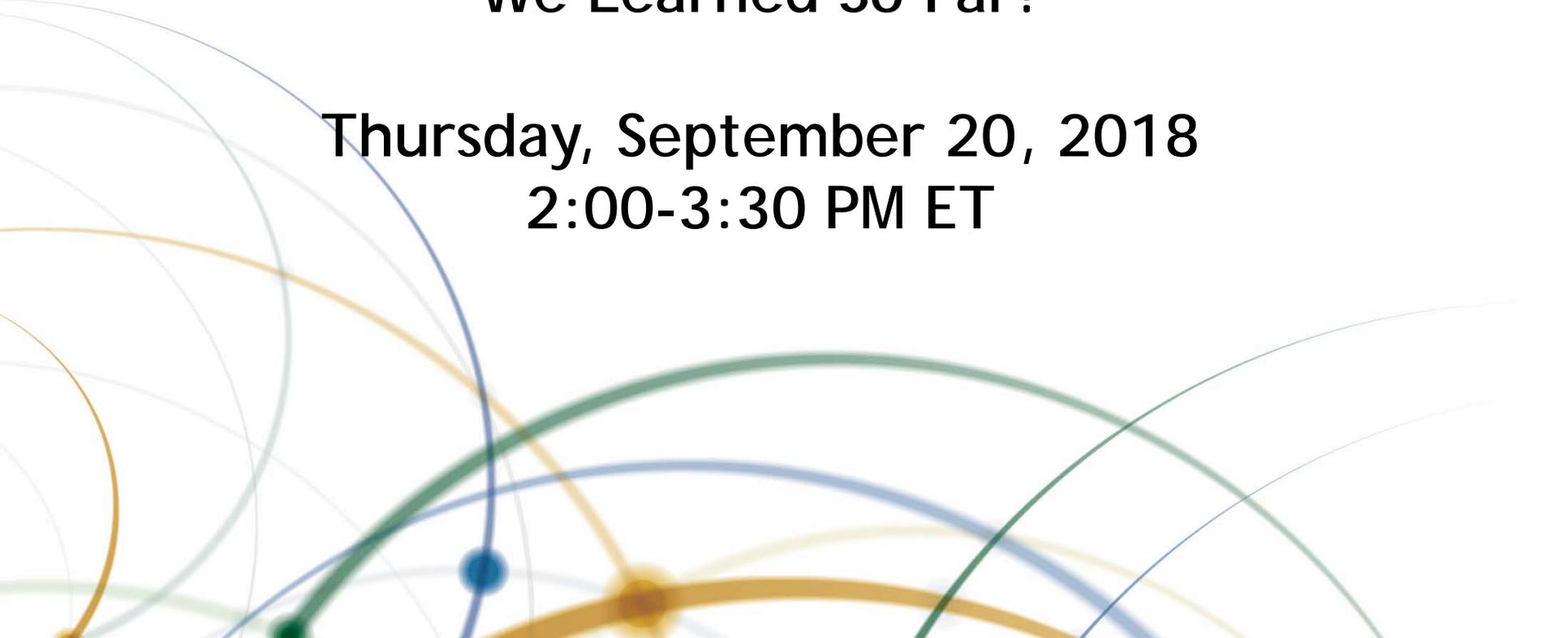


TRANSPORTATION RESEARCH BOARD

**Continuous Access Priced Managed Lanes: What Have
We Learned So Far?**

**Thursday, September 20, 2018
2:00-3:30 PM ET**



The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.



REGISTERED CONTINUING EDUCATION PROGRAM



Purpose

Share case studies from the operations of continuous access priced managed lane projects in California, Washington, and Minnesota.

Learning Objectives

At the end of this webinar, you will be able to:

- Identify current practices and characteristics involved in planning, procurement, design, and implementation of continuous access managed lanes
 - Describe the various design and system elements to include in the planning and design of these facilities and the implications of such choices
 - Identify common performance metrics to be used in evaluating continuous access managed lanes
 - Identify operational trade-offs when considering continuous access among the various design and operational approaches for managed lanes
- 



Continuous Access Priced Managed Lanes – What Have We Learned So Far?

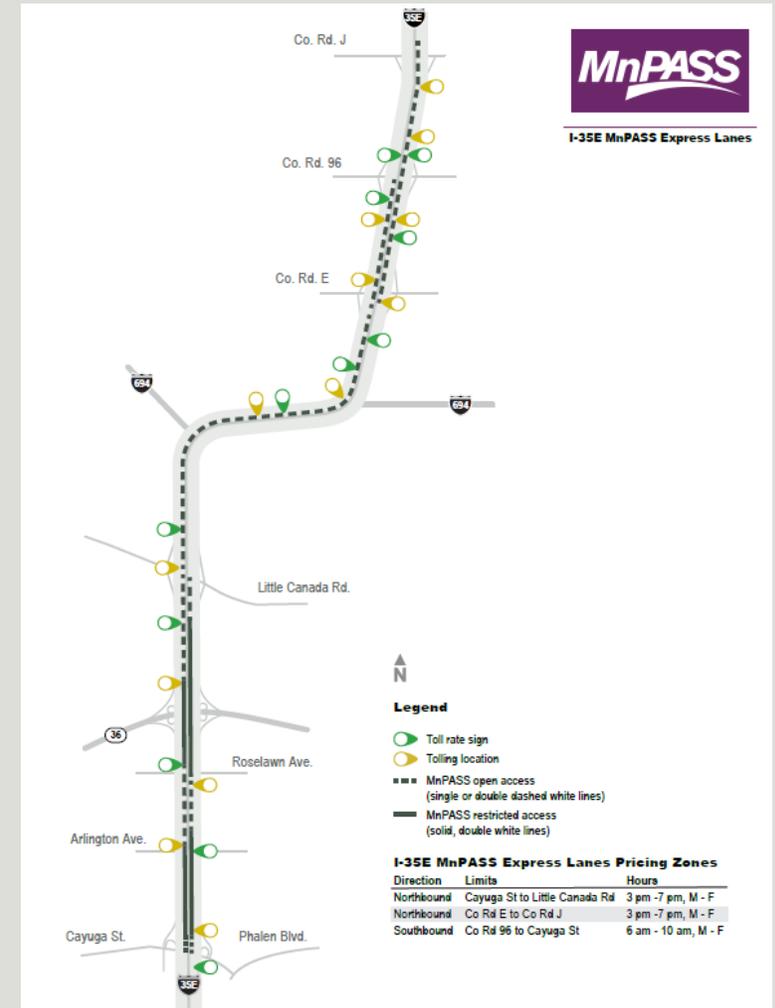
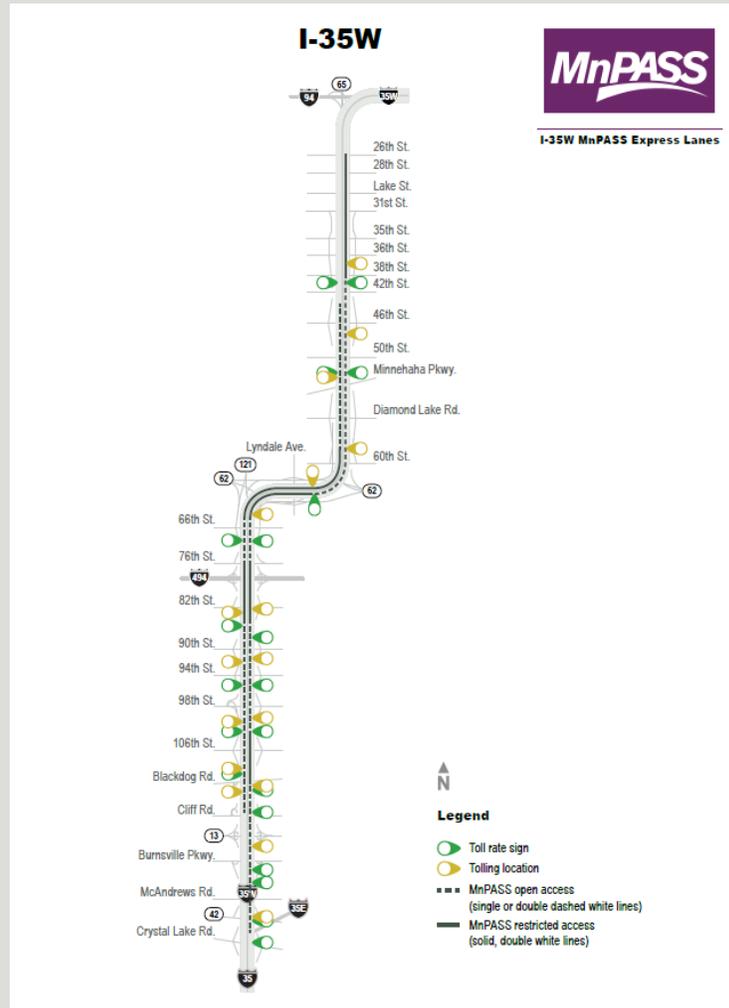
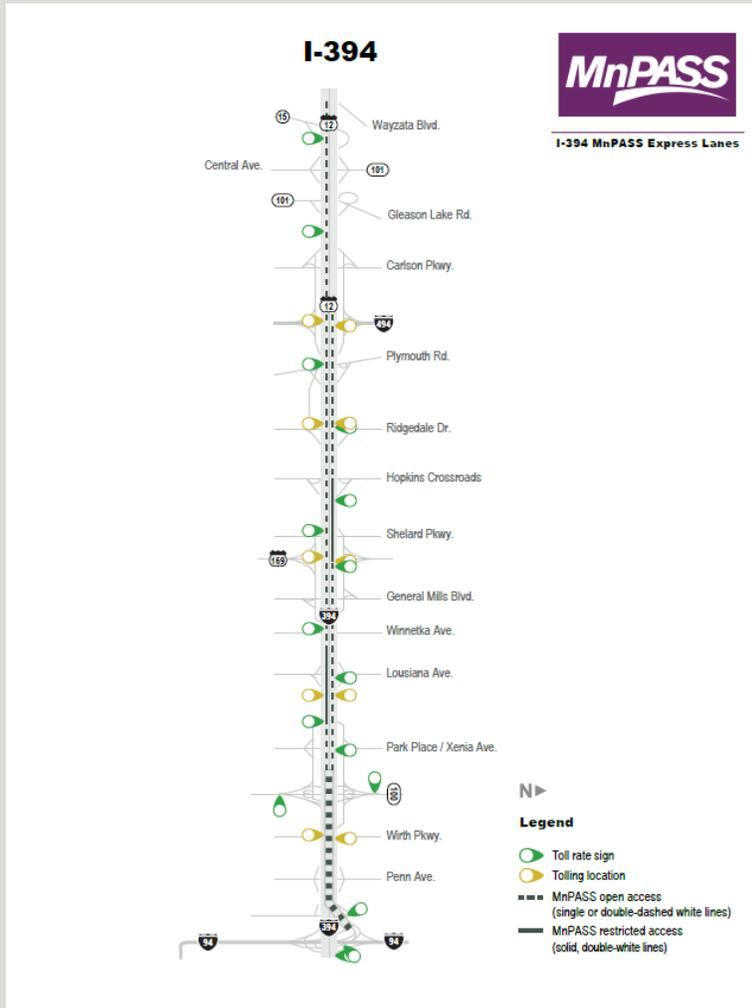
Kiet T. Ly
MnPASS Operations Engineer

