# Wrong-Way Driving (WWD) Analysis

2025 TexITE Fall Meeting


stv WSDOT

September 25, 2025

# Meeting Agenda

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- Background
- How We Do It
- WSDOT WWD Project
- Conclusions

# STV
# Market Sectors

**Transportation**

**Airports**

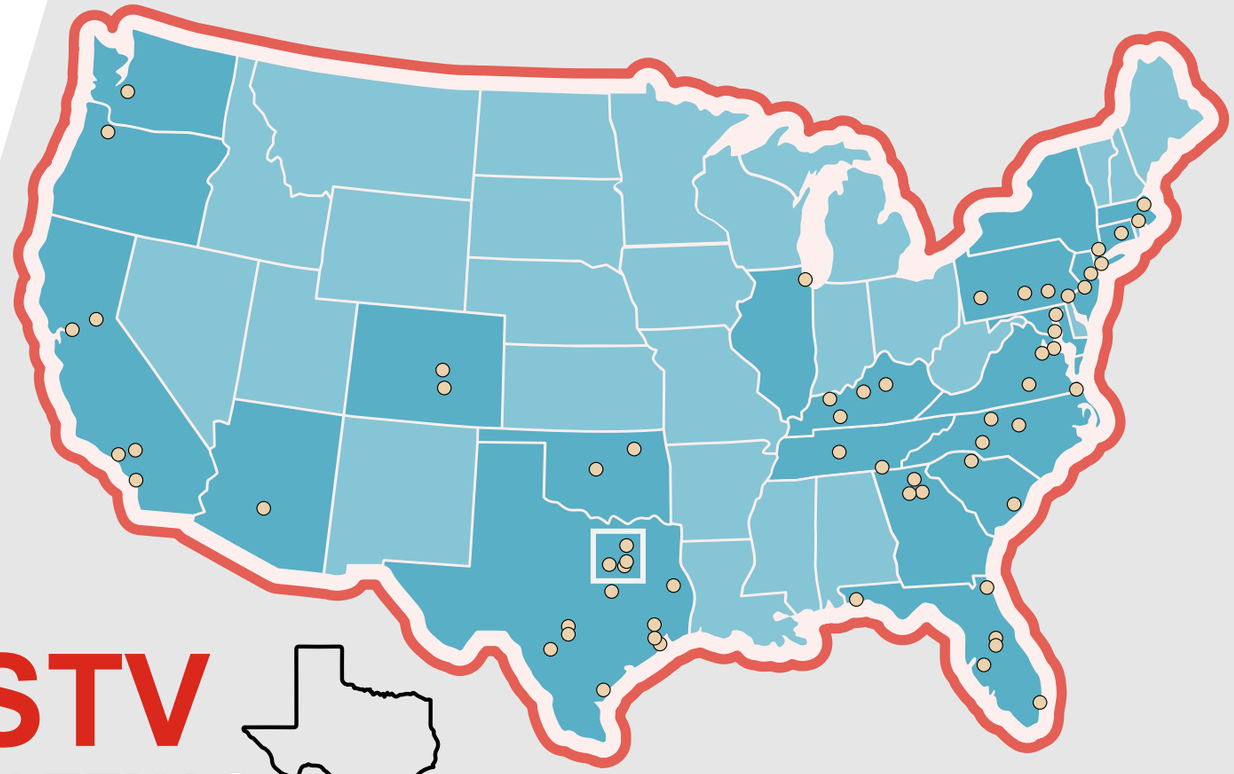
**Transit and Rail**

**Buildings**
Corporate, Commercial, State and Municipal

**Federal Programs**

**Water**

The STV Centers of Excellence are national practices that partner with our Operating Groups.



## STV
## IN TEXAS

- Established in Dallas **since 1980**
- SAME Member **since 1968**
- 400 employees in Texas/Oklahoma

# Background

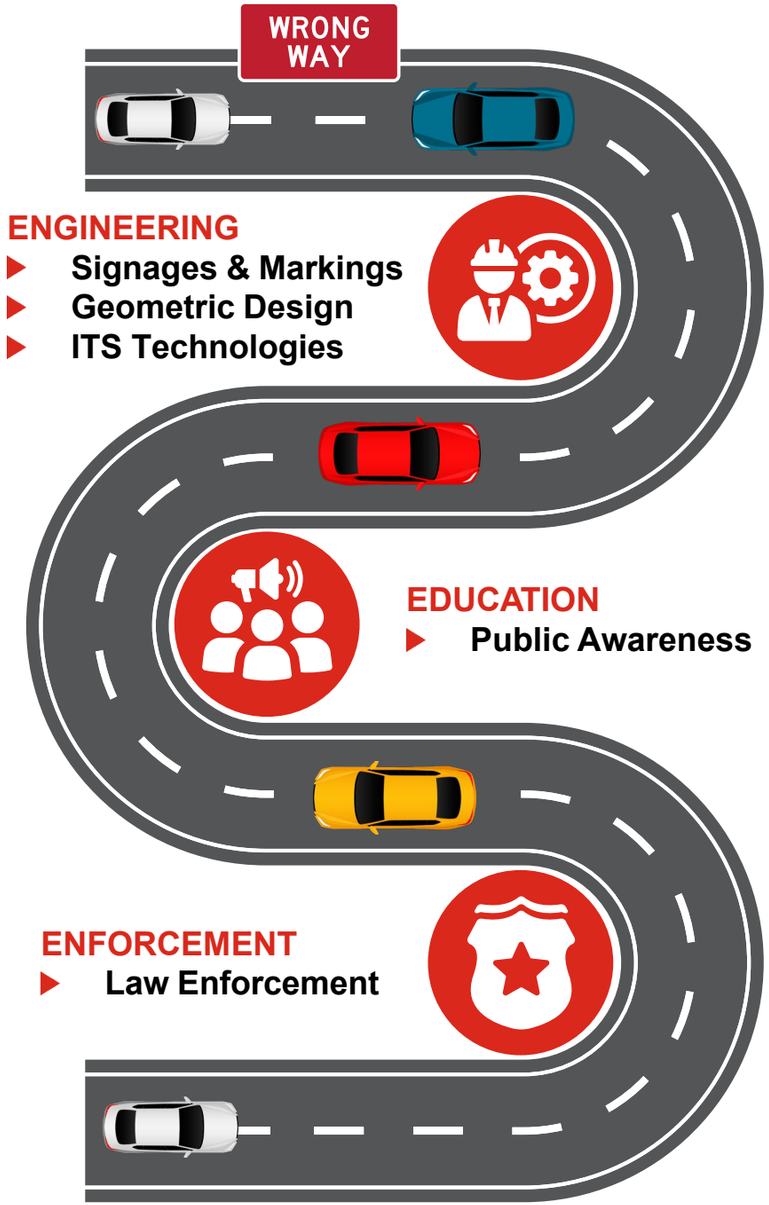
- WWD is the act of traveling against the traffic flow on physically divided highways
- A rate of 1.34 fatalities per WWD fatal crash, while a rate of 1.10 fatalities per fatal crash for other crash types
- Around 460 fatalities per year, an increase from the 360 fatalities per year from 2004 to 2009 reported by NTSB

**4,140**

WWD Fatalities

**3,029**

Fatal WWD Crashes from 2012 to 2020 in the US



# How We Do It

## Data Collection

- Crashes & incidents
- Crash reports
- Google Maps
- Site visit
- Other data sources

## Data Analysis

- Network screening
- Potential hotspots
- Potential entry points
- Crash characteristics
- Location characteristics

## WWD Score & Countermeasures

- WWD crash score for location ranking
- Safety countermeasures recommendations

# WSDOT WWD Project

## Objective

To identify and analyze locations across the state with potential for WWD incidents and to develop appropriate draft recommendations to enhance safety on Washington's highway system.

