

MARIN

COMMUNITY WILDFIRE PROTECTION PLAN

SEPTEMBER 2026

This document contains blank pages to accommodate two-sided printing.

Acknowledgements

Bryan Penfold, Sonoma Technology

Scott Farley, Willow Labs

Hannah Young, Vibrant Planet

Charlotte Jourdain, Project Coordinator

The 2026 CWPP was coordinated and funded by Marin Wildfire Prevention Authority using Measure C funds. Tiburon Fire Protection District funded the work relevant to their jurisdiction.

The following individuals were invited to represent their organization or community through the creation of the CWPP process, and provide input through meeting and review requests. Participants received regular updates and opportunities to review draft documents, attend regular meetings, and meet with staff and consultants as needed.

Andrew Ludwig
Anne Crealock
Anthony Alcozer
Anthony Sandrini
Belle Cole
Bill Tyler
Boone Vale
Bree Hardcastle
Buffy McQuillen
Carl Sanders
Cyndy Shafer
Daniel Elkington
Daniel Franco
David Briggs
David Taylor
Ernie Rivera
Fred Hilliard
Gary Musante
Gavin Albertoli
Hannah Tarling
Hector Garcia
Jacob Dadmun
James Chayka
Jennifer Gauna
Jim Chayka
Jim Fox
Jon Campo
Jordan Reeser
Joshua Bertain
Kate Anderson
Kristen Dybala
Larry Pasero
Loren Jenkins
Luke Bishop
Luke Fretwell
Lynne Osgood
Madison Mead
Mark Lockaby
Marshall Nau
McKenna Ramiro
Mischon Martin
Naftali Moed
Nick Brubaker
Nicole Marcucci
Noah Macchia
Quinn Gardner
Robert Bastianon
Rosa Schneider
Ruben Martin
Sarah Labberton
Sarah Minnick
Sean Condry
Shaun Horne
Stephen Marcotte
Thomas Edwards
Todd Lando
Tony Walls
Tori Renae Norville

Prepared For







































































Signatures

The Marin County Community Wildfire Protection Plan (CWPP) was developed in accordance with the Healthy Forests Restoration Act. The plan was developed collaboratively among county stakeholders including federal, state, local, and private landowners and local fire departments throughout the county. The plan includes a prioritized list of hazardous fuel reduction strategies and addresses measures that community members can take to reduce structural ignitability. The undersigned have reviewed the Marin County CWPP and accept this document as the final report representing 2026.

_____

Jason Weber, Marin County Fire Chief

_____

Tommy Hellyer, Tiburon Fire Chief

_____

Abraham Roman, City of San Rafael Fire Chief

_____

Jesse Peri, Stinson Beach Fire Chief

_____

Dan Peters, Novato Fire Chief

_____

George Krakauer, Bolinas Fire Chief

_____

Mark Pomi, Kentfield Fire Chief

_____

David Briggs, Inverness Fire Chief

_____

Dan Mahoney Ross Valley Fire Chief

_____

Chris Gove, Muir Beach Fire Chief

_____

Ruben Martin, Central Marin Fire Chief

_____

Todd Lando, President, Fire Safe Marin

_____

Tom Welch, Southern Marin Fire Chief

_____

Mark Brown, Executive Officer, Marin Wildfire Prevention Authority

Adopted By

_____ _____

President / Chairperson, Marin County Board of Supervisors **Date**

_____ _____

Mayor, City of Larkspur **Date**

_____ _____

President / Chairperson, Novato Fire Protection District **Date**

_____ _____

Mayor, Town of Corte Madera **Date**

_____ _____

Mayor, Town of Fairfax **Date**

_____ _____

President / Chairperson, Kenfield Fire Protection District **Date**

_____ _____

President / Chairperson, Inverness Public Utility District **Date**

_____ _____

President / Chairperson, Marinwood Community Services District **Date**

_____ _____

Mayor, City of San Rafael **Date**

_____ _____

Mayor, Town of San Anselmo **Date**

_____ _____

President / Chairperson, Muir Beach Community Services District **Date**

President / Chairperson, Stinson Beach Fire Protection District	**Date**
President / Chairperson, Bolinas Fire Protection District	**Date**
Mayor, City of Mill Valley	**Date**
Mayor, Town of Ross	**Date**
President / Chairperson, Sleepy Hollow Fire Protection District	**Date**
President / Chairperson, Southern Marin Fire Protection District	**Date**

Contents

Acknowledgements i
Prepared For ii
Signatures iii
Adopted By iv
Acronyms vii

Executive Summary 1
Overview 1
Deliverables 2
Cross-Cutting Recommendations 2
Vision for Implementation 4

1. Approach and Framework 7
1.1 Guiding Principles for the 2026 CWPP 9
1.2 Assumptions and Limitations 10
1.3 Previous Marin County CWPPs 11

2. Marin County: Geographic Setting and Wildfire Context 15
2.1.1 Fire History and Ignition Patterns 16
2.1.2 Fire Hazard Severity Zones 17
2.1.3 Wildland Urban Interface 18
2.1.4 Marin Fire Weather and Climate Projections 19
2.1.5 Demographics 22
2.1.6 Marin County Values at Risk 24
2.1.7 Agencies and Organizational Structure 31

3. Existing Investment in Wildfire Prevention and Preparedness 35
3.1 Strategic Framework 35
3.1.1 Wildfire Detection 36
3.1.2 Alerting 36
3.1.3 Vegetation Management 38
3.1.4 Residential Risk Reduction 39
3.1.5 Evacuation Preparation 42
3.1.6 Public Outreach and Education 44

4. Fire Response and Suppression 47

5. Prioritizing Risk-Reduction Activities 49
5.1 Risk Assessment Models and Tools 50
5.2 Evacuation Zones 51
5.3 Prioritization Methodology 52

5.4 Public Outreach and Education 52
5.5 Near-Community Vegetation Management 54
5.6 Vegetation Management in Open Space 56
5.7 Fire Detection 58
5.8 Alerting 59
5.9 Evacuation Planning 61
5.10 Roadside Clearance 62
5.11 Residential Risk Reduction 64

6. Stakeholder Engagement and Insights 67
6.1 Stakeholder Engagement Summary 67
6.2 Public Engagement 68
6.2.1 Fire Safe Marin's Public Education and Outreach Role 68
6.2.2 May 2 Public Forum 69
6.2.3 Story Map, Local Data, and Resident Input 70
6.2.4 Continuing Engagement and Implementation 70

Appendix A. Marin County Fire Weather Assessment 73
Appendix B. Marin County Fire Weather and Climate Change Assessment 101
Appendix C. Marin County Social Vulnerability Assessment 119
Appendix D. Alerting and Warning Systems 139
Appendix E. Marin County Vegetation Management Assessment 143
Appendix F. Marin County Fire Structure Vulnerability Assessment 161
Appendix G. Marin County Assessment of Local Preparedness 189
Appendix H. Marin County Fire Evacuation Risk Assessment 193
Appendix I. Marin County Fire Response Assessment 207
Appendix J. Infrastructure Exposure Assessment 237
Appendix K. Wildfire Hazard Assessment 241
Appendix L. Detailed Prioritization Logic 263
Appendix M. Wildfire Risk Assessments and Modeling Tools 269
Appendix N. Fuel Model Details 275
Appendix O. Homework Questions, Comments, and Responses 279
Appendix P. Data Sources 285

Tables

Table 1. CWPP stakeholders. 67

Acronyms

Acronym	Definition
ACS	U.S. Census Bureau American Community Survey
AOI	Area of Interest
ATC	Marin Wildfire Advisory/Technical Committee
BP	Burn Probability
CAD	Computer-Automated Dispatch
CAL FIRE	California Department of Forestry and Fire Protection
CalEPA	California Environmental Protection Agency
CalOES	California Governor's Office of Emergency Services
CalPAWS	California Public Alert and Warning System
CAP	Common Alerting Protocol
CBO	Community-Based Organization
CCI-PP	California Climate Investments – Priority Populations
CDC	Centers for Disease Control and Prevention
cELI	Conditional Ember Load Index
cEPI	Conditional Ember Production Index
CEQA	California Environmental Quality Act
CFBI	Composite Fire Behavior Index
CFL	Characteristic Flame Length
cRPS	Conditional Risk to Potential Structures
CSA	County Service Area (e.g., County Fire CSA 13)
CSD	Community Services District
CWPP	Community Wildfire Protection Plan
DP	Damage Potential

Acronym	Definition
DSA	Marin Wildfire Defensible Space Alliance
DSI	Marin Wildfire Defensible Space Home Evaluation (Inspection) program
EAS	Emergency Alert System
EMS	Emergency Medical Services
ERA5	ECMWF Reanalysis v5 (ERA5-Land reanalysis weather dataset)
ESP	Ecologically Sound Practices Partnership
ESRI	Environmental Systems Research Institute (GIS software/imagery provider)
EZ	Evacuation Zone
FEMA	Federal Emergency Management Agency
FHSZ	Fire Hazard Severity Zone
FOD	Fire Occurrence Database
FSim	Large-fire simulator (by the USFS Missoula Fire Sciences Lab)
FTYPE	Feature Type (NHD attribute field)
GGNRA	Golden Gate National Recreation Area
GHG	Greenhouse Gas
GIS	Geographic Information System
IBHS	Insurance Institute for Business & Home Safety
IPAWS	FEMA Integrated Public Alert and Warning System
JPA	Joint Powers Authority
LANDFIRE	Landscape Fire and Resource Management Planning Tools (federal program)
LOCA	Localized Constructed Analogues (climate downscaling method)
LRA	Local Responsibility Area
LRAD	Long Range Acoustic Device
MCFD	Marin County Fire Department
MCI	Mass Casualty Incident

Acronym	Definition
MEFD	Mean Maximum Ember Flight Distance
NFPA	National Fire Protection Association
NGDA	National Geospatial Data Asset (FEMA program)
NHD	USGS National Hydrography Dataset
NHS	National Historic Site
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OEM	Marin County Office of Emergency Management
OSFM	California Office of the State Fire Marshal
PG&E	Pacific Gas and Electric Company
POD	Potential Operational Delineation
PSPS	Public-Safety Power Shutoff
PUD	Public Utility District (e.g., Inverness PUD)
RAWS	Remote Automatic Weather Station
RCP	Representative Concentration Pathway (e.g., RCP8.5 emissions scenario)
ROS	Rate of Spread
RPS	Risk Perception Survey (Marin Wildfire Risk Perceptions Survey)
RS	Ratio of fire responses to structures
SES	Structure Exposure Score
SIAM	Structure Ignition Assessment Model
SMFD	Southern Marin Fire District
SMS	Short Message Service (text messaging)
SOD	Sudden Oak Death
SPLAT	Strategically Placed Local Area Treatment
SRA	State Responsibility Area

Acronym	Definition
SSD	Structure Separation Distance
SVI	CDC Social Vulnerability Index
TFRA	Temporary Fire Refuge Area
UCCE	University of California Cooperative Extension
UNESCO	United Nations Educational, Scientific and Cultural Organization
USFS	United States Forest Service
USGS	United States Geological Survey
VPD	Vapor Pressure Deficit
WEA	Wireless Emergency Alert
WES	Wildfire Exposure Score
WildEST	Wildfire Exposure Simulation Tool
WUI	Wildland-Urban Interface

Executive Summary

Overview

The 2026 Marin County Community Wildfire Protection Plan (CWPP) establishes a unified, countywide framework for reducing wildfire risk to communities. The purpose of the CWPP is to identify where wildfire risk is highest, where communities are most vulnerable, and where investments in mitigation can deliver the greatest reduction in potential wildfire impacts.

This CWPP provides a unified action plan for wildfire risk reduction for the many stakeholders in Marin, including land managers, fire agencies, utilities, emergency managers, and resident groups. It was developed through a collaborative, multi-agency planning process that brought together fire agencies, land managers, Marin County departments, cities and towns, and other stakeholders. The process included an inventory of existing conditions and an assessment of current programs. In addition, the CWPP integrated a wide variety of science-based risk analyses to provide a robust, quantitative view of risk. This comprehensive approach ensures that the Plan accounts for existing investments in wildfire risk reduction and provides a forward-looking set of recommendations that reflect both local expertise and the best available wildfire science. This comprehensive CWPP provides a common, justifiable narrative to help residents, community groups, and agencies align to promote a safer, more fire adapted Marin County.

The CWPP is a dynamic and actionable planning framework that supports coordinated decision-making processes across County agencies. By combining multiple lines of evidence, including potential wildfire behavior, the likelihood of ignitions in given locations, community exposure, evacuation difficulty, structure vulnerability, and fire response capacity, the prioritization framework provides data-driven, geographically specific recommendations for implementing the policies, projects, and programs with the greatest opportunity to reduce wildfire risk. This CWPP uses a consensus-based approach to support transparent, defensible, and explainable prioritization rationale. The framework is designed to be updated and dynamic over time as projects are implemented, conditions change, and new information becomes available.



This plan recognizes that the areas of Marin County that are at highest risk of wildfires and its areas of highest social vulnerability do not always overlap. The County considers both areas when approaching risk reduction strategies: prioritization decisions are driven by fire-behavior science, while grant and outreach program design draw on **Appendix C. Marin County Social Vulnerability Assessment** to ensure that risk-reduction investments reach the county's most vulnerable residents. A Spanish-language version of this summary will be published alongside the English original at the time of final Plan approval.

Deliverables

Key deliverables from the CWPP include:

- A countywide summary of wildfire risk and a prioritized set of geographically specific opportunities for risk reduction, based on conditions as of 2025.
- A dynamic, updatable prioritization framework that can be used in future years to refresh recommendations as conditions change and mitigation projects are implemented.
- A public-facing storymap that explains the CWPP process, findings, and recommendations in a clear and accessible way and helps residents understand how the Plan supports community safety.
- A set of supporting datasets, maps, and technical resources that enable agencies to integrate wildfire risk and fire behavior information directly into project planning, grant applications, and program implementation.

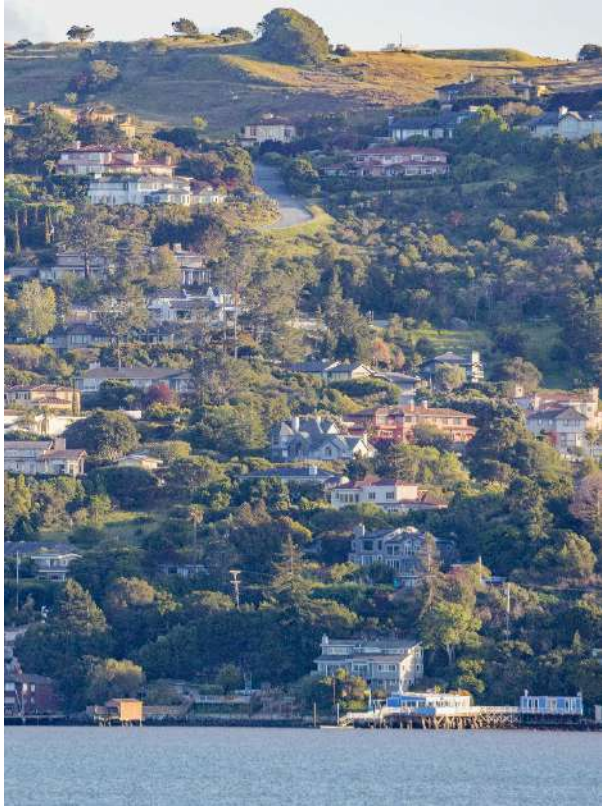
Cross-Cutting Recommendations

This CWPP identifies several overarching strategic principles for fire planning and investment in Marin County:

Fire Adaptation, not Fire Exclusion: Fire is a natural and necessary ecological and cultural process in Marin County's ecosystems. Wildfire preparedness programming should be based on the expectation that wildfires will continue to occur in these fire-adapted landscapes. The objective of County and local programs should be to reduce the impacts of wildfires on life, property, and critical community assets, rather than to attempt to prevent wildfires altogether.

Prepare for a Changing Climate: Climate change is lengthening and intensifying fire seasons in Marin County. Planning should anticipate longer fire seasons, more severe autumn fire weather events, increased fire activity outside of the traditional dry season, and more severe multi-year droughts. More frequent wintertime atmospheric rivers are anticipated to produce robust annual grass crops, elevating the risk of rapid fire spread in subsequent dry seasons. "Routine" fire weather conditions are expected to increase in frequency and severity, placing additional strain on fire

resources in the County. Fire prevention efforts should be designed for more frequent and more severe wildfire activity. Fire response agencies should plan for year-round fire seasons with increased fire danger throughout the year. The risk reduction activities in this plan are prioritized with the implicit understanding that climate change will drive longer, more intense fire seasons and fire suppression staff will be taxed due to increased fire frequency and severity.



Prioritize Community Safety: Prioritize programs that reduce risks to life and property. Mitigation efforts should focus on addressing the vulnerabilities that allow fire to become established and spread within communities and on ensuring safe evacuation and reliable warning systems. After these critical vulnerabilities are addressed, additional investments can target other values at risk to provide broader community and environmental benefits.

Continuous, Coordinated, and Systematic Wildfire Risk Reduction: Alignment and coordination across agencies, jurisdictions, and programs are essential to achieving meaningful risk reduction. Focus on targeted, cross-cutting initiatives rather than isolated or distributed projects. Coordinated action across jurisdictions and tactics can produce compounding benefits that exceed the impact of many independent initiatives. Integrated, place-based efforts, such as pairing targeted vegetation management with intensive on-parcel risk reduction within a single neighborhood, can deliver more effective and durable risk reduction outcomes than programming without geographic and thematic alignment. Further, consider integrating wildfire risk into plans for new development in the County and ensure that land use planning works systematically with fire prevention planning. Progress should be evaluated using standardized, data-driven performance metrics wherever possible.

Plan Explicitly for Rare, Catastrophic Events: The greatest wildfire losses occur during rare, extreme wind-driven fires exacerbated by severe drought conditions. Preparedness, mitigation, and evacuation planning should explicitly account for these high-consequence scenarios in addition to average or most-likely scenarios. Risk reduction activities designed to meet the most severe wildfire scenarios are also likely to be effective during average scenarios; however, the opposite is not always true.

Local Operational Playbooks: Fire agencies and evacuation managers should create operational pre-plans for evacuation and firefighting response under a variety of likely fire scenarios. Emergency managers should communicate evacuation routes in advance and work with communities to ensure

evacuation plans are in place and understood. Agencies should consider expanded efforts to identify potential congestion points and evaluate the role of temporary fire refuge areas (TFRAs) where appropriate. Planning should include residents, community groups, fire agencies, and facilities or populations with special needs.

Demographic-Specific Planning: Wildfire preparedness and risk reduction programs should be designed to meet the needs of Marin County's communities. Data sources, such as the Marin Wildfire Risk Perceptions Survey and **Appendix C. Marin County Social Vulnerability Assessment**, identify population-specific needs and barriers, including those of renters, older adults, non-English speakers, and other socially vulnerable populations who may face structural barriers to residential wildfire risk mitigation. Outreach, education, and assistance programs should be tailored to reach these resident groups, and partner directly with community-based organizations already trusted by these groups. Marin Wildfire and partner agencies will expand needs-based grants programs and prioritize outreach and evacuation guidance for populations with the greatest documented need.

Emphasize Resident Action: Residents play a critical role in reducing wildfire risk at both the parcel and community scale. Programs should continue to emphasize the importance of low-cost, high-impact actions for homes, including vent and gutter screens, an ember-resistant 5-foot zone around the home (Zone Zero), and replacing combustible fences. Education, incentives, and enforcement should be coordinated between community organizations and fire agencies to increase adoption of fire-safe landscaping and home hardening practices. Consider focusing incentive programs to areas where fire may transition into the built environment and where public dollars can be most effective in reducing community risk.

Partner for Landscape Resilience: More than 50% of the land in Marin County is protected open space, which includes a mosaic of county, state, and federal parklands and preserves. These lands are recognized globally as a biodiversity hot spot and are included in the Golden Gate Biosphere Reserve designated by UNESCO) in 1988. As identified in the Marin Regional Forest Health Strategy (*Forest Health Strategy*), a Regional Priority Plan developed with funding from the Department of Conservation's Regional Forest and Fire Capacity Program, the more than 118,000 acres of forest and woodland in Marin County are irreplaceable natural resources. The *Forest Health Strategy* details how Marin County's land managers and fire agencies are working together to advance actions that will promote forest health and ecosystem resilience at landscape scale in the face of climate change and other stressors. This CWPP will support continued collaboration to ensure fire prevention and landscape resilience efforts are complimentary and coordinated wherever they intersect.

Vision for Implementation

The CWPP is designed to be used as a reference for prioritizing wildfire resilience investments, designing projects, and coordinating programs across agencies. It is intended to inform budgeting, grant applications, capital planning, and annual work programs.

In addition, the CWPP can steer policy discussions, drive changes to local and state building codes and ordinances, and promote insurability in Marin County.

The CWPP framework and underlying datasets will be updated annually; completed projects will be reflected in the data, priorities will be recalculated, and programs will adapt based on measured outcomes.

The CWPP is not designed to supplant local expertise. Local fire agencies bring place-based knowledge that helps to contextualize and operationalize the recommendations in the CWPP into programs and tactics appropriate at the neighborhood scale. Instead, the CWPP is designed to outline a set of strategic guiding principles and foster inter-agency communication among fire and land management agencies in Marin County.

Marin Wildfire Prevention Authority member agencies can submit proposals for MWPA funding as part of the annual work plan development process. For fire prevention activities in the Tiburon / Belvedere peninsula, please contact the Tiburon Fire District.



1. Approach and Framework

The 2026 Marin County Community Wildfire Protection Plan (CWPP) provides a science-based assessment of wildfire hazard and wildfire risk in Marin County, California. This CWPP's purpose is to guide fire agencies, land managers, and community stakeholders in identifying and implementing coordinated, effective, and durable programs to reduce wildfire risk, protect life and property, and enhance long-term community resilience.

This is the fourth edition of the Marin County CWPP. Building upon previous plans published in 2005, 2016, and 2020, the updated CWPP provides new recommendations based on the latest available wildfire science, improved spatial risk assessments, and new analytical approaches to reflect the evolving wildfire environment in Marin County. The updated CWPP is dynamic and forward-looking and emphasizes programs with measurable risk reduction outcomes for communities.

Fire speed, size, and severity are increasing across the globe. As extreme fire behavior and wildfire disasters become increasingly common, Marin County must continue to recognize, mitigate, and adapt to potential wildfire threats to communities. Because budgets are limited, it is equally important that agencies effectively prioritize their limited resources to support the programs with the highest potential for risk reduction in the areas where the threat is greatest.

This plan focuses on identifying and prioritizing risk reduction opportunities with the highest potential for improving community safety and reducing the risk to critical infrastructure. In particular, the assessments focus on:

- **Structures:** Marin is home to about 255,000 people living in more than 112,300 households. This plan provides targeted recommendations for structural hardening and defensible space to reduce the likelihood of home ignition, as well as areas where vegetation management could slow fire spread, reduce fire intensity, and increase the probability of successful firefighter engagement before structures are impacted.
- **Roads and Evacuation Routes:** The safety of lives is critically important during a wildfire. The CWPP evaluates evacuation routes and identifies (1) opportunities for roadside clearance to increase fire resilience; (2) improvements to alerting systems to help residents know when, where, and how to safely evacuate; and (3) integrated vegetation management in the open space to lower the chances of fast-moving fires reaching evacuation routes while residents are evacuating.
- **Utilities and Infrastructure:** Water, electricity, and communication systems are critical assets needed for a community to thrive. The CWPP addresses risks to these assets and provides recommendations for vegetation management around these assets to ensure that residents have access to safe drinking water, emergency communications and alerts systems, and continuous electricity.

- **Watersheds:** The majority of Marin's clean drinking water is supplied by watersheds within the county. The CWPP identifies opportunities for preserving access to clean water through vegetation management in order to prevent abnormally high fire severity during a wildfire, reduce tree mortality, and limit the likelihood of post-fire mudslides. The plan leverages the Marin Regional Forest Health Strategy to integrate ongoing science-based, ecological resilience planning and implementation efforts operating at landscape scale.
- **Schools, Hospitals, and Emergency Facilities:** Critical community assets like schools and hospitals are important to the long-term health of the community and may require additional time or resources to safely evacuate. The CWPP identifies the location of these assets in the context of fire spread patterns and highlights opportunities for evacuation planning and other forms of risk reduction efforts to these important locations.
- **Demographics:** Marin is home to people from many backgrounds. The CWPP addresses risks to traditionally underserved populations by integrating census data and local survey data and provides recommendations designed to meet the needs of Marin's residents.

This CWPP focuses on actions that directly reduce risk to people, homes, and critical infrastructure. Activities such as hardening homes, reducing fuels near communities, and improving detection and alerting systems lower the likelihood of impacts to lives and property during wildfires and escaped prescribed fire operations. As these risks decrease, fire agencies gain greater flexibility to implement large-scale prescribed burning with fewer constraints and stronger public support. The CWPP prioritizes immediate, community-level risk reduction with the goal of unlocking effective, long-term, landscape-scape wildfire management in the future.



In accordance with the U.S. Healthy Forest Act of 2003, the CWPP provides specific, prioritized recommendations for vegetation management and structural hardening. Numerous stakeholders were involved in the preparation of the CWPP, and outreach and engagement with land managers, fire officials, and the public were key elements of the plan's development.

Unlike previous CWPPs, which comprised a standalone planning effort every five to ten years, this CWPP introduces a dynamic prioritization framework. The data, models, and resulting recommendations are updated annually as risk in the county changes. As risk reduction activities are completed (such as shaded fuel breaks and home hardening), the component risk assessments can be updated and the prioritization process re-run so that new prioritized lists of activities are generated. The goal of the dynamic system is to promote annual, ongoing, coordinated fire risk reduction activities across the county and to provide stakeholders with timely, science-driven information to guide decision-making processes over the next five to ten years.

