

# Prioritizing Intersections based on Kinetic Energy

Alex Webb

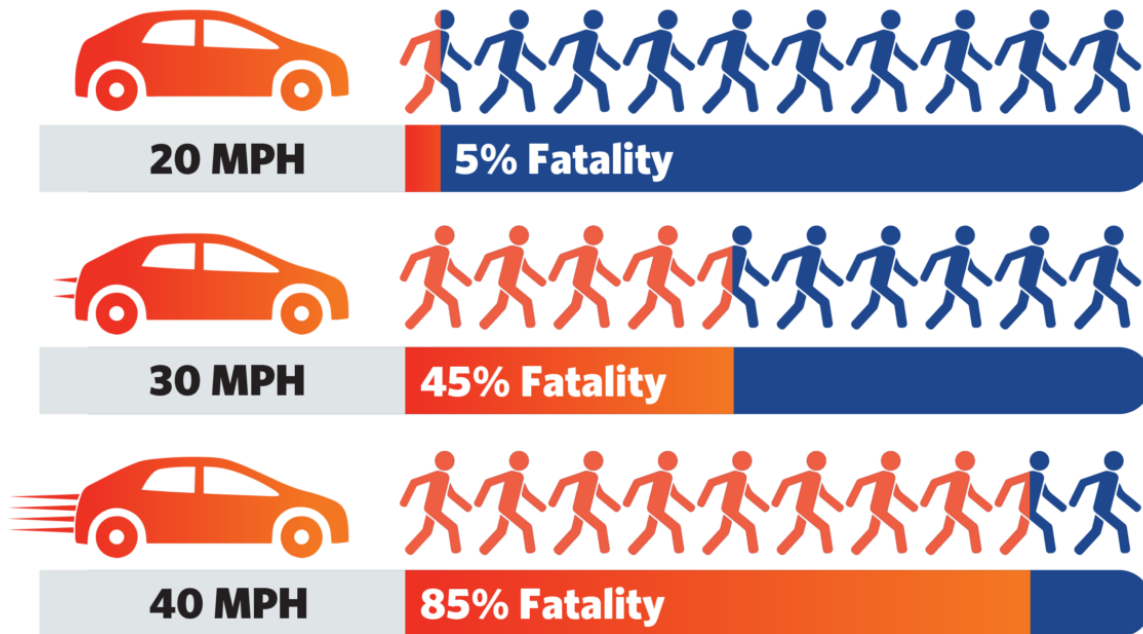
Transportation Engineer

Traffic Safety Administration

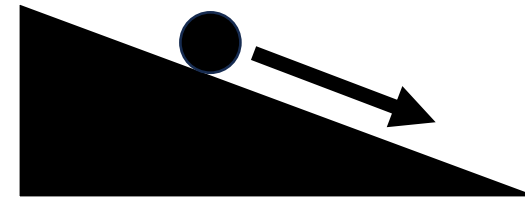