# WWD Project Tasks

QAQC

**TASK 1: PROJECT MANAGEMENT**

- Project Management and Coordination

**TASK 2: DATA ANALYSIS**

- Region Support
- Location Identifications
- Site Survey

**TASK 3: DEVELOP MITIGATION**

- Research Best Practice
- Develop Mitigation Measures

**TASK 4: FINAL REPORT**

- Develop Report to WSDOT
- Assist with Final Report to the Legislature

# TASK 2: DATA COLLECTION & ANALYSIS

- 2.1 Assist Region Offices
- 2.2 Identify Locations or Corridors for Countermeasures
- 2.3 Conduct Site Surveys

# TASK 2 | Assist Region Offices

## Southwest Region (SWR)


- **Plan:** Develop a list of locations for implementing safety measures
- **Data:** Five years of WSDOT State Patrol log of WWD incident data and WWD crashes
- **STV Support:** Discussed their data and location selection, provided answers to their queries, and offered best practices for data analysis

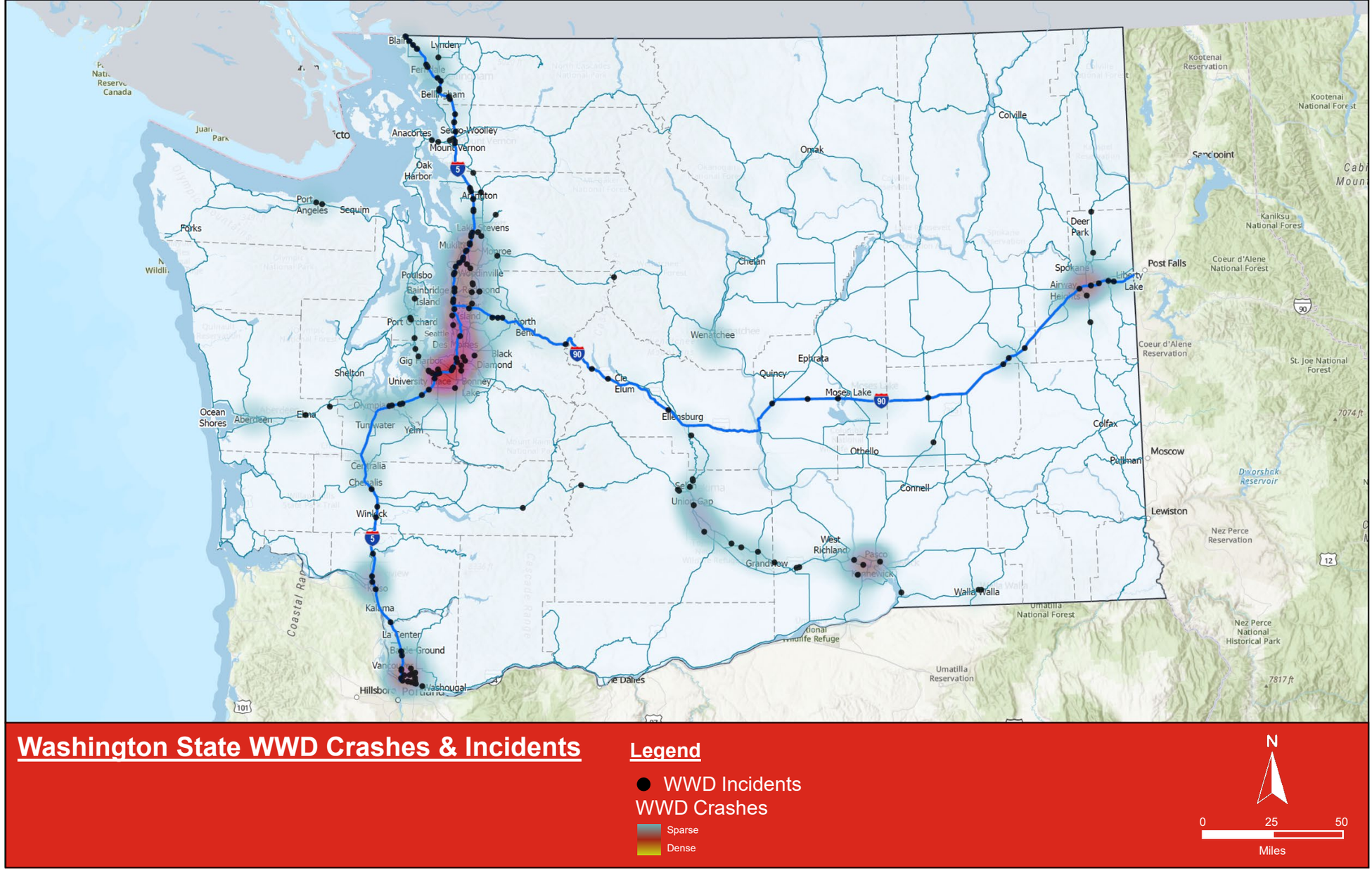
## North Central Region (NCR)


- **Plan:** Selected 23 locations for safety measures, including: signage (WWD, OW, DNE, & LED), and striping
- **STV's Support:** Discussed their proposed improvements, suggested additional safety measures, and provided sources for the effectiveness of WWD LED signs

