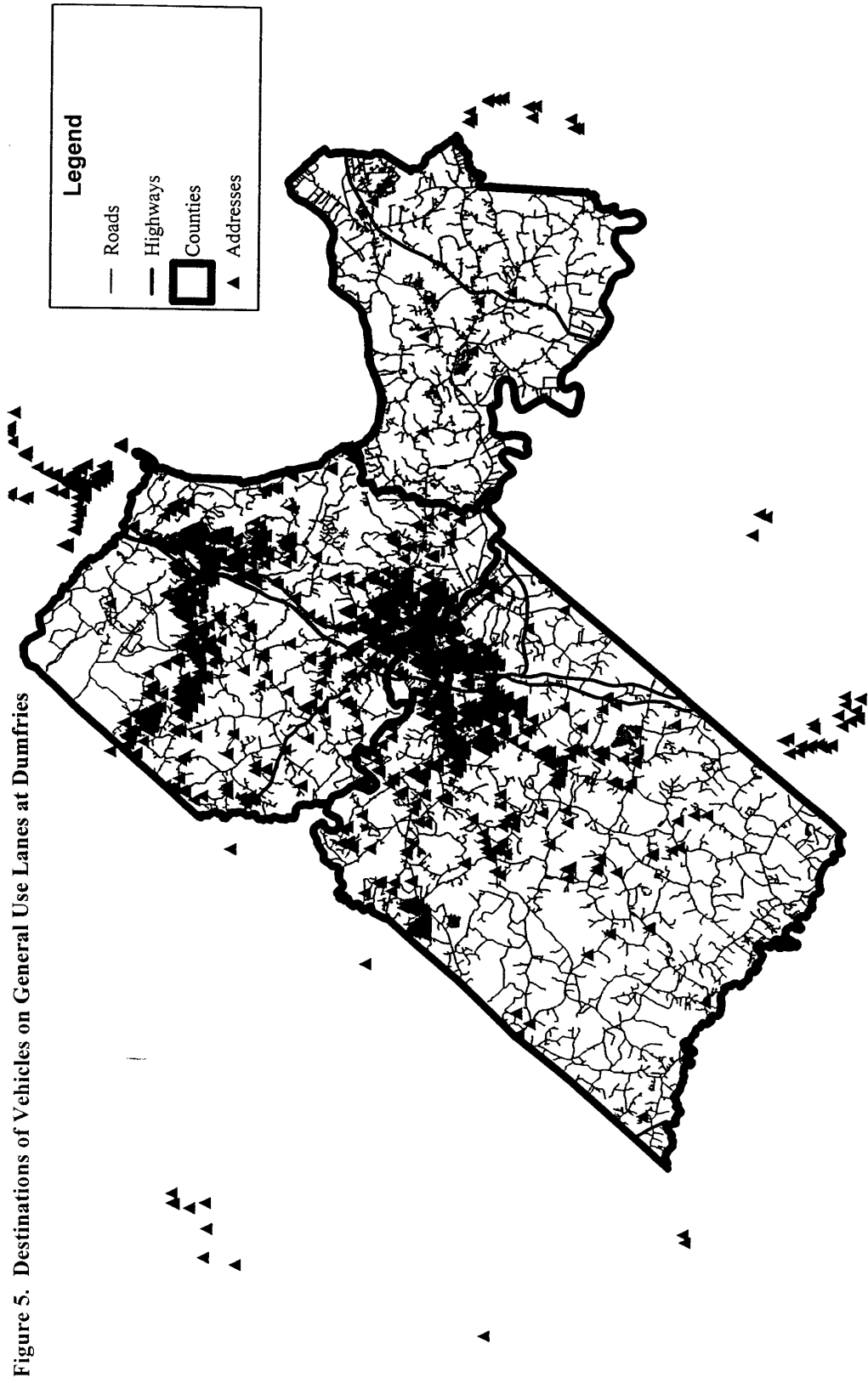


Figure 5. Destinations of Vehicles on General Use Lanes at Dumfries

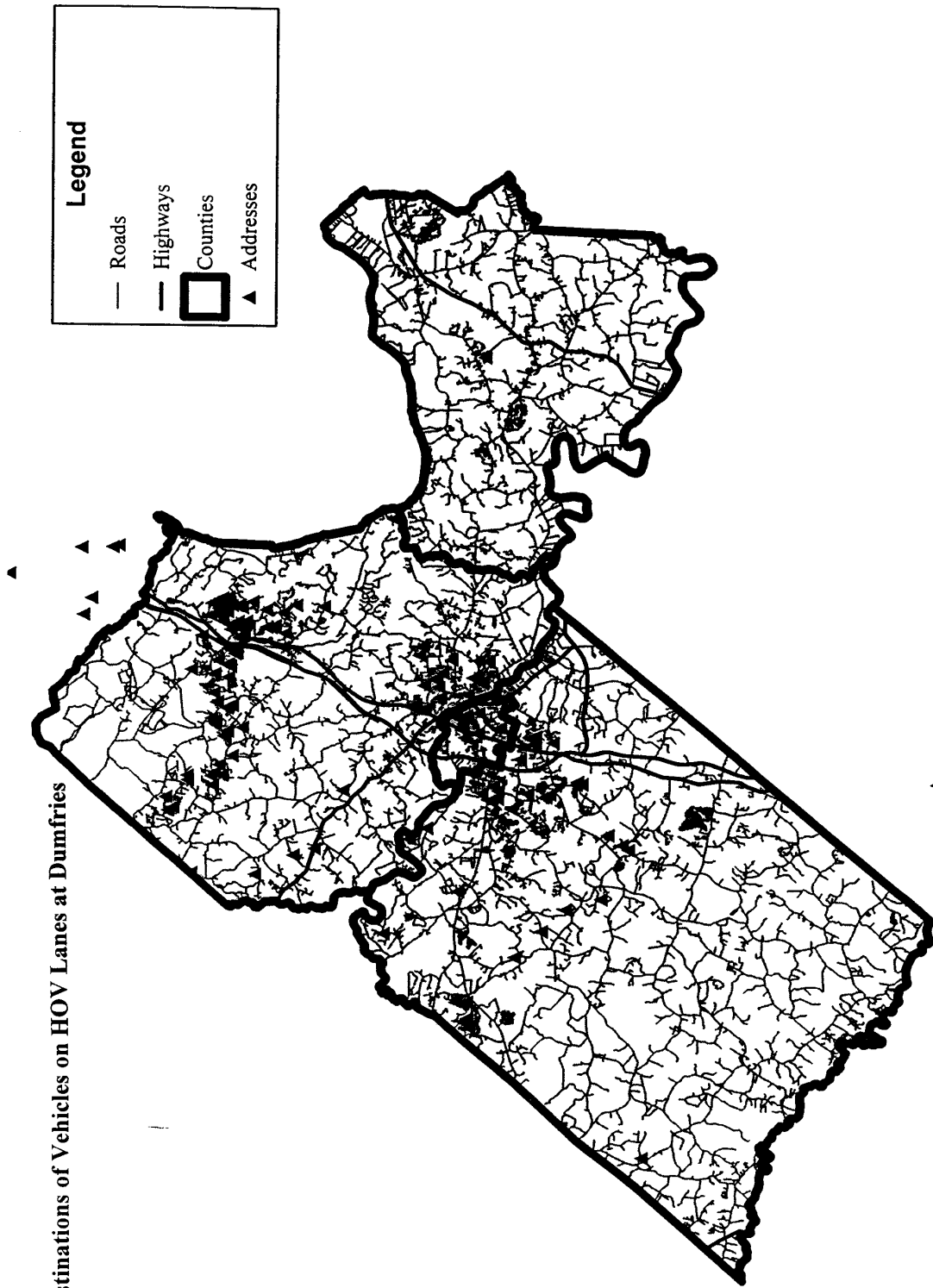
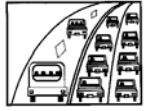


Figure 6. Destinations of Vehicles on HOV Lanes at Dumfries



2025 Person Trips from County Line to FAMPO Pivot Districts

The first step was to obtain an estimate of *total* PM peak hour person trips crossing at the County line and destined to the FAMPO pivot districts. This was done by factoring the 2000 person trip table using zonal growth factors from the FAMPO model (i.e., Growth Factor #1 in Figure 4). In this way, growth in future travel demand to the FAMPO region was based on local land use and network assumptions imbedded in the FAMPO model.

