Managed Lanes Network Development Strategy – Phase I

Managed Lane Hours of Operation

MARICOPA ASSOCIATION OF GOVERNMENTS

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Revision History

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1.0	12/09/11	Initial draft for internal review	JCL
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1.0 BACKGROUND

The Maricopa Association of Governments (MAG) is working in cooperation with the Arizona Department of Transportation (ADOT), Federal Highway Administration (FHWA), and other regional partner agencies to explore the regional managed lanes system, including determining future needs for High-Occupancy Vehicle (HOV) system expansion and the potential for introducing enhanced lane management techniques such as value pricing in the form of High-Occupancy Toll (HOT) lanes, and active traffic management. The outcome of this effort will be a MAG Managed Lanes Network Development Strategy – Phase I Report that will guide future planning and investment in HOV and Managed Lanes facilities in the region.

The purpose of the MAG Managed Lanes Network Development Strategy – Phase I study is to examine the existing and planned freeways in the region to identify where managed lanes strategies, policies or actions could improve overall system efficiency. For those corridors where such strategies or policies are considered most promising, the study will then provide an action plan that establishes the framework for subsequent phases to further define the network concept including establishing a preliminary concept of operations and design concept, develop corridor specific concepts including preliminary design and environmental clearance, and complete implementation including business rules, market grade traffic and revenue forecasts, construction and operations.

To support the evaluation of the managed lanes network in the MAG region, a series of technical "white papers" have been developed to examine the relevant issues by drawing upon the substantial and growing research and experience on managed lanes around the nation. These white papers will assess the pros and cons associated with each relevant issue to better enable the regional partners to reach conclusions on the feasibility and specific technical aspects of managed lanes for the Phoenix area.

1.1. Purpose and Methodology

The purpose of this white paper is to summarize policies, procedures, considerations and best practices related to setting hours of operation for priced managed lane facilities. There are a range of issues that need to be considered prior to changing existing managed lane hours of operation or implementing tolling hours on existing HOV lanes. These issues include:

- Public support
- Policy consistency
- Driver behavior
- Revenue vs. cost

This white paper briefly investigates each of these issues with the intent of informing policy decisions for a managed lanes system in the greater Phoenix area.

1.2. Maricopa County HOV Lane Hours of Operation

HOV lanes in Maricopa County currently operate part time. Occupancy restrictions on the lanes are in effect Monday through Friday between 6:00 AM to 9:00 AM, and 3:00 PM to 7:00 PM. During all other periods and during weekends the HOV lanes effectively operate as general purpose lanes and are open to all traffic.

The implementation of pricing on Maricopa County HOV lanes may necessitate a reevaluation of the existing HOV hours of operation. Allowing vehicles that do not meet the required occupancy requirement to pay a toll to use the lane may affect driver behavior and cause peak period spreading, which may warrant expansion of the hours of operation to capture shoulder hours. Any expansion of the hours of operation needs to be weighed against the potential for negative public reaction due to perceived takeaway of hours during which the lanes effectively operate as general purpose lanes. The cost to provide enforcement during hours for which tolling is in effect also needs to be considered, particularly if the enforcement costs are not justified by the amount of revenue collected. In the context of a network of managed lanes, each of these issues needs to be evaluated to ensure a policy that can be easily communicated and understood by drivers. These considerations are explored in more detail in the following sections.

2.0 HOURS OF OPERATION CONSIDERATIONS

2.1. National Trends

About half of all HOV lane miles in the United States operate on a part-time basis during AM and PM peak periods. Part time implementation of HOV lane occupancy requirements is intended to provide reliability and time savings for carpoolers during the most congested periods of the day. During off-peak periods, part-time HOV lanes open to all drivers ensuring that the lane is not unnecessarily underutilized during periods of low demand. However, the introduction of variable pricing as a strategy to manage demand can allow a facility to be more fully utilized during expanded periods, ensuring reliability and time savings are maintained outside of traditional AM and PM peak periods by charging higher tolls during periods of unexpected congestion and charging lower tolls when demand is lower.

A majority of the HOT lanes in the country operate full-time, with a couple of exceptions:

- I-680 (San Francisco Bay Area, CA) and SR-167 (Seattle, WA) operate during "daytime" hours (e.g., 5:00 AM to 7:00 PM) and are open to all during overnight hours. Tolling is in effect on SR-167 seven days a week and is in effect on I-680 during weekdays only.

