Toolkit

Vermont Systemic Safety Risk-Based Screening for Intersections

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September 2024

Contents

Orientation

This guide provides access to useful tools to assess the safety of intersections in Vermont using risk-based safety screening.

The guide also provides general information on systemic intersection safety and background on the risk-based safety screening analysis that was performed. Users are invited to read the compendium of technical memoranda for a more detailed discussion of the project.

Within this guide, click on green boxes for links to other websites or documents.

Technical Memoranda

Background

The Vermont Agency of Transportation led the risk-based screening project with federal funds through the Transportation Records Coordinating Committee and with a state match from state funds. The consulting firm VHB was retained to perform the analysis work. The Operations and Safety Bureau built this guide and tools to provide access to the results for implementation.

The principal purpose of the project was to apply the systemic safety approach to intersection crashes for proactively implementing treatments at locations with crash correlated characteristics.

The crash data used for this risk-based analysis consisted of fatal, suspected serious injury and suspected minor injury crashes (KAB crashes) for the crash reporting period 2017 to 2021. In addition, for the same period, for certain pedestrian models, all injury types (KABC) or all severity types (KABCO) were used.

The risk-based screening covers the following crash type and facility type combinations.

Category #	Crash Type	Control Type	Characteristics	Severity
Category 1	Left Turn	Minor Stop-Controlled		KAB
Category 2	Left Turn	Minor Stop-Controlled	With at Least One State-Owned Leg	KAB
Category 3	Rear-End	Unsignalized [i]		KAB
Category 4	Rear-End	Signalized	With at Least One Non-State Leg	KAB
Category 5	Angle/Broadside	Signalized	Urban, Four-Leg with No State Legs	KAB

Category #	Crash Type	Control Type	Characteristics	Severity
Category 6	Angle/Broadside	Minor Stop-Controlled	T-Intersections with One or More Nonstate Legs	KAB
Category 7	Angle/Broadside	Minor Stop-Controlled		KAB
Category 8	Head-On	Minor Stop-Controlled	T-Intersections with at Least One Nonstate Leg	KAB
Category 9	Single Vehicle	Minor Stop-Controlled	T-Intersections with One or More Nonstate Legs	KAB
Category 10	Collision with a Fixed Object			KAB
Category 11	Pedestrian-Vehicle			KAB
Category 12	Pedestrian-Vehicle		Pedestrian in Marked Crosswalk at Intersection[ii]	KABCO
Category 13	Pedestrian-Vehicle		Pedestrian not in a Marked Crosswalk	KABCO
Category 14	Bicycle-Vehicle			KAB
Category 15	Pedestrian-Vehicle		Nighttime	KABC

i. Includes four-leg minor stop-controlled intersections, uncontrolled t-intersections, minor stop-controlled t-intersections and y- intersections, and four-leg all-way stop-controlled intersections.
ii. Because the VTrans intersection inventory does not include marked crosswalks, the model used all intersections. Users should verify crosswalk presence before advancing a site for review.

Risk-Based Intersection Screening Toolkit

The risk-based intersection screening toolkit, aka the Toolkit, can be used to view and access safety data focused on systemic, risk-based analysis to assess the vulnerability of an intersection for certain types of crashes and to identify remedial treatments and prioritize efforts to reduce the number of fatal and serious injury intersection crashes.

Users should understand that risk is relative, not a certainty. It is possible that no intersection crashes will happen at an intersection, but that, on average, if one were to happen, an intersection categorized as primary or high risk is an intersection for which a crash would be more likely to occur. This does not

characterize the intersection as safe versus unsafe but provides a way to proactively assess a location for the possibility of future intersection crashes and intervene.

The Toolkit contains the following tools: 1) An interactive risk-based map; 2) An interactive risk-based table; 3) The countermeasure matrix; 4) The prioritized countermeasure implementation rankings.

The tools are summarized in the next table and discussed in turns.

Tool	Type	Use the Tool To	Access it Here
Risk Map	GIS Map	* Review the systemic safety of one or more intersections * Develop a list of top sites to review	Go to Map
Risk Table	Dashboard	* Review the systemic safety of one or more intersections * Develop a list of top sites to review * View all crash types for one or more intersections at once	Go To Risk Table
Countermeasure Matrix	PDF	* Identify mitigation measures for a site	Go to Matrix
Prioritized Countermeasure Rankings	Excel Spreadsheet	* Select a countermeasure and identify primary risk intersections for possible implementation * Determine how a primary risk intersection ranks for a given countermeasure	Go to Spreadsheet

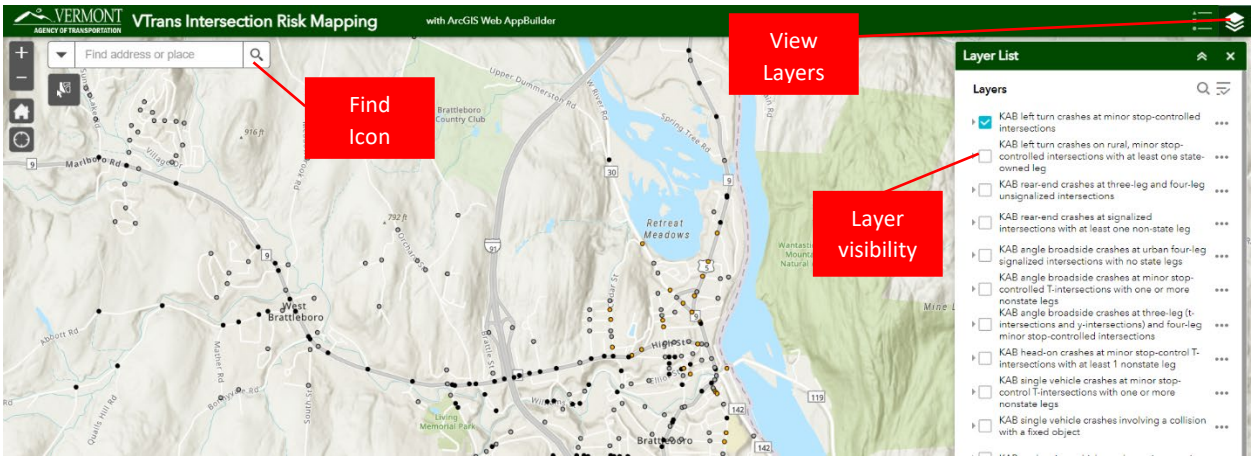
Tool 1: Risk-Based Map

Geographic information system (GIS) risk layers are available for 15 focus crash/focus facility combinations. Intersections are represented on the map by a colored dot.

For each layer, five categories of risk are displayed corresponding to five percentile score bins: Minimal Risk, Low Risk, Medium Risk, High Risk, and Primary Risk. Intersections that are classified as primary risk for a given crash type have the highest likelihood for a crash of that type occurring while intersections classified as minimal risk have the lowest likelihood of a crash happening.

Risk Category	Percentile Score Range	Color
Primary Risk	95-100	**Black**
High Risk	85-94	**Red**
Medium Risk	60-84	**Orange**
Low Risk	30-60	**Yellow**
Minimal Risk	0-30	**Green**
Not a Focus Facility	N/A	**Gray**

A percentile rank may contain more intersections than its percentile category. As an illustration, the 95th percentile group represents the intersections with the top 5% scores for a focus crash type and facility. However, it is possible for more than one intersection to have the same score and therefore a larger percentage of intersections (greater than 5%) could be associated with the 95th percentile rank.



To go to a specific intersection, pan and zoom to the location with the mouse or click in the Find box and enter the name of the intersection in the search box.

Click on the Layer icon to see the risk layers. Only one risk layer can be displayed at a time. To switch between layers, click inside the box next to the layer's name.

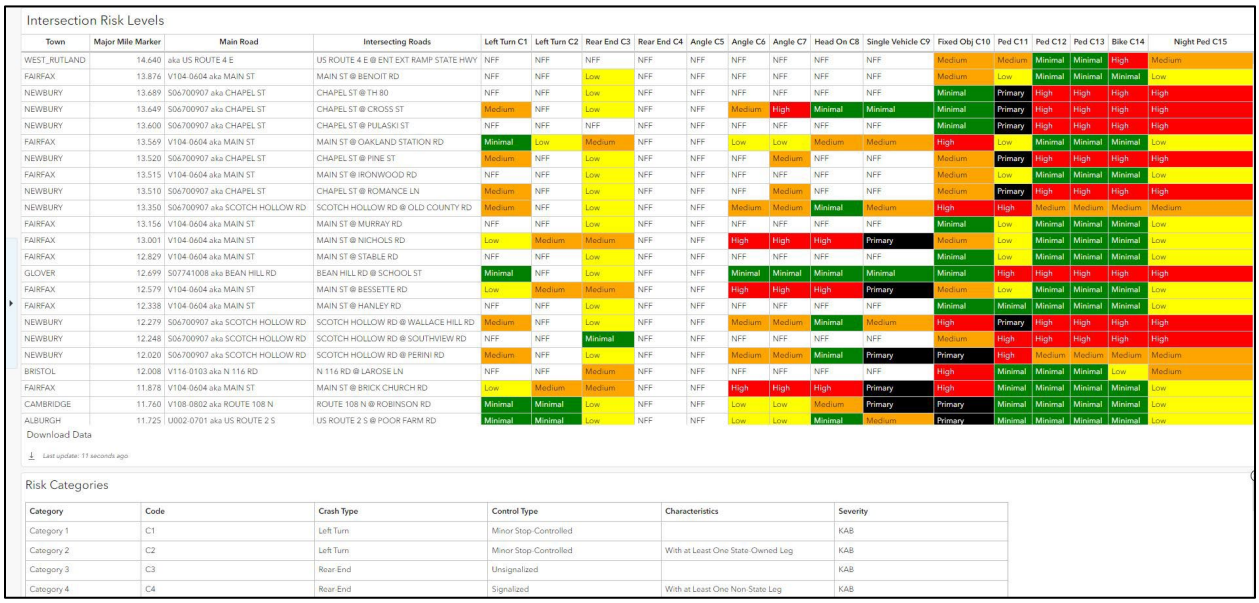
To view data pertaining to an intersection, click on an intersection (dot).

Explore the risk map:

Risk Map Tool

Tool 2: Risk-Based Table

In addition to being viewed as a map, the results of the risk-based screening can also be viewed in a tabular format. Under this tabular format, the risk levels for all 15 combinations can be viewed at the same time. The same five risk levels and color schema displayed on the map are used for the tabular tool as well. See the previous discussion of the risk-based map for a description.



