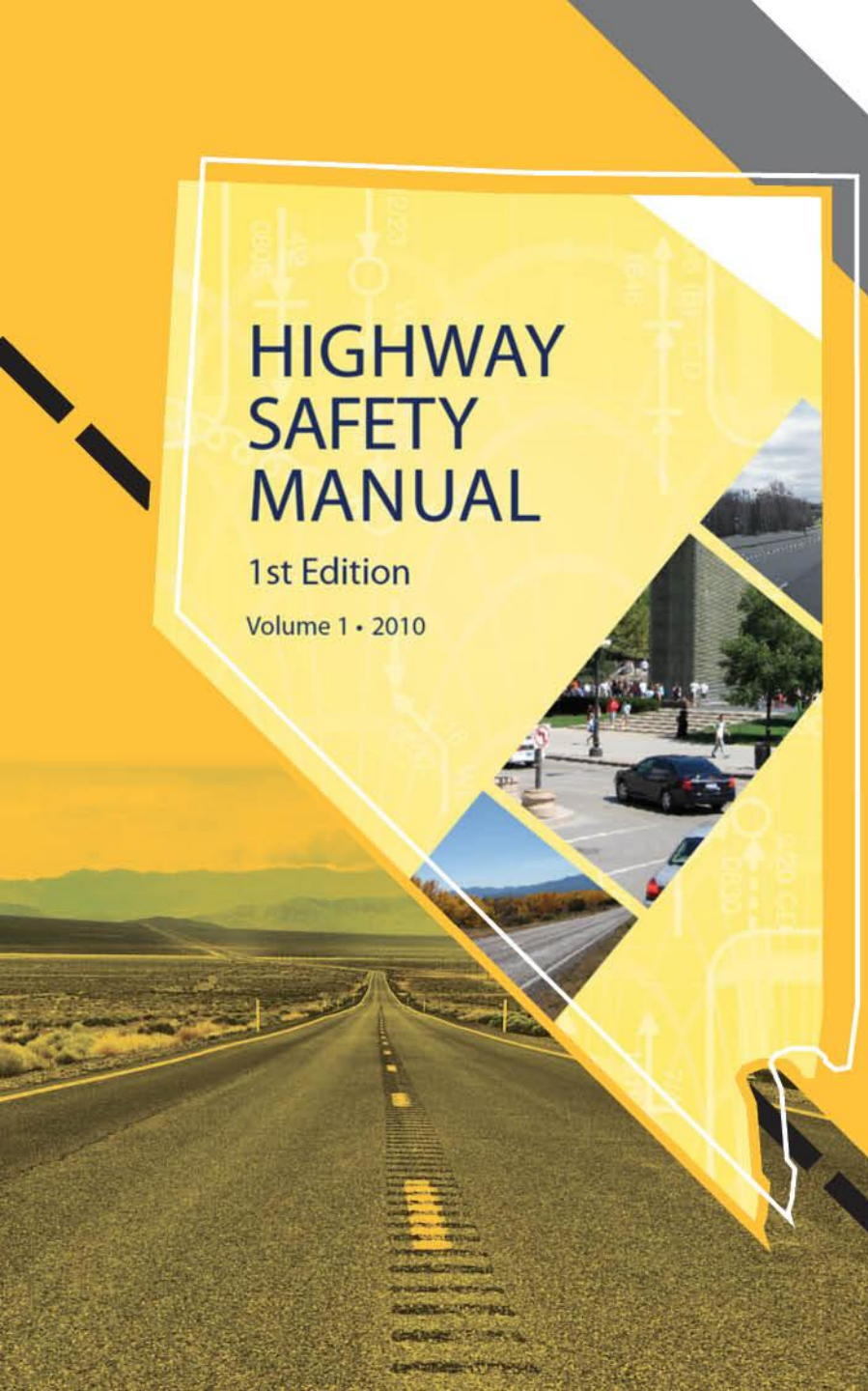
Highway Safety Manual

AMPO Annual Conference
10/23/13



Kimley-Horn and Associates, Inc.

