Determining Traffic Flow Conditions for Worst Hour Noise Levels – Case Study

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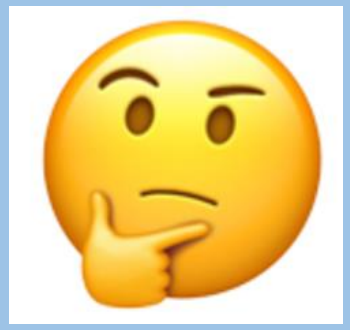


Are We Over-Designing Sound Walls (Height) ?

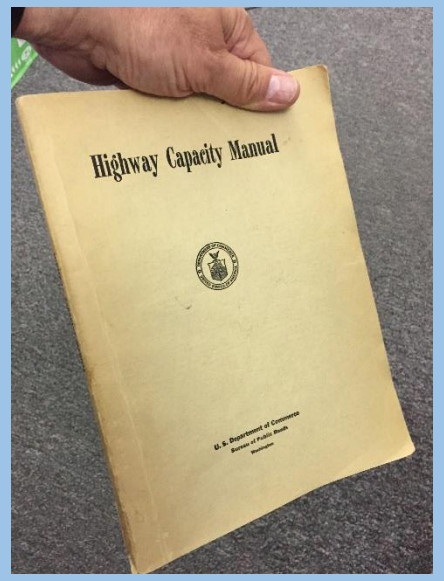
The peak traffic hour is generally not the noisiest hour. During rush hour traffic, vehicle speeds and heavy truck volumes are often low. Free-flowing traffic conditions just before or after rush hour often yield higher noise levels.

Caltrans 2013 Technical Noise Supplement, Section 3.3.1.1

- **1978 FHWA guidance states worst noise hour occurs at LOS C.**
- **1800-2100 pc/hr/ln is often assumed in CA; - is this over design ?**
- **What is the maximum flow-rate of vehicles at the ‘worst noise hour’ ?**

- Review Traffic Flow Fundamentals
- Caltrans Extensive Freeway Monitoring System
- Locate Good Study Location
- Simultaneous Collect Traffic Flow & Acoustic Data

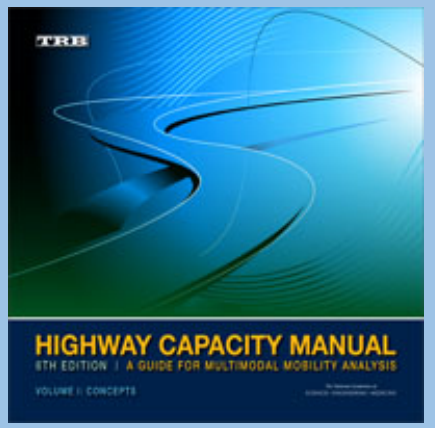
Highway Capacity Manual



1950 – 1st Edition 147 pages

Capacity, the ability of a transportation facility or service to meet the quantity of travel demanded of it.

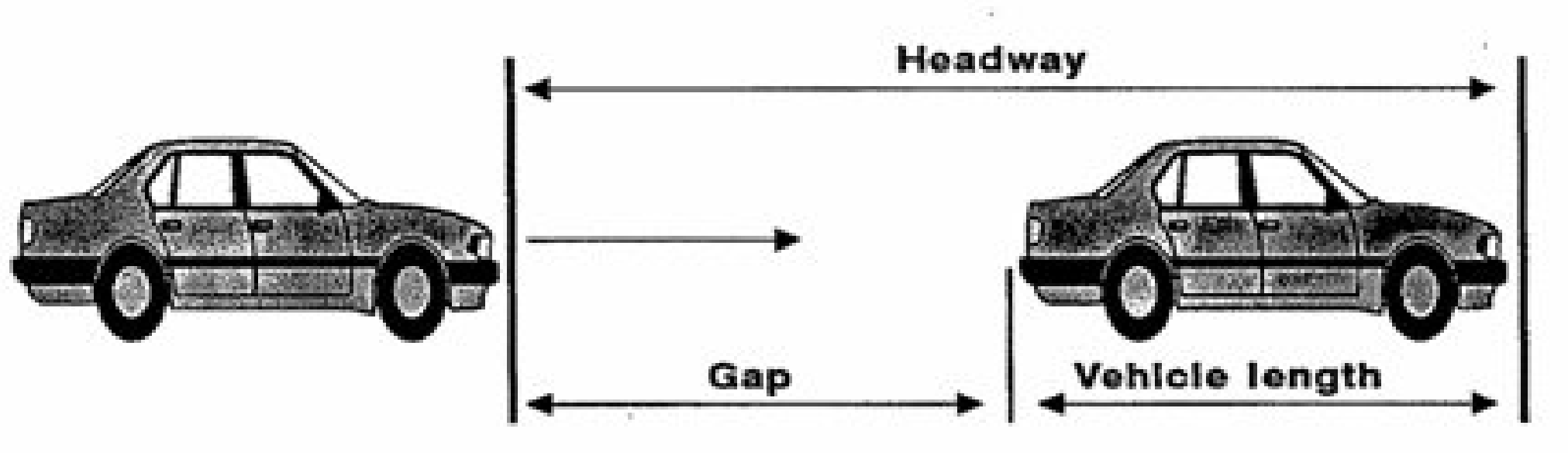
DECADES of Observation and Data



HCM6
2016 — 6th Edition

The HCM2010 has been split into four volumes:
Volume 1 – Concepts;
Volume 2 - Uninterrupted Flow;
Volume 3 - Interrupted Flow; and
Volume 4 - Applications Guide (electronic only)

Basic Concept: Space Between Vehicles



- 60 min x 60 sec/min = 3600 sec/hour
- 3600 sec/hour ÷ 2 sec / vehicle = 1800 pc/hour/lane

