

The Neighborhood Evacuation Vulnerability (NEV) Score:

A Universal Model for Neighborhood Evacuation Risk



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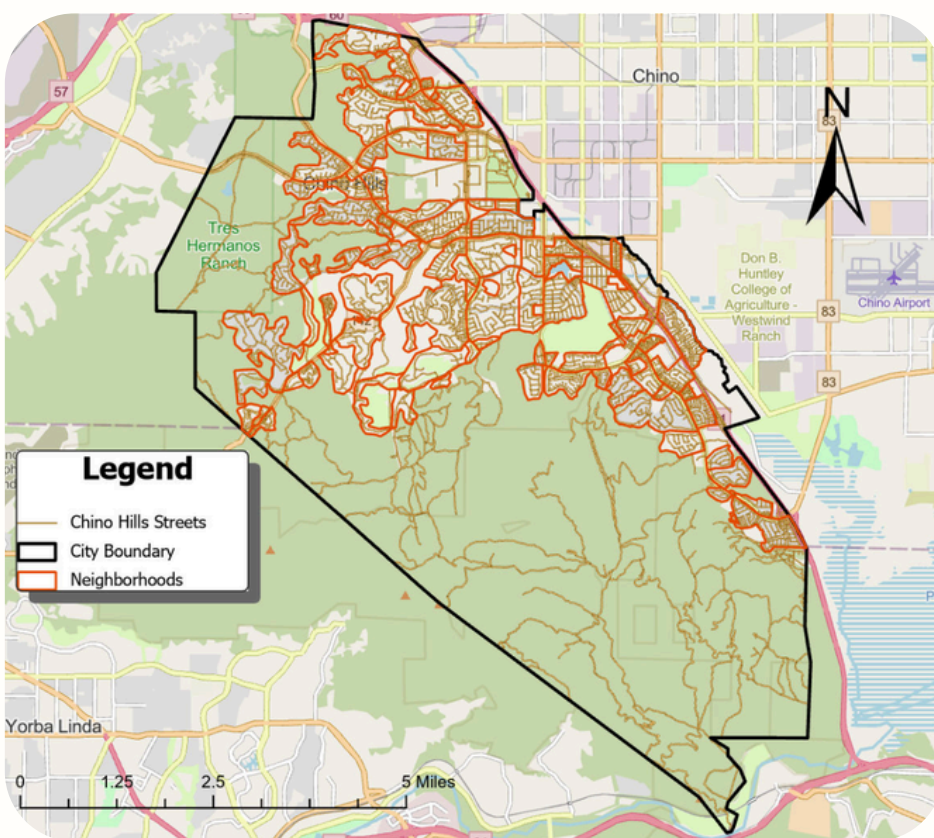
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Introduction

- The Problem:** Wildfire risk in the Wildland-Urban Interface (WUI) is rising, but evacuation success isn't just about the fire risk; it's about the road network and social resilience.
- The Goal:** To create a universal, open-source and data-driven index that pinpoints where infrastructure and equity issues intersect.

The variables measured use different units (e.g., raw counts vs. density), so they cannot be compared directly. To solve this, all data was transformed to a 0.0 to 1.0 scale.