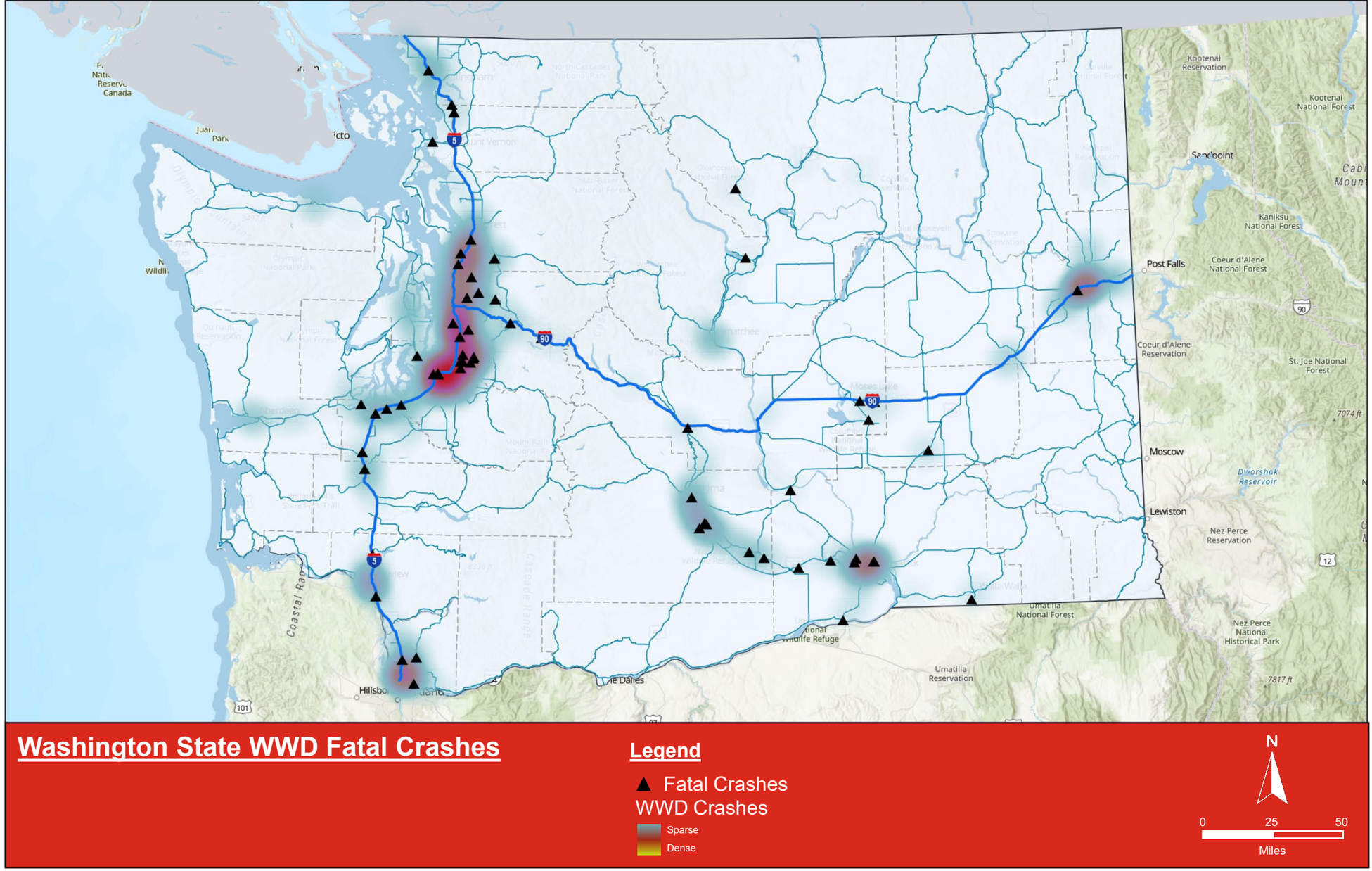
## South Central Region (SCR)


- **Plan:** Selected 7 Locations for safety measures, including: signage (WWD, OW, & DNE) and striping
- **STV's Support:** Discussed their proposed improvements and suggested additional safety measures

# TASK 2
# Data Analysis



# TASK 2
# Data Analysis



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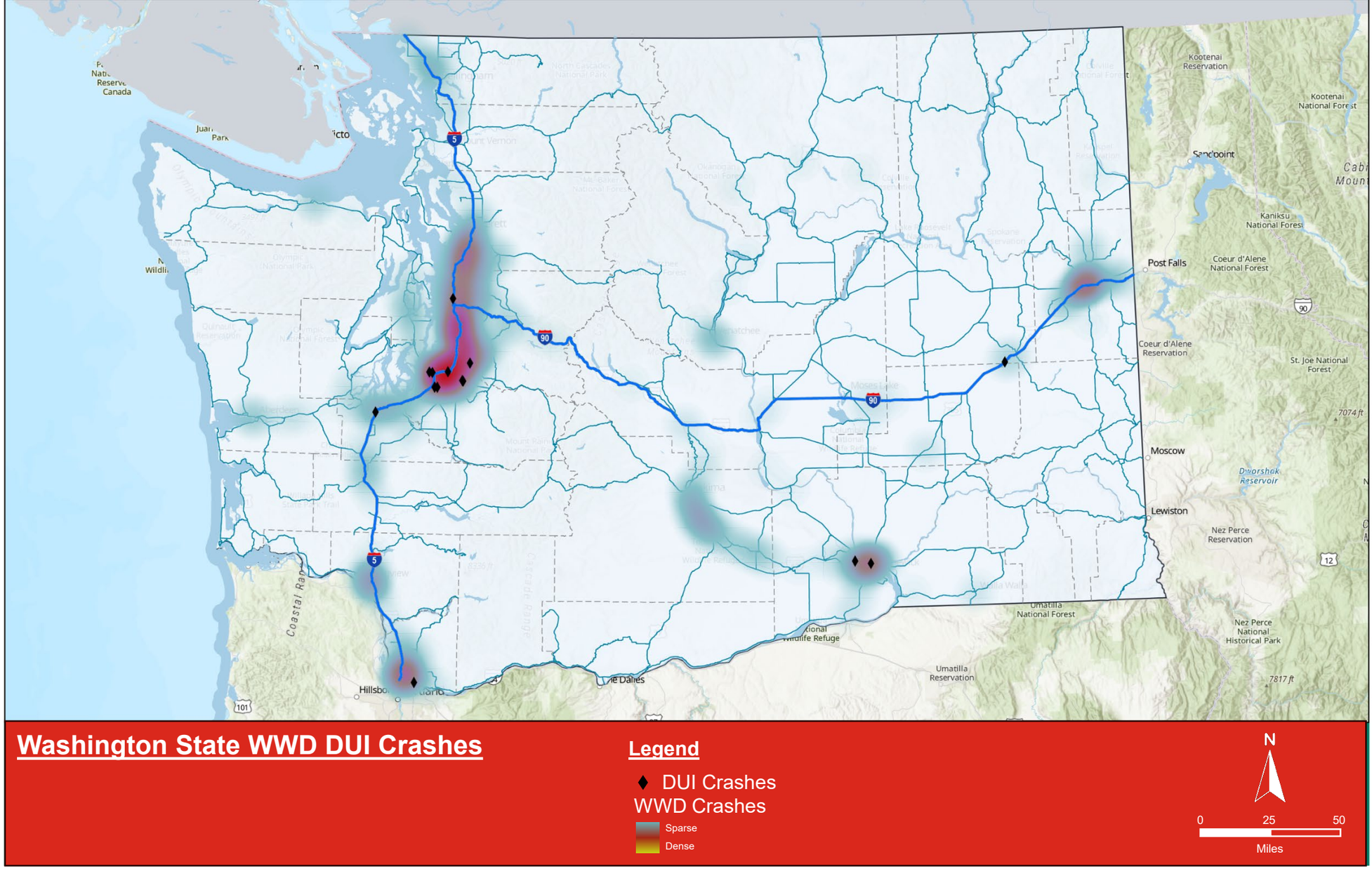

