HOV Lanes:
Issues and Options for Enforcement

FINAL REPORT 552

June 2004

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16. Abstract

KEY FINDINGS

- No technology exists that can fully automate HOV occupancy enforcement, because no technology exists that can see through metal vehicles and pick out the people inside.
- Of the factors that limit the ability to see inside a vehicle, the most pernicious is window tinting, because of the threat it poses to law enforcement. Opaque auto glass tinting can hide not only a weapon, but also the person reaching for it.
- Adequate enforcement requires extensive space in the median. In many instances it is not feasible to provide this space.
- Current statutes that require officers to have vehicles to pull over to the right are inappropriate for HOV enforcement

KEY RECOMMENDATIONS

- Where feasible to do so, highway design should allow for sheltered observation areas and wide, long citation areas, with adequate entrances and exits, in the median next to the HOV lane.
- An optics expert should review Arizona's law regulating auto glass tinting, to see if current restrictions allow for adequate video imaging.
- Prominently post the fine for HOV violations on roadside signs.
- Randomly, but periodically, utilize special enforcement followed by routine enforcement.
- Evaluate increased penalties for HOV violations.
- Have engineers meet with highway patrol officers before design concepts are finalized.
- Consider implementing HOT lanes on HOV lanes by charging full price for single occupancy vehicles (SOVs), half price for high occupancy vehicles with two or more occupants (2+ HOVs) and nothing for high occupancy vehicles with three or more occupants (3+ HOVs).
- Monitor new technology as it emerges and reconsider implementing it if it appears feasible and warranted.
- Evaluate establishing enforcement areas near HOV entry and exit ramps.
- Consider installing a "hot line" for citizens to call to report HOV violators.

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SI (MODERN METRIC) CONVERSION FACTORS*

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
	AREA			
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yards	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
	VOLUME			
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: Volumes greater than 1000L shall be shown in m^3.			
	MASS			
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000lb)	0.907	megagrams (or "metric ton")	mg (or "t")
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5(F-32)/9 or (F-32)/1.8	Celsius temperature	°C
	ILLUMINATION			
fc	foot candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
	FORCE AND PRESSURE OR STRESS			
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
	LENGTH			
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
	AREA			
mm^2	Square millimeters	0.0016	square inches	in^2
m^2	Square meters	10.764	square feet	ft^2
m^2	Square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	Square kilometers	0.386	square miles	mi^2
	VOLUME			
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	Cubic meters	35.315	cubic feet	ft^3
m^3	Cubic meters	1.308	cubic yards	yd^3
	MASS			
g	grams	0.035	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (or "metric ton")	1.102	short tons (2000lb)	T
	TEMPERATURE (exact)			
°C	Celsius temperature	1.8C + 32	Fahrenheit temperature	°F
	ILLUMINATION			
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
	FORCE AND PRESSURE OR STRESS			
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

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GLOSSARY OF ACRONYMS

ADOT	Arizona Department of Transportation
CHP	California Highway Patrol
CMAQ	Congestion Mitigation and Air Quality improvement program
DART	Dallas Area Rapid Transit
DPS	Arizona Department of Public Safety
DUI	Driving Under the Influence
EPA	Environmental Protection Agency
FHWA	Federal High Way Administration
HOT	High Occupancy Tolls
HOV	High Occupancy Vehicle
LOS	Level Of Service
MAG	Maricopa Association of Governments
NHTSA	National Highway Transportation Safety Administration
SOV	Single Occupancy Vehicle
TCM	Transportation Control Measures
TEA – 21	Transportation Equity Act for the 21st century
TTI	Texas Transportation Institute
VMT	Vehicle Miles Traveled

EXECUTIVE SUMMARY

In 2001, 67 percent of Maricopa County residents thought traffic was a very serious (25 percent) or somewhat serious (42 percent) problem. Yet to the open-ended question, "What should be done to reduce traffic?" just 4 percent came up with "increase carpooling."[1]

A 2002 study for the Maricopa Association of Governments (MAG) and the Arizona Department of Transportation (ADOT) projected future demand for High Occupancy Vehicle (HOV) lanes and High Occupancy Toll (HOT) lanes or Value lanes. The study recommended constructing at least one pair of HOV lanes on every freeway in the MAG region – construction that will cost hundreds of millions of dollars.

Without adequate enforcement, violation rates on these HOV lanes will be high. So will dissatisfaction among legitimate carpoolers and transit users. With no enforcement, HOV lanes would revert to general-purpose lanes. In that case, the federal government could order the state to repay federal funds used in their construction.

KEY FINDINGS

- No technology exists that can fully automate HOV occupancy enforcement, because no technology exists that can see through metal vehicles and pick out the people inside. Equipment and officers are thwarted by the same problems – children or sleeping adults who do not show through the window. Only a traffic stop can tell for sure if a vehicle is violating occupancy requirements.
- Of the factors that limit the ability to see inside a vehicle, the most pernicious is window tinting, because of the threat it poses to law enforcement. Opaque auto glass tinting can hide not only a weapon, but also the person reaching for it.
- Adequate enforcement requires extensive space in the median. In many instances it is not feasible to provide this space.
- Current statutes that require officers to have vehicles to pull over to the right are inappropriate for HOV enforcement

KEY RECOMMENDATIONS

- Where feasible to do so, highway design should allow for sheltered observation areas and wide, long citation areas, with adequate entrances and exits, in the median next to the HOV lane.
- An optics expert should review Arizona's law regulating auto glass tinting, to see if current restrictions allow for adequate video imaging. Although occupancy enforcement cannot be automated, cameras have been used in advance warning

[1] "KAET Poll: Traffic Seen as Serious Problem; Most Oppose Transportation Tax Proposal," *KAET-TV, Walter Cronkite School of Journalism and Telecommunication;* 7/24/2001

systems. They need to be able to see through auto glass, as do officers. Once tinting levels and fines for noncompliance are set, officers should be equipped with tint-meters, trained in how to use them and encouraged to check every time they make a stop and cite every time they see a violation.

- Prominently post the fine for HOV violations on roadside signs. Use electric signs when available for periodic reminders.
- Randomly, but periodically, utilize special enforcement followed by routine enforcement.
- Evaluate increased penalties for HOV violations.
- Have engineers meet with highway patrol officers before design concepts are finalized wherever HOV or HOT/Value lanes are contemplated.
- Consider implementing HOT lanes on HOV lanes by charging full price for single occupancy vehicles (SOVs), half price for high occupancy vehicles with two or more occupants (2+ HOVs) and nothing for high occupancy vehicles with three or more occupants (3+ HOVs).
- Monitor new technology as it emerges and reconsider implementing it if it appears feasible and warranted.
- Evaluate establishing enforcement areas near HOV entry and exit ramps.
- Consider installing a “hot line” for citizens to call to report HOV violators.

INTRODUCTION

BACKGROUND

This report was prepared for the Arizona Department of Transportation (ADOT) to explore options for dealing with the problem of High Occupancy Vehicle (HOV) lane enforcement, specifically freeway HOV lane enforcement.

SCOPE

Funding for this research project was $15,000. Reviews of academic, environmental, law enforcement and transportation literature were conducted. Customized surveys were developed and distributed and responses were analyzed. Final deliverables are this report and a separate PowerPoint presentation.

METHODOLOGY

The project manager was John Semmens of the Arizona Transportation Research Center (ATRC). The project researcher was Lisa Markkula of Marketing Intelligence, LLC.

Literature review included academic journals, company and professional association websites, government reports, newspapers and publicly available data. Sources of secondary data include the Bureau of Transportation Statistics, the Environmental Protection Agency (EPA) and the National Highway Transportation Safety Administration (NHTSA). A bibliography is attached.

Literature searches used the U.S. Department of Transportation's TRIS Online, the Library of Congress' Thomas system, the University of Arizona's SABIO information gateway, LexisNexis (an online legal information database), Google, EBSCO (a general journals database), ABI/Inform (an academic and business publications database), Arizona's ALIS Online, and other sources/search engines.

After the literature review, an email survey was developed and approved. Respondents were supervisors of patrol officers responsible for enforcing HOV lane restrictions in 35 metropolitan areas. To maximize the potential benefit from this panel of experts, open-response as well as closed-response questions were asked.

Different types of HOV lanes pose different problems for law enforcement. The main difference is whether or not a concrete barrier separates the HOV lane from adjacent general-traffic lanes. Arizona's HOV lanes have no such barriers. For this reason, surveys were customized, listing only non-barrier-separated HOV lanes in the respondent's jurisdiction and asking questions specifically about those lanes.

Responses were analyzed using descriptive statistics, frequencies and non-parametric testing methods. Survey analysis had four goals:

- Reflect law enforcement officer perceptions of problems in HOV lane enforcement.
- Measure frequency and severity of problems.
- Determine variables most often mentioned in connection with ease or difficulty of enforcing HOV lane restrictions.
- Obtain suggestions for better HOV lane enforcement.

OVERVIEW

This report has six sections:

- Executive Summary
- Introduction
- Literature Review
- Survey Analysis
- Conclusions and Recommendations
- Appendix

The Literature Review section contains the most in-depth discussions of issues, including:

- The history and purpose of HOV lanes
- High Occupancy/Toll (HOT) lanes, Value lanes and variable pricing
- Common problems in HOV enforcement
- A comparison of different enforcement types and highway designs
- Visibility of enforcement and violation rates
- Problems automating HOV occupancy enforcement
- Recommended enforcement area design

The Conclusions and Recommendations section makes suggestions for consideration. But review of ADOT or Department of Public Safety (DPS) operations is beyond the scope of this report. Where suggestions are made, ADOT and/or DPS may already be following them or have good reason not to do so.

The Appendix contains statistical output from Statistical Package for the Social Sciences (SPSS), a statistical software package, and other attachments too detailed to include in the body of the report.

LITERATURE REVIEW

TYPES OF HOV LANES

There are five types of HOV lanes, characterized by their direction of flow and degree of separation from adjoining lanes.

- Barrier-separated concurrent
- Buffer-separated concurrent
- Non-separated concurrent
- Barrier-separated contra-flow (reversible)
- Non-separated shoulder lane (concurrent)

Barrier-separated HOV lanes are separated from adjacent general-traffic lanes by a physical barrier – usually concrete. Concurrent and contra-flow lanes are the opposite of each other. Concurrent HOV traffic is headed in the same direction as adjoining lanes. Contra-flow HOV traffic is headed in the opposite direction. Buffer-separated lanes have a buffer: a painted neutral area between the HOV and the mixed-flow lanes. Non-separated lanes have no buffer. A white line separates both buffer and non-separated HOV lanes from mixed-flow lanes.

Contra-flow lanes are reversible. During peak hours, they "borrow" one or more lanes from the off-peak direction. To avoid head-on collisions, moveable barriers – either rubber pylons or moveable concrete – separate contra-flow lanes from oncoming traffic. So-called zipper lanes use 12 or 18-inch wide moveable concrete barriers weighing 1,500 lbs. According to the manufacturer, one mile of lane can be moved in less than 15 minutes.[2]

Figure 1. Zipper Lane

Concurrent HOV lanes may be barrier-separated, buffer-separated or non-separated. Shoulder lanes – wide shoulders used as HOV lanes during peak hours – are non-separated. Just three states allow carpools to use shoulder lanes.[3] Another allows shoulder lane use by transit buses only.[4, 5]

[2] Quickchange Moveable Barrier System (QMB); Source: Barrier Systems Inc.
[3] California, Maryland and Washington
[4] Minnesota
[5] Cambridge Systematics with URS, Inc., *Twin Cities HOV Study Final Report* (Minnesota Dept. of Transportation; February 2002), 5-3.

HOV lanes may also be categorized by whether they are on the left (as is usually the case) or the right.

Barrier-separated lanes are easier to enforce than buffer or non-separated lanes. They are much more expensive, however. Of the various types of barriers, the most expensive in the short run – fixed concrete barriers – are the least expensive in the long run. Moveable barriers have significantly higher operating and maintenance costs. Other fixed barriers, such as Thrie Beam or Three-Cable Barriers, also have higher life cycle costs.[6]

Figure 2. Thrie Beam Barrier

Figure 3. Three-Cable Barrier[7]

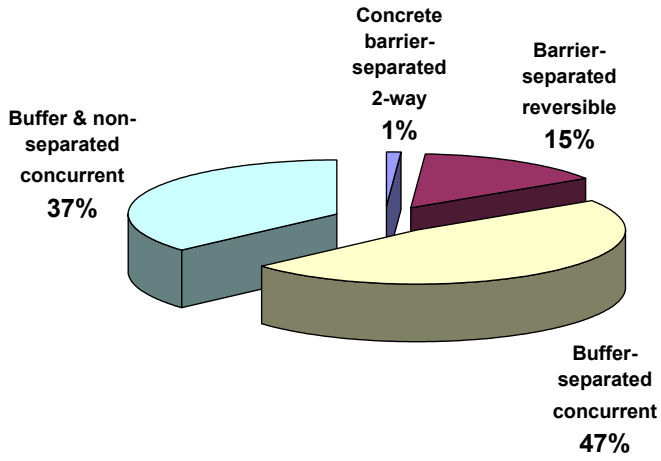

Figure 4. U.S. HOV Total Highway Miles by Type

Furthermore, other fixed barriers – especially the Three-Cable Barrier – are less visible than concrete barriers. Reflective coatings or other modifications might be necessary to

[6] California Dept. of Transportation, *California Highway Barrier Aesthetics* (June 2002), 2-3.
[7] *Ibid.*; pp. 2-3

obtain approval for use as HOV lane barriers, at additional cost. Or they could be rejected for other reasons.

Disadvantages of moveable barriers include the slow changeover time. Plus, moveable concrete barriers are very heavy – anywhere from 1.35 to 4.75 million pounds per mile.[8] Letting them sit for hours under Arizona's intense summer sun might damage the freeway.

Whether fixed or moveable, barrier-separated lanes are used less often, and for shorter distances, than other types of HOV lanes – a result of their considerably higher cost. (See Figure 4 above and Figure 5 below.)

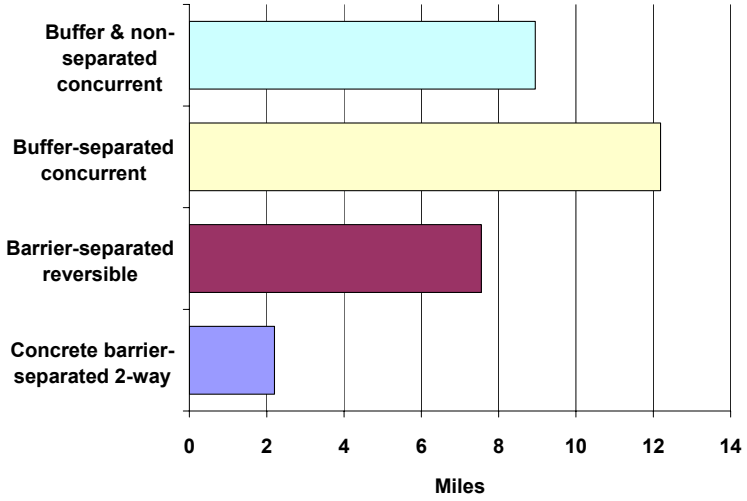

Figure 5. Average Mile Length of U.S. HOV Lanes by Type[9]

Another disadvantage to barrier-separation is that it limits exit from the HOV lane, discouraging use by commuters for whom exit points are inconvenient.

Shoulder HOV lanes raise obvious safety concerns about confusion over lane use and lack of emergency pull outs for disabled vehicles.

Buffer and non-barrier separated HOV lanes also raise safety concerns. HOV traffic usually travels at higher speeds than congested general traffic. This can make entering or exiting the HOV lane a challenging maneuver. Incident rates on buffer and non-separated HOV lanes are roughly twice that of barrier-separated HOV lanes: two to three incidents per million miles of travel versus about 1.4 incidents per million miles of

[8] Source: Barrier Systems Inc.
[9] Source: Federal Highway Administration, U.S. Dept. of Transportation

travel.[10] The more difficult the driving conditions, the less likely it is that violators will be pulled over and ticketed.

TYPES OF HOV LANE RESTRICTIONS

HOV lanes are restricted by vehicle type, occupancy requirement, and hours of operation.

Some HOV lanes operate 24 hours; others revert to general traffic (or shoulder) use outside designated peak periods. Most HOV lanes today have two-or-more person occupancy requirements (2+), although some have three-or-more (3+) or even four-or-more (4+) person occupancy requirements. Some HOV lanes are restricted to transit buses only; others allow buses, taxis and vanpools only.

Besides emergency vehicles, a number of other vehicles may be granted access to HOV lanes, regardless of the number of occupants. These include tow trucks, motorcycles, and alternative fuel vehicles.

Recently, HOT lanes and Value lanes have granted access to single occupant vehicles (SOVs) as well as HOVs. SOVs pay the full toll. HOVs receive a discount or pay nothing. Some HOT lanes use variable pricing (discussed later) to manage demand. Those are called Value lanes.

Two trends are occurring with respect to HOV lane restrictions. Occupancy restrictions are being relaxed while hours of operation are being expanded. (See Figure 6 below.)

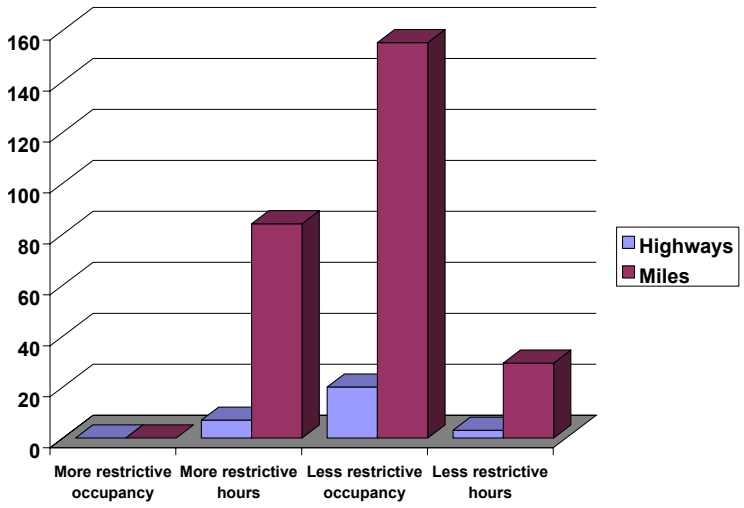

Figure 6. HOV Restriction Changes by Number of Highways and Miles[11]

[10] Cambridge Systematics with URS, Inc. *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation*;* February 2002), 5-4.
[11] Source: Federal Highway Administration, U.S. Dept. of Transportation

To take one example, Houston's Katy Freeway (I-10) opened in October 1984. Its HOV lanes were restricted to buses and authorized vanpools only. Six months later, 4+ carpools were added. Seven months later, 3+ carpools were added. In August 1986, less than two years after opening, 2+ carpools were added.[12]

HISTORY AND PURPOSE

Clean Air Act

HOV lanes originated as an environmental measure to reduce emissions by reducing vehicle use. Federal Clean Air Act Amendments of 1990 require that areas designated as severe or extreme ozone nonattainment areas enact Transportation Control Measures (TCMs). The Clean Air Act includes 16 TCMs (Title 1, Part A, Sec. 108(f)(1)(A) i – xvi), one of which is conversion to or construction of HOV lanes. (See Exhibit 1, Appendix.)

Both the federal Clean Air Act of 1990 and the Intermodal Surface Transportation Efficiency Act of 1991 limit "new highway construction to HOV lanes in urban areas that do not comply with clean air requirements."[13] While states can add mixed-flow lanes if increased emissions are offset by other TCMs, doing so would be very difficult, because vehicles contribute "as much as 50 percent of ozone and 90 percent of carbon monoxide" emissions.[14]

Congress provides funding incentives for HOV lane construction through the Congestion Mitigation and Air Quality Improvement Program (CMAQ), funded through the Transportation Equity Act for the 21st Century (TEA-21). Over the last five years, up to $8.1 billion in federal transportation funds have been available for state and local projects that reduce vehicle emissions. HOV and HOT/Value lane projects qualify under four of the five main funding categories:

- Travel demand management strategies
- Transit improvements
- Shared ride services
- Traffic flow improvements
- Pedestrian and bicycle programs[15]

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[12] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest* (Annapolis, Maryland:The Chesapeake Bay Foundation, August 1, 1994), 13.
[13] Katherine F. Turnbull and Dennis Christiansen, "HOV Lessons," *Civil Engineering* 62 no. 9 *(*September 1992): 74-75.
[14] California. Legislative Analyst's Office. *HOV Lanes in California: Are They Achieving Their Goals?* (January 7, 2000).
[15] United States. Environmental Protection Agency. *Environ mental Fact Sheet: The Congestion Mitigation and Air Quality Improvement Program (CMAQ)* (February 1999), 1-2

Federal Agency Involvement

The Environmental Protection Agency and the U.S. Department of Transportation jointly oversee different aspects of the many regulatory requirements involved in HOV lane design, funding, construction, and operations. Changing lane restrictions is not a simple process. Still, roughly 30 freeways have done so successfully, the majority relaxing restrictions rather than tightening them. Two freeways in New Jersey (I-80 and I-287) dropped restrictions entirely. Normally, this would mean that the state would have to repay federal funds used in the lanes' construction. But congressional lawmakers inserted language into the federal budget that New Jersey would not have to pay back funding if the lanes "failed to reduce congestion or improve air quality."[16]

Goals of HOV and HOT/Value Lanes

Goals for HOV lanes include:

- Decrease fuel consumption and emissions by decreasing vehicle use
- Increase person (not vehicle) throughput by using highways more efficiently
- Increase traffic flow by decreasing congestion due to shift to transit and ridesharing
- Increase traffic flow by decreasing congestion due to shift to off-peak travel times
- Increase transit use and ridesharing by offering time savings

Goals that HOT/Value lanes have added to this list include:

- Shift highway construction and maintenance costs from the taxpayer to the user
- Increase vehicle (and person) throughput by allowing SOVs to use excess capacity in the HOV lane
- Generate revenue for the state

Success Measures

Although the primary purpose of HOV lanes is to reduce vehicle emissions, their success or failure in accomplishing this task is not known. Direct measurement is impossible. Vehicle miles traveled (VMT) is an often-used correlate for emissions, but congestion also creates emissions. The interaction of these two variables plus innumerable others, such as length of trip (shorter trips generate more emissions per VMT), vehicle age, fuel consumption and maintenance, makes emissions reduction from HOV lane use extremely difficult to model.

