Incorporating Data-Driven Safety Analysis in Traffic Impact Analysis

2020 ITE Western & Mountain District Meeting

July 1, 2020





VIRTUAL
2020 Annual Meeting
Joint Western & Mountain Districts

Broadcast to you June 28 - July 1

'O kākou ka 'oi
"Together we are the best"

Jerry Roche, P.E.
U.S. Department of Transportation
Federal Highway Administration

What is Data-Driven Safety Analysis?

- The application of the latest **evidence-based** tools and approaches to safety analysis
- Provides reliable **estimates** of an **existing or proposed** roadway's **expected safety performance**

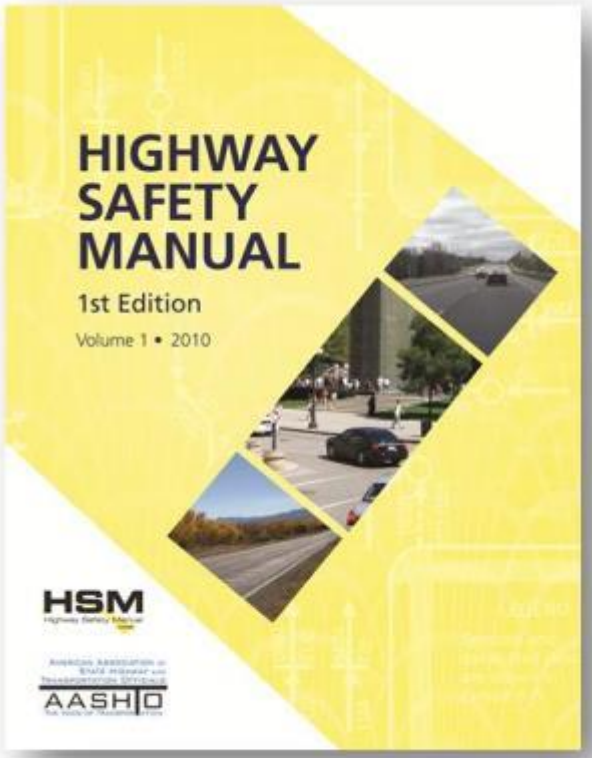
Source: Microsoft Clipart

- Helps agencies **quantify** the **safety impacts** of **transportation decisions**, similar to the way agencies quantify:
  - traffic growth
  - environmental impacts
  - pavement life
  - construction costs
  - traffic operations

Vision for DDSA

Future **safety performance** is considered in **ALL** transportation investment decisions

Foundational DDSA Methods:
the AASHTO Highway Safety Manual, first edition



Source: AASHTO

2010 Release:

- Rural Two-Lane Roads
- Multilane Rural Highways
- Urban/Suburban Arterials

2014 Supplement:

- Freeway Segments
- Ramps
- Ramp Terminals

New Research for HSM 2nd Ed:

- E.g. 6-lane urban arterials, All Way Stop intersections, Roundabouts, SPUIs

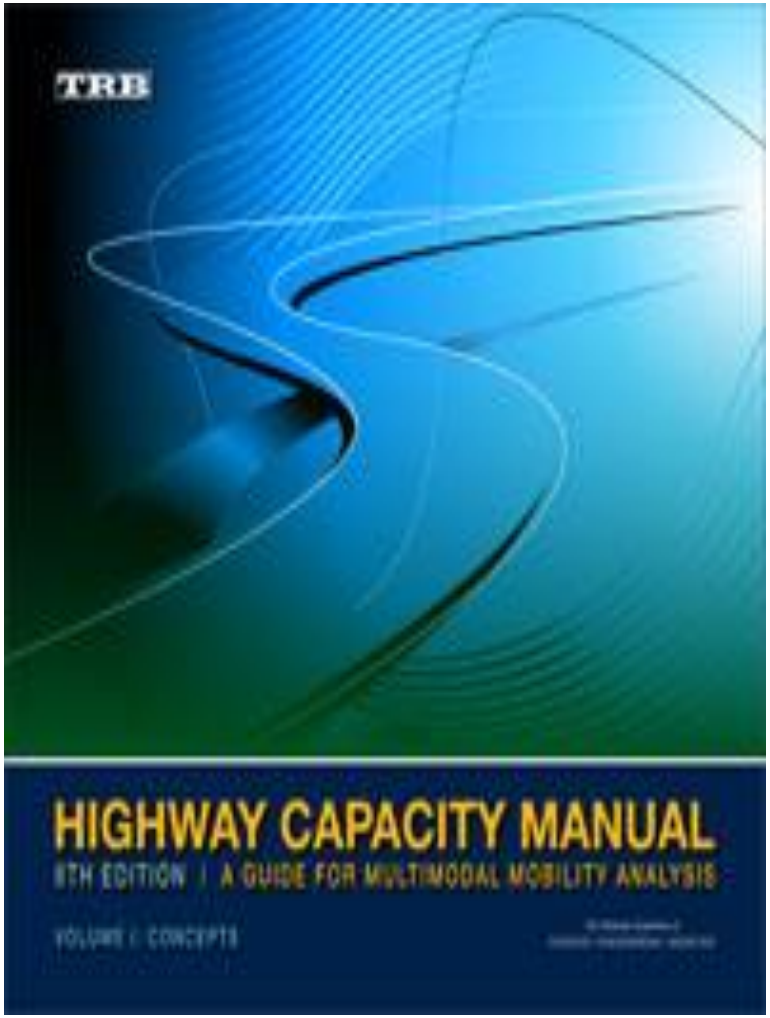
The Vision for the HSM

A Document Akin To the HCM…

1. Definitive; represents quantitative 'state-of-the-art' information

2. Widely accepted within professional practice of transportation engineering

3. Science-based; updated regularly to reflect research



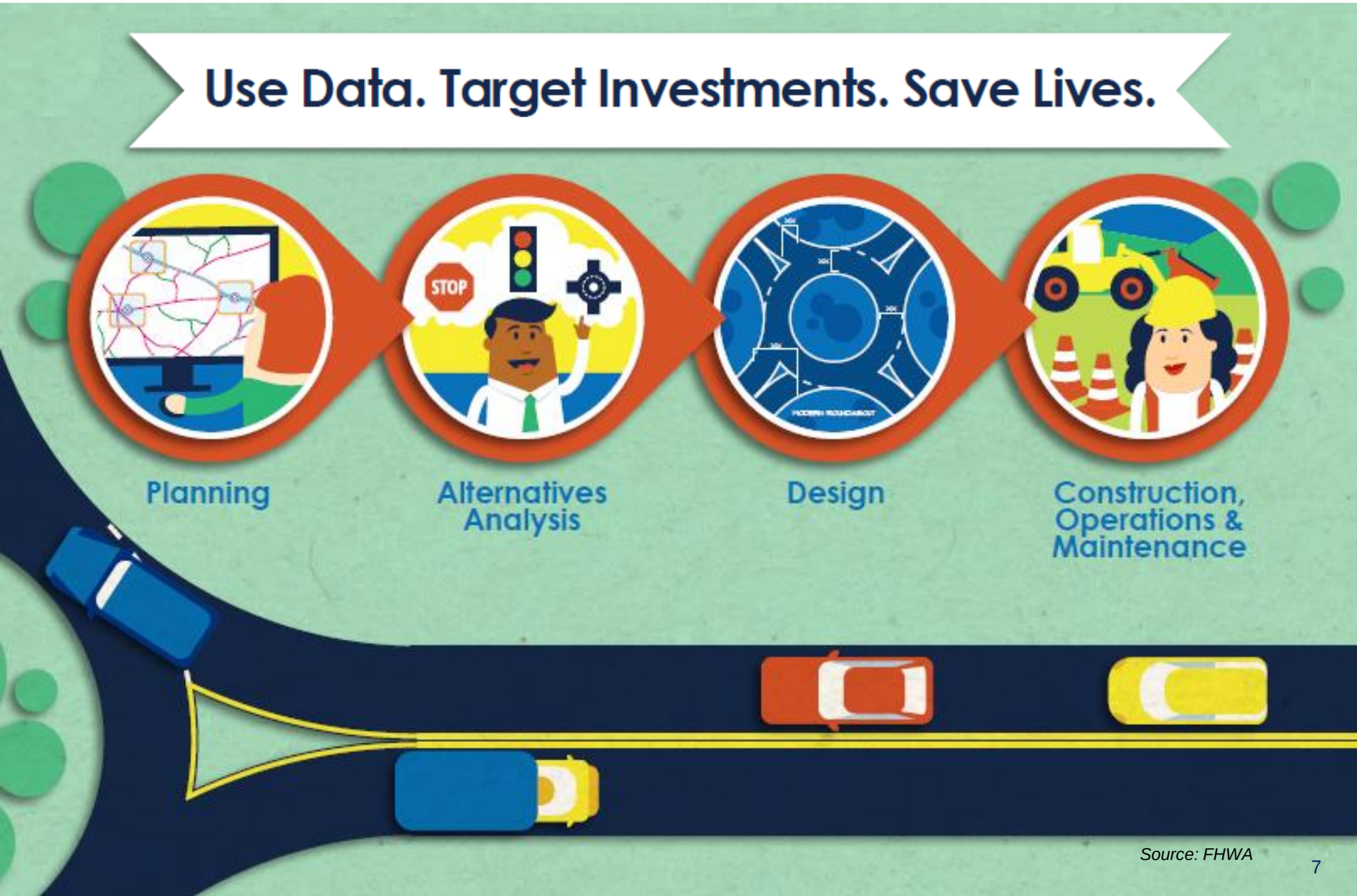
Source: Transportation Research Board

The HSM has resulted in the development of:

- Spreadsheets
- Software Products
- Guidance Documents
- Crash Modification Factors Clearinghouse