Applying the Highway Safety Manual at the Regional and Local Level

- Presenters
  - Devin Moore, Kimley-Horn and Associates
    - Devin.Moore@Kimley-Horn.com
  - Michael Colety, Kimley-Horn and Associates
    - Mike.Colety@Kimley-Horn.com

Agenda

- Traffic Safety Background
- Highway Safety Manual (HSM) Overview
- HSM Tools
- Questions

Traffic Safety Background

- Far too many people are dying from traffic crashes
- Traffic safety is an epidemic
- Decade of Action for Road Safety launched by United Nations 5/12/11
- FHWA has established Toward Zero Deaths
- Some states have set a goal of Zero Fatalities
  - Is that possible?
  - What is a good goal for your family?

How many people are killed on America's roads?

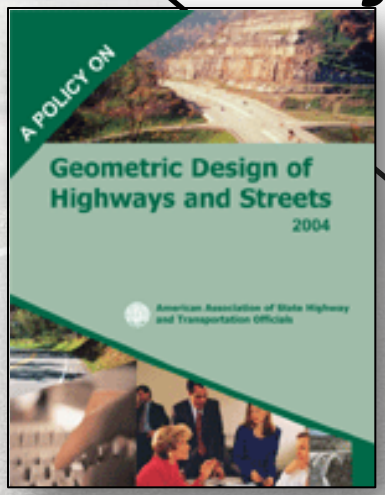
Highway Safety Manual (HSM) Overview

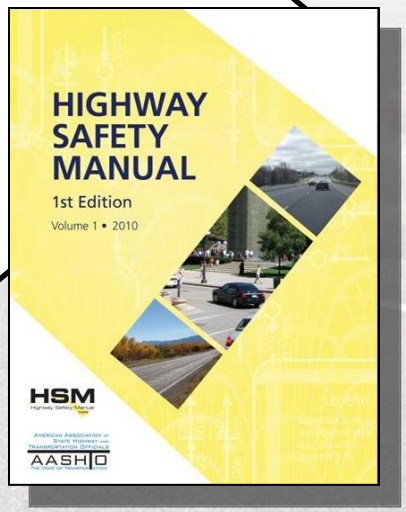
- Proven and science-based approach
- Characterizes the safety effects (i.e., crash frequency and severity) of decisions and actions
- Highway Safety Manual V1 released 2010 by AASHTO
- Based on Highway Capacity Manual
- Not mandated by FHWA