Headway 'Drives' Lane Capacity

Familiar Concept: Level Of Service

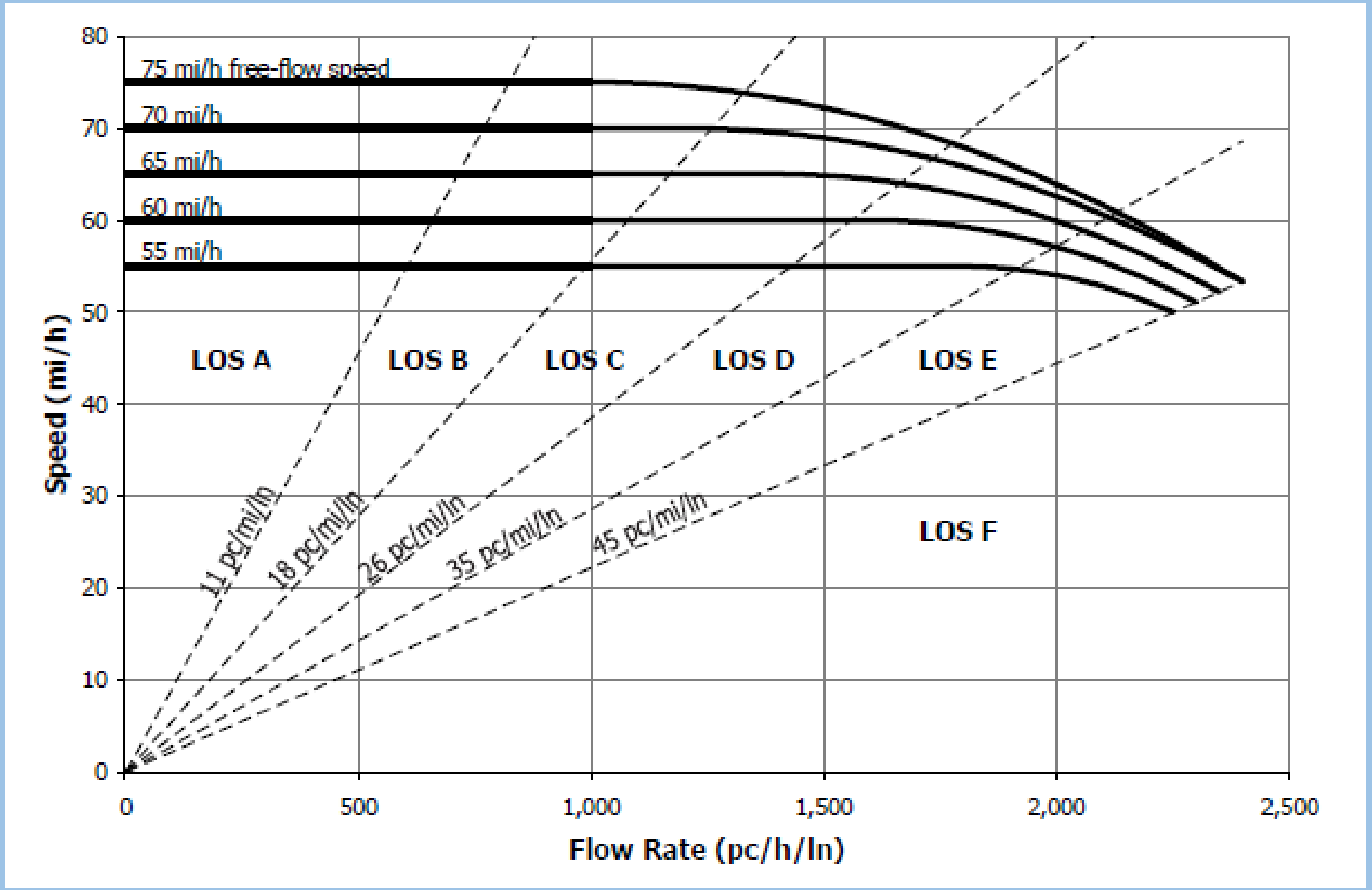
2000 HCM

Traffic Flow Rate 'Grade'

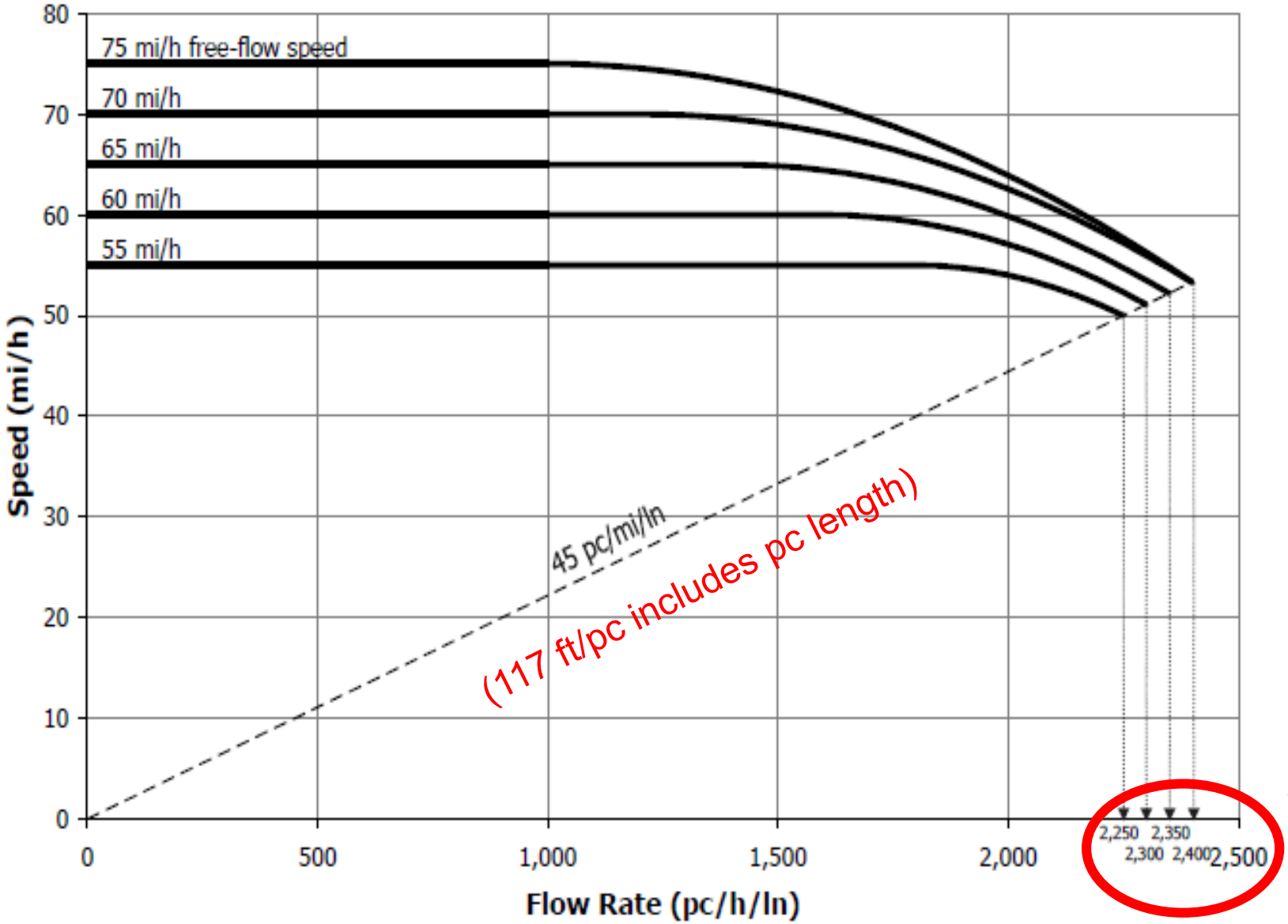
LEVELS OF SERVICE
for Freeways

Level of Service	Flow Conditions	Operating Speed (mph)	Technical Descriptions
A		70	Highest quality of service. Traffic flows freely with little or no restrictions on speed or maneuverability. **No delays**
B		70	Traffic is stable and flows freely. The ability to maneuver in traffic is only slightly restricted. **No delays**
C		67	Few restrictions on speed. Freedom to maneuver is restricted. Drivers must be more careful making lane changes. **Minimal delays**
D		62	Speeds decline slightly and density increases. Freedom to maneuver is noticeably limited. **Minimal delays**
E		53	Vehicles are closely spaced, with little room to maneuver. Driver comfort is poor. **Significant delays**
F		<53	Very congested traffic with traffic jams, especially in areas where vehicles have to merge. **Considerable delays**

