



# Leveraging Esri Technology to Improve the Safety of State Roadways

*Presented by*  
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# Presentation Overview

- What is the issue we are trying to solve?
- What is safety management?
- How can Esri technology help?

# Crash Fatalities

- Worldwide:
  - $\approx$  1.35 million people die each year on roads
    - 3,700 people die on the roads every day
- United States:
  - $\approx$  40,000 killed in crashes (2018)
  - $\approx$  4.5 million seriously injured in crashes
  - Every 7 seconds someone is hurt in a car crash.

“Forty-thousand deaths is unacceptable,” said **Nicholas Smith, interim president and CEO of NSC**. “We cannot afford to tread water any more. We know what works, but we need to demonstrate the commitment to implementing the solutions. **Roadway deaths are preventable by doubling down on what works, embracing technology advancements and creating a culture of safer driving.**”

What is safety management?



# Overview of Safety Management

## Purpose

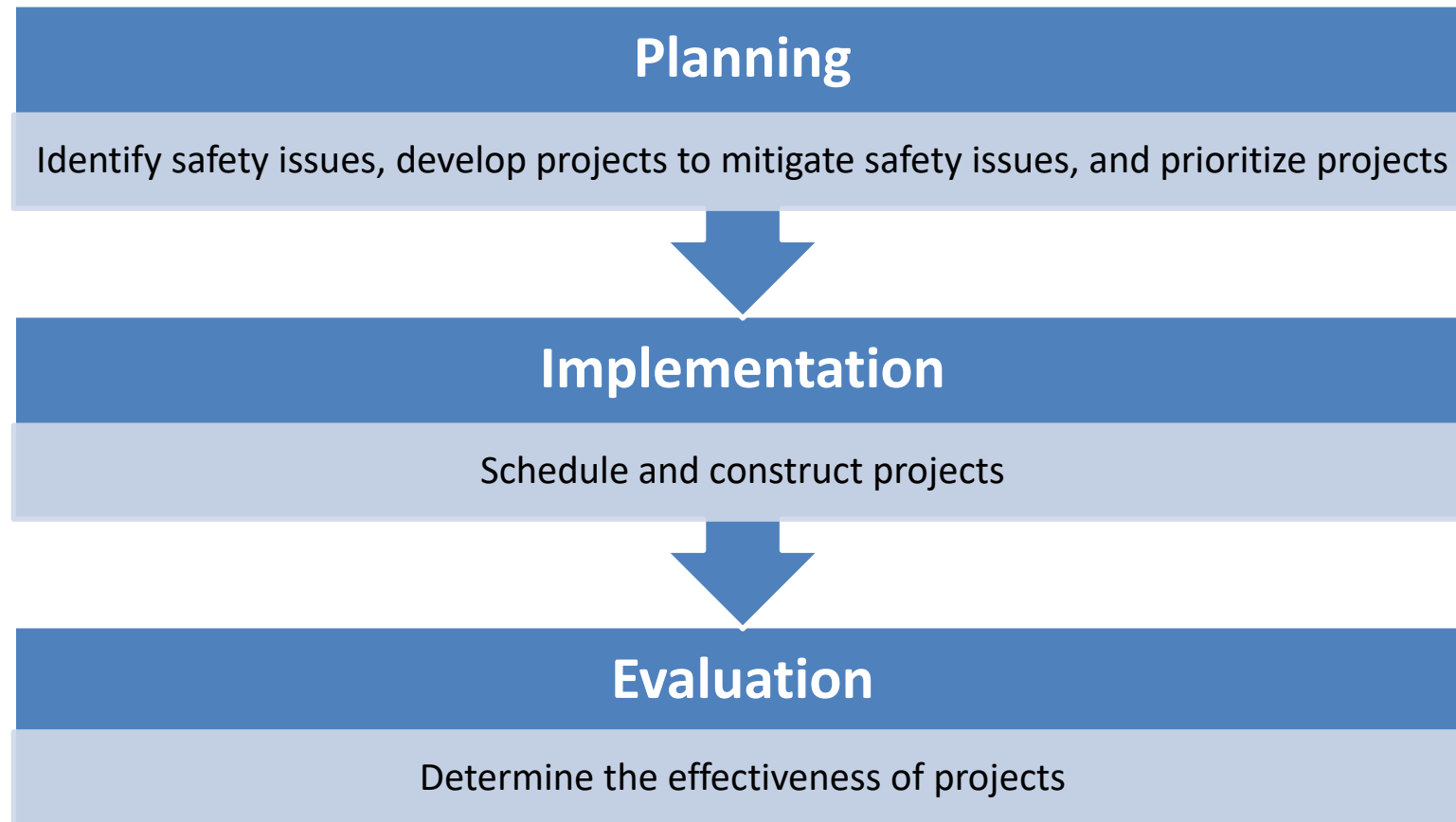
"Achieve a **significant reduction** in traffic **fatalities and serious injuries** on **all public roads**, including non-State-owned roads and roads on tribal land."

