On-Call Simulation Modeling Training

Scoping the Analysis for SLO US101

presented to

Caltrans D5

presented by

Cambridge Systematics, Inc.

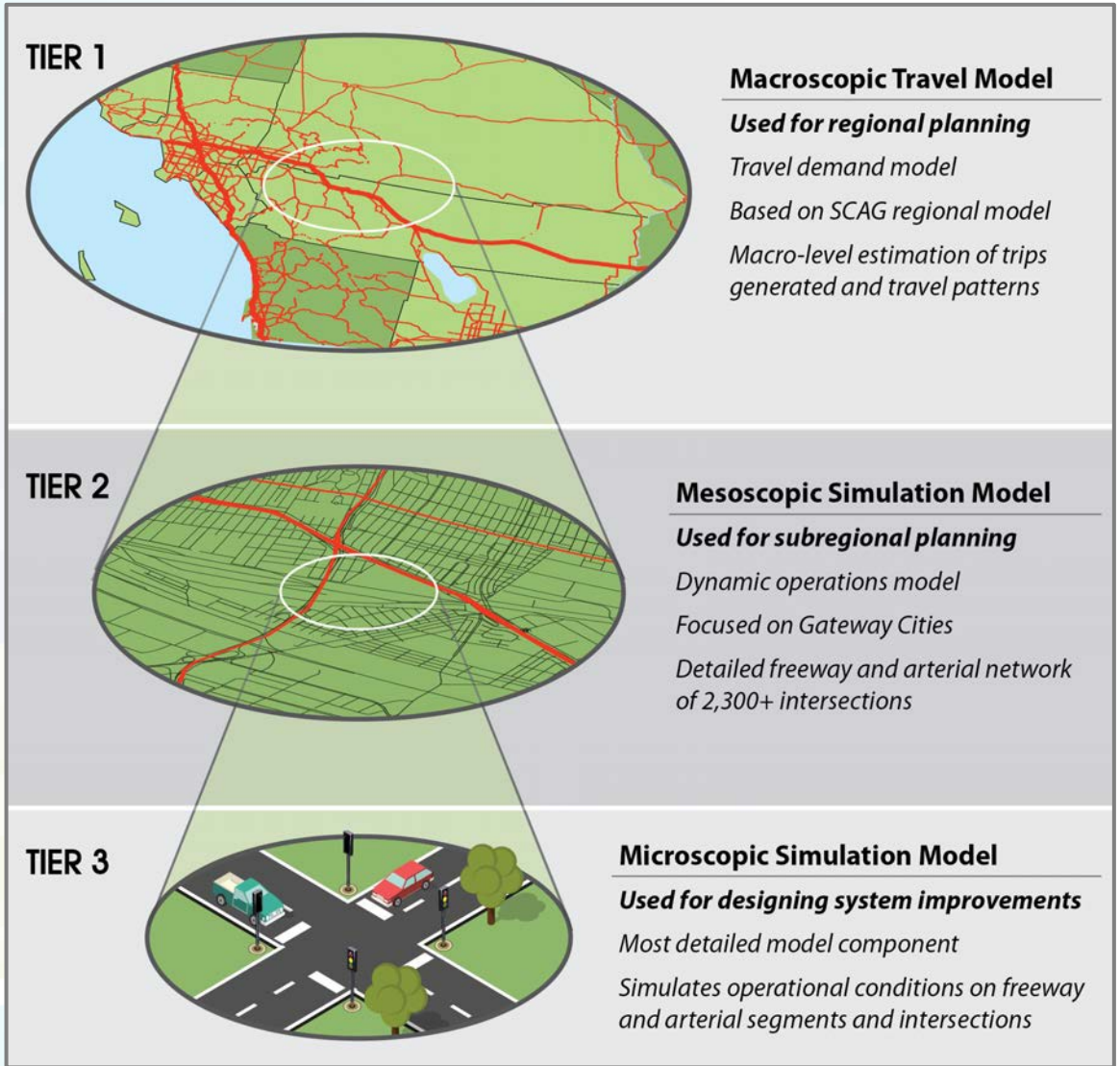
June 2018

Overview

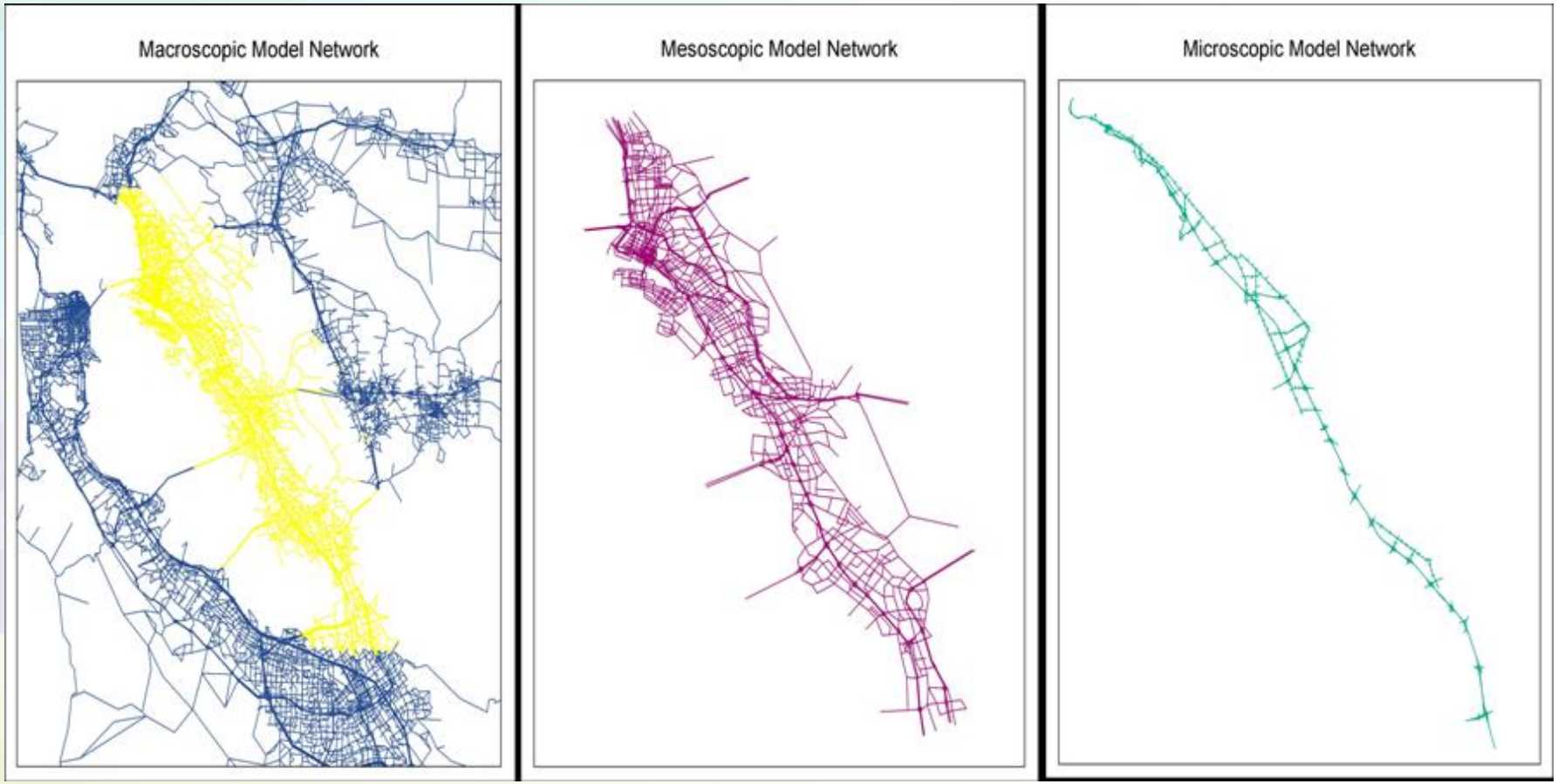
- Background and objectives
- Simulation overview
- Scoping a simulation project
  - Interactive exercise
- Selecting the appropriate analysis tool
  - Interactive exercise
- Data needs for model development and calibration
  - Types of data required
  - System performance profiles
  - Diagnostics
  - Data preparation and challenges
  - Operational conditions

Macro, Meso and Micro Modeling

- *Macro* - Long range traffic forecasts, regional patterns and mode shift
- *Meso* - Traveler information, HOT lanes, congestion pricing, regional diversion
- *Micro* - Detailed analysis of physical improvements and traffic control strategies, congested conditions



Analysis Resolutions



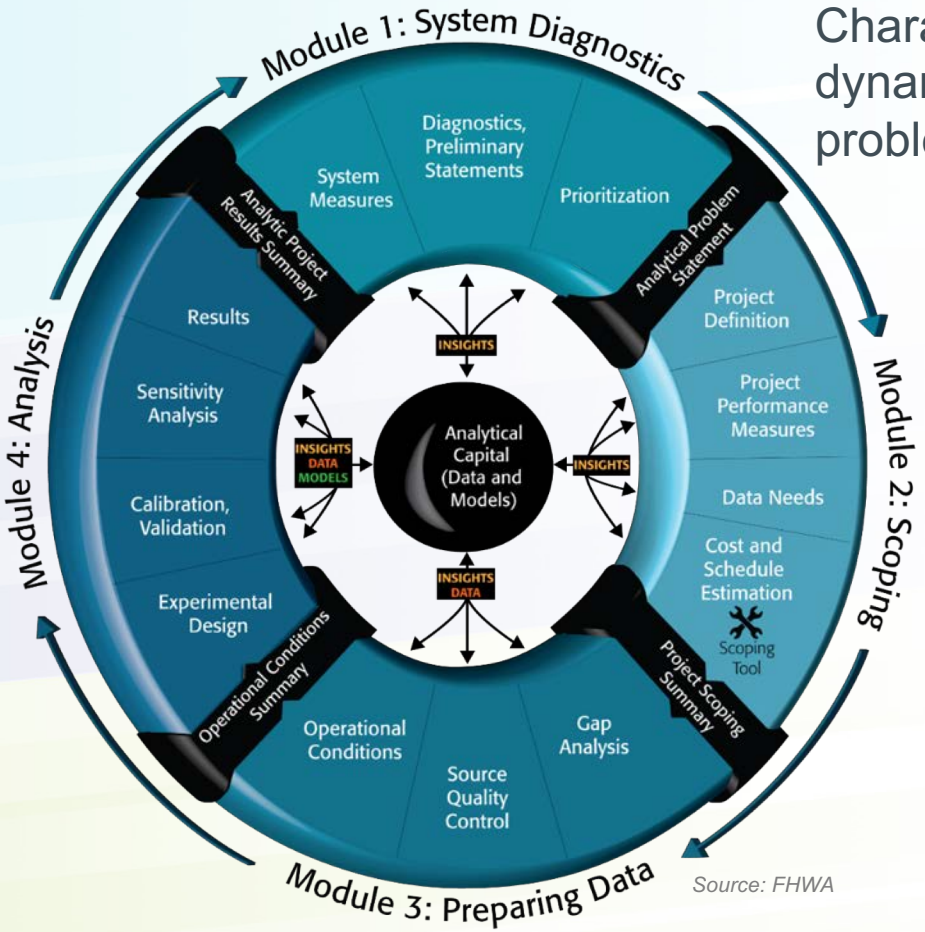
Simulation is Preferred for the Analysis of Congestion

- **Conditions suited for Microsimulation Modeling:**
  - Significant congestion with low speeds
  - Longer periods of congestion than one hour
  - Queues spillback from one freeway segment to another
  - Queues spillback from one intersection to another
  - Queues overflow turn pockets
  - Queues from city streets back up onto freeway
  - Queues from freeway ramps back up onto streets

Analysis Scoping

The 21st Century Analytical Project Scoping Process

Characterize system dynamics and diagnose problems.



Source: FHWA

Conduct and document transportation analyses.

Perform data-driven transportation analysis project scoping.

Collect and organize the data needed to conduct a transportation analysis.

Components of a Scoping Plan

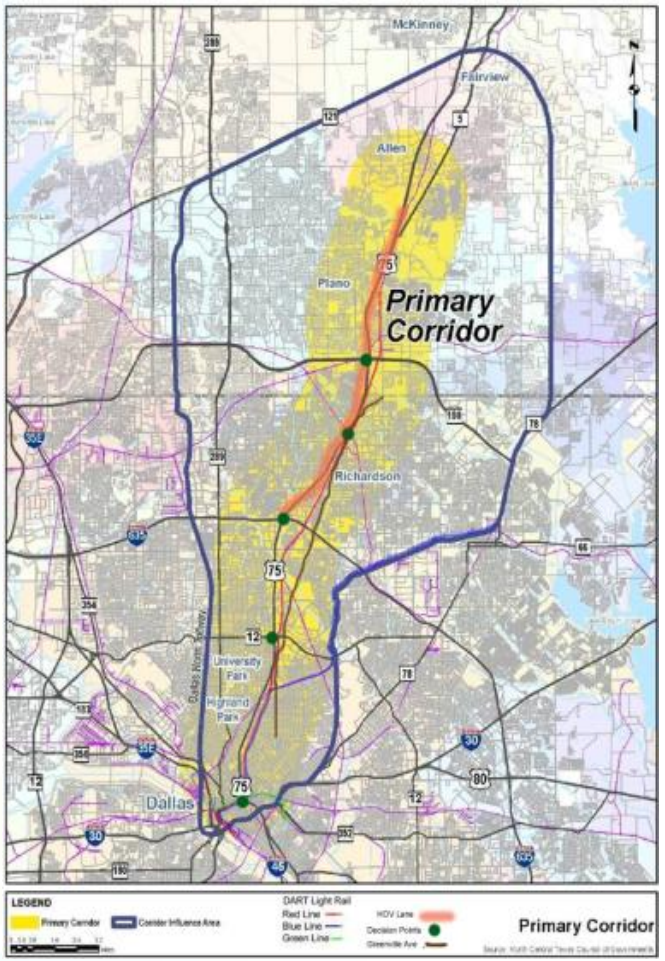
- Project definition
- Affected Stakeholders
- Selection of the appropriate analysis tool type
- Performance measures to be used in the analysis
- Analysis data requirements
- Preliminary list of alternatives to be studied, including analysis scenarios and transportation mitigation strategies
- Expected cost, schedule, and responsibilities for the analysis

Project Definition

- Describe the purpose of the project.
- Provide the project background.
- Document existing operational conditions.
- Identify underlying causes.
- Present the problems and issues that the analysis is intended to address.
- The objectives should be “SMART”.
  - **S**pecific, **M**easurable, **A**ctionable, **R**ealistic, and **T**ime-bound.