HCM Speed/Flow Rate Curve

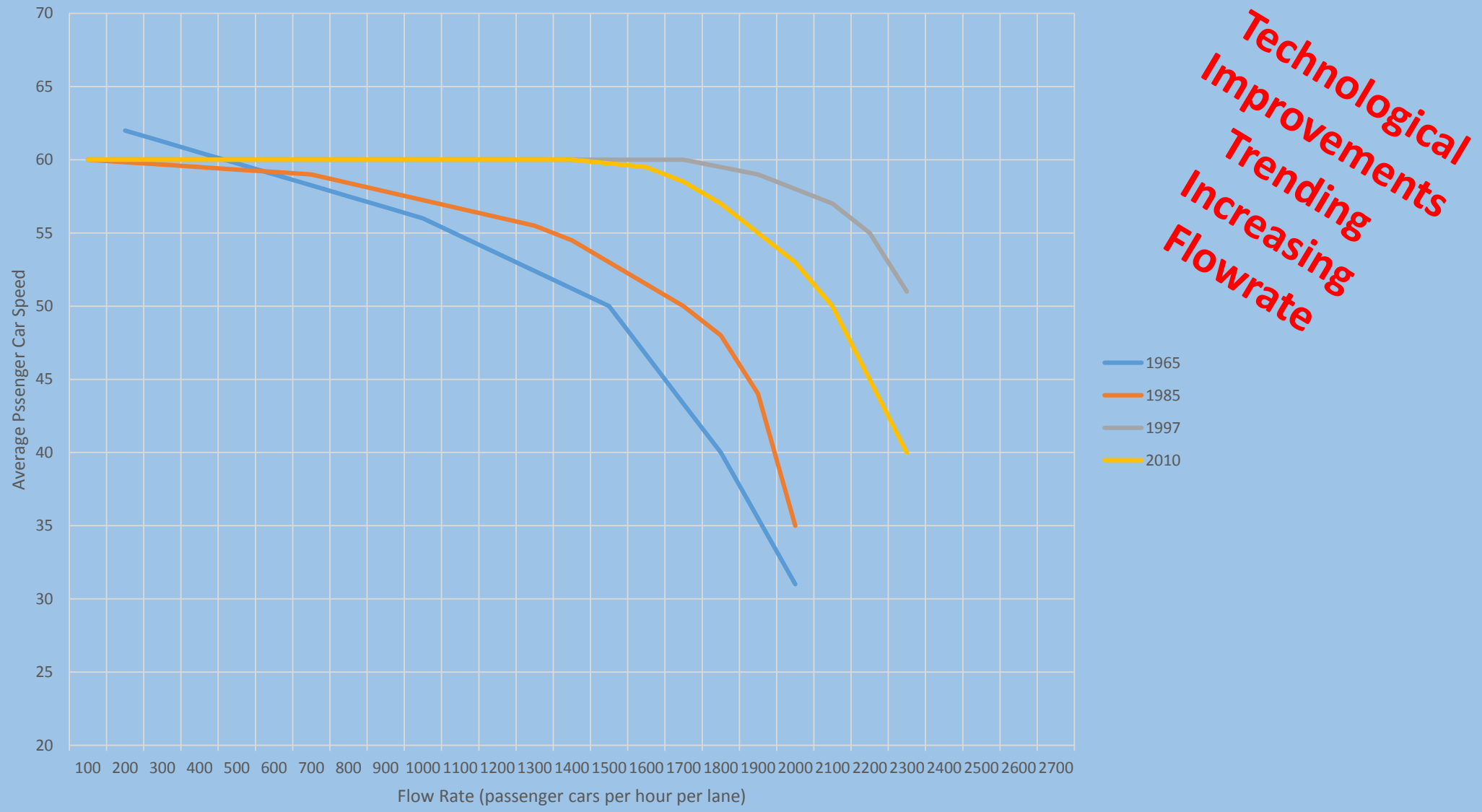


Maximum Speed/Flow Rate

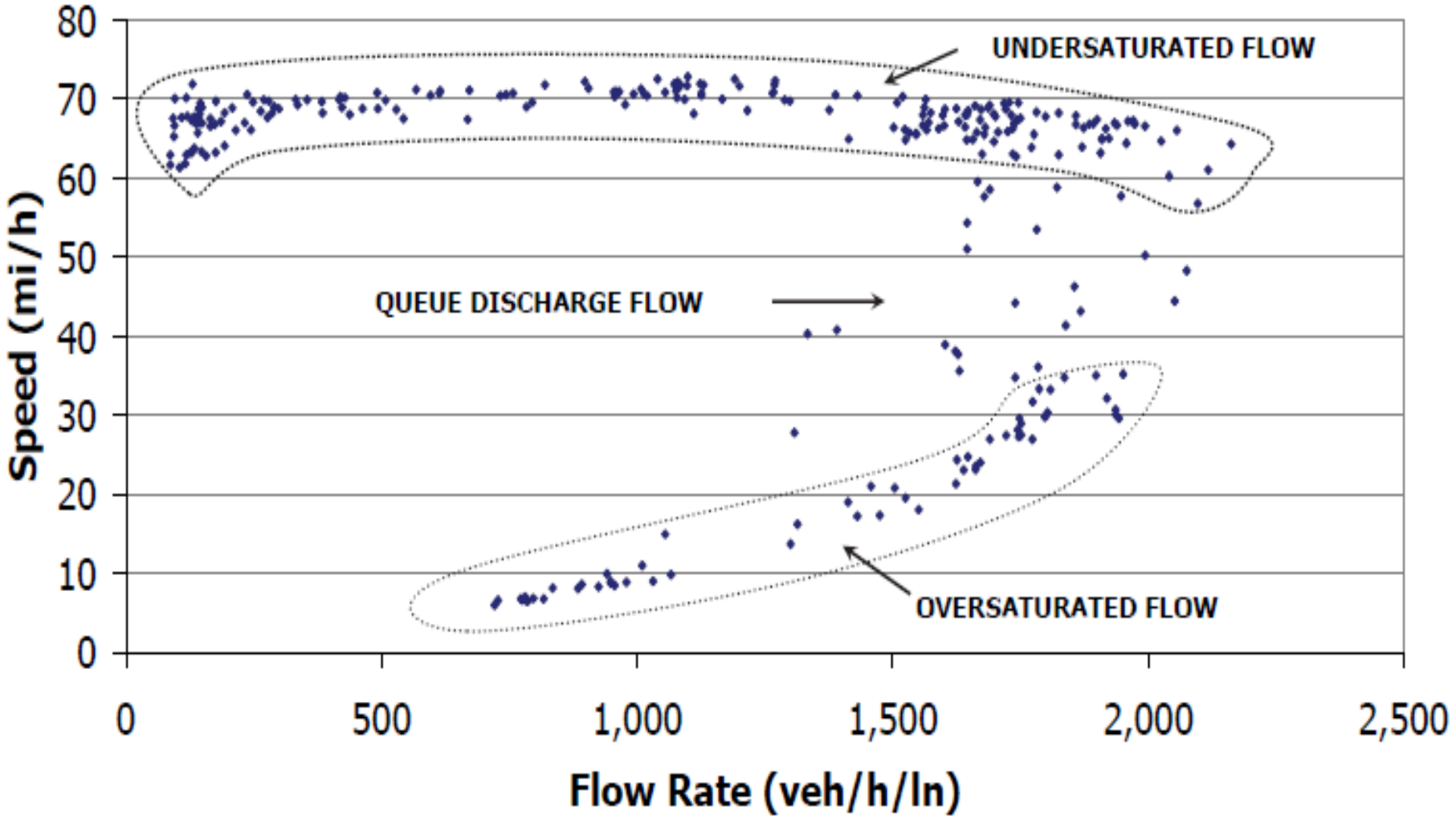


Based on highest 10-15 period; expanded to hour

Traffic Volume and Speed Reported