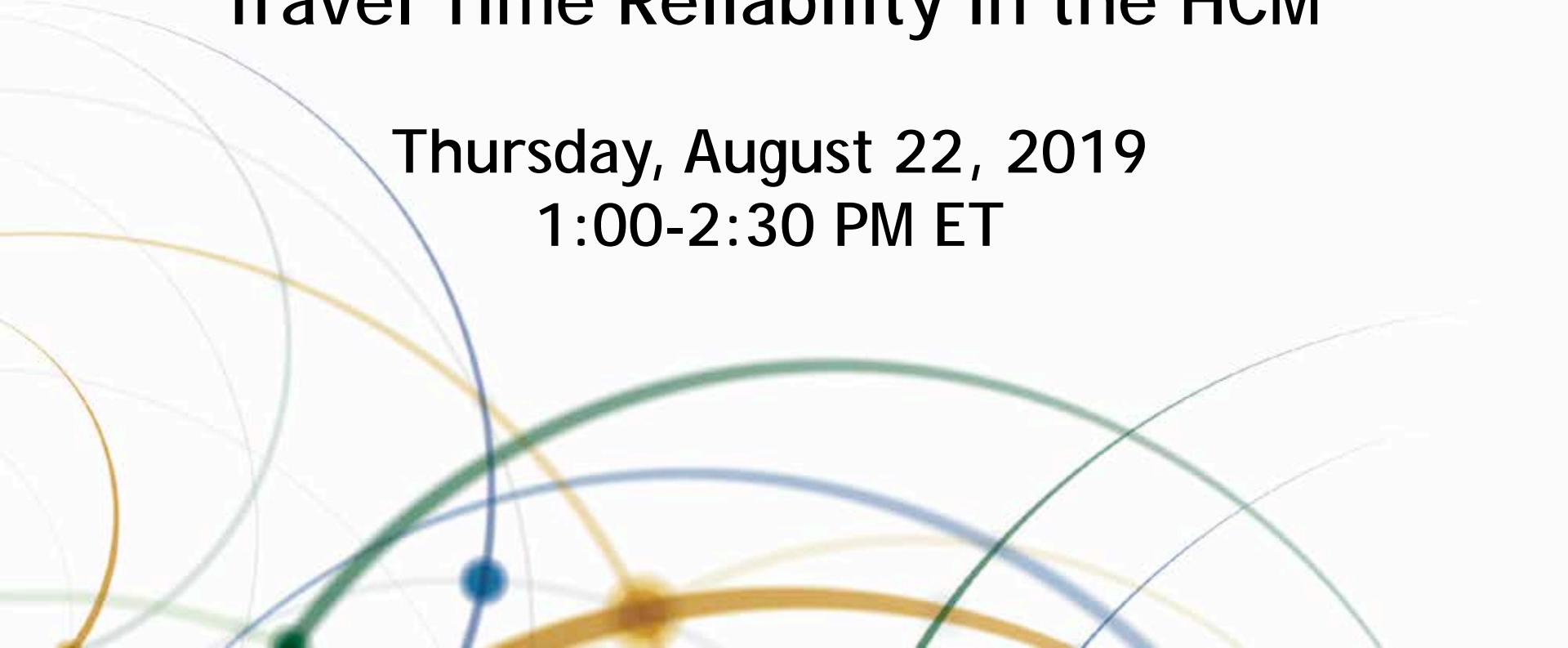


TRANSPORTATION RESEARCH BOARD

# Not Your Average Analysis: Introducing Travel Time Reliability in the HCM

Thursday, August 22, 2019  
1:00-2:30 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

To discuss travel time reliability estimation methods in the [Highway Capacity Manual](#) (HCM), Sixth Edition: A Guide for Multimodal Mobility Analysis.

## Learning Objectives

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

- Apply travel time reliability methods



A blue car is shown from a side-rear perspective, driving on a two-lane highway. The road is paved and has a white dashed line in the center. The landscape is dry with low-lying vegetation. The sky is blue with some clouds. The car's side mirror and part of its body are visible on the right side of the frame.

# Predicting Travel Time Reliability with the Highway Capacity Manual (6<sup>th</sup> edition)

# Learning Outcomes

- § Understand the unique capabilities of the HCM methods in predicting reliability
- § Learn, at a high level, about the steps in the HCM reliability method
- § Learn about the ability of the HCM to predict the impacts of various non-recurring sources of congestion on performance
- § Understand the ability of HCM methods to predict the benefits of traffic operations measures to improve reliability

# Presenters



## § Richard Dowling, PE, Ph.D.

- Senior Principal, Kittelson & Associates, Inc.
- Past Chair, TRB Highway Capacity & QOS Committee
- Key contributor to HCM Reliability methodology

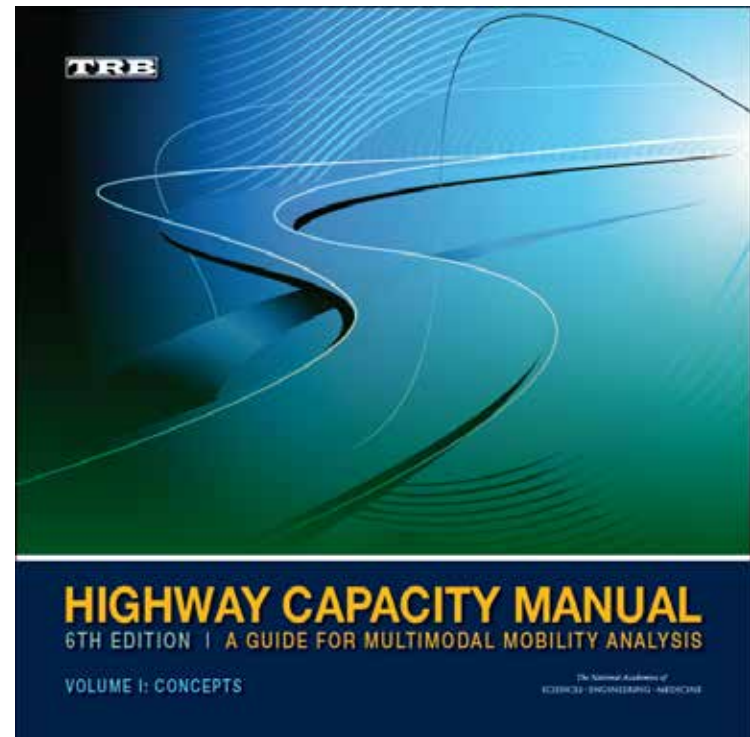


## § Tyrone Scorsone

- Associate Planner, Kittelson & Associates, Inc.
- Past member, TRB Highway Capacity Committee
- Contributor to HCM reliability methodology

# Presentation Overview

- § Introduction to Reliability Analysis
- § Overview of the HCM Reliability Method
- § Applying the HCM method
- § Summary





# INTRODUCTION TO RELIABILITY ANALYSIS





# What is Travel Time Reliability

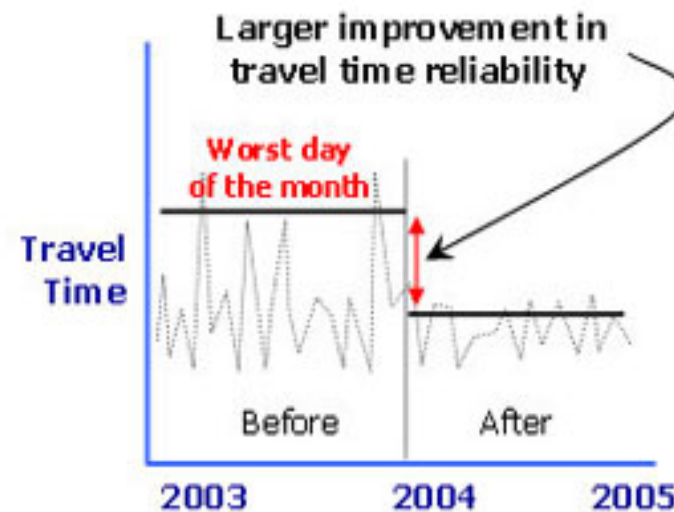
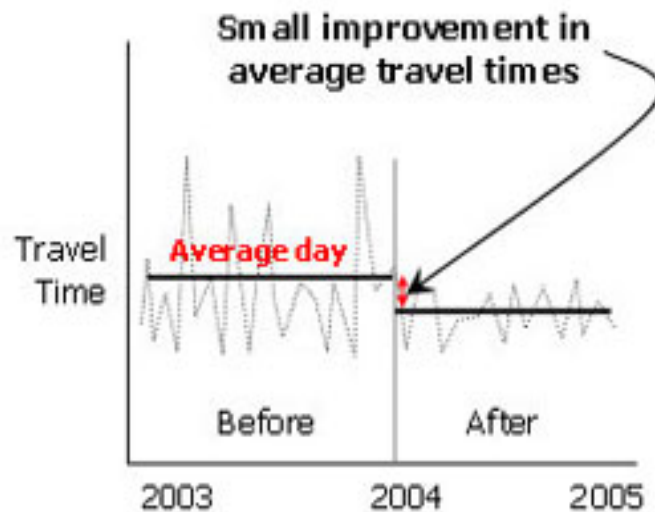
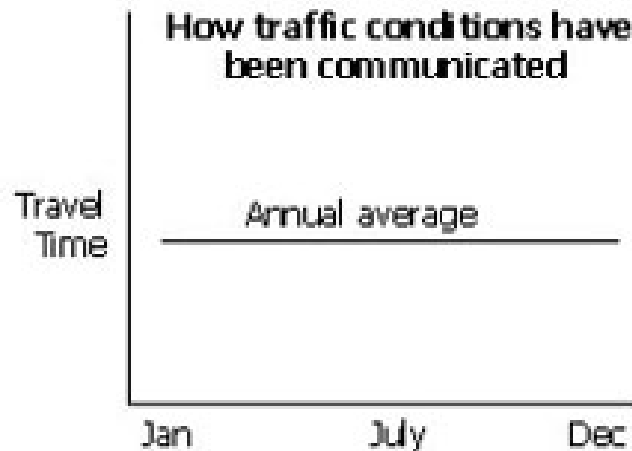
A measure of the likelihood that you will be on time, could be presented through:

1. Percent of trips achieving an identified travel time/speed
2. Ratio of the average conditions to the worst weekly mobility conditions (80<sup>th</sup> percentile)
3. Ratio of the free flow conditions to worst monthly mobility conditions (95<sup>th</sup> percentile)

# WHY DO WE ANALYZE THE AVERAGE DAY?



# Reliability and Active Traffic Management in the HCM



Source: FHWA

# Why go to the trouble of evaluating reliability?

§ Reliability opens up a whole new world of options for addressing congestion problems.

- Transportation System Management and Operation Strategies (TSM&O).
- If you can't solve a capacity problem the traditional way with more lanes, at least with TSM&O you can:
  - § Identify highly cost-effective solutions you can implement in the short term.
  - § Squeeze a few more years of service life out of your facility, by increasing whole-year throughput efficiency of your facility.

# FHWA Reliability Monitoring Requirements

- § 2015 FAST Act required FHWA to establish performance monitoring requirements.
- § In 2017 FHWA published 23 CFR Part 490: National Performance Management Measures for NHS and Interstate highway system.
  - Includes reliability measures
  - The question: Will the agency's capital improvement program help or hinder it in achieving its performance objectives?



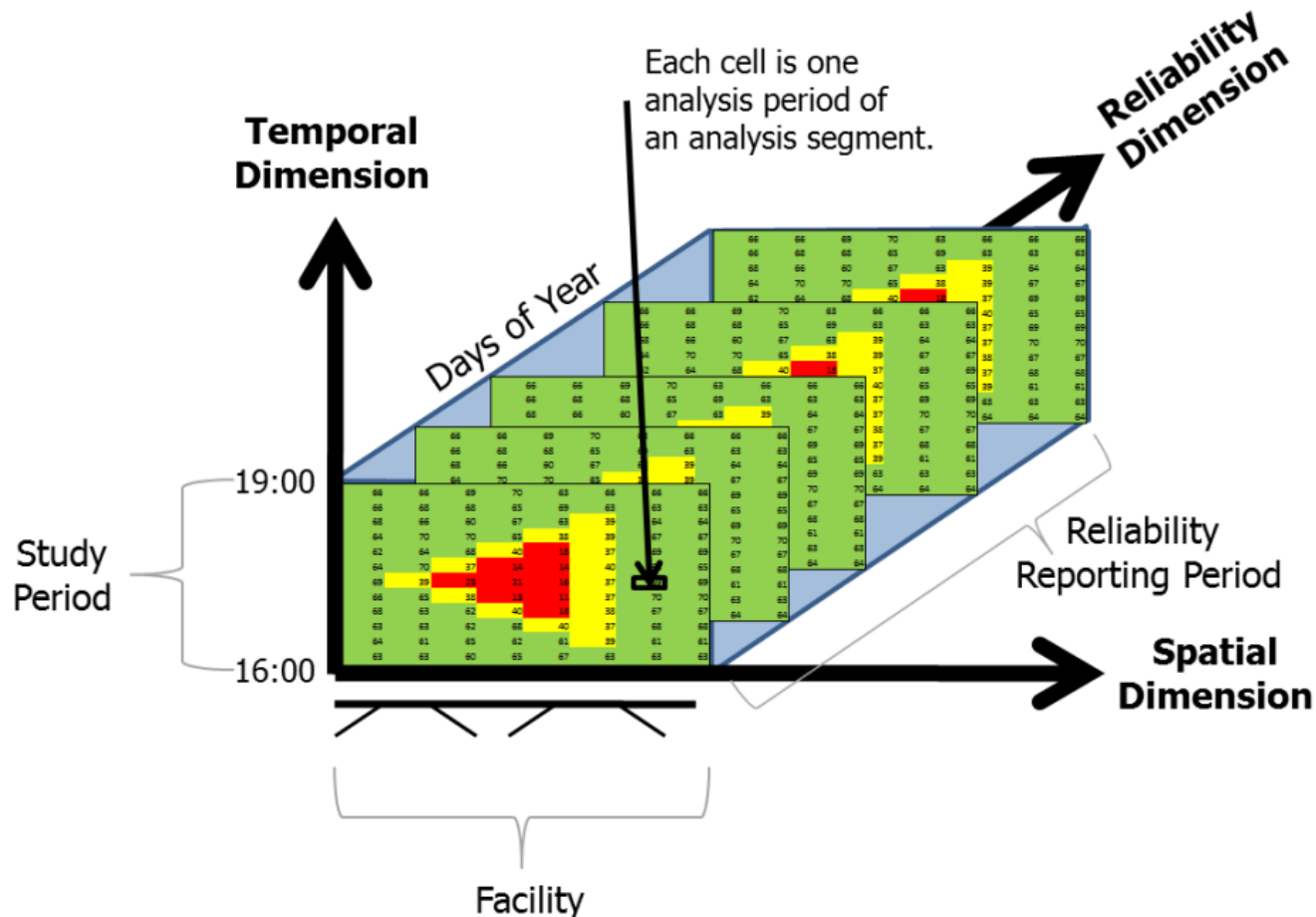
# Two Reasons for Considering Reliability

- § It's a good idea. It increases the range of solutions available to planners and engineers.
- § We will have to anyway. We will have to monitor reliability to comply with the FAST Act.

