Commission Briefing Paper 4G-04

Evaluation of the Potential Applicability of HOV, HOT and BRT Lanes

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on the potential applicability of several types of managed lanes to improve traffic conditions: high-occupancy vehicle lanes (HOV), high-occupancy toll lanes (HOT), and bus rapid transit lanes (BRT)/Express Bus Lanes (XBL).

Background and Key Findings

Transportation agencies are unable to build enough capacity to keep up with growing demand. Many factors, including increased construction costs, right-of-way limitations, environmental concerns, and societal impacts, contribute to the escalating challenges of adding new general-purpose lanes—especially in developed urban areas. Moreover, many agencies are grappling with a serious transportation funding crisis.[1]

As a result, transportation agencies are seeking ways to better manage the flow of traffic on existing facilities. Typically, this has been done by using lane management strategies that regulate demand, separate traffic streams to reduce turbulence, and utilize available and unused capacity. Application of such operational policies is evolving into the notion of "managed lanes." The managed lanes concept is gaining interest around the country as an approach that combines these elements to make the most effective and efficient use of a freeway facility.

The managed lane concept is typically a "freeway-within-a-freeway" where some lanes within the freeway cross section are separated from the general-purpose lanes. Ideally, the managed lanes facility would have the flexibility to change in concept over time to respond to growth and changing needs, and the operation of and demand on the facility is managed using a combination of techniques to achieve the best operations possible.

High-occupancy vehicle (HOV) lanes, high occupancy toll (HOT) lanes, or bus rapid transit (BRT)/Express Bus Lanes (XBL) lanes are all examples of managed lanes. Each of these concepts offers unique benefits; therefore, careful consideration should be given to operational

[1] Background material excerpted from *Managed Lanes – A Primer,* FHWA publication FHWA-HOP-05-031

goals and objectives when choosing a lane management strategy. Project goals may include increasing transit use, providing choices to the traveler and generating revenue.

HOV lanes have been around for decades. The idea was to focus on "moving more people, not more vehicles" through congested corridors by dedicating lanes to vehicles with more than one occupant. In some urban areas, there is an expectation that all or most new capacity will be for HOV, and in some this expectation is backed up by clean air requirements. In other areas, there are suggestions to eliminate the special treatment afforded to carpools if the lanes appear to be underutilized – sometimes called "the empty lane syndrome."

Some areas have responded to the empty lane syndrome by reducing the occupancy requirement. Others have turned the HOV lanes into HOT lanes, where vehicles that do not meet the occupancy requirement can use the lanes for a fee. BRT systems try to offer the speed and comfort of light rail systems with the flexibility of buses not confined to fixed tracks. Often, such systems use dedicated lanes on freeways or arterials, and sometimes they use HOV or HOT lanes.

Whether HOV, HOT and BRT/XBL lanes will work in a particular urban area or corridor is heavily dependent on local conditions. There are also high expectations about the potential effectiveness of these lanes at managing traffic congestion and/or generating revenue. There is even debate in the industry regarding how effective these treatments are. Sometimes, the implementation obstacles can be considerable.

There is a cost involved with becoming part of a carpool or with using transit – schedules need to be coordinated with others, and there is a potential loss of privacy and control over one's own space. This is somewhat offset by the cost savings of sharing the cost of the trip among all the passengers in the HOV vehicle. In particular, commuter vanpools offer significant savings compared to driving alone. There is also a cost involved with using a HOT lane – an out of pocket monetary cost. In both cases, these costs must be balanced by the benefits – usually travel time savings or reliability over otherwise congested highways. Therefore, for HOV and HOT treatments to work, there still must be congestion in the general purpose lanes. HOV, HOT, and BRT/XBL lanes serve to reduce that congestion to a lower level than would otherwise occur.

It is increasingly costly and difficult to build more capacity in urban areas. HOV, HOT and BRT/XBL lanes have proven to be effective ways to make the most out of highway investments. In some cases, some combination of these approaches may be appropriate, depending on local conditions.

In this paper, we provide an overview of the expectations and realities of these special lanes, and provide insights into their potential usefulness to improve highway operations looking into the future.