HSM = Substantive Safety

Nominal Safety

Substantive Safety





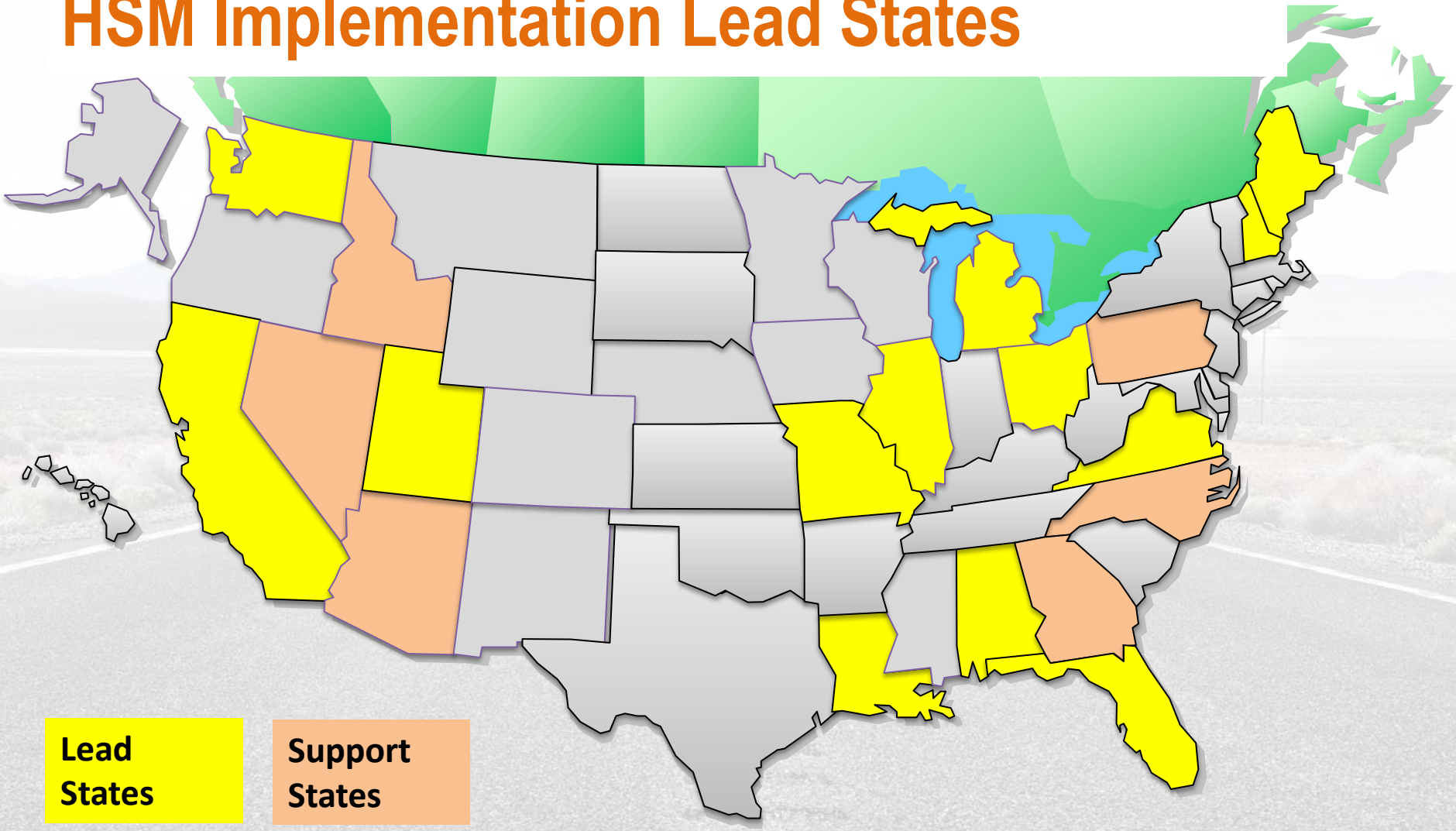
Standards Compliance

Expected or Actual Crash Frequency and Severity

HSM Primary Benefits

- Better safety analysis tools to support decision making
- Cost-effective investments in safety
- More lives saved and serious injuries avoided

HSM Implementation Lead States



Where Does HSM Fit in Project Cycle

- All transportation projects, although limitations on data
- Applies to:
  - Planning
  - Pre-design and Scoping
  - Design
  - Construction
  - Operations

Applying the HSM in Planning

- Incorporate HSM into Long-Range Plans
  - Access Management Policy
  - Roundabout First Policy
- Incorporate HSM into Corridor Planning
  - Frequency of intersections
  - Frequency of driveways
  - Parking
  - Median types

Applying the HSM in Pre-design and Scoping

- Project scoping
  - Safety of project design alternatives
  - Component of project prioritization
- Environmental Analysis
  - Evaluate alternatives

Applying the HSM in Design & Construction

- Design Alternatives
  - Geometric parameters such as lane or shoulder width, rumble strips
  - Design exceptions
  - Design criteria
  - Time duration of work zones

Applying the HSM in Operations

- Performance measures
  - Safety performance evaluation
- Operations
  - Before/after studies
  - Operational strategies such as signal timing, signal phasing, or roundabouts versus signals