*--FHWA Highway Safety Improvement Program (HSIP)*

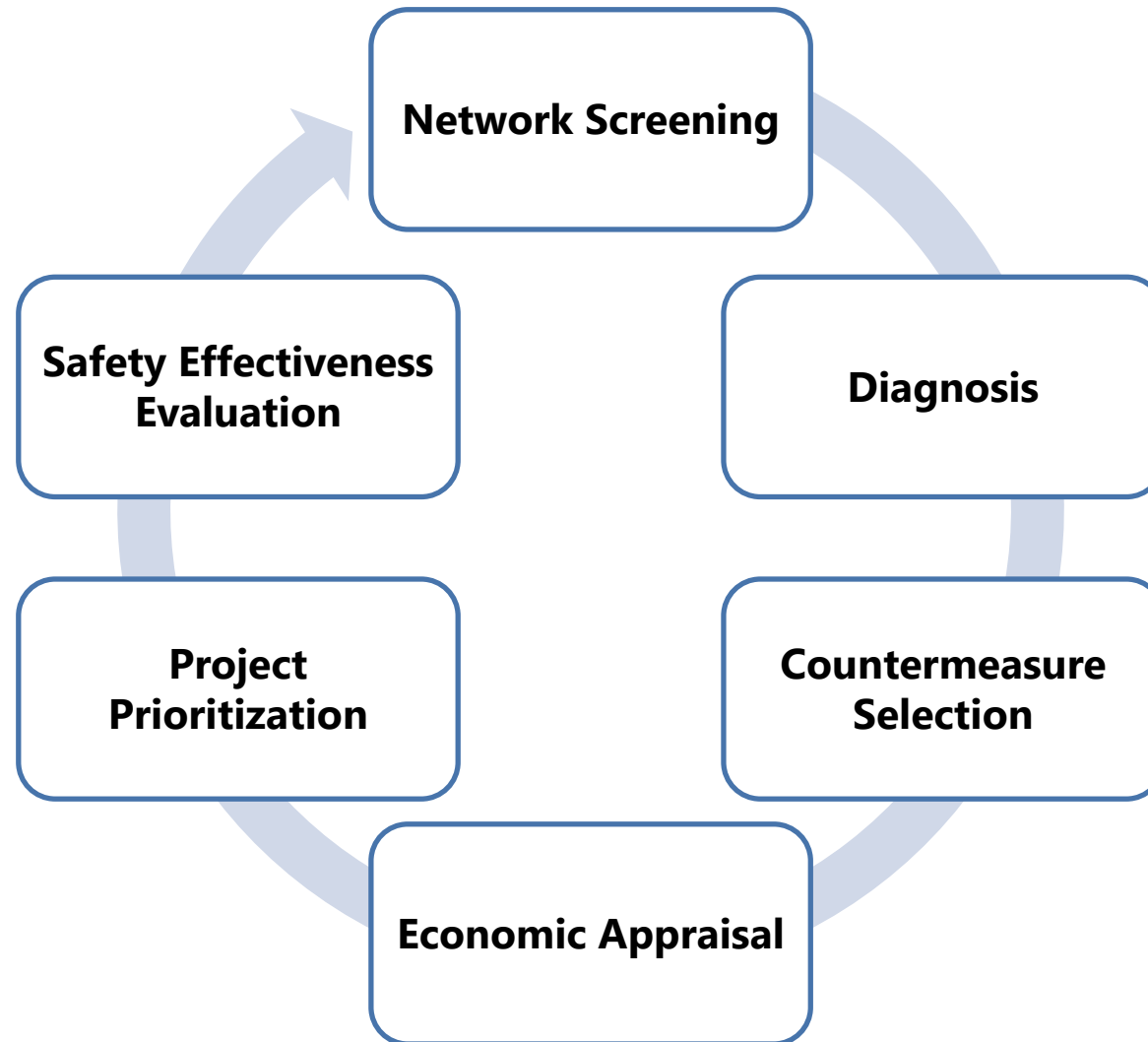


# Overview of Safety Management

## Process

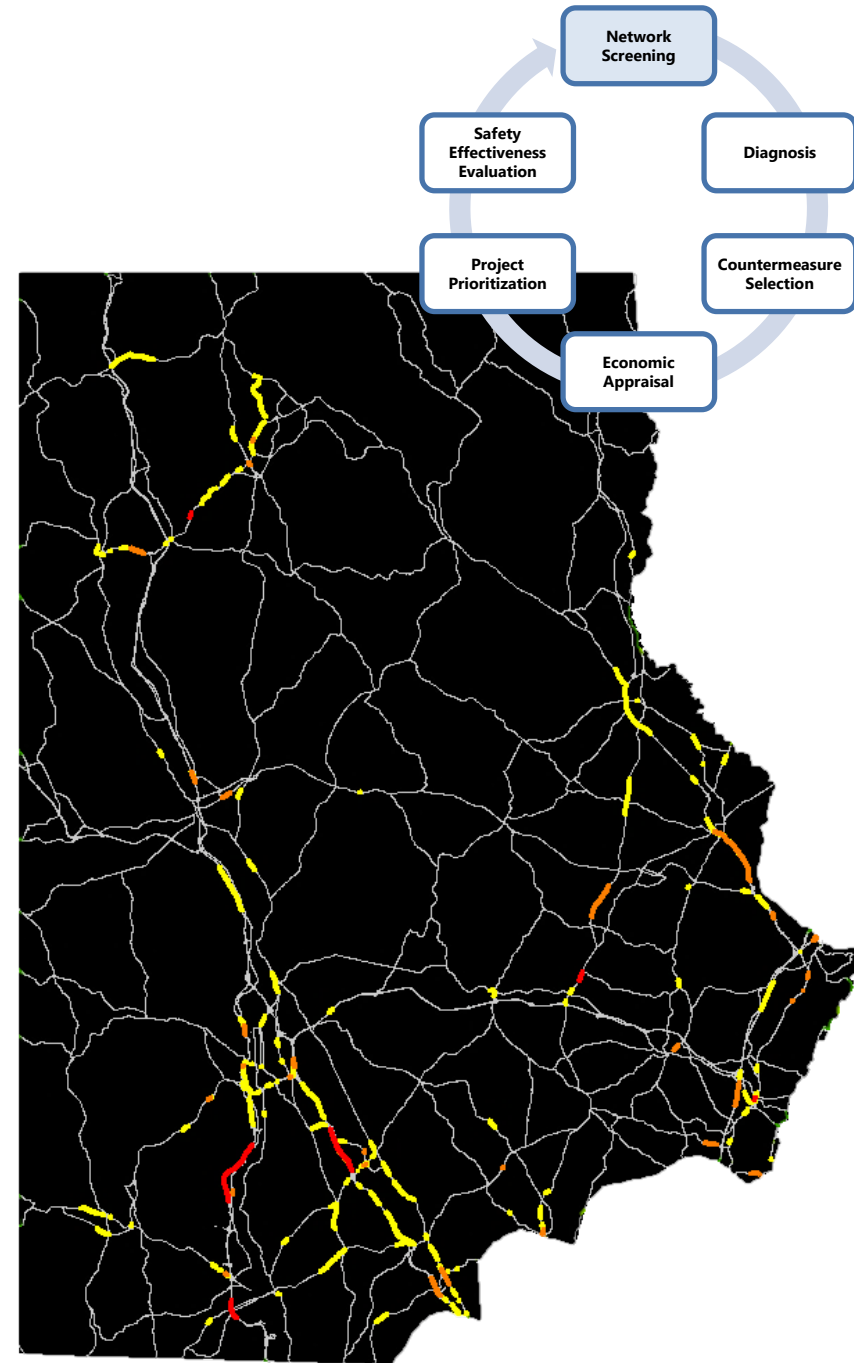


# 6-Step Safety Management Process



# Network Screening

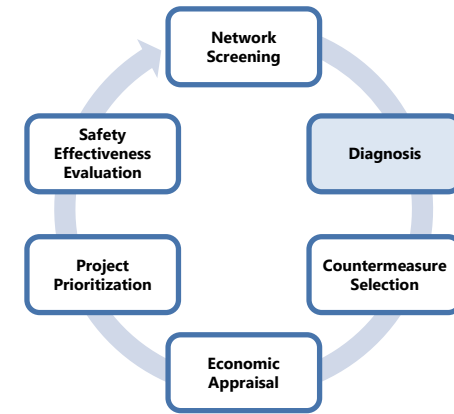
- **Objective:** Select sites for further investigation
- Pare-down network to manageable list





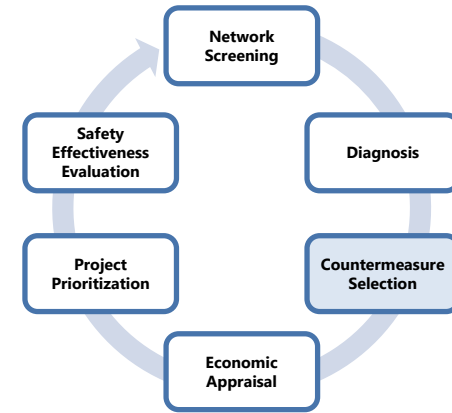
# Diagnosis

- **Objective:** investigate sites with promise
  - Understand crash patterns
  - Diagnose underlying factors



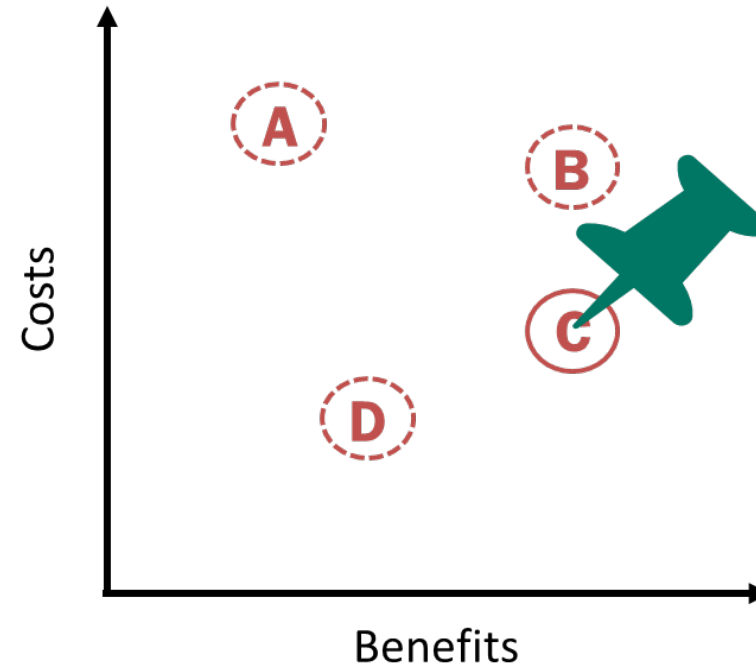
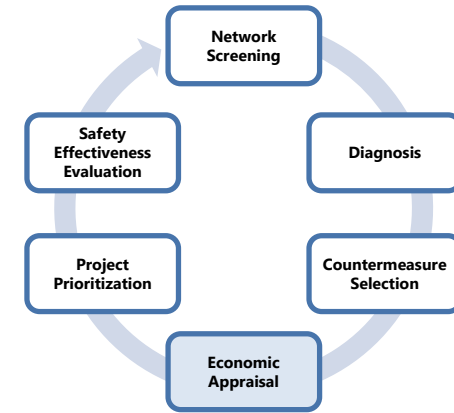
# Countermeasure Selection