# Factors Influencing Reliability



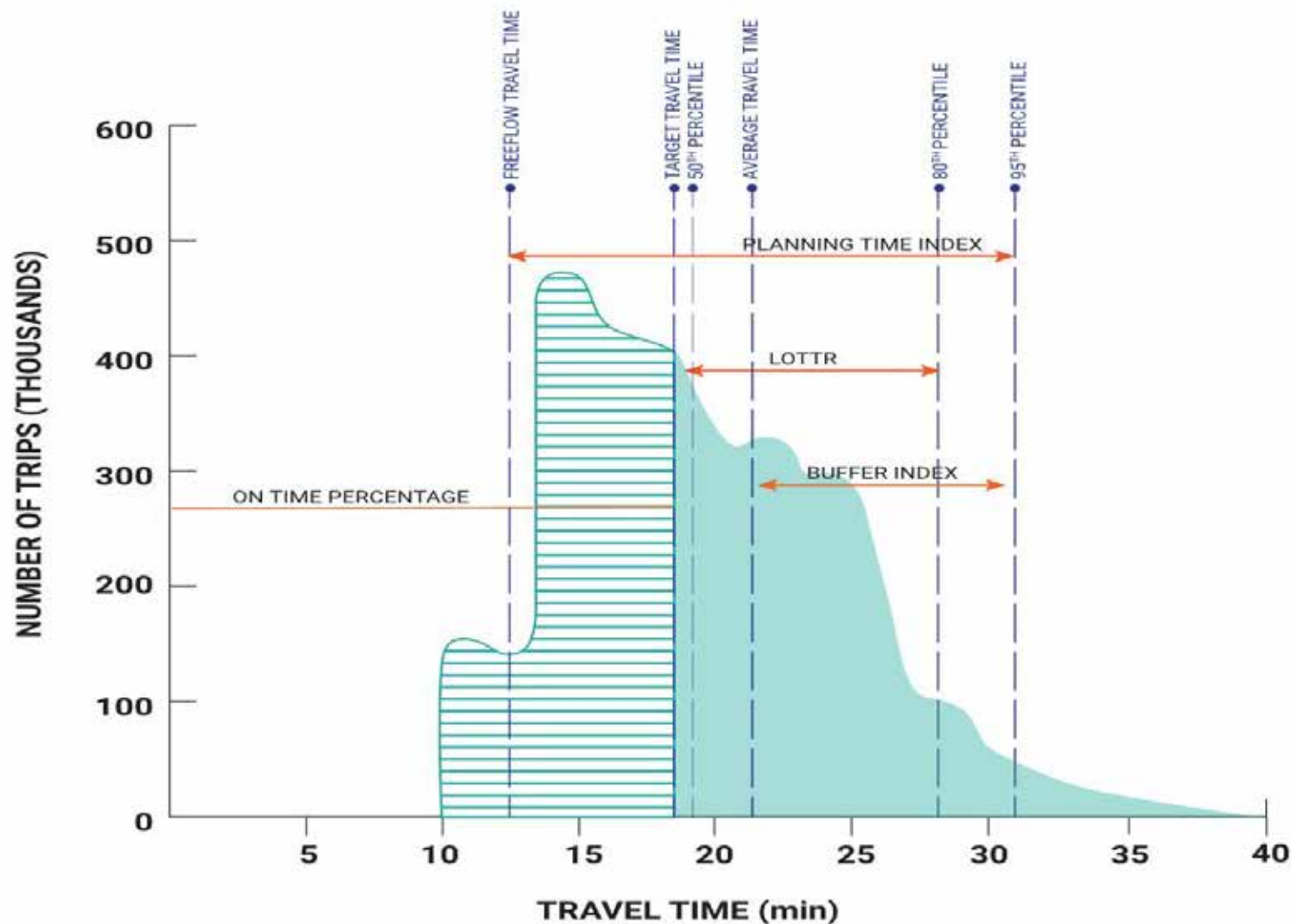
# Reliability Analysis in the HCM



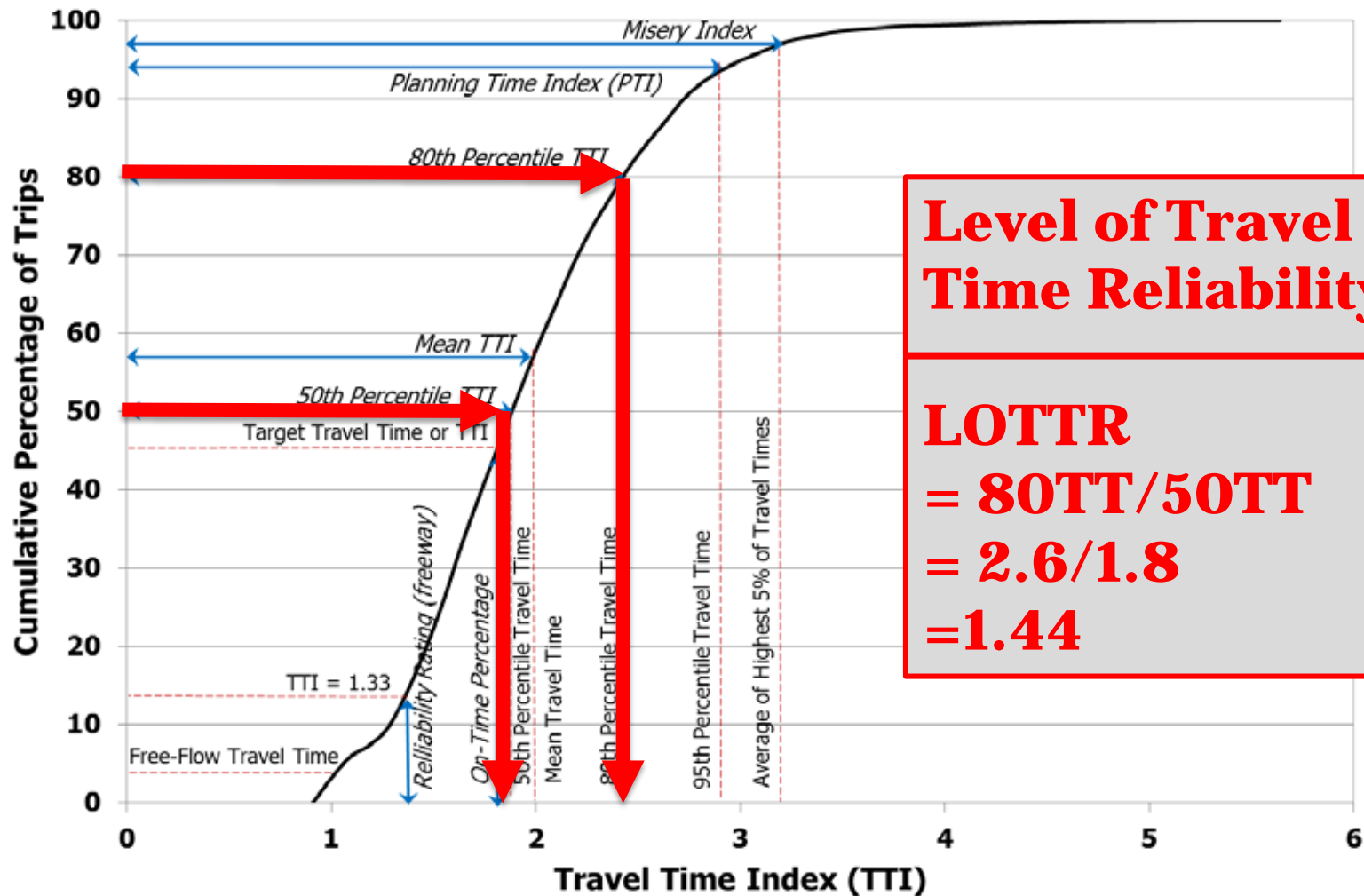
**Exhibit 11-1**

Schematic Representation of Freeway Reliability Analysis Time-Space Domain

# Generating the Travel Time Distribution for Reliability Analysis



# Reliability Performance Measure Examples



**Level of Travel  
Time Reliability**

$$\begin{aligned}\text{LOTTR} &= 80\text{TT}/50\text{TT} \\ &= 2.6/1.8 \\ &= 1.44\end{aligned}$$



# A Measure of Effectiveness

**Exhibit 37-1**  
Freeway Ramp Metering,  
SR-94, Lemon Grove,  
California



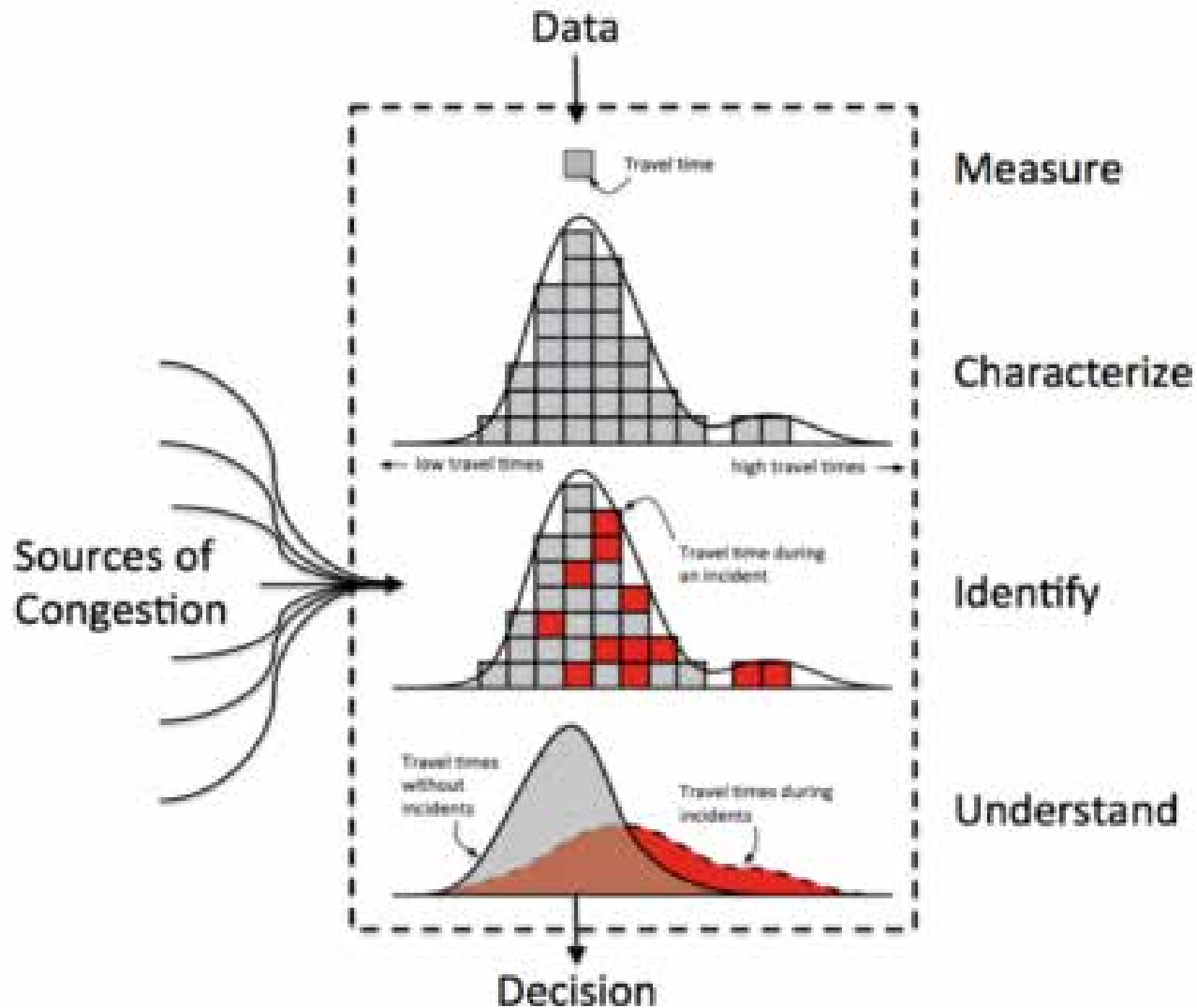
**Exhibit 37-2**  
Minnesota Dynamic Pricing for  
HOT Lanes