To guide subsequent project-specific analyses and additional planning efforts, a variety of Geographic Information System (GIS) data layers are included as a key output of this CWPP, such as:

- Fire behavior characteristics (including flame length, rate of spread, and ember distribution)
- Fire pathways and community entry points
- Fuel model and vegetation structure data
- Fire resilient roads
- Fire response time analysis
- Structure separation distances

1.1 Guiding Principles for the 2026 CWPP

The 2026 edition of the Marin County CWPP is designed to deliver actionable, scientifically grounded guidance for fire agencies, land managers, and community partners. The CWPP is guided by the following principles:

- **Actionable:** Analyses and recommendations are spatially explicit and tied to specific actions with measurable outcomes.
- **Data-Driven and Stakeholder Informed:** Recommendations are grounded in the best available science, modeling, and data and are refined through engagement with local fire agencies, land managers, and community stakeholders to integrate local expertise and ensure feasibility.
- **Prioritized:** The plan identifies opportunities for risk reduction and ranks recommendations based on wildfire risk, supporting informed decision-making processes and helping agencies allocate limited budgets to programs that have the greatest impact.
- **Comprehensive:** The CWPP evaluates wildfire impacts across several themes, including vegetation management, residential risk reduction, evacuation, alerting, detection, and protection of critical infrastructure, creating a broader scope than previous CWPPs.
- **Dynamic:** The framework is designed to evolve over time, reflecting completed mitigation projects, new programs and policies, updated science, and future changes in land use and development patterns.

- **Supportive:** The CWPP is both informed by, and can inform, local subject matter experts in their decision making.

1.2 Assumptions and Limitations

The CWPP is a strategic planning document, aimed to help guide high-level programming and policy discussions for community risk reduction at an annual timescale. This approach provides a useful alignment of Marin County stakeholders and creates a shared risk reduction framework; however, it comes with several important assumptions and limitations:

- The CWPP and associated modeling efforts complement local knowledge and expertise. The CWPP is designed to provide a science-based, data-driven tool for staff to incorporate into program development; however, each agency brings local, on-the-ground expertise that will help further refine project design and implementation. The combination of data-driven analysis and ground-truth expertise is a strong combination for building successful, effective programs.[1]
- Because one potential use of the CWPP system is to seek funding for risk reduction activities, local practitioners are encouraged to use the many data layers and quantitative modules of the CWPP to construct grant applications and project proposals for programs that align with local expertise. While the relative prioritization rankings and zone-specific summaries are key outputs to this work, areas not mentioned in these summaries may still be high-priority candidates for risk reduction. Program staff can use the many fire modeling and risk assessment tools to identify characteristics that highlight the unique risks to those areas. When paired with on-the-ground expertise and locally focused narrative, the data provided by the CWPP can help quantify and guide program design while bolstering local funding applications.
- The CWPP is based on modeling of wildfire behavior and characteristics. While these models are widely used throughout Marin County and the western United States, they come with inherent assumptions. Although these models are useful and help provide robust, quantitative risk assessments, their results should always be interpreted in conjunction with local expertise.
- The CWPP is designed to evaluate and prioritize risk reduction activities in and around the wildland urban interface. While Marin's open spaces can support wildfire growth, this plan focuses specifically on the areas where wildland fire can come into contact with homes and community infrastructure. In collaboration with fire prevention agencies, land managers in Marin continue to plan and implement projects to reduce fuel accumulation, increase wildfire resilience, and promote forest health on open space and watershed lands. This CWPP acknowledges those contributions and builds on them to produce recommendations for

[1] National Academies of Sciences, Engineering, and Medicine. (2017). *Using Science as Evidence in Public Policy*.

community risk reduction. The Marin Regional Forest Health Strategy,[2] a Regional Priority Plan developed with funding from the California Department of Conservation's Regional Forest and Fire Capacity Program, provides a comprehensive framework to promote forest health and wildfire resilience at landscape scale in Marin County. Since releasing the *Forest Health Strategy* in 2023, One Tam partners Marin County Parks, California State Parks, Marin Municipal Water District, the National Park Service (NPS), and the Golden Gate National Parks Conservancy, together with the Federated Indians of Graton Rancheria and other regional partners, have leveraged grant and agency funding to increase the pace and scale of this critical work.

- The datasets that the CWPP relies upon can be incomplete, and additional datasets that would help further refine CWPP recommendations may be unavailable. For example, the CWPP lacks information about road widths throughout the county, limiting the ability to evaluate constrained evacuation flow due to narrow, congested roads. Project staff and program managers should become familiar with the strengths and the limitations of the available datasets and evaluate whether additional data should be collected prior to program implementation. As a dynamic tool, this CWPP will be updated regularly and can incorporate new datasets as they become available. Through this CWPP process, datasets requested by stakeholders but were unavailable or incomplete included:
  - Road widths
  - Evacuation travel paths and traffic modeling
  - Fire response timing from computer-automated dispatch (CAD) systems in the county
  - Fire ignition locations from county CAD systems
  - Drinking water infrastructure and assets
  - Urban conflagration analysis
  - Cell phone and data network coverage

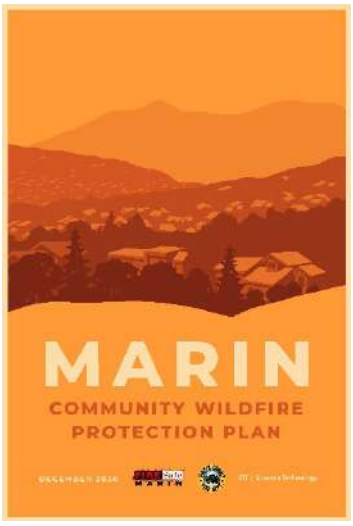
1.3 Previous Marin County CWPPs

Previous Community Wildfire Protection Plans for Marin County were completed in 2005, 2008, 2016, and 2020.[3] As the fourth update to the CWPP, this plan builds on the strategic objectives established in earlier editions. It refreshes and improves the assessment of wildfire risk across the county by integrating new tools for assessing wildfire likelihood, severity, and consequences and integrates local knowledge from land managers and fire officials from a wide stakeholder coalition. Further, it

[2] Golden Gate National Parks Conservancy. (2023). Marin Regional Forest Health Strategy. Tamalpais Lands Collaborative (One Tam). https://www.onetam.org/our-work/forest-health-resiliency

[3] In addition, as a contract county, Marin County Fire and CAL FIRE jointly prepare and periodically update the Marin County Unit Strategic Fire Plan. The Unit Plans draw heavily on the Marin County CWPP.





strengthens recommendations to reduce losses of life, property, and critical community assets due to wildfires and provides geographically specific guidance to support effective mitigation planning.

Since the last CWPP was completed in 2020, the wildfire environment has changed in several significant ways: fire behavior has intensified, large and fast-moving fires have become more common, and impacts in the wildland-urban interface (WUI) have increased in the form of urban conflagration fires. These changes reflect the need for a forward-looking mitigation strategy that prioritizes specific activities and adapts to new threats.

Nationally, developments since 2020 include:

- Substantial increase in WUI disaster fires nationally, including the 2021 Marshall Fire (Colorado), the 2023 Lahaina Fire (Hawaii), and the 2025 Palisades and Eaton Fires (California). Each of these fires destroyed thousands of homes and critical community assets, making them some of the most destructive fires in history.
- Increasing effects of climate change, including an increase in high severity days with abnormally high vapor-pressure deficits. Dry conditions lead to increases in dry, flammable fuels and seasonal droughts in many parts of the country.[4]
- Continued increases in fire size and the frequency of "megafires," with exceptionally large fires becoming more frequent. Nationally, the August Complex (2020), the Dixie Fire (2021), and the Smokehouse Creek Fire (2023) each burned over a million acres.
- Large-scale investments have been made in wildfire preparedness and fuel reduction. Nationally, the Bipartisan Infrastructure Law (2021) and Federal Emergency Management Agency (FEMA) programs created new funding streams for wildfire resilience projects. In addition, California state programs, including those through CAL FIRE and the California Office of Emergency Services (CalOES) have provided funds for local agencies to implement risk reduction activities. Many of these programs are funded through California Proposition 4 (2024), which provides nearly $1.5 Billion for wildfire resilience programs, statewide.
- Increasing availability of technical and data-driven solutions for fire planning and mitigation, including advanced detection, monitoring, and prediction capabilities. Remote sensing has improved, leading to more accurate methods for mapping fuel types and loads. Modeling

[4] Hermann, M., Wernli, H., & Röthlisberger, M. (2024). Drastic increase in the magnitude of very rare summer-mean vapor pressure deficit extremes. Nature Communications, 15, Article 7022. https://doi.org/10.1038/s41467-024-51305-w

software has matured and improved, providing more robust assessments of fire risk, possible consequences, and expected return on investment for different risk reduction strategies.

- More nuanced understanding of the drivers of WUI disaster fires. While recent fires have resulted in tragic consequences, scientists have leveraged post-fire surveys and close observation to gain a better understanding of structure-to-structure fire spread dynamics, evacuation bottlenecks, and the effectiveness of different mitigation strategies.

Within Marin County, significant organizational, operational, and analytical advances since 2020 have expanded the county's capacity for pre-fire risk reduction. Key developments include:

- Formation of the Marin Wildfire Prevention Authority, a 17-member agency Joint Powers Authority focused on coordinating wildfire resilience programs in the county. Marin Wildfire is funded by Measure C, a 10-year parcel tax approved by voters, providing approximately $25 million per year in fire prevention funding for Marin County.



- Implementation of approximately 2,200 acres of Measure-C funded vegetation management, and thousands of acres of fuels reduction and forest health projects undertaken by land management and local fire jurisdictions.



- Near-comprehensive defensible space home evaluations in the wildland urban interface, providing detailed data on the vulnerabilities on residential parcels in the county and valuable interactions between residents and fire prevention specialists, through Marin Wildfire's Defensible Space Home Evaluation Program (DSI) and local equivalents.
- Detailed analysis of risks to evacuation across the county and designation of evacuation routes in accordance with California state bills SB99 and AB747.
- Integration of science-based modeling and strategic measures to guide decision-making processes and track risk reduction progress over time.
- Creation of a centralized Emergency Command Center for Fire and Emergency Medical Services (EMS) call-taking and dispatching of all fire agencies in the County, providing on-site, 24/7 Command and Control capacity for faster fire response and monitoring.
- Updated Wildfire Hazard Severity Maps covering the State Responsibility Area (SRA) and Local Responsibility Area (LRA).

- Legislation and public policy pushes to guide wildfire resilience throughout the State of California, including AB 3074, which requires homeowners in Very High Fire Hazard Severity Zones to create an ember-resistant Zone Zero (0 to 5 feet from the home).
- Development of the unified Marin Regional Forest Health Strategy (2023), which outlines a science-based, locally informed strategy for maintaining Marin's natural resources, including a detailed discussion of fire ecology and threats to forested ecosystems arising from continued fire suppression and climate change.

Due to the increasing severity of the wildfire environment nationally and the accelerated pace of wildfire resilience locally, coordinated action through an updated CWPP is an important next step for Marin County. The 2026 edition of the CWPP provides an updated assessment of wildfire risk in Marin County and establishes a framework for ongoing risk reduction planning aligned with current conditions, available resources, and emerging best practices.

2. Marin County: Geographic Setting and Wildfire Context

Marin County is located in the North San Francisco Bay Area in California. The county is approximately 520 square miles (332,800 acres) with a population of approximately 254,407.[5] The county is bordered by Sonoma County to the northeast, the San Francisco Bay to the east, and San Francisco to the south, with the Pacific Ocean along its western border. Most of the county's population resides in the eastern, developed region of the county along the Highway 101 corridor. The more sparsely populated west region of the county—in and around the Point Reyes Peninsula—is a popular local tourist region covered by parklands and recreation areas. The northwest of the county is rural, agricultural rangeland.

County-wide, approximately 60,000 acres (18% of the county's land area) falls within the WUI where residences (i.e., homes and other structures) are adjacent to or intermixed with open space and wildland vegetation.



[5] Census Reporter. (2023). Marin County, CA profile. Retrieved December 11, 2025, from https://censusreporter.org/profiles/05000US06041-marin-county-ca/.

2.1.1 Fire History and Ignition Patterns

Marin County's native vegetation evolved with the presence of frequent wildfires, ignited both by natural causes (lightning) and by the Coast Miwok. Short intervals of 2 to 20 years between wildfires promoted the health and regeneration of native grasslands, oak woodlands, and forests, favoring plant species that were best adapted to fire. These frequent, low-intensity wildfires were beneficial to sustaining a heterogeneous landscape, supporting and expanding native grasslands, increasing biodiversity, and maintaining the productivity of chaparral and coastal scrub ecosystems.

Today, most wildfires are suppressed due to their potential to negatively affect human communities and local economies. Decades of suppression have resulted in significant departure from precolonial fire regimes. Many forested areas in the county (>62%) have not burned for more than 70 years; historically, these areas would have likely burned two or three times in this interval.[6] Fire exclusion has negatively impacted ecosystems, changing their structure and composition, and caused fuel accumulation likely to drive more intense fire behavior when a fire does occur.

On average, there have been about 25 wildland fires per year in the county since 2006. Human activity, including recreation, roads, transmission lines, and residential settlement patterns, are responsible for most ignitions in Marin County with roughly 96% of fires within the last 20 years occurring within a quarter mile of urban/developed environments. Only an average of about 1% of attributable fires were caused by natural ignition sources, such as lightning. Mechanical equipment, vehicles, debris burning, power generation and distribution, and smoking are common fire ignition mechanisms. Arson is also a frequent ignition mechanism, as about 8% of fires are started with malicious intent.[7]



Due to robust fire response, fires in Marin County are usually contained by firefighters when they are still very small. Between 2006 and 2020, the median fire size was just 0.1 acre.[8] The most significant fires in Marin County in recent history included the 1995 Vision Fire, which burned more than 12,000 acres and destroyed about 50 structures around Inverness in October 1995; and the 2020 Woodward Fire, which burned about 5,000 acres in remote parts of the Point Reyes National Seashore in August 2020.

[6] One Tam. (2023). Marin Regional Forest Health Strategy. https://www.onetam.org/sites/default/files/pdfs/marin_regional_forest_health_strategy_2023.pdf.
[7] Short, Karen C. 2022. Spatial wildfire occurrence data for the United States, 1992-2020 [FPA_FOD_20221014] (6th Edition). Fort Collins, CO: Forest Service Research Data Archive. https://doi.org/10.2737/RDS-2013-0009.6
[8] ibid.

• • • Insights • • •

Fire Adaptation, Not Fire Exclusion

Fire is an important cultural and natural ecological process in Marin County's landscapes, many of which are adapted to burn. Human-caused ignitions are likely to occur and may spread rapidly through vegetative fuels. Wildfire preparedness programs in Marin County should be designed with the expectation that fires will occur regularly. The objective of these programs should be to reduce the potential impacts of wildfires on life, property, and critical community assets, rather than to prevent wildfire occurrences altogether.

The Federated Indians of Graton Rancheria and the Coast Miwok are present-day partners in Marin County's wildfire resilience work. County fire agencies and land managers welcome continued and expanded collaboration on cultural burning and other traditional stewardship practices.

See the Marin Regional Forest Health Strategy at **https://www.onetam.org/forest-health** for more information on Marin County's fire history, the relationship between native ecosystems and fire, Coast Miwok stewardship with fire prior to colonization, and opportunities to partner with the Federated Indians of Graton Rancheria to restore cultural burning and other forms of beneficial fire.

2.1.2 Fire Hazard Severity Zones

Fire Hazard Severity Zones (FHSZ) classify the likelihood and potential intensity of wildfires. The California Office of the State Fire Marshal (OSFM) defines and maps wildfire hazard classifications. Parcels within high and very high fire hazard severity zones must adhere to specific legal requirements, including mandatory defensible space, adherence to WUI building codes, and disclosing fire risk during real estate transactions.

In Marin, 4.1% (4,647) of structures are located within a Very High fire hazard severity zone. An additional 10.1% (11,452 structures) are located within a High fire hazard severity zone, and 12.3% (13,979 structures) are located within a Moderate zone. The remaining 76% of structures are located outside of the OSFM's designated zones.

While FHSZs define a legal framework for enforcing defensible space and other requirements, they are a measure of hazard, not risk. While these maps help illuminate where a high-severity fire is likely to occur, they do not show the areas where such a fire would have the greatest consequences on Marin's communities. For example, FHSZ delineations do not incorporate evacuation, alerting, or fire

detection programs, nor do they evaluate aspects of the built environment, including defensible space and home hardening or conflagration potential. In contrast, the CWPP is a risk assessment tool that combines both hazard and consequence assessments to evaluate areas for how fire could affect important community values at risk. Thus, the CWPP provides a more nuanced and robust tool for planning and mitigation activities than the FHSZ and is capable of creating an action-oriented plan for risk reduction.

2.1.3 Wildland Urban Interface

The WUI is defined as the area where structures and human development meet or intermingle with undeveloped wildland vegetation.[9] In Marin, there are more than 69,400 homes within the WUI.[10] That figure comprises nearly 62% of the 111,000 housing units in the county.[11]

Due to the large number of at-risk homes within the WUI in Marin County, there is a high risk of fires affecting residences, people, and livelihoods. Throughout this CWPP, the focus is placed on risk reduction activities that can address these impacts to the built environment.



[9] Radeloff, V. C., Hammer, R. B., Stewart, S. I., Fried, J. S., Holcomb, S. S., & McKeefry, J. F. (2005). The wildland–urban interface in the United States. Ecological Applications, 15(3), 799–805. https://doi.org/10.1890/04-1413.
[10] Halstead, R. (2022, April 22). Marin officials: Housing mandate shouldn't trump safety. Marin Independent Journal. https://www.marinij.com/2022/04/22/marin-officials-housing-mandate-shouldnt-trump-safety/
[11] Metropolitan Transportation Commission. (n.d.). Housing units: Marin County. Bay Area Census. https://census.bayareametro.gov/housing-units?location=marin_county.

2.1.4 Marin Fire Weather and Climate Projections

Fire Weather

Fire weather patterns are important influences on fire intensity, speed, and direction. Marin County is located in a Mediterranean climate regime where precipitation is concentrated in the winter and early spring. Strong high pressure systems (the Pacific High) combined with cool, moist air over the Pacific Ocean can create persistent fog conditions along the coast and inland valleys for much of the summer. The highest severity fire weather conditions occur in the fall when vegetation is dry at the conclusion of the annual growing season and when large-scale pressure gradients create hot, dry, and windy conditions. Neighboring counties (Sonoma and Napa) have experienced extreme wildfire events during periods of high wind in early October.

The 2025 Los Angeles, 2023 Lahaina, and 2021 Marshall fires highlighted the role of fire weather patterns in driving large-loss urban fires. These disaster fires were driven by a combination of common factors, including:

- Extremely high wind speeds, often blowing downslope and exhibiting mountain wave characteristics
- A wet previous winter, resulting in increased herbaceous vegetation growth
- Sustained drying in the fall and winter, often with delayed season-ending precipitation

These conditions are commonly exhibited in Marin County and are projected to increase in frequency as climate change progresses. High-severity fire weather events in Marin County typically occur in one of two ways:

- **Diablo Wind Events:** This scenario represents a northeast wind event, perhaps the most common driver of high-severity fire weather in Marin County. These winds typically occur in the fall, when a high-pressure system develops over the Great Basin and a low-pressure system sits offshore over the Pacific Ocean; this pressure gradient drives hot, dry air downslope



from the continental interior, across the Sierra Nevada and Coast Ranges, and offshore toward the coast. As the air descends, it compresses and warms, leading to very low humidity and high temperatures. Diablo Wind events have driven some of the most consequential fire activity in the Bay Area, including the 2017 Northern California wildfires, the 1991 Oakland Hills fire, the 1929 Mill Valley fire, and the 1923 Novato to Bolinas Ridge Fire.

- **West Wind Events:** This scenario represents a dry onshore wind event, occurring when dry air that was previously pushed offshore during a Diablo wind event is driven back inland by a reversal in the pressure gradient. This creates a short-lived but dry and gusty westerly wind blowing from the Pacific Ocean toward the coast. Unlike the typical moist sea breezes, this return flow brings dry air back into coastal areas that were depleted of moisture during the preceding Diablo event. Moist onshore winds are common throughout coastal California, particularly in Marin. Dry onshore winds are rare, occurring only once every several years. However, these events can pose a significant fire risk and present control problems for fires driven by the preceding Diablo event by creating a sudden wind shift.

These two scenarios represent the two most frequent low-moisture, high-wind fire weather patterns facing the county. A detailed review of other potential fire weather events suggests that while fire weather events are experienced differently in different parts of the county, the observed data records indicate that including alternative fire weather regimes would not significantly change fire prevention planning beyond the northeast and west fire weather scenarios described previously.

For more detailed information on fire weather in Marin County, readers should refer to **Appendix A. Marin County Fire Weather Assessment**.

Climate Change

Climate change is well underway, and changes in fire weather patterns, the timing and duration of annual precipitation, and wind regimes are already occurring in Marin County. While predicting the exact timing of specific weather events is infeasible, evaluating multi-annual trends in humidity, precipitation, temperature, and wind is possible using advanced climate models.

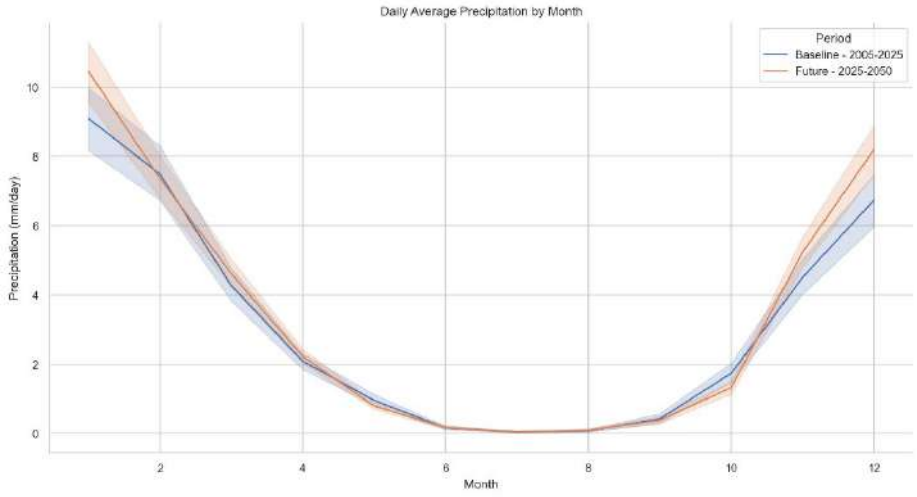
A detailed review of climate change projections for Marin County indicates that fire seasons will become longer. While overall precipitation is projected to increase in the next several decades, the seasonality of this precipitation is likely to create longer periods with limited precipitation. Marin County will experience fewer days in the spring with appreciable precipitation, and season-ending precipitation events in the fall will be delayed. Because October often coincides with peak Diablo wind conditions, an increase in the likelihood of Diablo wind events occurring before the arrival of seasonal moisture is expected. Fire managers should prepare for the increased severity of these events and leverage expanded vegetation management, increased fire response staffing, and coordinated work with homeowners to reduce the impacts of this trend.

Increased winter precipitation during intense atmospheric river events will drive increased herbaceous vegetation (grass) growth and result in elevated fire behavior the following year. Throughout the western United States, atmospheric river precipitation has been shown to correlate with elevated fire risk due to an expected increase in the availability of fine annual grasses and shrubs the following growing season. Fine fuels drive rapid rates of fire spread, particularly during wind-driven fires.

Fire season months are projected to become drier, and consecutive dry periods will lengthen. Increases in the duration of low-moisture periods will increase by up to 30%. Sustained drying will drive increased fire behavior and create elevated fire weather conditions for a greater portion of the fire season. While overall maximum wind speeds are projected to remain similar until at least mid-century, wind speeds during dry periods will increase substantially. An increase in the number of consecutive dry and windy days, paired with this increase in wind velocity, will drive increased fire activity throughout the summer and fall.

Climate models do not indicate an increase in the frequency or characteristics of the highest-severity fire weather events. However, they do indicate a substantial increase in the number of days with low relative humidity and moderate wind speeds. These "average" fire weather days may double by the middle of the twenty-first century. Further, climate models suggest that Marin County will experience an increase in the number of consecutive low-humidity, moderately windy days of at least 20%. These moderate days are anticipated to expand wildland fire call volume and place an increased strain on fire suppression resources.

For more detailed information on climate change and its effects on fire behavior in Marin County, readers should refer to **Appendix B. Marin County Fire Weather and Climate Change Assessment**. For more insight into the potential effects of climate change on Marin's forest ecosystems, see Chapter 4: Climate Change and other Forest Health Stressors, in the Marin Regional Forest Health Strategy.[12]



Daily average precipitation by month in Marin County, showing the dry periods in the summer months.

[12] https://www.onetam.org/sites/default/files/pdfs/marin_regional_forest_health_strategy_2023.pdf#nameddest=Ch4_ClimateChange_Stressors

• • • Insights • • •

Fire Operations Should Consider Out-of-Season Weather Events

For fire prevention planning purposes, the two primary extreme fire weather scenarios (west and northeast) capture the dominant fire dynamics and should be used to prioritize risk reduction activities with the greatest benefit. However, from an operational perspective, fire managers should consider out-of-season fire weather events capable of bringing significant fire weather to Marin County outside of the normal fire season (e.g., a Diablo-type event occurring in December or January). Consider staffing and response capabilities in the context of these potential events.