John Hourdos
University of Minnesota

September 20, 2018

MnPASS.org/MnPASS.net

MnPASS Corridors Overview



MnPASS Express Lanes

- MnPASS = MN's system of priced managed lanes (or High Occupancy Toll Lanes)
- MnPASS lanes currently in operation:
 - I-394 since 2005
 - I-35W since 2009
 - I-35E since 2015
- MnPASS is a key strategy for improving the efficiency of the region's highway and transit systems by providing a reliable, congestion-free option for commuters during peak-travel times.



What are the Benefits of MnPASS?

MnPASS lanes reduce and better manage congestion in a manner that's sustainable over the long-term by:

- **Increasing person throughput**

A single MnPASS lane can carry twice as many people as a single general purpose lane during peak-hour congestion

- **Improving travel time reliability**

Transit buses and commuters can plan for and rely on a 50-55 mph trip in a MnPASS lane (general purpose lanes are much less reliable)

- **Improving bus transit service/ridership and increasing carpooling**

More than 80% of the people using the MnPASS lanes are either riding on buses or in carpools

Lanes Separation Overview

- When I-394 MnPASS was constructed, the access spacing was very limited with about 80% of the MnPASS lane being restricted by Double Solid White Lines with access locations roughly every mile.
- On I-35W, only about 25% of the MnPASS lane has restricted access with most of the corridor being open with the exception of major bottleneck locations and high congestion areas at the Minnesota River Bridge, I-494 interchange, and Hwy 62 interchange.
- I-35E has similar characteristics as I-35W.

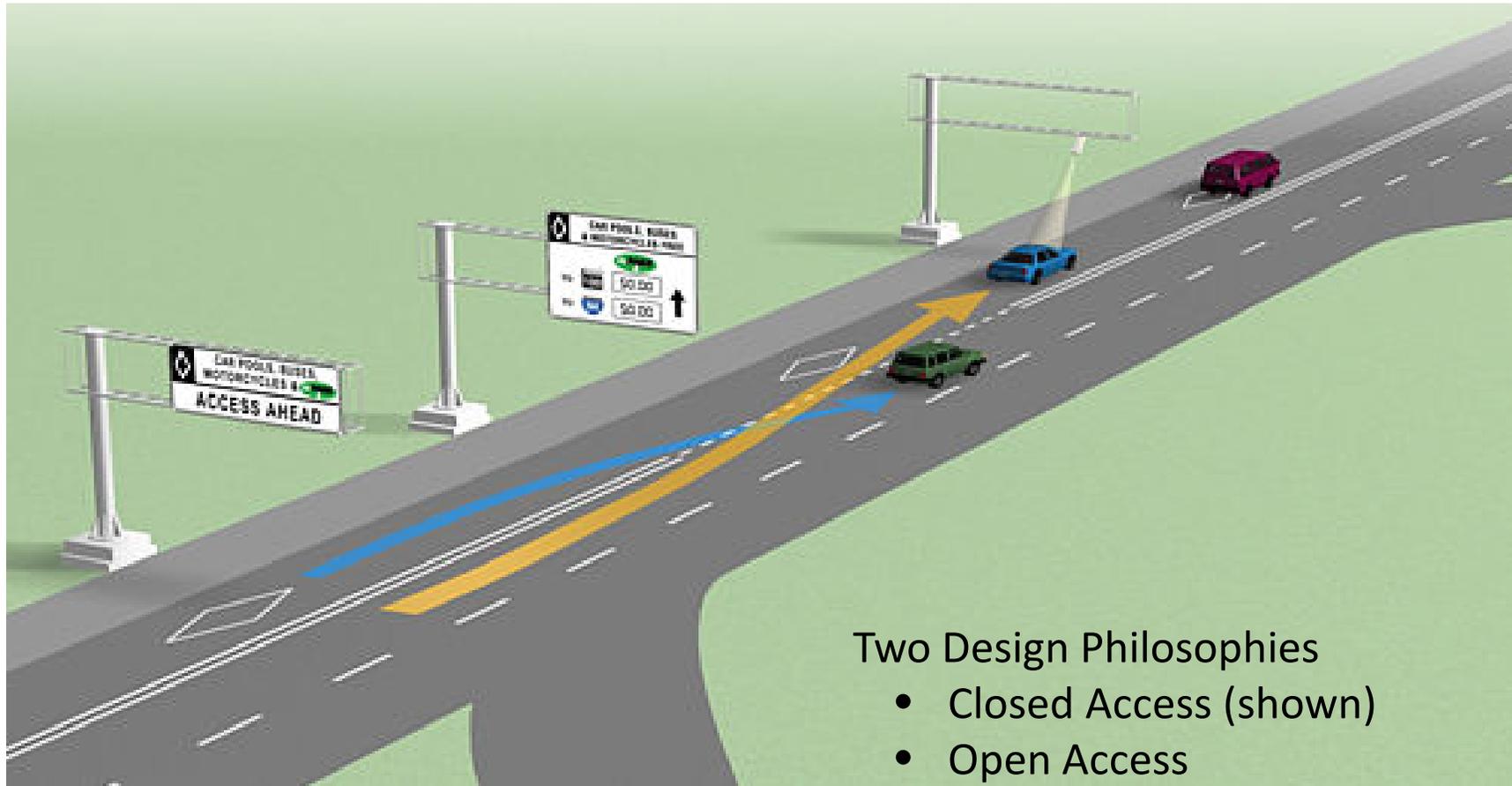


Lanes Separation Overview

Differences in opinion related to MnPASS access spacing led to different designs on I-394 and I-35W:

- When 35W MnPASS was implemented, we wanted a more open design to allow more flexibility for users to get into the lane which would hopefully increase usage. However, on I-394, we had gotten complaints about limited access and people not being able to get in when they wanted to. Transit even had concerns as they would sometime have to wait in congestion to get to the access point rather than jumping into the MnPASS lane before the congestion started. Since 394 and 35W had different designs, we had an opportunity to study which worked better in terms of mobility and safety.
- The study found that both access designs work, but more open access may be favorable in most locations to give motorists more opportunities to enter and exit the lane. The study did however find that as traffic volumes in the MnPASS lane increases, there is a need to maintain segments of Double Solid White Striping in high congestion areas.

HOT Lane Access



- Difference is in the ratio between the lengths of
 - Restricted Lane Change sections (double white line) and
 - Allowed Lane Change sections (broken white line)

Two Different HOT Lane Access Philosophies

Interstate 35 W

“Open” Access design.

- 25% Double White
- 75% Broken White



Interstate 394 (original)

“Closed” Access design.