**Exhibit 37-5**  
Variable Speed Limit Signs,  
Rotterdam, The Netherlands



# From Data to Decisions

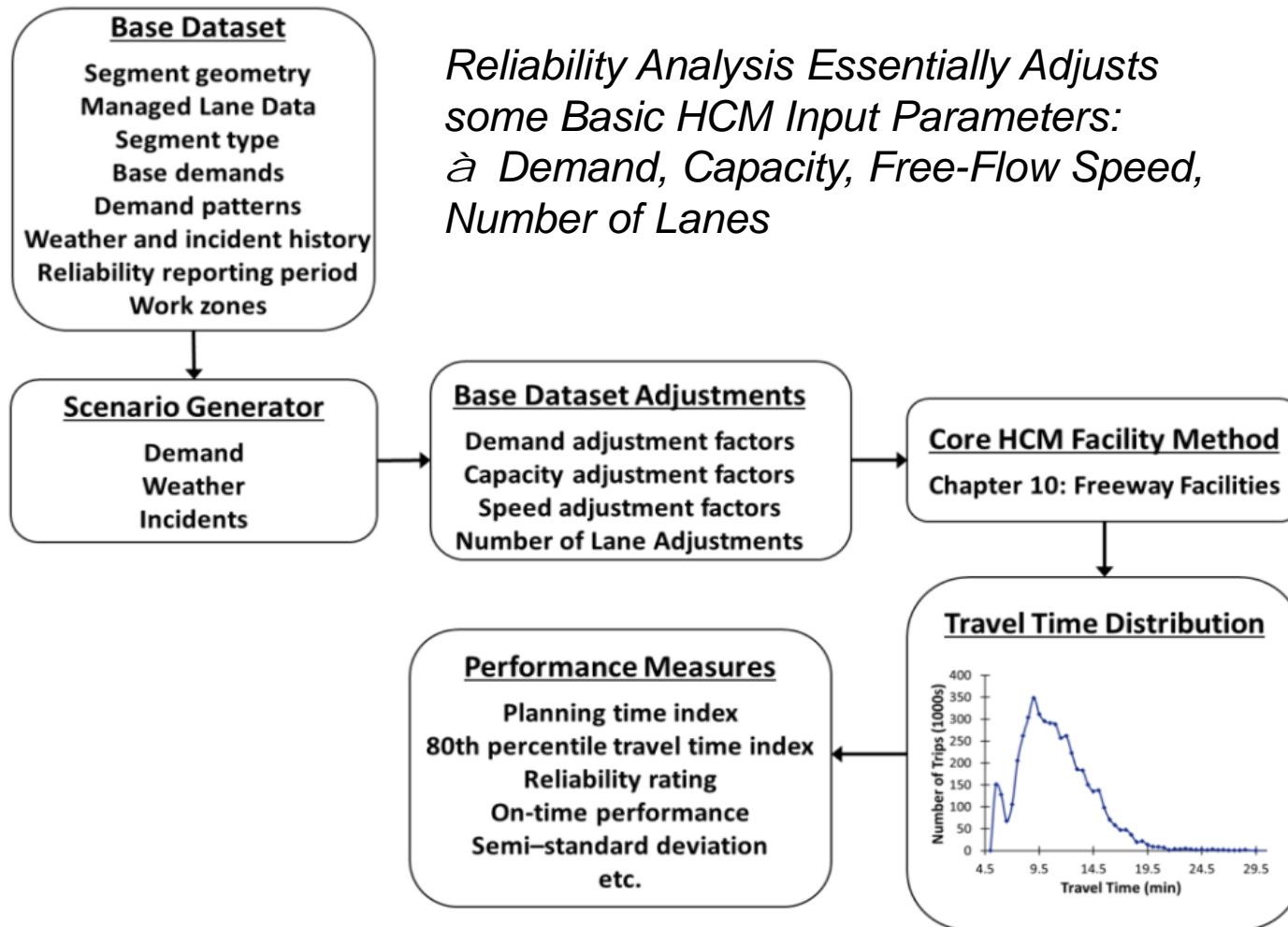


# OVERVIEW OF HCM RELIABILITY METHOD





# High Level View of Reliability Methodology in Chap. 11



**Exhibit 11-7**  
Freeway Reliability  
Methodology Framework

# Considered Recurring and Non-Recurring Sources of Congestion in HCM Reliability Analysis

## § Recurring Sources

- Traffic Demand Variations

## § Non-Recurring Sources

- Incidents (Crashes, Stalls, etc.)
- Severe Weather Conditions
- Work Zones
- Demand Surges (special events)





# Traffic Demand Variation

- § Variation by day of the week (Mon – Sun) and month of year.
- § Default patterns embedded into *the 6<sup>th</sup> edition of HCM* should facility specific data are not available
- § Use of facility-specific demand data highly recommended

Scenario Generator

Properties GP - Demand GP - Work Zones GP - Incidents Weather

Days in RRP

- ☒ Monday
- ☒ Tuesday
- ☒ Wednesday
- ☒ Thursday
- ☒ Friday
- ☐ Saturday
- ☐ Sunday

Select All

Select Weekdays

Select Weekends

Daily Demand Multipliers

|           | Monday   | Tuesday  | Wednesday | Thursday | Friday   |
|-----------|----------|----------|-----------|----------|----------|
| January   | 0.822158 | 0.822158 | 0.838936  | 0.864104 | 0.964777 |
| February  | 0.84871  | 0.84871  | 0.866031  | 0.892012 | 0.995936 |
| March     | 0.920502 | 0.920502 | 0.939288  | 0.967466 | 1.080181 |
| April     | 0.975575 | 0.975575 | 0.995484  | 1.025349 | 1.144807 |
| May       | 0.973608 | 0.973608 | 0.993477  | 1.023281 | 1.142499 |
| June      | 1.021796 | 1.021796 | 1.042649  | 1.073929 | 1.199047 |
| July      | 1.132925 | 1.132925 | 1.156046  | 1.190728 | 1.329453 |
| August    | 1.032614 | 1.032614 | 1.053688  | 1.085299 | 1.211741 |
| September | 1.063101 | 1.063101 | 1.084797  | 1.117341 | 1.247516 |
| October   | 0.995243 | 0.995243 | 1.015554  | 1.046021 | 1.167888 |
| November  | 0.995243 | 0.995243 | 1.015554  | 1.046021 | 1.167888 |
| December  | 0.978525 | 0.978525 | 0.998495  | 1.02845  | 1.148269 |

Urban Default Values Rural Default Values Saved Facility Specific User Input Values

# Reliability Incidents Parameters

## Frequency of Incidents

## Severity Distribution

## Duration Distribution

Scenario Generator

Properties GP - Demand GP - Work Zones GP - Incidents Weather

**Incident Frequencies**

| Month | Frequency |
|-------|-----------|
| Jan   | 0.29      |
| Feb   | 0.30      |
| Mar   | 0.33      |
| Apr   | 0.34      |
| May   | 0.35      |
| Jun   | 0.36      |
| Jul   | 0.40      |
| Aug   | 0.37      |
| Sep   | 0.37      |
| Oct   | 0.35      |

Calculate Frequencies...

Use Seed File Values

Frequencies represent the number of incidents per study period per month.

A red background indicates that the frequency values have not been set or are very small (<0.01)

**Incident Durations**

| Incident Severity  | Distribution % | Mean Duration | Std. Dev. | Minimum Duration | Maximum Duration |
|--------------------|----------------|---------------|-----------|------------------|------------------|
| Shoulder Closure   | 75.4           | 34.0          | 15.1      | 8.7              | 58.0             |
| One Lane Closure   | 19.6           | 34.6          | 13.8      | 16.0             | 58.2             |
| Two Lane Closure   | 3.1            | 53.6          | 13.9      | 30.5             | 66.9             |
| Three Lane Closure | 1.9            | 67.9          | 21.9      | 36.0             | 93.3             |
| Four Lane Closure  | 0.0            | 67.9          | 21.9      | 36.0             | 93.3             |

Use National Default Data

Use Default Durations

Use Saved Seed File Distribution

Use Save Seed File Durations

**Adjustment Factors**

**Capacity Adjustment Factors (CAFs)**

| Segment Lanes | Shoulder Closure | 1 Lane Closure | 2 Lane Closure | 3 Lane Closure | 4 Lane Closure |
|---------------|------------------|----------------|----------------|----------------|----------------|
| 2             | 0.81             | 0.7            |                |                |                |
| 3             | 0.83             | 0.74           | 0.51           |                |                |
| 4             | 0.85             | 0.77           | 0.5            | 0.52           |                |
| 5             | 0.87             | 0.81           | 0.67           | 0.5            | 0.5            |

**HFS Adjustment Factors (SAFs)**

| Segment Lanes | Shoulder Closure | 1 Lane Closure | 2 Lane Closure | 3 Lane Closure | 4 Lane Closure |
|---------------|------------------|----------------|----------------|----------------|----------------|
| 2             | 1.0              | 1.0            |                |                |                |
| 3             | 1.0              | 1.0            | 1.0            |                |                |
| 4             | 1.0              | 1.0            | 1.0            | 1.0            |                |
| 5             | 1.0              | 1.0            | 1.0            | 1.0            | 1.0            |

**Demand Adjustment Factors (DAFs)**

| Segment Lanes | Shoulder Closure | 1 Lane Closure | 2 Lane Closure | 3 Lane Closure | 4 Lane Closure |
|---------------|------------------|----------------|----------------|----------------|----------------|
| 2             | 1.0              | 1.0            |                |                |                |
| 3             | 1.0              | 1.0            | 1.0            |                |                |
| 4             | 1.0              | 1.0            | 1.0            | 1.0            |                |
| 5             | 1.0              | 1.0            | 1.0            | 1.0            | 1.0            |

**Lane Adjustment Factors**

| Segment Lanes | Shoulder Closure | 1 Lane Closure | 2 Lane Closure | 3 Lane Closure | 4 Lane Closure |
|---------------|------------------|----------------|----------------|----------------|----------------|
| 2             | 0                | -1             |                |                |                |
| 3             | 0                | -1             | -2             |                |                |
| 4             | 0                | -1             | -2             | -3             |                |
| 5             | 0                | -1             | -2             | -3             | -4             |

Generate Scenarios Only

Generate and Run Scenarios

Cancel

## Impact of Incidents on Capacity, Speed, and Demand

# Characterizing Inclement Weather Conditions

- § Capacity and Free-Flow Speed Effects of Weather
- § Defaults included in HCM6
- § Weather Probabilities by Month of Year and Hour of Day
- § Probabilities for the 96 largest metropolitan areas in the US are included in HCM 6th Edition computational engines

# Impact of Severe Weather Conditions on HCM Parameters

## Exhibit 11-20

Default CAFs by Weather Condition

| Weather Type        | Weather Event Definition        | Capacity Adjustment Factors |            |            |            |            |
|---------------------|---------------------------------|-----------------------------|------------|------------|------------|------------|
|                     |                                 | 55<br>mi/h                  | 60<br>mi/h | 65<br>mi/h | 70<br>mi/h | 75<br>mi/h |
| Medium rain         | > 0.10-0.25 in/h                | 0.94                        | 0.93       | 0.92       | 0.91       | 0.90       |
| Heavy rain          | > 0.25 in/h                     | 0.89                        | 0.88       | 0.86       | 0.84       | 0.82       |
| Light snow          | >0.00 – 0.05 in/h               | 0.97                        | 0.96       | 0.96       | 0.95       | 0.95       |
| Light-medium snow   | >0.05 – 0.10 in/h               | 0.95                        | 0.94       | 0.92       | 0.90       | 0.88       |
| Medium-heavy snow   | >0.10 – 0.50 in/h               | 0.93                        | 0.91       | 0.90       | 0.88       | 0.87       |
| Heavy snow          | >0.50 in/h                      | 0.80                        | 0.78       | 0.76       | 0.74       | 0.72       |
| Severe cold         | < -4°F                          | 0.93                        | 0.92       | 0.92       | 0.91       | 0.90       |
| Low visibility      | 0.50 – 0.99 mi                  | 0.90                        | 0.90       | 0.90       | 0.90       | 0.90       |
| Very low visibility | 0.25 – 0.49 mi                  | 0.88                        | 0.88       | 0.88       | 0.88       | 0.88       |
| Minimal visibility  | < 0.25 mi                       | 0.90                        | 0.90       | 0.90       | 0.90       | 0.90       |
| Non-severe weather  | All conditions not listed above | 1.00                        | 1.00       | 1.00       | 1.00       | 1.00       |

Source: Zegeer et al. (1).

Note: Speeds given in column heads are free-flow speeds.

## Exhibit 11-21

Default SAFs by Weather Condition

| Weather Type        | Weather Event Definition        | Speed Adjustment Factors |            |            |            |            |
|---------------------|---------------------------------|--------------------------|------------|------------|------------|------------|
|                     |                                 | 55<br>mi/h               | 60<br>mi/h | 65<br>mi/h | 70<br>mi/h | 75<br>mi/h |
| Medium rain         | > 0.10-0.25 in/h                | 0.96                     | 0.95       | 0.94       | 0.93       | 0.93       |
| Heavy rain          | > 0.25 in/h                     | 0.94                     | 0.93       | 0.93       | 0.92       | 0.91       |
| Light snow          | >0.00 – 0.05 in/h               | 0.94                     | 0.92       | 0.89       | 0.87       | 0.84       |
| Light-medium snow   | >0.05 – 0.10 in/h               | 0.92                     | 0.90       | 0.88       | 0.86       | 0.83       |
| Medium-heavy snow   | >0.10 – 0.50 in/h               | 0.90                     | 0.88       | 0.86       | 0.84       | 0.82       |
| Heavy snow          | >0.50 in/h                      | 0.88                     | 0.86       | 0.85       | 0.83       | 0.81       |
| Severe cold         | < -4°F                          | 0.95                     | 0.95       | 0.94       | 0.93       | 0.92       |
| Low visibility      | 0.50 – 0.99 mi                  | 0.96                     | 0.95       | 0.94       | 0.94       | 0.93       |
| Very low visibility | 0.25 – 0.49 mi                  | 0.95                     | 0.94       | 0.93       | 0.92       | 0.91       |
| Minimal visibility  | < 0.25 mi                       | 0.95                     | 0.94       | 0.93       | 0.92       | 0.91       |
| Non-severe weather  | All conditions not listed above | 1.00                     | 1.00       | 1.00       | 1.00       | 1.00       |

Source: Zegeer et al. (1).

Note: Speeds given in column heads are free-flow speeds.

