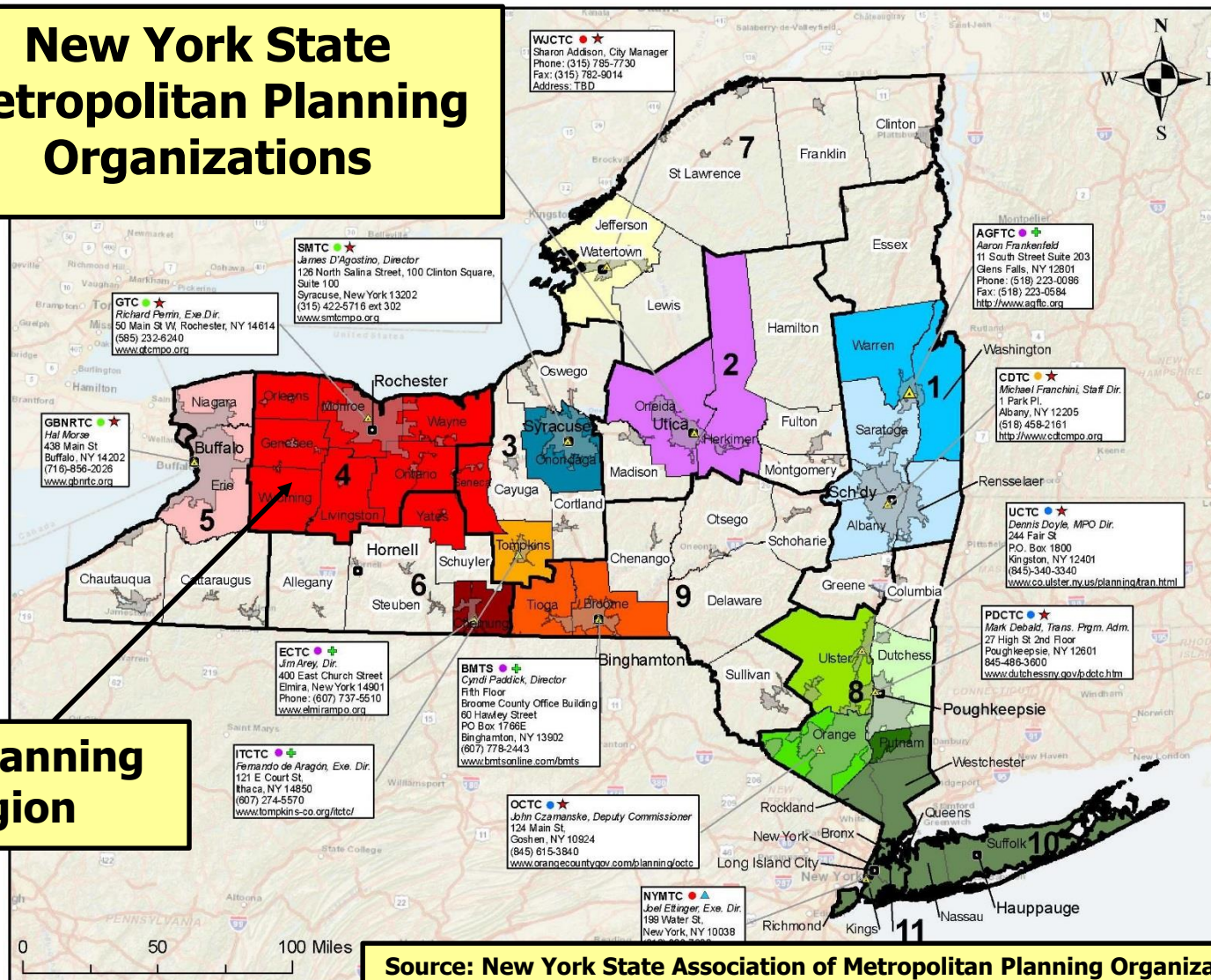


# **Assessing Transportation Asset Vulnerability to Hazard Impacts in the Genesee-Finger Lakes Region**



**Joseph M. Bovenzi, AICP      Frederick A. Frank, LEED AP BD+C**  
**AMPO Annual Conference – Savannah, Georgia**  
**October 18, 2017**