Intersection Risk Levels

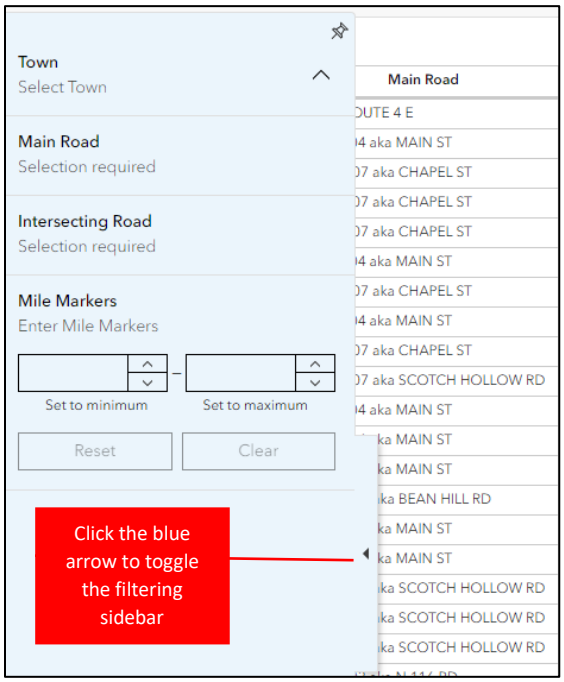
Town	Major Mile Marker	Main Road	Intersecting Roads	Left Turn C1	Left Turn C2	Rear End C3	Rear End C4	Angle C5	Angle C6	Angle C7	Head On C8	Single Vehicle C9	Fixed Obj C10	Ped C11	Ped C12	Ped C13	Bike C14	Night Ped C15
WEST_RUTLAND	14.640	aka US ROUTE 4 E	US ROUTE 4 E @ ENT EXT RAMP STATE HWY	NFF	NFF	NFF	NFF	NFF	NFF	NFF	NFF	NFF	Medium	Medium	Minimal	Minimal	High	Medium
FAIRFAX	13.876	V104 0604 aka MAIN ST	MAIN ST @ BENOIT RD	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Medium	Low	Minimal	Minimal	Minimal	Low
NEWBURY	13.689	S06700907 aka CHAPEL ST	CHAPEL ST @ TH 80	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Minimal	Primary	High	High	High	High
NEWBURY	13.649	S06700907 aka CHAPEL ST	CHAPEL ST @ CROSS ST	Medium	NFF	Low	NFF	NFF	Medium	High	Minimal	Minimal	Minimal	Primary	High	High	High	High
NEWBURY	13.600	S06700907 aka CHAPEL ST	CHAPEL ST @ PULASKI ST	NFF	NFF	NFF	NFF	NFF	NFF	NFF	NFF	NFF	Minimal	Primary	High	High	High	High
FAIRFAX	13.569	V104 0604 aka MAIN ST	MAIN ST @ OAKLAND STATION RD	Minimal	Low	Medium	NFF	NFF	Low	Low	Medium	Medium	High	Low	Minimal	Minimal	Minimal	Low
NEWBURY	13.520	S06700907 aka CHAPEL ST	CHAPEL ST @ PINE ST	Medium	NFF	Low	NFF	NFF	NFF	Medium	NFF	NFF	Medium	Primary	High	High	High	High
FAIRFAX	13.515	V104 0604 aka MAIN ST	MAIN ST @ IRONWOOD RD	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Medium	Low	Minimal	Minimal	Minimal	Low
NEWBURY	13.510	S06700907 aka CHAPEL ST	CHAPEL ST @ ROMANCE LN	Medium	NFF	Low	NFF	NFF	NFF	Medium	NFF	NFF	Medium	Primary	High	High	High	High
NEWBURY	13.350	S06700907 aka SCOTCH HOLLOW RD	SCOTCH HOLLOW RD @ OLD COUNTY RD	Medium	NFF	Low	NFF	NFF	Medium	Medium	Minimal	Medium	High	High	Medium	Medium	Medium	Medium
FAIRFAX	13.156	V104 0604 aka MAIN ST	MAIN ST @ MURRAY RD	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Minimal	Low	Minimal	Minimal	Minimal	Low
FAIRFAX	13.001	V104 0604 aka MAIN ST	MAIN ST @ NICHOLS RD	Low	Medium	Medium	NFF	NFF	High	High	High	Primary	Medium	Low	Minimal	Minimal	Minimal	Low
FAIRFAX	12.829	V104 0604 aka MAIN ST	MAIN ST @ STABLE RD	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Minimal	Low	Minimal	Minimal	Minimal	Low
GLOVER	12.699	S07741008 aka BEAN HILL RD	BEAN HILL RD @ SCHOOL ST	Minimal	NFF	Low	NFF	NFF	Minimal	Minimal	Minimal	Minimal	Minimal	High	High	High	High	High
FAIRFAX	12.579	V104 0604 aka MAIN ST	MAIN ST @ BESSETTE RD	Low	Medium	Medium	NFF	NFF	High	High	High	Primary	Medium	Low	Minimal	Minimal	Minimal	Low
FAIRFAX	12.338	V104 0604 aka MAIN ST	MAIN ST @ HANLEY RD	NFF	NFF	Low	NFF	NFF	NFF	NFF	NFF	NFF	Minimal	Minimal	Minimal	Minimal	Minimal	Low
NEWBURY	12.279	S06700907 aka SCOTCH HOLLOW RD	SCOTCH HOLLOW RD @ WALLACE HILL RD	Medium	NFF	Low	NFF	NFF	Medium	Medium	Minimal	Medium	High	Primary	High	High	High	High
NEWBURY	12.248	S06700907 aka SCOTCH HOLLOW RD	SCOTCH HOLLOW RD @ SOUTHVIEW RD	NFF	NFF	Minimal	NFF	NFF	NFF	NFF	NFF	NFF	Medium	High	High	High	High	High
NEWBURY	12.020	S06700907 aka SCOTCH HOLLOW RD	SCOTCH HOLLOW RD @ PERINI RD	Medium	NFF	Low	NFF	NFF	Medium	Medium	Minimal	Primary	Primary	High	Medium	Medium	Medium	Medium
BRISTOL	12.008	V116 0103 aka N 116 RD	N 116 RD @ LAROSE LN	NFF	NFF	Medium	NFF	NFF	NFF	NFF	NFF	NFF	High	Minimal	Minimal	Minimal	Low	Medium
FAIRFAX	11.878	V104 0604 aka MAIN ST	MAIN ST @ BRICK CHURCH RD	Low	Medium	Medium	NFF	NFF	High	High	High	Primary	High	Minimal	Minimal	Minimal	Minimal	Low
CAMBRIDGE	11.760	V108 0802 aka ROUTE 108 N	ROUTE 108 N @ ROBINSON RD	Minimal	Minimal	Low	NFF	NFF	Low	Low	Medium	Primary	Primary	Minimal	Minimal	Minimal	Minimal	Low
ALBURGH	11.725	U002 0701 aka US ROUTE 2 S	US ROUTE 2 S @ POOR FARM RD	Minimal	Minimal	Low	NFF	NFF	Low	Low	Minimal	Medium	Primary	Minimal	Minimal	Minimal	Minimal	Low

Download Data

Last update: 11 seconds ago

Risk Categories

Category	Code	Crash Type	Control Type	Characteristics	Severity
Category 1	C1	Left Turn	Minor Stop-Controlled		KAB
Category 2	C2	Left Turn	Minor Stop-Controlled	With at Least One State-Owned Leg	KAB
Category 3	C3	Rear-End	Unsignalized		KAB
Category 4	C4	Rear-End	Signalized	With at Least One Non-State Leg	KAB



Expend the filtering sidebar by clicking on the blue arrow tab. To view a specific intersection, go to the list of towns and select a town. Then go to the list of main roads and select the road of interest. Finally, select the desired intersection from the list of intersecting roads. For main roads with mile markers, the main road can also be filtered using a range of mile markers.

For each filter, use the search box to quickly find an item. Select multiple items, by checking each item.

Explore the risk table:

Risk Table Tool

Tool 3: Countermeasure Matrix

The countermeasure matrix is divided into four tables. General standard countermeasures are proposed for all sites and more targeted treatments are suggested for medium, high and primary risk sites. The high-risk level countermeasure table is shown below for illustration.

Risk Level	Countermeasure (Focus Crash and Facility Type)	Target Crash Types and Facilities								
		Left turn & angle crashes, minor stop controlled (1, 2, 6, 7)	Rear-end crashes, unsignalized (3)	Rear-end crashes, signalized (4)	Angle crashes, signalized (5)	Head-on crashes, minor stop controlled (8)	Single vehicle crashes (9, 10)	Pedestrian-vehicle crashes (11, 12, 13)	Bicycle-vehicle crashes (14)	Pedestrian-vehicle crashes at night (15)
High	Reduce Intersection Skew	●	●			●	●	●	●	●
	Double-Up and Oversize Advance Signage, Upgrade to Fluorescent Sheeting[20]	●	●	●	●	●	●	●	●	●
	Curb Extensions							●		●
	Advanced Dilemma Zone Detection			●	●					
	Protected Left-Turn Phasing				●			●		●
	Flashing Yellow Arrow				●					
	Dedicated Bicycle Lanes								●	

In these tables, the countermeasures are applicable to all sites at the applicable risk level or above. For example, medium risk level countermeasures are applicable to medium risk, high risk, and primary risk sites. Therefore, for primary risk sites, choose countermeasures from the medium, high or primary risk level countermeasures. For high-risk sites, choose from medium or high-risk level countermeasures and for medium risk sites, choose from medium risk level countermeasures only. General standard countermeasures are applicable to all risk levels.

In suggesting these countermeasures, it is assumed that the signage recommended in the Manual on Uniform Traffic Control Devices is already present.

An entity that selects sites for remedial or preventive action should perform a more detailed diagnosis of the sites before implementing a specific countermeasure.

Explore the countermeasure matrix:

Countermeasure Matrix Tool

Learn more about the countermeasures:

VTrans Countermeasure Package Briefs

Tool 4: Prioritized Implementation Rankings

Primary risk sites are prioritized for the implementation of the following countermeasures for each focus crash type/focus facility type combination as applicable:

- Roundabout
- Mini Roundabout
- All-Way Stop-Control
- Intersection Lighting
- Dedicated Turn Lane
- Raised Crosswalk (outside of State ROW)
- High-Friction Surface Treatment (HFST)
- Protected Bicycle Lanes with Bike Boxes and Bike Signals

The specific relationship between the prioritized countermeasures and the focus crash type/focus facility type combinations is shown below.

Focus Facility Type #	Crash Type	Prioritized Countermeasures							
		Roundabout	Mini-Roundabout	All-Way Stop Control	Intersection Lighting	Dedicated Turn Lanes	Raised Crosswalk	High-Friction Surface Treatment	Protected Bike Lanes with Bike Boxes and Bike Signal
1	Left turn minor stop-controlled	Yes	Yes	Yes	Yes	Yes		Yes	
2	Left turn rural, minor stop-controlled	Yes	Yes	Yes	Yes	Yes		Yes	
3	Rear-end unsignalized		Yes	Yes	Yes	Yes		Yes	
4	Rear-end signalized				Yes	Yes		Yes	
5	Angle urban four-leg signalized				Yes	Yes		Yes	
6	Angle minor stop-controlled T-intersections	Yes	Yes	Yes	Yes	Yes		Yes	
7	Angle minor stop-controlled intersections	Yes	Yes	Yes	Yes	Yes		Yes	
8	Head-on minor stop-controlled T-intersections	Yes	Yes	Yes	Yes	Yes		Yes	
9	Single vehicle minor stop-controlled T-intersections				Yes			Yes	
10	Single vehicle with a fixed object				Yes			Yes	
11	Pedestrian-vehicle	Yes	Yes	Yes	Yes		Yes	Yes	
12	Pedestrian-vehicle with pedestrian in marked crosswalk	Yes	Yes	Yes	Yes		Yes	Yes	
13	Pedestrian-vehicle with pedestrian not in marked crosswalk	Yes	Yes	Yes	Yes		Yes	Yes	
14	Bicycle-vehicle	Yes	Yes	Yes	Yes				Yes
15	Pedestrian-vehicle nighttime	Yes	Yes	Yes	Yes		Yes		

The ranking criteria consider crash risk and feasibility of installation using planning level data. For example, for the installation of dedicated turn lanes, the ranking criteria are:

- One point for every target crash of KAB severity.