2025 Origins by Mode from Dumfries to Pivot Districts

The second step was to allocate 2025 total PM peak hour person trips produced above to LOV, HOV, bus and rail modes. This was accomplished by deriving growth factors (i.e., Growth Factor #2 in Figure 4) by mode from select link runs from the MWCOG mode choice model for 2000 and 2025. The MWCOG mode choice model forecasts home-to-work person trips by mode based on cost and service parameters. The MWCOG modeled area includes the Washington DC metropolitan area and extends into Spotsylvania County. Mode choice forecasts from the MWCOG model were used to estimate the proportion of person trips using each mode. Note that the person trip projections from the MWCOG model were used only to determine relative shares of the various modes. The absolute projections of person travel came from the FAMPO model, which provided a greater level of detail and more reliable demand estimates in the FAMPO area.

2025 Person Trips by Mode from County Line to FAMPO Pivot Districts

A 2025 baseline PM peak hour person trip table was created based on the previous two steps in the process: 1) total peak hour person trips and 2) allocated of person trips to modes. The baseline person trip table was one of the primary inputs to the pivot point modeling procedure, which is described next.

In development of the 2025 PM peak hour person trip table, the MWCOG constrained long-range transportation plan was assumed. This included improved transit and new HOV facilities. Specific projects in the MWCOG constrained long-range plan that affected the study corridor included the following:

- I-95 widened to 8 lanes from Newington to VA 123.
- Metrorail/VRE station at Potomac Yards.
- I-395 HOV restriped to 3 lanes.
- Extension of HOV lanes from Quantico Creek to Stafford County line.
- Provision of I-495 HOV lanes from I-95/I-395 interchange to American Legion Bridge.
- Addition of HOV access on I-395 to and from the south at Seminary Road interchange.

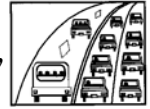


Figure 7 summarizes the total number of vehicle and person trips by mode for Year 2025 baseline PM peak hour conditions at the Prince William/Stafford County Line. This includes all trips; those destined to the FAMPO region and also those destined to locations beyond the FAMPO region.

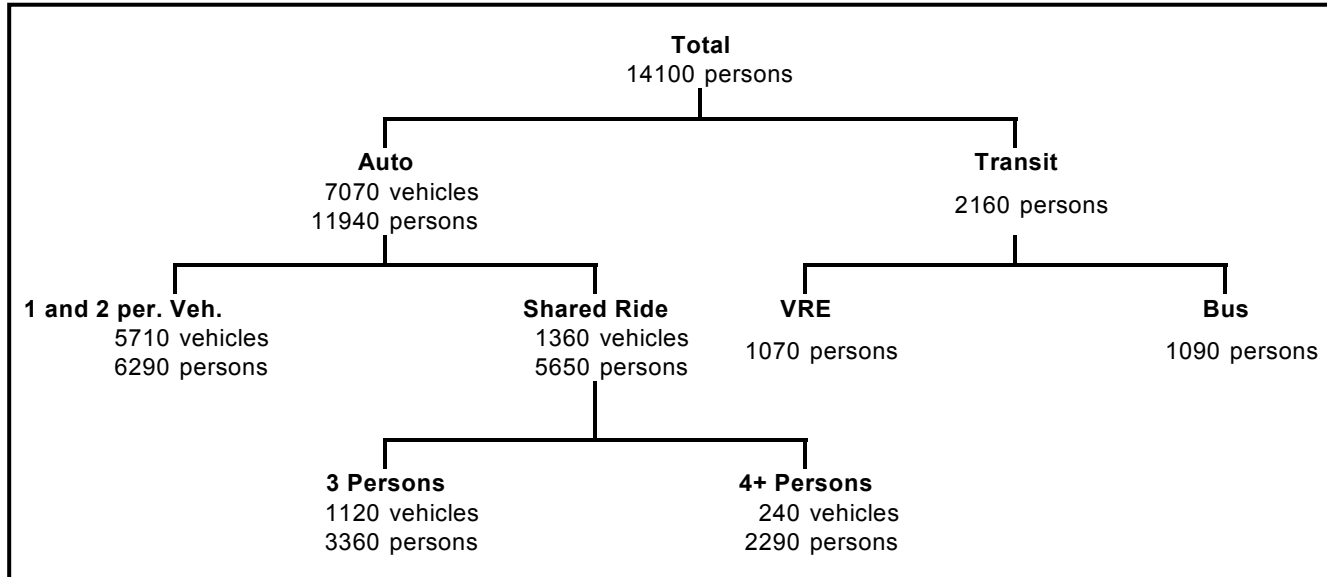


Figure 7. Year 2025 PM Peak Hour Baseline Volumes.

Description of Pivot Point Model

In order to forecast HOV person and vehicle volumes and transit ridership changes that might occur due to addition of HOV or general use lanes on I-95 in the FAMPO area north of VA 3 to the County Line, a unique travel forecasting procedure was used. This procedure incorporates a mode split model, as shown in Figure 8, that was initially developed for the I-395 corridor in the mid-1980's. This model, known as the Shirley Highway Model, generates estimates of the number of people who would use LOV, HOV and transit modes based on changes to their respective travel times and costs. The Shirley Highway Model was augmented by a sub-mode model developed for Virginia Railway Express (VRE) in the mid-1990's, which was used to estimate how many transit passengers would use Metrorail, bus, or VRE.

The model was used to determine how many travelers would change mode from a baseline condition during particular hours of the day based on a change in relative travel times during the PM peak hour period. For example, it was assumed that new HOV lanes would operate at free-flow conditions, and to the extent that the general-purpose lanes operate under less than free-flow conditions, there will be an incentive for travelers to utilize the HOV lanes. This type of model is known as a *pivot point mode split model* because it produces forecasts by “pivoting” from baseline conditions. The model was applied to trips between the County Line and the pivot districts in the FAMPO region.

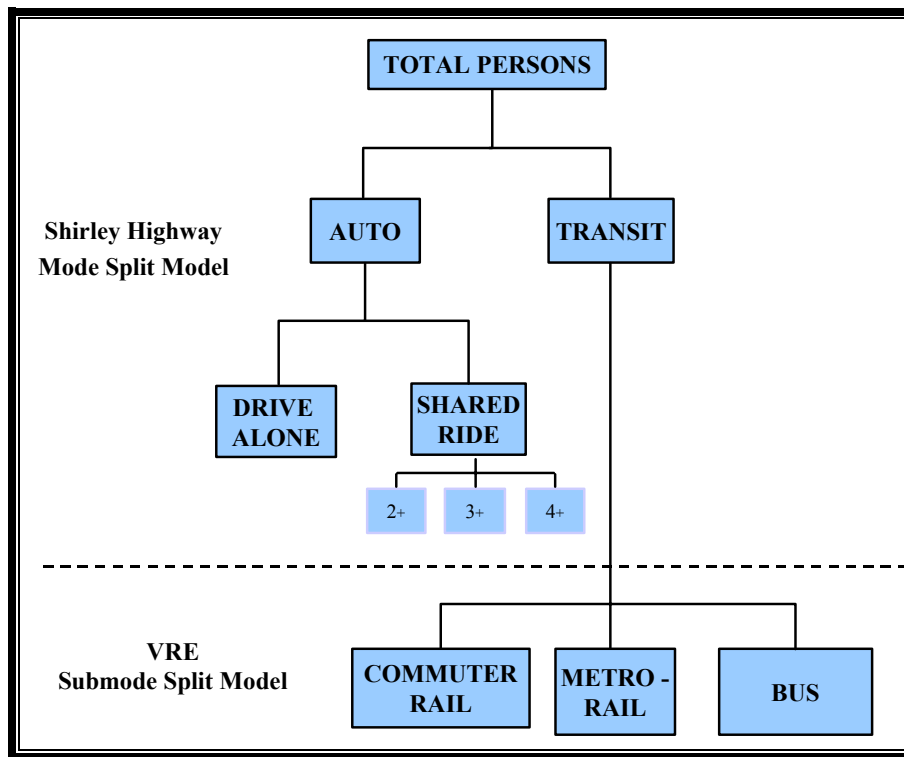


Figure 8. Mode Split Model (Pivot Point Model).