# Weather Conditions Configuration in FREEVAL

Listing of 96 largest metropolitan area in US where weather information is available

Scenario Generator

Properties GP - Demand GP - Work Zones GP - Incidents **Weather**

Please enter probabilities, durations, and adjustment factors for weather events, or fill by specifying the nearest metropolitan area:

Nearest Metropolitan Area: **Raleigh,NC** Extract Longterm Regional Weather Data Use Values Stored In Seed Export Import

|               | Med Rain | Heavy Rain | Light Snow | LM Snow | MH Snow | Heavy Snow | Severe Cold | Low Vis | Very Low Vis | Min Vis | Normal Weather |
|---------------|----------|------------|------------|---------|---------|------------|-------------|---------|--------------|---------|----------------|
| January       | 0.9%     | 0.4%       | 1.4%       | 0.1%    | 0.0%    | 0.0%       | 0.0%        | 1.1%    | 0.0%         | 0.6%    | 95.5%          |
| February      | 0.9%     | 0.0%       | 0.8%       | 0.1%    | 0.0%    | 0.0%       | 0.0%        | 0.7%    | 0.0%         | 0.3%    | 97.1%          |
| March         | 0.8%     | 0.8%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.3%    | 0.0%         | 0.3%    | 97.7%          |
| April         | 0.3%     | 0.4%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.0%    | 0.0%         | 0.0%    | 99.3%          |
| May           | 1.2%     | 1.4%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.1%    | 0.0%         | 0.0%    | 97.4%          |
| June          | 0.8%     | 1.3%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.0%    | 0.0%         | 0.0%    | 97.8%          |
| July          | 1.1%     | 1.6%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.0%    | 0.0%         | 0.0%    | 97.4%          |
| August        | 0.5%     | 0.7%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.3%    | 0.0%         | 0.0%    | 98.5%          |
| September     | 1.1%     | 1.0%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.0%    | 0.0%         | 0.0%    | 97.9%          |
| October       | 0.5%     | 0.2%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.9%    | 0.0%         | 0.1%    | 98.3%          |
| November      | 1.1%     | 0.6%       | 0.0%       | 0.0%    | 0.0%    | 0.0%       | 0.0%        | 0.0%    | 0.0%         | 0.0%    | 98.3%          |
| December      | 0.8%     | 0.6%       | 0.8%       | 0.3%    | 0.0%    | 0.0%       | 0.0%        | 1.5%    | 0.0%         | 0.4%    | 95.5%          |
| Avg Dur (min) | 40.22    | 33.69      | 93.09      | 33.35   | 21.66   | 7.30       | 0.00        | 76.17   | 0.00         | 144.88  |                |
| CAF           | 0.93     | 0.86       | 0.96       | 0.91    | 0.89    | 0.78       | 0.92        | 0.90    | 0.88         | 0.90    | 1.00           |
| SAF           | 0.95     | 0.93       | 0.92       | 0.90    | 0.88    | 0.86       | 0.95        | 0.95    | 0.94         | 0.94    | 1.00           |
| DAF           | 1.00     | 1.00       | 1.00       | 1.00    | 1.00    | 1.00       | 1.00        | 1.00    | 1.00         | 1.00    | 1.00           |

Generate Scenarios Only Generate and Run Scenarios Cancel

Likelihood of Different Weather Conditions

Impact of Weather Conditions on Capacity, Speed and Demand



# Consideration of Work Zones in Reliability Analysis

- § The reliability analysis can accommodate the impact of scheduled long term work zones in the analysis.
- § Short term maintenance jobs can be modeled as minor incidents
- § The impact of work zone events incorporate all the capacity and free flow speed models that were developed in NCHRP 03-107.

# Work Zones Configuration

## Configuring Work Zone Event

## List of Modeled WZ events

The screenshot shows the 'Scenario Generator' window with the 'GP - Work Zones' tab selected. The interface is divided into several sections:

- Work Zone Time and Location:** Contains date pickers for Start (Jan 1 Wed) and End (Jan 7 Tue), segment pickers (Start: 3, End: 4), and analysis periods (2 (17:15) to 5 (18:15)).
- Work Zone Parameters:** Includes Severity (1 Lane Closure), Area Type (Urban), Barrier Type (Concrete), Work Zone Speed Limit (55.0), and Lateral Distance (1 ft.).
- List of Modeled WZ events:** A table with columns 'Add', 'Remove', and 'Remove All'. It contains one event: '1 Lane Closure: Jan 1 Wed - Jan 7 Tue (Seg. 3 - 4) (Per. 2 - 5)'.
- Work Zone Adjustment Factors:** A table with columns for adjustment factors (CAF, SAF, DAF) and segments (Seg 3, Seg 4).

At the bottom, there is a text box explaining the adjustment factors and three buttons: 'Generate Scenarios Only', 'Generate and Run Scenarios', and 'Cancel'.

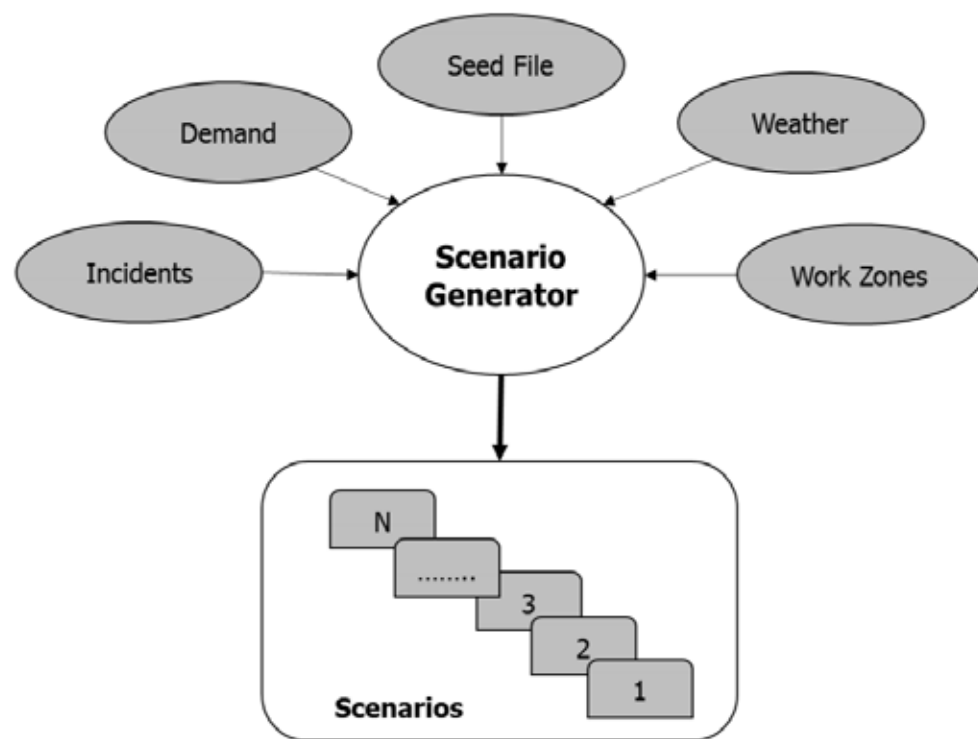
| *   | Seg 3 | Seg 4 |
|-----|-------|-------|
| CAF | 0.95  | 0.95  |
| SAF | 0.93  | 0.93  |
| DAF | 1.00  | 1.00  |

Impact of WZ on Capacity, Speed and Demand based on NCHRP 03-107

# How Reliability Scenarios are Generated

§ Method uses both deterministic and stochastic modeling in an optimization scheme to generate scenarios.

- **Traffic Demand Variations**  
(Modeled Deterministically)
- **Incidents**  
(Modeled Stochastically)
- **Severe Weather Conditions**  
(Modeled Stochastically)
- **Scheduled Work Zones**  
(Modeled Deterministically)



# Replication of Scenarios

- § The recommended number of replications is a function of the duration of the reliability reporting period (RRP)

## Exhibit 11-9

Recommended Number of Replications for Scenario Generation

| RRP Duration (months) | Number of Days Considered | Recommended Number of Replications | Resulting Number of Scenarios |
|-----------------------|---------------------------|------------------------------------|-------------------------------|
| 1                     | 5 (all weekdays)          | 48                                 | 240                           |
| 2                     | 5                         | 24                                 | 240                           |
| 4                     | 5                         | 12                                 | 240                           |
| 6                     | 5                         | 8                                  | 240                           |
| 9                     | 5                         | 6                                  | 270                           |
| 12*                   | 5                         | 4*                                 | 240*                          |
| 12                    | 2 (weekend only)          | 10                                 | 240                           |
| 12                    | 7 (all days)**            | 3                                  | 252                           |

Notes: RRP = reliability reporting period.

\*Default value.

\*\*Not desirable; separating weekday and weekend reliability analysis is preferred.

# Scenario Generation in the Facility Time-Space Domain

- § Each Scenario may contain several non-recurring events
- § Example shows a single scenario with the effects of a rain event (R) lasting 45 min, a two-lane closure incident (I-2) lasting one hour and a shoulder-closure incident (I-S) lasting 15 min.

| Analysis Period | Segment Number |   |     |   |   |   |   |           |   |    |
|-----------------|----------------|---|-----|---|---|---|---|-----------|---|----|
|                 | 1              | 2 | 3   | 4 | 5 | 6 | 7 | 8         | 9 | 10 |
| 1               |                |   |     |   |   |   |   |           |   |    |
| 2               |                |   |     |   |   |   |   |           |   |    |
| 3               | R              | R | R   | R | R | R | R | R         | R | R  |
| 4               | R              | R | R   | R | R | R | R | R         | R | R  |
| 5               | R              | R | R   | R | R | R | R | R and I-2 | R | R  |
| 6               |                |   |     |   |   |   |   | I-2       |   |    |
| 7               |                |   |     |   |   |   |   | I-2       |   |    |
| 8               |                |   |     |   |   |   |   | I-2       |   |    |
| 9               |                |   |     |   |   |   |   |           |   |    |
| 10              |                |   |     |   |   |   |   |           |   |    |
| 11              |                |   | I-S |   |   |   |   |           |   |    |
| 12              |                |   |     |   |   |   |   |           |   |    |

## Exhibit 11-5

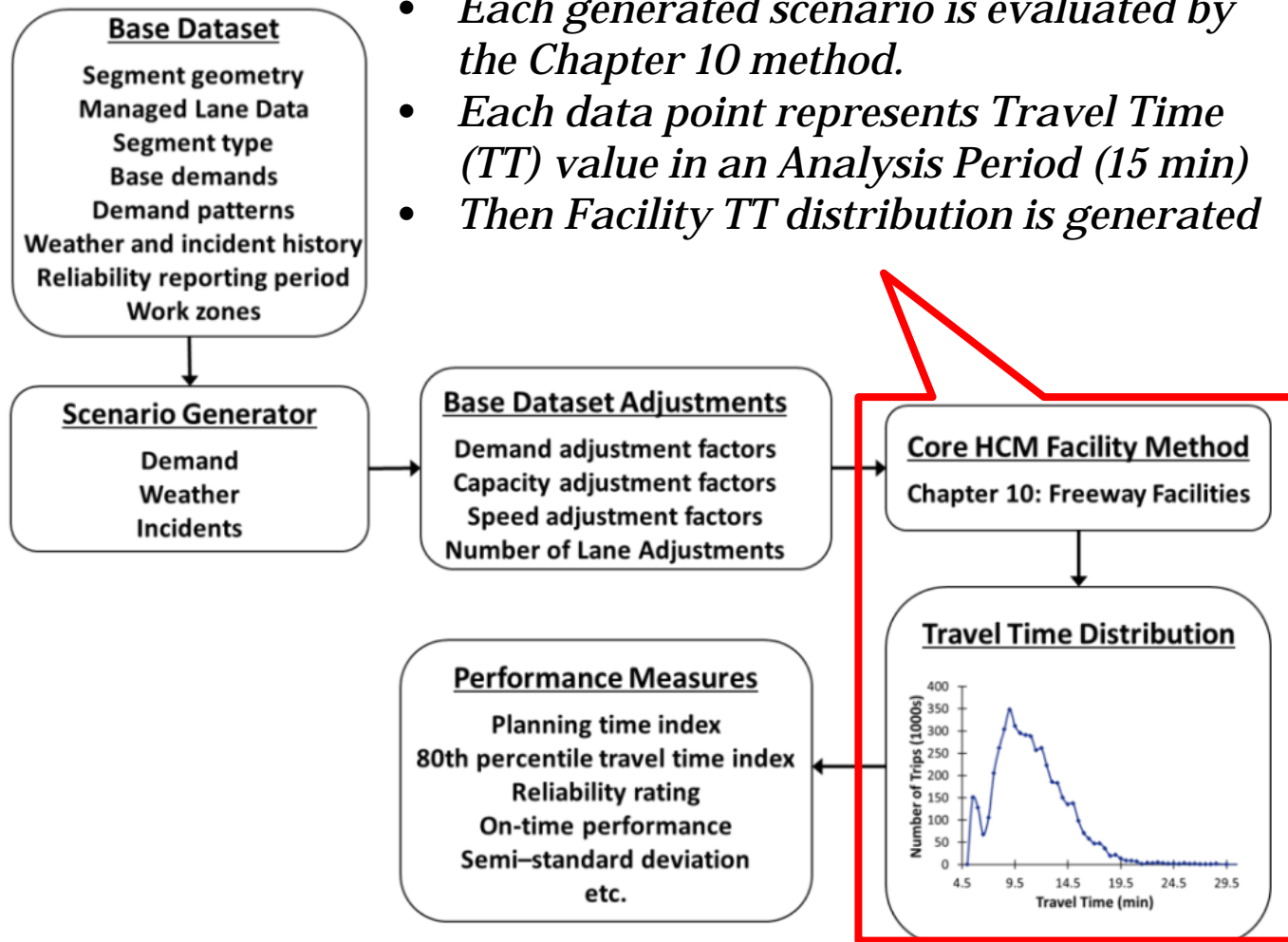
Scenario Illustrating Weather and Incident Events