Neighborhood Selection

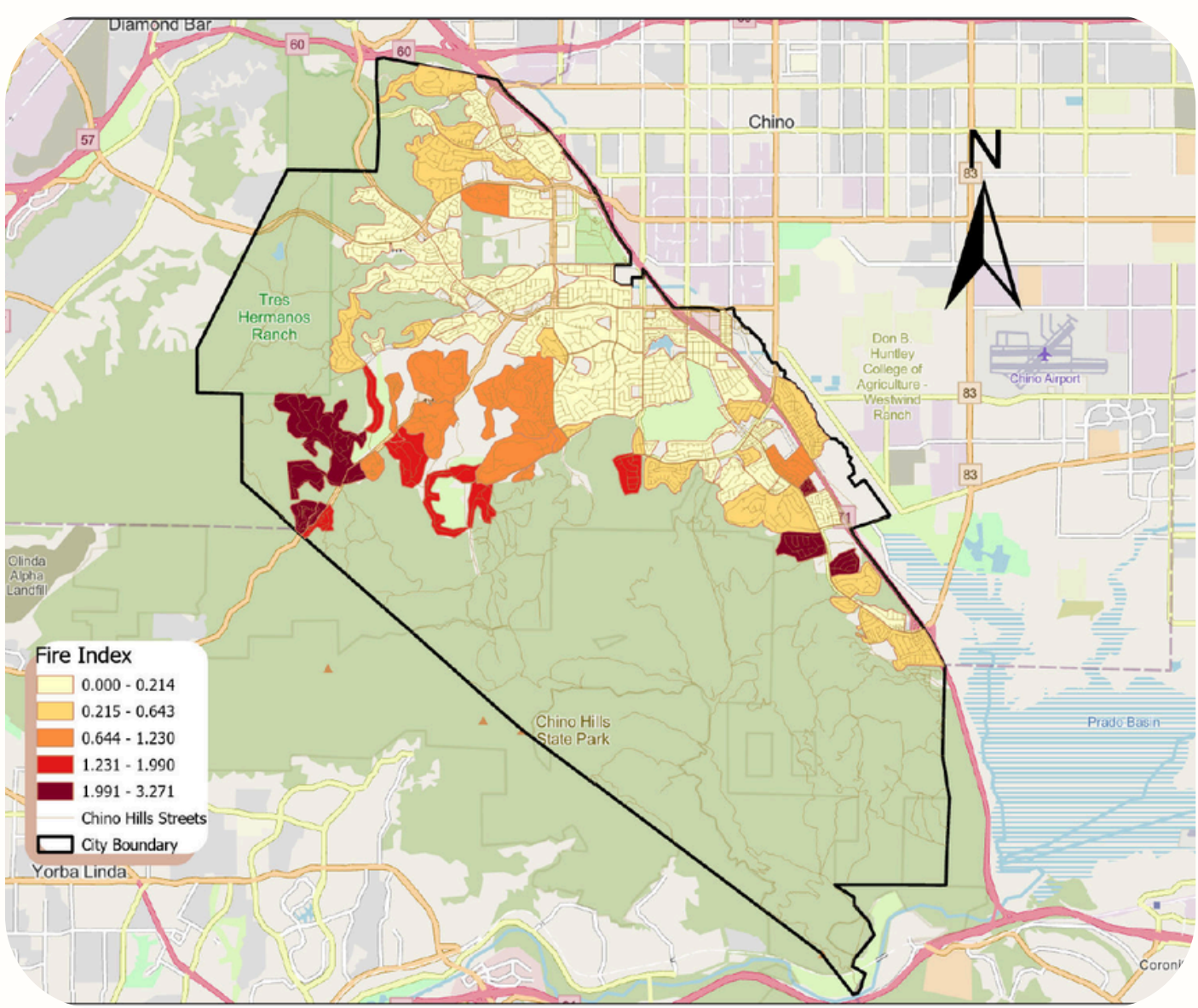


- Study Area:** Chino Hills, CA (divided into 85 neighborhoods).
- Precision Mapping:** If a housing tract was physically disconnected from another by topography or roadway, it was treated as a distinct unit, and the Census (Block Groups) data was then proportioned to these custom boundaries using Areal Interpolation in GIS.
- Why Chino Hills?** High Fire Hazard Severity Zone (FHSZ) exposure and complex "dendritic" (tree-like) road layouts.

Pillars of Vulnerability

Fire Vulnerability (20%)

FHSZ Hazard Evaluation: This data measures the long-term likelihood of fire behavior based on factors such as fire history, terrain, existing fuel (natural vegetation), and more.



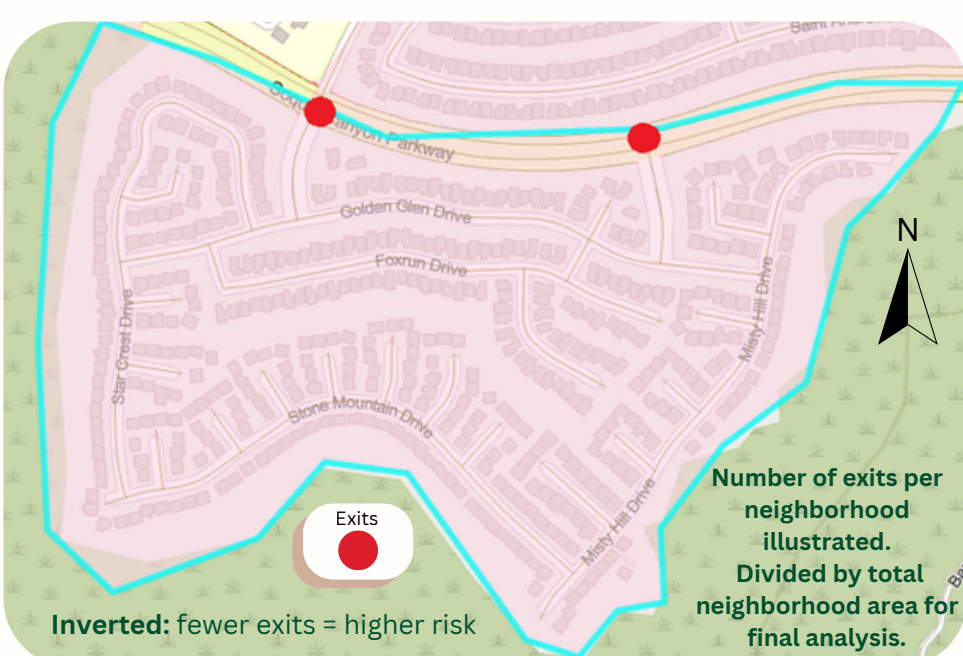
Universal Utility: This pillar is modular, swapping "Fire Hazard" for "Flood Zone" or "Sea Level Rise" adapts the NEV score to any region or disaster.

Fire and Resource Assessment Program (FRAP).