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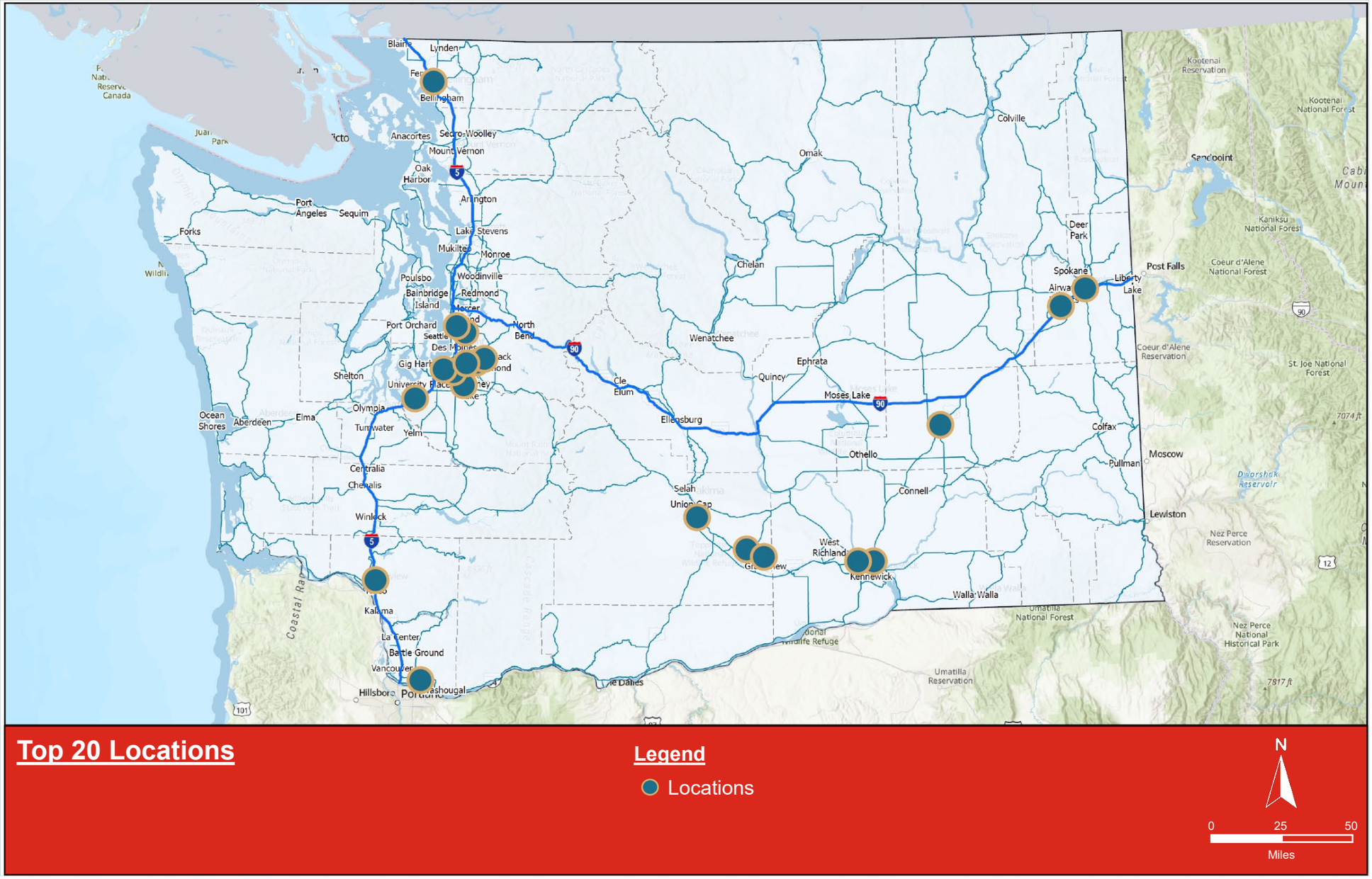
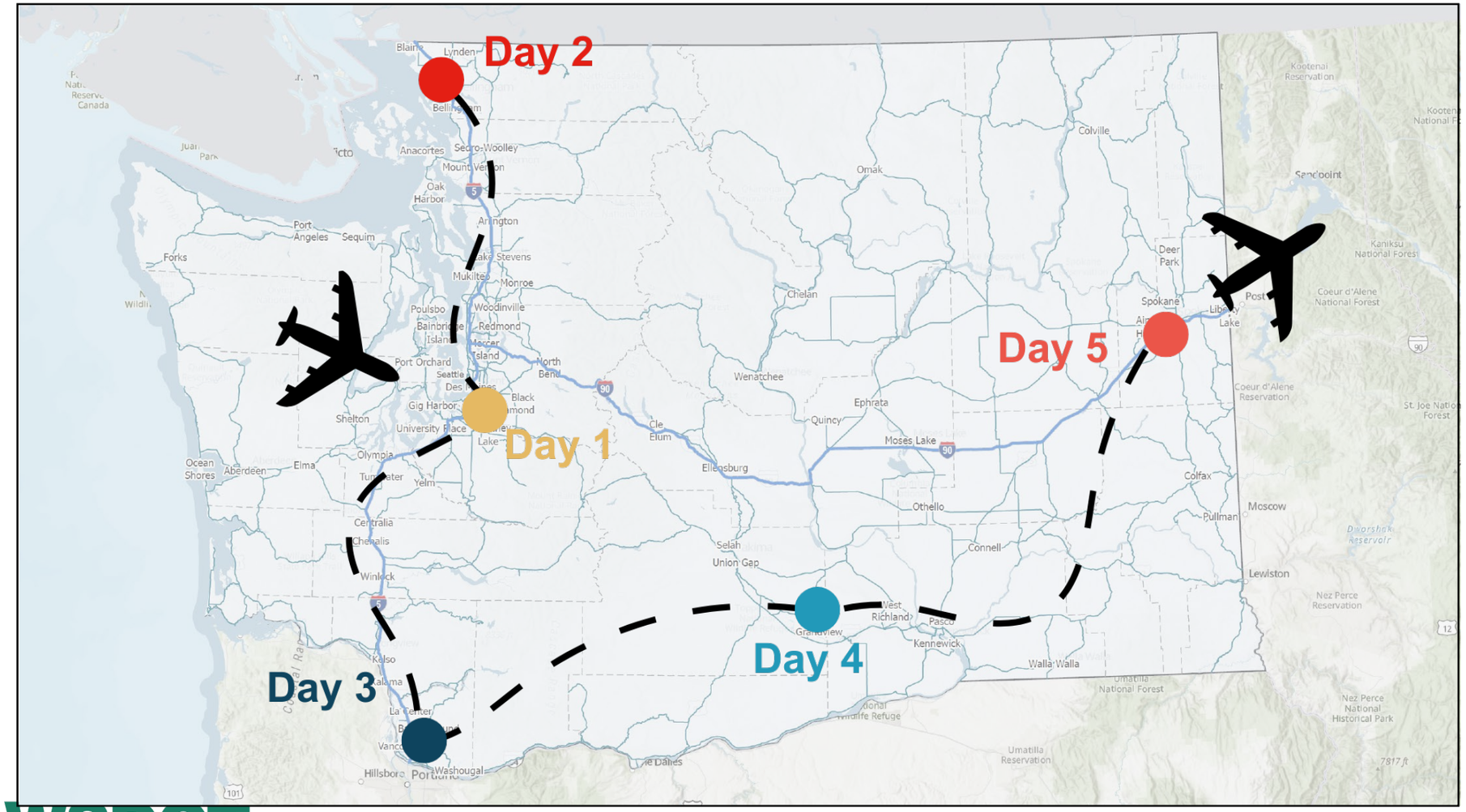
# Data Analysis



