

# TRANSPORTATION RESILIENCE PLANNING UPDATE

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## Transportation Resilience Improvement Plan (TRIP) Progress Update

Katherine Rainone, AICP  
Transportation Planner

TPB Board Meeting  
January 17, 2024



National Capital Region  
**Transportation Planning Board**

# Today's Agenda

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- Resilience/Vulnerability, TRIP/PROTECT overview
- Regional TRIP process/timeline
- Risk-based vulnerability assessment – methodology and preliminary results
- Other TRIP components completed to date
- Next steps



# Vulnerability and Resilience Defined

- **Vulnerability** is the degree to which a system **is susceptible to, or unable to cope with adverse effects** of natural hazards
- **Resilience** is the ability **to anticipate, prepare for, and adapt** to changing conditions and **withstand, respond to, and recover** rapidly from disruptions from natural hazards



Motorists stranded on a section of Canal Road in Washington DC due to flash flooding on July 8, 2019 (WTOP, 2019)



# PROTECT Program

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- Projects in the TRIP will be eligible for a **7% cost-share reduction** for the Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (**PROTECT**) Discretionary Grant Program
  - Additional **3% reduction** if incorporated into the TPB long-range transportation plan
- The TRIP must include several required elements, including but not limited to:
  - Address immediate and long-range planning activities and investments related to resilience
  - Demonstrate a systemic approach to resilience
  - Include risk-based assessment of vulnerabilities to current and future weather events and natural disasters
- **PROTECT** aims to help make surface transportation more resilient to natural hazards, including climate change, sea level rise, flooding, extreme weather events, and other natural disasters through support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk coastal infrastructure



# TRIP Objectives and Purpose

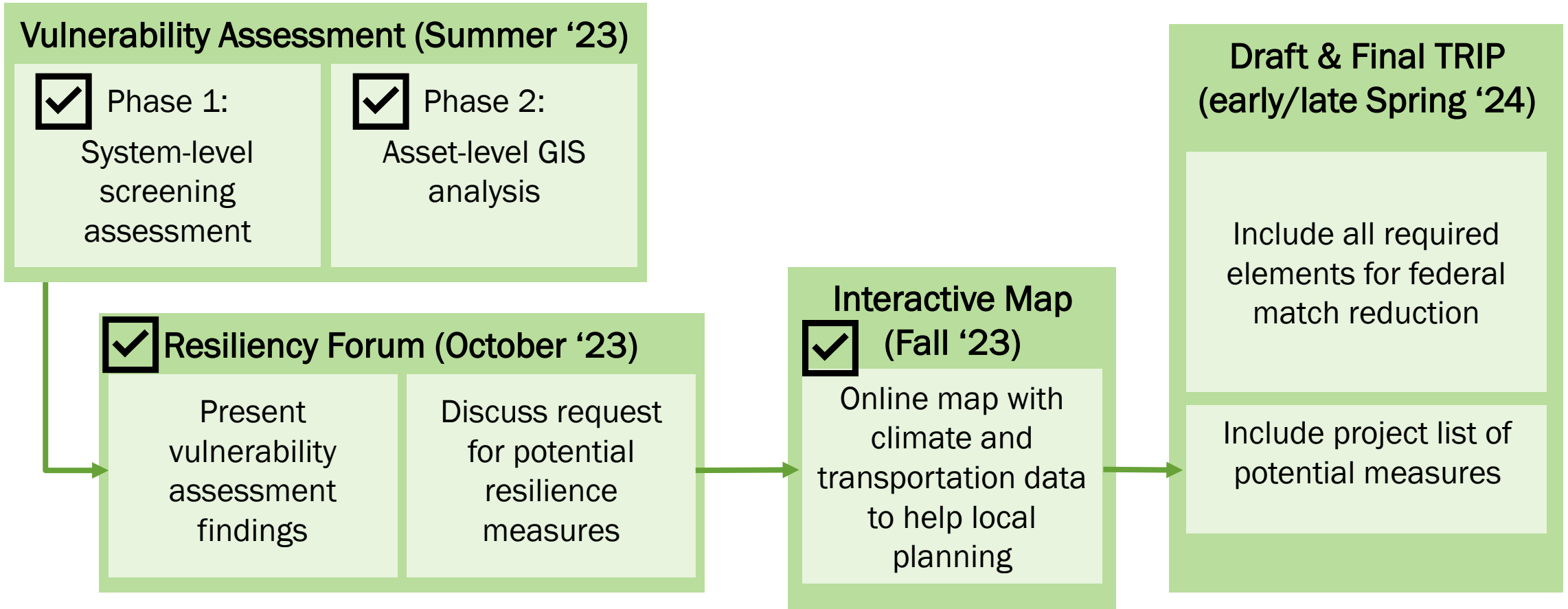
- Develop a Transportation Resilience Improvement Plan (TRIP) in collaboration with member organizations that will:
  - Contribute to member organizations' understanding of and planning for climate change risk and resilience
  - Identify priorities for resilience investment
  - Better position the region for federal funding and match reduction under the PROTECT program



Damage to Hunter Mill Road in Fairfax County from Tropical Storm Lee (Flicker/VDOT, 2011)



# Process and Timeline








# Regional Stakeholder Participation

- **Working Group** – quarterly meetings
  - State DOTs
  - Locality representatives
  - Transit agencies
- **Regional Transportation Resilience Forum**
  - Wider audience than working group
    - Regional partners
    - Advocacy groups
    - MPO representatives from outside our region



# Phase 1: System-Level Analysis

TABLE 1. SUMMARY SYSTEM-LEVEL ANALYSIS RESULTS FOR MWCOG REGION (INFRASTRUCTURE IMPACTS ON LEFT; SERVICE AND CUSTOMER IMPACTS ON RIGHT)

					
	Extreme Heat	Inland Flooding	Coastal Flooding	Extreme Winter	Extreme Wind
Roads and highways					
Bridges					
Public transit					
Active transport					
Airport					
Maritime					
Stormwater					

Legend:

High sensitivity	Medium sensitivity	Low sensitivity	Impacts to infrastructure	Impacts to customers and service

- Pairs that moved on to Phase 2:**
- **Extreme heat:** Public transit, active transport
  - **Inland flooding:** Roads and highways, bridges, public transit, stormwater
  - **Coastal flooding:** Roads and highways, bridges, public transit, stormwater, maritime
  - **Extreme winter:** Public transit, active transportation
  - **Extreme wind:** Roads and highways, public transit





# Phase 2: Asset-Level Analysis (Literature Review)

For flagged Phase 1 pairs not well suited to a GIS analysis, we completed a qualitative literature review, with a focus on:

- Historical trends and future conditions for each hazard
- Previous events and impacts for each pair

