HSM PREDICTIVE METHODS IN PRELIMINARY ENGINEERING

2017 ILLINOIS THE CONFERENCE

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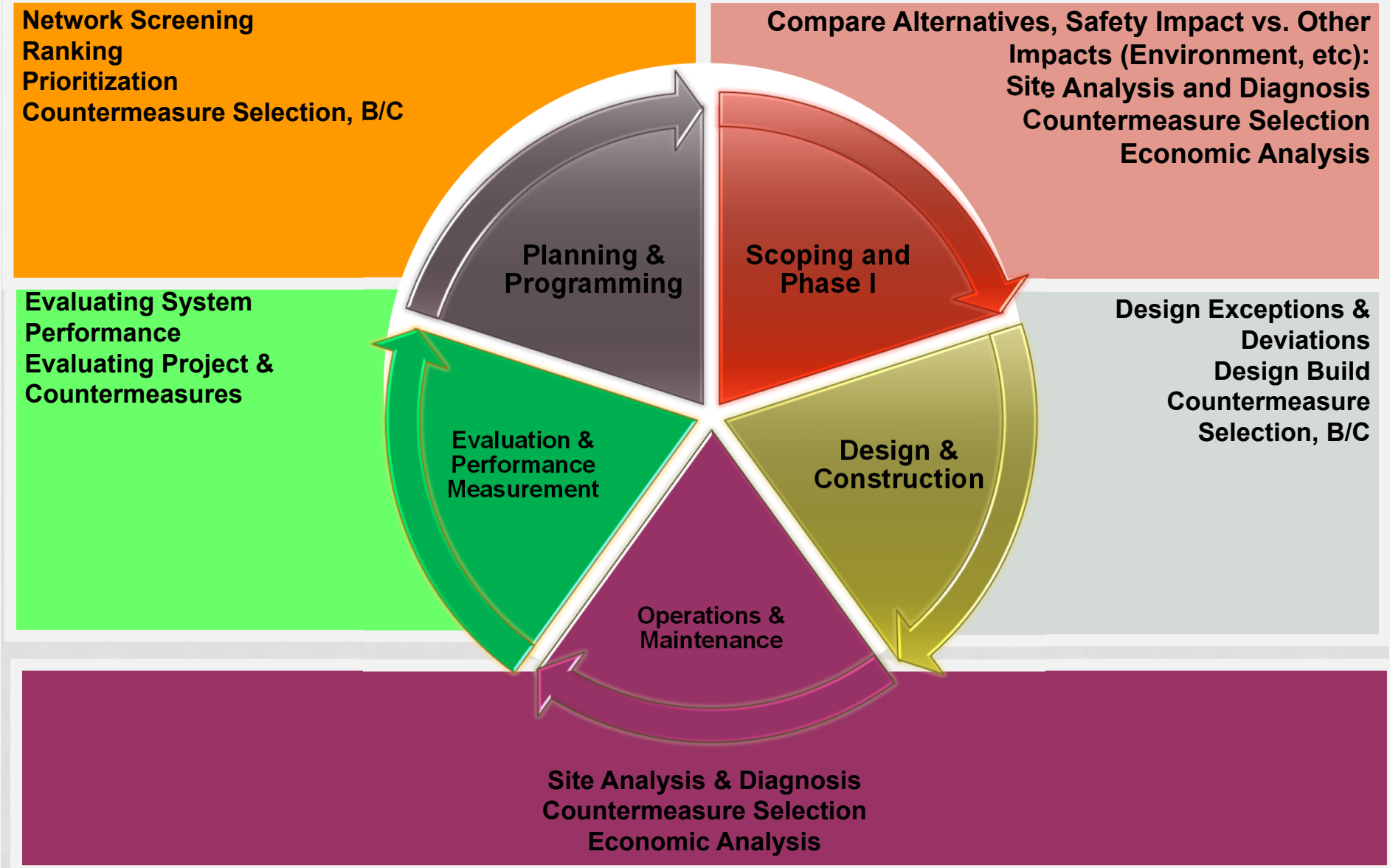
OUTLINE

- Safety & Transportation Management Process
- What is HSM?
- Illinois HSM Predictive Tool
- Phase 1 Examples
  - US 20 at Marengo Beck Road
  - IL Route 47 in Woodstock

SAFETY & TRANSPORTATION MANAGEMENT PROCESS



ADVANCEMENT IN SAFETY KNOWLEDGE

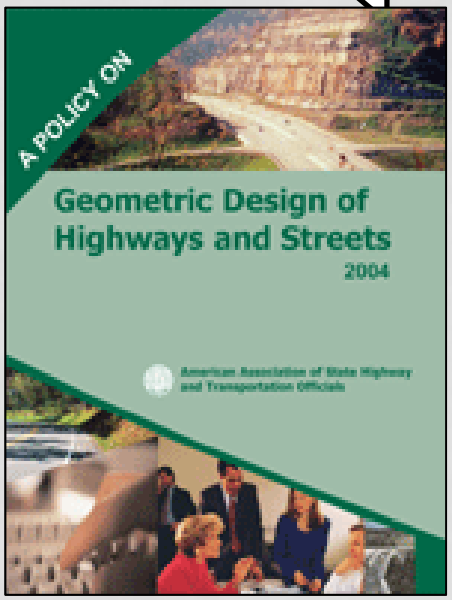
Policies, Guidelines, Best Practices, Research

Objective Predictions

THE HSM IS A TOOL TO CHANGE HOW WE CONSIDER SAFETY

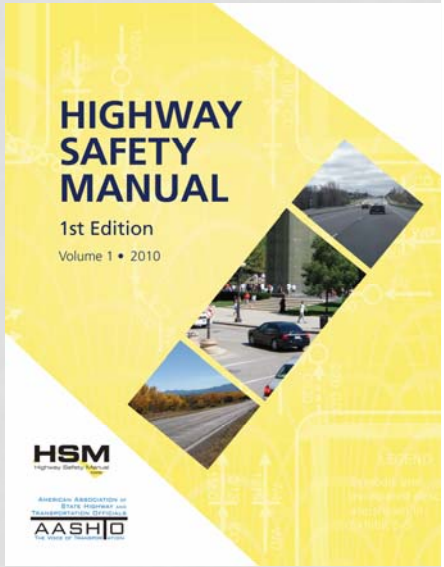
Nominal Safety

Substantive Safety



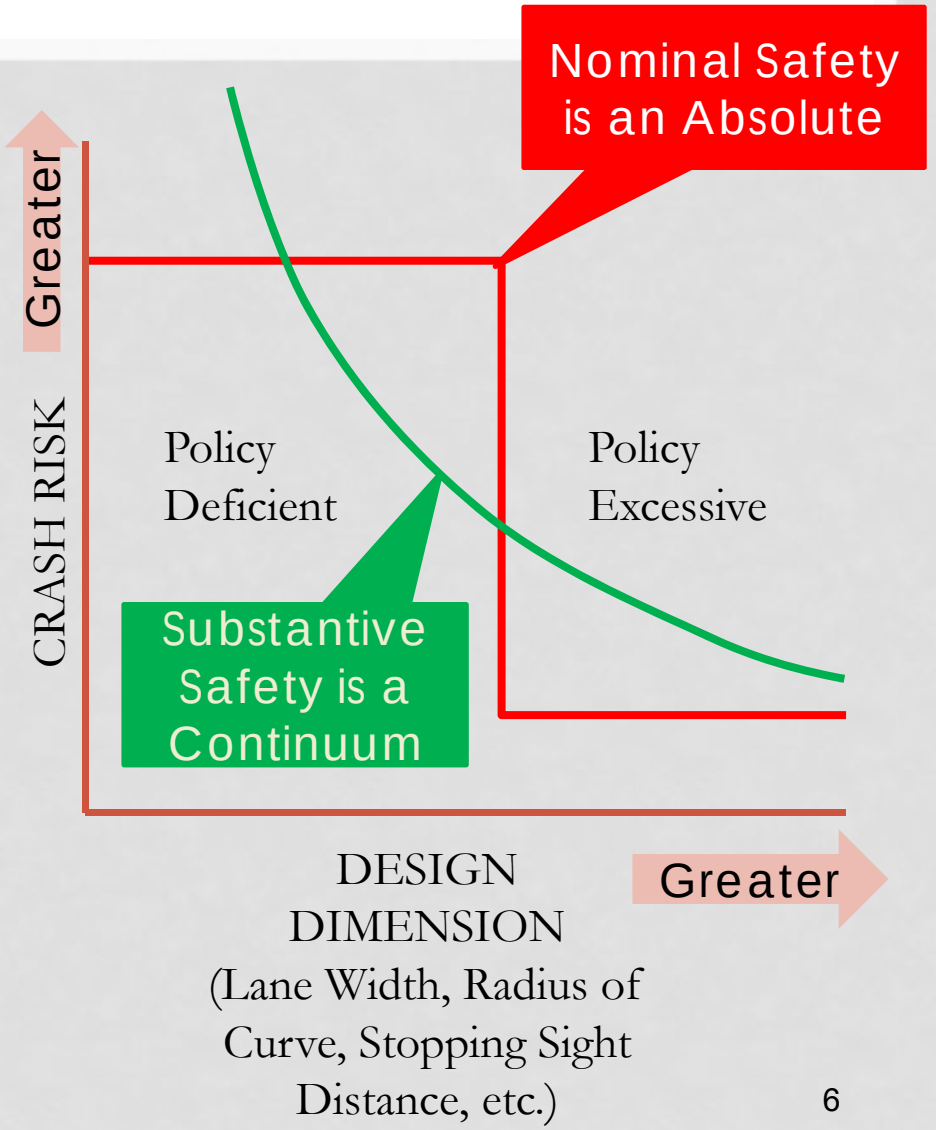
Examined in reference to <u>compliance with standards, warrants, guidelines</u> and sanctioned design procedures