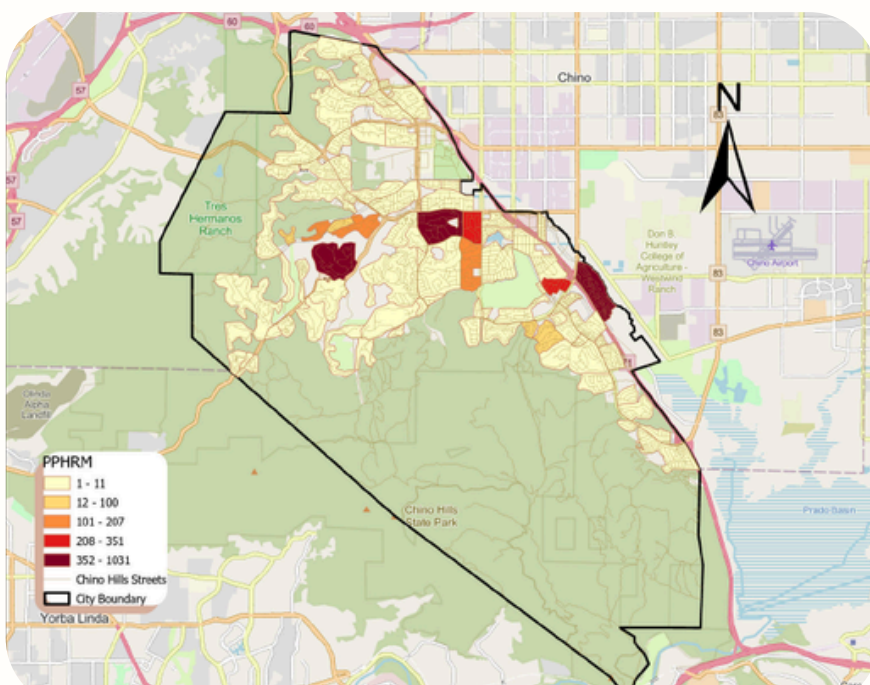
Physical Vulnerability (40%)

Exit Junction Density (16%): The number of paths out of a neighborhood.

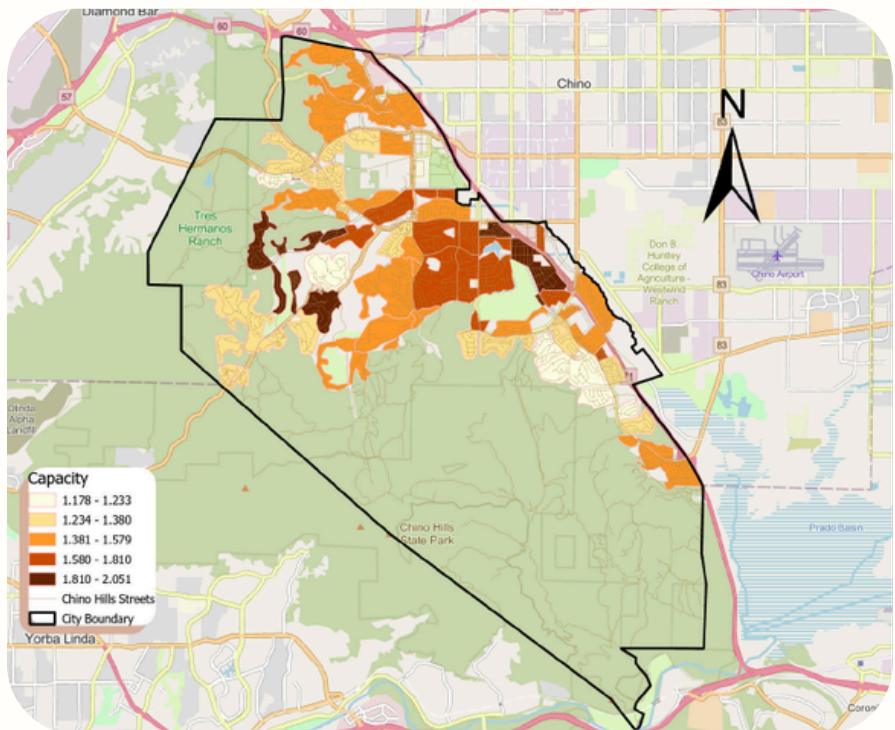
Neighborhood 23



People per Household to Roadway Miles (12%): Household density per available exit lane (The "Bottleneck" factor).

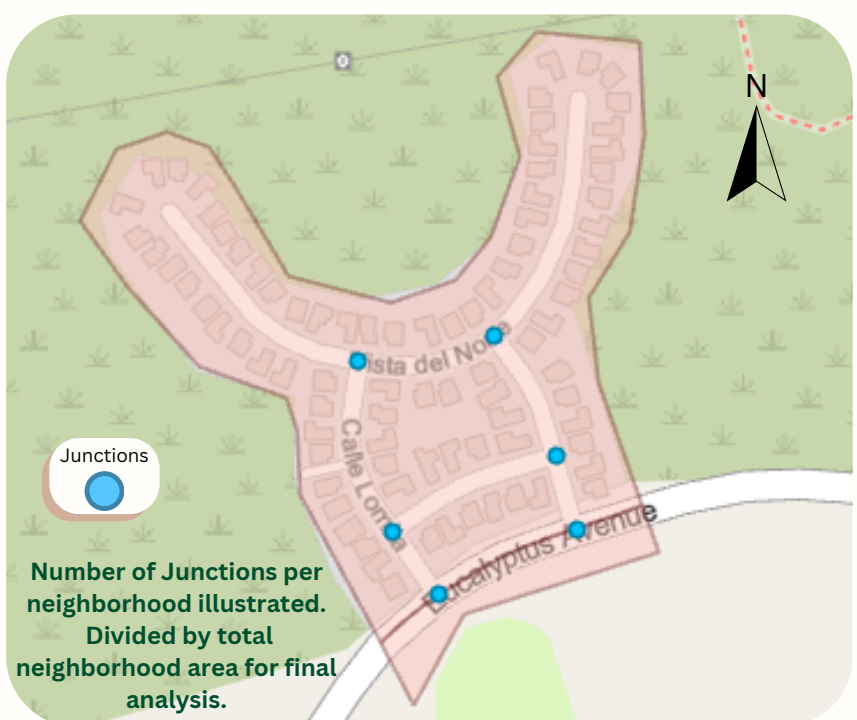


Arterial Capacity (8%): Average minutes per mile to traverse connected major arterials.