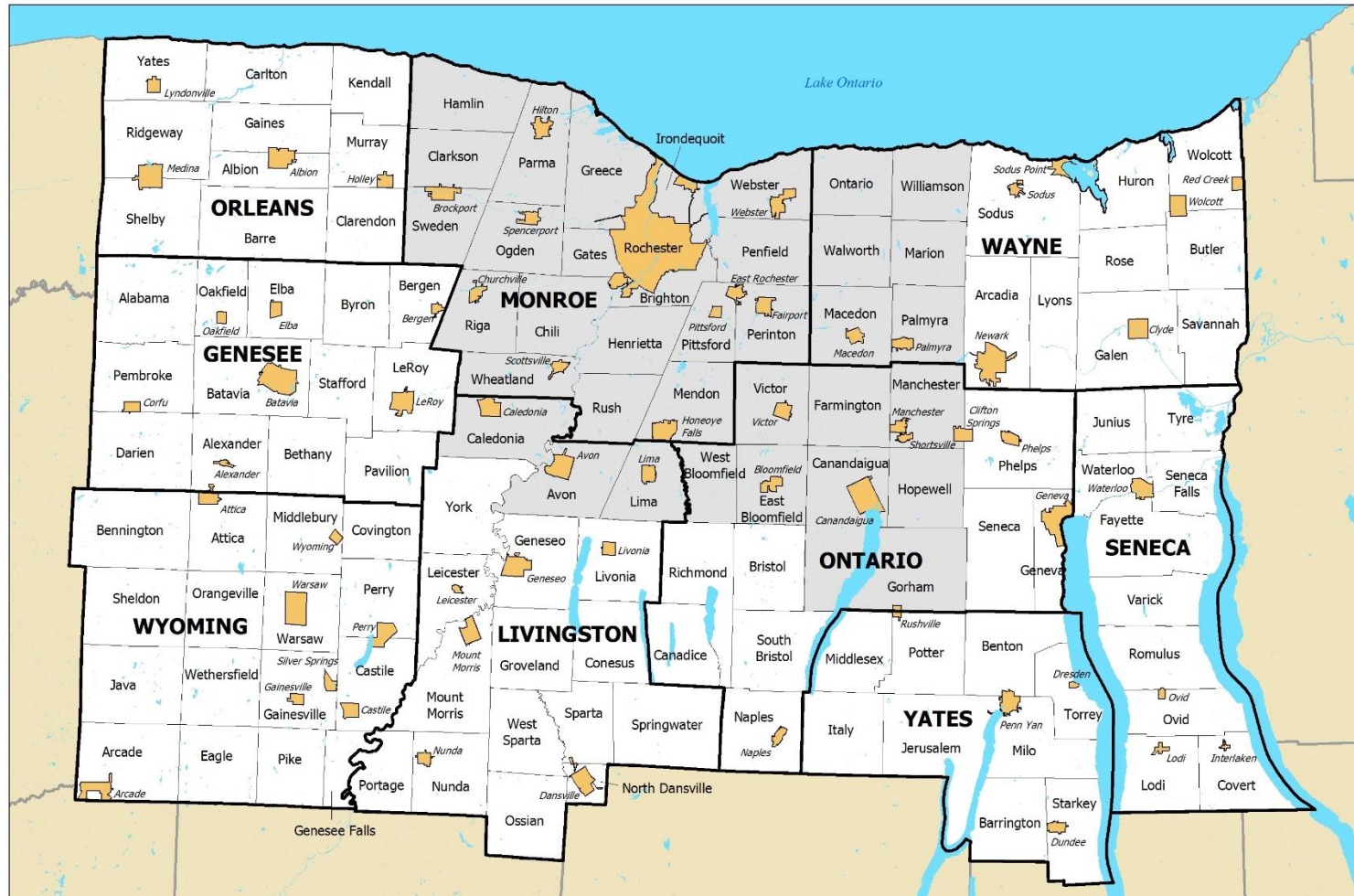
# New York State Metropolitan Planning Organizations







**Source: New York State Association of Metropolitan Planning Organizations (NYSAMPO)**



## GTC Nine-County Planning Region and Rochester Metropolitan Planning Area



 Towns
  Cities and Villages  
 Counties
  Metropolitan Planning Area (MPA)

**GENESEE TRANSPORTATION COUNCIL**  
January 2016

## **Planning for Hazard/Climate Change Impacts**

### **➤ Long Range Transportation Plan 2035**

#### **❑ Emerging Opportunities and Issues – The Impacts of Climate Change: Mitigation and Adaption**

- Lessen the expected impacts of climate change on transportation infrastructure by reducing GHGs**
- Evaluate the vulnerability of critical infrastructure to ensure hazard impacts are accounted for in design and operations**

### **➤ Unified Planning Work Program**

#### **❑ Task Number 5750 – *Genesee Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment***

## **Study Purpose and Background**

### **➤ Purpose**

- ❑ Determine the vulnerability of critical transportation assets to natural and human-caused hazards**
- ❑ Propose solutions for preventing and/or reducing hazard impacts on those assets**

### **➤ Background**

- ❑ No previous region-wide assessments**
  - Need to understand *system* vulnerabilities in addition to *asset* vulnerabilities**
- ❑ Limited funds for transportation infrastructure projects**
  - Inform programming of scarce federal funds**

## **Study Purpose and Background (*continued*)**

### **➤ Background**

#### **❑ Broad scope**

- Includes infrastructure (roads, bridges, culverts) and facilities (operations centers, highway garages, fuel storage)**

#### **❑ Build on Climate Change adaptation initiatives**

- Extreme weather events drive up operations, maintenance, and repair costs**



## **Participants**

- **New York State Department of Transportation**
- **New York State Thruway Authority**
- **New York State Police**
- **Rochester Genesee Regional Transportation Authority**
- **County and City of Rochester Agencies:**
  - ❑ **Highway/Public Works**
  - ❑ **Emergency Management**
  - ❑ **Planning**
  - ❑ **Law Enforcement**



