T&E COMMITTEE #2
September 19, 2022

M E M O R A N D U M

September 14, 2022

TO: Transportation and Environment Committee

FROM: Glenn Orlin, Senior Analyst

SUBJECT: Predictive Safety Analysis[1]

PURPOSE: Briefing

In its Final Draft of what would become the 2020-2024 Growth and Infrastructure (G&I) Policy, the Planning Board proposed a new transportation adequacy test that would evaluate accident experience as part of a proposed development and would have required the developer to pay for a portion of its mitigation:

> **Safety System Adequacy.** Safety system adequacy will be defined through a Vision Zero test. This test will entail a safety performance analysis that will be performed utilizing a safety performance function (SPF). A SPF is an equation used to predict the number of crashes per year at a location as a function of exposure, land use and roadway or intersection characteristics. Development can impact the factors that influence the estimated number of crashes. The county is conducting a Predictive Safety Analysis for estimating SPFs and the estimated number of crashes for common crash types. Upon Planning Board approval following completion of the Predictive Safety Analysis, safety system adequacy will be defined as providing a reduction in the overall estimated number of crashes (based on SPFs) for the build conditions at all intersections and street segments within the study scope. This method should factor in development-generated site trips as well as development-related changes to the transportation network and public space. If the number of expected crashes is found to increase with the new development traffic, safety mitigation must be applied in order to reduce the overall number of expected crashes at study intersections and street segments to below predevelopment levels. The developer should make a fair share contribution to mitigation at study intersections that are not direct access points to the development [p. 71].

However, because its Predictive Safety Analysis tool was still under development at the time, the Council did not include this test as part of the adopted G&I Policy. The idea was that once it was ready the Council would review it as part of an off-cycle amendment to the G&I Policy.

[1] Key word: #sidewalks

The tool has now been developed, and the Planning staff wishes to brief the Committee on how it would work. Its PowerPoint is on ©1-31; a much shorter overview will be made to the full Council on September 20 as part of the larger Vision Zero briefing. The full report can be found here: https://montgomeryplanning.org/wp-content/uploads/2022/09/PSA-Final-Report-September-2022.pdf.

The Board is not recommending a G&I Policy amendment at this time, but it may include it as a proposal in the 2024-2028 update two years from now. Instead, the tool would be used by Planning staff in developing master plan and other recommendations, and it has encouraged others, including the Department of Transportation, to make use of it as well. DOT Director Conklin has been invited to the briefing to comment on the tool.

Staff anticipated to attend this worksession include:

Casey Anderson, Chair, Planning Board (tentative)
Jason Sartori, Section Chief, Countywide Planning and Policy (CP&P)
Dave Anspacher, Transportation Supervisor, CP&P
Jesse Cohn McGowan, Planner III, CP&P
Christopher Conklin, Director, Department of Transportation

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Predictive Safety Analysis

Montgomery Planning

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Predictive Safety Analysis

A proactive approach to identifying safety challenges and solutions

- Estimate the expected number of crashes at intersections and segments for key crash types
- Identify safety priorities and effective mitigations
- Working with UNC Highway Safety Research Center

Predictive Safety Analysis

A proactive approach to identifying safety challenges and solutions

The Predictive Safety Analysis uses **crash risk** to understand existing safety challenges, rather relying on crash history.

Crash history is the basis of most crash analysis, but **it is biased by the random nature of crashes**. Even though one intersection has no crashes, and another has one or two, the underlying crash risk at both may be the same.

Reliance on crash history is a particular problem for bicycle crashes, which are **relatively rare** compared to other crash types.