Junction Density (4%): Traffic friction caused by stops and turns.

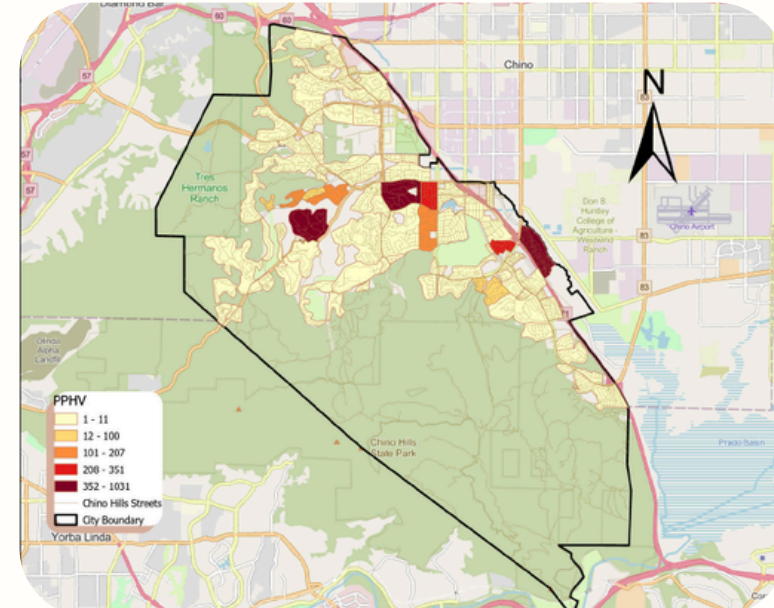
Neighborhood 56



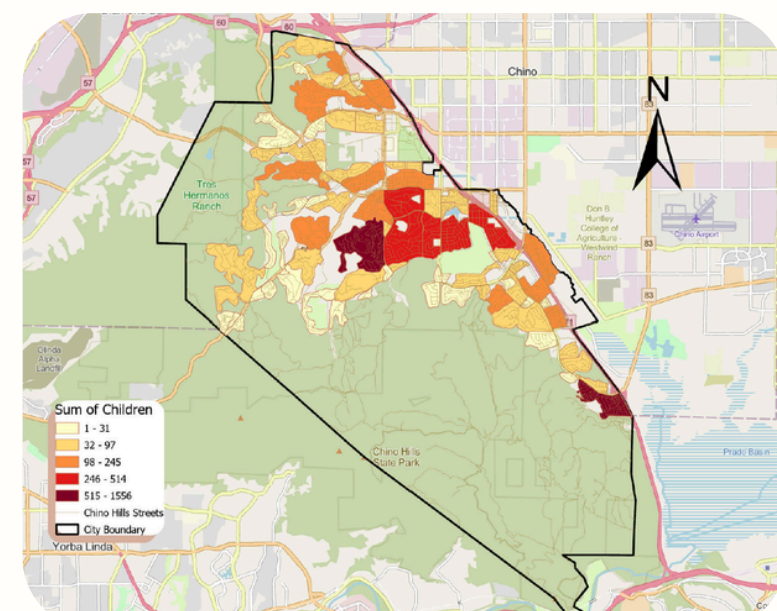
TIGER/Line street networks, SCAG travel demand models, & American Community Survey (ACS) 5-year estimates (2024)

Human Vulnerability (40%)

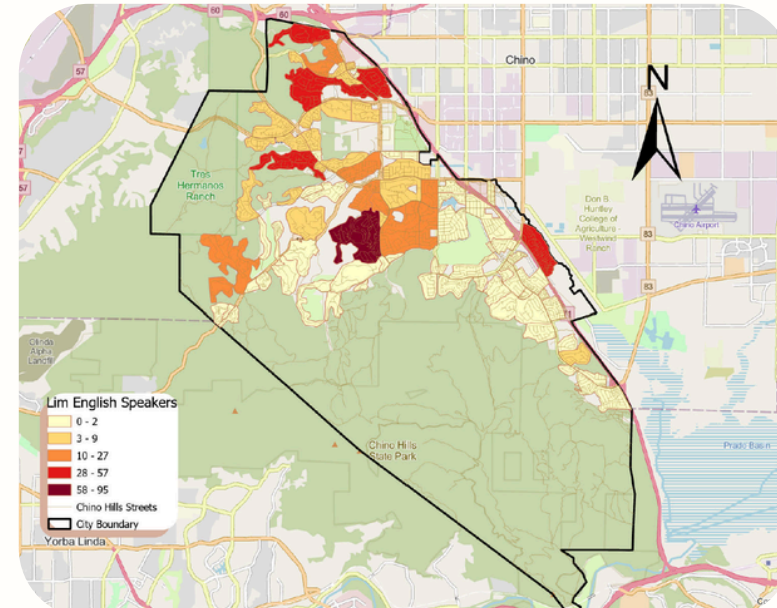
Household Evacuation Strain (15%): Measures the number of people per household to vehicles available. The "Do You Have a Ride?" factor.