- Reversible facilities on I-15 (San Diego, CA), I-25 (Denver, CO) and I-394 (Minneapolis, MN) close during short intervals to facilitate the change the direction of travel.

- Concurrent flow facilities on I-35W and I-394 (Minneapolis, MN), including a segment utilizing part-time shoulder running, operate during extended AM and PM peak periods only.

2.2. Hours of Operation Policy Options

There are advantages and disadvantages associated with various policies for setting managed lane hours of operation. For a managed lanes network in Maricopa County where HOV lanes currently operate part-time, there are several issues to consider when assessing whether to maintain or expand the hours of operation. These are summarized in Table 2-1 below and are described in greater detail in the following sections.

Table 2-1 Policy Options for Managed Lane Hours of Operation

Option	Pros	Cons	Experience
Maintain existing hours of operation (part-time) •6:00 AM to 9:00 AM •3:00 PM to 7:00 PM	• Consistent practice • Hours can be expanded as demand necessitates • Limits public concerns • Reduces O&M costs	• Limits revenue • Does not address mid-day congestion • Complicates signage • "Grace period" around peak shoulders • Does not address intermittent or spot congestion	• Phoenix-area HOV lanes
Expanded peak period hours of operation (part-time) •5:00 AM to 10:00 AM •2:00 PM to 8:00 PM	• Incentivizes travel during shoulder hours • Limits public concerns • Collects revenue during most congested periods	• Limits revenue • Does not address mid-day congestion • Complicates signage • Does not address intermittent or spot congestion	• I-394 / I-35W (Minneapolis)
Expand to daytime hours of operation (part-time) •5:00 AM to 8:00 PM	• Covers periods most likely to generate demand • "Future proof" system • Limits dedicated O&M and enforcement to revenue-periods	• Change from existing policy, reduces support • Complicates signage • "Grace period" around hours of operation • Does not address intermittent or spot congestion	• SR-167 (Seattle) • I-680 (Bay Area)
Expand to 24 / 7 hours of operation	• Consistency • Collects revenue across all times of day • Preserves congestion free option at all times of day • No grace periods	• Change from existing policy, reduces support • O&M and enforcement costs, even in low revenue periods	• I-95 (Miami) • SR 91 (Orange County) • I-15 (Salt Lake City) • I-10 (Houston)

2.2.1. Maintain Existing Hours of Operation

The Phoenix-area currently features a part-time strategy for the regional HOV system, with the lanes open between 6:00 AM to 9:00 AM, and 3:00 PM to 7:00 PM. In general, these hours of operation conform to the experienced levels of congestion on the system. The first option for the managed lanes network would be to adopt a similar policy for hours of operation. Consistent with the existing practice, this would potentially limit public concerns but it would also limit revenue and not allow for flexibly responding to congestion when it occurs intermittently throughout the day.

2.2.2. Expand the Peak Period Hours

If managing travel in the shoulders of the peak periods is desired, so as to better balance travel in the peak hours of the peak periods, then expanding the hours of operation may be warranted. For example, the hours of operation may need to be extended (e.g., 5:00 AM to 10:00 AM, or 2:00 PM to 8:00 PM) in order to incentivize travel during peak shoulders and smooth the effects of pricing. It should be noted that the benefits and concerns with this strategy generally remain the same as that of maintaining the existing hours of operation with the exception of increased potential for public concern regarding the reduction in the number of general purpose hours of operation.

2.2.3. Expand to Daytime Hours

One of the potential benefits of a priced managed lanes network is to provide a flexible allocation of capacity throughout the day. If congestion occurs at 11 am for one reason or another, then having an active managed lanes system can help accommodate those periods of demand as they occur. Expanding hours of operation to include all daytime hours (e.g., 5:00 AM to 8:00 PM) provides flexibility throughout the day, but it does constitute a more significant departure from the existing policy.

2.2.4. Expand to 24 / 7 Hours

If consistency of operations is the primary objective, then a 24 hours / 7 days a week policy may be warranted. Although this policy collects revenue throughout all hours, the marginal cost for enforcement and operations in low-volume periods may be greater than revenue collected at these times of day. However, this option does provide the greatest level of flexibility for engaging the managed lanes system in responding to congestion – whenever they occur.

3.0 CONSIDERATIONS FOR CHOOSING AN HOURS OF OPERATION POLICY

3.1. Public Support

The biggest challenge associated with expanding hours of operation when converting part-time HOV lanes to HOT lanes is the perception that a previously toll-free travel option is being taken away. To limit public concerns, extensive outreach is needed to educate the public on the goals of expanded hours of operation. Although recurrent congestion typically occurs during weekday peak periods, a policy that manages demand during more extensive hours can provide time savings and reliability during periods of unexpected congestion that occur outside of the peak periods. With an effective variable pricing strategy, the impact to general purpose lane traffic can be minimal when expanding hours of operation.