The <u>expected or actual crash frequency and severity</u> for a highway or roadway



NOMINAL VS. SUBSTANTIVE SAFETY

- Nominal safety is the use and adherence to engineering standards and practices
- Substantive safety is the performance of the street or highway as measured by frequency of traffic crashes and their outcomes (severity).



WHAT ARE BENEFITS OF USING HSM PREDICTIVE METHODS IN PLANNING?

- Improve Safety Outcomes
- Make Better Use of Limited Resources/Maximize Benefit
- Provide Objective Evaluation of Project Alternatives
  - Evaluate Effects of:
    - Minor Design Revisions/Enhancements
    - Potential Design Exceptions or Policy Variances
- Make Better Choices for Our Transportation Investments
- Stave Off Public/Political Pressure (When Not a "Good" Choice)

Part A

Introduction
Human Factors
Fundamentals

Part D

Crash Modification
Factors (CMFs)

Part B

Roadway Safety
Management
Process

Part C

Predictive Method

HSM PREDICTIVE METHODS

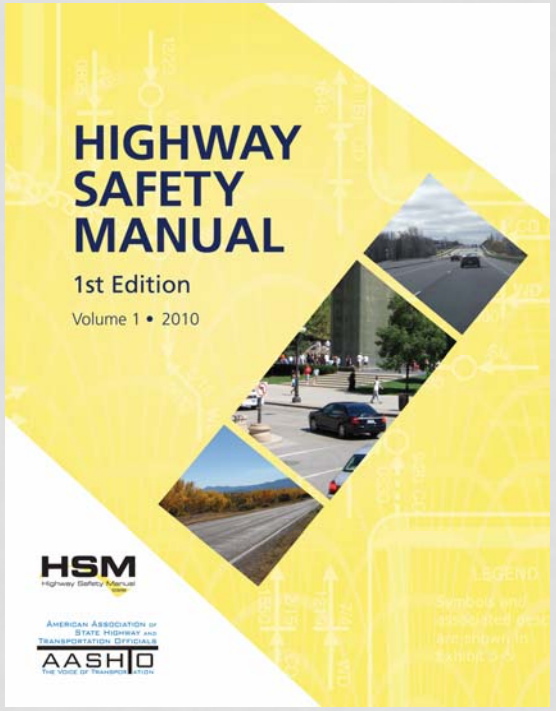
Part A

Part B

Part C

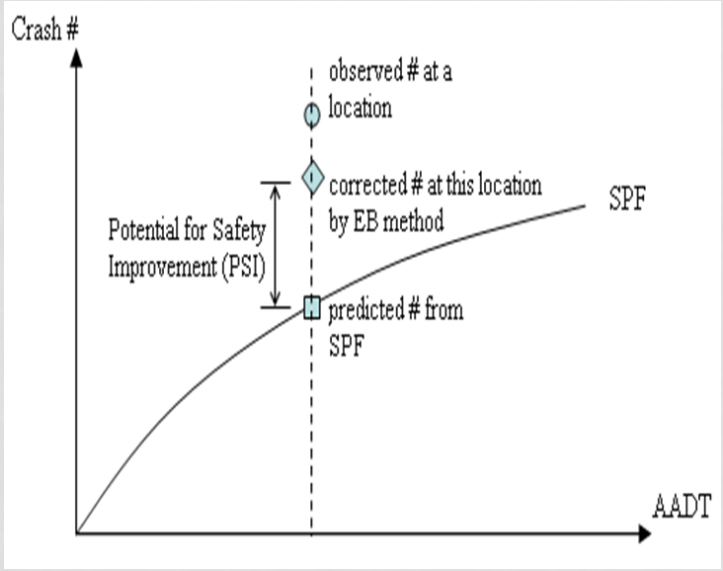
Part D

- Part C Methodology Includes:
  - Safety Performance Functions
  - Crash Modification Factors
  - Calibration Factor
- Applications
- Example Problems
- References

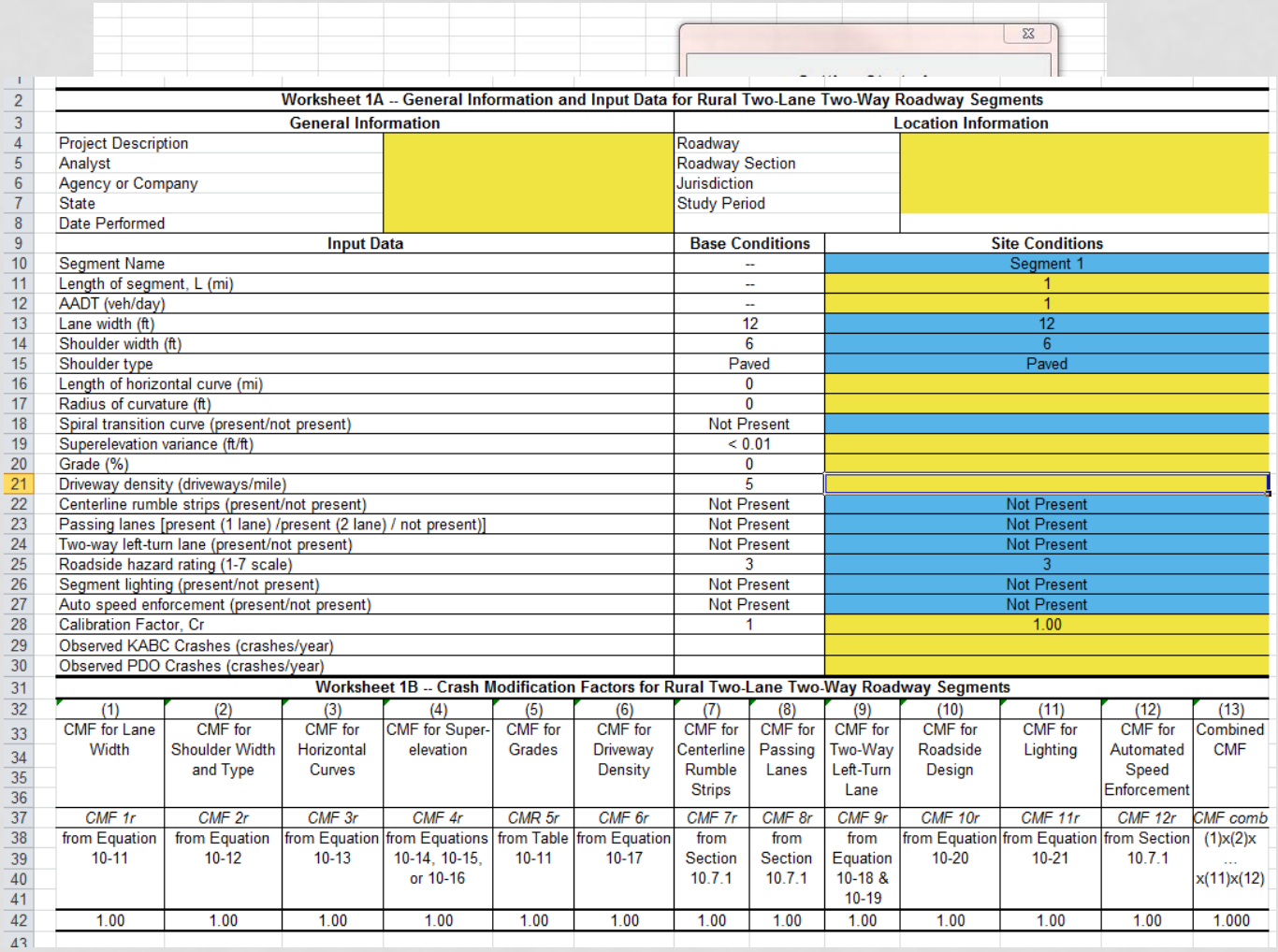


SAFETY PERFORMANCE FUNCTIONS & CALIBRATION

- Calibrated HSM Part C Models with Data from Illinois
  - This project developed the SPF Illinois calibration factors as well as the crash severity and collision type distribution tables specific to:
    - Chicago Metro Area (District 1)
    - Downstate (Districts 2-9)
- HSM Predictive Model User Guide
  - Includes Examples



