



U.S. Department of Transportation
Federal Highway Administration

Congestion Pricing

A PRIMER:
EVOLUTION OF SECOND GENERATION
PRICING PROJECTS



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LIST OF ACRONYMS

BRT	bus rapid transit
CPPP	Congestion Pilot Pricing Program
EIS	Environmental Impact Statement
ETL	express toll lane
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
HCTRA	Harris County Toll Road Authority
HOT lanes	high-occupancy toll lanes
HOV lanes	high-occupancy vehicle lanes
MnDOT	Minnesota Department of Transportation
MPO	metropolitan planning organization
MTC	Metropolitan Transportation Commission (Bay Area)
PSRC	Puget Sound Regional Council
SANDAG	San Diego Association of Governments
TSP	Transit Signal Priority
TXDOT	Texas Department of Transportation
UPA	Urban Partnership Agreement
VDOT	Virginia Department of Transportation
VPPP	Value Pricing Pilot Program
WSDOT	Washington State Department of Transportation

Introduction

THE PRIMER SERIES

States and local jurisdictions are increasingly discussing congestion pricing as a strategy for improving transportation system performance. In fact, many transportation experts believe that congestion pricing offers promising opportunities to cost-effectively reduce traffic congestion, improve the reliability of highway system performance, offer added choice for drivers and transit users, and improve the quality of life for residents, many of whom are experiencing long delays due to traffic congestion in regions across the country.

About this Primer Series

The Congestion Pricing Primer Series is part of Federal Highway Administration's outreach efforts to introduce the various aspects of congestion pricing to decision-makers and transportation professionals in the United States. The primers are intended to lay out the underlying rationale for congestion pricing and some of the technical issues associated with its implementation in a manner that is accessible to non-specialists in the field. Titles in this series include:

- *Congestion Pricing Overview.*
- *Economics: Pricing, Demand, and Economic Efficiency.*
- *Non-Toll Pricing.*
- *Technologies That Enable Congestion Pricing.*
- *Technologies That Complement Congestion Pricing.*
- *Transit and Congestion Pricing.*
- *Income-Based Equity Impacts of Congestion Pricing.*
- *Congestion Pricing Institutional Issues.*
- *Evolution of Second Generation Pricing Projects.*
- *Congestion Pricing: Effective Approaches to Streamlining Back Office Operations.*

When the primer series originated, congestion pricing was still a relatively new concept in the United States. The Federal Highway Administration (FHWA) embarked on an outreach effort to introduce the various aspects of congestion pricing to decision makers and transportation professionals. One element of FHWA's congestion pricing outreach program is this Congestion Pricing Primer series. The aim of the primer series is not to promote congestion pricing or to provide an exhaustive discussion of the various technical and institutional issues one might encounter when implementing a particular project; rather, the intent is to provide an overview of the key elements of congestion pricing, to illustrate the multidisciplinary aspects and skill sets required to analyze and implement congestion pricing, and to provide an entry point for practitioners and others interested in engaging in the congestion-pricing dialogue.

The concept of tolling and congestion pricing is based on charging for access and use of our roadway network. It places responsibility for travel choices squarely in the hands of the individual traveler, where it can best be decided and managed. The car is often the most convenient means of transportation; however, with a little encouragement, people may find it attractive to change their travel habits, whether

through consolidation of trips, car-sharing, by using public transportation, or by simply traveling at less-congested times. The use of proven and practical demand-management pricing that we freely use and apply to every other utility is needed for transportation.

The application of tolling and road pricing to solve local transportation and sustainability problems provides the opportunity to solve transportation problems with substantially fewer resources. It could mean that further gas tax, sales tax, or motor vehicle registration fee increases are not necessary now, or in the future. The idea of congestion pricing is a conceptual first step, not a complete plan of action. It has to be coordinated with other policy measures and environmental measures for sustainability.

THE PURPOSE OF THIS VOLUME

While pricing of managed lanes has been in place for over 20 years, most of the projects have been conversions of existing high-occupancy vehicle (HOV) lanes into high-occupancy-toll (HOT) lanes. These are the first generation projects.

This primer explores the evolution of first-generation pricing strategies into more complex express toll lanes using new or expanded capacity. For purposes of this primer, the second-generation pricing projects refer to variably priced lanes and variable tolls on entire roadways. Pricing changes throughout the day, either on a variable daily schedule or dynamically based on the level of congestion and demand for the managed lanes.

The second generation movement also includes the implementation of integrated networks of priced roadways within urban regions. The primer explains these differences and provides insights from case studies around the United States. The primer concludes with guidance for agencies looking to develop second-generation pricing projects.



What are Second Generation Congestion Pricing Projects?

Second generation congestion pricing projects had their genesis over 40 years ago, when high-occupancy vehicle (HOV) lanes were created on urban freeways. These projects aimed at

The Federal Highway Administration Role in Roadway Pricing

Since 1992, the Value Pricing Pilot Program (VPPP, formerly Congestion Pricing Pilot Program) has played an essential role in the development and deployment of road pricing throughout the United States. As congestion pricing was being introduced and proposed on projects (mostly high-occupancy toll (HOT) lane conversions) in major cities, it was perceived as a radical concept. Sponsors of early projects were faced with opposition regarding several key issues that were common across the country. It is likely that several of the initial projects that were supported by the VPPP may not have occurred, had there not been this national focus and shared research.

Grant funding from VPPP provided support for State and local transportation agencies to test the concept of congestion pricing in their regions. The early projects performed essential research into critical issues such as equity, privacy, enforcement, outreach, and revenue generation potential that were common to many of the projects. These projects also examined potential threats that would potentially derail them.

The Congestion Pricing program's most important contribution to the industry is its continuing support for early research on these issues and testing of operational schemes and technology. The same projects that experienced several setbacks due to these critical issues (up to a decade to complete) set the stage for far more significant priced roadway facilities and networks (second generation projects) in their regions.

maximizing vehicle occupancy and person throughput on freeways by restricting use of a lane or lanes for buses, carpools and vanpools. HOV lanes became a “relied upon approach to lane management.”⁽¹⁾ Over the years, HOV lanes became either too successful or not successful enough. The result was a situation where the lanes were either over-crowded or under-utilized, both of which created dilemmas for decision makers.

The emergence of electronic tolling offered the ability to “better manage dedicated lanes through both eligibility restrictions and pricing.” The term high-occupancy toll (HOT) lane was introduced as the first generation of priced managed lanes, in which HOVs continue to travel free with ineligible vehicles paying for the privilege of using the lane. The HOV to HOT conversions have helped to blunt criticism of HOV lanes and have opened new opportunities to manage travel demand. Since the 1990s, pricing has become a preferred strategy by states and regions for efficiently managing the available capacity in the lanes.

First-generation HOT lanes offered a solution: convert the existing HOV lanes into priced facilities, keeping the HOV priority but selling any unused capacity to users willing to pay for the privilege of saving time within the HOT lanes. This worked well for HOV projects where the HOV lanes were under utilized, since there was plenty of capacity to sell and nobody was inconvenienced.

By charging a fee for other vehicles, pricing could help ensure that demand would not exceed capacity.⁽¹⁾ The implied “win-win” solution would demonstrate that:

- Free flow could be maintained.
- High-occupancy vehicles (HOVs) would receive the highest priority.
- Revenues would be available to help cover a portion of the operations costs and possibly some of the project costs, including subsidies to transit service.

At the other extreme, over-used HOV lanes faced a situation where the HOV occupancy definition needed to be raised, usually from 2+ to 3+, in order to maintain acceptable travel speeds. Changing the

occupancy definition to 3+ would fix the HOV lane operational problems, but the pendulum could quickly swing to an empty-lane syndrome with too few HOV 3+ vehicles. Pricing offers the opportunity to shift to an HOV 3+ operation while allowing other vehicles, including HOV 2 vehicles, to buy into the lane capacity and maintain more optimal freeway lane operations. While operationally efficient, the decision to charge new tolls to HOV 2 users has been a difficult process in several regions.

Table 1. Characteristics of Priced Lane Projects.

First Generation Priced Lanes ¹	Second Generation Priced Lanes ²
Features: • Conversion of HOV lanes to HOT • Typically one lane in each direction • Limited additional capacity provided	Features: • Added capacity provided to existing HOV lanes or previously unmanaged roadways • Targeted capacity expansion of existing roadways • Networks of priced lanes
Typical Objectives: • Maximize HOV and transit users • Encourage growth of alternative modes • Optimize use of lanes • Manage overused HOV lanes through pricing • Provide congestion free choices for drivers and transit users	Typical Objectives: • Maximize lane efficiency • Balance vehicle and person throughput with revenue generation

¹Eligible HOVs use the facility free and unregulated by price.

²Efficiency is gained by fully regulating access to the priced lanes. Second generation priced lane facilities could have the option to charge all vehicles.

HOT = high-occupancy toll, HOV = high-occupancy vehicle

Source: Adapted from D. Ungemah, "HOT Lanes 2.0- An Entrepreneurial Approach to Highway Capacity," Presentation Slides for National Road Pricing Conference in Houston, TX, June 2010

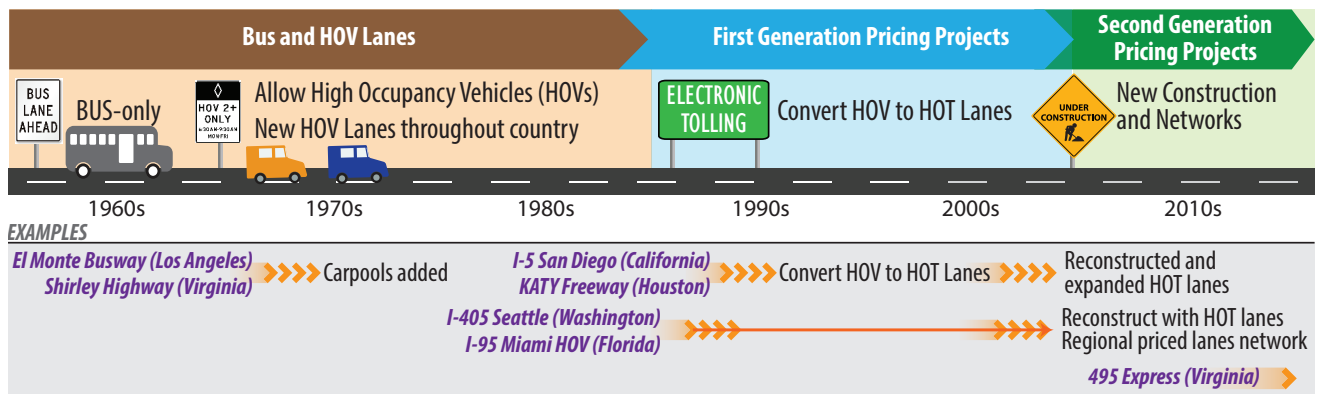


Figure 1. Illustration. Timeline Depicting The Evolution of Roadway Pricing from the 1960s through Today.

HOW ARE FIRST AND SECOND GENERATION PRICED LANES DIFFERENT?