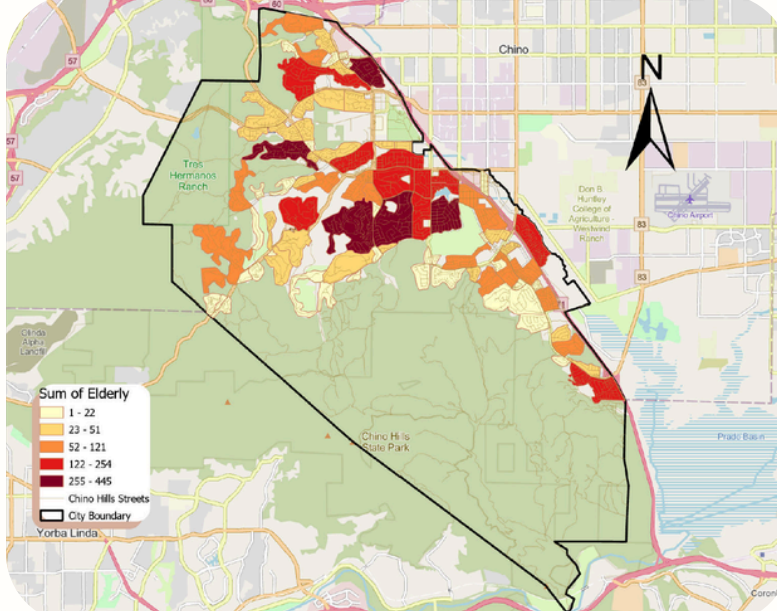
Children Under 15 (10%): Measures the presence of minors who require extra time and logistics to move safely



Limited English-Speaking Households (10%): Identifies residents who may miss or struggle to understand official emergency alerts.



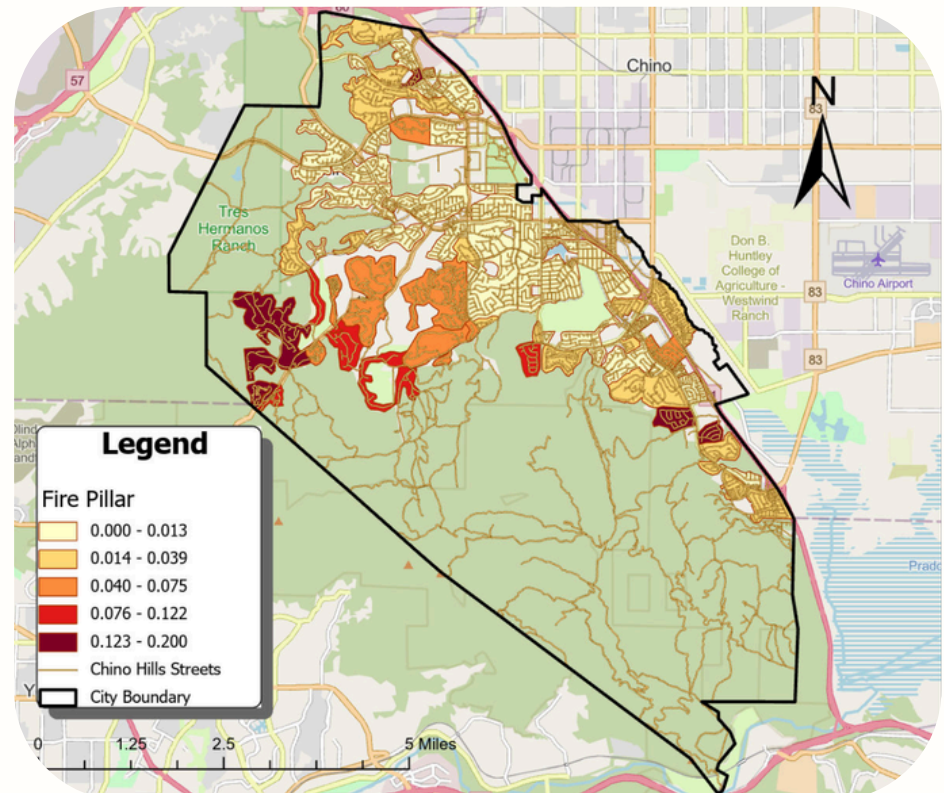
Elderly 65+ (5%): Highlights populations at higher risk for physical impairments or the need for specialized transport.