District Department of Transportation

# Kinetic Energy and Crash Severity



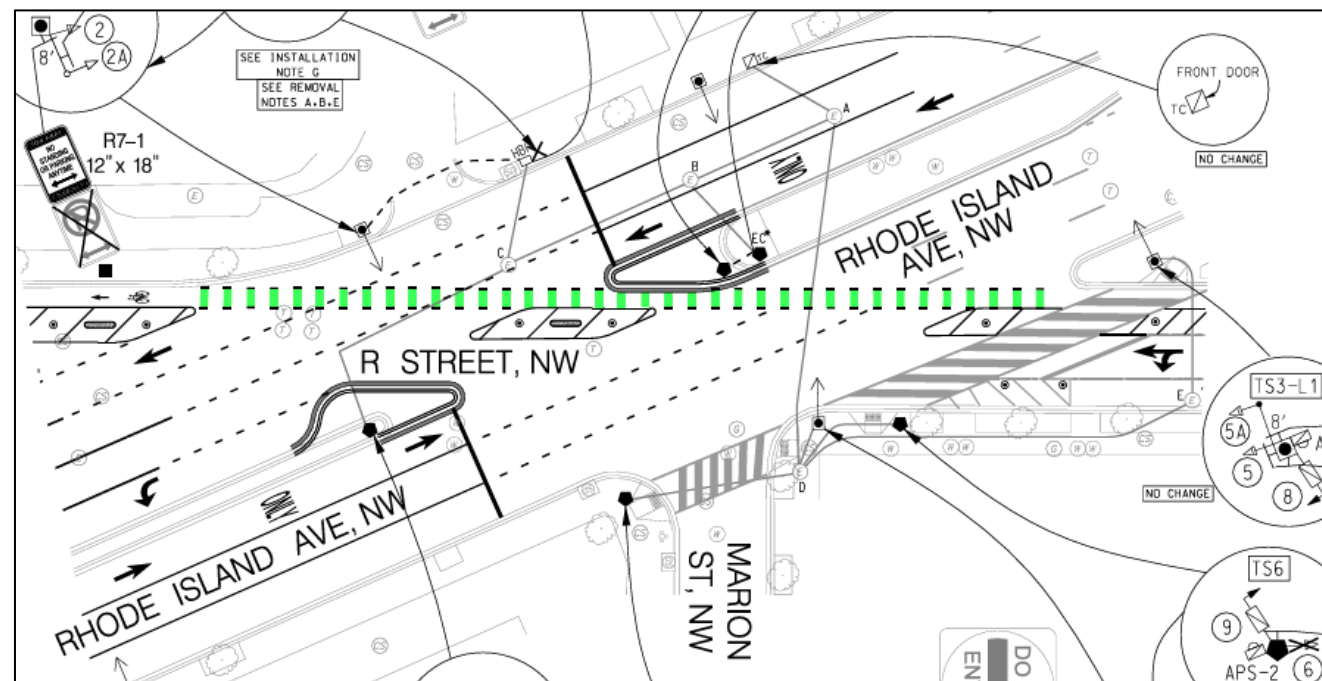
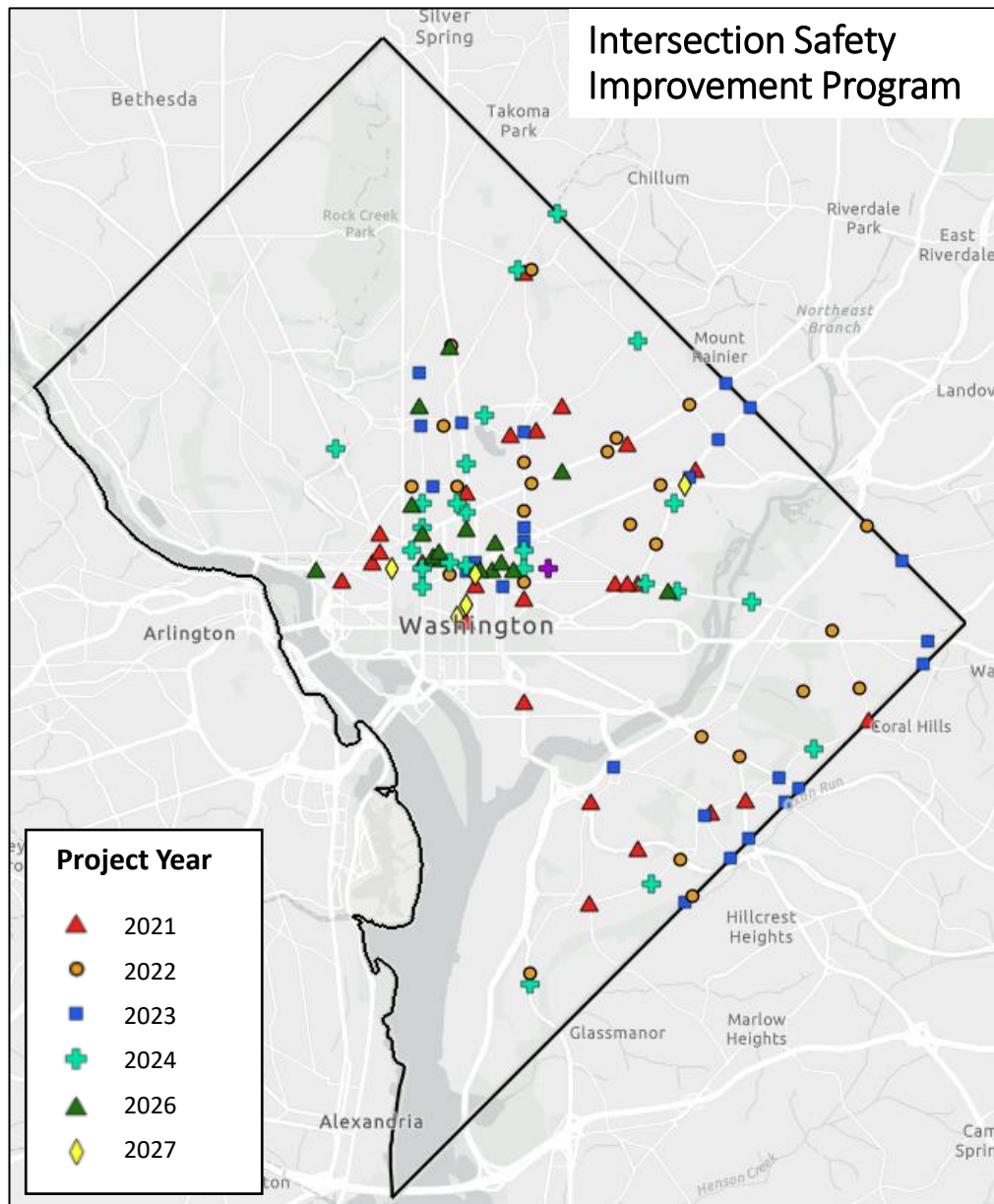
*Chicago Metropolitan Agency for Planning*