Development of Travel Times

Having created the 2025 baseline PM peak hour person trip table by mode, it was necessary to develop estimates of travel times for each future year alternative. Two alternatives were tested: 1) extension of existing HOV lanes to VA 3 and 2) addition of one general use lane in each direction to VA 3. These two alternatives were selected to evaluate the effects of adding HOV versus non-HOV capacity to I-95. Vehicle operating speeds, which were used to derive travel time, were estimated using FRESYS, a freeway operations analysis program that is capable of accounting for the effects of congestion and queuing, and also analyzes a long section of freeway. The data input is minimal, including basic geometry and traffic data. Outputs from this program include density, LOS, speeds, and volume/capacity ratio for each link of the section.

As described above, the pivot point mode split model must have an existing condition to pivot from. This is also true with travel time input. The pivot point model does not require the absolute travel time but rather the change in travel time. Using the vehicle volumes in the Year 2025 Baseline trip table, FRESYS output provided “baseline” link speeds for both the LOV and HOV volumes (speeds are the same under baseline conditions because there are no separate HOV lanes). Considering construction of a HOV lane, the improved travel time for HOV is based on free-flow speed (uncongested) throughout the roadway section. The LOV vehicles would also experience a change in travel time due to construction of a HOV lane because less vehicle volume would be on the



general use lanes. Again, FRESYS was used to determine the link speeds with these volumes. FRESYS was used also to evaluate the travel time savings for both the LOV and HOV lanes if there are four general use lanes.



IV. ANALYSIS RESULTS

2025 Demand Projections by Mode

The 2025 baseline condition represented three general use lanes only in each direction on I-95 in the FAMPO area. Two alternatives were analyzed for the 2025 PM peak hour. The first alternative included three general use lanes in each direction and a HOV facility (i.e., either a separate facility or concurrent flow “diamond” lanes). The second alternative assumed four general use lanes in each direction. The basic output of the pivot point model for each of these alternatives was the number of person trips by mode at the Prince William/Stafford County Line in Year 2025, as well as person and vehicle volumes on I-95 between the County Line and VA 3, which are presented later in this section. This includes HOV person trip demand forecasts for the HOV alternative. Summaries of person and vehicle demand by mode under the baseline and two build alternatives are shown in Figure 9. These values provided the basis for evaluation of the alternatives.

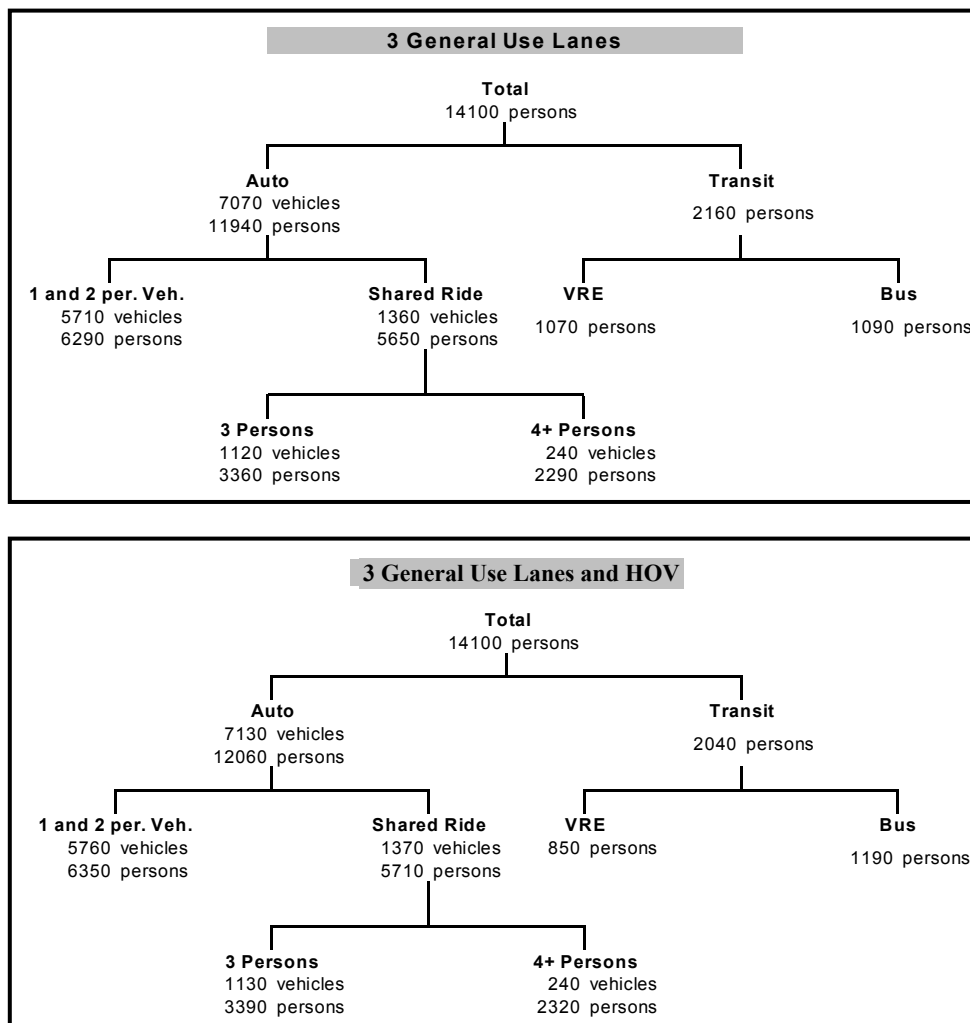


Figure 9. 2025 PM Peak Hour Person Trips by Mode at the Prince William/Stafford County Line.

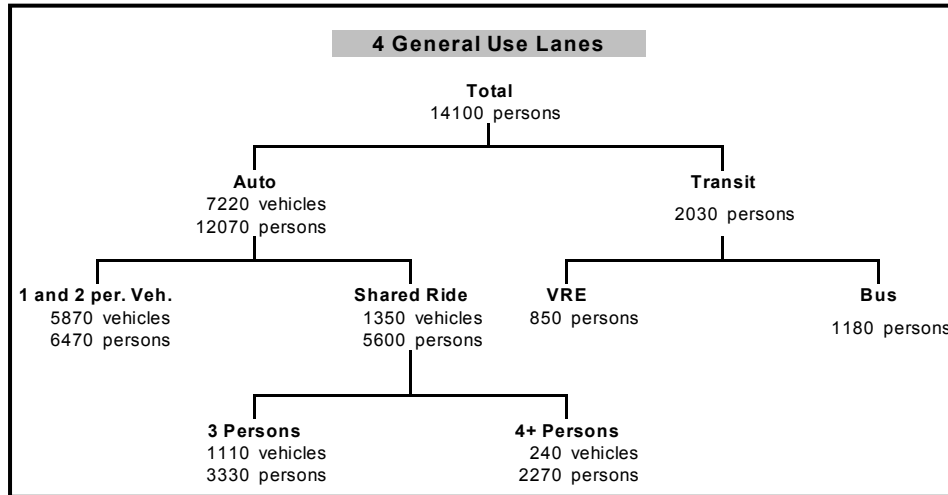
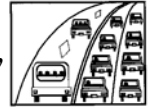


Figure 9 (continued). 2025 PM Peak Hour Person Trips by Mode at the Prince William/Stafford County Line.

