



Safety Analysis Factors for Transit Case Study: East Colfax BRT

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April 5, 2023



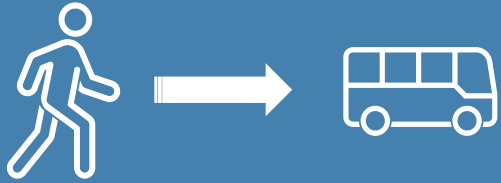
Today's Session

- Importance of Integrating Roadway Safety into Transit
- Case Study Background Information
- Historical Safety Evaluation
- Predictive Safety Methodology
- Model Results
- Pedestrian Considerations
- Conclusions

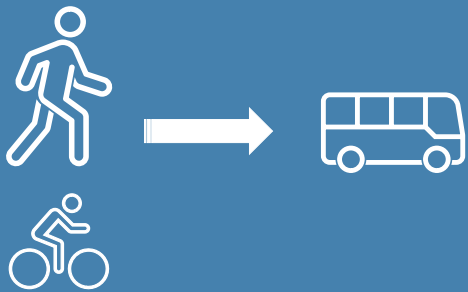


The Importance of Road Safety in Transit Planning

94% - Metro Tucson



86% - Metro Phoenix



- **Sun Tran** - Most passengers – 94% - walk to their first stop from their origin location, and to their destination from their final stop - 95%. *
- **Metro Phoenix** - Majority of riders walk to their first transit stop - 79%, with another 7% of people biking.**
- **Flagstaff in Motion** – one of their overarching recommendations is to improve access to the existing bus system – enhanced pedestrian crossings, bus stop additions, integrate e-bike/e-scooters

*2022 Tucson On-Board Survey

**Valley Metro – 2018 Rider Satisfaction Survey Total Market



The Importance of Road Safety in Transit Planning



New Projection: U.S. Pedestrian Fatalities Reach Highest Level in 40 Years

Resource Type
News Releases
FOR IMMEDIATE RELEASE
May 19, 2022

CONTACT: Adam Snider, 202-580-7930
202-365-8971 (after hours)

Growing death toll underscores the urgent need for a multi-layered approach to protect people on foot from dangerous driving

WASHINGTON, D.C. – Drivers struck and killed an estimated 7,485 people on foot in 2021 – the most pedestrian deaths in a single year in four decades and an average of 20 deaths every day, according to a new estimate released today by the Governors Highway Safety Association (GHSA). To provide

- Arizona ranks 6th, with the highest Pedestrian Fatality Rate by State Per 100,000 (2021)*
 - Behind: New Mexico, Florida, Louisiana, South Carolina, Arkansas
- Pedestrian deaths are on the rise:
 - Per capita, Phoenix sees more traffic deaths than any other city of its size , according to U.S. Highway Traffic Safety Administration statistics.
 - The number of pedestrians killed on our streets have almost doubled compared to last year. *“To this day we have seen 45 fatalities related to pedestrian collisions. Last year at this time, we were at 25,” said Tucson Police Officer Frank Magos.***

*May 2022 – Governors Highway Safety Association, Pedestrian Traffic Fatalities by State

**<https://www.kold.com/2022/12/01/deadly-pedestrian-crashes-rise-tucson/>



Taking Action and Prioritizing Safety

ADOT - Arizona 2024 Statewide Strategic Traffic Safety Plan
(*upcoming planning effort*)

Local Agencies – Vision Zero and Roadway Safety Action Plans

Federal Safer Streets For All: SS4A – \$4.7 million in AZ for Safety Planning Efforts (applications for next year’s funding anticipated in April 2023)

Arizona

Lead Applicant	Project Title	Type of Plan	Urban/Rural	Funding Award
City of Glendale	City of Glendale Safe Streets for All Action Plan Funding Application	Action Plan	Urban	\$799,834.00
City of Mesa	Transportation Comprehensive Safety Plan Development	Action Plan	Urban	\$750,000.00
City of Phoenix	City of Phoenix Supplemental Action Plan	Supplemental Action Plan	Urban	\$460,000.00
City of Scottsdale	City of Scottsdale Street Safety Action Plan	Action Plan	Urban	\$300,000.00
City of Tolleson	Creation of City’s First Action Plan to Eliminate Roadway Serious Injuries and Fatalities	Action Plan	Urban	\$200,000.00
MetroPlan (Flagstaff Metropolitan Planning Organization)	MetroPlan Flagstaff Vulnerable Road Users Safety Plan	Action Plan	Rural	\$201,360.00
Pima County	Pima County Safe Streets for All: Creating a Culture of Safety for Our Community	Action Plan	Urban	\$1,520,000.00
Town of Prescott Valley	Town of Prescott Valley Transportation Safety Action Plan	Action Plan	Rural	\$544,896.00
Total Arizona				\$4,776,090.00

The Importance of Road Safety in Transit Planning

When improving your transit routes – integrate a road safety evaluation

- Work with your Street Transportation Department

Station placement and upgrades

- Connectivity – can people safely get to the transit stop, what barriers are there for people walking
- Accessibility – sidewalks and bus stop
- Crossings – can people get to the bus on the other side of the street
- Comfort & Safety – elements at bus stop, lighting, etc.



A quick note on acronyms

- **BRT:** Bus Rapid Transit
- **HIN:** High Injury Network
- **COC:** Communities of Concern
- **HSM:** Highway Safety Manual
- **NCHRP:** National Cooperative Highway Research Program
- **CMF:** Crash Modification Factor
- **FHWA:** Federal Highway Admistration
- **AADT:** Average Annual Daily Traffic