As the first generation high-occupancy vehicle (HOV) to high-occupancy toll (HOT) conversion projects have matured, there has been a movement to “second generation” priced lanes. Second-generation projects include one or more of the following features: the extension of existing HOT lanes, provision of newly constructed priced lanes, and the development of priced lane networks.

The Federal Highway Administration (FHWA) Priced Managed Lane Guide⁽⁴⁾ provides a good summary of this evolution (see chapter 1, page 1-11):

While the [first-generation HOT lanes were relatively] simple facilities with limited points of access and egress, many newer priced managed lane projects include multiple access points that integrate them with multiple activity centers. Projects like the I-15 Express in San Diego also include transit centers and park-and-ride lots serving new bus rapid transit (BRT) service operating on the managed lanes.

Several regions with existing priced managed lanes and others with keen interest in developing new priced managed lane capacity have begun to incorporate significant focus on this model into long-range Regional Transportation Plans and separate Managed Lane Network Plans. The movement toward coordinating the implementation of priced managed lanes at a regional scale rather than one corridor at a time stems from a desire to improve regional connectivity and improve travel options. It also fosters broader regional goals of improved transit connectivity and rideshare program participation levels. Cities that have adopted regional Managed Lane plans include Atlanta, Charlotte, Houston, Miami, Northern Virginia, Minneapolis-St. Paul, Phoenix, San Diego, San Francisco, and Seattle.¹

Table 1 contrasts some of the major characteristics between the first and second-generation projects.

TYPES OF SECOND GENERATION PRICING PROJECTS

The second-generation projects have been implemented on the following facility types:

1. New roadway capacity.
2. Networks of priced managed lanes.
3. Priced managed roadways.

New Roadway Capacity

Recognizing the limited capacity of a single HOV/HOT lane to accommodate future travel demands, projects have emerged that have added roadway capacity to create a dual-lane priced facility. The extension of the I-15 HOT lanes in San Diego² is a good example of a facility that was designed to meet the growing travel demands in the corridor while maintaining priority for HOVs and transit.

Other regions were faced with the need to add roadway capacity and determined that building managed lanes provided better freeway operations and gave them the flexibility to manage the facility to meet changing demands. These projects to add capacity have needed to address directly the tradeoffs between user eligibility (e.g. transit, carpools, vanpools, and single occupant vehicles), pricing levels, and funding opportunities.

Challenges of a Priced Managed Lane Network

- Coordinating among multiple State, regional and local agencies.
- Reconciling these agencies’ differing operating rules.
- Coordinating funding.
- Communicating to a wider set of users.
- Designing corridor connections.

1 Since 2012, Dallas has also adopted a regional managed lane plan.

2 SR 91 in Orange County, CA was actually the first HOT lane (1995), but it was not designed with HOV and transit priority in mind.

Adding pricing to the equation enhances agencies' ability to manage demand while providing needed funding to cover a portion of the costs. Typically, priced managed lanes have provided funds to cover all or a portion of the operations and maintenance costs. Unlike fully tolled roadways, managed lanes do not usually provide pricing revenues sufficient to fully fund the construction costs of the lanes. Second-generation "express toll lanes" (ETLs)³ offer greater revenue generation potential, but are also more expensive to construct.

Networks of Priced Managed Lanes

Another defining feature of second-generation projects is the ability to create networks of priced managed lanes. Over the years, regions have developed high-occupancy vehicle (HOV) lane systems to provide continuous priority treatments for carpools and transit. Many transit agencies rely on a network of HOV lanes to provide reliable freeway bus rapid transit (BRT) service. Major investments in HOV direct access ramps, transit centers, and park-and-ride facilities usually augment the HOV lanes.

As the HOV lanes have become more crowded, the reliability of bus service has diminished in several regions, creating a need to better manage demand in the lanes. Regions have responded by converting the HOV lanes to networks of priced managed lanes. In the San Francisco Bay Area, a network of priced managed lanes was adopted as the regional strategy by the Metropolitan Transportation Commission (MTC). Other examples include HOT-networks underway in Atlanta, Dallas, Minneapolis, Seattle, San Diego, South Florida, Houston, Northern Virginia and Los Angeles. Agencies have found that creating a priced managed lane network is more complex than converting existing HOV lanes to HOT lanes.

While some regions are turning HOV networks into

HOT networks, other regions are building on the success of single-facility priced managed lanes. Experience has shown that once a priced lane has been in operation and is understood by the public, it has created opportunities to either extend the managed lanes on the existing facility (e.g. I-15 in San Diego; SR 91 in Orange County, I-95 in Miami) or to connect two or more HOT/ETL facilities (e.g. I-495 and I-95 in Northern Virginia). While geographical expansion does create technical challenges, more often it is the institutional issues that become the most complex, since more agencies and interest groups become involved.

Priced Managed Roadways

As multiple-lane priced managed lanes become part of the mainstream, it is not difficult to envision a future of fully priced roadways where total demand is managed through a combination of pricing and operational strategies. Fully priced facilities are different than toll roads, which are priced for the purpose of generating revenues and usually are not focused on managing demand. Conversely, fully priced managed roadways would have two functions: managing demand and generating revenue. These two functions can conflict with each other, but the concept of priced managed roadways would be to balance the desire for generating needed transportation funds with ensuring that the roadways are operating as efficiently as possible.

The policy framework for priced managed roadways is being established in some regions. For example, the Puget Sound Regional Council (PSRC) in Seattle has adopted its 2040 transportation vision that assumes that all major freeways would be actively managed and priced. Currently, the region's extensive HOV lane network is being transformed into a HOT network, but the ultimate plan is to fully price and manage the freeways. One starting point is the SR 520 Bridge, which is currently tolled and managed using variable pricing. The bridge is tied to HOV lanes on one end, but HOVs (except transit and vanpools) do not receive any toll discount.⁴

³ The *Priced Managed Lane Guide* distinguishes HOT lanes, where qualified vehicles travel at no cost, and ETLs, where all vehicles pay a variably priced toll to use the lanes. In practice, there are projects that are using the term "express toll lane" or "express lane" more generically to denote a priced managed lane that may or may not charge a toll to HOVs.

⁴ The SR 520 bridge project was the recipient of FHWA funds through the Urban Partnership Agreement (UPA) program.

Table 2. Challenges and Opportunities Moving to Second Generation Pricing Projects.

Topic	Summary of Key Challenges and Opportunities
Technology	• Most second-generation projects are not constrained by technology. Advancements in vehicle detection and ability to employ dynamic pricing options allow flexibility in design and operations. • Differences in operations among regional corridors (e.g. eligibility rules, time-of-day, variable versus dynamic pricing) complicate how transponders (with switchable features as appropriate) should be designed.
Institutional	• Project champions are needed to build and maintain political support moving from first to second generation priced roadways. • Existing organizational structures may not be adequate to oversee implementation and coordination among agencies as a network expands.
Planning/Policy	• Regional transportation plans that include roadway pricing help to ease the implementation of priced facilities in a phased manner over time. • Planning becomes more complex due to network-scale decisions related to legal, financial and regulatory issues. • Complications can be reduced by deciding up-front who plans, designs and operates the facilities.
Design	• Providing a consistent design within and among corridors is important for public understanding and safety. This can be difficult where roadway pricing projects have evolved over time. • Priced roadways may be most effective in corridors that use Intelligent Transportation Systems (ITS) for traffic flow management and traveler information.
Operations	• Expansion of roadway pricing in a region is dependent on having a clear policy for priced lane user eligibility and toll rates. • Standard operating procedures for the organization(s) responsible for running the facilities may not be adequate as tolling expands within the region. For example, back office operations, may need to be substantially revamped.
Financial	• Expanding roadways or developing priced lane networks is more expensive and complex than high-occupancy vehicle to high-occupancy toll conversion projects. However, multiple-lane priced roadways offer greater revenue potential and funding flexibility. • Be clear up-front on how and to whom revenues will be allocated.
Communications	• Projects with early public education lead to smoother implementation. • Clear communications among the partner agencies is essential as the pricing projects become more complex and regional.

As second-generation projects mature, new challenges and opportunities have emerged, as summarized in Table 2. These issues are explored further using case study examples. Each case study also includes text boxes that note the evolution of managed lanes and one that defines the FHWA role.

Case Studies

Several projects around the country exemplify the opportunities and challenges facing second generation pricing projects. Six case studies were selected to highlight projects that are in different stages of development and illustrate a wide range of topics. The case studies are generally organized starting with those that have made some progress, gradually building to the states/regions that have progressed the farthest.

Each of these six regions has achieved successful second generation pricing projects through very different means. There is a spectrum of successful

approaches, ranging from Minneapolis, which is using minimal new infrastructure, to Houston, which has built substantial capacity increases. One common feature in each case study is the emphasis on providing more reliable transit service within the corridor or region.

Each of the following case studies describes the evolution of managed lanes, highlights key lessons learned, and defines the Federal Highway Administration (FHWA) role in implementing the projects.



Figure 2. Photo. I-95 Express Toll Lanes in Florida.

Table 3. Case Studies and Highlights.

Case Study	Highlights
Southeast Florida	• The region developed a common vision and established project champions. • The project created dual express toll lanes by converting an HOV lane to a HOT lane and added a lane. • The focus was on building a managed lanes network with an innovative concept of operations. • The region instituted Express Buses and TSP as part of the project. • Multiple agencies and FDOT districts coordinated successfully. • Early successes resulted in an extension of HOT lanes in the corridor and new I-595 ETLs.
Northern Virginia	• The region is one of first to have HOV lanes, including systems that have been operational for over 40 years. • An unsolicited private proposal to build dual express toll lanes in median of I-495 created the impetus for the project. • Successful implementation of the I-495 project resulted in a new public-private express toll lane project on I-95/395. • The process required extensive reorganization and leadership within VDOT to adapt to the public-private partnership paradigm.
Puget Sound	• An initial HOV to HOT lanes conversion evolved into a dual HOT lane system and full roadway tolling. • The region tied the regional managed lane system plan to the 2040 vision for managed roadways. • The region's managed lanes also function as key transit corridors. • Developing the initial portion of the network required extensive coordination within WSDOT and among 20 agencies. • The regional partners needed to deal with different operating rules on each facility. • The project resulted in expanded vanpool and bus services.
Minneapolis/St. Paul	• The initial conversion from HOV to HOT lanes on one project led to acceptance of pricing in other corridors. • The region instituted the innovative use of shoulders for bus travel. • The new corridor managed lane includes an HOV conversion and sections of new lanes. • Implementation of a vision for a regional HOT network is underway.
Houston	• Katy Freeway represents a full evolution from reversible HOV lane to HOT lane conversion to dual express toll lanes within rebuilt freeway. • Strong partnerships grew among State and regional agencies for planning, implementation and operations. • Partnership and strong leaders contributed to effective public communication.
San Diego	• I-15 started as reversible HOV lanes, then became HOT, and is now operated as a dynamically priced by-the-mile system on a 20-mile, bidirectional managed lanes facility. • The region's emphasis is on new transit service and use of toll revenues to help support transit operations. • The successes have led to an express toll lane network expansion to I-5, I-805, and SR 52.