FEMA/Marvin Nauman



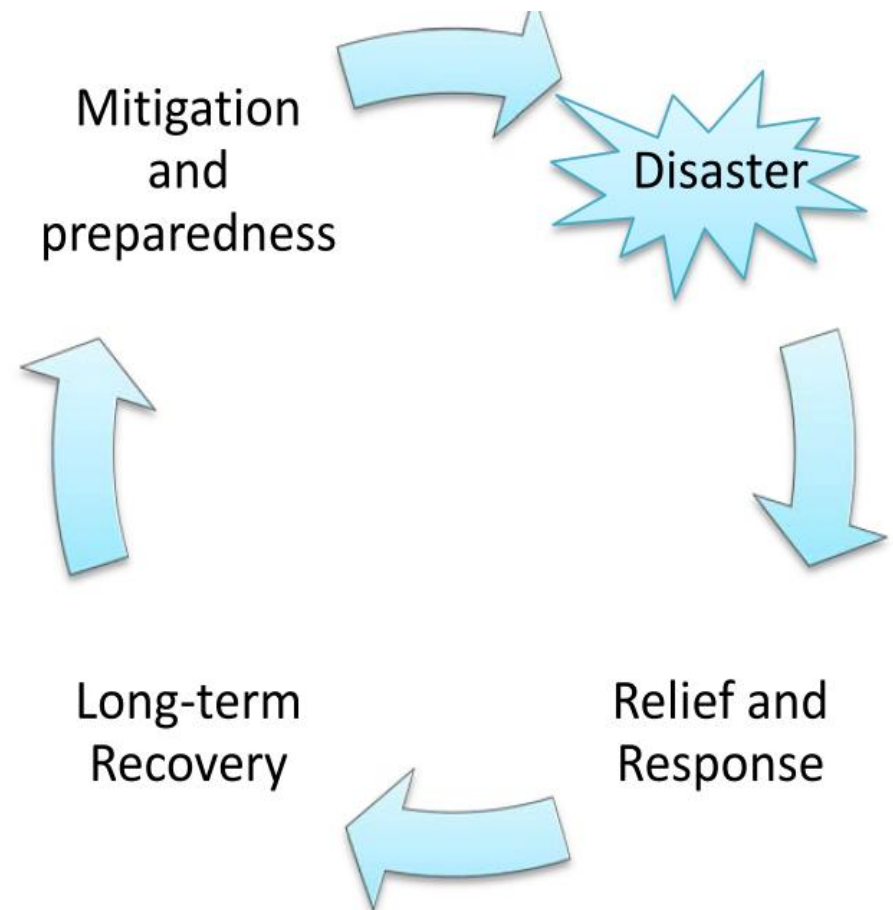
## **Critical Transportation Assets**

- **Assets which are essential to the functioning of a community's transportation system**
  - ❑ **Support Safety, Efficiency, and Reliability**
- **Four categories:**
  - ❑ **Infrastructure – *Roads, Bridges, Overpasses, Tunnels, Culverts***
  - ❑ **Facilities – *Operations Centers, Highway/Public Works Garages, Fuel Storage, Transit Garages, Police/Fire Stations***
  - ❑ **Equipment – *Traffic Signals, Signage, ITS Field Devices, Communications Network, Fleet Vehicles***
  - ❑ **Personnel – *Employees, Contractors, Vendors***



## Resiliency

- **Ability to adapt to changing conditions and prepare for, withstand, and rapidly recover from disruption**
- **Enhance assets to a “New Normal”**



## **Vulnerability**

- **Physical feature or operational attribute that renders an asset open to deliberate harm or susceptible to a hazard**

- ☐ **Location**
- ☐ **Design**
- ☐ **Operation**



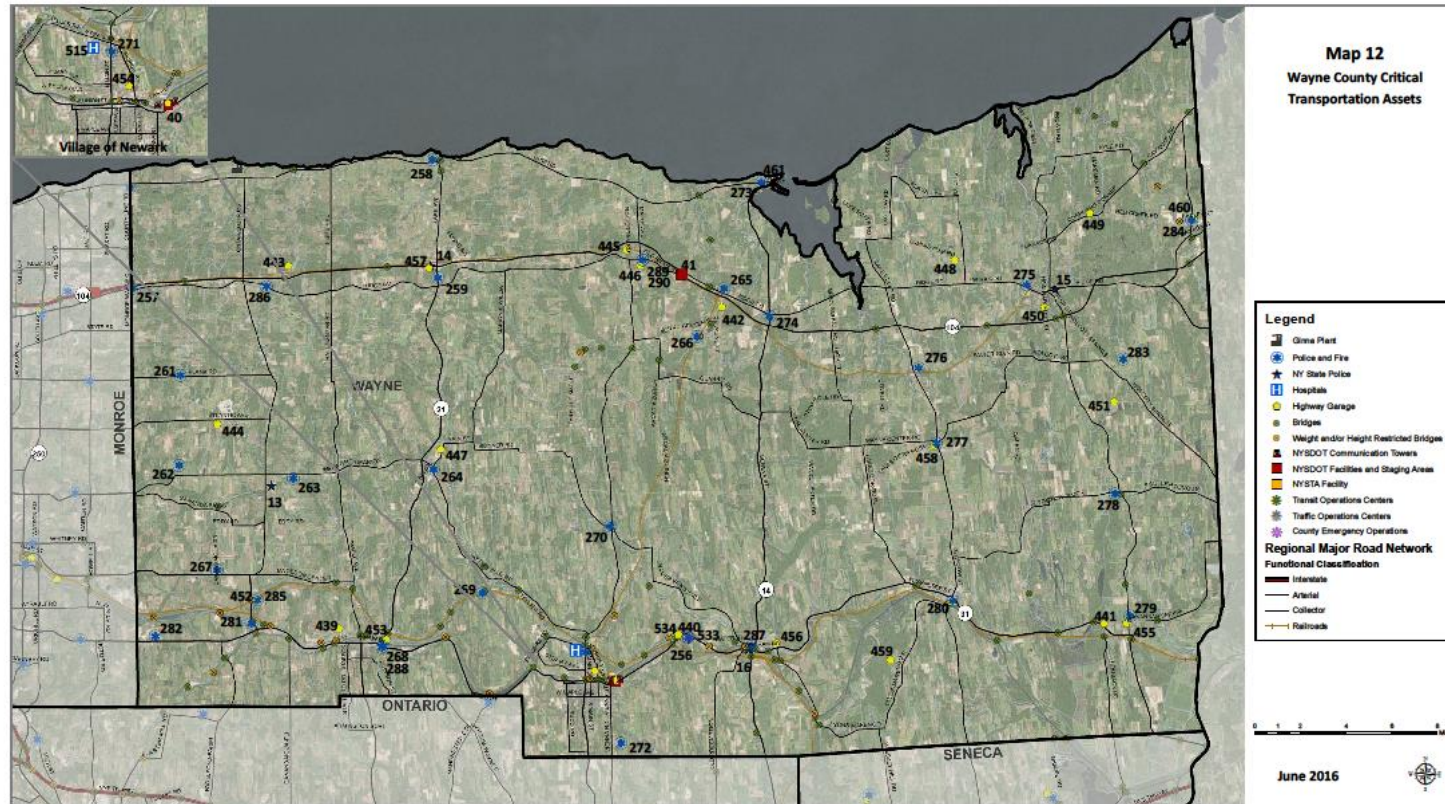
- **Vulnerability Assessment – Process of identifying system/asset vulnerabilities**

