Building Roads for Safety

A Tradeoff on Our Mobility

AUG
2024

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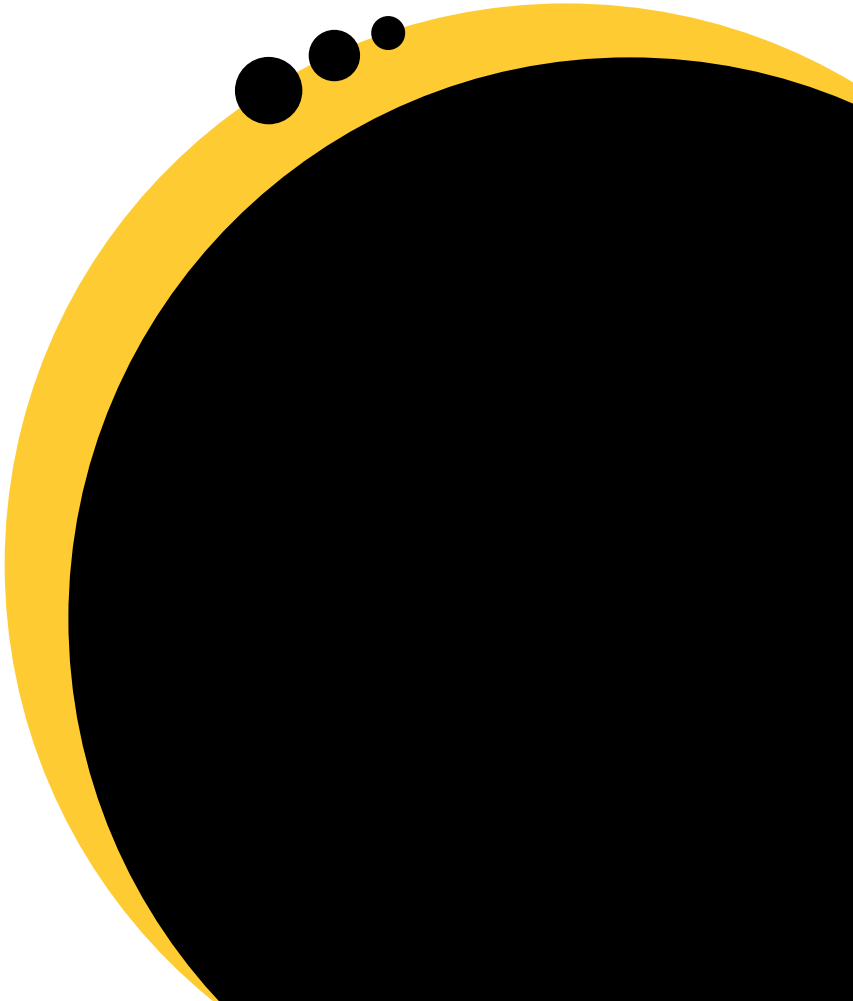
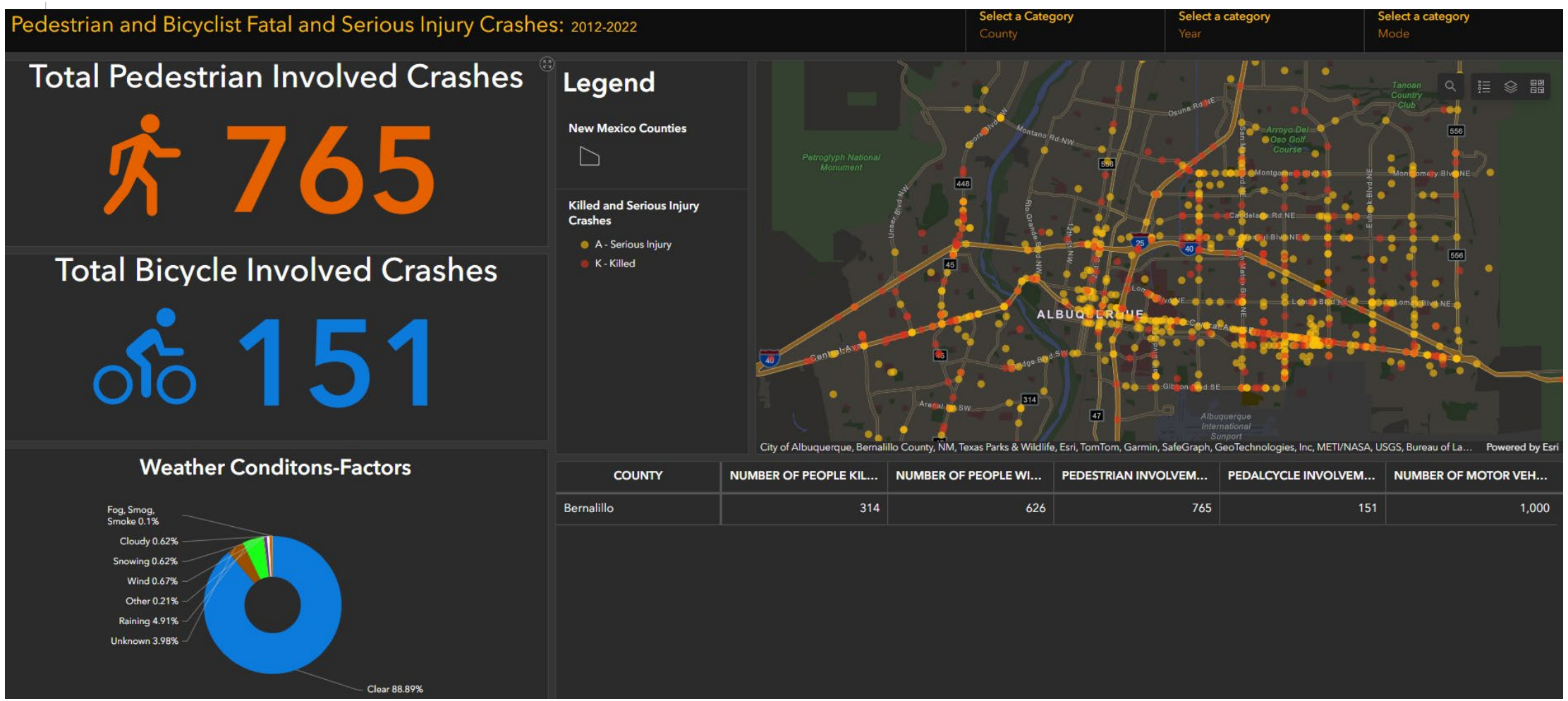
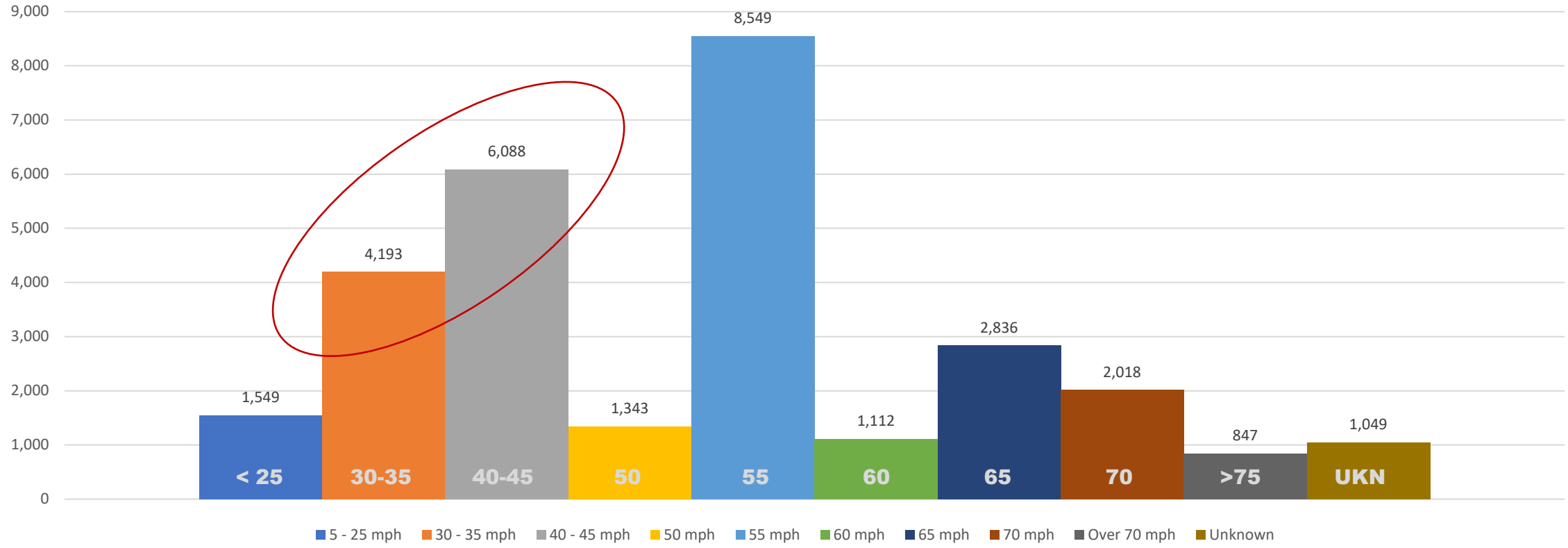
Contents