Source: AASHTO, AASHTOWare, Roadway Safety Foundation

DDSA throughout the Project Development Process



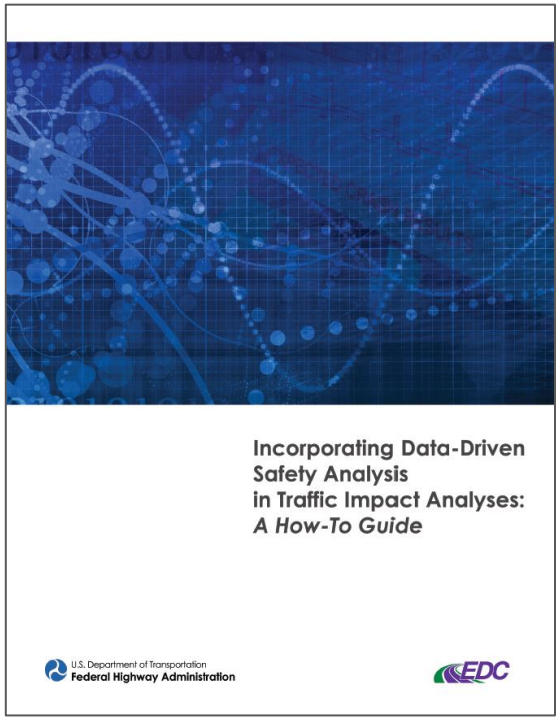
Source: FHWA

DDSA How-To Guides

A series of instructional guides illustrating how Data-Driven Safety Analysis can be incorporated and applied in common transportation tasks and processes, with the goal of helping agencies assess future safety performance and make more-informed decisions.

Incorporating DDSA in:

- Traffic Impact Analyses (link)
- Intersection Control Evaluation
- Road Diets (Reconfiguration)
- Site-specific Curve Improvements
- Systemic Curve Improvements
- Lane/Shoulder Allocation