Prepare for an Increase in the Frequency of Moderate Fire Weather

Fire managers should plan for an increased number of dry, moderately windy days that will increase the workload for fire response agencies throughout the fire season. Consider expanding public engagement campaigns to reduce ignitions during elevated fire weather periods and actively engage residents on local evacuation protocols. Agencies should also consider increasing staffing and equipment capabilities to handle the additional wildland call volume.

2.1.5 Demographics

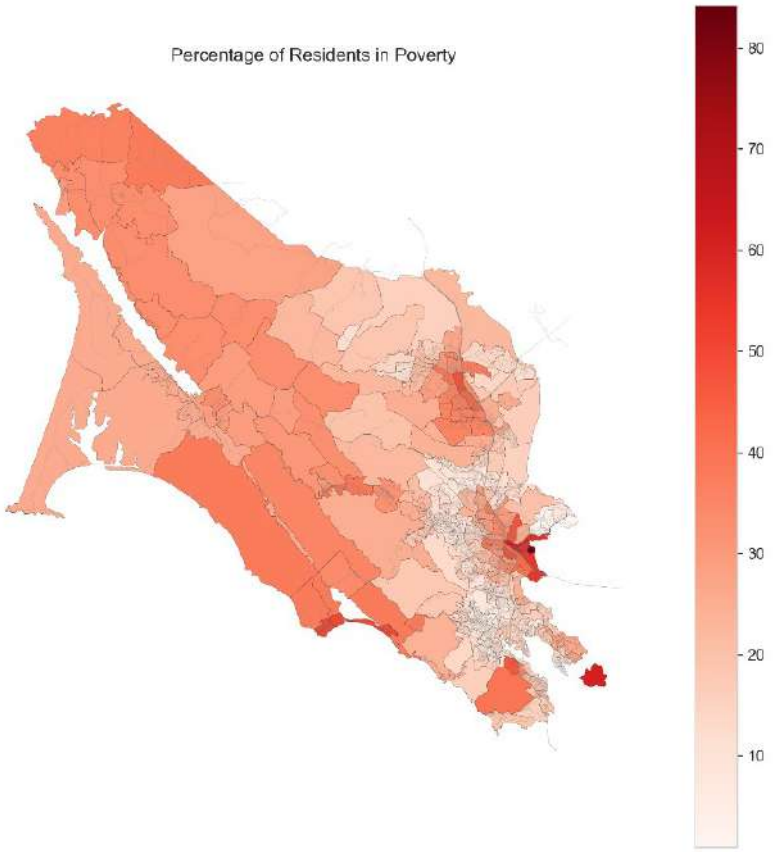
While Marin County is one of the most affluent counties in the United States, with more than 37% of residents earning more than $200,000 annually, the county is also home to many lower-income, linguistically isolated, and traditionally underrepresented residents. These populations have fewer resources and face structural and linguistic barriers to wildfire preparedness.

Approximately 47% of Marin County's population resides in areas with median household incomes below 80% of the statewide median.[13] An estimated 9.1% of residents live below the federal poverty line.[14] Low-income residents are located throughout the county, but are most common in the Canal neighborhood of San Rafael, central Novato, and Bolinas. Many lower-income residents rent their homes and are not responsible for the maintenance of their home or landscaping, which make

[13] Data from the California Climate Investments Priority Populations dataset. **https://www.caclimateinvestments.ca.gov/priority-populations**

[14] Data from the US Census Bureau.

traditional resident education programs that focus on defensible space and home hardening ineffective. About 34% of all households are renter-occupied.[15]



About 18% of Marin County's population is estimated to live in households where English is spoken not at all or less than well.[16] Residents in below or near-poverty and other lower-income households are disproportionately affected by language barriers, which can complicate access to emergency information, evacuation guidance, and mitigation programs. Spanish is the most commonly spoken non-English language in the county.[17]

People of color often face structural barriers that can limit access to emergency preparedness resources and services. The Canal and Spinnaker Point areas of eastern San Rafael, the Davison and Rowland areas of Novato, and Marin City have high populations of non-white residents. In West Marin, transient farm worker communities also face structural barriers to preparedness resources and may struggle to find resources and alerts in their language. Alternative information channels, such as increased wildfire focus by community-based organizations in these areas, may be appropriate.

Finally, more than 23% of the county's population is over the age of 65.[18] Projections indicate that this segment of the population will continue to grow in the coming years. Aging populations face additional challenges to disaster preparedness and evacuation. In addition to mobility difficulties, older adults may face particular challenges using technology, an important part of understanding when and how to evacuate. Indeed, nationwide, it is estimated that less than one in ten adults over the age of fifty are subscribed to disaster related apps or text notifications from local emergency management agencies,[19] and so may benefit from alternative communication mechanisms.

---

[15] Ibid.
[16] Data from the CalEnviroScreen dataset. https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-40
[17] Data from the Marin Wildfire Risk Perceptions Survey.
[18] Data from the U.S. Census Bureau.
[19] AARP Research. (2023, August 30). *Older adults could be better prepared for natural disasters*. AARP. Available at https://www.aarp.org/pri/topics/technology/internet-media-devices/disaster-preparedness-50-plus/

• • • Insights • • •

Risk Based Grants

Consider implementing grants programs that incorporate both risk and need. Many areas of high wildfire risk also have high average incomes; conversely, many areas of lower wildfire risk have the greatest proportion of socially vulnerable people. For grants and incentive programs, consider identifying areas where high wildfire risk overlaps with high social vulnerability. The tools produced in this CWPP should help identify these areas on an ongoing basis. Grants that target areas that have high wildfire risk and address the financial needs of residents can have outsized impacts on risk reduction in high consequence areas.

Bridging the Digital Divide

Because of the high proportion of older adults in Marin, resources to help this population navigate the technology needed to receive and respond to emergency alerts could be particularly useful during a large-scale evacuation.

Engage the Renter

Consider implementing programs that empower renters to work with landlords to create defensible space and home hardening. Work with community-based organizations (CBOs) and other groups to ensure that renters carry adequate renters insurance, have evacuation plans, and are registered for emergency alerts at their current address.

For more detailed information on the unique programming needs of socially vulnerable residents in Marin County, readers should refer to **Appendix C. Marin County Social Vulnerability Assessment**.

2.1.6 Marin County Values at Risk

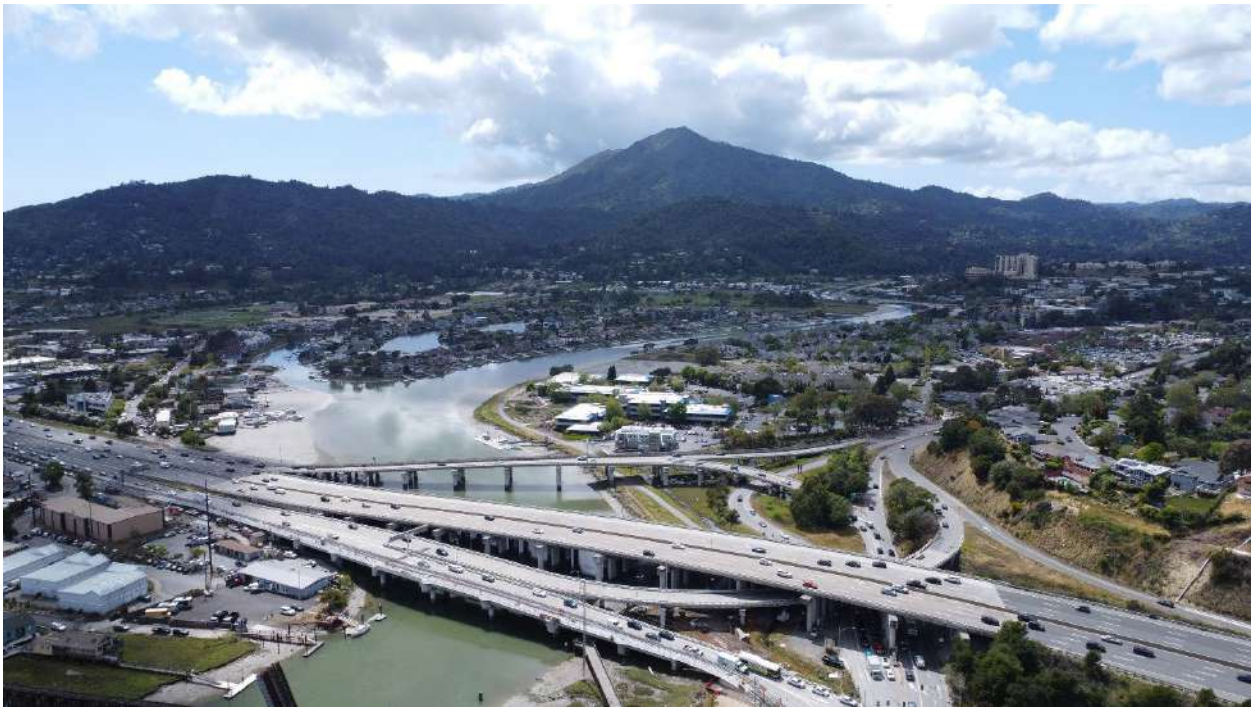
A core component of the CWPP is to identify the likely consequences of a fire when it occurs. To do this, local, state, and federal GIS datasets were used to identify values at risk. Values at risk are homes, businesses, community infrastructure, and other assets needed for a thriving community.

Homes

There are approximately 112,359 living units in Marin County with a median home value of approximately $1.5 million. The built environment is concentrated in and around the Highway 101

Corridor. Other areas are more rural with larger lots and more isolated structures. About two-thirds of households are owner-occupied; the remainder are occupied by renters. Approximately 72% of residences are single-family homes; multi-unit buildings account for about 27% of households.[20]

The population in Marin County is relatively stable. More than 90% of residents live in the same house that they lived in a year ago and about 40% of residents moved into their current home before 2010. The average household is home to 2.4 people.



Many of Marin's communities are densely developed with low structure separation distance. Recent disaster fires have spread through the built environment via structure-to-structure spread, highlighting the importance of structure separation distance and community design in fire spread. Structure separation distances can be used as a proxy for areas where a fire could spread by radiant and convective heat between structures. Countywide, the median separation distance is just 16.7 feet. More than 68% of structures are less than 30 feet from their nearest neighbor. Just 12% of structures are located more than 100 feet from their nearest neighbor.

Structures located less than 30 feet from one another are at the highest risk of ignition via structure to structure spread. Areas that have low separation distances, are contiguous with vegetative fuels, and have on-parcel vulnerabilities, are those at the greatest risk of setting off a cascade of structure-to-structure ignitions. Expanded defensible space and coordinated residential risk reduction in these communities are recommended.

[20] Ibid.

Wildfire and Insurance

High wildfire risk to homes in Marin County has recently led to a secondary problem: insurability. Like many other Californians, many residents in Marin County face difficulty obtaining insurance coverage from major carriers.[21] Difficulties getting insurance in high wildfire risk areas can have downstream impacts on housing markets, as prospective homebuyers are often unable to secure the insurance required by lenders to finalize a mortgage. With more than $101 billion in total property value, a healthy real estate market is an important element of a stable economy in Marin County.[22]

The California FAIR plan, the insurer of last resort, insures more than 4,360 policies in the county, accounting for nearly $7.4 billion in value. FAIR plan enrollment in Marin grew by 72% between 2023 and 2024 and another 51% between 2024 and 2025.[23] Inverness has the greatest concentration of FAIR plan policies in the county. FAIR plan policies tend to be expensive and have lower limits on coverage than traditional policies. Further, after the 2025 LA fires, the FAIR plan was sued over allegations of systematically denying and limiting smoke damage claims.[24] While the FAIR plan provides an important safety net, it is not a viable alternative to a healthy, competitive private insurance market.

In high risk areas like Marin, parcel- and community-scale mitigation can reduce not only structure-losses but facilitate real estate transactions and reduce lending friction by improving a property's wildfire risk score in the eyes of an insurer. The California Department of Insurance's Sustainable Insurance Strategy now encourages insurers to incorporate variables related to property characteristics and local mitigation conditions with the goal of aligning mitigation actions with insurance availability and pricing.

While the end goal should not be insurability, the risk reduction activities addressed in this CWPP can help to create an environment that is safer for homes and more defensible for insurers.

Utilities

Water, electricity, and communications infrastructure are foundational community assets that ensure residents can continue to access clean drinking water, reliable power, and timely emergency information during and after wildfires. Disruption to these systems can rapidly escalate risk by affecting public health, evacuation, firefighting operations, and recovery.

---

[21] Federal Reserve Bank of San Francisco. (2023). Climate risk and the housing market: Evidence from wildfire-prone areas. **https://www.frbsf.org/**

[22] County of Marin. (2023, June 29). Marin's assessment roll climbs 6.34% countywide. **https://www.marincounty.gov/news-releases/marins-assessment-roll-climbs-634-countywide**

[23] California FAIR Plan Association. (2025). Policy growth by fiscal year (residential, commercial and BOP lines): Data by county (FY25 report). **https://www.cfpnet.com/wp-content/uploads/2025/11/CFP-5-yr-PIF-County-FY25-All-251114.pdf**

[24] California Department of Insurance. (2025, August 1). Department of Insurance expanding coverage for Californians who need it most. **https://www.insurance.ca.gov/0400-news/0100-press-releases/2025/release054-2025.cfm**

Water facilities include pump stations, dams, and other facilities that facilitate water distribution. Water facilities are located throughout the county but are concentrated within and around the Mount Tamalpais watershed, which provides more than 75% of the drinking water consumed by Marin residents. The CWPP includes 44 water facilities, including 26 pump stations, 8 dams, and 10 other distribution facilities.

Electric infrastructure includes power generation facilities, transmission lines, and substations. Recent wildfire history has demonstrated that electrical infrastructure can both contribute to ignition risk and be highly vulnerable to wildfire impacts. Wildfire-caused power outages can disrupt water delivery, communications, medical services, and evacuation operations, compounding overall community risk. The CWPP includes 60 electric stations and about 130 linear miles of transmission lines.

Communications infrastructure is vital to ensure residents receive emergency alerts and communications. Communications assets include cell towers and AM/FM broadcasting towers. Loss or damage to these installations can significantly impair emergency response and public safety, particularly in fast-moving fire scenarios or during power outages. The CWPP includes 165 communications assets. A future update of the plan could also incorporate cell phone and data network coverage; however, a reliable countywide data source was not available for this analysis.



Community Facilities

Marin County has a wide variety of community facilities, including schools, healthcare facilities, government and emergency response buildings, and community centers. These facilities serve as important community gathering places and provide essential services, but they also pose unique evacuation and fire management challenges. Many host large numbers of people, serve vulnerable populations, or require coordinated transportation and staff assistance to evacuate safely, and some must maintain critical operations during emergencies. These factors can complicate evacuation timing, traffic management, and emergency response, and increase the consequences of delayed or disrupted evacuation. As a result, community facilities warrant special consideration in wildfire preparedness planning, including site-specific evacuation planning, coordination with facility operators and first responders, and, where appropriate, enhanced defensible space, vegetation management, and structural hardening.

Marin County public schools serve approximately 30,077 students. As of 2025, there were 46 public elementary schools, 9 public middle schools, and 8 public high schools,[25] with an additional 49 private schools educating about 8,600 students.

Emergency healthcare infrastructure is essential for maintaining life-safety services during and after a wildfire event. Hospitals are highly sensitive to wildfire impacts, including smoke infiltration, road closures affecting staff access, and reliance on stable utility grids. A loss of function at these facilities can severely strain regional emergency capacity during an emergency. The CWPP evaluates risk for three major hospitals.

Fire stations and law enforcement installations represent the frontline of public safety and incident management. Fire stations are the primary defense nodes for community protection, housing the personnel and equipment required for initial attack and structure defense. Law enforcement infrastructure is equally foundational to coordinating large-scale emergency response, serving as the nerve centers for emergency logistics and traffic control. Protecting these stations is critical to ensuring that fire suppression, rescue capabilities, and evacuation coordination remain operational throughout a wildfire's duration. The CWPP includes 48 fire stations and 17 law enforcement assets.

Aviation infrastructure serves as a critical logistics hub for both regional mobility and aerial firefighting operations. Wildfire impacts, such as poor visibility from smoke or direct damage to runways and hangars, can ground these vital resources and sever a key evacuation and supply route. Marin County is served by two regional airports.

Libraries play an important role as information hubs and serve as cultural and educational centers for the community. These facilities also provide climate-controlled environments for vulnerable populations escaping smoke and heat. Damage to or closure of libraries can limit the community's

[25] Education Data Partnership. County summary: Marin County. Ed-Data. Retrieved December 23, 2025, from https://www.ed-data.org/county/Marin

access to emergency resources as well as pose a risk to vital cultural and educational resources. The CWPP evaluates risk for 17 library facilities.

Recreation



Marin County boasts approximately 160,000 acres of parks and public lands. These lands are vital to Marin residents and visitors as a source of recreation. The local, regional, state, and federal parklands support a wide variety of recreational opportunities, including hiking, biking, picnicking, wildlife viewing, water access, and more. A trail network of more than 800 linear miles provides access for hikers, cyclists, equestrians, and other recreational uses.

Marin County's open spaces are an important driver for the local economy. In 2022, there were more than 17 million visitors to the Golden Gate Recreation Area (GGNRA) and Muir Woods.[26] The Point Reyes National Seashore consistently draws more than 2.2 million visitors annually.[27] The Mount Tamalpais Watershed sees about 2 million visitors each year. Altogether, these visits spurred more than $1.25 billion in spending in adjacent communities. This spending supported more than additional 12,014 jobs and provided hundreds of millions of dollars to local businesses.[28]

Ecosystems and Ecosystem Services

Marin County has nearly 118,000 acres of forest and woodland that are a vital resource for wildlife, residents, and visitors. The county is home to a wide variety of plants, including several rare and locally endemic species. The California Native Plant Society and the California Department of Fish and Wildlife characterize Marin County as one of the most biodiverse parts of the state. The most

[26] This figure includes data for the Fort Point National Historic Site (NHS) and other areas of the GGNRA outside of Marin. More information is available from the NPS. (2023, August 25). Visitor spending to GGNRA, Muir Woods National Monument and Fort Point NHS set new record in 2022. U.S. Department of the Interior. **https://www.nps.gov/goga/learn/news/visitor-spending-to-ggnra-sets-record-in-2022.htm**

[27] National Park Service. (2025, March 14). Park statistics – Point Reyes National Seashore: Annual visitation, geographical data, and other management statistics. U.S. Department of the Interior. https://www.nps.gov/pore/learn/management/statistics.htm

[28] National Park Service. (2024, September 10). Visitor spending effects – Economic contributions of National Park visitor spending. U.S. Department of the Interior. **https://www.nps.gov/subjects/socialscience/vse.htm**

unique and distinctive plant communities are coast redwood forests, open canopy oak woodlands, evergreen hardwood forests, Douglas fir forests, bishop pine forests, chaparral ecosystems, coastal shrublands, grasslands, streambanks and lakeshores, freshwater marshes, saltwater marshes, and dunes. Marin County is also home to serpentine ecosystems, which support a large number of Marin County's rare and endangered plant populations.

Climate change, land use, fire suppression, invasive species, plant diseases, and other factors threaten the biodiversity and richness of Marin's essential ecosystems. Fire and other forms of disturbance are important drivers of ecosystem health and diversity. In the absence of fire, Douglas-fir forest is expanding into grassland, shrubland, and oak woodland habitat in many parts of the county. Fire exclusion also threatens chaparral species, many of which are endemic to Marin, and can lead to unnatural fuel arrangements and the loss of biodiversity. Climate change is also spurring the expansion of forest pathogens like sudden oak death (SOD), which can drive tree mortality and fuel accumulation in forests throughout Marin County.

Many of Marin's residents receive clean drinking water from local watersheds. Marin Water serves more than 190,000 residents, and more than 75% of their water supply is derived from the Mount Tamalpais watershed. The North Marin Water district provides additional water management services in the greater Novato area and West Marin Point Reyes areas. Landscape stewardship is critical to ensuring the long-term sustainability and health of the watersheds that provide clean water to Marin residents.

Marin County is committed to developing sustainable and ecologically responsible solutions to fuel management. The Ecologically Sound Practices Partnership (ESP) is a community resource that advises Marin's fire professionals, defines management best practices, and offers expertise and recommendations on specific projects to protect the biodiversity and resilience of Marin's landscape and ensure that ecological values are retained or restored during project implementation. Additionally, a working group of the Marin Wildfire Prevention Authority in partnership with ESP and resource managers recently conducted a biomass recovery study to ensure that biomass utilization pathways support wildfire prevention and landfill diversion, while also reducing greenhouse gas (GHG) emissions in Marin County.[29]

For more information on Marin's ecosystems and the services they provide, readers are encouraged to review the Marin Regional Forest Health Strategy,[30] which provides data, analysis, and local knowledge integrated into a comprehensive management strategy for Marin's forested landscapes. This CWPP acknowledges the importance of ecosystem stewardship; however, it focuses primarily on reducing vulnerabilities in and around the built environment. The objective of this thoughtful sequencing is to enable large-scale use of beneficial fire without the looming specter of these burns morphing into community disaster fires.

[29] Marin Resource Conservation District. (n.d.). Marin biomass project. **https://www.marinrcd.org/programs/home2/marinbiomassproject/**
[30] **https://www.onetam.org/forest-health#document**

2.1.7 Agencies and Organizational Structure

Marin County Fire Department (MCFD) is the primary agency responsible for wildland fire response within the county. CAL FIRE contracts with the MCFD to provide wildland fire protection and associated fire prevention services for approximately 200,000 acres of SRA. In addition, MCFD provides wildland fire protection services to approximately 100,000 acres of federal lands, including the GGNRA, the Muir Woods National Monument, and the Point Reyes National Seashore.

Other parts of the county are served by local fire departments and fire protection districts. These agencies include:

- Central Marin Fire Department, serving Corte Madera, Larkspur, and Greenbrae
- Southern Marin Fire, covering Mill Valley, Sausalito,
- Tiburon Fire Protection District, covering the Town of Tiburon and the City of Belvedere
- Kentfield Fire Protection District
- Ross Valley Fire Department, serving Ross, San Anselmo, and Fairfax ,and Sleepy Hollow Fire Protection District
- San Rafael Fire Department
- Marinwood Fire Department
- Novato Fire Protection District
- Stinson Beach Fire Protection District
- Bolinas Fire Protection District
- Inverness Public Utility District



Marin County has a well-organized local mutual aid system based on the principles of resource sharing and cooperation with a goal of providing the public with the highest level of service that no one agency is equipped to provide. These agreements include resources from all fire agencies, law enforcement agencies, volunteer fire departments, CalOES, NPS, CAL FIRE, and local landowners.

In March 2020, Measure C created the Marin Wildfire Prevention Authority (Marin Wildfire), a 17-member-agency joint powers authority (JPA). Marin Wildfire's mission is to develop and implement a comprehensive wildfire prevention strategy for Marin County.[31] Measure C provides approximately $25 million annually to fund fire prevention work.

Fire Safe Marin, Marin County's Fire Safe Council, promotes public and private partnerships to enhance wildfire safety and build Firewise Communities.[32] Fire Safe Marin is a nonprofit organization with the dual mission of reducing wildland fire hazards and improving fire-safety awareness in Marin County. Fire Safe Marin receives significant investments through Marin Wildfire, CAL FIRE Grants, Pacific Gas and Electric Company (PG&E) Grants, other state and federal entities, and private donations.

The Marin County Office of Emergency Management (OEM) is the lead agency for emergency alerting in Marin County. OEM can issue countywide and localized alerts, and send alerts on behalf of cities, towns, and special districts to ensure consistent public messaging during incidents. OEM uses AlertMarin[33] as the countywide alerting "brand", using tools within the federal Integrated Public Alert and Warning System (IPAWS), which can deliver alerts through mobile phones, televisions, radios, cables, and the National Oceanic and Atmospheric Administration (NOAA) Weather Radios.

Graton Rancheria is the only federally recognized tribe with ancestral territory in Marin County. Graton Rancheria comprises Coast Miwok and Southern Pomo peoples who are traditionally and culturally affiliated with the CWPP Program Area. The Tribe retains Traditional Knowledge about the lands, waters, environments, beings, and relationships that are essential to land stewardship and cultural and natural resource management in the CWPP Program Area.

Finally, land managers are important stakeholders for fire risk reduction. Vegetation management projects on public lands and watersheds can reduce risk to adjacent communities. In addition to departments in the cities and towns, land management agencies in the county include:

- Marin County Parks/Open Space District
- Marin Water
- U.S. National Parks Service and U.S. Fish and Wildlife Service
- California State Parks
- ESP

[31] Tiburon and Belvedere are not members of the Marin Wildfire Prevention Authority JPA and have their own wildfire preparedness plans.
[32] The National Fire Protection Association (NFPA) established the Firewise Communities Program to encourage local fire safety solutions by involving homeowners to take individual responsibility for preparing their homes for the risks of wildfires. The Firewise program uses their website (**http://www.firewise.org/**) to provide information and promotes ways to keep homes from igniting.
[33] Alert Marin is an alerting service provided by SirCom, **https://sircom.org/**

• • • Insights • • •

Integrated Fire Planning

Coordination and alignment of objectives is an important step towards fire resilience. While the CWPP is an important collaborative strategic planning effort, coordination on tactical project planning should be pursued whenever possible. Coordinated, cross-jurisdictional efforts enable strong partnerships and allow multiple agencies to align complementary tactics, such as vegetation management, residential risk reduction, evacuation improvements, and infrastructure protection, within a single planning context. This integrated approach produces compounding, "network" effects that can reduce wildfire risk more effectively and durably than actions undertaken by any single agency or program in isolation.