# TASK 2
# Data Analysis

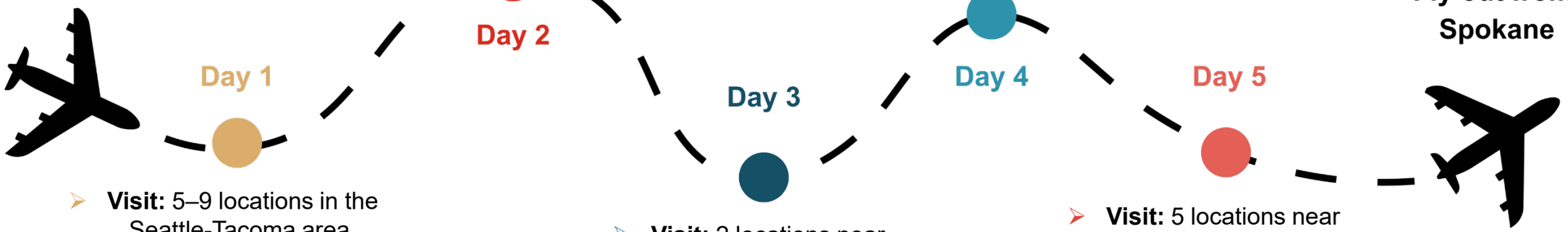
| Category | Criteria/Threshold | Points | Category | Criteria/Threshold | Points |
|---|---|---|---|---|---|
| WWD Crash History | No WWD crashes | 0 | Interchange Geometry Complexity | Standard Diamond | 0 |
| | 0.1–<0.25 WWD crashes/yr | 5 | | Moderate Complexity (e.g., Folded Diamond) | 15 |
| | 0.25–<0.5 WWD crashes/yr | 10 | | High Complexity (Unconventional Designs) | 30 |
| | 0.5–<1.0 WWD crashes/yr | 15 | Traffic Volumes (Mainline & Ramp AADT) | Determine percentile rank among all locations | |
| | 1.0–<1.5 WWD crashes/yr | 20 | | ≤10th percentile | 1 |
| | >=1.5 WWD crashes/yr | 25 | | ≤20th percentile | 2 |
| | Fatal WWD Crash (per crash) | +50 | | ≤30th percentile | 3 |
| Non-Crash WWD Incidents | Each documented incident | +5 each (up to 50 max) | | ≤40th percentile | 4 |
| DUI-Related Crashes | 1–2 DUI-related WWD crashes | 10 | | ≤50th percentile | 5 |
| | 3–5 DUI-related WWD crashes | 20 | | ≤60th percentile | 6 |
| | >5 DUI-related WWD crashes | 30 | | ≤70th percentile | 7 |
| Older Driver Involvement | 1–2 older-driver WWD crashes | 10 | | ≤80th percentile | 8 |
| | >2 older-driver WWD crashes | 20 | | ≤90th percentile | 9 |
| Proximity to Liquor Establishments | Within 0.7 mi | 10 | | >90th percentile | 10 |
| | 0.7–<2.0 mi | 5 | High-Volume Bonus | Both Mainline & Ramp >70th percentile | +5 |
| | >=2.0 mi | 0 | Visibility & Signage Factors | Poor/Obstructed Visibility of WWD Signs | +10 |
| Confusing Median/ Midblock U-Turns | Present | +10 | | Enhanced Mitigation (LED signs, detection) | -5 (subtract) |

# TASK 2 | Site Visit Plan



# TASK 2 | Site Visit Itinerary

**Fly in to Seattle**



**Day 1**

- **Visit:** 5–9 locations in the Seattle-Tacoma area.
- **Travel:** Fly into Seattle-Tacoma International Airport (SEA).
- **Stay:** Overnight in Seattle or Tacoma.

**Day 2**

- **Visit:** Remaining Day 1 locations (if any) + Northern Washington.
- **Travel:** Drive north from Seattle.
- **Stay:** Overnight in Seattle or Tacoma.

**Day 3**

- **Visit:** 2 locations near Vancouver.
- **Travel:** Drive south from Seattle to the Vancouver area.
- **Stay:** Overnight in Yakima or nearby.

**Day 4**

- **Visit:** 5 central locations.
- **Travel:** Drive from Yakima and head toward Spokane.
- **Stay:** Overnight in Spokane or nearby.

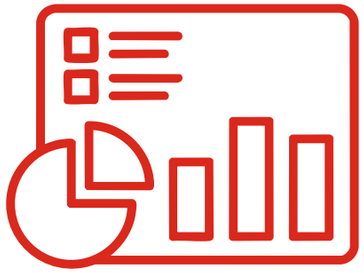
**Day 5**

- **Visit:** 5 locations near Spokane.
- **Travel:** Complete visits and fly out from Spokane International Airport (GEG).