Crash Data Focus Areas



COUNTY	NUMBER OF PEOPLE KIL...	NUMBER OF PEOPLE WI...	PEDESTRIAN INVOLVEM...	PEDALCYCLE INVOLVEM...	NUMBER OF MOTOR VEH...
Bernalillo	314	626	765	151	1,000

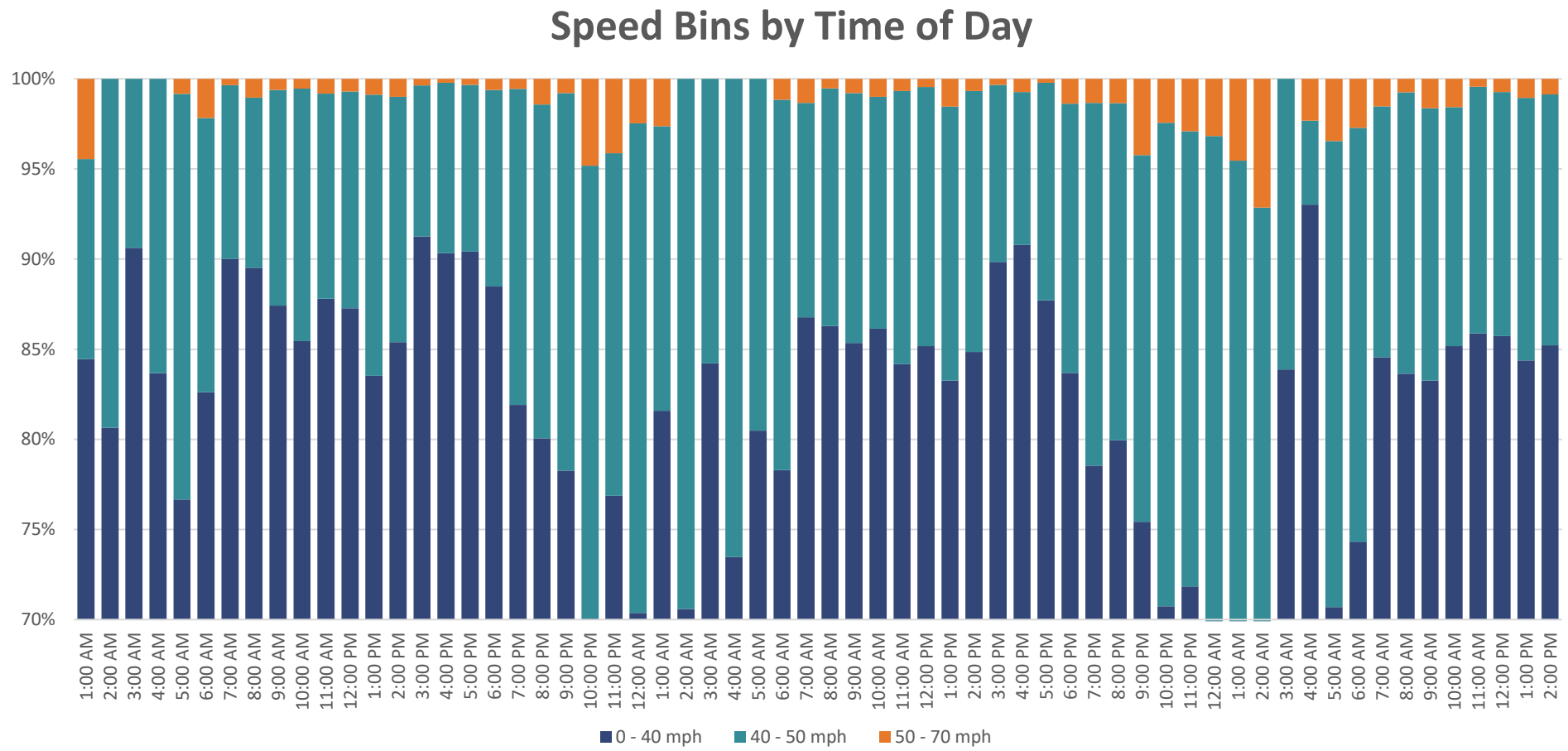


Fatality Analysis Reporting System (FARS), Fatality and Injury Reporting System Tool (FIRST)