Geographic Scope
US 75 Corridor Networks

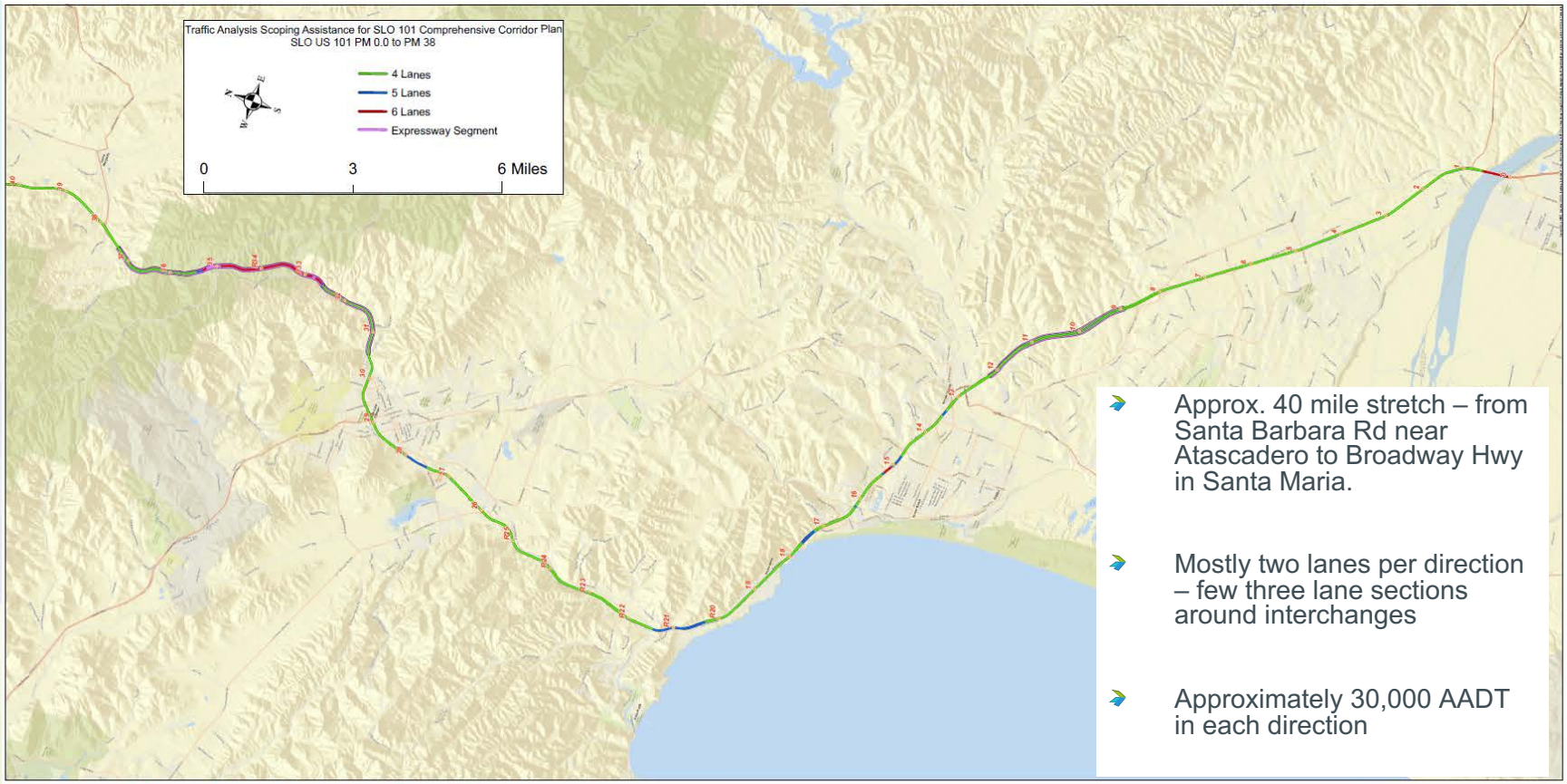
- Freeway with continuous Frontage Roads
- Managed HOV lanes
- Dallas North Tollway
- 167 Miles of Arterials
- DART Bus Network
- DART Light Rail
- 900 Signals
- Multiple TMCs
- Regional ATIS



Document Existing Operational Conditions

- Average daily and peak traffic levels
- Directionality of traffic flow
- Variability of traffic flow
- Status of construction activities
- Known bottlenecks
- Queuing conditions
- Free flow and average peak speeds
- Summary incident and accident statistics for the study area

SLO US 101 Corridor

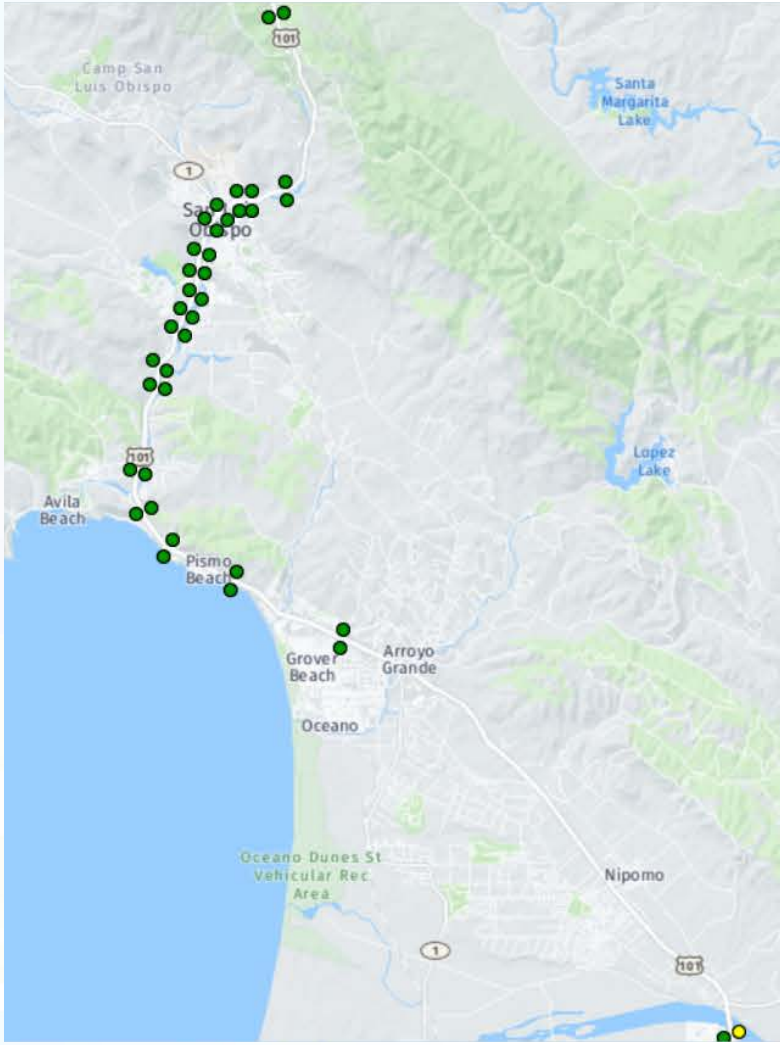


- Approx. 40 mile stretch – from Santa Barbara Rd near Atascadero to Broadway Hwy in Santa Maria.
- Mostly two lanes per direction – few three lane sections around interchanges
- Approximately 30,000 AADT in each direction

PeMS Data and Data Quality

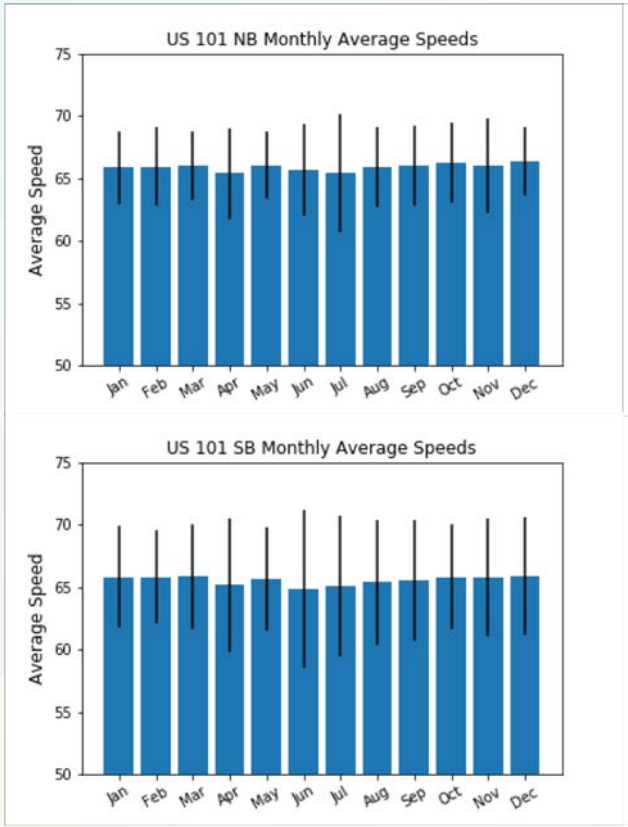
- One-hour data collected from 27 mainline PeMS stations along the corridor for 2017.
- Good quality data, with over 90% observed data reported along the corridor

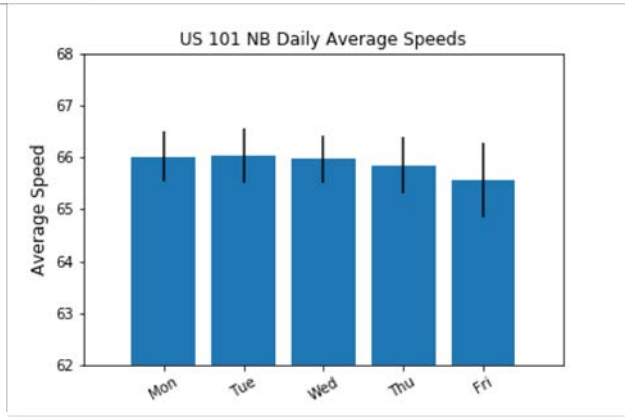
SB PeMS Station Name	Average % Detector Health
BROADWAY HWY 135 101 SB VDS MLSB	78.8
OAK PARK BLVD 101 NB VDS MLSB SB	96.3
SHELL BEACH RD 101 NB VDS MLSB S	54.9
SPYGLASS DR 101 SB VDS MLSB SB	96.4
AVILA BEACH DR 101 NB VDS MLSB S	99.2
SAN LUIS BAY DR 101 SB VDS MLSB	99.3
SO HIGUERA ST EXIT 101 NB VDS ML	95.7
SO HIGUERA ST ON RAMP ST 101 NB	94.6
LOS OSOS VALLEY RD 101 SB VDS ML	98.4
PRADO RD CMS 101 NB VDS MLSB SB	99.1
PRADO RD 101 NB VDS MLSB SB	98.7
MADONNA RD 101 SB VDS MLSB SB	95.9
MARSH ST 101 SB VDS MLSB SB	96.6
BROAD ST 101 SB VDS MLSB SB	99.7
TORO ST 101 NB VDS MLSB SB	98.1
GRAND AVE IN SLO AT 101 SB VDS M	96.8
MONTEREY ST 101 NB VDS MLSB SB	83.2
FOX HOLLOW RD 101 NB VDS MLSB SB	99.7
PM 36.06 DIRT ROAD SLO 101 SB VD	99.5
TASSAJARA CREEK RD 101 NB VDS ML	98.0
HWY 58 AT 101 SB VDS MLSB SB	97.4
PM 39.88 SLO 101 NB VDS MLSB SB	99.3
SANTA BARBARA RD 101 NB VDS MLSB	99.6
SAN DIEGO RD 101 NB VDS MLSB SB	49.6
SANTA ROSA RD 101 SB VDS MLSB SB	99.7
CURBARIL AVE 101 NB VDS MLSB SB	93.4
TRAFFIC WAY 101 SB VDS MLSB SB	98.0

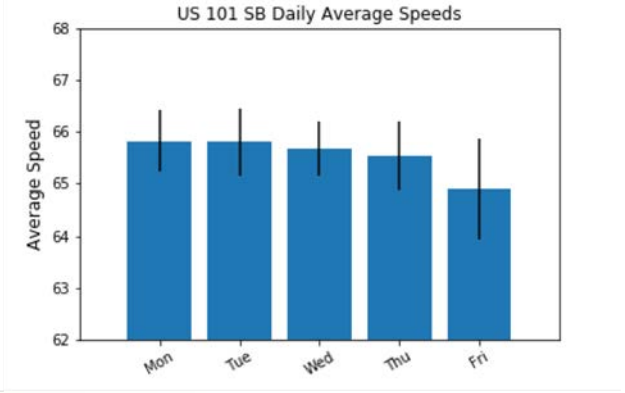


General Traffic Conditions

- Overall statistics computed from PeMS detector data.
- Lower and less reliable speeds present in the summer.
- Friday is the weekday with the lowest average speeds in both directions.

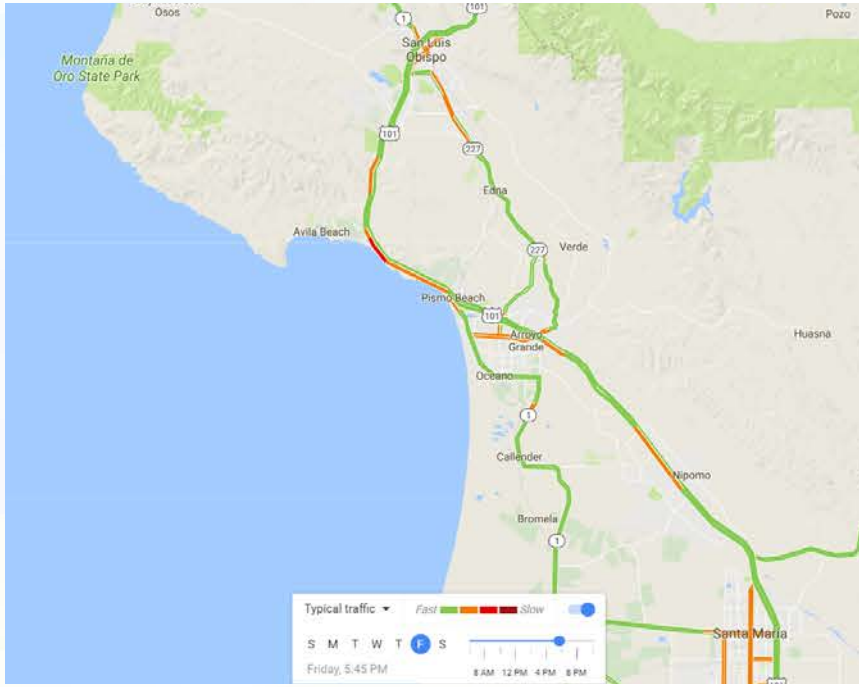






US 101 Typical Speeds

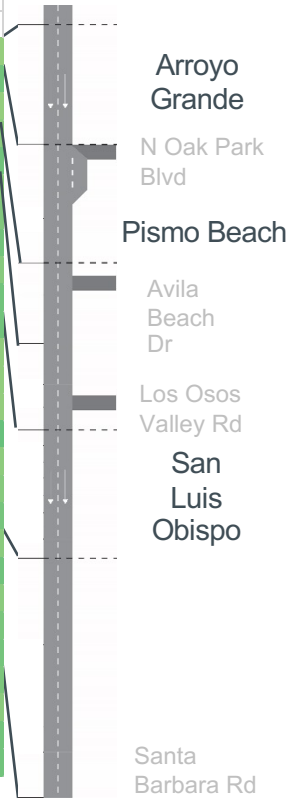
- Typical speeds from Google Maps.
- The lowest speeds on a weekday are typically observed on Friday afternoons, from 5 to 6 PM.



US 101 NB Congestion

- The lowest speeds are present in San Luis Obispo during the PM period.