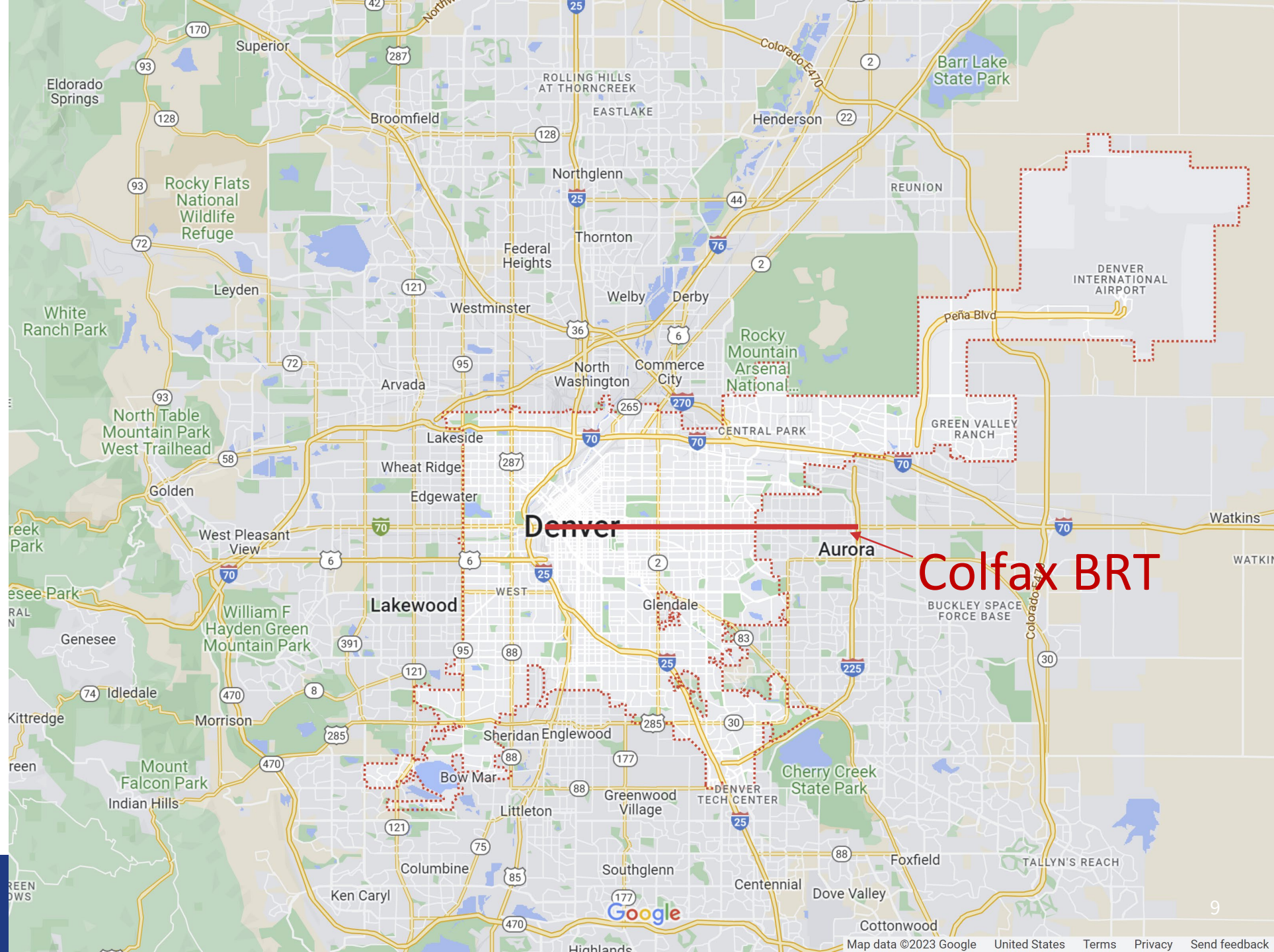


East Colfax Avenue BRT Denver, CO Case Study



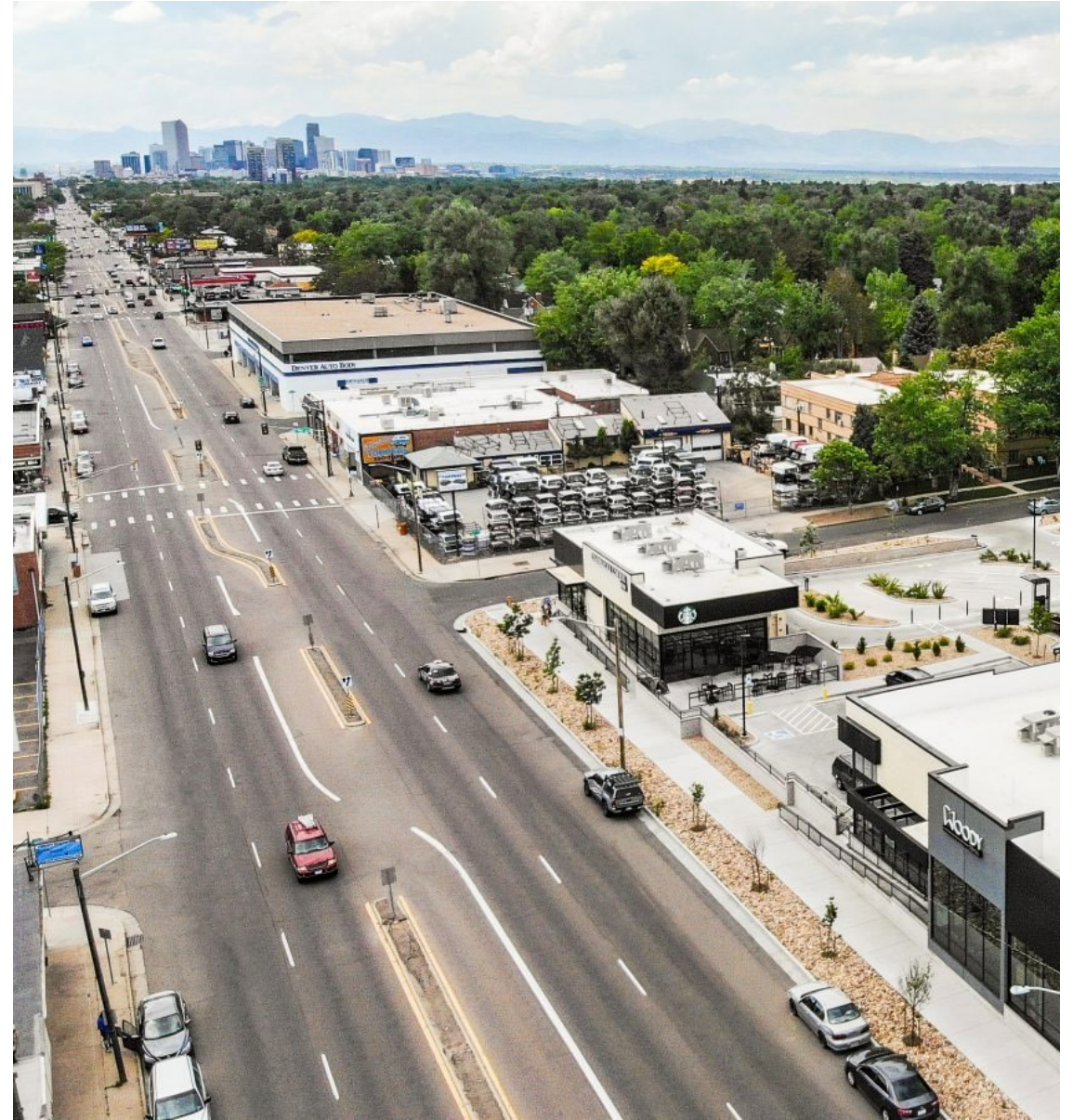
Location

- Downtown Denver/ Aurora



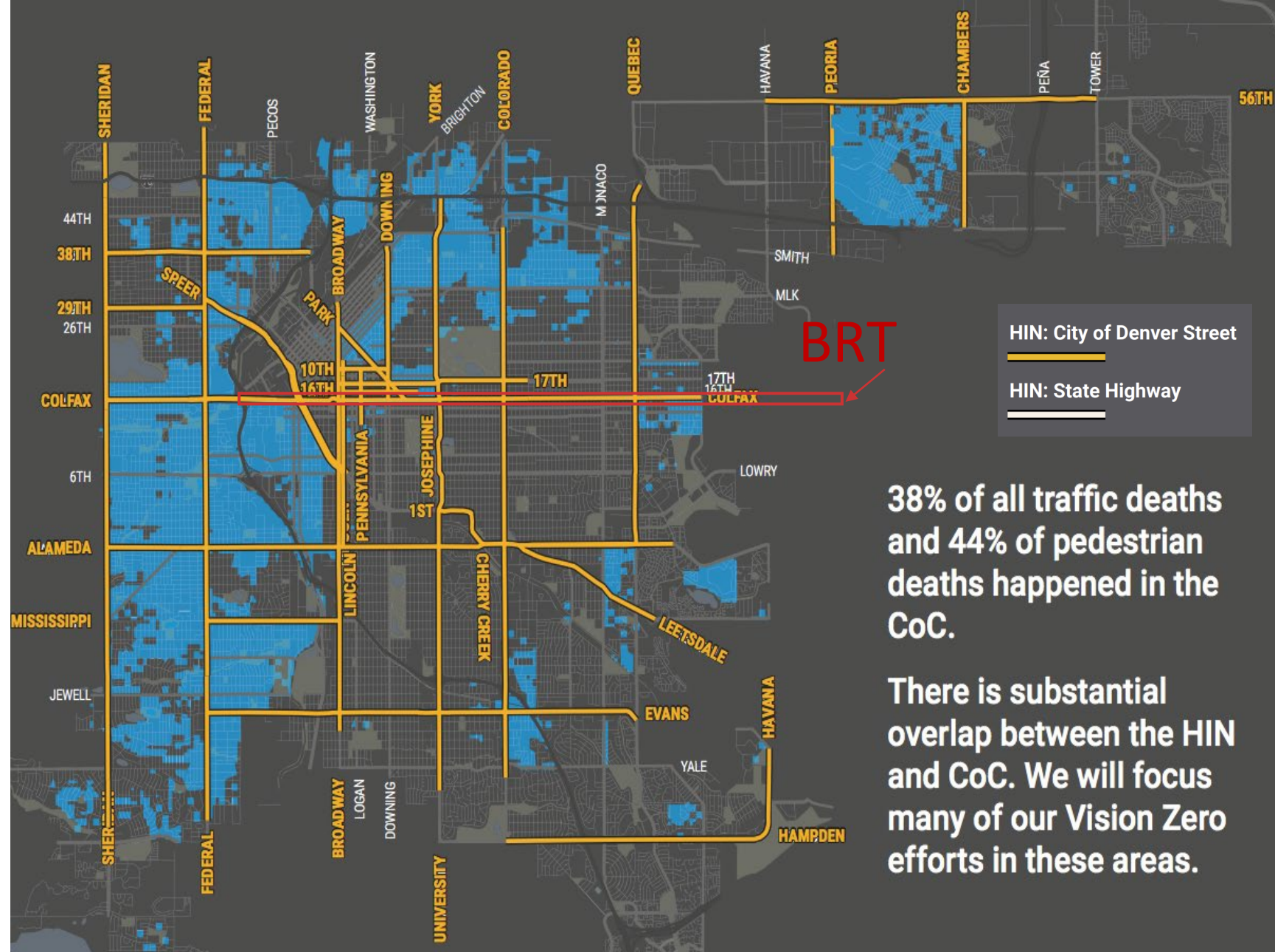
The area

- Front-facing commercial, nearby residential on cross streets
- East corridor (downtown) is busier than west portion (Aurora)
- 2 lanes in each direction
- On-street parallel parking



The need

- Highest bus ridership corridor within the region
- Adjacent to Communities of Concern
- Part of Denver's High Injury Network



38% of all traffic deaths and 44% of pedestrian deaths happened in the CoC.

There is substantial overlap between the HIN and CoC. We will focus many of our Vision Zero efforts in these areas.



The project



Graphic source: City of Denver, Winter 2019 report <https://qr.page/g/3FqMcPYi37w>

Project Need

DEMAND: Colfax Avenue has the highest bus ridership of any corridor in the region. The 15/15L routes combined see 7 million annual boardings — over 22,000 per weekday — and weekday ridership is projected to increase to over 50,000 in 2035.