Arterial Speed Management

Narrow Roads / Wide Nodes

- Number of Lanes needed for Peak Hours can Lead to Off-Peak speeding



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Lane Narrowing

- Lane Narrowing for Land Use / Roadway Function

- Why Wait for a Road Diet

Access Management, U-turns, and Loons

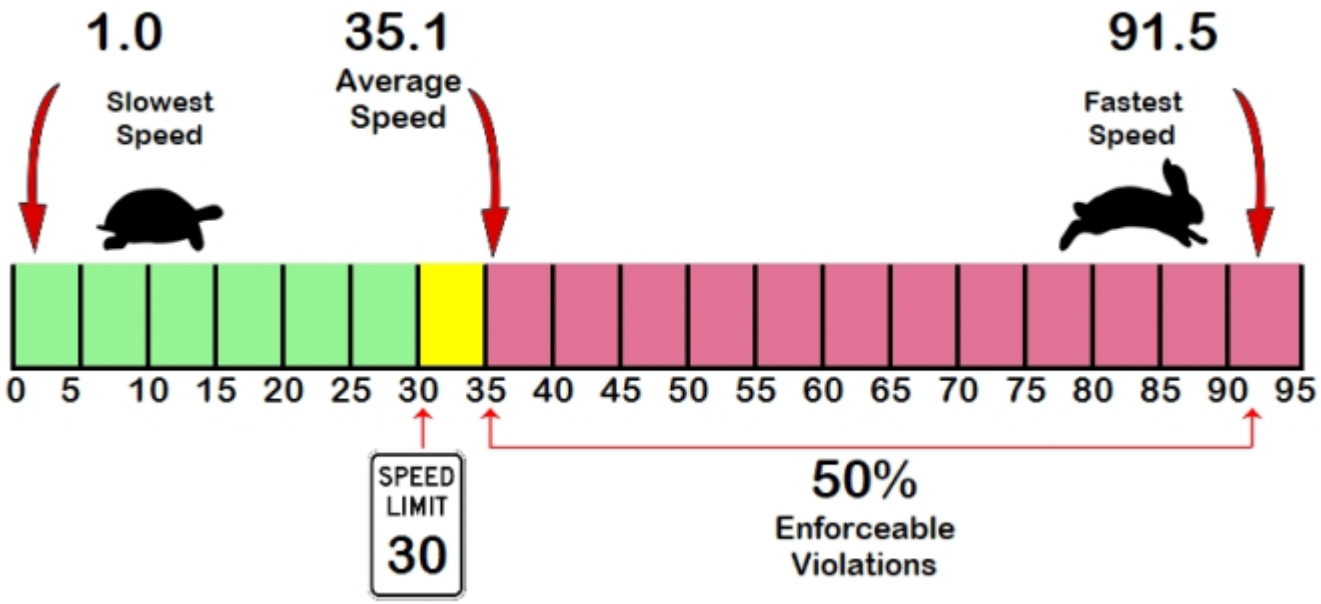
Median U-Turns

Reduce Severe Injuries on Left-turn Conflicts by nearly 70%

Reduced Total Crashes by >30%

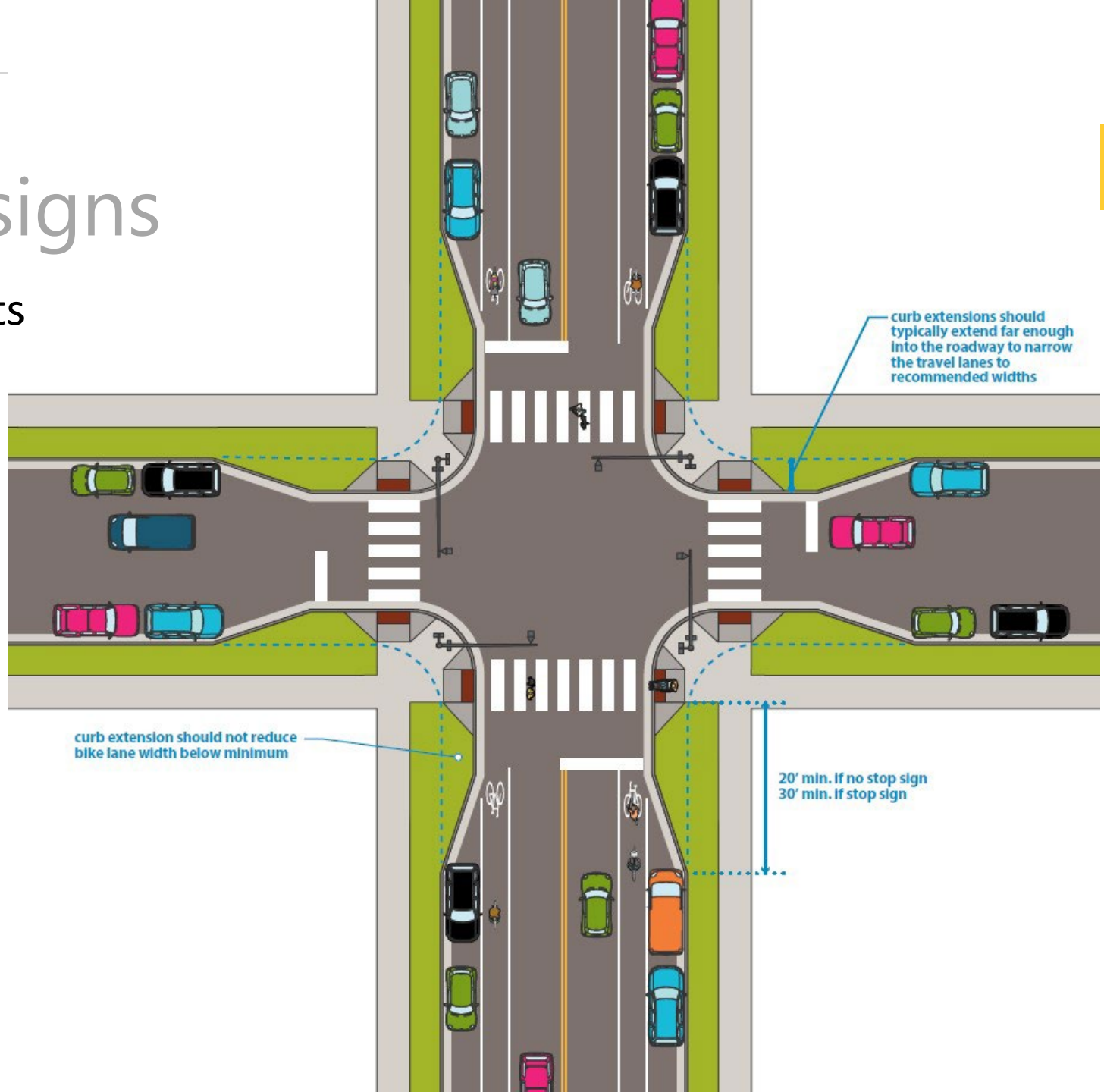
Enforcement / Automated Enforcement

- Recommend Site Selection for Safety
  - School Zones
  - Rail Crossing Violations
  - Speed Infractions
    - Big Data Analysis



Intersection Designs

- Curb Extensions / Bulbouts
- Reduced Corner Radius
- Crossings at the Corners
  - Sight Lines



Channelized Right Turns

- Acceleration Lane Conflicting with Bicycle and Pedestrian Movements

(08-2020)