HSM CRASH PREDICTION TOOL



Worksheet 1A -- General Information and Input Data for Rural Two-Lane Two-Way Roadway Segments

General Information		Location Information	
Project Description		Roadway	
Analyst		Roadway Section	
Agency or Company		Jurisdiction	
State		Study Period	
Date Performed			

Input Data	Base Conditions	Site Conditions
Segment Name	--	Segment 1
Length of segment, L (mi)	--	1
AADT (veh/day)	--	1
Lane width (ft)	12	12
Shoulder width (ft)	6	6
Shoulder type	Paved	Paved
Length of horizontal curve (mi)	0	
Radius of curvature (ft)	0	
Spiral transition curve (present/not present)	Not Present	
Superelevation variance (ft/ft)	< 0.01	
Grade (%)	0	
Driveway density (driveways/mile)	5	
Centerline rumble strips (present/not present)	Not Present	Not Present
Passing lanes [present (1 lane) /present (2 lane) / not present)]	Not Present	Not Present
Two-way left-turn lane (present/not present)	Not Present	Not Present
Roadside hazard rating (1-7 scale)	3	3
Segment lighting (present/not present)	Not Present	Not Present
Auto speed enforcement (present/not present)	Not Present	Not Present
Calibration Factor, Cr	1	1.00
Observed KABC Crashes (crashes/year)		
Observed PDO Crashes (crashes/year)		

Worksheet 1B -- Crash Modification Factors for Rural Two-Lane Two-Way Roadway Segments

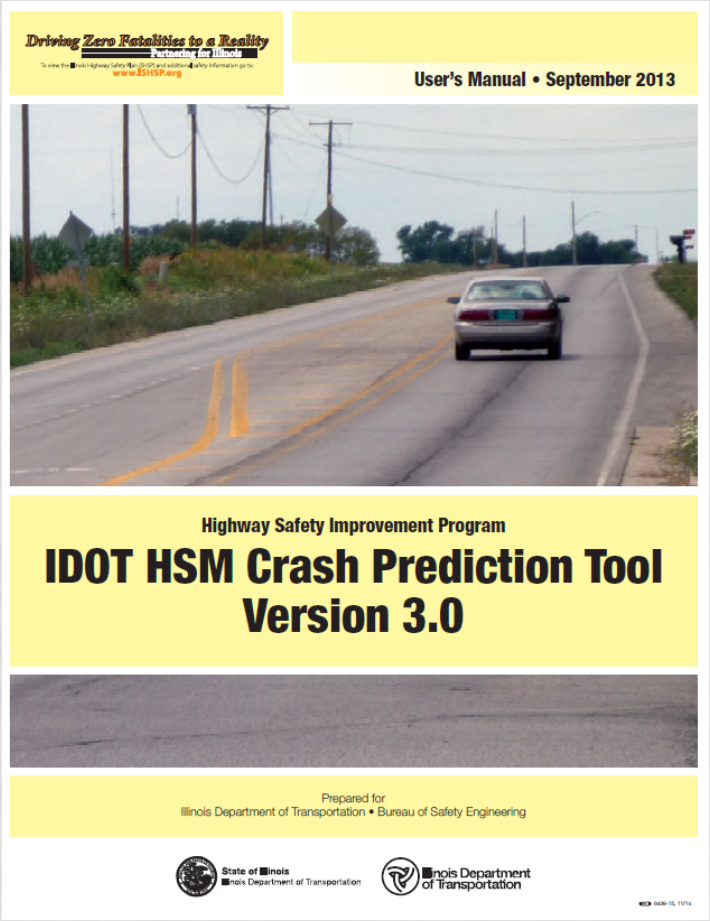
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
CMF for Lane Width	CMF for Shoulder Width and Type	CMF for Horizontal Curves	CMF for Super-elevation	CMF for Grades	CMF for Driveway Density	CMF for Centerline Rumble Strips	CMF for Passing Lanes	CMF for Two-Way Left-Turn Lane	CMF for Roadside Design	CMF for Lighting	CMF for Automated Speed Enforcement	Combined CMF
CMF 1r	*CMF 2r*	*CMF 3r*	*CMF 4r*	*CMR 5r*	*CMF 6r*	*CMF 7r*	*CMF 8r*	*CMF 9r*	*CMF 10r*	*CMF 11r*	*CMF 12r*	*CMF comb*
from Equation 10-11	from Equation 10-12	from Equation 10-13	from Equations 10-14, 10-15, or 10-16	from Table 10-11	from Equation 10-17	from Section 10.7.1	from Section 10.7.1	from Equation 10-18 & 10-19	from Equation 10-20	from Equation 10-21	from Section 10.7.1	(1)x(2)x ... x(11)x(12)
1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.000

IDOT HIGHWAY SAFETY MANUAL CRASH PREDICTION TOOL

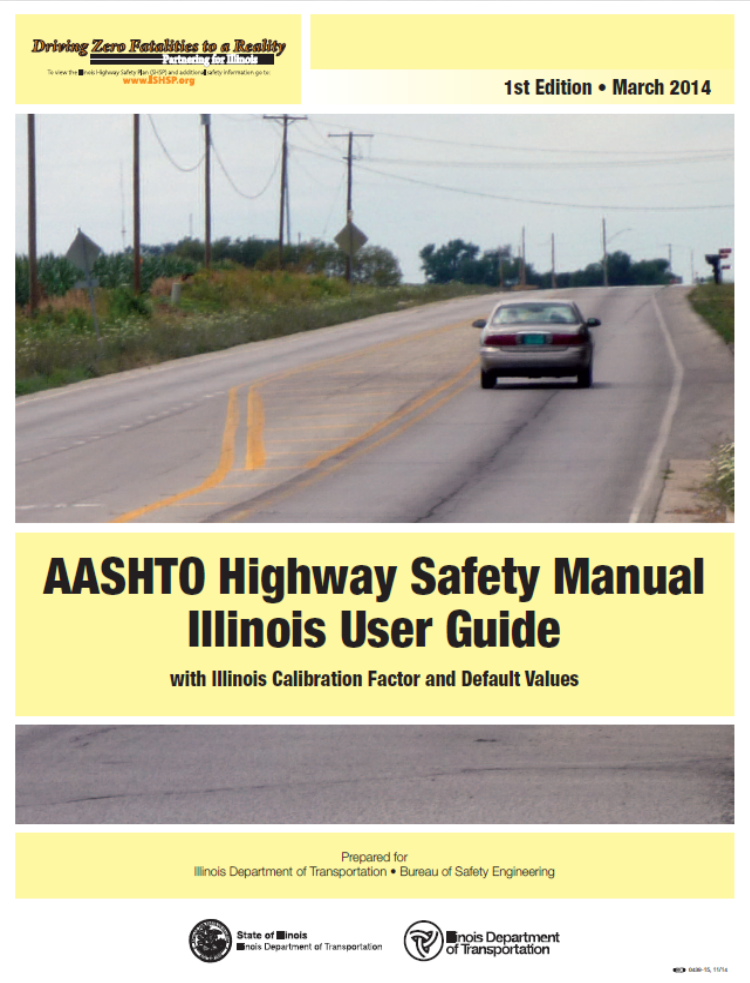
The tool was developed based on the NCHRP 17-38 excel spreadsheet and incorporates the SPF Illinois calibration factors, crash severity distribution tables and collision type distribution tables into the crash predictive models, including examples.