# Evaluation of Scenarios and Methodology Outputs

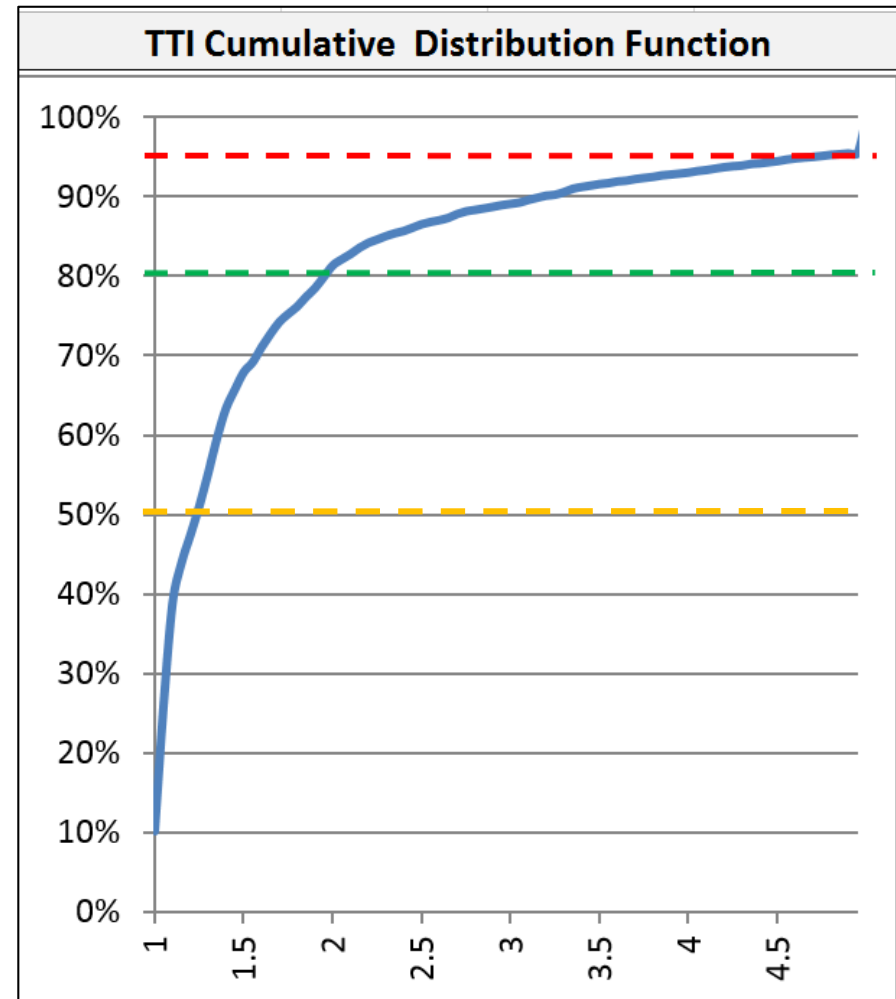
- *Each generated scenario is evaluated by the Chapter 10 method.*
- *Each data point represents Travel Time (TT) value in an Analysis Period (15 min)*
- *Then Facility TT distribution is generated*

**Exhibit 11-7**  
Freeway Reliability  
Methodology Framework



# Reliability Performance Measures

- § Reliability analysis produces “**reliability performance measures**” that include the impact of recurring and non-recurring sources of congestion.
- § All performance measures are based on the estimated travel time distribution.
- § To normalize and enable comparisons across facilities, travel times are divided by the free flow travel time resulting in **Travel Time Index (TTI)** distribution.



# Reliability Performance Measures from the TTI Distribution

## § Potential Performance Measures Derived from Distribution

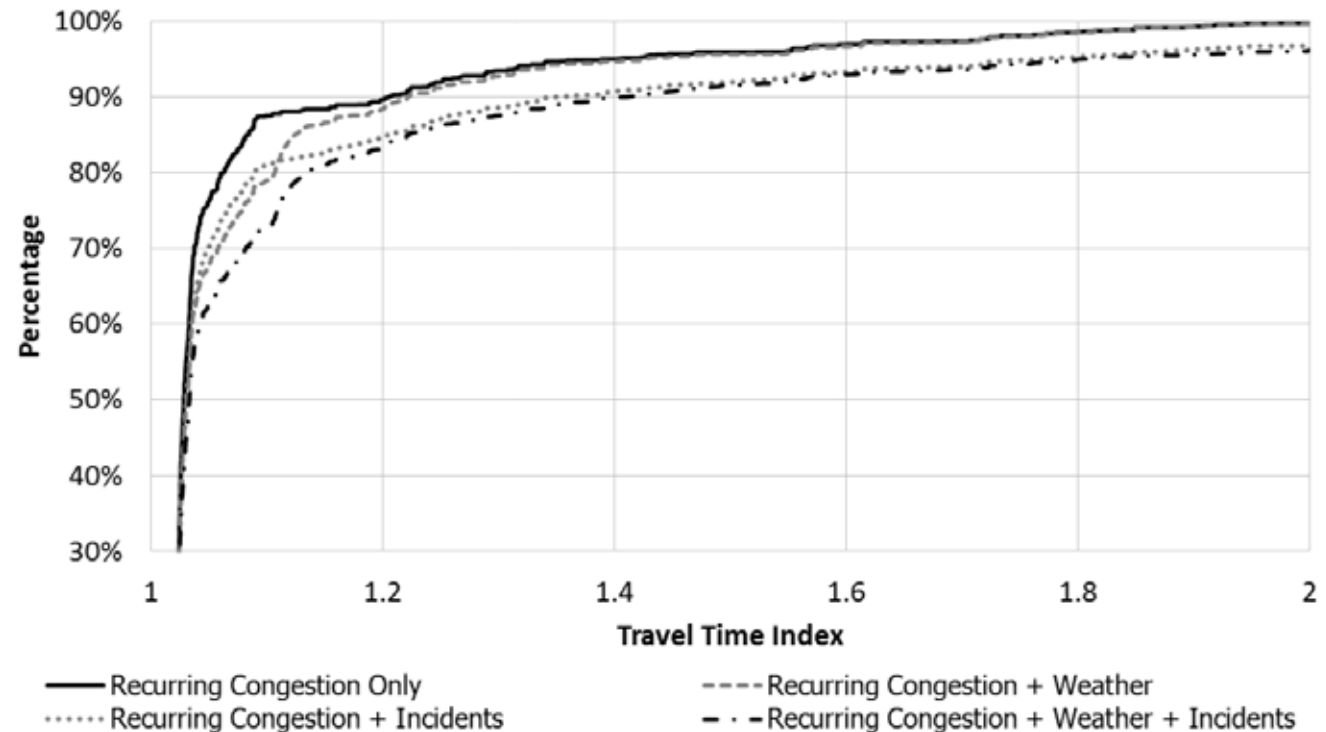
- 95<sup>th</sup> % TTI (PTI)
- 80<sup>th</sup> % TTI
- 50<sup>th</sup> % TTI (Median)
- Reliability Rating – *how often the facility performs satisfactorily defined as the fraction of facility VMT operating below a TTI of 1.33*
- Failure and on-time measures (%)
- Misery Index - *average of the worse 5% TTI's*
- Semi-Standard Deviation– *standard deviation from TTI=1*
- Standard Deviation
- %VMT at TTI>2
  - § Percent vehicle-miles traveled at TTI greater than 2

 Used to calculate LOTTR

# Illustrating the Effect of Different Sources on Reliability

## Exhibit 11-14

Illustrative Effects of Different Non-Recurring Sources of Congestion on the TTI Distribution



# APPLYING THE HCM TO RELIABILITY ANALYSIS





# Applications of HCM Reliability Method

- § Predicting the reliability impacts of freeway investment options.
  - Adding lanes
  - Adding HOT or HOV lanes
- § Predicting the reliability benefits of transportation system management and operations strategies (TSMO).
  - Part-time shoulder use
  - Ramp metering
  - Speed harmonization

# HCM Provides the Analytical Framework

§ HCM provides the analytical framework for evaluating TSMO, but some linkages are missing.....

- Insufficient US experience to predict:
  - § Impacts of TSMO measures on crash experience
  - § Impacts of TSMO measures on incident clearance times
  - § Impacts of speed harmonization on speeds (driver compliance)
  - § Impacts of CAV on crash experience, capacities, speeds.
- Analyst must estimate these impacts off-line and input them into the HCM reliability method.
  - § HCM method has the placeholders for these linkages.

§ Research into some of these linkages is on the way

# Example Application #1 – Performance Management

## § The Problem:

- Agency's system reliability performance has deteriorated over last few years and new FHWA rules require agency to establish a reasonable reliability objective that it can achieve with its proposed LRTP.

## § The Question:

- What can the agency's LRTP be expected to achieve (in the way of improved reliability) over the next 5 to 10 years?
  - § Supplemental question: How might the CIP be tweaked with TSM&O strategies to deliver the desired reliability improvement?
  - § For Regional Reliability: SHRP2-L04 Incorporating Reliability Performance Measures in Operations and Planning Modeling Tools

# How can the Sixth Edition HCM help?

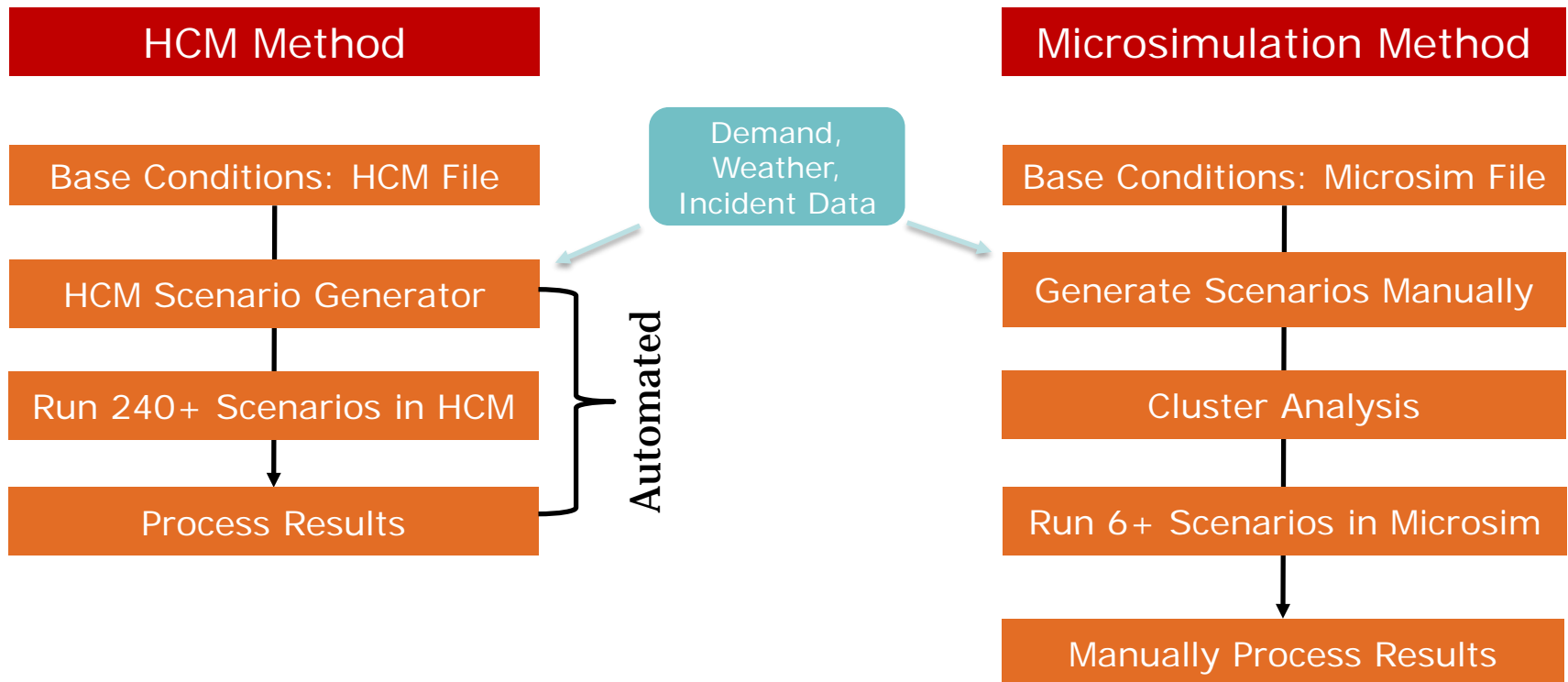
§ Until HCM 6<sup>th</sup> Edition the only way to realistically predict reliability was to use microsimulation.

- Code and calibrate microsimulation model for facility.
- Develop set of incident and weather scenarios
- Run simulation model several times
- Pool the results.

§ With the 6<sup>th</sup> Edition of the HCM, practitioners now have highly cost-efficient tool for predicting the reliability effects of infrastructure investments.

# The Highway Capacity Manual vs Microsimulation

## § Predicting Reliability: the HCM vs Microsimulation





# Steps to Applying the 6<sup>th</sup> Ed. HCM for Reliability

- § Step 1: Define your measures of reliability.
- § Step 2: Gather data for recurrent congestion HCM analysis.
- § Step 3: Calibrate HCM model for recurrent congestion.
- § Step 4: Run HCM reliability analysis (Future Baseline)
- § Step 5: Evaluate results.
- § Step 6: Select TSMO measures.
- § Step 7: Re-run HCM (TSMO Alternatives).
- § Step 8: Evaluate Results.