ACCESS/DESTINATIONS: Will provide access to nearly 280,000 jobs in 2035, while serving Downtown, Auraria Campus, Anschutz Medical Campus, and nearly 50 schools.

MOBILITY: Provides more reliable service, decreases transit travel time by up to 15 minutes compared to 2035 “no-build” travel times, and provides connections to 3 RTD rail stations and 16 bus routes.

SAFETY: Supports Vision Zero through shorter pedestrian crossings with less exposure to vehicle traffic, reduction of conflicts and driver expectations.

PLACEMAKING: Increases investment by attracting new residential and commercial development.

EQUITY AND AFFORDABILITY: Provides affordable access to jobs and services and reduces household transportation cost burden.

In 2035:



Up to
50,000 daily riders



Access to
280,000 jobs



Up to 15 minute
transit travel time improvement

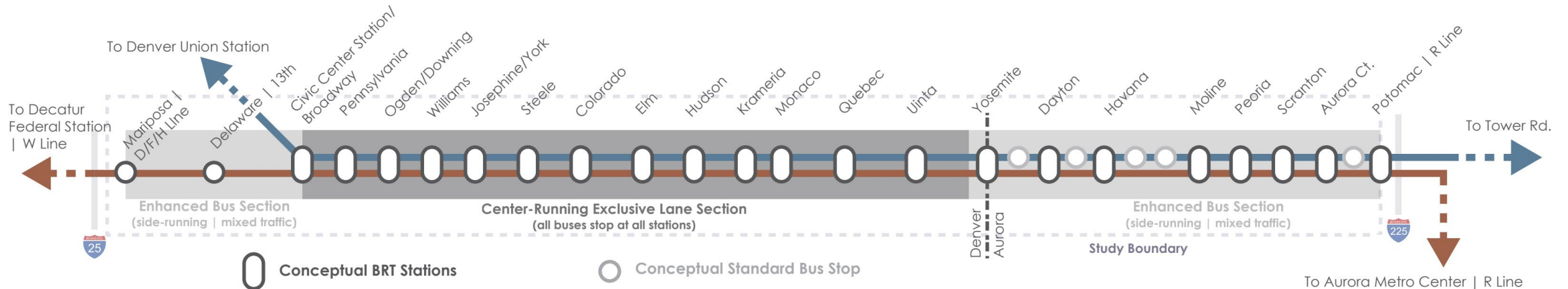
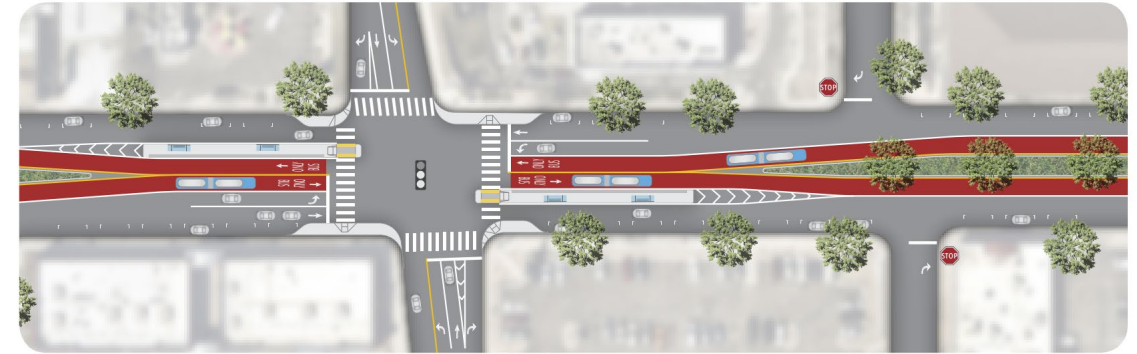


Learn more about the project
ColfaxBRT.org

The project

- Final stages of development. Safety evaluation performed at 30% design stage.
- Segments with side-running buses on the extremities, center running exclusive lane from Broadway to Yosemite (middle corridor in Denver).