$$\text{Kinetic Energy} = \frac{1}{2}mv^2$$

$m$  = mass

$v$  = velocity



# Kinetic Energy Management Factor

## ***Purpose***

Develop a single measure to quantify risk at intersections using the principle of Kinetic Energy

## ***Applications***

- Prioritize future projects at the riskiest locations
- Allow other staff to quickly find risky locations within a project area

## ***Why not just look at crash history?***

- There is randomness in where crashes occur
- The dataset of Fatal and Serious crashes is relatively sparse

Texas Ave between D St and Dubois St SE



Injury Crashes



All Crashes



# Fatal and Serious (K+A) Crash Potential

$$\text{K+A Potential} = 0.75 \times (\text{Predicted K+A Crashes}) + 0.25 \times (\text{Observed K+A Crashes})$$

The estimated number of K+A crashes over the next 10 years assuming crash trends continue.

Predicted  
K+A Crashes

=

Crash  
Pattern  
Potential

×

Truck/Bus  
Adjustment  
Factor

×

Speed  
Adjustment  
Factor

$m$

$v^2$

# Collect Multi-Year Crash and Contextual Data

**6,676**

unique intersections

**192,580**

intersection-related  
crashes

**3,132**

fatal and serious  
injury crashes

**10 years**

2015–2024 study  
period

## INTERSECTION-LEVEL INPUTS

- **Crash data** crash type, severity, location
- **Speed data** posted speed limit, 85<sup>th</sup> percentile operating speed
- **Route context** truck and bus through-route indicator

## VALIDATION DESIGN

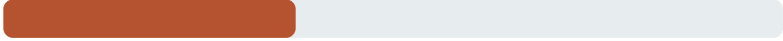
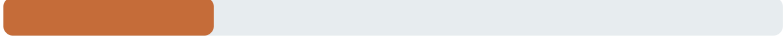
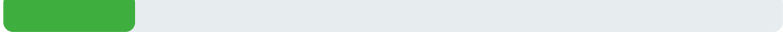
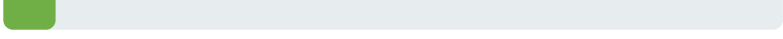
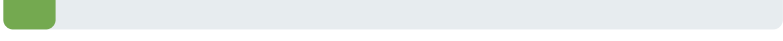
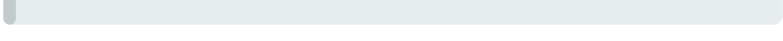
**2015–2019**