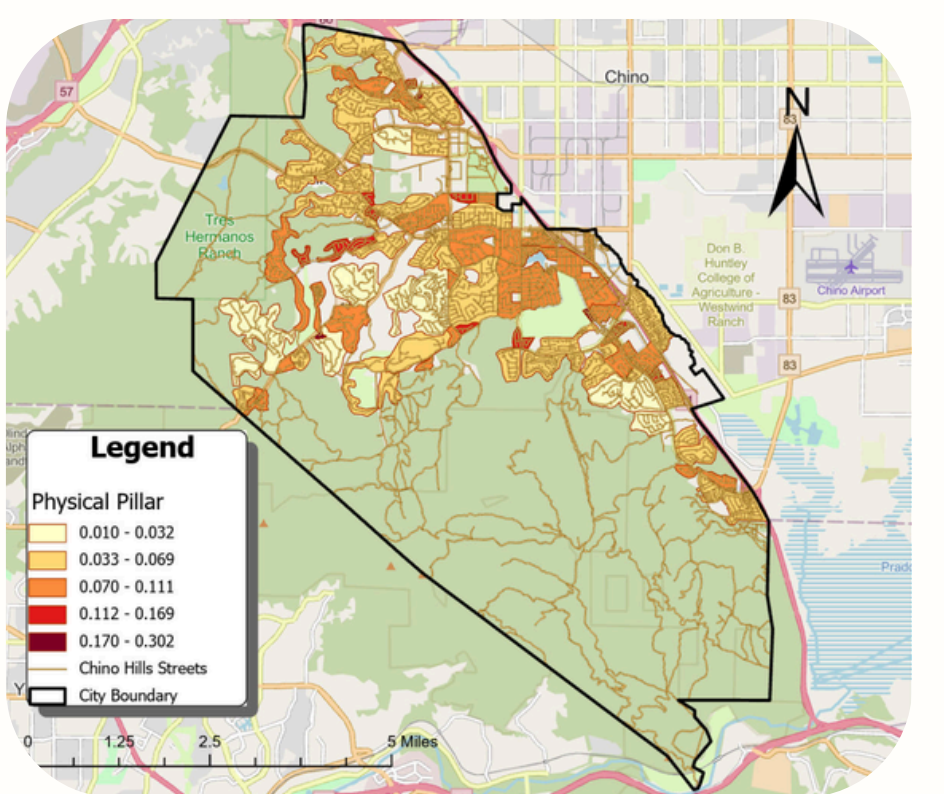
American Community Survey (ACS) 5-year estimates (2024) & (2015)*
*2015 Census data was used for the Limited English Speaker variable, as that was the most recently available data.