The 2025 HOV demand projections were based on the assumption that the current HOV 3+ restriction will remain in place for the entire I-95/I-395 HOV facility. An earlier study that was completed in 1998, the *I-95/I-395 HOV Restriction Study*, examined the potential effects of reducing the HOV occupancy restriction to two or more persons (i.e., HOV 2+). This study found that a reduction in the vehicle occupancy requirement would result in significantly higher volumes on the HOV lanes, which would cause travel speeds to drop by as much as 50 percent, with a corresponding degradation in level of service to LOS E and F on some sections. In southern Prince William County near Dumfries for example, a switch to HOV 2+ was projected to result in a tripling of HOV vehicles and a doubling of HOV persons by 2010. This increased congestion and decreased HOV speeds would also negatively affect bus and vanpool services through increased operating costs and decreased revenue.

Given these serious negative impacts on HOV operations, a switch to HOV 2+ on a HOV extension in the FAMPO portion of the I-95 corridor would not be beneficial. The advantages of HOV travel, primarily reduced travel time and higher reliability, would not be found, and vanpool and bus operations would also suffer.

Evaluation Results

As stated earlier in this report, there were two goals resulting in four MOE’s by which the alternatives were evaluated. The findings of this evaluation are summarized below.

Goal #1. Improve multimodal person trip mobility within the corridor study area.

- Objective: Decrease person trip travel times.



The bar charts in Figure 10 show the PM peak hour travel times by mode for each of the alternatives. The travel time is for vehicles traveling from the Prince William/Stafford County Line and proceeding on I-95 south to Route 3. The results show an approximate 7-minute travel time savings for both the LOV and HOV modes under either build alternative. This is about a 25% reduction in travel time. The travel time on VRE to go the equivalent distance, which is 39 minutes, does not change under any of the alternatives.

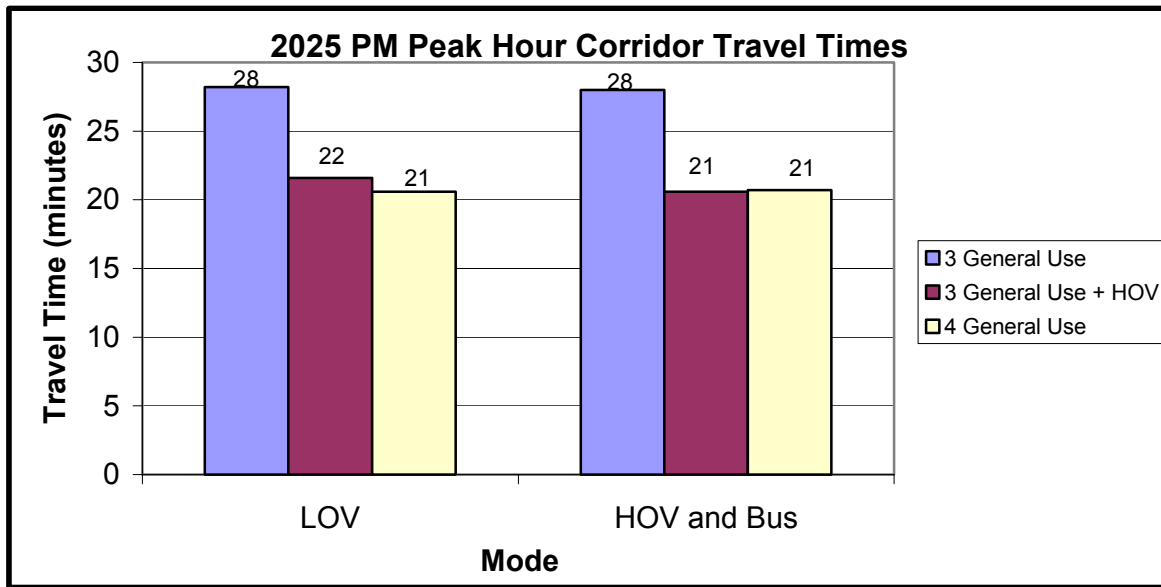


Figure 10. 2025 PM Peak Hour Corridor Travel Times by Mode for Alternatives.

Another related measure of effectiveness that was quantified for each alternative is person hours of travel, or PHT. This measure is reflective of the number of person trips in each mode (LOV, HOV, bus and VRE commuter rail) and the travel times associated with each mode. It is calculated by multiplying the number of person trips using each mode by the travel time for each mode. For example, if 1,000 persons are traveling in a particular mode and each trip takes 2 hours, then there are 1,000 persons times 2 hours equals 2000 person hours of travel for that mode. PHT values by mode are summed for all modes to quantify a corridor-level PHT value for each alternative. The lower the PHT value, the better the alternative serves to decrease total person trip travel times.

Figure 11 shows the total corridor-level person hours of travel on the HOV (where applicable) and general use lanes during the PM peak hour under each alternative. As shown, both the HOV lane alternative and four general use lane alternative reduce PHT, as compared to the baseline alternative, by approximately 22 percent. Both build alternatives are equally effective in decreasing person trip travel times on I-95.

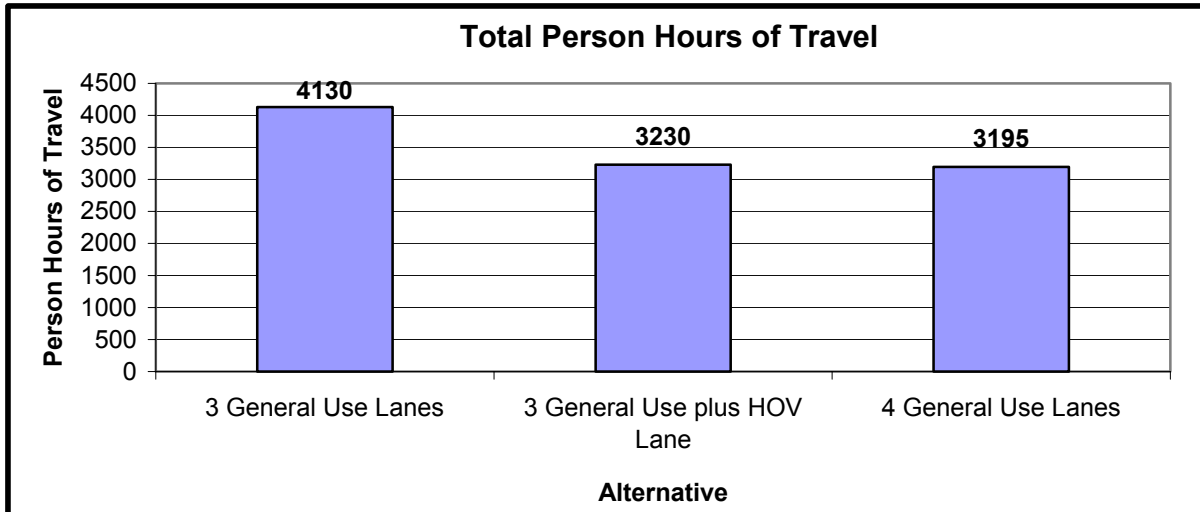


Figure 11. 2025 PM Peak Hour Person Hours of Travel (PHT) for Baseline and Build Alternatives

- *Objective: Improve traffic operations on I-95 general use lanes.*

Level of service (LOS) on the I-95 section just south of the Stafford County/Prince William County Line was calculated for conditions under the baseline and two alternatives, with the result that I-95 is projected to be operating at LOS F during the PM peak hour in 2025 under baseline conditions. LOS F is indicative of forced or breakdown traffic flow, such as can be found upstream of bottlenecks. LOS F conditions are found where a freeway segment's volume exceeds its capacity. Both alternatives are expected to improve level of service conditions along the same section to LOS E. LOS E describes a freeway segment that is operating at capacity, with resulting unstable flow characteristics that are susceptible to disruptions and incidents. Either of the two build alternatives can be expected to improve traffic operations on I-95, as compared to the baseline.

Goal #2. Enhance efficiency of total transportation system.

- *Objective: Increase person movement capacity of I-95 in the study area.*

Addition of a HOV facility with either one concurrent flow HOV lane in each direction or two barrier-separated HOV lanes on I-95 will result in a higher person movement capacity for I-95 than will addition of a fourth general use lane in each direction, assuming prevailing and projected automobile occupancy rates. The increased person movement capacity afforded by adding one HOV lane as opposed to one more general use lane in each direction will be as much as 50 percent. In the existing HOV lanes north of the study area, for example, the HOV lanes carry over 5,000 people on two lanes, while there are only 4,800 people on four general use lanes. Accordingly,



provision of two barrier-separated reversible HOV lanes would add more person movement capacity during the peak periods than provision of one concurrent flow HOV lane in each direction.