- One point if no lighting is present.
- One point if major approach speed limit exceeds 35 MPH.
- One point if major road AADT exceeds 10,000

The VTrans intersection inventory does not have AADT or posted speed limit data for non-Federal-aid approaches to intersections. In these cases, the following values were assumed: 500 vehicles per day at urban intersection approaches, 250 vehicles per day at rural intersection approaches, 25 mph posted speed limit.

View the countermeasure ranking criteria for primary risk sites:

Countermeasure Ranking Criteria

The rankings of primary risk sites for the implementation of countermeasures can be viewed in the supplied Excel Spreadsheet. This spreadsheet contains the complete ranked dataset. Definitions and instructions on how to use the spreadsheet are provided as tabs within the spreadsheet.

The table example shown here illustrates the priority ranking of primary risk intersections for dedicated turn lanes (column N, FFT1_TURN_LANE_RANK displays the sorted ranking). In this table, the lower the rank, the higher the priority. A site ranking of 1 is of higher priority than a site ranking of 10.

B	C	D	E	F	G	H	I	J	K	L	M	N
Town	RPC	MajorRoute	MinorRoute	MajorRoadN	MinorRoadN	Major_MN	Minor_MN	FFT1_Left	FFT1_ROU	FFT1_ROU	FFT1_TURN_LANE_SCORE	FFT1_TURN_LANE_RANK
MIDDLEBURY	AC	U007-0111	L0111003073	US ROUTE 7 N	EXCHANGE ST	0	0	FFT1_Left	4	178	6	1
MORRISTOWN	LC	V015-0807	L0807003011	VT ROUTE 15 W	NEEDLES EYE RD	0	0	FFT1_Left	3	233	4	2
BURLINGTON	CC	U007-0403	-	SHELBURNE ST	PROCTOR AVE	0.609	0	FFT1_Left	3	233	4	2
NEW_HAVEN	AC	U007-0113	S01830113	ETHAN ALLEN	RIVER RD	0.556	0	FFT1_Left	3	233	4	2
BRATTLEBORO	WR	U005-1302	-	PUTNEY RD	TOWN CRIER DR	0	0	FFT1_Left	1	581	4	2
RUTLAND	RR	U004-1120	S32141120	US ROUTE 4 E	POST RD	0.82	2.4	FFT1_Left	1	581	4	2
BRATTLEBORO	WR	U005-1302	-	PUTNEY RD	HARDWOOD WA	0	0	FFT1_Left	1	581	4	2
HARTFORD	TR	N98701408	I091-0000NR012A	BUGBEE ST	I-91 EXIT 12 RAM	0.412	0.265	FFT1_Left	4	178	4	2
COLCHESTER	CC	V002A0405	V127-0405	MAIN ST	MAIN ST	2.266	0.142	FFT1_Left	8	18	4	2
BRIGHTON	NV	V105-0504	V114-0504	VT ROUTE 105	EAST HAVEN RD	2.197	4.472	FFT1_Left	2	327	3	10
DANVILLE	NV	U002-0303	V002B0303	US ROUTE 2 E	PARKER RD EXT	7.339	0	FFT1_Left	3	233	3	10
HARDWICK	NV	V015-0305	V016-0305	VT ROUTE 15 E	VT ROUTE 16	5.76	0	FFT1_Left	2	327	3	10
FERRISBURG	AC	U007-0105	-	US ROUTE 7	LEWIS CREEK DR	0	0	FFT1_Left	1	581	3	10
FERRISBURG	AC	U007-0105	-	US ROUTE 7	ROUND BARN RI	0	0	FFT1_Left	1	581	3	10
HYDE_PARK	LC	V015-0805	L0805003060	ROUTE 15 E	FITCH HILL RD	2.017	0	FFT1_Left	2	327	3	10
HYDE_PARK	LC	V015-0805	L0805002001	VT ROUTE 15 E	CENTERVILLE RD	2.16	0	FFT1_Left	2	327	3	10

View the Prioritized Implementation Rankings spreadsheet for primary risk sites:

Prioritized Implementation Rankings Spreadsheet Tool

Practical Usage Examples

The guidance provided in this section is intended to show users how to use the Toolkit to answer typical questions. The examples of practical usage that are demonstrated here include the following:

Practical Usage #	Practical Usage Name	Question to Answer
Practical Usage 1	Reviewing the Systemic Safety of an Intersection	How is the intersection expected to perform
Practical Usage 2	Identifying Potential Mitigation Measures for a Site	What are the suggested countermeasures for the conditions
Practical Usage 3	Developing a List of Top Sites to Review for an Area	What are the top X sites in an area, for example, what are the top 25 sites where the risk of angle crashes is high?
Practical Usage 4	Selecting a Countermeasure and Identifying Locations for Possible Implementation	What are the locations where this countermeasure could be implemented

Detailed steps on how to use the Toolkit for each of the pratical usages listed above are provided to assist users.

Practical Usage 1 Reviewing the Systemic Safety of an Intersection

Practical Usage 1 demonstrates how to use the toolkit to review the systemic safety of an intersection. A typical question to answer is: Is this intersection at risk for intersection crashes?

Case Description

A user is interested in assessing the risk-based safety of the intersection of US 5 and VT 25a in Fairlee. This is a three-way intersection with stop control on VT 25a. The intersection is located at mile point 3.24 on US 5. VT 25a is also known as Bridge St. The user first looks at the risk map (Case A) and then at the risk table (Case B).

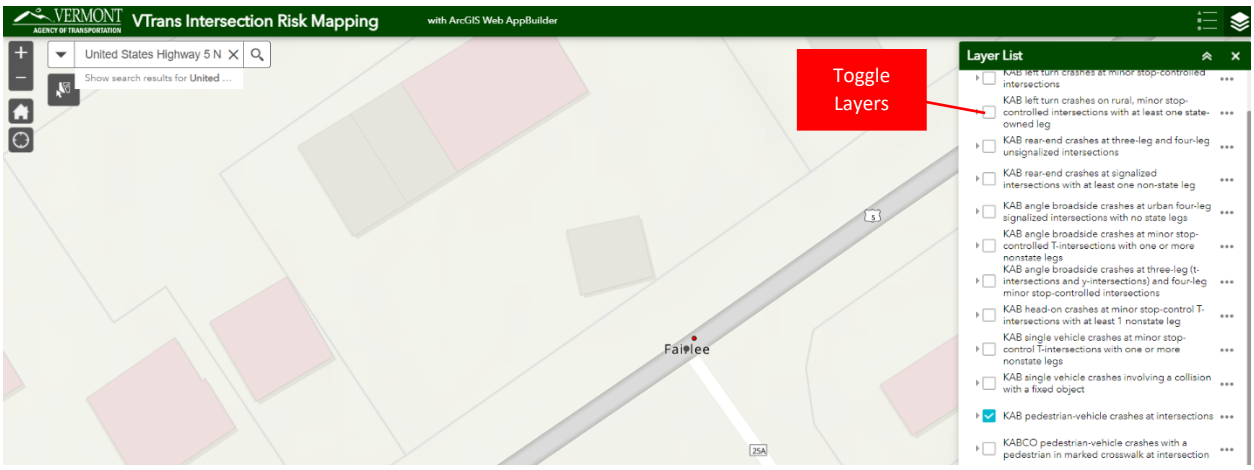
Case A – Risk-Based Map

Step 1 Go to the Intersection

To go to the intersection, the user can pan and zoom with the mouse to the location. Alternatively, the user can use the search box and enter the name of the intersection as shown below (US 5 and VT 25a Fairlee VT). The user then clicks on the appropriate location from the list. The map is redirected to the intersection.

Step 2 Review the Risk Levels

The user visually looks at the intersection on the map and toggles on and off the applicable risk layers to determine the risk level for each crash type. To toggle the risk layers on and off, the user clicks inside the boxes to the left of the layers' names.



The 1st layer in the list, **KAB left turn crashes at minor stop-controlled intersections**, is applicable to this intersection. The user turns on this layer. The intersection is displayed with a black dot, indicating that the intersection is categorized as primary risk for left turn crashes.

To view another crash type, the user turns off the visibility of this current layer. The user continues down the list of risk layers and turns on the layer **KAB rear-end crashes at three-leg and four-leg unsignalized intersections**. For this crash type (rear-end crashes), the intersection is categorized as high risk (red dot).

The user turns off this layer and turns on the next applicable layer, **KAB angle broadside crashes at three-leg (t-intersections and y-intersections) and four-leg minor stop-controlled intersections**. For this crash type (broadside crashes), the intersection is categorized as primary risk.

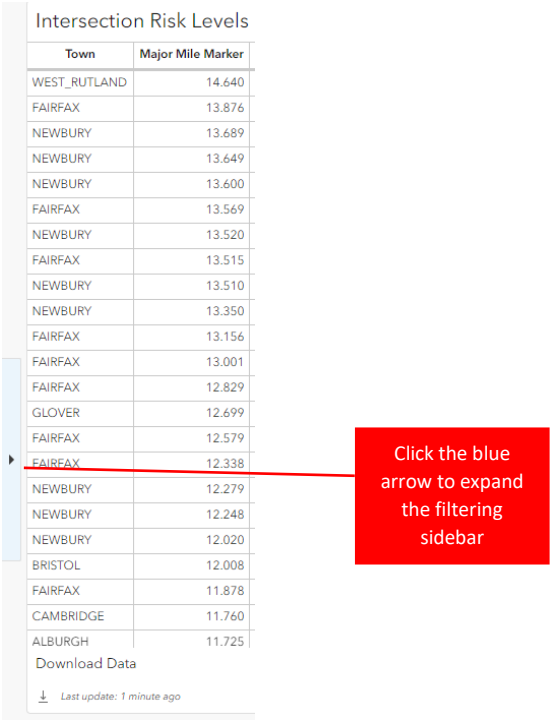
The user is curious about crash types related to active transportation. The user reviews the following layers sequentially, **KAB pedestrian-vehicle crashes at intersections**, **KAB bicycle-vehicle crashes at intersection**, and **KABC pedestrian vehicle-crashes at intersections occurring at night**. The user determines that the intersection is rated as high risk for all three crash types.