**Fly out from Spokane**

# TASK 2
# Data Analysis

| Loc ID | Interchange Type | # of Crashes | # of Incidents | # of Fatal Crashes | AADT ML | AADT R | # of DUI Crashes | # of Crashes with Older Driver | Poor visibility? | Presence of Confusion? | Enhanced Mitigation? | Liquor Store Distance | WWD Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Parclo | 2 | 0 | 2 | 59000 | 4600 | 1 | 1 | Yes | No | No | 1.8 | 170 | 1 |
| 2 | Parclo | 3 | 3 | 1 | 52000 | 5800 | 2 | 2 | Yes | No | No | 0.3 | 145 | 2 |
| 3 | Modified Diamond | 4 | 0 | 1 | 73000 | 49000 | 2 | 0 | No | Yes | No | 0.3 | 142 | 3 |
| 4 | Parclo | 2 | 1 | 1 | 74000 | 14000 | 1 | 0 | Yes | No | No | 3.3 | 122 | 4 |
| 5 | Half Diamond | 2 | 1 | 1 | 213000 | 4600 | 2 | 0 | Yes | No | Yes | 0.5 | 120 | 5 |
| 6 | Diamond | 3 | 0 | 1 | 63000 | 6400 | 3 | 0 | Yes | No | No | 0.3 | 118 | 6 |
| 7 | Half Diamond | 5 | 0 | 0 | 207000 | 9600 | 3 | 1 | Yes | Yes | No | 0.7 | 114 | 7 |
| 8 | Parclo | 3 | 0 | 1 | 25000 | 3000 | 2 | 0 | Yes | No | Yes | 0.4 | 109 | 8 |
| 9 | Parclo | 2 | 0 | 1 | 29000 | 3700 | 2 | 0 | Yes | No | No | 0.7 | 106 | 9 |
| 10 | Diamond | 2 | 0 | 1 | 62000 | 3700 | 2 | 1 | Yes | No | No | 1.2 | 105 | 10 |
| 11 | Diamond | 2 | 1 | 1 | 79000 | 15000 | 1 | 0 | No | No | No | 1 | 103 | 11 |
| 12 | Parclo | 2 | 0 | 1 | 56000 | 920 | 0 | 0 | Yes | No | No | 2.4 | 92 | 12 |
| 13 | Diamond | 2 | 2 | 1 | 126000 | 400 | 1 | 0 | No | No | No | 2.5 | 90 | 13 |
| 14 | Diamond | 2 | 1 | 1 | 9200 | 140 | 2 | 0 | Yes | No | No | 15 | 87 | 14 |
| 15 | Diamond | 3 | 0 | 1 | 30000 | 1200 | 2 | 0 | No | Yes | Yes | 2.7 | 84 | 15 |
| 16 | Diamond | 4 | 0 | 0 | 63000 | 8200 | 3 | 0 | Yes | Yes | No | 1.1 | 73 | 16 |
| 17 | Parclo | 3 | 0 | 0 | 40000 | 8500 | 3 | 0 | No | No | No | 0.3 | 71 | 17 |
| 18 | Diamond | 3 | 0 | 0 | 53000 | 3900 | 1 | 1 | No | Yes | No | 1.2 | 59 | 18 |
| 19 | Diamond | 3 | 0 | 0 | 102000 | 8800 | 1 | 1 | No | No | Yes | 0.8 | 57 | 19 |
| 20 | Parclo | 2 | 0 | 0 | 40000 | 2100 | 2 | 0 | Yes | No | No | 1 | 56 | 20 |



# TASK 3: Mitigation Strategies Development

- 3.1 Research Best Practices
- 3.2 Develop Mitigation Measures

# TASK 3
# Develop Mitigation



# Safety Countermeasures

## California Department of Transportation

**BACKGROUND**[1]

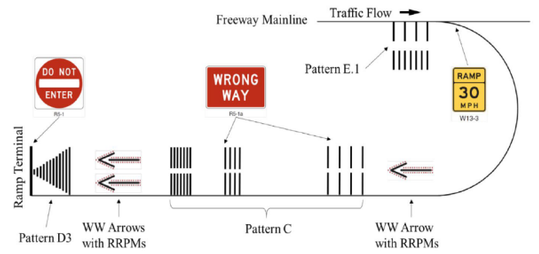
California Department of Transportation (Caltrans) has developed and tested a range of engineering countermeasures to enhance WWD detection, deterrence, and prevention. By combining enhanced conventional treatments with novel technological solutions, Caltrans aims to systematically reduce WWD-related crashes across California.

**ENGINEERING COUNTERMEASURES FOR WWD**[1,2,3]

Caltrans has employed a combination of enhanced conventional countermeasures and innovative treatments aimed at addressing the root causes of WWD. These efforts focus on making countermeasures more visible and effective for all drivers, particularly intoxicated individuals who are overrepresented in WWD crashes.

**Enhanced Pavement Markings and Signage**

- Enlarged "DO NOT ENTER" and "WRONG WAY" Signs
  - To improve visibility, Caltrans installed oversized signs, particularly at freeway exit ramps.
  - These larger signs help increase driver awareness, especially under low-visibility conditions.
- LED-Illuminated "DO NOT ENTER" and "WRONG WAY" Signs
  - Flashing LED borders continuously illuminate to catch drivers' attention as they enter exit ramps incorrectly.
- Two-Way Retroreflective Raised Pavement Markers (RPMs)
  - These markers, implemented at 60 exit ramps provide visual cues to both right-way and wrong-way drivers by reflecting red for wrong-way movements and clear for right-way traffic.
- Bidirectional Pavement Markings
  - Caltrans piloted specialized pavement markings with a biangular profile.
  - These markings produce bidirectional visibility with unidirectional messaging.
  - Additionally, these thermoplastic panels enhance nighttime visibility, even for impaired drivers.
- Directional Rumble Strips
  - Installed at selected locations to generate vibrations that provide haptic feedback to intoxicated or inattentive drivers.

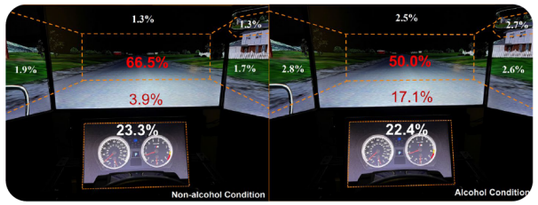




**Technology-Based Wrong-Way Driver Detection Systems**

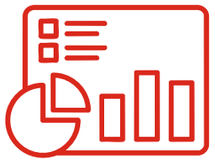
- Active Detection and Alert Systems
  - Radar-based WWD detection and notification systems were installed at pilot locations in San Diego and Sacramento.
  - These systems use thermal imaging sensors with infrared illumination to improve detection accuracy.
  - Upon detecting a wrong-way vehicle, the system triggers flashing beacons and sends an immediate notification to Caltrans TMCs and the California Highway Patrol (CHP).
- Video-Based Site Monitoring (VBSM) Systems
  - Caltrans partnered with UC Davis to develop a video-based monitoring system that independently assesses the effectiveness of detection systems. This system helped identify the precise locations and characteristics of WWD events.