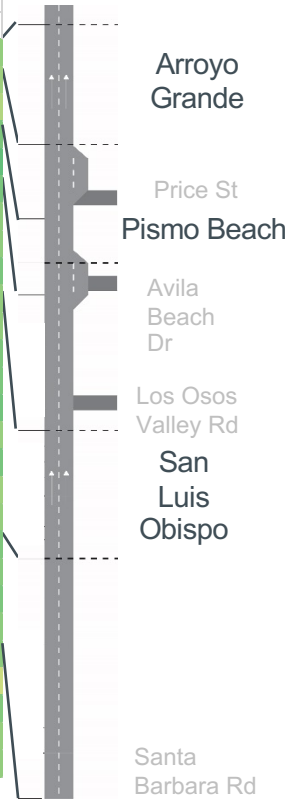
	Hour																							
Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
BROADWAY HWY 135 101 SB VDS MLNB	66	66	66	66	66	67	62	66	66	66	66	66	66	66	65	65	65	66	66	67	66	66	66	66
OAK PARK BLVD 101 NB VDS MLNB NB	69	69	69	69	68	68	63	58	59	63	63	64	64	64	63	64	64	65	66	67	67	68	68	69
SHELL BEACH RD 101 NB VDS MLNB N	67	66	67	66	66	66	64	62	62	63	63	62	62	62	62	62	62	62	64	65	65	66	66	66
SPYGLASS DR 101 SB VDS MLNB NB	67	67	66	67	67	68	67	63	63	65	65	65	65	65	65	65	66	66	67	68	67	67	67	67
AVILA BEACH DR 101 NB VDS MLNB N	69	69	69	69	69	68	65	61	61	62	63	63	63	63	63	63	63	63	65	67	67	68	68	69
SAN LUIS BAY DR 101 SB VDS MLNB	67	67	67	67	67	68	67	64	64	65	65	65	65	65	65	65	66	65	67	68	67	67	67	67
SO HIGUERA ST EXIT 101 NB VDS ML	68	68	68	68	68	68	64	62	62	63	62	63	63	63	64	64	64	64	66	67	67	67	67	68
SO HIGUERA ST ON RAMP ST 101 NB	69	69	68	68	68	68	66	64	64	64	64	64	64	64	64	64	64	64	66	67	68	68	68	69
LOS OSOS VALLEY RD 101 SB VDS ML	67	67	67	67	67	68	68	66	66	66	65	65	65	66	65	65	65	64	67	68	67	68	67	67
PRADO RD CMS 101 NB VDS MLNB NB	69	69	69	69	68	68	65	64	64	64	63	63	63	63	63	63	63	62	65	67	68	68	68	69
PRADO RD 101 NB VDS MLNB NB	69	69	69	69	68	68	66	64	64	64	63	63	63	63	63	63	62	60	65	67	67	68	68	69
MADONNA RD 101 SB VDS MLNB NB	67	66	66	67	67	67	67	65	64	64	64	63	63	64	63	63	62	60	64	67	67	67	67	67
MARSH ST 101 SB VDS MLNB NB	67	66	66	66	67	67	67	64	64	64	63	63	63	63	63	62	61	59	63	67	67	67	67	67
BROAD ST 101 SB VDS MLNB NB	66	66	66	66	67	67	67	64	63	63	63	63	63	63	63	63	62	58	63	66	66	67	67	67
TORO ST 101 NB VDS MLNB NB	69	69	69	69	69	69	68	66	66	66	65	64	64	64	64	63	62	58	64	68	68	68	69	69
GRAND AVE IN SLO AT 101 SB VDS M	67	66	66	66	66	67	67	68	67	67	67	67	67	67	65	65	64	58	65	68	67	67	67	67
MONTEREY ST 101 NB VDS MLNB NB	68	68	68	68	67	67	66	66	66	66	65	65	65	65	64	63	62	56	64	66	66	67	67	67
FOX HOLLOW RD 101 NB VDS MLNB NB	69	69	69	69	69	68	67	67	66	65	63	63	63	63	63	63	62	59	64	67	67	67	68	68
PM 36.06 DIRT ROAD SLO 101 SB VD	67	67	66	66	67	67	67	68	67	67	67	67	67	67	67	66	66	65	66	67	67	67	67	67
TASSAJARA CREEK RD 101 NB VDS ML	69	69	69	69	69	68	68	68	67	67	66	65	65	65	64	64	64	64	66	68	68	68	68	69
HWY 58 AT 101 SB VDS MLNB NB	67	66	66	66	67	67	67	67	67	67	67	67	67	67	66	65	65	65	67	68	67	67	67	67
PM 39.88 SLO 101 NB VDS MLNB NB	68	68	68	68	68	68	67	67	67	66	64	63	64	63	63	63	63	63	65	67	67	67	68	68
SANTA BARBARA RD 101 NB VDS MLNB	69	69	69	69	69	68	67	67	67	66	66	65	65	64	63	63	63	63	66	67	67	67	68	68
SAN DIEGO RD 101 NB VDS MLNB NB	68	68	68	67	67	67	66	65	65	67	67	67	67	66	66	65	65	66	67	68	68	68	68	68
SANTA ROSA RD 101 SB VDS MLNB NB	67	67	67	67	67	67	67	68	67	67	67	67	67	67	66	65	64	64	67	68	67	67	67	67
CURBARIL AVE 101 NB VDS MLNB NB	69	69	69	69	69	68	67	66	65	64	64	64	64	64	64	63	63	64	66	67	67	68	68	69
TRAFFIC WAY 101 SB VDS MLNB NB	69	69	69	69	69	68	68	66	65	65	64	64	64	64	64	64	63	64	66	68	67	68	68	69



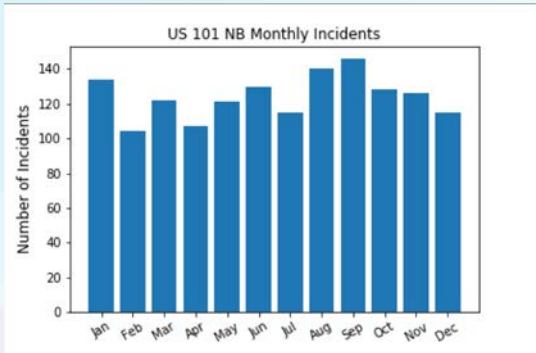
US 101 SB Congestion

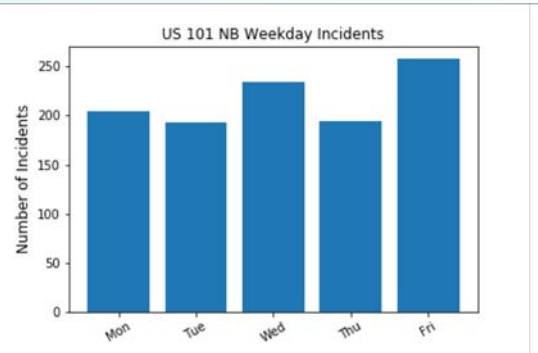
- There is a recurring bottleneck at Pismo Beach in the PM peak period, reducing speeds to an average of 35 mph.

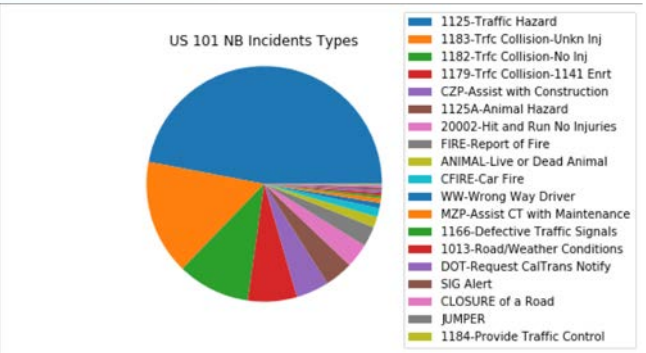
	Hour																							
Name	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
BROADWAY HWY 135 101 SB VDS MLSB	67	67	67	67	67	67	67	66	66	65	65	65	65	65	64	63	63	62	64	67	67	67	67	67
OAK PARK BLVD 101 NB VDS MLSB SB	66	66	66	66	66	66	65	63	62	63	63	63	63	63	63	63	60	57	61	62	64	65	66	66
SHELL BEACH RD 101 NB VDS MLSB S	65	65	65	65	65	65	65	65	64	64	64	63	63	63	62	59	56	56	61	64	64	65	65	65
SPYGLASS DR 101 SB VDS MLSB SB	69	69	69	69	69	69	68	67	67	66	65	65	64	64	61	51	38	35	55	66	67	67	68	68
AVILA BEACH DR 101 NB VDS MLSB S	70	70	70	69	70	70	70	70	70	69	69	67	67	67	65	59	44	38	60	69	69	69	70	70
SAN LUIS BAY DR 101 SB VDS MLSB	69	69	69	69	69	69	68	67	67	66	65	65	64	64	63	61	59	58	64	67	67	68	68	69
SO HIGUERA ST EXIT 101 NB VDS ML	67	67	67	67	67	67	67	67	66	65	64	64	63	63	62	58	54	55	64	66	66	67	67	67
SO HIGUERA ST ON RAMP ST 101 NB	67	67	66	66	67	67	67	67	67	66	65	65	64	64	63	59	53	56	64	67	66	66	67	67
LOS OSOS VALLEY RD 101 SB VDS ML	69	69	69	69	69	68	67	67	67	67	66	66	66	65	64	61	55	60	65	67	67	67	68	68
PRADO RD CMS 101 NB VDS MLSB SB	67	66	66	66	66	67	67	66	65	65	65	64	63	62	61	59	55	58	65	67	67	67	67	67
PRADO RD 101 NB VDS MLSB SB	67	66	66	66	66	67	67	67	66	66	66	65	64	63	63	59	55	57	66	67	67	67	67	67
MADONNA RD 101 SB VDS MLSB SB	69	69	69	69	69	68	67	67	66	66	66	65	64	64	63	61	59	61	66	67	67	67	68	68
MARSH ST 101 SB VDS MLSB SB	69	69	69	69	69	68	67	66	65	65	64	64	63	63	62	61	61	61	65	67	67	68	68	68
BROAD ST 101 SB VDS MLSB SB	69	70	70	70	69	69	68	66	65	64	64	63	63	63	62	60	60	60	64	66	67	68	69	69
TORO ST 101 NB VDS MLSB SB	66	66	66	66	67	67	67	65	65	66	66	65	65	65	65	63	63	63	66	67	67	67	67	67
GRAND AVE IN SLO AT 101 SB VDS M	69	69	68	69	68	69	67	65	65	66	67	67	66	66	65	65	66	66	67	68	68	68	68	69
MONTEREY ST 101 NB VDS MLSB SB	66	65	65	65	66	66	66	65	65	66	66	66	66	66	65	65	66	66	67	67	66	66	66	66
FOX HOLLOW RD 101 NB VDS MLSB SB	67	66	66	66	67	67	66	65	65	65	65	65	65	64	64	64	64	64	66	67	67	67	67	67
PM 36.06 DIRT ROAD SLO 101 SB VD	69	69	69	69	69	68	66	61	62	65	66	65	65	65	65	64	64	64	67	68	68	68	68	68
TASSAJARA CREEK RD 101 NB VDS ML	67	67	67	67	67	68	67	63	63	66	66	66	66	66	65	65	65	65	67	68	68	68	68	68
HWY 58 AT 101 SB VDS MLSB SB	68	68	68	68	69	68	66	60	60	65	67	66	66	66	65	65	65	65	67	68	68	68	68	68
PM 39.88 SLO 101 NB VDS MLSB SB	67	67	66	67	67	68	67	65	64	67	68	67	67	67	67	66	67	67	68	68	67	67	67	67
SANTA BARBARA RD 101 NB VDS MLSB	67	67	67	67	67	68	68	65	66	68	68	67	67	67	67	67	67	67	68	68	67	68	68	67
SAN DIEGO RD 101 NB VDS MLSB SB	62	62	61	62	63	65	65	64	64	65	65	65	65	65	65	65	65	65	66	65	65	65	64	63
SANTA ROSA RD 101 SB VDS MLSB SB	68	68	69	68	68	68	65	63	63	65	65	65	64	64	63	62	63	64	66	67	67	67	67	68
CURBARIL AVE 101 NB VDS MLSB SB	67	67	66	66	67	67	67	65	66	67	67	66	66	66	65	65	65	65	67	67	67	67	67	67
TRAFFIC WAY 101 SB VDS MLSB SB	67	67	66	66	67	67	68	65	65	65	65	65	65	64	64	64	64	65	66	67	67	67	67	67

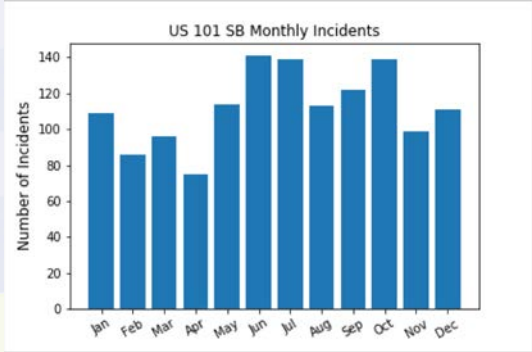


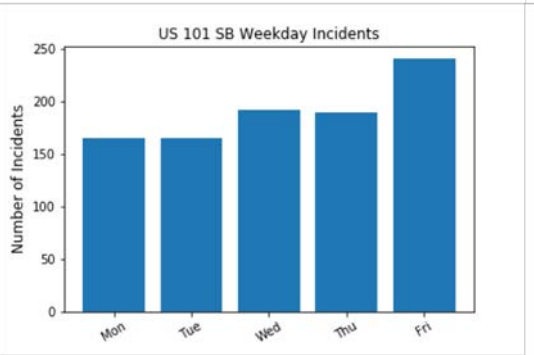
Incident Summary

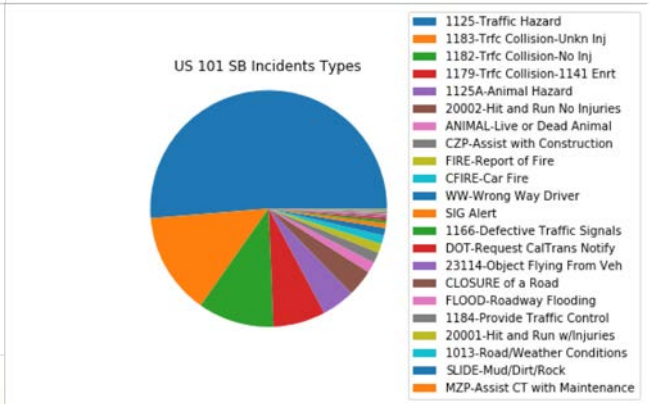












US 101 NB Incidents

- Total number of incidents reported by CBP in 2017.Most incidents reported near South Pismo Beach.

	Hour																							
Name	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
OAK PARK BLVD 101 NB VDS MLNB NB	1	1	2	2	5	6	10	24	15	16	15	8	14	18	19	11	11	3	12	11	7	11	1	7
SHELL BEACH RD 101 NB VDS MLNB N	2	0	0	0	0	0	5	8	14	4	2	7	3	8	6	4	5	5	1	3	2	1	3	2
SPYGLASS DR 101 SB VDS MLNB NB	0	0	0	0	0	1	1	3	2	4	4	2	3	2	1	2	0	0	0	1	1	0	0	1
AVILA BEACH DR 101 NB VDS MLNB N	0	0	0	1	0	1	2	3	0	3	2	0	1	0	1	0	2	0	0	0	1	0	0	1
SAN LUIS BAY DR 101 SB VDS MLNB	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	1	1	0	0	0	0	1
SO HIGUERA ST EXIT 101 NB VDS ML	0	1	2	0	2	1	2	6	2	2	4	2	2	4	4	2	4	1	4	2	1	1	1	2
SO HIGUERA ST ON RAMP ST 101 NB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOS OSOS VALLEY RD 101 SB VDS ML	0	1	0	0	0	2	3	1	2	3	2	3	1	1	5	2	2	0	3	2	2	1	2	3
PRADO RD CMS 101 NB VDS MLNB NB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
PRADO RD 101 NB VDS MLNB NB	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	2	2	1	1	0	0	0	0
MADONNA RD 101 SB VDS MLNB NB	0	1	0	0	1	0	0	0	1	1	4	0	0	0	3	6	1	6	2	2	2	0	0	0
MARSH ST 101 SB VDS MLNB NB	1	0	0	0	1	0	0	1	3	2	1	0	5	1	0	0	4	1	0	0	0	0	0	0
BROAD ST 101 SB VDS MLNB NB	0	0	0	0	0	0	0	0	0	0	0	2	1	3	0	2	1	0	0	0	0	0	0	0
TORO ST 101 NB VDS MLNB NB	0	2	3	0	0	0	0	0	1	2	0	1	1	1	1	0	1	1	0	1	1	1	0	2
GRAND AVE IN SLO AT 101 SB VDS M	0	1	1	0	0	0	1	1	1	2	1	2	0	0	1	1	0	3	0	1	3	0	0	1
MONTEREY ST 101 NB VDS MLNB NB	0	0	1	0	1	1	1	2	1	2	0	1	2	0	1	2	5	1	0	0	3	0	0	0
FOX HOLLOW RD 101 NB VDS MLNB NB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PM 36.06 DIRT ROAD SLO 101 SB VD	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
TASSAJARA CREEK RD 101 NB VDS ML	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HWY 58 AT 101 SB VDS MLNB NB	0	0	0	1	0	1	0	3	1	1	2	4	2	2	3	1	3	0	2	1	2	2	1	3
PM 39.88 SLO 101 NB VDS MLNB NB	0	1	0	1	1	1	2	2	2	1	5	5	2	3	1	3	0	0	0	2	1	1	1	0
SANTA BARBARA RD 101 NB VDS MLNB	1	0	0	0	0	0	0	1	1	1	0	1	2	1	2	3	0	0	0	1	1	2	1	0
SAN DIEGO RD 101 NB VDS MLNB NB	0	0	0	1	2	1	0	0	0	0	1	2	0	0	1	0	0	1	1	0	0	0	0	0
SANTA ROSA RD 101 SB VDS MLNB NB	0	0	0	0	0	0	0	1	0	0	1	0	2	0	2	1	1	0	3	0	0	1	1	2
CURBARIL AVE 101 NB VDS MLNB NB	0	1	1	0	0	0	0	0	0	1	2	2	1	0	0	2	0	0	2	0	0	0	0	0
TRAFFIC WAY 101 SB VDS MLNB NB	0	0	0	1	0	1	0	3	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0

US 101 SB Incidents

- Most incidents reported near South Pismo Beach, where congestion is present in the corridor.