ETL = express toll lane

FDOT = Florida Department of Transportation

HOT = high-occupancy toll

HOV = high-occupancy vehicle

TSP = transit signal priority

WSDOT = Washington State Department of Transportation

SOUTHEAST FLORIDA

Florida's first managed lane (1976) was a 14-mile segment of I-95 that operated as a concurrent flow high-occupancy vehicle (HOV) lane during peak periods. It was eventually expanded to 21 miles between I-395 and I-595. Over the years, this lane struggled with performance due to the high level of HOV 2+ vehicles, high violation rates in the HOV lanes, and congestion on the I-95 general purpose lanes.

Highlights

- Developed common vision and project champions.
- Created dual express toll lanes by converting an HOV lane to a HOT lane and adding a lane.
- Focus on building a priced managed lane network with innovative concept of operations.
- Successfully coordinated among multiple agencies and FDOT districts.

In 2002, the Florida Department of Transportation (FDOT) began to study the idea of converting the HOV lanes on I-95 to high-occupancy toll (HOT) lanes. The study estimated the project would be feasible, so FDOT received a grant from the Value Pricing Program for funds to conduct public outreach and a tolling and revenue study, which was finalized in 2006. This ultimately led to FDOT's successful proposal under the Urban Partnership Agreement.

The resulting 7-mile I-95 express facility converted a single HOV lane each way into two HOT lanes in each direction. The extra lane was created by narrowing the travel lanes from 12 feet to 11 feet and narrowing the shoulders. Additionally, the existing HOV lane buffer was reduced to 1 foot of separation between the general use lanes and the proposed managed lanes. Construction also included some bridge and interchange improvements to maintain continuity of the dual managed lane facility. The design included pylon

separation rather than concrete barriers, because of limited right of way. Innovative operational aspects of the project included shifting from HOV-2 to HOV-3 eligibility and requiring eligible carpools to register with the local ride-sharing agency. These characteristics differentiate I-95 from a conventional HOV to HOT conversion project.

The I-95 project was the first step in creating a two-county network of express toll lanes. Phase 1-A of the project, the southern half of northbound lanes, opened in 2008. Phase 1-B opened in 2010. Phase 2, extending the lanes 14 miles northward, will be opened in 2015.

Given the success of the 95 Express project, FDOT and its partners developed a plan to construct multiple Express Lane (EL) corridors across the Southeast Florida region to create an EL network. Four entities – FDOT District 4, FDOT District 6, FDOT Florida's Turnpike Enterprise (FTE) and the Miami-Dade Expressway Authority (MDX) – will be involved in the EL network deployment. The roles and responsibilities of these agencies and specific design and operational guidance were prepared during the Southeast Florida Express Lanes Network Regional Concept for Transportation Operations (RCTO) project. The RCTO that was developed using Value Pricing Pilot Program (VPPP) funding is one of the first of its kind and has

The Federal Highway Administration Role

Florida was awarded congestion pricing funds under the original program to vary the toll on two bridges in Lee County. That original project led to several follow-on studies in Lee County in addition to other parts of the state. Miami's first project was a project on the Florida turnpike in 2000. In 2003, the Florida Department of Transportation (FDOT) was awarded Value Pricing Pilot Program (VPPP) funds to evaluate HOT lanes on I-95 in Miami-Dade County. In 2004, they received additional VPPP funding to conduct outreach. Fort Myers and Orlando have also been awarded VPPP funds to examine pricing-related strategies.

been instrumental in making it possible for the region to move ahead with future corridors.

The I-95 express lanes serve as an important part of the growing Bus Rapid Transit (BRT) network. Additional BRT vehicles were purchased as part of the project. The service network operates on the managed expressway lanes as well as on special-use lanes on three major arterials: Biscayne Boulevard, Flagler Street, and Kendall Drive. The buses also have transit vehicle priority at 50 signalized intersections and two uniquely branded BRT stations. As the managed lane network expands, FDOT hopes to allocate a portion of the revenues to subsidize transit service to support the BRT system.

The I-95 project involved two FDOT districts, the Florida Turnpike Authority, two counties, and two metropolitan planning organizations (MPO). There was no formal “agreement” between FDOT and the Turnpike Authority, but staff was given specific authority during project planning, construction and operation. The project team also gained cooperation with the various transit agencies agreeing to help with transferring passengers and setting up rules regarding fares.

Ongoing Work

FDOT is moving ahead with an express toll lanes network in South Florida. Since the opening of the

I-95 project, FDOT has completed efforts to add three reversible express toll lanes on I-595 in Ft. Lauderdale, and work is under way on extending the I-95 managed lanes north to Ft. Lauderdale. Other ongoing work includes adding priced managed lanes in the median of I-75 and on the north-south portion of the Palmetto Expressway in Miami. The Florida Turnpike is also adding managed “premium toll” lanes to the southern portion of its Homestead Extension in South Miami-Dade and to the Veterans Expressway in the Tampa Bay Region. These would be the first managed lanes on a toll road in the United States.

FDOT’s vision is to deploy express toll lanes and networks throughout the State. Work is underway in Jacksonville (I-295), Orlando (I-4 Ultimate Project), and the Tampa Bay region (I-4, I-75, and I-275). The FHWA VPPP also funded a Bus Toll Lanes Proof-of-Concept study in the Tampa-Hillsborough County region. The bus toll lane concept envisions premium transit service operating on newly built priced-managed lanes that would function as the “fixed guideway” component of a BRT network. The bus toll lane is not a HOT lane in that it would not give toll discounts based on vehicle type or occupancy. The bus toll lane concept could be considered a second or third generation priced managed facility if it moves ahead to implementation.

Table 4. Evolution of the Southeast Florida Managed Lanes.

Initial Design	• Concurrent flow HOV lanes on I-95. Peak period operation only.
First Generation Pricing Project	• Went directly into a second-generation project by converting an HOV lane to HOT, combined with a lane addition and expanded buffer.
Second Generation Pricing Project	• Extended HOT express lanes on I-95 using some new construction and added supporting facilities such as park-and-ride lots.
Next Steps	• Complete I-95 Express Lanes and other regional express toll lane projects. Continue to work on express toll lane system. Pursue bus toll lanes.

HOT = high-occupancy toll, HOV = high-occupancy vehicle



Websites

95 Express Managed Toll Lanes In Miami Dade & Broward Counties: <http://www.95express.com/>
 South Florida Express Lanes Network: <http://www.95express.com/pages/related-info/south-florida-express-lanes-network>

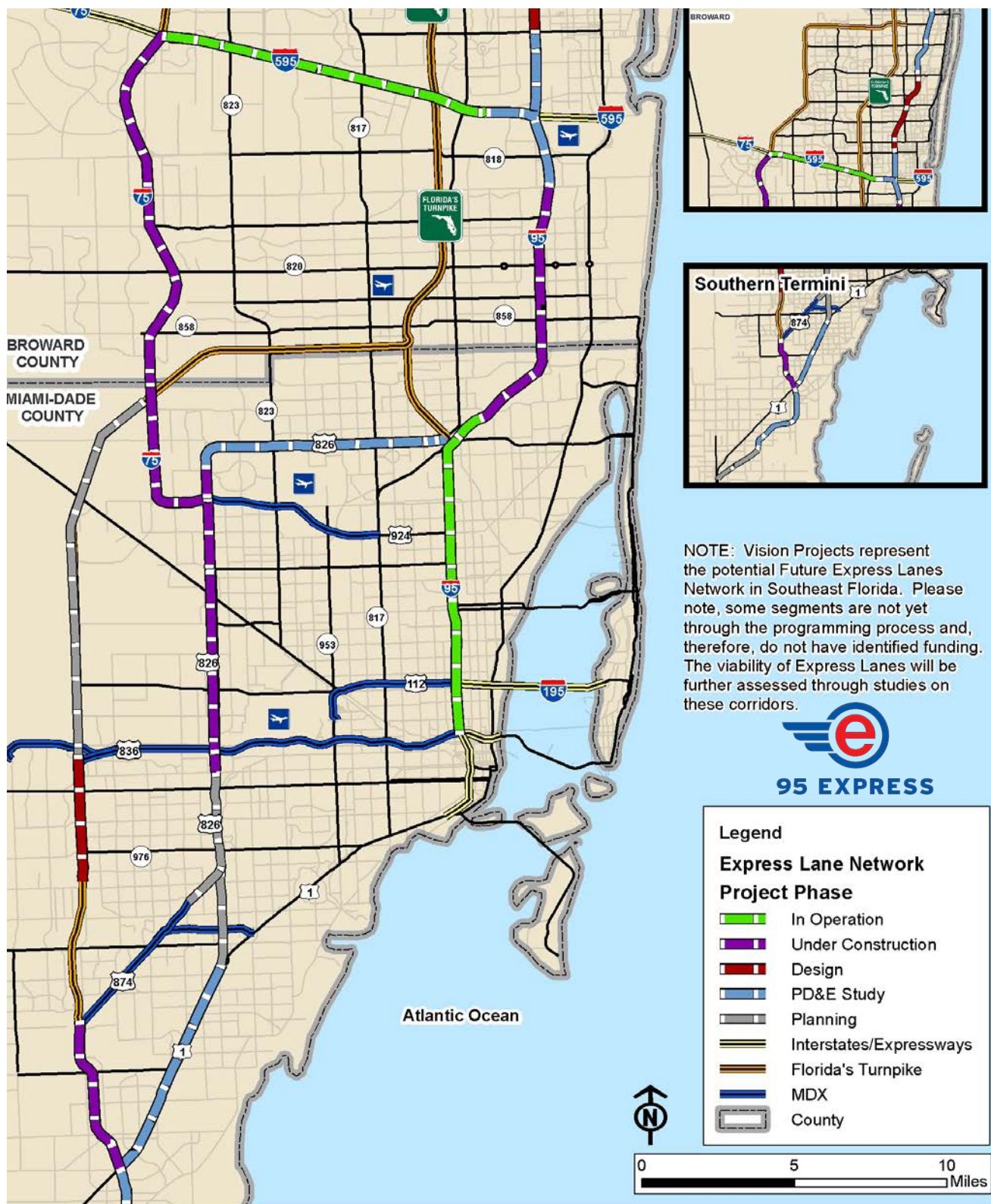


Figure 3. Map. The Current and Planned Express Toll Lane Network in the Greater Miami Area.
(Source: Florida Department of Transportation)

Table 5. Southeast Florida Challenges and Opportunities.