Literature Review Pairs	
<ul style="list-style-type: none"><li>• Inland flooding:<ul style="list-style-type: none"><li>• Stormwater</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Extreme winter:<ul style="list-style-type: none"><li>• Public transit</li><li>• Active transportation</li></ul></li></ul>
<ul style="list-style-type: none"><li>• Coastal flooding<ul style="list-style-type: none"><li>• Stormwater</li><li>• Maritime</li></ul></li></ul>	<ul style="list-style-type: none"><li>• Extreme wind:<ul style="list-style-type: none"><li>• Roads and highways</li><li>• Public transit</li></ul></li></ul>



# Phase 2: Asset-Level Analysis (GIS Analysis)

- For pairs with available data: Completing an asset-level GIS analysis using asset-specific data, exposure indicators, and criticality indicators

## GIS Pairs

- Extreme heat:
  - Public transit
- Inland flooding:
  - Roads and highways
  - Bridges
  - Public transit
- Coastal flooding:
  - Roads and highways
  - Bridges
  - Public transit

## Key Climate Datasets

Hazard	Dataset
Temperature	Land Surface Temperature
Inland Flooding	FEMA 100/500 Year Floodplain Maps
Sea Level Rise	NOAA Digital Coast 2 Ft Sea Level Rise

## Key Criticality Elements

Criticality Element
MWCOG Equity Emphasis Areas (for all pairs)
Functional Class (for roads and bridges)
Detour Length (for bridges)



# Preliminary Results

Table 20: Assets with medium-high vulnerability.

	Bus	Rail Line	Rail Stop	Roads	Bridges
Number of assets with medium-high vulnerability to multiple hazards	140	13 miles	1	7.3 miles	N/A



Figure 7. Summary of assets with high vulnerability to inland flooding (light blue) and sea level rise (medium blue). Bridge flood vulnerability was based on condition data (dark blue). Some assets are vulnerable to both hazards and are counted in both categories.

Vulnerability of Rail Lines to Extreme Heat

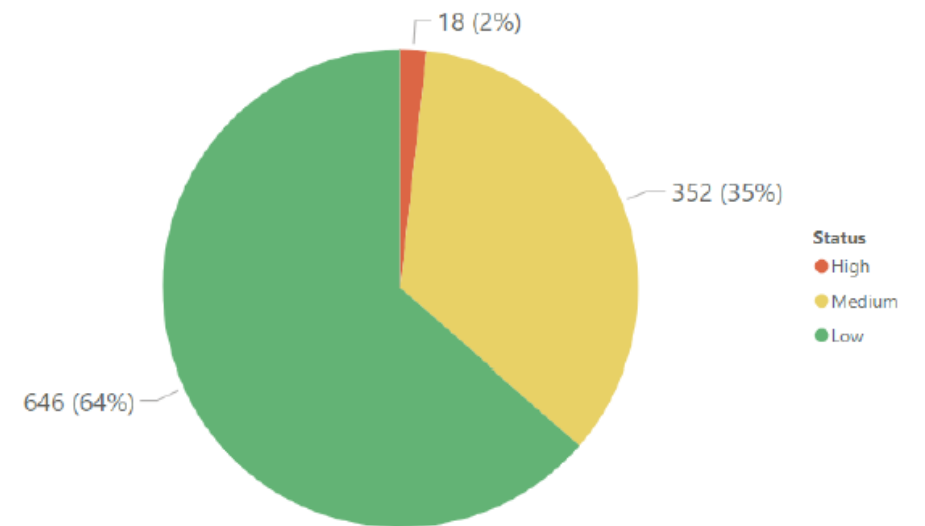
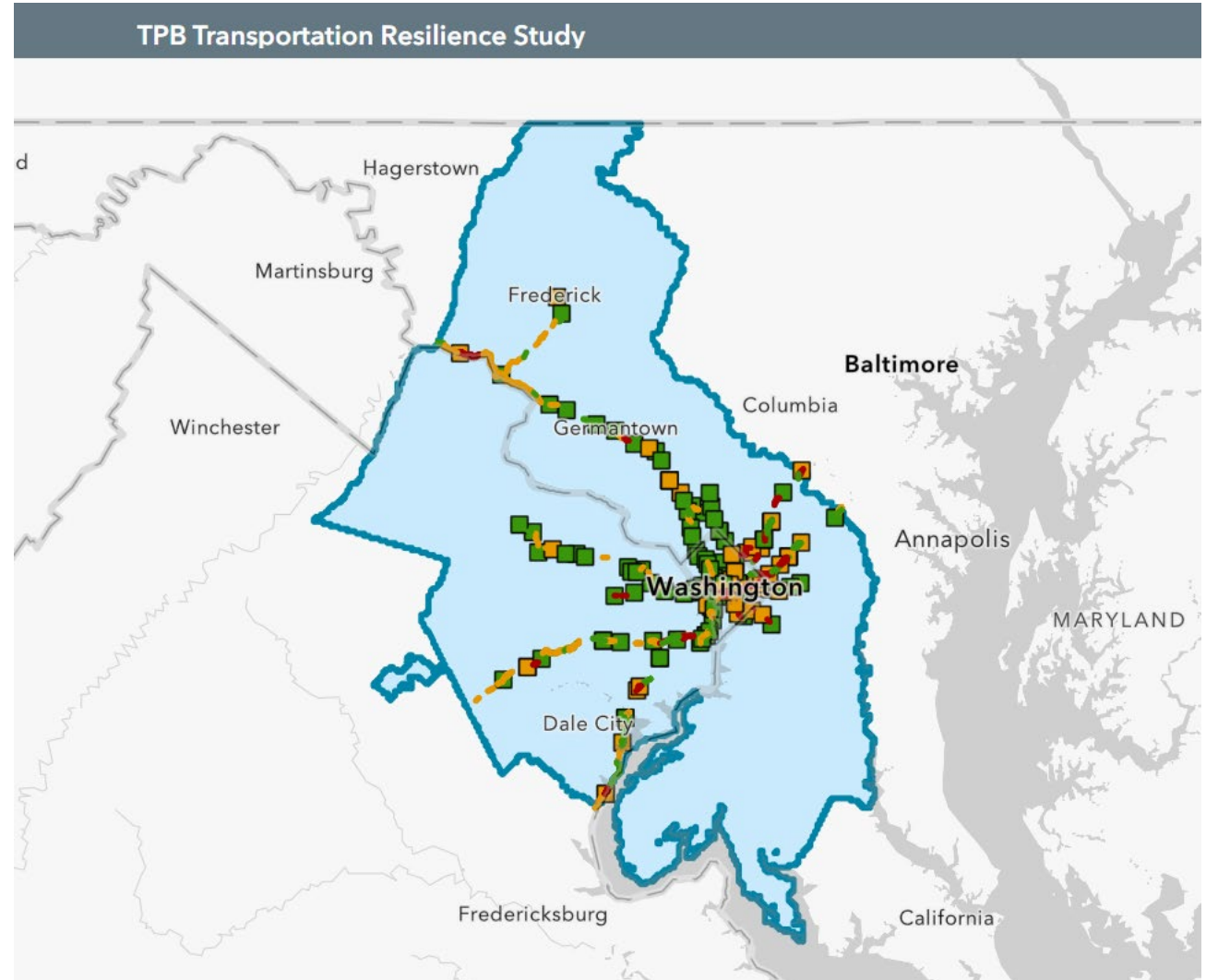