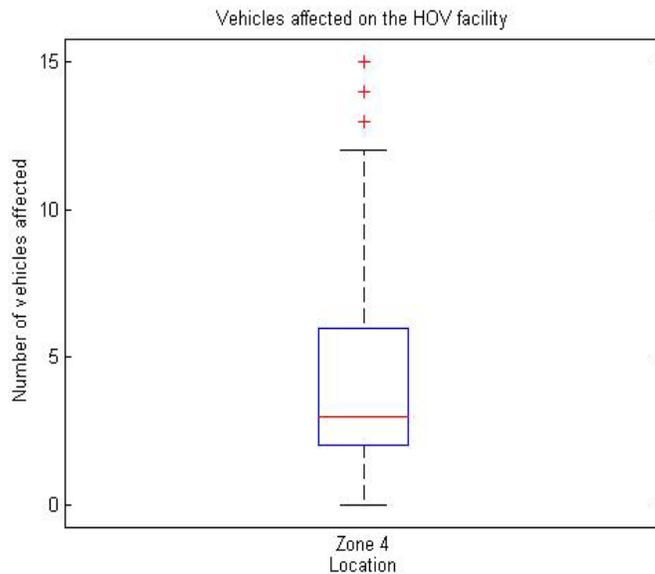
- 80% Double White
- 20% Broken White



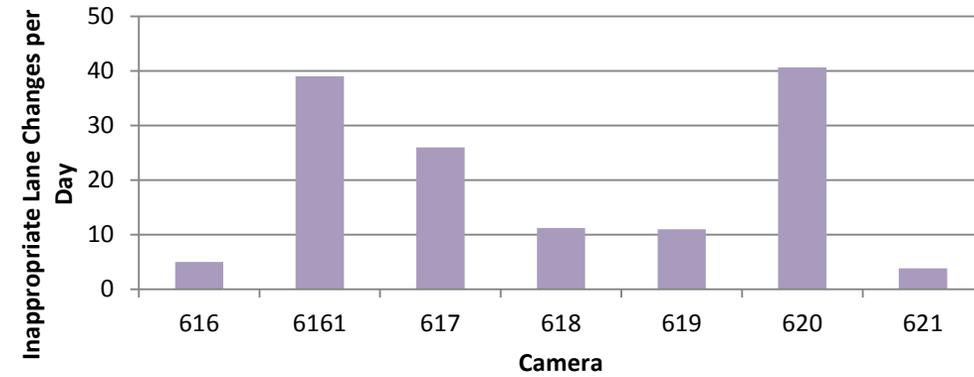
Research Objective #1

- Evaluate and compare the two design philosophies of Restricted and Open access design in terms of Safety and Mobility.
 - Define metrics for assessing mobility and safety
 - Detect and measure shockwaves
 - Shockwave frequency is a surrogate for mobility issues
 - Shockwave length is a surrogate for safety issues
 - Test the hypothesis that the open access design of I-35W produces significantly more "near misses" than the closed access design of I-394

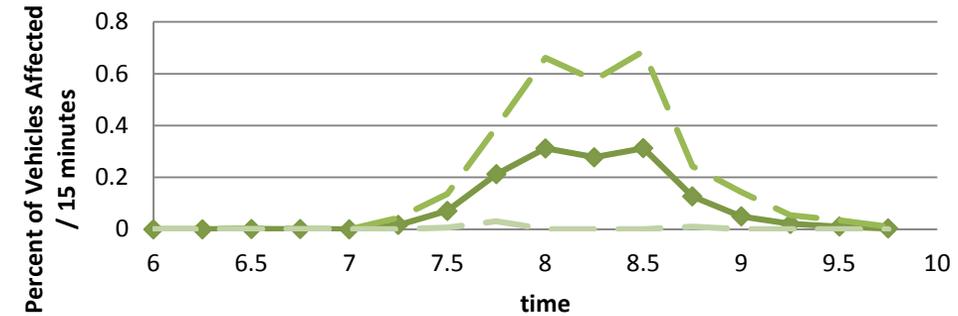
Zone 4: Northbound Highway 62 to 38th street



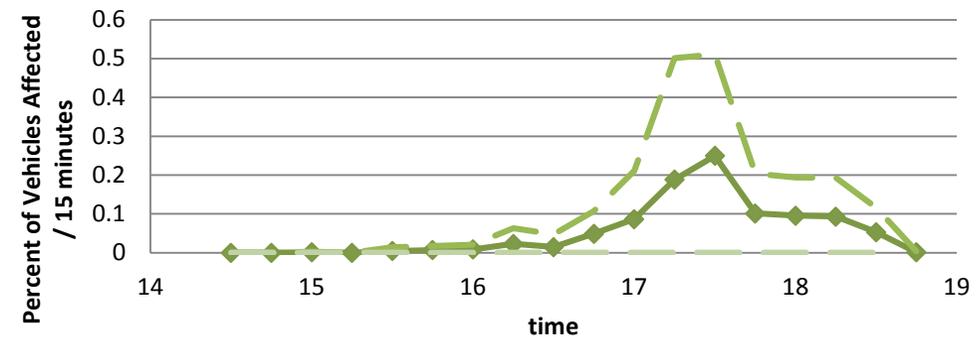
Average Inappropriate Lane Changes per Day AM



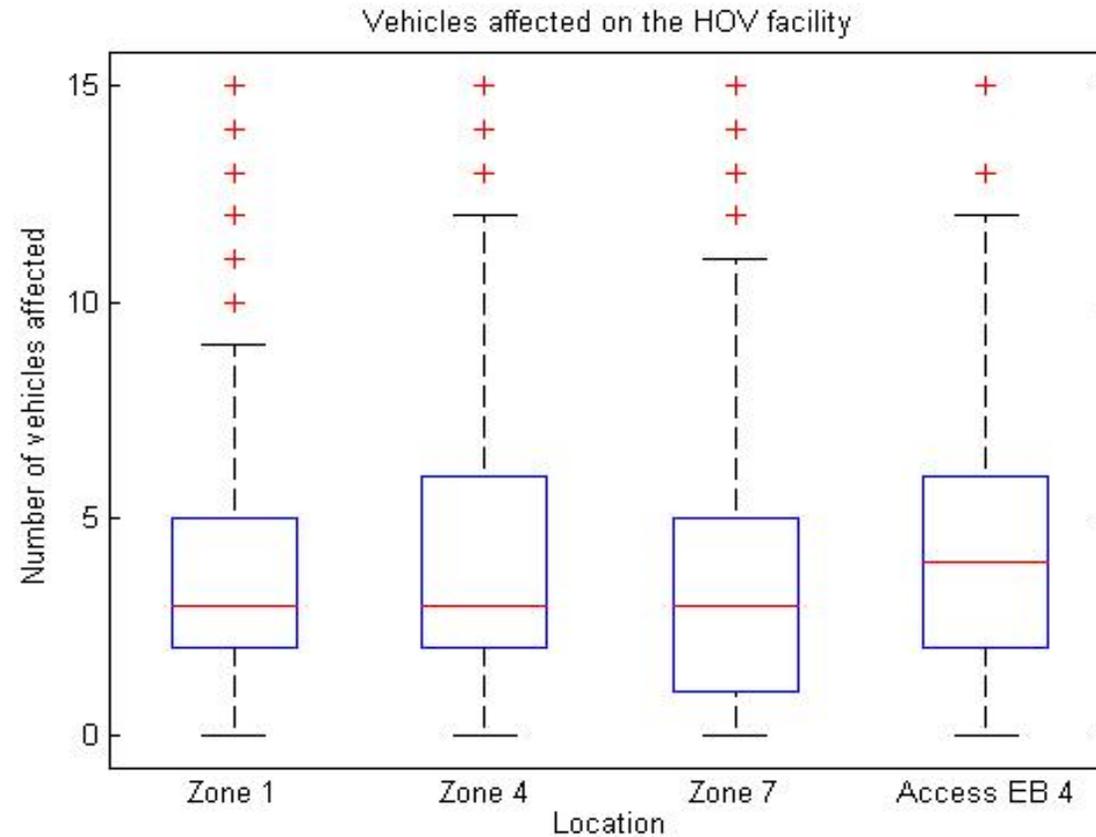
Average Percent of Vehicles Affected by Shockwaves AM



Average Percent of Vehicles Affected by Shockwaves PM



Comparison between facilities on I-394 (original) and I-35W



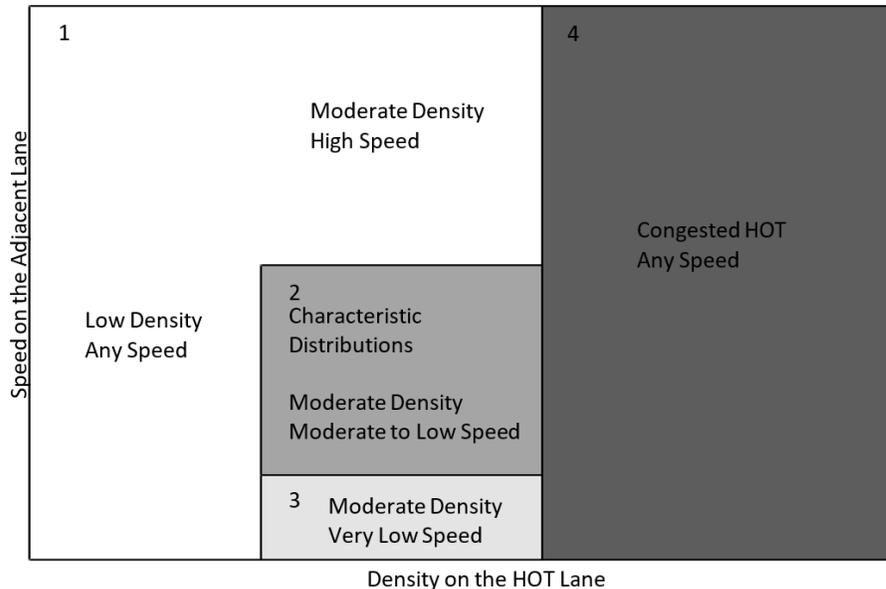
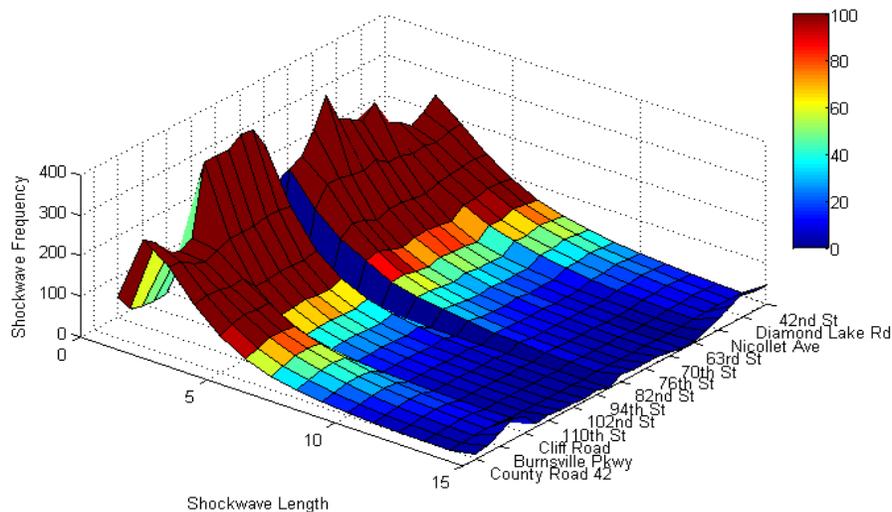
Analysis Findings