3. Existing Investment in Wildfire Prevention and Preparedness

3.1 Strategic Framework

As the coordinating wildfire prevention entity in most of Marin County, the Marin Wildfire Prevention Authority (Marin Wildfire) is responsible for developing and implementing effective wildfire prevention and preparedness programs with demonstrable risk-reduction outcomes. To support this mission, Marin Wildfire has established a set of goals and strategic measures to track community progress across key dimensions of wildfire risk mitigation. These measures are organized around Marin Wildfire's five programmatic goals and are designed to identify where programs are performing as intended and where additional focus or investment is needed to achieve meaningful risk reduction.

Marin Wildfire's strategic framework is an effective tool for tracking wildfire risk and mitigation progress over time. On the other hand, the purpose of the CWPP is to identify and prioritize locations in which multiple risk factors align to heighten risk to communities. Fire agencies and land managers can use the CWPP to design and implement targeted programs that address these high-risk areas using effective, place-based tactics. Marin Wildfire's strategic framework can then be applied to evaluate program effectiveness and demonstrate progress toward defined outcomes. The CWPP is not intended to replace Marin Wildfire's existing strategic measures; rather, it complements them by providing a spatially explicit toolset to support policy development, program design, implementation, and adaptive management.

Marin Wildfire has implemented public-facing interactive web dashboards that show the progress towards its goals in real time. These dashboards can be accessed via Marin Wildfire's website.

Links:

- **Progress on Vegetation Management**
- **Progress on Defensible Space and Home Hardening**
- **Progress on Detection, Alert, and Evacuation**
- **Progress on Public Outreach and Education (coming soon)**

3.1.1 Wildfire Detection

Marin County's urban population and extensive road network, combined with a robust wildfire camera-based detection system, make early wildfire detection very likely in most parts of the county. The AlertCalifornia system includes 12 camera sites in Marin and three additional cameras in adjacent counties that provide overlapping views into Marin. These cameras allow fire personnel, dispatchers, and emergency managers to rapidly confirm ignitions, assess fire growth, and coordinate multi-agency response. This configuration provides near-comprehensive coverage of the county. Approximately 80% of the land area in Marin County is visible by at least one wildfire-detection camera, and about 65% of the area is visible from two or more cameras.

Furthermore, more than 80% of the county's area is within 0.6 miles (1 km) of a road. Road access increases the likelihood of community detection, via 911 calls, and facilitates rapid emergency responder access. Approximately 99,600 acres of the county are located more than 1 km from roads. These roadless areas are concentrated in the northern and western portions of the county.



3.1.2 Alerting

Emergency alert and warning systems are important components of disaster management. They provide situational awareness and recommended actions to those at risk. County of Marin and Operational Area partners (cities, towns, and special districts) utilize multiple, redundant alerting systems to ensure residents are provided with timely notifications. In the coming years, Marin County

will be developing and implementing a comprehensive Alerting and Warning Plan that will provide strategic and operational guidance on roles and responsibilities for emergency alerting.

Forms of alerting in Marin include:

- **AlertMarin:** the county's primary emergency alert system for action-oriented alerts. AlertMarin is intentionally reserved for situations in which recipients are being asked to take concrete protective actions such as "evacuate now," "prepare to evacuate," or "shelter in place." Utility customer data, obtained via SB821 from PG&E, is used to supplement notification contact information provided by community members during high-risk incidents.
- **Wireless Emergency Alerts (WEAs):** sends a "push notification" from each participating cell tower to all compatible mobile devices within a defined geographic area. The system does not rely on short message service (SMS) text messages, stored phone numbers, or contact lists. WEA messages are accompanied by a distinctive tone and vibration pattern designed to capture attention, even when a phone is silenced. WEA is especially valuable for warning residents, visitors, and travelers that are not subscribed to AlertMarin.

WebEOC is a redundant tool that can be used to send WEAs. While OEM is responsible for most alerting in the county, some local jurisdictions also have their own alerting authority. The City of Novato is authorized to send WEAs directly through IPAWS. Several cities and police agencies use Nixle for local public safety notifications. Nixle is used primarily for police and fire activity information, road closures and traffic impacts, informational wildfire and smoke updates, and community advisories and recovery information. Nixle is usually used to provide broader, ZIP code-based informational messages compared with targeted, action-oriented warning messages from the AlertMarin system.

Comprehensive outdoor alerting systems provide an additional layer of communication during wildfires and other emergencies. Southern and Central Marin are served by a network of 20 high-powered speaker installations (Long Range Acoustic Device, LRAD) capable of broadcasting voice messages and tones over long distances in the event of a wildfire, evacuation, or other public safety threat. This system can deliver real-time instructions that are audible across neighborhoods, open spaces, and major transportation corridors. Other parts of the county, including much of West Marin, are served by Hi-Lo sirens that provide alerting, but no instructions, to dispersed populations. Some agencies have other acoustic warning capabilities, such as portable LRAD systems that can be employed during large-scale evacuations.

For additional information on alerting and evacuation warnings, readers should refer to **Appendix D. Alerting and Warning Systems**, which describes the role of OEM and the legal and technical details about the alerting systems in Marin County.

3.1.3 Vegetation Management

Vegetation management is a key aspect of fire preparedness and prevention and a core element of Marin County's strategic approach to wildfire risk reduction. Measure C has provided funding for numerous vegetation-management projects. From 2020 to late 2025, approximately 2,200 acres of vegetation in Marin County have been treated, primarily through near-community shaded fuel breaks. Projects for treating thousands of additional acres have been proposed, approved, and moved through the regulatory process. Furthermore, member agencies and land-management partners have completed additional vegetation management projects that either specifically or tangentially address wildfire risk reduction.





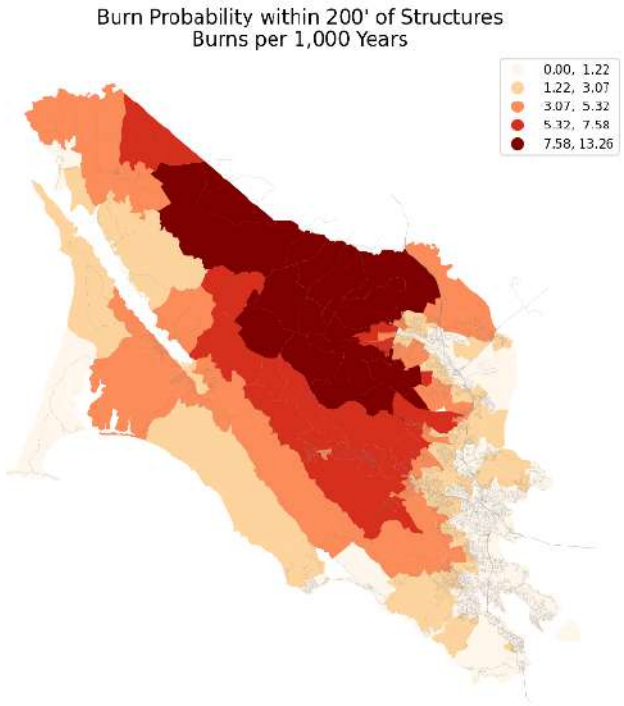
On average, across Marin Wildfire vegetation management projects, modeling studies highlight the anticipated benefits of the fuel reduction:

- A 55% average reduction in composite fire behavior, a metric which incorporates rate of spread, flame length, canopy fire activity, and firefighter access.
- A 78% average reduction in the area with flame lengths greater than 4 feet, a commonly used threshold to determine the effectiveness and safety of ground-based firefighters engaging in the fire, and a 61% average reduction in flame length, a key indicator of fire intensity.
- A 77% reduction in the likelihood of canopy fire activity within the treated areas. Canopy fire activity indicates very active fire behavior and can pose a danger to firefighters and the public.

For additional information on vegetation management and projected effectiveness, readers should refer to **Appendix E. Marin County Vegetation Management Assessment**, which reviews the methods for evaluating vegetation management projects and catalogs recent Measure C-funded fuel-reduction initiatives.

3.1.4 Residential Risk Reduction

Risk reduction on residential parcels is one of the most important elements of community wildfire resilience and a cornerstone of Marin's wildfire preparedness strategy. Reducing vulnerabilities on and around homes, particularly those at the edge of the community, can prevent fire from transitioning into the built environment and provide firefighters with a safer environment in which to work. Ongoing work to reduce residential vulnerability in Marin includes community engagement, a comprehensive data-focused home evaluation program, and a complementary chipper program for green waste disposal.



Firewise Neighborhood Associations

The national Firewise USA recognition program provides a collaborative framework to help communities get organized, find direction, and take action to increase the ignition resistance of their homes and community and to reduce wildfire risks at the local level. Firewise communities provide a personalized and customized approach to deliver fire prevention messaging. Residents in these communities are more likely to take proactive measures, such as home hardening and creating defensible space, to reduce wildfire risk and protect their homes.

More than 90 Firewise neighborhoods coordinate fire preparedness activities for more than 21,000 homes (about one in every four homes in the county), promoting local leadership and community engagement. Through the Firewise framework, communities organize local assessments, develop annual action plans, and implement local defensible-space and home-hardening projects.

Home Evaluation Programs

Home evaluation programs, in which trained staff evaluate vulnerabilities on residential parcels, are a core tenet of wildfire risk reduction programming in Marin County. Marin Wildfire provides funding and staff support for these programs across its 17-member agency jurisdictions. Twenty percent of Measure C funds are allocated to defensible-space and home-hardening efforts annually. During these visits, inspectors evaluate residential properties, assess whether they meet WUI defensible space, vegetation management, and fire-resilient construction standards, and provide residents with

site-specific guidance. By educating residents on their defensible-space and structural-hardening responsibilities, these evaluations help reduce risk to homeowners and their neighbors.



At the conclusion of each evaluation, homeowners are provided with a comprehensive online report that includes specific recommendations for improving their home's ability to survive a wildfire. Information about a home's compliance with state and local defensible space standards is also provided.

Evaluation frequency, schedule, and outcomes vary by jurisdiction to meet the needs of each agency. Four different program models are practiced across the county:

Marin Wildfire Defensible Space Alliance (DSA):[34] Approximately 35,000 evaluations are conducted annually. The objective of the DSA is to inspect all WUI parcels within the Alliance's jurisdiction at least once every three years; some parcels are inspected more frequently.

Novato Fire Protection District: Home evaluations available on demand in Novato. Residents can request an evaluation year-round. Approximately 6,470 evaluations were completed in 2025. Residents that receive evaluations are subsequently eligible for grant funding to resolve issues found on their parcel.

San Rafael Fire Department and Marinwood Community Services District (CSD): High-risk parcels in the WUI are evaluated regularly with the objective of evaluating every parcel at least once every three years. Approximately 4,142 evaluations were completed in 2025. Like other programs, residents are provided with valuable informational materials and can qualify for grant funding with recent evaluations. Citations may be imposed for residents who fail to resolve certain fire code violations.

Tiburon Fire District: The Tiburon Fire District conducts approximately 1,000 defensible space and home evaluations annually with the goal of inspecting all of the parcels in the WUI every year. Additional inspections are available upon resident request. Results are communicated to residents via a written inspection report delivered by email or mailed to residents; the goal is to provide education and information for compliance.

[34] Includes Bolinas Fire District, City of Larkspur, County of Marin Fire, Inverness Fire District, Kentfield Fire District, Sleepy Hollow Fire District, Stinson Beach Fire District, Town of Corte Madera, Town of Fairfax, Town of Ross, and Town of San Anselmo, City of Mill Valley, Southern Marin Fire District, and Muir Beach CSD.

Across the Marin Wildfire JPA,[35] about 60% of residents who received a defensible space home evaluation opened their wildfire risk report at least once. In 2025, about 40% of residents opened their report within 15 days of receiving it. Each report details parcel-specific recommendations for vegetation-management and home-hardening improvements identified by the inspector during the parcel visit. Opening this report is an important part of resident engagement with the wildfire problem: when residents become aware of the vulnerabilities of their property, they are more likely to take steps to mitigate those vulnerabilities. Conversely, when residents do not open their report, meaningful action is less likely to occur; if work is undertaken, it may not target the most impactful mitigation measures.

About one in four Marin residents have resolved more than half of the defensible space violations identified in their reports. Significant risk remains on residential parcels, and a key recommendation of the CWPP is to identify areas in which additional investment in residential risk reduction could yield the greatest benefit.

For additional information on structure vulnerabilities, readers should refer to **Appendix F. Marin County Fire Structure Vulnerability Assessment**, which evaluates risk factors on residential parcels.

Chipper Programs

Vast amounts of vegetative material are removed every year from parcels throughout Marin County via Chipper Programs. These programs provide free or reduced-cost vegetation removal and can help residents dispose of debris created during defensible space implementation. Marin Wildfire and some member agencies offer chipping services to residents. More than 17,000 cubic yards of vegetation are collected and disposed of annually through these programs.

Tiburon Fire District offers five Chipper Day events from May to September each year. At these events, residents of Tiburon and Belvedere are able to drop off all green waste, regardless of species and size, to be hauled for free. On average, this program removes 2,840 cubic yards of vegetation per year. The City of Belvedere also offers free curbside pickup of green waste for residents.

For further context around county Chipper Programs, readers should refer to **Appendix G. Marin County Assessment of Local Preparedness**, which provides quantitative metrics for the Marin Wildfire and Tiburon Fire Protection District programs.

[35] Metrics for Tiburon and Belvedere are not available, as those jurisdictions do not use the Fire Aside platform to track resident engagement.



3.1.5 Evacuation Preparation

Designated evacuation routes have been established for communities in Marin. In accordance with SB99, the safety elements of local general plans must analyze the local road network within their area of responsibility and identify residential areas lacking at least two emergency evacuation routes. Furthermore, as specified by California AB747, planners in Marin must evaluate the designated evacuation routes for safety and viability during a variety of emergency scenarios.

In 2023, Marin Wildfire released a comprehensive evacuation risk assessment to evaluate the safety and capacity of roadways in Marin to support wildfire evacuation. This study helped local officials identify and prioritize areas of concern and actions that could mitigate evacuation risks throughout Marin County. Recommendations from this study included enhanced fuel-reduction programs for evacuation routes, more comprehensive evacuation pre-planning processes, planning for temporary safe locations and sheltering-in-place, traffic restrictions during Red Flag Warning days, and enhanced evacuation drills. The full report is available on the Marin Wildfire website.[36]

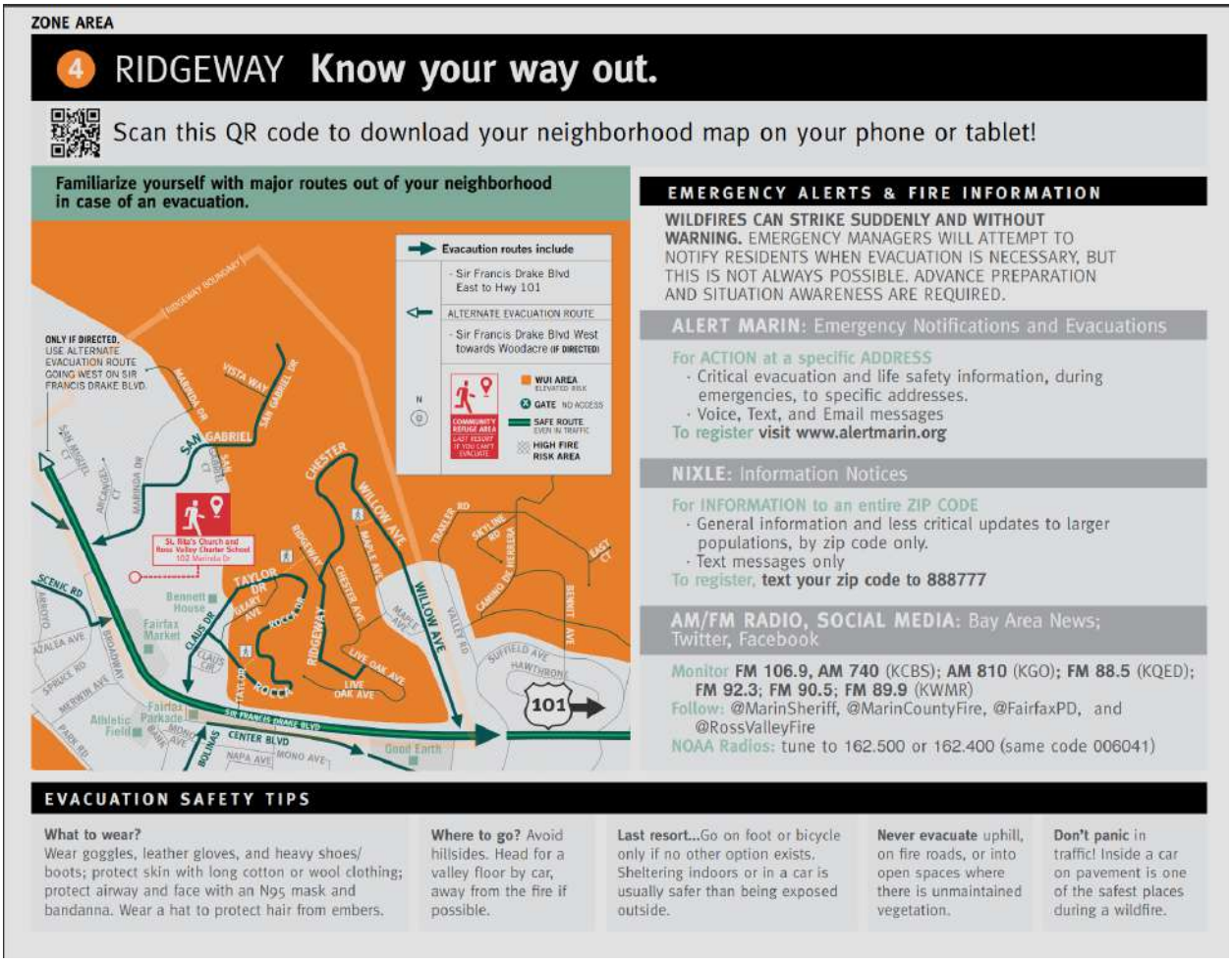
Marin County and its agencies have contracted with Genasys and use this platform to create, manage, and communicate evacuation zones during wildland fires and other incidents, ensuring a consistent, shared operational picture across agencies. The system was adopted countywide beginning in 2021 and is actively maintained as part of ongoing emergency management operations.

[36] **https://www.marinwildfire.org/project/evacuation-ingress-egress-risk-assessment**

Community-specific wildfire evacuation maps have been produced to guide residents during evacuation. These maps provide clear, actionable information on evacuation routes, alert and emergency notification systems, and step-by-step evacuation checklists. Maps are available online through Fire Safe Marin.[37] Fire Safe Marin's role is informational; it aggregates and links to maps produced by jurisdictions using the county's system.

Evacuation drills are conducted regularly. Marin County schools conduct regular emergency drills that include fire as part of a comprehensive preparedness plan. Furthermore, Marin County organizes annual, voluntary wildfire evacuation drills encouraging residents to practice evacuating with their go-bags to a designated spot.

For additional information on evacuation safety, readers should review **Appendix H. Marin County Fire Evacuation Risk Assessment**, which discusses evacuation risk assessment and review the Evacuation Ingress/Egress Risk Assessment.



[37] https://firesafemarin.org/prepare-yourself/evacuation-guide/evacuation-maps/

• • • Insights • • •

Local Operational Playbooks

Marin residents are extremely concerned about being trapped on roadways during evacuation and not receiving emergency alerts. Fire and evacuation managers should help provide additional specific guidance about where to go during an emergency, the routes to take, and how to prepare. When available, consider integrating local data, fire-spread analysis, and/or traffic modeling to improve these plans. Consider addressing special evacuation considerations for schools, medical facilities, community centers, and other community assets if appropriate.

Temporary Fire Refuge Areas

Consider expanding evacuation plans to include temporary fire refuge areas. These areas are predefined areas where residents can take shelter during a fire. Refuge areas can help to alleviate traffic bottlenecks and increase safety by diverting travel during a wildfire. Additional studies, particularly traffic flow modeling and simulation studies, should be performed to identify the most appropriate refuge locations, their capacities, and their role in larger evacuation strategies.

3.1.6 Public Outreach and Education

Marin Wildfire, in coordination with local fire agencies and community stakeholders, delivers clear, actionable, and measurable guidance and assistance to help residents and property owners take meaningful steps toward creating fire-adapted communities. This work includes a range of outreach and engagement activities, including public meetings and community events, field trips and site tours, and presentations and trainings. The agency also provides expert testimony and technical briefings at the state level to inform wildfire safety legislation and policy.

Engaging residents via trusted, high-credibility partners is essential to strengthening community awareness and adoption of wildfire-safe practices. Marin Wildfire has identified a set of strategic partners and professional networks that can significantly expand the reach and impact of wildfire education materials throughout the county. These partners include Marin builders, the Marin Association of Realtors, landscaping and landscape architecture firms, plant nurseries, home-hardening vendors, property managers, and local chambers of commerce. Ongoing partnerships also include Fire-Smart Landscaping programs delivered in partnership with the University of California Cooperative Extension (UCCE) Marin Master Gardeners.

Tiburon Fire District also supports public education and engagement efforts. Tiburon Fire District supports residents via evacuation and emergency preparedness presentations at homeowners' associations meetings, public events, and annual school field trips.



Fire Safe Marin supports and coordinates public wildfire-prevention outreach for Marin Wildfire and local fire agencies throughout Marin County. Each year, Fire Safe Marin connects with thousands of residents through dozens of community events. Fire Safe Marin has a long history of participating in public events in the county and has built a dedicated outreach team of "Ambassadors," along with the equipment, materials, and vehicles to support this work. The organization also maintains a strong digital presence, with more than 150,000 website visits, active social media usage, and regular e-newsletters. Fire Safe Marin produces original educational media, including short instructional videos and a growing YouTube library. Fire Safe Marin's existing communications experience about fire prevention is unique in facilitating this outreach work on behalf of Marin Wildfire and member agencies.

Marin Wildfire, local fire agencies, and local land management agencies are also working to educate the public about the benefits of prescribed and managed fire in Marin's fire-dependent ecosystems. Resources like the OneTam's frequently asked questions on prescribed burns[38] are important tools for garnering public support for prescribed fire projects.

Risk Perceptions Survey

To better understand the needs of traditionally underrepresented groups, Marin Wildfire conducted a Wildfire Risk Perceptions Survey in 2022 and 2023. Focus groups and interviews with 220 participants informed the survey design. The survey involved partnerships with community organizations serving low-income residents, residents of color, and individuals with access and functional needs. The results of this study were provided to CBOs and local fire departments to enable these organizations to more effectively engage with their communities.

Respondents expressed a high level of concern about wildfire risk, particularly related to safe evacuation. Traffic congestion during evacuations was the most significant concern, and many respondents reported limited preparedness, lack of evacuation plans, and uncertainty about where to

[38] One Tam. (n.d.). FAQs: Prescribed burns in Marin. **https://www.onetam.org/faqs-prescribed-burns-marin**

seek temporary refuge. While most residents have received and understood emergency alerts, substantial concerns remain about alert reliability and network coverage.

The survey results also identified major challenges related to residential risk reduction. Many respondents—particularly renters—lack responsibility or authority over exterior maintenance and landscaping, limiting their ability to reduce wildfire risk on their property. Residents were more likely to perceive wildfire risk from neighborhood or nearby open-space vegetation than from their own parcels, highlighting a knowledge gap regarding the importance of on-parcel mitigation.

• • • Insights • • •

Partnering with Community Organizations

Multiple data sources underscore the importance of equity-focused and demographically informed wildfire planning. Ongoing partnerships with community-based organizations (CBOs) and Community Resilience Teams (CRTs) enable agencies to engage residents via diverse and trusted communication channels and address the specific preparedness, evacuation, and risk-reduction needs of historically underserved communities.

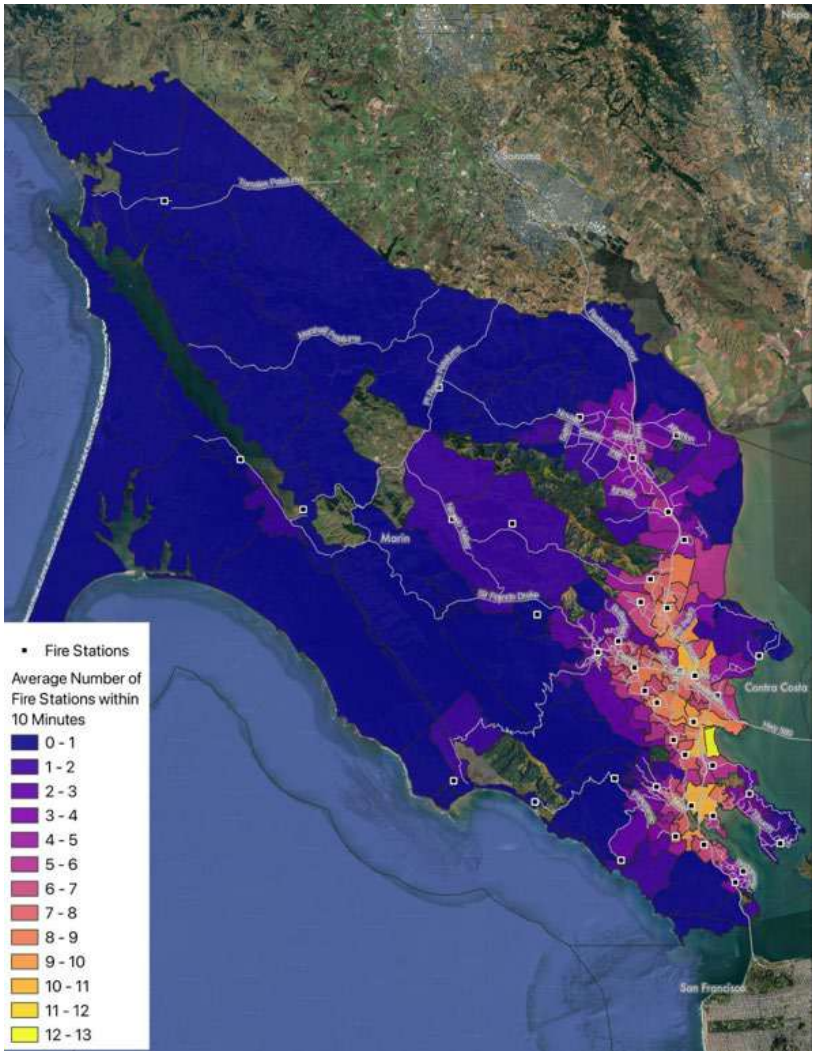
4. Fire Response and Suppression

Pre-fire mitigations are most effective when accompanied by a robust firefighting response. Local agencies in Marin are well prepared to engage with significant wildland fires.