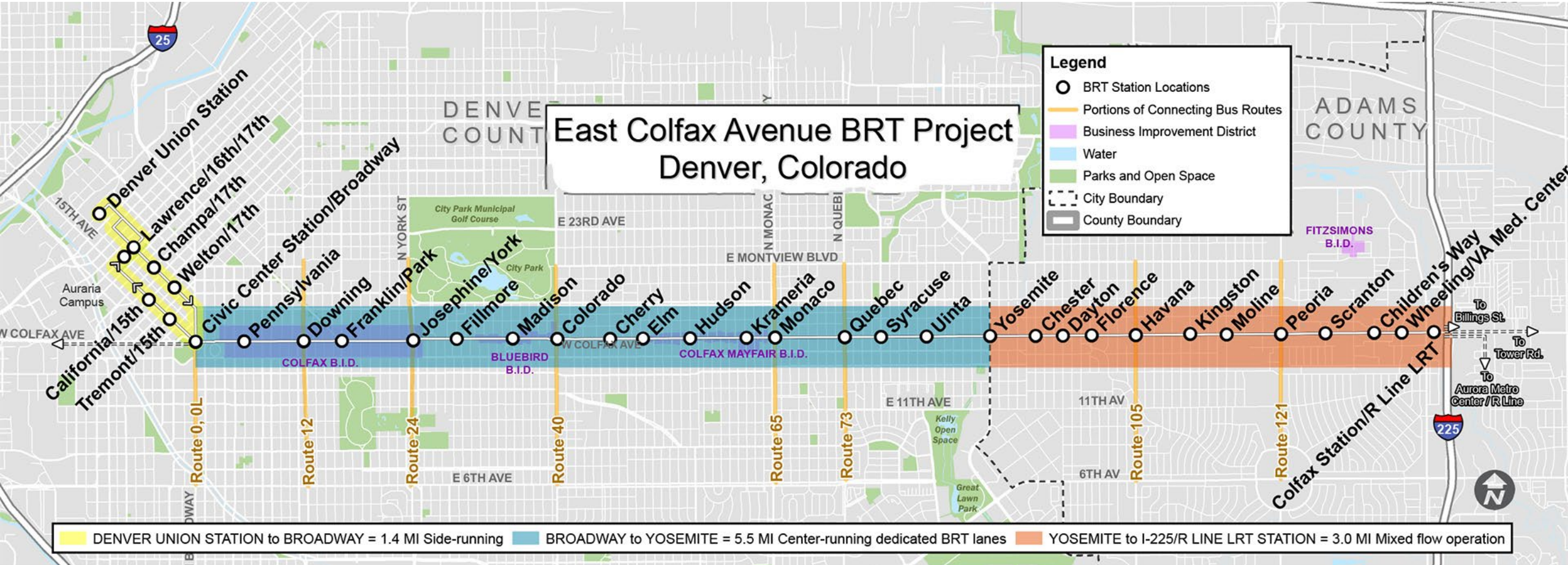
Station Area Conceptual Plan View



Note: Station locations to be refined and finalized during the design phase



The project



Study Area Segments



- 21 segments, approximately 0.5 miles in length
- Segmented based on consistent roadway characteristics



Study Area Intersections

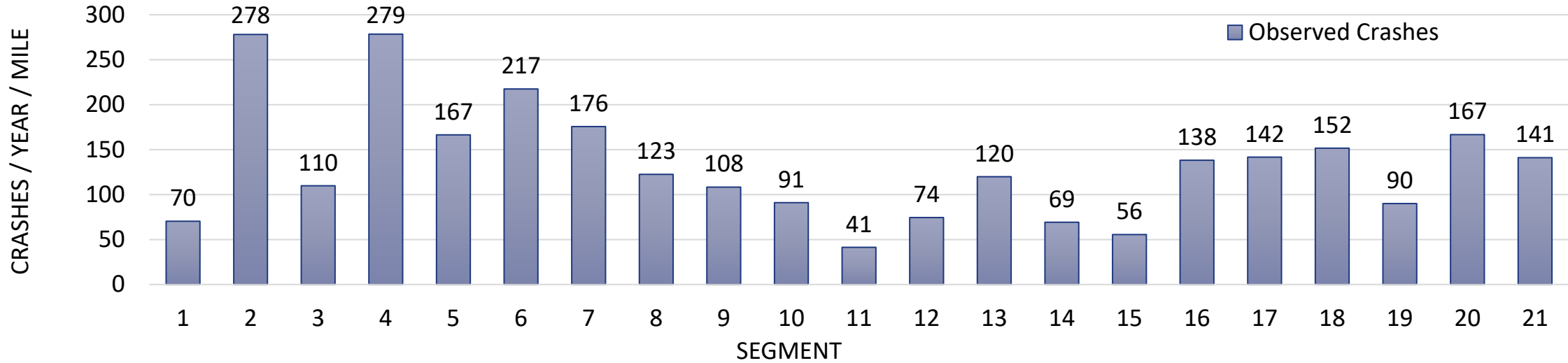
- 42 signalized intersections exist along the corridor
- 23 intersections compatible for predictive safety analysis



Historical Crash Data (2015-2019)