Case B – Risk-Based Table

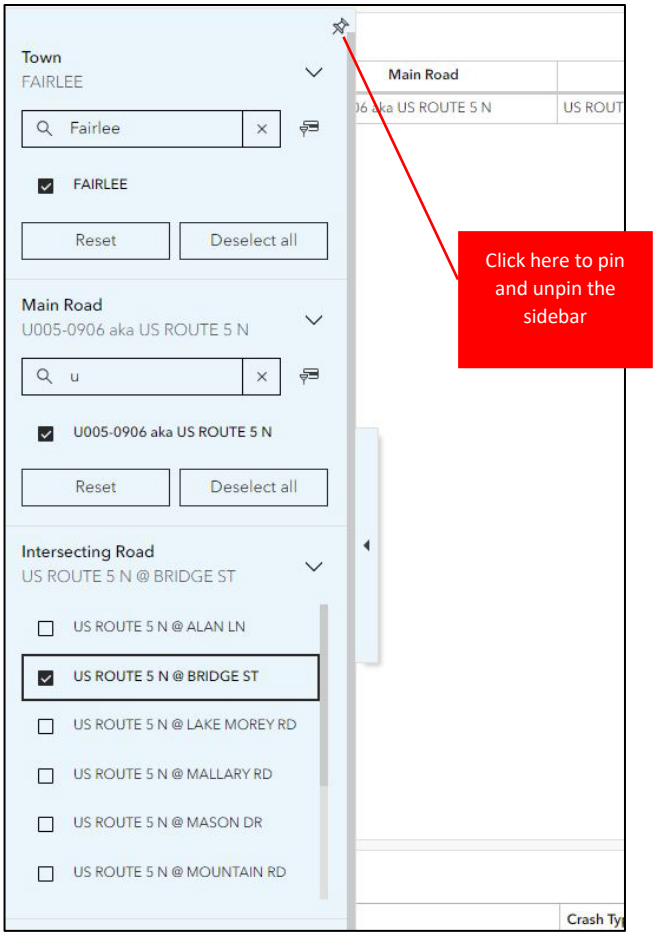
In addition to viewing the risk levels on the map as shown in Case A, the user can also view the risk levels for all applicable crash types using the Risk-Based Table.

Step 1 Go to the Intersection

The user first clicks the blue arrow tab on the left-hand side of the dashboard to expand the filtering sidebar.



To view the risk levels for the intersection, the user must first select the town, then the main road and then the intersection from the list of intersecting roads. In the **Town** filter, the user searches first for Fairlee by typing Fairlee in the search box. The user then searches for U005 in the search box for **Main Road**. A number of options are presented. The user identifies “U005-0906 aka US ROUTE 5 N” as the main road that is associated with VT25a (Bridge ST). The user scrolls down the list of intersections in the **Intersecting Road** filter and clicks on the one called US ROUTE 5 N @ BRIDGE ST. The risk levels for the intersection are displayed.

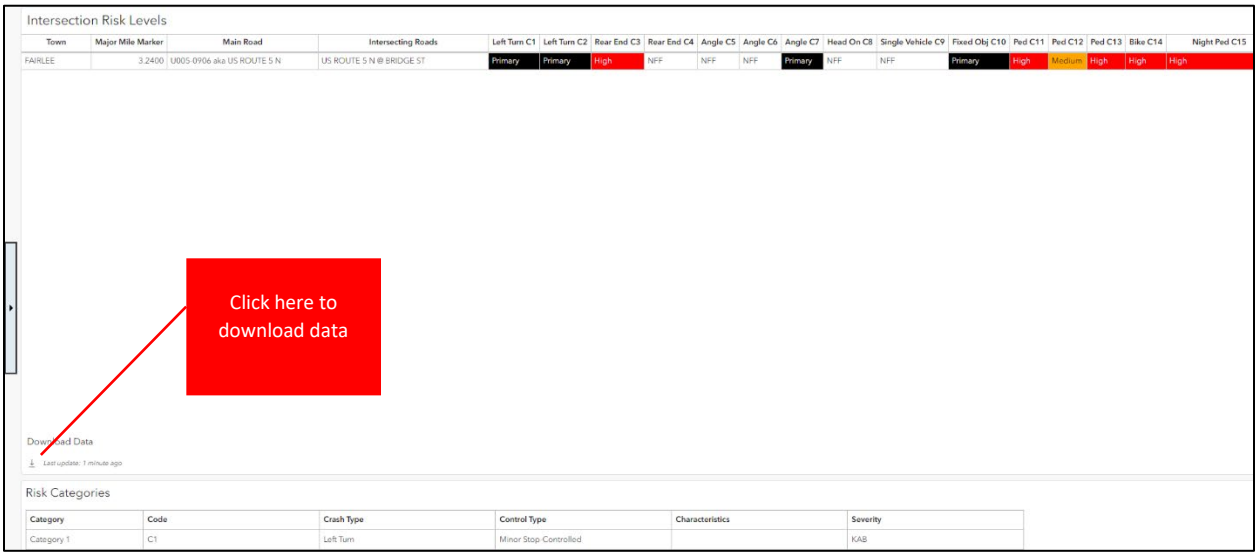


Step 2 Review the Risk Levels

In the Risk-Based Table, the crash type and facility type combinations are displayed in columns. The columns are in the same order as the list of risk layers on the map. The labeling of the columns is slightly different than for the risk layers and the table shown below the risk table (or the table shown on page 1 of this document) should be consulted for a full description. The crash type and facility type combinations that are not applicable are shown in grey with the caption Not a Focus Facility.

The user explores the table for the US 5 and VT 25a intersection. The user determines that the intersection is classified as primary risk for left turn (Left Turn Category_1) and broadside (Angle Category_7) crashes and as high risk for rear-end (Rear-End Category 3), pedestrian (Ped Category_11), bike (Bike Category_14) and nighttime pedestrian (Night Ped Category_15) crashes.

To download data to Excel in CSV format, the user clicks on the **Download Data** button in the lower left corner (Note that the colored cell formatting is not carried over).



Practical Usage 2 Identifying Potential Mitigation Measures for a Site

Practical Usage 2 demonstrates how to identify potential countermeasures for an intersection, for a given crash type and risk level. A typical question to answer is: What are suggested countermeasures for the conditions?

Case Description

This is a continuation of the previous example for Practical Usage 1. A user was interested in assessing the systemic safety of the intersection of US 5 and VT 25a in Fairlee. The user determined that this intersection was classified as primary risk for left turn and broadside crashes and as high risk for rear-end, pedestrian, bike and nighttime pedestrian crashes. The user now wants to identify which countermeasures could be considered to prevent some of these crash types.

Step 1 Select a Crash Type

The first step is to select a crash type to further evaluate using the countermeasure matrix. The user wants to explore countermeasures for angle crashes.

Step 2 Recall the Risk Level

The second step is to identify the risk level of the intersection with respect to the selected crash type. For this intersection, the user determined that the intersection was listed as primary risk for angle crashes.

Step 3 Explore the Countermeasure Matrix

Since the intersection is classified as primary risk for angle crashes, the user can review the countermeasures from the medium, high, or primary risk level tables as the lower-level measures are also applicable to primary risk sites. The user should also look at the Standard table to see if these measures are currently in place. The user opens the **Countermeasure Matrix** tool and reviews the strategies listed in the high risk level table by selecting the column that corresponds to the **angle crash type at minor stop-controlled intersections**.

Risk Level	Countermeasure (Focus Crash and Facility Type)	Target Crash Types and Facilities								
		Left turn & angle crashes, minor stop controlled (1, 2, 6, 7)	Rear-end crashes, unsignalized (3)	Rear-end crashes, signalized (4)	Angle crashes, signalized (5)	Head-on crashes, minor stop controlled (8)	Single vehicle crashes (9, 10)	Pedestrian-vehicle crashes (11, 12, 13)	Bicycle-vehicle crashes (14)	Pedestrian-vehicle crashes at night (15)
High	Reduce Intersection Skew	●	●			●	●	●	●	●
	Double-Up and Oversize Advance Signage, Upgrade to Fluorescent Sheeting[20]	●	●	●	●	●	●	●	●	●
	Curb Extensions							●		●
	Advanced Dilemma Zone Detection			●	●					
	Protected Left-Turn Phasing				●			●		●
	Flashing Yellow Arrow				●					
	Dedicated Bicycle Lanes								●	

The user also looks at the primary risk level table. The user is curious about all-way stop control and further uses the **Prioritized Implementation Rankings spreadsheet** tool to see how the intersection ranks among primary risk sites for left turn and angle crashes for this countermeasure based on the preliminary analysis of planning level data.

Risk Level	Countermeasure (Focus Crash and Facility Type)	Target Crash Types and Facilities								
		Left turn & angle crashes, minor stop controlled (1, 2, 6, 7)	Rear-end crashes, unsignalized (3)	Rear-end crashes, signalized (4)	Angle crashes, signalized (5)	Head-on crashes, minor stop controlled (8)	Single vehicle crashes (9, 10)	Pedestrian-vehicle crashes (11, 12, 13)	Bicycle-vehicle crashes (14)	Pedestrian vehicle crashes at night (15)
Primary	Convert to Roundabout	●				●		●	●	●
	Dedicated Left- or Right-Turn Lane	●	●	●	●	●				
	Convert to Mini-Roundabout	●	●			●		●	●	●
	Convert to All-Way Stop-Control	●				●		●	●	●
	Lighting	●	●	●	●	●	●	●	●	●
	Raised Crosswalk							●		●
	HFST	●	●	●	●	●	●	●	●	●
	Protected Bicycle Lanes with Bike Boxes/Signals								●	

The user opens the **Prioritized Implementation Rankings spreadsheet** tool and filters by Town, MajorRoute and MinorRoadName to see the rankings for the US 5 and VT 25a intersection.

Town	RPC	MajorRoute	MinorRoute	MajorRoadN	MinorRoad	Major_MM	Minor_MM	FFT1_ALL_WAY_STOP_RANK	FFT2_ALL_WAY_STOP_RANK	FFT7_ALL_WAY_STOP_RANK
FAIRLEE	TR	U005-0906	V025A0906	US ROUTE 5	BRIDGE ST	3.24	0	3	1	6

The user locates the appropriate column for the angle crash type (category 7 which corresponds in the table to FFT7). The user sees that the rank of the intersection is 6 (In this tool, more than one intersection may have the same rank. In this case, after doing a pivot table analysis, the user sees that there are 35 intersections that have a rank of 6 and that there are five other intersections that have a higher rank). For this category, there are 1409 intersections, and the US 5 and VT 25a intersection is among the top ranking for potential all-way stop control suitability.

Row Labels	Count of FFT7_ALL_WAY_STOP_RANK
1	1
2	4
6	35
41	52
93	162
255	1155
(blank)	
Grand Total	**1409**

The user also looks at the ranking for the left turn crash type since this intersection is also classified as primary risk for this crash type (categories 1 and 2 correspond to FFT1 and FFT2 in the spreadsheet).