Calibrate

**2020–2024**

Validate

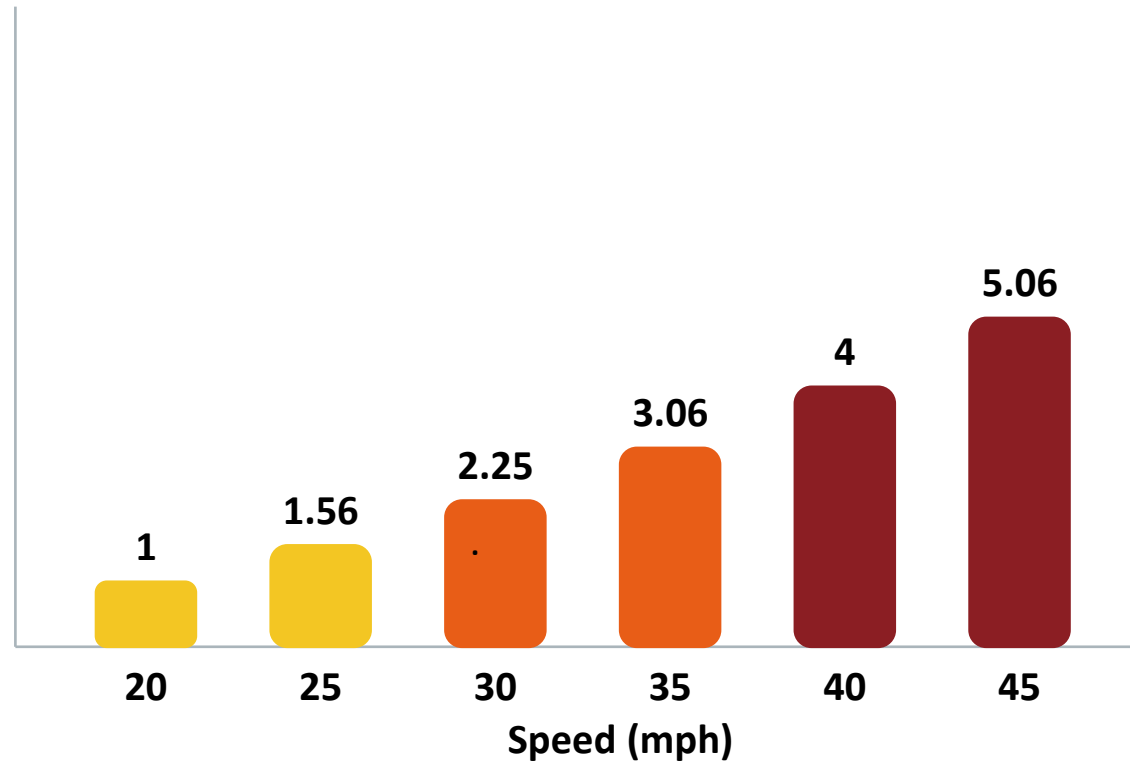
# Estimate Base K+A Probability

| Crash Type             | Total  | K+A   |                                                                                       | P(K+A) |
|------------------------|--------|-------|---------------------------------------------------------------------------------------|--------|
| VRU                    | 13,440 | 1,258 |    | 9.36%  |
| Non-collision          | 662    | 39    |    | 5.89%  |
| Head-on                | 3,150  | 118   |    | 3.75%  |
| Unknown                | 7,516  | 203   |    | 2.70%  |
| Fixed object           | 7,881  | 201   |    | 2.55%  |
| Right angle            | 11,744 | 241   |    | 2.05%  |
| Left-turn hit vehicle  | 21,723 | 367   |    | 1.69%  |
| Rear-end               | 41,477 | 277   |   | 0.67%  |
| Right-turn hit vehicle | 9,585  | 64    |  | 0.67%  |
| Parked vehicle         | 25,920 | 165   |  | 0.64%  |
| Side swipe             | 43,298 | 189   |  | 0.44%  |
| Backing crash          | 6,184  | 10    |  | 0.16%  |

# Adjustment Factor: Speed

$$AF_{\text{Speed}} = \frac{(\text{Maximum Operating Speed})^2}{20^2}$$

**Max. Operating Speed** – the highest value among posted speed limits and Replica 85<sup>th</sup> percentile speeds at a given intersection



# Adjustment Factor: Truck and Bus Route

| Truck/Bus Route? | Intersection Count | 2015-24     |             |               |
|------------------|--------------------|-------------|-------------|---------------|
|                  |                    | All Crashes | K+A Crashes | % K+A Crashes |
| Yes              | 1,847              | 118,317     | 1,989       | 1.68%         |
| No               | 4,829              | 74,263      | 1,143       | 1.54%         |

## VEHICLE MASS SURROGATE



**1.68%**

K+A on  
truck/bus routes

vs.