	Hour																							
Name	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**
OAK PARK BLVD 101 NB VDS MLSB SB	1	3	5	4	2	1	3	9	8	13	9	11	17	14	12	16	19	13	22	11	15	5	6	4
SHELL BEACH RD 101 NB VDS MLSB S	2	0	1	0	1	0	1	1	1	2	5	3	1	7	2	4	7	4	3	4	1	3	1	0
SPYGLASS DR 101 SB VDS MLSB SB	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	2	3	0	2	0	0	0
AVILA BEACH DR 101 NB VDS MLSB S	0	0	0	0	0	0	1	0	0	2	0	2	3	3	0	3	4	9	4	3	1	1	2	1
SAN LUIS BAY DR 101 SB VDS MLSB	0	1	1	0	0	0	0	0	1	0	1	2	0	1	0	2	2	1	0	3	0	0	1	0
SO HIGUERA ST EXIT 101 NB VDS ML	0	0	0	2	0	1	1	1	2	0	0	1	1	1	2	2	5	5	1	3	1	0	1	0
SO HIGUERA ST ON RAMP ST 101 NB	0	0	0	2	2	0	0	1	1	2	1	2	3	3	1	3	2	2	1	1	3	1	0	0
LOS OSOS VALLEY RD 101 SB VDS ML	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
PRADO RD CMS 101 NB VDS MLSB SB	1	0	0	0	1	0	1	2	1	0	4	2	3	4	5	2	6	8	4	2	1	2	1	1
PRADO RD 101 NB VDS MLSB SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
MADONNA RD 101 SB VDS MLSB SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MARSH ST 101 SB VDS MLSB SB	1	0	0	1	1	0	1	0	1	0	1	1	4	3	5	5	4	2	1	0	3	0	3	1
BROAD ST 101 SB VDS MLSB SB	1	0	2	0	1	1	1	1	1	0	2	1	1	0	1	1	3	3	1	0	0	0	1	0
TORO ST 101 NB VDS MLSB SB	0	0	0	0	0	1	0	1	0	2	1	4	1	0	1	0	2	1	1	1	1	0	0	1
GRAND AVE IN SLO AT 101 SB VDS M	0	0	0	0	0	1	0	0	2	0	1	1	0	0	1	0	0	2	0	0	0	1	0	0
MONTEREY ST 101 NB VDS MLSB SB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
FOX HOLLOW RD 101 NB VDS MLSB SB	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0
PM 36.06 DIRT ROAD SLO 101 SB VD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TASSAJARA CREEK RD 101 NB VDS ML	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HWY 58 AT 101 SB VDS MLSB SB	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1
PM 39.88 SLO 101 NB VDS MLSB SB	0	0	1	0	2	1	2	5	5	3	0	1	3	3	3	1	0	0	2	0	2	1	0	1
SANTA BARBARA RD 101 NB VDS MLSB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
SAN DIEGO RD 101 NB VDS MLSB SB	1	0	3	1	1	0	2	0	2	2	2	2	1	1	2	0	1	1	1	3	1	1	1	1
SANTA ROSA RD 101 SB VDS MLSB SB	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CURBARIL AVE 101 NB VDS MLSB SB	1	0	0	0	0	0	1	4	0	3	2	0	1	0	0	2	1	0	2	2	0	1	0	0
TRAFFIC WAY 101 SB VDS MLSB SB	1	0	1	0	0	1	1	0	2	3	1	2	1	6	2	4	1	2	0	0	1	1	1	2

Affected Stakeholders

- Identify a complete set of stakeholders and partners who ***fully*** represent the agencies and organizations affected by the project.
  - e.g., highway or roadway agencies, transit agencies, program managers and stakeholders, freight industry groups, bike/pedestrian groups, emergency responders, toll authorities, media representatives.
- To minimize the risk of having to redo parts of the analysis late in the process, agencies with reviewing and/or approving authority over the analysis ***should be at the table from the start of the project***.

Performance Measures for the Analysis

Mobility

(travel time, delay, throughput)

Reliability

(changes in the Planning Index, changes in the standard deviation of travel time)

Emissions and Fuel Consumption

(monetized using costs per ton of pollutants released and the purchase price of fuel)

Benefits and Cost Comparison

(capital costs, operations and maintenance costs, annualized costs)

Safety

Accidents or crashes in the study area (fatalities, injuries, property-damage-only accidents). *This is an area deserving of new research.* *Limited data on the direct impact of mitigation strategies on safety*

Analysis Details

Study Area, Facility Types, and Affected Modes	• Study area must cover beyond the end of the of the full spatial extent of queues/congestion in the baseline and future years of analysis. • May be necessary to include all modes in the study area for mode shift.
Analysis Time Period	• Time period defined (AM/PM/Midday peak hour and/or peak period, off-peak period, etc.) must cover the beginning and end of full temporal extent of queues and congestion in the baseline and future years of analysis.
Alternatives Definition	• Scenarios should include geometric and operational alternatives to be analyzed and compared to the baselines.
Analysis Time Horizon	• A future baseline model (or future no-build alternative) is the basis for comparison between alternatives in a future time horizon.

Project Scoping Summary Elements - 1

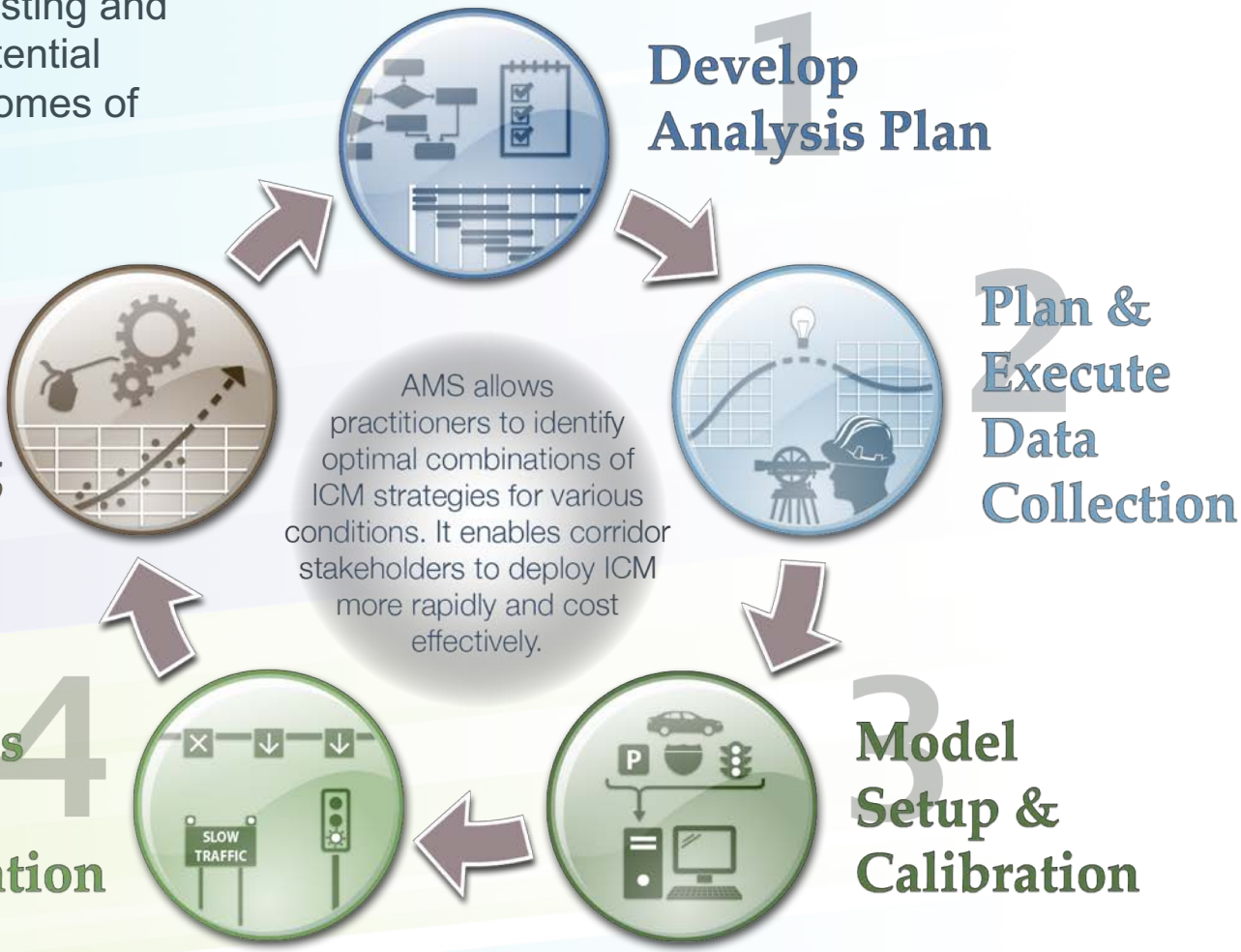
Project Definition	A concise statement of the overall system problem includes cross-validation and other insights from stakeholders on the nature of the issue and potential solutions.
Geographic Scope	The geographic area to be covered by the analytical project includes a statement of the required detail of representation within this geographical area.
Temporal Scope	The times of day, days of week, seasonality, and years of operation are assessed in the analytical effort. This includes an assessment of the simulation horizon.
Candidate Hypothesis	The candidate hypothesis represents the leading underlying cause of the system performance issue.
Analytical Approach	This element describes of the proposed method for evaluating the effectiveness of the mitigating strategies in resolving the system performance issue.
Selected Tool Type(s)	The one or more tool types will be used in the analytical approach. This section should identify if existing models are to be employed, or if new models must be developed.
Data Requirements	A summary of data will be used to characterize operational conditions, represent alternatives, and model the geographic and temporal aspects of the system.

Project Scoping Summary Elements - 2

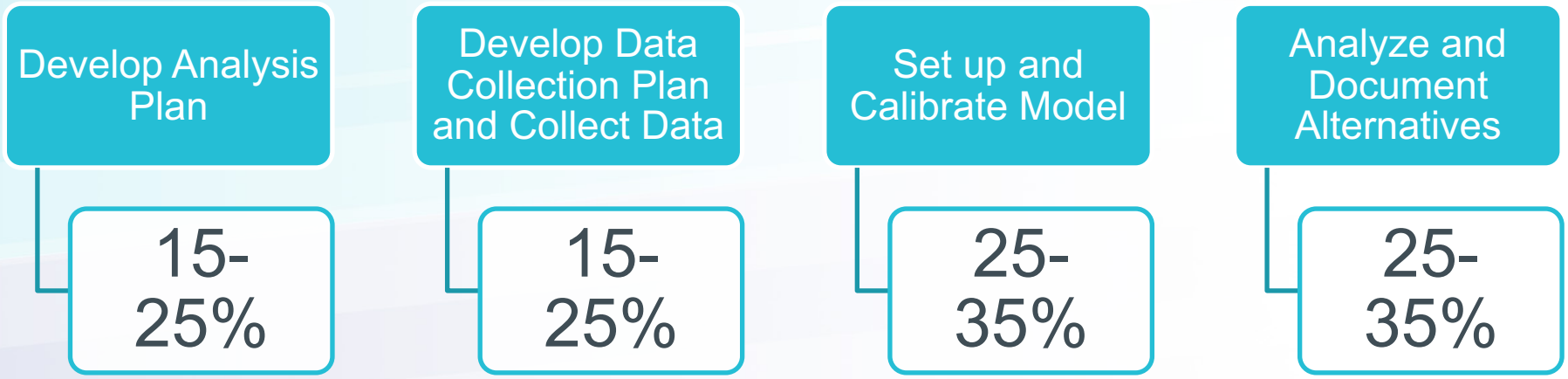
Preliminary List of Alternatives	High-level description of the alternative solutions and/or operational practices will be assessed within the analytical project.
Key Operational Conditions	The set of travel demand, incident, and weather conditions under which a meaningful examination of alternative impacts must be conducted.
Selected Performance Measures	The measures of system performance selected for the effort. These measures should be most suited to differentiate alternatives, be meaningful to stakeholders, and can be well-represented/estimated within the proposed analytical approach.
Expected Costs	The projected cost of the analytical project, including data collection.
Expected Schedule	The projected time to conduct the analysis, including data collection.
Expected Assignment of Responsibilities	An assessment of responsibilities related to the project and how those responsibilities are allocated among departments, contractors, and other organizations engaged in the effort.
Risks	A summary of risks comprising risks in data collection, technical risks, and non-technical risks.

ICM Analysis, Modeling, and Simulation (AMS) Framework

A guide for forecasting and evaluating the potential benefits and outcomes of ICM.



Estimated Level of Effort



Cost Implications

Seemingly similar projects may require different levels of effort for a number of reasons:

- Experience of project manager, analysis team, and reviewers.
- The project purpose, objectives, and scope.
- The availability of good data for model calibration.
- Temporal and spatial resolution requirements for the analysis.
- The number and complexity of the alternatives being analyzed.
- Performance measures used.
- Software used.
- The amount of documentation, meetings, and presentations required.
- Number and effectiveness of project reviews conducted.
- The extent of stakeholder involvement.

Interactive Exercise Using the Scoping Tool

Analysis Scoping Tool
Summary of Example User Inputs

Transportation Analysis Project Costing Tool

Developed for the USDOT by:

CAMBRIDGE SYSTEMATICS

Press This Button to Start

Summary of User Inputs:

Name of Study Area:	Standard TIS
Number of Intersections:	8
Number of Freeway Ramps:	2
Base Model Availability:	Yes
Is the Base Model Calibrated:	No
Number of Analysis Horizons:	3
Number of Alternatives:	3
Number of Representative Days:	2
Number of Peak Periods	2
Data Collection Requirements:	Medium
Complexity of Analysis Scenarios:	Simple
Complexity of Methodology:	Stochastic/Dynamic
Complexity of Outputs:	Simple
Analyst Experience:	Some

Note: This Transportation Analysis Costing Tool is provided "as is" without warranty of any kind, and without any documentation, user's guide, or maintenance agreement

Analysis Scoping Tool
Example Output

	Transportation Analysis Project Costing Tool						
OUTPUT REPORT							
Estimate of Labor Hours Required to Complete the Analysis of:							
	Standard TIS						
			Engineer/				
		Manager	Planner	Technician	Total	Lower	Upper
	Project Task	Hours	Hours	Hours	Hours	Bound	Bound
1	Develop workplan, analysis plan, and project management	30	30	10	**70**	**60**	**80**
2	Select analysis tool	10	10	-	**20**	**20**	**20**
3	Develop data plan and process data	-	-	40	**40**	**40**	**40**
4	Define clusters and representative days	30	50	-	**80**	**70**	**90**
5	Develop and calibrate baseline model(s)	20	40	70	**130**	**120**	**170**
6	Develop future baseline model(s)	30	30	30	**90**	**80**	**100**
7	Analyze alternatives	90	180	90	**360**	**320**	**400**
8	Reports and presentations	30	30	10	**70**	**60**	**80**
	Total Labor Hours	**240**	**370**	**250**	**860**	**770**	**980**