Here also the user notices that the intersection ranks among the top intersections for all-way stop control (ranking 3rd with 146 other intersections out of 1484 and two other higher-ranking ones for category 1 and ranking 1st with 3 other intersections out of 250 for category 2).

Practical Usage 3 Developing a List of Top Sites to Review for an Area

Practical Usage 3 illustrates how to use the Toolkit to create a list of potential sites to review for preventive remedial action. A typical question to answer is: What are the top sites in a geographic location where the likelihood of a certain crash type happening is likely?

Case Description

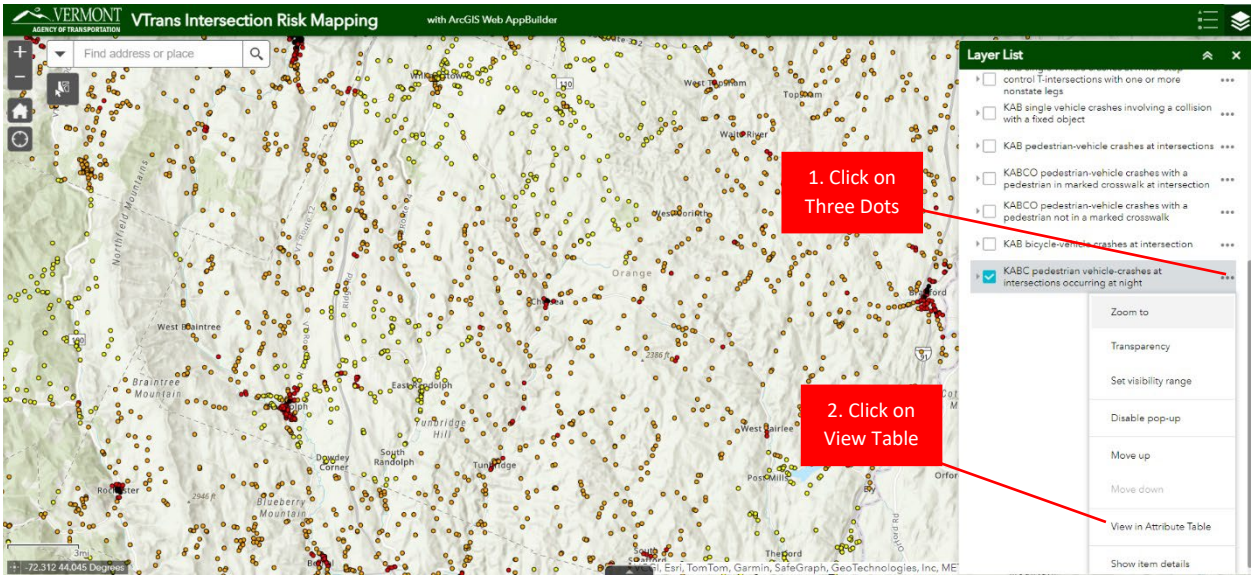
A town manager wants to know where nighttime pedestrian crashes could take place in the future and where to target improvements. Assume the town of interest is Jericho and that the town manager is concerned with nighttime pedestrian safety.

Step 1 Select a Focus Type

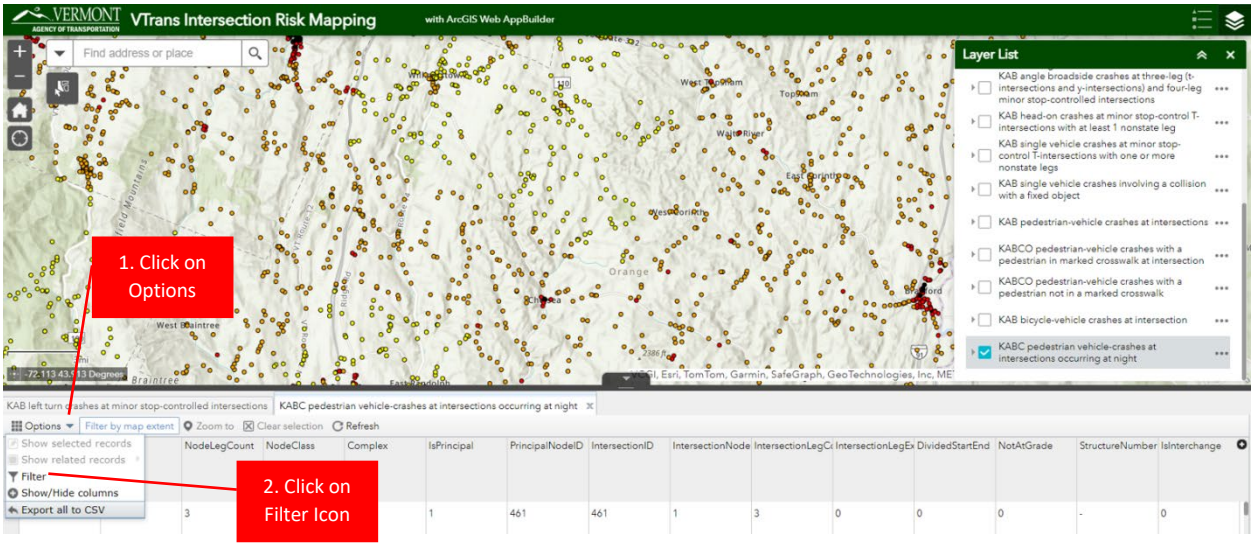
Using the Risk-Based Map, from the right pane, the user turns on the layer for **KABC pedestrian vehicle-crashes at intersections occurring at night** by clicking on the **Eye** icon.

Step 2 Select a Location (jurisdiction and/or road)

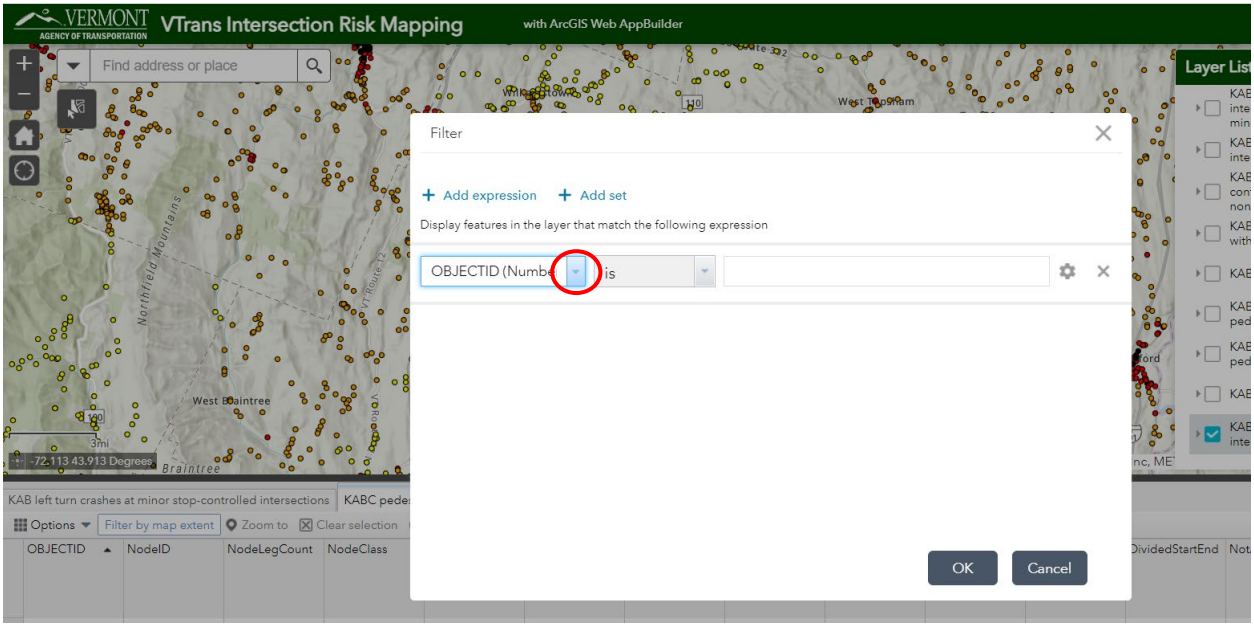
The user clicks on the three dots at the right of the layer's name and then goes to View in Attribute Table. A table appears at the bottom with a tab of the selected layer.

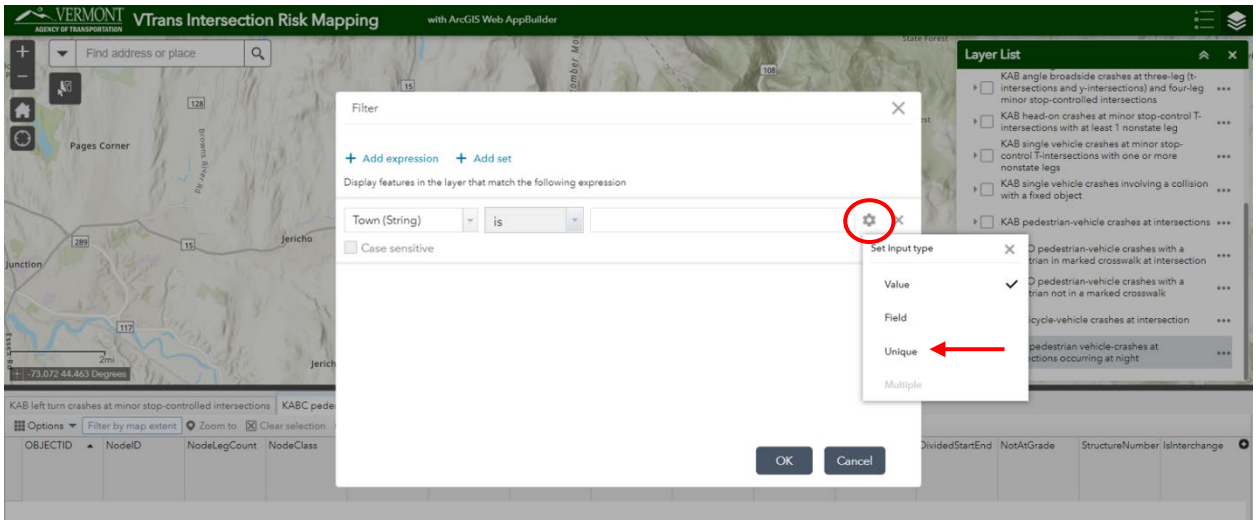


The user clicks on **Options** at the top of the table and then on the **Filter** icon to execute a query. A filter dialogue box is displayed. The user then clicks on the **Add Expression** button. An Expression selection box appears.