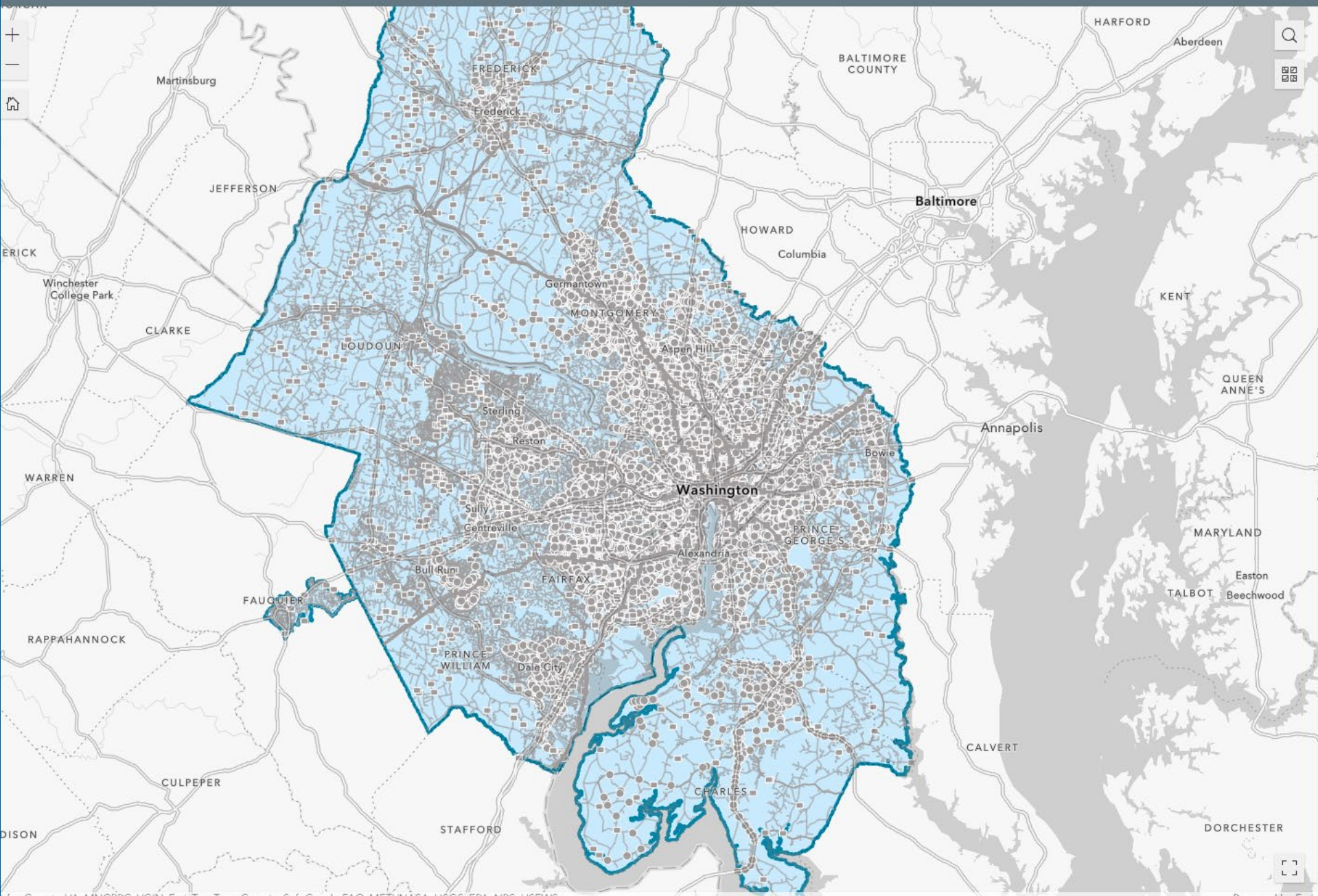
Figure 2. Breakdown of rail lines with low, medium, and high vulnerability to extreme heat.




# Interactive Mapping Tool

- The results of the Vulnerability Assessment have been integrated into an [Interactive Mapping Tool](#) on the TPB ArcGIS website
- The Mapping Tool layers transportation asset, climate, and equity spatial data to identify highly vulnerable assets
- Agencies can use the Mapping Tool to evaluate their assets and services