Final Scores & Findings

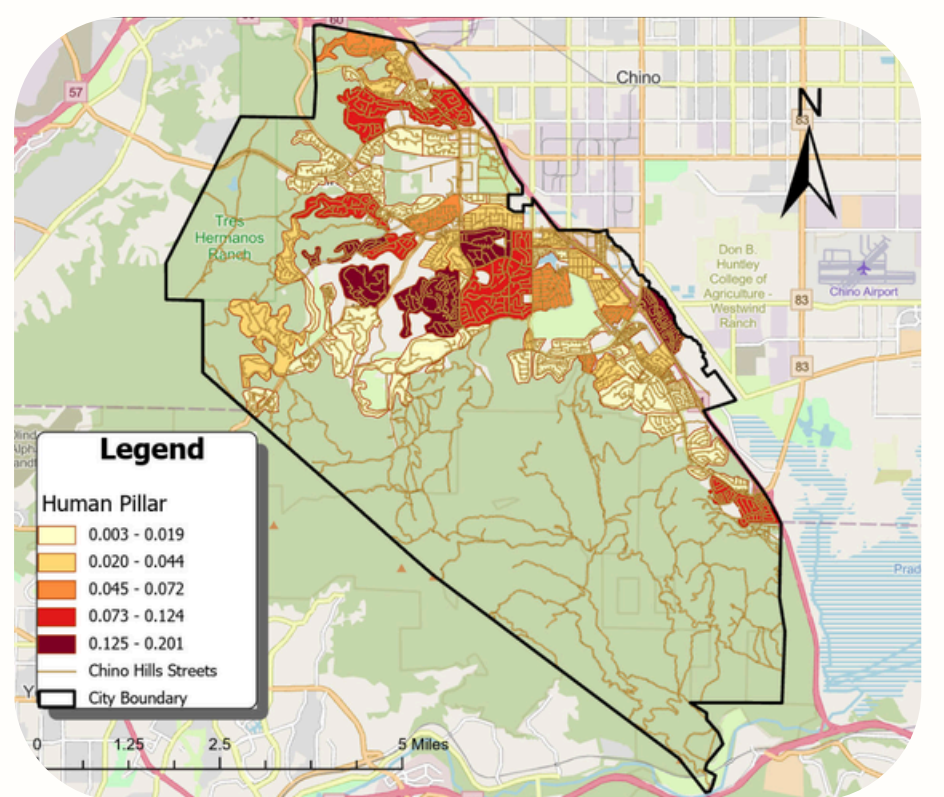
Fire Vulnerability



Physical Vulnerability



Human Vulnerability

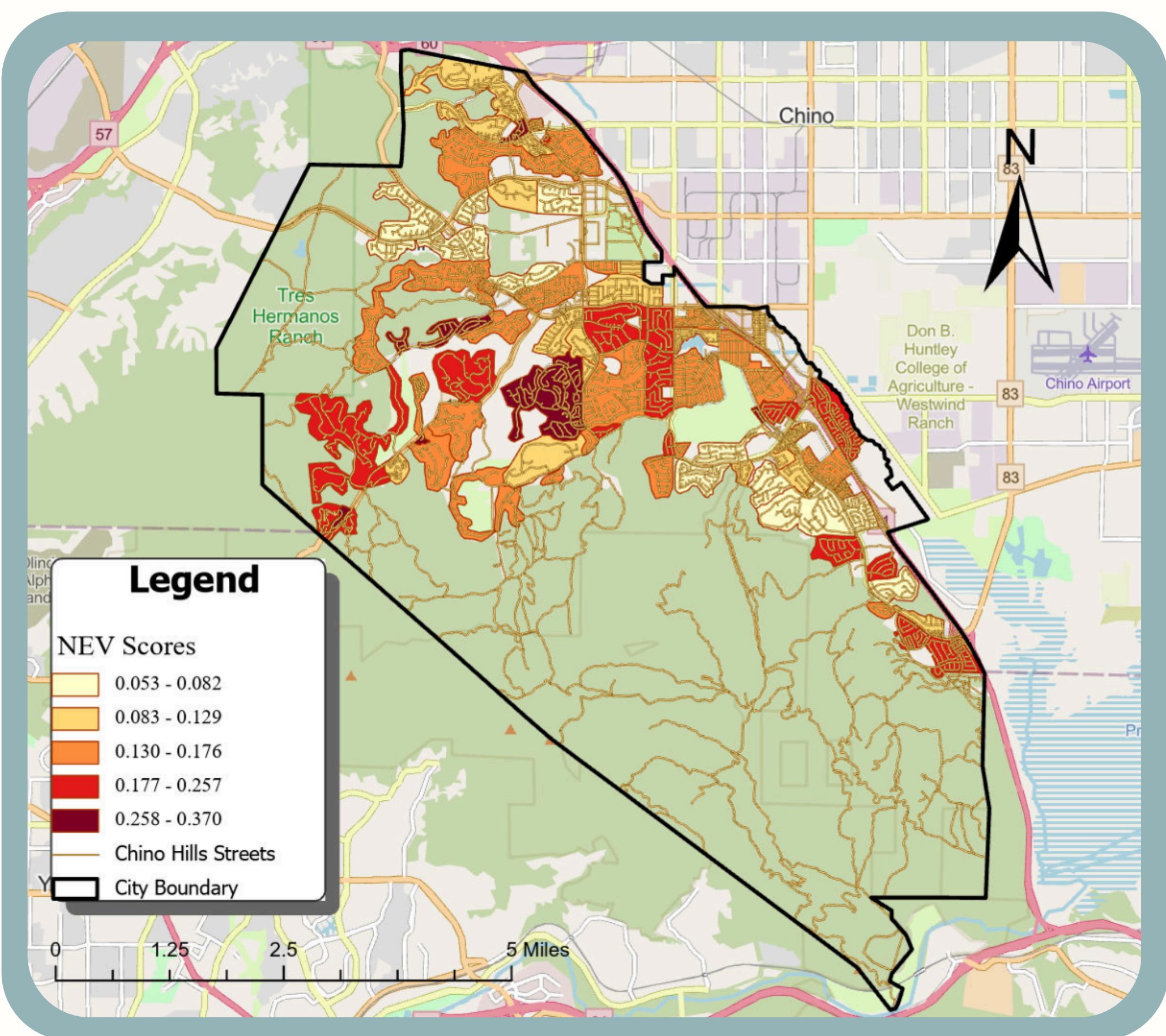


The NEV Score Formula:

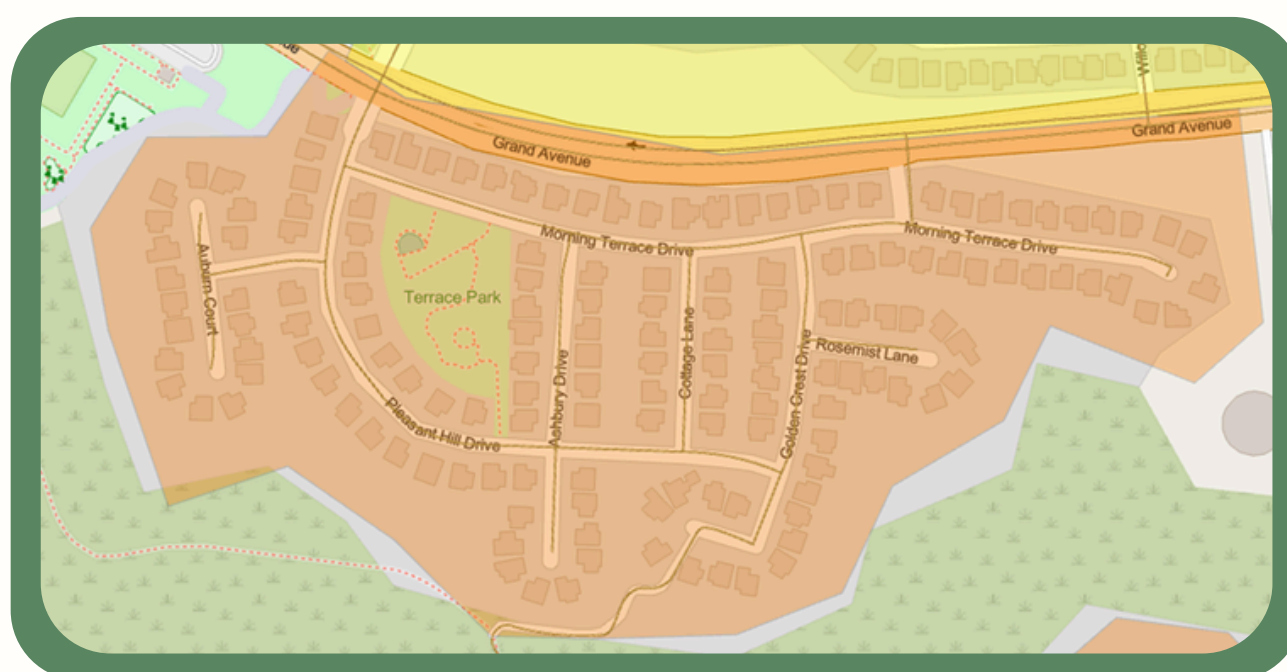
$$NEV\ Score = \sum (W_i \times X_i)$$

Where W is the variable weight and X is the standardized 0-1 value.