Technology • Anticipated transit technical challenges related to passenger transfers and fare integration. • Accounted for time to develop dynamic tolling software. • Used existing SunPass transponder technology and back-office operations.
Institutional • Defined a strong project vision. • Determined organizational structure from the onset, with clear lines of responsibility among the various agencies. • Developed a concept of operations early and refined as project was implemented. • Coordinated with authorizing agencies in the initial stages. • Appointed a strong project manager, who delegated responsibility to team members.
Planning/Policy • Planned for future phases of project. • Established a comprehensive schedule. • Included design/operations professionals in planning process. • Planned additional resources for project opening. • Planned for the future network integration.
Design • Obtained additional lane on I-95 through lane and shoulder narrowing. • Provided additional buffer width by using pylons. • Developed adopted standard for express toll lane signing. • Designed toll gantries for potential future roadway expansion.
Operations • Enforcement was difficult during HOV operations but simplified during the HOV-to-HOT conversion project with widened buffers and limited access points, along with the carpool registration requirement. • All users must have SunPass transponder.
Financial • Each entity that implements portions of the express toll lanes network will use financing methods authorized by its governing legislation. • Public-private partnership delivery will be considered based on State law.
Communications • Kept public officials informed of project changes. • Coordinated communications among the project partners. • Developed a distinct “flying e” logo and name: “Southeast Florida Express Lanes Network.”

HOT = high-occupancy toll, HOV = high-occupancy vehicle

NORTHERN VIRGINIA

Northern Virginia was one of the first regions to implement high-occupancy vehicle (HOV) lanes, which eventually developed into a system of HOV lanes on I-395, I-66, and I-95. A missing piece to the HOV system was the Capitol Beltway (I-495), which provides a cross-county connection between the radial freeways. In response, the Virginia Department of Transportation (VDOT) initiated a large planning process along I-495 focused on adding HOV lanes. During the Environmental Impact Study (EIS), an opportunity was created through a private sector proposal (see text box) that changed the focus of the managed lanes project.

Highlights

- One of first regions to have HOV lanes, including systems that have been operational for over 40 years.
- Unsolicited private proposal to build dual express toll lanes in median of I-495.
- Successful implementation led to new Public Private express toll lane project on I-95/I-395.
- Public private partnership required extensive reorganization and leadership within VDOT.

VDOT signed a contract with the concessionaire in December 2007, and construction began on the 495 Express Lanes, rebranded as the E-ZPass Express Lanes. Opened in 2012, the 14-mile priced

managed lanes segment of I-495 extended from the Springfield Interchange to a point north of the Dulles Toll Road. The design added two express toll lanes in each direction, replaced more than 50 overpasses and bridges, reconstructed ten interchanges, and added direct HOV/high-occupancy toll (HOT) connections to the I-95/I-395 HOV lanes. The HOT lanes allow HOV 3+ and transit vehicles to travel free, while dynamic tolls are used to manage the other traffic.

The public-private project created several institutional challenges for VDOT. While the State already had public-private partnership authority with the Public-Private Transportation Act (PTA) of 1995, the Legislature was reluctant to relinquish control over the public-private partnership projects. Also, since the HOT lane proposal from the private sector was unsolicited, there initially was no project champion from a public agency or the political sectors. The State appointed an independent review panel, which ended up voting in favor of the private consortium proposal. Once the design with HOV/HOT lanes and transit provisions was clarified, the Virginia Secretary of Transportation supported the project. VDOT also created the Office of Transportation Public Private Partnerships (OTPP), renamed the Virginia P3 Office, or VAP3, effective in 2014. Both the public and private sector partners were integrated into a team to deliver the project successfully.

Injecting Private-Sector Initiatives to Create a Priced Managed Roadway

In Northern Virginia, a complex planning process was already underway for the Capital Beltway (I-495) expansion when the unsolicited high-occupancy toll (HOT) lane proposal arrived from the concessionaire. At that time, the I-495 alternatives being considered would result in substantial right-of-way acquisitions and high capital cost. The concessionaire proposal promised a smaller project footprint with a much lower price tag. It also brought high-occupancy vehicle (HOV)/HOT lanes and transit benefits into the corridor. After substantial review, this design concept was added as a new alternative and the Environmental Impact Statement (EIS) process was restarted and completed. Having the EIS process already underway streamlined the approvals and was seen as a positive factor by the private applicant, the Fluor Corporation/Transurban team.

The Federal Highway Administration Role

Value Pricing Pilot Program (VPPP) awarded funds to the Virginia Department of Transportation to study high-occupancy toll (HOT) lanes in 2003. However, the funds were redirected to evaluate HOT lanes in the Hampton Roads area. In 2011 VPPP awarded the state funds to examine the public acceptability of pricing in the Washington, DC, region (project conducted by the Metropolitan Washington Council of Governments (MWCOC) Transportation Planning Board).

While the 495 Express Lanes were being implemented, the topic of converting other high-occupancy vehicle (HOV) lanes was explored. This led to the creation of the I-95 Express Lanes project, which is a separate public-private partnership. The project proposed to construct and operate HOT lanes along a 29-mile portion of the existing, reversible, HOV-3 facility on I-95 and I-395. A third reversible lane was also added from the Prince William Parkway to the project's northern terminus between Duke Street and Edsall Road. To the north of this point, the reversible facility will continue to operate as an HOV 3+ facility. New HOV ramps were constructed, park-and-ride lots were expanded and funds were used to make other local transit improvements.

VDOT is currently studying the possibility of implementing HOT lanes along I-66 outside the Beltway for a distance of about 25 miles, to US 15 in the Haymarket area. The State is looking for approval in 2015 with an opening possibly by 2021. In addition, VDOT is studying I-66 inside the Beltway for conversion during peak periods only from HOV to HOT as a VDOT owned and operated managed lane facility.

Table 6. Evolution of Northern Virginia Managed Lanes.

Initial Design	• HOV lanes on I-95, I-395, and I-66. Combination of concurrent flow and reversible HOV lanes.
First Generation Pricing Project	• None.
Second Generation Pricing Project	• Construction of I-495 Express Lanes with two added HOT lanes in each direction on the Capitol Beltway. • I-95/395 Express Lanes, which is a combination of an HOV to HOT conversion and lane additions.
Next Steps	• Exploring the possibility of creating HOT lanes on I-66 outside of the Beltway for 25 miles. • Studying conversion of HOV to HOT lanes during peak periods on I-66 inside the Beltway.

HOT = high-occupancy toll, HOV = high-occupancy vehicle



Websites

Virginia Megaprojects – I-495 HOT Lanes: <http://www.vamegaprojects.com/about-megaprojects/i495-hot-lanes/>
I-495/I-95 Express Lanes: <https://www.expresslanes.com/>



Figure 4. Map. The Northern Virginia Managed Lanes Facilities.
(Source: Virginia Department of Transportation)

Table 7. Northern Virginia Challenges and Opportunities.

Technology • Needed new switchable transponders called E-ZPass Flex to support the Express Lanes. Allows users to declare as an HOV 3+ on the I-495 and I-95 Express Lanes. New back-office operations were created by Transurban.
Institutional • Extensive reorganization needed within VDOT to implement the public-private partnership project on I-495. This organization is now working well and facilitated the I-95 Express Lanes project. • Concerns by Arlington County and the City of Alexandria resulted in changes in the final design of the I-95 Express lanes project.
Planning/Policy • Ongoing planning for the I-495 improvements was interrupted by the unsolicited HOT lane proposal. A new alternative was added to the environmental impact review process. • Expanding network creates challenges for toll policy and public information.
Design • Reconstruction of I-495 required new overpasses and interchanges along with supporting infrastructure. The result was a state-of-the-practice express lane design.
Operations • VDOT needed to revise the E-ZPass operations to allow self-declaration of HOV status. Enforcement areas were designated on I-495. • Similar operations are present on I-95/I-395, although tolled (non-HOV eligible) vehicles must exit the lanes at the Alexandria city boundary, where the facility reverts to an HOV lane.
Financial • Public-private partnership proposal provided needed funding to implement the projects along with State and Federal funding.
Communications • Extensive public outreach for the 495 Express Lanes gained support after previous planning efforts could not reach a consensus on a viable project. • Existing HOVs using I-95/I-395 must obtain an E-ZPass flex and switch it into HOV mode to receive a free trip. This is a change from several decades of ongoing HOV operations in the corridor.

HOT = high-occupancy toll, HOV = high-occupancy vehicle, VDOT = Virginia Department of Transportation



Figure 5. Photo. Construction of the I-495 Express Lanes in Northern Virginia.

PUGET SOUND, WASHINGTON

The Puget Sound region in Washington State has had one of the Nation's largest regional high-occupancy vehicle (HOV) systems for many years. It features 235 miles of managed facilities.

The Washington State Department of Transportation (WSDOT) first considered a priced managed roadway system in 2006 when the Washington State Legislature asked WSDOT to conduct a study on the feasibility of adding up to two express toll lanes to I-405 that would connect with existing high-occupancy toll (HOT) lanes on SR 167. This would form a seamless 50-mile Eastside Corridor.⁵ The first phase is scheduled to open in late 2015. It will include a dual express toll lane system from downtown Bellevue to Bothell/Woodinville, and an existing carpool lane from SR 522 to I-5 will be converted to a single express toll lane. The remaining sections south of Bellevue will be added as funding becomes available to increase capacity along I-405.

Highlights

- Initial HOV to HOT conversion has evolved into a dual express toll lane system and full road-way tolling.
- The regional managed lane system plan is tied to the 2040 vision for managed roadways.
- Managed lanes also function as key transit corridors.
- Developing the initial portion of the network required extensive coordination within WSDOT and among 20 agencies.
- The regional partners needed to deal with different operating rules on each facility.

The other major priced managed roadway currently under construction is the SR 520 Bridge

Replacement Project. This project is being partially funded with toll revenues generated by the SR 520 full-facility pricing project, which was funded as part of FHWA's Urban Partnership Agreement (UPA) grant program. The SR 520 full-facility pricing project charges variable tolls on all lanes of the existing floating bridge across Lake Washington. This project is unique because it initiated pricing on an existing bridge. The project was designed to manage demand and generate revenue to help fund the new bridge prior to completion of the replacement bridge, which is under construction.

An underlying objective of the managed lane program is to ensure ongoing reliability for transit, which relies strongly on the regional managed lane network to maintain efficient transit operations. Pricing provides WSDOT with another demand management tool to enable reliable speeds to be achieved on the managed lanes throughout the day.

Building a network of priced managed lanes creates design and operational challenges. Since most of the actions include converting and expanding the existing HOV lane system, the design needs to integrate those features without needing to totally rebuild the freeway infrastructure. For example, there are several HOV direct-access ramps along I-405 that are being retrofitted to better accommodate added toll traffic while maintaining reliable access for HOVs and transit. There are also different HOV eligibility rules that may be in place for each corridor. These will need to be reconciled as part of the concept of operations and public outreach process.

A key feature of the Puget Sound program is continuous interagency planning and collaboration. For example, the SR 520 Bridge tolling project has been a joint effort between WSDOT, King County Metro (transit service provider), and the Puget Sound Regional Council (PSRC). These agencies collaborated on the Urban Partnership proposal and have remained active partners during implementation of the pricing project. WSDOT is the overall lead for the project, requiring coordination between

⁵ Priced managed lanes on I-405 were initially considered in 2002 as part of a programmatic Environmental Impact Study for the I-405 Master Plan. This concept was further studied and then supported with state legislation. Priced managed lanes were successfully tested along SR 167, helping to build support for the I-405 express lanes project.