Staff Comments

New provisions in SAFETEA-LU (codified at 23 U.S.C. 166) address the changing role of HOV facilities in an effort to reduce congestion, improve air quality, and maximize throughput using

current or anticipated excess HOV lane capacity. These provisions provide States additional flexibility in managing the use of capacity and permit more exceptions to the minimum vehicle occupancy requirements for HOV facilities, so long as the performance of the HOV lane is continuously monitored and continues to meet specified performance standards. Thus, States are encouraged to allow vehicles that do not meet the occupancy requirements to use HOV lanes as a means to make the best use of the current and anticipated HOV lane capacity. Examples would be, allowing HOT vehicles, or qualified low emission and energy-efficient vehicles, to use HOV lanes if excess capacity exists on the lanes.

FHWA will soon publish updated HOV program guidance to clarify the new opportunities and requirements provided in SAFETEA-LU to operate and manage HOV facilities. FTA has also recently published the final policy in reference to HOT lanes and fixed guideway miles in the Federal Register and provides expertise in the deployment of BRT.

High-Occupancy Vehicle (HOV) Lanes

HOV Lane Background

High Occupancy Vehicle (HOV) facilities serve to increase the total number of people moved through a congested corridor by offering two kinds of travel incentives: a substantial savings in travel time, along with a reliable and predictable travel time. Because HOV lanes carry vehicles with a higher number of occupants, they move significantly more people during congested periods, even if the number of vehicles that use the HOV lane is lower than on the adjoining general purpose lanes. In general, carpoolers, vanpoolers, and bus patrons are the primary beneficiaries of HOV lanes although the users of the other lanes also benefit due to reduced congestion in those lanes when some former solo-drivers shift to the HOV lanes to take advantage of their benefits. There are about 100 HOV facilities nationwide, representing over 1000 route-miles. There are also HOV lanes in Canada and in a wide variety of locations abroad.[2]

For the most part, HOV lanes look like any other street or highway lane, except that HOV lanes are typically delineated with signs and diamonds painted on the pavement or are on a separate facility. But there is a great deal of variety in the design and operation of HOV lanes. Some, called concurrent flow lanes, lie adjacent to, and operate in the same direction, as the general purpose lanes. Others, called contraflow lanes, operate in the opposite direction of adjacent lanes, enabling HOVs to drive on the "wrong" side of the highway with barriers separating them from oncoming traffic. Reversible lanes, usually placed in the highway median, run in one direction in the morning, then in the opposite direction in the afternoon. Busways are usually physically separated from adjacent lanes, and are reserved for bus use only. These are discussed in further detail in the section below on Bus Rapid Transit (BRT). HOV lanes are delineated by several methods, including barriers, medians, rumble strips, buffer areas, and pavement markings.

Use eligibility is set according to local travel conditions, levels of existing congestion, and projected use of the lane. If there are a high number of existing two-person carpools, then letting

[2] Excerpted from FHWA's Freeway Management Program website, at: http://ops.fhwa.dot.gov/freewaymgmt/faq.htm, accessed on December 18, 2006.

them all in might cause congestion in the HOV lane. If there are not enough three-person carpools and buses, then the lane might be perceived by the public as "empty." In all cases, eligibility for use of the lane is designed to allow for reliable travel at, or near, free flow speeds without allowing the lane to become perceived by the public as either underutilized or congested. The balancing of these objectives can be difficult. Some states, in an effort to achieve this balance, have experimented with eligibility rules, changing them by time of day or raising or lowering the occupancy requirements.

Operating hours vary from state to state and facility to facility. Some states operate their HOV lanes only during rush hours, when traffic is heaviest and HOV lanes are most likely to save time for car-poolers and transit users. During off-peak hours, these states either open the lanes to all traffic or simply close them until the next scheduled opening. Other states operate their HOV facilities around the clock. This approach helps to provide ridesharing incentives at all times, and provides travel time savings during times of unexpected congestion, for example, during special events or when there is an incident or accident.

HOV Lane Effectiveness

Studies of existing HOV facilities have pointed to these findings regarding operational effectiveness:[3]

- HOV lanes carry more people than a congested mixed-flow lane. Each HOV lane typically transports twice as many people as a mixed-flow lane during the peak hour.

- In some cases, HOV lanes are underutilized, carrying fewer vehicles per lane than their mixed-flow counterparts. Effective HOV lanes should carry between 400 and 1,500 vehicles per hour per lane.

- HOV lanes generally offer travel time savings as well as reliable travel times. Time savings vary based on the congestion levels of the general purpose lanes.-

- Busways and bus lanes move the highest number of commuters.

- Violation rates vary significantly across the country depending on the level and method of enforcement and local public acceptance. Concurrent flow HOV lanes with limited physical separation typically have higher violation rates than barrier-separated lanes.