Across all jurisdictions, there are 76 fire engines, of which about 40% are designed specifically for wildland firefighting. There are also six water tenders for helping establish water supplies at rural incidents and two dozers for cutting firebreaks. Furthermore, Marin County Fire staffs four handcrews that provide support for fire suppression and pre-fire mitigation activities.

These fire resources are distributed across the county and are strategically located to serve residents rapidly. Spatial network analysis indicates that the vast majority of structures in Marin can be reached within 10 minutes of fire engine travel time.

In the event of a major wildland fire, resources from neighboring jurisdictions will assist, in accordance with existing automatic and mutual aid agreements. Fire responders from other counties may take longer to arrive and may arrive with limited coordination compared with responders within the same county, who regularly train together and respond to incidents together. Particularly in areas along the Sonoma County border, adjacent county mutual aid plays an important role in the initial fire response. No agency in Marin is capable of preventing large-scale structure loss alone. Automatic aid and mutual aid resources are important in preventing large-consequence fires in Marin. Prioritizing



initiatives that ensure smooth communication and practicing inter-agency operational tactics and strategies will maximize the effectiveness of mutual aid.

Aid agreements also facilitate resource prepositioning. During certain fire weather conditions, additional resources can be positioned and upstaffed within the county and the surrounding region. These agreements ensure that sufficient firefighting response resources are available during periods of high fire danger.

Marin County is also well covered by regional aerial firefighting resources. In addition to hosting an exclusive-use firefighting helicopter in Novato (a partnership between Pacific Gas & Electric and Marin County Fire), two Firehawk helicopters, capable of nighttime operations, two C-130 large airtankers, and nearly a dozen S-2T airtankers are located within about 30 minutes' flight-time of the county.

For additional information on fire suppression and response in Marin, readers should refer to **Appendix I. Marin County Fire Response Assessment**, in which local and mutual aid suppression resources are tallied and response times throughout the county are modeled.

• • • Insights • • •

Combined Strength from Pre-Fire Mitigation and a Robust Fire Response

Prioritize additional fire-mitigation activities in areas in which fire response will take longer. There may be fewer firefighters than structures needing structure defense in these areas. Additional home hardening, defensible space, vegetation management, and evacuation initiatives in these areas can slow fire growth and resist its transition into the built environment, while providing additional time for firefighters to arrive to perform offensive and defensive actions. Firefighters are safer and more effective when engaging in fire suppression in resilient and prepared communities compared with communities with hazardous fuels and unprepared homes. In areas where evacuation is difficult, firefighters often spend time and energy assisting evacuations, rather than suppressing the fire, which can lead to increased fire growth and community damage.

5. Prioritizing Risk-Reduction Activities

The primary objective of this CWPP is to provide data-driven recommendations for various types of risk-reduction activities based on the risk profile of different areas of the county. The results of this prioritization analysis are designed to help plan and select mitigation strategies that meet the specific needs of Marin communities. This prioritization analysis uses evacuation zones as a method for geographically partitioning the county into distinct neighborhoods.

Specifically, the goals of this prioritization analysis include:

1. Identifying which risk-reduction activities are most important in each evacuation zone.
2. Creating maps of the relative priority of each mitigation activity across the county.
3. Supporting local subject matter experts build better, more data-informed programs by complementing on-the-ground knowledge



The CWPP addresses risk across several Prioritization Themes that characterize different types of risk and highlight potential activities to address those risks. These Prioritization Themes include:

1. **Vegetation Management Near Communities:** Maintain appropriate vegetation management in the areas between the wildlands and the built environment.

2. **Vegetation Management In Open Space:** Maintain appropriate vegetation management throughout the county's open spaces, including in parks, watersheds, and other vegetated areas, and around key utility assets.
3. **Roadside Vegetation Clearance:** Maintain safe travel conditions along evacuation routes.
4. **Fire Detection:** Ensure fires are detected quickly.
5. **Alerting:** Promote safe evacuations via robust public alerting systems and ensure residents are ready and able to act on the alerts.
6. **Evacuation Planning:** Maintain safe evacuation plans and prepare for contingencies.
7. **Residential Risk Reduction:** Reduce structural ignitability on all parcels via defensible space and provide resources on fire-adapted building codes. Assist the community with the creation of defensible spaces, fire-adapted structures and homes, and fire-adapted landscaping through grants and direct assistance.

Previous Marin County CWPPs provided more general recommendations. The theme-based prioritization system of this CWPP enables stakeholders to disaggregate risk into various components based on their mission, authority, available funding sources, partnerships, and other on-going priorities. For example, stakeholders responsible for safe evacuation can review the Alerting, Evacuation Planning, and Roadside Clearance themes, while defensible space inspection programs can review the Residential Risk Reduction theme. This approach is designed to provide a flexible and explainable system, while enabling stakeholders to take action on different kinds of risk throughout the county.

The CWPP relies on Marin Wildfire's system of strategic measures to track risk reduction towards each of the risk reduction activity themes.

5.1 Risk Assessment Models and Tools

Many wildfire risk-assessment tools are available. Each tool has its own strengths and weaknesses, and each tool provides recommendations with specific caveats and focuses. The goal of the CWPP is to identify areas of consensus where many tools indicate high risk to a particular type of community asset. This approach ensures that programs are being prioritized where there is the greatest chance of success for risk reduction. The goal of the consensus analysis is not to create a "perfect" wildfire risk model; rather, it is to overcome the tool-specific limitations associated with each risk-assessment method.

The tools included in the CWPP range from wildland fire behavior models, assessments of risk in the built environment, and methods for characterizing roadway safety. In the following section, these different methods for risk assessment are brought together into a single unified risk-assessment framework. Each of these tools have been vetted and evaluated by Marin Wildfire and agency staff

prior to inclusion in the CWPP. A full description of each of the methods is provided in **Appendix M. Wildfire Risk Assessments and Modeling Tools**.

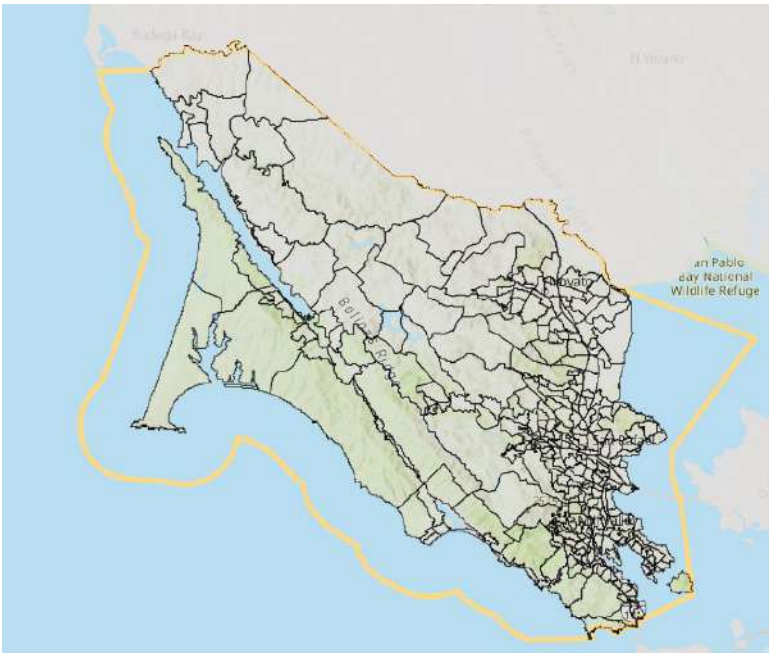
The tools incorporated into the CWPP's prioritization process include assessments of the following factors, among others:

- Burn probability
- Potential flame length, rate of spread, and canopy fire activity
- Ember production, transport, and deposition
- On-parcel vulnerabilities
- Roadways where travel is difficult and where evacuees could be exposed to unsafe conditions
- Fire response travel time

The risk models employed in the CWPP are robust and proven tools for evaluating and measuring wildfire risk. They leverage contemporary science and integrate fire-spread dynamics, principles of thermodynamics, and fire response information. However, these tools should not be used in isolation. Rather, they should be incorporated into planning and project implementation by local subject matter experts. Armed with data and the ability to track risk over time, program staff can supplement their local, on-the-ground knowledge with defensible metrics to demonstrate the efficacy of their programs.

5.2 Evacuation Zones

The CWPP uses evacuation zones (EZs) as prioritization units. EZs function as discrete units within which each risk is evaluated and mitigation activities are prioritized. EZs were established by fire operations teams throughout Marin County using recommendations developed by Genasys. Each EZ has a permanent name and identifier that creates an ideal system for ongoing prioritization and tracking changes over time. Furthermore, EZs reinforce the connection between fire preparedness and response, and they can be communicated with the public directly.



5.3 Prioritization Methodology

The CWPP prioritizes actions using a consensus-based approach that highlights locations where multiple risk indicators act in concert to result in elevated risk. For each theme, prioritization follows a consistent, repeatable process:

- **Identify values at risk.** Each theme considers only the values that matter for that topic. For example, utility assets are a key value in the Vegetation Management Near Communities theme, but these assets are not considered in the Detection theme.
- **Identify risk assessments.** As with values at risk, not all risk assessments are appropriate for all themes. The CWPP identifies the most appropriate tools to use for each theme.
- **Analyze local risk.** For each risk-assessment tool, the risk assessment in the vicinity of each value at risk is calculated. For example, the Near-Community Vegetation Management theme considers flame lengths within 200 feet of structures.
- **Aggregate results.** Risk scores from all applicable values and assessments are combined and summarized at the evacuation-zone scale.
- **Ranking.** Zones are converted to percentile rankings to enable clear comparison and support decision making.
- **Recommendations.** Recommendations are formulated for each zone based on the risk factors within each zone.

Because reducing wildfire risk requires acting where fire behavior is most severe, the core prioritization methodology is based on fire-behavior science rather than social vulnerability or demographics. Social vulnerability data are applied separately, to help guide the recommended design of grant and outreach programs so that risk-reduction efforts also reach the county's most vulnerable residents.

5.4 Public Outreach and Education

Underpinning many community wildfire resilience initiatives are effective public outreach and engagement programs that help residents understand what to do, why these initiatives are important, and how their actions can contribute to community-scale risk reduction. Because public outreach is a cross-cutting theme, it is not considered as a standalone prioritization theme in this CWPP. Instead, public outreach is integrated throughout as recommendations for targeted programming initiatives that support specific risk reduction strategies. Fire agencies in the county, Marin Wildfire, and Fire Safe Marin all engage in many different forms of community outreach and education.

In addition to theme-specific recommendations, this CWPP offers several overarching recommendations for future outreach and education programs in the county:

- **Development and coordination of new and existing Firewise communities:** Firewise communities provide a personalized and customized approach to deliver fire-prevention messaging. Residents in these communities are more likely to take proactive measures, such as home hardening and creating defensible space, to reduce wildfire risk and protect their homes. Because these neighborhoods commit to risk reduction, they can serve as coordinated hubs for residential risk reduction and roadside vegetation clearance. Firewise neighborhoods also offer benefits to evacuation and alerting by creating a more deeply integrated community of neighbors who can look out for one another during an emergency.

  Firewise communities commit to engaging in a number of prevention and education activities annually, which require support and materials. Fire agencies in Marin should support the expansion of the Firewise program in Marin County by supporting existing Firewise neighborhoods and helping foster the creation of new Firewise groups when possible. Consider providing regular hands-on education for these groups or financial or material support, when appropriate.

- **Community events:** Marin Wildfire and member agencies take advantage of existing public events happening across the county throughout the year to raise awareness and provide resources about fire adaptation, fire agencies, Fire Safe Marin, and Marin Wildfire. These organizations should continue to have active involvement in public events throughout the county to ensure that fire-prevention messaging is being shared as broadly as possible.



- **School education and outreach:** Marin County fire agencies recognize the importance of early, consistent wildfire education delivered via trusted community channels, particularly schools. Schools provide a unique and credible pathway to reach parents, caregivers, and families of school-aged children with actionable wildfire-preparedness information. Education of school-age children reinforces the importance of local evacuation preparedness planning, emphasizes the agency of local residents in reducing fire risk, and creates effective dialogue around fire risk reduction.

  Rather than creating new standalone programs, local fire agencies should leverage existing school events, organizational structures, and relationships to reinforce family preparedness

behaviors that reduce wildfire risk and improve community resilience. Fire agencies and emergency managers should integrate local evacuation playbooks as one element of school education and outreach programs.

- **Integrate novel approaches:** Wildfire preparedness education based on data, knowledge, or information alone does not always result in people taking risk-reduction action. Zone Zero compliance is triggering fight-flight-freeze reactivity in the public (e.g., defensiveness, resistance, distrust, and blame). Marin Wildfire and local fire agencies should create and implement programs and training that raise awareness about how fight-flight-freeze neurobiology can prevent personal mitigation action and behaviors. Agencies should provide training to build internal capacity and interpersonal skills, including co-regulation, communication, and empathy.

Marin Wildfire's Goal 4 outlines data-driven measures for tracking progress towards outreach and education goals. These metrics include:

- The percent of residents that meaningfully interact with their Wildfire Risk evaluation inspector
- The percent of parcels organized into fire-focused communities (Firewise, The Insurance Institute for Business & Home Safety (IBHS) prepared)
- Partnerships with organizations and vendors, including but not limited to those involved with home preparedness: builders, realtors, landscape architects and landscapers, nurseries and home-hardening vendors, property managers, and chambers of commerce
- Partnerships with unique needs communities from a fire-risk perspective

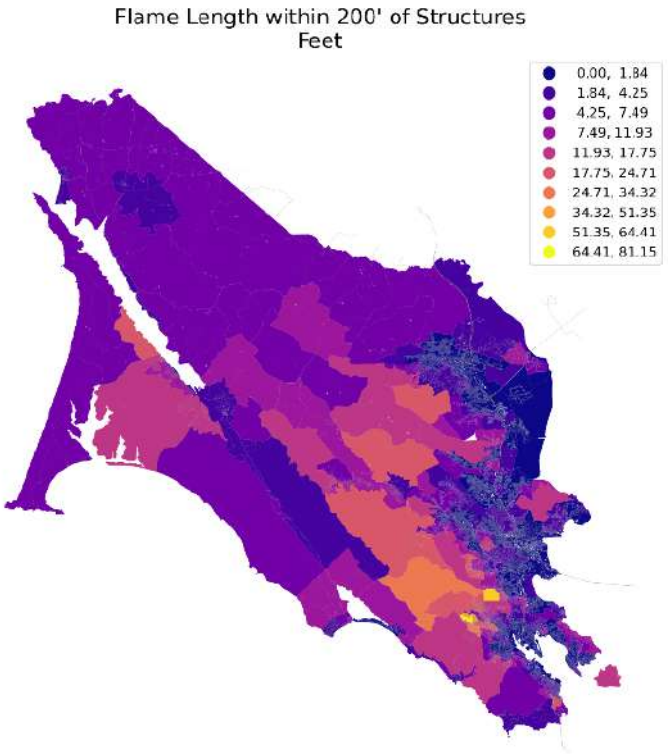
5.5 Near-Community Vegetation Management

Vegetation management near communities is prioritized where high-severity fire is projected to impact structures and infrastructure (energy, water, or communications). The goal of this theme is to identify where targeted shaded fuel breaks, mowing programs, or intensive herbivory could provide the greatest impact towards slowing fast-moving fire spreading towards communities or critical community assets. More distant fuel treatments, such as forest health projects or strategically placed local area treatments (SPLATs) are covered by the next theme, which addresses risk reduction potential further from the built environment.

Near-community vegetation management is prioritized where:

- Flame length is high within 200 feet (90 meters) of structures, indicating the potential for high-severity and difficult-to-suppress fires around homes.
- Entry points or fire pathways that enter the built environment are present, indicating the potential for rapid fire spread affecting residences in the community.

- Many structures are present, indicating the potential for vegetation management to affect many residents at once.



Recommended actions for these areas include:

- Targeted vegetation management to reduce fuel loads near residential structures (shaded fuel breaks), with a particular focus on interrupting the fire pathways capable of bringing fire into the community.
- Targeted vegetation management to reduce fuel loads near key infrastructure locations (such as pump stations, transmission towers, and substations). Vegetation management in these areas can help prevent ignition of these assets and ensure continuity of service during a large-scale wildfire.
- Strategic grazing and/or mowing programs to interrupt fire pathways in lighter fuels. These programs should focus on the areas where wind, fuel, and terrain align to produce rapid fire spread towards communities.
- Coordination with residents to maximize the effectiveness of vegetation management. In areas where agencies are creating shaded fuel breaks, consider additional messaging, defensible space inspection coverage, or incentive programs to reduce the vulnerability of parcels adjacent to the management project. Coordinated action can bring network effects that increase the value of vegetation management alone.
- Continue to maintain existing vegetation management projects and ensure adequate budget to re-treat key areas regularly. Consider prioritizing areas along fire pathway entry points to help slow fire growth before it becomes established within the community.
- In areas where hazardous materials facilities may be exposed to wildfires, ensure that these facilities have adequate defensible space and that they have contingency plans for a wildfire evacuation. Ensure that responding firefighters are aware of local hazardous materials facilities and are equipped with the proper equipment when responding to fires in these areas.

The metrics used to track progress towards this goal include:

- **Acres Approved for Treatment:** This metric tracks the acres approved for vegetation management treatment via regulatory processes like CEQA.[39]
- **Acres of Treatment Implemented:** This metric evaluates the acres of strategic fuel reduction completed.
- **Flame Length Reduction:** Flame length is an observable measure of fire intensity. This metric tracks the change in flame length within the treatment areas, highlighting areas where fire intensity is measurably decreased due to management activities.
- **Attackable Area Increase:** This metric tracks the change in the area within a treatment project with flame lengths less than 4 feet, which are likely to be accessible to ground-based firefighters for fire suppression.
- **Composite Fire Behavior Reduction:** Because fire behavior is multidimensional, this metric tracks the change in a composite fire behavior metric (including flame length, rate of spread, canopy fire activity, attackable area, and ember flight distance) within treated areas.

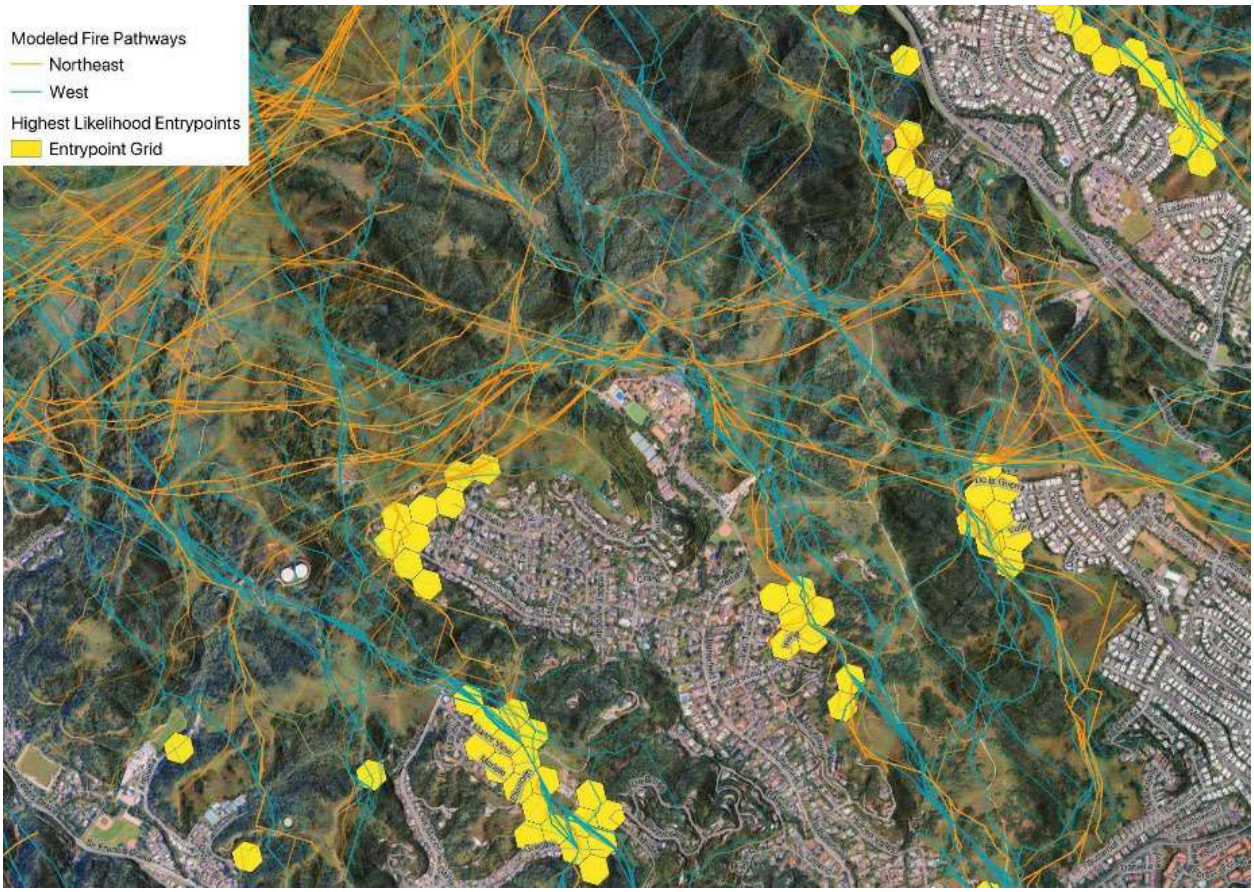
5.6 Vegetation Management in Open Space

Vegetation management in open spaces can be effective at maintaining healthy ecosystems and watersheds and preventing rapid fire development and the spread of fire towards other values at risk. This theme is designed to identify areas where landscape-scale management, Potential Operational Delineations (PODs), and SPLATs could provide the most benefit. Drinking water headwaters are evaluated to identify areas where pre-fire vegetation management can prevent runoff and water-quality issues arising from unplanned high-severity fires.

Prioritization factors for vegetation management in the open space include:

- Fire pathways that lead into the built environment, indicating the ability for vegetation management to interrupt fire spread before it reaches the community.
- Relatively low fire response capacity, indicating areas where fire responders may be delayed due to difficult access or long travel times.
- Burn probability, flame length, ignition risk, and rate of spread are high near utility infrastructure. Utilities include energy, water, and communications infrastructure. This analysis indicates the potential exposure that could compromise community safety by causing failures in electric or water distribution or the inability to send timely emergency alerts due to impacted communications infrastructure.

[39] California Environmental Quality Act (CEQA). [40] California Wildfire and Forest Resilience Task Force. (2022). California's strategic plan for expanding the use of beneficial fire. **https://wildfiretaskforce.org/wp-content/uploads/2022/05/californias-strategic-plan-for-expanding-the-use-of-beneficial-fire.pdf**



- High flame length and likely canopy fire activity, particularly within drinking water headwaters, indicating the potential for high-severity fires to cause tree mortality and subsequent issues to drinking water supply or runoff.
- High burn probability and ignition risk, indicating the likelihood of new fire starts that could be addressed via ongoing management.

Recommended actions for these areas include:

- In areas where contemporary fire suppression has caused substantial deviation from "natural" fire return intervals, consider re-introducing beneficial fire as a tool to maintain this landscape. Large-scale, low-intensity broadcast burns are recommended in areas with the potential for high-severity, high-mortality wildfires, particularly within watershed headwaters, to lower the likelihood of post-fire flooding and water-quality impacts. Work with public information officers and communications staff to educate the public on the benefits and risks of prescribed fires. Leverage existing communication tools, such as California's Strategic Plan for Expanding the Use of Beneficial Fire.[40]

[40] California Wildfire and Forest Resilience Task Force. (2022). California's strategic plan for expanding the use of beneficial fire. https://wildfiretaskforce.org/wp-content/uploads/2022/05/californias-strategic-plan-for-expanding-the-use-of-beneficial-fire.pdf

- SPLATs along fire pathways leading into communities to slow fire growth and enable evacuation and firefighter ingress.
- Develop projects that incorporate both ecological and fire risk reduction benefits.
- Transmission lines cause elevated ignition risks, may be vulnerable during a fire, and can cause extended power outages if affected by fire. Consider vegetation management along rights of way to limit impact of ignitions and wildland fire exposure. Work with electric utility partners, including Pacific Gas & Electric, to ensure ongoing maintenance of vegetation management along high-risk transmission line corridors.
- High-severity fires may adversely affect drinking water availability and quality in areas that are the source of drinking water. Consider low-intensity broadcast burning and other landscape-scale vegetation management to reduce the risk of water quality and/or post-fire runoff impacts of unplanned high-severity fires.
- Consider extended clearance around infrastructure assets to ensure continuity of service during a wildfire. Assets include energy (substations and solar plants), water (pump stations, dams, and other facilities), and communications (AM/FM broadcast towers and cellular towers). Vegetation management should be conducted to ensure that these assets, which are often located in remote areas, can withstand a wildfire with minimal firefighter intervention.