- **Objective:** identify potential treatments to target underlying safety issues
  - Consider 4E approach
    - Engineering
    - Education
    - Enforcement
    - Emergency Response



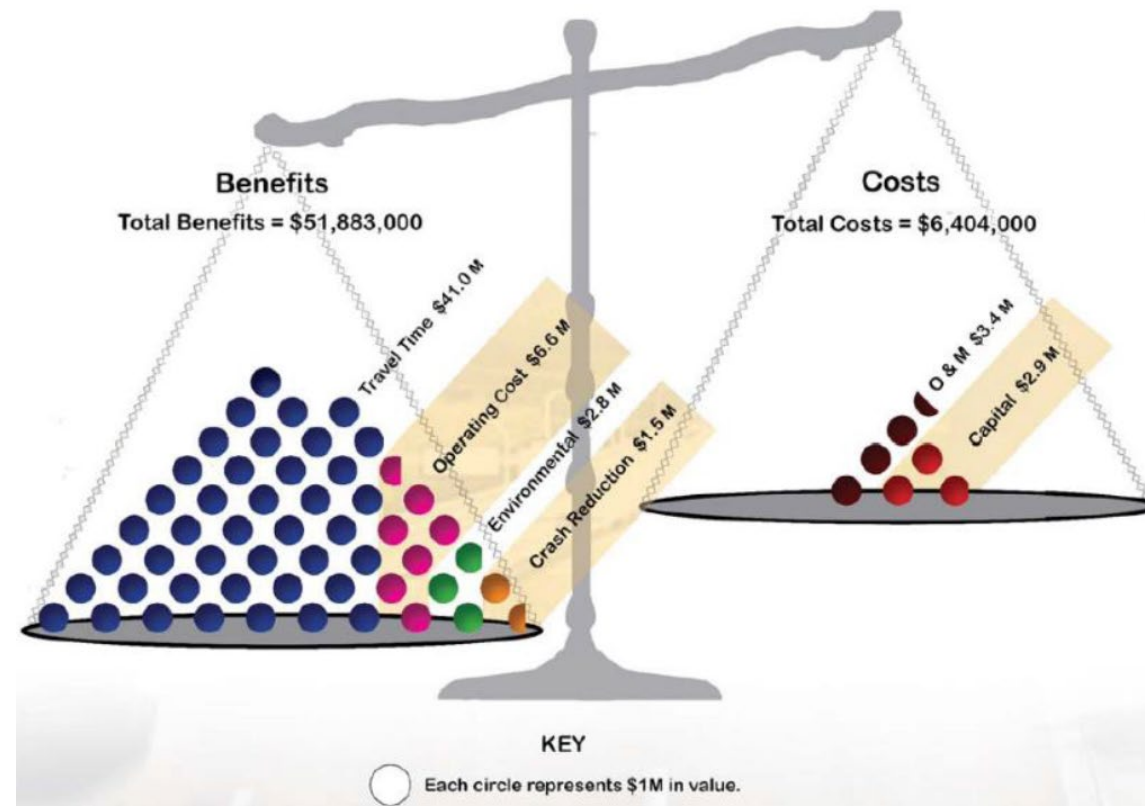
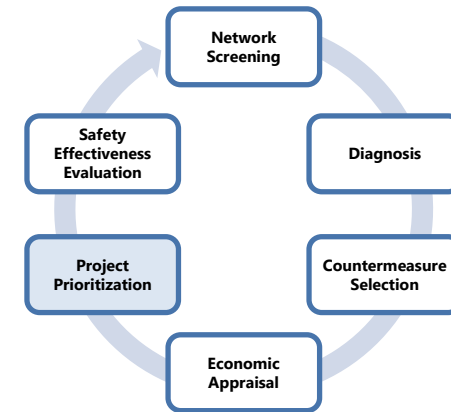
# Economic Appraisal

- **Objective:** Compare relative costs and benefits of alternatives
  - Perform benefit/cost analysis
  - Identify economically-efficient alternatives
  - Select final countermeasures



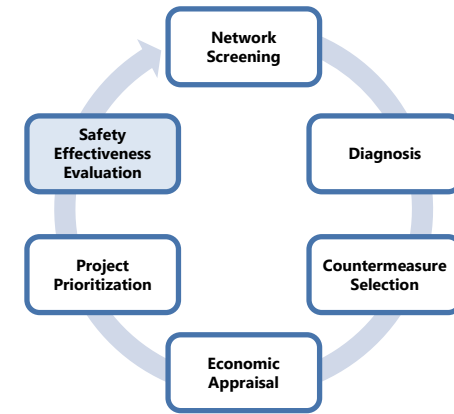
# Project Prioritization

- **Objective:** Develop portfolio of projects for a given fiscal year that maximizes the return on investment