in Various Editions of the Highway Capacity Manual Over the Years



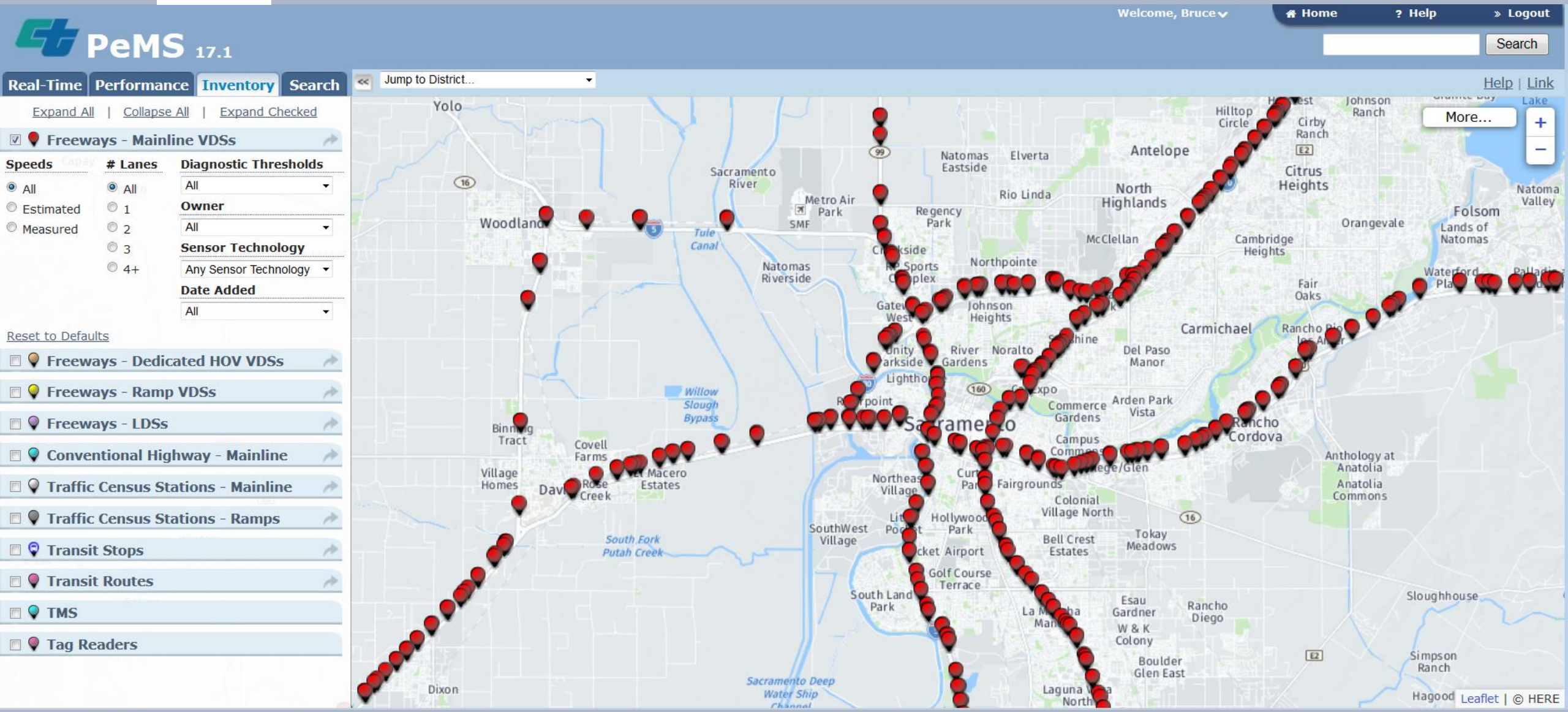
Observed Speed/Flow Rate Conditions



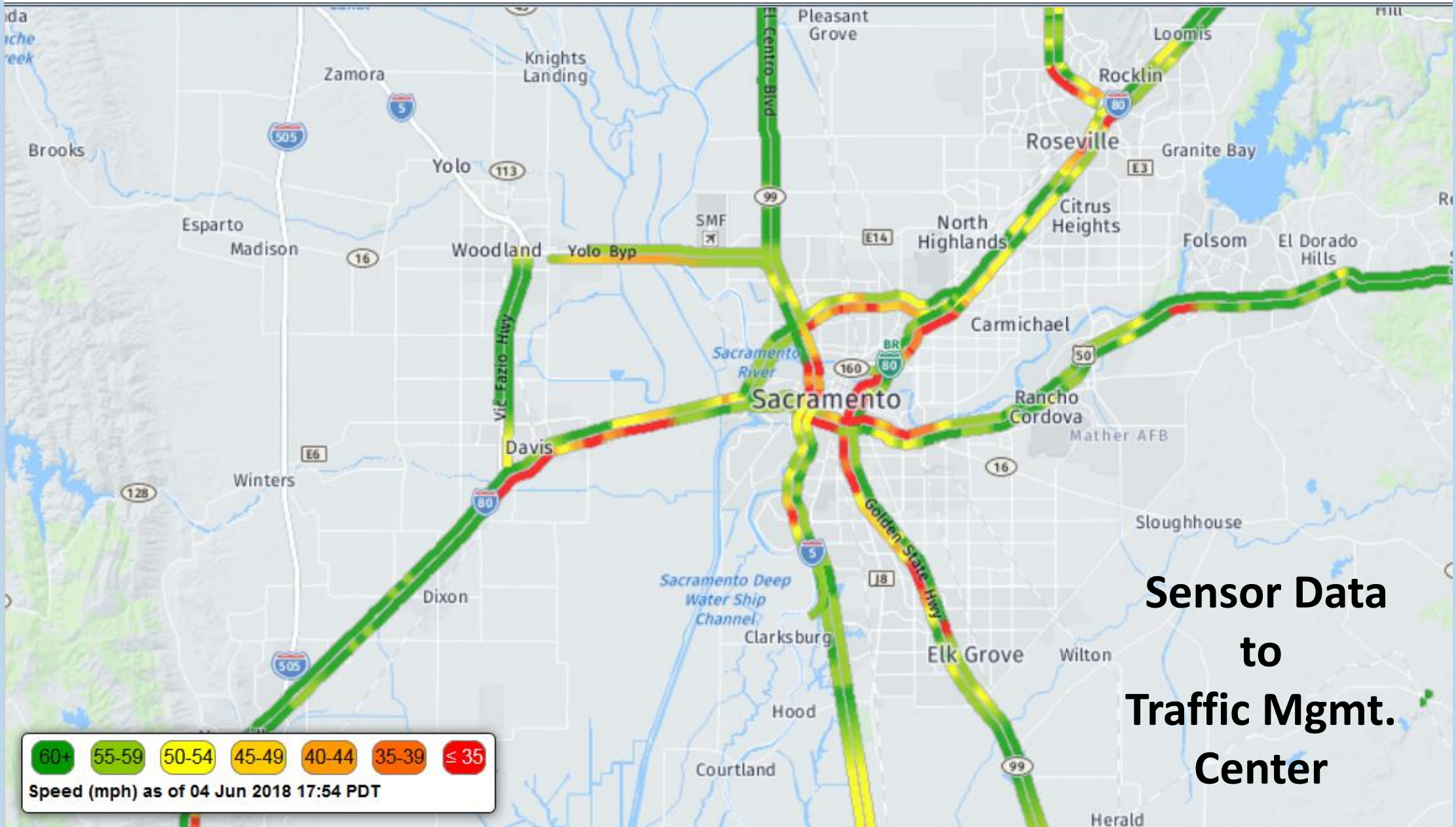
Note: I-405, Los Angeles, Calif.