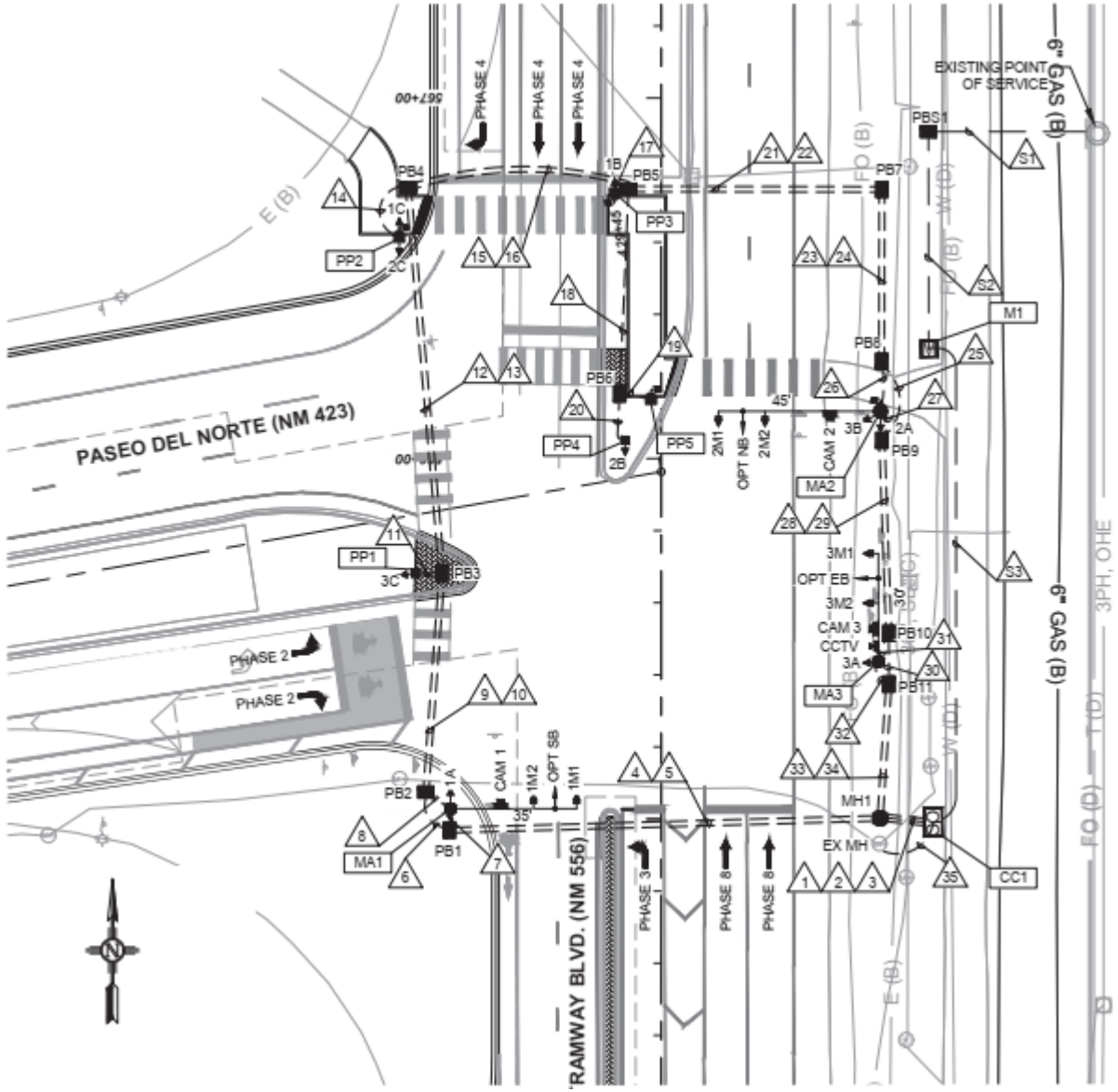
Channelized Right Turns

- Right Turn Reduced to Yield Control
- High volumes Continue to Conflict with Bicycle and Pedestrian Movements

(10-2020)

Channelized Right Turns

- Right Turn Lanes Collapsed into the Intersection



Let August 2024

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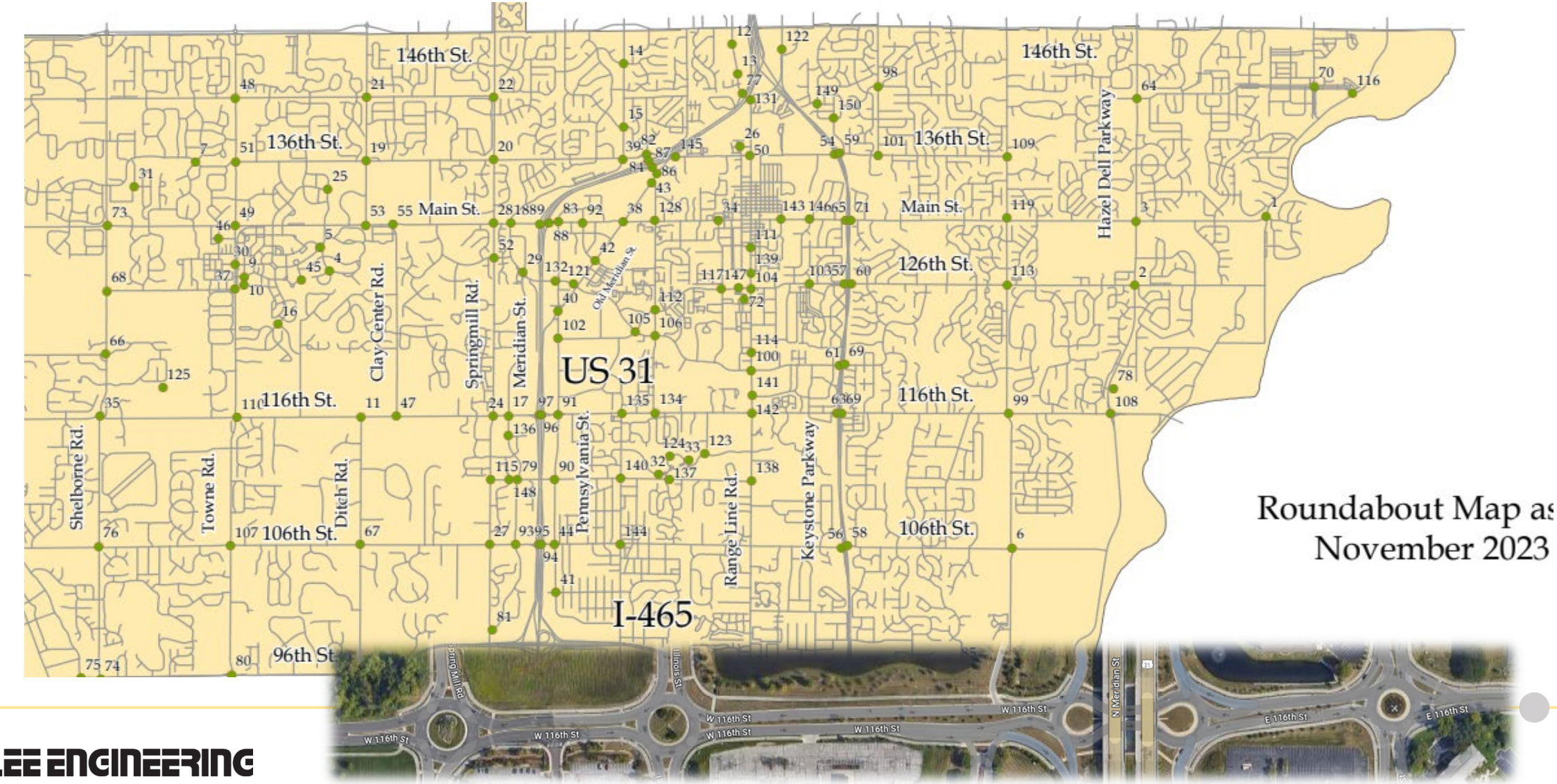
- Reduced Speeds
- Reduction in Crash Severity
- Veiled Truck Aprons for Restricted Passenger Vehicle Paths
- Reduced Conflict Points
- Improved ISD

Roundabouts

Carmel, IN



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2022 Injury Crashes Statistics for Carmel and Other Indiana Cities

City	Population[1]	Total # of Injuries[2]	% Pop. Vs. Total Injuries	# of Roundabouts[3]
Carmel	101,964	200	**0.20%**	**145**
Westfield	54,605	153	0.28%	35
Fishers	101,966	360	0.35%	23
Noblesville	72,748	402	0.55%	35
Greenwood	65,406	379	0.58%	7
Kokomo	59,671	393	0.66%	2
Indianapolis[4]	880,621	6,813	0.77%	15[4]
Anderson[5]	55,099	471	0.85%	2[5]
Mishawaka	50,913	458	0.90%	1
Columbus	51,268	525	1.02%	3
Ft. Wayne	267,927	2,775	1.04%	15
Bloomington	79,107	846	1.07%	8
South Bend	103,110	1,203	1.17%	8
Valparaiso	34,565	473	1.37%	8
Evansville	115,749	1,643	1.42%	1

Carmel, Indiana

Five Year Average Trend of Vehicle Fatalities for Indiana Cities (based on 100K population)