Crash Modification Factor (CMF)

$$CMF = \frac{\text{EXPECTED CRASHES WITH TREATMENT}}{\text{EXPECTED CRASHES WITHOUT TREATMENT}}$$

CMF = 1.0	Expected to have no impact on safety
CMF < 1.0	Expected to reduce crashes
CMF > 1.0	Expected to increase crashes

$$CRF = (1 - CMF) * 100$$

10.1 crashes / year x 0.91 (CMF) x 1.04 (CMF) =	9.6 crashes / year: a reduction of 0.5 total crashes per year and a CRF of 5%

CMF Application

- CMFs from HSM Part D, FHWA CMF Clearinghouse (4 stars or above)
- CMF selected must match project
  - Situational – area type, time of day
  - Geometrics – number of lanes, driveway density
  - Operational – ADT, crash history
- Applying multiple CMFs must be used cautiously

Why Not Use Just Historical Crash Data?

- Variation in short term crash data

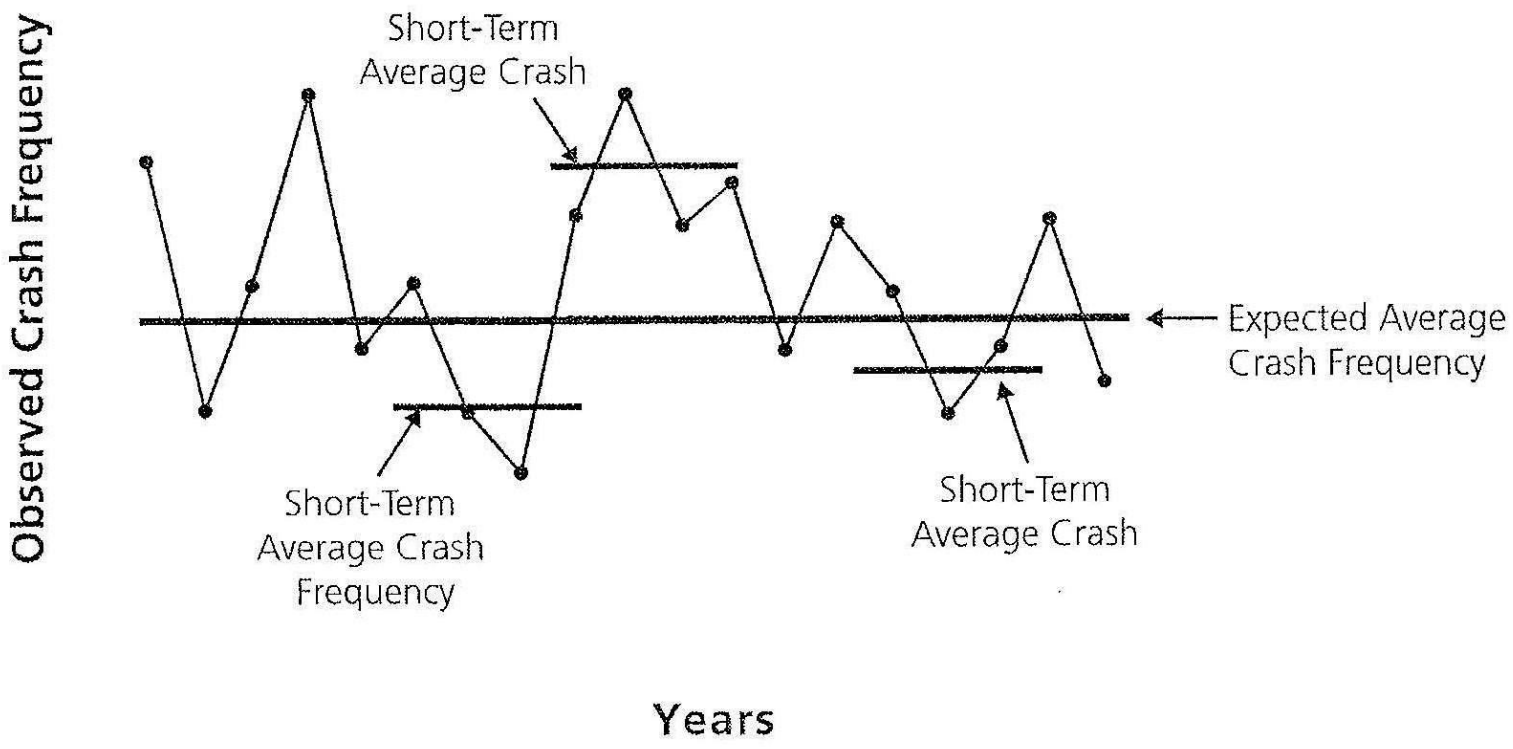


Figure 3-4. Variation in Short-Term Observed Crash Frequency

Why Not Use Just Historical Crash Data?