Even reducing SOV use does not necessarily reduce emissions. Driving to pick up passengers is additional driving, as is driving to the Park-and-Ride. Such short trips

[16] Laurence Arnold, "Deemed a failure, carpool experiment on two Jersey highways nears end." The Associated Press State & Local Wire; 11/27/1998

contribute substantially to emissions. The authors of a study for The Chesapeake Bay Foundation cite the EPA:

> "As much as half of an average trip's pollution is during the engine's warm-up ('cold start') and cool-down ('hot soak'). When people drive to meet a bus or carpool, their car emissions are still high enough that the air quality benefits of their ridesharing are minimal [EPA, 1992]."[17]

On the other hand, more visible success measures, such as capacity utilization and even person throughput, may be poorly understood and applied.

Person and vehicle throughput are two different – and sometimes conflicting – goals. The most successful HOV lanes at moving people are bus-only lanes. During peak periods, Route I-495, a bus-only lane, moves about 35,000 commuters per hour through the Lincoln Tunnel between New York and New Jersey. Judging by vehicle throughput, however, the lane is underutilized, moving just over 700 vehicles per hour.[18]

Alternative fuel and hybrid vehicles provide another example of how person and vehicle throughput conflict. Arizona is one of three states that allow single occupancy hybrid vehicles to use HOV lanes.[19] Although two motorists in two hybrid vehicles may use less fuel than if they traveled together in one conventional vehicle, they use more of another scarce resource – roadway.[20]

Motorcycles waste even more roadway per passenger, since it is not lateral distance, but longitudinal stopping distance that matters. Per passenger, they pollute about as much as cars.[21] And motorcycles are more prone to accidents, and more serious accidents, than cars – another reason they should not be on lanes that are supposed to be free-flowing.

Vehicle throughput is a poor measure of success because cars (and motorcycles) take up so much more roadway than buses to move the same number of people. As one article put it, "At freeway speeds, a full bus can carry as many people as a line of carpools up to a mile long."[22] This is why no HOV lane should be considered a success if it fails to generate demand for transit or to make transit needs a top priority.

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[17] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 11

[18] Cambridge Systematics with URS, Inc. *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation*;* February 2002) pp. 5-5 - 5-7

[19] Arizona, Maryland and Virginia.

[20] Dana Wilkie, "To those in the commuter lane, add solo drivers like Darrell Issa," (Washington, D.C.: Copley News Service, 6/13/2002)

[21] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 10

[22] *Ibid.*

Generating Demand for HOV Use

"Empty" HOV lanes irritate non-users and tempt lawbreakers. Some irritation and temptation is a good thing, however. Both are natural reactions to a desirable good for which one is not yet willing to pay the price. The desirable good is shorter travel time, meaning later departure and/or earlier arrival. The price for using "empty," free-flowing HOV lanes is the inconvenience of transit or ridesharing. Conversely, the price for avoiding that inconvenience is longer travel time, earlier departure, and/or later arrival. The time savings provided by their relative lack of congestion is the incentive to use HOV lanes. Therefore,

"The success and utilization of HOV facilities is dependent on congestion occurring in the adjacent mixed-flow lanes."[23]

In fact, the Federal Highway Administration's (FHWA) *Freeway Management Handbook* says that: "The two criteria that most commonly appear to influence HOV viability are congestion and travel time savings." FHWA defines congestion as average freeway speeds of 30 mph or less during the peak hour or 35 mph or less during the peak period, which is over 20 mph below the threshold to qualify as Level of Service F (LOS F). According to FHWA,

> "Travel time savings has become one of the most reliable predictors of HOV viability, and ***it must potentially exist to encourage mode shifts.*** For most treatments, a projected 5-minute or more savings per trip is generally recognized as a prerequisite."[24] *(emphasis added)*

The tables below show the effect of decreasing congestion by increasing freeway speeds just 10 mph. To cross the 5-minute time savings threshold at the lower freeway speeds, a commuter would have to travel 5 miles in the HOV lane. To do so at the higher freeway speeds, miles traveled would have to more than double.

[23] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), § 2-2.

[24] U.S. Dept. of Transportation, Federal Highway Administration, *Module 6. HOV Treatments. Freeway Management Handbook* (August 1977), 6-7, 8.

Table 1. HOV Time Savings at 30-35 mph Freeway Speeds

	HOV Lane	General Purpose Lanes	
		Peak Hour	Peak Period
Miles/hour	65	30	35
Travel time	4.6 min.	10 min.	8.6 min.
HOV time Saved/5 mile trip vs.	--	5.4 min.	4 min.

Table 2. HOV Time Savings at 40-45 mph Freeway Speeds

	HOV Lane	General Purpose Lanes	
		Peak Hour	Peak Period
Miles/hour	65	40	45
Travel time	12 min.	19.5 min.	17.3 min.
HOV time Saved/13 mile trip vs.	--	7.5 min.	5.3 min.

Trip length increases time savings and demand for HOV use. Other factors that increase time savings and demand include proximity to work locations and availability of transit along the corridor.[25]

Perceived time savings may also increase demand for HOV use. A study for the Minnesota Department of Transportation found that, "In general, the SOV users perceived the travel time savings of the HOV lanes (which they did not use) as being considerably less than that perceived by the users of the lanes."[26] Among HOV users, perceived savings were longer than actual travel time savings, "… but it is not unusual for travelers to perceive both travel time savings and penalties (such as waits at ramp meters or bus stops) to be longer than reality."[27]

Similarly, a study for the California Department of Transportation found that:

> "Violators, carpoolers, and general drivers alike greatly overestimate the average time savings afforded by HOV lanes. … Perceived time savings were approximately double the savings recorded during the heaviest traffic period, and nearly four times the average savings realized by drivers throughout the evening commute. This tendency to perceive greater time

[25] California. Legislative Analyst's Office. *HOV Lanes in California: Are They Achieving Their Goals?* (January 7, 2000)
[26] Cambridge Systematics with URS, Inc., *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation; February 2002), 6-16.
[27] *Ibid.;* p. 6-14

> savings in the carpool lane undoubtedly makes the carpool lanes appear more attractive to drivers than to statisticians comparing raw numbers…."[28]

This finding should not be taken to reduce FHWA's criteria, which is based on actual time savings and experience. While the threshold for HOV viability may be 5 minutes in actual time savings, it may be 10 minutes in perceived time savings. This finding suggests that it would be wrong to use a marketing communications strategy mentioning actual time saved. Doing so might discourage potential users and disappoint current users. It also suggests a possible communications strategy to deter violators: emphasize the time costs of being pulled over and ticketed.

Time savings may also be increased by HOV queue bypass ramps. During a demonstration project on the Santa Monica Freeway,

> "Evaluators found that … the converted HOV bypass lanes, in combination with the timing of the ramp meters to which general purpose traffic was subject, gave more time savings to HOVs than did the converted freeway lanes themselves [Billheimer, et al.]."[29]

Sprawl

More transportation professionals, as well as the public, are coming to question the assumption that cities can "build their way out of congestion." This strategy has enjoyed short-term success, but brought serious negative long-term effects. Atlanta, Georgia is an example. With 12 lane freeway sections crossing downtown, it has

> "… the longest commutes of any U.S. urban area (including Los Angeles), increasing concerns about quality of life and business competitiveness, and failure to meet federal air quality standards resulting in countless lawsuits and the temporary withholding of federal highway funds."[30]

The Phoenix area continues to grow exponentially. A recent report for the Maricopa Association of Governments conceded that with a 50 percent population increase and a 70 percent travel increase projected over the next 20 years; "even an aggressive freeway construction program will have difficulty keeping pace with growth."[31]

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[28] John W. Billheimer, *HOV Lane Violation Study, Final Report* (California Dept. of Transportation; January 1990), 1-24.

[29] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 20.

[30] Cambridge Systematics with URS, Inc. *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation*;* February 2002), 11-1.

[31] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), § 2-1

Freeway expansion, including HOV or HOT/Value lane expansion, should take into account the theory of induced travel demand, which holds that:

> "… in the long run (five years or more), expansion of the transportation system rarely alleviates congestion because increases in the system's capacity are subsequently consumed by drivers' demand for better mobility."[32]

When the Seattle area downgraded occupancy requirements from 3+ to 2+, there was a large increase in vehicles in the HOV lanes, but no significant decrease in the number of vehicles in the general-traffic lanes. [Ulberg, 1992] Vehicle occupancy went down overall while the relative share of SOVs went up. The authors of a study for The Chesapeake Bay Foundation explain:

> "People left buses (now slowed by the traffic) for carpools and left vanpools and larger carpools for 2+ carpools. They also shifted onto the freeway from parallel arterials, and traveled more at peak periods. And they took trips that formerly they would not have made at all."[33]

When HOV lanes pull vehicles from general-traffic lanes,

> "By a phenomenon known as latent demand, solo drivers who had previously taken the bus, stayed home, or driven at another time or by another route are attracted by the decline in congestion [Newman and Kenworthy]."[34]

In the short run, when congestion has eased, people consider housing and jobs that are farther away than they would have if commuting were more difficult and time-consuming. In the long run, when congestion returns, these people are unhappier than before, because their commutes now are much longer than they were then. Sprawl is encouraged by these temporary windows in traffic congestion.[35] In addition to longer commutes, "Areas of urban sprawl generate more motor vehicle trips than traditional cities, and are more difficult to serve by transit [Relogle]."[36]

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[32] California. Legislative Analyst's Office. *HOV Lanes in California: Are They Achieving Their Goals?* (January 7, 2000)
[33] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 13
[34] *Ibid.;* p. 11
[35] *Ibid.;* pp. 11-12
[36] *Ibid.;* p. 13

Several studies have now quantified the effects of induced travel demand. Using annual data for 30 urban California counties from 1973 to 1990, a 1995 University of California at Berkeley study "found that a 1 percent increase in lane miles induces a 0.9 percent increase in VMT in metropolitan areas within five years." A 1999 EPA study "found that about 25 percent of new VMT can be attributed to induced demand."[37]

Travel Choice Trends

Carpool use is declining nationally – 19 percent in the 1980s alone.[38] Responsible factors include work-related travel during the day, variable work hours, free parking at work and complex childcare arrangements.

> "The largest declines occurred in carpools of four or more (over 50 percent decline) and three (almost 40 percent decline). Even two-person carpools for commuting went down by ten percent. Between 1980 and 1990 daily transit ridership to work also declined slightly to six million; solo driving was the only commuting mode that increased, to a record-high 84.2 million – three quarters of all trips [Pisarski]."[39]

A 1999 telephone poll of 500 adult licensed drivers in Maricopa County found that 79 percent of those polled had used HOV lanes, but that 66 percent did so sparingly (less than 20 percent of the time) or not at all.[40] This suggests opportunistic use rather than behavior modification. In other words, people use the HOV lane when they would have rideshared anyway. By including the smallest possible family unit, two-person occupancy requirements make opportunistic use more likely, since people who live together often travel together anyway. According to an article in the *Financial Executive,* 43 percent of carpoolers are members of the same household.[41] Still, some two-car couples may be persuaded to use one car for commuting by the time savings of the HOV lane.

According to the FHWA, 2+ occupancy requirements:

> "…accomplish little more than rearranging traffic in lanes according to number of occupants. The number of vehicles using the HOV lane may

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[37] California. Legislative Analyst's Office. *HOV Lanes in California: Are They Achieving Their Goals?* (January 7, 2000)

[38] Robert W. Poole, Jr. and C. Kenneth Orski, "HOT Lanes: A Better Way to Attack Urban Highway Congestion,"*Regulation* 23, no. 1 (2000): 16

[39]Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 3-4.

[40] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System.* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), § 3-4.

[41] "The right lane?" *Financial Executive* 10 no. 1 (Jan/Feb 1994): 64.

> increase but this is offset by a decrease in the average vehicle occupancy in the other lanes. Use of HOV lanes with a two person minimum per vehicle does not generally accomplish the purpose for which priority treatments are implemented; i.e., to move more people in fewer vehicles and encourage people to use high occupancy vehicles. [FHWA, February 4, 1985]."[42]

Yet HOV lanes continue to move more people. It would be interesting to see if that were still the case after taking transit out of the equation.

HOT LANES, VALUE LANES AND VARIABLE PRICING

> *"Pricing is society's most common and effective way to allocate scarce goods among competing priorities. ... If prices for road and bridge access and for parking better reflected the societal cost of the driving decision, congestion would be much less [Johnson]."*[43]

HOT and Value lanes charge commuters for the time savings HOV lanes provide. Value lanes are the same as HOT lanes, but price is variable, depending on congestion in the Value lane.

HOT and Value lanes may encourage commuters for whom cost is paramount to use transit or rideshare. A 1999 survey by RIDES (RIDES for Bay Area Commuters, Inc., operated by the Bay Area's Transportation Demand Management Program) found that "the most important factor influencing (their) decisions to carpool (cited by 18 percent of respondents) was not time savings, but rather cost savings (such as free toll, shared fuel, and parking costs)." During its first three months of operation, 3+ HOVs paid no toll on SR 91 and there was a more than 40 percent increase in 3+ HOVs. According to RIDES, "These findings suggest that efforts to increase HOV lane usage through increased marketing should emphasize the cost savings, in addition to the time savings, of carpooling relative to driving alone."[44]

San Diego's I-15 provides an example of value pricing. Part of the federal "Congestion Pricing Pilot Program," the experimental program started with a flat-rate monthly pass, later replaced by a per-trip toll that changed with traffic volume in the HOV lane.

> "Electronic signs in front of the entrance to the HOV lanes notify motorists of the current toll as they approach the toll lanes. A motorist

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[42]Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994), 5.
[43] *Ibid.;* p. 25
[44] California. Legislative Analyst's Office. *HOV Lanes in California: Are They Achieving Their Goals?* (January 7, 2000)

who wants to use the HOV lanes simply passes through a special lane where overhead antennas scan the windshield-mounted transponder and automatically deduct the posted toll from the motorist's prepaid account."[45]

Initially, 3+ HOVs used the lanes for free, but nowthey pay half price.[46]

Price is selected from a table of minimum to maximum rates using level of congestion and time of day. Every six minutes, data from pavement loop detectors at the tolling zone are read. Two six-minute traffic counts are added together and compared to the table to determine price. Price is then shown on electronic toll display signs. The normal maximum price increase in any six-minute period is $0.50. During a severe traffic incident, if the lanes hit LOS C, the fee could go as high as $8.00 to maintain LOS. If that were not high enough to maintain LOS C, the lanes would be closed to SOVs.[47]

Figure 7. FasTrak Transponder[48]

HOT and Value lanes raise objections that they are "Lexus lanes" where the rich speed past the poor. Sharing the lane with the Lexus, however, are transit buses and carpools, as well as the low-income user who is running late and may lose his job if he does not arrive within a reasonable amount of time. Using HOT lane revenues for transit rather than road construction helps deflect such criticism.[49]

A California Polytechnic professor found that "a large majority" of commuters on State Route 91 did not use the HOT lanes regularly. Twenty-three percent used it every day. Thirty-three percent used it less than once a week. Higher income motorists used the lanes more often than lower income motorists, but, "All commuters, irrespective of income or occupation, tend(ed) to use the toll lanes to avoid being late for work, to arrive

[45] Lee Hultgren and Kim Kawada, "San Diego's Interstate 15 High-Occupancy / Toll Lane Facility Using Value Pricing." *ITE Journal* 69 no.6 *(*June 1999): 17.
[46] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System.* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), § 2-15.
[47] Lee Hultgren and Kim Kawada, "San Diego's Interstate 15 High-Occupancy / Toll Lane Facility Using Value Pricing." *ITE Journal* 69 no.6 *(*June 1999): 25-26.
[48] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System.* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), § 2-15.
[49] Robert W. Poole, Jr. and C. Kenneth Orski, "HOT Lanes: A Better Way to Attack Urban Highway Congestion,"*Regulation* 23, no. 1 (2000): 20.

at appointments on time, or to pick up children at daycare facilities." Users saved an average 12-13 minutes of travel time and perceived the lanes as being safer and more reliable. Furthermore, HOT lanes did not seem to undermine ridesharing in the short run, as carpooling increased on both SR 91 and I-15.[50]

According to different sources at the San Diego Association of Governments (SANDAG), carpooling on I-15 shot up anywhere from 52 percent to 72 percent.[51]

Like HOV lanes, the effect of HOT and Value lanes on emissions is not known. Even their effect on VMT is not known. They may actually increase VMT in two ways: 1) by offering a way for SOV drivers to enjoy a relatively congestion-free trip; and 2) by adding incentive to travel during off-peak periods. (See Table 3 below.)

Table 3. Incentives to Travel Off-peak

24 hour HOV	Peak-only HOV	HOT lane	Value lane
♦ Peak period congestion	♦ Peak period congestion	♦ Peak period congestion	♦ Peak period congestion
	♦ Additional lanes now open to SOVs – no incentive to rideshare off-peak	♦ HOT travel cheaper – if congestion exists off-peak, still an incentive to rideshare because HOV pays less than SOV	♦ Value lane travel cheaper – if congestion exists off-peak, still an incentive to rideshare because HOV pays less than SOV

Value pricing can be used specifically to encourage shifts to off-peak travel times. In August 1998, Lee County, Florida implemented value pricing on two bridges: traditional bottlenecks. Its LeeWay value pricing plan – "a 50 percent toll discount for trips made during 'shoulder' periods" (immediately before and after periods) – was a success. Using pricing to control flow on these two bridges influenced traffic flow throughout much of the county.[52]

[50] *Ibid.;* pp. 18-19.
[51] Marianne Jakevich, "Mixed reviews for the HOV lanes," *The American City & County* 116, no. 15 (2001): 68.
[52] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System.* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002),. §2-20.

Shifting travel to off-peak periods serves the goal of reducing congestion. Since congestion adds to emissions, it also serves the goal of reducing emissions. But it should be remembered that encouraging travel off-peak does not just encourage peak users to shift travel times. It also encourages new trips, increasing VMT and increasing emissions.

ARIZONA EXPERIENCE

Arizona has no HOT or Value lanes yet. All the state's freeway HOV lanes are in Maricopa County. Figures 8a through 8d below show planned and existing HOV lanes from the 2003 MAG Regional Transportation Plan.

(Existing HOV lanes in Figures 8a and 8b are indicated with darker lines.)