## **Transportation Vulnerability Assessment Process**

- 1. Identify a community's or region's critical transportation assets (Inventory Assets)**
- 2. Identify the natural and human-caused hazards that can impact that critical assets (Hazard Extents)**
- 3. Understand the consequences of hazard events on your transportation assets (Hazard Impacts)**
- 4. Prioritize transportation assets that are most vulnerable to hazard events (Prioritize Assets)**
- 5. Develop strategies to avoid or minimize impacts to vulnerable assets (Strategies)**

## Inventory – Critical Transportation Infrastructure

- Roads
- Bridges
- Culverts
- Railroads
- DPW Garages
- Operations Centers
  - Traffic
  - Transit
- Emergency Management Facilities
- Hospitals
- Police/Fire
- National Guard





## **Identify and Profile Hazards**

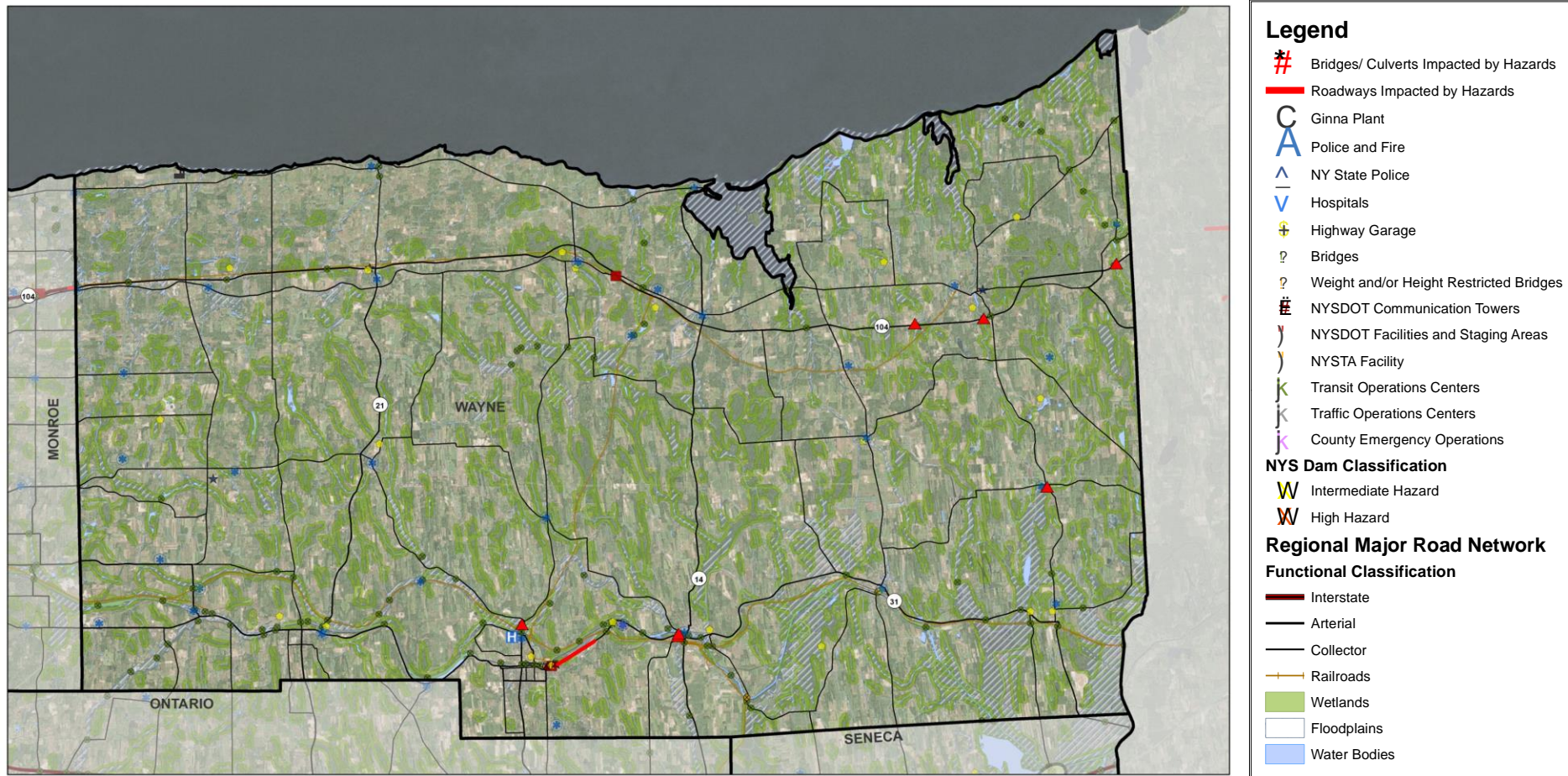
### **Natural**

- **Floods**
- **Winter Weather**
- **Severe Storms**
- **Landslides**
- **Seismic Activity**
- **Sinkholes**
- **Extreme Temperatures**
- **Wildfire**

### **Human-Caused**

- **Structural Failure**
- **Fire**
- **Hazardous Material Spills**
- **Roadway accidents**
- **Derailments**
- **Sabotage/Acts of Terrorism**