Key Steps

1. Compile data
2. Estimate volumes
3. Identify key crash types
4. Develop Safety Performance Functions
5. Identify high-risk locations
6. Identify countermeasures

1. Compile Data

Transportation Characteristics

- Speed limit
- Number of lanes
- Roadway slope
- Presence and type of crosswalk
- Presence and type of bicycle facility
- Roadway classification
- Intersection control
- Lighting
- Transit service

Land Use Characteristics

- Parks
- Hospitals
- Gas stations
- Parking lots
- Schools
- Government facilities
- Shopping centers
- Alcohol-serving locations
- Population density
- Employment density

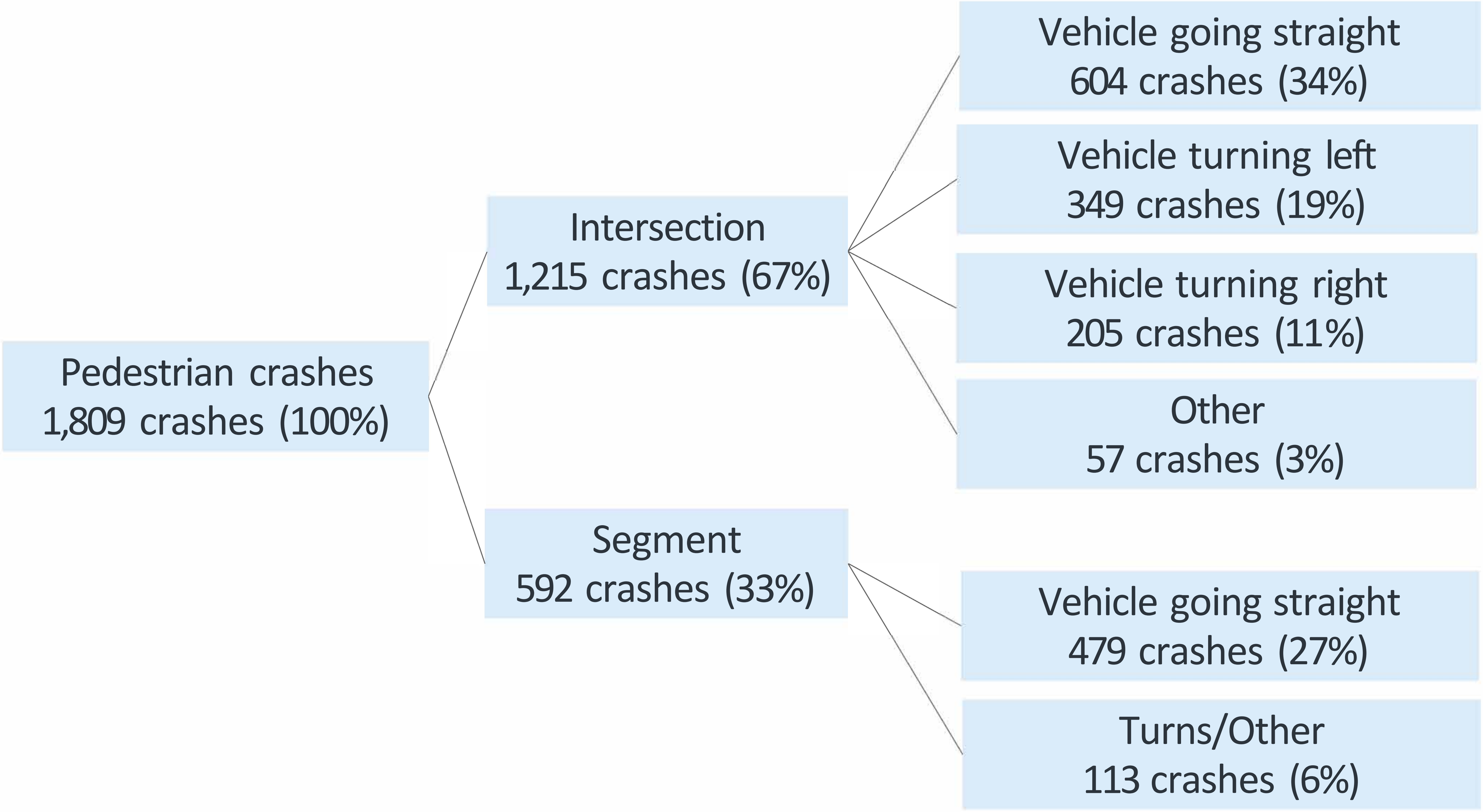
Demographic Characteristics

- Equity Emphasis Areas
- Income distribution
- Race/ethnicity distribution

2. Estimate Volumes

- Pedestrian, bicycle, and driver activity is referred to as exposure
- Exposure is a common variable in estimating crashes
- Compiled counts from development projects, MCDOT, and SHA
- Standardize counts based on time of day, day of week, season
- Estimate counts at all intersections and segments based on transportation, land use, and demographic attributes

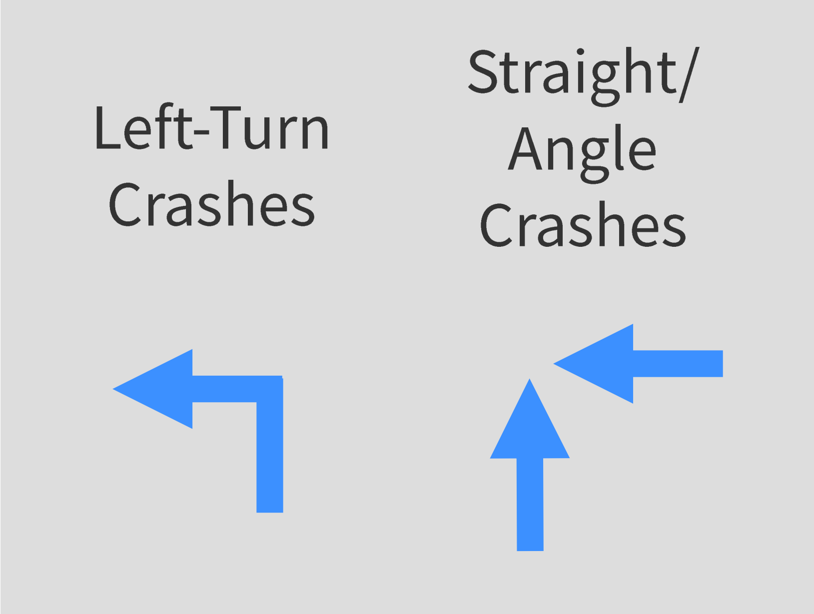
3. Identify Key Crash Types



Balance capturing most crashes with crash types linked to countermeasures

3. Identify Key Crash Types

- Pedestrian crashes after dark at intersections
- Pedestrian crashes along segments with vehicles going straight
- Bicycle crashes at intersections
- Left-turn crashes at intersections (all modes)
- Motor vehicle straight/angle crashes at intersections
- Single vehicle crashes along segments



3. Identify Key Crash Types

Crash types address crashes of all severities to provide a large same size of locations. These crash types were selected given their high injury rates, and overall, they capture a large percentage of severe injuries and fatalities.

Crash Types Summary (2015-2019)

Crash Type	% Severe Injuries & Fatalities
Pedestrian Crashes	73%
Bicycle Crashes	65%
Motor Vehicle Crashes	41%
All Crash Types	**49%**

4. Develop Safety Performance Functions

Annual Pedestrian Crashes at an Intersection =

A*Number of Daily Pedestrians +

B*Number of Daily Vehicles +

C*Speed Limit of Major Road +

D*Speed Limit of Minor Road +

E*Number of Intersection Approaches +

F* Number of High-Visibility Crosswalks

This is an illustrative example and not based on real data!