- Today each access type works well on its respective freeway
- Shockwave activity similar between sites
- “Gates” attract more lane changes
 - Worked well on I-394 since 90% of demand comes from three distinct interchanges.
- Open Access on I-35W provides better service
 - Demand on I-35W spread over more interchanges
 - Interchanges are more frequent.
 - In the future MnDOT may have to restrict access in high congestion areas (or raise the price).
- **Need to know when to restrict access and if access must be restricted how to design the gates.**

Research Objective #2

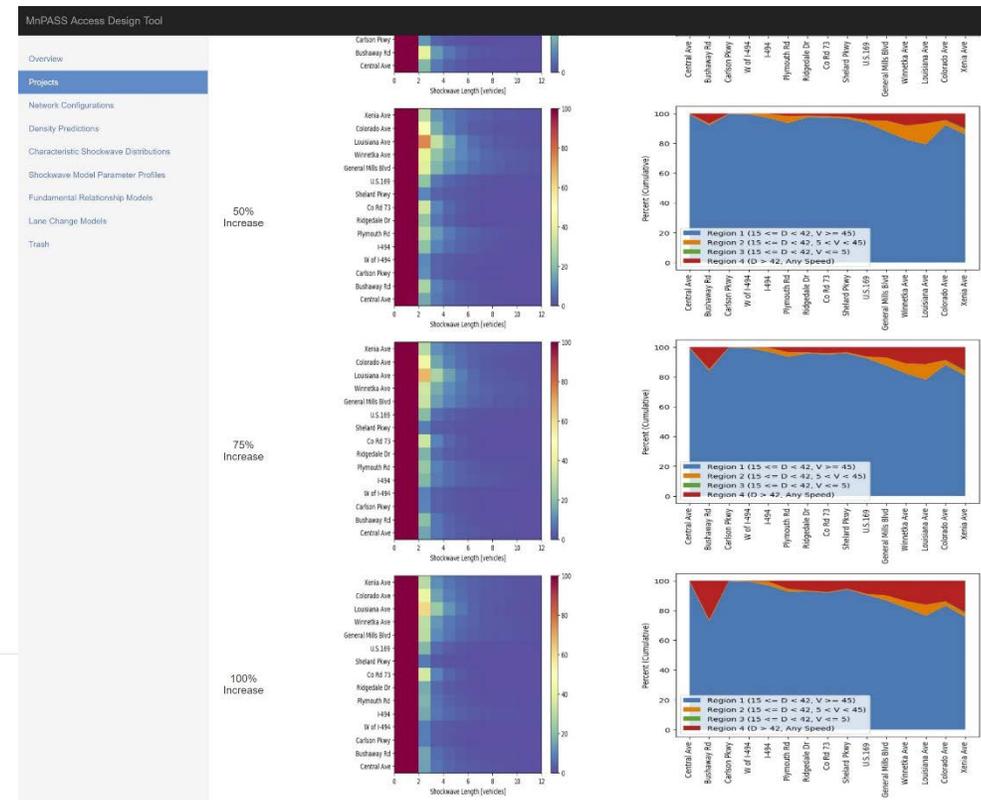
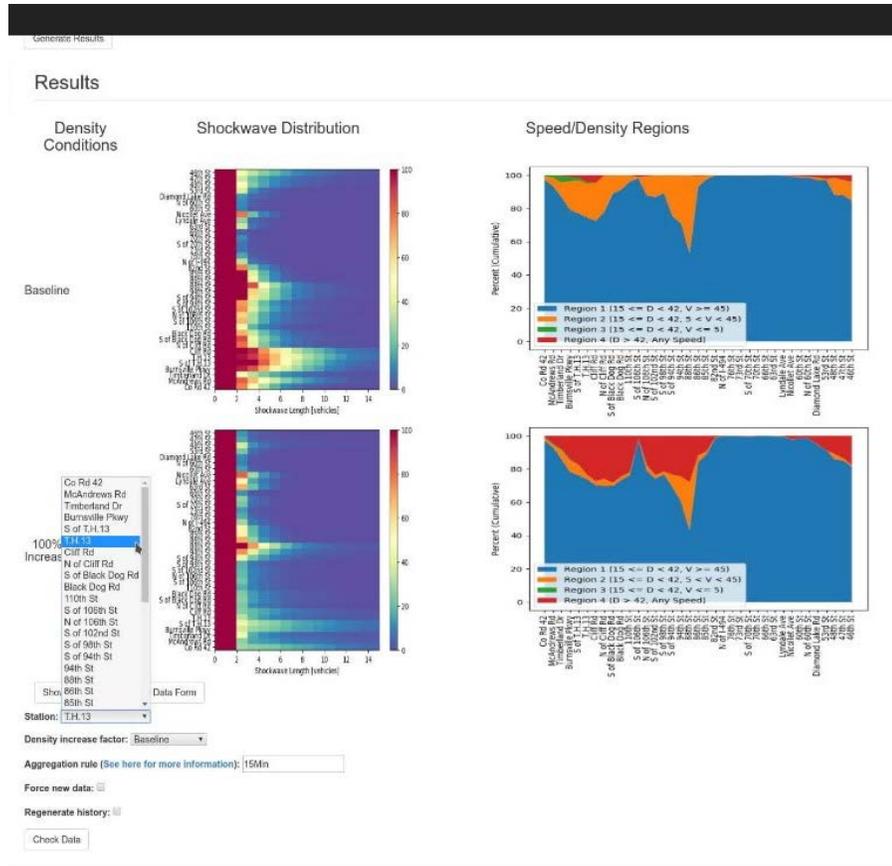
Develop a methodology that would identify locations where the access to the HOT lane should be restricted.

- Monitor current facility status and compare with historical values.
- Predict future conditions of mobility and safety assuming hypothetical changes in HOT demand.



MnPASS Access Design Tool

Utilizes car following and lane changing models combined with flow-density relationships and Monte Carlo simulation.



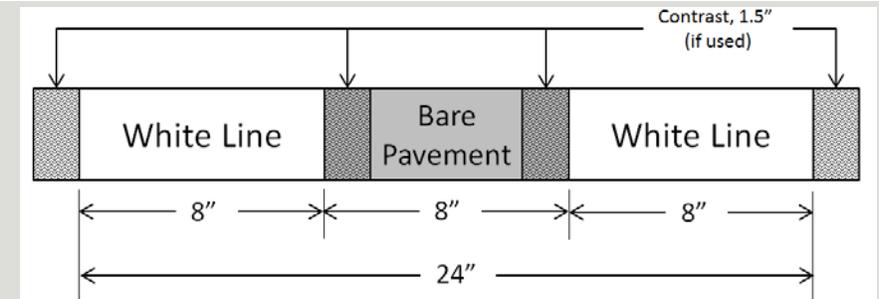
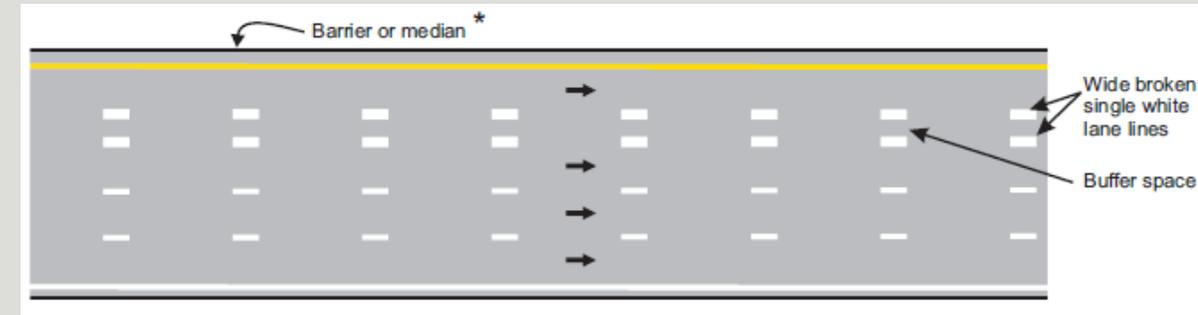
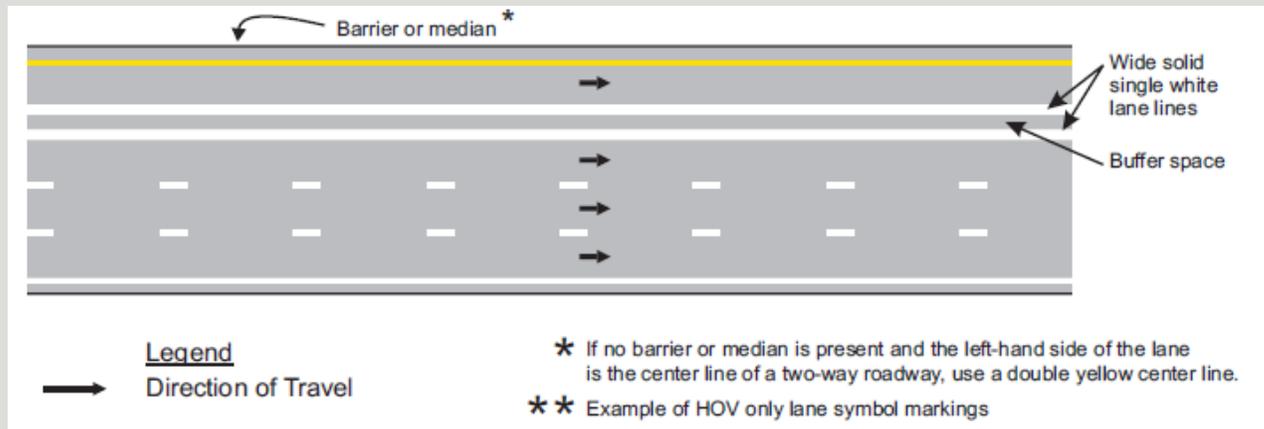
Research Objective #3

Develop a methodology and tool to determine optimal lane changing regions on Closed Access sections.