Illinois data used to develop calibration factors specific to:

* Chicago Metro Area (District 1)
* Downstate (Districts 2-9)



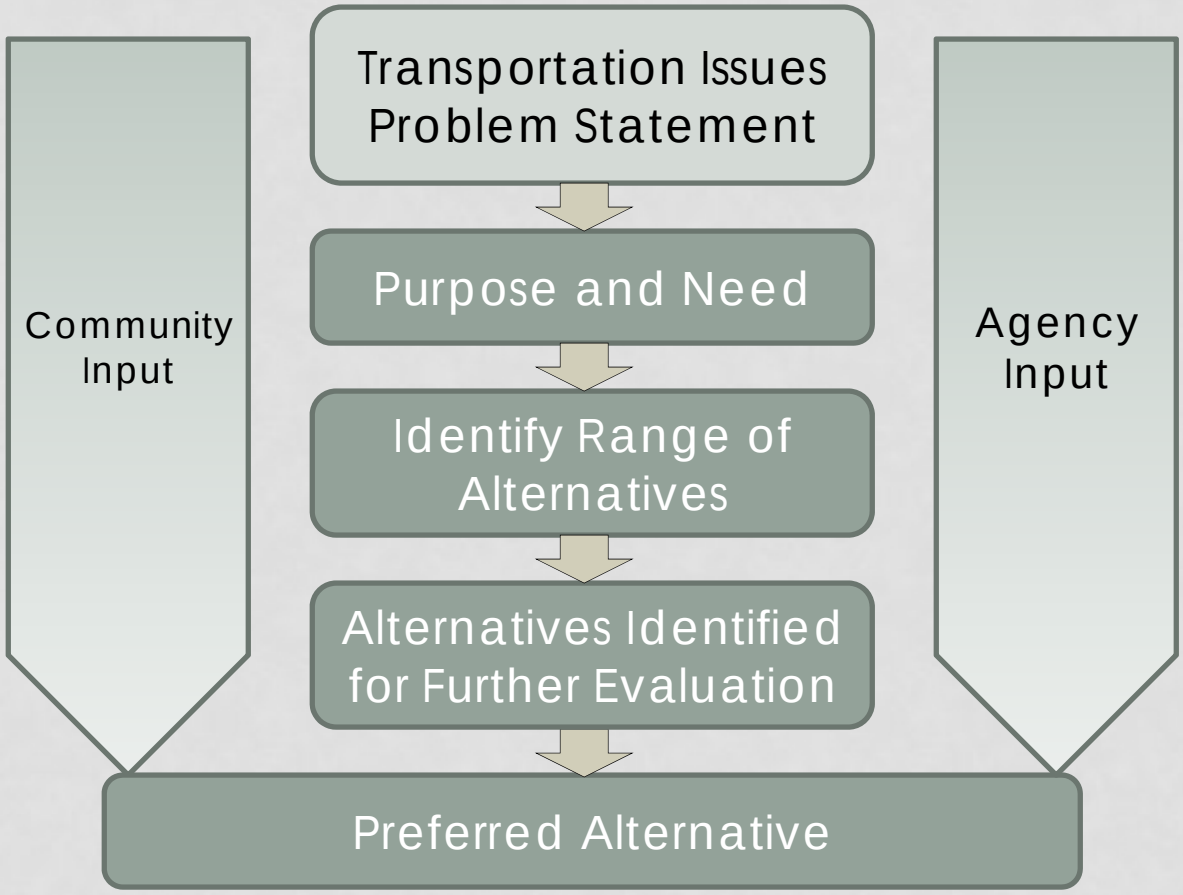
AASHTO HIGHWAY SAFETY MANUAL ILLINOIS USER GUIDE



This guide provides step-by-step procedure for applying the HSM Part C crash predictive models for safety analysis in Illinois.

* Includes Examples

PHASE I PROCESS

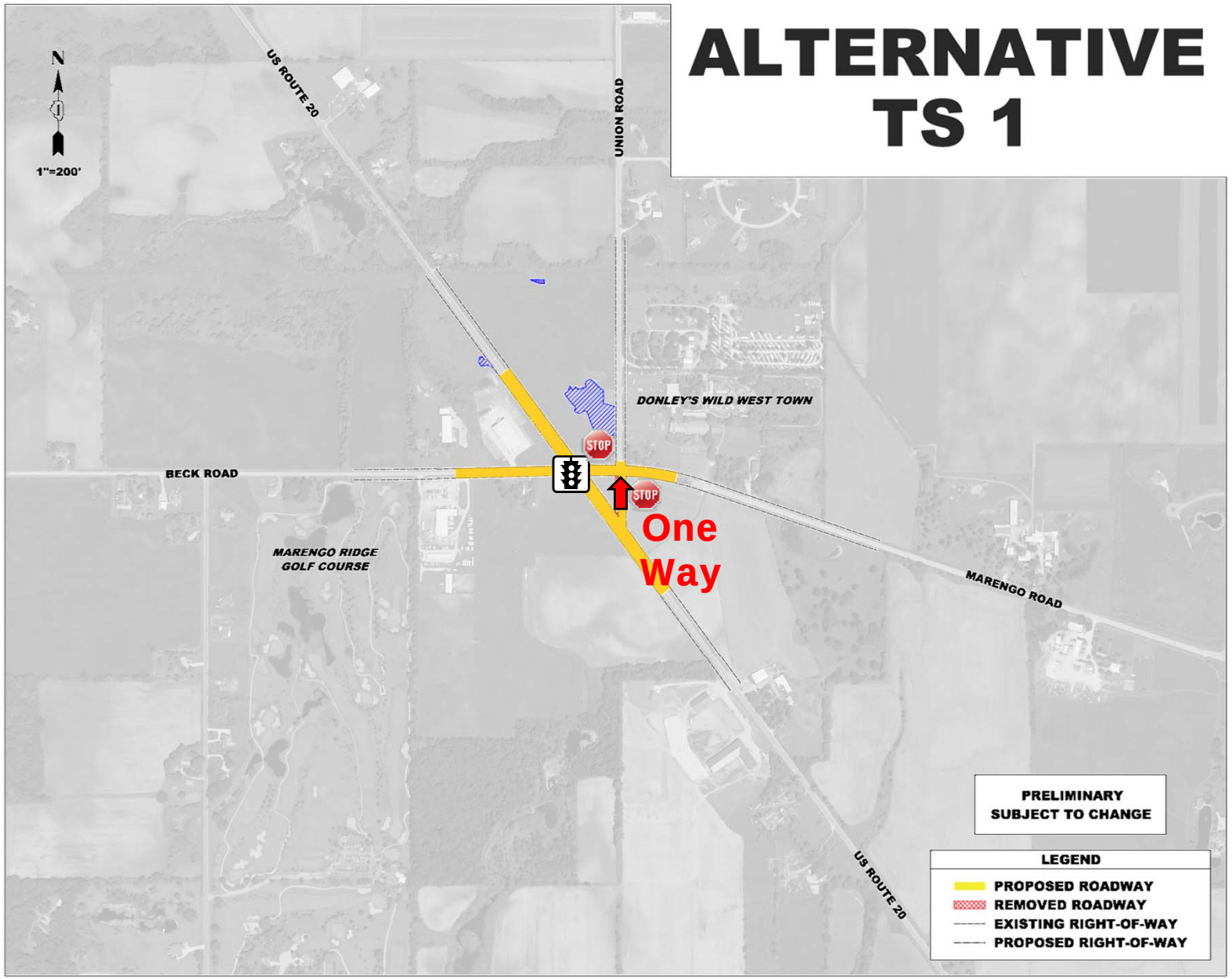


ALTERNATIVES ANALYSIS

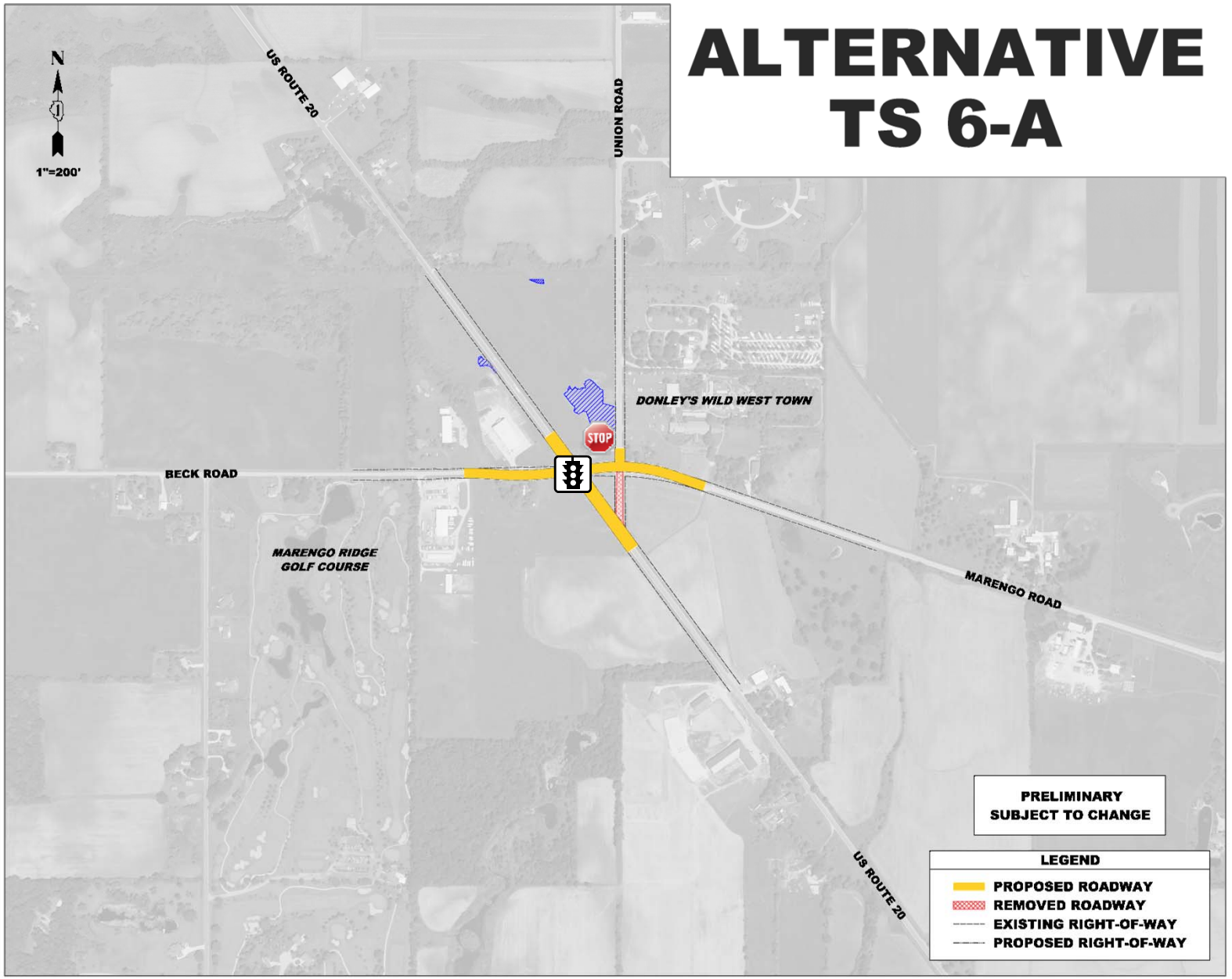
- Roundabouts
  - US 20 at Marengo Beck Road
- Raised Curb Median
  - IL Route 47 in Woodstock