Metrics used to track progress towards this objective are the same metrics used to track progress towards the Near-Community Vegetation Management objective.

5.7 Fire Detection

Although the likelihood of fire detection in Marin is already very high, some areas of the county may benefit from additional investments in detection capabilities. Detection is a priority in areas that are (a) not covered by the viewshed of a wildfire camera and (b) located far from roads and settlements. Other areas are already likely to have rapid detection, either due to resident reporting through 911, wildfire detection cameras, or both.

Priority for investments in fire detection is highest in areas with:

- A low percentage of space covered by fire detection cameras, indicating a large portion of the evacuation zone is “blind” to the cameras.
- A high ignition risk and a rate of spread within areas not covered by wildfire cameras, indicating the potential for rapid development within the blind spot.
- A high ignition risk and rate of spread within areas more than 1,000 m from roads, indicating the potential for rapid growth in areas that are difficult for firefighters to reach and less likely to be observed by passing vehicles.



Recommended actions in areas where detection is a priority include:

- Installing additional wildfire detection cameras to reduce blind spots, particularly in remote areas far from communities where rapid fire growth is anticipated.
- Pre-positioning apparatuses to increase the rate of fire response in remote areas with difficult access.
- Manned or unmanned (fixed-wind, rotorwing, Unmanned Aerial Vehicle/drone) aircraft flights over areas where detection is difficult during periods of significant fire weather.
- Coordination with energy utilities and planning public-safety power shutoffs (PSPS) to reduce the likelihood of utility-caused ignition in hard-to-detect areas.
- Evaluate satellite-detection capabilities as space-borne systems become more capable of providing high-resolution, near-real-time wildfire detection support.

Metrics used to track progress towards this objective include:

- **Detectable Acres:** Percentage of acres visible from two or more camera installations that would enable the detection of a 50-foot smoke column.

5.8 Alerting

AlertMarin, the countywide alerting system for Marin, advises community members to take action to protect themselves during and after emergencies. The Alerting prioritization theme is focused on increasing AlertMarin subscriptions and pre-incident planning, including incorporating demographic data into planning efforts to support community members that may be at increased risk due to accessibility or mobility challenges.

Prioritization factors for the Alerting theme include:

- The percentage of parcels with at least one active AlertMarin subscription, indicating areas where few community members are subscribed to geographically targeted, action-oriented emergency warnings.
- Fire pathways and high rates of spread within 200 feet of structures, indicating areas where fire is likely to move quickly into communities and can trigger rapid evacuations.
- Household characteristics (Social Vulnerability Index [SVI] Theme 2), indicating access and functional needs or transportation issues that could limit the ability to quickly and effectively evacuate after receiving an emergency alert.



In areas identified by the Alerting prioritization theme, recommended actions include:

- Evaluate existing public education campaigns to help community members understand alert channels, sign-up process, and definitions of different evacuation terminology.
- Continue to enhance alerting system effectiveness by encouraging sign-ups for AlertMarin and maintaining modernized alerting capabilities.
- Continue to partner with CBOs, including Community Resiliency Teams, neighborhood associations, faith-based groups, tenant coalitions, and cultural centers, to help distribute preparedness and evacuation messaging before and during emergencies. Consider new partnerships to drive sign-ups in low subscription areas. Identify alternative messengers in communities with limited trust in law enforcement or government agencies to increase compliance and reduce fear during evacuation orders.
- Ensure that evacuation and emergency alerts are accessible in both English and Spanish.
- Establish the Marin County Alert and Warning Annex to the Marin Emergency Operations Plan.
- Advocate for and support policy changes at the state and federal level to address gaps in WEA data coverage and ensure emergency managers have the data from cellular providers necessary to successfully send alerts.

Metrics for tracking progress towards the Alerting prioritization theme include:

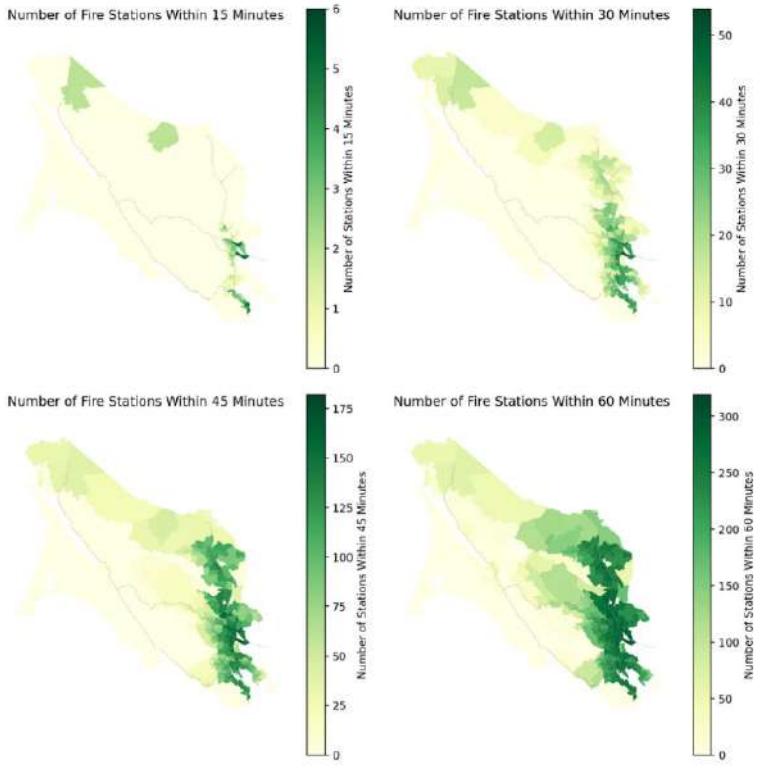
- **Alert Marin Subscriptions:** The percent of all parcels that have at least one AlertMarin subscription.

Additional measures may be developed in the future.

5.9 Evacuation Planning

The evacuation Planning theme identifies areas where additional planning and evacuation management should be implemented. Evacuation Planning is distinct from the Alerting and Detection themes and covers activities beyond roadside vegetation management.

Evacuation planning is prioritized in areas in which:



- The burn probability is high within 200 feet of structures and roadways, indicating a high likelihood of fire exposure and potential evacuations.
- Fire pathways and entry points are near structures and along roadways, indicating the potential for fast-moving fires to impact these assets.
- There are high roadway difficulty scores, highlighting road segments that have a complex geometry (curvy, multi-way intersections, etc.), have a high potential for collisions, or are on steep grades.
- There is relatively low fire response capacity, indicating areas where fire responders may be delayed due to difficult access or long travel times.
- There is a relatively large population, indicating areas where a significant number of residents may need to evacuate during a wildfire event.

Recommended risk reduction activities for this theme include:

- Continue public outreach and engagement to help residents understand the evacuation process and where to go during an evacuation.
- Identifying local evacuation playbooks for each zone, potentially including temporary fire refuge areas (TFRAs), and coordinating the execution of these plans with local agencies, law enforcement, and community residents. Develop evacuation-decision points informed by fire behavior modeling and fire weather characteristics.

- Prohibiting parking along key evacuation routes during Red Flag Warning days to ensure adequate road supply for evacuations.
- Preparing local playbooks for law enforcement and public works to manage intersections likely to create traffic bottlenecks.
- Performing community-specific evacuation drills to familiarize residents with the evacuation process and local evacuation routes.
- Enhance planning for older adults, individuals with mobility-related disabilities, caregivers, and service animals, alongside children, the unhoused by developing zone-specific response plans that identify transportation resources and specific assistance requirements.
- Work with school districts to ensure that school staff, children, and parents are familiar with evacuation procedures. Identify and document evacuation routes and backup plans. Evacuation plans are recommended for all schools, even those outside of the wildland urban interface, given the potential for large-scale urban fire spread and potentially limited communications between parents and school administrators during a severe fire event.
- Medical and other emergency facilities that may need to be evacuated should consider advanced evacuation planning. Staff should be familiar with evacuation procedures. Operational playbooks are recommended for all hospitals and senior facilities. These facilities face unique constraints and may require specific resources (such as ambulances) during evacuation.

Metrics to track progress towards evacuation planning have not yet been developed.

5.10 Roadside Clearance

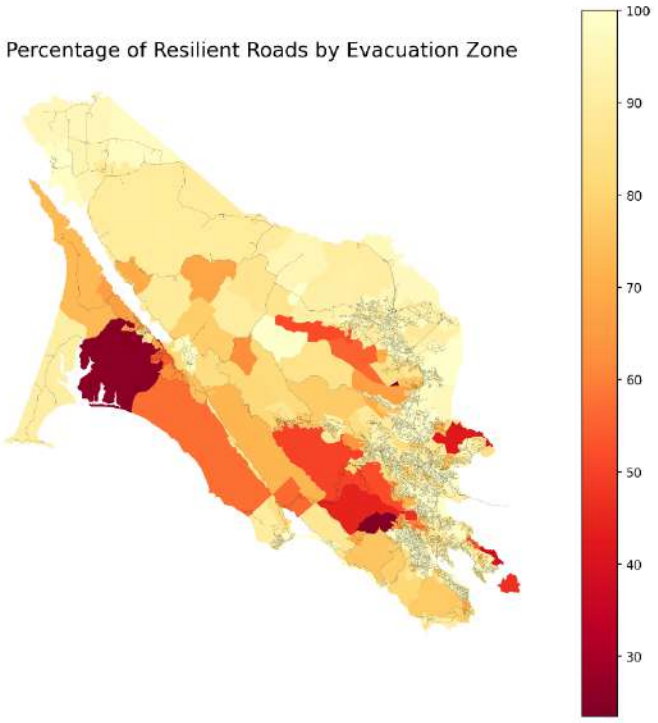
Roadside clearance is recommended in areas where evacuation routes may not support safe evacuations due to adjacent fire conditions. In these locations, targeted roadside vegetation management can remove hazardous fuels to enable safer ingress for firefighters and egress for evacuating residents. These treatments can also reduce the likelihood of roadside ignitions by lowering fuel continuity and ignition susceptibility along high-risk road segments.

Note that while the CWPP prioritizes evacuation zones for roadside clearance, the roads themselves are the priority objective. Often, major roads form the border of the evacuation zone. Staff should review these maps carefully when considering roadside clearance programs. Moreover, conditions can vary on small scales, and targeted, site-specific roadside clearance projects can make substantial differences in evacuation safety and firefighter ingress.

The highest priority areas for roadside clearance are those with:

- A high burn probability and ignition risk along roadways, indicating a high likelihood of fire exposure or new fire starts.

- A high flame length and likely canopy fire activity along roadways, indicating the potential for high-severity fire conditions that could threaten egress or ingress.
- A high fraction of non-fire-resilient roads, indicating that roadways in the zone may not support safe evacuation during peak fire conditions due to high-severity fire adjacent to the roadway.
- The presence of fire pathways along public roadways, indicating a high likelihood of rapid fire exposure, which could impact evacuation.



In areas identified by the Roadside Clearance prioritization theme, recommended actions include:

- Clear roadside vegetation in areas anticipated to produce high flame lengths, which could compromise evacuation routes. Prioritize clearance along designated evacuation routes, which are anticipated to serve many evacuees during an evacuation and may be the only way out of the community.
- Consider targeted clearance along roadways where canopy mortality may cause standing dead trees to fall and compromise evacuation routes.
- Ensure roadway vegetation allows fire apparatus ingress. Clear vegetation both horizontally and vertically along roadways to ensure both access for firefighters and egress routes for residents.
- Manage lighter fuels through mowing or weed-whipping to reduce the potential for vehicle-caused ignitions in areas of high ignition risk.
- Coordinate road maintenance and vegetation management among fire agencies, the California Department of Transportation, and the Marin County Department of Public Works to ensure clearance and limit traffic bottlenecks during peak fire season.
- Defensible space around vulnerable bridges on evacuation routes is recommended to ensure they are not compromised during a large-scale evacuation.

Metrics to evaluate progress towards the roadside clearance theme include:

- Fire-Resilient Roads: The percent of road miles that are fire resilient. Cars provide protection from heat, embers, and smoke during a wildfire evacuation. Fire-resilient roadways have been cleared of vegetation so that, at the peak intensity of the fire, the temperature inside the car is expected to rise no more than 3°F per minute.

5.11 Residential Risk Reduction

The Residential Risk Reduction theme addresses the potential to address wildfire risk via on-parcel risk reduction, including defensible space and home hardening. This theme prioritizes activities in areas in which high-density structures are likely to be exposed to fast-moving wildfires and where resident action could yield benefits that extend well beyond individual properties.

Prioritization factors for the residential risk reduction theme include:

- A high rate of spread within 200 feet of residential structures, indicating the potential for fast-moving vegetation fires to ignite structures.
- High structure exposure scores (SES) within 200 feet of residential structures, indicating a high probability of high-severity fires and embercast.
- High on-parcel risk scores, indicating numerous on-parcel vulnerabilities, including combustible building materials, structure design, or defensible space violations.
- Presence of a fire pathway entrypoint, indicating the potential for fire to quickly move from the wildland into the built environment.
- A relatively low fire response capacity, indicating areas where fire responders may be delayed due to difficult access or long travel times.
- Low structure separation distance, indicating areas of high-density buildings where urban fire may become established.

Recommended activities for zones identified by this theme include:

- Focus inspections and re-inspections on high-risk parcels to ensure compliance with defensible space requirements. Consider enforcement in these areas, when applicable.
- Develop a risk-based grants program that supports residents in high-risk, low-resource areas. Grants should focus on high-return-on-investment activities, such as vent screens, combustible fences, and vegetation in Zone Zero.
- Expand resident outreach and engagement to increase understanding of parcel-level wildfire risk in areas with high risk and low engagement. Use direct mail or home-to-home outreach to encourage participation in defensible-space and home-hardening programs. Identify and

collaborate with CBOs, Firewise leaders, and neighborhood groups to further promote engagement.

- Focus chipper programs in high-risk zones to derive benefits from on-parcel vegetation removal.
- Coordinate outreach and assistance efforts with community-based organizations to reach renters, elderly residents, and non-English-speaking households who may face barriers to participation. Consider deploying Spanish-speaking inspectors and bilingual materials when performing defensible space inspections in zones that have many Spanish-language-speaking residents. While resources in other languages could be useful for some residents, focusing on Spanish speakers is likely to provide the greatest opportunity for sharing important information with non-English speakers.
- Enable residents to schedule inspections or make appointments with defensible space inspectors to maximize the educational benefits of home evaluations, if desired.
- Pilot innovative incentives programs that address the social aspects of resistance to residential risk reduction.



- For Marin Wildfire member agencies using Fire Aside, provide accurate, detailed, and up-to-date information on each of the approximately 120 "discoveries." Campaigns should be developed to increase awareness about the inspection reports, create a call to action, and provide a continuum of branding and vocabulary so that the language in the Wildfire Risk Report is integrated with information available via other member agency outlets.
- Support residents in implementing the recommended mitigations outlined in their wildfire risk reports (or inspection summary) and provide reference resources to residents, such as plant lists, landscaping design advice, and contractor lists.

The metrics used to track progress towards this goal include:

- **Evaluation Progress:** tracks the number of evaluations of residential parcels, calibrated against an agency-set target for evaluation coverage, providing a measurement of progress against a predetermined benchmark.

- **Resident Engagement:** reports the degree to which Marin County residents are engaging with their on-parcel risk factors by tracking the number of residents who open their Wildfire Risk Report.
- **Mitigation Progress:** tracks the percentage of parcels that resolve at least 50% of all defensible space violations found on their parcel.
- **Reducing Risk on Private Parcels:** tracks the percentage of evaluated parcels with at least one unresolved issue identified as high risk via a multi-dimensional analysis of the risk attributable to each finding identified in the home evaluations.
- **Reducing Flame Length:** counts the number of evaluated parcels for which all remaining fire hazards have a projected flame length of 4 feet or less, a threshold at which fires are anticipated to be easier to control.
- **Grant Program Contribution to Risk Reduction:** tracks the contribution of the Marin Wildfire's grants program to the overall mitigation effort by evaluating the percentage of residential risk factors resolved with the assistance of Marin Wildfire grant funds.

Public-facing dashboards are available to show progress towards risk-reduction goals on these measures.

6. Stakeholder Engagement and Insights

6.1 Stakeholder Engagement Summary

A key requirement when developing a CWPP is stakeholder and community involvement and collaboration. A CWPP provides a mechanism for obtaining community input and identifying where wildfire risk is highest, where communities are most vulnerable, and where investments in mitigation can deliver the greatest reduction in potential wildfire impacts. The information contained in this plan reflects the collaboration of county stakeholders made up of fire agencies, land managers, county departments, and other groups and organizations. Table 1 lists the stakeholders that are included in the CWPP stakeholder group.

Table 1. CWPP stakeholders.

Fire Agencies			
Marin County	Southern Marin	Bolinas	Central Marin
Inverness	Kentfield	Novato	Tiburon
Stinson Beach	San Rafael	Muir Beach	Ross Valley
Special Districts			
Marinwood Community Services District		Inverness Public Utilities District	
One Tam Partners and Land Management Agencies			
NPS		California State Parks	
Marin Water		Marin County Parks	
Parks Conservancy			
Private Groups, Private Foundations, and Educational Services			
PG&E	Point Blue	Firewise Communities	Fire Safe Marin
ESPs	Homeowners Associations and Property Owners Associations	UC Agriculture and Natural Resources	
County and Local Government Agencies			
City of Larkspur	City of San Rafael	Town of Tiburon	Law Enforcement Agencies
Muir Beach Community Services District	City of Belvedere	Town of Fairfax	Town of Corte Madera
Town of San Anselmo	Town of Ross	City of Mill Valley	OEM

A variety of collaboration strategies were used to interact with the stakeholder community, including:

- Monthly project updates and presentations delivered via regular stakeholder meetings, often delivered in combination with Marin Wildfire's Advisory/Technical Committee (ATC) meetings.
- One-on-one and small-group stakeholder meetings with local officials, fire personnel, community leaders, and land managers.
- Surveys and homework assignments developed to collect input, feedback, and local knowledge-based validation from stakeholders on project data inputs, initial fire modeling results, and prioritization methodology (see **Appendix O. Homework Questions, Comments, and Responses**).
- Regular office hours to solicit feedback and answer questions on CWPP prioritization results.

Feedback was reviewed and incorporated throughout the planning process to ensure the plan reflects local conditions and community perspectives. Data collected throughout the feedback process are provided in several of the attached appendices and constitute a valuable resource for ensuring that ongoing planning efforts continue to reflect the place-based knowledge of agency staff and other stakeholders.

6.2 Public Engagement

Meaningful public engagement was central to the development of Marin County's CWPP. The educational outreach kept residents, landowners, community organizations, Firewise leaders, local partners, and fire agencies informed, while creating opportunities to share local knowledge, raise concerns, and help shape wildfire risk reduction priorities. The engagement strategy increased awareness of wildfire risk and shared responsibilities, incorporated neighborhood-specific experience into strategic planning, strengthened coordination among residents and agencies, and translated CWPP data into practical actions residents could take at home and with neighbors.

6.2.1 Fire Safe Marin's Public Education and Outreach Role

Fire Safe Marin played a major role in making the CWPP process visible, understandable, and actionable. Its work went beyond event promotion by translating technical planning, wildfire risk data, and agency priorities into clear public education. Fire Safe Marin, in collaboration with Marin Wildfire and the CWPP consultant team, published nine CWPP-related news articles on its website (visit the Fire Safe Marin's **Articles website** [**firesafemarin.org/resources/articles-2/**] and select the CWPP tab), each focused on specific facets of the plan and helping residents understand each topic, why it mattered, and how agency-level work connects to resident-level home hardening, defensible space, evacuation planning, Chipper Days participation, and neighborhood coordination.

Fire Safe Marin also distributed the CWPP in front of multiple audiences through email and social media. It sent 10 email blasts across three targeted subscriber lists, which cumulatively reached 23,514 recipients and generated open rates ranging from 28% to 51%. Fire Safe Marin and Marin Wildfire published 12 social media posts across Facebook, Instagram, and X to reinforce key messages before and after the Marin Wildfire Preparedness Public Forum, the countywide event on May 2, 2026, where the CWPP was publicly unveiled. The outreach efforts directed residents to articles on the CWPP's various topics, Public Forum information, new resources, and next steps related to the CWPP.

To extend outreach across the county, Fire Safe Marin prepared a media kit for 13 partner agencies. The kit included 10 individually branded social media posts formatted for Facebook, Instagram, and X, so each agency could share consistent CWPP messaging through trusted local channels. The cross-agency effort delivered engagement, likes, reposts, and shares at levels not previously seen in a collaborative partner-agency outreach campaign.

The campaign also included strong newspaper visibility through the Marin Independent Journal: two half-page ads, seven front-page strip ads, seven digital roadblock ads, and month-long placement in the Marin Independent Journal's daily newsletter. Together, the website, email, social media, partner-agency, and newspaper outreach created a coordinated public information campaign that built awareness before the Public Forum on May 2, supported participation during the rollout, and kept residents connected to the work ahead.

6.2.2 May 2 Public Forum

On May 2, 2026, Marin Wildfire, Fire Safe Marin, and local fire agencies hosted the Marin Wildfire Preparedness Public Forum to deepen public awareness and engagement on the CWPP. Nearly 200 residents, Firewise leaders, fire professionals, and community members attended the event, which unveiled this new CWPP and focused on wildfire risk, preparedness, and shared action.



The forum brought together every fire agency and district in Marin County, as well as related partner agencies that included Marin County Parks and Open Space, Marin Master Gardeners, the County's OEM, and others. Presentations framed the CWPP as a shared roadmap for long-term wildfire safety, and topic expert panelists answered resident questions, discussed local priorities, and described future preparedness work. The discussion also highlighted work already underway, including vegetation management efforts that exceeded initial targets, and more than 150,000 residential wildfire risk evaluations completed since 2020.

After the presentations and panel, attendees moved through topic-focused stations at their own pace. Residents spoke directly with fire department staff and specialists working on vegetation management, defensible space inspections, fire-smart landscaping, grant funding, Chipper Days, evacuation planning, detection and alert systems, and more. Handouts, checklists, and other takeaways helped residents continue to learn more information and take action after the event.



6.2.3 Story Map, Local Data, and Resident Input

A major feature of this 2026 CWPP and the main public-facing component of the rollout was the interactive **Story Map** (**https://storymaps.arcgis.com/stories/a4f41c9b87a7406ebe67d0a45c68e973**). This resource lets residents explore wildfire risk in their own neighborhoods, allowing them to search for their address and understand their specific needs around vegetation management, evacuation access, home hardening, and other risk factors. It also supports more informed conversations about where future work and funding could be prioritized.

6.2.4 Continuing Engagement and Implementation

Following the May 2 Public Forum, a public comments period (May 2 to May 19, 2026) allowed residents and community members to review the proposed priorities in their area and submit questions and comments via email. No change to the priorities outlined in the CWPP were made following the comments period. Marin Wildfire and consultants made small adjustments for clarity and responded to resident questions.

The CWPP engagement process was more than a one-time event. It built trust, strengthened relationships, and connected residents to wildfire preparedness work across Marin County. Public education has continued beyond CWPP adoption, as successful implementation depends on ongoing outreach and collaboration. Fire Safe Marin has encouraged residents to review the CWPP **Story Map**, open and act on their Wildfire Risk Reports, participate in Chipper Days, improve defensible space and home hardening, work with neighbors through the Firewise framework, and stay connected to project updates and mitigation opportunities. Together, these intended actions are helping turn the CWPP from a countywide strategic planning effort into a practical, neighborhood-level wildfire risk reduction initiative.



2026 Marin County Community Wildfire Protection Plan: Appendices

Appendix A. Marin County Fire Weather Assessment

Appendix B. Marin County Fire Weather and Climate Change Assessment

Appendix C. Marin County Social Vulnerability Assessment

Appendix D. Alerting and Warning Systems

Appendix E. Marin County Vegetation Management Assessment

Appendix F. Marin County Fire Structure Vulnerability Assessment

Appendix G. Marin County Assessment of Local Preparedness

Appendix H. Marin County Fire Evacuation Risk Assessment

Appendix I. Marin County Fire Response Assessment

Appendix J. Infrastructure Exposure Assessment

Appendix K. Wildfire Hazard Assessment

Appendix L. Detailed Prioritization Logic

Appendix M. Wildfire Risk Assessments and Modeling Tools

Appendix N. Fuel Model Details

Appendix O. Homework Questions, Comments, and Responses

Appendix P. Data Sources

Appendix A. Marin County Fire Weather Assessment

A.1 Executive Summary

As part of the 2026 Marin County CWPP update, this quantitative analysis utilizes historical surface weather records, remote sensing data, and climate change projections to evaluate potential shifts in fire-weather patterns not captured by the existing modeling scenarios.

The 2025 Los Angeles and 2023 Lahaina fires highlighted the role of shifting fire-weather patterns in driving large-loss urban fires. A literature review suggests that these disaster fires were driven by a combination of common factors:

- Extremely high wind speeds, often blowing downslope
- Wet winters resulting in increased herbaceous growth,
- Sustained drying in the fall and winter, often with delayed season-ending precipitation.

Marin Wildfire's wildfire risk analyses evaluate fire behavior under two high-severity fire-weather scenarios: a north/northeast "Diablo" wind and a west "reversal" wind. This analysis (and **Appendix B. Marin County Fire Weather and Climate Change Assessment**) aims to identify currently overlooked fire-weather factors that could align with these common denominators and produce extreme fire behavior in the next decade.

This analysis addresses the following objectives:

1. Evaluate whether the existing scenarios accurately reflect near-worst-case wind and fuel moisture,
2. Determine whether the scenarios should be adjusted or additional scenarios added to better capture high-severity fire weather in Marin County.