- Public acceptance of HOV lanes varies by metro area, but generally, HOV lanes are accepted as a good idea when the corridors experience recurring congestion.

HOV Lane Challenges

Like other transportation solutions, HOV lanes have their limitations and weaknesses. Operating HOV lanes at an optimum level can be a tough challenge. The following list summarizes the major challenges facing HOV lane operations.

[3] Cambridge Systematics, Inc., *Twin Cities HOV Study Final Report*, prepared for Minnesota Department of Transportation, February 2002.

- Enforcement – An essential element of the management and operations of HOV lanes is strong and consistent enforcement, so that it will operate as designed. However, still others would argue that the limited police budget and manpower should be used to address more important social problems. Enforcement and violation rates largely depend on the type of HOV facility, enforcement manpower and consistency, availability of refuge areas, number of access and egress points, general public acceptance, and severity of violation penalties.

- Congestion – In many regions, HOV lane volumes have remained consistently low since opening day. Some argue that HOV lanes are in place to encourage greater mode choice by travelers and improve transit operations and reliability.

- Safety – HOV lanes present some complex safety issues. Among these are the merge zones at entrance and exit points to the HOV lanes, potential large speed differential between adjacent lanes on non-barrier separated facilities, and provisions in refuge areas for breakdowns or enforcement. Since most HOV lanes are usually located on the inside (left most) part of the freeway, vehicles must weave their way through several traffic lanes to get to the HOV lanes, and later from the HOV lanes to the freeway exit.

- Performance Monitoring and Evaluation Programs – HOV data, including violation rates and average occupancy, are still limited. By having a rich source of data, in addition to better models, HOV lane demand predictions would be more accurate. Also, publishing up-to-date benefits of HOV lanes would likely increase public satisfaction and political support.

HOV Lane Examples

There are HOV lanes in 19 states covering a wide variety of applications. Here is a brief sampling.

- The best example of a high productivity bus way is Route I-495, a 2.5-mile bus way connecting New York City with New Jersey via the Lincoln Tunnel, which carries over 700 buses during the peak hour, transporting approximately 35,000 commuters.

- The southern California region (Los Angeles, Orange, Riverside, and San Diego Counties) has over 360 route miles of HOV lanes on their regional freeway network, making these lanes a vital part of that congested transportation network.

- The HOV lanes on the Shirley Highway in the Washington DC area are renowned for the use of casual carpooling where drivers pick up riders at certain locations to meet the occupancy requirements.

High-Occupancy Toll (HOT) Lanes

HOT Lane Background

HOT (High-Occupancy Toll) lanes grew out of the recognition that some traditional HOV lanes were underutilized. The HOT lane concept varies in detail from one application to another, but in general refers to HOV lanes where vehicles that do not meet the occupancy requirement are also permitted access to these lanes for a fee, which varies based on current congestion level.

HOT lanes became more feasible with the advent of electronic toll collection (ETC) in the late 1980s and early 1990s, where vehicles could pay a toll without having to stop at a toll booth. Prior to the use of ETC, stickers were used to identify vehicles that had paid the monthly fee.

HOT Lane Effectiveness

HOT lanes have the potential to afford a variety of benefits to both motorists and transit users.

- Trip Time Reliability: Traffic volumes on HOT lanes are managed to ensure superior, consistent, and reliable travel times, particularly during peak travel periods.

- Travel Time Savings: HOT lanes allow HOV, such as transit vehicles and paying non-HOV motorists, to travel at higher speeds than vehicles on congested general-purpose lanes.

- Financial Support: HOT lane revenues may be used to support operations and maintenance of the lanes, transit improvements or other local demand management strategies, and enforcement.

HOT Lane Challenges

- Public Acceptance: Some members of the public continue to be skeptical with respect to paying tolls, particularly when toll-free alternatives are available. In some cases, the public has concerns about the private sector being in the business of collecting and setting tolls for a profit.

- Equity: Equity considerations may emerge in public discussions, including "Lexus Lane" concerns and geographic concerns.

- Revenue and Demand Forecast: Setting the prices on a simple HOT lane with one entry and exit point is relatively straightforward. The calculation of proper rate gets a little more complicated in a single corridor with multiple access points. When moving to several corridors or network, the management problem gets considerably more difficult.