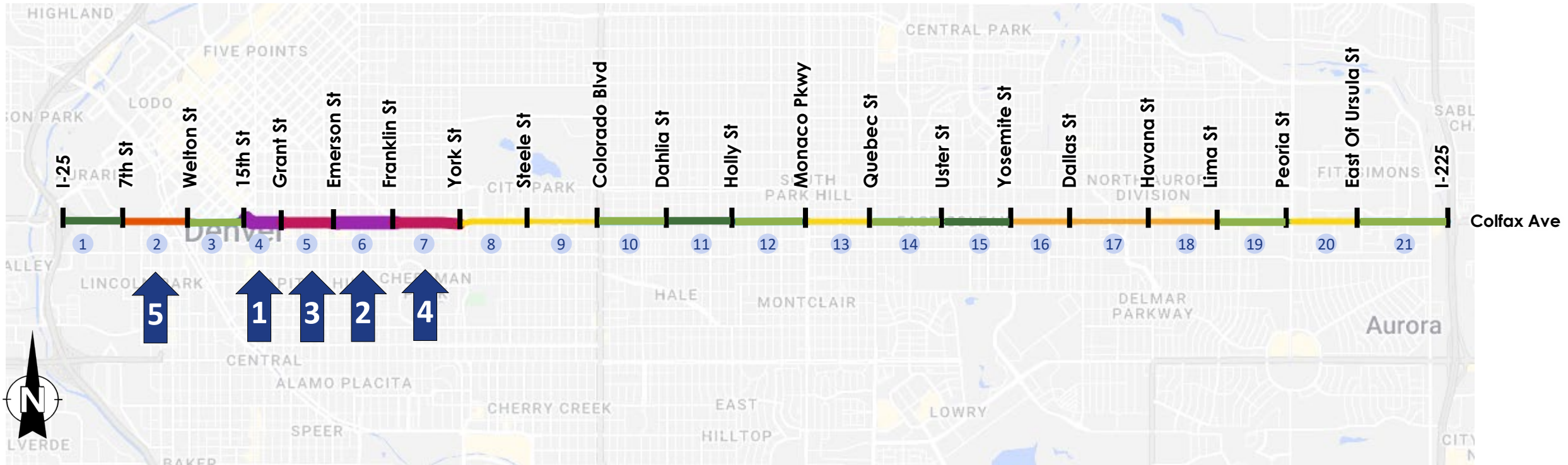
Historical Crashes Segments



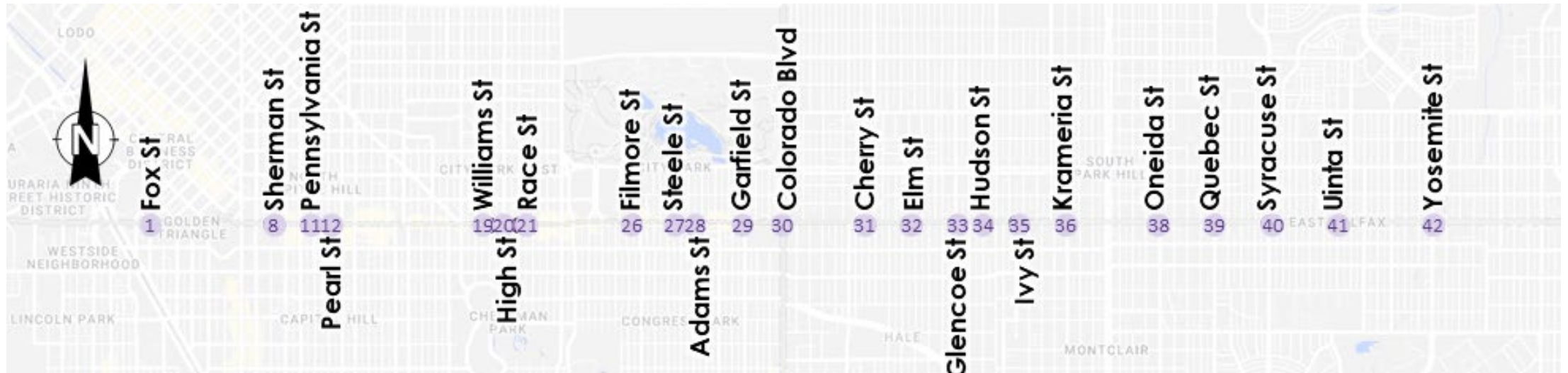
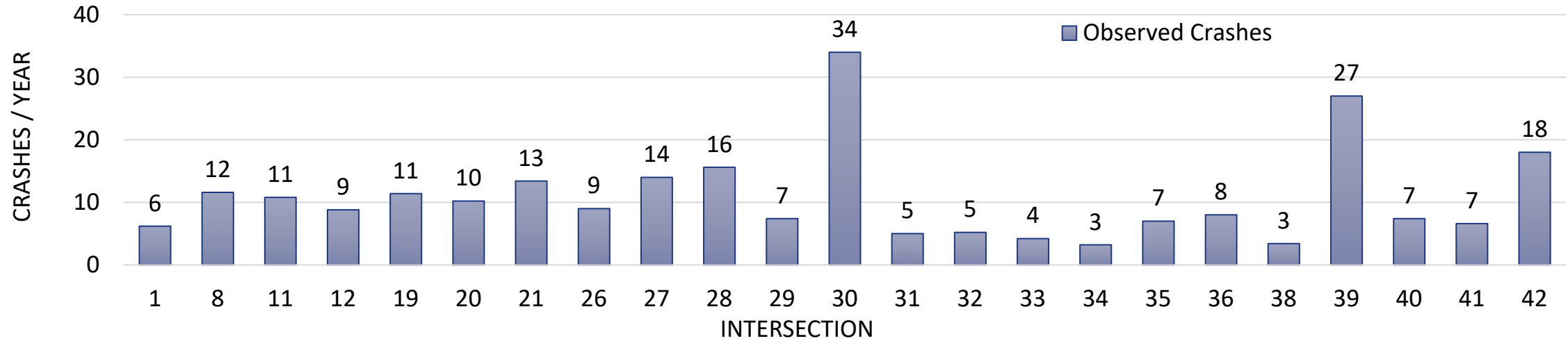
Historical Safety Evaluation (2015-2019)

Segments

Crash Rate ■ <5 ■ 5.0-9.9 ■ 10.0-12.4 ■ 12.5-14.9 ■ 15.0-17.4 ■ 17.5-19.9 ■ ≥20 (Crashes/Million Vehicle Miles)



Historical Crashes Intersections



Historical Safety Evaluation (2015-2019)

Intersections

Crash Rate (Crashes/Million Entering Vehicles)



Historical Safety Evaluation (2015-2019)