Source: California Department of Transportation, 2008.

Performance Management System — PeMS

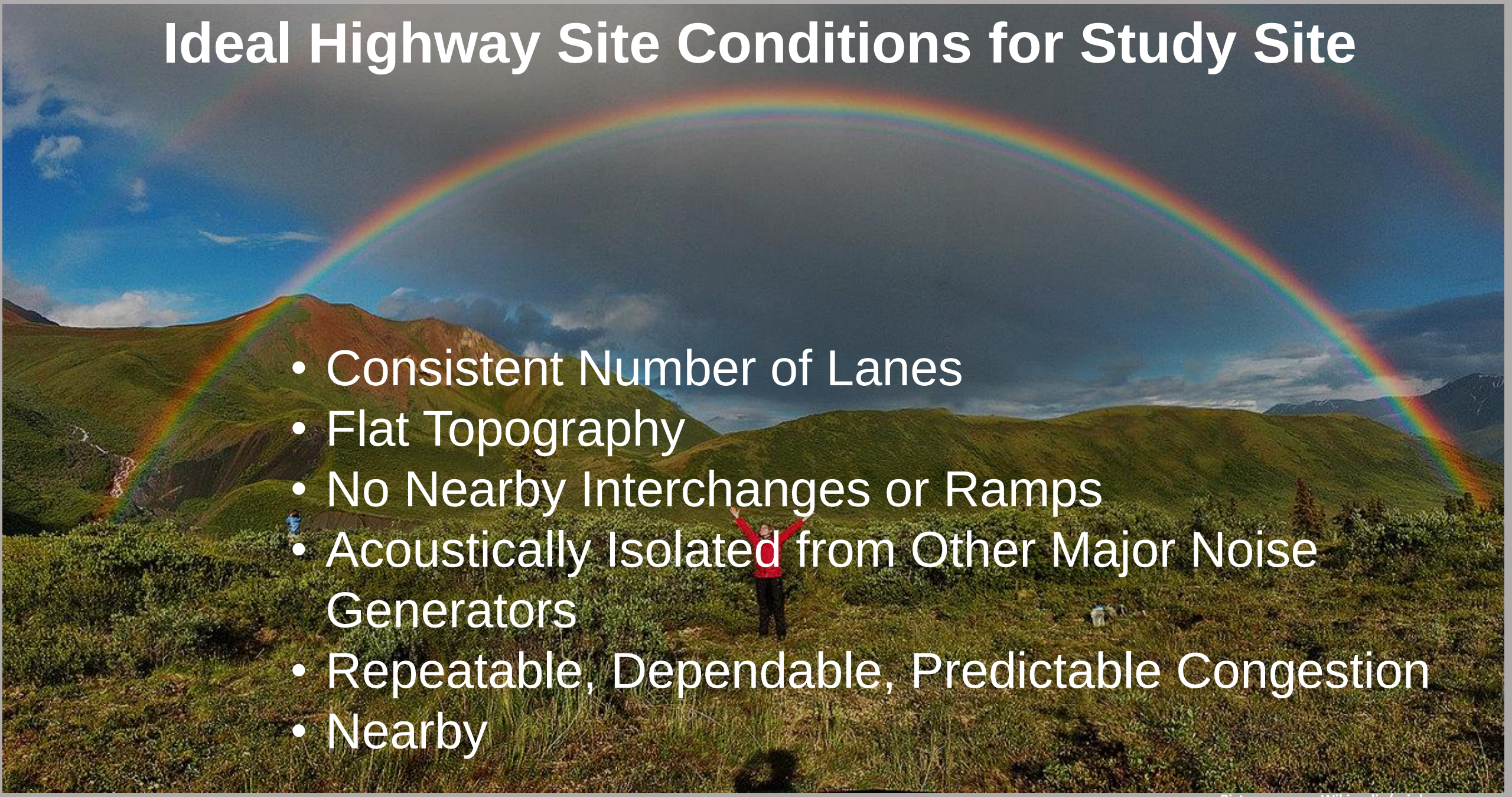


CALIFORNIA DEPARTMENT OF
TRANSPORTATION



Sensor Data to Traffic Mgmt. Center

Ideal Highway Site Conditions for Study Site



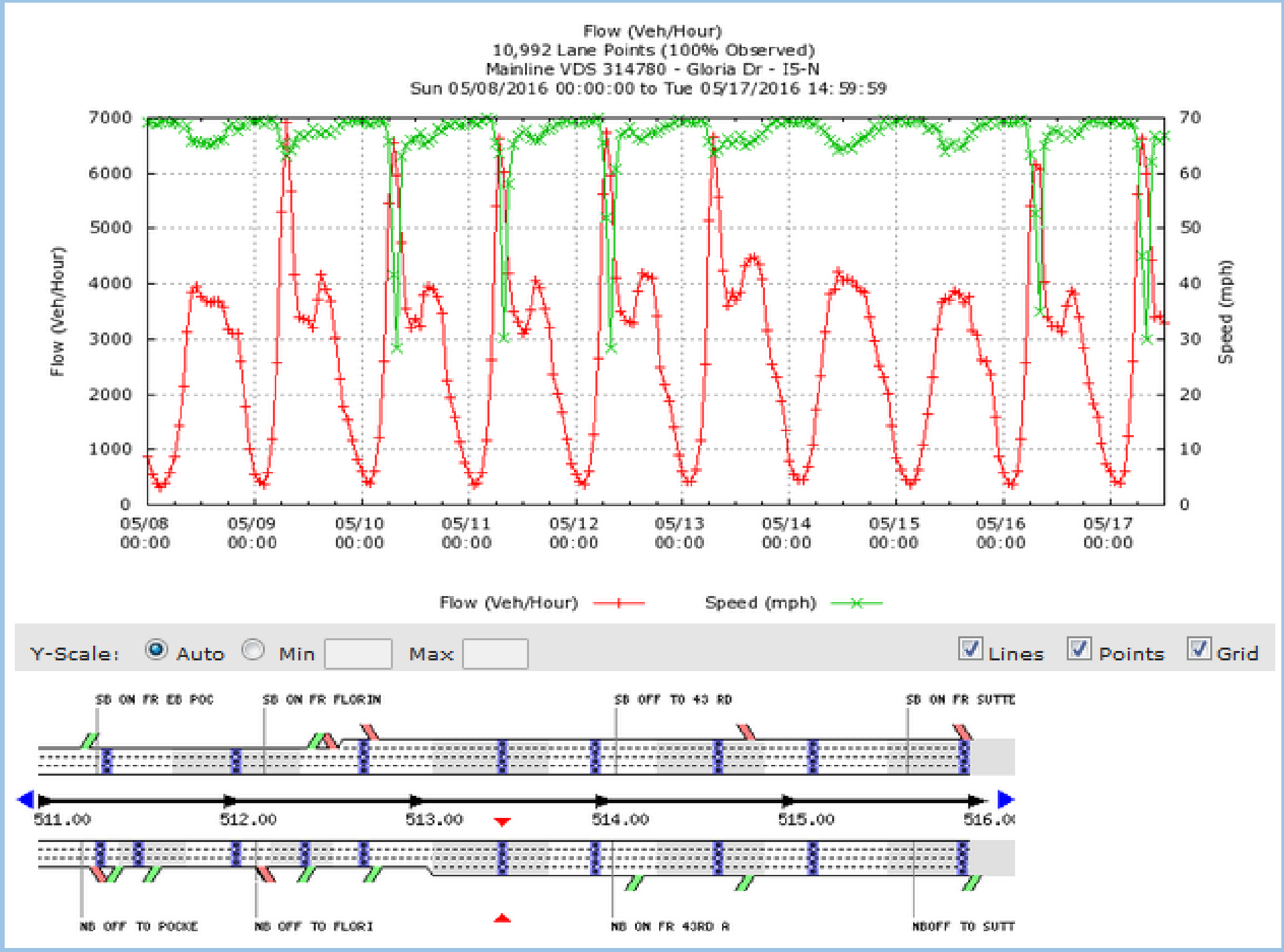
- Consistent Number of Lanes
- Flat Topography