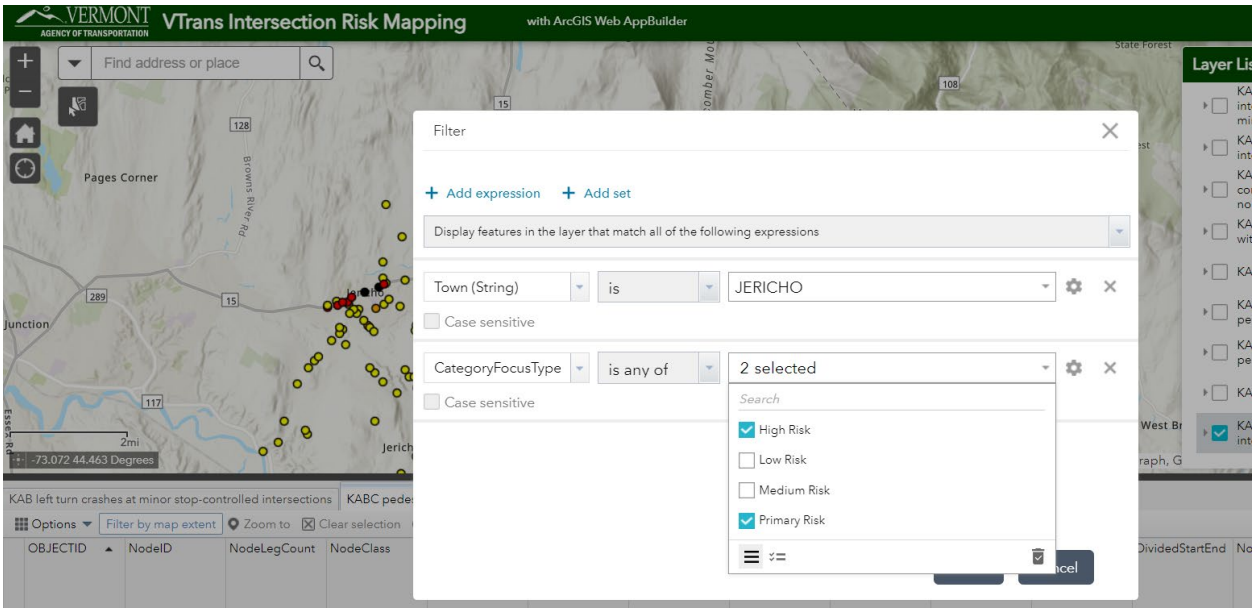


The user then clicks on the down arrow in the **Expression box** and scrolls down to **Town**. The user clicks on **Town**. The user selects **is** as the condition and clicks on the **Wheel Icon** and selects **Unique** to see a list of town names. The user clicks on the dropdown arrow and scrolls down and selects JERICHO.

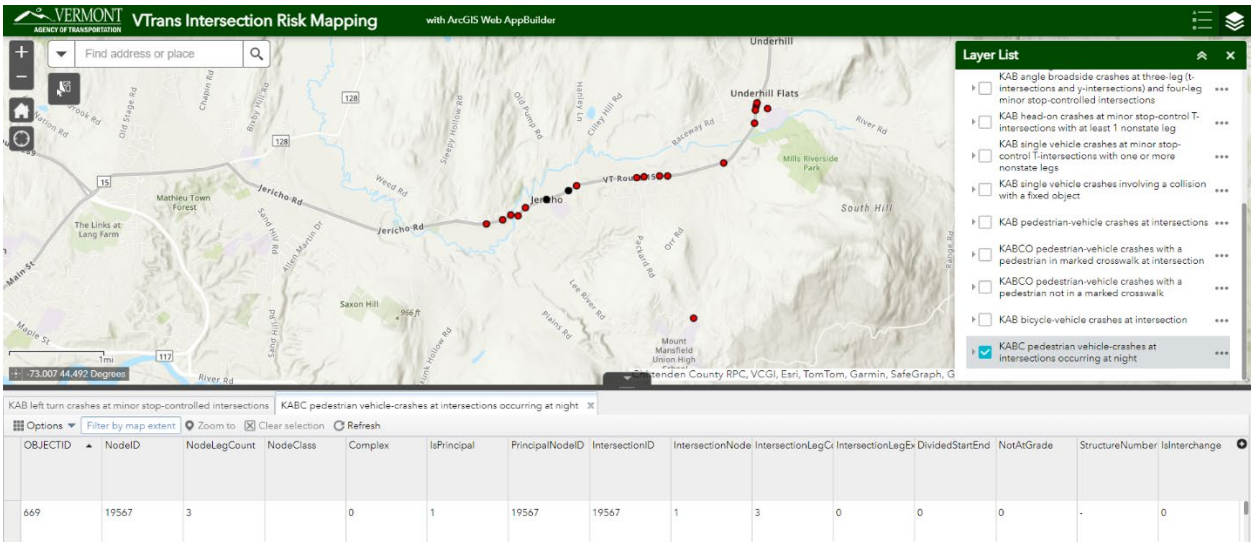




The user clicks on a new Add Expression to set another criterion. The user repeats the previous steps to filter by the nighttime ped crash type. In the **Expression box**, the user clicks on the down arrow and scrolls down to **CategoryFocusType15** and selects it. The user selects **is any of** as the condition and then clicks on the dropdown arrow of the last box and selects the risk levels to consider. Here, the user selects high risk and primary risk. The user clicks on **OK**.

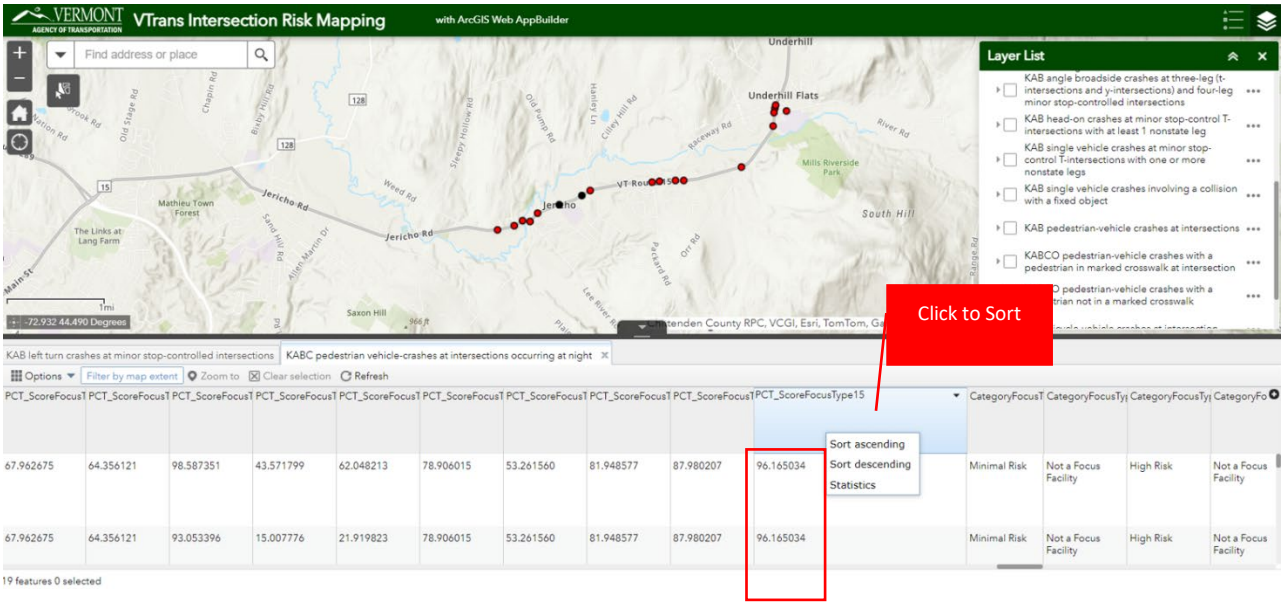


To zoom to the selection, the user goes in the layer pan for **KABC pedestrian vehicle-crashes at intersections occurring at night** and clicks on the three dots to open a new menu. The user then clicks on **Zoom to** to view the area of interest.



Step 3 Review the Filtered Data

The user now wants to prioritize the list of sites. In the table, the user scrolls to the right to the **PCT_ScoreFocusType15** field and sorts this field in descending order. This will produce a list of the sites with the highest percentile values at the top.



Step 4 Create a List of Sites

The user examines the table and selects as many rows as the number of desired sites to review by highlighting a row and while holding the **Shift Key**, selecting additional rows. Here, the user only wants to review sites with a percentile score above 90. The user only wants to view the selected sites in the table and clicks on **Options** and then on the **Show selected records**.

The user desires to view the selected intersections on the map and clicks on the **Zoom to** icon at the top of the table to zoom to the selected sites.

The user wants to manipulate the data in Excel and print a list of sites. To do this, the records need to be exported to CSV. To export the data, the user clicks on **Options** and then on **Export selected to CSV**. the four dots in the toolbar and then on Export. Export selected to CSV.

Practical Usage 4 Selecting a Countermeasure and Identifying Locations for Possible Implementation

Practical Usage 4 explains how to use the Toolkit to find locations where a selected countermeasure could be constructed. A typical question to answer is: What are the locations where this countermeasure could be implemented?

Case A Description

An engineer is interested in installing signage to prevent the occurrence of broadside crashes at minor stop-controlled intersections.

Step 1 Chose a Countermeasure to Implement

For this case, the user is interested in low-cost signage countermeasures.

Step 2 Match the Countermeasure to a Crash a Type

For this scenario, the user is interested in minor stop-controlled intersections.

The user opens the **Countermeasure Matrix** tool. The user goes first to the medium risk table and locates the countermeasure (i.e., signage) in the countermeasure matrix (for this case, the user identifies **Double-Up or Oversize Advance Signage, Upgrade to Fluorescent Sheeting** as an option). The user then identifies which crash types the countermeasure is associated with (for this case, the user confirms that the countermeasure is applicable to angle crashes).

Risk Level	Countermeasure (Focus Crash and Facility Type)	Target Crash Types and Facilities								
		Left turn & angle crashes, minor stop controlled (1, 2, 6, 7)	Rear-end crashes, unsignalized (3)	Rear-end crashes, signalized (4)	Angle crashes, signalized (5)	Head-on crashes, minor stop controlled (8)	Single vehicle crashes (9, 10)	Pedestrian-vehicle crashes (11, 12, 13)	Bicycle-vehicle crashes (14)	Pedestrian-vehicle crashes at night (15)
Medium	Double-Up or Oversize Advance Signage, Upgrade to Fluorescent Sheeting	•	•	•	•	•	•	•	•	•
	Retroreflective Sheeting on Sign Posts	•	•	•	•	•	•	•	•	•
	Enhanced Pavement Markings that Delineate Intersection[23]	•	•			•	•	•	•	•

The user also looks at the high risk table. In this case, the user identifies **Double-Up and Oversize advance Signage, Upgrade to Fluorescent Sheeting** and confirms that it is applicable to angle crashes. In addition to being a countermeasure suitable for high risk sites, this countermeasure is also appropriate for primary sites.