Transit Crashes



Predictive Safety Methodology



PREDICTIVE SAFETY SCOPE

EXISTING MODEL

- Existing (2019) traffic volumes
- Existing roadway conditions

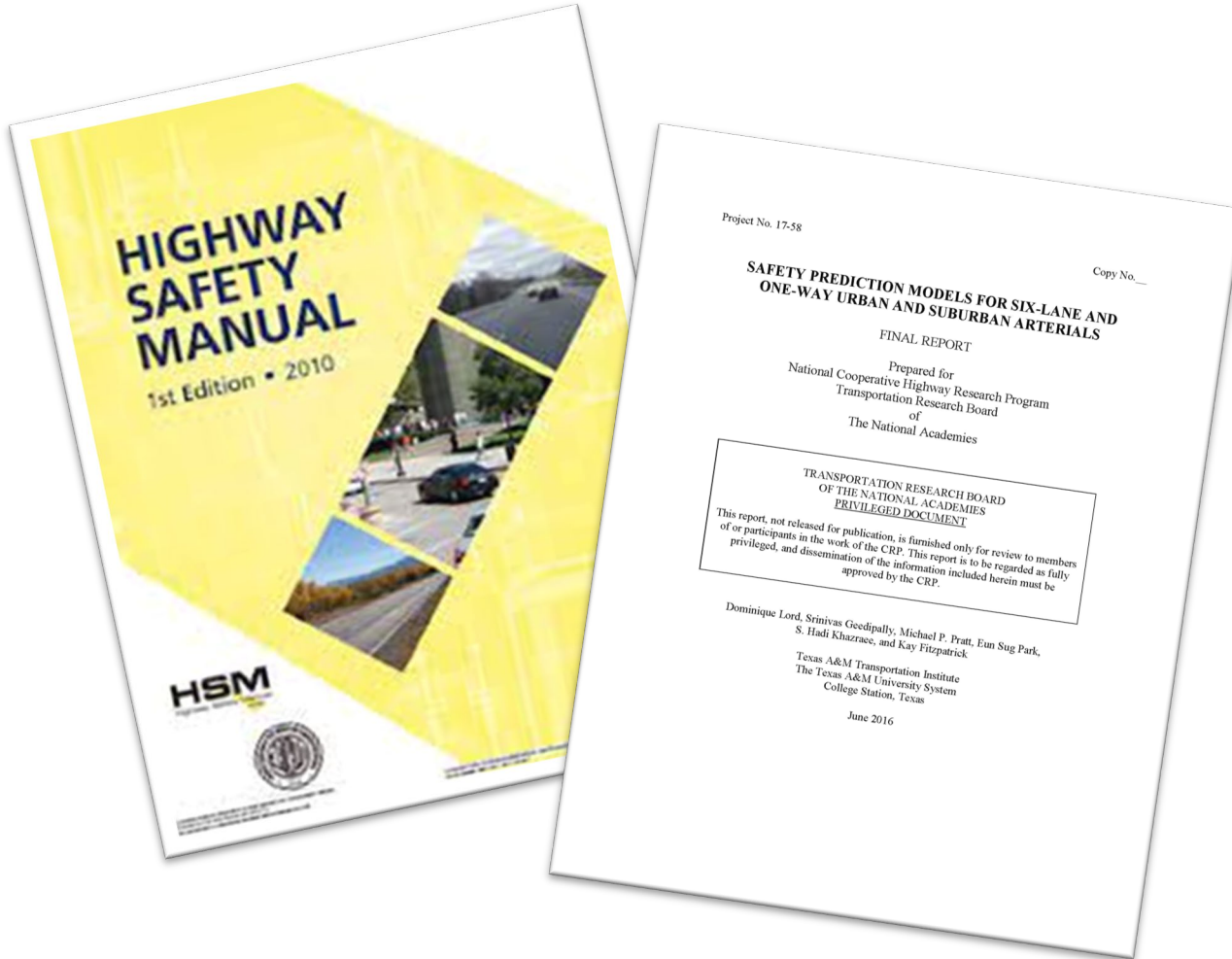
2040 NO BUILD MODEL

- 2040 traffic volume projections **without** BRT improvements
- Existing roadway conditions

2040 BUILD MODEL

- 2040 traffic volume projections **with** BRT improvements
- **Build** roadway conditions

Predictive Safety Methodology



- Based on Highway Safety Manual (HSM) and NCHRP 17-58
- Develop Models
 - Existing
 - 2040 No Build
 - 2040 Build
- Evaluation of segments (21) and signalized intersections (23)
- Calculate predicted crashes
- Use observed crashes to determine expected number of crashes



Adjustments to the HSM Methodology

- The methodology presented by the HSM and NCHRP do not account for transit implementation
- Crash Modification Factors (CMFs) were used to assess the impact of BRT

Crash modification factors are used to compute the expected number of crashes after implementing a countermeasure on a road or intersection.

- Other design changes were also considered on the built scenario, such as turn restrictions, number of lanes, and increased expected pedestrian volume.

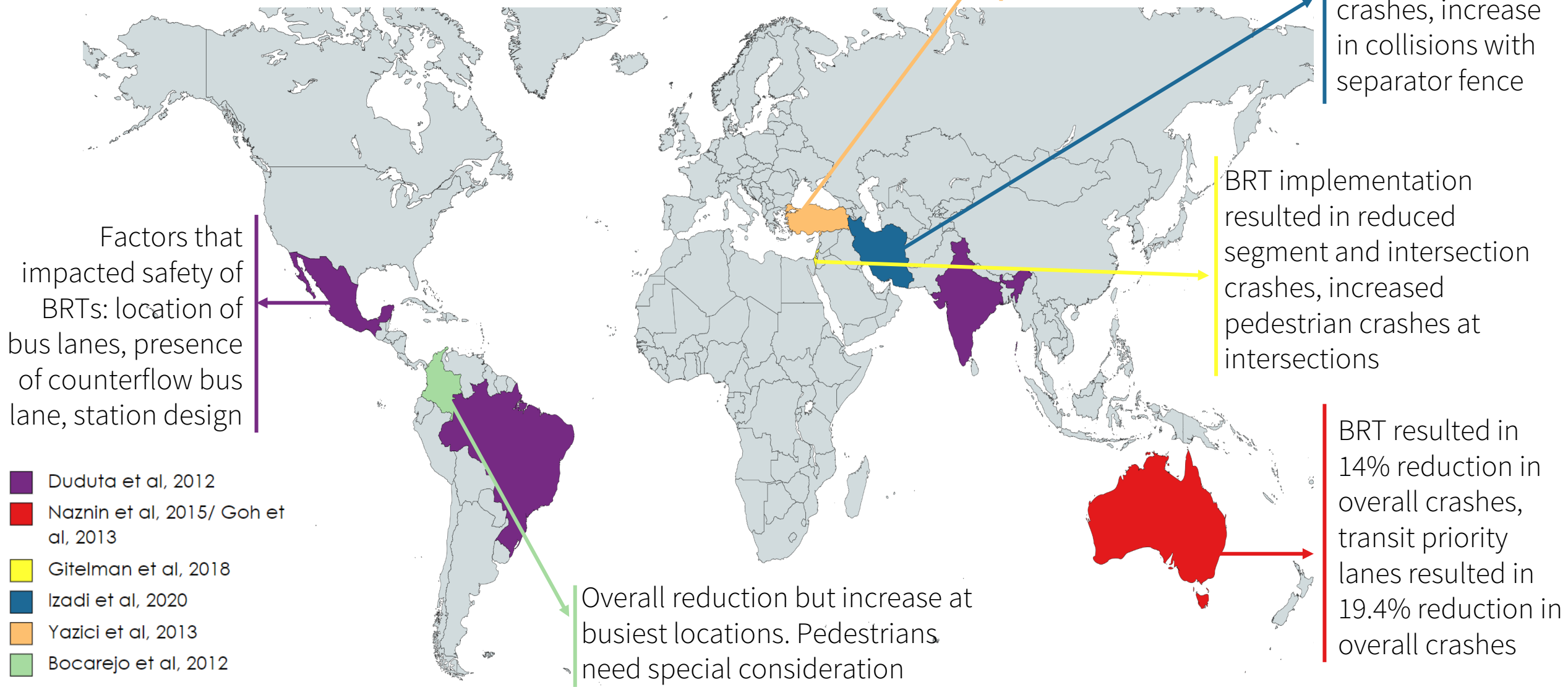


BRT Best Practices – Operation and Safety

- Recommended Features
 - BUS ONLY lane markings
 - Red/terracotta pavement surface color
 - Restriction of all left-turns, except through signalized protected-only left-turn phasing
 - Pedestrian improvements and wayfinding to/from each station platform
- Optional Features
 - Vertical separation elements
 - Flexible delineators to improve nighttime visibility



Past Research



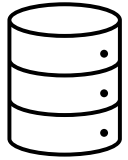
Application of Transit CMFs

- CMF information was obtained from the CMF Clearinghouse resource by FHWA
 - Special characteristics may be incorporated by applying additional CMFs to the safety performance functions
- Transit CMF applied to select intersections:
 - CMF 9664: Implement transit signal priority - overall crash reduction of 12.7%
 - Transit CMF applied to select segments:
 - CMF 7274: Implement transit lane priority – overall crash reduction of 19.4%



Predictive Safety Methodology

Input Data for Segments



Local data

- Crash history
- AADT
- Presence of automated enforcement



Virtual review

- Speed Limit
- Segment length
- Cross-section/number of lanes
- Median barrier – type and width
- Parking – type and coverage of segment

- Presence of lighting
- Driveway density and characteristics
- Roadside objects – density and average offset

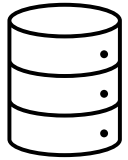
6-lane segments only:

- Lane and outside shoulder width
- Number of rail grade crossings



Predictive Safety Methodology

Input Data for Intersections



Local data

- Crash history
- AADT on major and minor street
- Pedestrian volumes (estimated)
- Left turn phasing
- Red-light cameras