The screenshot displays the MnPASS Access Design Tool interface. On the left is a navigation menu with options like Overview, Projects, Network Configurations, Density Predictions, and Simulation/Results Plot Parameters. The main area contains simulation settings such as Aggregation rule (15Min), Force new data, Regenerate history, and Simulation/Results Plot Parameters. A warning message states: "WARNING! 15% of density data at station Louisiana Ave for the selected time period is above the critical density of 45 VPM! Density data is capped at this level in the model, which may cause erroneous results. It is recommended to select the next station, but you may proceed at your own risk!". To the right is an Access Restriction Diagram showing a road layout with detectors for downstream and upstream stations, gate start and end percentiles, and distances to ramp gore. Below the diagram is a Histogram of Simulation Results and Gate Design Recommendation, showing the number of observations versus distance from station (ft). The histogram indicates a design distance from station of 737.0 ft and a suggested end point of 1265.0 ft (Gate Length: 528.0 ft).

Conclusion

- Since the study showed open access worked well, we decided to make 394 and 35W open access during a paving project and future MnPASS projects.
- Further evaluate the study and analyze “before and after” conditions.
- MnPASS Access Design Tool
- Implements the recommendations in Design Technical Memorandum No. 16-04-TS-01 “MnPASS Lanes Design and Implementation Guidelines”.



MnPASS Enforcement

- Planning
- Operations
- Enforcement
- CSC



Thank you!

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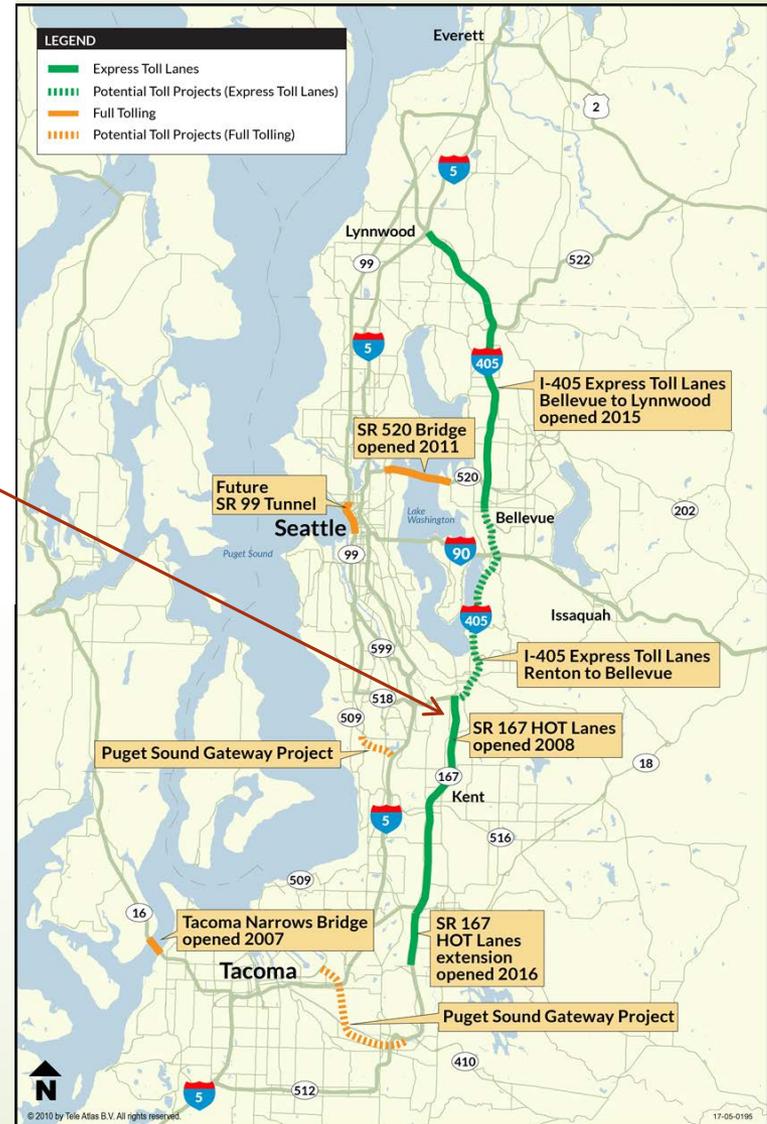
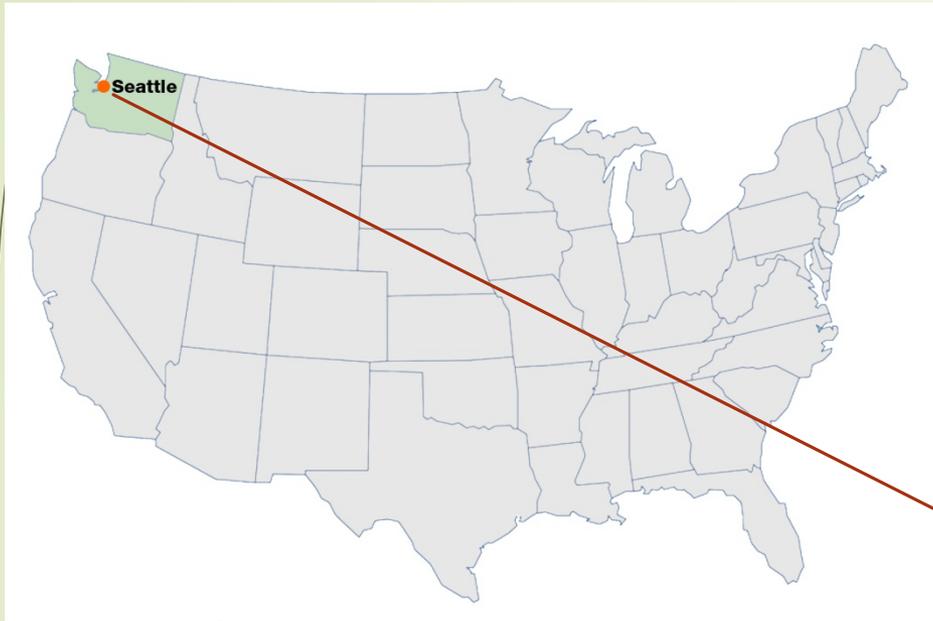
Continuous Access Retrofit

SR 167 HOT Lanes Continuous Access Demonstration Project

Tyler Patterson
System Operations Manager

Webinar
September 2018

Where in the world is SR 167?



Current tolled facilities:

- Tacoma Narrows Bridge (2007)
- SR 167 HOT Lanes (2008)
- SR 520 Bridge (2011)
- I-405 Express Toll Lanes (2015)

SR 167 HOT lanes overview

Why HOT lanes on SR 167?

- Highly congested route
- Under-used HOV lanes at 2+
- Provide drivers a choice

- Opened May 3, 2008
- Tolls adjust automatically to keep HOT lane traffic flowing at 45 mph or faster
- Going on 11 years of a 4 year pilot



SR 167 HOT lane features

- Free to buses, 2+ carpools and motorcycles
- Solo drivers pay a single toll to travel any distance on route
- *Good To Go!* pass required for non-HOV
- Single HOT lane in each direction
- Electronic signs indicate toll rate before each entry point
- 14 access points
- **Limited access** – HOT lane separated from general purpose lanes by double white line, which is illegal to cross



Pre-HOT lanes:

SR 167 had two general purpose lanes and one HOV lane.



Post HOT lanes: HOV lanes were converted to a single HOT lane in each direction.

SR 167 HOT lanes meeting goals

HOT Lanes are meeting objectives

Objectives	Goal Met?	Accomplishments
Free Flow Traffic	✓	<ul style="list-style-type: none">• HOT lanes Speeds >45mph• Travel Times more reliable
Reduced Congestion	✓	<ul style="list-style-type: none">• Daily tolled volumes up• Corridor transit volumes up
Improved Safety	✓	<ul style="list-style-type: none">• Average collision rate• Incident response time down
Demonstrated Ability to Finance Improvements	✓	<ul style="list-style-type: none">• HOT lanes generating revenue since April 2011
Equitable Use of Facility	✓	<ul style="list-style-type: none">• Annual surveys show both low and high income drivers use HOT lanes

Why restricted access on SR 167?