- Regression-to-the-mean

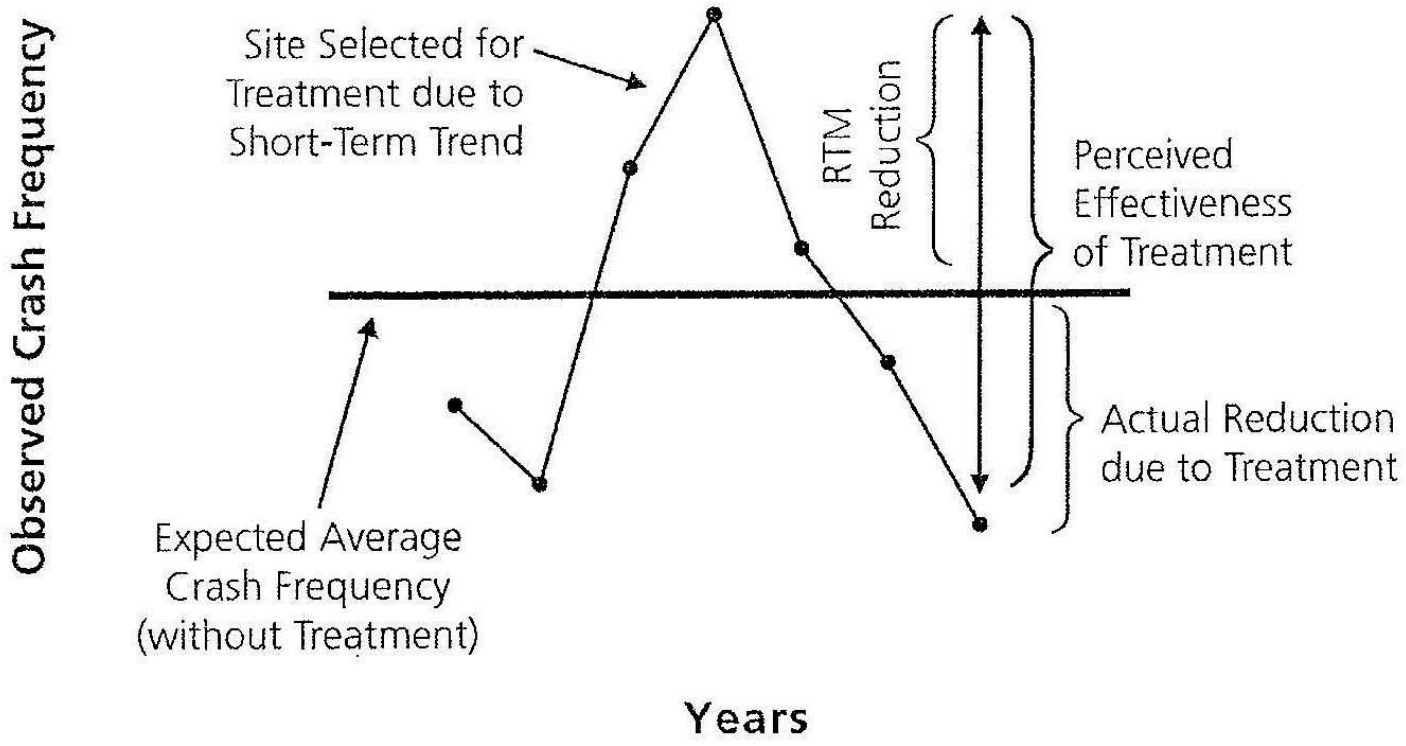
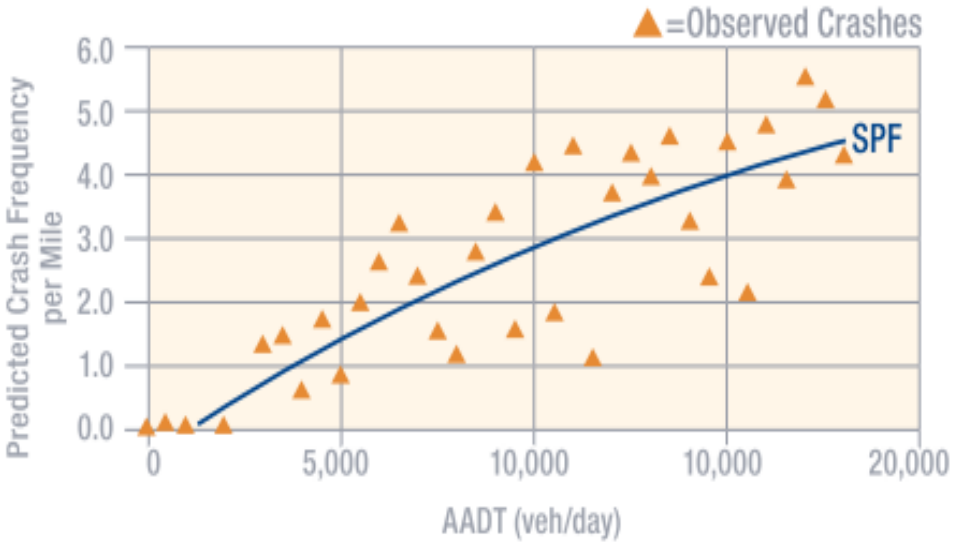


