

Freeway Bottlenecks: Innovative Mitigation Strategies & Improved Modeling Approaches

ITE Mid-Colonial Annual Meeting (Philadelphia, PA)

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Presentation Objective

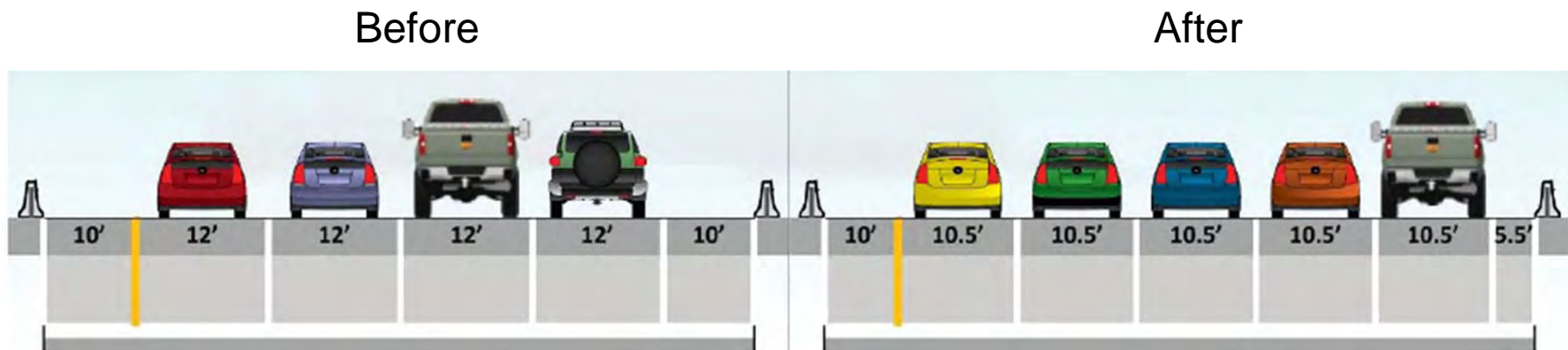
- Discuss three ongoing, related FHWA projects
 - Improved modeling of freeway bottlenecks
 - Innovative/emerging bottleneck mitigation strategies
 - Not requiring CAV technology
- Provide status update on all three projects
- Provide professional opinion on the likely outcomes
 - For all mitigation strategies and modeling approaches

Summary of Projects

- Narrowing of Freeway Lanes and Shoulders
 - 75% complete
- Alternative Designs for Merge/Diverge Areas
 - 40% complete
- Improved Simulation of Freeway Bottlenecks
 - Scheduled to start in mid-2018

Project #1 Objectives

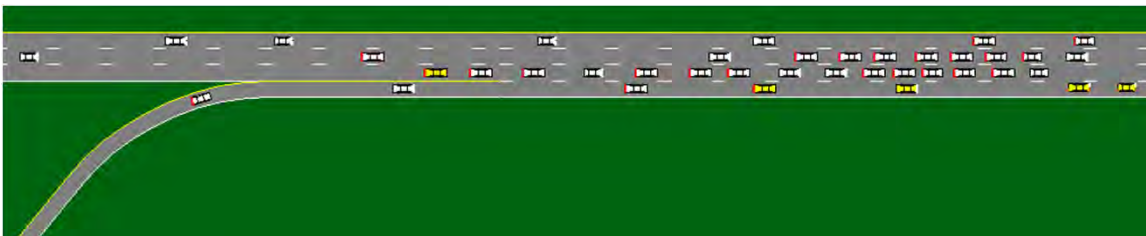
- Narrowing of Freeway Lanes and Shoulders
 - Collect data at real world sites
 - Update the HCM procedure
 - Update microsimulation tools
 - Multi-objective (operations & safety) recommendations