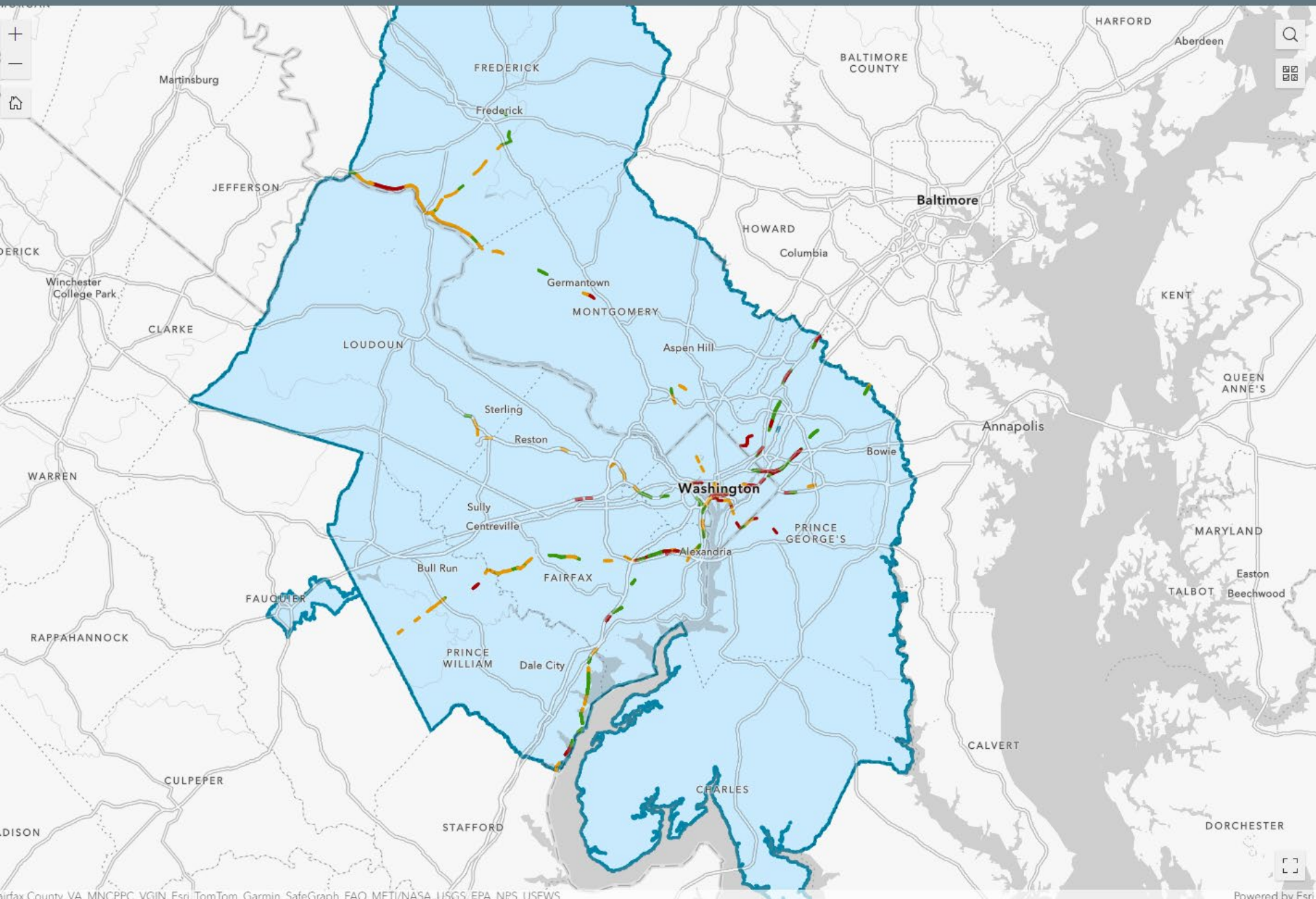





Layers	Legend
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<input type="checkbox"/>	SLR Risk Score - Rail Routes ...
<input type="checkbox"/>	Temperature Risk Score - Rail Routes ...
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<input type="checkbox"/>	Inland Flooding Risk Score - Rail Stops ...
<input type="checkbox"/>	Temperature Risk Score - Rail Stops ...
<input checked="" type="checkbox"/>	<b>Rail Stops</b> ...
<input type="checkbox"/>	Inland Flooding Risk Score - Bridges ...
<input checked="" type="checkbox"/>	<b>Bridges</b> ...
<input type="checkbox"/>	Inland Flooding Risk Score - Bus Stops ...
<input type="checkbox"/>	Temperature Risk Score - Bus Stops ...
<input checked="" type="checkbox"/>	<b>Bus Stops</b> ...
<input type="checkbox"/>	Inland Flooding Risk Score - Roads ...
<input type="checkbox"/>	SLR Risk Score - Roads ...
<input checked="" type="checkbox"/>	<b>Roads</b> ...
<input checked="" type="checkbox"/>	<b>Active Transportation</b> ...
<input type="checkbox"/>	Inland Flooding Zones - Hazard ...
<input checked="" type="checkbox"/>	<b>Median Surface Temperature (°F) - Hazard</b> ...
<input type="checkbox"/>	Strong Wind Events (NRI) - Hazard ...
<input type="checkbox"/>	Sea Level Rise (ft.) - Hazard ...
<input type="checkbox"/>	Tree Canopy Coverage (MRLC) ...

  
 Click the button below to add data to the map. Once the data layer is added, click the layer's 'Actions' button and 'Add to map'.