Another common concern that can be impacted by hours of operation is the "empty lane syndrome." This is a term commonly used to refer to managed lane facilities that are significantly underutilized, which can frustrate the public, particularly if the facility is chronically underutilized during periods of severe congestion in the adjacent general purpose lanes. To combat underutilization, a policy that extends hours of operation outside of traditional peak periods should be coupled with a variable pricing strategy that lowers toll rates appropriately when traffic in the managed lane drops below a predetermined threshold.

3.2. Network Policy Consistency

Consistency in operational policy for a managed lane network is necessary to avoid motorist confusion. The goal of the network concept is to ensure that motorists perceive seamless, uninterrupted travel over all segments within the network. Therefore, it is desirable that the hours of operation for each segment in the network (particularly interconnected or contiguous segments) be the same. Varying operational hours for individual segments can be confusing to motorists and may disrupt seamless travel over the network.

Hours for which occupancy restrictions and/or tolling is in effect should be clearly communicated to motorists through the appropriate use of roadside signage. The Federal Highway Administration's 2010 Manual on Uniform Traffic Control Devices (MUTCD) provides standards and guidance for managed lane signage and pavement markings. Signs displaying managed lane hours of operation should conform to the standards articulated in the MUTCD for regulatory signs.

Figure 3-1 Example Regulatory Sign Displaying HOV Hours of Operation

For HOT lanes and other priced managed lanes, the MUTCD does not specify how hours of operation should be displayed on the sign. Operators in Minnesota have opted to display "CLOSED" (on reversible segment and dynamic shoulder lane) and "OPEN" (for use of managed lanes by general purpose traffic during off-peak hours) in lieu of the current price, as shown on Figure 3-2. Finally, for facilities that implement fixed or time-of-day pricing, a toll schedule should be made available to the public. For example, the toll on the SR-91 Express Lanes varies by day of the week and by hour of the day according to a predetermined schedule, which is posted on the toll operator's website (Figure 3-3). In the case of the I-25 Express Lanes in Denver, signs are placed on the Downtown street grid showing the hours of operation and price (Figure 3-4), although these do not conform to the MUTCD.