**RESEARCH & SIMULATION TESTING OF COUNTERMEASURES**[1&3]

Caltrans is involved in research to assess the effectiveness of various WWD countermeasures, particularly for intoxicated drivers. In collaboration with Auburn University, Caltrans conducted studies using intoxicated drivers in simulators to evaluate their responses to different countermeasures. **These studies confirmed that flashing LED-bordered signs were highly effective in deterring wrong-way entries. Eye-tracking technology revealed that intoxicated drivers are more likely to focus on the road directly in front of them, emphasizing the importance of in-road warnings like bidirectional pavement markings.**




[1] AASHTO Innovation Initiative (AII) Wrong Way Driver Systemic Approach Webinar, https://aii.transportation.org/Documents/AII%20Wrong%20Way%20Driver%20Systemic%20Approach%20Presentation.pdf
[2] Caltrans Systemic Approach to Wrong Way Driving Safety: Effective Practices Brief, https://aii.transportation.org/SiteAssets/Pages/Systemic-Approach-to-Wrong-Way-Driver-Safety/AASHTO_AII_WWD_Effective_Practices_Brief_Caltrans_FINAL.pdf
[3] Deterrence and Detection of Wrong-Way Drivers on California Highways, https://aii.transportation.org/Documents/Caltrans%20Wrong%20Way%20Driver%20Presentation.pdf



# TASK 3
# Develop Mitigation

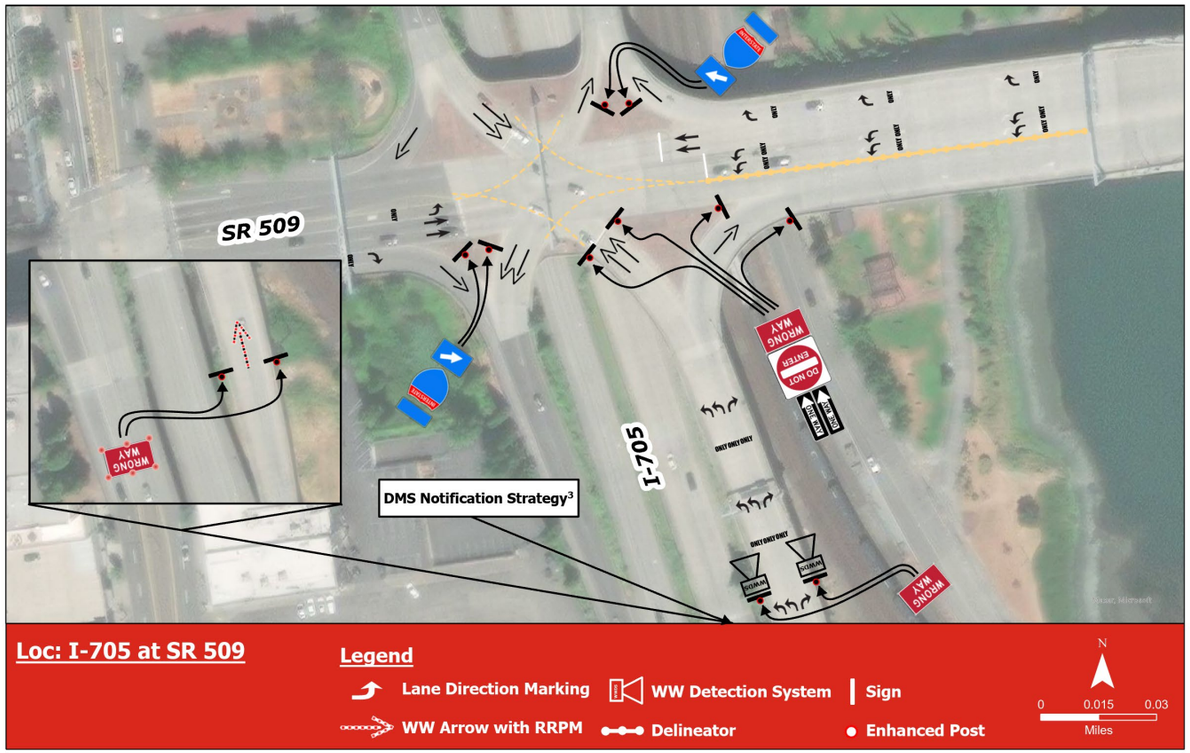
| Loc ID | ITS Detection System & DMS Notification[1] | Low-Mounted Wrong Way" & "Do Not Enter" Signs | "Wrong Way" Sign | "One Way" Sign | LED-Enhanced "Wrong Way" Sign | "No Left/Right Turn" Signs | Interstate/ Route Guide Signs | Reflective Sheeting on Signposts | Lane Direction & Pavement Markings | Wrong-Way Arrows with RRPMs | Median Extension / Delineators |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 2 | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| 3 | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | |
| 4 | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 5 | ✓ | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | |
| 6 | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 7 | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 8 | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 9 | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| 10 | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 11 | | ✓ | ✓ | | | | ✓ | ✓ | ✓ | ✓ | |
| 12 | | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| 13 | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 14 | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| 15 | | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 16 | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 17 | | ✓ | ✓ | ✓ | | ✓ | | ✓ | ✓ | ✓ | |
| 18 | | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 19 | | | | | | | | ✓ | ✓ | ✓ | |
| 20 | | ✓ | ✓ | ✓ | | | | ✓ | ✓ | ✓ | |

[1]Locations 1-7 prioritized for ITS Detection and WW System due to the ranked WWD potential score evaluation performed as part of this assessment.