Key Findings

- A review of surface observations at surface weather observing locations indicates that Marin Wildfire's two standard fire-weather scenarios are well-suited to capture the high-severity fire weather events in Marin County.
  - Thematically, these two scenarios represent the two most frequent low-moisture, high-wind fire-weather patterns facing the County. While other types of lower-severity fire

weather does occur, the evidence does not indicate that an alternative scenario would capture additional high-severity weather events beyond those already modeled.

  - **Diablo Wind:** The northeast wind scenario captures very high-severity weather. Fuel moisture in this scenario is at or above the 98th percentile. Wind speed is above the 99th percentile. Statistical analysis suggests that the modeled combination of fuel moisture and wind speed likely overestimates the severity of north wind events in Marin County; however, because climate change is likely to result in increased drying, no modifications are recommended.
  - **West Wind:** Fuel moisture values are between the 80th and 90th percentile for this scenario. Statistical analysis indicates that this scenario underrepresents the fuel moisture and atmospheric humidity during wind reversals. An alternative fire-weather scenario is recommended.

- An assessment of the Middle Peak, Barnaby, and Robinhood Remote Automatic Weather Station (RAWS) stations indicates that different parts of the county experience variations in wind speeds and directions. This analysis investigated several other potential fire-weather scenarios, including:
  - A southeast wind event, common in Novato, with moderate-to-high wind speeds and moderate fuel moisture.
  - A winter frontal passage, with dry north winds preceding a significant precipitation event.
  - A winter Diablo-type wind event, with high winds and moderately dry fuel moisture.

Key Recommendations

More Severe West Wind Scenario: The west wind scenario currently used for program planning may underrepresent the severity of dry west wind events, particularly in the context of climate change-driven shifts in atmospheric and fuel moisture. We recommend a west wind scenario with lower dead fuel moisture contents, lower herbaceous fuel moisture, and stronger wind speeds. Such events have been observed in Marin County in recent years and are expected to become more frequent in the coming decades. Specifically, we recommend using the 2015 Valley Fire scenario to capture high-severity conditions in Marin County.

Do Not Add Another Wind Scenario for Fire Prevention Planning: Based on the alternate fire-weather events we investigated, we do not recommend adding an additional fire-weather scenario. The alternative events are capable of driving active fire behavior that could cause loss in Marin County communities. However, they exhibit lower-severity conditions than the two existing scenarios (Diablo and West wind events). We recommend creating fire-prevention plans based on the highest-severity conditions; landscapes and communities resilient to the most extreme fire behavior are also likely to be resilient to lower-severity fires.

Fire Operations Should Consider Out-of-Season Weather Events: For fire-prevention planning purposes, the two existing fire-weather scenarios are likely sufficient to build robust, data-driven risk reduction strategies. However, from an operational perspective, fire managers should consider out-of-season fire-weather events capable of bringing significant fire weather to Marin County outside of the normal fire season (e.g., a December Diablo-type event). Consider staffing and response capabilities in the context of these potential events.

A.2 Review of Existing Fire-Weather Scenarios

The current fire-weather scenarios used in wildfire risk assessments in Marin County are based on historical data and reflect two of the most common modes of fire weather experienced in the County. These generalized planning scenarios define reasonably high-severity fire-weather conditions and have been designed to characterize the conditions with the potential for catastrophic fire spread. Planning scenarios are not intended to exactly represent a particular moment in time; rather, their objective is to reflect the potential for high-severity, wind-driven fire growth during common fire-weather patterns. Planning scenarios are also not designed to capture low-severity or "average" fire weather; if a community is resilient to a high-severity fire-weather event, it is also resilient to an event with lower wind speeds or higher fuel moisture.

Diablo

This scenario represents a northeast wind event, perhaps the most common driver of high-severity fire weather in Marin County. These winds typically occur in the fall, when a high-pressure system develops over the Great Basin and a low-pressure system sits offshore over the Pacific Ocean; this pressure gradient drives hot, dry air downslope from the continental interior, across the Sierra Nevada and Coast Ranges, and toward the coast. As the air descends, it compresses and warms, leading to very low humidity and high temperatures. Diablo events have driven some of the most consequential fire activity in the Bay Area, including the 2017 Napa fires, the 1991 Oakland hills fire, and the 1929 Mill Valley fire.[41]

While Diablo events often occur several times per year, Marin Wildfire's scenario is based on the October 2017 Diablo event that drove the catastrophic growth of the Tubbs Fire in Santa Rosa. This scenario was adjusted and modified for use in the 2020 CWPP. **Figure A-1** shows the hourly progression of the 2017 fire-weather event on October 8 and 9, 2017, using data from the ECMWF Reanalysis v5 (ERA5) Land Reanalysis dataset. In this animation, arrows represent the wind speed and direction experienced at each 9-km grid cell; the arrow color represents the relative humidity at each location. Relatively moist west and northwest winds preceded the strong, dry northeast wind event, which began around 8:00 p.m. local time and continued until about 7:00 a.m. the following day (i.e., October 9), as shown in the chart in **Figure A-2**.

[41] **https://www.nytimes.com/1929/07/04/archives/california-fire-destroys-100-homes-races-down-mount-tamalpais-and.html**

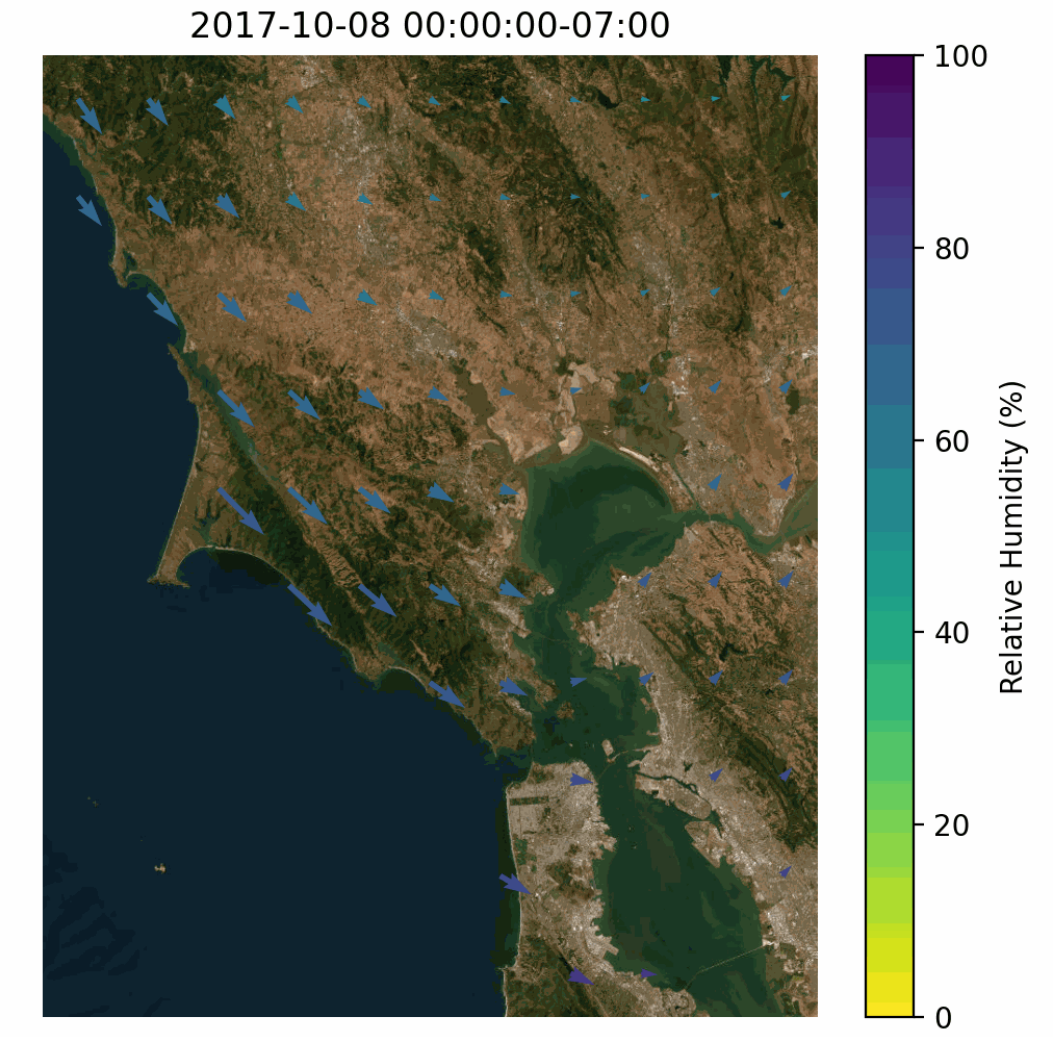


Figure A-1. Wind speed, wind direction, and relative humidity during the October 2017 Diablo wind event.

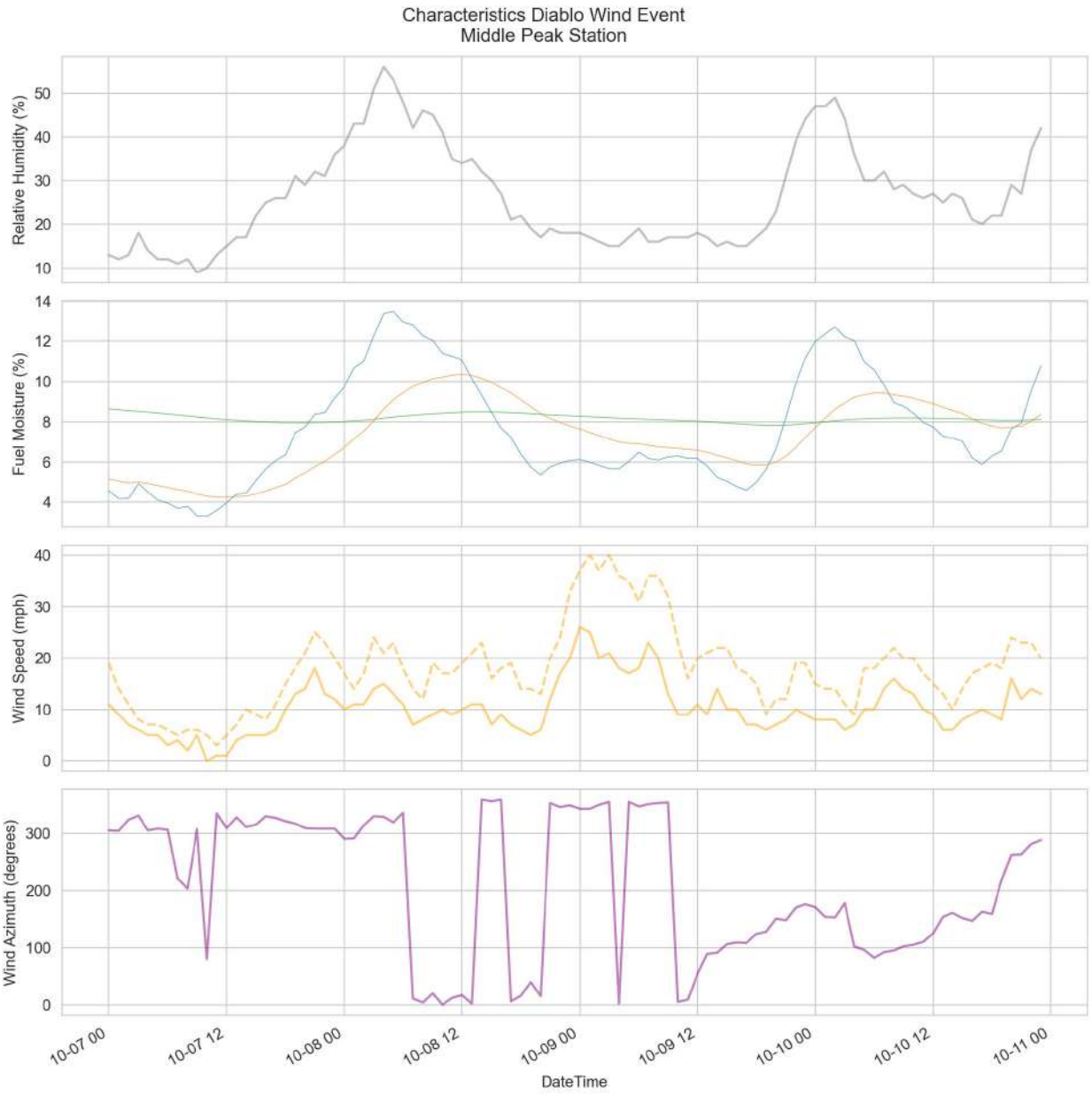


Figure A-2. Time series of a characteristic Diablo wind event on October 8, 2017, as recorded at the Middle Peak RAWS station.

Table A-1 lists the characteristic weather and fuel moisture values representative of this event, adjusted for inclusion in the 2020 CWPP.

Table A-1. Characteristic fire-weather parameters used in the Diablo fire-weather planning scenario.

Parameter	Diablo Wind (2017)
Wind Speed	30 mph
Wind Direction	45°
Air Temperature	87° F
Cloud Cover	0%
1-h Fuel Moisture	3
10-h Fuel Moisture	4
100-h Fuel Moisture	6
Live Herbaceous Fuel Moisture	3
Live Woody Fuel Moisture	67
Time	22:00
Date	October 8, 2017

West Wind Reversal

This scenario represents a dry onshore wind event, occurring when dry air that was previously pushed offshore during a Diablo wind event is driven back inland by a reversal in the pressure gradient. This situation creates a short-lived but dry and gusty westerly wind blowing from the Pacific Ocean toward the coast. Unlike typical moist sea breezes, this return flow brings dry air back into coastal areas that were depleted of moisture during the preceding Diablo event. Moist onshore winds are common throughout coastal California, particularly in Marin County. Dry onshore winds are rare, occurring only once every several years. However, these events can pose a significant fire risk and present control problems for fires driven by the preceding Diablo event by creating a sudden wind shift.

The current west wind planning scenario is based on an October 2020 west wind event, illustrated in **Figure A-3**. As shown, strong west winds accompanied by low-to-moderate relative humidity occur in the afternoon of October 8. As shown in **Figure A-4**, these winds persist for approximately 4-6 hours before the pressure gradients break down and low-velocity, moist winds return.

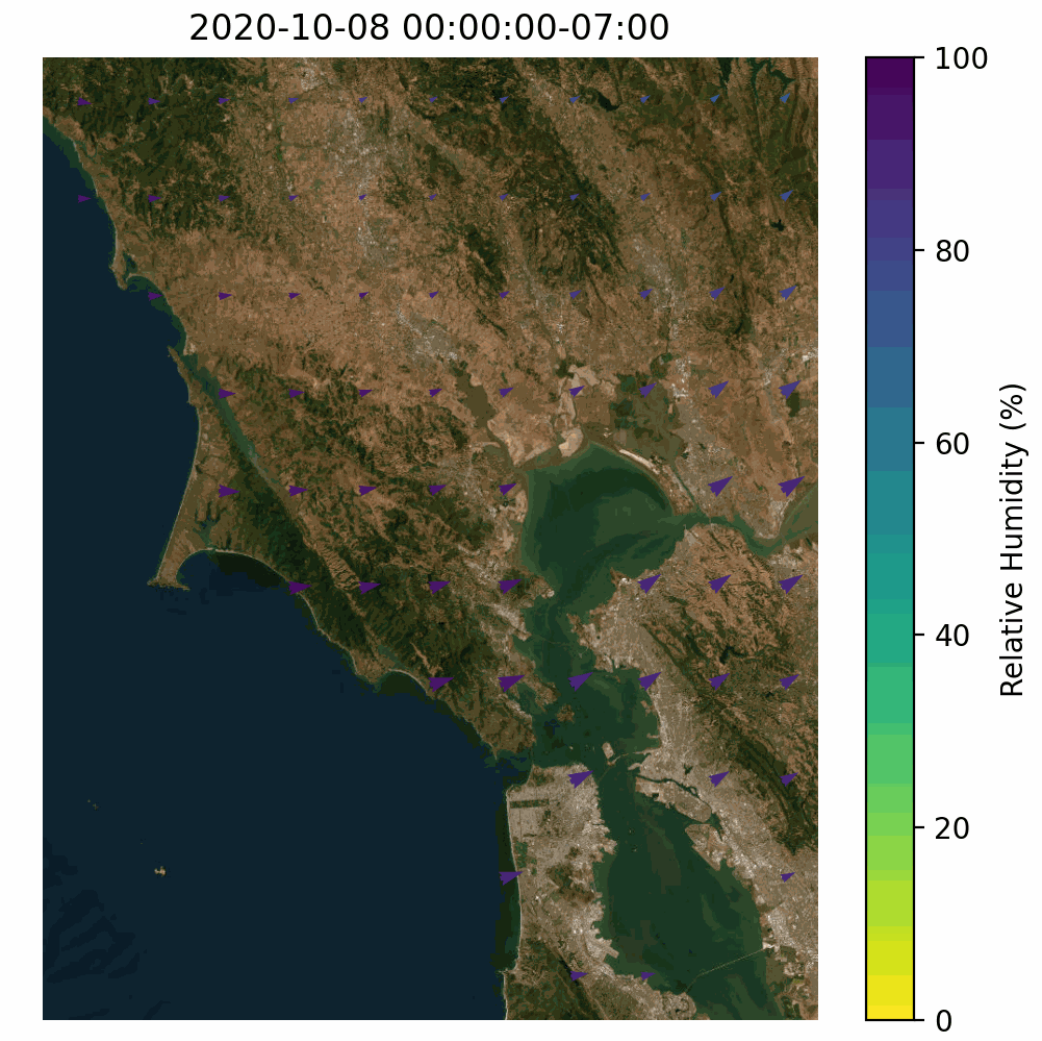


Figure A-3. Wind speed, wind direction, and relative humidity during the October 2020 West wind event.

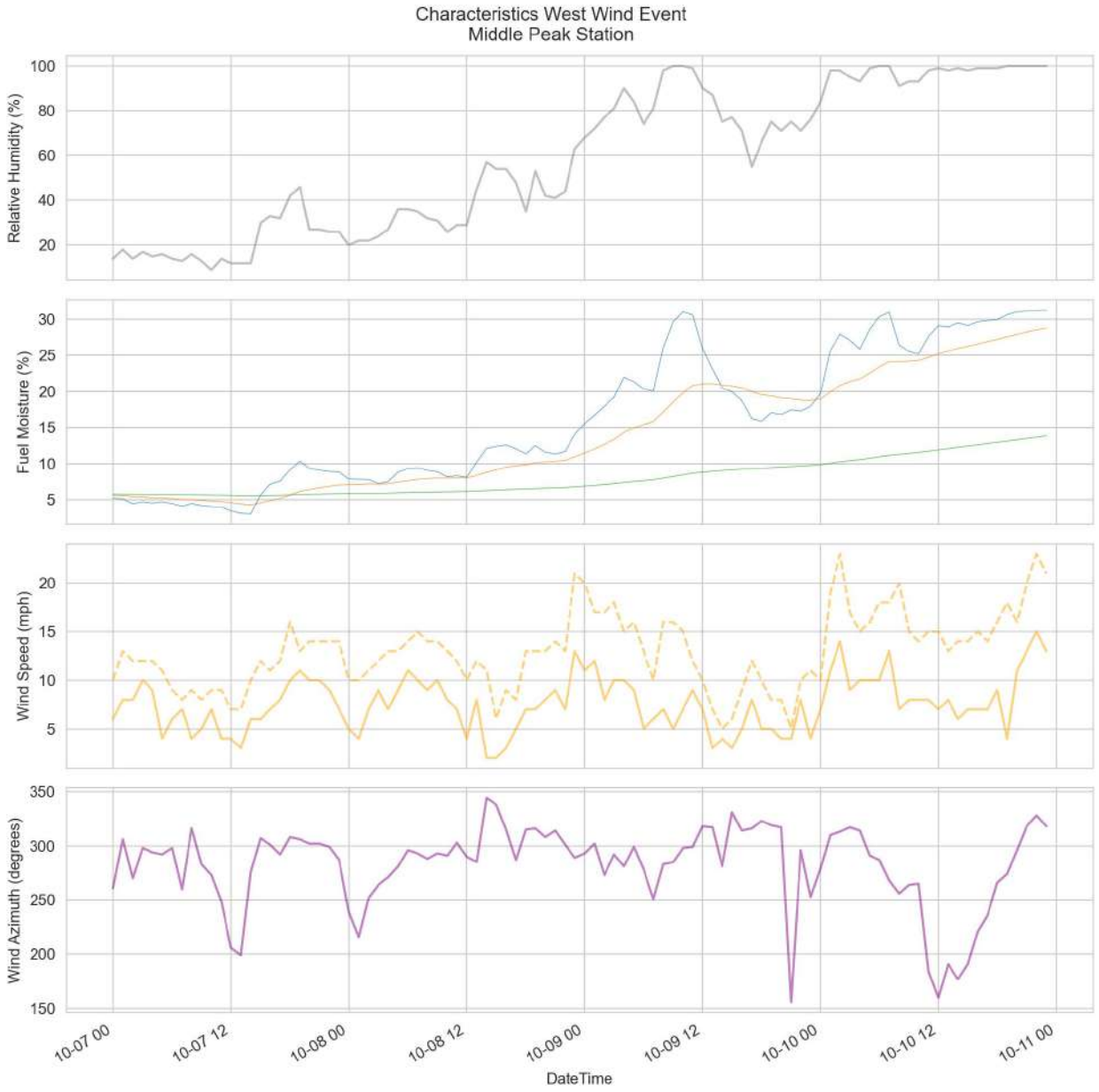


Figure A-4. Time series of a characteristic Diablo wind event on October 8, 2020, as recorded at the Middle Peak RAWS station.

The parameters used for the west wind planning scenario are listed in **Table A-2**.

Table A-2. Characteristic fire-weather parameters used in the West fire weather-planning scenario.

Parameter	West Wind (2020)
Wind Speed	18 mph
Wind Direction	266°
Air Temperature	60° F
Cloud Cover	0%
1-h Fuel Moisture	8
10-h Fuel Moisture	9
100-h Fuel Moisture	7
Live Herbaceous Fuel Moisture	70
Live Woody Fuel Moisture	70
Time	16:00
Date	October 8, 2020

A.3 Severity Analysis

As shown in **Table A-3**, the Diablo event represents a very high-percentile fire-weather event. The selected fuel moisture values equate to percentiles at or above the 98th percentile for 1-, 10-, and 100-h fuel moisture for Middle Peak and at or above the 99th percentile at the Woodacre RAWS. Wind speed percentiles for this event are in the 99th percentile.

The West wind scenario is less severe, particularly when evaluated at the Middle Peak RAWS station. When evaluated at the Woodacre RAWS station, the chosen 1- and 10-h fuel moisture values are around the 91st percentile, and the 100-h fuel moisture value is in the 99th percentile. However, the fuel moistures at the more exposed Middle Peak RAWS station are much lower (i.e., 77-80th percentile). These lower fuel moisture values translate to lower availability of light dead and herbaceous fuels, corresponding to reduced rates of spread in modeled fire behavior. While this event is likely to result in significant fire-weather activity, it may underestimate the fire behavior experienced in some instances, particularly in exposed areas dominated by light, flashy fuels.

Table A-3. Percentile values of the fire-weather planning scenario characteristics at the Middle Peak and Woodacre RAWS stations.

Characteristic	Percentile - Middle Peak	Percentile - Woodacre
West Wind		
1-h Fuel Moisture	80.0	91.1
10-h Fuel Moisture	77.3	90.7
100-h Fuel Moisture	95.2	99.8
Wind Speed	90.4	97.1
Diablo Wind		
1-h Fuel Moisture	98.6	99.7
10-h Fuel Moisture	98.0	99.6
100-h Fuel Moisture	99.4	100
Wind Speed	99.8	99.9

While the Diablo planning scenario represents fuel moistures and wind speeds that are individually high severity, the simultaneous occurrence of these extremely dry and extremely windy conditions is very rare. Based on the Middle Peak historical record, when the fuel moisture is as critically low as that represented in the Diablo scenario, wind speeds exceeding 20 mph are anticipated to occur only about every 34 years. Wind speeds of 30 mph *and* critically low fuel 1-, 10-, and 100-h fuel moistures have not been observed in the recent historical record and are projected to occur less than once every 100 years. **Figure A-5** shows the return intervals for different wind speeds when the fuel moistures are equal to or less than the moisture levels listed in Tables A-1 and A-2. While exceptionally dry northeast wind events are expected annually, they tend to be lower velocity and/or higher moisture than represented by the current planning scenario. However, because climate change is projected to result in drier conditions throughout California, this scenario may be representative of near-future extreme fire-weather conditions.