Figure 3-5. Regression-to-the-Mean (RTM) and RTM Bias

Predictive Method

SAFETY PERFORMANCE FUNCTION (SPF)



Predictive Method

SPF CRASH MODIFICATION FACTOR

The crash predictions are calculated based on the particular roadway conditions for a homogenous site/segments specified by a SPF. These SPFs have particular CMFs associated with their development and are included in the HSM for that particular roadway type. All of the CMFs associated with a SPF in the HSM may be applied to the crash reduction calculations, unlike the CMF method, which is limited to three.

- $\text{CMF} = \dfrac{\text{Expected crashes with treatment}}{\text{Expected crashes without treatment}}$
- CMF = 1.0 = Expected to have no impact on safety
- CMF < 1.0 = Expected to reduce crashes
- CMF > 1.0 = Expected to increase crashes

Predictive Method

CALIBRATION FACTOR

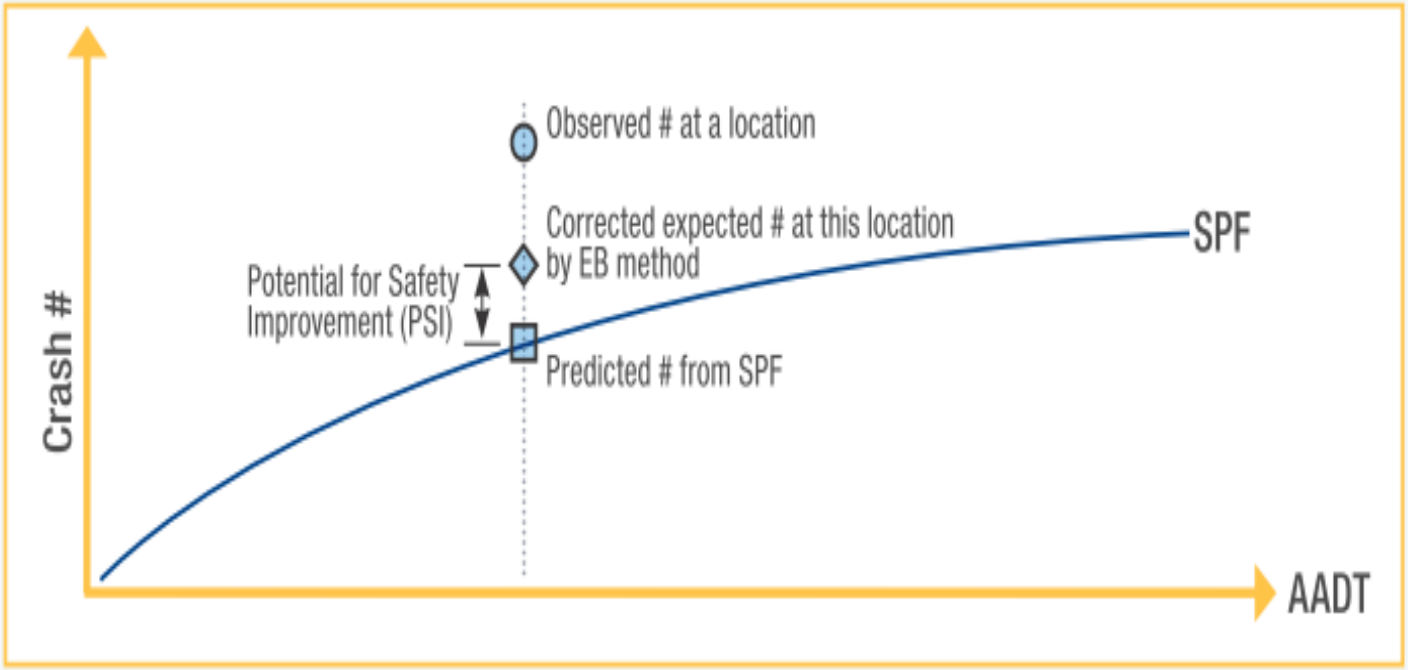
A **calibration factor (C)** is applied to adjust the estimated crashes from national data to local conditions by comparing observed crashes for 30 to 50 local sites and the crashes predicted from the national data. Available calibration factors that are to be used will be listed on NDOT's PSP website and do not need to be calculated on a project basis. If a calibration factor is not available for specific SPF on the NDOT PSP website, a calibration factor of 1 should be used.