Virtual review

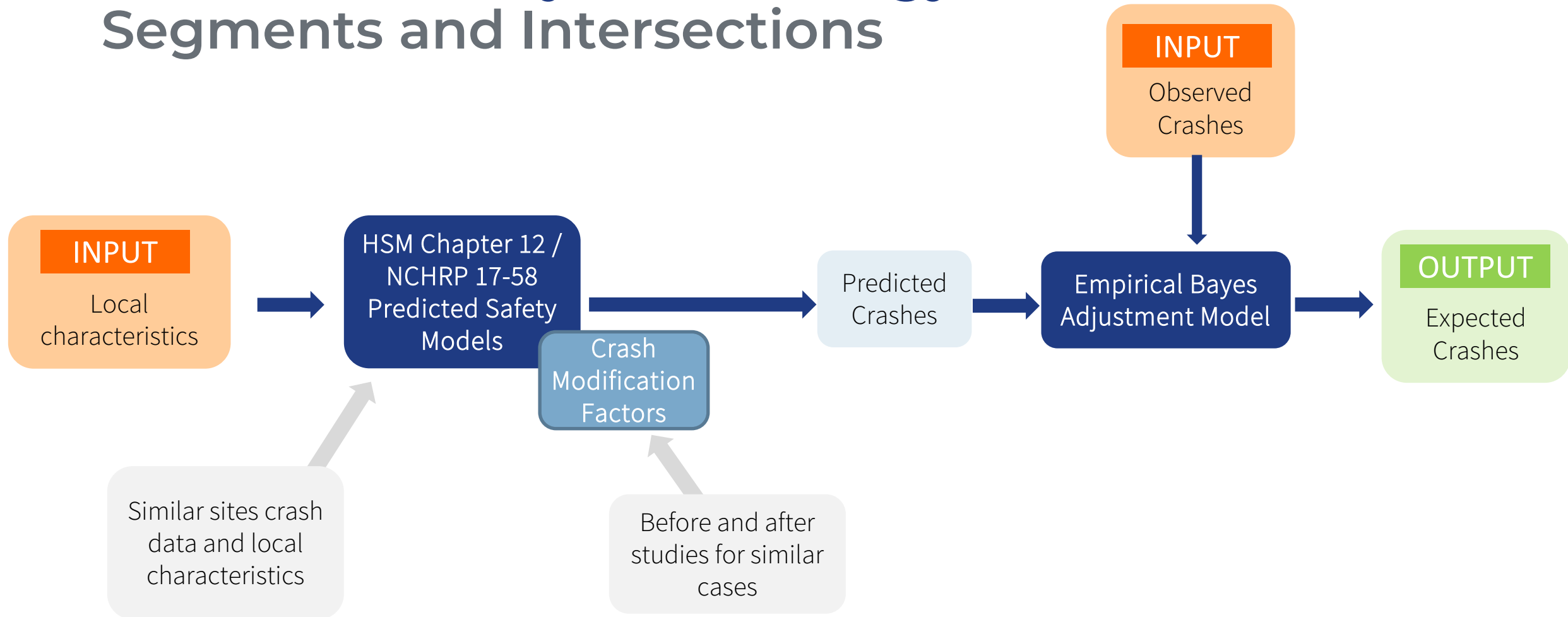
- Presence of schools, bars, and bus stops within 1000 ft of the intersection
- Intersection type (number of legs,

lanes per approach, signalized vs unsignalized)

- Presence of intersection lighting
- Dedicated turn lane configuration
- Right turn on red restrictions
- Number of lanes to be crossed by pedestrian



Predictive Safety Methodology Segments and Intersections



2019 Existing Model

- Existing (2019) traffic volumes
- Existing roadway conditions

2040 No Build Model

- Projected 2040 traffic volumes (without BRT)
- Existing roadway conditions

2040 Build Model

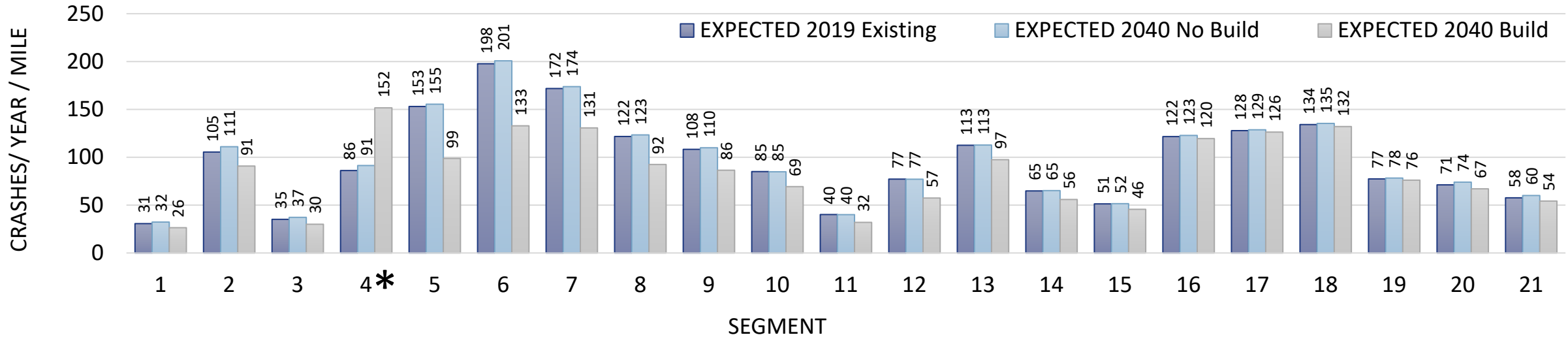
- Projected 2040 traffic volumes (with BRT)
- Future build conditions
- Key updates:
 - lane configuration
 - signal operation
 - incorporation of transit-related CMFs



Model Results

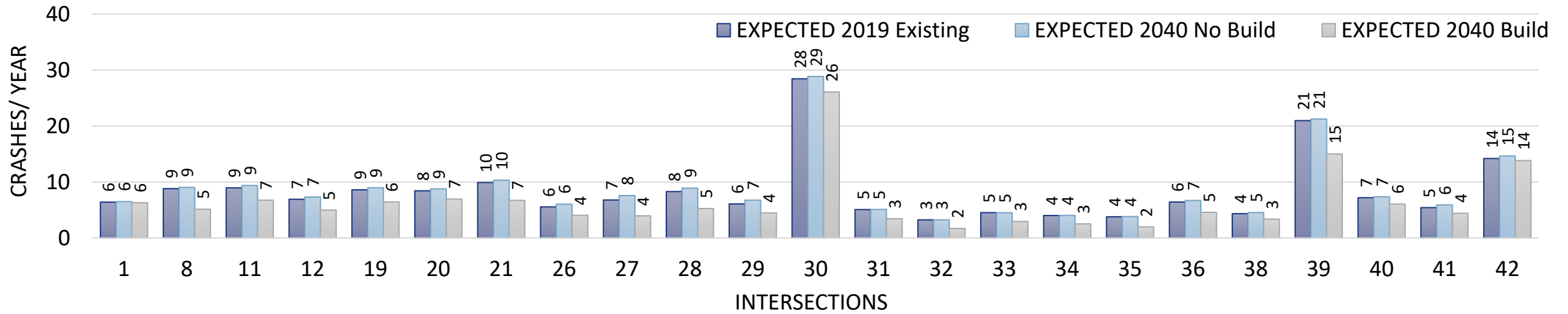


Predictive Safety Results – Model Comparison Segments



*Note: Between the No Build and Build scenario, the cross-section of Segment 4 changes from a 6-lane divided arterial (6D) to a 4-lane divided arterial (4D). The change in roadway type requires use of a different analysis tool; NCHRP 17-58 is used for 6D and HSM is used for 4D. The change in methodology resulted in an apparent increase in crashes in the 2040 Build model; however, based on qualitative review of the improvements proposed and trends of other segments, the increase in crashes is not anticipated in practice.