4. Develop Safety Performance Functions

Pedestrian segment crashes with vehicles going straight

Statistically significant variables		Relationship to crashes
Exposure	Pedestrian traffic	+
	Motor vehicle traffic	+
Transportation	Segment length	+
	Dead end	-
	Street class (state road, major road)	+
	Parking lots	+
	Number of marked crosswalks	+
	Bus routes	+
Land Use	Alcohol establishments	+
	Recreational points of interest	-
	Business points of interest	-
Demographics	Population density	+
	Income	-

4. Develop Safety Performance Functions

- **Observed Crashes** are the historical crashes. These are the basis of most crash analysis but are biased by the random nature of crashes.
- **Predicted Crashes** are the outcome of the SPFs and account for the characteristics in the SFP equation. They are useful for identifying sites which may not have many observed crashes but have the potential to be high-crash sites based on their characteristics.
- **Empirical-Bayes (EB) Crashes ("Crash Risk")** weighs both observed and predicted crashes based on 1) how well the SPF predicts crashes and 2) the number of predicted crashes at the specific location. EB crashes are the most reliable estimate of the underlying crash frequency at a given location based on all available information.

5. Identify High-Risk Locations

- **Total Annual Crash Risk** the sum of the crash risk for each crash type. This assessment determines which areas have the greatest overall crash risk.
- **Hot Spot Analysis** looks at the top 200 locations with the highest crash risk. This analysis determines the specific locations with the greatest safety challenges and can inform stand-alone capital projects.
- **Average Annual Crash Risk** applies a broader lens to understanding crash risk by dividing the number of crashes by the number of locations for each crash type. This analysis determines type of locations with the greatest safety challenges and can inform systemic improvements.

5. Identify High-Risk Locations

Equity Emphasis Areas vs. Non-Equity Emphasis Areas

EEA	# Ints.	Intersection Crashes				# Segs.	Segment Crashes	
		Ped Dark	Bike	Left Turn	Angle		Ped Seg	Single Veh
Total Crash Risk (# Annual Crashes)								
EEA	3,049	48	24	251	278	5,040	32	124
Non-EEA	13,607	56	61	477	569	26,002	51	661
Hot Spot Analysis (# Locations within the Top 200)								
EEA	3,049	108	66	80	78	5,040	134	26
Non-EEA	13,607	92	134	120	122	26,002	66	174
Average Crash Risk (# Annual Crashes)								
EEA	3,049	0.02	0.01	0.08	0.37	5,040	.007	.025
Non-EEA	13,607	0.00	0.00	0.04	0.19	26,002	.002	.026

Highlighted cells have the highest value for any column.

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		+272%	**+72%**	**+130%**	**+92%**		**+226%**	**-4%**

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5. Identify High-Risk Locations

Complete Streets Design Guide Area Type (Annual Crashes)

CSDG Area Type	# Ints.	Intersection Crashes				# Segs.	Segment Crashes	
		Ped Dark	Bike	Left Turn	Angle		Ped Seg	Single Veh
Total Crash Risk (# Annual Crashes)								
Downtown	359	31	11	85	92	760	12	41
Town Center	808	20	11	131	144	1,719	17	83
Suburban	12,165	36	48	337	472	22,591	38	428
Country	1,027	0	2	22	20	1,898	3	155
Hot Spot Analysis (# Locations within the Top 200)								
Downtown	359	84	45	22	26	760	51	3
Town Center	808	45	36	42	42	1,719	75	20
Suburban	12,165	42	89	87	99	22,591	36	94
Country	1,027	0	0	1	4	1,898	1	68
Average Crash Risk (# Annual Crashes)								
Downtown	359	0.09	0.03	0.24	0.76	760	0.02	0.06
Town Center	808	0.03	0.01	0.18	0.74	1,719	0.01	0.05
Suburban	12,165	0.00	0.00	0.03	0.17	22,519	0.00	0.02
Country	1,027	0.00	0.00	0.02	0.16	1,898	0.00	0.08

Highlighted cells have the highest value for any column.