Figure 3-2 Example Regulatory Sign for Dynamically Priced Managed Lanes

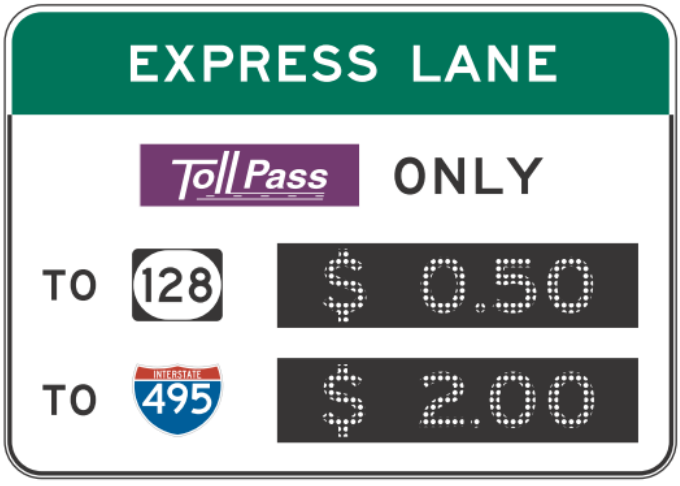


Figure 3-3 Example Time of Day Toll Schedule

91 Express Lanes **Toll Schedule** — Effective July 1, 2011 — **Eastbound** SR-55 to Riverside Co. Line

	Sun	M	Tu	W	Th	F	Sat
Midnight	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
1:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
2:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
3:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
4:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
5:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
6:00 am	$1.30	$2.10	$2.10	$2.10	$2.10	$2.10	$1.30
7:00 am	$1.30	$2.10	$2.10	$2.10	$2.10	$2.10	$1.30
8:00 am	$1.65	$2.10	$2.10	$2.10	$2.10	$2.10	$2.10
9:00 am	$1.65	$2.10	$2.10	$2.10	$2.10	$2.10	$2.10
10:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
11:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
Noon	$3.05	$2.10	$2.10	$2.10	$2.10	$3.15	$3.05
1:00 pm	$3.05	$2.90	$2.90	$2.90	$3.15	$4.95	$3.05
2:00 pm	$3.05	$4.15	$4.15	$4.15	$4.25	$3.10	$3.05
3:00 pm	$2.55	$4.45	$3.70	$3.95	$5.45	$9.75	$3.05
4:00 pm	$2.55	$5.05	$7.30	$7.80	$9.45	$8.85	$3.05
5:00 pm	$2.55	$4.85	$6.75	$8.00	$9.30	$7.50	$3.05
6:00 pm	$2.55	$4.45	$3.60	$3.60	$4.40	$5.35	$2.55
7:00 pm	$2.55	$3.15	$3.15	$3.15	$4.55	$5.00	$2.10
8:00 pm	$2.55	$2.10	$2.10	$2.10	$2.90	$4.55	$2.10
9:00 pm	$2.10	$2.10	$2.10	$2.10	$2.10	$2.90	$2.10
10:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$2.10	$1.30
11:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30

91 Express Lanes **Toll Schedule** — Effective July 1, 2011 — **Westbound** Riverside Co. Line to SR-55

	Sun	M	Tu	W	Th	F	Sat
Midnight	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
1:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
2:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
3:00 am	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
4:00 am	$1.30	$2.45	$2.45	$2.45	$2.45	$2.45	$1.30
5:00 am	$1.30	$4.00	$4.00	$4.00	$4.00	$3.85	$1.30
6:00 am	$1.30	$4.15	$4.15	$4.15	$4.15	$4.00	$1.30
7:00 am	$1.30	$4.60	$4.60	$4.60	$4.60	$4.45	$1.75
8:00 am	$1.75	$4.15	$4.15	$4.15	$4.15	$4.00	$2.10
9:00 am	$1.75	$3.30	$3.30	$3.30	$3.30	$3.30	$2.55
10:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.55
11:00 am	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
Noon	$2.55	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
1:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
2:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.10	$2.95
3:00 pm	$2.95	$2.10	$2.10	$2.10	$2.10	$2.55	$2.95
4:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$2.55	$3.10
5:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$2.55	$3.10
6:00 pm	$3.10	$2.10	$2.10	$2.10	$2.10	$3.05	$2.55
7:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$2.10	$2.10
8:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
9:00 pm	$2.55	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
10:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30
11:00 pm	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30	$1.30

Figure 3-4 Example Sign for Time of Day Priced Managed Lanes

Another option for managed lanes is to change the occupancy requirement from HOV-2+ to HOV-3+ according to a given schedule, as is the case on the I-10 El Monte Busway in Los Angeles County, CA. This makes sense in situations where carpool demand during peak periods approaches or exceeds available capacity. Any policy that varies occupancy requirements throughout the day should be preceded by an extensive public outreach effort to educate the public.