- *Objective: Increase HOV and transit mode shares.*

Average vehicle ridership (AVR) is a measure used to quantify relative levels of high occupant vehicle usage, including buses and rail modes, between alternatives. AVR is calculated by dividing the total number of person trips by the total number of private non-transit vehicles, excluding vanpools. As such, as AVR increases, less vehicles are being used to transport the same number of persons. The analysis for this study found that AVR is projected to remain relatively constant across the 2025 baseline and two build alternatives, thus indicating that provision of HOV lanes will not lead to a significant shift in modal shares. It is important to note; however, that although VRE’s mode share decreases by approximately 1 percent under the build alternatives, this represents a 20 percent drop in VRE projected PM peak hour ridership on the Fredericksburg line. This equates to a loss of approximately 200 riders, 100 of which are projected to switch to commuter bus. This analysis assumed existing VRE service and did not assume potential track and service improvements. Figure 12 shows projected mode shares under the baseline and two build alternatives.

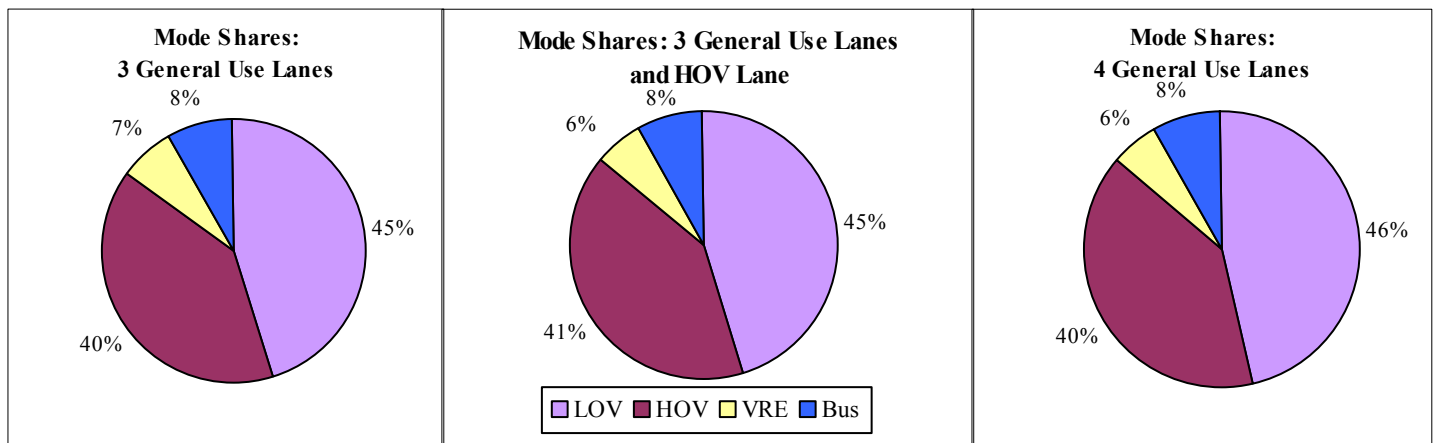


Figure 12. 2025 PM Peak Hour Mode Shares for the Baseline and Build Alternatives.

HOV Assessment

According to Wellander and Leotta (TR News, Number 214, May-June 2001), the most significant measure of whether a HOV lane is meeting its primary goal is person throughput – the number of persons carried on a HOV lane per hour. If the HOV lane carries more persons than each of the adjacent general-purpose lanes during the congested hours, then the HOV person throughput is effective. A person-throughput effectiveness index is used to quantify this objective. If the index is greater than one, then the HOV lane is carrying more people than each of the adjacent general purpose lanes. Using the



volumes for the 3 general use lanes plus one concurrent flow HOV lane, the index is projected to be 2.6 at the Prince William/Stafford County Line. The index is projected to be 1.3 if two new HOV lanes are provided on a barrier-separated two-lane reversible facility. Therefore, either of these HOV scenarios would be considered effective in terms of person throughput.

A second related measure is lane utilization. Lane utilization refers to the number of vehicles using the HOV lane. Guidelines referenced by Wellander and Leotta from National Cooperative Highway Research Program (NCHRP) Report 414 (*HOV Systems Manual*, 1998) indicate a minimum threshold of 400 to 800 vehicles per hour per lane (vphpl) and a maximum threshold of 1,200 to 1,500 vphpl for a concurrent-flow freeway HOV lane. In this case, if the fourth lane becomes a HOV lane, the number of persons using the lane in the PM peak hour will be the HOV persons plus bus persons or 6900 persons using this lane. This is approximately 1400 vehicles (including buses), which is within the threshold of good HOV utilization.

Apart from quantifiable analyses, there are also general benefits/disbenefits to consider. Past research has indicated that even if there is the same number of person hours of travel with HOV and without HOV as this analysis has indicated, adding a HOV lane prepares for future potential utilization of the facility. Also, there are two main reasons people use HOV facilities: time savings and reliability. Time savings were quantified and discussed above. As for reliability, a HOV lane will have less vehicles (even for the same number of persons), thus resulting in less vehicle conflicts leading to less potential for crashes, especially on a barrier-separated facility. Additionally, there will be virtually no trucks in the HOV lanes during the restricted periods, thus increasing reliability of the HOV lane and driver convenience.

Generally accepted guidelines for assessing the performance and value of HOV lanes include the following (*An Evaluation of HOV Lanes in Texas*, 1996, Texas Transportation Institute.):

1. Daily HOV lane person trips should be in the range of 10,000 to 15,000 or greater.
2. The HOV lane should move a greater percentage of persons during the peak hour than the percentage of total directional capacity the HOV lane represents. For example, in this case, a new HOV lane would represent 25 percent of directional lane capacity and should therefore carry more than 25 percent of the total directional person trips.
3. The HOV lane should increase average vehicle occupancy by at least 10 percent to 15 percent.
4. More than 25 percent of the total carpools using the HOV lane should be new carpools created because of the HOV lane.



5. More than 25 percent of the total bus riders using the HOV lane should be new bus riders created because of the HOV lane.

The results of this analysis show that addition of a HOV facility from VA Route 3 northward would satisfy the first two criteria, but not the final three.

The Federal Highway Administration strongly supports HOV lanes as a cost-effective and environmentally friendly option to help move people along congested urban and suburban Routes (*Federal-Aid Highway Program Guidance on High Occupancy Vehicle (HOV) Lanes*, March 28, 2001). FHWA states HOV lanes increase the total number of persons moving through a corridor due to two travel time incentives: a substantial savings in travel time and a reliable and predictable travel time. Their policy does warn, however, that if there isn't significant congestion on the general use lanes during the peak period and if there is not a significant job base beyond the HOV lanes, then it will be difficult to attract riders. The analysis for this study showed that by 2025 traffic volume levels will be reaching capacity for portions of the study corridor, with resulting congestion on these sections. In addition, there is certainly a significant job base north of the FAMPO area to attract HOV commuters.

As mentioned previously in the report, there has been a large increase in HOV person trips on I-95 from 1997 to 2000, according to MWCOG data. This shift is assumed to be partly due to the construction occurring on I-95 around the Springfield interchange that has given greater incentive to carpool. With this in mind, a sensitivity analysis was performed in which 20% of the Baseline 2025 HOV persons were converted to LOV persons as a way of reflecting completion of the construction project. The pivot point model was then run for the same two alternatives (3 general use lanes with HOV and 4 general use lanes). The resulting person hours of travel time for this shifted condition are shown in Table 6.