https://safety.fhwa.dot.gov/rsdp/resources.aspx

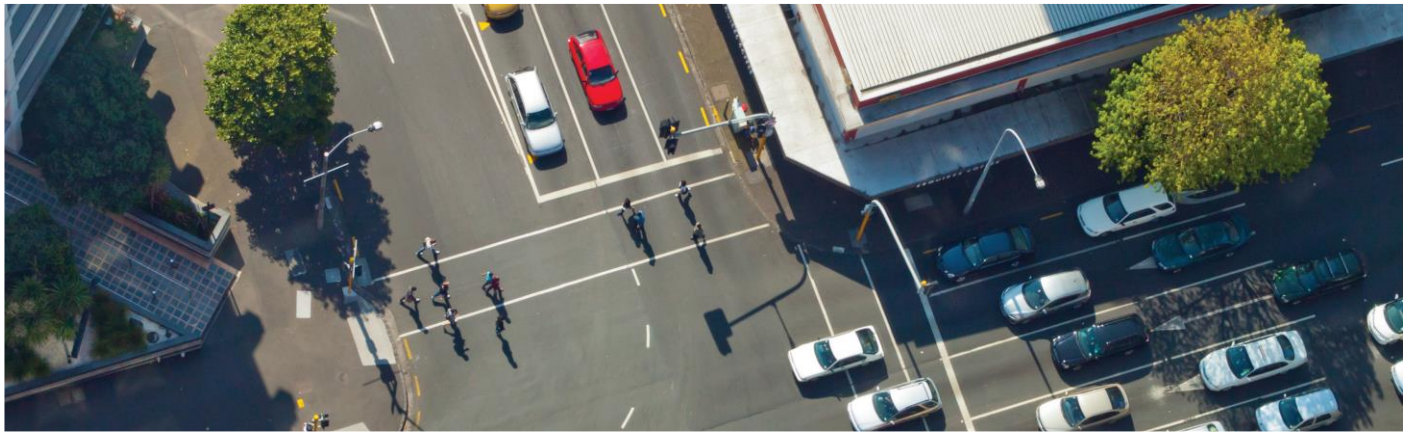
Traffic Impact Analyses

- Engineering Studies that estimate the impacts of a proposed traffic generator on the transportation system

- Traditionally focused on capacity and operational aspects of increased traffic volume
  - Assumed improvements to address operational impacts *would also provide safety benefits*

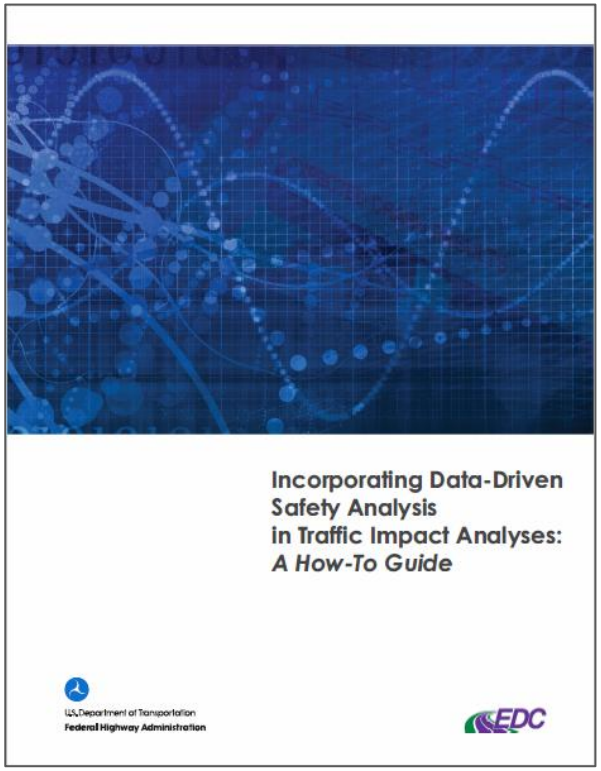
The almighty peak periods…

Oftentimes, operational analysis focuses on an hour, or even fraction of an hour…



What is operationally better for peak-period operations is not necessarily what is best for safety under the full range of conditions…

Incorporating DDSA in Traffic Impact Analyses



Proposed Development

- Identify the Study Area
- Develop the Site Plan
- **Develop Ingress/Egress Conceptual Plan**
- On-Site/Off-Site Land Use

Existing Conditions

- Document Physical Characteristics
- Collect Traffic Volumes and Non-motorized Data
- **Identify and Obtain Safety Data**
- **Evaluate Pedestrian and Bicycle Accommodations**
- **Summarize Data and Identify Safety Issues**
- Perform Capacity/Queueing Analyses for Existing Conditions

Projected Growth

- Background Traffic Forecasting
- On-Site and Off-Site Development Traffic Forecasting
- Build and No-Build Conditions Total Traffic

Traffic Analysis

- **Develop Preliminary Alternatives**
- Evaluate Site Access
- Perform Capacity/Queueing Analysis
- Traffic Control/Geometric Consideration
- **Perform Safety Analysis of Each Preliminary Alternative**
- **Compare Alternatives and Make Recommendations**

Benefits of incorporating DDSA into TIAs

- Identify existing safety issues
- Identify future safety issues in advance
- Reduced delay caused by crashes
- Improved pedestrian accommodation
- Improved ingress/egress