Final NEV Score Map

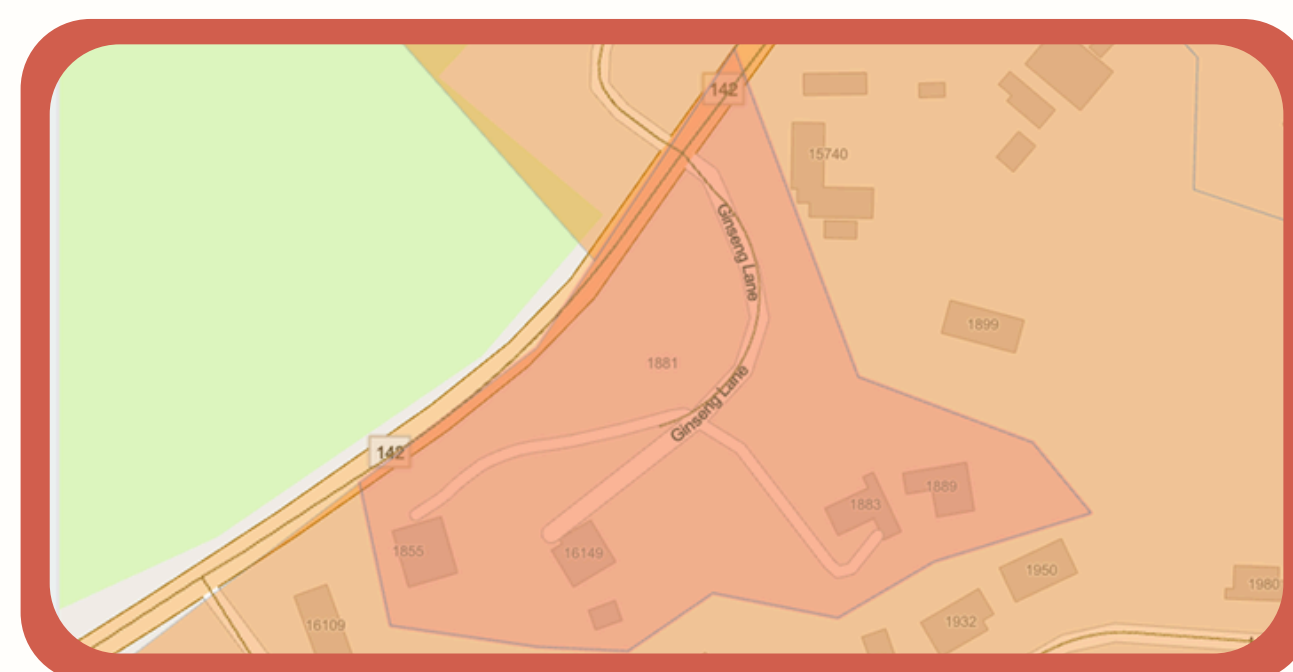


Neighborhood 55 earned the lowest NEV Score, serving as a model for what a resilient evacuation zone looks like.



- Infrastructure:** High junction connectivity and multiple exit points to major arterials
- Human Factor:** Lower socioeconomic barriers and higher vehicle ownership rates
- Hazard:** Geographically situated in a low-risk fire zone

Neighborhood 44 earned the highest NEV Score in the study, identifying it as the top priority for emergency intervention.



- Infrastructure:** Dendritic (tree-like) road network with only one exit, creating a high probability of total gridlock.
- Human Factor:** High scores in Household Evacuation Strain, meaning more residents rely on external aid or public transit rather than personal vehicles.
- Hazard:** Situated in a Very High Fire Hazard Severity Zone.

Recommendations

- Infrastructure & Physical Capacity**
 - Emergency Egress Mandates:** Construct gated "emergency-only" access roads in dendritic (dead-end) neighborhoods, as seen in Neighborhood 44.
 - ITS:** Implement Intelligent Transportation Systems to automate "Green Wave" signals on major arterials during evacuations.
- Equity & Human Vulnerability**
 - Pre-Positioned Transit:** Establish Emergency Assembly Points in high-strain zones; dispatch municipal buses automatically upon evacuation orders.
 - Vulnerability Registry:** Maintain a "Door-to-Knock" registry for the elderly and children for priority assistance.
 - Multilingual Alerts:** Target neighborhoods with limited English proficiency with automated, culturally specific alerts.
 - EMS Staging:** Pre-position ambulances and large-capacity transport vehicles in high-risk clusters during Red Flag Warnings.
- Planning & Future Resilience**
 - NEV Development Standard:** Require new residential projects to maintain or improve the local NEV Score as a condition of approval.
 - Targeted Grants:** Prioritize state/federal resilience grants for the top 10% highest-scoring NEV neighborhoods.