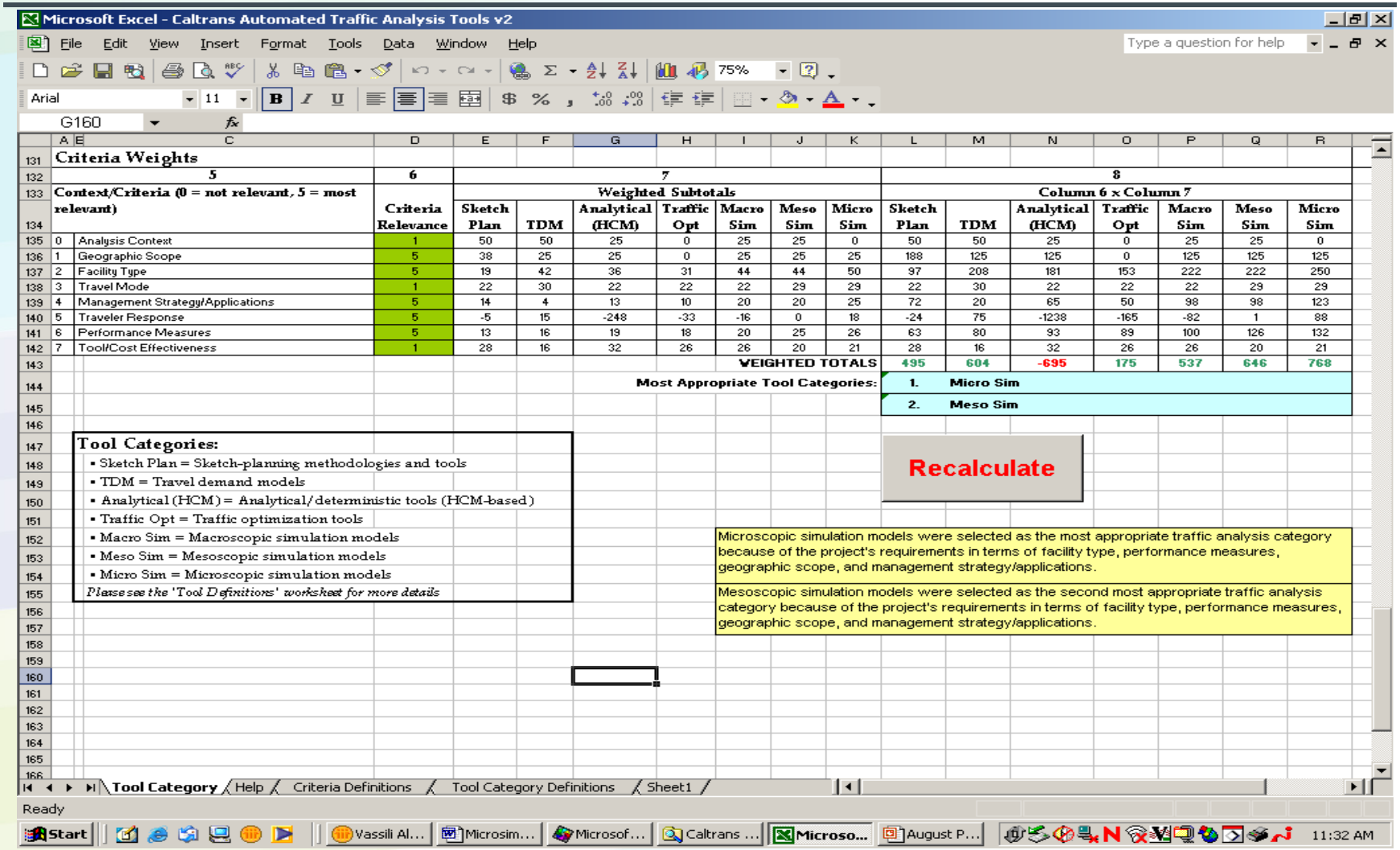
Analysis Tool Selection

Analysis Context: Planning, Design, or Operations/Construction

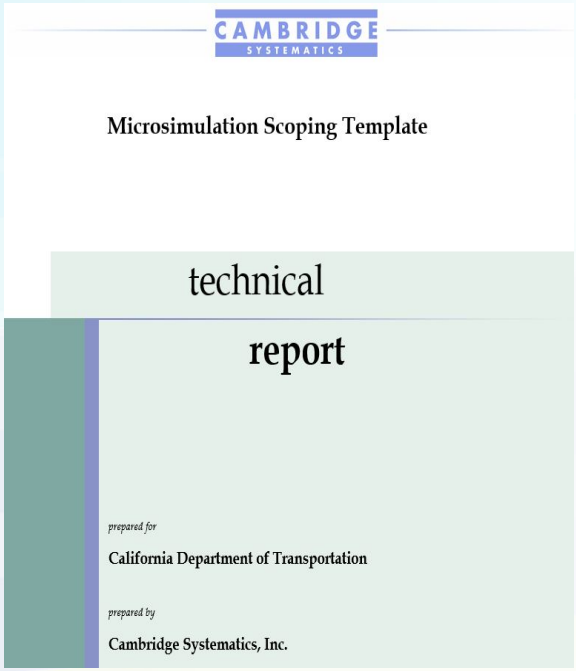
1	2	3	4	5	6	7
Geographic Scope	**Facility Type**	**Travel Mode**	**Management Strategy**	**Traveler Response**	**Performance Measures**	**Tool Attributes**
What is your study area?	Which facility types do you want to include?	Which travel modes do you want to include?	Which mgmt strategies should be analyzed?	Which traveler responses should be analyzed?	What performance measures are needed?	What operational characteristics are important?
• Isolated Location • Segment • Corridor/ small network • Region	• Isolated intersection • Roundabout • Arterial • Highway • Freeway • HOV lane • HOV bypass lane • Ramp • Auxiliary lane • Reversible lane • Truck lane • Bus lane • Toll plaza • Light rail	• SOV • HOV (2, 3, 3+) • Bus • Rail • Truck • Motorcycle • Bicycle • Pedestrian	• Freeway mgmt • Arterial intersections • Arterial mgmt • Incident mgmt • Emergency mgmt • Work zone • Special event • APTS • ATIS • Electronic payment • RRX • CVO • AVCSS • Weather mgmt • TDM	• Route diversion (pre-trip and en-route) • Mode shift • Departure time choice • Destination change • Included/ foregone demand	• LOS • Speed • Travel time • Volume • Travel distance • Ridership • AVO • v/c ratio • Density • VMT/PMT • VJJT/PHT • Delay • Queue length • # stops • Crashes/duration • TT reliability • Emissions/fuel • Noise • Mode shift • Benefit/cost	• Tool capital cost • Effort (cost/training) • Ease of use • Popular/well-trusted • Hardware requirements • Data requirements • Run time • Post-processing • Documentation • User support • Key parameters user definable • Default values • Integration • Animation

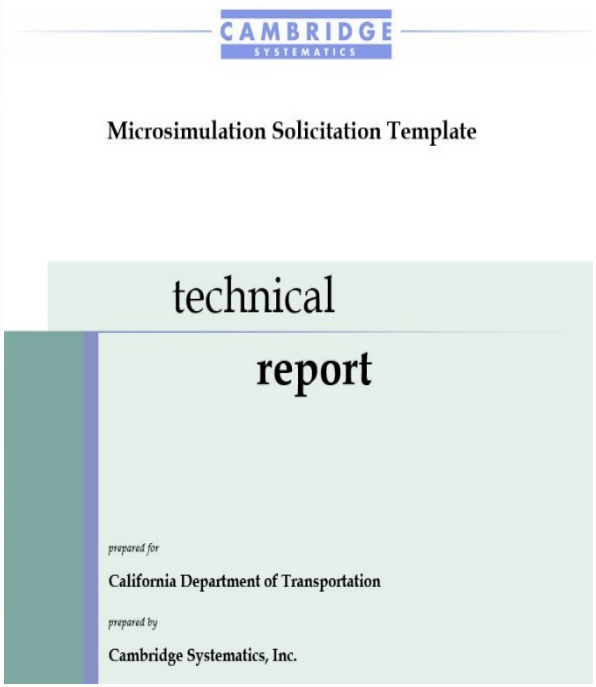
Interactive Exercise Using the Analysis Tool Selection Methodology

Which Analysis Tool Type to Use



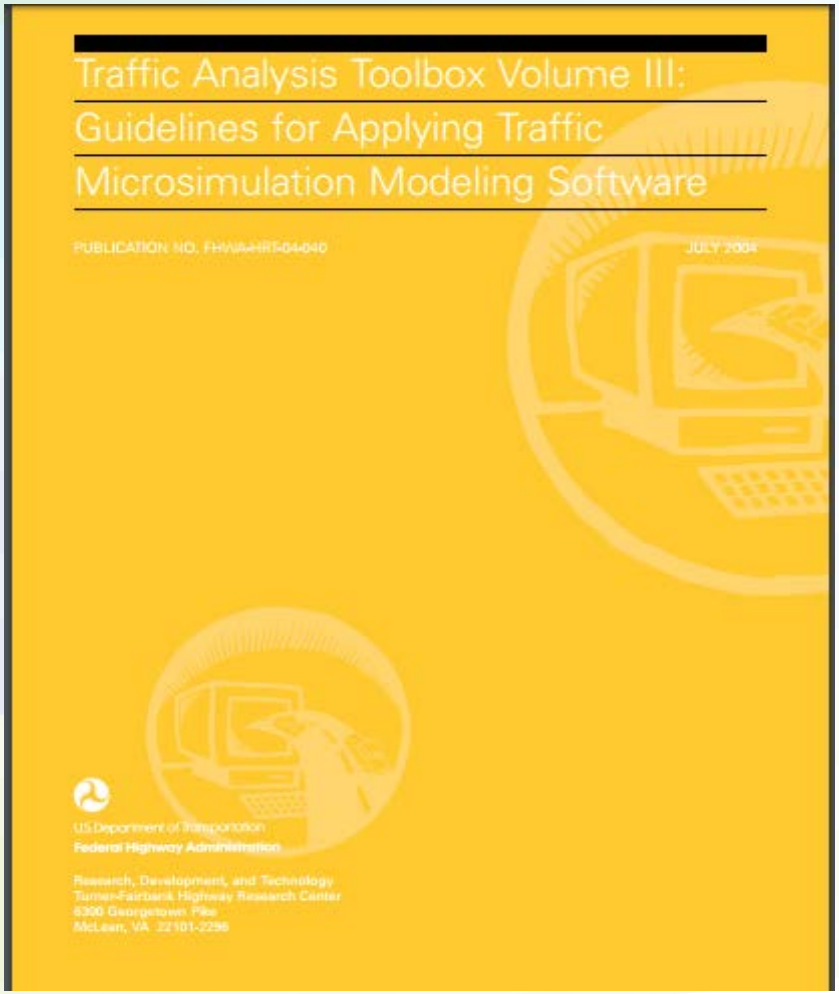
Data and Resources

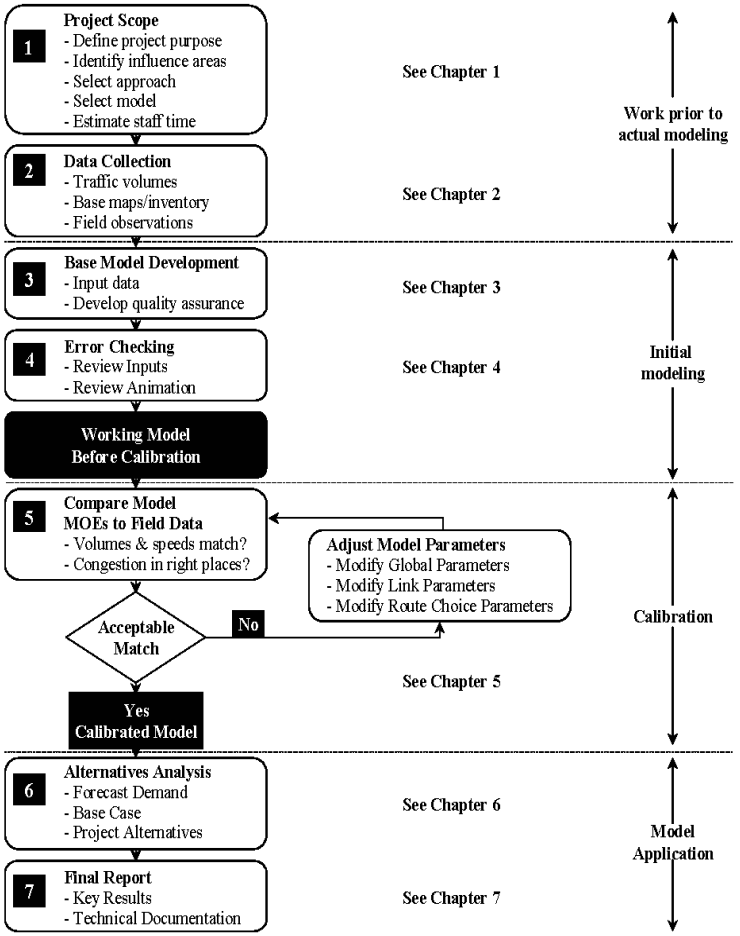




Data Needs for Model Development and Calibration

Model Calibration Requirements - FHWA Microsimulation Guidance





Developed by the FHWA Traffic Analysis Tools Team and later adapted from *Advanced Corsim Training Manual*, Short, Elliott, Hendrickson, Inc., Minnesota Department of Transportation, September 2003.

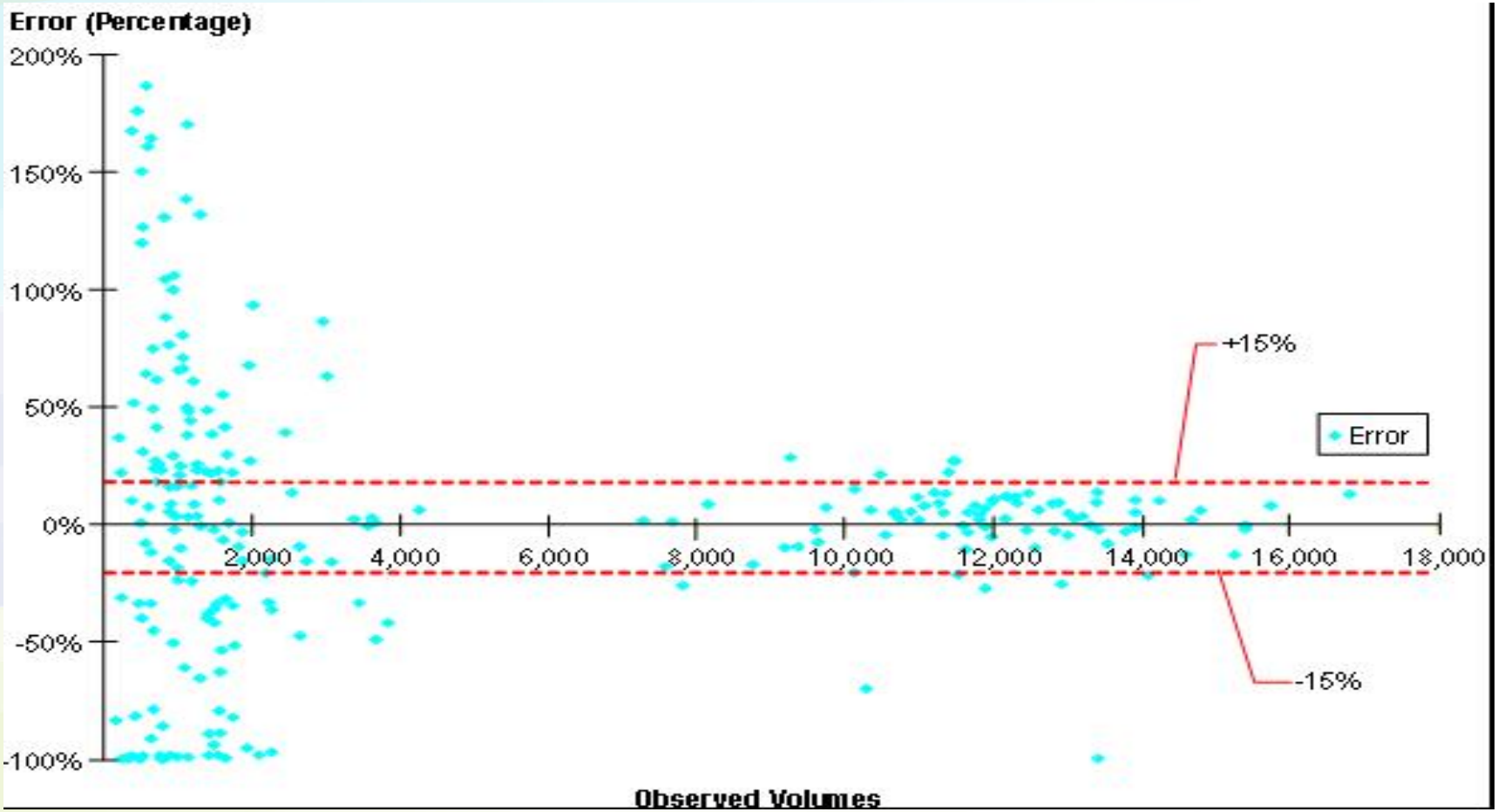
Analysis Model Input Types

- Network geometry
- Traffic control data (signal timings, signs, …)
- Travel demand (O-D), traffic volumes, and intersection turning movements
- Performance data, such as queue locations, queue lengths, travel times, and speeds
- Data on vehicle characteristics, such as vehicle classifications or vehicle mix

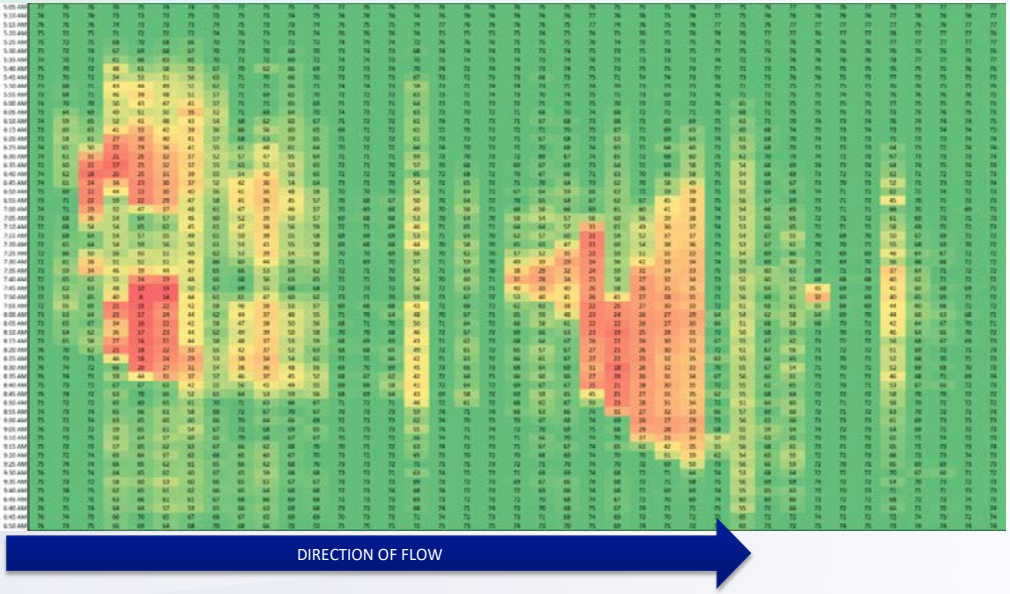
Types of Data

Travel Demand	Traffic Control	Physical Geometry
• Traffic counts • Vehicle classification counts • Speeds • Travel times • Congestion • Queuing observations	• Signs • Signal control • Timing plans	• Rectified aerial photography • Base mapping files