Risk Level	Countermeasure (Focus Crash and Facility Type)	Target Crash Types and Facilities								
		Left turn & angle crashes, minor stop controlled (1, 2, 6, 7)	Rear-end crashes, unsignalized (3)	Rear-end crashes, signalized (4)	Angle crashes, signalized (5)	Head-on crashes, minor stop controlled (8)	Single vehicle crashes (9, 10)	Pedestrian-vehicle crashes (11, 12, 13)	Bicycle-vehicle crashes (14)	Pedestrian-vehicle crashes at night (15)
High	Reduce Intersection Skew	●	●			●	●	●	●	●
	Double-Up and Oversize Advance Signage, Upgrade to Fluorescent Sheeting[20]	●	●	●	●	●	●	●	●	●
	Curb Extensions							●		●
	Advanced Dilemma Zone Detection			●	●					

Step 3 Create a List of Candidate Sites

The next step is to identify the intersections along a specific road or within a geographic area such as a county or a town that matches the risk level(s) isolated in Step 2.

The user generates a prioritized list of intersections following the steps presented in Practical Usage Example #3. The user then evaluates the suitability of the candidate sites for advance signage by reviewing the sites.

Case B Description

A planner wants to develop a project to implement high friction surface treatment at several locations in Chittenden County. The user is aware that certain countermeasures were ranked for primary risk sites and that the results of this screening can be reviewed with the **Prioritized Implementation Rankings spreadsheet** tool. The user wants to look at the screening to identify minor stop-controlled intersections where to implement high friction surface treatment to prevent angle collisions.

Step 1 Select a Countermeasure

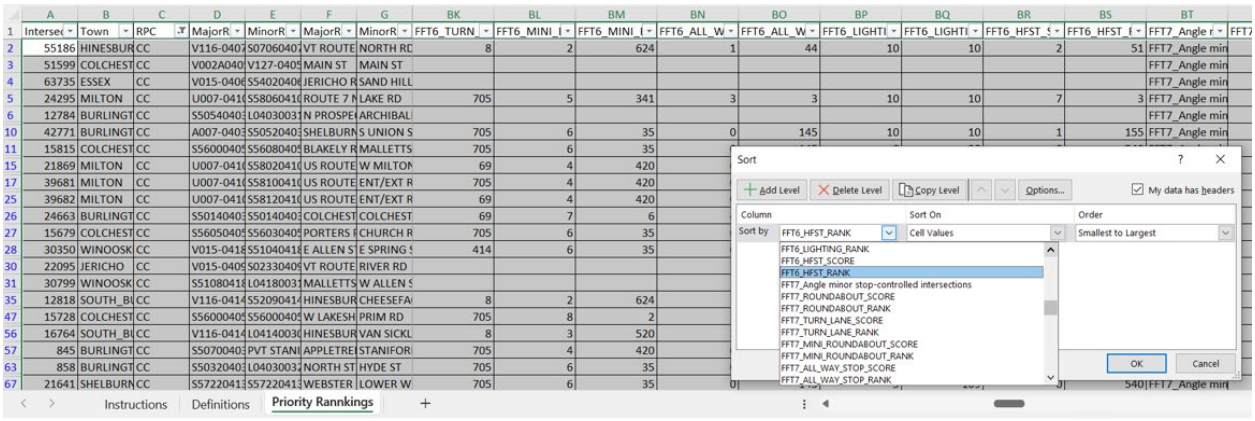
The user determines which countermeasures were prioritized for each facility type by looking in the table shown on page 7 of the User Guide (reproduced below). While high friction surface treatment is applicable to most facility types, the user is interested in angle crashes at minor stop-controlled intersections. These are categories 6 and 7.

Focus Facility Type #	Crash Type	Prioritized Countermeasures							
		Roundabout	Mini-Roundabout	All-Way Stop Control	Intersection Lighting	Dedicated Turn Lanes	Raised Crosswalk	High-Friction Surface Treatment	Protected Bike Lanes with Bike Boxes and Bike Signal
1	Left turn minor stop-controlled	Yes	Yes	Yes	Yes	Yes		Yes	
2	Left turn rural, minor stop-controlled	Yes	Yes	Yes	Yes	Yes		Yes	
3	Rear-end unsignalized		Yes	Yes	Yes	Yes		Yes	
4	Rear-end signalized				Yes	Yes		Yes	
5	Angle urban four-leg signalized				Yes	Yes		Yes	
6	Angle minor stop-controlled T-intersections	Yes	Yes	Yes	Yes	Yes		Yes	
7	Angle minor stop-controlled intersections	Yes	Yes	Yes	Yes	Yes		Yes	
8	Head-on minor stop-controlled T-intersections	Yes	Yes	Yes	Yes	Yes		Yes	
9	Single vehicle minor stop-controlled T-intersections				Yes			Yes	
10	Single vehicle with a fixed object				Yes			Yes	
11	Pedestrian-vehicle	Yes	Yes	Yes	Yes		Yes	Yes	
12	Pedestrian-vehicle with pedestrian in marked crosswalk	Yes	Yes	Yes	Yes		Yes	Yes	
13	Pedestrian-vehicle with pedestrian not in marked crosswalk	Yes	Yes	Yes	Yes		Yes	Yes	
14	Bicycle-vehicle	Yes	Yes	Yes	Yes				Yes
15	Pedestrian-vehicle nighttime	Yes	Yes	Yes	Yes		Yes		

Step 2 Sort the Records

The user opens the **Prioritized Implementation Rankings spreadsheet** tool and first filters the records with the RPC column, using CC for CCRPC. In this tool, a priority rank of 1 is of more importance than a rank of 50).

The user then sorts the records by ascending order using the **FFT6_HFST_RANK** column (shown in the second table below). The user also notes the corresponding ranking in column FFT7_HFST_RANK. The users will also sort by column FFT7_HFST_RANK and note how the order changes in column **FFT6_HFST_RANK.**



Intersectio	Town	RPC	MajorRoute	MinorRoute	MajorRoadN	MinorRoadN	FFT6_HFST_RANK	FFT7_HFST_RANK
43964	WINOOSKI_CI	CC	V015-0418	S51020418	E ALLEN ST	DION ST	1	1
11081	SOUTH_BURLINGTON	CC	U007-0414	L0414003046	SHELBURNE RD	LINDENWOOD DR	2	4
24295	MILTON	CC	U007-0410	S58060410	ROUTE 7 N	LAKE RD	3	6
63997	SOUTH_BURLINGTON	CC	V116-0414	PVT COMMERCE SQ	HINESBURG RD	COMMERCE SQ SHOPPING	3	6
7176	BURLINGTON	CC	U007-0403	-	SHELBURNE ST	PROCTOR AVE	5	9
49849	ESSEX	CC	V117-0406	S54080406	RIVER RD	N WILLISTON RD	5	9
12818	SOUTH_BURLINGTON	CC	V116-0414	S52090414	HINESBURG RD	CHEESEFACTORY RD	10	13
27321	WILLISTON	CC	V002A0417	L0417003006	ESSEX RD	RIVER COVE RD	13	20
33245	ESSEX	CC	V015-0406	L0406003753	CENTER RD	SAYBROOK RD	13	20
15728	COLCHESTER	CC	S56000405	S56000405	W LAKESHORE DR	PRIM RD	22	44
16764	SOUTH_BURLINGTON	CC	V116-0414	L0414003023	HINESBURG RD	VAN SICKLEN RD	22	44

Step 3 Review the Prioritized Data

The user singles out the top-ranking intersections. The user confirms, from a pivot analysis, that these sites are ranking among the top ones given that more than one site could have the same rank.

For category 6 (FFT6), the user notices that the sites ranked 1 to 5 have a total of ten sites, and that there is only one site each in rank 1 and rank 2 and that there are two sites ranked 3 and five ranked five. The user will further investigate the sites for the suitability of the high friction surface treatment at these locations.

Row Labels	Count of FFT6_HFST_RANK
1	1
2	1
3	2
5	5
10	3
13	9
22	29
51	104
155	385
540	488
(blank)	
Grand Total	**1027**

Row Labels	Count of FFT7_HFST_RANK
1	1
2	1
3	1
4	2
6	3
9	4
13	7
20	24
44	54
98	147
245	497
742	668
(blank)	
Grand Total	**1409**

Systemic Safety Concepts

This section provides supporting information for using the risk-based intersection screening toolkit and explains how safety measures are implemented, what is systemic safety and what KABCO means.

Three Engineering Approaches for Improving Safety

There are three ways to implement safety engineering countermeasures.

1 **Site-Specific Approach** (hot-spot or crash-based):

- Improvements are made at specific sites, usually those with a high frequency of crashes.
- An example is installing a traffic signal at a high crash intersection.

2 **Systematic Approach** (policy-based):

- Improvements are made to the entire road system, often as a policy.
- An example is installing backplates with a signal project.

3 **Systemic Approach** (risk-based):

- Improvements are made at locations that have the greatest risk.
- An example is installing a double large arrow sign at the stem of T-intersections.

Systemic Safety

The systemic method looks at crash history to identify factors that correlate with a particular crash type.

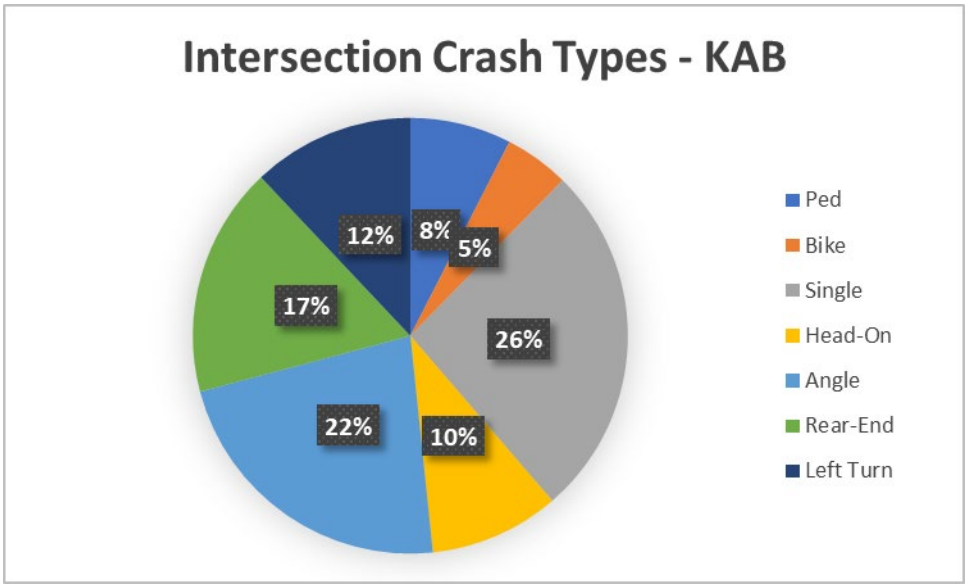
The more factors that are present at a site, the greater the likelihood of a crash happening at this site.

The systemic method aims at implementing treatments at the sites with these common factors. It is proactive and some of the sites treated may have no observed crashes yet.

What is a Focus Crash Type?

A crash type is a category associated with a crash. It often describes the manner of collision or what a vehicle collided with.

Focus crash types are used in systemic safety analysis. They represent crash types with large proportions of fatal and serious injury crashes.



The intersection focus crash types considered for the risk-based evaluation are:

- Left Turn Crashes;
- Angle/Broadside Crashes;
- Rear-End Crashes;
- Pedestrian-Vehicle Crashes;
- Bike-Vehicle Crashes
- Single Vehicle Crashes
- Head-On Crashes

What is a Focus Facility?