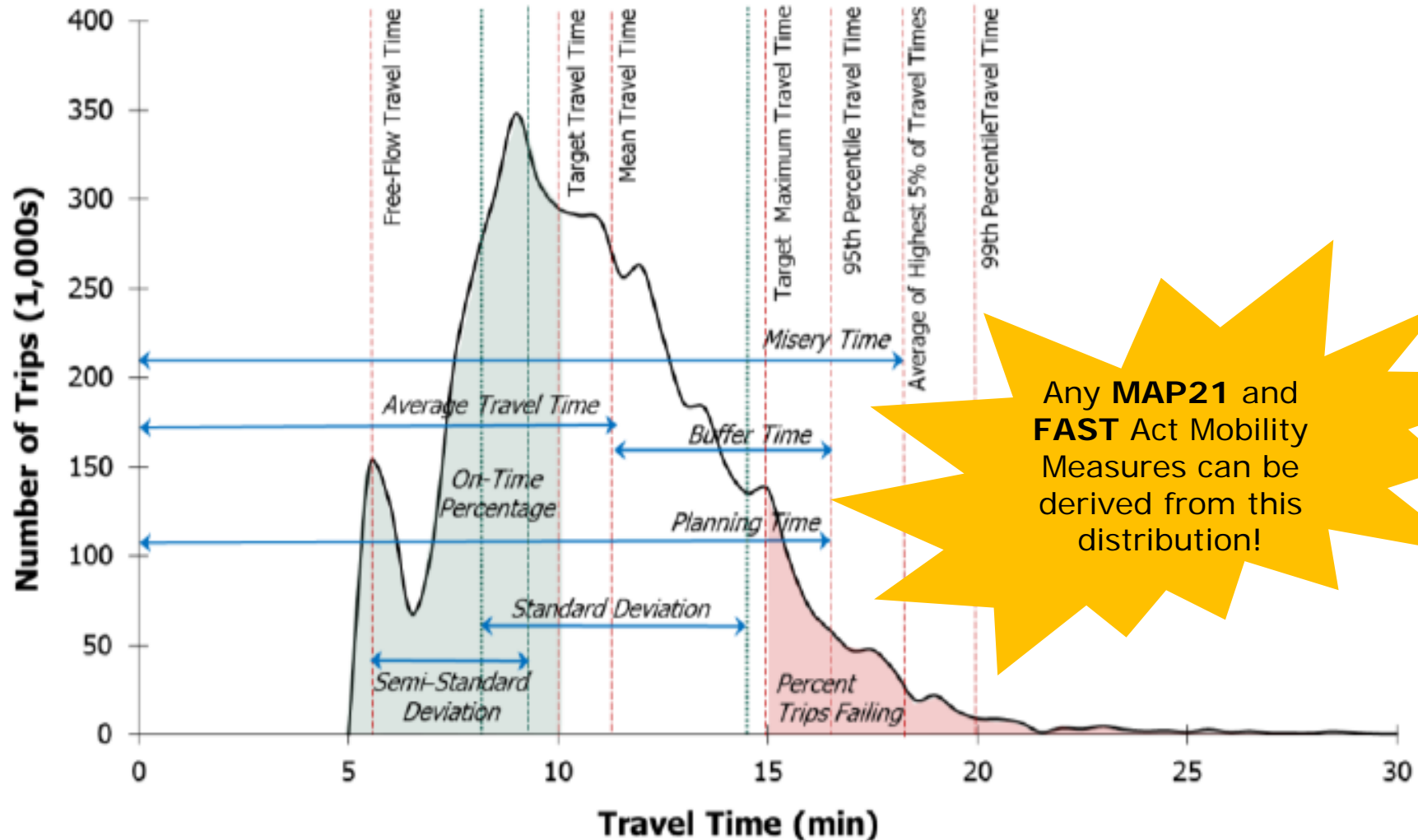
# Step 1: Set Reliability Performance Measures

- § HCM can't do entire system all at once (Use SHRP2-L04), but can do individual freeway or street facilities.
- § Select facility(s) that LRTP investments will impact for HCM reliability analysis.
- § Compute FHWA's reliability performance measures.
  - FHWA has established two reliability measures:
    - § % of Interstate that has reliable travel times.
    - § % of non-interstate NHS with reliable travel times.

# Step 1 (cont): Set Performance Measures

- § Level of Travel Time Reliability (LOTTR)
  - $\text{LOTTR} = 80\% \text{ Travel Time} / 50\% \text{ Travel Time}$
- § Compute LOTTR over one year for weekdays,
  - AM Peak (6-10AM), Midday (10-4 PM), PM Peak (4-8 PM)
  - Also for weekend days, 6AM to 8 PM.
- § A segment is reliable for the specified time period if its  $\text{LOTTR} < 1.50$
- § System performance is length weighted percent of segments with  $\text{LOTTR} < 1.50$

# Relating HCM to FHWA Performance Measures



# Step 2: Gather Data

| Required Input Data (Freeway Analysis)            | Conventional HCM Analysis | HCM Reliability Analysis |
|---------------------------------------------------|---------------------------|--------------------------|
| Lane widths and right-side lateral clearance (ft) | •                         | •                        |
| Ramp density (per mile)                           | •                         | •                        |
| Percentage heavy vehicles (%)                     | •                         | •                        |
| Terrain type/specific grade                       | •                         | •                        |
| Number of directional lanes                       | •                         | •                        |
| Peak hour factor (decimal)                        | •                         | •                        |
| Driver population factor (decimal)                | •                         | •                        |
| Segment length (mi)                               | •                         | •                        |
| Directional demand (veh/h)                        | •                         | •                        |
| Variability of demand                             |                           | •                        |
| Incident and crash frequencies                    |                           | •                        |
| Severe weather frequencies                        |                           | •                        |
| Work zone frequencies                             |                           | •                        |

# Step 3 Calibrate HCM Model – Recurring Congestion

## § Calibrate HCM for recurring congestion (no incidents)

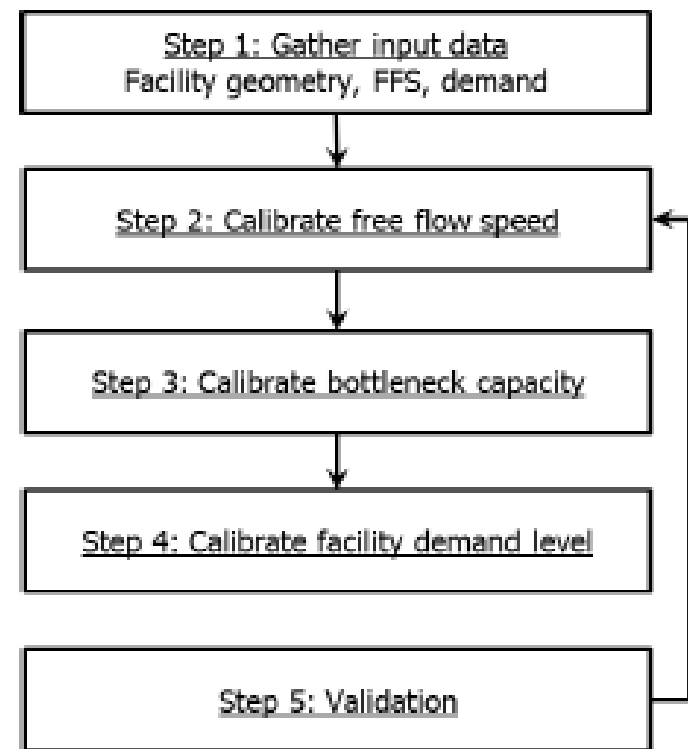
- Calibrate HCM default speed-flow curve

§ free-flow speed

§ capacity

§ Demands

– counts  $\leftrightarrow$  demand.

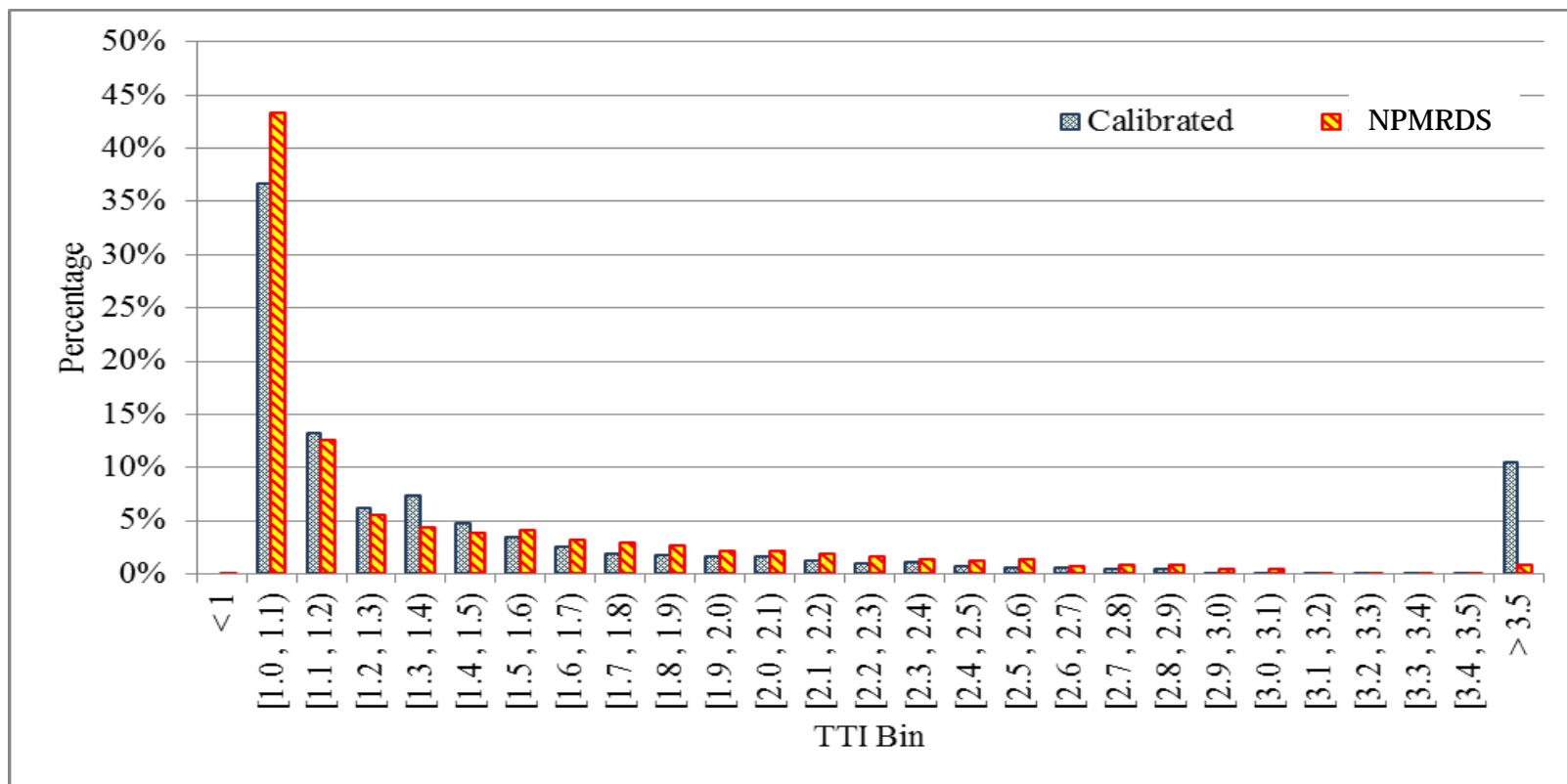




# Step 3 Calibrate HCM – Non-Recurring Congestion

## § Calibrate HCM reliability method against NPMRDS

- Useful for error checking incident and weather data used.



# Step 4: Run HCM Reliability Analysis

§ Separate HCM reliability analysis run for each FHWA reliability study period:

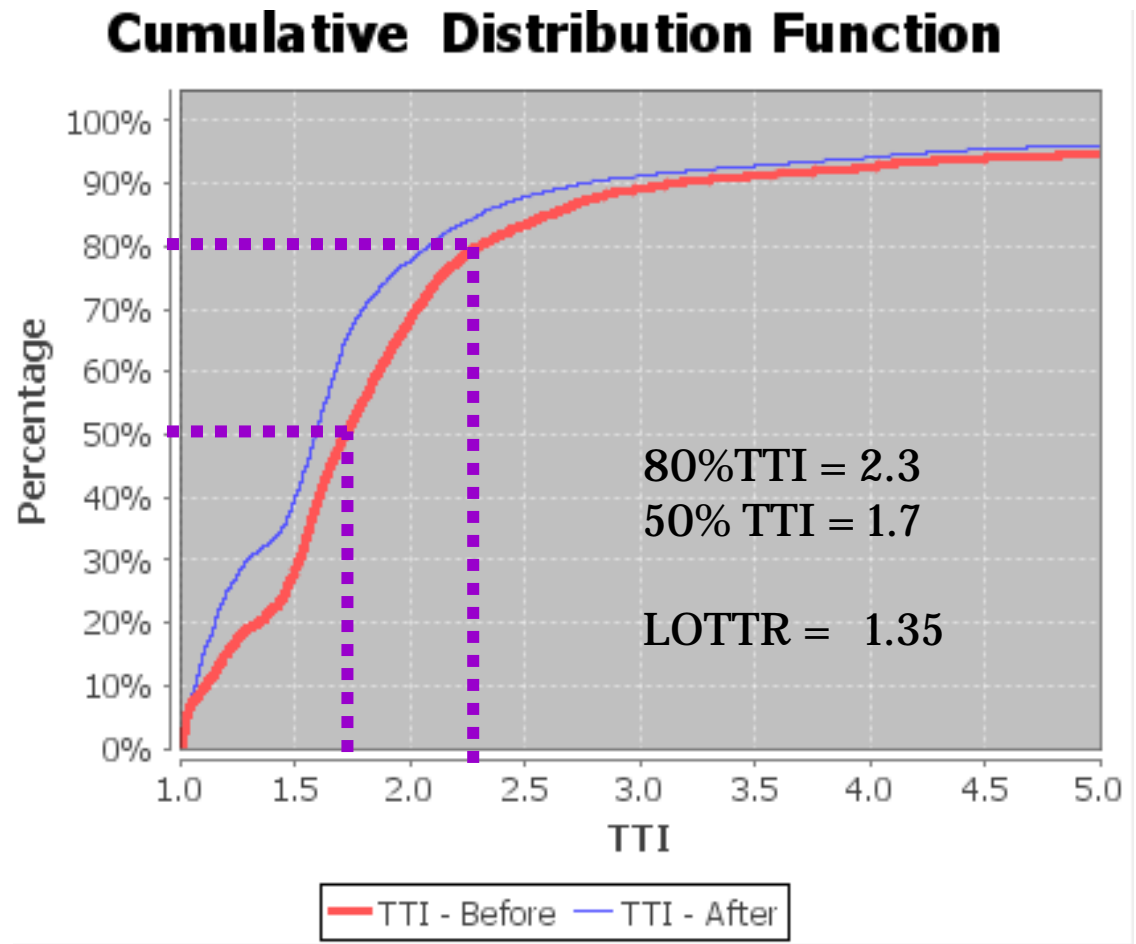
- AM peak 6-10 AM
- Midday 10 AM – 4 PM
- PM peak 4-8 PM
- Weekends 6 AM – 8 PM

§ HCM can do infinitely long study periods, but most software can't.

