MEMORANDUM Arlington County
2022 Crash Hot Spot Analysis Methodology
(Dataset: 2016 – 2020 VDOT Crash Data)

Overview

Under *Action Item A3: Annual Crash Analysis*, the Vision Zero Action Plan states that the Vision Zero team will perform crash hot spot reviews of all reported crashes to identify individual intersections or locations that experience relatively high numbers of crashes with the target to implement quick-build crash mitigation measures. The Vision Zero team will conduct a hot spot analysis roughly every two years and then assess and implement safety treatments at each location over that two-year period.

To track the effectiveness of safety improvements at hot spots over time, the Vision Zero team maintains an inventory of hot spots, including crash data and applied treatments. The team will assess improvements at each identified hot spot to ensure the treatments implemented effectively reduce crashes at the hot spot.

The term "hot spot" is relative. Compared to larger jurisdictions with higher volume and higher speed roads, Arlington's hot spots can have significantly fewer crashes and/or injuries. However, we recognize the importance of identifying safety needs from our crash data and implementing safety improvements wherever possible to achieve Arlington's Vision Zero goals.

This memo describes the process used to derive the 2016 – 2020 Arlington County Crash Hot Spots (2022 Hot Spot Analysis), which was completed in 2022.

Datasets

The 2022 Hot Spot Analysis uses the datasets in Table 1.

Table 1. Datasets Used in Crash Hot Spot Development

Dataset	Creator
Crash data	VDOT (maintained by Arlington County)
Street centerlines	Arlington County
Signalized intersections	Arlington County
Unsignalized intersections	Fehr & Peers (see Step 1 below)
Midblock locations	Fehr & Peers (see Step 1 below)
Traffic volume estimates	StreetLight
Hard-braking incidents	WeJo

Step 1. Process and Create Datasets

Once crash data have been assembled for the desired time horizon (in this case, 2016 – 2020), the following steps are completed to ready the data for the hot spot analysis:

- Remove freeway crashes from the crash dataset

- Remove crashes along I-66, I-395, and George Washington Memorial Parkway
- Keep crashes at ramps intersecting surface streets

- Classify street centerlines as *arterial* or *neighborhood* based on the GIS attributes shown in Table 2 below

Table 2. Street Centerline Classifications for Hot Spot Development

Street Centerline Type		**Hot Spot Designation**	
GIS ID	GIS Label Name	Arterial	Neighborhood
0	New		X
90	Other Jurisdiction	X	
10	Controlled Access	X	
21	Other Principal Arterial	X	
25	Minor Arterial	X	
31	Neighborhood Principal		X
35	Neighborhood Minor		X
50	Private Street		X
60	Access Ramp	X	

- Use combinations of *location type* and *street type* to establish *buffer distances*, as shown in Table 3. Buffer distances are used in GIS to assign a crash to one of the three location types: *signalized intersection*, *unsignalized intersection*, or *midblock location* (midblock also includes *ramp locations*, which are disaggregated from midblock in Step 5)

Table 3. Buffer Distances for Assigning Crashes to Location Types

GIS ID	**Location Type**	**Street Type**	**Buffer Distance**
1.1	Signalized intersection	Arterial intersecting arterial	100'
1.2	Signalized intersection	Arterial intersecting neighborhood	100'
2.1	Unsignalized intersection	Arterial intersecting arterial	100'
2.2	Unsignalized intersection	Arterial intersecting neighborhood	100'
3	Signalized intersection	Neighborhood intersecting neighborhood	50'
4	Unsignalized intersection	Neighborhood intersecting neighborhood	50'
5	Midblock location	Not at intersection: Arterial	N/A
6	Midblock location	Not at intersection: Neighborhood	N/A

Note: Buffer distances were established using an iterative process that considered intersection size and proximity of nearby intersections. Crashes not assigned to a signalized or unsignalized intersection are assigned to a midblock location.

- Create *unsignalized intersection* dataset
  - Using GIS, merge all street centerlines into one polyline
  - Break polyline at locations where two line segments intersect at an angle (i.e., not end-to-end)
  - Create new point feature from the above intersections as the basis for the unsignalized intersection dataset
  - Manually review unsignalized intersections to remove any signalized intersections or points that were not actual non-signalized intersections
- Create *midblock location* dataset
  - Using GIS, merge segments of the County's street centerline dataset as necessary to create unique midblock polylines
  - Manually review midblock locations for accuracy
- Identify all road segments where a crash occurred as the basis for acquiring StreetLight and WeJo data
  - Select road segments (midblock or intersection approach) where a crash occurred to pull 2019 StreetLight "All Vehicle" traffic volume estimates from VDOT StreetLight portal
  - Use the same road segments (midblock or intersection approach) to pull October 2019 WeJo hard-braking data from Fehr & Peers' WeJo dataset
- Conduct quality assessment of datasets for accuracy

Step 2. Join Crash Data to Roads

Complete the following processes to create a spatial connection between crash data, location data, StreetLight traffic volume estimates, and WeJo hard-braking data:

- Using buffer distances from Table 3, create a buffer around each signalized, unsignalized, and midblock location to assign crashes to each of these location types
- Use the following hierarchy for crash assignment:
  - Assign signalized intersection crashes first, then non-signalized intersections, and then midblock locations
  - Assign crashes to only one location
- Assign StreetLight traffic volume estimates and WeJo hard-braking data to each roadway location
  - Each crash is assigned to a location, and each location has volumes and hard-braking data joined to it; therefore, each crash will receive an associated volume and hard-braking value
- QA/QC buffers, crash assignments to locations, and volume/hard-braking data assignments to locations

Step 3. Determine Equity Emphasis Areas

Census Block Groups meeting *either* of the following criteria are considered Equity Emphasis Areas. These thresholds are derived from ART's Title VI analysis using 2014 data:

- Block Groups with 50%+ households with a median household income below $50,000 *(note: this metric was modified from Title VI low income qualifying criteria—which recommends filtering to 17.5%+ household with a median household income below $50,000—because the 50% cut off would more acutely program crash interventions in the top equity areas in the County)*
- Block Groups with 38.5%+ minority population

Crashes that fall within the above Block Groups are considered Equity Emphasis Area crashes. Crashes that fall outside those Block Groups are considered Countywide crashes.

Step 4. Weight and Normalize Crashes

Weighting and normalizing crashes involves the following steps:

- Export crash dataset to Excel
- Determine crash severity weighting using the values in Table 4.

Table 1. Crash Severity Weighting

Crash Severity	Weighting
Fatal injury	3
Severe injury	2
Visible injury	2 *Note: This weight was originally 1. It was adjusted through the sensitivity testing described in Step 5.*
Nonvisible injury	1
Property damage only	0.2
Hard-braking incident	0.02

Note: Crash severity weighting was based on a scan of weights used in other Vision Zero cities.

- Use Excel to run weighting formulas for all crashes:
    - Formula for signalized and unsignalized intersections
        - [(# fatal crashes x fatal crash weight) + (# severe injury crashes x severe injury crash weight) + (# visible injury crash x visible injury crash weight) + (# nonvisible injury crashes x nonvisible injury crash weight) + (# property damage only crashes x property damage only crash weight) + (total number of hard-braking per intersection x hard-braking incident weight)] / Largest StreetLight volume per intersection = *Intersection Index*

    - Formula for midblock locations
        - [(# of fatal crashes x fatal crash weight/StreetLight volume per crash location)+ (# of severe crashes x severe crash weight/StreetLight volume per crash location) + (continued for each crash severity type within each midblock location) + ([total hard-braking within segment x hard-braking incident weight]/StreetLight Volume)] / length of midblock street centerline segment = *Midblock Index*
- In Excel, run formulas to determine index for each of the following areas:
    - Countywide
        - All crashes
        - Pedestrian crashes
        - Bike crashes
    - Equity Emphasis Areas
        - All crashes
        - Pedestrian crashes
        - Bike crashes
- QA/QC Excel formulas and outputs for accuracy

Step 5. Conduct Sensitivity Testing

The 2016 – 2020 Crash Hot Spot analysis was the County's first attempt to apply weighting and normalization. A sensitivity test was conducted to ensure that weighting and normalization factors were not creating unwanted distortion in the hot spot selection process:

- Duplicate the crash data Excel spreadsheet to test the sensitivity of different weighting/normalization factors on the number, type, and severity of crashes per location
- Use the sensitivity testing spreadsheet to determine the top 20 crash locations and evaluate how scoring changes if visible injury crashes are changed from 1 to 2, and how StreetLight traffic volume estimates impact the index score
    - The outcome of the sensitivity testing was to keep the volume estimates in the formulas and adjust the weighting for visible injury crashes from 1 to 2
    - This process also informed the decision to break midblock crashes into two subgroups: midblock and ramp
- The sensitivity testing informed the final hot spot inclusion criteria per location type:
    - *Exclude* any location with *fewer than 5 vehicle-only crashes* over the five-year period
    - *Exclude* any location with *fewer than 3 pedestrian crashes* over the five-year period
    - *Exclude* any location with *fewer than 2 bike crashes* over the five-year period
    - *Include* any location that does not meet the crash threshold but has *100+ hard-braking events*

Step 6. Finalize Crash Hot Spots

Steps 1-5 resulted in a final list of 69 crash hot spots, which were documented through:

- Produce final map infographic of crash hot spots showing:
  - Hot spots (1-69)
  - Crash location and location type
    - Signalized intersections
    - Unsignalized intersections
    - Midblock locations
    - Ramp locations
  - Crash hot spots in Equity Emphasis Areas
  - Top hot spots by mode
    - All crashes
    - Pedestrian crashes
    - Bike crashes
  - Hot spot inclusion in previous 3-year hot spot analysis
- An internal geodatabase and tracking spreadsheet

Project Team

This project was a collaboration with staff from Arlington County Transportation Engineering & Operations, Fehr & Peers, and Toole Design.