We thought it would:

- Reduce toll evasion
- Help enforcement
- Improve safety
- Serve the long trips
 - *A highway within a highway*
- It was what all of our friends were doing!
- Implemented 1500' - 2000' long access points
 - Access located just downstream of on-ramps
- Illegal to cross double white line
- \$136 ticket by WSP



Listening to customers

"Our members have indicated that the number one complaint they have received for the SR 167 HOT Lane Pilot Program is the access control restrictions." - PSRC

ILLEGAL
TO CROSS
DOUBLE
WHITE
LINE

"Too many drivers violating the double white line crossing restrictions without any apparent penalties. Creates a real safety hazard." - survey respondent

"We have seen already that dedicated access points can make it difficult for transit to use if not located appropriately...a continuous access treatment would remove this uncertainty for transit." - Sound Transit

2011 University of Washington Access study

8

Findings:

- ▶ Drivers cross double white lines to get **into** the HOT lane
- ▶ Wait for safe gap
 - May not have safe gap while driving length of access point
 - Access point may not be conveniently located to reach exit
- ▶ Signal before changing lanes
- ▶ The sheep follow the flock



Improving SR 167 HOT lane access

\$520,000 Federal Value Pricing Program grant to demonstrate more-open access on the SR 167 corridor.

Funding includes:

- Restriping and signage changes
- Public information and outreach
- Evaluating new access

Project goals

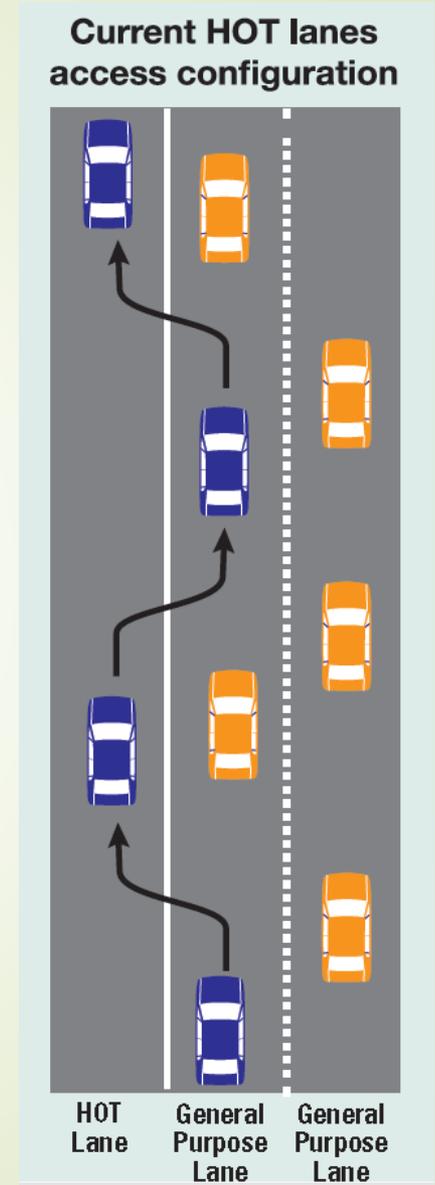
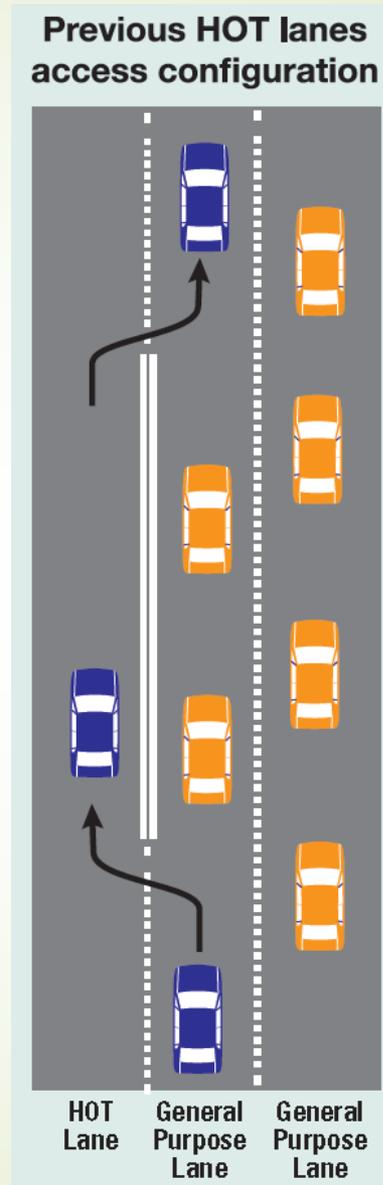
- Improve access for HOT lanes drivers
- Evaluate effects on revenue
- Understand customer responses, attitudes and concerns
- Determine if the new HOT lane access works

Striping changes

- Accomplished via a design-bid-build project
- Project duration three weeks

Work Activities

- Remove second white stripe to create one continuous solid stripe separating the HOT toll and general purpose lanes.
- Left double white stripe at the start and the end of the HOT lane



Signing Changes

Work Activities

- ▶ Signing removals and changes



Install Plaque on Existing Access Signs (8 signs). Plaque will say PASSES ONLY.



Illegal To Cross Double White Line Sign - to be removed (41 signs).



Next Exit Signs - to be removed (8 signs).

Initial SR 167 Continuous Access Results

WSDOT's Initial Results

Traffic

- Increased volumes in HOT lanes (both paying and non-paying)
 - 10% growth in transactions
 - HOVs are largest increase
- Slightly decreased speeds in HOT and GP lanes

Revenue

- Increased toll revenue
 - 50% in September 2014, but returned to normal
- Increased toll rate
 - More frequent high prices
 - \$9 maximum toll reached more often

Customers

- Increased customer satisfaction
- Increased complaints about price
- Decreased complaints about violators

Safety

- No dramatic change



December 2014 customer email survey

- More convenient: 82 percent agree
 - Easier to use: 80 percent agree
 - More useful: 77 percent agree
 - Slower: 21 percent agree
-
- Sent to 44,000 customers; nearly 4,000 responded

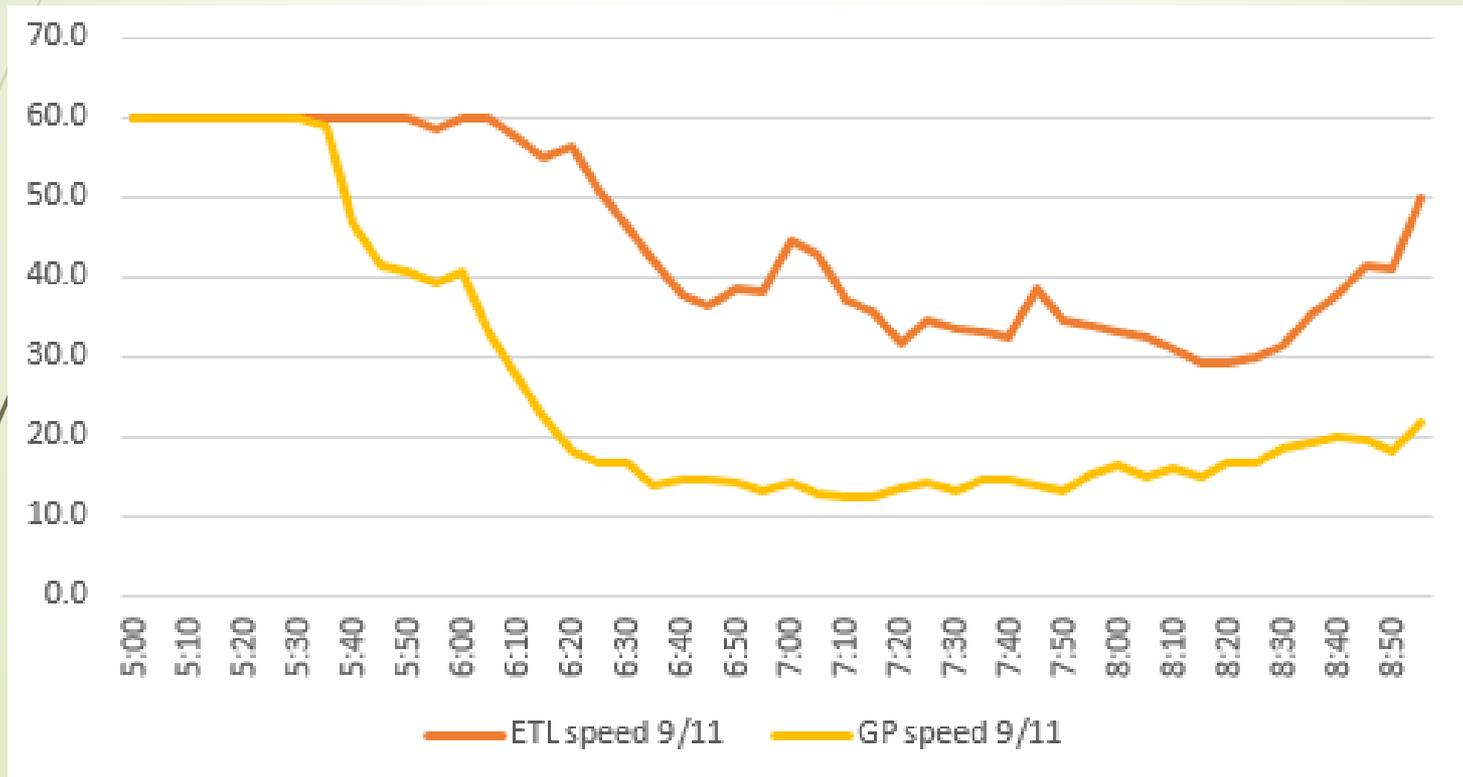


Friction

General Description: "Sympathy Slowing"