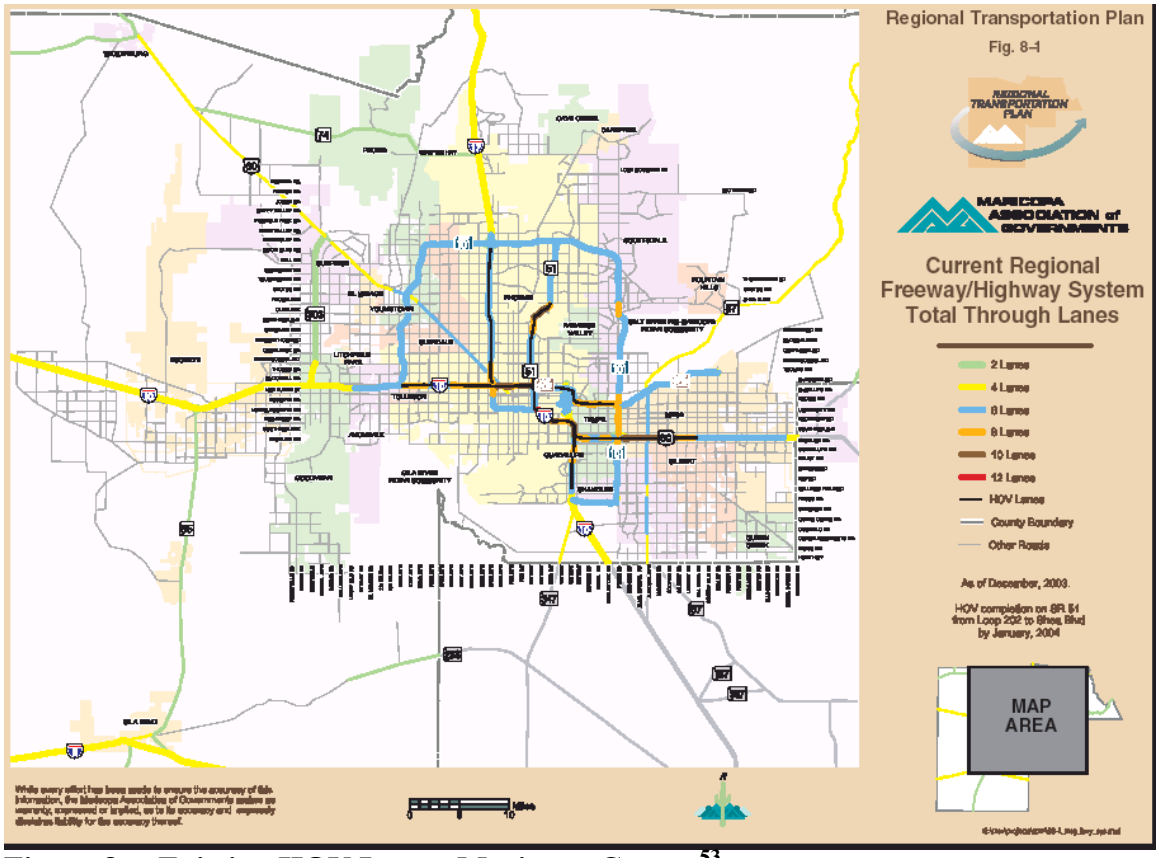

Figure 8a. Existing HOV Lanes, Maricopa County[53]

[53] Maricopa Association of Governments, *Regional Transportation Plan,* (November 25, 2003), §8-3/4.

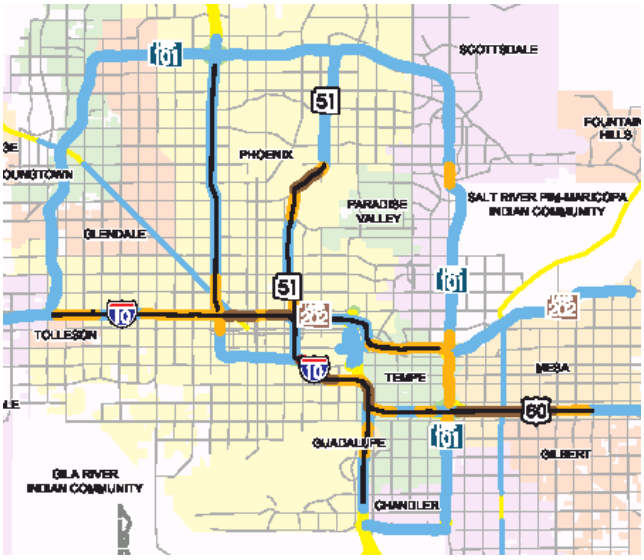

Figure 8b. Existing HOV Lanes, Maricopa County (Zoomed)[53]

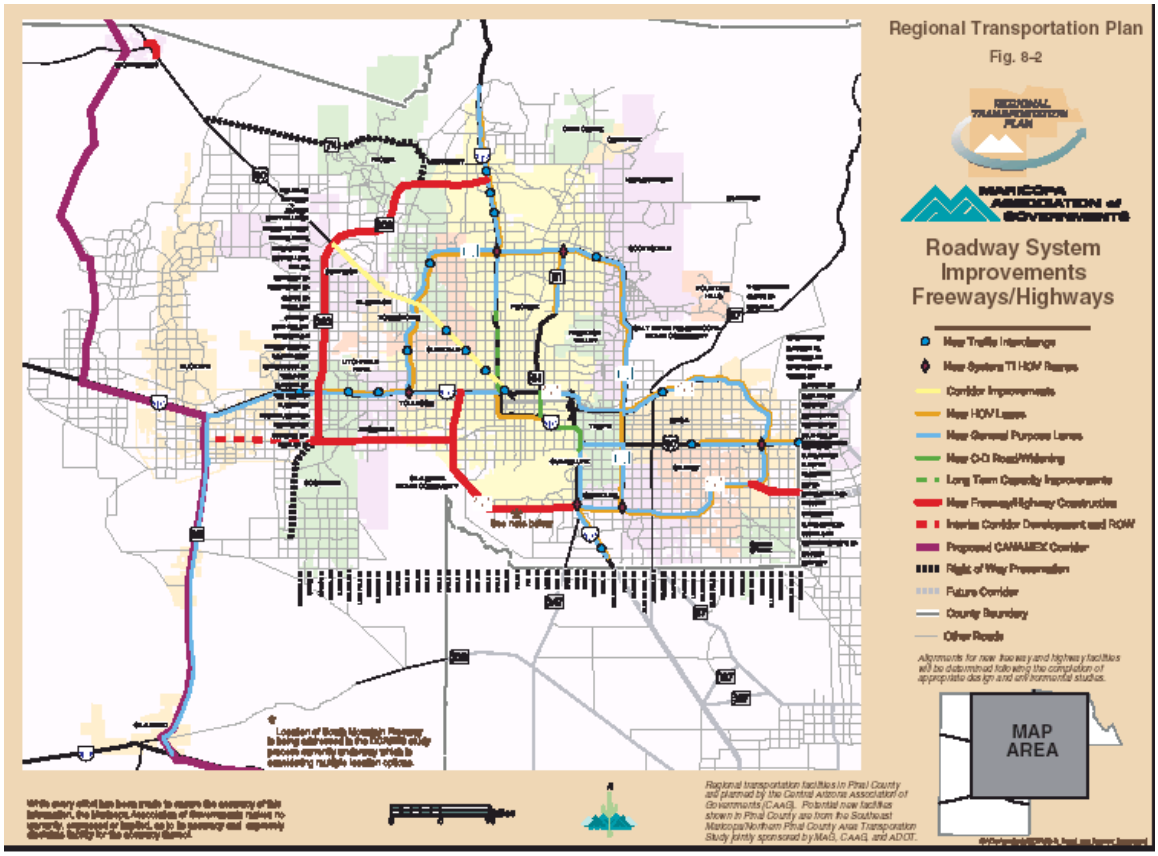

Figure 8c. Future HOV Lanes, Maricopa County [53]

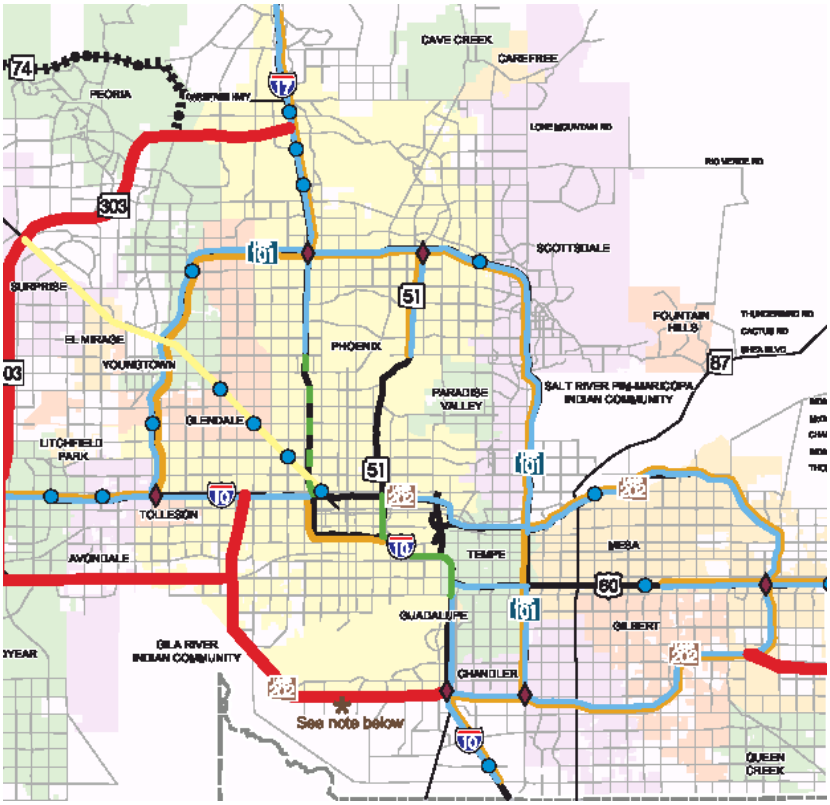

Figure 8d. Future HOV Lanes, Maricopa County (Zoomed) [53]

Arizona has three times begun the process of developing HOT lanes. A private consortium submitted a proposal in 1993 for I-10 and other corridors. MAG and ADOT approved the concept, but FHWA turned it down. Later, another private consortium proposed HOT lanes on Superstition Freeway, Price Freeway and Pima Freeway, but withdrew that proposal in 1997. ADOT submitted proposals to FHWA in 1997 and 1998 for I-10 and I-17. Neither proposal was implemented.[54]

A 2002 study recommends planning to add at least one pair of HOV lanes on all freeways in the MAG region.[55] HOT and Value lanes are considered for the future.

The study includes a 1999 telephone poll of adult licensed drivers in Maricopa County. Upon first explaining the Value lane concept, approximately 40 percent approved. 47

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[54] *Ibid.;* p. § 1-2
[55] *Ibid.;* p. § 4-14

percent disapproved. After extensive explanation, 50 percent approved.[56] This small improvement suggests that a major public relations campaign should be undertaken before implementing Value lanes.

ENFORCEMENT

> *"Visible and effective enforcement promotes fairness and maintains the integrity of the managed lane facility to help gain acceptance among users and non-users."*[57]

Issues in HOV lane enforcement include:

- Aggressive drivers
- Visibility of enforcement
- Priority of regulatory enforcement by officers also responsible for highway safety enforcement
- Safety of enforcement areas
- Ability of officers to see passengers

Aggressive Driving

National, state and local traffic enforcement agencies are paying more attention to the problem of aggressive driving than in the past. More than just road rage, aggressive driving can include HOV buffer, ramp and even occupancy violations.

The National Highway Traffic Safety Administration (NHTSA) suggests that jurisdictions start an enforcement program by defining aggressive driving and then review their laws to see what penalties they provide. Assigning special teams to enforcement can provide opportunities for public education. Officer Jockers, a spotter on the aggressive driving enforcement team in St. Petersburg, Florida, became a local celebrity. In "Where's Jockers?" segments, television news shows carried Officer Jockers live from his unorthodox spotting posts – atop a lawn mower, waiting at a bus stop, leaning on road construction equipment, etc.[58]

Aggressive driving enforcement programs can also encourage officers to place greater emphasis on HOV lane enforcement. As one survey respondent wrote:

> "Our philosophy here is that there is no public safety issue with people illegally using the HOV lanes or the HOV ramps. However, we have

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[56] *Ibid,;* p. § 3-4

[57] A. Scott Cothron, Douglas A. Skowronek and Beverly T. Kuhn, *Enforcement Issues on Managed Lanes*, Project Bulletin 4160-11B; Project 0-4160: Operating Freeways with Managed Lanes (Texas Transportation Institute).

[58] United States. National Highway Traffic Safety Admininstration, "Aggressive Driving Enforcement: Strategies for Implementing Best Practices," http://www.nhtsa.dot.gov/people/injury/enforce/aggressdrivers/aggenforce/toc.html (accessed February 9, 2005).

> studied it and have proven that the people who do violate the HOV ramps and lanes are the same people who routinely violate other moving traffic violations and are a threat and danger to the motoring public when they are in normal traffic. We use the HOV ramps and lanes (when and where they can be enforced) as a way for the public to sort themselves out and deliver those people who present a threat to the motoring public right to us for enforcement."

Visibility of Enforcement

Citizen awareness of enforcement efforts serves two purposes: 1) increases acceptance of HOV lanes; and 2) deters violators.[59] While no study was found confirming that visibility of enforcement increases acceptance, it is logical to assume that this is so. Support for HOV lanes is high, as shown by a 1999 telephone poll of Maricopa County adult licensed drivers:. 86 percent approved – and 62 percent strongly approved – of the HOV concept.[60] If lanes are abused with impunity, citizens may become angry that a resource they value is being squandered.

The deterrent effect of citizen awareness of enforcement efforts has been studied. Specifically, studies indicate that the presence of a marked police vehicle reduces illegal driving behavior. In an experiment conducted in Wilmington, North Carolina, testing a speed limit sign, a radar-enforced sign, and a marked police vehicle, only the marked police vehicle

> "… produced systematic changes in driving speed. The majority of drivers exposed to the marked vehicle showed large reductions in driving speed. Furthermore, these reductions occurred even when the driver's initial speed was below the posted speed limit."[61]

Similarly, during FHWA focus groups to develop a pedestrian safety campaign:

> "All drivers in both groups reported that the presence of law enforcement had a 'strong effect' on their behavior. They said that they 'slow down and drive more carefully' when police officers are present."[62]

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[59] John W. Billheimer, *HOV Lane Violation Study, Final Report* (California Dept. of Transportation; January 1990), 1-26

[60] Parsons Transportation Group, Inc. *High Occupancy Lanes and Value Lanes Study Final Report: High Occupancy Vehicle Facilities Policy Guidelines and Plan for the MAG Freeway System.* (Arizona Department of Transportation; Maricopa Association of Governments; Regional Public Transportation Authority; December 2002), p. § 3-4

[61] Mark Galizio; Lee A. Jackson and Frank O. Steele, "Enforcement Symbols and Driving Speed: The Overreaction Effect," *Journal of Applied Psychology* 64 (June 1979): 311-315.

[62] Tamara Redmon, "Assessing the Attitudes and Behaviors of Pedestrians and Drivers in Traffic Situations," *ITE Journal* 73, no. 4 (April 2003): 26-30.

For the public, visibility of enforcement may mean seeing marked police vehicles looking for, pursuing, or citing HOV violators.

Types of Enforcement

HOV lane enforcement may be routine, using existing staff; special, using dedicated staff; or combined.[63] Highway patrol agencies may set up special enforcement for one-time events or assign officers periodically to renew visibility. Some jurisdictions use ongoing special enforcement through separate divisions or even agencies, such as Dallas Area Rapid Transit (DART).

Special enforcement brings increased staffing and emphasis to HOV lane enforcement. Officers assigned to routine enforcement primarily look for threats to public safety, such as reckless driving and Driving Under the Influence (DUI). HOV violations, unless they threaten public safety, are of secondary importance. Officers assigned to special enforcement, however, primarily look for HOV violations.

Highway Design and Enforcement Methods

Highway design dictates how enforcement is done. Methods used depend on whether or not the following elements are present:

- Barrier separation
- Enforcement areas (observation and citation)
- Median shoulder

Barrier-separated HOV lanes are easier to enforce, because entry and exit are restricted. They require special enforcement, however, because routine patrol vehicles cannot easily enter the lanes. Bus-only lanes are a possible exception to this requirement, as they reportedly "have almost no violations when separated by barriers from surrounding traffic, and a minimal amount when these barriers are absent."[64] Adequate observation and citation areas also make enforcement easier. Without a safe observation post in the median, officers must look for violators in the rear-view mirror while driving in the adjacent mixed-flow lane. If there is no adequate citation area or median shoulder, officers must escort violators across several lanes of heavy traffic to the right-hand shoulder or an exit ramp.

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[63] A. Scott Cothron, Douglas A. Skowronek and Beverly T. Kuhn, *Enforcement Issues on Managed Lanes*, Project Bulletin 4160-11B; Project 0-4160: Operating Freeways with Managed Lanes (Texas Transportation Institute).

[64] Christopher K. Leman, Preston L. Schiller and Kristin Pauly, *Re-Thinking HOV – High Occupancy Vehicle Facilities and the Public Interest.* (Annapolis, Maryland: The Chesapeake Bay Foundation, August 1, 1994) p. 15

Lane crossings are difficult due to congestion and the speed differential between the HOV and the mixed-flow lanes. The time savings generated by congestion and the speed differential is the incentive for commuters to choose ridesharing or transit. But congestion also occurs in the HOV lanes. Using 1998 figures, Table 4 below shows available feet and seconds between cars in HOV lanes in Maricopa County, assuming cars are evenly spaced. The "two-second rule" states that there should be two seconds between cars – in other words, that two seconds should go by from the time leader Car A passes a point to the time follower Car B passes that same point.

Table 4. 1998 Maricopa County HOV Lane Use: Interval Between Cars

HOV Lane	AM	Vehicles /hour	Feet Between Cars	Seconds Between Cars	PM	Vehicles /hour	Feet Between Cars	Seconds Between Cars
I-10/Papago	EB	1600	195	2.0	WB	1600	195	2.0
I-10/Papago	WB	1100	292	3.1	EB	1300	244	2.6
I-10/Maricopa	NB	1100	292	3.1	SB	1200	266	2.8
L-202/Red Mountain	WB	900	361	3.8	EB	800	409	4.3

Assuming:

Average Car Length = 20 feet
MPH = 65

If adjacent general traffic lanes are moving at 35 mph (FHWA's upper threshold for HOV lane success), they can move up to 1500 VPH (Vehicles Per Hour) and still have 2 seconds between cars. This would leave 103.2 feet between cars on average – about half the space between cars on the most heavily congested HOV lanes. Any acceleration in the general traffic lanes would reduce the time between the patrol vehicle and the leading car to less than 2 seconds. Entry into the most heavily congested HOV lanes would reduce the time between the patrol vehicle and the following car to less than 2 seconds, but the following car could slow down.

The Texas Transportation Institute recommends a minimum 1200-foot departure taper for high-speed enforcement areas. Those 1200 feet are for vehicles to accelerate from 0 to 65 mph. A proportionate distance for patrol vehicles to go from 35 to 65 mph would be over 550 feet. Yet officers would have less than half that distance in which to accelerate if they used the entire 195 feet between cars in the HOV lane.

A lack of enforcement areas and median shoulders causes some of the most common problems officers encounter in HOV lane enforcement.

Common Problems

In 1990, as part of a study on HOV lane violations, California Highway Patrol (CHP) officers identified the following enforcement problems:

Table 5. Common Enforcement Problems

Baby on board ♦ "Officers on all study projects cited the problem of pulling over a suspected violator only to find that a sleeping adult or a small child below window level made the vehicle a legitimate carpool."[65]
Hazardous pursuits ♦ Other vehicles can nose into HOV lane at any point during pursuit
Lack of median ♦ Must drive in adjoining lane and look for violators in rear-view mirror ♦ No "escape hatch" when pursuing violators in HOV lane ♦ Must escort violators across several lanes, disrupting traffic ♦ Citations less visible, so less deterrent effect
Nested violators ♦ Difficult to pursue violators "nested" in between vehicles ♦ Especially if a bus or truck brings up the rear ♦ Especially if there is no median lane to accelerate in

Comparison of Routine and Special Enforcement and Different Highway Designs

The study mentioned above conducted experiments comparing routine and special enforcement on four freeways with different highway designs.

State Route 101 in Marin and SR 55 in Orange County had no median shoulder and "minimal" right-hand shoulders. On SR 101, the median was tried as an observation area, but abandoned. According to the lead motor officer, it was "… not a particularly dangerous place (to sit on a motorcycle) … just not particularly safe." The enforcement area on SR 55 was used as an observation area, but was too narrow to use as a citation area. The enforcement area on SR 91 was wide enough to use both for observations and citations (14 feet wide and 1300 feet long), although the rest of the median was narrow. SR 101 in Santa Clara had an 11-foot median shoulder used both as an observation and as a citation area.[66]

[65] John W. Billheimer, *HOV Lane Violation Study, Final Report* (California Dept. of Transportation; January 1990), p. 1-18

[66] *Ibid.;* pp. 1-11, 1-13, 1-15

Not having an enforcement area or median shoulder affected enforcement methods as well as visibility of enforcement. Officers were uncomfortable looking in the rear-view mirror for violators while driving, as it was potentially hazardous. Patrol vehicles in traffic are also less conspicuous than patrol vehicles stationed at an observation area, reducing visibility of enforcement. To ticket violators, officers had to escort them across several lanes of traffic to get to the right-hand shoulder or an exit, disrupting traffic. Also, "… the fact that tickets are issued away from the HOV lanes minimizes the possibility that the ticketing activity will deter potential violators."[67]

On the two freeways where enforcement was most difficult, SR 55 and SR 101 in Marin, the first wave of special enforcement significantly lowered violation rates. Rates remained low as enforcement returned to historic levels "and stayed between 5 percent and 10 percent during and after the second wave of special enforcement." On the two freeways with adequate pull out areas next to the HOV lane, SR 91 and SR 101 in Santa Clara, special enforcement had no significant impact. These freeways, however, had historically low violation rates.