Neudorff, Jenior, Dowling, Nevers, FHWA-HOP-16-060, 2016

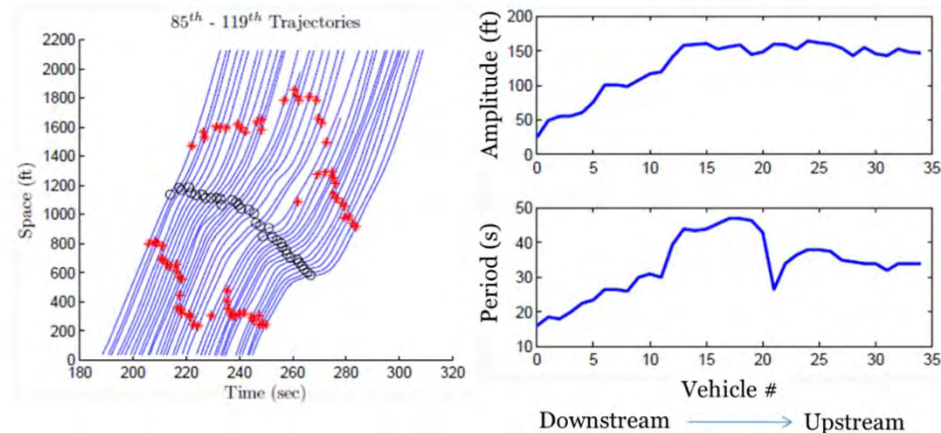
Project #2 Objectives

- Alternative Designs for Merge/Diverge Areas
 - Review merge/diverge issues at typical on/off-ramps
 - Review similar issues at managed (HOV/HOT) lanes
 - Come up with new (non-CAV) mitigation strategies
 - Conduct simulations to evaluate effectiveness



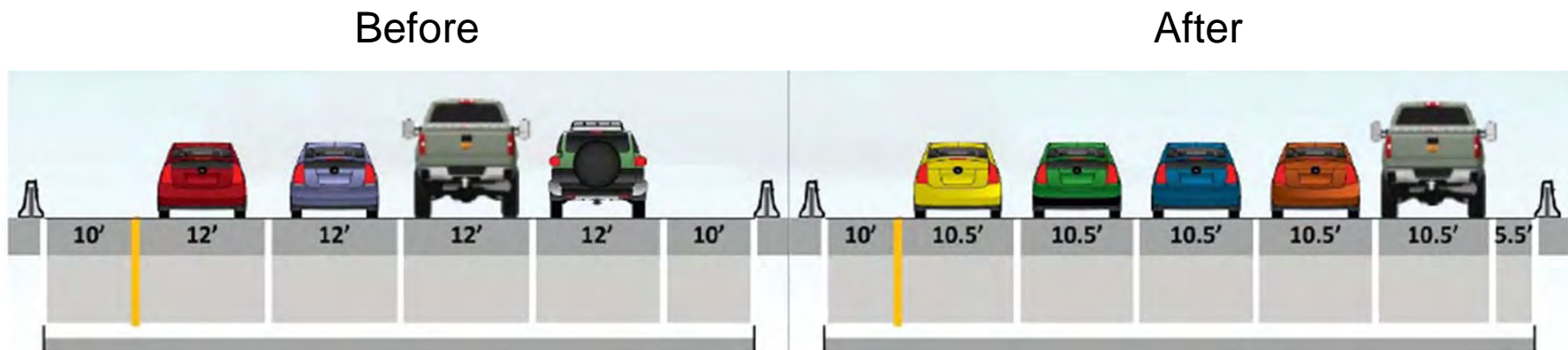
Project #3 Objectives

- Improved Simulation of Freeway Bottlenecks
 - Driver behavior believed to be different at bottlenecks
 - Collect data at real-world bottlenecks
 - Develop new car-following and lane-changing models
 - Old models will still be used in uncongested areas



Project #1 Status Update

- Narrowing of Freeway Lanes and Shoulders
 - New models for the HCM
 - New models for safety prediction
 - Simulation models under development