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5. Identify High-Risk Locations

Complete Streets Design Guide Street Type:
Total Crash Risk (# Annual Crashes)

CSDG Street Type	# Ints.	Intersection Crash Types				# Segs.	Segment Crash Types	
		Ped Dark	Bike	Left Turn	Angle		Ped Seg	Single Veh
Major Highway	18	1	1	11	13	16	0	19
Boulevard	1,191	29	33	334	359	1,217	16	194
Downtown Blvd	134	20	6	57	58	161	7	14
Town Center Blvd	225	13	6	70	89	288	10	31
Downtown Street	210	13	4	26	26	336	5	11
Town Center Street	138	1	1	11	12	191	2	9
Neighborhood Conn	2,825	8	14	64	132	2,997	10	112
Country Conn	280	0	1	14	13	226	1	57
Country Road	90	0	0	1	1	60	0	4
Industrial Street	50	0	0	5	1	59	0	3
Neighborhood Street	9,132	9	6	21	55	21,168	20	227
Rustic Road*	183	0	0	2	4	317	1	36

Highlighted cells have the highest value for any column.

5. Identify High-Risk Locations

Complete Streets Design Guide Street Type:
Hot Spot Analysis (# Locations within the Top 200)

CSDG Street Type	# Ints.	Intersection Crash Types				# Segs.	Segment Crash Types	
		Ped Dark	Bike	Left Turn	Angle		Ped Seg	Single Veh
Major Highway	18	1	0	2	5	16	2	10
Boulevard	1,191	50	109	109	104	1,217	39	59
Downtown Blvd	134	48	29	18	16	161	30	0
Town Center Blvd	225	35	21	22	25	288	58	6
Downtown Street	210	40	8	3	5	336	19	0
Town Center Street	138	0	0	2	3	191	5	1
Neighborhood Conn	2,825	2	7	5	17	2,997	6	10
Country Conn	280	0	0	2	2	226	0	30
Country Road	90	0	0	0	0	60	0	0
Industrial Street	50	0	0	2	0	59	0	0
Neighborhood Street	9,132	1	6	1	1	21,168	5	59
Rustic Road*	183	0	0	2	0	317	0	10

Highlighted cells have the highest value for any column.

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5. Identify High-Risk Locations

Complete Streets Design Guide Street Type:
Average Crash Risk (# Annual Crashes)

CSDG Street Type	# Ints.	Intersection Crash Types				# Segs.	Segment Crash Types	
		Ped Dark	Bike	Left Turn	Angle		Ped Seg	Single Veh
Major Highway	18	0.05	0.03	0.60	1.08	16	0.02	1.17
Boulevard	1,191	0.02	0.03	0.28	0.81	1,217	0.01	0.16
Downtown Blvd	134	0.16	0.05	0.43	1.09	161	0.04	0.09
Town Center Blvd	225	0.06	0.03	0.31	1.33	288	0.04	0.11
Downtown Street	210	0.06	0.02	0.12	0.33	336	0.01	0.03
Town Center Street	138	0.01	0.01	0.08	0.32	191	0.01	0.05
Neighborhood Conn	2,825	0.00	0.00	0.02	0.15	2,997	0.00	0.03
Country Conn	280	0.00	0.00	0.05	0.22	226	0.00	0.25
Country Road	90	0.00	0.00	0.01	0.12	60	0.00	0.06
Industrial Street	50	0.01	0.01	0.10	0.28	59	0.01	0.04
Neighborhood Street	9,132	0.00	0.00	0.00	0.03	21,168	0.00	0.01
Rustic Road*	183	0.00	0.00	0.01	0.26	317	0.00	0.12

Highlighted cells have the highest value for any column.

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5. Identify High-Risk Locations

Portion of Total Annual Crash Risk included in Top 200 Locations

Crash Type	% Crash Risk in Top 200
Motor vehicle straight/angle crashes at four-legged intersections	48%
Pedestrian crashes after dark at intersections	47%
Left-turn crashes at intersections (all modes)	46%
Single vehicle crashes along segments	27%
Bicycle crashes at intersections	25%
Pedestrian crashes along segments with vehicles going straight	23%

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5. Identify High-Risk Locations

Key Takeaways

- Investments need to balance location types with high total crash risk, hot spots, and location types with high average crash risk.
- Prioritization needs to look beyond crash history, as only 55% of fatalities and 46% of severe injuries occurred in top 200 intersections and roadway segments.
- Safety improvements in Equity Emphasis Areas should be prioritized.
- While much of the county is suburban, downtown and town center area types (and their associated street types) have high average crash risk.