Violations were observed for 3 ½ months after the first wave of special enforcement and for 2 ½ months after the second wave of special enforcement. On all four freeways, violation rates stayed below 10 percent with routine enforcement. On the two freeways with dedicated observation areas, SR 91 and SR 55, violation rates remained below 5 percent.[68] This suggests that the presence of a median enforcement area may be a greater deterrent than the presence of an officer issuing a citation. Drivers may assume that activity they see there is HOV lane enforcement, while activity occurring on the right-hand shoulder or off an exit ramp could be any kind of enforcement.

In fact, awareness of HOV lane enforcement was lowest on SR 55 and SR 101 in Marin, which had no enforcement area or usable median shoulder. More than 25 percent of the drivers on these freeways said that they had "never seen" CHP ticket an HOV violator. Awareness of enforcement was highest on SR 91 and SR 101 in Santa Clara, where enforcement is carried out on the median. Less than 10 percent of the drivers on SR 101 in Santa Clara said that they had never seen an HOV enforcement stop.[69]

Would-be HOV violators may also estimate how difficult it would be for an officer to pull them over, and thus how likely it is that they will be pulled over. Median enforcement areas make traffic stops much easier. As long as patrol vehicles are there with some regularity, even an empty median enforcement area may deter HOV violators.

[67] *Ibid.;* p. 1-16
[68] *Ibid.;* pp. 1-15, 1-16
[69] *Ibid.;* p. 1-25

Although visible enforcement is desirable, heavy enforcement can be disruptive, due to rubbernecking. To avoid that, the study recommended that officers:

- Work separately
- Spread out
- Use one pursuit vehicle
- Have no more than one car waiting to be ticketed at any time
- Release violators cited in the median back into the HOV lane
- Assign one officer unless there are no median citation areas; then assign one spotter and one pursuit[70]

Study findings suggest that drivers may not notice a gradual reduction of enforcement. Over two-thirds of drivers surveyed during the second wave of special enforcement believed that enforcement levels had "stayed about the same" over the past three months. In fact, they had increased substantially with the first wave of special enforcement, dropped back to historic levels and then increased again substantially with the second wave of special enforcement.[71]

Survey and focus group research found that drivers tended to overestimate low violation rates and were "likely to be insensitive to violation changes in the 10 percent range." From experience, the authors state that "heavy consistent doses of special enforcement" would be needed to bring violation rates below 5 percent on buffer and non-separated HOV lanes, but "steady" routine enforcement with "moderate" special enforcement would be able to keep violation rates in the 5 percent to 10 percent range. Since the difference between a 5 percent and a 10 percent violation rate had little effect on driver perceptions or lane performance, California set its enforcement target at a violation rate of 10 percent.[72]

Other findings to come out of the study were:

- Violations do not increase as time savings increases[73]
- Occupancy violators are more likely to be drivers who cross the buffer illegally than legitimate carpoolers.[74]
- Drivers believed that raising fines and posting them on the freeway would deter violators.
- 62 percent of survey respondents did not know the fine and those who claimed they did "greatly underestimated it."[75]

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[70] *Ibid.;* p. 1-17
[71] *Ibid.;* p. 1-16
[72] *Ibid.;* p. 1-27
[73] *Ibid.;* pp. 1-7, 1-8
[74] *Ibid.;* p. 1-9
[75] *Ibid.;* p. 1-26

Ability to See Inside the Vehicle

Generally, officers cannot see inside vehicles to verify occupancy at night or in bad weather. While these factors are uncontrollable, another major factor limiting visibility is at least potentially controllable.

A.R.S. §28-959.01 regulates auto glass tinting in Arizona. Table 6 below shows how much light must be transmitted and how much can be reflected for window tinting to be legal in Arizona.

Table 6. Auto Glass Tinting Allowed in Arizona

	Light Transmission	Luminous Reflectance
Windshield (if top only and bottom 29" above driver's seat)	N/A	N/A
Front side windows	at least 33 percent ± 3 percent	no more than 35 percent ± 3 percent
Rear side windows	N/A	no more than 35 percent ± 3 percent
Rear window (if left and right outside mirrors positioned correctly)	N/A	N/A

N/A = not applicable

Officers report that auto glass tinting is a major problem in HOV enforcement. (Arizona's survey respondent rated it 5 on a scale of 1 to 7 in difficulty added to enforcement, with 7 being "extremely difficult.") This raises two questions: First, is the law adequate to ensure that officers can see inside vehicles? And second, how is the law being enforced? It seems unlikely that enforcement is carried out regularly, since many vehicles on the road have opaque windows and enforcement requires special equipment.

Auto glass tinting could be restricted further. Objections raised would include cost, environmental impact (more need to run air conditioning), freedom of choice, personal comfort, privacy and property rights (window tinting protects upholstery from sun damage). Transparent UV coating could address environmental, personal comfort and property rights concerns. Still, many people would be affected by the change.

However, because opaque auto glass poses far more serious problems at traffic stops, such as the inability to see whether an occupant is bending down to reach beneath the seat, possibly to retrieve a weapon, it may be feasible to phase in further restrictions.

Penalties

In 2002, the average penalty for HOV lane violations was $150 nationally.[76] Arizona's penalty was highest among survey respondents, at $365 for first and subsequent violations. When the high fine was introduced in 2000 (at the time, $350), an additional 77 percent court surcharge brought the total to a hefty $619. Previously, the fine had been $100. Arizona was also the only state among survey respondents to assign points for HOV violations. At least in 2000, however, fines, fees and points could be wiped out for motorists eligible to complete diversion.[77]

HIGHWAY DESIGN

> *"We sat with the department of transportation when they were designing and building the HOV areas. We told them what we wanted and needed in order to enforce it. They didn't take our needs into account and we don't work it." – Highway Patrol Supervisor*[78]

The 1990 California study concluded:

> "The difficulties encountered in enforcing Marin 101 suggest that mainline HOV lanes lacking a substantial median shoulder should not be contemplated if space cannot be found for at least one well-designed enforcement area."[79]

The Texas Transportation Institute (TTI) makes different design recommendations based on whether an area is for low-speed or high-speed enforcement. Low-speed enforcement areas have vehicle speeds usually below 45 mph, such as "ramps, reversible lane entrances, and queue bypasses." By default, high-speed enforcement areas have vehicle speeds usually 45 mph or above.[80] (See Table 7 below.)

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[76] Cambridge Systematics with URS, Inc. *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation*;* February 2002) p. 5-10

[77] "Hefty HOV fine drawing concern," The Associated Press State & Local Wire; 9/21/2000

[78] John W. Billheimer, *HOV Lane Violation Study, Final Report* (California Dept. of Transportation; January 1990).

[79] *Ibid*.

[80] A. Scott Cothron, Douglas A. Skowronek and Beverly T. Kuhn, *Enforcement Issues on Managed Lanes*, Project Bulletin 4160-11B; Project 0-4160: Operating Freeways with Managed Lanes (Texas Transportation Institute).

Table 7. Highway Design Recommendations for HOV Enforcement Areas[81]

	Low Speed Enforcement Area	High Speed Enforcement Area
Length	At least 100 feet, preferably up to 200 feet on high volume facilities, excluding approach and departure tapers	Preferably 1300 feet for enforcement/observation area, excluding approach and departure tapers
Width	At least 14 to 15 feet	At least 14 to 15 feet
Approach Taper	At least 2:1 or 30 feet	At least 115:1 or 1725 feet
Departure Taper	At least 10:1 or 150 feet	At least 80:1 or 1200 feet
Interval	At least every 2-3 miles	At least every 2-3 miles

According to the California study, "one well-designed enforcement area" was the minimum requirement. In addition, a 14-foot median shoulder should run the entire length of the HOV lane – for safety and for enforcement.[82] The shoulder should have diagonal Botts Dots (raised pavement markers) placed at intervals to warn drivers that it is not a lane and to warn officers of approaching vehicles.[83]

In another comment on highway design, the study found that wider buffer lanes seemed to discourage illegal buffer crossings, but in order to keep cars from stopping on the buffer, it recommended that buffer lanes be "no more than four feet wide."[84]

TECHNOLOGIES

Ideally, HOV lane enforcement would be fully automated, thus avoiding the problems of high-speed traffic stops. Unfortunately, that is not possible with existing technology.

Both video and infrared cameras have been tested for applications in HOV lane enforcement.

In one study, officers looked at videotape of an HOV lane and tried to spot occupancy violators. Three or four cameras fed video to a television monitor showing all cameras simultaneously in split screen mode. Cameras picked up vehicles as they came into view,

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[81] A. Scott Cothron, Douglas A. Skowronek and Beverly T. Kuhn, *Enforcement Issues on Managed Lanes*, Project Bulletin 4160-11B; Project 0-4160: Operating Freeways with Managed Lanes (Texas Transportation Institute).
[82] John W. Billheimer, *HOV Lane Violation Study, Final Report* (California Dept. of Transportation; January 1990).
[83] *Ibid.;* p. 1-22
[84] *Ibid.;* p. 1-19

so different vehicles appeared together on the monitor. To see different angles of the same vehicle (front, side and rear or front, side, rear and eye-level), an officer would have to follow the vehicle as it disappeared from one part of the screen and reappeared in another. Playback taking up to a minute was usually necessary. Having different angles of the same vehicle appear together on the monitor would have required $50,000 worth of time-delay equipment and continuous adjustment as traffic speeds changed.

Researchers found that:

> "The need to search for the second view proved so bothersome in an on-line environment that some viewers ignored the second view and made decisions solely on the basis of the view from the initial camera."[85]

Best results were obtained with a high-speed (1/1000th second shutter speed) color camera with a 14:1 zoom lens.[86] Still, the camera's vision was inferior to the human eye, especially in bright sunlight. NTSC (National Television System Committee) video can capture contrast ratios of 10 to 1, but the contrast between a car's exterior and interior on a sunny day can be 100 to 1.

Other problems encountered were the same as those faced by human observers. Enforcement was not feasible after dark or in poor visibility. The false alarm rate was 21 percent to 51 percent, mainly due to children and reclining adults. Another 11.4 percent were impossible to estimate, due to "lighting, glare, tinted windows, headrests, windshield posts and high windows."[87]

> "The most undesirable filters encountered were the privacy screens, or tinted windows, installed in many new vehicles. These tinted screens keep both cameras and roadside observers from viewing the interior of vehicles."[88]

The cameras' high false alarm rate disqualifies them from use in fully automated occupancy enforcement. Unlike occupancy violations, however, cameras easily identified illegal buffer crossings, with no false alarms.[89]

In an earlier study, the Texas Department of Transportation and Dallas Area Rapid Transit (DART) tested a partially automated "advance warning" occupancy enforcement system on a contraflow HOT/HOV lane. Called "HOVER," the system used three or

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[85] John W. Billheimer, Ken Kaylor and Charles Shade, *Use of Videotape in HOV Lane Surveillance and Enforcement: Final Report* (Los Altos, CA: State of California Department of Transportation, March 1990), 4-5, 16-17, 38
[86] *Ibid.;* p.5
[87] *Ibid.;* p. 6
[88] *Ibid.;* p. 34
[89] *Ibid.*

more cameras, for front, side and rear (license plate) views. License plates were read automatically and checked against a database of registered car pools.[90] (Of course, registering as a car pool does not guarantee that a vehicle meets occupancy requirements.)

Conceivably, cameras could be used in fully automated buffer enforcement. Then occupancy enforcement could focus on areas where it is legal to cross the buffer. Barrier-separated HOV lanes are easier to enforce because vehicles cannot duck in and out of the lane. Law enforcement can wait for violators at entrances or exits. A comprehensive camera network, along with clearly marked pavement and possibly signage to make sure the public understands where it can and cannot cross the buffer, might set up a "virtual" barrier. If successful, occupancy enforcement could concentrate on areas where it is legal to cross the buffer.

Camera surveillance would also enable quicker response to traffic incidents. For that reason, the Washington Department of Transportation maintains constant camera surveillance on its HOV shoulder lanes on SR 520.[91]

Infrared cameras have also been tested for use in automated HOV lane enforcement. In the first stage of the study, cameras using different bandwidths of infrared were tested for their ability to capture clear images at freeway speeds. In the second stage of the study, a fuzzy neural network was "taught" to identify faces in the digital signal.[92]

Researchers hoped that mid-infrared (thermal) cameras would prove effective. Mid-infrared works day and night without any need for illumination. Another plus is that the human body maintains a constant temperature (dummies, of course, are room temperature). A drawback is that it cannot penetrate the windshield, due to the special composition of that glass. Also, transmission is severely disrupted if the defroster is on for more than 30 minutes. At that point, the air's thermal signal becomes stronger than the passenger's thermal signal. Unfortunately, although mid-infrared could capture a clear signal at up to 20 mph, it could not do so at 65 mph.[93] (See Figure 9 below.)

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[90] "First Automated HOV Enforcement System in US to be Tested in Dallas" *The Urban Transportation Monitor* 11, no. 17 (September 12, 1997): 1-2.

[91] Cambridge Systematics with URS, Inc. *Twin Cities HOV Study Final Report.* (Minnesota Dept. of Transportation*;* February 2002) p. 5-10

[92] Ioannis Pavlidis, Peter Symosek, Vassilios More1las, Bernard Fritz, Nikolaos P. Papanikolopoulos and Robert Sfarzo, *Automatic Passenger Counting in the HOV Lane* (St. Paul, MN: Minnesota Dept. of Transportation, June 1999), p. 29

[93] *Ibid.;* pp. 8-10

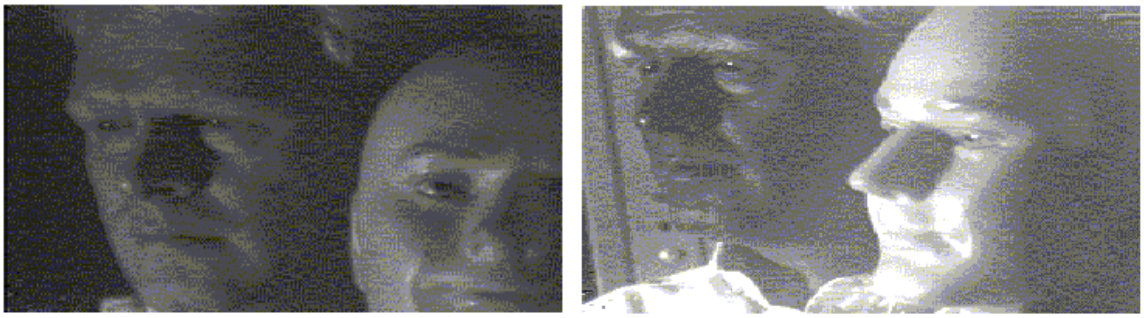

Figure 9. Mid-infrared Snapshots at Low and High (65 mph) Speeds[94]

Researchers next turned to near-infrared. Near-infrared cameras require near-infrared illumination, which is safe and invisible to the human eye. Near-infrared cannot penetrate metal or heavy clothes. Researchers found that near-infrared could work at highway speeds if the camera were equipped with a polarizing filter during the day, illumination at night, a zoom lens and a 1.4 -x μm (where x >1.4 μm) band pass filter to capture the difference in infrared reflectivity between a passenger and a dummy.[95]

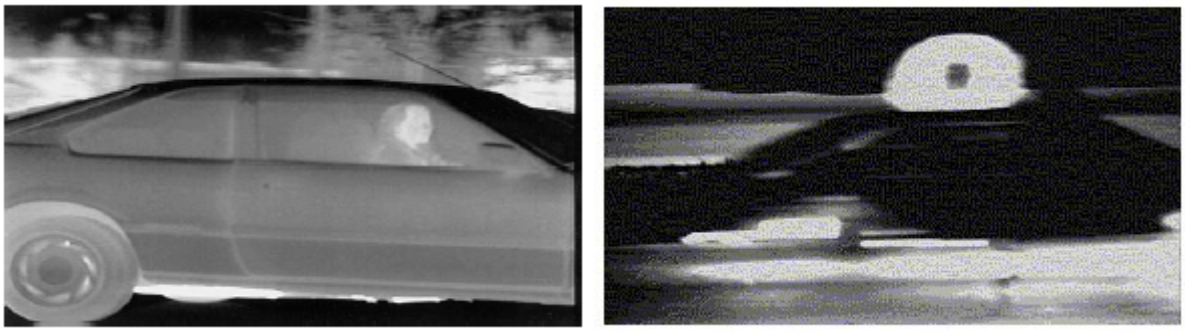

Figure 10. Comparison of Near Infrared With and Without Band Pass Filter[96]

"Caucasian male and dummy head in the range 1.1-1.4 μm."

"Caucasian male and dummy head in the range 1.4-1.7 μm."

Although the study was successful in capturing images with sufficient clarity for software to recognize faces, it was no more able to see below glass and detect a sleeping child or adult than video cameras or human observers. With current technology, only a traffic stop can determine occupancy.

[94] *Ibid.;* p. 13
[95] *Ibid.;* pp. 12, 15
[96] *Ibid.;* p. 24

SURVEY RESEARCH

METHODOLOGY

Because Arizona only has buffer-separated HOV lanes, which require different enforcement from barrier-separated HOV lanes, surveys were sent only to jurisdictions with lanes similar to Arizona's. Thirty-five metropolitan areas in 17 states have buffer or non-separated HOV lanes. (See Table 8 below.)

Table 8. U.S. Buffer and Non-Separated HOV Lane Jurisdictions

State	City/County	State	City/County
AZ	Phoenix	HI	Honolulu
CA	Alameda County	MD	State
CA	Contra Costa County	MN	Minneapolis
CA	Los Angeles and Los Angeles County	NJ	State
CA	Marin County	NY	New York City
CA	Orange County	NY	Suffolk and Nassau County
CA	Riverside County	OR	Portland
CA	Sacramento	TN	Memphis
CA	San Bernardino County	TN	Nashville
CA	San Diego/San Diego County	TX	Dallas
CA	Santa Clara/San Mateo Counties	TX	Houston
CO	Denver	UT	Salt Lake City
CT	Hartford	VA	Norfolk/Hampton/Virginia Beach
FL	Ft. Lauderdale	VA	Northern Virginia
FL	Miami	WA	Seattle
FL	Orlando	WA	Vancouver
GA	Atlanta		

Surveys were customized for each respondent, listing buffer and non-separated HOV lanes in that jurisdiction and directing questions specifically to those lanes.

Respondents were direct supervisors of patrol officers responsible for enforcing HOV lane restrictions. To maximize the potential benefit from this panel of experts, open-response as well as closed-response questions were asked.

Responses were analyzed using descriptive statistics, frequencies and non-parametric testing methods. Survey analysis had four goals:

- Reflect law enforcement officer perceptions of problems in HOV lane enforcement
- Measure frequency and severity of problems
- Determine variables most often mentioned in connection with ease or difficulty of enforcing HOV lane restrictions
- Obtain suggestions for better HOV lane enforcement

ENFORCEMENT OFFICER SUPERVISOR SURVEY

Verifying Occupancy

Officers reported that tinted auto glass was the most frequently encountered problem, with babies/children in car seats and reclining adults tied for second place. Lower scores for bad weather and nighttime lighting could be explained by enforcement not being attempted under those conditions.