Example Observed vs Modeled Volumes



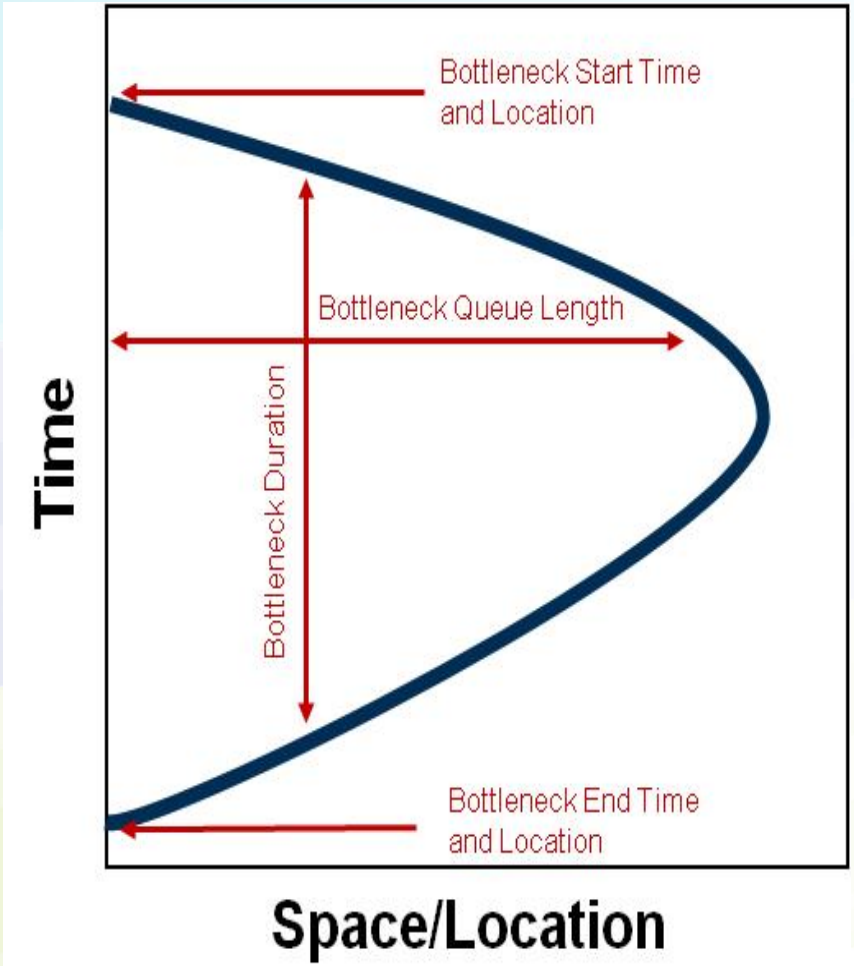
Speed Diagram for an Analysis Scenario

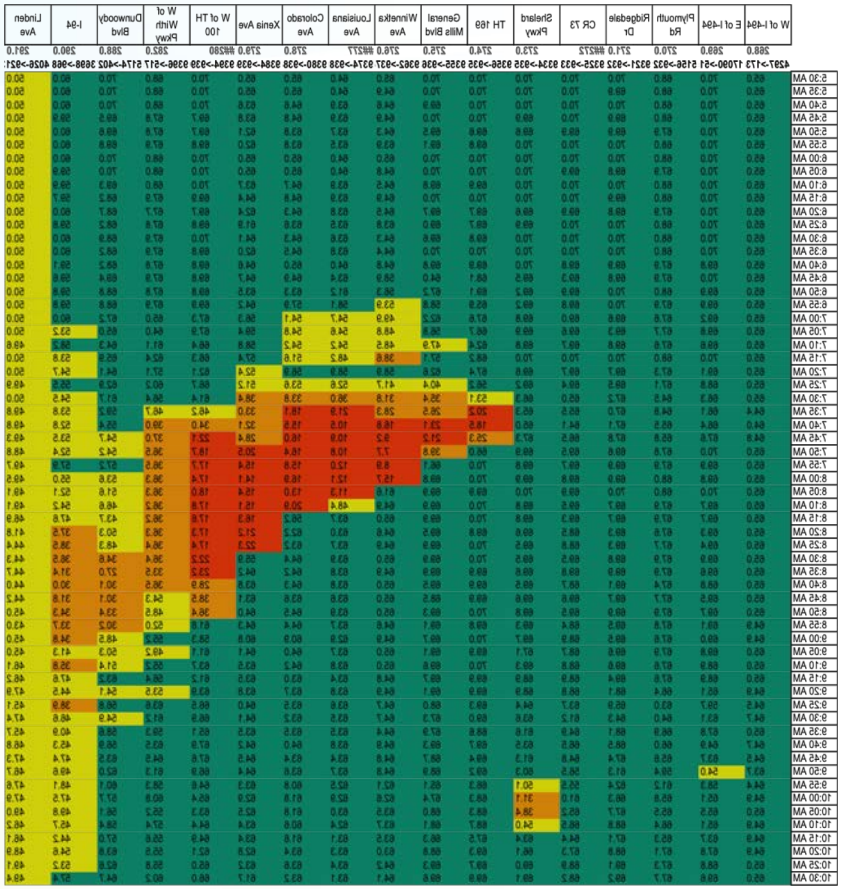


(Source: Federal Highway Administration.)

This type of diagram helps the analyst compare observed and modeled speeds in space and in time, so an assessment can be made about whether the model can adequately replicate existing conditions.

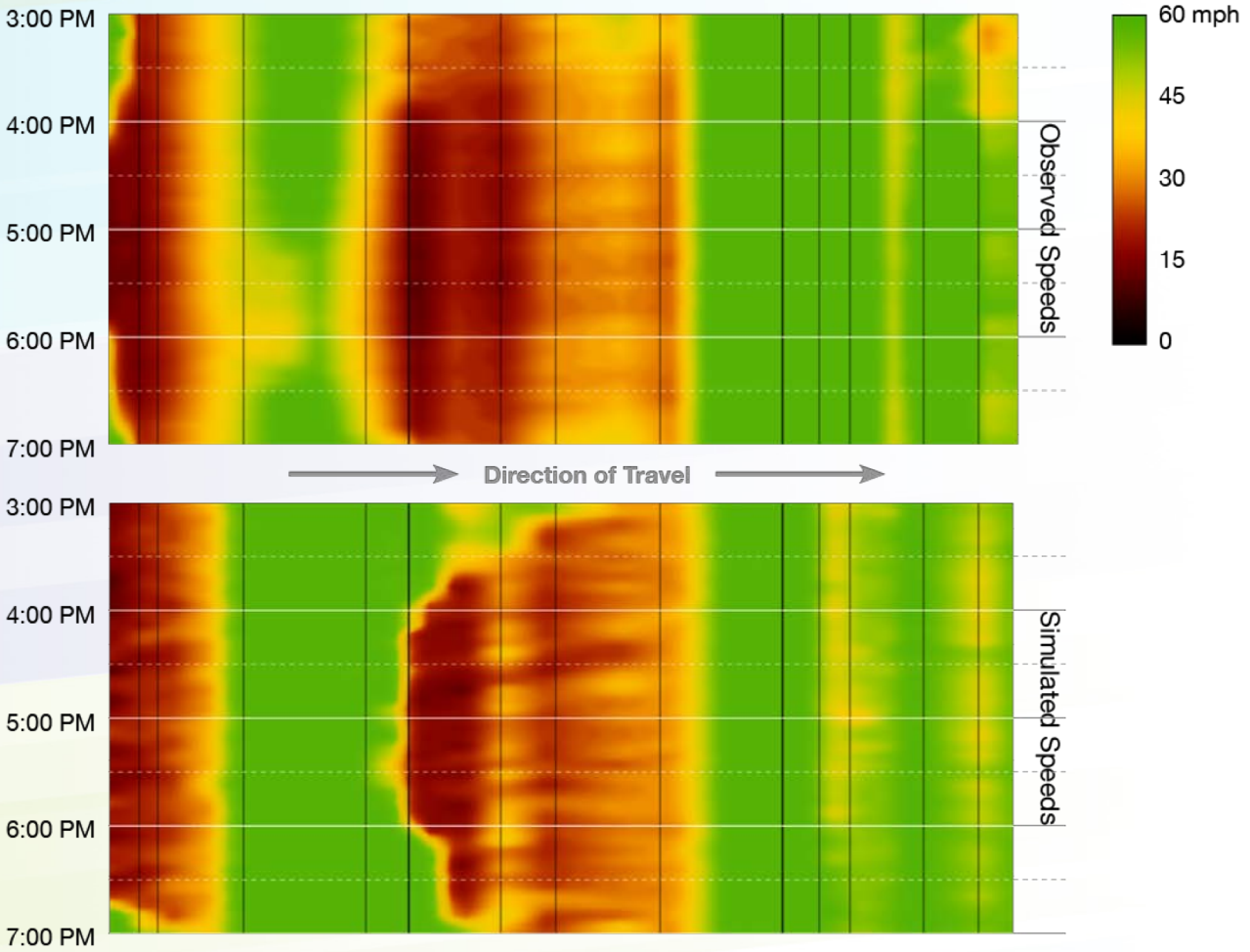
Substep 3.4: Example Speed Contour Diagram





Example Bottleneck Model Calibration

PM Eastbound



Available Databases

Transportation Databases - Federal

Database	Description	Extents
FHWA Highway Performance Monitoring System (HPMS)	Data on the extent, condition, performance, use and operating characteristics of the nation's highways. Also captures characteristics of some arterial and collector functional systems.	Nationwide
FHWA National Bridge Inventory (NBI)	Condition data on more than 600,000 bridges located on Interstate Highways, U.S. highways, State and county roads, and publicly-accessible bridges on Federal lands.	Nationwide
FHWA National Household Travel Survey (NHTS) Add-On	Supplementary survey data purchased by State DOTs, MPOs, and COGs for their local areas.	Survey Partners (also known as Add-Ons) exist nationwide

Transportation Databases – State and Regional

Database	Description	Extents
Caltrans Performance Measurement System (PeMS)	Real-time and historical traffic data collected from nearly 40,000 individual freeway detectors.	All major metropolitan areas in California
Location-Based Services Data	Set of mobile phone location based services data used to glean insights into linked trips and tours, robust demographics, and travel purpose.	Southern California
Arterial Performance Measurement Tool (APMT)	Establishes baseline performance conditions for selected subregional arterial corridors, such as travel demand, productivity, mobility and reliability.	Specific to Los Angeles County
Caltrans Automated Pavement Condition Survey	Condition data collected at highway speeds using specialized vehicles with inertial profilers, transverse laser system, and high resolution cameras for all lanes	Within the State of California

Transportation Databases – State and Regional

Database	Description	Extents
Statewide Integrated Traffic Records System (SWITRS)	Data gathered from collision scenes by California Highway Patrol staff and members of its Allied Agencies.	Within the State of California
California Vehicle Inventory and Use Survey (CA-VIUS)	State-level vehicle inventory survey that has collected information about commercial vehicle operations from establishments that operate trucks on California's roadways.	Mostly geared towards trucks that operate in California
Caltrans Traffic Counts	Individual Caltrans Districts have calculated the volumes hourly, daily, and monthly to derive an annual average daily traffic count.	Within the State of California
Truck Activity Monitoring System	Uses inductive loop signature technology to obtain high resolution truck data at	Various locations

Transportation Databases – Private Sector

Database	Description	Extents
INRIX	Real-time, historical and predictive traffic information using anonymous, real-time aggregated GPS probe data from a wide array of commercial vehicle fleets, connected cars and mobile apps.	Nationwide and in 45 countries
Streetlight Data	Collection of anonymized location records created by mobile phones, GPS devices, connected cars, commercial trucks, fitness trackers, etc.	Nationwide
Airsage	Collection of real-time mobile signals, GPS and other location data to produce and process billions of anonymous data points every day.	Nationwide

Transportation Databases – Other

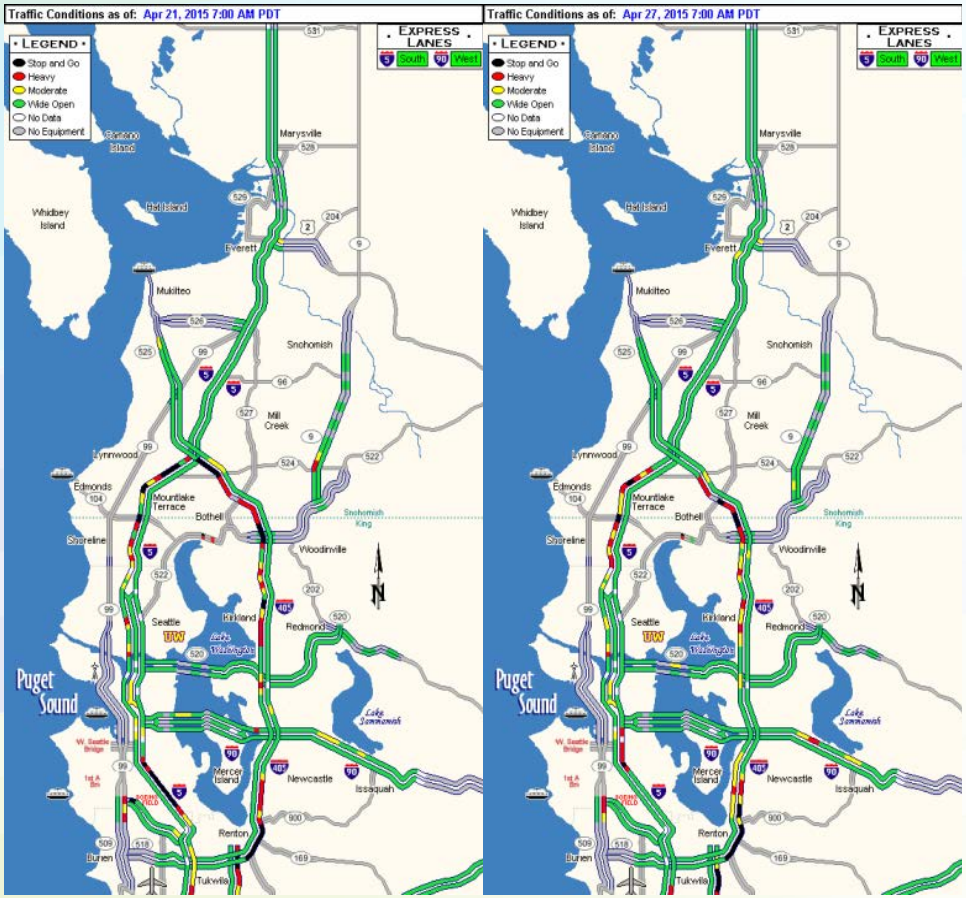
Database	Description	Extents
American Transportation Research Institute (ATRI)	Real-time anonymized freight truck GPS data (e.g., periodic time, location, speed) sourced through unique industry partnerships.	Nationwide

System Performance Profiles

System Profiles

- Characterize system performance
  - Is the system is getting better or worse?
- Identify anything missing in the profile so the profile can be improved over the long term.
- Profile examples:
  - Congestion Profiles
  - Reliability Profiles
  - Safety Profiles