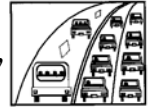
Table 6. PM Peak Hour Person Hours of Travel for Sensitivity Analysis

Alternative	Person Hours of Travel	Percent Reduction
3 General Use Lanes	4220	—
3 General Use Lanes plus HOV	3260	23 %
4 General Use Lanes	3195	24 %

The person hours of travel show that even if the original baseline condition HOV person trips was abnormally high due to the interchange construction project, reducing the baseline HOV persons still results in over a 20% decrease in person hours of travel time.

Induced Travel Demand

In theory, transportation system improvements that add capacity, in this case additional HOV or general use lanes on I-95, can result in increased vehicle travel on improved facilities and/or potential changes to land use development and regional travel demand patterns. This phenomena has been referred to as induced demand, which is generally



defined as any increase in total daily travel over an entire transportation system that results from a change in transportation system capacity. As such, induced demand refers to entirely new travel, either longer or new trips, as opposed to diverted trips or mode shifts.

The concept of induced demand has been the subject of research at both the Federal and local levels. MWCOG, for example, recently completed a study on induced travel demand and how it was being addressed in their regional travel forecasting process. The conclusion of this study was that the MWCOG travel forecasting process currently captures induced travel through their modeling and cooperative land use forecasting processes, although induced travel is not necessarily separated from other increases in travel. A sensitivity analysis was performed to address the issue of induced travel demand for this study.

The pivot point model was used for the sensitivity analysis by assuming a 10 percent increase in highway person trips destined to the FAMPO region during the PM peak hour. It was felt that this would represent an upper bound in terms of a potential induced demand level from the FAMPO region. A corresponding increase in travel time savings of three minutes that would be found under the HOV and general use lane build alternatives was also assumed based on the premise that the 10 percent increase in highway person trips would result in lower speeds on I-95 under baseline conditions. The primary results of the sensitivity analysis, assuming induced demand, included:

1. Overall person trips on I-95, which include through trips, increased by 7 percent.
2. Overall transit person trips remained constant, but with a 3 percent shift from VRE to bus usage under the HOV alternative.
3. 75 percent of the new highway person trips were assigned to the HOV mode under the HOV alternative.
4. 25 percent of the new highway person trips were assigned to the HOV mode under the general use lane alternative.

These results indicate that as demand increases beyond the 2025 levels used for the initial analysis (i.e., baseline with no induced demand), congestion will increase on I-95 to the extent that addition of HOV will result in mode shifts to HOV modes, including carpool, vanpool and bus. This shift will not be seen with addition of a general use lane, as 75 percent of the induced highway person trips under this alternative would be assigned to the LOV mode.

The conclusion of this sensitivity analysis is that as highway person movement, and corresponding vehicle flows, increase beyond the 2025 baseline levels used for this analysis, HOV modes will become more attractive with potential travel time savings from an extension of the HOV facility to VA Route 3 reaching a level that will compel shifts from LOV to HOV modes.



V. CONCLUSIONS

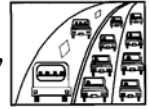
The objective of this study was to determine if an extension of the existing HOV lanes would be an effective strategy to accommodate future peak commuter demands in the I-95 corridor in the FAMPO region. Two build alternatives were evaluated; the first assumed addition of a HOV facility and the second assumed addition of a fourth general use lane in each direction. The additional lanes, whether HOV or general use, were tested from the Stafford County/Prince William County line as far as VA Route 3 to the south.

The analysis results described in the previous section demonstrate a need to add capacity to this portion of I-95; however, they are less definitive with respect to the question of whether added capacity should be in the form of HOV or general use lanes. With respect to the goal of improving multimodal trip mobility within the corridor, both build alternatives have the same effects on person hours of travel and level of service on I-95, and both are shown to provide improvement over baseline conditions, which assume three general use lanes in each direction.

In general, the feasibility of providing HOV lanes is assessed in terms of: 1) projected HOV utilization and 2) increased usage of high occupant modes, such as carpools, vanpools and buses. This analysis has shown that the HOV facility would be projected to carry appropriate levels of person trips as compared to national guidelines; however, there is not projected to be a significant shift in mode share as a result of extending the HOV facility southward into the FAMPO region. There are two primary factors behind this finding: 1) a large proportion of commuters in this corridor are already using high occupant modes due to the significant travel time benefits gained in the I-95/I-395 corridor to the north of the FAMPO region and 2) although the I-95 general use lanes are projected to be congested in the FAMPO region in 2025, the actual travel time savings between VA 3 and the Stafford County/Prince William County Line is estimated to be approximately seven minutes over this eighteen-mile portion of I-95. The pivot point model is predicting that this seven-minute travel time saving alone is not enough to entice more people to change modes. In other words, this extra seven-minute travel time saving, combined with the approximate forty-minute travel time saving already formed north of the FAMPO region, is still not enough to induce a significant shift to HOV modes.

In addition to this quantitative assessment, there are more qualitative factors and considerations that need to be considered, including:

1. The beneficial effects of HOV facilities on regional air quality and fuel consumption. The effects on vehicle emissions are especially important given Federal funding guidelines and potential constraints for nonattainment areas.
2. Identification of a potential need for a HOV facility at this stage in regional long range planning will provide the flexibility to keep HOV as an option in future transportation planning and programming efforts.
3. Provision of HOV lanes, particularly a barrier-separated facility, will provide the flexibility to address heavy seasonal directional traffic flows, respond to



- major incidents on the general use lanes, provide an opportunity to separate auto and truck traffic, and implement potential ITS applications.
4. The I-95 corridor is already oriented to HOV modes due to the success of the existing HOV lanes. Many commuters from the FAMPO region are currently taking advantage of these HOV opportunities through carpool, vanpool and commuter bus use.
 5. Construction of an extension of the two-lane barrier-separated reversible facility in the median of I-95 will have negative aesthetic impacts due to loss of trees and vegetation in the median.

If it were to be determined that a HOV facility should be provided, there would be several considerations that would need to be addressed:

1. *How far south should the HOV lanes extend?*

Table 7 shows the assignment table for HOV volumes. This is output from the pivot model for the alternative of three general use lanes and a HOV lane. The biggest drop in HOV person and vehicle volumes in the PM peak hour is at Route 610. However, projected HOV person volumes are still relatively high, at over 4,100, north of VA 3. Additionally, Figure 13 shows that the vast majority of person hour travel time savings on the HOV and general use lanes found under the HOV alternative are between the programmed Route 627 and US Route 17 interchanges. Note that there are projected to be 780 person hours of travel on this link under baseline conditions, which will decrease to 300 to 305 person hours of travel under the build alternatives. This is a result of congestion relief provided by an additional lane for HOV persons that can be used to bypass congestion on the general use lanes on this link. These results indicate that a HOV facility should be extended to VA Route 3.

Table 7. 2025 Assignment of PM Peak Hour HOV and Bus Person Volumes for 3 General Use Lanes Plus HOV Alternative.

Link	HOV Person Volume	Bus Person Volume	Total HOV Person Volume	Total HOV Vehicle Volume
Russell Road at Prince William/ Stafford County Line	5,705	1,190	6,895	1,405
N of Route 610	5,530	1,140	6,670	1,365
N of Route 630	4,145	785	4,930	1,020
N of Programmed Route 627 Interchange	3,935	730	4,665	970
N of US Route 17	3,610	670	4,280	885
N of VA Route 3	3,535	633	4,168	870
S of VA Route 3	2,270	30	2,300	550