Year	Carmel	Fishers	Westfield	Greenwood	Noblesville	Anderson	Kokomo	Indianapolis	Bloomington	Ft. Wayne	South Bend	Mishawaka	Evansville	Columbus	Valparaiso
2004	3.1	2.8	10.2	7.6	9.9	13.3	14.6	8.3	6.5	5.6	14.2	10.4	9.6	9.2	16.0
2005	3.2	4.9	13.4	10.4	10.8	16.5	16.4	9.5	8.5	6.9	14.9	11.6	10.5	8.7	22.1
2006	2.8	5.7	13.2	9.6	11.9	15.3	18.6	10.1	12.2	7.1	10.4	11.6	12.5	14.2	19.9
2007	4.3	7.5	13.2	12.7	13.2	14.6	21.2	10.3	13.1	7.0	10.3	12.0	13.4	23.3	24.5
2008	3.6	6.9	12.7	10.8	12.7	13.6	19.6	10.5	13.6	7.5	9.7	11.5	13.4	27.7	28.2
2009	3.7	7.2	9.7	11.0	10.7	11.2	17.0	9.5	11.6	7.4	8.0	10.1	13.9	24.6	32.6
2010	3.6	5.6	7.8	9.2	11.4	10.6	15.8	9.3	12.5	6.2	6.6	9.7	13.0	30.0	34.6
2011	3.5	4.8	9.4	9.1	10.6	8.8	14.2	9.2	11.3	6.0	6.6	11.0	11.6	25.1	35.0
2012	2.6	3.0	10.6	6.4	9.8	9.6	11.5	9.1	12.8	7.2	7.8	10.6	12.0	19.1	32.1
2013	2.2	3.4	9.4	7.0	8.5	9.3	11.2	8.7	11.0	7.2	8.3	9.0	12.7	16.8	26.0
2014	2.2	2.6	6.4	5.3	8.0	13.3	11.7	9.2	10.8	7.6	10.7	7.9	13.1	19.5	22.5
2015	1.9	2.6	5.1	5.2	8.8	12.7	13.4	9.7	9.2	8.7	10.7	7.5	14.7	22.2	18.0
2016	1.8	2.8	3.5	4.8	8.6	13.8	15.2	10.0	10.6	9.9	11.8	7.4	14.3	24.1	19.1
2017	1.8	3.0	3.3	6.8	8.5	15.2	16.9	10.5	10.0	10.4	14.0	7.4	14.7	26.1	22.0
2018	2.2	2.5	5.6	6.6	8.4	18.9	19.7	11.1	11.1	10.8	14.1	11.8	14.1	32.8	26.6
2019	2.1	2.8	6.3	7.3	7.3	16.8	20.4	11.6	10.6	11.4	13.3	14.5	12.3	30.1	22.3
2020	2.3	4.0	6.3	6.5	7.3	17.1	19.7	12.5	10.8	11.9	15.3	16.5	12.7	26.1	22.7
2021	2.3	4.6	8.0	6.8	6.7	18.2	17.5	13.4	9.8	10.9	20.7	21.8	12.9	22.6	24.8
2022	2.4	4.9	7.0	6.8	6.9	16.8	16.1	14.3	10.7	10.7	19.9	22.5	11.9	19.8	22.9

Carmel, Indiana

- Median Islands
- Splitter Islands
- Chicanes

Horizontal Deflection

- Proven to Increase Yield Compliance and Reduce Speeds

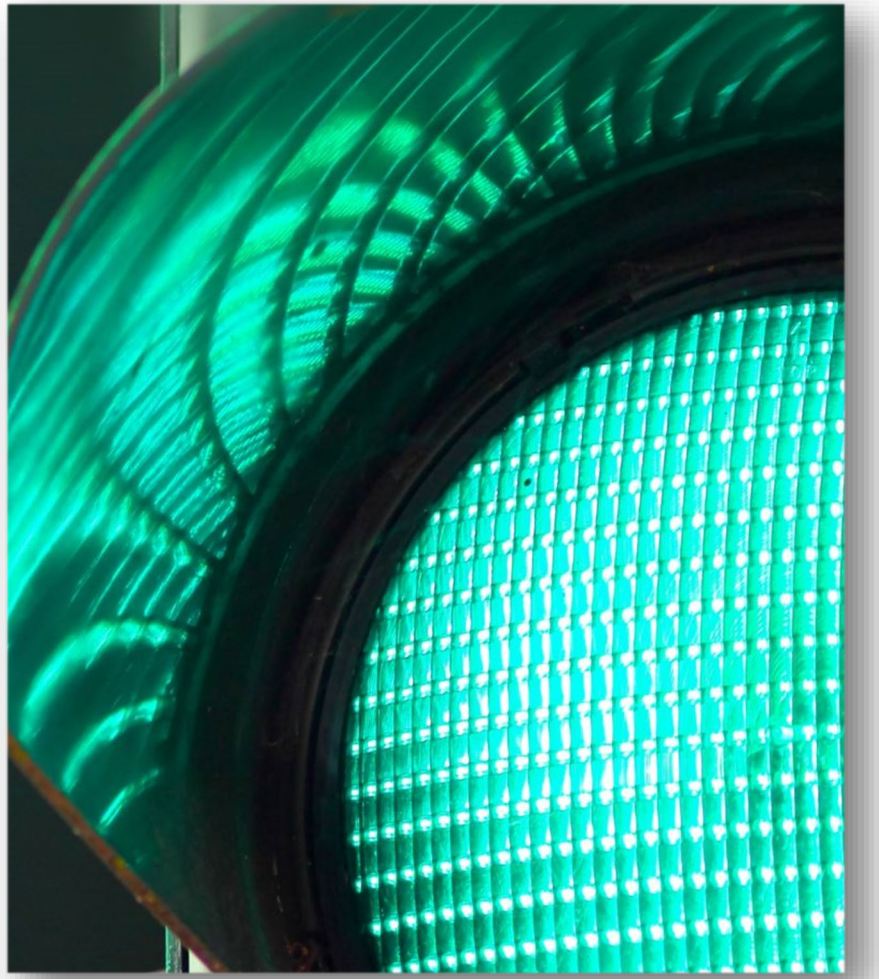
R1-6 Pedestrian Gateways

Pedestrian Hybrid Beacons

- To Coordinate or Not
  - Peak Hour TOD
- Interconnected for Maintenance

Signalized Opportunities

- Vehicle Operations
  - Protected / Prot-Pmt / Permitted Phasing
  - Flashing Yellow Arrows
  - Enhanced Rest-in-Red Systems
- Pedestrian Operations
  - Pedestrian Scramble
  - Leading Pedestrian Intervals
  - Turn Lane Pedestrian Indicator
  - Blank-out Turn Restrictions
  - Right Turn on Red Prohibition