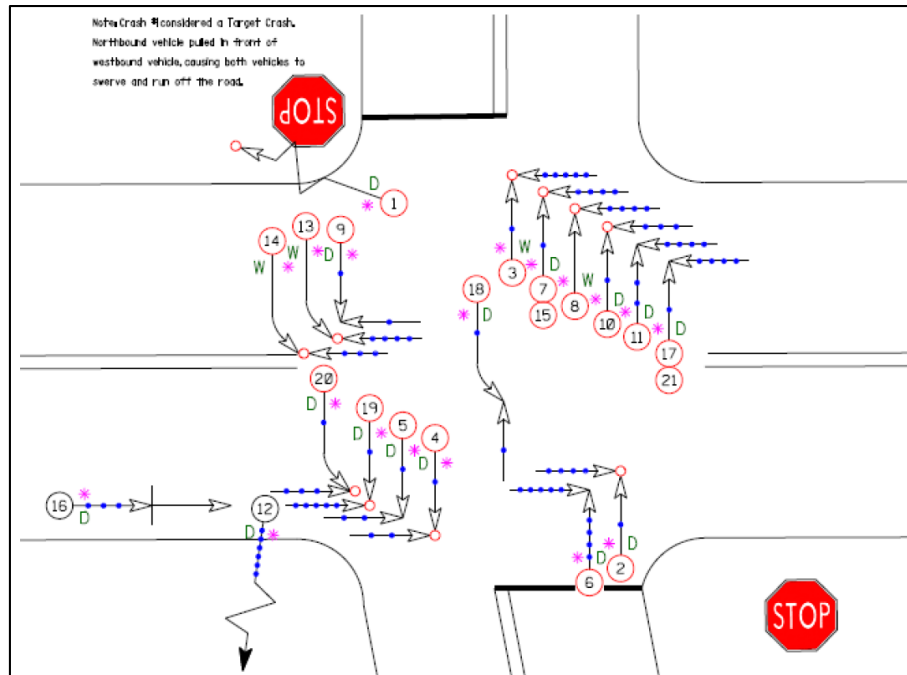


# Safety Effectiveness Evaluation

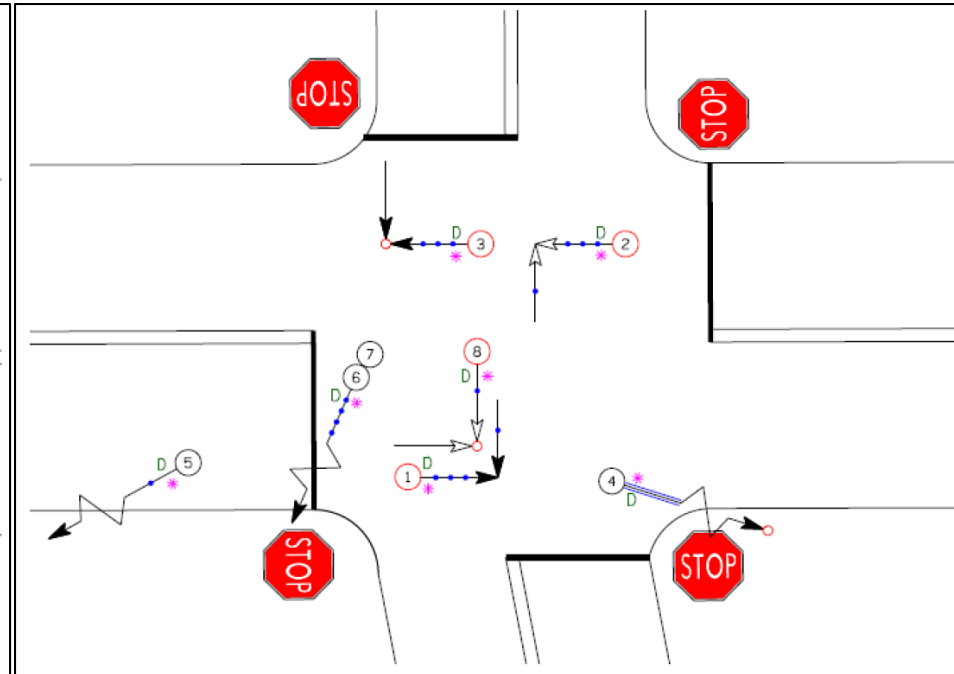
- **Objective:** Determine how projects have affected safety performance
  - Use results to make future decisions, allocate funds, and change policies



## Before



## After



How are states improving their  
process with Esri technology?





# MassDOT's Objectives

- **Replace** and enhance the **existing crash geocoder** system
- Leverage Esri **Roads and Highways**
- **Validate** and **geo-locate** crash data **in real time**
- Develop a **new crash database** that will:
  - interface with the **new geocoder** and validator system
  - be the **system of record** for crash locations
  - support a new, **public-facing crash data portal**
  - provide **real-time synchronization** with the RMV Crash Database
  - provide relevant **data redaction** within key workflows

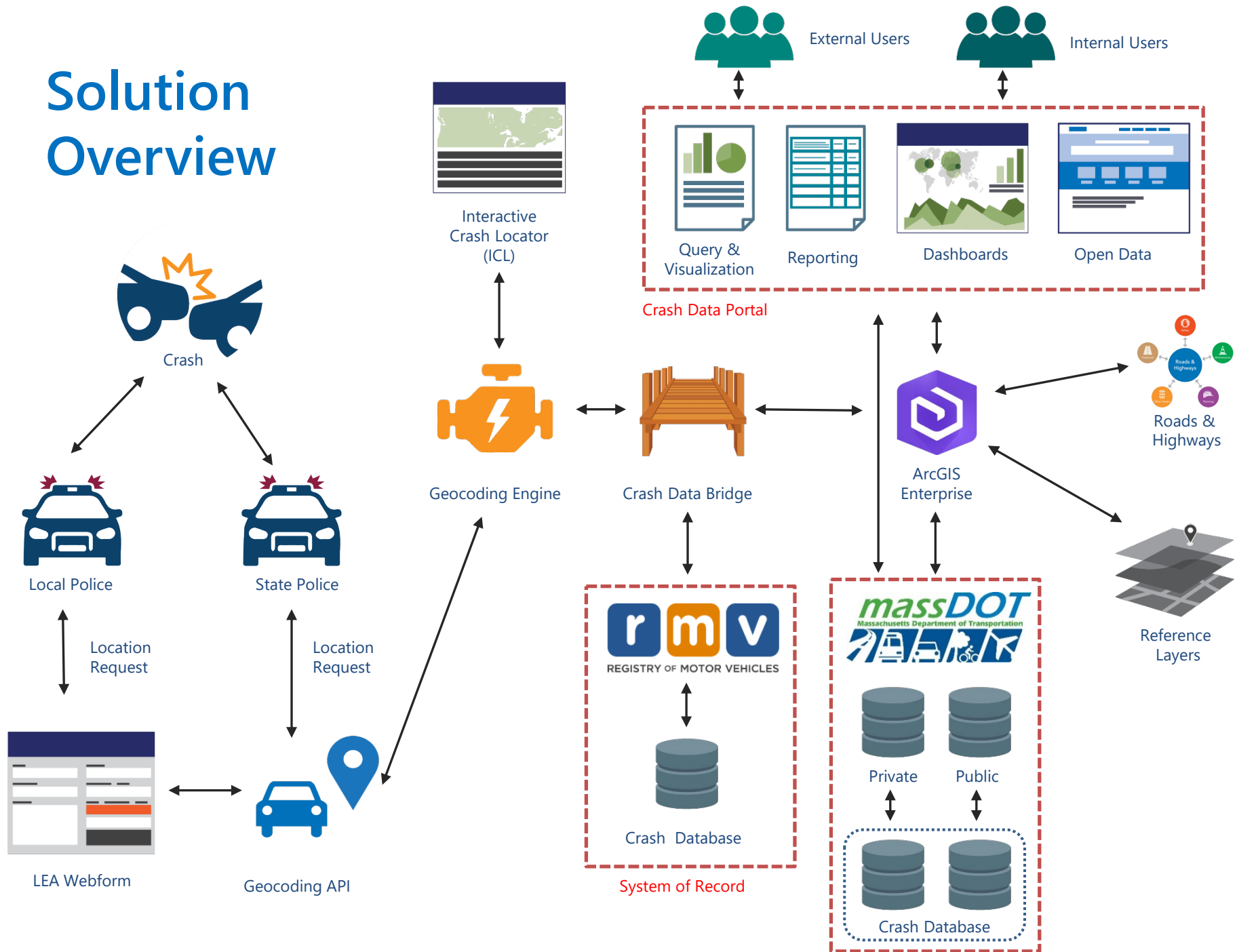
# Solution Overview

The diagram illustrates the solution architecture for crash data management and analysis. It is organized into several key components and their interactions:

- Crash Data Portal:** A red dashed box at the top right containing four main functions:
  - Query & Visualization:** Represented by a bar and pie chart icon.
  - Reporting:** Represented by a table icon.
  - Dashboards:** Represented by a world map and bar chart icon.
  - Open Data:** Represented by a document icon. This portal is accessible to **External Users** and **Internal Users**.
- System of Record:** A red dashed box at the bottom center containing:
  - Registry of Motor Vehicles (RMV):** Represented by 'r', 'm', and 'v' icons.
  - Crash Database:** Represented by a stack of three database cylinder icons.
- MassDOT Data:** A red dashed box at the bottom right containing:
  - Private and Public Databases:** Each represented by a stack of three database cylinder icons.
  - Crash Database:** A blue dotted box containing two more database cylinder icons.
- Core Processing and Integration:**
  - Geocoding Engine:** Represented by an orange car icon with a lightning bolt.
  - Crash Data Bridge:** Represented by a wooden bridge icon.
  - ArcGIS Enterprise:** Represented by a purple hexagon icon.
- Data Sources and Reference:**
  - Crash Data:** Represented by a map icon with a lightning bolt.
  - Roads & Highways:** Represented by a circular network of road icons.
  - Reference Layers:** Represented by a map icon with a location pin.
- User Interaction and Data Entry:**
  - Crash:** Represented by a car crash icon.
  - Local Police:** Represented by a blue car icon with red stars.
  - State Police:** Represented by a blue car icon with red stars.
  - LEA Webform:** Represented by a form icon.
  - Geocoding API:** Represented by a blue car icon and a location pin.