- No Nearby Interchanges or Ramps
- Acoustically Isolated from Other Major Noise Generators
- Repeatable, Dependable, Predictable Congestion
- Nearby

Picture source: Wikipedia/rainbow

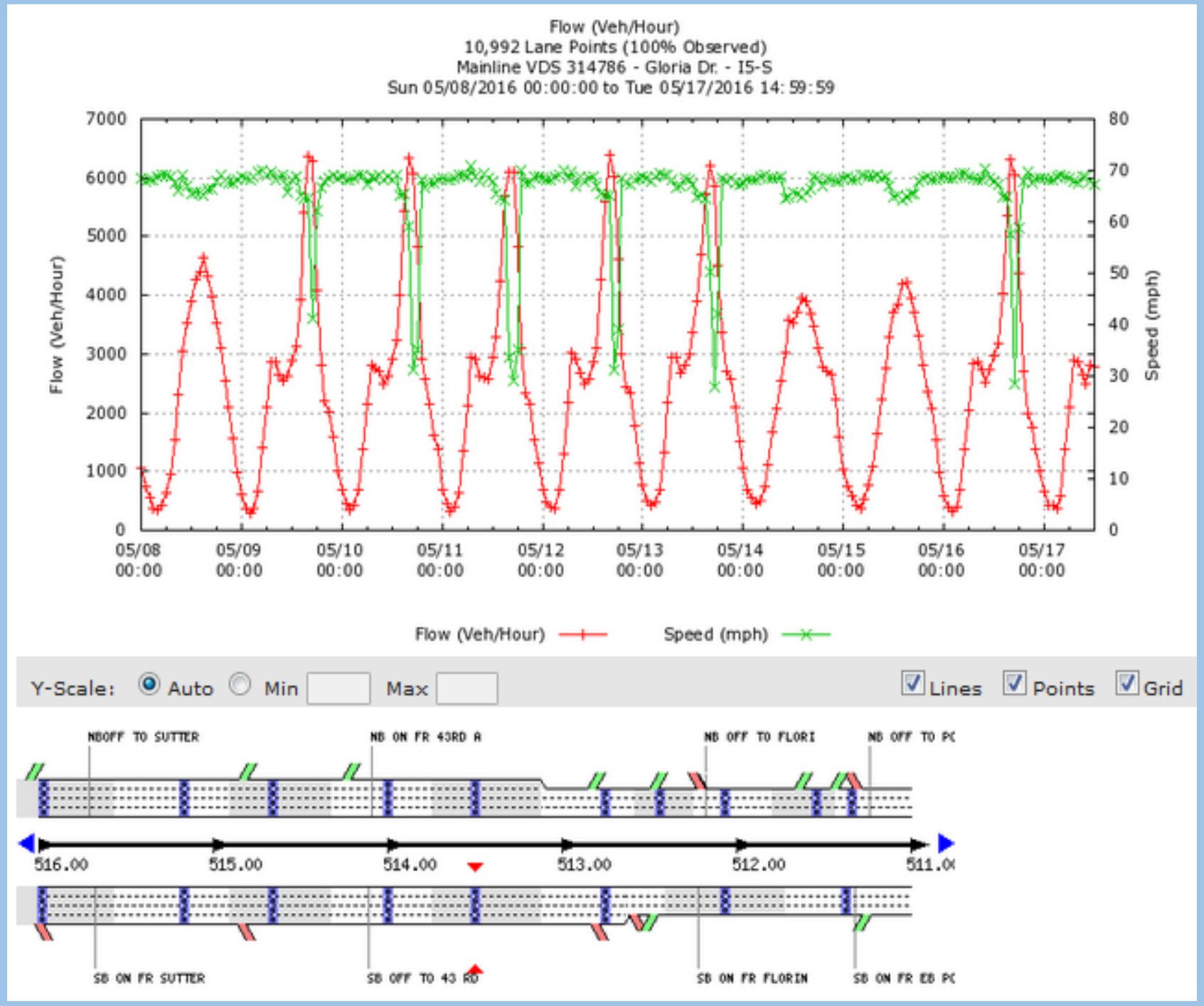
Ideal Study Location – Consistent Lane Cross-section in Isolated Location
Elevated 6 Lane Causeway in dry quiet Flood Plain, No Interchanges or Ramps