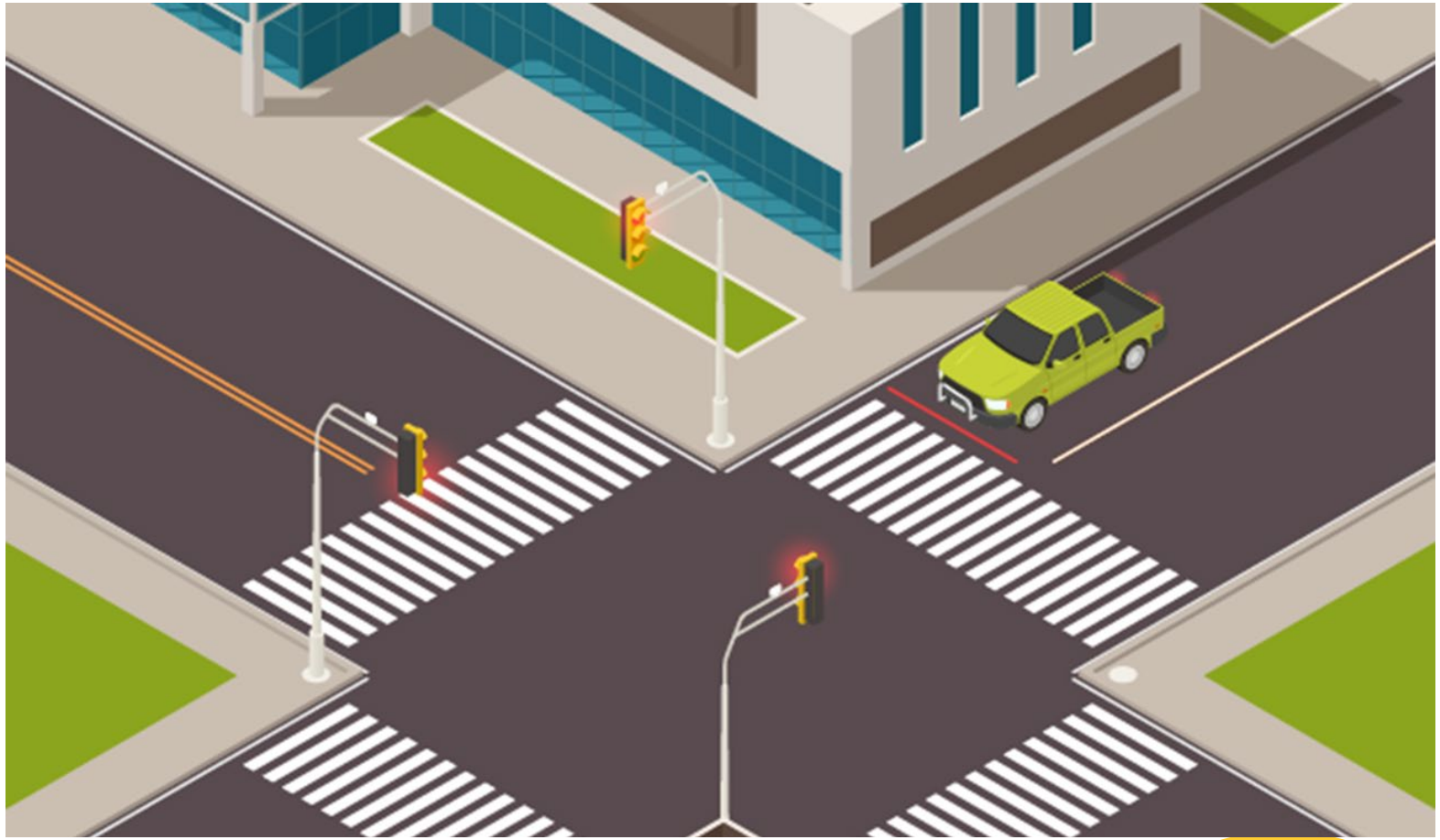
Flashing Yellow Arrows

- Breaks up the “green ball” connection to the left-turn
- Allows Protected Only by Time of Day
- Allows for Pedestrian-Protect Phasing

Stopbar Detection

Typically installed at Isolated Intersections

Primarily used to reduce delay



Traditional Rest-In-Red

Enhanced Rest-In-Red Overview

- Signal is Resting-in-Red in all directions.

The approaching vehicle is detected by the advanced detector and its speed is measured.

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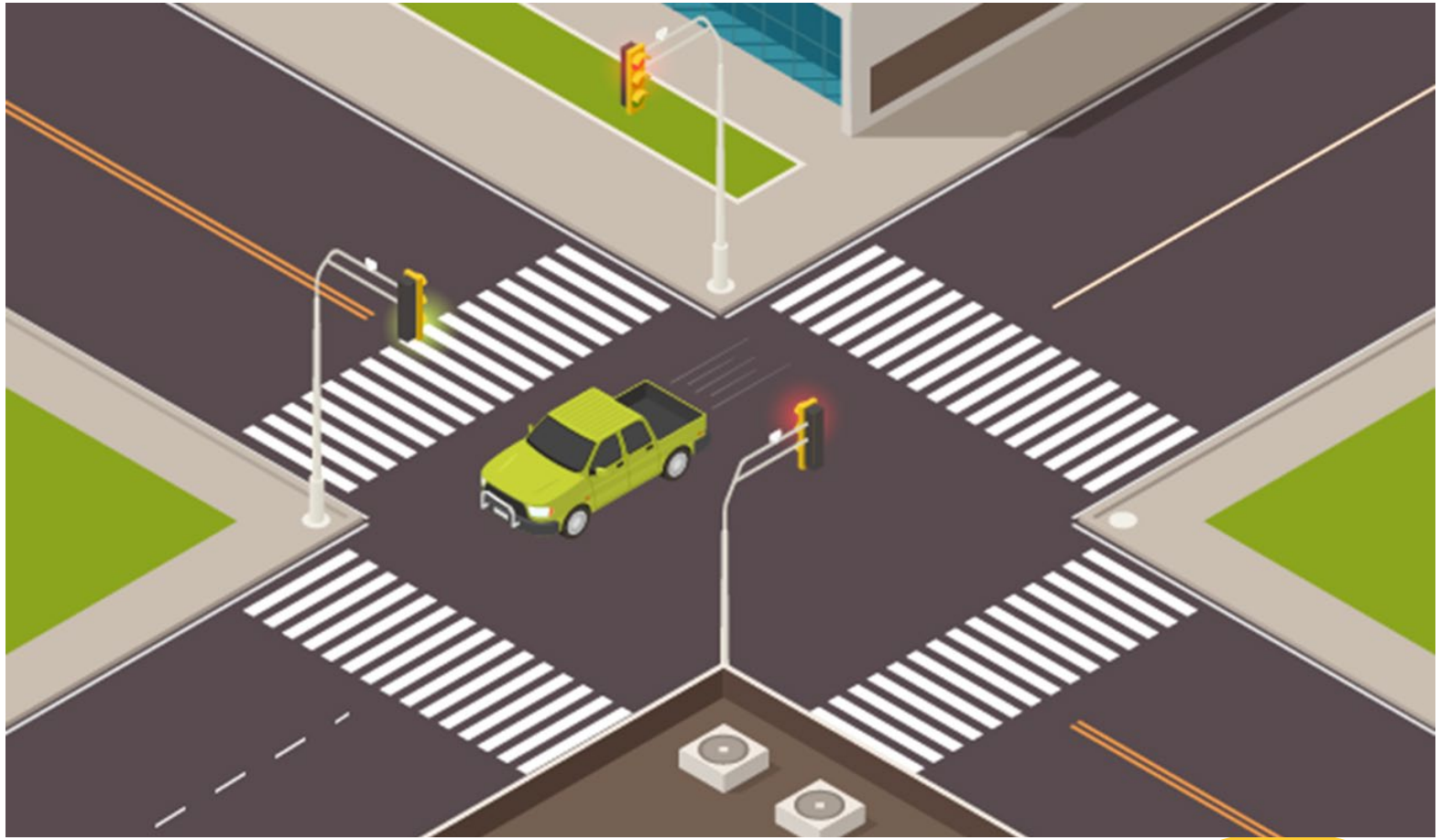
- If the measured speed is less than the desired speed…
- The request is made to the traffic signal.
- If there are no other operations ongoing, a green indication is immediately given.