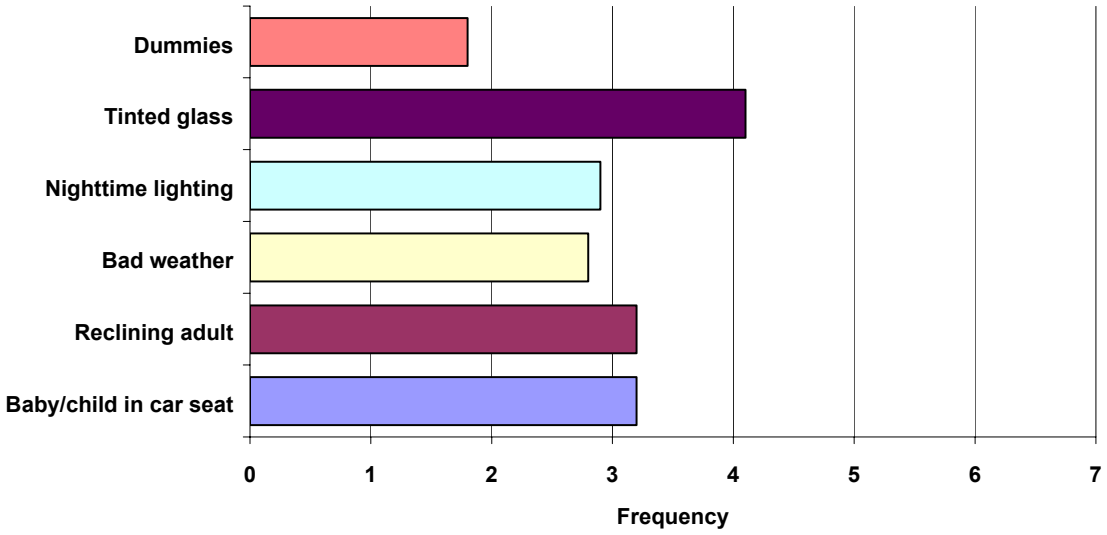

Figure 11. Average Frequency of Problem
0= never, 7 = almost always

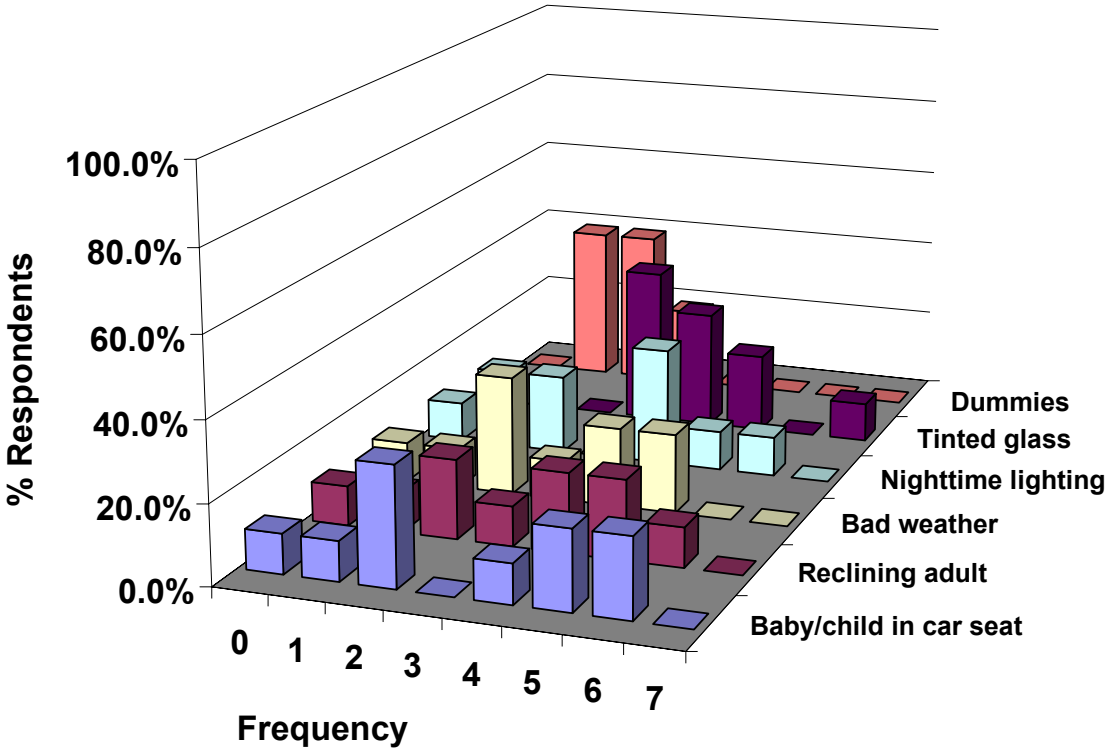

Figure 12. Frequency of Problem
0= never, 7 = almost always

Difficulty Added to Enforcement

Officers reported the greatest degree of difficulty with problems that jeopardize safety. General traffic lane congestion added the most difficulty to HOV lane enforcement, followed by inadequate citation and observation areas and the speed differential between HOV and mixed-flow lanes.

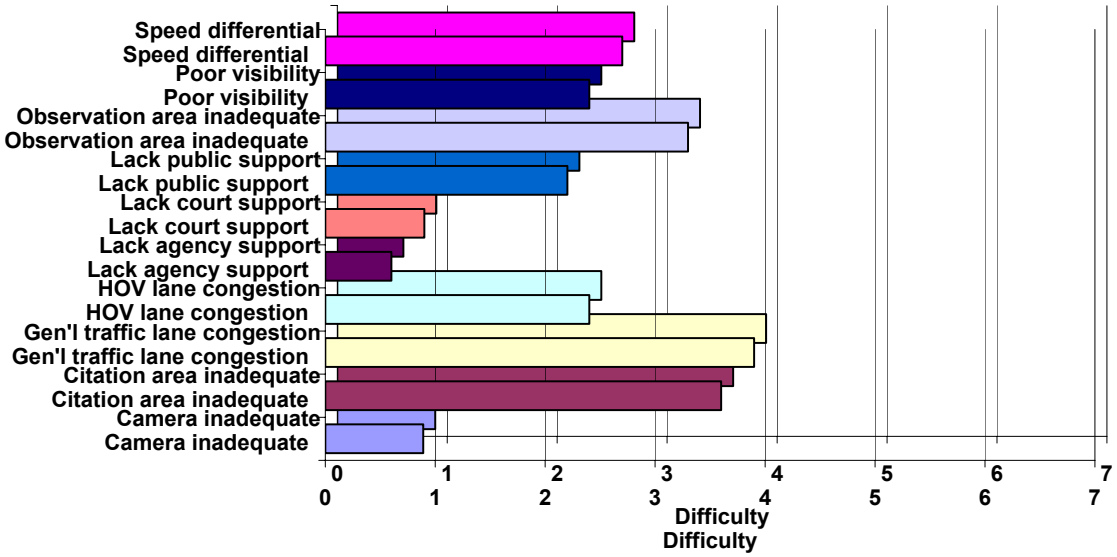

Figure 13. Average Difficulty of Problem
0= not difficult at all, 7 = extremely difficult

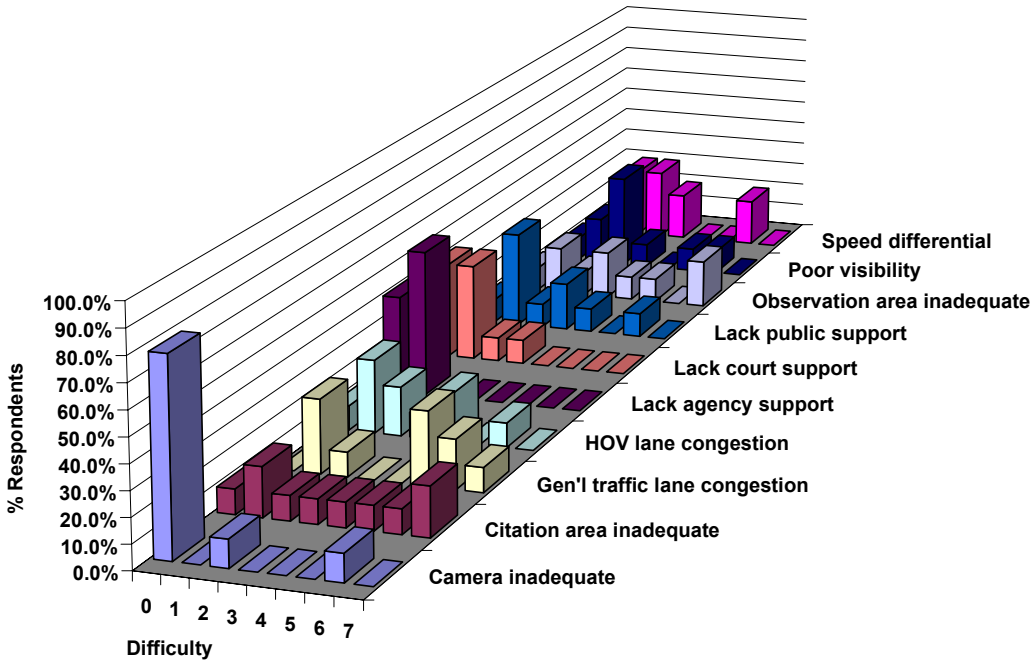

Figure 14. Difficulty of Problem
0= not difficult at all, 7 = extremely difficult

Fines

Among respondents, Arizona had by far the highest fine for HOV violations: $365. Average fines were:

- First offense: $129
- Second offense: $146
- Third offense: $196

No respondent reported having jail or driver's license suspension penalties. Just one state, Arizona, reported assessing points (3) against the violator's license.

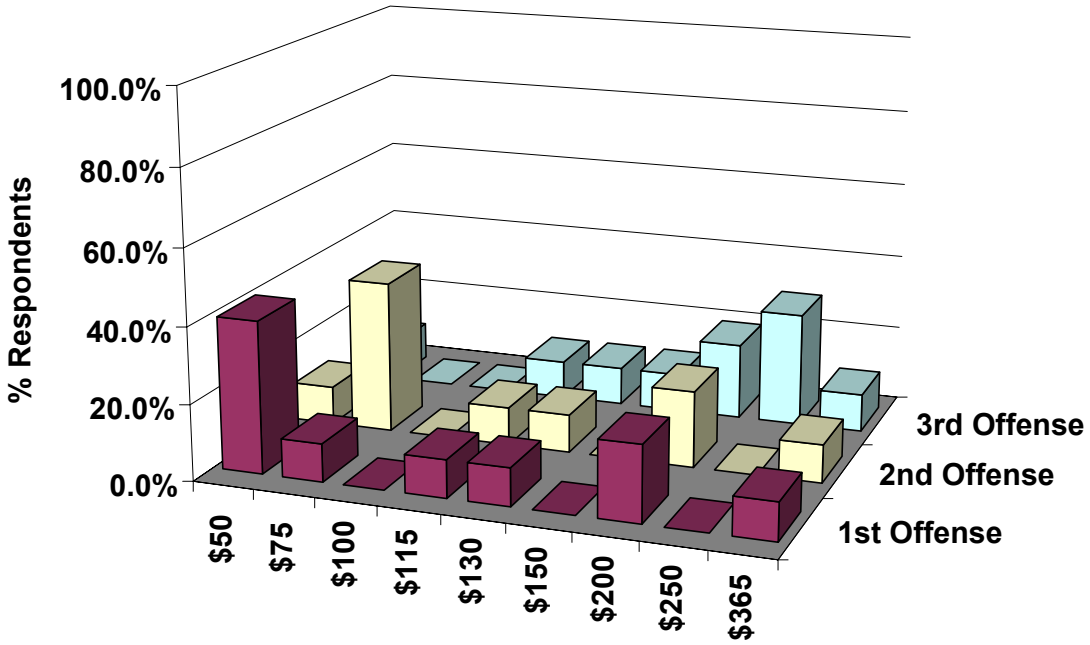

Figure 15. Fines for HOV Violation

Observation Area

Safety concerns were officers' number one priority.

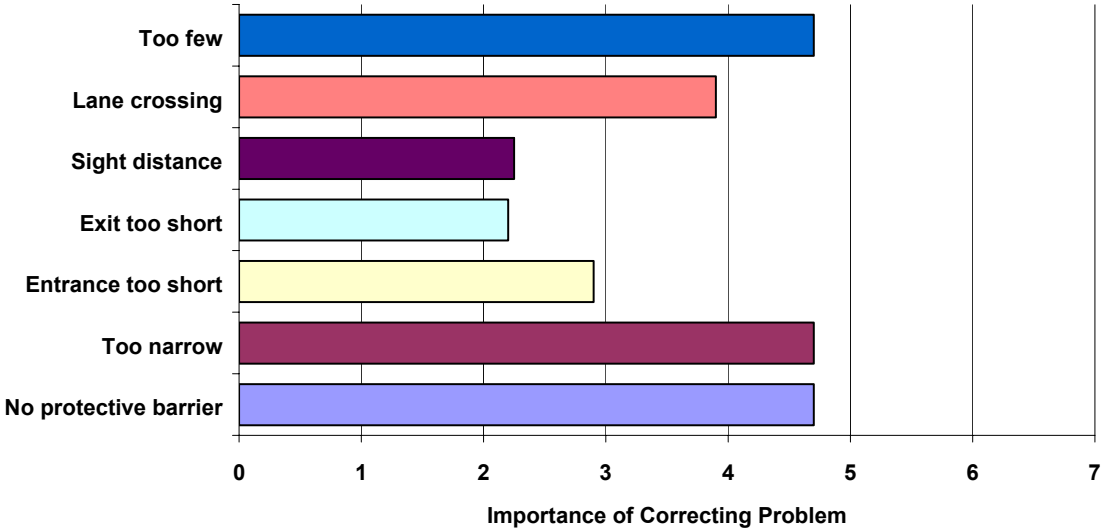

Figure 16. Average Importance of Correcting Observation Area Problems
0 = not a problem, 7 = extremely important

Three problems tied as most important to correct:

- Too few observation areas
- No protective barrier
- Observation area too narrow

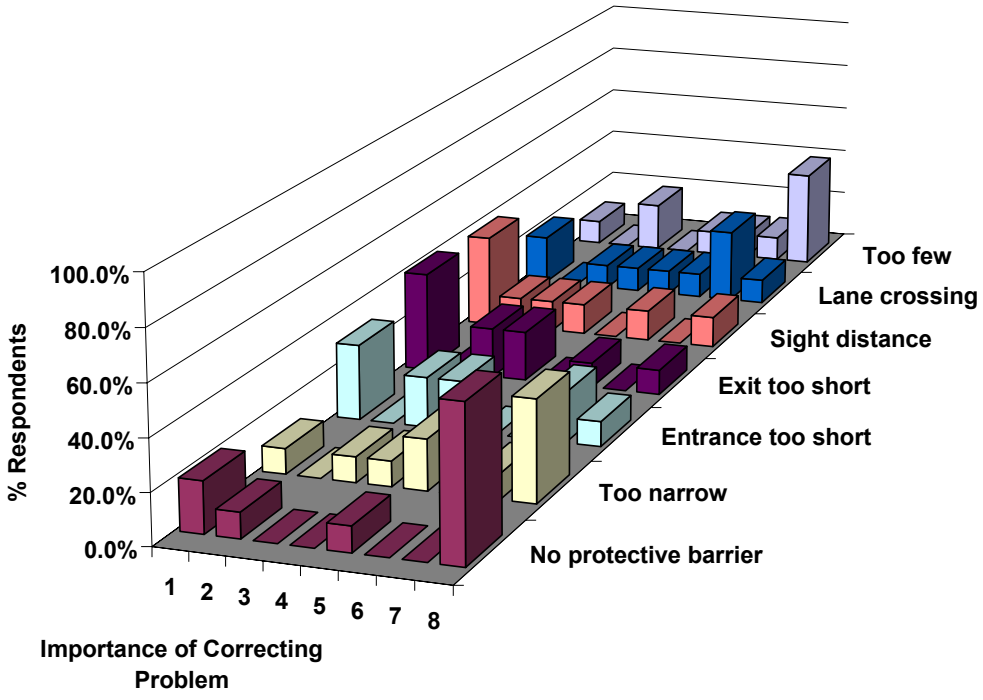

Figure 17. Importance of Correcting Observation Area Problems
0 = not a problem, 7 = extremely important

Coming in second were problems with lane crossing.

Citation Area

Respondents assigned greater importance to correcting problems in citation areas, which civilians would have to navigate, than to problems in observation areas, but that difference was not statistically significant. (See Table 9 below and Output 1, Appendix.)

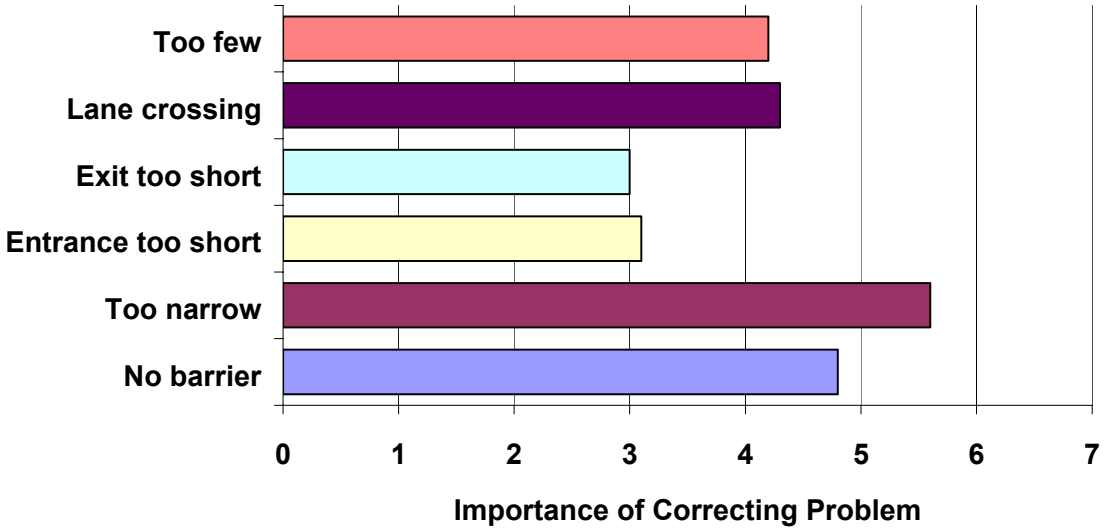

Figure 18. Average Importance of Correcting Citation Area Problems
0 = not a problem, 7 = extremely important

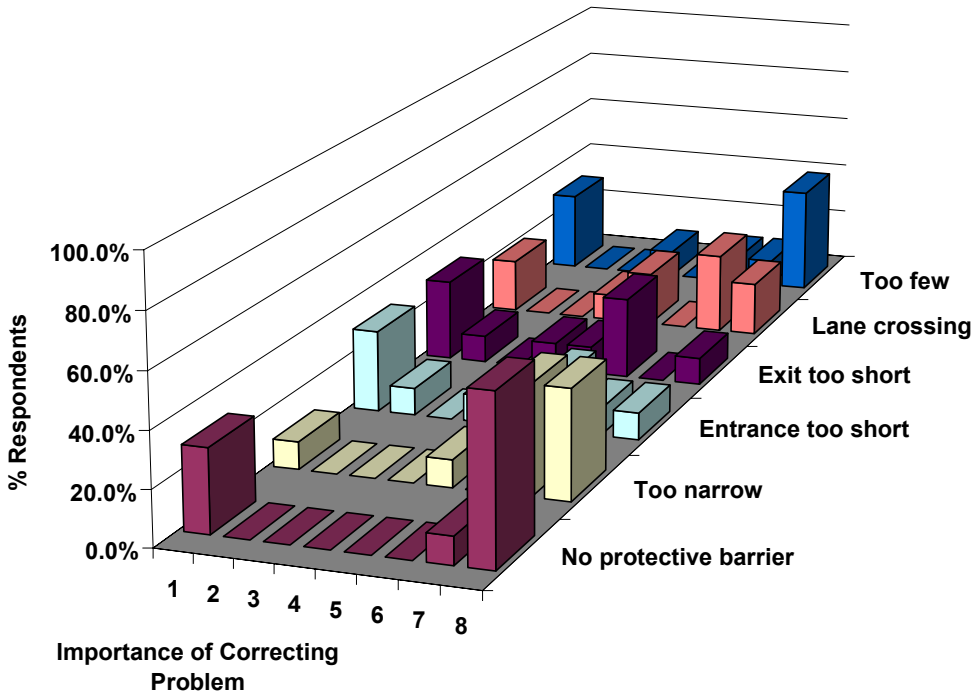

Figure 19. Importance of Correcting Citation Area Problems
0 = not a problem, 7 = extremely important

Officers' answers were significantly correlated, in that what was felt to be important for an observation area was felt to be important for a citation area as well. The exception to this was "entrance too short." (See Output 2, Appendix.)

Table 9. Average Importance of Correcting Problems: Officer Only vs. Public

Problem	Observation Area	Citation Area
Too few	4.7	4.2
Lane crossing	3.9	4.3
Exit too short	2.2	3.0
Entrance too short	2.9	3.1
Too narrow	4.7	5.6
No protective barrier	4.7	4.8

0 = not a problem, 7 = extremely important

Citation areas that were too narrow were most important to correct, gaining almost a full point in importance over observation areas that were too narrow.

The left shoulder was the most preferred citation area, followed by off the exit ramp and the right shoulder. Choices here reflect possibilities in respondents' jurisdictions and not necessarily an "ideal" citation area. Only one respondent reported using the buffer, rating it "least preferred."