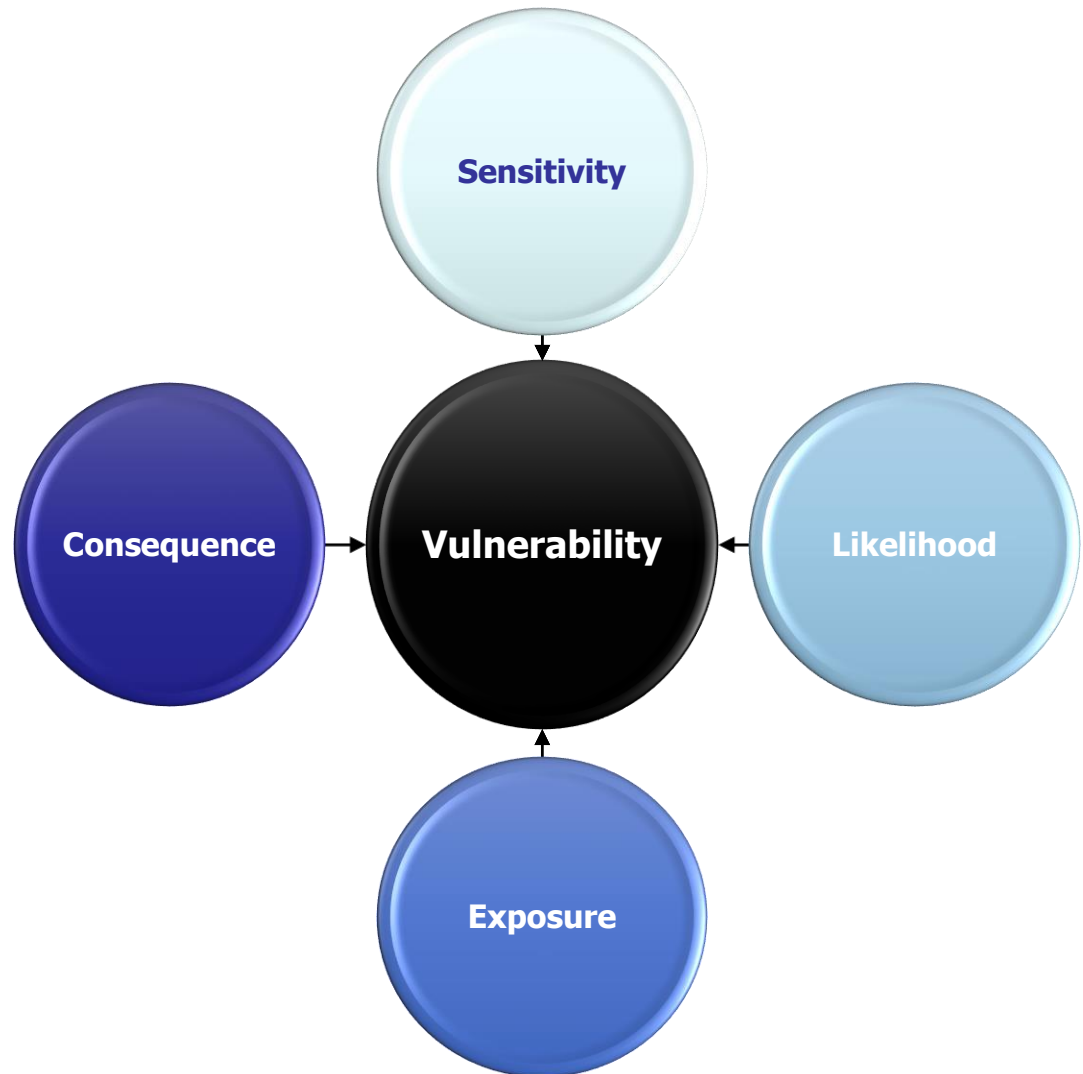
## Wayne County: Asset Vulnerability



# When is a Transportation Asset Vulnerable?

## Four Key Factors:

- **Sensitivity** – Can the transportation system operate with this asset impacted?
- **Likelihood** – What is the likelihood/ frequency of a hazard impacting the asset?
- **Exposure** – Is the asset exposed to multiple hazards and for long durations of time?
- **Consequence** – What is the severity of the hazard impact on the asset?