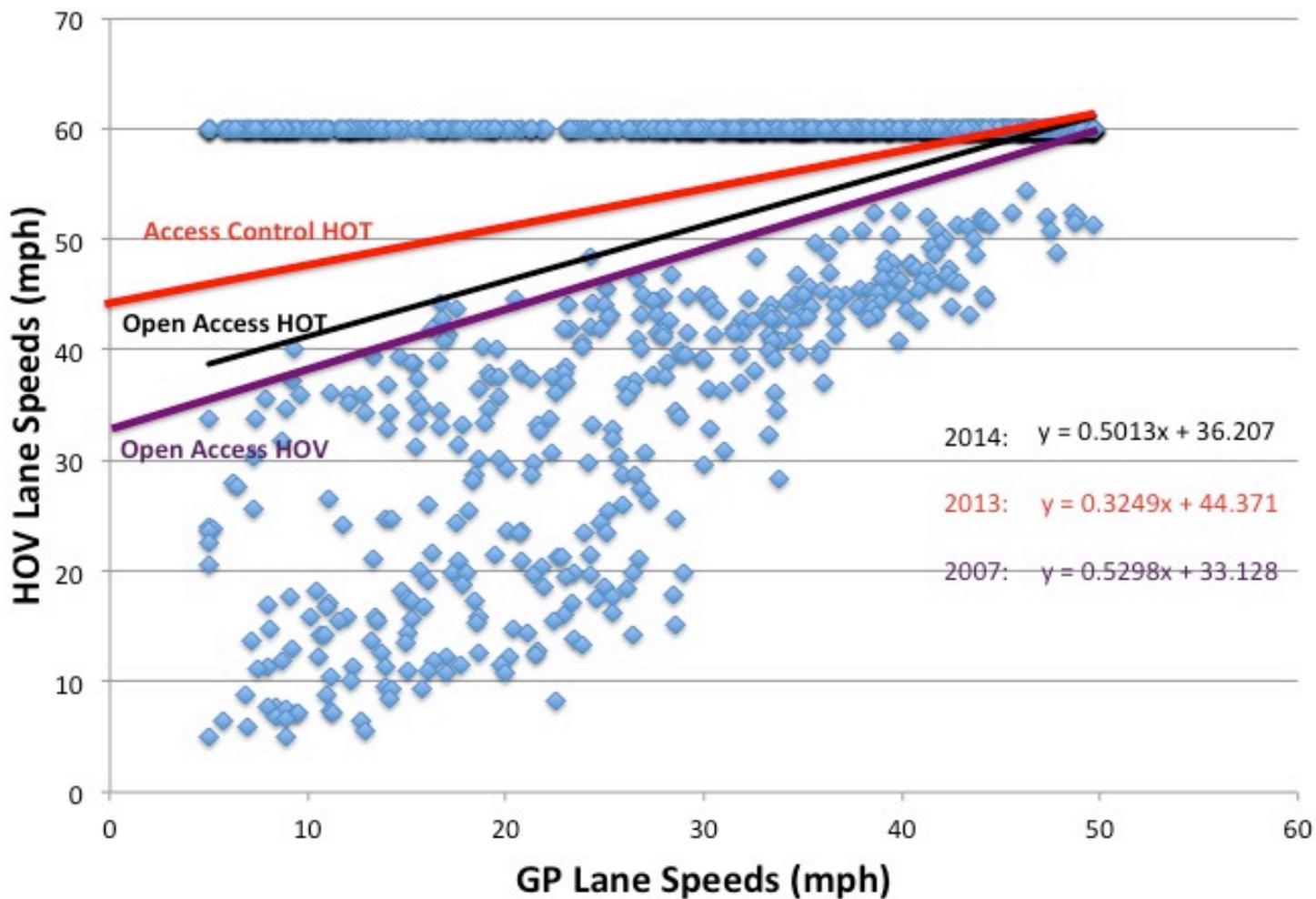
- Depending on the horizontal spacing between the GP lanes and ETLs, drivers feel uncomfortable with a sizable speed differential.
- Speed differential rarely exceeds 20 mph under the best conditions

I-405 Express Toll Lane Speed vs. General Purpose Speed (9/11/2018)



Friction Effects: HOV Lane Speeds Versus GP Lane Speeds

2007: Open Access HOV, 2014: Open Access HOT, 2013: Restricted Access HOT



Observations

Drivers use the very left side of the HOT lane

- Seems to be more pronounced than before

Drivers will stay in the HOT lanes as long as possible (exit late)

- No change

Drivers will enter the lanes when they see the value in front of them.

- Previously drivers merged into the lanes as quickly as possible based on price.

Drivers enter the lanes without even seeing the price, but don't seem to be using it as a queue jump.

Lessons Learned

Merging movements create congestion

- Concentrating merging (limited access), increases the impact → slower speeds
- Dispersing merging (continuous access), decreases the impact → higher speeds

Unpredictable merging increases friction

- More sections with limited access, increases the predictability → higher speeds
- More sections with continuous access, decreases the predictability → lower speeds

Other Considerations

Skip Stripe

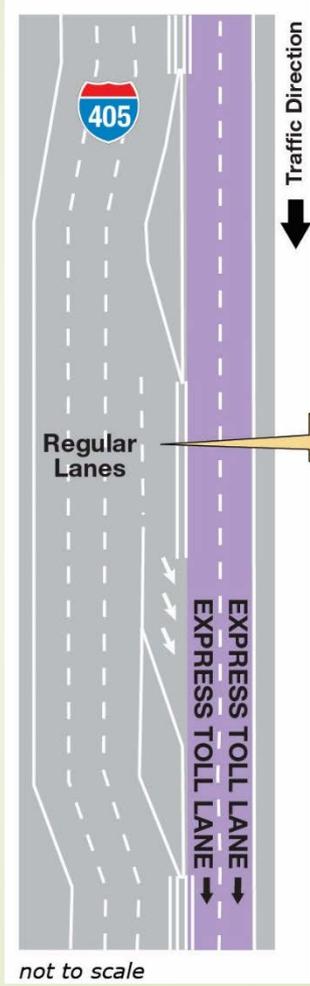
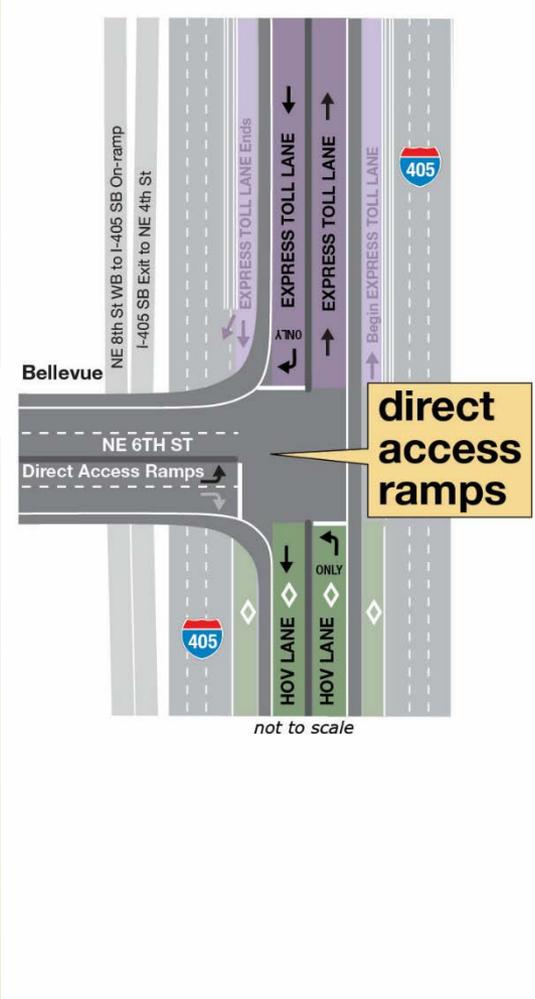
Direct Access

Weave Lane

Ingress Only



P



Date, time and initials of last edit

Questions?