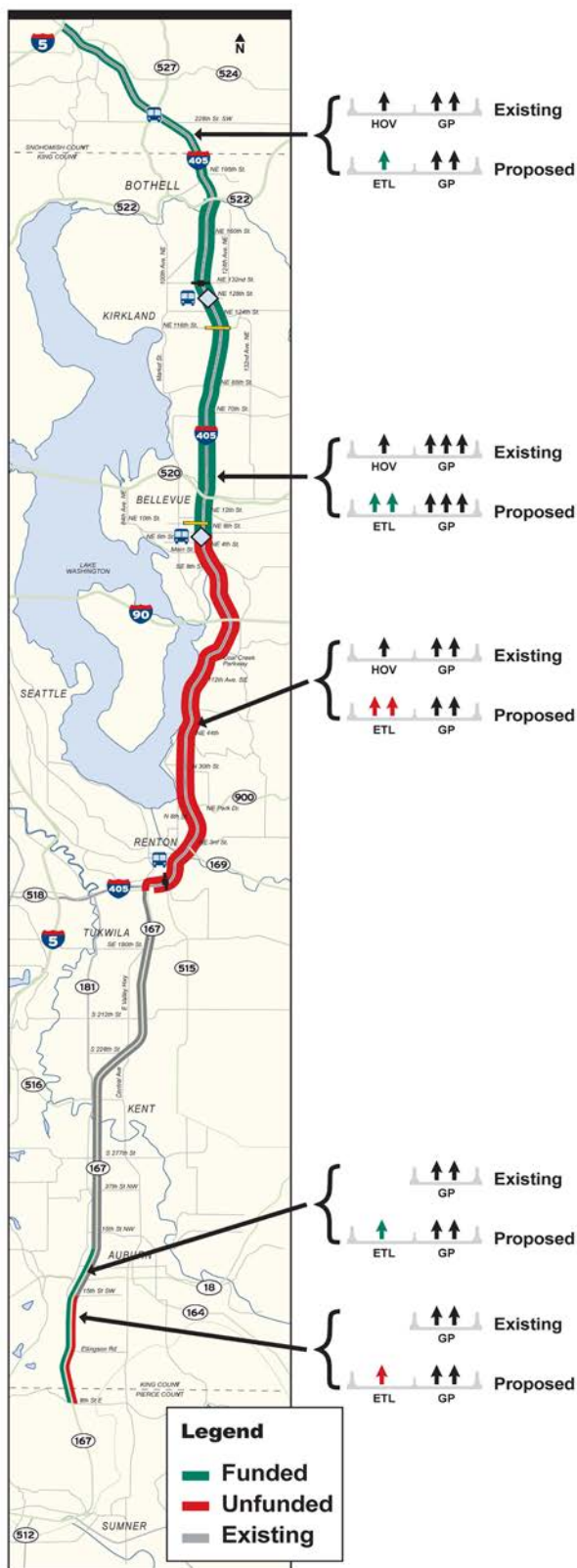


Figure 6. Map. Existing and Proposed Priced Managed Lanes for SR 167 and I-405 in the Puget Sound Region. (Source: Washington State Department of Transportation)

A Vision for Regional Pricing

The Puget Sound Regional Council (PSRC) Vision 2040 plan (adopted in 2010) envisions priced freeways throughout the region. The intent is to manage and finance the highway network as a system of fully tolled facilities. The creation of priced managed lanes using the high-occupancy vehicle (HOV) lane system as a backbone is the first step towards future fully priced roadways.

Washington State Department of Transportation's (WSDOT) Toll Division, the Northwest Region, and the SR 520 mega-project office,⁶ which is constructing the new 520 floating bridge. Local agencies on both ends of the bridge are also actively engaged.

A strong public process has helped to build support for roadway pricing. A tolling implementation committee was established in 2010 to gauge and build public support and to provide guidance to the legislature. WSDOT also identified pricing champions in both the public and private sectors. The Secretaries of the WSDOT, past and present, have been stalwart supporters of the implementation of pricing to achieve the many PSRC regional policy goals. The following projects fit within those policy goals: the SR 520 Bridge (i.e., a fully tolled facility), priced managed lanes on SR 167, and forthcoming express toll lanes on I-405. Also important is the leadership provided by major businesses such as Boeing and Microsoft, whose employees commute along these roadways. The private sector leadership has helped bolster legislative support to continue the pricing program.

⁶ The mega-project office reports directly to WSDOT headquarters in Olympia, WA.

The Federal Highway Administration Role

The State's early Value Pricing Pilot Program (VPPP) awards were focused on non-toll strategies (parking cash out and GPS-based pricing). In 2003, the State received funds to study high-occupancy toll (HOT) lanes on SR 167. The project was implemented in 2008. Subsequently, VPPP funded projects to evaluate the express toll lanes concept were undertaken in 2009 and they are currently piloting continuous access on SR 167. Full facility pricing began on the existing SR 520 bridge in December 2011. The facility is tolled by time of day, and toll revenue generated will be used to pay for part of the construction costs of the new floating bridge.

Table 8. Evolution of Puget Sound Managed Lanes.

Initial Design	• HOV lanes on 235 miles of regional freeways. Combination of concurrent flow and reversible HOV lanes.
First Generation Pricing Project	• Converted single-lane SR 167 HOV lanes to HOT lanes.
Second Generation Pricing Project	• Added variable tolls on SR 520, which includes an existing bridge crossing Lake Washington. A new bridge is under construction. • Creating dual express toll lanes on I-405, eventually tying to the existing SR 167 HOT lanes.
Next Steps	• Complete I-405 Express Toll Lanes and SR 520 bridge replacement. Continue to work on priced managed lane system and regional priced freeway vision.

HOT = high-occupancy toll, HOV = high-occupancy vehicle

 Websites WSDOT – I-405 Express Toll Lanes: http://www.wsdot.wa.gov/Tolling/405/ WSDOT – High-occupancy Vehicle (HOV) Lanes: http://www.wsdot.wa.gov/HOV/



Figure 7. Photo. Existing SR 520 Bridge in Washington Prior to Replacement.

Table 9. Puget Sound Challenges and Opportunities.

Technology • Needed to update Good-to-Go transponders and back-office operations to accommodate addition of SR 167 and SR 520 pricing projects. Toll system was originally developed for the Tacoma Narrows bridge project. • Switchable transponders allowed self-declaration of HOV status on SR 167. • The upcoming I-405 express lanes require WSDOT to change to a declarable transponder in order to allow HOV 3+ to travel free during peak periods and HOV 2+ to travel free during off-peak periods.
Institutional • Extensive coordination was needed within WSDOT among the Toll Division, Northwest Region, and Headquarters Offices. • More than 20 agencies were involved in Eastside Corridor Express Toll Lanes. WSDOT created an executive committee to coordinate State, regional, and local interests. • The state Transportation Commission sets the toll rates with input from WSDOT and other stakeholders.
Planning/Policy • While there may be differing eligibility rules on each facility, WSDOT is striving to the extent possible to provide consistent messaging for the customer. • WSDOT conducted regional tolling studies with the goal of eventually implementing pricing on all freeways consistent with the regional transportation plan. • I-405 master plan was modified to accommodate the dual-lane express system.
Design • SR 167 was a pilot HOV-to-HOT conversion with limited access points. It subsequently became a permanent facility, but the design was converted to allow continuous HOV/HOT access. • Freeway-to-freeway HOV/HOT connection is a high priority linking SR 167 and I-405 to provide seamless transition within Eastside corridor. • Creating express toll lanes on I-405 requires some changes in express lane buffers and direct HOV access ramps, which were not designed to accommodate non-HOV traffic.
Operations • Enforcement was straight-forward during first generation SR 167 HOV-to-HOT conversion project. Connection to I-405 may create modified HOV eligibility rules and self-declaration process. • SR 520 Bridge charges all vehicles, with the exception of transit and vanpools that are exempted[1] if registered and have a Good to Go! Pass. • The SR 520 corridor includes Active Transportation Demand Management.
Financial • Revenues collected on I-405 will be dependent on HOV eligibility rules. • WSDOT needing to collaborate with Sound Transit and FTA on funding responsibilities and performance requirements for existing direct access ramps along I-405, which were partially funded for HOV and transit access only.
Communications • The public has been supportive of HOV lane system; extensive public outreach is being conducted to gain support for the Eastside Corridor tolling project. • Implementing SR 167 HOT lanes as a “pilot project” helped to gain public support as it has become more successful. • There is a continuing need to educate the public on the function of pricing on SR 520 as a tool for both traffic management as well as funding. The success of the UPA project funded by USDOT helped to reinforce that message.

FTA = Federal Transit Administration

HOT = high-occupancy toll

HOV = high-occupancy vehicle

UPA = Urban Partnership Agreement

USDOT = United States Department of Transportation

WSDOT = Washington State Department of Transportation

MINNEAPOLIS/ST. PAUL, MINNESOTA

The greater Minneapolis-St. Paul region has implemented two managed lane projects on I-394 and I-35W. Both of these facilities started as high-occupancy vehicle (HOV) lanes and were subsequently converted to high-occupancy toll (HOT) lanes under the MnPASS program. The HOT lanes allow HOV 2+ and transit to travel free, while single-occupancy vehicles (SOV) can buy into the lanes using dynamic pricing.

Highlights

- The initial conversion from HOV to HOT lanes on one project led to acceptance of pricing in other corridors.
- The region instituted the innovative use of shoulders for bus travel.
- The new corridor managed lane includes an HOV conversion and sections of new lanes.
- Implementation of a vision for a regional HOT network is underway.

The MnPASS project objectives, first applied to I-394, were as follows:

- Improve efficiency by increasing the person- and vehicle-carrying capabilities of existing HOV lanes.
- Maintain free-flow speeds for transit and carpools.
- Implement electronic toll collection for dynamic pricing and electronic enforcement.

The I-394 conversion resulted when the facility's underutilized HOV lane came under increased political and public scrutiny. The new MnPASS managed lanes were opened along the 11-mile corridor in 2005 and featured dynamic pricing. These were the first HOT lanes to use double-striped lines rather than physical barriers.

The I-35W MnPASS lanes, supported under the Urban Partnership Agreement (UPA) program, were opened in 2009 and included 8 miles of an HOV to HOT conversion project, plus a 3 mile priced

dynamic shoulder lane. The dynamic shoulder lane is used as a priced managed lane during peak periods, and then returned to a shoulder during off-peak periods. The priced dynamic shoulder lanes were an outgrowth of the region's system of bus-only shoulders and were considered a better way of utilizing existing infrastructure as an interim solution.

Both the I-394 and I-35W MnPASS lanes could be considered first generation priced facilities in that they converted existing HOV lanes into HOT lanes, and in the case of I-35W, converted an existing shoulder into a peak period HOT lane. The move into second generation priced facilities will occur in 2015, when MnPASS will add new lanes to a 4-mile section of I-35E, north of St. Paul.