## Vulnerability Assessment Scale

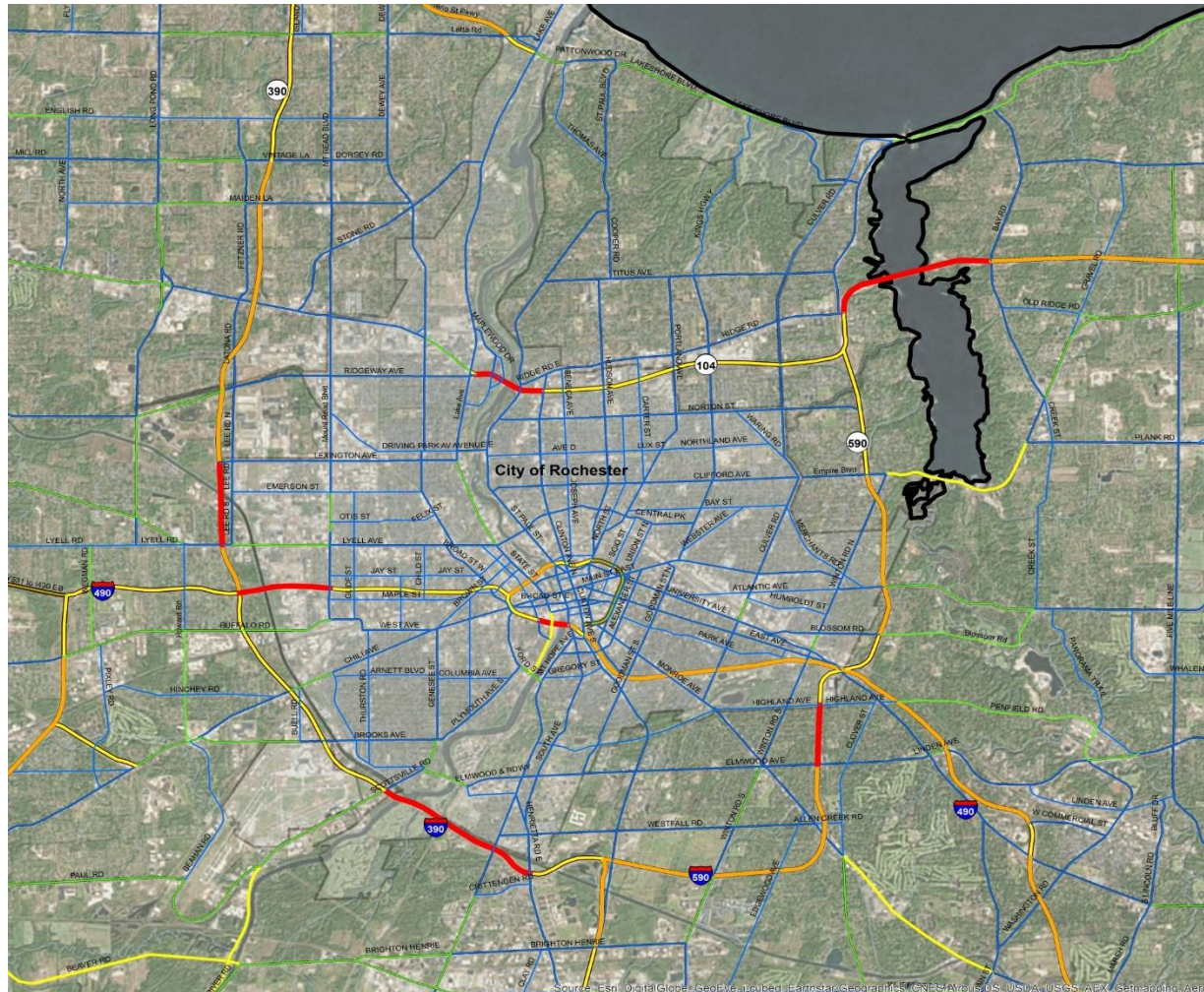
	1	2	3	4	5
	Insignificant = 1	Minor = 2	Moderate = 3	Major = 4	Catastrophic = 5
<b>Sensitivity</b>	Partial closure, no detour needed	Partial closure, minor detour needed	Full closure but available detours	Full closure, few detours	Full closure, extensive detours, transportation system fails
<b>Likelihood</b>	Occurs once every 25 years	Occurs once every 10 years	Occurs once every 5 years	Occurs once per year	Occurs more than once per year
<b>Exposure</b>	Hazard duration less than 1 hour  Very localized (partial impact of single asset)	Hazard duration a couple hours  Localized (full impact of single asset)	Hazard duration 1 day  Scattered (multiple assets impacted)	Hazard duration 2-3 days  Widespread (all assets in a geography are impacted)	Hazard duration 3+ days  Widespread impacts to all assets
<b>Consequence</b>	Delays or loss of operations/ use up to 30 minutes  A few minor injuries  Financial impact	Delays or loss of operations/ use up to one hour  Some minor injuries	Loss of operations/ use up to two days  Multiple injuries requiring hospitalization	Loss of operations up to 30 days  Multiple severe injuries and/or a single fatality	Loss of operations/ use exceeding 30 days  Multiple severe injuries and/or fatalities



## Vulnerability Assessment Scale

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## Example of Prioritized Road Segments