Example: Proposed new development

- **Pharmacy with a drive-thru**

Trip Generation Calculation for AM and PM peak hour trips			
Proposed Development	**Gross Trips**	**Pass-By Capture**	**Net New Trips**
Pharmacy with Drive-Through	46 (24 in/22 out)	49.0%	23 (12 in/11 out)
	123 (62 in/61 out)		63 (32 in/31 out)
AM peak hour; PM peak hour			

Tool: ITE Trip Generation report, 9th Edition

Trip Distribution and Volume Forecasting

Figure 7: Trip and Pass by Assignment

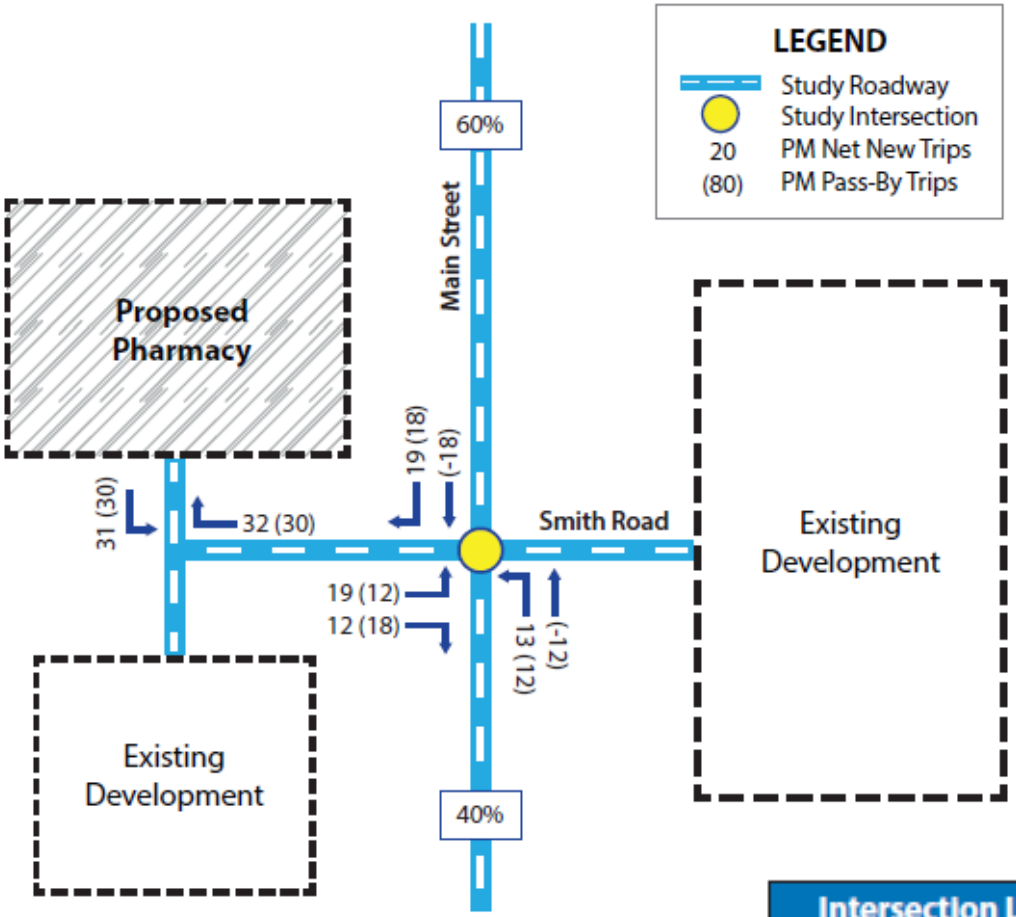
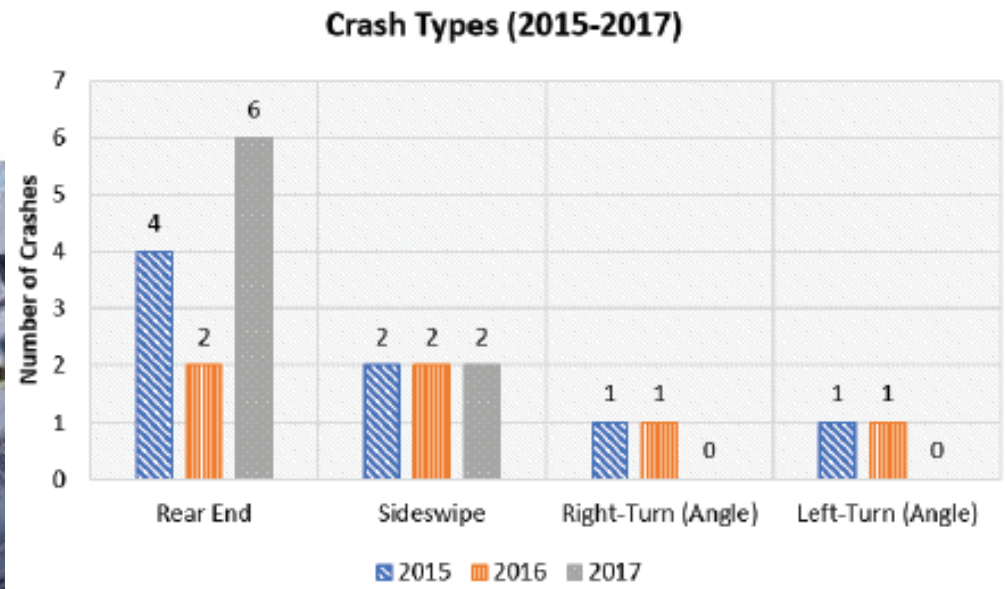