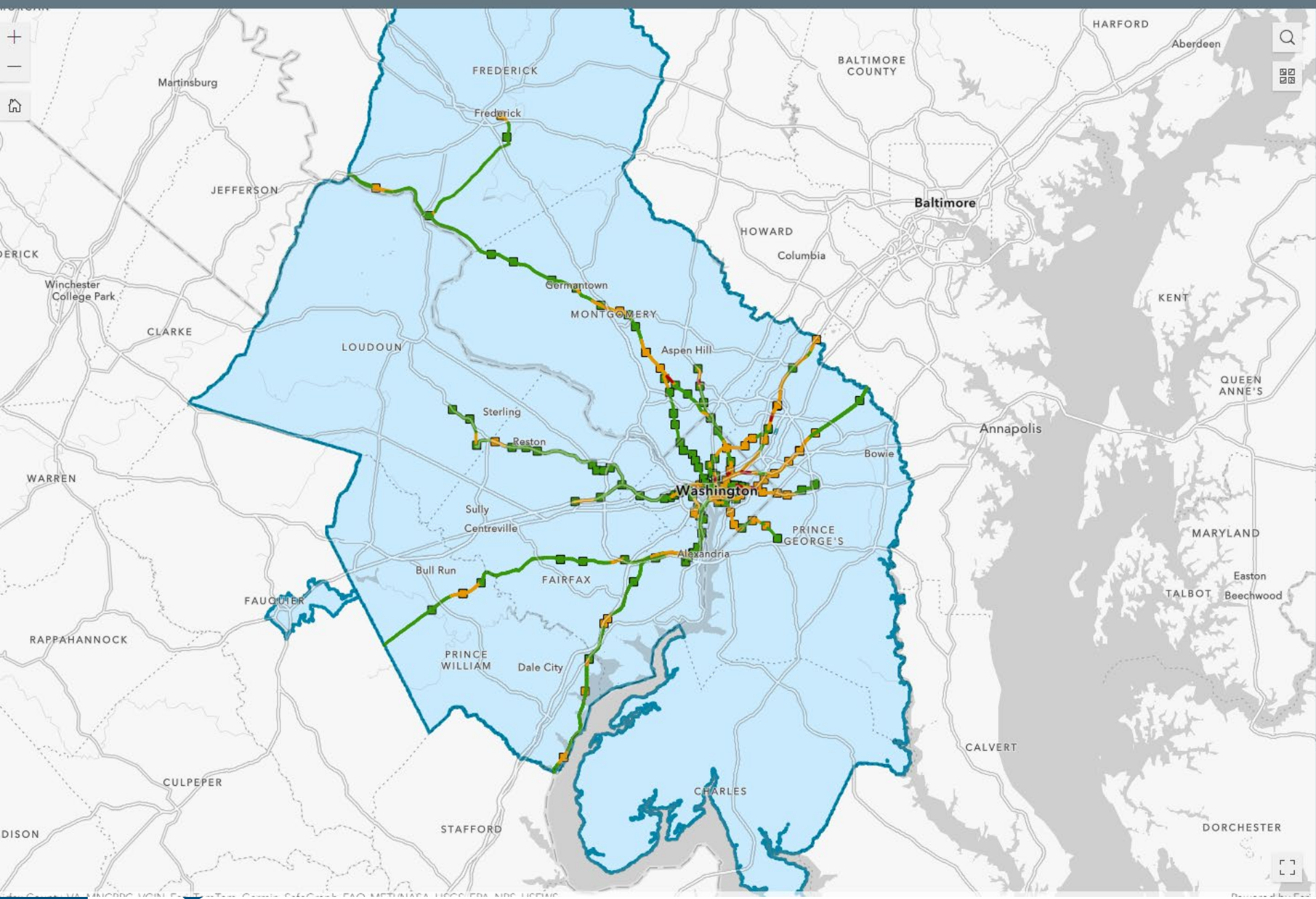
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Layers	Legend
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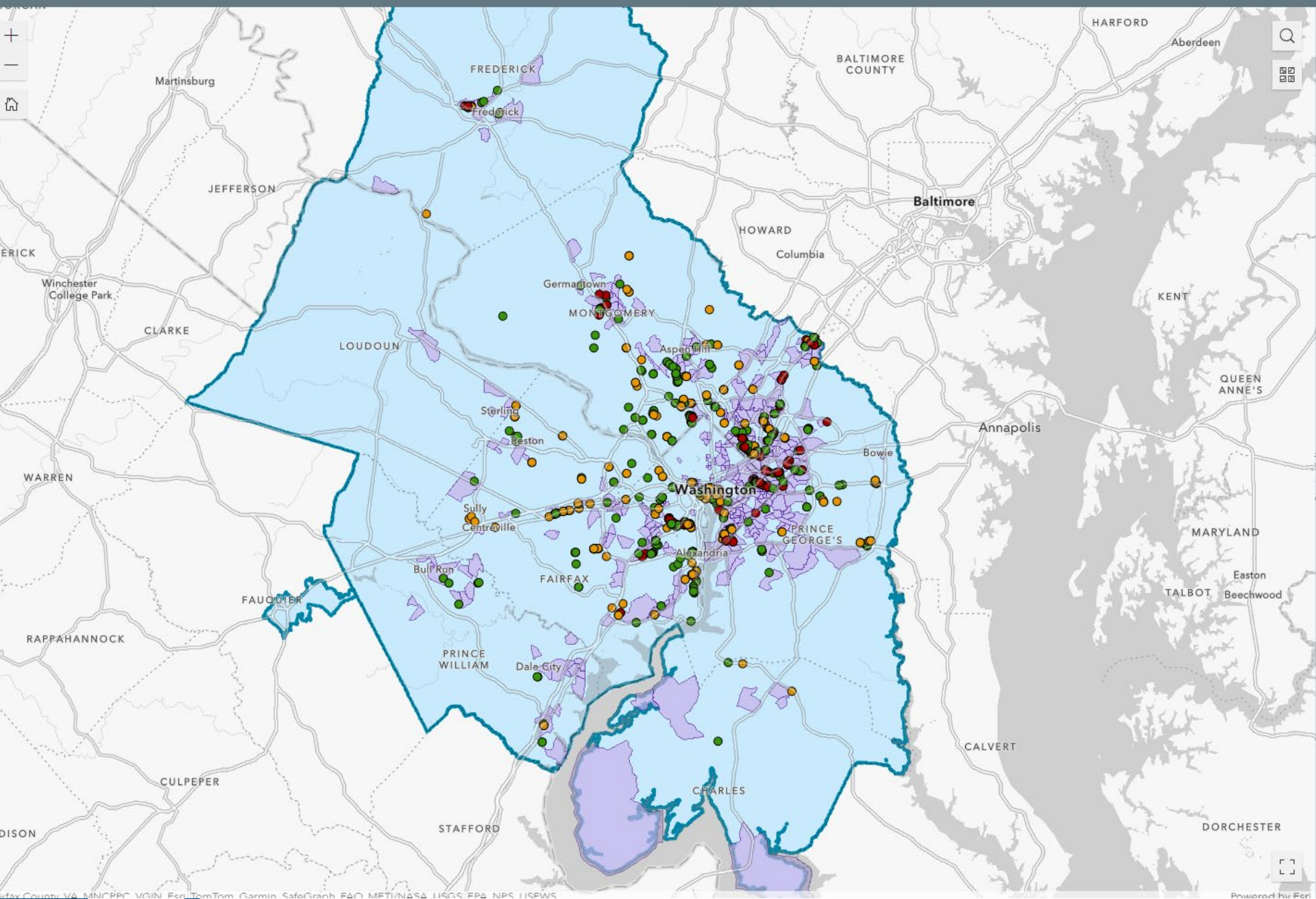
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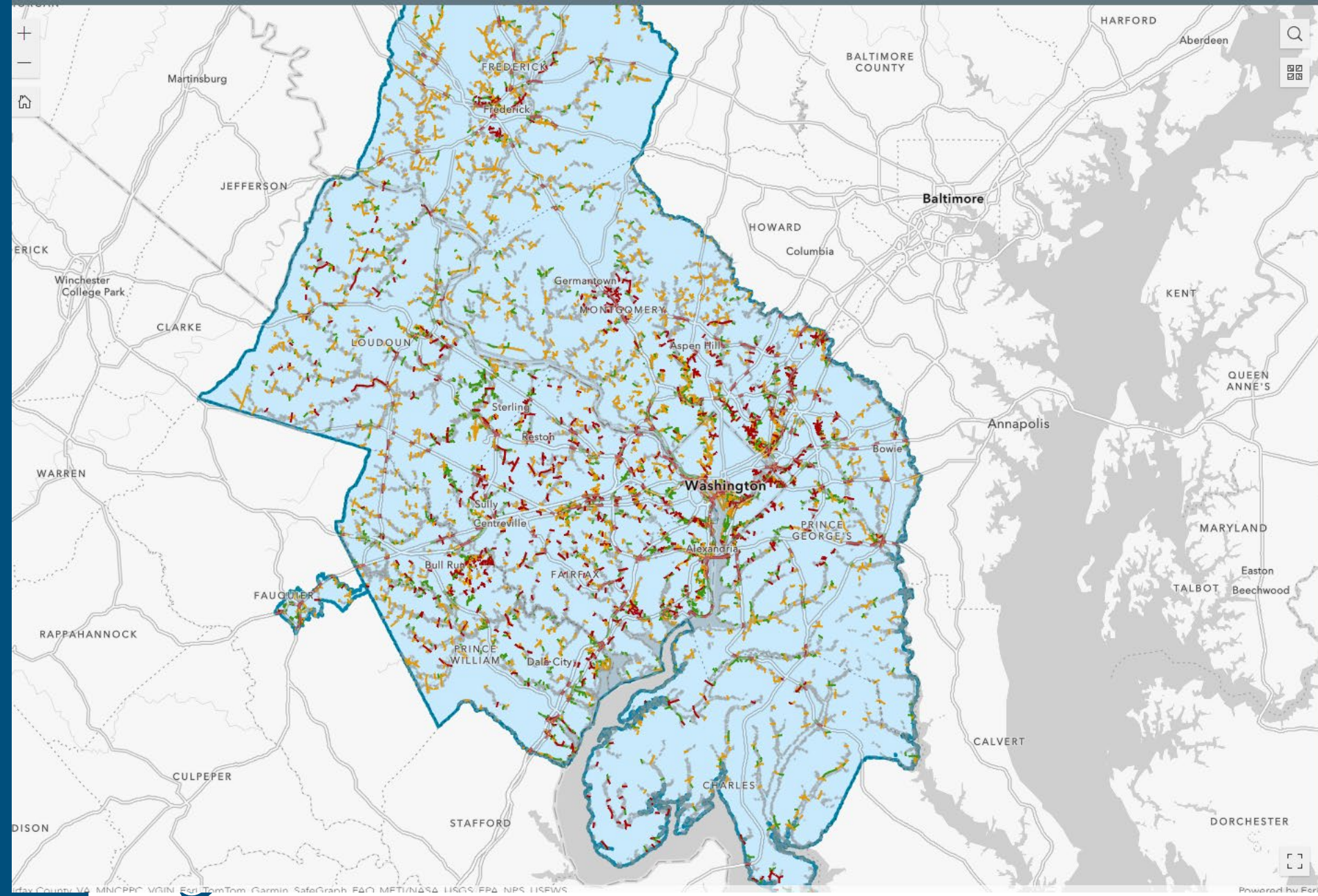
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<input type="checkbox"/>	Temperature Risk Score - Bus Stops ...
<input type="checkbox"/>	Bus Stops ...
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<input type="checkbox"/>	Roads ...
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<input type="checkbox"/>	Strong Wind Events (NRI) - Hazard ...
<input type="checkbox"/>	Sea Level Rise (ft.) - Hazard ...
<input type="checkbox"/>	Tree Canopy Coverage (MRLC) ...
<input checked="" type="checkbox"/>	Equity Emphasis Areas ...
<input checked="" type="checkbox"/>	Transportation Planning Board (TPB) Boundary ...