$$C = \frac{\sum \text{Observed Crashes (all sites)}}{\sum \text{Predicted Crashes (all sites)}}$$

Predictive Method

EMPIRICAL BAYS WEIGHTING

The estimated crashes are further refined through a weighting process using the Empirical Bayes (EB) method.



Predictive Method

- Sample results table

Predictive Method results table:

	Annual Crashes	Annual Crash Reduction	CRF
Existing Condition	100	--	--
Project Alternative A	95	5	5%
Project Alternative B	90	10	10%

Benefit-Cost Ratio

$$BCR = \frac{PV_{BENEFITS}}{PV_{COSTS}}$$

$PV_{BENEFITS}$ = Present value of project benefits
PV_{COSTS} = Present value of project costs

Fatal	$5,339,711
Injury A	$285,349
Injury B	$104,302
Injury C	$59,037
PDO	$9,638

Benefit-Cost Ratio Sample Table

	Alt. 1	Alt. 2	Alt. 3
	CL Rumble Strip	RSA Curve at MP 9	Superelevation Improvements
Total Alternative Cost	$65,693	$1,474,704	$945,031
Total Annual Benefit Including 2% Growth Per Year	$270,273	$228,808	$52,956
Total Annualized Cost	$9,518	$106,429	$69,998
Benefit-Cost Ratio	28.40	2.15	0.76
Average Annual Net Return	$260,755	$122,380	($17,043)

HSM Tools

HSM Part	Supporting Tool
Part B: Roadway Safety Management Process	SafetyAnalyst www.safetyanalyst.org
Part C: Predictive Method	IHSDM www.ihsdm.org
Part D: Crash Modification Factors	FHWA CMF Clearinghouse www.cmfclearinghouse.com

- NCHRP 1738 Spreadsheets
  - Publicly available spreadsheets for Part C

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