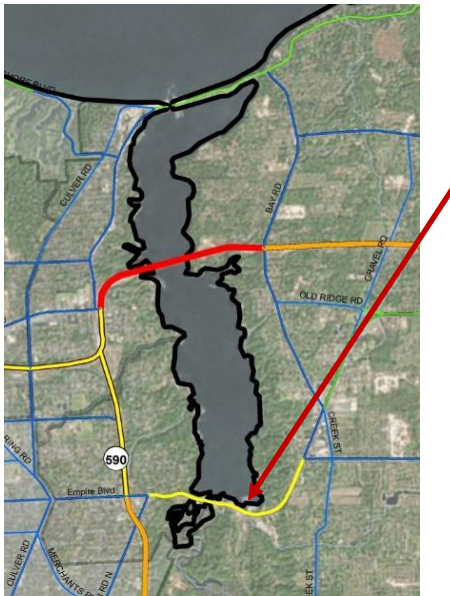
### Legend

#### Roadway Vulnerability Vulnerability Category

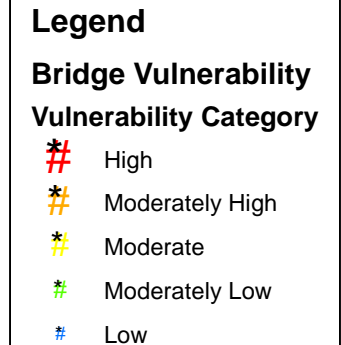
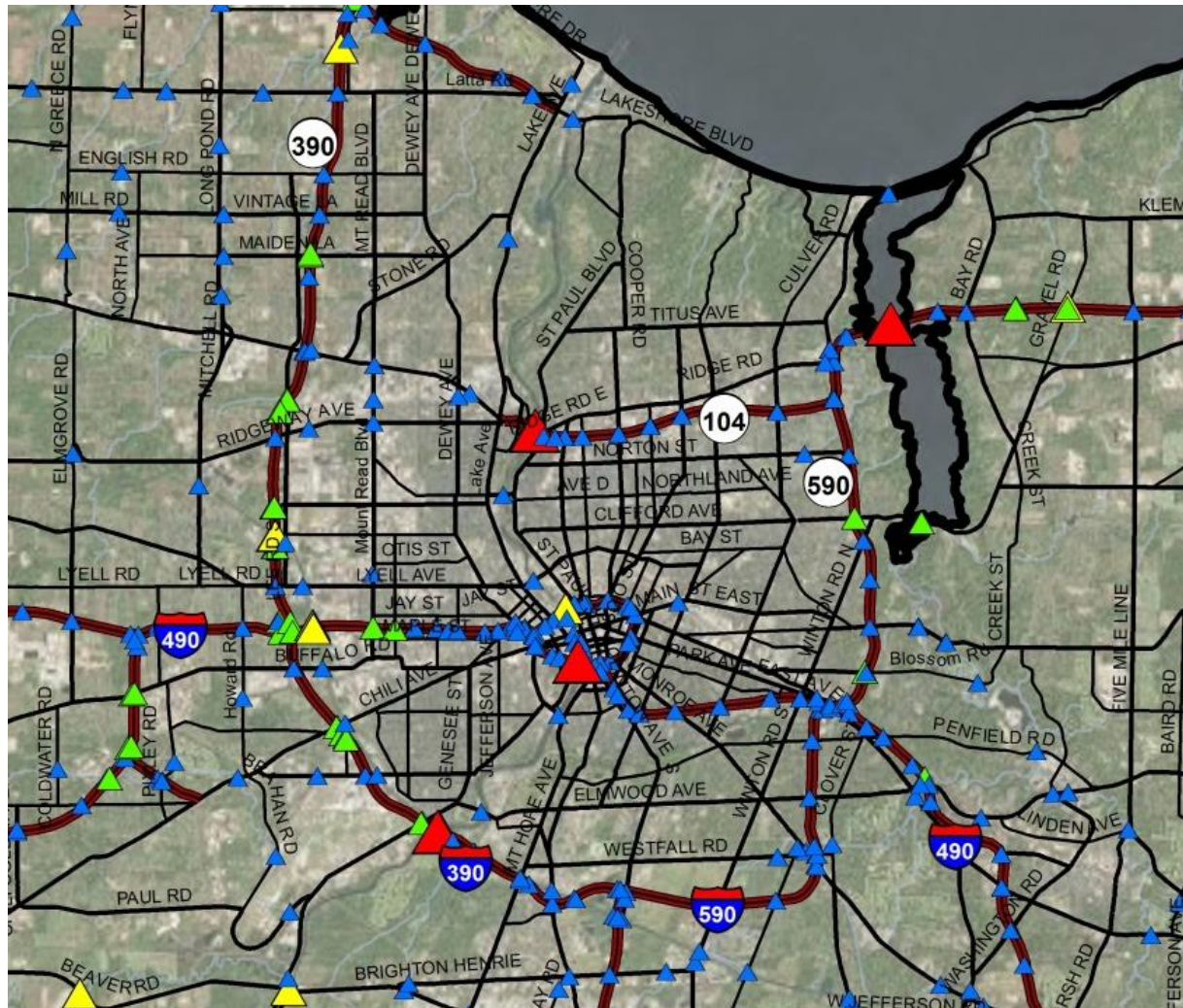
- High
- Moderately High
- Moderate
- Moderately Low
- Low



## **Empire Blvd. (NYS Route 404)**

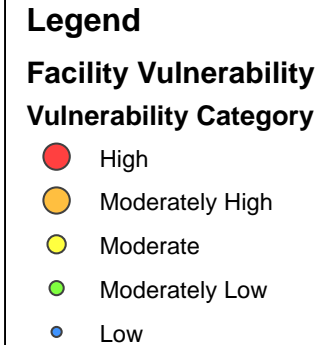
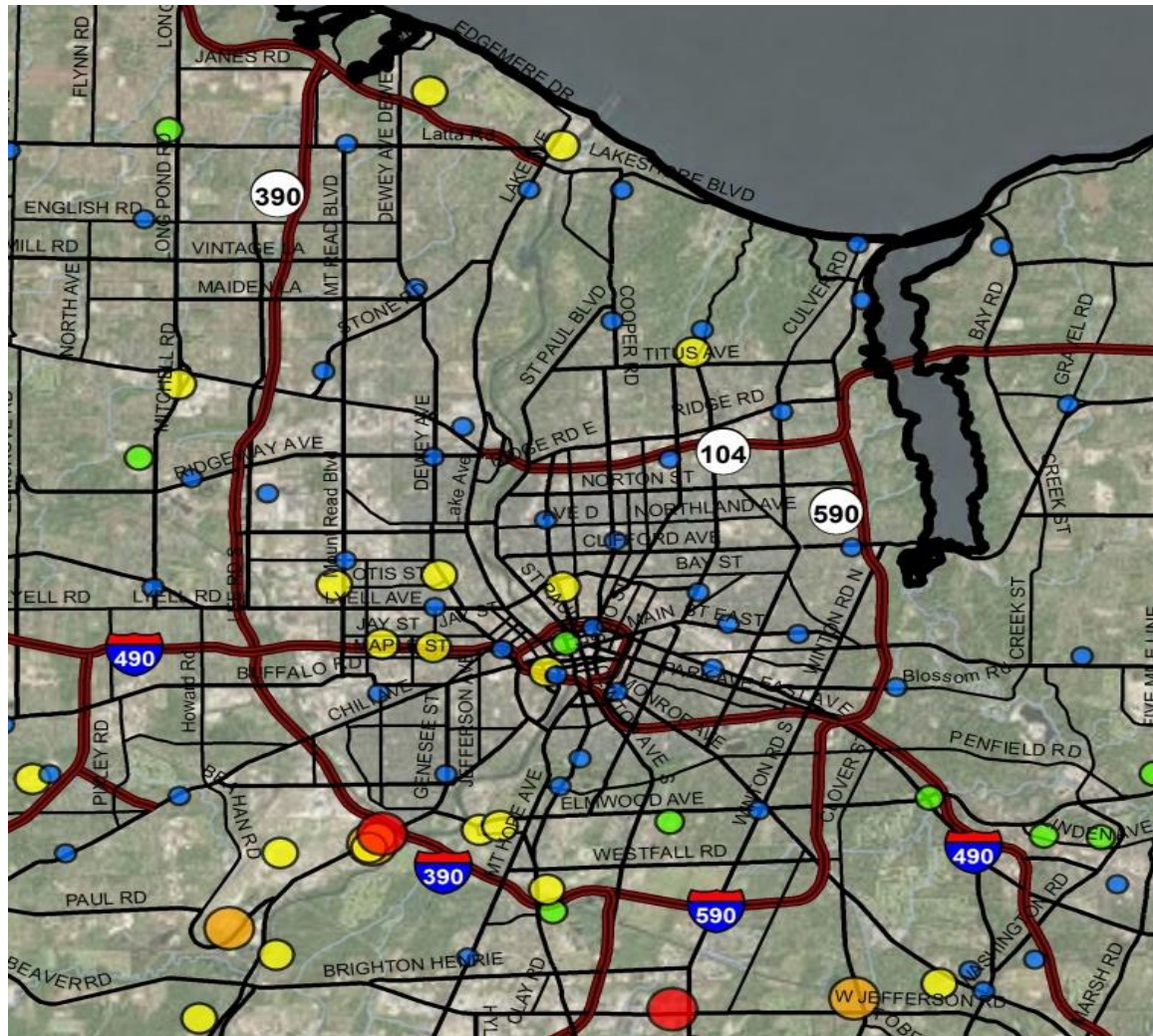