# TASK 3 | Develop Mitigation

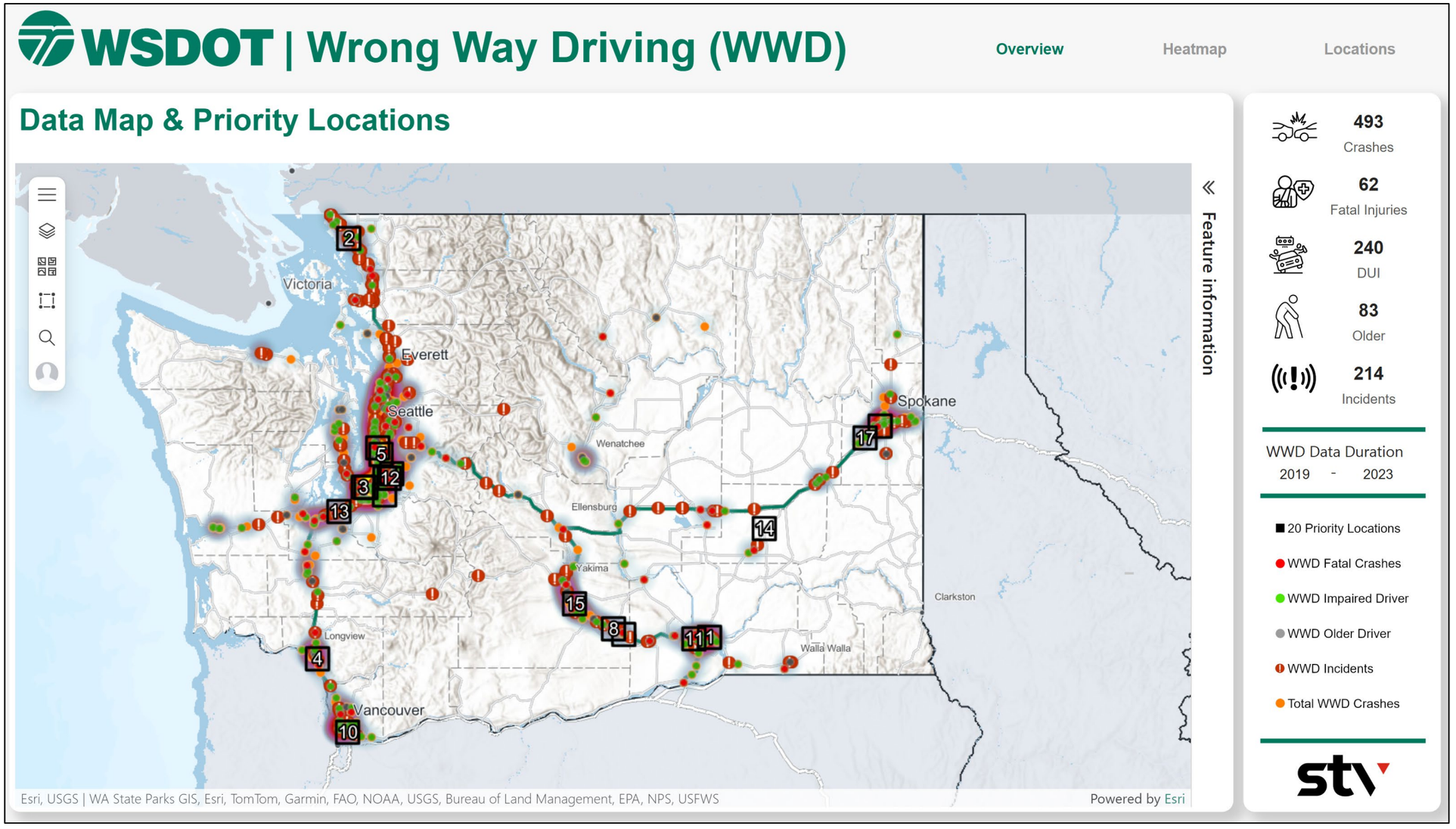
## WWD Final Report: Identified Location in Ferndale, WA


## WWD Final Report: Recommended Mitigation Measure



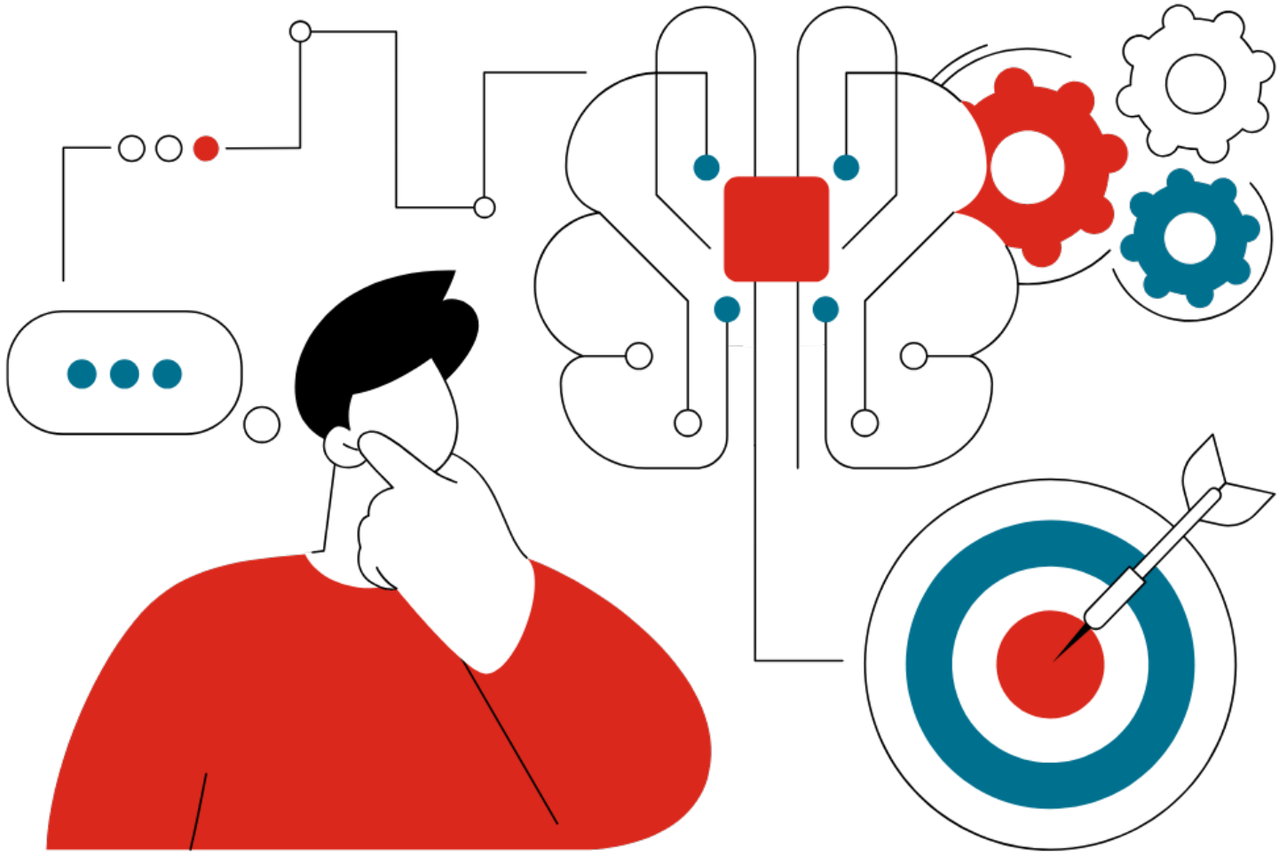
**WWD Power BI Dashboard with GIS Maps integrated**

# TASK 3
# Develop Mitigation



# CONCLUSIONS

- WWD remains a critical and addressable safety challenge across jurisdictions
- Data-driven approaches enable early identification of potential locations
- Tiered mitigation strategies help tailor cost-effective solutions
- Interactive dashboards and real-time third-party data integrations offer scalable tools for monitoring, prioritization, and tracking over time



# THANK YOU!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