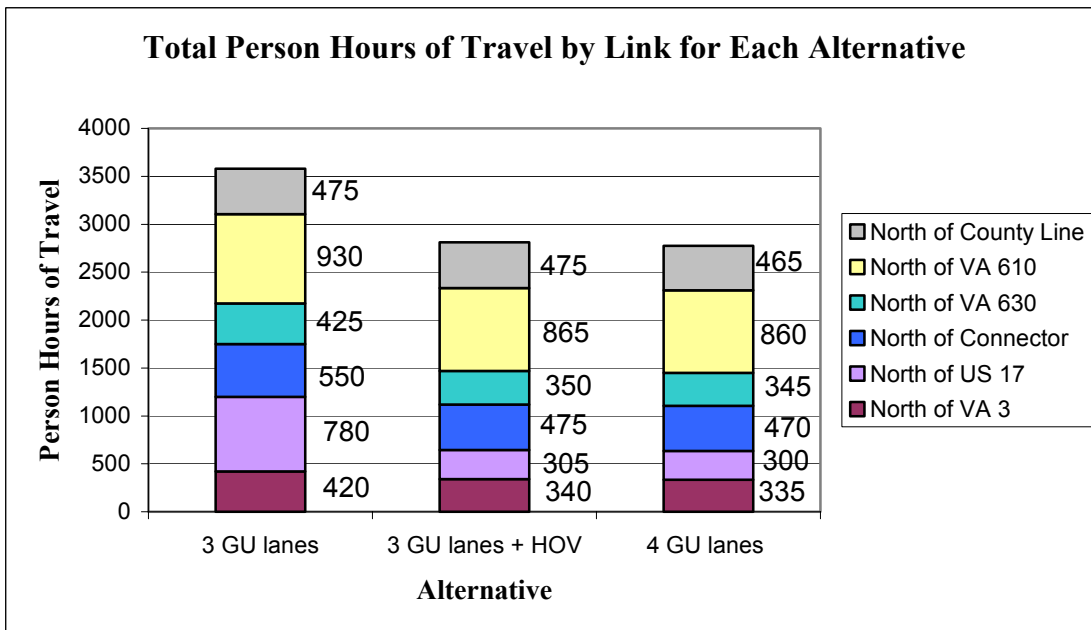
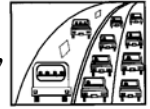
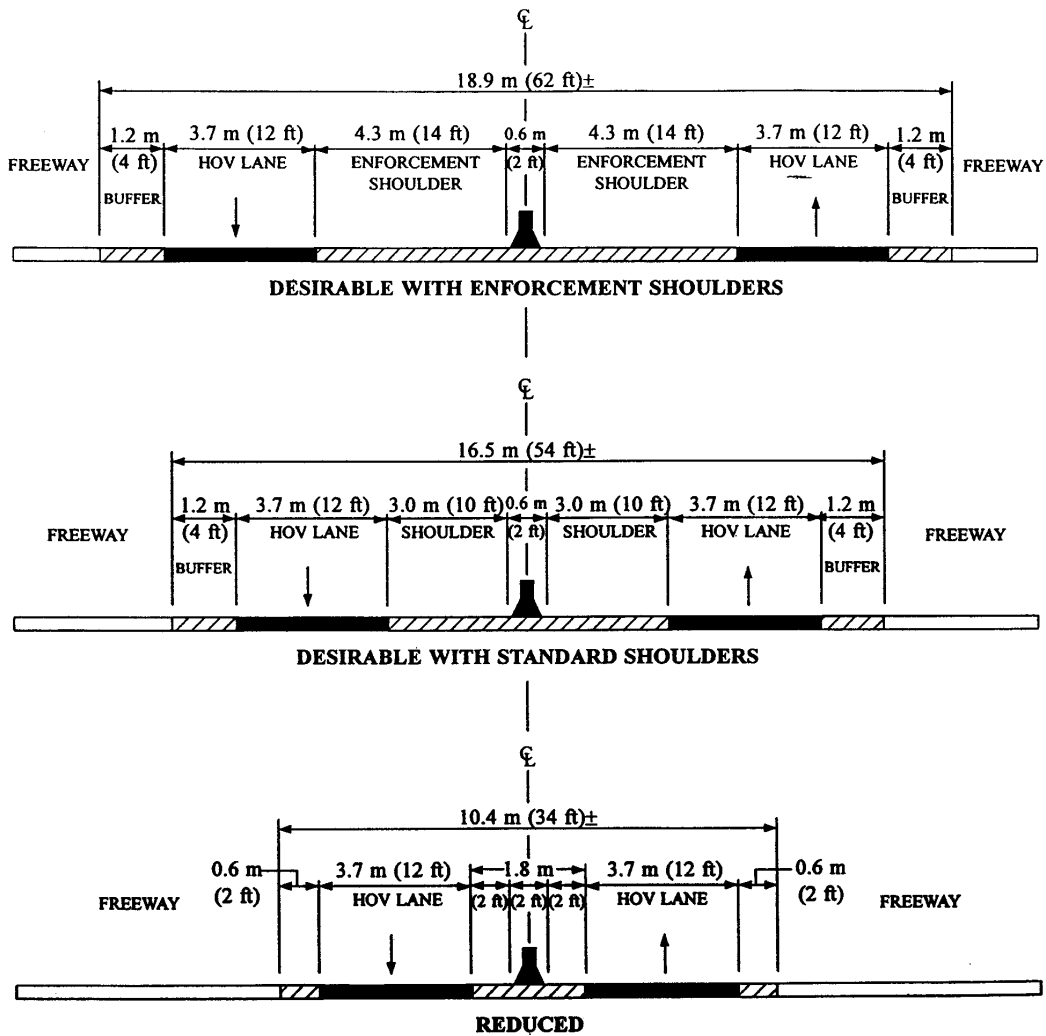
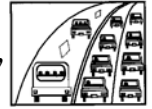


Figure 13. 2025 PM Peak Hour HOV and LOV Person Hours of Travel for Each Alternative.

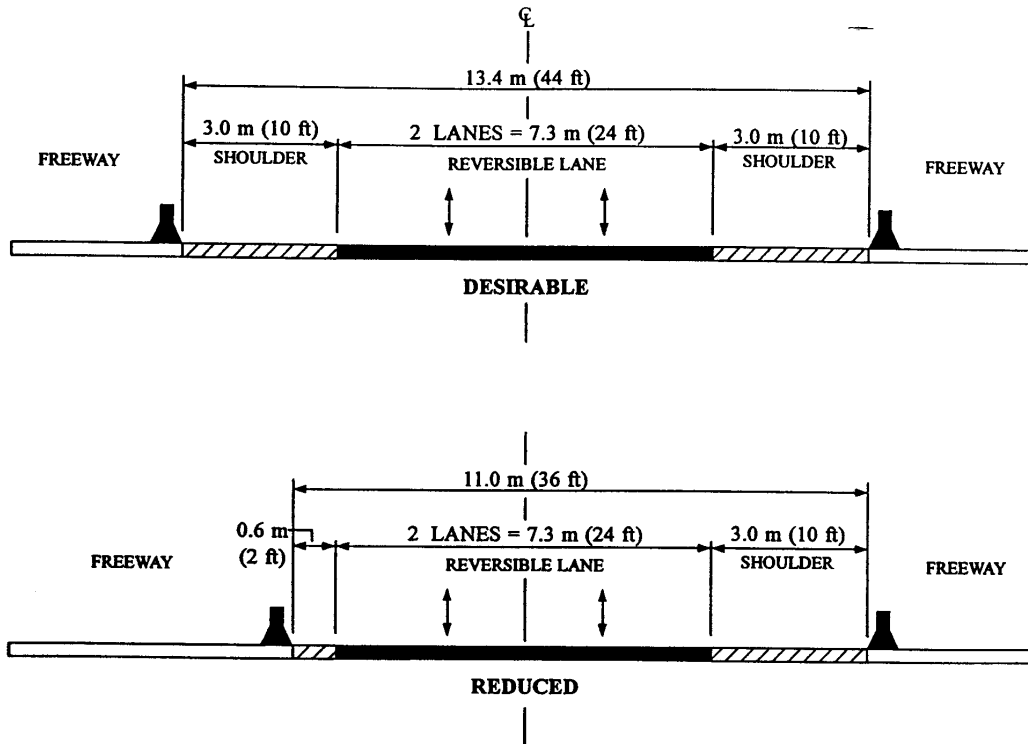
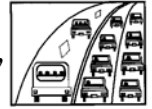
2. *Should the HOV facility consist of one concurrent flow lane in each direction, or a continuation of the separated reversible two-lane facility currently in place in Northern Virginia?*

Figures 14 and 15 show examples of cross sections for concurrent flow and separated HOV facilities. Note that concurrent flow HOV lanes, often referred to as “diamond” lanes, are normally in the left-most lane of travel in each direction. Although the typical cross-sections shown in Figure 14 display a buffer between the HOV and general use (GU) lanes, in situations where the HOV lanes are restricted to HOV use during peak periods only, it may not be appropriate to provide such a buffer. I-66 and the Dulles Toll Road HOV lanes are an example. Table 8 presents a comparison of the two types of HOV facilities as they relate to key considerations.