Click the button below to add data to the map. Once the data layer is added, click the layer's 'Actions' button and 'Add to map'.

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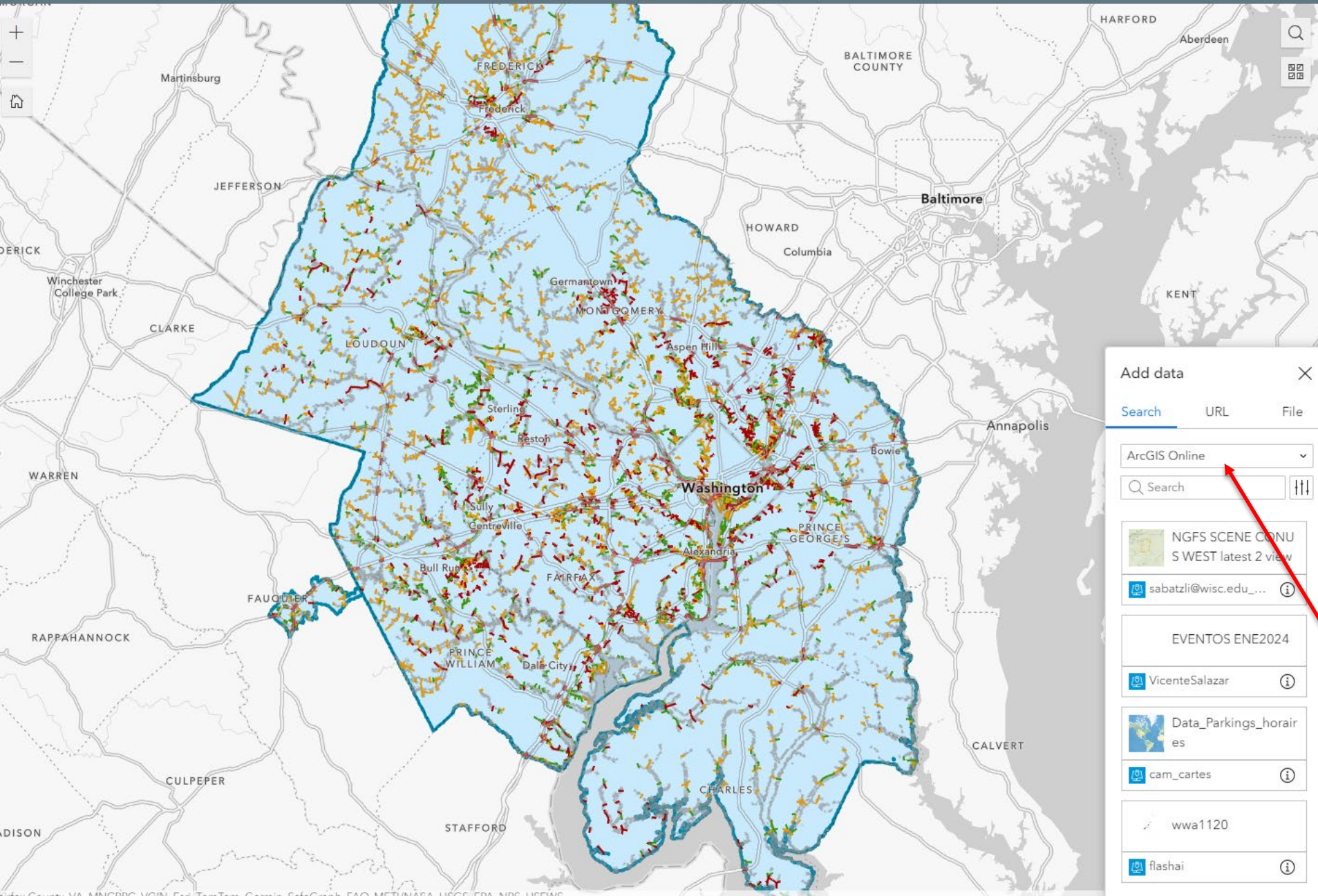


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<input checked="" type="checkbox"/>	Transportation Planning Board (TPB) Boundary ...



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Layers Legend

- Inland Flooding Risk Score - Rail Stops ...
- Temperature Risk Score - Rail Stops ...
- Rail Stops ...
- Inland Flooding Risk Score - Bridges ...
- Bridges ...
- Inland Flooding Risk Score - Bus Stops ...
- Temperature Risk Score - Bus Stops ...
- Details ...
- Export ...
- Bus Stops ...
- Inland Flooding Risk Score - Roads ...
- SLR Risk Score - Roads ...
- Roads ...
- Active Transportation ...
- Inland Flooding Zones - Hazard ...
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- Tree Canopy Coverage (MRLC) ...
- Equity Emphasis Areas ...
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Add data