**1.54%**

K+A off route

$$AF_{\text{Truck/Bus}} = 1.09$$

# Example Calculation

Crashes at Benning Rd & 34<sup>th</sup> St NE (2015-2024)

| Crash Type             | Crashes |   | Base P(K+A) |   | E(K+A)      |
|------------------------|---------|---|-------------|---|-------------|
| Non-Collision Accident | 1       | X | 5.89%       | = | 0.06        |
| Side Swiped            | 56      | X | 0.44%       | = | 0.25        |
| Unknown                | 15      | X | 2.70%       | = | 0.41        |
| Rear End               | 72      | X | 0.67%       | = | 0.48        |
| Parked Vehicle         | 6       | X | 0.64%       | = | 0.04        |
| Head On                | 8       | X | 3.75%       | = | 0.30        |
| Fixed Object           | 11      | X | 2.55%       | = | 0.28        |
| VRU                    | 13      | X | 9.36%       | = | 1.22        |
| Right Angle            | 4       | X | 2.05%       | = | 0.08        |
| Left Turn Hit Veh.     | 64      | X | 1.69%       | = | 1.08        |
| Right Turn Hit Veh.    | 18      | X | 0.67%       | = | 0.12        |
| Backing Crash          | 6       | X | 0.16%       | = | 0.01        |
| <b>Total =</b>         |         |   |             |   | <b>4.32</b> |

- Intersection Name: Benning Road & 34<sup>th</sup> Street NE
- Max. operating speed: 37 mph
- On truck/bus route: Yes
- K+A crashes (2015-24): 8 crashes

$$\begin{array}{ccccccc}
 \boxed{\text{Crash Pattern Potential}} & \times & \boxed{\text{Truck/Bus Adjustment Factor}} & \times & \boxed{\text{Speed Adjustment Factor}} & = & \text{Predicted K+A Crashes} \\
 4.32 & & 1.09 & & 3.42 & & 16.11
 \end{array}$$

# Top 10 Locations

| Intersection Name                              | All Crashes (15-24) | KA Crashes (15-24) | Predicted (K+A) | K+A Potential |
|------------------------------------------------|---------------------|--------------------|-----------------|---------------|
| New York Ave & Bladensburg Rd NE               | 1146                | 17                 | 48.22           | 40.41         |
| New York Ave & Montana Ave NE                  | 823                 | 7                  | 34.08           | 27.31         |
| N St & New York Ave NW                         | 483                 | 15                 | 30.60           | 26.70         |
| Benning Rd & Minnesota Ave NE                  | 589                 | 14                 | 30.36           | 26.27         |
| Stanton Rd & Suitland Pkwy SE                  | 319                 | 7                  | 32.60           | 26.20         |
| Kenilworth Ave & Nannie Helen Burroughs Ave NE | 344                 | 6                  | 29.19           | 23.39         |
| Kenilworth Ave & Eastern Ave NE                | 260                 | 3                  | 24.61           | 19.21         |
| Barnaby Ter & Wheeler Rd SE                    | 934                 | 21                 | 18.51           | 19.13         |
| Fairlawn Ave & Pennsylvania Ave SE             | 525                 | 8                  | 21.90           | 18.43         |
| 36th Pl & New York Ave NE                      | 223                 | 9                  | 21.17           | 18.13         |

# Network-wide Results

## Full 2015–2024 Network Application

| Risk Tiers                      | Int. Count | All Crashes | % All Crashes | % K+A Crashes |
|---------------------------------|------------|-------------|---------------|---------------|
| 95-100 <sup>th</sup> Percentile | 334        | 58,927      | 30.6%         | 36.0%         |
| 85-95 <sup>th</sup> Percentile  | 668        | 49,559      | 25.7%         | 29.0%         |
| 70-85 <sup>th</sup> Percentile  | 1,001      | 37,450      | 19.5%         | 22.4%         |
| <70 <sup>th</sup> Percentile    | 4,673      | 46,644      | 24.2%         | 12.6%         |