EXISTING CONDITIONS

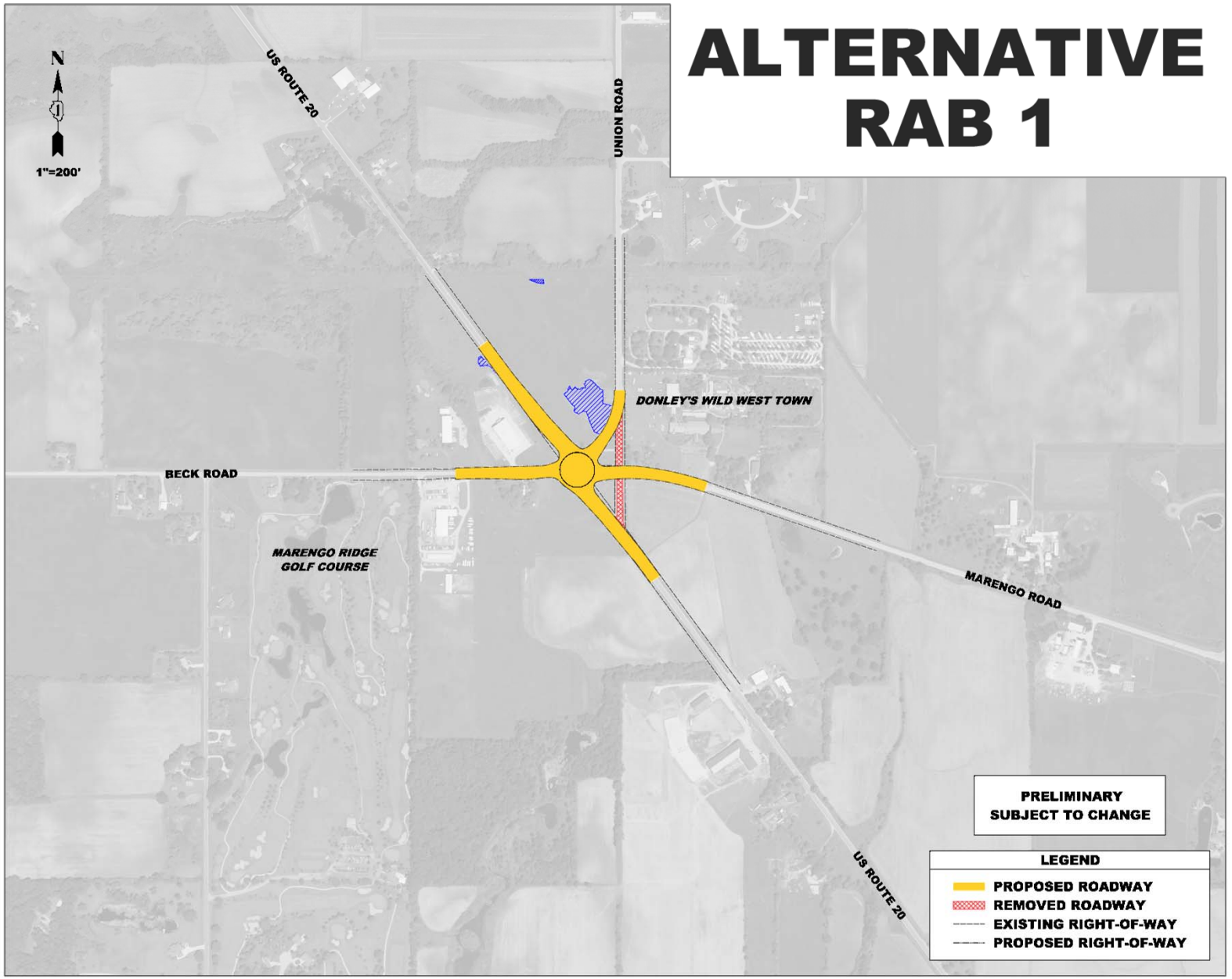
ALTERNATIVE TS 1



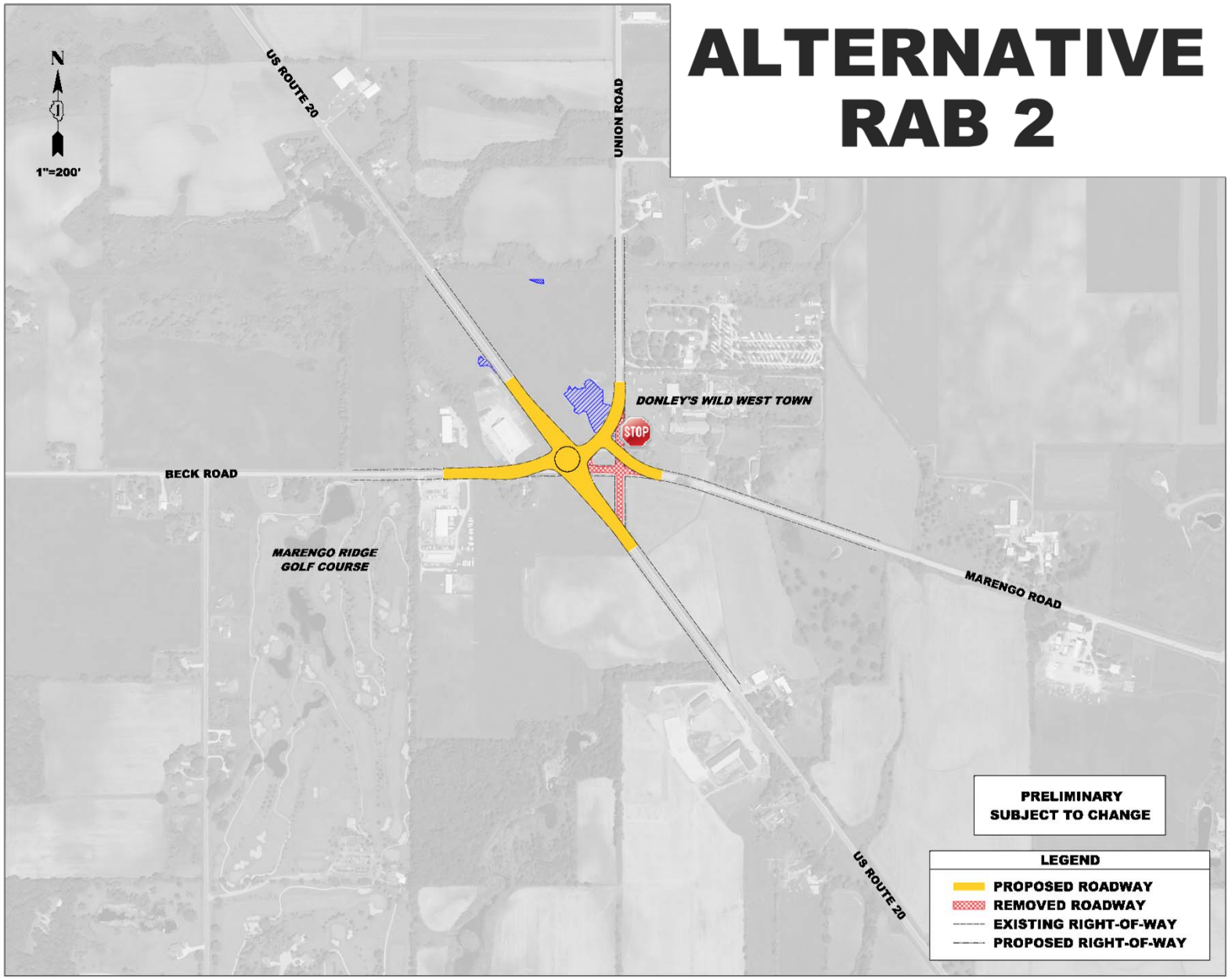
ALTERNATIVE TS 6-A



ALTERNATIVE RAB 1



ALTERNATIVE RAB 2



ALTERNATIVES COMPARISON

- **Total Crash Reduction**

  A comparison of total crashes between the 2040 No Action Scenario and 2040 Alternative Scenario