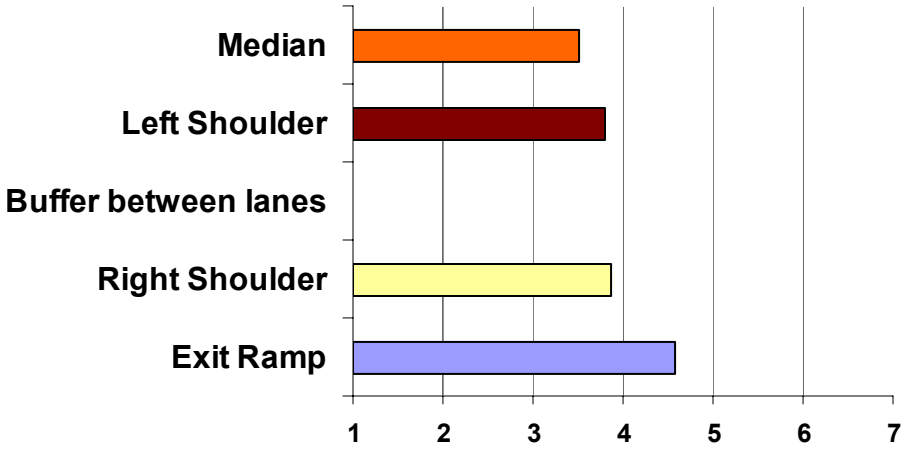

Figure 20. Average Citation Area Preference
0 = least preferred, 7 = most preferred

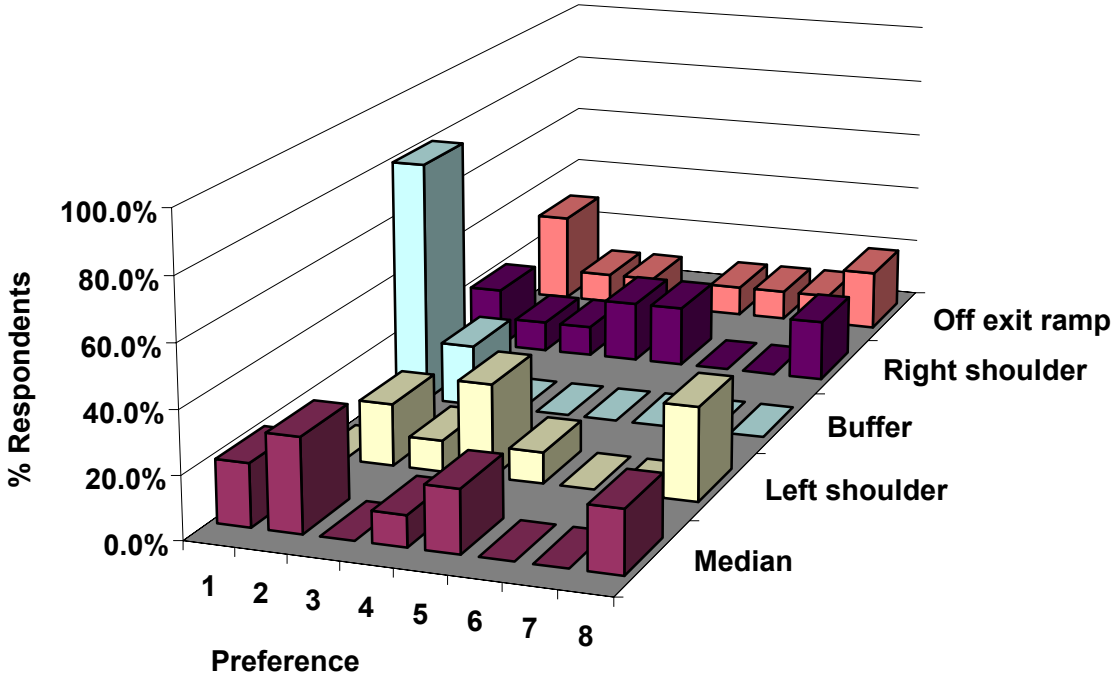

Figure 21. Citation Area Preference
0 = least preferred, 7 = most preferred

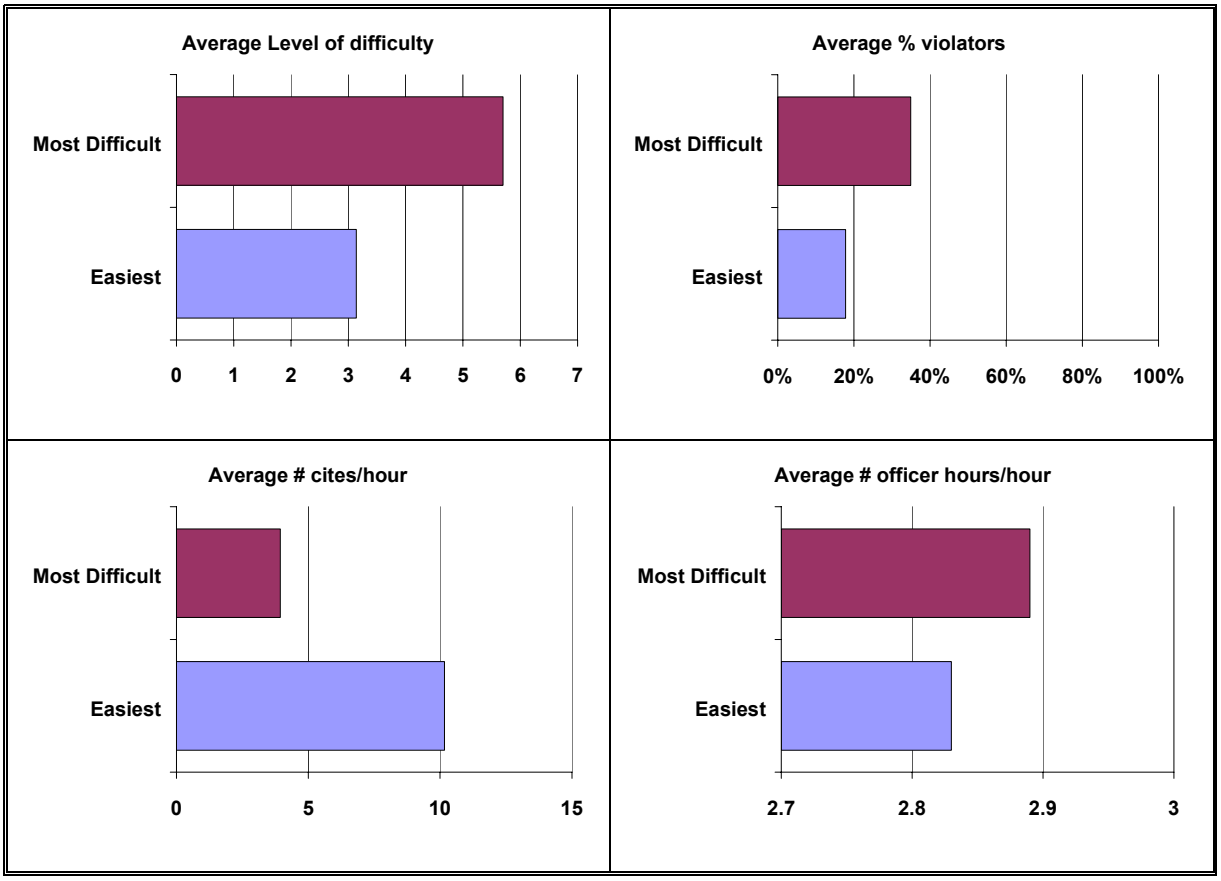

Figure 22. Comparison of Easiest and Most Difficult to Enforce HOV Lanes

There is disparity between HOV lanes rated "easiest to enforce" in respondents' jurisdictions and those rated "most difficult to enforce." Differences are significant in difficulty and in violation rates, both of which are higher for most difficult to enforce HOV lanes. Differences in citations issued and hours spent on enforcement were not statistically significant. (See Output 3, Appendix.)

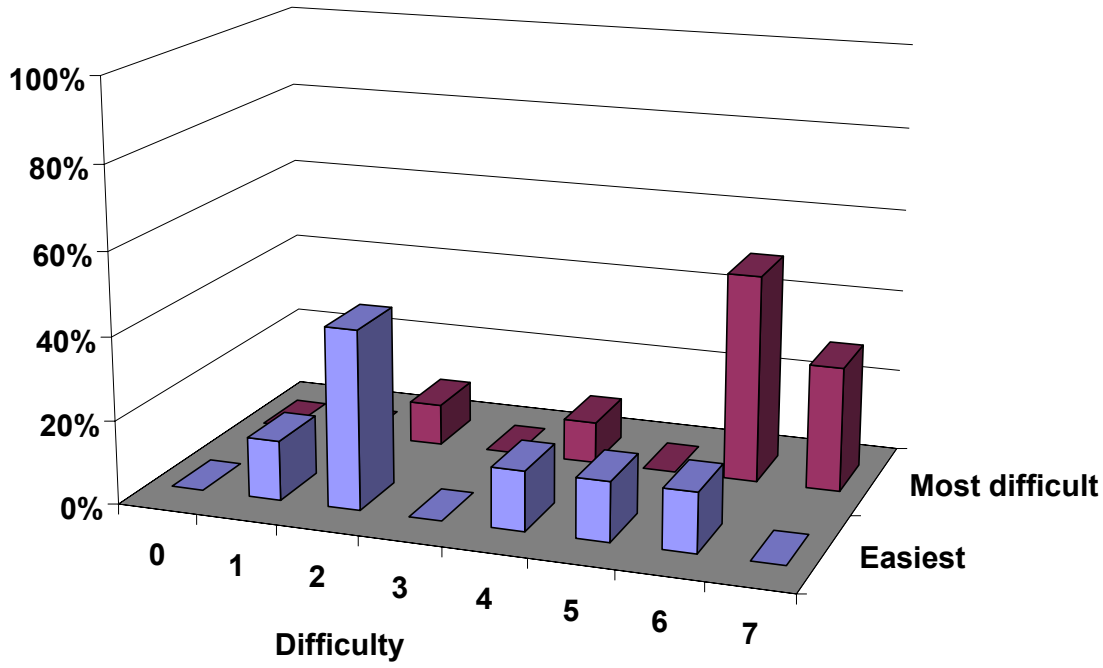

Figure 23. Difficulty of Enforcement
0 = least difficult, 7 = most difficult

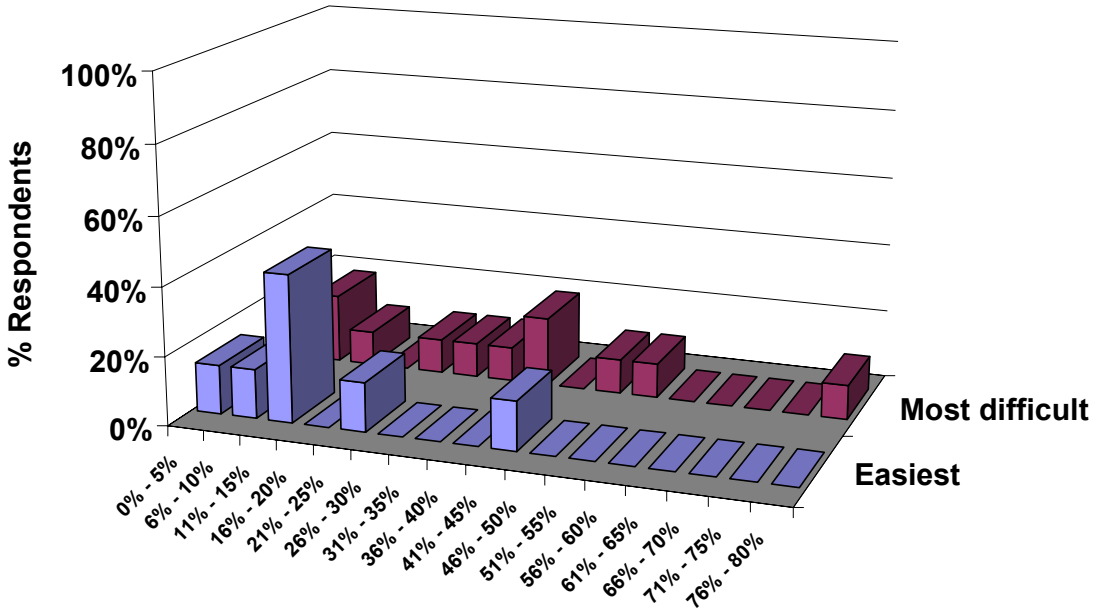

Figure 24. Percent of Violators

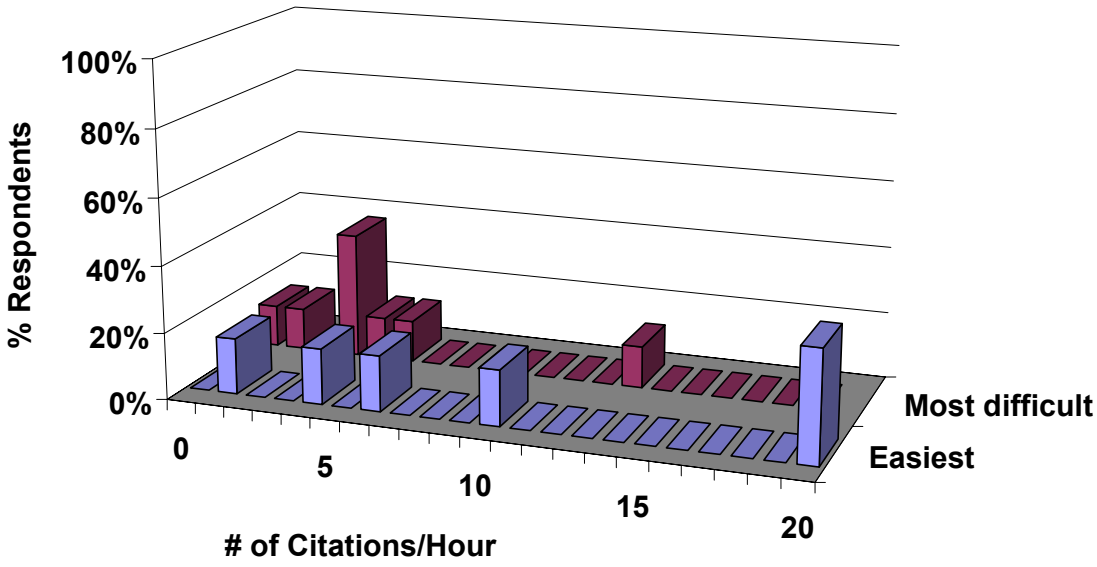

Figure 25. Citations Per Hour During Peak

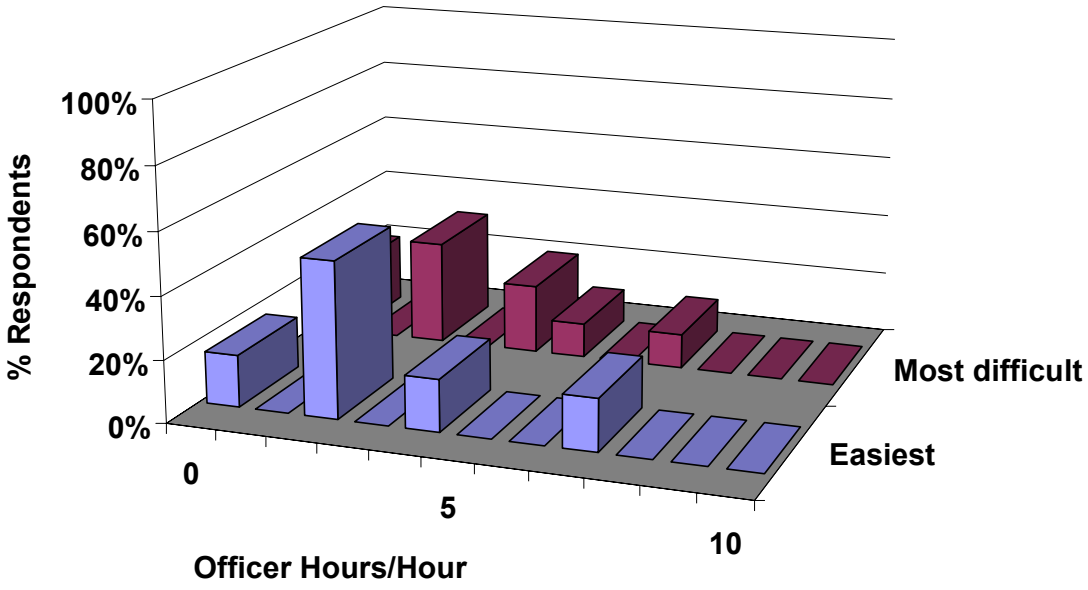

Figure 26. Officer Hours Per Hour During Peak

FINDINGS AND RECOMMENDATIONS

Findings and recommendations are offered as suggestions for consideration. Review of ADOT or DPS operations is beyond the scope of this report. Where suggestions are made, ADOT and/or DPS may already be following them or have good reason not to do so.

KEY FINDINGS

- No technology exists that can fully automate HOV occupancy enforcement, because no technology exists that can see through metal vehicles and pick out the people inside. Equipment and officers are thwarted by the same problems – children or sleeping adults who do not show through the window. Only a traffic stop can tell for sure if a vehicle is violating occupancy requirements.
- Of the factors that limit the ability to see inside a vehicle, the most pernicious is window tinting, because of the threat it poses to law enforcement. Opaque auto glass tinting can hide not only a weapon, but also the person reaching for it.
- Adequate enforcement requires extensive space in the median. In many instances it is not feasible to provide this space.
- Current statutes that require officers to have vehicles to pull over to the right are inappropriate for HOV enforcement

KEY RECOMMENDATIONS

- Where feasible to do so, highway design should allow for sheltered observation areas and wide, long citation areas, with adequate entrances and exits, in the median next to the HOV lane.
- An optics expert should review Arizona's law regulating auto glass tinting, to see if current restrictions allow for adequate video imaging. Although occupancy enforcement cannot be automated, cameras have been used in advance warning systems. They need to be able to see through auto glass, as do officers. Once tinting levels and fines for noncompliance are set, officers should be equipped with tint-meters, trained in how to use them and encouraged to check every time they make a stop and cite every time they see a violation.
- Prominently post the fine for HOV violations on roadside signs. Use electric signs when available for periodic reminders.
- Randomly, but periodically, utilize special enforcement followed by routine enforcement.
- Evaluate increased penalties for HOV violations.
- Have engineers meet with highway patrol officers before design concepts are finalized wherever HOV or HOT/Value lanes are contemplated.
- Consider implementing HOT lanes on HOV lanes by charging full price for single occupancy vehicles (SOVs), half price for high occupancy vehicles with two or more

- occupants (2+ HOVs) and nothing for high occupancy vehicles with three or more occupants (3+ HOVs).
- Monitor new technology as it emerges and reconsider implementing it if it appears feasible and warranted.
- Evaluate establishing enforcement areas near HOV entry and exit ramps.
- Consider installing a “hot line” for citizens to call to report HOV violators.

APPENDIX

EXHIBIT 1. 16 Transportation Control Measures
EXHIBIT 2. Survey With Responses

OUTPUT 1. Sign Test – Observation vs. Citation Area
OUTPUT 2. Spearman Correlation – Observation vs. Citation Area
OUTPUT 3. Sign Test – Most Difficult vs. Easiest to Enforce

EXHIBIT 1. 16 Transportation Control Measures

"(i) programs for improved public transit;
(ii) restriction of certain roads or lanes to, or construction of such roads or lanes for use by, passenger buses or high occupancy vehicles;
(iii) employer-based transportation management plans, including incentives;
(iv) trip-reduction ordinances;
(v) traffic flow improvement programs that achieve emission reductions;
(vi) fringe and transportation corridor parking facilities serving multiple occupancy vehicle programs or transit service; 28
(vii) programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use;
(viii) programs for the provision of all forms of high-occupancy, shared-ride services;
(ix) programs to limit portions of road surfaces or certain sections of the metropolitan area to the use of non-motorized vehicles or pedestrian use, both as to time and place;
(x) programs for secure bicycle storage facilities and other facilities, including bicycle lanes, for the convenience and protection of bicyclists, in both public and private areas;
(xi) programs to control extended idling of vehicles;
(xii) programs to reduce motor vehicle emissions, consistent with title II, which are caused by extreme cold start conditions;
(xiii) employer-sponsored programs to permit flexible work schedules;
(xiv) programs and ordinances to facilitate non-automobile travel, provision and utilization of mass transit, and to generally reduce the need for single-occupant vehicle travel, as part of transportation planning and development efforts of a locality, including programs and ordinances applicable to new shopping centers, special events, and other centers of vehicle activity;
(xv) programs for new construction and major reconstructions of paths, tracks or areas solely for the use by pedestrian or other non-motorized means of transportation when economically feasible and in the public interest. For purposes of this clause, the Administrator shall also consult with the Secretary of the Interior; and
(xvi) program to encourage the voluntary removal from use and the marketplace of pre-1980 model year light duty vehicles and pre-1980 model light duty trucks." (Title 1, Part A, Sec. 108(f)(1)(A) i – xvi, U.S. Code

EXHIBIT 2. Survey with Responses

Arizona Department of Transportation Survey on HOV Enforcement – To Highway Patrol Managers

The Arizona Department of Transportation is interested in learning how other states enforce HOV lane restrictions. We appreciate your help and will provide you with a copy of our final report.

You may click on or tab between the gray shaded areas ( ) to enter answers directly on the form below, or print out the survey and fill it in by hand. Please return completed surveys by email lisa@mktg-intelligence.com or fax (520) 321-1649 as soon as possible.

If you have any questions, please contact Lisa Markkula at (520) 321-0110 or lisa@mktg-intelligence.com.