A focus facility is where a focus crash type happens most frequently. For example, rural two-lane roads three-way intersections.

The focus facility types corresponding to the focus crash types previously listed are:

- All Unsignalized;
- Minor Stop-Controlled;
- Minor Stop-Controlled With at Least One State-Owned Leg;
- Signalized With at Least One Nonstate-Owned Leg;
- Signalized Urban, Four-Leg with No State-Owned Legs;
- Minor Stop-Controlled T-Intersections with One or More Nonstate Legs
- Minor Stop-Controlled T-Intersections with at Least One Nonstate Leg

The relationship between the focus crash types and the facility types produced 15 combinations of focus crash types and focus facility types.

Minor Stop-Controlled Intersections

KAB left turn crashes at minor stop-controlled intersections
KAB left turn crashes on rural, minor stop-controlled intersections with at least one state-owned leg
KAB angle/broadside crashes at minor stop-controlled T-intersections with one or more nonstate legs
KAB angle/broadside crashes at three-leg and four-leg minor stop-controlled intersections
KAB head-on crashes at minor stop-controlled T-intersections with at least one nonstate leg
KAB single vehicle crashes at minor stop-controlled T-intersections with one or more nonstate legs

Unsignalized Intersections

KAB rear-end crashes at three-leg and four-leg unsignalized intersections

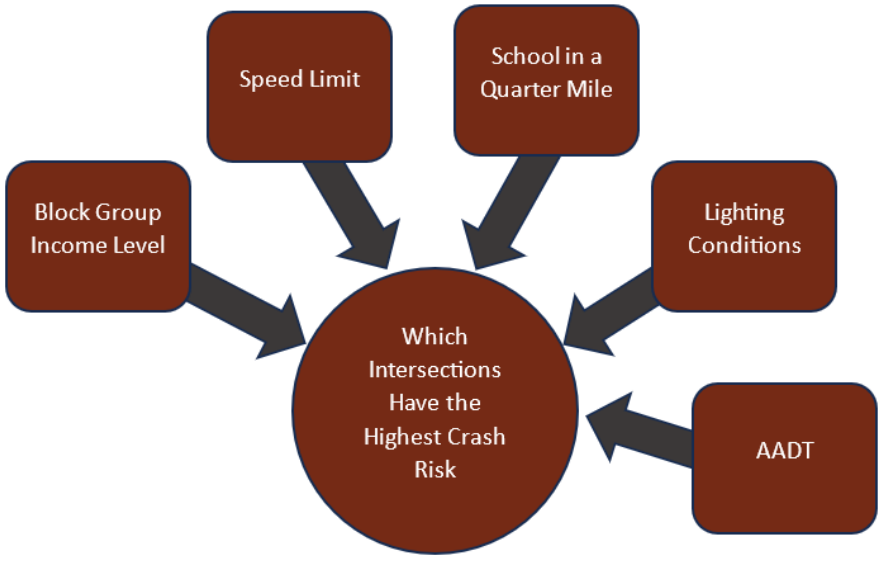
Signalized Intersections
KAB rear-end crashes at signalized intersections with at least one non-state leg
KAB angle/broadside crashes at urban four-leg signalized intersections with no state legs

All Intersections

KAB single vehicle crashes involving a collision with a fixed object
KAB pedestrian-vehicle crashes at intersections
KABCO pedestrian-vehicle crashes with a pedestrian in marked crosswalk
KABCO pedestrian-vehicle crashes with a pedestrian not in a marked crosswalk
KABC nighttime pedestrian vehicle-crashes
KAB bicycle-vehicle crashes

What are Risk Factors?

Risk factors are the common characteristics associated with the focus crash type/facility type combinations.



Risk factors are used to identify where crashes are most likely. However, the common elements being correlated with crashes does not necessarily imply a causal relationship or that they represent an inferior aspect of the roadway.

For this risk-based assessment, the risk factors were identified using binary logit modeling.

Binary logit models are a form of regression models. They differ from linear regression in that linear regression aims at predicting the value of a variable (e.g., number of crashes) while binary logit models are used to estimate the probability that an event happens (e.g., left turn crashes will occur, yes/no).

Binary Logit General Form

$$\ln[p/(1-p)] = a + b_1X_1 + b_2X_2 + \ldots + b_kX_k$$

where,

P : Probability that event Y = 1 given X

Y : Dependent Variable

X_1, X_2, X_k : Independent Variables

$a, b_1 \ldots b_k$: Model Parameters

As with linear regression, there is a dependent variable and one or more independent variables. For instance, to predict the occurrence of left turn crashes, the dependent variable, we may want to see how the number of intersection legs and the approach AADT, the independent variables, affect the likelihood of left-turn crashes happening. The variables considered for generating the risk factors for this project included attributes related to intersection geometry, traffic control, adjacent land use, adjacent population, and other intersection and socioeconomic characteristics.

The association between the independent variables and an outcome is measured by the odds ratio. Odds ratios > 1 indicate a positive effect, odds ratios < 1 indicate a negative effect.

The p-value measures whether there is a relationship between the dependent and an independent variable. A relationship exists when the p-value is low (often p-value <0.05). A high p-value indicates that it cannot be concluded that a relationship exists. In this case, the variable is said to be insignificant. For this risk-based analysis, given the small sample size, factors with a p-value exceeding 0.300 were generally considered insignificant and removed.

A sample table of partial binary logit model outputs for the angle/broadside crashes at minor stop-controlled T-Intersections is shown.

Variable	Odds Ratio	Standard Error	z-value	P>|z|	95% Confidence Interval		Weight
Area is Urban	1.85	0.34	3.38	<0.01	1.3	2.65	1
Alcohol is sold within a quarter mile	2.13	0.38	4.26	0	1.5	3.01	1
Total Approach AADT > 8,000 veh/day	2.53	0.5	4.7	0	1.72	3.73	1
Minor approach speed limit is over 30 mph	3.41	0.69	6.09	0	2.3	5.07	2
Over 30% of persons in the Block Group have a commute of 15 minutes or less	1.79	0.3	3.43	<0.01	1.28	2.5	1

The risk factors listed in the sample table include area type, alcohol sold, total approach AADT >80000 veh/day, minor approach speed limit over 30 mph and over 30% of people in the block group with a commute of 15 minutes or less.

The higher odds ratio (3.41) for the factor minor approach speed limit is over 30 mpg indicates that this variable has a greater influence on the occurrence of an angle/broadside crash. For this reason, this variable is assigned a greater weight (2).

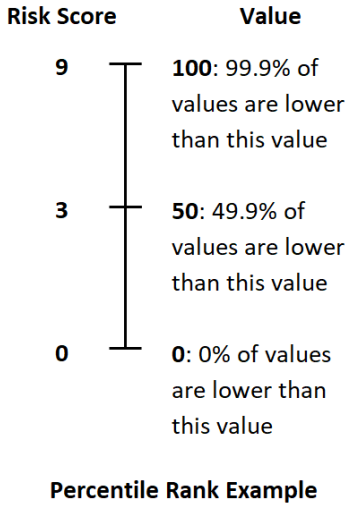
Refer to the compendium of technical memoranda to review the risk factors used to develop the risk score:

Technical Memoranda

Risk Determination

To determine risk, intersections were scored for each focus crash type/focus facility type combination based on the presence of the risk factors at the intersection and their assigned weights. As a risk scoring example, assume that three risk factors associated with the nighttime pedestrian crash type are present at an intersection and that they have a weight of 1, 1, and 2 respectively. The risk score for this intersection, for this crash type, would then be 1+1+2 = 4.

Each intersection was assigned a percentile rank based on its total score relative to the other intersections within its focus crash and facility types. The percentile ranks were then used to assign the segments a risk category following five categories of risk: Minimal Risk, Low Risk, Medium Risk, High Risk, Primary Risk.



Percentile Rank Example

Crash Severity

Crash severity is based on the highest level of injury suffered by any of those involved in a crash. For example, if two people were involved in a crash, and one suffered a serious injury and the other person suffered a non-serious injury, the crash is classified as a serious injury crash.

The KABCO scale is used to refer to the severity of a crash.

K Fatal
A Suspected Serious Injury
B Suspected Non-Serious Injury
C Possible Injury
O Property Damage Only Crashes

Glossary

Term	Definition
AADT	Annual Average Daily Traffic
FHWA	Federal Highway Administration
Focus Crash Type	The crash type that represents the greatest number of severe crashes across the roadway system being analyzed and provides the greatest potential to reduce fatalities and severe injuries
Focus Facility Type	The facility type on which the focus crash type most frequently occurs
KABCO	Crash Severity is coded using the KABCO scale, as per the Model Minimum Uniform Crash Criteria (MMUCC) based on the most severe injury to any person involved in the crash
K (Fatality)	A fatality is any injury that results in death within 30 days after the motor vehicle crash in which the injury occurred. PLEASE NOTE: The National Highway Traffic and Safety Administration's (NHTSA) definition under the Fatal Analysis Reporting System (FARS) requirement, a "fatal injury must only be used if the death occurred within thirty consecutive 24-hour time periods from the time of the crash". If a death happens after the 30-day period, code as Injury Crash type and the injury is coded as Suspected Serious Injury (A)
A (Suspected Serious Injury)	A suspected serious injury is any injury other than fatal which results in one or more of the following: ~ Severe laceration resulting in exposure of underlying tissues/muscle/organs or resulting in significant loss of blood ~ Broken or distorted extremity (arm or leg) ~ Crush injuries ~ Suspected skull, chest or abdominal injury other than bruises or minor lacerations ~ Significant burns (second and third degree burns over 10% or more of the body) ~ Unconsciousness when taken from the crash scene ~ Paralysis
B (Suspected Minor Injury)	A suspected minor injury is any injury that is evident at the scene of the crash, other than fatal or serious injuries. Examples include lump on the head, abrasions, bruises, minor lacerations (cuts

Term	Definition
	on the skin surface with minimal bleeding and no exposure of deeper tissue/muscle)
C (Possible Serious Injury)	A possible injury is any injury reported or claimed which is not a fatal, suspected serious or suspected minor injury. Examples include momentary loss of consciousness, claim of injury, limping, or complaint of pain or nausea. Possible injuries are those which are reported by the person or are indicated by his/her behavior, but no wounds or injuries are readily evident
O Property Damage Only (No Apparent Injury)	No apparent injury is a situation where there is no reason to believe that the person received any bodily harm from the motor vehicle crash. There is no physical evidence of injury and the person does not report any change in normal function
Risk Factor	A representation of risk in characteristics associated with the locations where the type of targeted crash types occurred
Systemic Safety Improvement	An improvement that is widely implemented based on high-risk roadway features that are correlated with particular crash types, rather than crash frequency
Systemic Safety Management	The systemic safety management approach is used to program implementation of proven safety treatments across a large number of sites to reduce crash potential using crash prediction models or rating systems based on roadway features correlated with particular sever crash types