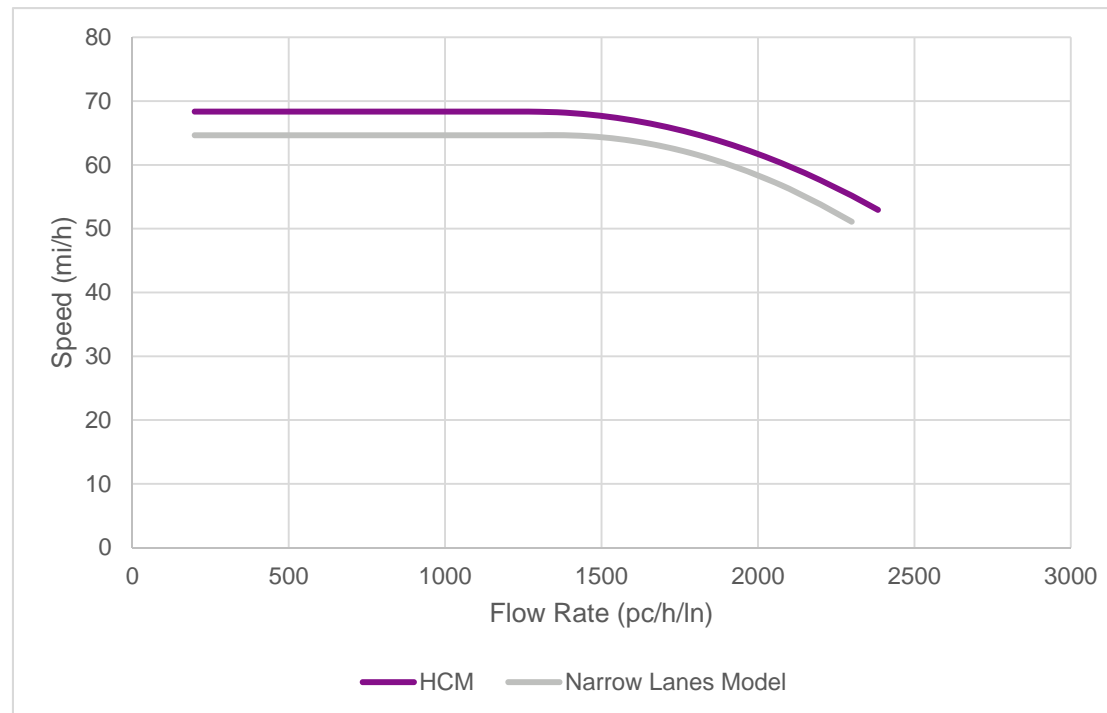
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Project #1 Status Update

$$FFS = BFFS - f_{LW} - f_{RLC} - 3.22 \times TRD^{0.84}$$

$$FFS = 4.99 + 1.0982 \text{ Number of lanes} + 0.0833 \text{ Shoulder Width} + 0.9906 \text{ SL1} + 0.6964 \text{ SL2} \\ - 0.3744 \text{ Lane Width} + 0.0 \text{ Type_basic} - 1.6963 \text{ Type_diverge} - 1.1524 \text{ Type_merge} \\ + 0.01917 \text{ Lane Width} * \text{SL2} \quad (4)$$