§ So pick representative 4 hour period for HCM analysis of weekend

# Step 5: Evaluate Results

- § Identify 50<sup>th</sup>% segment travel time and 80<sup>th</sup>% travel time for each study period.
- § Note that HCM provides facility results. FHWA performance measures of length weighted segment results.



# Step 6: Select TSMO Measures

## § Get Candidate TSMO Measures from FHWA Guide

- Designing for Transportation Management and Operations: A Primer, FHWA-HOP-13-013, February 2013

## § Some examples:

- Traffic incident management.
- Corridor, freeway, and arterial management.
- Active transportation and demand management.
- Work zone management.
- Road weather management.
- Emergency management.
- Traveler information services.
- Congestion pricing.
- Parking management.
- Freight management.

# Step 6 (cont): Group TSMO Options into Alternatives

1. Baseline
2. Geometric Treatment Alternative
  - bottleneck mitigation Segments 7-11
3. Incident Management Alternative
  - improve incident response time
4. Safety Treatment Alternative
  - reduce crash rate on facility
5. Demand Management Alternative
  - promote peak spreading

# Step 7: Rerun HCM, Evaluate Results

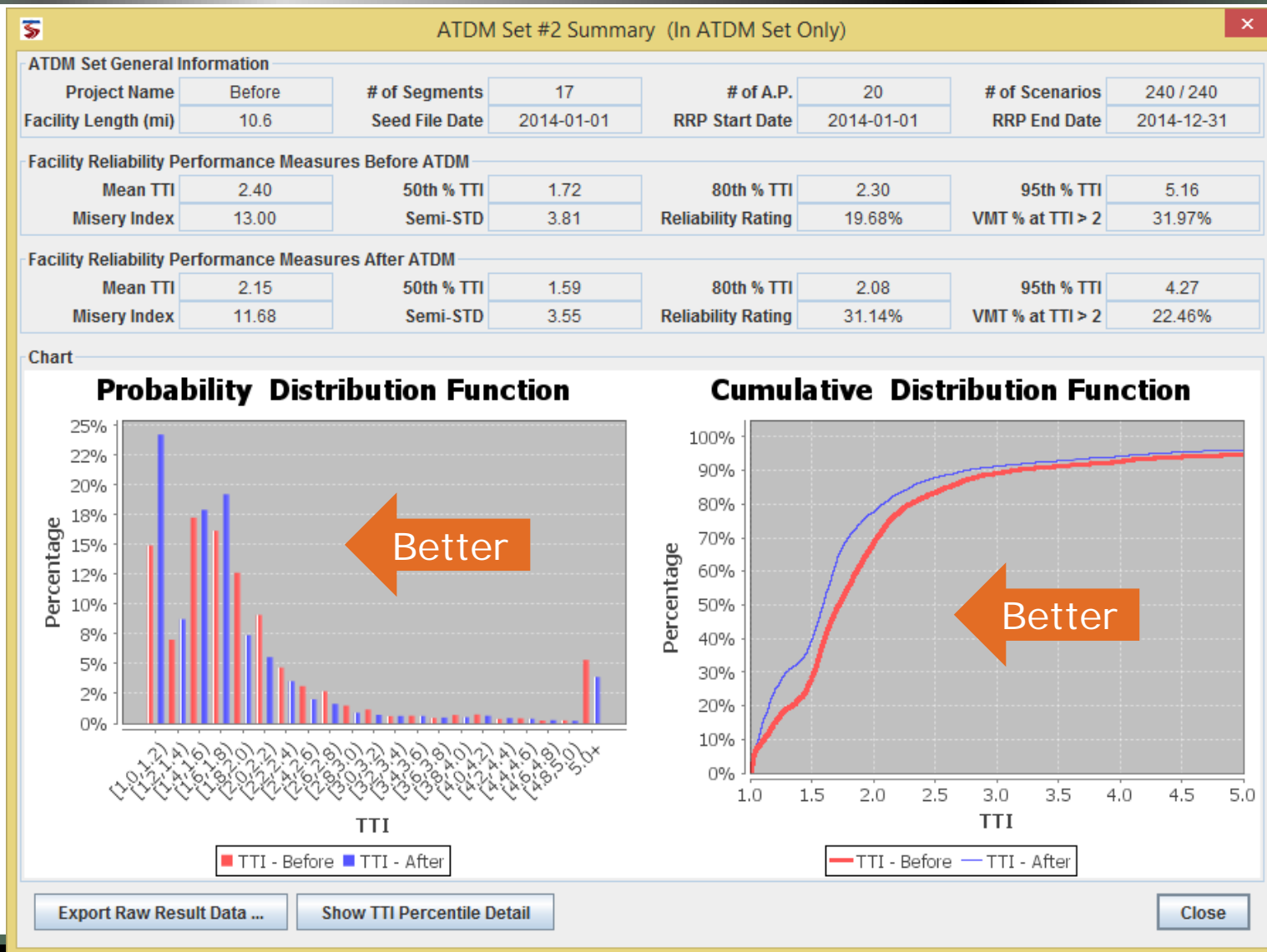
§ The Challenge: To identify effects of TSMO on:

- Demands
- Speed-flow equations
  - § Free-flow speed
  - § Capacity

§ HCM has set up the framework for evaluating the effects of TSMO, but does not (yet) provide the specific numbers

- See Chapter 37, “ATDM: Supplemental”, of HCM for advice.

# Step 8: Evaluate Impacts on Travel Time Distribution





# Step 8. Evaluate Results – Inspecting individual days

§ Before

Time

| Analysis Period   | Seg. 1 | Seg. 2 | Seg. 3 | Seg. 4 | Seg. 5 | Seg. 6 | Seg. 7 | Seg. 8 | Seg. 9 | Seg. 10 | Seg. 11 | Seg. 12 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|
| #1 6:00 - 6:15    | 75.0   | 67.8   | 74.4   | 68.5   | 75.0   | 70.3   | 74.8   | 71.3   | 74.9   | 67.6    | 74.8    | 69.9    |
| #2 6:15 - 6:30    | 71.9   | 68.7   | 73.2   | 66.1   | 70.1   | 69.0   | 72.3   | 67.7   | 68.9   | 68.3    | 71.5    | 66.7    |
| #3 6:30 - 6:45    | 72.2   | 68.4   | 73.7   | 65.0   | 68.8   | 68.8   | 71.3   | 68.8   | 67.1   | 67.1    | 69.9    | 65.5    |
| #4 6:45 - 7:00    | 69.2   | 68.5   | 71.5   | 63.8   | 65.3   | 65.3   | 68.7   | 64.3   | 64.3   | 64.3    | 68.1    | 63.3    |
| #5 7:00 - 7:15    | 69.9   | 68.0   | 72.7   | 64.3   | 67.0   | 67.0   | 71.1   | 67.1   | 67.5   | 67.5    | 71.5    | 66.5    |
| #6 7:15 - 7:30    | 68.9   | 68.2   | 71.6   | 63.8   | 65.5   | 65.5   | 69.6   | 64.9   | 64.9   | 64.9    | 69.7    | 65.1    |
| #7 7:30 - 7:45    | 61.8   | 61.8   | 65.0   | 58.1   | 46.0   | 42.8   | 28.0   | 58.1   | 58.1   | 62.8    | 35.4    | 58.1    |
| #8 7:45 - 8:00    | 62.7   | 66.3   | 30.4   | 36.7   | 33.6   | 32.7   | 26.0   | 58.2   | 51.3   | 40.7    | 27.6    | 58.2    |
| #9 8:00 - 8:15    | 53.7   | 36.8   | 21.7   | 47.9   | 44.1   | 49.6   | 28.5   | 40.1   | 35.8   | 35.0    | 27.5    | 58.2    |
| #10 8:15 - 8:30   | 47.4   | 31.0   | 21.5   | 37.3   | 36.6   | 47.9   | 30.8   | 37.3   | 53.0   | 61.8    | 30.0    | 58.2    |
| #11 8:30 - 8:45   | 60.5   | 26.0   | 14.5   | 14.0   | 8.5    | 2.0    | 1.0    | 22.7   | 74.1   | 68.7    | 74.8    | 70.0    |
| #12 8:45 - 9:00   | 1.2    | 1.0    | 1.0    | 1.2    | 1.1    | 1.1    | 1.0    | 35.3   | 74.3   | 68.7    | 74.8    | 69.9    |
| #13 9:00 - 9:15   | 1.3    | 1.4    | 1.2    | 1.6    | 1.2    | 1.2    | 1.0    | 35.3   | 74.3   | 68.6    | 74.8    | 70.1    |
| #14 9:15 - 9:30   | 1.6    | 2.3    | 3.2    | 5.0    | 14.1   | 32.3   | 36.1   | 58.3   | 58.3   | 58.3    | 64.3    | 61.6    |
| #15 9:30 - 9:45   | 22.2   | 32.1   | 22.8   | 39.8   | 38.9   | 58.2   | 64.0   | 59.7   | 59.7   | 59.7    | 64.4    | 60.6    |
| #16 9:45 - 10:00  | 31.8   | 30.8   | 23.1   | 40.6   | 39.0   | 58.2   | 63.3   | 58.9   | 58.9   | 58.9    | 63.5    | 60.2    |
| #17 10:00 - 10:15 | 31.3   | 31.1   | 22.9   | 39.8   | 38.9   | 58.2   | 63.3   | 74.8   | 57.7   | 34.4    | 50.4    | 64.4    |
| #18 10:15 - 10:30 | 27.9   | 25.7   | 18.0   | 29.0   | 23.8   | 50.5   | 70.1   | 74.9   | 69.5   | 46.4    | 54.5    | 65.9    |
| #19 10:30 - 10:45 | 20.9   | 20.9   | 15.2   | 24.3   | 22.9   | 50.5   | 70.8   | 67.7   | 68.3   | 68.2    | 71.1    | 67.0    |
| #20 10:45 - 11:00 | 26.3   | 20.7   | 17.5   | 48.2   | 40.8   | 58.2   | 64.1   | 60.2   | 60.2   | 60.2    | 65.0    | 62.3    |

Distance

§ After

Time

| Analysis Period   | Seg. 1 | Seg. 2 | Seg. 3 | Seg. 4 | Seg. 5 | Seg. 6 | Seg. 7 | Seg. 8 | Seg. 9 | Seg. 10 | Seg. 11 | Seg. 12 |
|-------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|---------|---------|
| #1 6:00 - 6:15    | 75.0   | 67.8   | 74.4   | 69.1   | 75.0   | 70.6   | 74.8   | 71.5   | 74.9   | 67.6    | 74.8    | 70.0    |
| #2 6:15 - 6:30    | 71.9   | 68.7   | 73.2   | 66.9   | 71.4   | 69.2   | 73.3   | 69.0   | 71.4   | 68.4    | 73.2    | 67.6    |
| #3 6:30 - 6:45    | 72.2   | 68.4   | 73.7   | 67.2   | 72.1   |        |        |        |        |         | 73.2    | 67.6    |
| #4 6:45 - 7:00    | 69.2   | 68.5   | 71.5   | 66.0   | 69.0   |        |        |        |        |         | 71.3    | 66.6    |
| #5 7:00 - 7:15    | 69.9   | 68.0   | 72.7   | 66.6   | 70.6   |        |        |        |        |         | 73.5    | 67.7    |
| #6 7:15 - 7:30    | 68.9   | 68.2   | 71.6   | 66.1   | 69.1   |        |        |        |        |         | 72.7    | 67.3    |
| #7 7:30 - 7:45    | 61.8   | 55.5   | 30.6   | 38.1   | 58.4   |        |        |        |        |         | 63.8    | 62.4    |
| #8 7:45 - 8:00    | 57.1   | 32.4   | 22.5   | 36.4   | 58.2   |        |        |        |        |         | 62.4    | 60.9    |
| #9 8:00 - 8:15    | 64.6   | 59.6   | 30.5   | 36.4   | 58.2   | 58.2   | 62.8   | 61.3   | 58.4   | 58.4    | 62.7    | 61.3    |
| #10 8:15 - 8:30   | 65.7   | 65.7   | 60.4   | 36.7   | 58.2   | 58.2   | 62.9   | 61.5   | 58.6   | 58.6    | 63.6    | 62.2    |
| #11 8:30 - 8:45   | 68.2   | 59.2   | 30.8   | 23.2   | 6.0    | 3.9    | 1.3    | 35.9   | 74.3   | 68.7    | 74.8    | 70.0    |
| #12 8:45 - 9:00   | 2.8    | 1.2    | 1.1    | 1.3    | 1.3    | 1.3    | 1.2    | 36.1   | 74.3   | 68.7    | 74.8    | 70.0    |
| #13 9:00 - 9:15   | 1.5    | 1.6    | 1.4    | 1.7    | 1.4    | 1.4    | 1.2    | 36.1   | 74.3   | 68.6    | 74.8    | 70.0    |
| #14 9:15 - 9:30   | 2.3    | 3.8    | 4.4    | 8.1    | 16.7   | 38.7   | 62.2   | 61.2   | 58.2   | 58.2    | 64.2    | 62.8    |
| #15 9:30 - 9:45   | 28.2   | 32.1   | 23.1   | 37.5   | 38.9   | 58.2   | 64.0   | 62.5   | 59.8   | 59.8    | 64.5    | 63.0    |
| #16 9:45 - 10:00  | 31.3   | 31.2   | 22.7   | 37.5   | 39.0   | 58.2   | 63.3   | 61.9   | 59.1   | 59.1    | 63.7    | 62.2    |
| #17 10:00 - 10:15 | 31.0   | 31.8   | 22.7   | 36.9   | 38.9   | 58.2   | 63.3   | 61.9   | 61.5   | 34.7    | 50.4    | 64.3    |
| #18 10:15 - 10:30 | 27.8   | 28.6   | 18.0   | 26.9   | 23.8   | 50.5   | 70.1   | 67.2   | 71.7   | 44.9    | 53.3    | 65.0    |
| #19 10:30 - 10:45 | 32.8   | 34.5   | 23.0   | 23.3   | 22.9   | 50.5   | 70.8   | 67.6   | 68.1   | 68.1    | 71.0    | 66.4    |
| #20 10:45 - 11:00 | 74.1   | 69.0   | 54.8   | 44.0   | 58.3   | 63.9   | 68.1   | 66.1   | 64.8   | 64.8    | 68.4    | 65.1    |

Queuing starts later,  
Clears sooner

# Step 8: Evaluate Selected Performance Results

| Reliability Performance Measure          | Base Condition | Bottleneck Treatment | Incident Management | Safety Treatment | Demand management |
|------------------------------------------|----------------|----------------------|---------------------|------------------|-------------------|
| Facility Mean Speed (mph)                | 49.7           | 55.0                 | 51.3                | 51.7             | 53.6              |
| Mean VHD in a 3hr study period           | 263            | 108                  | 213                 | 209              | 150               |
| 80 <sup>th</sup> % TTI)                  | 1.65           | 1.16                 | 1.61                | 1.61             | 1.29              |
| 50 <sup>th</sup> % TTI                   | 1.21           | 1.09                 | 1.17                | 1.16             | 1.12              |
| LOTTR (Level of Travel Time Reliability) | 1.36           | 1.06                 | 1.38                | 1.39             | 1.15              |
|                                          |                | Best                 |                     | ?                |                   |

# Recap

§ Using the HCM to evaluate how an agency can best achieve its reliability goals.