Search URL File

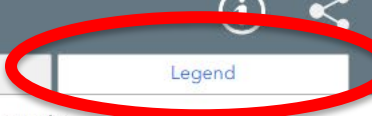
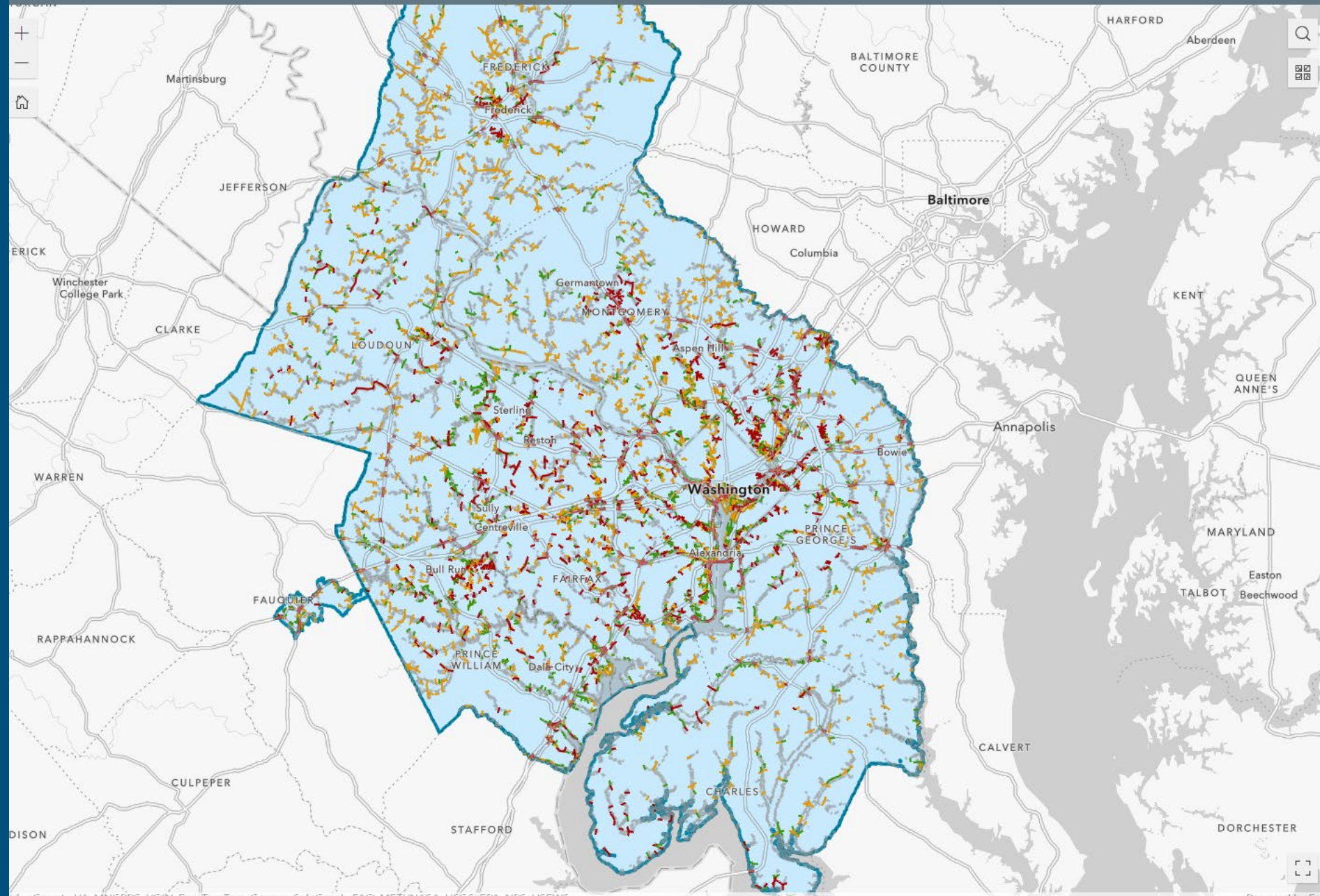
ArcGIS Online

Search

- NGFS SCENE CONUS WEST latest 2 view  
sabatzli@wisc.edu...
- EVENTOS ENE2024  
VicenteSalazar
- Data\_Parkings\_horaires  
cam\_cartes
- wwa1120  
flashai

Click the button below to add data to the map. Once the data layer is added, click the layer's 'Actions' button and Add to map.

**+ Click to add data**



Layers Legend

**Inland Flooding Risk Score - Roads**

Inland Flooding Risk Score

- > 2.49 - 3
- Medium: 2.0 to 2.49
- 0.01 - 1.99

**SLR Risk Score - Roads**

SLR Risk Score

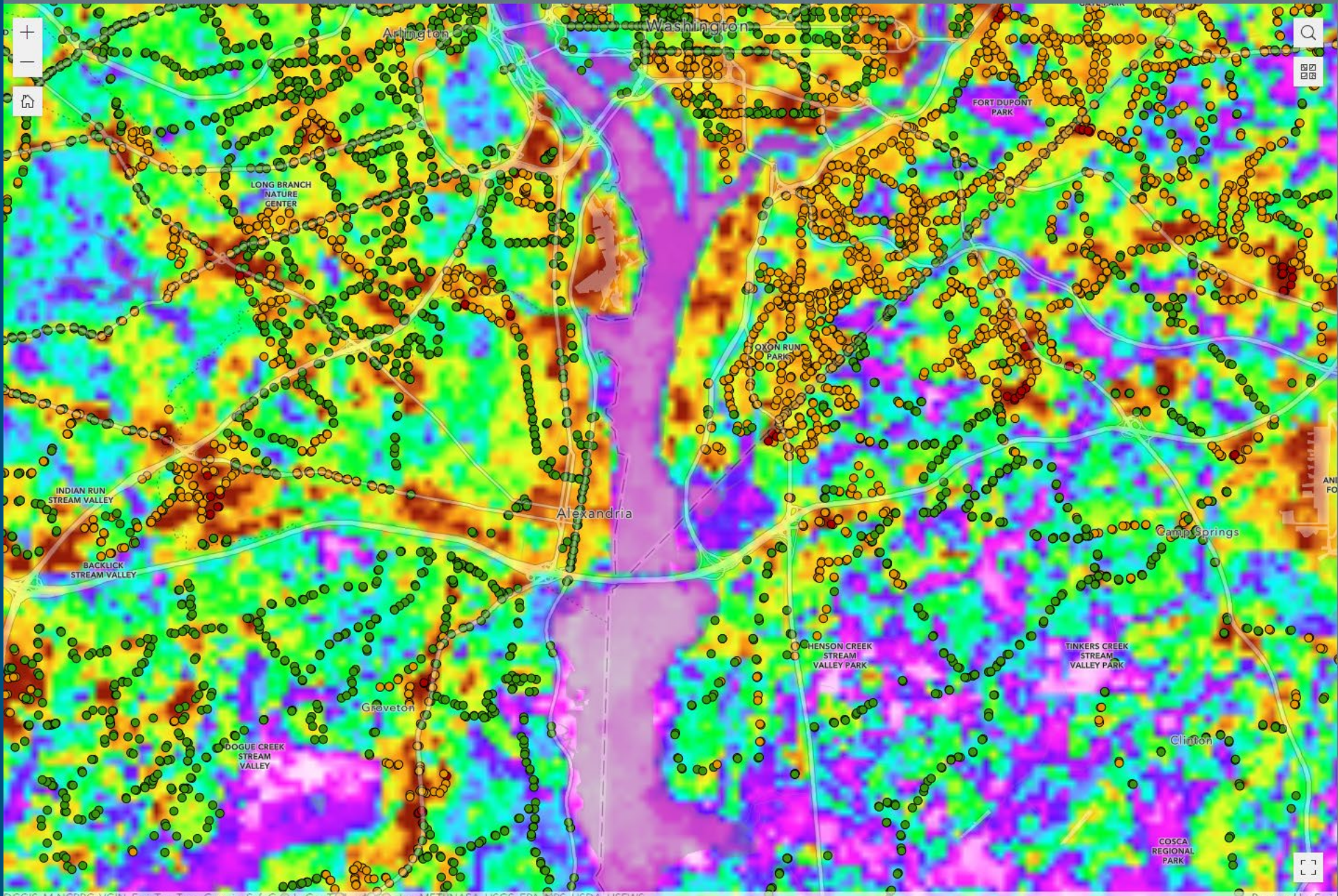
- High: 2.5 to 3.0
- Medium: 2.0 to 2.49
- Low: 0.01 - 1.99