**Interactions:**

- Local Police** and **State Police** send **Location Request** messages to the **LEA Webform** and the **Geocoding API**.
- The **Geocoding API** sends data to the **Geocoding Engine**.
- The **Geocoding Engine** interacts with the **Crash Data Bridge** and the **Crash Data** source.
- The **Crash Data Bridge** connects to the **System of Record** and **MassDOT Data**.
- The **System of Record** and **MassDOT Data** interact with **ArcGIS Enterprise**.
- ArcGIS Enterprise** interacts with the **Crash Data Portal** and **Reference Layers**.
- External Users** and **Internal Users** interact with the **Crash Data Portal**.





# Interactive Crash Locator (ICL)



Interactive  
Crash Locator  
(ICL)

MassDOT: Interactive Crash Locator (ICL)

Search

Spatial

Find Address or Location

Master Search

Town  
BOSTON

Police Agency Type  
Local police

Date From  
01/01/2017

Date To  
12/31/2017

Crash Geocoding States

☐ No Candidates

☐ Low Confidence

☐ Multiple Candidates

☐ One Candidate Not Geocoded

☒ Successfully Geocoded

Options

☐ Only Show Crashes with Narrative or Diagram

☐ Include "Not Enough Information"

☐ Include "Not Reportable"

☐ Restrict to Fatal Crashes Only

☐ Restrict to Crashes Where Speed Limit is Su

☐ Restrict to Crashes Where Location was GP

☐ Restrict to Crashes Where Junction Type is

☐ Restrict to Crashes Where Location Occur

Search

Reset

Map

City of Boston, MassGIS, Esri Canada, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, EPA, USDA

Powered by Esri

My Inbox

Search Results

Location

Location History

Candidates

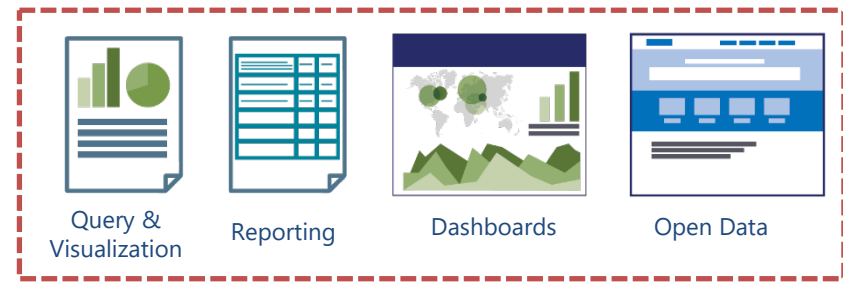
Narratives/Diagrams

Scanned Docs


Results: 2,020




<input type="checkbox"/>	Crash Number ↓	Geocoded	City Town Name	Crash Date	Crash Time	At Intersection	Address / Near Intersec...	Exit
<input type="checkbox"/>	4321094	Yes	BOSTON	1/21/2017	11:26 PM	SCHOOL STREET / PRO...		
<input type="checkbox"/>	4324425	Yes	BOSTON	2/12/2017	7:11 PM	BROOKLINE AVENUE / ...		
<input type="checkbox"/>	4328191	Yes	BOSTON	1/1/2017	11:46 AM	WASHINGTON STREET...		
<input type="checkbox"/>	4328201	Yes	BOSTON	1/1/2017	2:00 PM	PARK STREET / WALDE...		
<input type="checkbox"/>	4328257	Yes	BOSTON	1/4/2017	10:20 AM	HARRISON AVENUE / W...		
<input type="checkbox"/>	4328258	Yes	BOSTON	1/5/2017	2:44 PM	MASS AVENUE / WASHI...		
<input type="checkbox"/>	4329477	Yes	BOSTON	1/11/2017	8:25 AM		317 HEATH STREET/ SO...	
<input type="checkbox"/>	4329498	Yes	BOSTON	1/6/2017	11:55 AM		209 HEATH STREET	
<input type="checkbox"/>	4329602	Yes	BOSTON	1/10/2017	10:00 AM	TREMONT STREET / CO...		
<input type="checkbox"/>	4329605	Yes	BOSTON	1/5/2017	9:38 AM		10 VINING STREET	
<input type="checkbox"/>	4329607	Yes	BOSTON	1/27/2017	11:36 PM		100 feet N of MELNEA C...	
<input type="checkbox"/>	4329610	Yes	BOSTON	1/22/2017	6:20 PM	BROOKLINE AVENUE / ...		
<input type="checkbox"/>	4330941	Yes	BOSTON	2/17/2017	7:35 AM		500 CAMBRIDGE STREET	
<input type="checkbox"/>	4330995	Yes	BOSTON	1/24/2017	12:05 PM		3615 WASHINGTON ST...	
<input type="checkbox"/>	4331016	Yes	BOSTON	1/13/2017	7:26 AM		100 BLOSSOM STREET	


# Crash Data Portal




Crash Data Portal

LIVING   WORKING   LEARNING   VISITING & EXPLORING   YOUR GOVERNMENT

 **IMPACT Home**Welcome, Guest User   Log In




IMPACT is designed to encourage public safety initiatives and awareness specific to crash information. Within IMPACT you can engage with crash related data through easy to understand pre-built reports or conduct your own self-driven analysis. Please take the time to explore the various options and find what is right for you.



### Interactive Data Dashboards


IMPACT dashboards tell powerful data stories using maps, charts and tables based on complex analyses. These pre-built dashboards allow for interactive analysis and data exploration specific to a given data theme in a range of categories.


INTERACT



### Data Query and Visualization

Using the Data Query and Visualization tool you can conduct simple to sophisticated data queries to generate subsets of the crash data. This may be done at the crash level, the vehicle level or the person level. Once generated you can then visualize the data in three core ways: on charts, on tables, or spatially on a map. Though noted separately, these elements all work in tandem providing the ability to switch between the visualization methods seamlessly.


EXPLORE 



### Data Extraction

Using the data extraction service, you can request publicly available data by municipality and date range in several formats. The standard data report request form should be used when trying to obtain datasets of town-wide crash data for specific years. In addition, a link is provided to MassDOT's Open Data Portal for more large-scale data download capabilities where the entire crash data file may be downloaded for each year.


EXTRACT



### Reports


IMPACT provides a suite of pre-built reports for rapid access to cleanly organized information across a spectrum of categories. Some reports are configurable given desired date ranges and all are downloadable in several formats.

REPORTS



### Crash Tabulation and Charting

IMPACT provides this tool to aggregate selected data in a matrix to display two or more variables. The crosstab provides summary data and can be used to summarize the full crash database as well as subsets of the data, based on the user selected variables.

EXPLORE 

#### Reported Crashes YTD

2,118

As of: Mon Jun 24 2019

#### Reported Fatalities YTD (FARS)

159

As of: Wed Jun 19 2019

#### Reported Pedestrian Crashes YTD

34

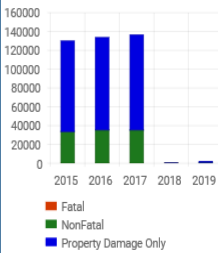
As of: Mon Jun 24 2019

#### Reported Bicyclist Crashes YTD

33

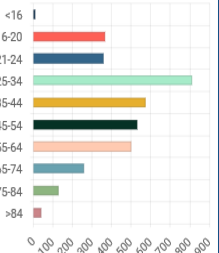
As of: Mon Jun 24 2019

#### Reported Crash Severity By Year (CDS)



As of: Mon Jun 24 2019

#### Reported Ages of Drivers in Crashes Year to Date



As of: Mon Jun 24 2019

MassDOT makes no representation as to the accuracy, adequacy, reliability, availability or completeness of the crash records or the data collected from them and is not responsible for any errors or omissions in such records or data. Under no circumstance will MassDOT have any liability for any loss or damage incurred by any party as a result of the use of the crash records or the data collected from them. Furthermore, the data contained in the web-based crash report tool are not an official record of what transpired in a particular crash or for a particular crash type. If a user is interested in an official copy of a crash report, contact the Registry (<http://www.mass.gov/rmr/>). In addition, any crash records or data provided for the years 2018 and later are subject to change at any time and are not to be considered up-to-date or complete. The data posted on this website, including crash records and other reports, are collected for the purpose of identifying, evaluating or planning the safety enhancement of potential crash sites, hazardous roadway conditions or railway-highway crossings. Under federal law, this information is not subject to discovery and cannot be admitted into evidence in any federal or state court proceeding or considered for other purposes in any action for damages that involves the sites mentioned in these records (see 23 USC, Section 409).