## Example of Prioritized Bridges





## Example of Prioritized Facilities



## **Hazard Mitigation Strategies**

### **➤ Five Categories:**

- ☐ **Planning and Policy**
- ☐ **Communication, Education, and Awareness**
- ☐ **Infrastructure and Construction**
- ☐ **Natural and Land Resource Protection**
- ☐ **Operations and Maintenance**



## **Planning and Policy Strategies**

- **Interagency/inter-municipal coordination and resource sharing**
- **Implement ITS/TSMO plan recommendations**
  - ❑ **Communications**
  - ❑ **Preparedness and Response**
- **Incorporate flood mitigation strategies into agency and local planning efforts**
- **Areas for additional investigation:**
  - ❑ **Watershed planning**
  - ❑ **Downstream hazard studies**



## **Communication and Education Strategies**

### **➤ Education and Awareness**

☐ **Training classes**

☐ **Public outreach**

### **➤ Improve flood risk assessment data**

☐ **Update and publicize flood maps**

### **➤ Publicize hazard mitigation techniques**





## **Infrastructure and Construction Strategies**

- **Green infrastructure**
  - ❑ **Rain gardens, permeable pavements, bioswales**
- **Relocation and elevation of critical infrastructure**
- **Improving stormwater drainage capacity and functionality**
- **Slope stabilization**



## **Natural/Land Resource Protection Strategies**

- **Protect and restore natural floodplains**
  - ❑ **Protect, enhance, and integrate natural landforms that mitigate flooding into transportation infrastructure**
- **Create and preserve floodplain, open space, wetland, and spill areas**



## **Operations and Maintenance Strategies**

- **Maintenance of drainage systems and flood control structures**

- ☐ **Replace undersized culverts**

- **Debris maintenance**

- ☐ **Clear debris from drainage ditches, catch basins, culverts, etc.**




## **Lessons Learned**

- **The planning process is as important as the final report because it develops partnerships and builds consensus to advance strategies**
  - ❑ **Interagency and inter-municipal coordination and cooperation**
- **Integrate vulnerability-related considerations into the transportation infrastructure investment decision-making process**
- **Integrate Vulnerability Assessment findings into the local land use and policy decision-making process**



## FHWA Case Study

- **GTC's *Vulnerability Assessment* was featured as an FHWA case study on resiliency planning**
- **Availability:**
  - ❑ **FHWA Website**
  - ❑ **Environment**
  - ❑ **Sustainability**
  - ❑ **Resilience**
  - ❑ **Case Studies**
- **Publication Number: FHWA-HEP-17-002**



FHWA-HEP-17-002

### Genesee-Finger Lakes Regional Critical Transportation Infrastructure Vulnerability Assessment

#### Overview

A series of recent severe weather events, including Hurricane Irene and Tropical Storm Lee, revealed vulnerabilities in New York State's transportation system. Future extreme weather events are expected to place greater strain on regional transportation infrastructure, driving up operations, maintenance, and repair costs. In response to these events, the Genesee Transportation Council (GTC), the Metropolitan Planning Organization (MPO) for the Greater Rochester region, completed an assessment of potential vulnerabilities of critical regional transportation infrastructure to natural and human-caused hazards in June 2016. This project was the first systematic region-wide attempt to assess the vulnerability of the transportation network. Figure 1 shows an example of damage to the transportation infrastructure in the region.

The assessment followed the Federal Highway Administration (FHWA) Climate Change and Extreme Weather Vulnerability Assessment Framework to identify critical infrastructure and assess infrastructure exposure, sensitivity, and vulnerability to the various hazards.




Figure 1. Example of damage to transportation infrastructure from natural hazards in New York. Source: GTC, 2016

Based on the hazard vulnerabilities, the project identified a broad range of strategies to reduce the impacts of hazards, including strategies related to planning and policy, communication, design and construction, and operations. The project also identified possible funding sources for adaptation strategies. FHWA and the Federal Transit Administration (FTA) provided financial assistance through the GTC.

#### Scope

This project focused on the nine-county Genesee-Finger Lakes Region of New York, including Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, and Yates Counties (see Figure 2). The regional policy basis for the project was the GTC Long Range Transportation Plan 2035, which identifies planning for the impacts of climate change as one of six emerging opportunities and issues the region will face over the next 25 years.

The assessment focused on vulnerability of critical transportation assets in three categories: roads, bridges, and facilities. The project assessed the vulnerability of these assets to natural and human-caused hazards, including: flooding, severe storms, high winds, extreme temperature, frequent freeze/thaw cycles, landslides, land subsidence, earthquakes, hazardous materials spills, terrorist attacks, sabotage, structural collapse, highway crashes, and derailments.

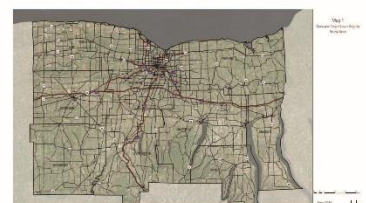


Figure 2. Map of the nine-county project area. Source: GTC 2016

## What's Next?

- **Integrate findings into investment decision-making process**
  - ❑ **Multi-year highway & bridge plan**
  - ❑ **TIP**
- **Develop Local Bridge Vulnerability Assessment**
- **Regional Flood Model**
  - ❑ **Better understand flood impacts**





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