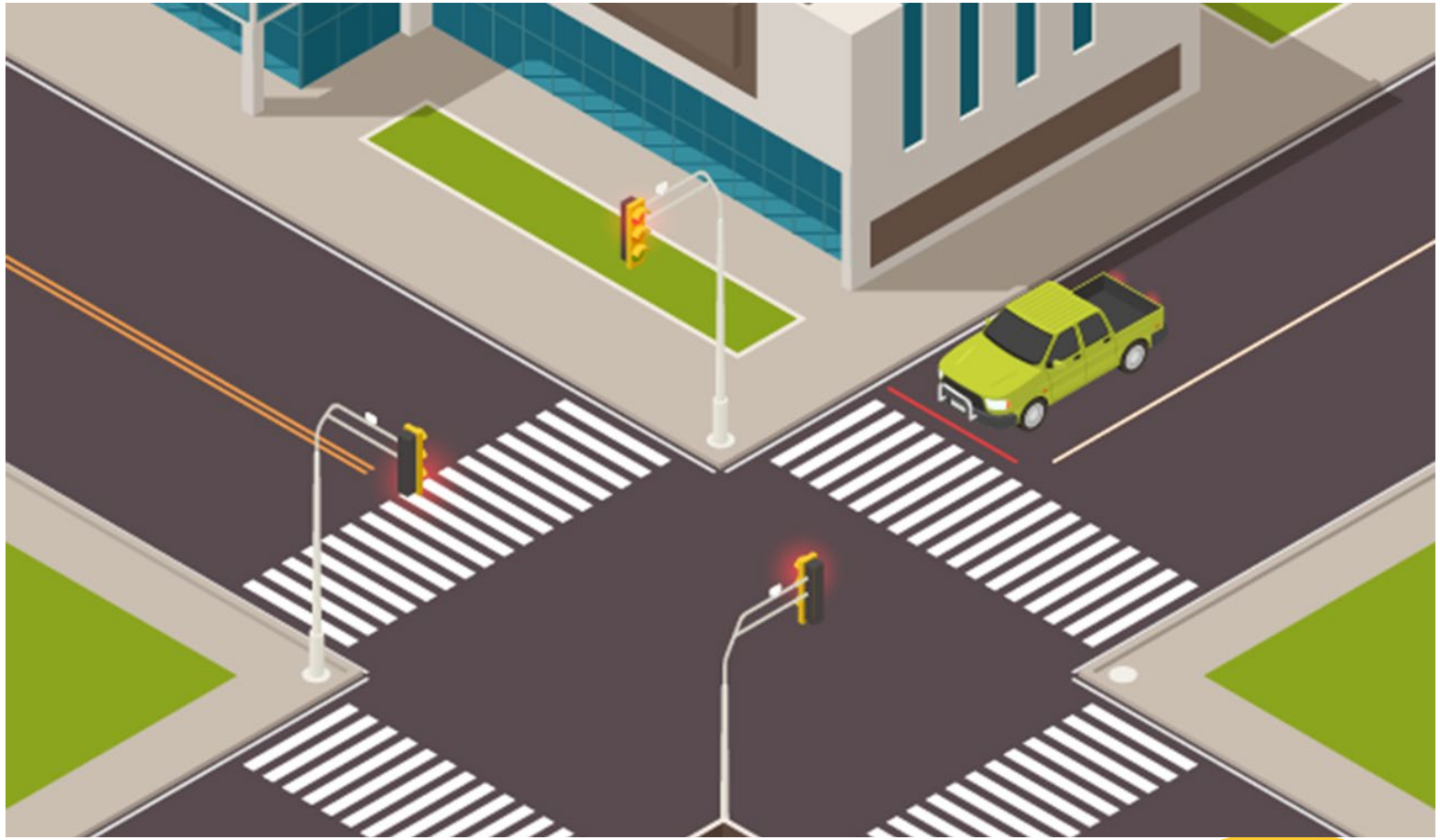


Enhanced Rest-In-Red Overview

If the measured speed is greater than the desired speed…

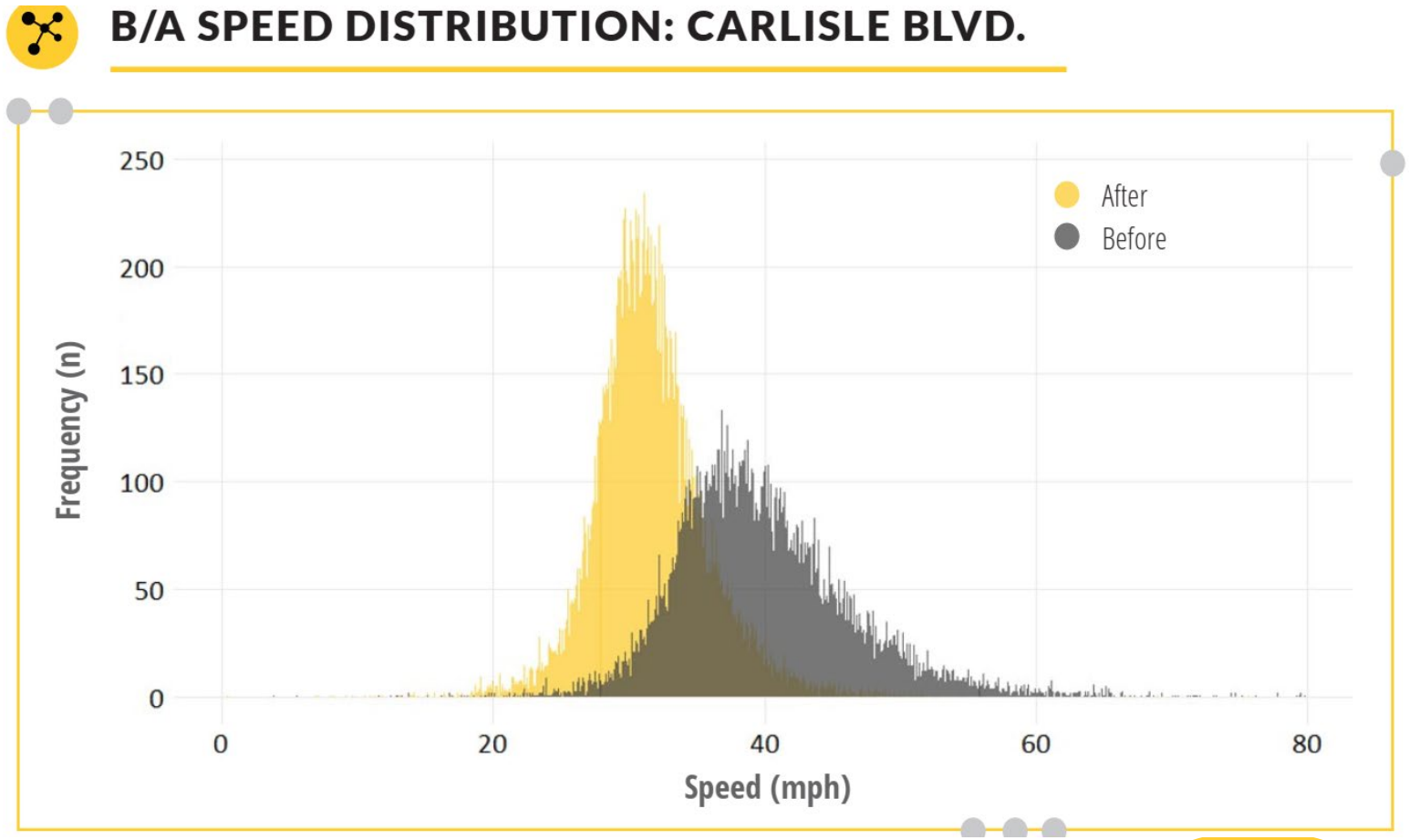
No advanced call is provided to the signal.

The vehicle is detected at the stop bar and the green indication request is made.