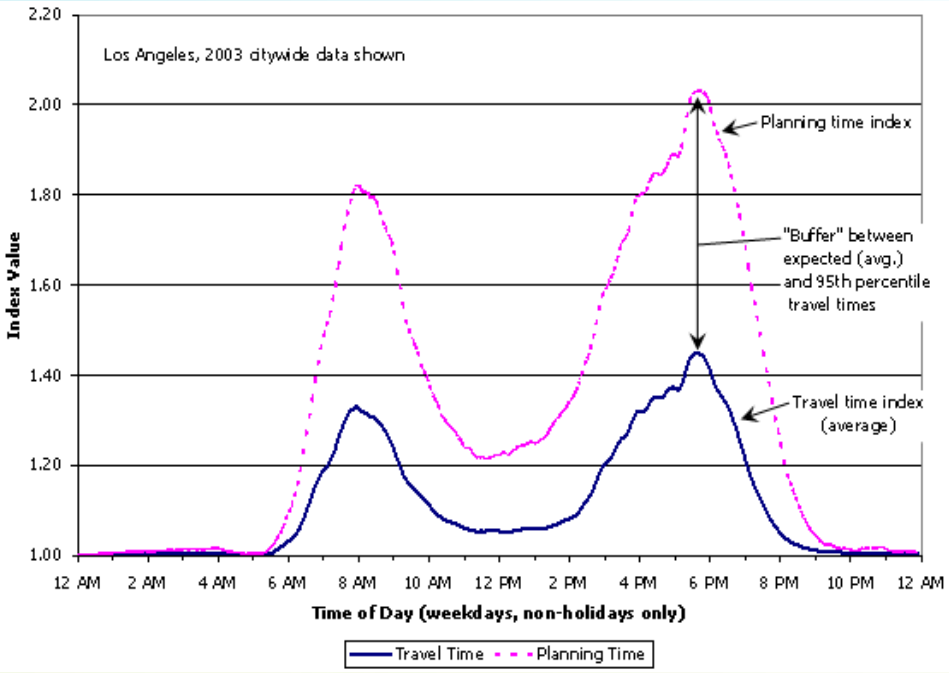
Congestion Profiles



Source: Washington State Department of Transportation

- Time-variant congestion measures:
  - Travel time
  - Vehicle speeds
  - Vehicle delay
  - Bottleneck throughput
  - Queue length
  - Vehicle stops

Reliability Profiles

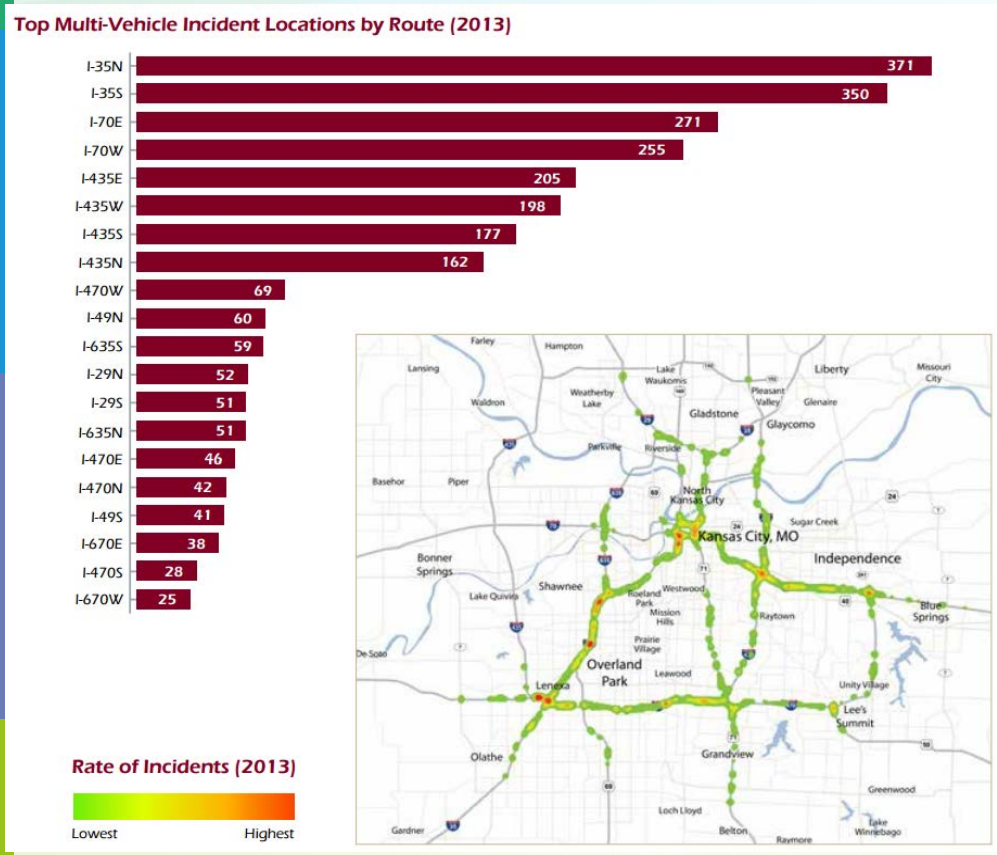


Source: Mobility Monitoring Program, http://mobility.tamu.edu/mmp

Travel time reliability measures:

- 90th or 95th percentile travel time
- Buffer index
- Planning time index
- Frequency that congestion exceeds a certain expected threshold

Safety Profiles

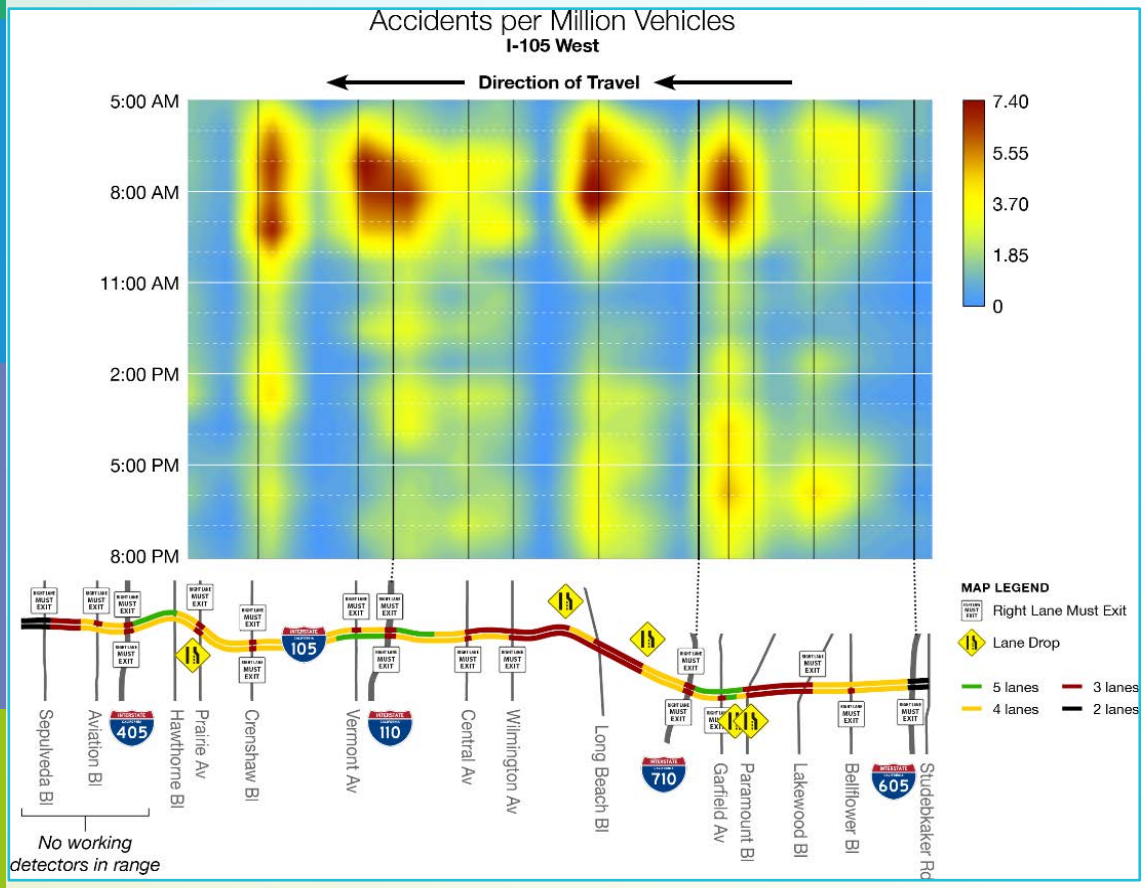


Source: Kansas City Scout

Safety measures:

- Crash rates
- Number of fatalities, injuries, property damage-only crashes

Accident Rates in Space and in Time



(Source: Federal Highway Administration.)

This figure shows how existing accident rates can be presented in space and in time and how this depiction can help analysts determine problematic locations and time spans when accident rates are greater than average.

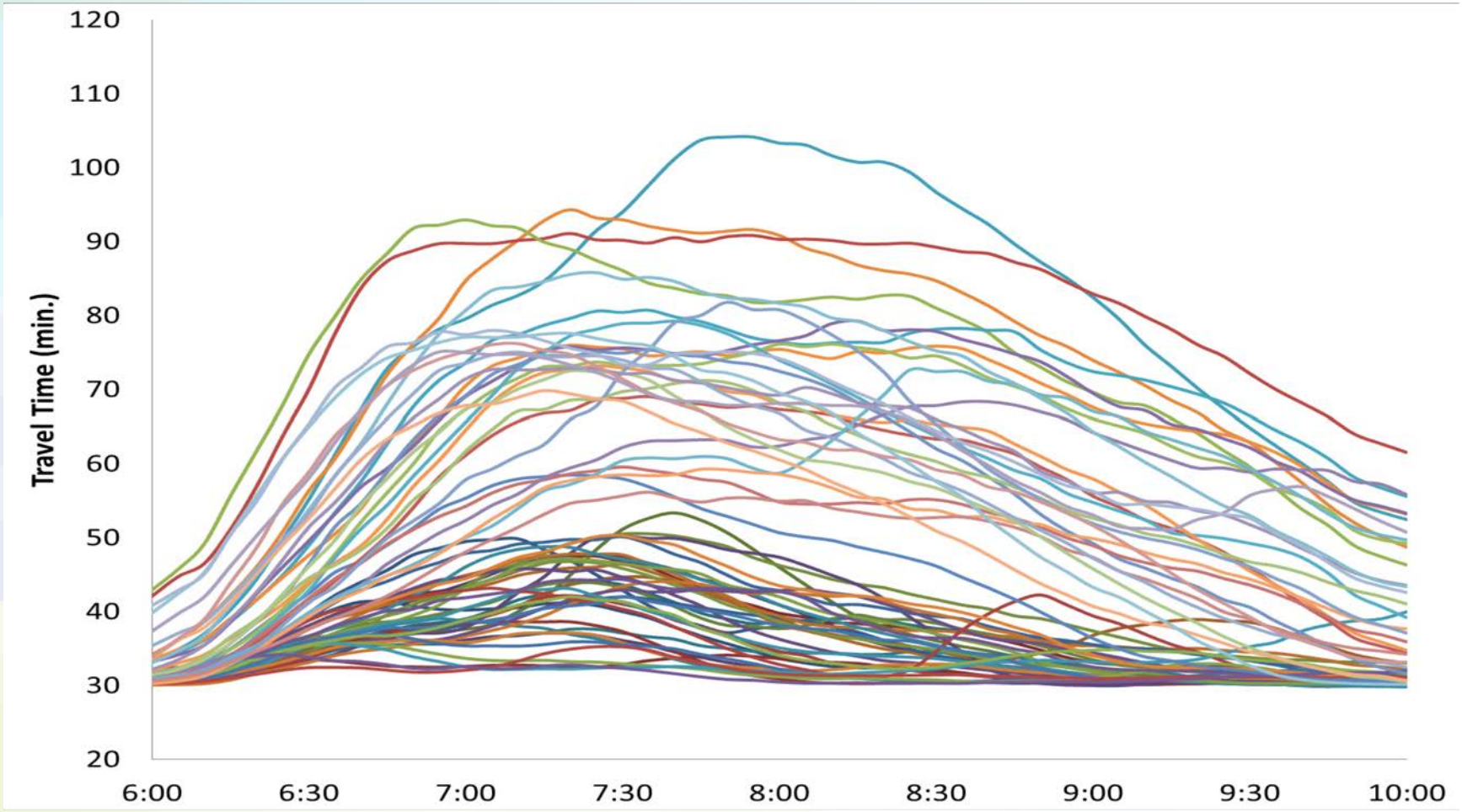
Special Considerations for System Profiles

- Inconsistent data
  - May not be comprehensive or collected consistently over time.
- Outlier events
  - Can cause bias if not separated from regular traffic conditions.
  - Operational conditions can be identified using cross reference approaches (data mining) or statistical approaches (cluster analysis).
- Seasonality and cyclical trends
  - Time series data that repeats every year.
  - Trends can be obtained by examining weekly, monthly, or seasonal averages of demand, congestion, and safety measures.

Operational Conditions

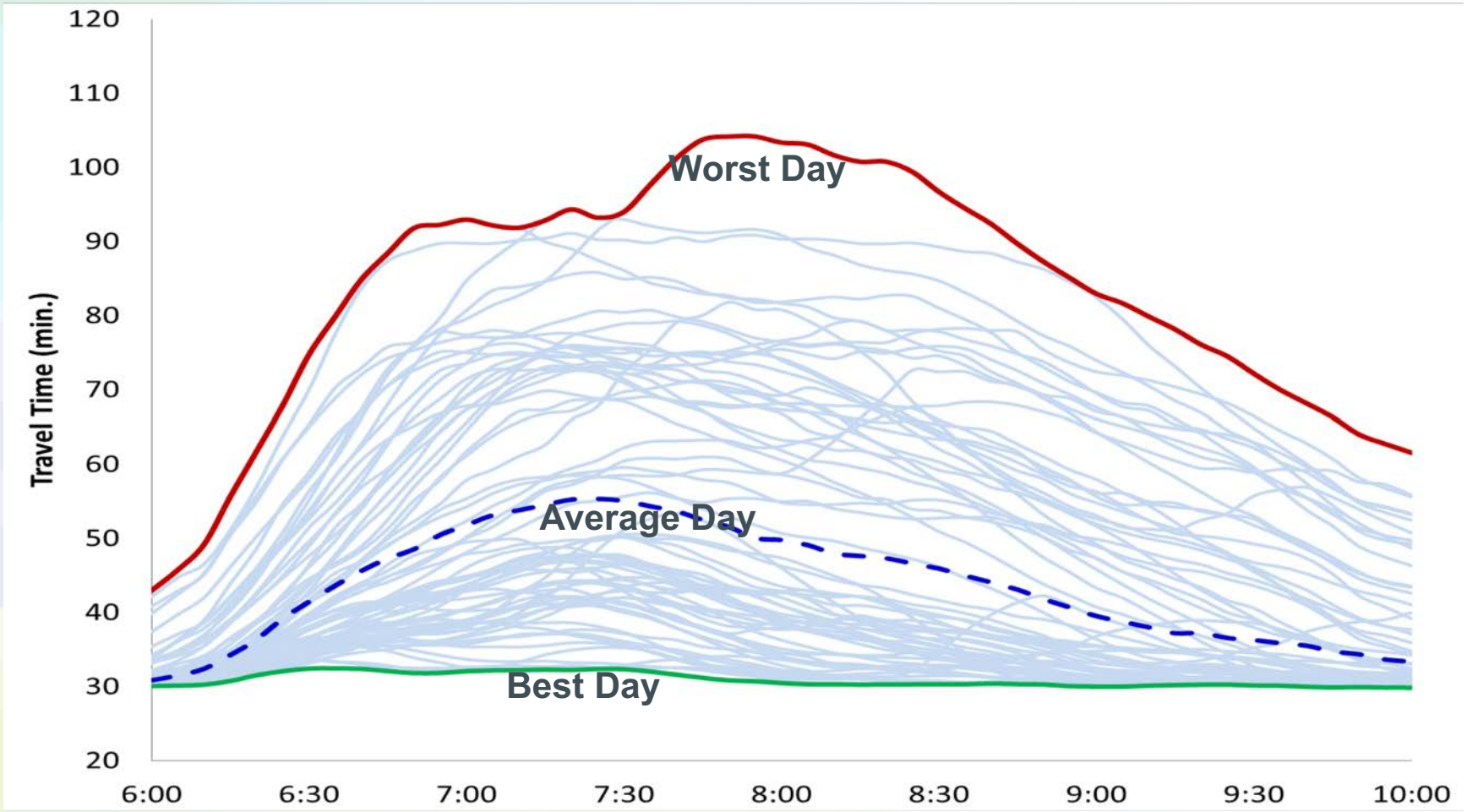
Real Systems Have Good Days and Bad Days