- **Severe Crash Reduction**

  A comparison of severe crashes between the 2040 No Action Scenario and 2040 Alternative Scenario

	TS 1	TS 6-A	RAB 1	RAB 2
Construction Cost	1.8M	2.4M	3.4M	3.9M
Total Crash Reduction	-33%	-37%	-65%	-59%
Severe Crash Reduction	-44%	-51%	-71%	-67%
Opening Day Operations				
2040 Traffic Operations				
ROW Impact				
Displacements				
Wetlands				
Access Change				
Driver Familiarity				

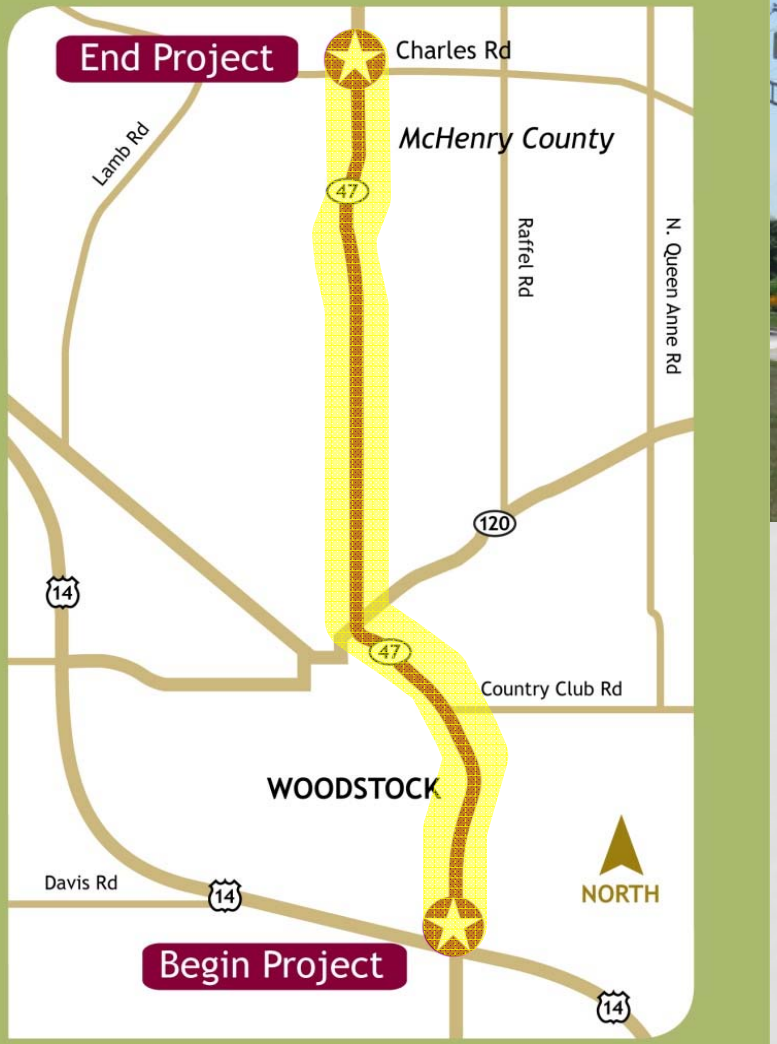
ALTERNATIVES COMPARISON

- **Driver Familiarity**

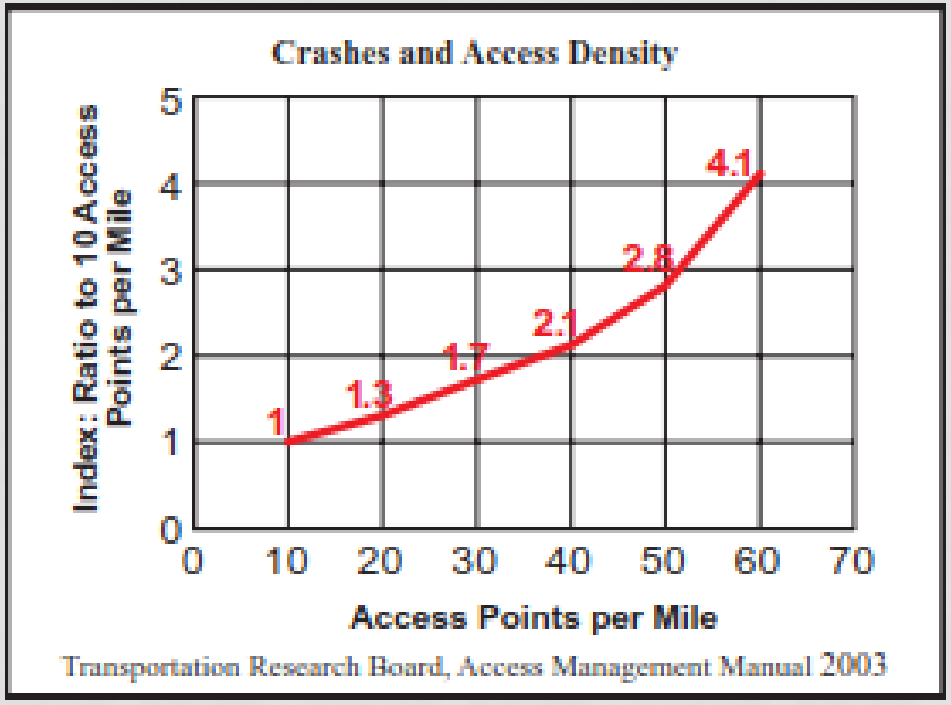
  Evaluation of driver comfort with the alternative geometry

	TS 1	TS 6-A	RAB 1	RAB 2
Construction Cost	1.8M	2.4M	3.4M	3.9M
Total Crash Reduction	-33%	-37%	-65%	-59%
Severe Crash Reduction	-44%	-51%	-71%	-67%
Opening Day Operations	3–D/E	3–D/E	3 - B	3 - B
2040 Traffic Operations	2 - F	1 - F	4 - B	1 - F
ROW Impact	0 AC	0.4 AC	2.6 AC	2.7 AC
Displacements	0	0	0	0
Wetlands	0 AC	0 AC	0.2 AC	0.3 AC
Access Change				
Driver Familiarity				

IL 47 IN WOODSTOCK STUDY



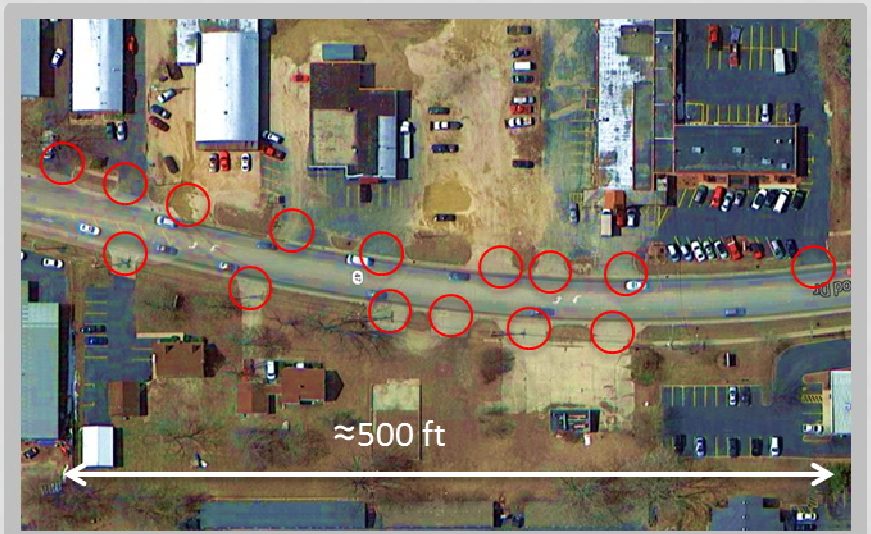
PURPOSE AND NEED – ACCESS MANAGEMENT



Transportation Research Board, Access Management Manual 2003

Existing Conditions:

- Greater than 300 access points
- 50 access points per mile (US 14 to Ware Road)
- ↑Driveways, ↑Crash Potential



ALTERNATIVES EVALUATION

Mainline

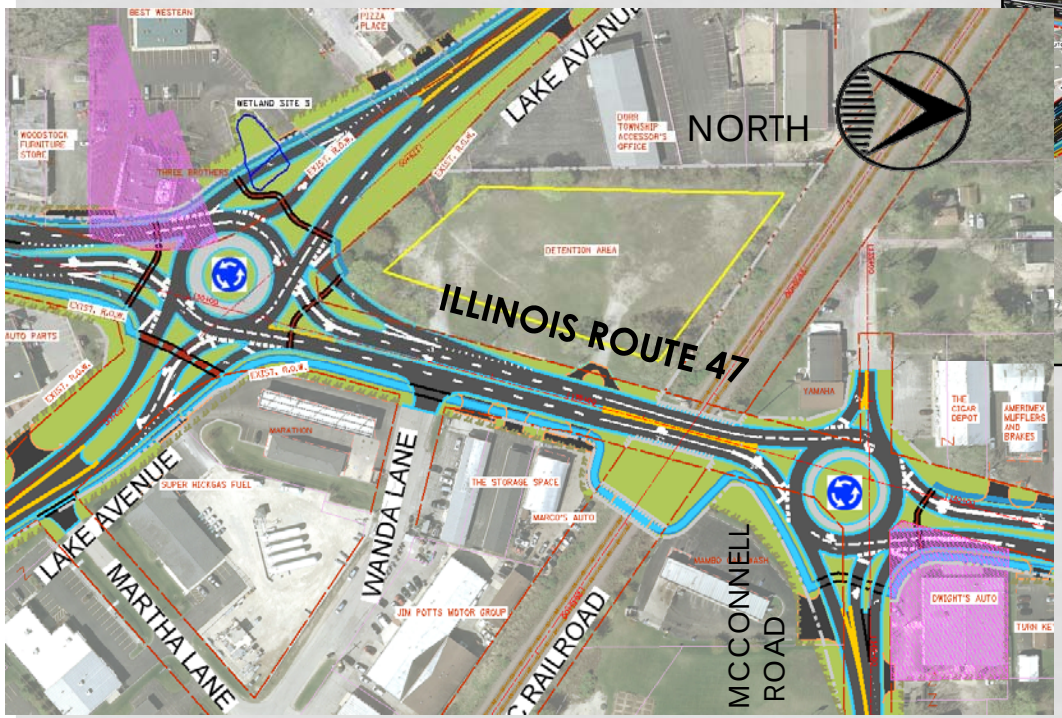
- Two lanes in each direction separated by a raised curb median

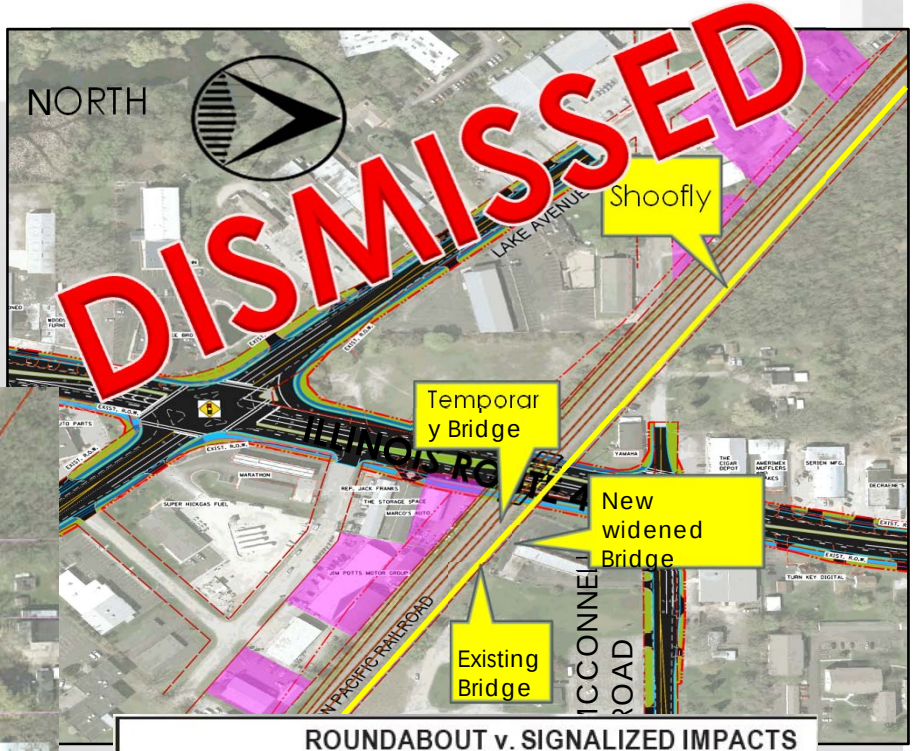
Typical Section Rendering: Looking North from IL Route 120 Intersection

ALTERNATIVES EVALUATION

Pros:

- 4 fewer relocations & 7 fewer affected parcels
- Less delay
- Does not impact the railroad bridge – saving approximately $30 million
- Reduces construction schedule by 1-2 years



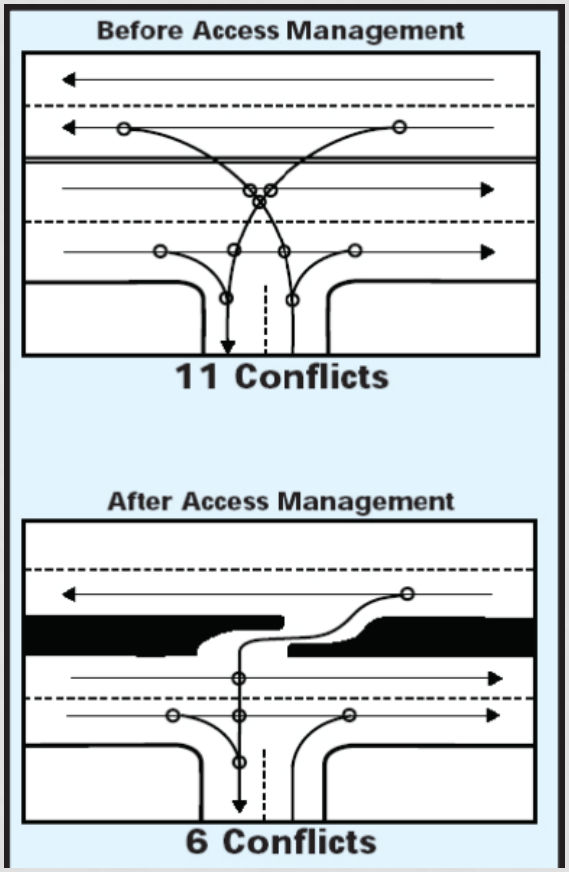


ROUNDABOUT v. SIGNALIZED IMPACTS

Impact	Roundabout	Signalized
Right of Way (ac.)	2.93	5.13
Affected Parcels	35	42
Commercial Relocations	2	4
Residential Relocations	0	2
Wetland Impacts (ac.)	0.008	0
Delay - Lake (s)	20.7 -C	37.4-D
Delay - McConnell (s)	11.1-B	18.5-B
Cost	$$	$$$$$

SAFETY ANALYSIS RESULTS
RAISED CURB MEDIAN VS. TWO-WAY LEFT TURN LANE (TWLTL)