**Inland Flooding Zones - Hazard**


- 100
- 500
- Extreme Scenario

**Transportation Planning Board (TPB) Boundary**

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Layers	Legend
<input type="checkbox"/>	Inland Flooding Risk Score - Rail Routes ...
<input type="checkbox"/>	SLR Risk Score - Rail Routes ...
<input type="checkbox"/>	Temperature Risk Score - Rail Routes ...
<input type="checkbox"/>	Rail Routes ...
<input type="checkbox"/>	Inland Flooding Risk Score - Rail Stops ...
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<input type="checkbox"/>	SLR Risk Score - Roads ...
<input type="checkbox"/>	Roads ...
<input type="checkbox"/>	Active Transportation ...



Click the button below to add data to the map. Once the data layer is added, click the layer's 'Actions' button and 'Add to map'.

[+ Click to add data](#)

# TRIP Project List

- The TRIP project list will be established using a project request form, which has been shared with this group and beyond to solicit project submissions
- The list of resilience projects should address, but are not limited to, the identified priority vulnerabilities
- The following resilience criteria will be used to help define a good/reasonable resilience project:

Resilience Criteria	Description
Eligible transportation asset	Roads and highways, bridges, public transit infrastructure, active transportation infrastructure, airports, maritime infrastructure, and stormwater infrastructure.
Qualifying project type for PROTECT	<ul style="list-style-type: none"> <li>• Resilience Planning (e.g., resilience planning activities, capacity building)</li> <li>• Resilience Improvements (e.g., improving drainage, elevating bridges)</li> <li>• Community Resilience and Evacuation Routes (e.g., redundant evacuation routes)</li> <li>• At-Risk Coastal Infrastructure – (e.g., relocate coastal highway infrastructure)</li> </ul>
Targets high priority risks	The proposed project protects the most vulnerable and critical assets/services identified via the MWCOG Climate Vulnerability Assessment or identified through local studies and assessments, or areas with historic evidence of natural hazard damage.
Reduces climate risks	The proposed project reduces the risks associated with one or more climate hazards: extreme heat, inland flooding, coastal flooding, extreme winter conditions, and extreme wind.





## Next Steps

- Continue to collect resilience project submissions
- Finalize project list once submission window closes (end of January 2024)
- Working Group meetings #3 & #4
- Draft and final version of plan
- Continued collaboration with member localities, state DOTs, other regions creating their own TRIPs
- Future Improvements

Route 50 in Prince George's County flooded after heavy rains in 2020. Source: WTOP News.



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National Capital Region  
**Transportation Planning Board**

# Additional slides

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# Phase 2 GIS Methodology: Extreme Heat



- Extreme heat & public transit
  - **Exposure indicator:** Land surface temperature (70% weighting)
  - **Criticality indicator:** MWCOG Equity Emphasis Areas (30% weighting)

Scoring Scale for Exposure

Indicator Value	Score
Top 1/3 of surface temperatures	3
Middle tier of surface temperatures (1/3-2/3) experienced in the study area	2
Bottom 1/3 of surface temperatures experienced in the study area	1

Scoring Scale for Criticality

Indicator Value	Score
Located in Equity Emphasis Area	3
Not located in Equity Emphasis Area	1





# Phase 2 GIS Methodology: Inland Flooding

- Inland flooding & roads and highways, bridges, and public transit
  - **Exposure indicator:** Located in FEMA Floodplain; or Bridge-specific indicators (70% weighting)
  - **Criticality indicator:** MWCOG Equity Emphasis Areas; Functional classification (roads and bridges only) (30% weighting)

## Scoring Scale for Exposure

Indicator Value	Score
Located in the 100-year floodplain	3
Located in the 500-year floodplain	2
Located in the 500-year floodplain + differential buffer	1
Not inundated	0

## Scoring Scale for Criticality Indicators

Indicator	Indicator Value	Score
MWCOG Equity Emphasis Area	Located in Equity Emphasis Area	3
	Not located in Equity Emphasis Area	1
Functional Classification	Interstate, Other freeways or expressways	3
	Other principal arterial	2
	Major and minor collector, minor arterial local	1

# Phase 2 GIS Methodology: Coastal Flooding



- Coastal flooding was analyzed for **roads and highways, bridges, and public transit**
  - **Exposure indicator:** Depth of inundation from a 2 feet sea level rise scenario; or Bridge-specific indicators (70% weighting)
  - **Criticality indicator:** MWCOG Equity Emphasis Areas; Functional classification (for roads and bridges only) (30% weighting)

## Scoring Scale for Exposure

Indicator Value	Score
Inundation of $\geq 1$ ft	3
Inundation of $0.5 < x \leq 1$ ft	2
Inundation of $0 < x \leq 0.5$ ft	1
Not inundated	0

## Scoring Scale for Criticality Indicators

Indicator	Indicator Value	Score
MWCOG Equity Emphasis Area	Located in Equity Emphasis Area	3
	Not located in Equity Emphasis Area	1
Functional Classification	Interstate, Other freeways or expressways	3
	Other principal arterial	2
	Major and minor collector, minor arterial local	1



# Phase 2: Asset-Level Analysis (GIS Analysis)

Asset	High (2.5-3)	Medium (2-2.5)	Low (0-2)
Bridges	Flood: 1	Flood: 39	Flood: 1,281
Bus stops	Temp: 196 SLR: 0 Flood: 173	Temp: 6,468 SLR: 0 Flood: 877	Temp: 15,560 SLR: 0 Flood: 378 (excluding 0s)
Rail Routes	Temp: 36 SLR: 37 Flood: 233	Temp: 716 SLR: 83 Flood: 322	Temp: 1,320 SLR: 4 (excluding 0s) Flood: 258 (excluding 0s)
Rail Stops	Temp: 0 SLR: 0 Flood: 1	Temp: 53 SLR: 0 Flood: 6	Temp: 107 SLR: 0 Flood: 4 (excluding 0s)
Roads	SLR: 123 Flood: 2,844	SLR: 49 Flood: 3,869	SLR: 44 (excluding 0s) Flood: 2,682 (excluding 0s)