Table 2: *Peak Period Pedestrian Counts*

Intersection Leg	AM Peak Period	PM Peak Period
North	10	13
South	9	11
East	13	16
West	11	12

Summarize and Visualize Crash Data



Operational Analysis: Existing & Future No-Build

Table 3: Intersection Capacity Analysis (Existing Conditions)

Year 2018 Delay (LOS)	Existing Conditions				
Peak Hour	EB	WB	NB	SB	Overall
AM Peak Hour – Average Control Delay in Seconds/ Vehicle (LOS)	48.5 (D)	52.9 (D)	5.0 (A)	4.9 (A)	7.4 (A)
PM Peak Hour – Average Control Delay in Seconds/ Vehicle (LOS)	35.6 (D)	54.9 (D)	13.6 (B)	13.4 (B)	16.7 (B)

Table 4: Intersection Capacity Analysis (Future Background)

Year 2020 Delay (LOS)	No-Build Conditions				
Peak Hour	EB	WB	NB	SB	Overall
AM Peak Hour – Average Control Delay in Seconds/ Vehicle (LOS)	47.3 (D)	52.4 (D)	5.7 (A)	5.5 (A)	8.0 (A)
PM Peak Hour – Average Control Delay in Seconds/ Vehicle (LOS)	35.5 (D)	60.9 (E)	14.1 (B)	14.0 (B)	17.6 (B)

Tool: TRB Highway Capacity Manual, 6th Edition

Develop Preliminary Alternatives

Alternative 1:

- Install retroreflective backplates
- Install ped facilities (curb ramps, crosswalk, ped signals) on north and south legs
- Optimize signal timings

Alternative 2:

- Install retroreflective backplates
- Install ped facilities (curb ramps, crosswalk, ped signals) on north and south legs
- Optimize signal timings
- Install SB Right-Turn Lane
- Change EB/WB lanes from shared left/thru lane + right lane to left lane + shared thru/right lane
- Change EB/WB left turn signal phase from permitted to protected-permitted

Operational Analysis: Alternatives 1 & 2

Table 5: Alternative 1 and 2 Intersection Capacity Analysis (2020 Total Conditions)

Year 2020 Delay (LOS)	Alternative 1					Alternative 2				
Peak Hour	EB	WB	NB	SB	Overall	EB	WB	NB	SB	Overall
AM Peak Hour – Average Control Delay in Seconds/Vehicle (LOS)	45.1 (D)	48.6 (D)	8.2 (A)	8.5 (A)	10.9 (B)	62.2 (E)	56.5 (E)	4.0 (A)	4.0 (A)	7.8 (A)
PM Peak Hour – Average Control Delay in Seconds/Vehicle (LOS)	56.0 (E)	50.2 (D)	18.1 (B)	19.5 (B)	23.0 (C)	58.6 (E)	57.0 (E)	5.5 (A)	5.6 (A)	12.0 (B)

Tool: TRB Highway Capacity Manual, 6th Edition

Predictive Safety Analysis

- HSM Part C (predictive method)
  - Spreadsheet developed under NCHRP 17-38
  - FHWA Interactive Highway Safety Design Model
- HSM Part D (Crash Modification Factors)
  - FHWA CMF Clearinghouse