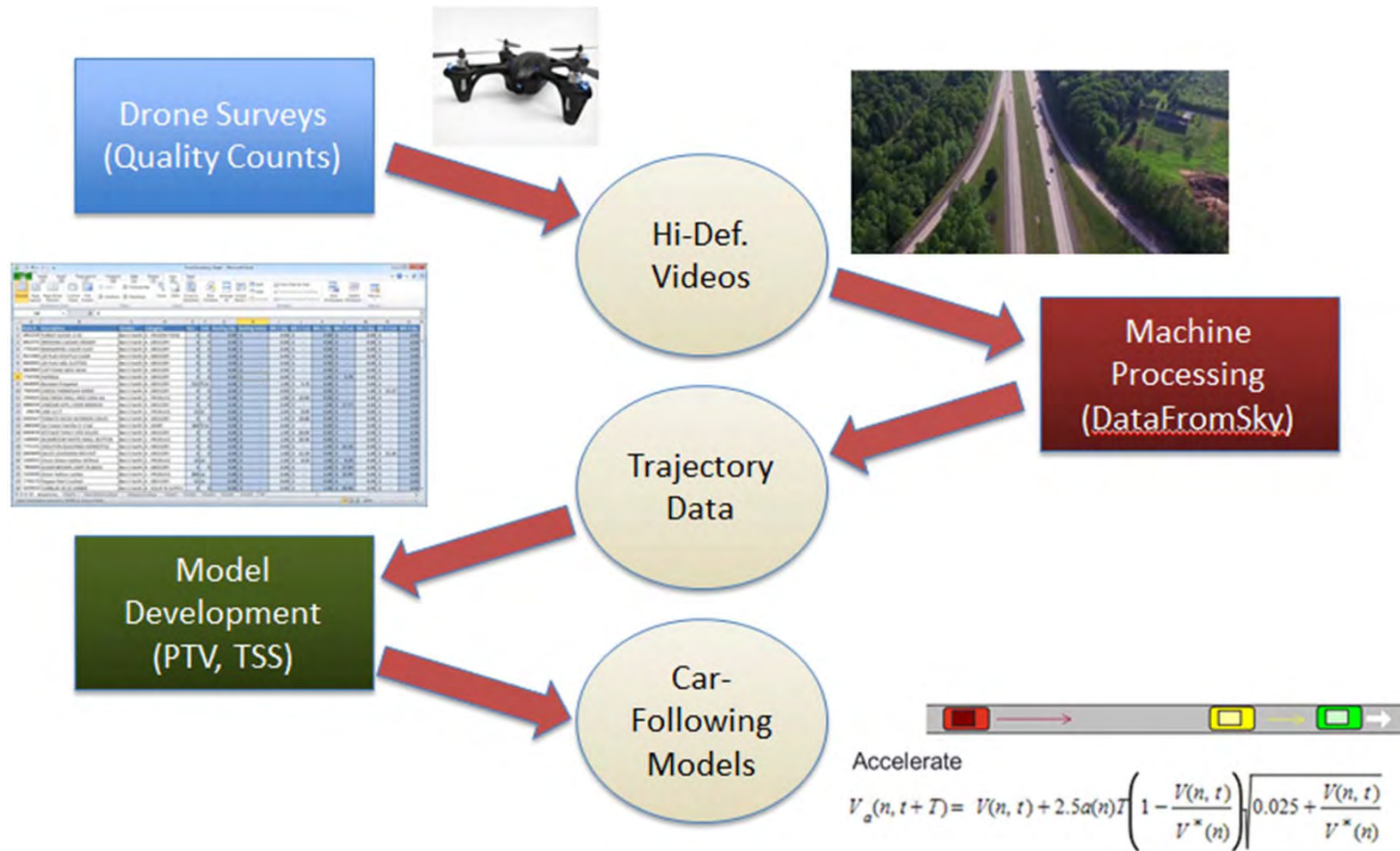
Project #1 Status Update

$$c \text{ (basic freeway segment)} = 2,200 + 10*(FFS_{adj} - 50)$$

Recommended Capacity Adjustment Factors (CAFs) by Lane Width

	11' lane CAF	10' lane CAF
Merge	0.90	0.74
Diverge	0.97	0.93
Basic	0.98	0.98

Project #1 Status Update



Project #1 Status Update

Location	Ax [Meters]	Bx (Add)
Dallas (12ft)	5.000	1.772
Dallas (11ft)	2.143	2.060
San Antonio (12ft)	5.526	1.476
San Antonio (11ft)	8.333	1.542
Honolulu (11ft)	2.143	1.434
Honolulu (10ft)	2.143	1.865
Ft Lauderdale (12ft)	3.333	2.645
Ft Lauderdale (11ft)	2.143	3.093

~10% headway increase
per foot of lane narrowing

Project #2 Status Update

- Alternative Designs for Merge/Diverge Areas
 - Innovative accel/decel lane designs
 - Speed optimization (e.g., dynamic calming devices)
 - Dynamic signal control (a.k.a., mainline metering)
 - Coordinated ramp metering (e.g., HERO)
 - Open-access managed lanes on the right
 - Managed lane access point optimization

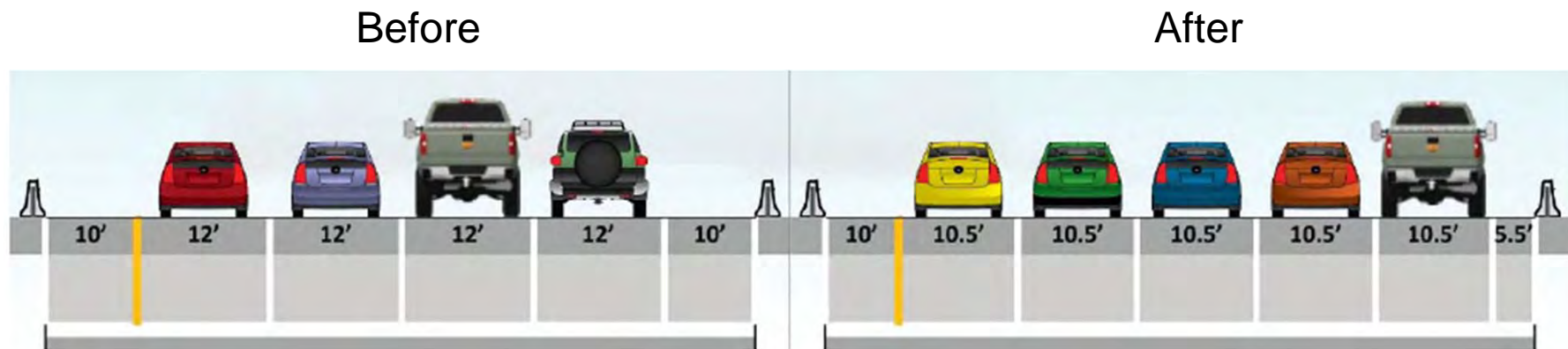




Most Likely Outcomes (Professional Opinion)