## § Eight Steps

- 1. Select reliability performance measures
- 2. Gather data
- 3. Calibrate HCM model
- 4. Run the HCM reliability analysis (Baseline)
- 5. Evaluate results
- 6. Select TSMO measures
- 7. Rerun HCM (Alternatives)
- 8. Evaluate results



Don't Forget to Calibrate!



# RECAP: RELIABILITY ANALYSIS WITH HCM



# Recap of Reliability Analysis Using HCM

## § Why Evaluate Reliability?

- It opens up more mitigation measures besides capacity

## § HCM Reliability Method

- Scenario generator tied into the HCM analysis engine.

## § Applying the HCM Reliability Method

- Active Transportation and Demand Management
- Transportation System Management and Operations (TSMO)

# Key Benefits and Advantages of Method

## § Reliability

- Consistent with MAP21 and FAST Act performance requirements
- Encompassing the effects of all sources of congestion on mobility measures --across an expanded time horizon
- Consistency with drivers' own daily driving experiences
- Key to selecting appropriate treatments depending on the relative contribution of congestion sources

## § Active Traffic and Demand Management

- Seamless tie in with reliability measures, as intended
- Provide non-construction options for mobility enhancement
- Enables the tailoring of strategies to scenarios

# Challenges and Limitations

## § Reliability

- Method limited by current HCM freeway facility model limitations (interacting bottlenecks, off-ramp queuing, etc.)
- Data needs challenges, especially on quantifying demand variation and incident details (type, severity, locations, etc.)
- Method confined to single facility, ignores corridor effects

## § ATDM Analysis

- Many of the ATDM strategies adjustment factors are based on very limited data

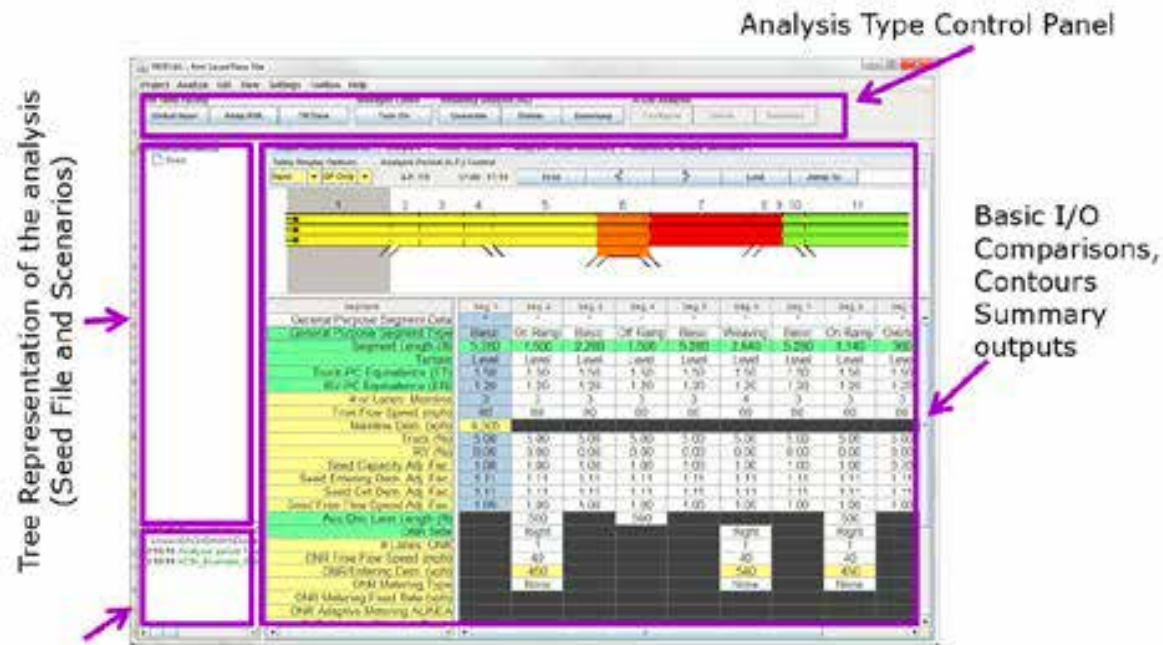


# Examples of Software Implementing HCM Method

- § Freeval
- § Streetval
- § HCS
- § HCM-Calc
- § Others

# Reliability Applications

## à Open-Source Tools Developed for HCM 6<sup>th</sup> Edition



## FREEVAL

à Freeway Facility and Reliability Analysis

## STREETVAL

à Arterial Facility and Reliability Analysis



# Available in HCM Volume 4 – Technical Reference Library à <http://hcmvolume4.org>

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## HIGHWAY CAPACITY MANUAL

6TH EDITION | A GUIDE FOR MULTIMODAL MOBILITY ANALYSIS

### VOLUME 4: APPLICATIONS GUIDE

Methodological Details Interpretations & Errata **Technical Reference Library** Applications Guides FAQs Discussion Forum HCM 2010













#### TECHNICAL REFERENCE LIBRARY

- Chapter 1: HCM User's Guide
- Chapter 3: Model Characteristics
- Chapter 5: Quality and Level-of-Service Concepts
- Chapter 7: Interpreting HCM and Alternative Tool Results
- Chapter 9: Capacity and Delay
- Chapter 11: Freeway Reliability Analysis**
- Chapter 13: Freeway Segment
- Chapter 15: Two-Lane Highways
- Chapter 17: Urban Street Reliability and ATDM
- Chapter 19: Signalized Intersections
- Chapter 21: All-way Stop-Controlled Intersections
- Chapter 23: Ramp Terminals and Alternative Intersections
- Chapter 25: Freeway Facilities: Supplemental
- Chapter 27: Freeway Weaving: Supplemental
- Chapter 29: Urban Street Facilities: Supplemental
- Chapter 31: Signalized Intersections: Supplemental
- Chapter 33: Roundabouts: Supplemental
- Chapter 35: Pedestrians and Bicycles: Supplemental
- Chapter 37: ATDM: Supplemental

- Chapter 2: Applications
- Chapter 4: Traffic Operations and Capacity Concepts
- Chapter 6: HCM and Alternative Analysis Tools
- Chapter 8: HCM Primer
- Chapter 10: Freeway Facilities Core Methodology
- Chapter 12: Basic Freeway and Multilane Highway Segments
- Chapter 14: Freeway Merge and Diverge Segments
- Chapter 16: Urban Street Facilities
- Chapter 18: Urban Street Research
- Chapter 20:
- Chapter 22:
- Chapter 24:
- Chapter 26:
- Chapter 28:
- Chapter 30:
- Chapter 32:
- Chapter 34:
- Chapter 36:

QUICK JUMP

## CHAPTER 11: FREEWAY RELIABILITY ANALYSIS

| TITLE                                                                                                                                                                                | SIZE     |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
|  Analytical Procedures for Determining the Impacts of Reliability Mitigation Strategies             |          |
|  Development of Tools for Assessing Wider Economic Benefits of Transportation                       | 14.7 MB  |
|  FREEVAL-2015e Computational Engine (Release 20160602)                                              | 5.9 MB   |
|  FREEVAL-2015e User's Guide                                                                         | 3.7 MB   |
|  IDAS User's Manual - Appendix B: IDAS Default Values                                             | 211.4 KB |
|  Incident Management Assistance Patrols: Assessment of Investment Benefits and Costs              | 6 MB     |
|  Incorporating Travel Time Reliability into the Highway Capacity Manual                           | 34.4 MB  |
|  Metropolitan Weather Database for Freeway Reliability Analysis                                   | 5.9 MB   |
|  NOAA National Centers for Environmental Information (formerly the National Climatic Data Center) |          |
|  Rainfall Frequency Atlas of the U.S.: Rainfall Event Statistics                                  |          |
|  Traffic Analysis Toolbox Volume XI: Weather and Traffic Analysis, Modeling and Simulation        | 2.1 MB   |
|  Weather History                                                                                  |          |

# Demo Videos: <http://go.ncsu.edu/FREEVAL>

The screenshot shows the YouTube channel page for "HCM 6th Ed Tools by ITRE". The channel banner features a red and blue stylized 'S' logo and an aerial view of a highway interchange. The page is organized into several sections:

- Left Sidebar:** Contains navigation links for Home, My Channel, Trending, Subscriptions, History, and Watch Later. Below these are subscription recommendations for Popular on YouTube, Music, Sports, and Gaming.
- Channel Header:** Displays the channel name "HCM 6th Ed Tools by ITRE" and a "Subscribe" button.
- Video Grids:**
  - FREEVAL 2015e Demos:** A section titled "Demo videos showing various capabilities of FREEVAL 2015e" containing five videos: "Introduction to FREEVAL 2015e" (91 views), "How to Create and Edit a Facility" (46 views), "Travel Time Reliability Analysis" (53 views), "Active Traffic and Demand Management Analysis" (24 views), and "Dynamic Strategy Selection" (20 views).
  - STREETVAL 2015e Demos:** A section containing three videos: "1. Introduction and Installation" (2:01), "2. Core Analysis (STREETVAL)" (5:51), and "3. Reliability Analysis" (9:30).
- Right Sidebar:** Lists "Popular channels" including Simply Nallogical, cutepolish, danooct1, Janelle Estep, Vee, and Are You Serious, each with a "Subscribe" button.

A URL bar at the bottom left shows the video link: [https://www.youtube.com/watch?v=jerNeS\\_yaak](https://www.youtube.com/watch?v=jerNeS_yaak).

# Reliability Analytical Tools

Licensed To: Windows Store User

**SWASHWARE**

**HCM-CALC**

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About...

Exit

Open Existing Project

Or

Start New Project

HCM Edition

☐ Fifth (2010) ☒ Sixth (2016)

Select Facility

- Freeway TTR/ATDM Utility
- Freeway Facility
- Basic Freeway Segment
- Weaving Segment
- On-Ramp Segment
- Off-Ramp Segment
- Multilane Highway Segment
- Two-Lane Highway Segment

Load



# Reliability Analytical Tools cont.

The image displays two overlapping software windows from the HCS7 suite. The top window, titled 'HCS7 Streets Reliability - [StreetsReliability].xsr \*1', features a menu bar with 'START', 'BASE', 'ANALYSIS', 'WEATHER', 'DEMAND', 'INCIDENT', 'SCENARIOS', 'EVENTS', 'SUMMARY', and 'REPORT'. The 'START' menu item is highlighted with a yellow oval. The main content area shows the title 'Streets Reliability' and a sidebar with 'Start' (New File..., Open File...) and 'Recent' sections. The bottom window, titled 'FreewaysReliabilityL.fsr\* HCS7 Freeways Reliability', has a similar menu bar including 'WORK ZONE' and 'SPECIAL EVENT'. Its main content area displays 'Freeways Reliability' and the 'HCS' logo. A sidebar on the right contains a 'Help' section with links to 'Topics', 'HCS Updates', 'HCS on the Web', 'McTrans on the Web', 'E-mail McTrans', and 'About HCS7'. The 'McTrans' logo is visible at the bottom of this window. Both windows include a copyright notice at the bottom: 'Copyright © 2019 University of Florida. All Rights Reserved.'

HCS7 Streets Reliability - [StreetsReliability].xsr \*1

START BASE ANALYSIS WEATHER DEMAND INCIDENT SCENARIOS EVENTS SUMMARY REPORT

Streets Reliability

Start  
New File...  
Open File...

Recent

FreewaysReliabilityL.fsr\* HCS7 Freeways Reliability

START BASE ANALYSIS WEATHER DEMAND INCIDENT WORK ZONE SPECIAL EVENT EVENTS SUMMARY REPORT

Freeways Reliability

Start  
New File...  
Open File...

Recent

Help  
Topics  
HCS Updates  
HCS on the Web  
McTrans on the Web  
E-mail McTrans  
About HCS7

HCS

McTrans

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HCS7™ Freeways Reliability Ver 6.1H EDITION | A GUIDE FOR MULTIMODAL MOBILITY ANALYSIS

# Questions?

## § Questions?