FREE Tools available at :

http://www.highwaysafetymanual.org/Pages/Tools.aspx

IHSDM Results

Alternative	2020 through 2040 Total Crash Frequency
Future No Build (with background growth and NO site traffic	112.3 (84.58 – PDO; 27.72 – FI)
Future Build (with site-related traffic)	129.91 (98.21 – PDO; 31.70 – FI)
Future Build (with site-related traffic and Alternative 1 improvements)	129.91 (98.21 – PDO; 31.70 – FI)
Future Build (with site-related traffic and Alternative 2 improvements)	119.66 (91.31 – PDO; 28.35 – FI)

**Future Build (with site-related traffic) and Future Build (with site-related traffic and Alternative 1 improvements) are expected to have the same total crash frequency because neither option includes geometric changes. The crash frequency for Alternative 1 will change after the application of CMFs, which is shown below*

IHSDM
Interactive Highway Safety Design Model

Tool: FHWA IHSDM, www.ihsdm.org

Application of additional CMFs

Table 7: Proposed Intersection Modifications and CMFs

Countermeasure	CMF Description	CMF ID & CMF Value	Clearinghouse Quality Level	Crash Applicability Description	Included In the Analysis?
Installation of cross-walk	"Install High-Visibility Crosswalk"	CMF ID: 4123 0.60	2 stars	Vehicle/Pedestrian Crashes	No
Install pedestrian countdown timer	"Install Pedestrian Countdown Timer"	CMF ID: 8790 0.912	3 stars	All crashes at the inter-section	Yes
Add retroreflective backplates	"3-inch yellow retro-reflective sheeting to signal backplates"	CMF ID: 1410 0.85	4 stars	All crashes at the inter-section	Yes
Optimize Signals	CMF does not exist	N/A	N/A	N/A	No

Source: FHWA CMF Clearinghouse

Table 8: Composite CMF and Applicable Crashes

Countermeasure	Crash Modification Factor	Applicable Crash Percentage
Install pedestrian countdown timer + install retrore-flective backplates	0.78[1]	100% of crashes

Crash Reduction from ped countdown timers + retro backplates = 22%

Tool: FHWA CMF Clearinghouse, http://www.cmfclearinghouse.org/

Crash Reduction Results

Table 9: Crash Reduction Results with Predictive Method and CMF Application

Alternative	20-Year IHSDM Crash Frequency (From Table 7)	Composite Crash Modification Factor	Applicable Crashes (%)	Total Crash Frequency with CMF (20 Years)	Total Crash Reduction (Count, 20 Years)	Total Crash Reduction (Percentage, 20 Years)
Future Build (with site-related traffic	129.91 (98.21 – PDO; 31.70 – FI)	N/A	N/A	N/A	N/A	0%
Future Build (with site-related traffic and Alternative 1 improvements)	129.91 (98.21 – PDO; 31.70 – FI)	0.78	100%	101.3 (76.6 – PDO; 24.7 – FI)	28.6 (21.6 – PDO; 7.0 – FI)	22.0%
Future Build (with site-related traffic and Alternative 2 improvements)	119.66 (91.31 – PDO; 28.35 – FI)	0.78	100%	93.3 (71.2 – PDO; 22.1 – FI)	36.6 (27.0 – PDO; 9.6 – FI)	28.2%

Benefit-Cost Analysis

Table 10: Comprehensive Crash-Level Costs

Severity	Comprehensive Crash-Level Cost (2016 dollars)
K	$11,295,400
A	$655,000
B	$198,500
C	$125,600
O	$11,900

Source: FHWA Crash Costs for Highway Safety Analysis
https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf

Table 11: Benefit-Cost Analysis Comparing Alternative 1 and Alternative 2 to the Future No-Build alternative

Alternative	Total Crash Reduction Difference	Present Value of Crash Cost Savings (20 Years)	Total Estimated Costs	Benefit-Cost Ratio
Alternative 1	24.7 (18.6 – PDO; 6.1 – FI)	$1,754,704	$115,000	15.3
Alternative 2	31.2 (22.9 – PDO; 8.3 – FI)	$2,370,463	$150,000	15.8

Mahalo!

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*FHWA cites specific tools as examples of ways to implement safety analysis approaches, not as an endorsement of these tools over others.