Not Ideal – OK; IH-5 Sacramento, CA

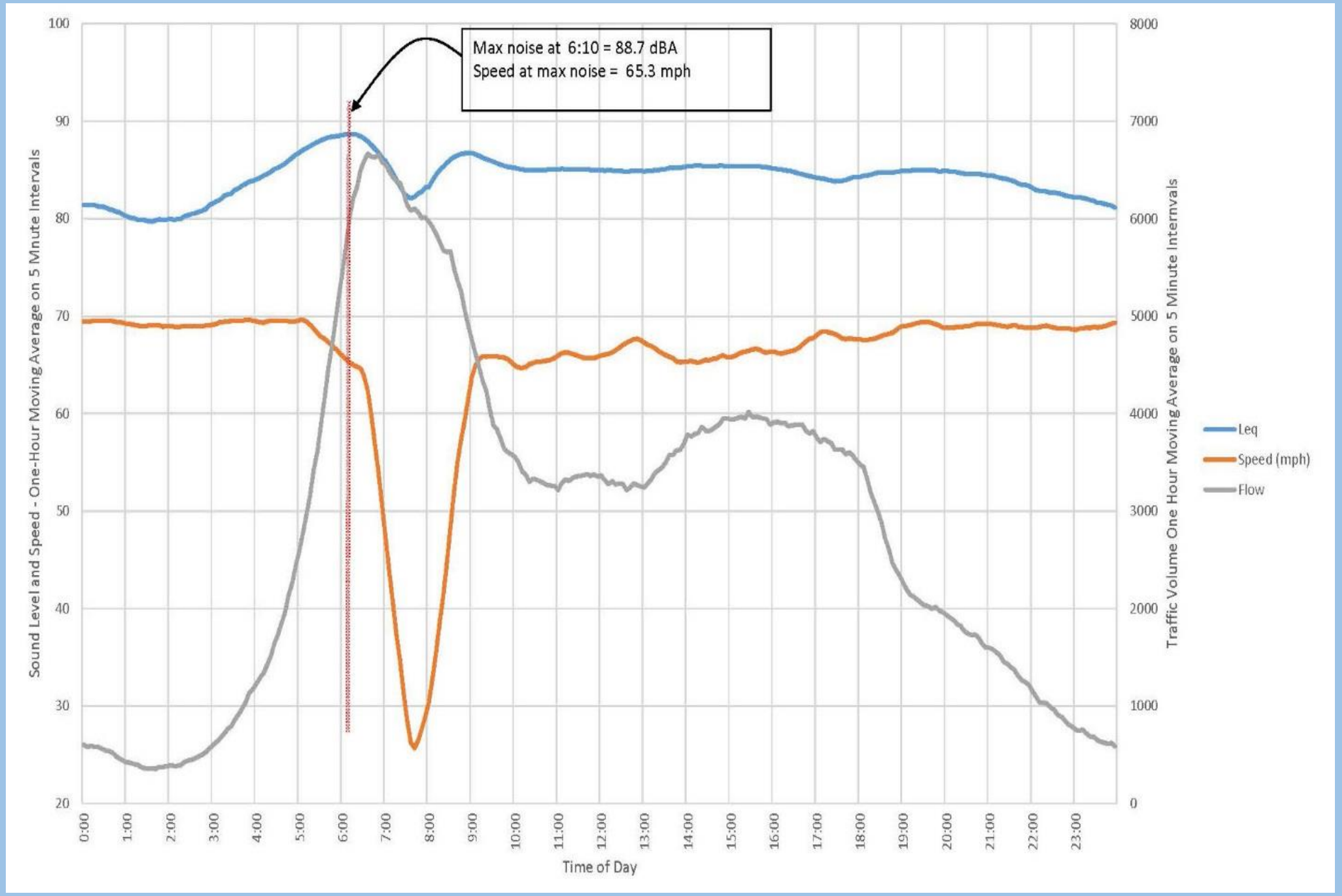
North Bound Weekly Traffic Pattern



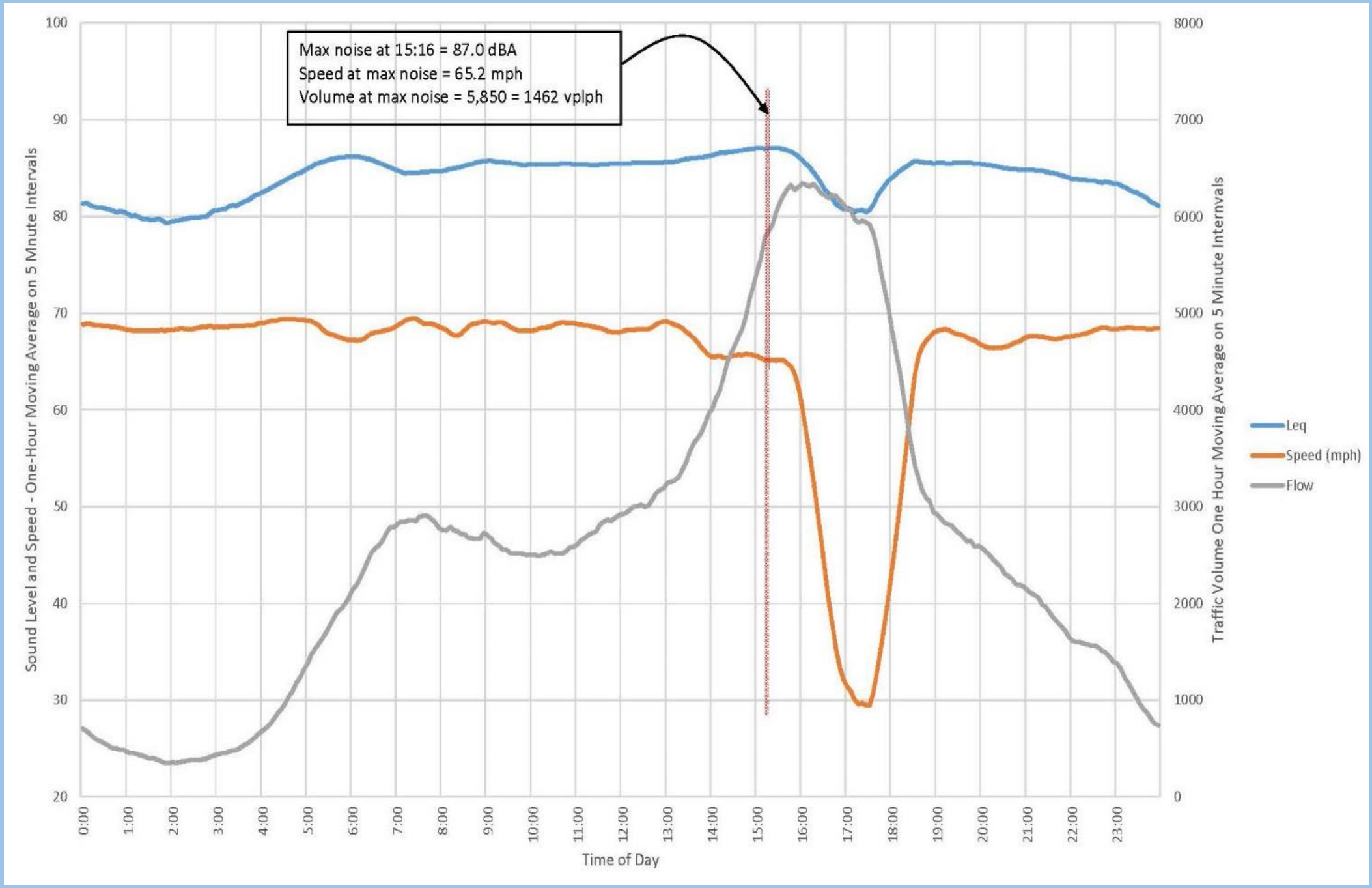
South Bound Weekly Traffic Pattern



AM Commute Sound Level, Traffic Volume, and Speed (Northbound)



PM Commute Sound Level, Traffic Volume, and Speed on I-5 (Southbound)

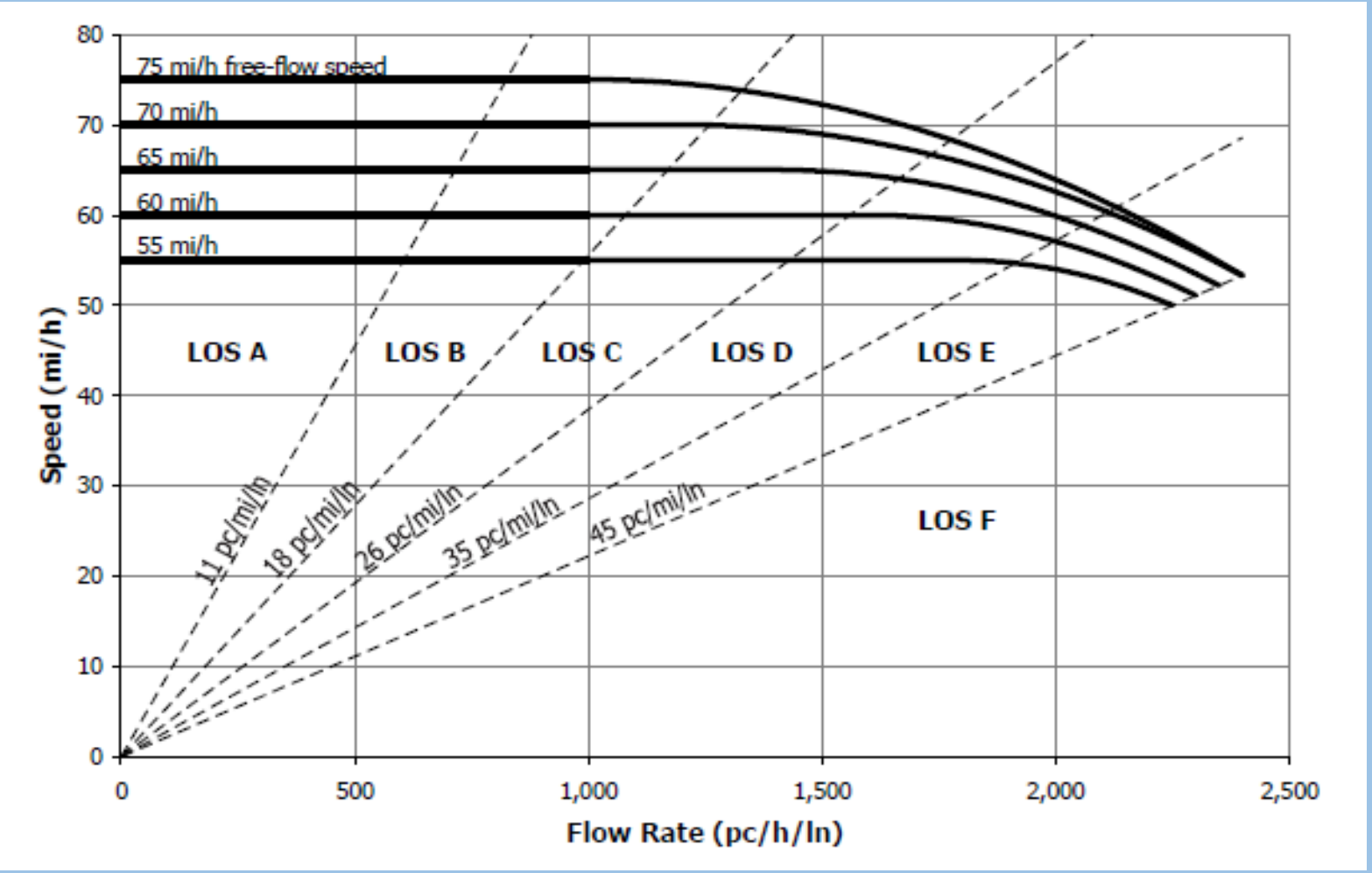


Northbound	Time	Speed (mph)	Truck %	pc/h/ln
Tuesday	6:10	65.3	1.70%	1518
Wednesday	6:10	65.2	2.80%	1505
Thursday	6:10	65.2	1.60%	1564
Friday	6:20	64.9	2.20%	1553
Average	6:12	65.2	2.08%	1535
Southbound	Time	Speed (mph)	Truck %	pc/h/ln
Tuesday	15:16	65.1	1.76%	1,656
Wednesday	15:01	64.1	2.28%	1,465
Thursday	15:26	65.1	1.10%	1,516
Friday	15:26	64.8	1.31%	1,559
Average	15:17	64.8	1.61%	1,549
NB-SB Average	NA	65.0	1.84%	1542

1 truck = 1.5 equivalent passenger vehicle

Conclusions

- **Worst Noise Hour occurs at average pc/hr/ln 1542 and 65 mph**
- **Consistent with current LOS C 1500+ pc/ln/hr**



Is Using Higher Flow Rate Over Predicting SPL and Over Designing Sound Walls?

NO
Decrease in Speed
or
Change in Vehicle Mix

Assumed Flowrate (pc/hr/ln)	Actual Flowrate (pc/hr/ln)	ΔSPL (dBA)
2200	1550	-1.52
2100	1550	-1.32
2000	1550	-1.11
1950	1550	-1.00
1900	1550	-0.88
1850	1550	-0.77
1800	1550	-0.65
1750	1550	-0.53
1600	1550	-0.14

ΔSPL = 10 Log10(N)
N is Ratio
Btw Diff. Flow Rates

Other Sources of Modeling Inaccuracy

- Type II SLM ± 1.5 dBA
- Meteorology ± 0-8dBA
- Pavement Acoustics ± 0-8dBA
- True Speed
- Actual Flow Rate
- True Traffic Mix

High Flow Rate
Similar To
Factor of Safety


FUTURE ?
Higher Flow Rates with Vehicle-to-Vehicle Communication ?