Predictive Safety Results – Model Comparison Intersections

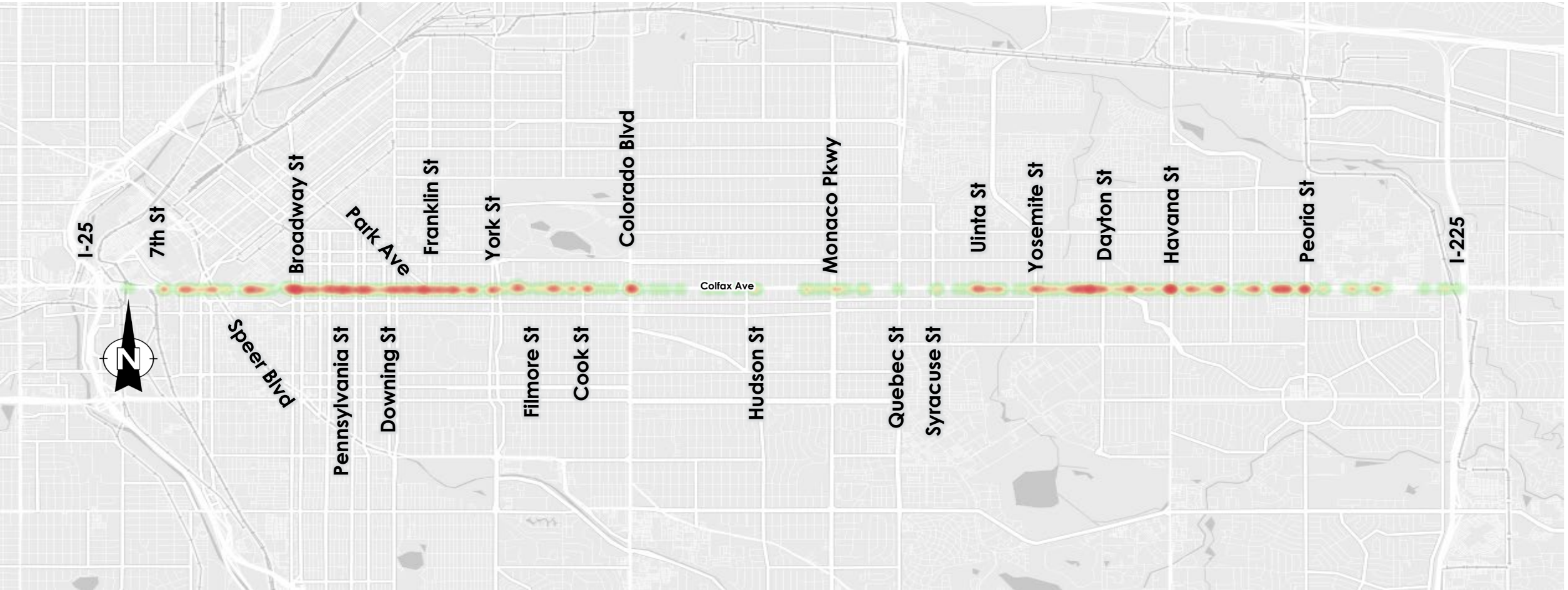


Pedestrian Considerations

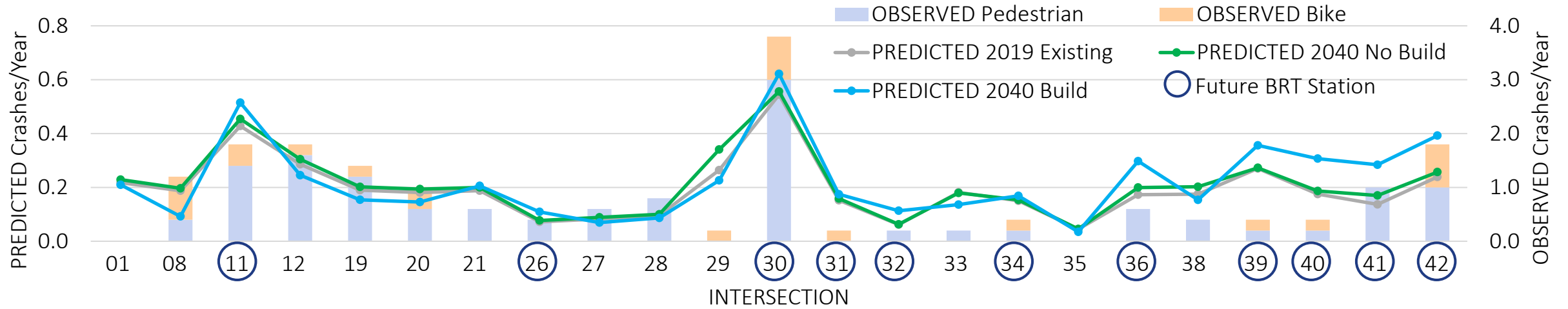


Pedestrian Considerations

Historical Crash Data (2015-2019)



Pedestrian Considerations Intersections



Conclusions



Conclusion

	Annual Expected Crashes		
	2019 Existing	2040 No Build	2040 Build
Studied Signalized Intersections	192.5	199.6 (+3.7%)	147.1 (-23.6%)
Studied Segments (Full Corridor)	958.1	974.0 (+1.7%)	828.1 (-13.6%)

Values in parenthesis indicate the percent change from the 2019 Existing Model.

- Along the corridor, the **2040 Build model** is anticipated to have a **13.6% reduction in crashes**, compared to the 2019 Existing model.
- At signalized intersections, the **2040 Build model** is anticipated to have a **23.6% reduction in crashes**, compared to the 2019 Existing model.



Conclusion

- The crash reductions associated with the 2040 Build model are associated with:
 - Installation of raised median
 - Protected-only left-turn operation at signalized intersections
 - Modified cross-section
 - Reduced traffic volumes
 - Implementation of transit priority lane
 - Implementation of transit signal priority
 - Reduced on-street parking
- While vehicular crashes are anticipated to decrease along the corridor and at intersections, consideration should be given to provide **enhanced safety features for pedestrians at intersections**, particularly at connections to station platforms.



Conclusion

- **Integrating safety** in transit planning is critical
 - Historical Safety Review – What has happened in the area/What is happening in the area
 - Predictive Safety Review – What can we expect in the area
- **Predictive safety** can serve as a tool to understand the safety impacts of planned transit projects, evaluating route options, identifying areas along transit corridors for additional improvements
- **Design** with pedestrian accessibility, connectivity, comfort, and safe crossings in mind
- Stay connected to **funding opportunities** - SS4A



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THANK YOU

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