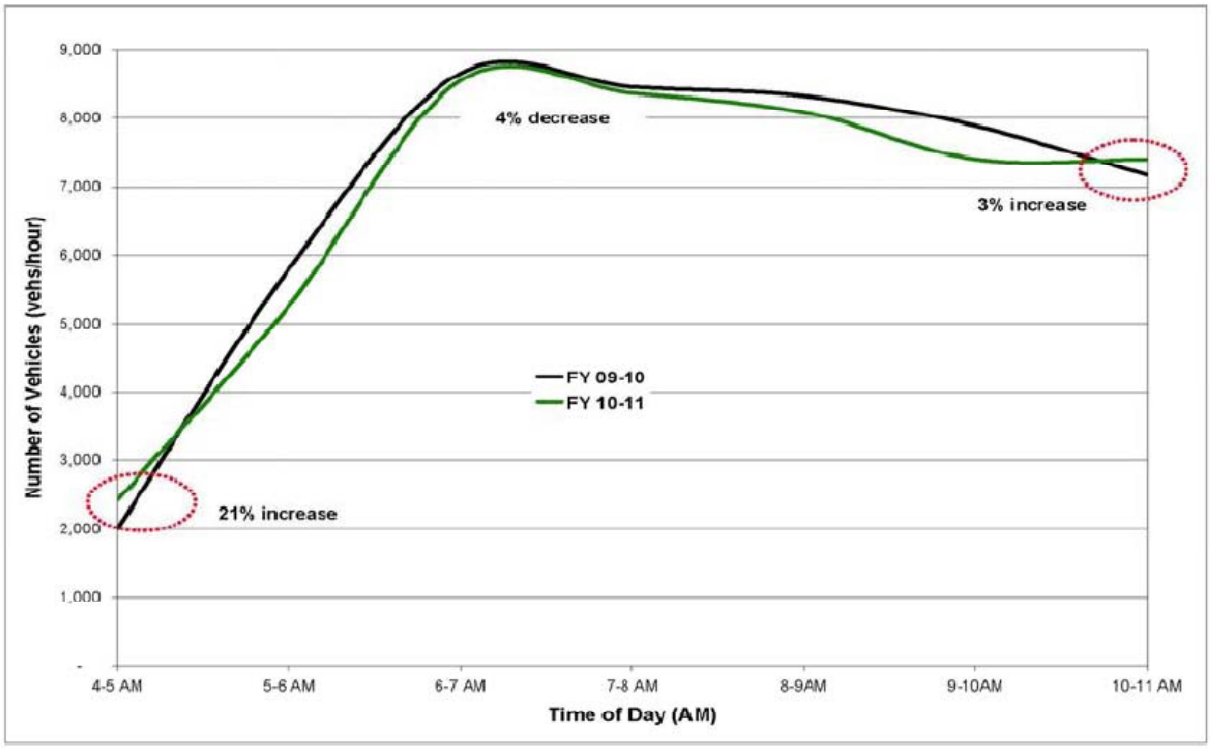
Consistency of policy regarding hours of operation over a network of managed lanes is also important for effective enforcement. Until technology allows for completely automated enforcement, managed lanes will rely on manual enforcement as the primary means for ensuring motorist adherence to occupancy and tolling restrictions. Consistent hours of operation over multiple facilities in a region serves to aid manual enforcement efforts and adherence to policy.

3.3. Driver Behavior

Experience around the country has shown that managed lane hours of operation are capable of changing motorist behavior. Although not specific to HOV lanes, results from the Bay Area indicate that charging higher tolls on toll facilities during peak periods and lower tolls during off-peak periods on the San Francisco-Oakland Bay Bridge has successfully shifted traffic out of the peak periods (see Figure 3-5 below). This time-of-day pricing was first implemented on the Bay Bridge in 2011 and was preceded by an extensive public outreach campaign to inform motorists of the hours during which higher and lower tolls would be charged. When first implemented, some motorists were observed to slow down in the lanes approaching the toll booths to wait for the toll to decrease at the specified hour. Motorists have also been observed stopping in the shoulders and waiting for the toll to change before going through the toll plaza.

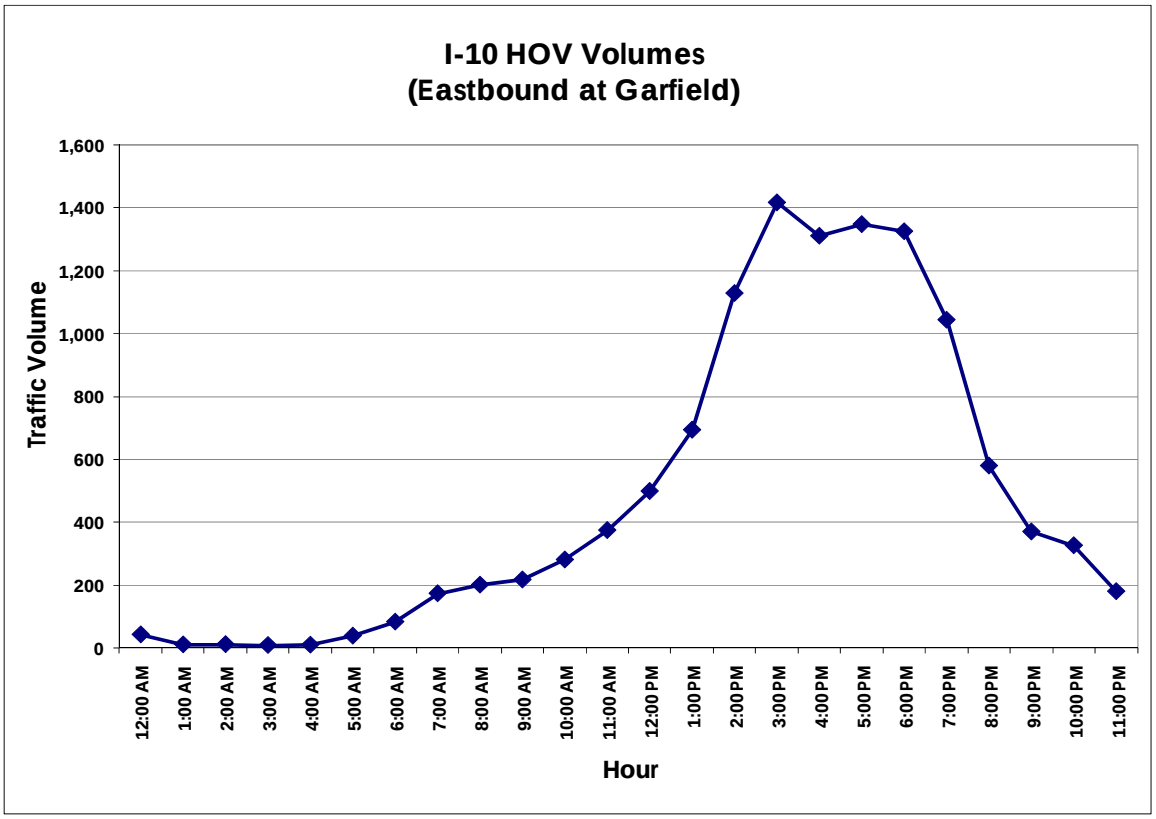
Similarly, on the I-10 El Monte Busway, which utilizes varying HOV occupancy requirements, the PM peak hour in the HOV lane occurs in the 2:00 PM to 3:00 PM hour (see Figure 3-6 below) immediately prior to the change in the afternoon occupancy requirement from 2+ to 3+. This phenomenon reflects the impact of 2 person carpools that have adjusted their travel behavior to utilize the facility before the occupancy requirement would preclude them from legally using the lane.