Enhanced Rest-In-Red Overview

Significant reduction and consolidation of the speed profile



Enhanced Rest-in-Red Operations

Pedestrian Scramble

Pedestrian Features

Leading Pedestrian Intervals

Requires Time to be Added or Taken from other Movements

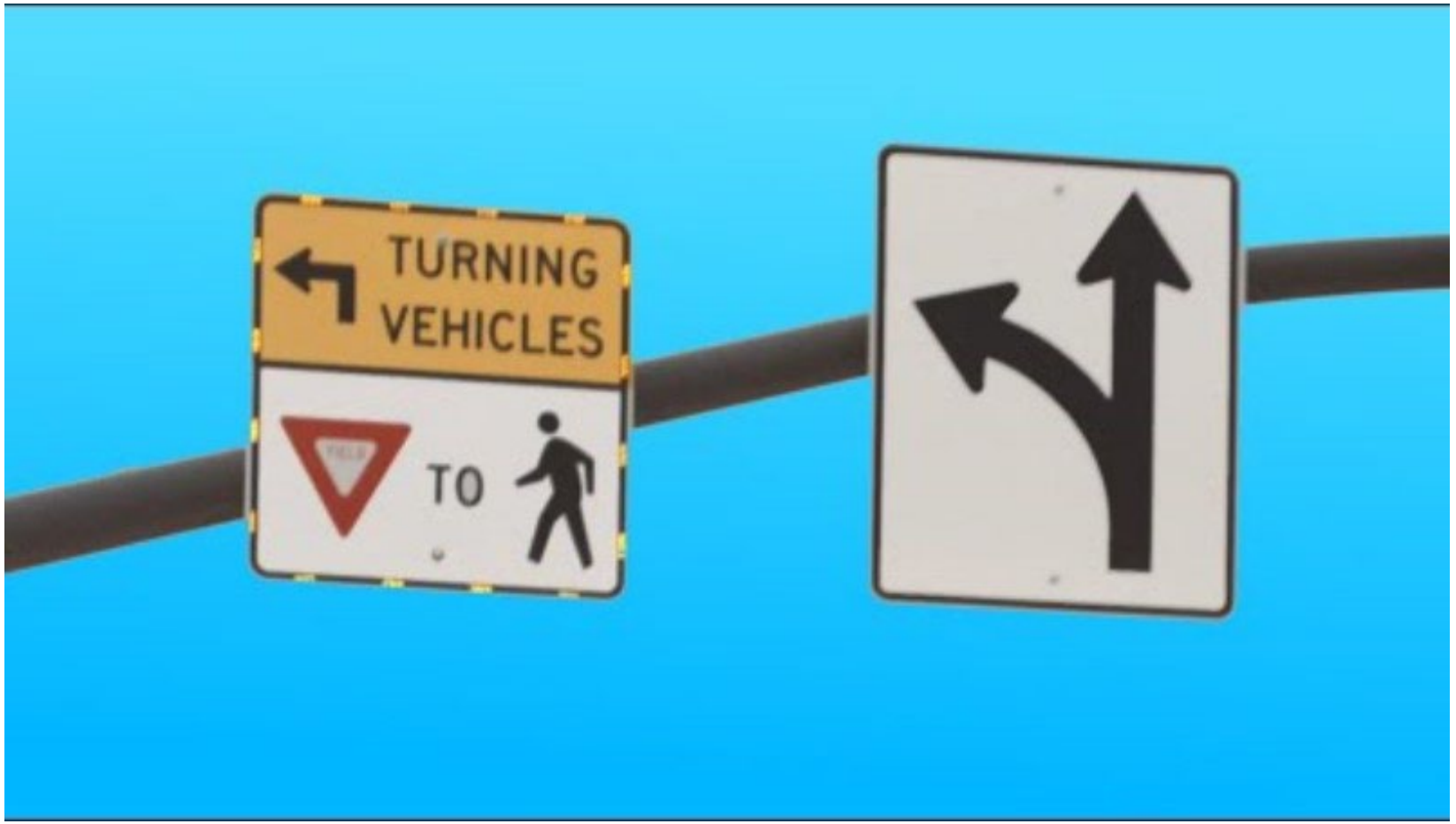
Pedestrian Protected Phasing

Restricts Permitted Movements during WALK and FLASH DON'T WALK

Blank Out Turn Restriction

Can Maintain Cycle Length and Splits

Turn Lane Pedestrian Indicator (TLPI)



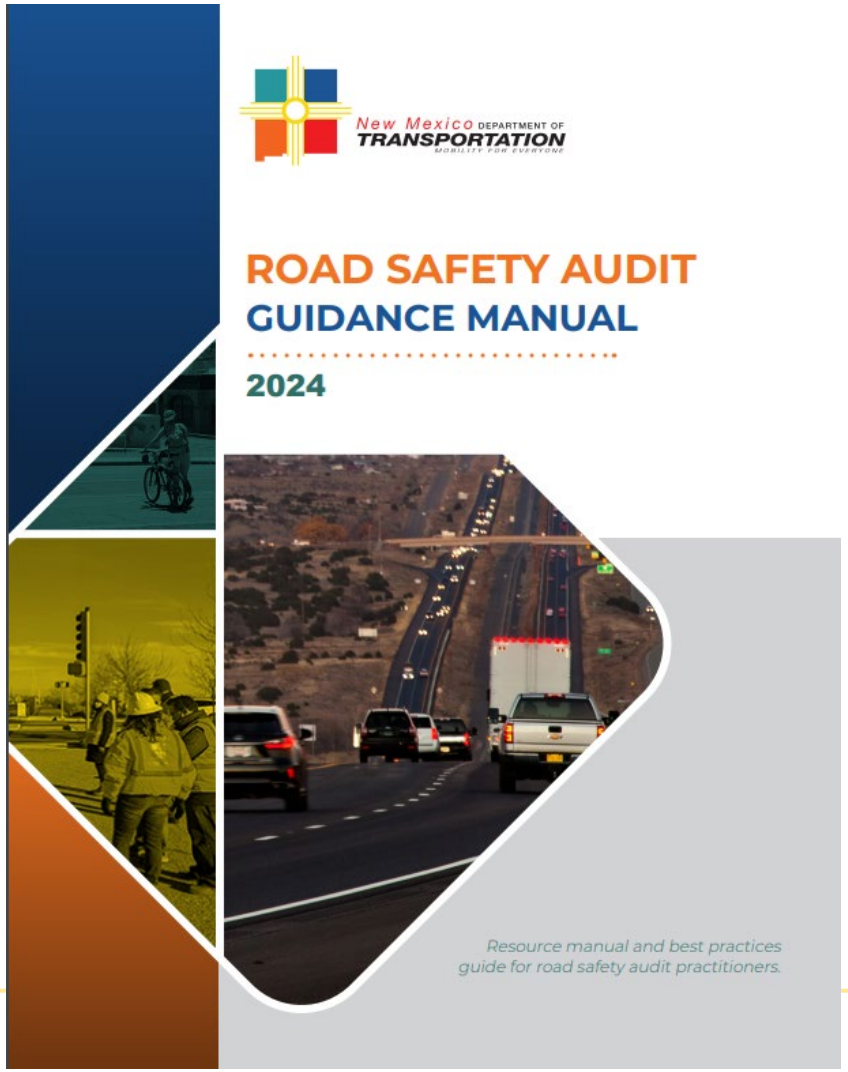
https://www.youtube.com/watch?v=zpygG9_Jkcg&embeds_referring_euri=https%3A%2F%2Fwww.pedsafety.com%2F&source_ve_path=Mjg2NjY

Proactive Roadway Design Safety Audits

Opportunities Exist to Inject the Road Safety Audit Process into the Design Process

Third-Party Review for Safety

Comparable to Value Engineering Process



https://www.youtube.com/watch?v=8kP6R0clBGYhttps://www.youtube.com/watch?v=8kP6R0clBGY