In 2016, the Minnesota Department of Transportation (MnDOT) plans to extend the I-35E MnPASS lanes further north through a combination of lane additions and an innovative approach through the I-35E/I-694 commons area. Because there was no need to add lanes through this recently reconstructed commons area, MnDOT decided to convert the inside southbound general purpose lane to a HOT lane during the morning peak period. In the northbound direction through the commons, there will be no HOT lane designation. This approach will be evaluated for a 1-2 year period, and modifications could be made depending on the evaluation results.

MnDOT and the Metropolitan Council (the region's metropolitan planning organization (MPO)) have a vision for a MnPASS system throughout the Twin Cities area. There are plans to extend the MnPASS lanes on I-35W south of Minneapolis, add MnPASS lanes on I-35W north of Minneapolis, and add MnPASS lanes on I-94 between Minneapolis and St. Paul. MnDOT is also evaluating and developing several other corridors for MnPASS lanes should additional funding become available.

The Federal Highway Administration Role

The first pricing funds were awarded in 1999 to conduct a regional study and public outreach. The Minnesota Department of Transportation (MnDOT) was awarded Value Pricing Pilot Program (VPPP) funds the next 6 years to study both toll- and non-toll-pricing applications.

In 2007, MnDOT obtained UPA funding to test several innovations to managed lanes along I-35W. In 2012, MnDOT received a VPPP grant to conduct a pre-implementation study of high-occupancy toll (HOT) lane options on I-35E.

Table 10. Evolution of Minneapolis Managed Lanes.

Initial Design	• HOV lanes operated on I-394 and I-35W.
First Generation Pricing Project	• Converted HOV lanes to HOT lanes. • Added priced dynamic shoulder to I-35W.
Second Generation Pricing Project	• Expanding HOT lane system by adding lanes to I-35E. • Exploring conversion of existing general purpose lane capacity.
Next Steps	• Planning and developing future priced managed lanes on several corridors.

HOT = high-occupancy toll, HOV = high-occupancy vehicle



Photo source: FHWA

Figure 8. Photo. I-35W MnPass Express Lanes in Minnesota.



Websites

Regional Transportation Management Center (RTMC) – Reports – MnDOT: <http://www.dot.state.mn.us/rtrmc/reports.html>

Table 11. Minneapolis Challenges and Opportunities.

Technology Used intelligent lane control signs over each lane to enable tolling on the shoulder during peak periods and to control variable speeds on all lanes. Currently installing advanced transponder enforcement technology and fully digital pricing signs.
Institutional - Built political constituency in first MnPASS projects and looking for opportunities to expand HOT lane acceptance throughout the region. - MnDOT is the region's sole toll agency and has a close working relationship with the region's MPO.
Planning/Policy - Two separate HOT lane system planning efforts led to the adoption of a HOT lane system vision in the MnDOT and MPO long range transportation plans. - In-depth HOT lane planning and development are underway on several corridors. - The primary policy goals are to maximize the movement of people through corridors during congested periods, increase transit use and carpooling, and provide commuters with a reliable and sustainable congestion-free option. - MnDOT is currently considering interoperability policies.
Design - MnDOT used design exceptions as needed to fit lanes within I-394 and I-35W. For I-35W, these variations were made easier due to the project being a UPA grant project and being on tight deadlines. - The priced dynamic shoulder design on I-35W was facilitated by a successful history with shoulder bus lanes.
Operations - Each corridor has some operational variations (e.g., reversible dual lane segment on I-394, priced dynamic shoulder lane segment on I-35W, and gap in the HOT lane on northbound I-35E), but most operational features are the same as or very similar to each other among the corridors (e.g., common signing, occupancy and pricing rules). - The managed lanes are primarily a single-lane system. - Managed lanes operate only during weekday peak periods.
Financial - Objective of MnPASS is to manage congestion, not to maximize revenue. - MnDOT & transit agency negotiated revenue splits. - I-35W was almost entirely funded by the Federal UPA program, which was key in facilitating public and political acceptance. - A portion of the I-35E corridor is being delivered using design-build. - Utilizing high return-on-investment strategies is critical (e.g. implementing within existing infrastructure and right-of-way footprint; coordinating with bridge and pavement preservation work; including transit advantage improvements like Park & Ride lots). - Funding for HOT lane system expansion is a challenge when virtually all of MnDOT's revenue is going to preserve existing infrastructure.
Communications - Familiarity with existing MnPASS projects helped to facilitate understanding of I-35E project. Generally with each corridor there is a different set of users with different expectations. - Extensive public outreach and surveys conducted to determine the most acceptable mix of strategies to extend I-35E to the north. - Emphasizing expansion of transit benefits and travel choices is important. - Focusing on customer value is key.

HOT = high-occupancy toll

HOV = high-occupancy vehicle

MnDOT = Minnesota Department of Transportation

MPO = metropolitan planning organization

UPA = urban partnership agreement

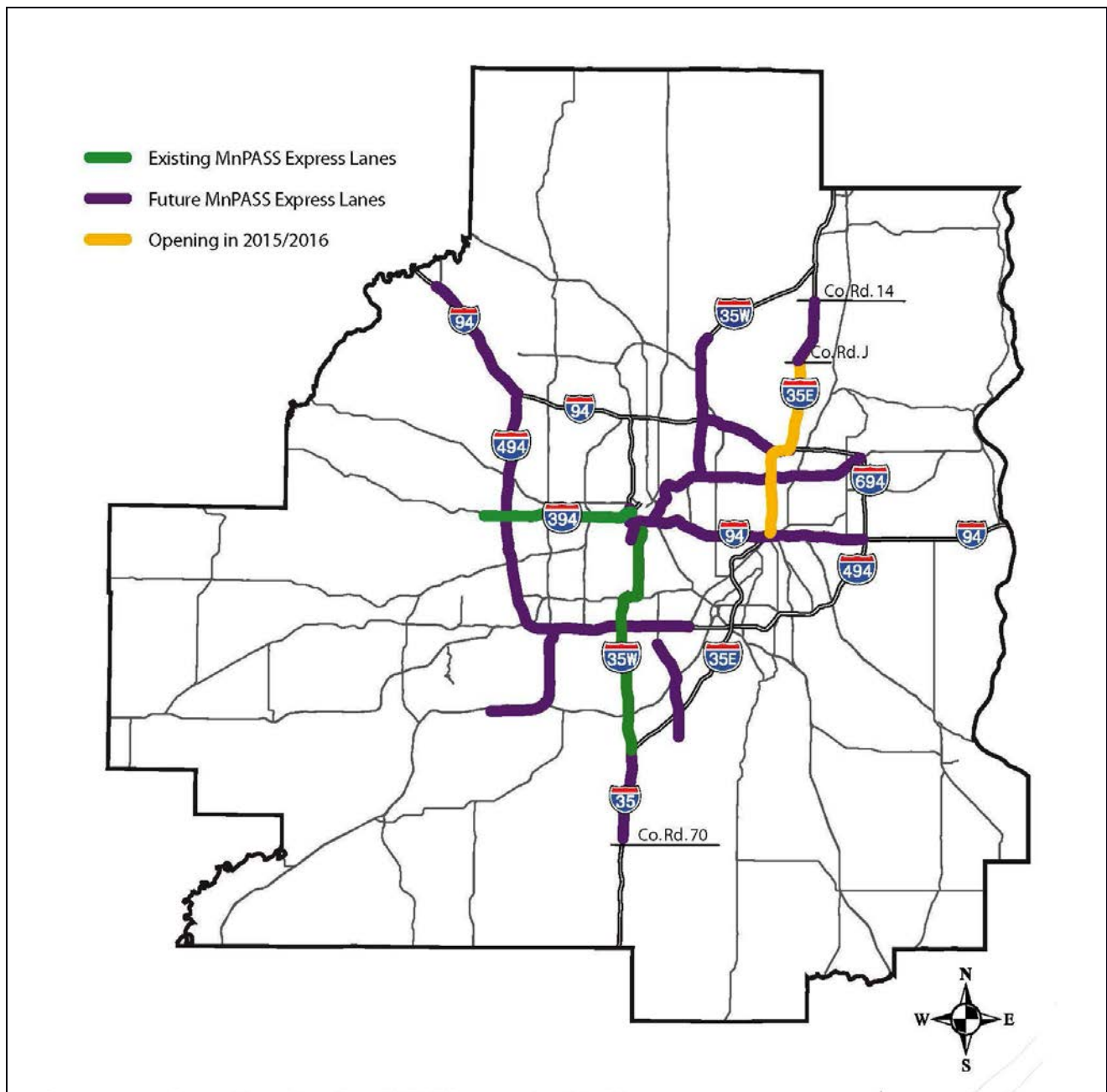


Figure 9. Map. The Existing and Future Managed Lanes in the Minneapolis/St. Paul Region.
(Source: Minnesota Department of Transportation)

HOUSTON, TEXAS

Houston's experience with managed lanes started in the late 1970's with the North Transitway (I-45) contraflow lanes. Subsequently, transitways (i.e. reversible managed high-occupancy vehicle (HOV) lanes) were developed along I-45 North (North), I-45 South (Gulf), I-10 (Katy), US 59 South (Southwest), US 59 North (Eastex) and US 290 (Northwest).

Highlights

- Katy Freeway represents full evolution from reversible HOV lane, to HOT conversion, to dual express toll lanes within rebuilt freeway.
- Strong partnership among State and regional agencies for planning, implementation and operation.
- Partnership and strong leaders contributed to effective public communication.

The transitways were primarily one-lane, reversible, barrier-separated facilities located in the median of a freeway. Houston Metropolitan Transit Authority of Harris County (Metro) and Texas Department of Transportation (TxDOT) jointly funded these projects under various agreements, which also involved Federal funding (Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) for the Gulf, North, Eastex, Southwest and Northwest corridors.

As this radial network of transitways was completed in the late 1990's, usage grew and several of the managed lanes started to have capacity problems due to high HOV usage. The region was also facing severe congestion on most of the general purpose lanes, leading to plans for freeway reconstruction and expansion on some corridors. The decisions that came next led to the development of second-generation managed lanes that also brought in pricing characteristics. The Katy Freeway (I-10)

serves as a good illustration of this evolution. The Katy HOV lane opened in 1984, and vehicle eligibility for the HOV lane gradually decreased from only transit and vanpools to all vehicles with two or more occupants. Growing travel demand led to overcrowding and slower speeds on the HOV lane during peak periods. In response, the Katy HOV lane was restricted to HOV 3+ during the peak hours, leading to "empty lane" syndrome.

In January 1998, the QuickRide pricing program began. The primary goal of this program was to increase the person throughput on the Katy HOV lane and in the Katy freeway corridor. The plan added pricing to allow HOV 2 users to "buy into" the HOV lane during the morning and evening peak periods—hence the name QuickRide. A post-implementation study that evaluated the QuickRide program found that demand for paid HOV-2 was relatively low and did not lead to significantly better freeway operations. During this time, TxDOT conducted an evaluation process to assess the current condition and future needs of the Katy Freeway corridor including the general-purpose lanes, the HOV lane, and local access roads. The study recommended a full reconstruction of the Katy Freeway. Due to the need for substantial capacity above what could be environmentally approved, two lanes in each direction were reserved as special use lanes.