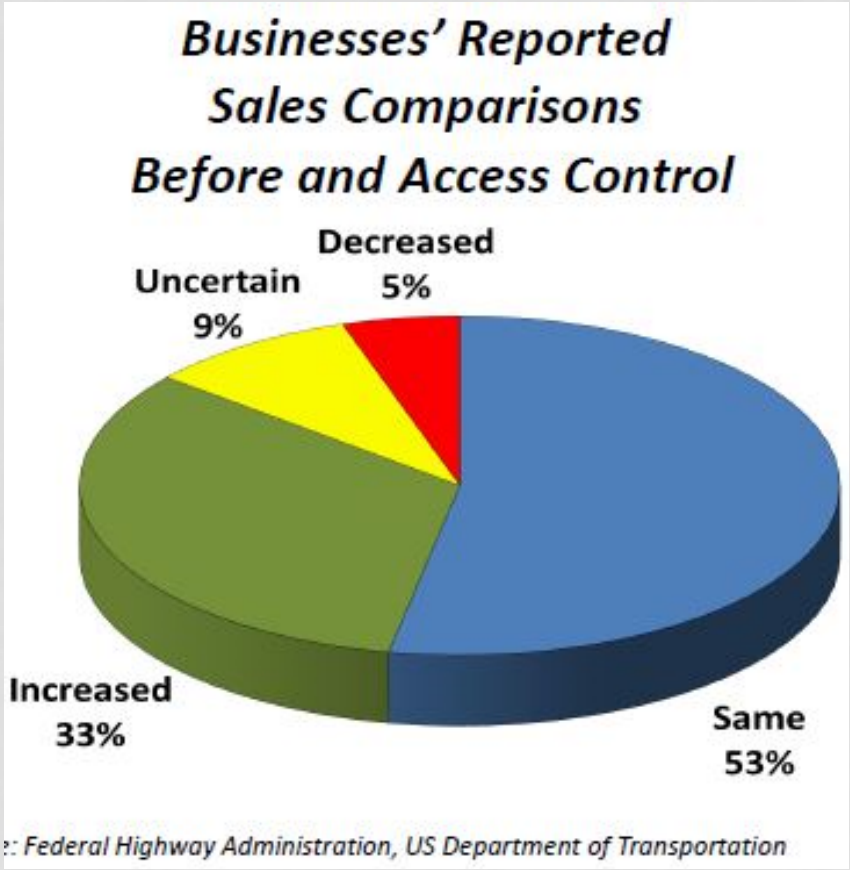
- National Level
  - Raised Curb Median reduced crash rate by **37%** and injury rate by **48%***
- Regional Level (Based on Chicagoland Studies)
  - Raised curb median reduced crash rate by **70%**
  - **85%** reduction in pedestrian & bike related crashes
- Project Level (Highway Safety Manual)
  - **8%** fewer total crashes anticipated for Raised Curb Median compared to TWLTL
  - **9%** fewer fatal and injury crashes anticipated for Raised Curb Median compared to TWLTL



*Source: U.S. Department of Transportation – Federal Highway Administration: Safe Access is Good for Business

WHAT IMPACT WILL THIS HAVE ON MY BUSINESS?

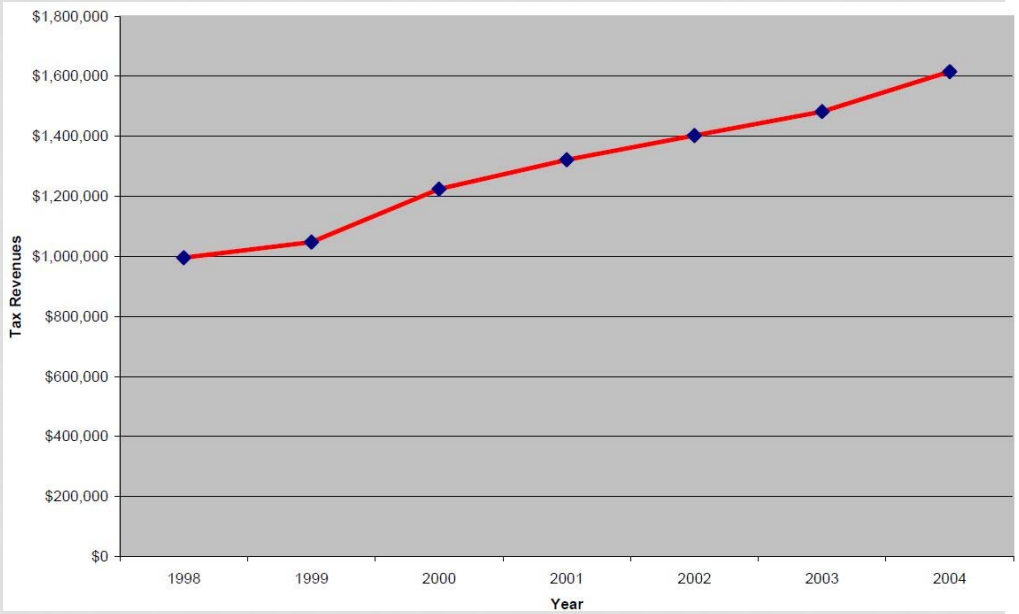
- "Before and After" studies along highways where access has been managed found vast majority of businesses do as well or better after the projects have been completed
- A safer, uncongested roadway will allow customers to get to your business compared with an unsafe, congested roadway which they will avoid



CASE STUDY- GOLDEN COLORADO

Installation of four roundabouts within half-mile long arterial resulted in:

- Slower speeds, but lower travel times and less delay at business access points
- Crash rates dropped by 88% and injury accidents reduced by 93%
- Sales tax revenues increased by 60%



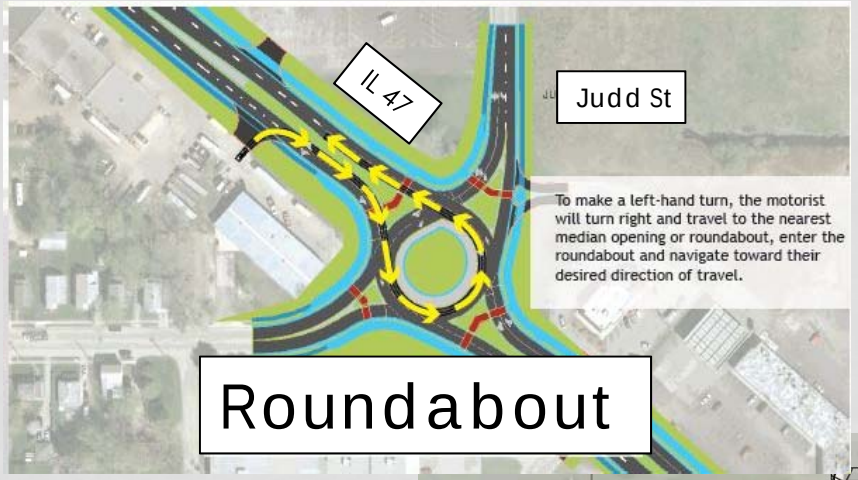
Roundabouts were installed in 1999

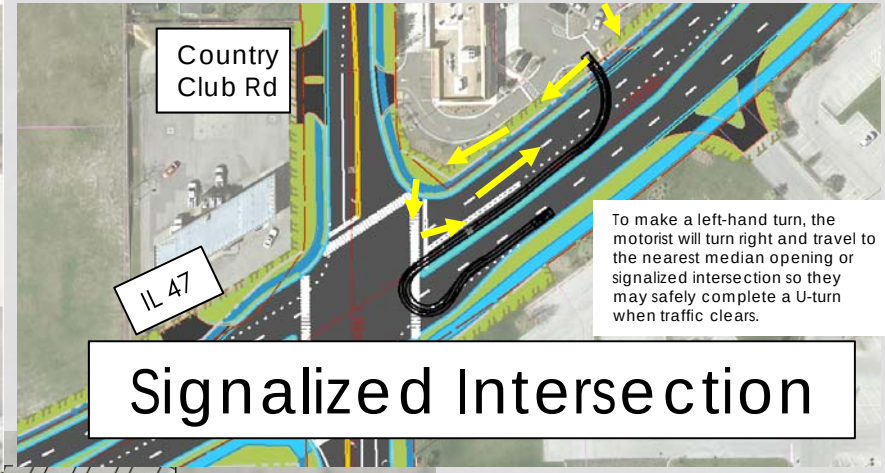
NOTE: Crash data was collected 3 years prior to installation and 5 years after

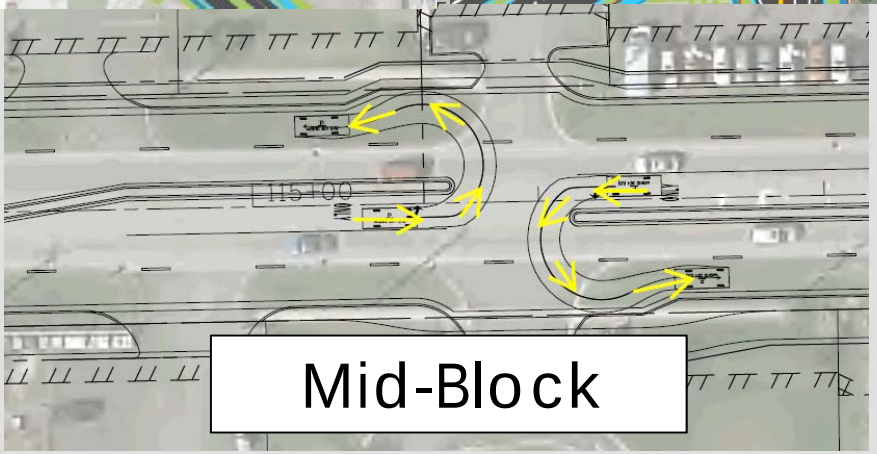
Source: Alex J. Ariniello, LSC Transportation Consultants, Inc. – Are Roundabouts Good For Business?

U-TURNS

How do you make a left hand turn with barrier median?







QUESTIONS?

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