HOT Lane Examples

I-15 HOT Lanes (San Diego, CA). This was the first HOT lane, where a two-lane reversible HOV facility in the middle of eight miles of I-15 in San Diego was opened to SOVs for a toll. The toll on the HOT lanes varies dynamically every six minutes based on the traffic level in the HOT lanes, with the aim at keeping the HOT lanes free-flowing. There is one entry and one exit point for this facility. The upfront capital costs were not extensive since the lanes already existed, and the only costs were for toll collection and enforcement. The lanes produce enough excess revenue to support improved transit service in the corridor.

An evaluation of this project[4] found that carpool volumes were 13 percent higher than at the program's beginning, and the new bus service saw a steady increase in ridership, but less than

[4] Evaluation material excerpted from remarks by Janusz Supernak of San Diego State University who led an evaluation study at a forum hosted by the University of Minnesota, accessed at: http://www.cts.umn.edu/news/report/2004/06/experts.html on January 4, 2007.

expected. The average travel time for toll paying solo drivers fell by about 4 to 6 minutes, but participants believed they saved about 20 minutes per trip. People thought pricing was fair and liked having a new option.

The region is now moving forward with an extension of the HOT lanes to the north, with two lanes in each direction, multiple access points, and special facilities for enhanced bus service. When fully operational in 2013, the BRT service will include frequent all-stop and point-to-point service at nine stations, including five off-line stations connected by direct access ramps, and two or more stations in the median of the freeway.[5]

I-394 MnPASS (Minneapolis, MN). In May 2005, the Minnesota Department of Transportation converted the existing I-394 HOV lanes to HOT lanes. I-394 is the primary east–west corridor between downtown Minneapolis and the western suburbs. The eastern portion of the HOT Lane (about 3 miles) is a reversible, two-lane, barrier-separated facility, whereas the western portion (about 6 miles in one direction and 9 miles in the other) is a single-lane HOV separated from the general purpose lanes by a solid white stripe pavement marking. Like the I-15 project in San Diego, the tolls vary dynamically according to traffic in the HOT lanes, ensuring that the lanes always remain free-flowing. A key advance on this project was multiple entry and exit points in the portion of the HOT lane separated by the striped pavement markings. There had been concern that lack of a more substantial barrier would result in drivers entering and exiting the lanes at unauthorized locations in order to avoid the toll, but this has not been the case. The lanes have proven popular with users, with demonstrated time savings.[6]

Bus Rapid Transit (BRT)/Express Bus Lanes (XBL)

Background

Bus Rapid Transit (BRT)/Express Bus Lanes (XBL) is an umbrella term for rubber-tired transit services that include some combination of a wide range of strategies to improve the attractiveness and effectiveness of fixed route bus transit services. Strategies include greater spacing between stops; distinctive vehicles and stations to establish a strong brand identity; higher profile stations with more passenger amenities; raised platforms and off-vehicle fare collection to speed boarding; dedicated lanes or busways; transit signal priority at intersections; real-time traveler information; and increased integration with surrounding land use.

BRT services operate with varying degrees of isolation from traffic, including mixed traffic on arterial streets or expressways, semi-exclusive curbside bus / right-turn lanes on arterial streets, expressway shoulders at congested locations, HOV or HOT lanes, bus-only "queue jump" lanes to bypass congestion approaching an intersection, bus-only transitways with at-grade intersections in the medians of arterial streets or boulevards, and fully grade-separated busways often located on separate right-of-way. Routes that combine several running way types are common.

[5] California Department of Transportation. *Bus Rapid Transit: A Handbook for Partners.* 2006. Available at http://transweb.sjsu.edu/mtiportal/research/publications/documents/BRT2006/BRT%20Caltrans%20Draft.pdf

[6] Cambridge Systematics, Inc., I-394 MnPASS Technical Evaluation, prepared for Mn/DOT, November 2006.

While BRT in some form may be applicable as an upgrade to existing bus routes operating in one or more major "Main Street" corridors in virtually every city in the United States, point-to-point BRT services have particularly great potential in addressing the growing mobility problems in suburban areas. In many of America's decentralized urban areas, the traditional downtown represents only one of many concentrations of residential, employment, commercial, and recreational activity. In these multi-centered regions, traditional downtown commutes are being eclipsed by travel between outlying residential areas and outlying activity centers. This phenomenon is occurring in cities of all sizes. Nationwide, suburb-to-suburb travel represents nearly half of all work trips and is growing faster than any other commute pattern.[7]

BRT Lane Effectiveness

Since the late 1990s, the Federal Transit Administration has been encouraging BRT/Express Bus Lanes as a lower-cost alternative to light rail.

- Even low-end BRT operating in mixed traffic can achieve as much as 25 percent savings in travel time and increased reliability by spacing stops farther apart and introducing transit signal priority.