The Harris County Toll Road Authority (HCTRA) made a proposal to finance the construction of the four special-use lanes in the median of the Katy Freeway between I-610 and SH 6 with the stipulation that the agency could operate them as a priced managed lane facility. The proposal by HCTRA to build, operate, and maintain the managed lane portion of the highway allowed the construction of the facility to be completed sooner. In turn, this action allowed TxDOT to prioritize funding for other managed lane corridors in the region.

Snapshot of other Houston Managed Lanes

NOTE: These are all considered first generation priced managed lanes.

Northwest Freeway (U.S. 290) QuickRide - Converted a reversible high-occupancy vehicle (HOV) lane to a high-occupancy toll (HOT) lane facility. The US 290 Northwest Freeway QuickRide conversion occurred in 2000 and was replaced in 2012 with a more advanced, dynamically priced ETC operation that allowed single occupant vehicles to pay to use the facility. This project is now in the process being replaced by an expanded, multilane, second-generation facility.

Gulf Freeway (I-45S) - Converted one reversible HOV lane to a HOT, HOV2+ free, time variable tolling (no tolling 7-8am / 4-6pm) lane with occupancy declared via declaration lanes at entrances.

North Freeway (I-45N) - Converted one reversible HOV lane to HOT (A1-33), HOV2+ free, time variable tolling lane with occupancy declared via declaration lanes at entrances.

Eastex Freeway (US-59N) - Converted one reversible HOV lane to HOT, HOV2+ / motorcycles ride free (5-11am / 2-8pm) lane.

Southwest Freeway (US-59S) - Converted one reversible HOV lane to HOT, time variable tolling, HOV2+ / motorcycles ride free (5-11am / 2-8pm) lane. Outer portion now transitions to one concurrent lane in each direction.

While Harris County Toll Road Authority (HCTRA) would operate the managed lanes, the general-purpose lanes remained under the jurisdiction of Texas Department of Transportation (TxDOT). A later pact with Metro was made in a tri-party agreement to allow transit vehicles to use the managed lanes for free as an effort to improve mobility on the corridor. This innovative delivery process provides a model for funding, operating, and maintaining the managed lanes. The tri-party agreement between TxDOT, HCTRA, and Federal Highway Administration (FHWA) was also innovative because it included components not commonly involved in the delivery of major transportation investments: These include (1) having a shared operating agreement, (2) financing the construction of managed lanes on an Interstate Highway through a county-based toll operator, and (3) using open road electronic tolling.

The Katy Freeway Managed Lanes on I-10, also referred to as the Katy Tollway, became fully operational in 2009. Two managed lanes operate (HOV 2+ discount) in each direction in the median of the facility, bounded by at least four general-purpose lanes in each direction and three or more frontage road lanes. The managed lanes terminate at the west end into a concurrent-flow HOV lane.

It was the first newly constructed managed lane project in Texas that included variably priced operations. The priced managed lanes occupy four lanes within the center of the freeway and contain channelized slip ramps with the general purpose lanes as well as flyover ramps with transit facilities and local streets. In 2014 HCTRA formally announced that they were no longer going to co-sponsor managed lane operations on the Katy Freeway Managed Lanes nor be a sponsor to the new US 290 Managed Lanes. TxDOT will likely take over sponsorship of these projects in 2015.

The Federal Highway Administration Role

Houston's first congestion pricing project was awarded under the Congestion Pricing Pilot Program in the late 1990s. Between 2002 and 2005, the Value Pricing Pilot Program (VPPP) funded pricing feasibility studies in Austin, Dallas, Houston and San Antonio to evaluate the feasibility of dynamic pricing.

The Dallas-Fort Worth area performed one of the first evaluations of pricing from a regional perspective. The Katy managed lanes helped to test the design for multilane treatments that have since been implemented on corridors in Texas and elsewhere.

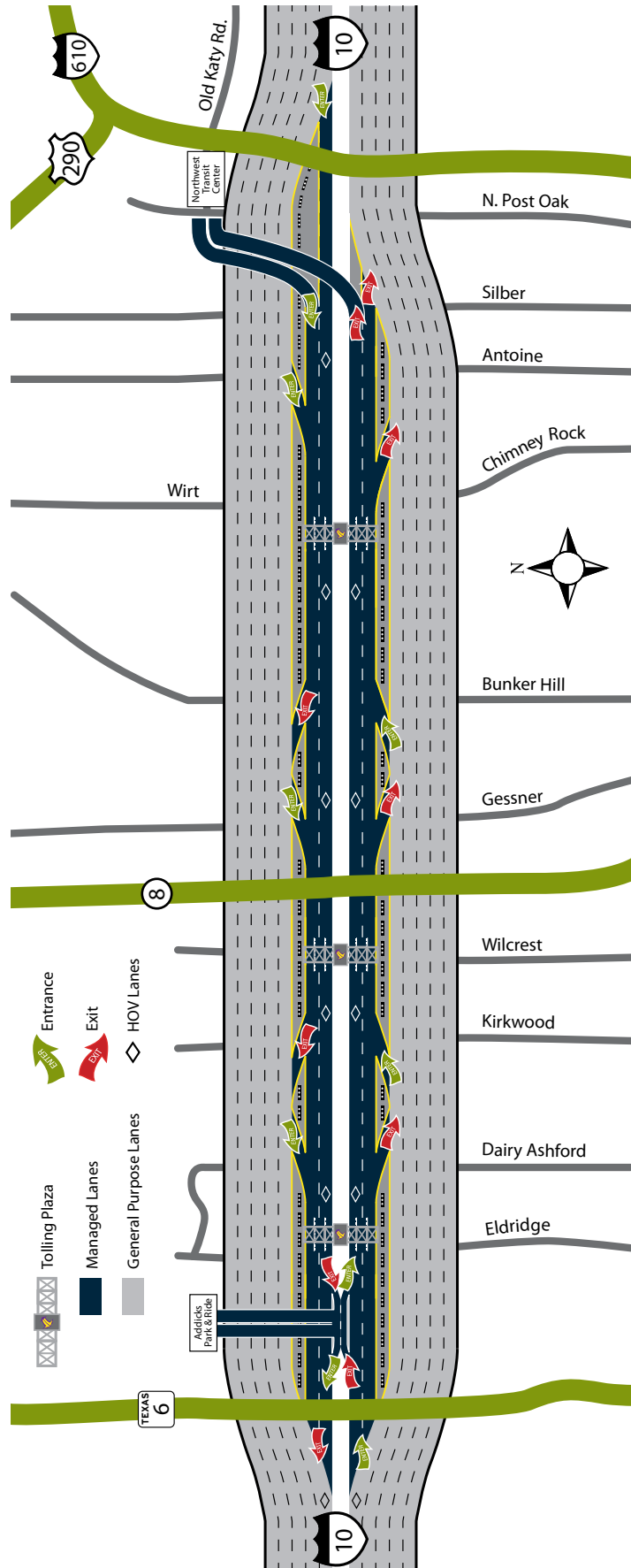


Figure 10. Diagram. The Katy Freeway Managed Lane Facility in Houston.
(Source: Harris County Toll Road Authority)



Figure 11. Photo. Gulf Freeway High-Occupancy Vehicle and High-Occupancy Toll Lanes at the Eastwood Transit Center in Texas.

Table 12. Evolution of Houston Managed Lanes.

Initial Design	• Single reversible HOV lanes on four radial freeways. Expanded to a total of six radial freeways by 1990s.
First Generation Pricing Project	• Converted reversible HOV lane to HOT. Katy Freeway charged HOV-2s during peak hours. Project was subsequently replaced by freeway reconstruction.
Second Generation Pricing Project	• Katy Freeway reconstructed and opened in 2009 with dual express toll lanes in each direction.
Next Steps	• Continue to work on priced managed lane system with Katy Freeway style reconstruction on US 290 corridor as funding permits. I-45N (North) is the only other corridor slated for some reconstruction, and HOT lane may retain same design. A new managed lane corridor is planned for the median of SH 288.

HOT = high-occupancy toll, HOV = high-occupancy vehicle

Table 13. Houston Challenges and Opportunities.

Technology • Included state-of-the-art tolling equipment as rebuild of Katy freeway. • Used existing HCTRA back office operations, enforcement, and transponder technology.
Institutional • Extensive coordination was needed between TxDOT, FHWA, and the Harris County Toll Road Authority. Later this group grew to include Metro to handle transit use of the managed lanes. • The effort had strong project champions at technical, agency, and political levels. • TxDOT has since needed to take over operations, as HCTRA has withdrawn from its role on the Katy and other regional priced managed lanes projects.
Planning/Policy • TxDOT determined that the original reversible lane HOT operation (originally intended only for a short term 5-8 year operational life) was unable to provide sufficient priority treatment for the long term, and a more robust strategy was needed.
Design • Two managed lanes operate in each direction in the median of the facility, bound by four or more general-purpose lanes and three or more frontage road lanes in each direction. • The roadways feature generous lane, shoulder, and buffer widths. • A wide inside shoulder at the tolling plazas gives enforcement vehicles a place to manually observe HOV occupancy compliance. • The Addicks Park-and-Ride Lot and the Northwest Transit Center are located at opposite ends of the Katy Managed Lanes project and provide services for users seeking carpools and transit services.
Operations • Having no formal concept of operations did not affect efficiency of operations, but would have been helpful in early concept design and placement of tolling infrastructure. • Differing occupancy policies created challenges in developing a seamless priced managed lane network. • Tolling operations are facilitated by long history of pricing in Texas.
Financial • Clear funding roles were achieved among the entities. • Funding was locally prioritized by agency partnering, thus accelerating the project schedule.
Communications • TxDOT and other local agencies built on the many years of experience with the Katy HOV and HOT lanes to build support. • Clear and coordinated messaging throughout project development and implementation contributed to the project's success.

HCTRA = Harris County Toll Road Authority
HOT = high-occupancy toll

HOV = high-occupancy vehicle
TxDOT = Texas Department of Transportation

SAN DIEGO, CALIFORNIA

The I-15 Express Lanes facility in San Diego offers an example of a priced managed lane project that contains an integral transit component. The I-15 facility, located northeast of downtown San Diego, started as a reversible, two-lane high-occupancy vehicle (HOV) facility that extended for 8 miles. Opened in 1988, the HOV lanes were underutilized for several years, with demand decreasing during the early 1990s. Also during this time, agencies sought to expand peak commuter transit service to the northeastern San Diego region.

Highlights

- I-15 started as reversible HOV lanes, then became high-occupancy toll (HOT), and is now operated as a dynamically-priced by-the-mile system on a 20-mile, bi-directional managed lanes facility.
- Emphasis on new transit service and use of toll revenues to help support transit operations.
- Success leading to express toll lane network expansion to I-5, I-805, and SR 52.