6. Identify Countermeasures

Speed Management
- Automated Enforcement – Speed Cameras
- Lower Speed Limit by 5 MPH
- Speed Humps

Pedestrian Crossings
- High-Visibility Crosswalks
- Raised Pedestrian Crosswalk
- Pedestrian Hybrid Beacon

Intersection Control
- Convert Side-Street Stop to All-Way Stop
- Install Traffic Signal
- Convert Median to a "Left-In-Only" Median

Signal Timing
- Increase All-Red Clearance Interval
- Implement Protected/Permissive Left Turn
- Implement Fully Protected Left Turn
- Leading Pedestrian Interval

Other Countermeasures
- Centerline Rumble Strips
- Lighting

6. Identify Countermeasures

Dynamic tools to evaluate different countermeasure scenarios through the following metrics:

- Potential Crash Reduction
- Cost per Crash Reduced
- Percent of Locations in Equity Emphasis Area

Print a list of top-ranked locations for each scenario, including whether it is on a state road or within an Equity Emphasis Area.

6. Identify Countermeasures

Example 1: Determining which Countermeasures to Implement

Example Scenarios for Reducing Angle Crashes with $350,000 (10-Year Impact)

Scenarios	Increase All Red Clearance*	All-Way Stop	Traffic Signal
Number of Locations	116	70	1
Total Estimated Cost	$348,000	$350,000	$350,000
Predicted Crash Reduction	2,557	311	47
Crash Reduction per Location	22.0	4.4	47.4
Cost per Crashes Reduced	$140	$1,130	$7,380
% of Locations in Equity Emphasis Areas	47%	21%	0%

* on Boulevards, Downtown Boulevards, Town Center Boulevards, Major Highways

6. Identify Countermeasures

This table presents the potential crash reduction and other metrics associated with allocating **$500,000** to specific systemic countermeasures.

Locations with the highest crash risk would be prioritized for implementation.