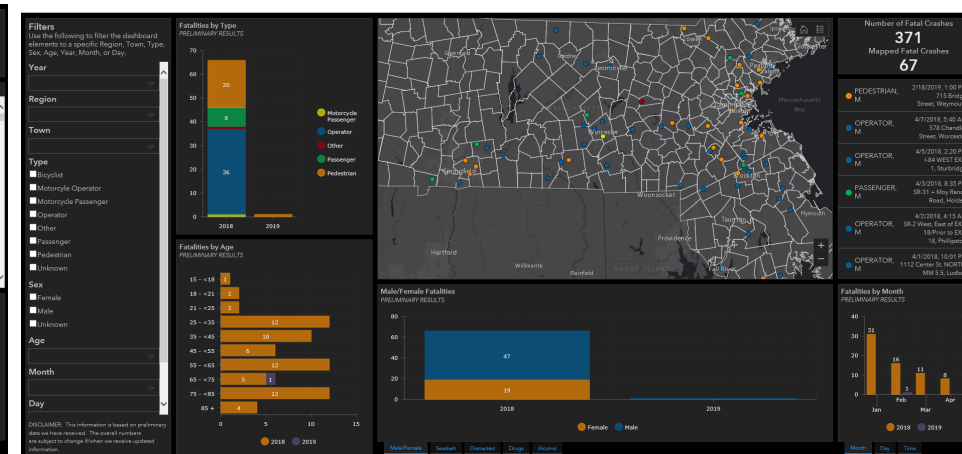
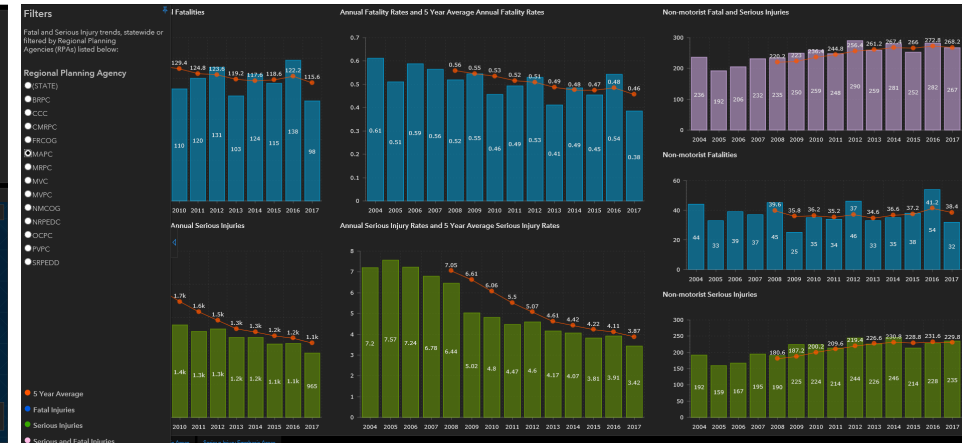
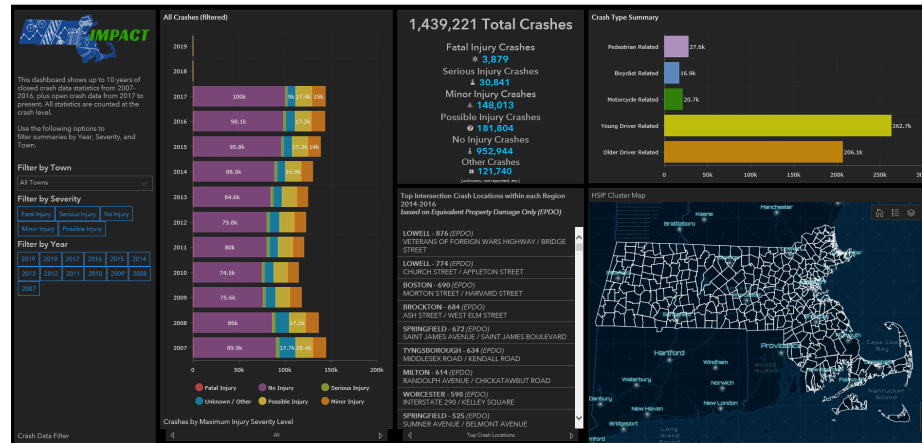
# Crash Analysis Dashboards