Person completing this survey:

Name: _____ Phone: ( ) -

Agency: _____ Email: _____

Division: _____ State: _____

Enforcement Problems

1. For officers under your supervision, please give your best estimate of how ***often*** each of the following items is a problem in HOV lane restriction enforcement. *Please check a selection for each.*

	N/A Not a problem	Almost never 1	2	3	4	5	6	Almost always 7
Baby/child in car seat	☐	☐	☐	☐	☐	☐	☐	☐
Reclining adult in vehicle	☐	☐	☐	☐	☐	☐	☐	☐
Bad weather	☐	☐	☐	☐	☐	☐	☐	☐
Nighttime lighting	☐	☐	☐	☐	☐	☐	☐	☐
Tinted glass	☐	☐	☐	☐	☐	☐	☐	☐
Use of dummies	☐	☐	☐	☐	☐	☐	☐	☐

Statistics

	Baby/child	Reclining adult	Bad weather	Nighttime lighting	Tinted glass	Dummies
N Valid	10	10	10	10	10	10
Missing	0	0	0	0	0	0
Mean	3.20	3.20	2.80	2.90	4.10	1.80
Std. Deviation	2.15	1.93	1.69	1.97	1.29	.79
Minimum	0	0	0	0	3	1
Maximum	6	6	5	6	7	3

Baby/child

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	1	10.0	20.0
	2	3	30.0	50.0
	3	1	10.0	60.0
	5	2	20.0	80.0
	6	2	20.0	100.0
	Total	10	100.0	

Reclining adult

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	1	10.0	20.0
	2	2	20.0	40.0
	3	1	10.0	50.0
	4	2	20.0	70.0
	5	2	20.0	90.0
	6	1	10.0	100.0
	Total	10	100.0	

Bad weather

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	1	10.0	20.0
	2	3	30.0	50.0
	3	1	10.0	60.0
	4	2	20.0	80.0
	5	2	20.0	100.0
	Total	10	100.0	

Nighttime lighting

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	2	20.0	30.0
	2	2	20.0	50.0
	4	3	30.0	80.0
	5	1	10.0	90.0
	6	1	10.0	100.0
	Total	10	100.0	

Tinted glass

		Frequency	Valid Percent	Cumulative Percent
Valid	3	4	40.0	40.0
	4	3	30.0	70.0
	5	2	20.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Dummies

		Frequency	Valid Percent	Cumulative Percent
Valid	1	4	40.0	40.0
	2	4	40.0	80.0
	3	2	20.0	100.0
	Total	10	100.0	

2. For officers under your supervision, please give your best estimate of how ***difficult*** each of the following items makes HOV lane restriction enforcement. *Please check a selection for each.*

	N/A Not a problem	Not at all difficult 1	2	3	4	5	6	Extremely difficult 7
Camera system inadequate	☐	☐	☐	☐	☐	☐	☐	☐
Citation area inadequate	☐	☐	☐	☐	☐	☐	☐	☐
General traffic lane congestion	☐	☐	☐	☐	☐	☐	☐	☐
HOV lane congestion	☐	☐	☐	☐	☐	☐	☐	☐
Lack of agency support	☐	☐	☐	☐	☐	☐	☐	☐
Lack of court support	☐	☐	☐	☐	☐	☐	☐	☐
Lack of public support	☐	☐	☐	☐	☐	☐	☐	☐
Observation area inadequate	☐	☐	☐	☐	☐	☐	☐	☐
Poor visibility	☐	☐	☐	☐	☐	☐	☐	☐
Speed differential between general traffic and HOV lanes	☐	☐	☐	☐	☐	☐	☐	☐

Statistics

		Camera inadequate	Citation area inadequate	Gen'l traffic lane congestion	HOV lane congestion	Lack agency support	Lack court support	Lack public support	Observation area inadequate	Poor visibility	Speed differential
N	Valid	9	10	10	10	10	10	10	10	10	10
	Missing	1	0	0	0	0	0	0	0	0	0
Mean		.89	3.60	3.90	2.40	.60	.90	2.20	3.30	2.40	2.70
Std. Deviation		2.03	2.59	2.38	1.84	.52	.99	1.81	2.45	1.84	1.89
Minimum		0	0	1	0	0	0	0	0	0	1
Maximum		6	7	7	6	1	3	6	7	6	6

Camera inadequate

		Frequency	Valid Percent	Cumulative Percent
Valid	0	7	77.8	77.8
	2	1	11.1	88.9
	6	1	11.1	100.0
	Total	9	100.0	
Missing	System	1		
Total		10		

Citation area inadequate

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	2	20.0	30.0
	2	1	10.0	40.0
	3	1	10.0	50.0
	4	1	10.0	60.0
	5	1	10.0	70.0
	6	1	10.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Gen'l traffic lane congestion

		Frequency	Valid Percent	Cumulative Percent
Valid	1	3	30.0	30.0
	2	1	10.0	40.0
	5	3	30.0	70.0
	6	2	20.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

HOV lane congestion

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	3	30.0	40.0
	2	2	20.0	60.0
	3	1	10.0	70.0
	4	2	20.0	90.0
	6	1	10.0	100.0
	Total	10	100.0	

Lack agency support

		Frequency	Valid Percent	Cumulative Percent
Valid	0	4	40.0	40.0
	1	6	60.0	100.0
	Total	10	100.0	

Lack court support

		Frequency	Valid Percent	Cumulative Percent
Valid	0	4	40.0	40.0
	1	4	40.0	80.0
	2	1	10.0	90.0
	3	1	10.0	100.0
	Total	10	100.0	

Lack public support

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	4	40.0	50.0
	2	1	10.0	60.0
	3	2	20.0	80.0
	4	1	10.0	90.0
	6	1	10.0	100.0
	Total	10	100.0	

Observation area inadequate

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	2	20.0	30.0
	2	1	10.0	40.0
	3	2	20.0	60.0
	4	1	10.0	70.0
	5	1	10.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Poor visibility

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	1	2	20.0	30.0
	2	4	40.0	70.0
	3	1	10.0	80.0
	5	1	10.0	90.0
	6	1	10.0	100.0
	Total	10	100.0	

Speed differential

		Frequency	Valid Percent	Cumulative Percent
Valid	1	3	30.0	30.0
	2	3	30.0	60.0
	3	2	20.0	80.0
	6	2	20.0	100.0
	Total	10	100.0	

Penalties

1. What are the penalties for the ***1st offense*** of violating HOV lane restrictions?
   Fine: $_____ Days jail: _____ Points: _____ Days driver license suspended: _____
2. Are penalties for the ***2nd offense*** the same as for the 1st offense? ☐ Yes ☐ No *(If yes, skip to next question.)*
   If no, what are the penalties for the 2nd offense?
   Fine: $_____ Days jail: _____ Points: _____ Days driver license suspended: _____
3. Are penalties for the ***3rd offense*** the same as for the 2nd offense? ☐ Yes ☐ No *(If yes, skip to next section.)*
   If no, what are the penalties for the 3rd offense?
   Fine: $_____ Days jail: _____ Points: _____ Days driver license suspended: _____

Statistics – First Offense

		Fine	Jail days	Points	Suspension days
N	Valid	10	10	10	10
	Missing	0	0	0	0
Mean		$128.50	.00	.30	.00
Std. Deviation		$102.12	.00	.95	.00
Minimum		$50	0	0	0
Maximum		$365	0	3	0

1st offense fine

		Frequency	Valid Percent	Cumulative Percent
Valid	$50	4	40.0	40.0
	$75	1	10.0	50.0
	$115	1	10.0	60.0
	$130	1	10.0	70.0
	$200	2	20.0	90.0
	$365	1	10.0	100.0
	Total	10	100.0	

1st offense jaildays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

1st offense points

		Frequency	Valid Percent	Cumulative Percent
Valid	0	9	90.0	90.0
	3	1	10.0	100.0
	Total	10	100.0	

1st offense suspdays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

Statistics – Second Offense

		Same as 1st?	Fine	Jail days	Points	Suspension days
N	Valid	10	10	10	10	10
	Missing	0	0	0	0	0
Mean		.60	$146.00	.00	.30	.00
Std. Deviation		.52	$89.87	.00	.95	.00
Minimum		0	$50	0	0	0
Maximum		1	$365	0	3	0

2nd offense same as 1st?

		Frequency	Valid Percent	Cumulative Percent
Valid	0	4	40.0	40.0
	1	6	60.0	100.0
	Total	10	100.0	

2nd offense fine

		Frequency	Valid Percent	Cumulative Percent
Valid	$50	1	10.0	10.0
	$100	4	40.0	50.0
	$115	1	10.0	60.0
	$130	1	10.0	70.0
	$200	2	20.0	90.0
	$365	1	10.0	100.0
	Total	10	100.0	

2nd offense jaildays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

2nd offense points

		Frequency	Valid Percent	Cumulative Percent
Valid	0	9	90.0	90.0
	3	1	10.0	100.0
	Total	10	100.0	

2nd offense suspdays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

Statistics – Third Offense

		Same as 2nd?	Fine	Jail days	Points	Suspension days
N	Valid	10	10	10	10	10
	Missing	0	0	0	0	0
Mean		.60	196.00	.00	.30	.00
Std. Deviation		.52	89.25	.00	.95	.00
Minimum		0	50	0	0	0
Maximum		1	365	0	3	0

3rd offense same as 1st?

		Frequency	Valid Percent	Cumulative Percent
Valid	0	4	40.0	40.0
	1	6	60.0	100.0
	Total	10	100.0	

3rd offense fine

		Frequency	Valid Percent	Cumulative Percent
Valid	$50	1	10.0	10.0
	$115	1	10.0	20.0
	$130	1	10.0	30.0
	$150	1	10.0	40.0
	$200	2	20.0	60.0
	$250	3	30.0	90.0
	$365	1	10.0	100.0
	Total	10	100.0	

3rd offense jaildays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

3rd offense points

		Frequency	Valid Percent	Cumulative Percent
Valid	0	9	90.0	90.0
	3	1	10.0	100.0
	Total	10	100.0	

3rd offense suspdays

		Frequency	Valid Percent	Cumulative Percent
Valid	0	10	100.0	100.0

Violation Observation Areas

1. Please give your best estimate of how important it would be to officers under your supervision for each of the following HOV ***observation*** area design problems to be fixed. If a problem does not exist in your division's jurisdiction, please check N/A. *Please check a selection for each.*

	N/A No areas with this problem	**Not at all important** **1**	**2**	**3**	**4**	**5**	**6**	**Extremely important** **7**
No protective barrier	☐	☐	☐	☐	☐	☐	☐	☐
Too narrow	☐	☐	☐	☐	☐	☐	☐	☐
Entrance too short	☐	☐	☐	☐	☐	☐	☐	☐
Exit too short	☐	☐	☐	☐	☐	☐	☐	☐
Sight distance too short	☐	☐	☐	☐	☐	☐	☐	☐
Lane crossing from observation area to HOV	☐	☐	☐	☐	☐	☐	☐	☐
Too few observation areas	☐	☐	☐	☐	☐	☐	☐	☐

Statistics – Observation Area

		No protective barrier	Too narrow	Entrance too short	Exit too short	Sight distance too short	Lane crossing to HOV lane	Too few
N	Valid	10	10	10	10	8	10	10
	Missing	0	0	0	0	2	0	0
Mean		4.70	4.70	2.90	2.20	2.25	3.90	4.70
Std. Deviation		3.16	2.50	2.64	2.39	2.60	2.56	2.58
Minimum		0	0	0	0	0	0	0
Maximum		7	7	7	7	7	7	7

Obs. area - no protective barrier

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	20.0	20.0
	1	1	10.0	30.0
	4	1	10.0	40.0
	7	6	60.0	100.0
	Total	10	100.0	

Obs. area - too narrow

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	2	1	10.0	20.0
	3	1	10.0	30.0
	4	2	20.0	50.0
	6	1	10.0	60.0
	7	4	40.0	100.0
	Total	10	100.0	

Obs. area - entrance too short

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	2	2	20.0	50.0
	3	2	20.0	70.0
	6	2	20.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Obs. area - exit too short

		Frequency	Valid Percent	Cumulative Percent
Valid	0	4	40.0	40.0
	2	2	20.0	60.0
	3	2	20.0	80.0
	5	1	10.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Obs. area - sight distance too short

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	37.5	37.5
	1	1	12.5	50.0
	2	1	12.5	62.5
	3	1	12.5	75.0
	5	1	12.5	87.5
	7	1	12.5	100.0
	Total	8	100.0	
Missing	System	2		
Total		10		

Obs. area - lane crossing to HOV lane

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	20.0	20.0
	2	1	10.0	30.0
	3	1	10.0	40.0
	4	1	10.0	50.0
	5	1	10.0	60.0
	6	3	30.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Obs. area - too few

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	2	2	20.0	30.0
	4	1	10.0	40.0
	5	1	10.0	50.0
	6	1	10.0	60.0
	7	4	40.0	100.0
	Total	10	100.0	

Violation Citation Areas

1. Please give your best estimate of the preferences of officers under your supervision for the following as ***citation*** areas for HOV lanes. If an area is not used in your division's jurisdiction, please check N/A. *Please check a selection for each.*

	N/A Not used	**Least preferred** 1	2	3	4	5	6	**Most preferred** 7
In the median	☐	☐	☐	☐	☐	☐	☐	☐
In the left shoulder	☐	☐	☐	☐	☐	☐	☐	☐
In the buffer between general traffic and HOV lanes	☐	☐	☐	☐	☐	☐	☐	☐
In the right shoulder	☐	☐	☐	☐	☐	☐	☐	☐
Off the exit ramp	☐	☐	☐	☐	☐	☐	☐	☐
Other *(please describe)* ____	☐	☐	☐	☐	☐	☐	☐	☐

Statistics – Citation Area

		Median	Left shoulder	Buffer	Right shoulder	Off exit ramp
N	Valid	10	10	10	10	10
	Missing	0	0	0	0	0
Mean		2.80	3.80	.20	3.10	3.20
Std. Deviation		2.66	2.39	.42	2.51	2.94
Minimum		0	1	0	0	0
Maximum		7	7	1	7	7

Cite area - median

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	20.0	20.0
	1	3	30.0	50.0
	3	1	10.0	60.0
	4	2	20.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Cite area - left shoulder

		Frequency	Valid Percent	Cumulative Percent
Valid	1	2	20.0	20.0
	2	1	10.0	30.0
	3	3	30.0	60.0
	4	1	10.0	70.0
	7	3	30.0	100.0
	Total	10	100.0	

Cite area - buffer

		Frequency	Valid Percent	Cumulative Percent
Valid	0	8	80.0	80.0
	1	2	20.0	100.0
	Total	10	100.0	

Cite area - right shoulder

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	20.0	20.0
	1	1	10.0	30.0
	2	1	10.0	40.0
	3	2	20.0	60.0
	4	2	20.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Cite area - off exit ramp

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	1	1	10.0	40.0
	2	1	10.0	50.0
	4	1	10.0	60.0
	5	1	10.0	70.0
	6	1	10.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Other

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	75.0	75.0
	4	1	25.0	100.0
	Total	4	100.0	
Missing	System	6		
	Total	10	100.0	

Other – description

Entrance turnaround area
There are no shoulders inside the reversible areas of the 394 HOV. There is no left shoulder in the 35W left lane HOV areas.

2. Please give your best estimate of how important it would be to officers under your supervision for each of the following HOV ***citation*** area design problems to be fixed. If a problem does not exist in your division's jurisdiction, please check N/A. *Please check a selection for each.*

	N/A No areas with this problem	Not at all important 1	2	3	4	5	6	Extremely important 7
No protective barrier	☐	☐	☐	☐	☐	☐	☐	☐
Too narrow	☐	☐	☐	☐	☐	☐	☐	☐
Entrance too short	☐	☐	☐	☐	☐	☐	☐	☐
Exit too short	☐	☐	☐	☐	☐	☐	☐	☐
Lane crossing from HOV to citation area	☐	☐	☐	☐	☐	☐	☐	☐
Too few citation areas	☐	☐	☐	☐	☐	☐	☐	☐

Statistics – Citation Area

		No barrier	Too narrow	Entrance too short	Exit too short	Lane crossing to cite area	Too few
N	Valid	10	10	10	10	10	10
	Missing	0	0	0	0	0	0
Mean		4.80	5.60	3.10	3.00	4.30	4.20
Std. Deviation		3.33	2.17	2.69	2.58	2.63	3.16
Minimum		0	0	0	0	0	0
Maximum		7	7	7	7	7	7

Cite area - no barrier

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	6	1	10.0	40.0
	7	6	60.0	100.0
	Total	10	100.0	

Cite area - too narrow

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	10.0	10.0
	4	1	10.0	20.0
	6	4	40.0	60.0
	7	4	40.0	100.0
	Total	10	100.0	

Cite area - entrance too short

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	1	1	10.0	40.0
	3	1	10.0	50.0
	4	1	10.0	60.0
	5	2	20.0	80.0
	6	1	10.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Cite area - exit too short

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	1	1	10.0	40.0
	3	1	10.0	50.0
	4	1	10.0	60.0
	5	3	30.0	90.0
	7	1	10.0	100.0
	Total	10	100.0	

Cite area - lane crossing to cite area

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	20.0	20.0
	3	1	10.0	30.0
	4	2	20.0	50.0
	6	3	30.0	80.0
	7	2	20.0	100.0
	Total	10	100.0	

Cite area - too few

		Frequency	Valid Percent	Cumulative Percent
Valid	0	3	30.0	30.0
	3	1	10.0	40.0
	5	1	10.0	50.0
	6	1	10.0	60.0
	7	4	40.0	100.0
	Total	10	100.0	

Freeway HOV Lanes

Below is a list of freeway HOV lanes in your division's jurisdiction which are ***not*** separated from general traffic lanes by a concrete barrier:

Example:

Route	Miles
I-270	15.50
I-270 (eastern spur)	3.00
I-270 (western spur)	3.00

1. Of the HOV lanes listed above, which one is ***easiest*** to enforce lane restrictions on? _____
   Why?

   Why answers appear at the end.

On the scale below, how would you rate this HOV lane?

1 Not at all difficult to enforce	2	3	4	5	6	7 Extremely difficult to enforce
☐	☐	☐	☐	☐	☐	☐

Statistics – Easiest to Enforce

		More than 1 HOV?	HOV lane name	How difficult easiest HOV?	percent violators	# cites/hour	# officer hours/hour
N	Valid	9	10	7	7	6	6
	Missing	1	0	3	3	4	4
Mean		.78		3.14	.1779	10.167	2.83
Std. Deviation		.44		1.86	.1295	8.159	2.40
Minimum		0		1	.04	1.0	0
Maximum		1		6	.43	20.0	7

More than 1 HOV?

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	22.2	22.2
	1	7	77.8	100.0
	Total	9	100.0	
Missing	System	1		
	Total	10	100.0	

Easiest HOV lane name

	Frequency	Valid Percent	Cumulative Percent
Valid	3	30.0	30.0
either 394	1	10.0	40.0
I-20	1	10.0	50.0
I-267 Dulles Commuter	1	10.0	60.0
I-65	1	10.0	70.0
I-66 inside Beltway	1	10.0	80.0
I-66 outside Beltway	1	10.0	90.0
US 67 Marvin D. Love Fwy.	1	10.0	100.0
Total	10	100.0	

How difficult easiest HOV?

		Frequency	Valid Percent	Cumulative Percent
Valid	1	1	14.3	14.3
	2	3	42.9	57.1
	4	1	14.3	71.4
	5	1	14.3	85.7
	6	1	14.3	100.0
	Total	7	100.0	
Missing	System	3		
	Total	10	100.0	

Easiest percent violators

		Frequency	Valid Percent	Cumulative Percent
Valid	.04	1	14.3	14.3
	.08	1	14.3	28.6
	.15	3	42.9	71.4
	.25	1	14.3	85.7
	.43	1	14.3	100.0
	Total	7	100.0	
Missing	System	3		
Total		10		

Easiest # cites/hour

		Frequency	Valid Percent	Cumulative Percent
Valid	1.0	1	16.7	16.7
	4.0	1	16.7	33.3
	6.0	1	16.7	50.0
	10.0	1	16.7	66.7
	20.0	2	33.3	100.0
	Total	6	100.0	
Missing	System	4		
Total		10		

Easiest # officer hours/hour

		Frequency	Valid Percent	Cumulative Percent
Valid	0	1	16.7	16.7
	2	3	50.0	66.7
	4	1	16.7	83.3
	7	1	16.7	100.0
	Total	6	100.0	
Missing	System	4		
Total		10		

2. Of the HOV lanes listed above, which one is ***most difficult*** to enforce lane restrictions on? _____
Why?

Why answers appear at the end.

On the scale below, how would you rate this HOV lane?