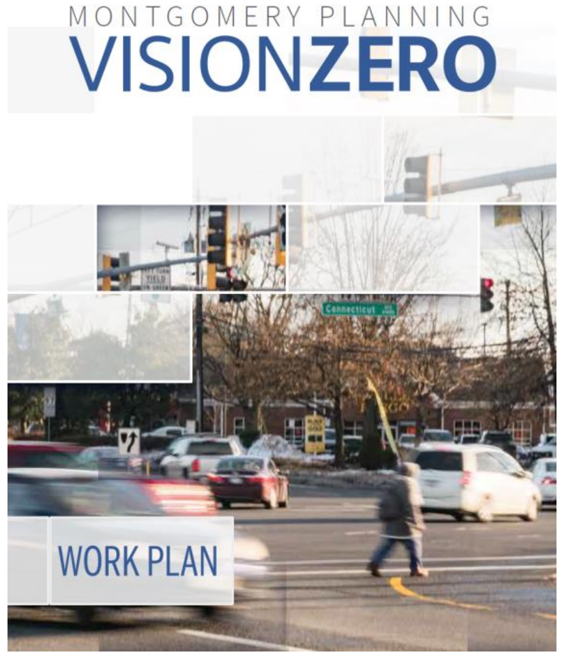
Total Estimated Cost:
$4,000,000

Systemic Countermeasure	Increase "All Red" Time at Signalized Intersections	Reduce Speeds by 5 mph	Only Permit Left Turns on Left Arrow	All-Way Stop Control	Speed Humps	Centerline Rumble Strips	High Visibility Crosswalks	Leading Pedestrian Interval
Context	Signalized intersections on Boulevards, Downtown Boulevards, Town Center Boulevards, Major Highways	Roads in country areas with speed limits > 25 mph	Signalized intersections in urban and suburban areas with a left-turn lane on the major approach and a current protected/ permissive phase	Side-street stop-controlled intersections with speed limits < 35 mph, daily vehicles < 10,000, and up to 2 lanes on any approach	Segments in urban and suburban areas with no marked crosswalk, 2 lanes, speeds ≤ 25 mph, and between 1,500 and 15,000 daily vehicles	Roads in country areas with two lanes	Signalized intersections with standard marked crosswalks, but not high-visibility crosswalks	Signalized intersections on Downtown Boulevards
Locations with Budget ($500k) of all Candidate Locations	166 of 316	333 of 484	10 of 271	100 of 443	100 of 11,191	43 of 1,850	40 of 296	68 of 68
Estimated Cost per Countermeasure	$3,000	$1,500	$50,000	$5,000	$5,000	$1.5/foot	$12,280	$3,000
Total Potential Crash Reduction (10 Years)	**3,264**	**1,078**	**443**	**371**	**180**	**121**	**96**	**90**
Potential Crash Reduction per Location (10 Years)	19.7	3.2	44.3	3.7	1.8	2.8	2.4	1.3
Cost per Crashes Reduced	$150	$460	$1,130	$1,350	$2,770	$4,080	$5,100	$2,260
% of Locations in Equity Emphasis Areas	36%	0%	50%	19%	61%	0%	53%	31%
Potential Crash Reduction (National Research)	20.2% reduction for all crashes in urban areas	56% reduction for all crashes in rural areas	42% reduction for urban and suburban crashes	68.1% reduction for all crashes, 43% reduction for pedestrian crashes in urban areas, and 75% reduction for angle crashes in urban areas	45% reduction for all crashes	14% reduction for all crashes in rural areas and 19.2% reduction for single-vehicle crashes in rural areas	37% reduction for pedestrian crashes in urban areas	17% reduction for all crashes and 19% reduction for pedestrian crashes

Applications

The Predictive Safety Analysis is the **first step** towards implementing a proactive approach to safety. Can be used to apply a **data-driven** approach to **recommendations, mitigation, and prioritization,** and can be incorporated into:

- CIP Project Funding
- Systemic Projects Prioritization
- Master Planning
- Regulatory Review
- Grant Applications



Link to Vision Zero Work Program

Building Knowledge and Partnerships

- **Develop a Vision Zero Toolkit**
- Engaging Hard-to-Reach Communities
- **Educate Community, Agency Staff, & Decisionmakers**
- Vision Zero E-Newsletter

Problem Verification

- Develop a Severe and Fatal Crash Dataset
- **Develop a Multimodal Volumes Data Collection Plan**
- **Collect Multimodal Counts and Traffic Speed Data**
- **Estimate Volumes Countywide**
- Create a Dataset to Store Counts and Speed Data
- **GIS Layers of Variables Associated with Crashes**
- **Develop Safety Performance Functions**
- Create a Pedestrian Level of Comfort Map

Develop Solutions

- Identify Best Practices for VZ in the Suburbs
- Develop Policies for Street Types
- Develop Complete Streets Design Guide

Incorporate Solutions into Work Program

- **Educate Staff on Vision Zero**
- Continuing Education
- Incorporate Corridor Master Plans into Work Program
- **Changes to State and Local Policies & Regulations**
- Develop Pedestrian Master Plan
- **Incorporate Vision Zero into Master Plans**
- **Incorporate Vision Zero into Development Review**
- **Incorporate Vision Zero into the GIP**
- **Capital Project Review**

Addressed through Predictive Safety Analysis

Can be addressed/updated with PSA findings

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- Incorporate Vision Zero into the GIP
- Capital Project Review

Addressed through Predictive Safety Analysis	Can be addressed/updated with PSA findings
Complete or Ongoing	Upcoming Priorities

Questions?

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