## Dashboards



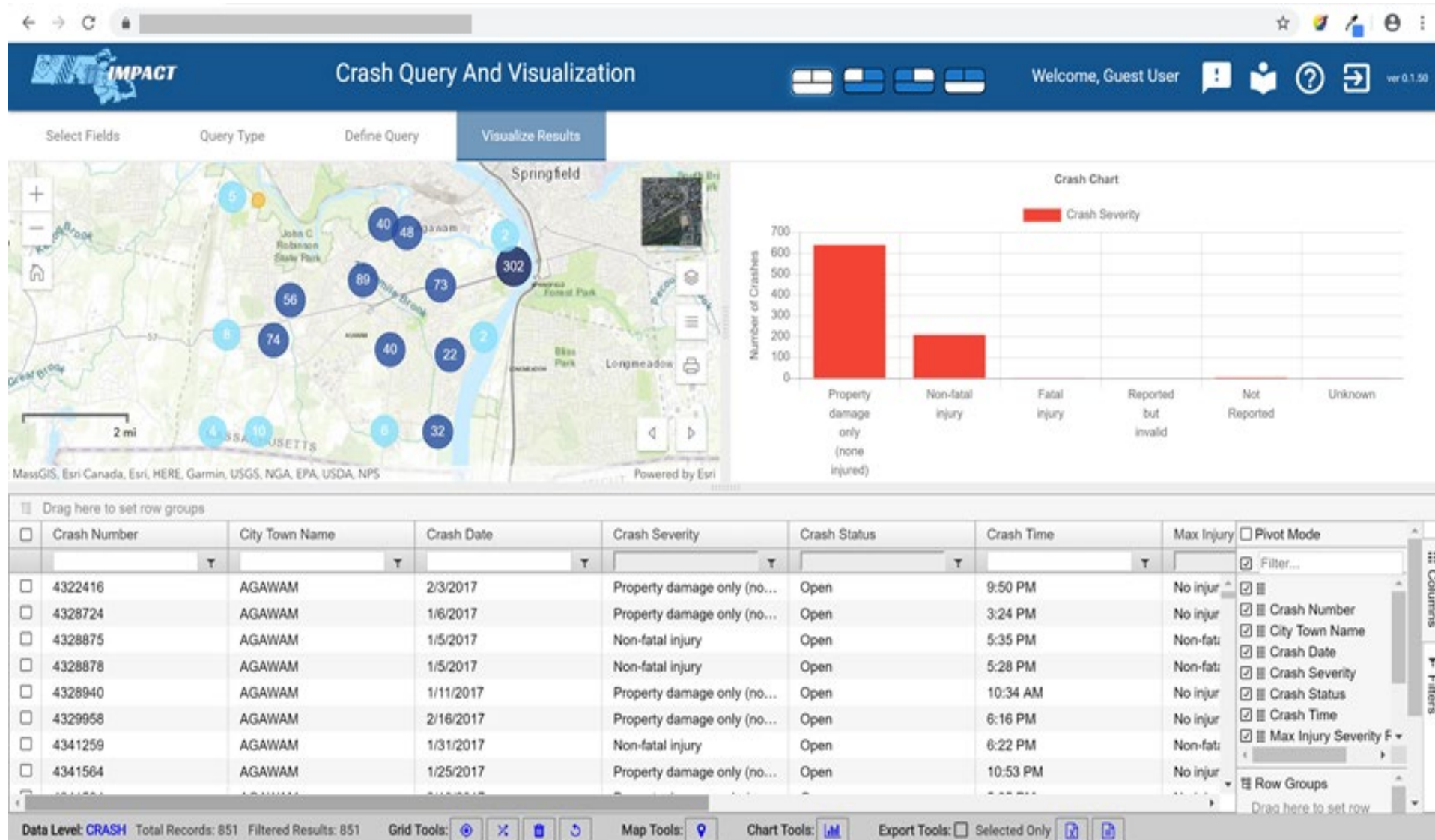
## Operations Dashboard



# Q&V – Visualize Results



Query &  
Visualization

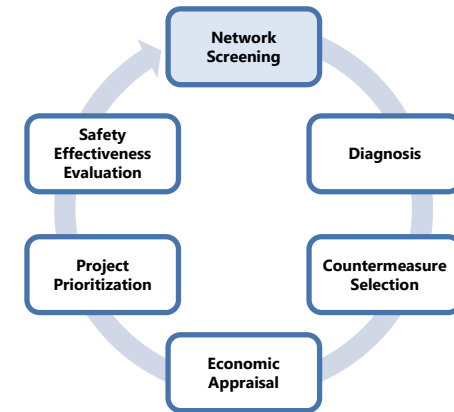




# CTDOT – Improving Crash Analysis



# Network Screening



Connecticut Roadway Safety Management System - CRSMS

Dashboard

Data Management

- Prepare Data for Analysis Tools
- Prepare Homogeneous Sites for SPF
- Update Network Screening SPFs
- Update Project Level SPFs
- Update Crash Comprehensive Cost
- Update Contributing Factors List
- Update Countermeasures List

Safety Analysis

- Network Screening
- Diagnosis
- Countermeasure Selection
- Economic Evaluation
- Prioritize Projects
- Safety Effectiveness Evaluation

CTStateRds

CT State Road Network Screening

ESTABLISH FOCUS IDENTIFY NETWORK (AREA OF INTEREST) IDENTIFY NETWORK (ROUTES) IDENTIFY NETWORK (FACILITIES) SELECT PERFORMANCE MEASURES SELECT SCREENING METHOD SCENARIO SUMMARY

Area of Interest (optional)

BOUNDARY TYPE Maintenance Districts

BOUNDARY NAME

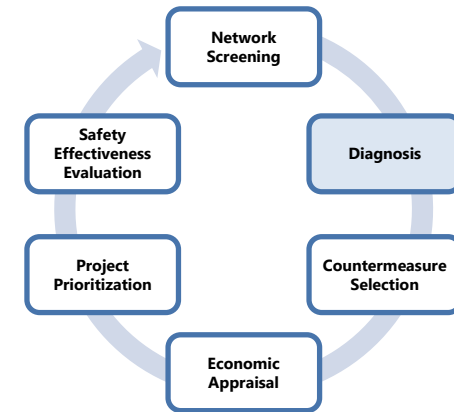
Item
4

1 items

RESET

BACK CONTINUE

# Diagnosis



Connecticut Roadway Safety Management System - CRSMS

<<

Dashboard

Data Management

Prepare Data for Analysis Tools

Prepare Homogeneous Sites for SPF

Update Network Screening SPFs

Update Project Level SPFs

Update Crash Comprehensive Cost

Update Contributing Factors List

Update Countermeasures List

Safety Analysis

Network Screening

Diagnosis

Countermeasure Selection

Economic Evaluation

Prioritize Projects

Safety Effectiveness Evaluation

< DIAGNOSIS

84-E between 61.63 and 61.88

Crash Date Range ① from 01/01/2015 to 04/27/2018

SAVE REPORT

MARK REPORT COMPLETE

DOWNLOAD REPORT

Map

Crash Data

Summary Statistics

Test of Proportions

Collision Diagram

Crash Tree

Supporting Documentation

Site Conditions

Diagnosis Report Summary

City of Hartford, MDC, MassGIS, UConn/CTDEEP, Esri, Canada, Esri, HERE, Garmin, INCREMENT P, USGS, EPA, USDA

Powered by Esri

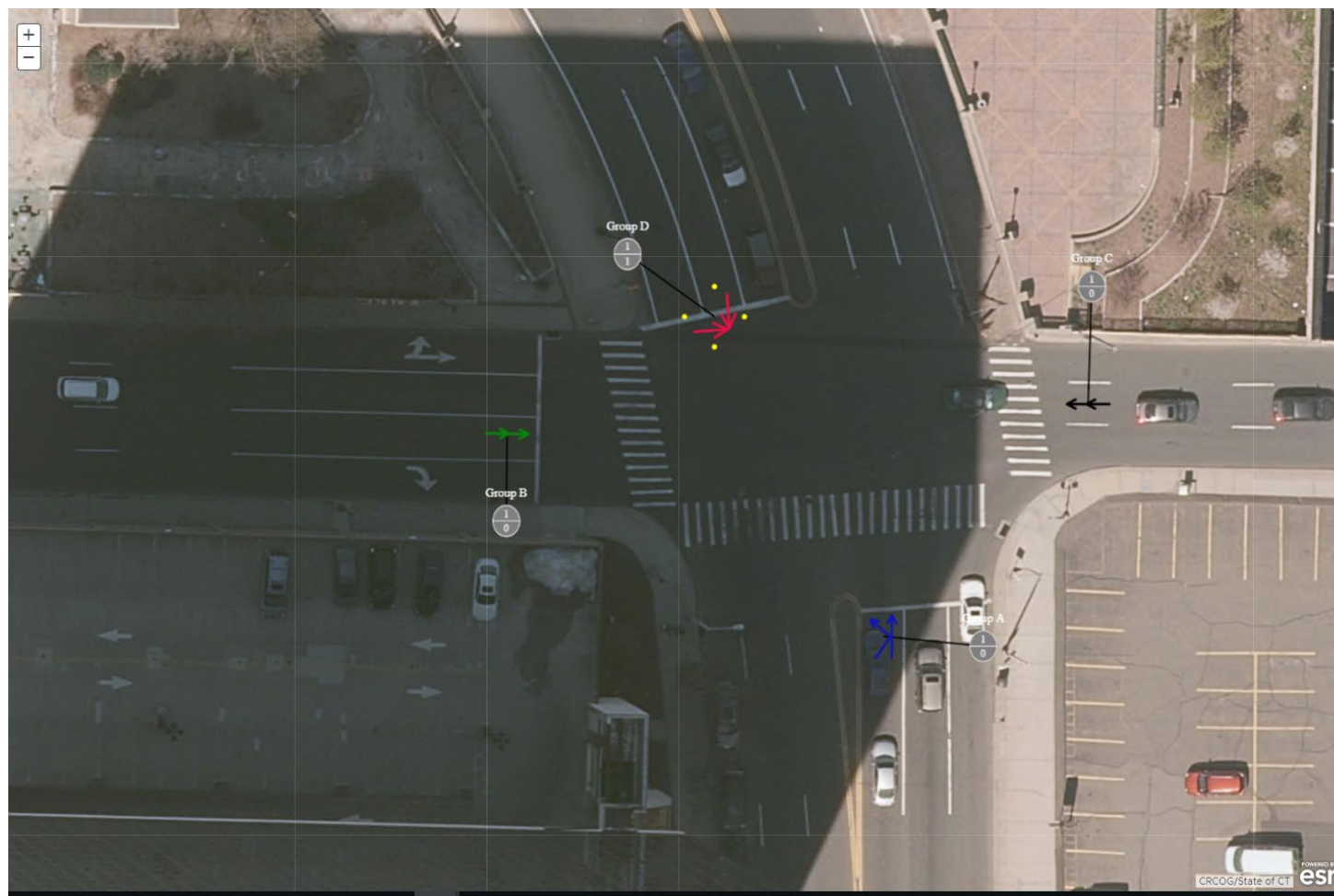
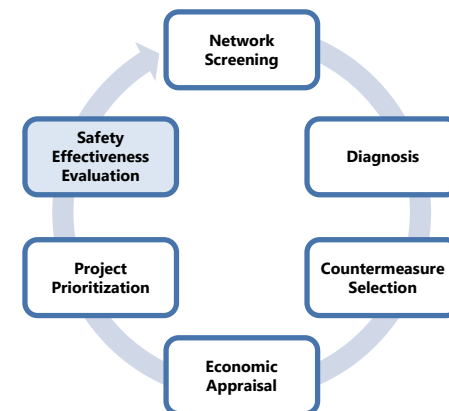
Map Summary