1 Not at all difficult to enforce	2	3	4	5	6	7 Extremely difficult to enforce
☐	☐	☐	☐	☐	☐	☐

Statistics – Most Difficult to Enforce

		HOV lane name	How difficult most difficult HOV?	percent violators	# cites/hour	# officer hours/hour
N	Valid	10	10	10	8	9
	Missing	0	0	0	2	1
Mean			5.70	.3490	3.938	2.89
Std. Deviation			1.57	.2236	3.803	2.32
Minimum			2	.09	.0	0
Maximum			7	.80	12.5	7

Most difficult HOV lane name

		Frequency	Valid Percent	Cumulative Percent
Valid	either 35W	1	10.0	10.0
	I-10 Katy (narrow buffer)	1	10.0	20.0
	I-17	1	10.0	30.0
	I-267	1	10.0	40.0
	I-40	1	10.0	50.0
	I-635 LBJ Fwy. EB & WB	1	10.0	60.0
	I-66 outside Beltway	1	10.0	70.0
	I-85 sections	1	10.0	80.0
	Rte. 267	1	10.0	90.0
	US 36	1	10.0	100.0
	Total	10	100.0	

How difficult most difficult HOV?

		Frequency	Valid Percent	Cumulative Percent
Valid	2	1	10.0	10.0
	4	1	10.0	20.0
	6	5	50.0	70.0
	7	3	30.0	100.0
Total		10		

Most difficult percent violators

		Frequency	Valid Percent	Cumulative Percent
Valid	.09	1	10.0	10.0
	.10	1	10.0	20.0
	.15	1	10.0	30.0
	.25	1	10.0	40.0
	.30	1	10.0	50.0
	.35	1	10.0	60.0
	.40	1	10.0	70.0
	.50	1	10.0	80.0
	.55	1	10.0	90.0
	.80	1	10.0	100.0
	Total	10	100.0	

Most difficult # cites/hour

		Frequency	Valid Percent	Cumulative Percent
Valid	.0	1	12.5	12.5
	1.0	1	12.5	25.0
	3.0	3	37.5	62.5
	4.0	1	12.5	75.0
	5.0	1	12.5	87.5
	12.5	1	12.5	100.0
	Total	8	100.0	
Missing	System	2		
	Total	10	100.0	

Most difficult # officer hours/hour

		Frequency	Valid Percent	Cumulative Percent
Valid	0	2	22.2	22.2
	2	3	33.3	55.6
	4	2	22.2	77.8
	5	1	11.1	88.9
	7	1	11.1	100.0
	Total	9	100.0	
Missing	System	1		
	Total	10	100.0	

3. For the easiest and most difficult HOV lanes to enforce in your jurisdiction, please give your best estimate of what percent of vehicles using HOV lanes are violating HOV restrictions during peak times, on average.

   Easiest to enforce restrictions: _____ percent of vehicles violate restrictions during peak

   Most difficult to enforce restrictions: _____ percent of vehicles violate restrictions during peak

4. For the easiest and most difficult HOV lanes to enforce in your jurisdiction, please give your best estimate of how many motorists per hour are cited for violating HOV restrictions during peak times, on average.

   Easiest to enforce restrictions: _____ motorists cited per hour during peak

   Most difficult to enforce restrictions: _____ motorists cited per hour during peak

5. For the easiest and most difficult HOV lanes to enforce in your jurisdiction, please give your best estimate of how many patrol officer hours ***per hour*** are spent enforcing HOV restrictions during peak times, on average.
   Example: 2 patrol officers working 6:00 am – 7:00 am = 2 patrol officer hours per hour

   Easiest to enforce restrictions: _____ patrol officer hours per hour during peak

   Most difficult to enforce restrictions: _____ patrol officer hours per hour during peak

Important: Please give us any suggestions you have for improving HOV enforcement. Thank you! *(If you are filling out the form electronically, the gray shaded area will expand.)*

Suggestions appear at the end.

1. Of the HOV lanes listed above, which one is ***easiest*** to enforce lane restrictions on? _____
   Why?

I-66 (inside Capital Beltway)	We can wait at the end of the ramp.
I-267 Dulles Connector	All lanes become HOV at that point. Anyone alone in a car is in violation no matter what lane.
I-20	Wide pavement shoulders both sides.
I-66 (outside Capital Beltway)	Have shoulders to pull violators on the exit ramp.
US 67 Marvin D. Love Fwy.	Though it is narrow, there is a left shoulder almost the entire length of the lane making enforcement easier for our motorcycle officers. Cars are still crowded but wider areas are located before and after bridges.

2. Of the HOV lanes listed above, which one is ***most difficult*** to enforce lane restrictions on? _____
Why?

I-10 Katy (narrow buffer)	Traffic congestion on the main lane makes it difficult to enforce. Vehicles use it for a passing lane.
Rte. 267	People can see us, and also too much traffic.
I-267	This road is not in my current area of assignment, but I worked there six years. Narrow shoulder, not enough enforcement areas.
I-85 sections	Narrow or no left shoulder and congestion.
U.S. 36	Lack of access for observation, traffic speeds too high and traffic density too great. This highway carries so much traffic, it is impossible to safely intercept and contact violators.
I-66 (outside Capital Beltway)	Some parts of the road have no shoulders to stop violator vehicles and shoulders are narrow in some parts.
I-394 EB or WB	It can be worked at the exits. There is no way out of it except for certain ramps. We can work it at the exits and get them at low speeds. But, you have to pick one of the exits as you can't really do any enforcement inside the HOV area.
I-495	Lack of uninterrupted enforcement lane to the left of the HOV lane; general traffic congestion during HOV hours of operation; difficulty in seeing into vehicles due to both illegal window tinting and decreased lighting during hours of darkness; loss of HOV lane markings during inclement weather, i.e. snow covered lanes.
I-635 LBJ Freeway both eastbound and westbound	This is a major loop between Dallas and the suburbs passing over the North Dallas Tollway and ending at I-35E on the west and Hwy 75 Central Expressway on the east. The movement of vehicles to and from the HOV lanes to either of these highways in addition to the usual traffic flow from entrances and exits to the major streets across 4 highway lanes into and out of the HOV lane causes major traffic problems.

Suggestions for improving HOV enforcement

Opinion: Construct solid barrier between HOV lanes and general purpose lanes, and provide area for enforcement.
A law enforcement representative should be involved during planning phase for an HOV lane.
1. Assess points – suspend licenses for excessive violations – over 3, should result in suspension 2. Have uniform HOV times and number of occupants per vehicle. 3. Remove exceptions to HOV – motorcycles, clean fuel vehicles – no relationship to high occupancy. Keep in mind HOV is a regulatory issue and not a safety issue. It strains resources that could be enforcing safety related laws.
1. Use unmarked vehicles for enforcement with low profile vehicles (no front or rear markings & no roof mounted lights) a secondary choice. 2. Equip all enforcement units with tint meters to actively enforce regulations regarding same. 3. Clearly & conspicuously posted signs detailing most common HOV violations & expected penalties for violating same. 4. Prohibit trucks and/or trailers from HOV lane.
A standard ratio needs to be developed regarding enforcement manpower of the HOV lanes i.e. 1 officer for every "X" miles of barrier-free double-white lane HOV lane. I find it hard to sell the need for more manpower to effectively enforce the HOV lanes. Comparable statistics or analysis would be a benefit in recommending proper staffing numbers and would fare much better at budget meetings when dealing with people of the opinion that "you did just fine with what you had last year," even though staffing last year was well below the projected need. Accidents, motorist assists, lane blockages and calls for service all take a bite out of the enforcement officers time. Staffing HOV lanes with adequate support staff i.e. courtesy patrol with "wrecker" capability would expedite the clearing of blockages of traffic lanes and reduce incidents of violations by keeping traffic more free flowing. I would recommend that your staff actually ride along with enforcement personnel as well as HOV lane support personnel to get a close up experience of the many aspects of working the HOV lanes. It is profoundly important that signage be adequate and be maintained. Every legal HOV lane entry and exit point should be well marked. "Criteria" signs (indicating what vehicles may use the lane) should be well posted at every legal entry of the HOV lanes. Such is not the case on some of our lanes. An effective plan should be in place to replace, repair and maintain signage including removing foliage so that signs can be clearly seen. All courts that will handle HOV citations should be educated as to what the lanes are all about and what charges they may be handling as a result of their enforcement. Judges should be well informed regarding the HOV lanes and should understand the effects of lax enforcement and prosecution how these adversely affect achieving overall compliance and smooth traffic flow in the HOV lanes and in the main lanes of traffic. The public should be bombarded with HOV lane information prior to the opening of HOV lanes in their areas. The diamond associated with the restricted HOV lane is not recognized by many motorists and "HOV" means nothing to many as well. Carpool lane, "Diamond" lane and such are adopted nicknames for the HOV lane, but not enough is done to properly educate the public beforehand as to what the lane is all about, what the guidelines for the use of the lane are, and exactly what the consequences of violating the rules and regulations of the lanes will be.

Basically we don't spend any time on enforcement in these areas. We are way too short staffed to spend time in there on proactive enforcement when we need to spend our time on being reactive to incidents.

We sat with MnDot when they were designing and building the 394 HOV areas. We told them what we wanted and needed in order to enforce it. They didn't take our needs into account and we don't work it.

The 394 HOV is a double lane area that is separated from EB and WB lanes by a cement Jersey barrier. It is reversible. There are gates at the entrances. These gates are manually opened and closed to allow for inbound and outbound traffic as appropriate. Inside the closed area, about 4 miles, there isn't any shoulder. The East end is at downtown Minneapolis. There are dedicated left lanes of 394 that are the left lanes West of the reversible area. So, EB (inbound) there is a dedicated HOV left lane that started a couple miles before the entrance to the reversible area that veers off of the regular traffic when it gets to the reversible area. The same is WB after traffic leaves the reversible area. There is a dedicated HOV left lane for traffic after thy leave the reversible area. It is closed and not open to traffic during non-rush hour times. It is opened for events downtown in the evening and weekends such as Twins and Vikings games or other large planned events.

35 is simply a dedicated left lane that used to be the shoulder. It is HOV only during certain hours. There is no left shoulder.

We do have a great number of HOV ramps and metered freeway entrance lights. We also have main line metering from interstate to interstate. We do work some of these with some regularity. They can be enforced.

Our philosophy here is that there is no public safety issue with people illegally using the HOV lanes or the HOV ramps. However, we have studied it and have proven that the people who do violate the HOV ramps and lanes are the same people who routinely violate other moving traffic violations and are a threat and danger to the motoring public when they are in normal traffic. We use the HOV ramps and lanes (when and where they can be enforced) as a way for the public to sort themselves out and deliver those people who present a threat to the motoring public right to us for enforcement.

Output 1: Sign Test – Observation vs. Citation Area

Frequencies

		N
Cite area - no barrier - Obs. area - no protective barrier	Negative Differences[a,b]	1
	Positive Differences[g,h,]	1
	Ties[m,n,o,p,q,r]	8
	Total	10
Cite area - too narrow - Obs. area - too narrow	Negative Differences[a,b]	1
	Positive Differences[g,h,]	4
	Ties[m,n,o,p,q,r]	5
	Total	10
Cite area - entrance too short - Obs. area - entrance too short	Negative Differences[a,b]	1
	Positive Differences[g,h,]	4
	Ties[m,n,o,p,q,r]	5
	Total	10
Cite area - exit too short - Obs. area - exit too short	Negative Differences[a,b]	0
	Positive Differences[g,h,]	4
	Ties[m,n,o,p,q,r]	6
	Total	10
Cite area - lane crossing to cite area - Obs. area - lane crossing to HOV lane	Negative Differences[a,b]	2
	Positive Differences[g,h,]	4
	Ties[m,n,o,p,q,r]	4
	Total	10
Cite area - too few - Obs. area - too few	Negative Differences[a,b]	2
	Positive Differences[g,h,]	3
	Ties[m,n,o,p,q,r]	5
	Total	10

a. Cite area - no barrier < Obs. area - no protective barrier

b. Cite area - too narrow < Obs. area - too narrow

c. Cite area - entrance too short < Obs. area - entrance too short

d. Cite area - exit too short < Obs. area - exit too short

e. Cite area - lane crossing to cite area < Obs. area - lane crossing to HOV lane

f. Cite area - too few < Obs. area - too few

g. Cite area - no barrier > Obs. area - no protective barrier

h. Cite area - too narrow > Obs. area - too narrow

i. Cite area - entrance too short > Obs. area - entrance too short

j. Cite area - exit too short > Obs. area - exit too short

k. Cite area - lane crossing to cite area > Obs. area - lane crossing to HOV lane

l. Cite area - too few > Obs. area - too few

m. Obs. area - no protective barrier = Cite area - no

n. Obs. area - too narrow = Cite area - too narrow

o. Obs. area - entrance too short = Cite area - entrance too short

p. Obs. area - exit too short = Cite area - exit too short

q. Obs. area - lane crossing to HOV lane = Cite area - lane crossing to cite area

r. Obs. area - too few = Cite area - too few

Test Statistics[b]

	Cite area - no barrier - Obs. area - no protective barrier	Cite area - too narrow - Obs. area - too narrow	Cite area - entrance too short - Obs. area - entrance too short	Cite area - exit too short - Obs. area - exit too short	Cite area - lane crossing to cite area - Obs. area - lane crossing to HOV lane	Cite area - too few - Obs. area - too few
Exact Sig. (2-tailed)	1.000[a]	.375[a]	.375[a]	.125[a]	.688[a]	1.000[a]

a. Binomial distribution used.

b. Sign Test

Output 2: Spearman Correlation – Observation vs. Citation Area

Correlations

			Obs. area - no protective barrier	Cite area - no barrier	Obs. area - too narrow	Cite area - too narrow	Obs. area - entrance too short	Cite area - entrance too short	Obs. area - exit too short	Cite area - exit too short	Obs. area - lane crossing to HOV lane	Cite area - lane crossing to cite area	Obs. area - too few	Cite area - too few
Spearman's rl	Obs. area - no prote barrier	Correlation Coeffic	1.000	.988**	.365	.600	.858**	.613	.705*	.618	.400	.795**	.607	.244
		Sig. (2-tailed)	.	.000	.299	.067	.001	.060	.023	.057	.252	.006	.063	.498
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - no barrie	Correlation Coeffic	.988**	1.000	.373	.581	.868**	.634*	.713*	.640*	.451	.826**	.628	.294
		Sig. (2-tailed)	.000	.	.288	.078	.001	.049	.021	.046	.191	.003	.052	.410
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Obs. area - too narr	Correlation Coeffic	.365	.373	1.000	.723*	.548	.341	.241	.302	.844**	.744*	.698*	.413
		Sig. (2-tailed)	.299	.288	.	.018	.101	.335	.502	.396	.002	.014	.025	.235
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - too narro	Correlation Coeffic	.600	.581	.723*	1.000	.631	.519	.342	.497	.601	.799**	.870**	.480
		Sig. (2-tailed)	.067	.078	.018	.	.050	.125	.333	.144	.066	.006	.001	.160
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Obs. area - entrance short	Correlation Coeffic	.858**	.868**	.548	.631	1.000	.616	.736*	.584	.711*	.854**	.654*	.265
		Sig. (2-tailed)	.001	.001	.101	.050	.	.058	.015	.076	.021	.002	.040	.459
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - entrance short	Correlation Coeffic	.613	.634*	.341	.519	.616	1.000	.914**	.991**	.512	.553	.491	.769*
		Sig. (2-tailed)	.060	.049	.335	.125	.058	.	.000	.000	.130	.097	.150	.009
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Obs. area - exit too s	Correlation Coeffic	.705*	.713*	.241	.342	.736*	.914**	1.000	.890**	.460	.505	.378	.559
		Sig. (2-tailed)	.023	.021	.502	.333	.015	.000	.	.001	.181	.137	.282	.093
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - exit too s	Correlation Coeffic	.618	.640*	.302	.497	.584	.991**	.890**	1.000	.473	.559	.457	.747*
		Sig. (2-tailed)	.057	.046	.396	.144	.076	.000	.001	.	.167	.093	.185	.013
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Obs. area - lane crossing to HOV lan	Correlation Coeffic	.400	.451	.844**	.601	.711*	.512	.460	.473	1.000	.767**	.666*	.515
		Sig. (2-tailed)	.252	.191	.002	.066	.021	.130	.181	.167	.	.010	.036	.128
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - lane crossing to cite area	Correlation Coeffic	.795**	.826**	.744*	.799**	.854**	.553	.505	.559	.767**	1.000	.798**	.376
		Sig. (2-tailed)	.006	.003	.014	.006	.002	.097	.137	.093	.010	.	.006	.285
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Obs. area - too few	Correlation Coeffic	.607	.628	.698*	.870**	.654*	.491	.378	.457	.666*	.798**	1.000	.633*
		Sig. (2-tailed)	.063	.052	.025	.001	.040	.150	.282	.185	.036	.006	.	.050
		N	10	10	10	10	10	10	10	10	10	10	10	10
	Cite area - too few	Correlation Coeffic	.244	.294	.413	.480	.265	.769**	.559	.747*	.515	.376	.633*	1.000
		Sig. (2-tailed)	.498	.410	.235	.160	.459	.009	.093	.013	.128	.285	.050	.
		N	10	10	10	10	10	10	10	10	10	10	10	10

**.Correlation is significant at the .01 level (2-tailed).

*.Correlation is significant at the .05 level (2-tailed).

Output 3: Sign Test – Most Difficult vs. Easiest

Frequencies

		N
How difficult most difficult HOV? - How difficult easiest HOV?	Negative Differences[a,b]	0
	Positive Differences[e,f,g]	7
	Ties[i,j,k,l]	0
	Total	7
Most difficult % violators - Easiest % violators	Negative Differences[a,b]	0
	Positive Differences[e,f,g]	7
	Ties[i,j,k,l]	0
	Total	7
Most difficult # cites/hour - Easiest # cites/hour	Negative Differences[a,b]	4
	Positive Differences[e,f,g]	1
	Ties[i,j,k,l]	1
	Total	6
Most difficult # officer hours/hour - Easiest # officer hours/hour	Negative Differences[a,b]	1
	Positive Differences[e,f,g]	1
	Ties[i,j,k,l]	4
	Total	6

a. How difficult most difficult HOV? < How difficult easiest HOV?

b. Most difficult % violators < Easiest % violators

c. Most difficult # cites/hour < Easiest # cites/hour

d. Most difficult # officer hours/hour < Easiest # officer hours/hour

e. How difficult most difficult HOV? > How difficult easiest HOV?

f. Most difficult % violators > Easiest % violators

g. Most difficult # cites/hour > Easiest # cites/hour

h. Most difficult # officer hours/hour > Easiest # officer hours/hour

i. How difficult easiest HOV? = How difficult most difficult HOV?

j. Easiest % violators = Most difficult % violators

k. Easiest # cites/hour = Most difficult # cites/hour

l. Easiest # officer hours/hour = Most difficult # officer hours/hour

Test Statistics[b]

	How difficult most difficult HOV? - How difficult easiest HOV?	Most difficult % violators - Easiest % violators	Most difficult # cites/hour - Easiest # cites/hour	Most difficult # officer hours/hour - Easiest # officer hours/hour
Exact Sig. (2-tailed)	.016[a]	.016[a]	.375[a]	1.000[a]

a. Binomial distribution used.

b. Sign Test

If drivers could call in to report HOV lane violations enforcement might be easier, compliance higher and dissatisfaction lower. An HOV “hot line” would be modeled on the “litterbug hot line” currently in-place.

Arizona cracks down on litterbugs with hot line

Associated Press

July 24, 2002 07:40:00

Peer pressure is being used to try to persuade people to stop littering.

Litterbug hot line

Call (602) 712-4683 to report litterbugs.
Toll Free outside of Maricopa County: 1-(877) 3-LITTER.

Witnesses can now call a hot line to report litterbugs' license plate numbers, descriptions of their vehicles, locations littering took place and items that were tossed.

The Arizona Department of Transportation will use the information to find the addresses of the litterbugs, and a nonprofit group - Arizona Clean and Beautiful - will send letters saying the dirty deeds didn't go unnoticed.

"No need to worry this time, even though fines under the law are steep," the letter says. "Our goal is to stop litter. Will you please tell whoever tossed the litter from your vehicle 'Please don't do that anymore.' "

ADOT has received numerous calls from people suggesting the state do something about litter, spokesman Doug Nintzel said.

"We're talking about public education rather than enforcement. You can't use this information to send somebody a ticket in the mail. It's a reminder," Nintzel said. "We'll probably have a few people who get upset, saying 'I don't litter,' and their license plate turns up. That's why we want the letter to be in a friendly reminder tone."

Litter bags will be enclosed with the letters. If the litterbug is driving a company vehicle, the note will be sent to the CEO with an invitation to attend an educational lunch along with a suggestion the company sponsor litter cleanups along streets and highways, said Leandra Lewis, executive director of Arizona Clean and Beautiful.

The program, which is estimated to cost at least $50,000 will be funded by Arizona Clean and Beautiful. Funding for the group comes from ADOT, other government agencies, corporations and individuals.

The program will keep track of places where people litter and the ZIP codes of offenders, Lewis said.

The state spends more than $2 million a year to clean up highway litter, but officials said it's not enough because the cleanup budget has remained the same despite a rapidly expanding freeway system.

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