TOP 5%

334 intersections

36.0%

of observed K+A crashes

TOP 15%

1,002 intersections

64.9%

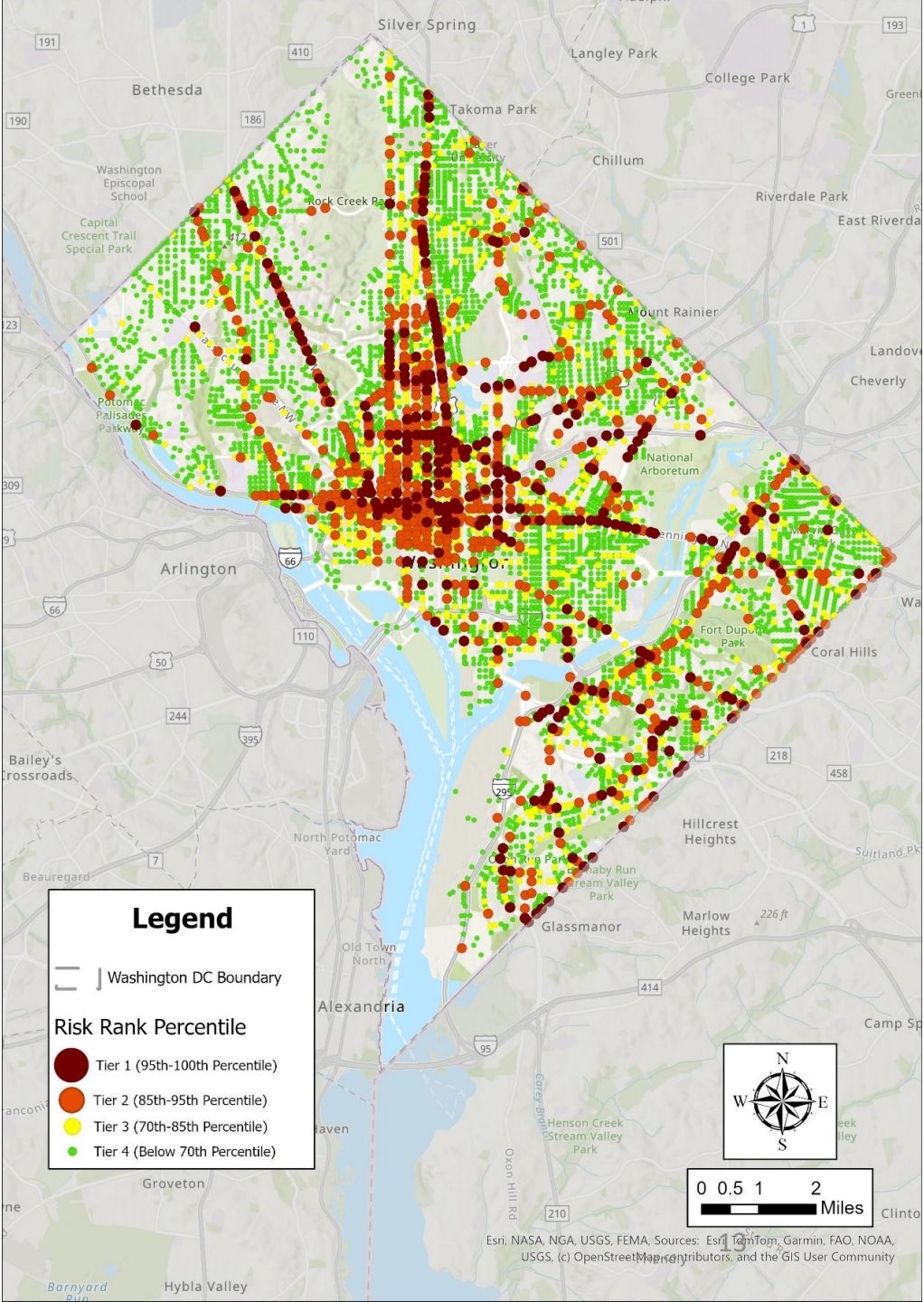
of observed K+A crashes

TOP 30%

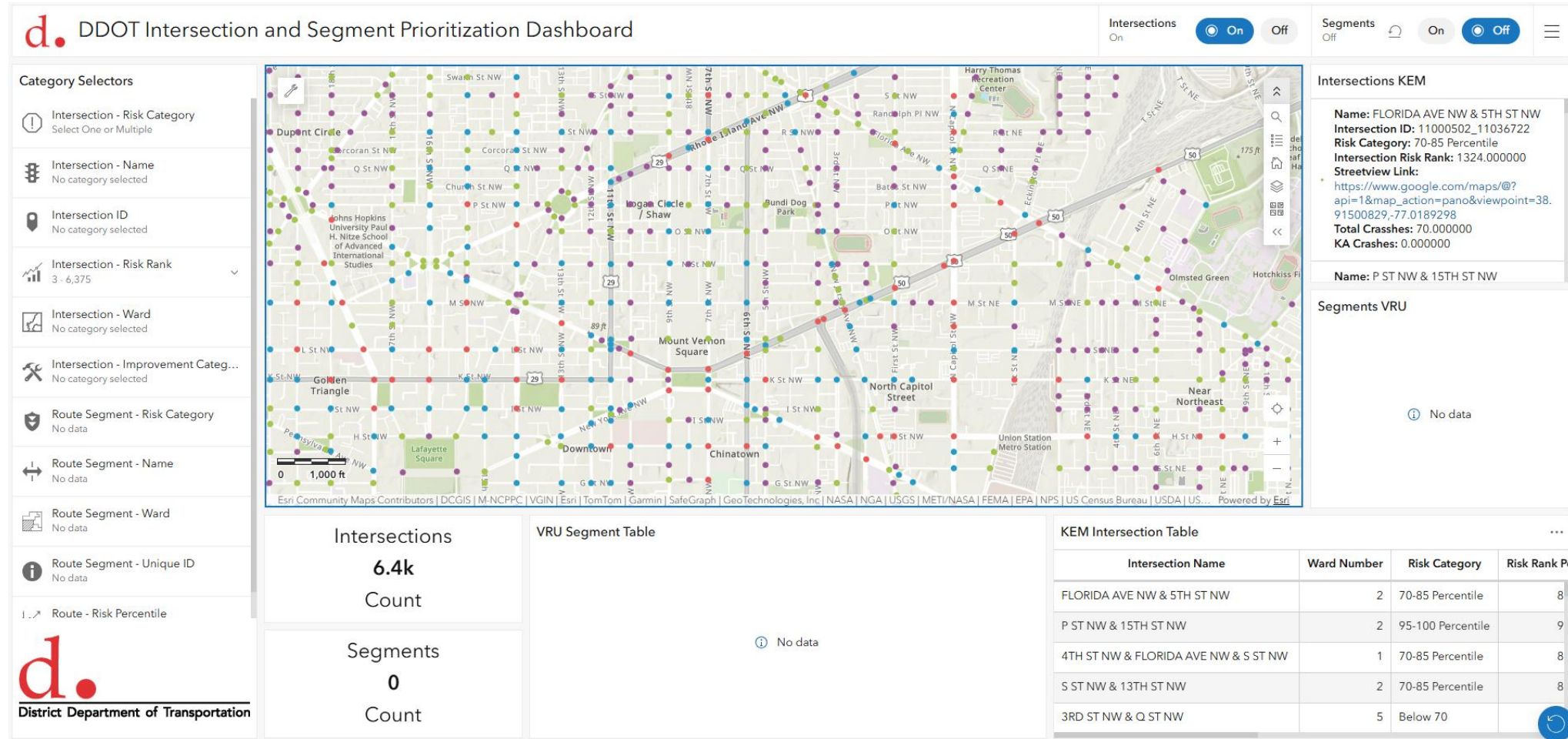
2,003 intersections

87.3%

of observed K+A crashes



# Interactive Dashboard





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District Department of Transportation

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