Source: HOV Systems Manual, NCHRP Report 414

Figure 14. Examples of Cross Sections for Concurrent Flow HOV Facilities Located on the Inside of a Freeway



Source: *HOV Systems Manual, NCHRP Report 414*

Figure 15. Examples of Cross Sections for Two-Lane Barrier-Separated Reversible HOV Facilities

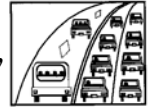


Table 8. Comparison of Considerations for Concurrent Flow HOV Lanes and a Barrier-Separated Reversible HOV Facility.

Considerations	Concurrent Flow HOV Lane	Separated Reversible Flow HOV Lanes
1. Operating Threshold Guidelines		
-minimum vphpl*	400-800	800-1,000
-maximum vphpl*	1,200-1,500	1,500-1,800
(*vehicles per hour per lane)		
2. Safety	Operate best if separated from general use lanes by barrier or buffer	Generally more safe
3. Enforcement	Level of difficulty depends on type of separation from general use lanes (i.e., no physical separation-enforcement is difficult)	More easily enforced
4. Construction Cost (based on Texas experience)	Approximately \$1 million per mile	Approximately \$5-6 million per mile

The projected vehicle volumes on the HOV lanes, as shown in Table 7, fit within the recommended thresholds of separated reversible facilities; however, north of Route 610 the projected HOV volume of 1,405 is approaching the maximum threshold for a concurrent flow HOV lane. Separated reversible HOV facilities are generally superior in terms of safety and ease of enforcement, but are also five to six times more costly.

3. *What are some possible design alternatives for the HOV facility?*

Table 9 shows exiting HOV vehicle volumes for the PM peak hour and PM peak period. It is important to emphasize that Table 9 shows vehicle volumes, as opposed to person volumes. Given the fact that many of the vehicles that would be exiting the HOV lanes at each interchange would all be high occupant vehicles, including buses, vanpools, and carpools, the number of persons exiting the HOV lanes will be six to eight times the number of vehicles. For example, the forty vehicles projected to be exiting the HOV lanes at U.S. Route 17 in the PM peak period will represent 240 to 320 person trips. Routes 610 and VA Route 3 experience the highest HOV exiting volumes. Approximately 70 to 75 percent of exiting HOV volumes are destined to areas west of I-95 at both locations.

If HOV construction includes a barrier-separated facility, then one solution may be to provide direct connection ramps at Route 610 and VA Route 3, while providing slip ramps to the mainline lanes for vehicles exiting at the other interchanges. With respect to cost, direct connection ramps are more costly to build than slip ramps.



The ultimate design of either type of HOV facility will be affected by improvements being considered as part of the I-95 Access/C-D study. For example, if a C-D system is to be put in place between Routes 17 and 3, it may be more cost effective to terminate the HOV facility north of US Route 17.

Table 9. Exiting 2025 PM HOV Volumes for Each Interchange.

Interchange	PM Peak Hour Exiting HOV Volume	PM Peak Period Exiting HOV Volume
Quantico	40	100
Route 610	345	860
Route 630	50	125
Programmed Route 627 Interchange	85	210
US Route 17	15	40
VA Route 3	320	800

4. *What are potential alternative uses of the HOV lanes during off-peak periods?*

A separated facility would add two additional lanes of capacity in one direction while concurrent flow lanes would add one additional lane in each direction. Separated lanes provide the opportunity for provision of express lanes in one direction for heavy seasonal volumes and additional capacity in case of an incident on the general use lanes.

5. *What HOV support facilities may need to be evaluated?*

Typical HOV support facilities include park and ride lots and transit stations. Although there are existing park and ride lots in the I-95 corridor, at Route 610, Route 630, US 17 and VA 3, extension of the HOV lanes may result in demand for park and ride lots beyond current capacity. For example, demand for HOV, including commuter bus, is projected to increase two and one-half times over existing demand in the I-95 corridor. Provision of improved transit facilities and/or expanded routes could also serve to support this increased HOV usage.

Closing

As a feasibility study, this study examined potential demand for extension of HOV lanes into the FAMPO region, effects of added HOV vs. general use capacity, and considerations with respect to the extent of a HOV facility, access to the facility and potential other uses



of a HOV facility. Further preliminary engineering studies will be required to address design and cost elements. In addition, the potential role for a HOV facility will need to be examined in the context of regional roadway and transit system improvements, such as new interchanges and/or collector-distributor facilities along I-95 and/or improvements and extensions to rail and bus transit services.

VI. PUBLIC COMMENT

A public involvement program was developed in April 2000 to supplement the goals of the I-95 Collector-Distributor (CD) Access Feasibility Study and the I-95 HOV Feasibility Study. Specific objectives of the program were to:

- Create public awareness of the purpose and scope of the project;
- Solicit input from citizens on issues and developments relevant to the scope of the project; and
- Report study results at key milestones.

Program activities were proactive, informative, and solicited broad input from citizens, elected/appointed officials, communities, interest groups, and agency representatives. The major components of the public involvement program are discussed below.

Public Involvement Activities

Developing a credible list of stakeholders was one of the first activities with which the public involvement team was involved. The team researched and identified potential stakeholders who worked in, resided, or commuted through the study corridor. Stakeholders who represented interested/affected constituencies who travel through this corridor were also included. The names and addresses of these key stakeholders were compiled into a mailing database of approximately 500 persons/agencies. It was anticipated that many of the stakeholders would represent their organizations and act as conduits by advising the study team of issues that should be considered within the studies' scope and by communicating findings back to their respective organizations. Key stakeholders included representatives from the following groups:

- Elected and appointed officials from Stafford and Spotsylvania Counties and the City of Fredericksburg;
- Federal, state, and local agency representatives within the study area;
- Business, environmental, community, civic, and homeowner organizations;
- Transit providers and patrons (private bus operators, rideshare coordinators, and VRE);
- Current/potential/non-HOV users;
- FAMPO and RADCO members;
- Local media (newspaper, television, and radio);



- Slugs;
- Virginia State Police; and
- Major employment centers.

The stakeholder database was used to invite citizens to public information meetings. These citizen meetings were held on July 27, 2000 and October 29, 2001. The first meeting was held in the early stages of the studies and the second was conducted towards the studies' conclusions. The general public, as well as the invited stakeholders, were welcome to attend the meetings. In addition to the personal invitations mailed to all stakeholders on the mailing database, the team prepared meeting notices for the project website (www.virginia DOT.org), newspaper ads, and press advisories.

At the public meetings, the study team distributed informational materials, which included the agenda, an overview of the presentation, fact sheets, and comment forms. Citizens had ample opportunities to ask questions, provide comments, complete comment sheets, and view study-related exhibits and maps.

Other communication methods used for these studies included the project website, which presented a description and location of the studies, contact information for the VDOT project manager, a calendar, and a status of the study. A toll-free hotline (1-800-862-1386), maintained by VDOT staff, was also employed during the course of the studies.

Summary of Comments

General comments and questions on the HOV Feasibility Study focused on the status of the study, need for HOV lanes, criteria being used to evaluate HOV lanes, and availability of funds for an extension of the HOV lanes. Public comment was divided on the issue of whether the HOV lanes should be extended into the FAMPO region.

Specific comments and questions related to HOV lane occupancy requirements (HOV 2+ or HOV 3+), time of operation, and lack of detailed construction cost estimates.

The study team provided responses to comments and questions to the extent that information was available to do so. It was noted that this was a feasibility study and that a formal decision on whether to extend the HOV lanes would ultimately be based on more detailed engineering studies, as well as an examination of their role in the context of other potential regional roadway and transit system improvements. The information in this report will be provided to the FAMPO Policy Committee for their consideration in planning and programming improvements to the transportation system in the Fredericksburg region.