Figure 3-5 Bay Bridge Traffic Before and After Time-of-Day Tolling



*Source: Bay Bridge Toll Evaluation-Final Report, November 2011, University of California Berkeley

Figure 3-6 I-10 Eastbound Traffic Volumes



These examples illustrate what typically happens with the application of congestion pricing. Motorists who are able to alter their time of travel will choose to travel during periods when the toll is lower, which causes traffic in shoulder hours to increase. This effect should be considered when setting hours of operation for a facility being converted from HOV to HOT. The original hours of operation for the HOV facility may need to be reevaluated once pricing is applied to account for the potential shift of vehicles into the shoulder hours.

In order to encourage carpooling, the primary goal of the HOV and HOT concepts, motorists must be aware of the hours during which occupancy restrictions are in effect. Without a predictable schedule to go by, carpool formation may be disrupted.

3.4. Revenue vs. Cost

Another factor to consider when evaluating hours of operation for a priced managed lane is the ratio of revenue collected versus cost incurred for enforcement. Although a 24/7 policy may be justified from an operational perspective, the cost to provide dedicated enforcement during low revenue periods (i.e., midday and nighttime hours) may not be recuperated. This does not mean that expanded hours of operation should be dismissed as a consideration. Instead, enforcement could be targeted during high revenue peak periods when enforcement activities are of the most benefit.

4.0 CONCLUSION

As one of several tools available for managing traffic, implementing a consistent policy for hours of operation for a managed lane facility should complement other demand management strategies such as occupancy restrictions, tolling policy and access treatments. In the context of a managed lanes network spanning a metropolitan area, efforts should also be made to ensure that policies such as hours of operation are consistent to promote familiarity and support of the managed lanes concept. Any expansion to the hours of operation coupled with the introduction of pricing will require extensive public outreach and further analysis to explore potential impacts to traffic.

For the MAG region, it is recommended that the hours of operation expand from the current part-time hours of operation with the introduction of pricing to ensure time savings and reliability benefits throughout a greater portion of the day. Initially this approach could include expanded peak period hours of operation (e.g., 5:00 AM to 10:00 AM; 2:00 PM to 7:00 PM) as a means to maintain part-time operations while affording greater ability to manage HOT demand during the shoulders of the peak period. This approach could also be accompanied by establishing system performance thresholds that would trigger further incremental expansion of hours of operation to ultimately achieve daytime hours of operation (e.g., 5:00 AM to 9:00 PM) across the system. This approach could also include consideration for implementing weekend hours of operation that would extend the ability to manage HOT demand during weekends when recreational and special event traffic in the MAG region can create congestion at certain times in specific corridors (e.g., recreational traffic on southbound I-17 on Sunday or holiday Monday afternoons; sporting or concert event traffic near University of Phoenix Stadium, Sun Devil Stadium, downtown Phoenix, spring training baseball stadiums).