Project #1 Likely Outcomes

- Narrowing of Freeway Lanes and Shoulders
 - Safety won't be a deal-breaker (see next slide)
 - Minor changes to HCM & simulation models
 - Narrow lanes will be a cost-effective mitigation strategy
 - Dynamic lane narrowing technology may emerge



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Project #1 Likely Outcomes

- If no demand increase after adding a lane
 - Outstanding benefit-cost ratios
 - Major reduction to crashes, travel times, densities
- If demand increases to fill the new lane
 - 10% increase in incidents
 - 15% increase in throughput
 - No change in density

Project #1 Likely Outcomes

- Dynamic lane narrowing technologies may emerge
 - Revert to 12-foot lanes during off-peak periods

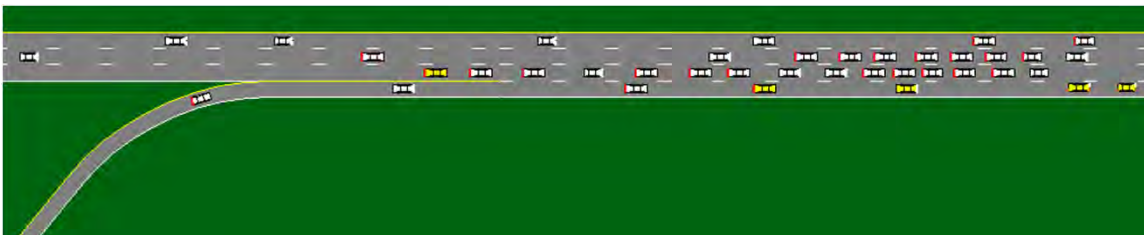


Source: SmartRoads, LLC

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Project #2 Likely Outcomes

- Alternative Designs for Merge/Diverge Areas
 - Innovative accel/decel lane designs: **limited application**
 - Dynamic traffic calming: **political challenges**
 - Dynamic signal control: **political challenges**
 - Coordinated ramp metering: **will find a niche**
 - Open-access ML on the right: **political challenges**
 - ML access point optimization: **insufficient data**

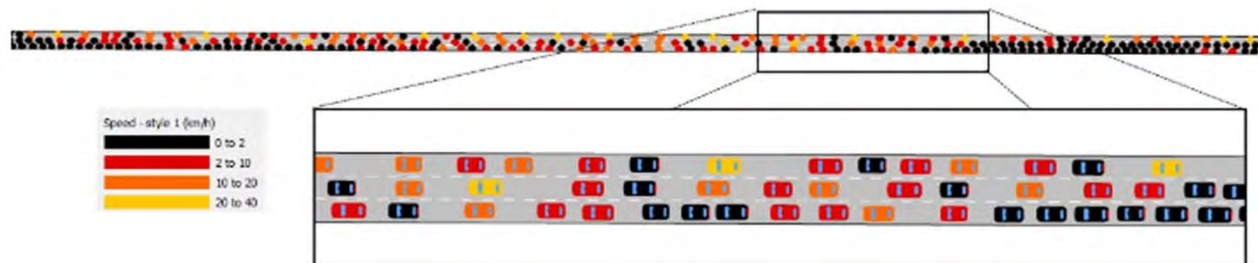


Project #3 Objectives

- Improved Simulation of Freeway Bottlenecks
 - Some tools will adopt multiple car-following models
 - Overall impact: capacities may increase
 - Aimsun already did this:

Car-Following model extension for congested highways

We've improved car-following in congested conditions by using a modified Gipps model to achieve more accurate simulated speeds.



<https://www.aimsun.com/aimsun/new-features/>

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Final Predictions

- Methods that will gain traction
 - Coordinated ramp metering
 - Static lane narrowing to add a freeway lane
 - Alternate car-following models for bottlenecks
- Methods facing political headwinds
 - Managed lanes on the right
 - Dynamic signal control on freeways
 - Dynamic lane narrowing technologies
 - Dynamic traffic calming devices on freeways



Thank you

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