☐ Include in report

Hints: Are crashes clustered at a spot or section along the segment? Do the adjacent land uses and environment affect the safety of this site?



# Safety Effectiveness Evaluation



## Collision Diagramming Tool

Print template: Letter ANSI A Landscape

PREVIEW AND SAVE

Crash Graphics Options

Draw Tools

General Options

UNDO CRASHGROUP REMOVAL

Select CrashGroup

Options for Selected CrashGroup

Select Letter Group

D

Rotate

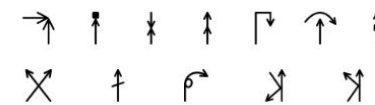
-180

86

180

Change Symbol

Color  
Red



REMOVE GROUP

Current CrashGroup Members



# Summary

- Top 10 Leading Causes of Death
- Embracing and applying technology can save lives

NHTSA's National Center for Statistics and Analysis

**NHTSA** **Top 10 Leading Causes of Death in the United States in 2015, by Age Group<sup>1</sup>**  
National Highway Traffic Safety Administration's National Center for Statistics and Analysis

RANK	Cause and Number of Deaths											Years of Life Lost <sup>2</sup>
	Infants Under 1	Toddlers 1-3	Young Children 4-7	Children 8-15	Youth 16-20	Young Adults 21-24	Other Adults			Elderly 65+	All Ages	
							25-34	35-44	45-64			
1	Perinatal Period 11,613	Congenital Anomalies 389	Malignant Neoplasms 360	<b>MV Traffic Crashes 744</b>	<b>MV Traffic Crashes 3,114</b>	<b>MV Traffic Crashes 3,415</b>	Accidental Poisoning 11,231	Malignant Neoplasms 10,909	Malignant Neoplasms 159,176	Heart Disease 507,138	Heart Disease 633,842	Malignant Neoplasms 23% (9,426,319)
2	Congenital Anomalies 4,825	Homicide 329	<b>MV Traffic Crashes 279</b>	Malignant Neoplasms 694	Suicide 2,441	Accidental Poisoning 2,620	Suicide 6,947	Accidental Poisoning 10,580	Heart Disease 111,120	Malignant Neoplasms 419,389	Malignant Neoplasms 595,930	Heart Disease 19% (7,767,386)
3	Heart Disease 292	Accidental Drowning 316	Congenital Anomalies 168	Suicide 663	Homicide 2,027	Suicide 2,798	<b>MV Traffic Crashes 6,261</b>	Heart Disease 10,387	Chronic Liver Disease 22,152	CLRD <sup>3</sup> 131,804	CLRD <sup>3</sup> 155,041	CLRD <sup>3</sup> 5% (1,880,774)
4	Homicide 263	Malignant Neoplasms 273	Accidental Drowning 163	Homicide 307	Accidental Poisoning 1,075	Homicide 2,601	Homicide 4,863	Suicide 6,936	CLRD <sup>3</sup> 131,804	Stroke 120,156	Stroke 140,323	Accidental Poisoning 4% (1,832,709)
5	Septicemia 180	<b>MV Traffic Crashes 249</b>	Homicide 136	Congenital Anomalies 261	Malignant Neoplasms 614	Malignant Neoplasms 747	Malignant Neoplasms 3,704	<b>MV Traffic Crashes 4,652</b>	Diabetes 20,378	Alzheimer's 109,495	Alzheimer's 110,561	Suicide 4% (1,553,110)
6	Influenza/Pneumonia 174	Heart Disease 132	Exposure to Smoke/Fire 70	Heart Disease 202	Heart Disease 352	Heart Disease 607	Heart Disease 3,522	Homicide 2,895	Accidental Poisoning 19,452	Diabetes 56,142	Diabetes 79,535	Stroke 4% (1,528,047)
7	Stroke 89	<b>MV Nontraffic Crashes<sup>4</sup> 88</b>	Heart Disease 61	Accidental Drowning 160	Accidental Drowning 261	Accidental Drowning 210	Chronic Liver Disease 844	Chronic Liver Disease 2,861	Stroke 17,423	Influenza/Pneumonia 48,774	Influenza/Pneumonia 57,062	<b>MV Traffic Crashes 3% (1,349,896)</b>
8	Nephritis/Nephrosis 85	Influenza/Pneumonia 76	CLRD <sup>3</sup> 55	CLRD <sup>3</sup> 135	Congenital Anomalies 181	Congenital Anomalies 159	Diabetes 798	Diabetes 1,986	Suicide 16,490	Nephritis/Nephrosis 41,258	Nephritis/Nephrosis 49,959	Diabetes 3% (1,237,459)
9	<b>MV Traffic Crashes 57</b>	Exposure to Smoke/Fire 73	<b>MV Other/Nontraffic Crashes<sup>4</sup> 43</b>	<b>MV Other/Nontraffic Crashes<sup>4</sup> 91</b>	<b>MV Other/Nontraffic Crashes<sup>4</sup> 101</b>	<b>MV Other/Nontraffic Crashes<sup>4</sup> 129</b>	Stroke 567	Stroke 1,788	<b>MV Traffic Crashes 10,043</b>	Septicemia 30,817	Accidental Poisoning 47,478	Chronic Liver Disease 2% (940,717)
10	Malignant Neoplasms 53	Perinatal Period <sup>5</sup> 45	Influenza/Pneumonia 41	Exposure to Smoke/Fire 69	Accidental Falls 83	Accidental Falls 128	HIV 529	HIV 1,055	Septicemia 8,316	Accidental Falls 28,486	Suicide 44,193	Perinatal Period 2% (922,063)
ALL <sup>1</sup>	23,455	3,376	2,096	4,995	12,461	16,942	51,517	73,088	532,279	1,992,283	2,712,630	All Causes 100% (41,462,779)

<sup>1</sup>Overall, motor vehicle crashes are the 13th leading cause of death. When ranked by specific ages they are the leading cause of death for ages 10 and 16 to 23.  
<sup>2</sup>Number of years calculated based on remaining life expectancy (2012 data from CDC) at time of death; percentages calculated as a proportion of total years of life lost due to all causes of death.  
<sup>3</sup>Heart a total of top 10 causes of death.  
<sup>4</sup>Includes MV traffic deaths not in FARS (e.g., deaths that occurred more than 30 days after a MV traffic crash). A motor vehicle non-traffic crash is any vehicle crash that occurs entirely in any place other than a public traffic way.  
<sup>5</sup>CLRD stands for Chronic Lower Respiratory Disease.  
<sup>6</sup>Heart with septemia.  
Data Source: National Center for Health Statistics, Mortality Data 2015, FARS 2015 Annual Report File

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[www.vhb.com](http://www.vhb.com)



Offices located throughout the east coast