2012 South Bound AM Peak Travel Times, I-405 Corridor



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

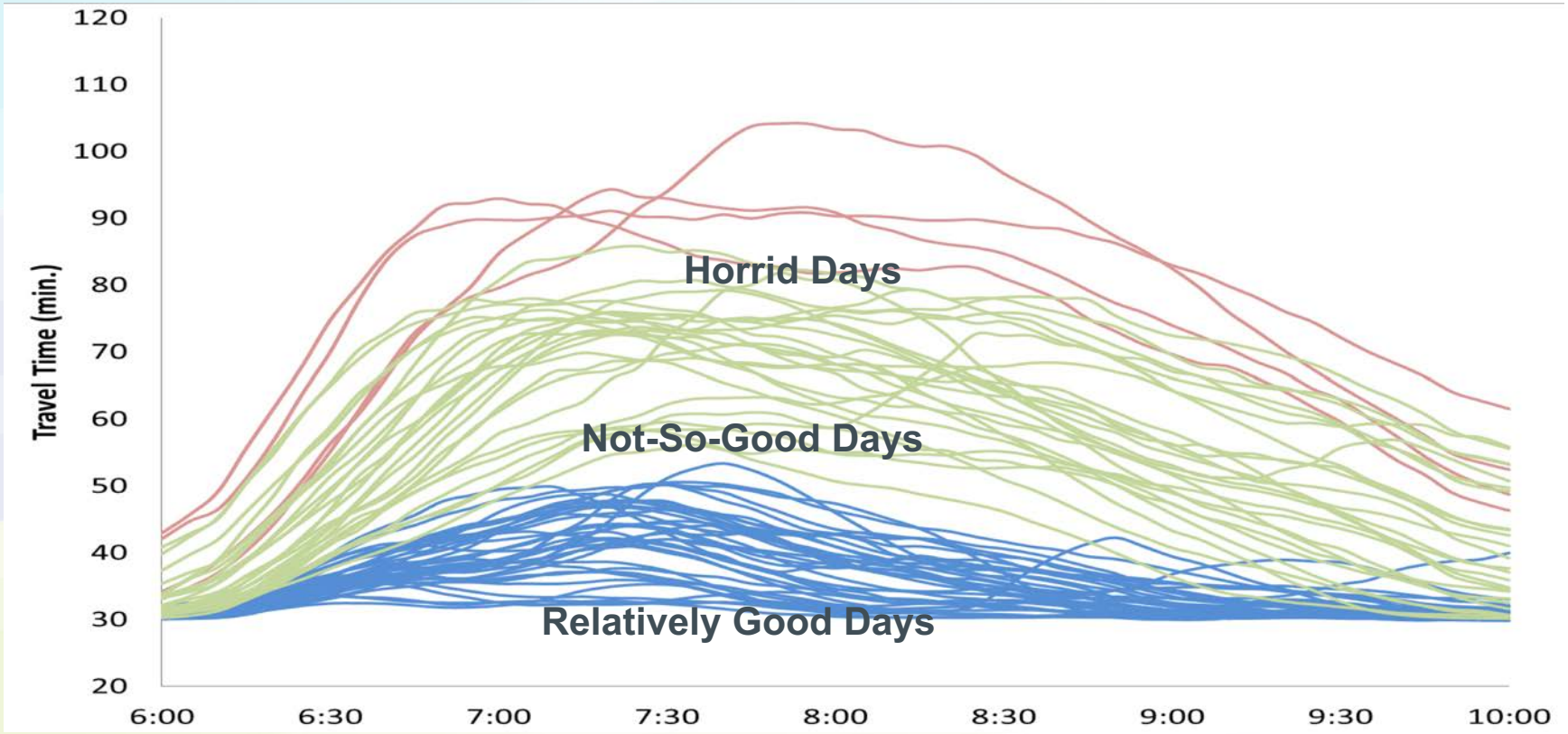
Even An Average Day Captures Only a Fraction of System Dynamics



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Use Cluster Analysis to Identify Distinct, Dissimilar Operational Conditions

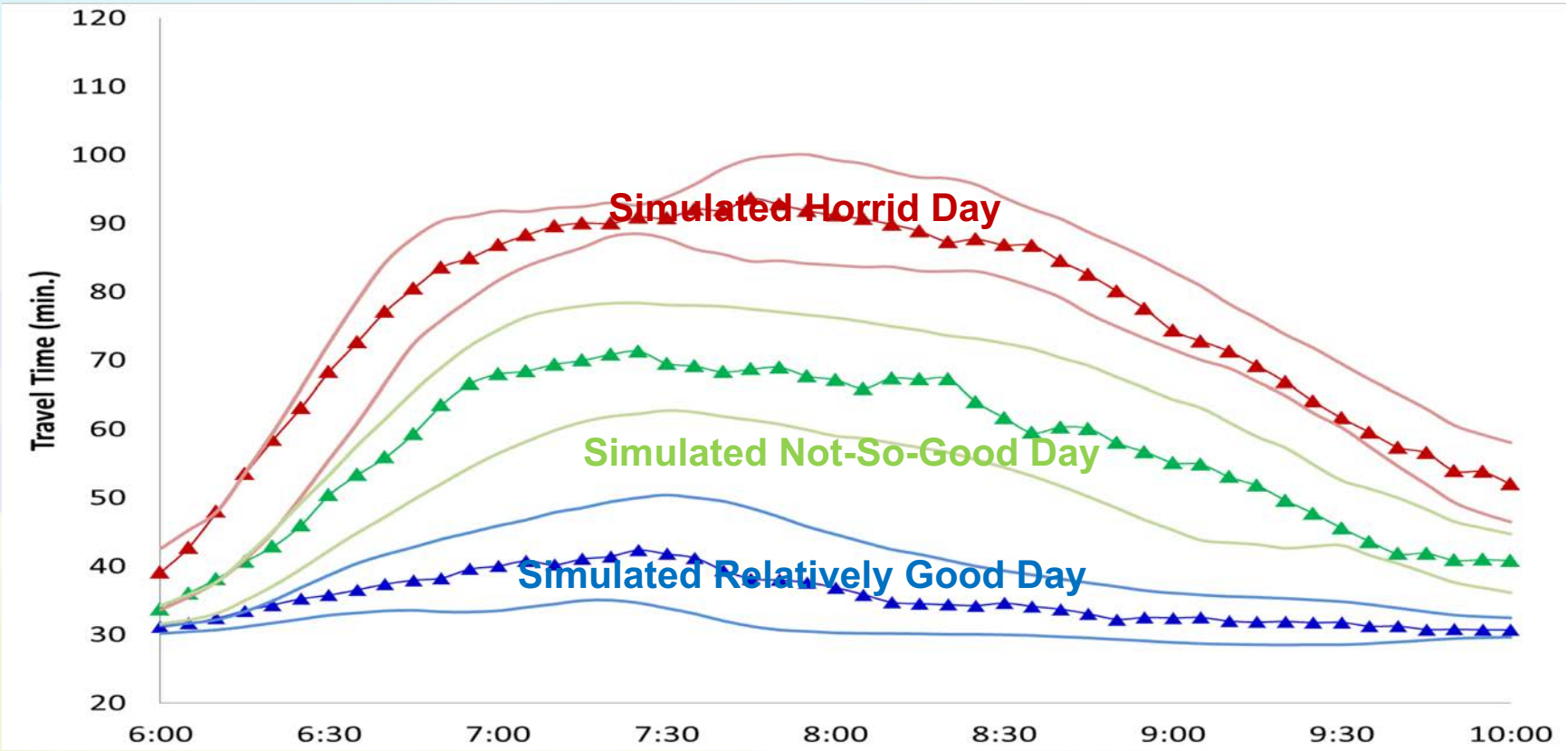
Cluster Analysis Done for Many Attributes, Not Just One Measure… (But We Can Only Show So Much In 2-Dimensions)



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Simulations Are Calibrated to Lie Within the Statistical Envelope

We Perform Statistical Testing to Determine if the Simulated Day Falls in the Envelope Under Many Trials



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

San Diego ICM - AMS Scenarios

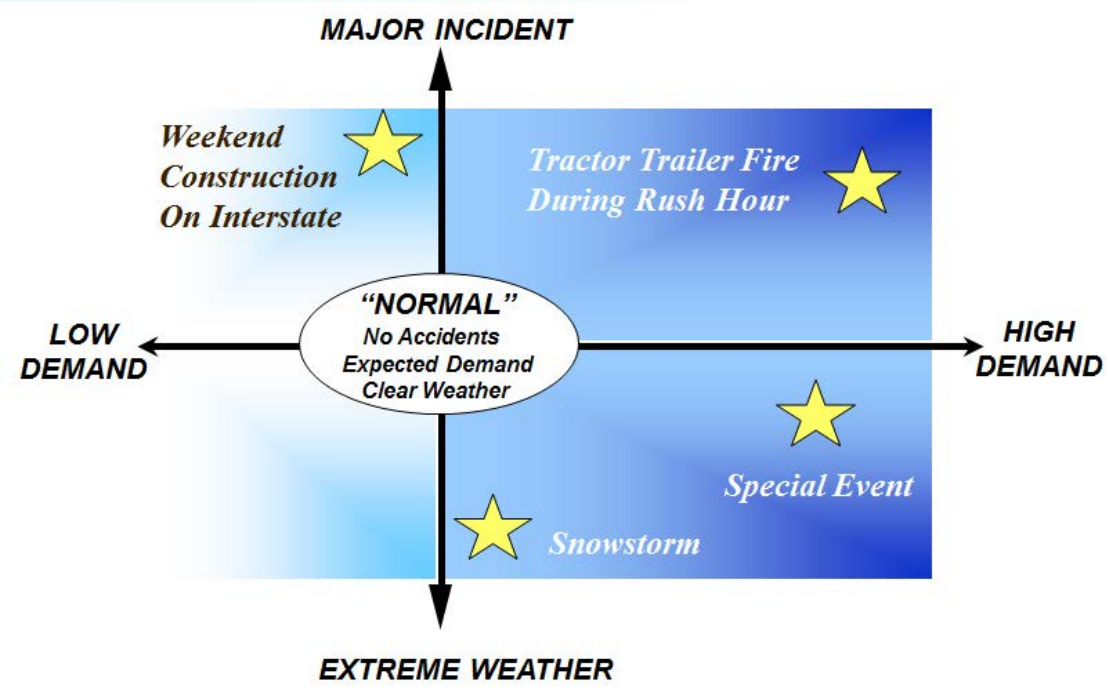
Summary of Best Matching Incident Results

#	Baseline Cluster by Direction and Time Period	Information from Baseline Cluster Analysis			Baseline Period	Post-Deployment Period			
		Days in Cluster	Total Cluster Day Impact (min.)	% of Total Analysis Time Period	Date	Date	DSS Event ID	DSS Plan Type Implemented	DSS Response ID
1	NB PM 4	25	63.25	24.0	10/12/12	7/7/14	639956	Ramps, Signals, ATIS	19536
2	SB AM 2	39	108.03	37.5	10/2/12	2/9/15	754666	Signals, ATIS	27929
3	NB PM 5	3	18.75	2.9	11/21/12	2/19/15	760369	Signals, ATIS	28292
4	SB AM 3	8	34.64	7.7	10/1/12	5/7/15	804238	Ramps, Signals, ATIS	30028
5	n/a, hypothetical	-	-	-	-	5/26/15		None. Managed lanes opened.	
6	SB AM 1	29	49.88	27.9	1/30/13	5/27/15	817649	Signals	30332
7	NB PM 2	8	23.36	7.7	1/15/13	6/9/15	842085	Ramps, Signals	30451
8	NB PM 1	17	41.82	16.3	1/28/13	6/16/15	845922	Ramps, Signals, ATIS	30617
9	NB PM 3b	36	99.72	34.6	1/30/13	5/5/14	853963	Ramps, Signals, ATIS	31039

Key Challenge for Analytical Projects

To fully leverage and use available data sources in the design and execution of meaningful analyses that properly represent and test the competing investment alternatives.

Various Operational Conditions



Analysis Techniques Used to Identify Representative Operational Conditions

- Cluster analysis
- Unit of observation
- Selecting attributes
- Travel time and bottleneck throughput attributes
- Enumerative or attribute stratification approaches
- Data-driven statistical methods
- Objective-focused operational conditions analyses
- Reliability analyses
- Rare events

Variables Used in Cluster Analysis

- Traffic flow rate (vehicles per hour) – Temporal and directional traffic flow rate
- Day of the incident
- Day-of-week
- Time of the incident
- Direction of traffic
- Duration of incidents (minutes)
- Travel time (minutes) – The calculated temporal average directional travel time along the corridor

Experimental Design for Analysis of Different Operational Conditions

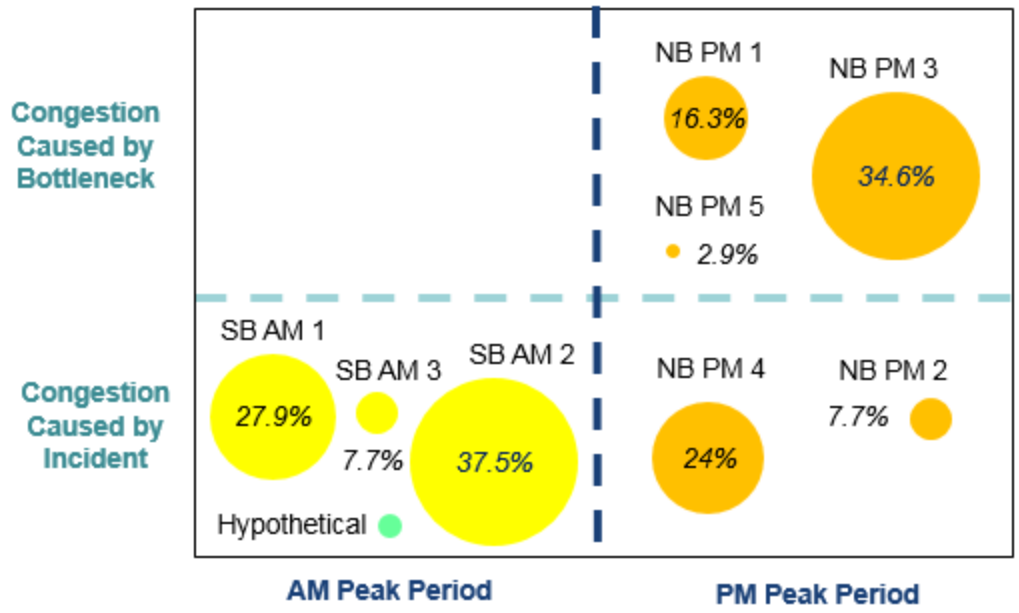
Highest Priority
- Scenarios with greatest frequency and impact

Lower Priority
- Scenarios with low likelihood but major impact
- Scenarios with frequent occurrence but limited impact

Lowest Priority
- Scenarios with low frequency and low impacts

Operational Condition Dartboard

Scenario Frequency



Note: The size of each circle represents the percent of total analysis time period.

Cluster Analysis and Operational Conditions Summary

Data Summary	All	Op. Con. 1	Op. Con. 2	Op. Con. 3	Op. Con. 4	Op. Con. 5	Op. Con. 6
Periods/Days	196	40 (20%)	25 (13%)	6 (3%)	41 (21%)	28 (14%)	56 (29%)
Operational Condition Characterization		Low Demand	Low Visibility	Weather + Incidents	Many Incidents	Bottleneck Trouble	Few Incidents
Representative Day		9/6/2014	7/18/2014	2/15/2014	8/19/2014	11/1/2014	9/15/2014
Attributes	**Avg.**	**Op. Con. 1**	**Op. Con. 2**	**Op. Con. 3**	**Op. Con. 4**	**Op. Con. 5**	**Op. Con. 6**
North Bound Bottleneck Duration (minutes)	74.46	21.0	71.4	55.0	69.1	128.0	93.2
South Bound Bottleneck Duration (minutes)	113.6	39.4	127.2	112.5	149.3	190.7	95.9
North Bound Maximal Travel Time (minutes)	54.9	48.8	57.0	69.2	58.7	57.5	52.6
South Bound Maximal Travel Time (minutes)	63.2	45.5	69.7	90.3	67.6	74.7	61.0
Number of Incidents (count)	1.64	1.63	1.60	2.67	2.98	1.21	0.79
Maximal Incident Duration (minutes)	22.8	27.7	21.1	62.3	28.5	20.0	13.2
Visibility (miles)	8.45	9.53	2.25	3.33	9.48	9.03	9.96

Operational Condition is denoted as "Op. Con."