Tyler Patterson

System Operations Manager

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ALAMEDA COUNTY TRANSPORTATION COMMISSION

Continuous Access Priced Managed Lanes in the Bay Area

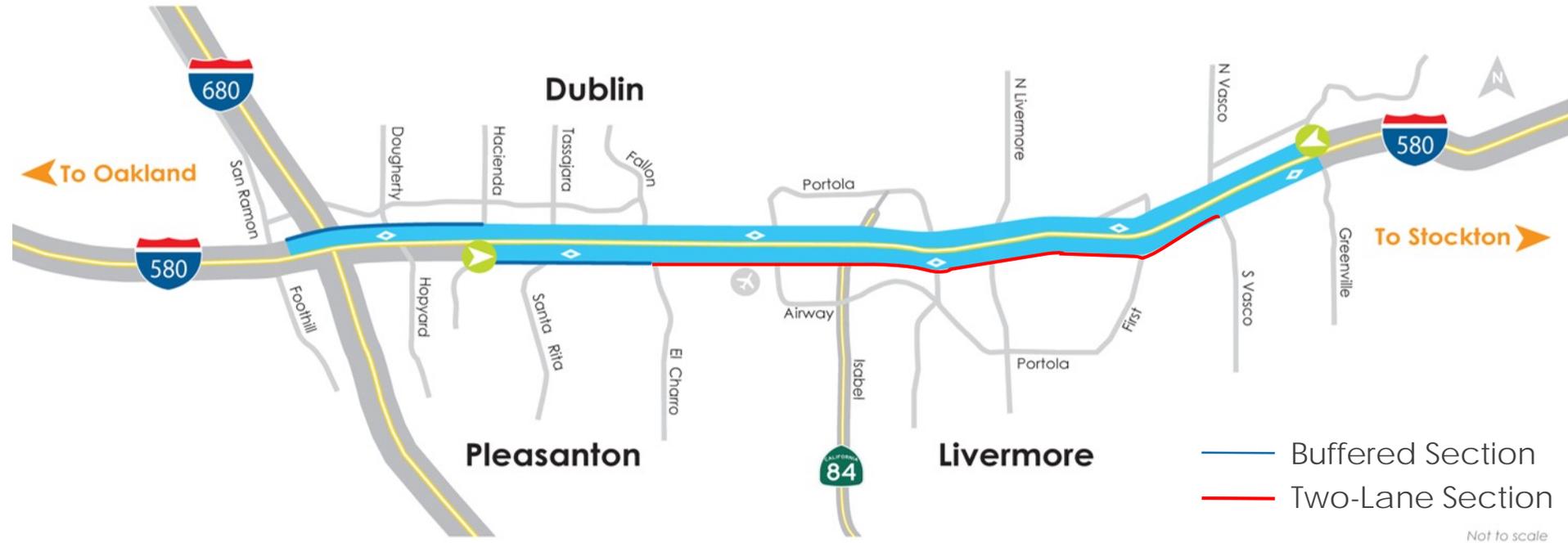


Transportation Research Board

Liz Rutman, Director of Express Lane Operations and Implementation

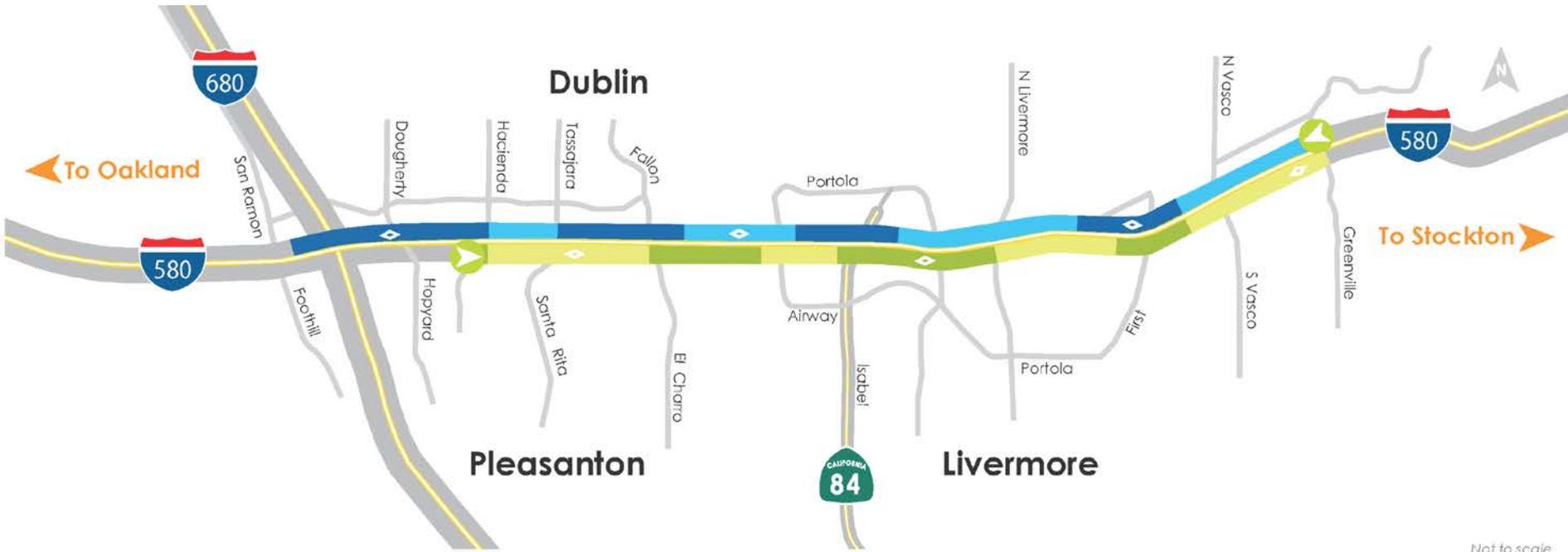
September 20, 2018

I-580 Express Lanes Overview



- “Near-Continuous” Access: buffered sections near I-680
- Two-lane section eastbound
- Gantries every $\frac{3}{4}$ - 1 mile apart

I-580 Express Lane Toll Zones



- 7 EB toll zones; 8 WB toll zones
- Nested zone tolling (not additive) → 64 quasi-independent toll rates

Continuous Access Business Rules

- Charge based on the entry and exit gantry
 - Discourage in/out behavior
 - Trip split if out of lane for more than 10 minutes
- Rate lock based on first read point
 - May not accommodate users entering near the end of the zone
- Toll system must detect tag with HOV occupancy for toll discount



Operational Challenges

- Speed differential ideal 10 – 15 mph
 - Too few users in peak hour may induce safety issue
 - Too many users reduces express lane benefits
- Volume less stable so pricing subject to fluttering
- Signage and Striping
 - Motorists enter EL “accidentally” due to skip stripe



Operational Challenges

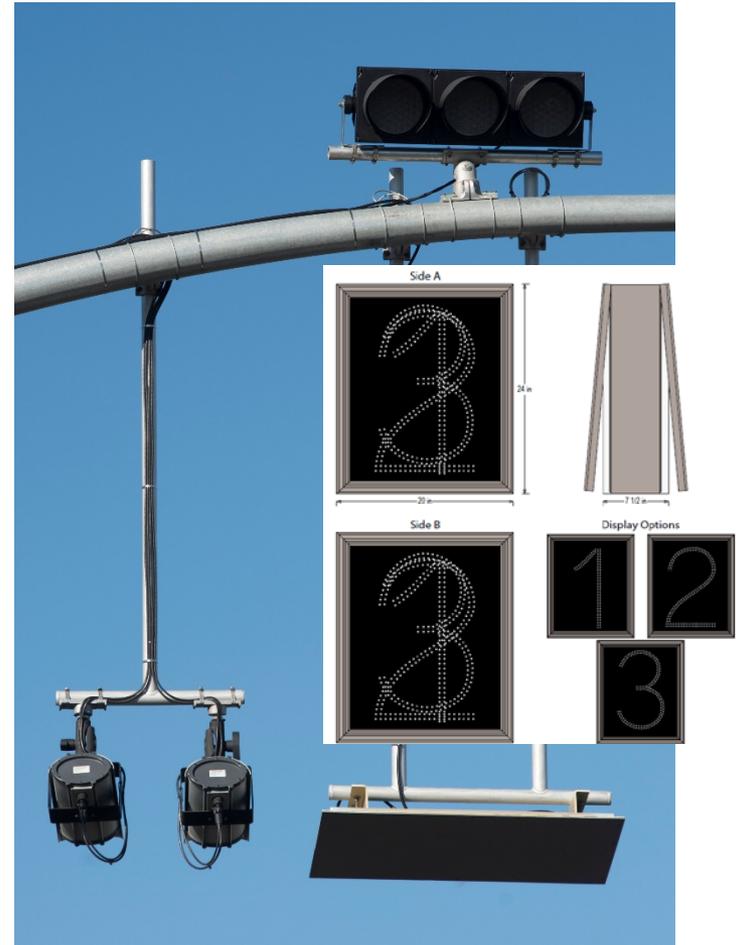
- Trip Formation
 - Motorists may legally skip toll points
 - ALL images must be reviewed
 - TSI must have robust logic and performance metrics



- Express lanes are used as overflow when GP lanes blocked by incident – OPEN TO ALL

Express Lane Enforcement

- Enforcement needed *everywhere*
- License Plate Cameras
- Manual Enforcement (CHP)
 - Median Enforcement Staging
 - Beacon lights reflect vehicle occupancy based on toll tag setting
 - New 1-2-3 Blank Out Sign for future deployments



I-580 EL Procurement

Know your scope before you procure

- Competitive TSI procurement
 - Limited access corridor
 - Toll tag reads only (no license plate capture)
- Public/Political influence changed the project
 - Continuous access corridor
 - Additional infill gantries due to access change
 - License Plate Capture and image-based trip formation

I-580 EL Procurement

RESULT: Contract Change Order

- OCR and IBT not competitively procured
- TSI not prepared to handle increased complexity of continuous access trip logic
- DVAS not included in change order
 - No way to verify tag/image correlation accuracy
- Operations & Maintenance agreement negotiated after start of live operations

I-580 EL Procurement

Performance Metrics are Key to Success

- Current I-580 Performance metrics
 - GO LIVE tag capture rate
 - Maintenance response/repair time
- Manual image review for low-confidence images paid per image
 - 31 gantries; over 30% of all images manually reviewed
 - No accuracy requirements or LDs
 - Benefit/Cost deemed unsatisfactory after 1 year

Remedy:

Toll System Upgrade via New Procurement

Alameda CTC Lessons Learned

- Continuous Access where it makes sense
- Effective Zone Tolling
 - Additive zone tolling
 - Minimize complexity
 - Encourage long-distance usage
- Continued Outreach Efforts
- Robust Procurement:
 - Well-Defined System Requirements
 - Key Performance Metrics
 - Long Term O&M

Thank You

For more information, visit

www.AlamedaCTC.org

Today's Speakers

- Chadi Chazbek, *Kimley-Horn and Associates*, Chadi.Chazbek@kimley-horn.com
- Kiet Ly, *Minnesota Department of Transportation*, kiet.t.ly@state.mn.us
- John Hourdos, *University of Minnesota*, hourd001@umn.edu
- Tyler Patterson, *Washington State Department of Transportation*, PatterT@wsdot.wa.gov
- Liz Rutman, *Alameda County Transportation Commission*, erutman@alamedactc.org



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