Using a Value Pricing Pilot Program (VPPP) grant from Federal Highway Administration (FHWA), San Diego converted the HOV lanes into a high-occupancy toll (HOT) facility. Renamed FasTrak, the I-15 HOT lanes' purpose was to better utilize the HOV lanes and ensure fast, reliable transit service. The managed lane operation was simple in that there was only one entry and exit point. Revenues from the HOT lanes were allocated to new corridor transit service, providing an additional travel choice to commuters.

The Federal Highway Administration Role

The FasTrak project was originally funded under the Congestion Pricing Pilot Program (CPPP). Future aspects of the project (exploring variable and dynamic pricing and enforcement) were funded under the Value Pricing Pilot Program (VPPP).

The success of the HOT lane conversion led to a major freeway reconstruction/expansion effort in 2012 between SR 163 and SR 78. This project added two HOT lanes in the existing section to create a bi-directional, four-lane facility and extended the project north by 12 miles, completing a 20-mile barrier-separated HOT facility. The managed lanes have a movable barrier that can allow various combinations of operations for the 4 combined HOT lanes and multiple access points to the general purpose highway lanes. In addition, direct access ramps, park-and-ride lots, and transit stations were added along the HOT lane section.

The HOT lanes allow HOV 2+ and transit to travel free, while single-occupancy vehicles (SOV) can buy into the lanes using dynamic pricing. This operation allows demand to be fully managed throughout the HOT lane facility.

The initial HOT Lane project included a new express bus service. Further expanded as part of the second-generation project, a 35-mile all-day bus rapid transit (BRT) line was implemented in 2014 connecting Escondido to downtown San Diego via the I-15 Express Lanes (branded as "Rapid"). Five direct connector ramps allow BRT vehicles (and carpools/vanpools/SOV toll users) access to off-line BRT stations and park-and-ride facilities. These connector ramps and stations are spaced roughly every 4 miles.

I-15 FasTrak currently generates toll revenues of nearly \$1 million per year for BRT service in the I-15 corridor. After covering operating expenses, the remaining revenues are earmarked to be spent on improving corridor transit service, an arrangement that helped to gain political and public acceptability of the project.

Due to the success of the FasTrak project, the San Diego Association of Governments (SANDAG) is working to expand the express toll lane network to I-5, I-805, and SR 52. Each facility will have unique character and design features but will have common branding and basic operating rules.

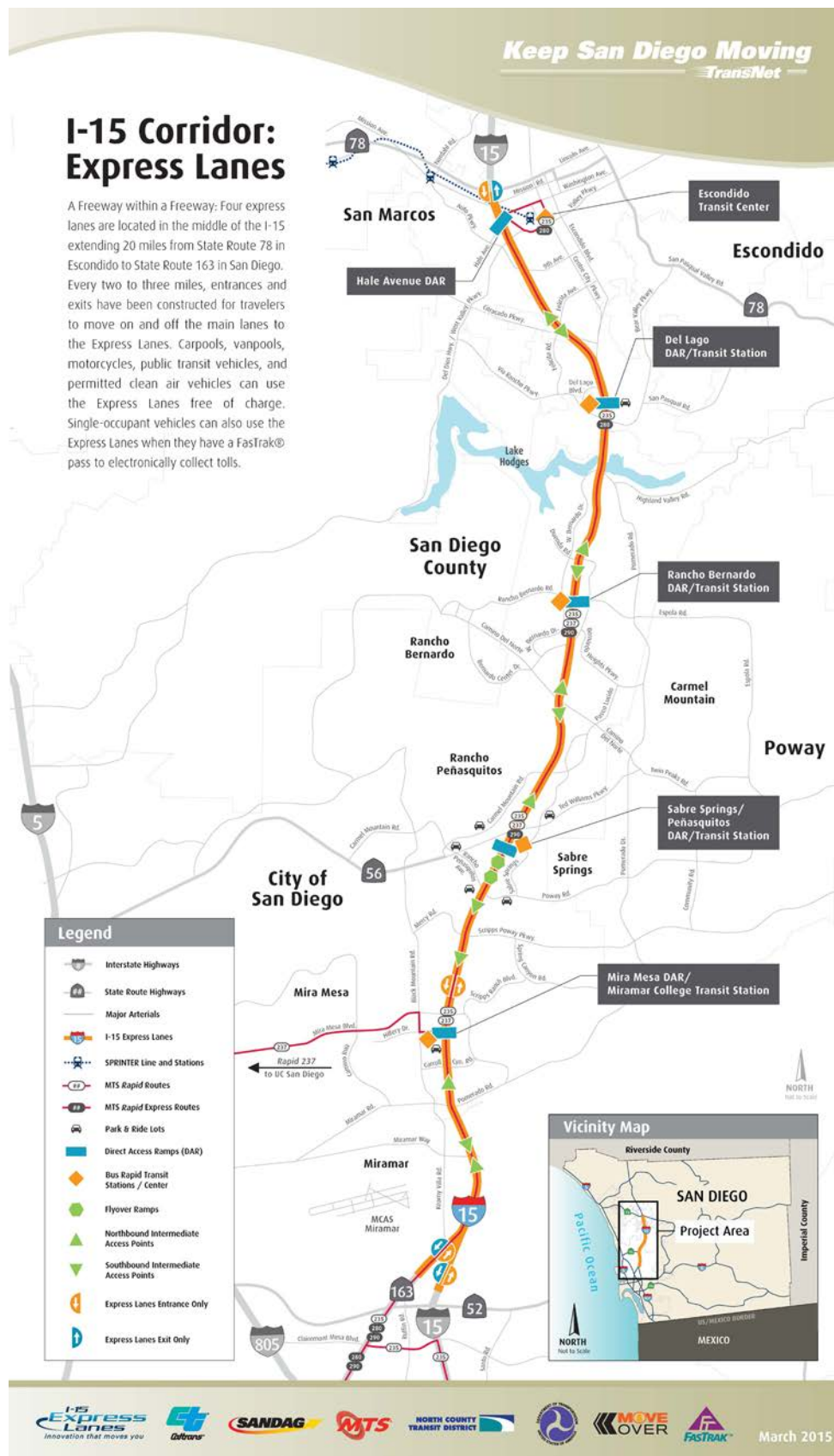


Figure 12. Screenshot. The San Diego I-15 Corridor Express Lanes.
(Source: San Diego Association of Governments)

Table 14. Evolution of I-15 Managed Lanes.

Initial Design	• Reversible HOV lanes with single entry/exit point (8 miles).
First Generation Pricing Project	• Converted HOV lanes to HOT lanes. Added peak express transit.
Second Generation Pricing Project	• Expanded HOT lane system to four lanes and extended to 20 miles. The system contains multiple access points and supporting facilities and services. All-day BRT service was also implemented.
Next Steps	• Plans exist to expand FasTrak on the I-5, I-805, and SR-52 corridors.

HOT = high-occupancy toll, HOV = high-occupancy vehicle



Websites

SANDAG, I-15 Express Lanes: <http://www.sandag.org/index.asp?projectid=34&fuseaction=projects.detail>.

Table 15. San Diego Challenges and Opportunities.

Technology • The complexity of dynamic pricing increased with the HOT lane extension and the addition of more access points. • SANDAG is investigating automated vehicle occupancy technology to identify and enforce a mix of users.
Institutional • The project had strong political champions. • The agencies involved needed to work out agreements to fund transit service from toll revenues. • SANDAG consolidated internal responsibilities to help facilitate implementation.
Planning/Policy • The project provided an opportunity to include new BRT transit service on corridor. • HOV 2+ vehicles were able to continue to travel for free on the corridor with multiple HOT lanes.
Design • Expansion required design integration of direct access ramps, transit stations, and park-and-ride facilities. • The facility features more complex signing for access and changeable toll rates.
Operations • Enforcement was simple during the first-generation phase due to single access points. Expanding the length and increasing access to the managed lanes creates additional enforcement needs. • Moveable barrier allows flexible management but must be adjusted regularly.
Financial • A major portion of revenues collected were earmarked to expanded transit service in corridor.
Communications • The public was supportive of extending HOT lanes and the supporting facilities and services. • Expansion of transit service with toll revenues addressed many of the equity issues.

BRT = bus rapid transit

HOT = high-occupancy toll

HOV = high-occupancy vehicle

SANDAG = San Diego Association of Governments



Figure 13. Photo. I-15 Express Lanes in California.

Summary

Priced managed lanes have evolved over the past 20 years. As these facilities transform from simple high-occupancy vehicle (HOV) to high-occupancy toll (HOT) lane conversions into major road expansions or regional networks, the planning, design, and implementation challenges are magnified. The case studies presented in this primer provide lessons learned in making these transformations and perspectives on how regions that have some HOV/HOT lanes can move to the next level of HOT networks or express toll lanes.

Each project and region is unique, but there are some cross-cutting lessons learned that should benefit future applications of second-generation priced managed lanes:

Technology

- Most second-generation projects are not constrained by technology, which is rapidly advancing.
- Second generation priced roadway projects are coinciding with advancements in vehicle detection and ability to employ dynamic pricing options.
- There is a need to provide transponders (with switchable features as appropriate) that can be flexibly used across a region.

Institutional

- Identify project champions to build a political constituency in the initial priced lane projects.
- Look for opportunities to expand those coalitions into other corridors or a regional network.
- Develop an organizational structure to oversee implementation and coordination among agencies.

Planning and Policy

- Develop regional transportation plans that include roadway pricing to help ease the implementation of priced facilities.
- Realize that a network of priced managed facilities will be phased over time. Plan each project for its unique features, but keep the broader vision in perspective.
- Consider network-scale decisions related to legal, financial and regulatory issues, so that the issues are not repeated for each project.
- Decide up-front who plans, designs and operates the facilities.

Design

- Provide a consistent design within and among corridors. The public needs to understand design treatments such as lane access and separation to safely navigate a network of priced facilities.
- Make sure there are well-designed connections between priced facilities.
- Use Intelligent Transportation Systems to manage traffic flow effectively and to provide consistent messaging to users.

Operations

- Develop a clear policy for priced lane user eligibility and toll rates. If part of a priced lane network is an HOV to HOT conversion, then the agency may need to continue eligibility for HOVs at free or reduced rates. This may complicate regional tolling policies for other corridors that have new express toll lane capacity added.
- Create a consistent process for motorists to declare their status within the lane. Reduce the need for switchable transponders to comply with different rules across corridors.
- Define standard operating procedures for the organization(s) responsible for running the facilities. Operating procedures are needed both between and within organizations. Procedures should become more regionalized as a network is deployed over several years.
- Coordinate back-office operations and traffic management centers.

Financial

- Expanding roadways or developing priced managed lane networks is more expensive and complex than HOV to HOT conversion projects.
- Agencies should be clear from the beginning about how and to whom revenues will be allocated.
- Multiple-lane priced roadways offer greater revenue potential and funding flexibility.
- New financial mechanisms may be appropriate, including public/private partnerships.

Communications

- Start early in the planning process to educate the public regarding the costs and benefits of the project(s).
- Clearly define the communication roles of each partner agency.
- Communicate how the toll rates work and any changes by time of day and corridor.
- Develop and apply a consistent branding that will be recognized and understood throughout a region.



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