- BRT represents a more customer-oriented business model for traditional fixed route bus services in urban arterial corridors. BRT represents a more cost-effective alternative to rail transit, especially in America's less dense urban and suburban travel markets. BRT/XBL also provides a way to derive more value from investments in HOV and HOT lanes. BRT's customer-friendly service features have contributed to corridor ridership increases of 25 percent or more compared to the more traditional services that they supplement or replace.[8]

- Point-to-point BRT services operating at least in part in expressway environments, such as in HOV or HOT lanes, provide a way to offer fast, reliable, and comfortable transit services that are an attractive travel alternative to the private automobile in suburb-to-suburb markets.

BRT Lane Challenges

- These dispersed travel patterns between many origins and many destinations at once are notoriously difficult to serve with traditional transit services, which work best bringing people from many locations to one concentrated area.

- Development around expressway interchanges rarely reaches transit-supportive densities, so that sufficient travel demand does not exist to justify a station that can be reached by walking. Stations located in the expressway right-of-way are most efficient for bus operations, but providing an attractive pedestrian environment for access to nearby development is often problematic. The center of a freeway is usually not a pleasant place to wait for a bus.

[7] Transportation Research Board. Commuting in America III: The Third National Report on Commuting Patterns and Trends. 2006. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/CIAIII.pdf

[8] Federal Transit Administration. Characteristics of Bus Rapid Transit for Decision-Making. August 2004. Available at http://www.fta.dot.gov/documents/CBRT.pdf

- There is growing interest in combining BRT with HOT lanes as a means of helping to address equity issues relating to affordability of high tolls charged on HOT lanes and potentially providing a revenue stream to subsidize the transit service. Imposing the high peak-period tolls that are required to manage demand in congestion-priced HOT lanes is more defensible when an attractive transit alternative is also provided.

BRT Lane Examples

Some BRT lane examples in the U.S. and abroad are described below.

Los Angeles MetroRapid. These upgraded arterial bus routes represent one of the first major successes with BRT in the United States. MetroRapid was initially a limited-stop service supplementing existing bus routes in mixed traffic in two corridors. It offered distinctive passenger facilities, countdown signs displaying minutes until the next bus arrives, specially painted buses and branding, and traffic signal priority. With travel time savings of 29 percent and corridor ridership gains of 33 percent in the Wilshire / Whittier corridor, the concept was rapidly applied elsewhere in Los Angeles and replicated in other cities.[9]

South Miami-Dade Busway. The Busway is a two-lane dedicated roadway that currently extends 13 miles in a former railroad right-of-way along U.S. 1 from the Dadeland South Metrorail station. The Busway has 21 stations with 4 park-and-ride lots. Five routes (including one express route, one local route and three minibus routes) serve the Busway and surrounding areas and offer a free transfer to Metrorail. The Busway is currently being extended another 6.5 miles to Homestead, Florida.[10]

Brisbane (Australia) TransLink Busway. Brisbane opened its first Busway in 2000 as part of a regional plan to supplement an existing rail transit system. The South East Busway is a fully grade-separated two-lane bus roadway that runs primarily along a radial expressway. The Busway system is being extended into a regional network of approximately 30 miles. More than 90 routes serve one or more Busway stations, typically in combination with operation on local streets. At its busiest section near the central business district, the Busway carries up to 15,000 passengers per hour in the peak direction.[11]

Bogotá (Colombia) TransMilenio. Bogotá opened its TransMilenio busway in 2000. The initial system included 24 miles of at-grade busways in the medians of three major arterial corridors and had 59 stations. A combination of 14 express routes, 3 local routes, and a number of feeder routes operated in the busways at intervals of as little as two minutes. The system has the distinction of having achieved full recovery of its operating costs shortly after opening.[12]

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[9] Transit Cooperative Research Program. Report 90: Bus Rapid Transit, Volume 1: Case Studies in Bus Rapid Transit. Transportation Research Board, 2003. Available at http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_90v1.pdf

[10] Miami-Dade Transit website. "South Miami Dade Busway." Available at http://www.miamidade.gov/transit/south_miamidade_busway.asp

[11] Queensland Government website. "TransLink Busway Network." Available at http://www.translink.qld.gov.au/qt/translin.nsf/index/TransLinkBusway

[12] TransMilenio website. "TRANSMILENIO S.A. y el Sistema de Transporte." Available at http://www.transmilenio.gov.co/transmilenio/frameset_gneral.htm