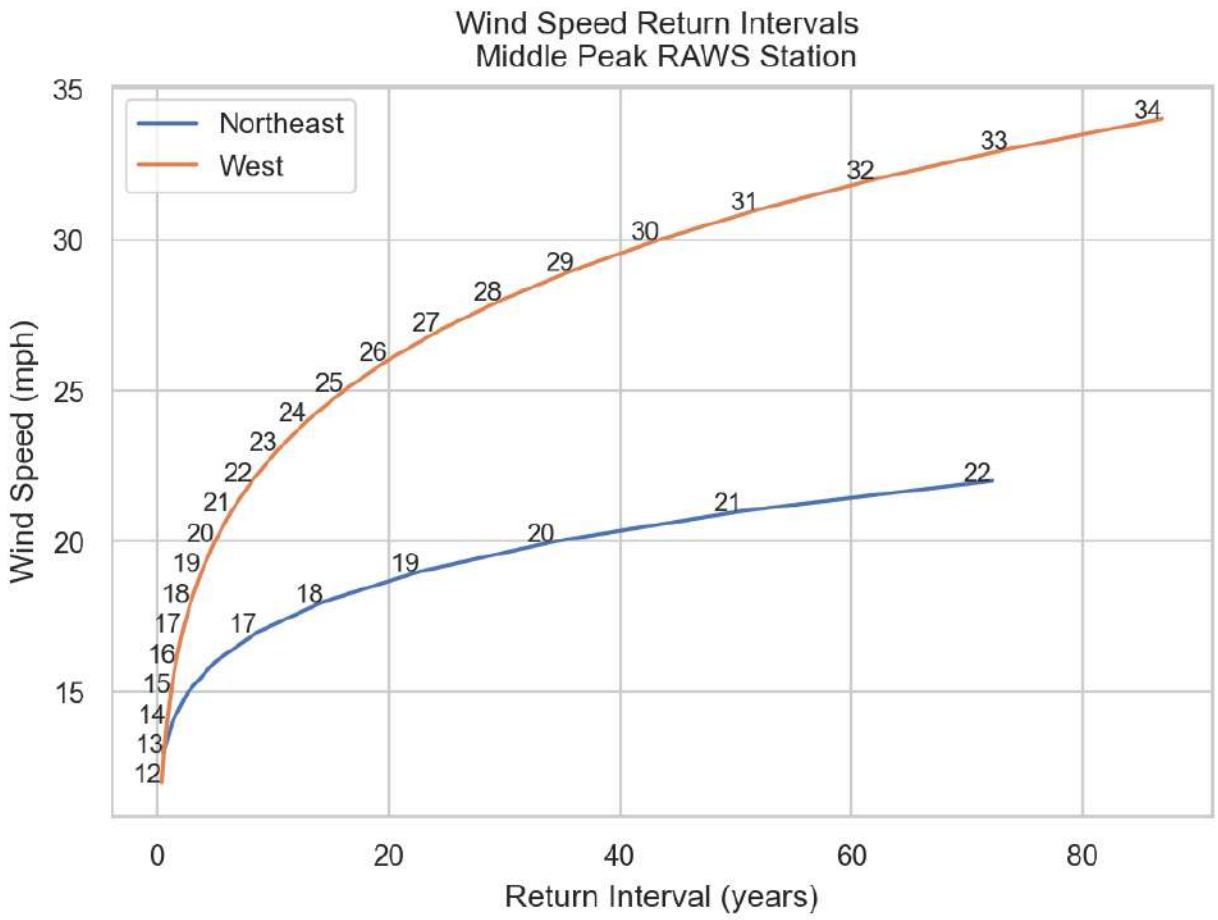


Figure A-5. Return intervals for different wind speeds, given the fuel moisture parameters for each of the planning scenarios noted above.

In contrast, the conditions represented by the West wind planning scenario are anticipated to occur much more frequently. Based on the fuel moisture conditions listed in Table A-2, a West wind of at least 18 mph is expected at least every 2.9 years. As shown in Figure A-5, the historical record suggests that significantly more severe wind speeds are possible at this moisture level.[42] Based on this assessment, West winds with wind speeds exceeding 30 mph are anticipated at this moisture level at least every 40-45 years.

[42] These return intervals are calculated using a generalized pareto distribution (GPD) fit to the Middle Peak RAWS time series. The GPD estimates the probability of occurrence of an event of at least a given severity. Northeast wind events are defined as 4-h periods with an average wind direction of between 330 and 90 degrees, average 1-h fuel moisture of less than 3%, average 10-h fuel moisture of less than 4%, and average 100-h fuel moisture of less than 5%. West wind events are defined as 4-h periods with an average direction of between 180 and 300 degrees, average 1-h fuel moisture of less than 8%, average 10-h fuel moisture of less than 9%, and average 100-h fuel moisture of less than 7%.

A.4 Considering Alternative Fire-Weather Events

The analysis above indicates two potential problems with the current fire-weather scenarios:

1. While the Diablo planning scenario is reflective of very high-percentile fuel moisture and wind speeds individually, these conditions generally do not co-occur in the same event. This planning scenario tends to overestimate the severity of potential Diablo wind events.
2. The West wind scenario likely overestimates the moisture content of dry West wind events, resulting in an underestimate of the fire behavior during these periods.

As will be explored in the following section, changes in atmospheric moisture are projected to result in significantly drier fuels over the next several decades.[43] Vapor pressure deficit, a measure of atmospheric moisture demand, is projected to increase by up to 11% between 2025 and 2050, compared with the period between 2005 and 2025. While wind speed regimes are projected to be similar in the next two decades compared with the recent past, they are anticipated to be accompanied by drier air and lower fuel moistures. **Therefore, the Diablo wind scenario is a reasonable approximation of high-severity fire weather likely to be experienced in the warmer, drier conditions projected in Marin County's near future. For this reason, we do not recommend significant changes in the parameters of the Diablo planning scenario.**

However, we do recommend altering the West wind planning scenario to reflect the realistic potential for drier, stronger wind events from the west. These changes would result in increased modeled fire behavior, including increases in rate of spread, flame length, and torching potential.

To identify an appropriate higher-severity scenario, **Figure A-6** shows the average return intervals for 4-hour average wind speeds when fuel moistures are at or above the 90th percentile (1-h ≤ 5%; 10-h ≤5%; 100-h ≤7%). Using this lower characteristic moisture content increases the moisture severity of the scenarios by about 10 percentile points (i.e., the scenarios shown in Figure A-6 are all at or above the 90th percentile in moisture compared with the 75-80th percentile indicated in Table A-3 and Figure A-5). Figure A-6 highlights that dry northeast wind events are substantially more common than West wind events, with northeast wind events of ≥ 30 mph likely to occur at least every other year. On the other hand, **Table A-4** shows a dry west wind event of ≥ 30 mph is projected to occur about once every 18 years.

[43] Rodrigues, Marcos, et al. VPD-Based Models of Dead Fine Fuel Moisture Provide Best Estimates in a Global Dataset. Agricultural and Forest Meteorology, vol. 346, 2024, 109868. **https://doi.org/10.1016/j.agrformet.2023.109868**.

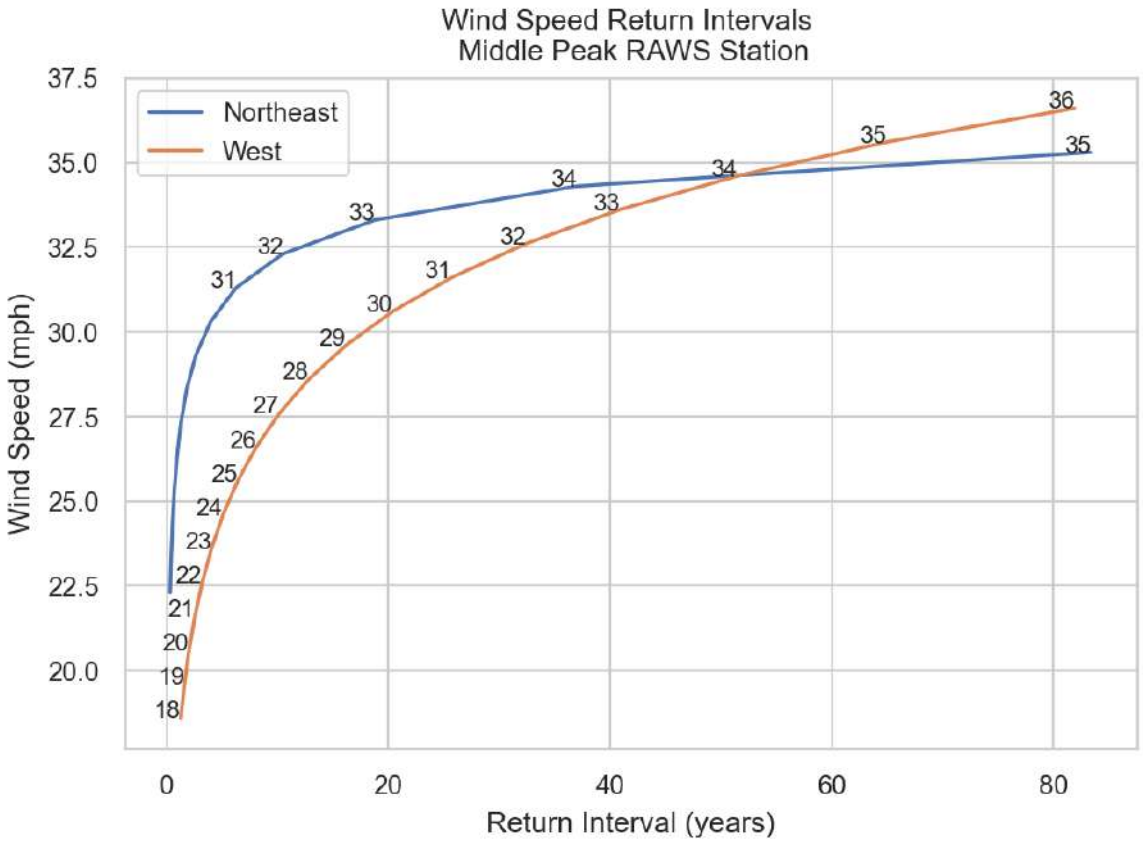


Figure A-6. Return intervals of different wind speeds when fuel moisture values are at or above the 90th percentile.

Table A-4. Estimated return intervals for West wind events of various sustained wind speeds when fuel moisture values are at or above the 90th percentile.

West Wind Speed	Return Interval (years)
18	1.1
20	1.9
25	6.2
30	17.9
35	64.9

As shown in **Table A-5**, a dry West wind with a sustained velocity of at least 25 mph is projected to occur at least once every 6 years. Such an event would be significantly drier (32% relative decrease in

fuel moisture) and substantially stronger (39% relative increase in wind speed). Modeling suggests that higher wind speeds at similar moisture contents are also possible, albeit more infrequent.

Table A-5. Proposed new West Wind fire-weather scenario.

Parameter	West Wind (Existing)	West Wind (Proposed)
Wind Speed	18 mph	31 mph
Wind Direction	266°	298° deg
1-h Fuel Moisture	8	5
10-h Fuel Moisture	9	4
100-h Fuel Moisture	7	5
Live Herbaceous Fuel Moisture	70	30
Live Woody Fuel Moisture	70	55
Time	16:00	12:00
Date	October 8, 2020	September 12, 2015

A review of the Middle Peak RAWS station identified several of these West wind events. For example, **Figure A-7** shows a time series of the Middle Peak observations from September 2015. This event was associated with the rapid growth of the Valley Fire in nearby Lake County. During this event, Middle Peak recorded relative humidity below 10% and sustained wind speeds of at or above 20 mph for nearly 12 hours. **Figure A-8** shows the regional development of this wind event.

Recommendation: Design a new West wind planning scenario based on the 2015 wind event that drove the Valley Fire. A new scenario would more accurately represent high-severity fire weather during periods of sustained drying. A proposed set of characteristics for this scenario are presented in Table 5. A fire-weather event with these characteristics would represent an approximately 1-in-20-year fire-weather event.

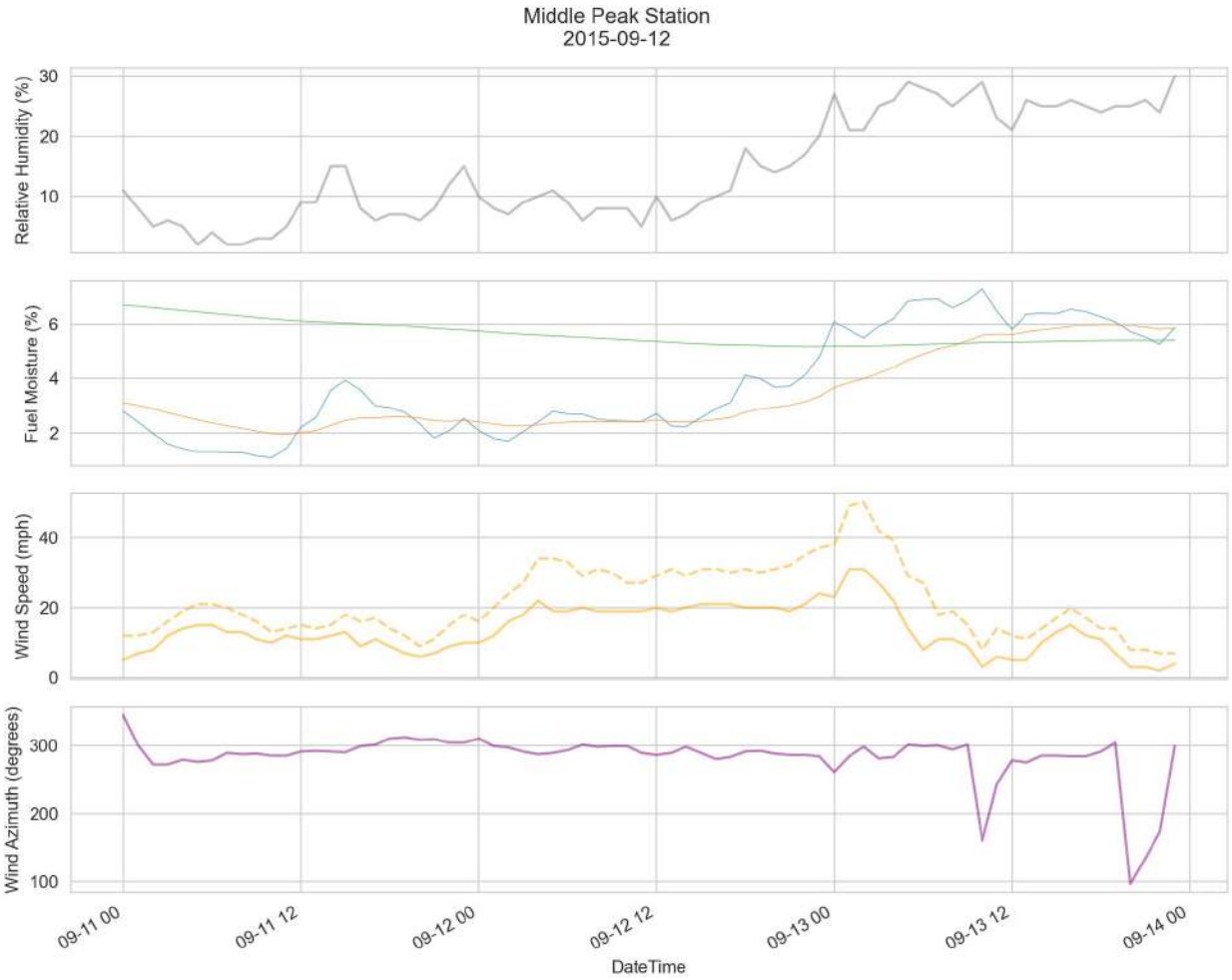


Figure A-7. Time series of the west wind event on September 12, 2015, as recorded at the Middle Peak RAWS station.

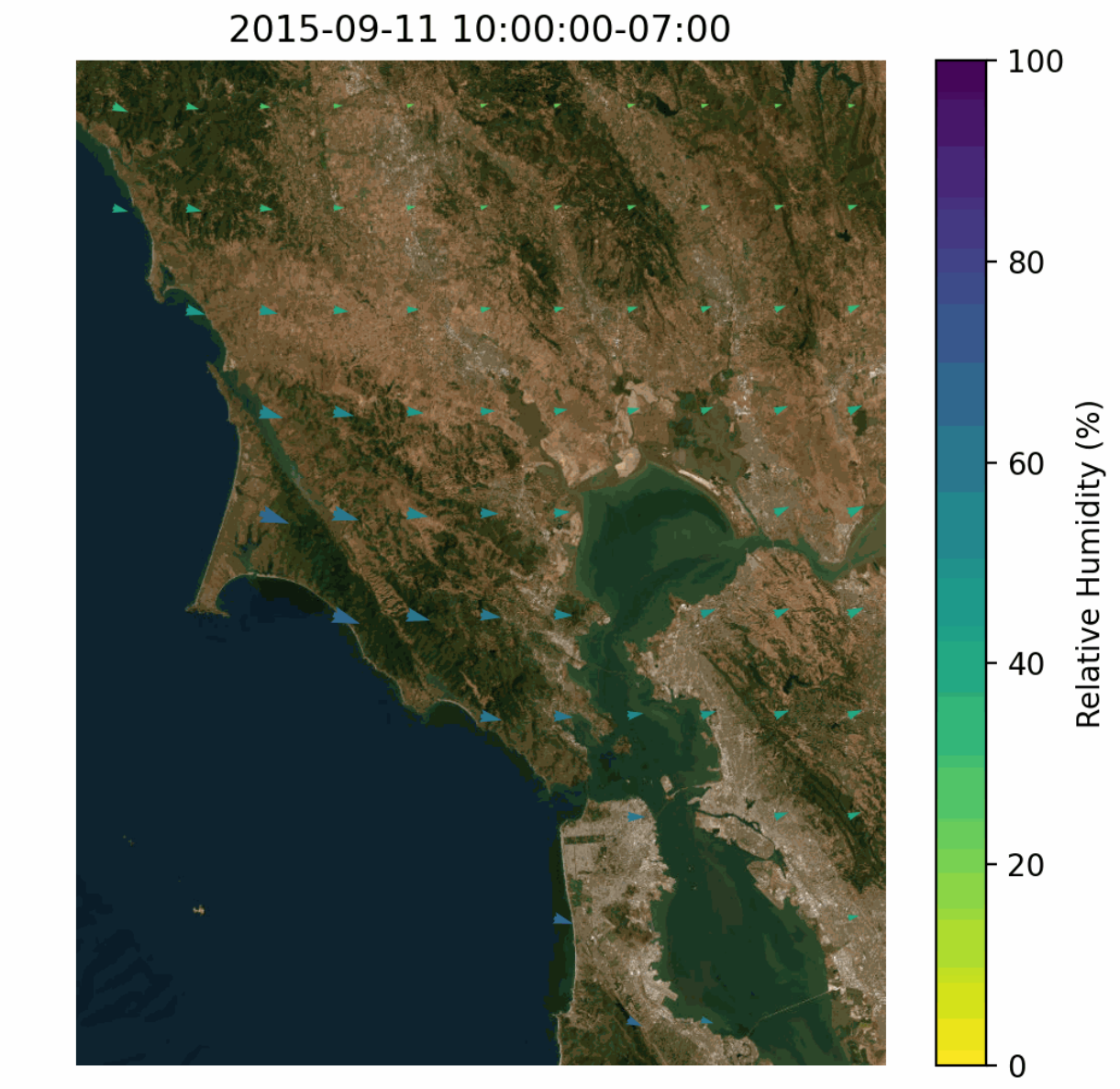


Figure A-8. Wind speed, wind direction, and relative humidity during the September 2015 West wind event.

A.5 Additional Fire-Weather Regimes

One objective of this analysis is to assess whether the fire-weather scenarios currently used for Marin Wildfire planning reflect the full suite of potential fire-weather events experienced in the County. In this section, we analyze the historical record to determine whether an additional fire-weather scenario would capture new, or more severe, phenomena not captured in the current set of scenarios.

Middle Peak

Figure A-9 shows wind rose histograms from (left) all weather records and (right) weather records during the July-October fire season, when fuels are cured and most receptive. This figure highlights that strong winds, particularly in the summer, are most common from the west-northwest.

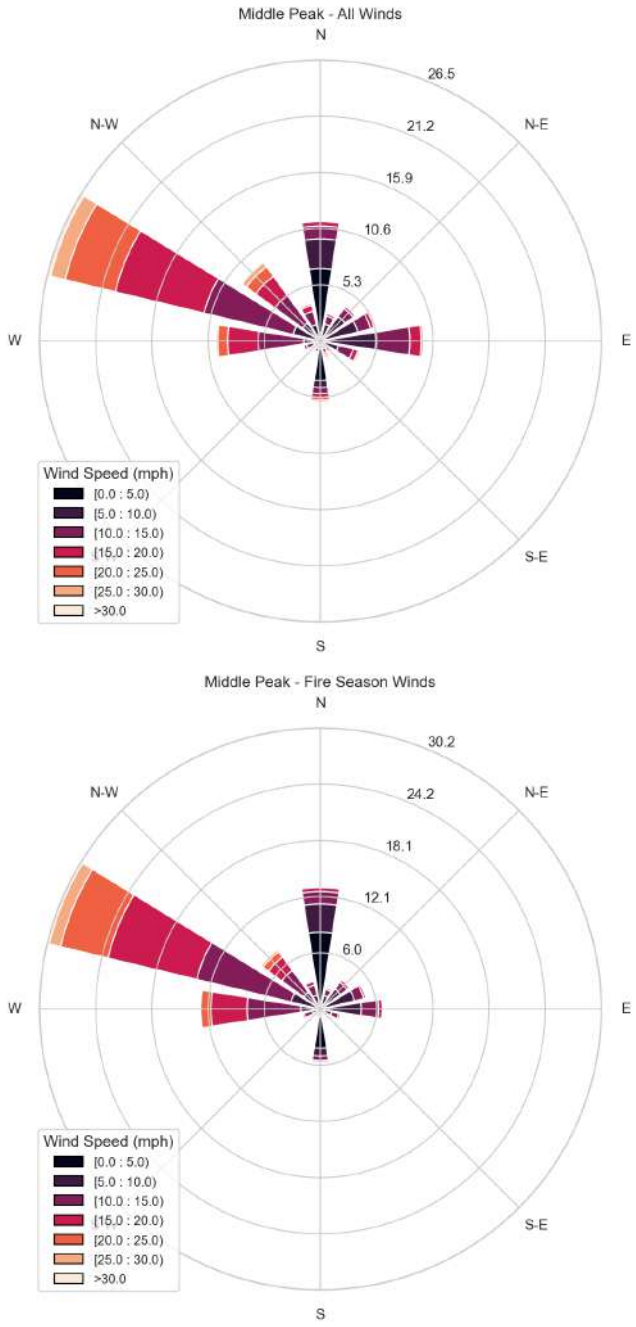


Figure A-9. Wind roses representing all winds recorded at the Middle Peak RAWS station (left) and those within the July-October fire season (right).

Figure A-10 shows the wind rose for the July-October fire season, filtered to hours when fine dead fuel moisture is low and relative humidity are both low. This figure indicates that there are few strong, dry wind events when the wind comes from a direction other than the northeast/east or the west. While about five percent of the dry fire season hours come from the south, these winds are light, rarely exceeding five miles per hour.

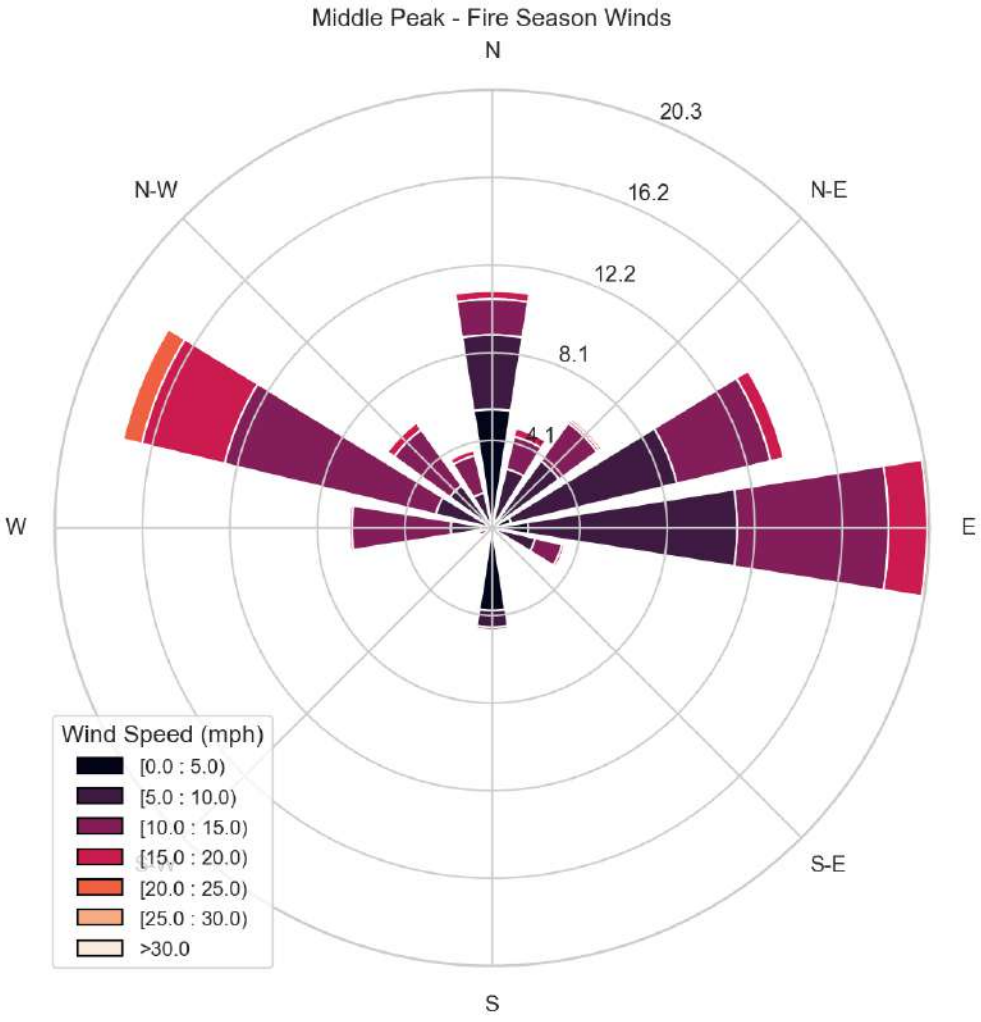


Figure A-10. Wind rose representing the frequency of winds during the fire season that occur during periods of extended drying and low relative humidity.

Novato

Figure A-11 shows the corresponding wind roses for the Novato Fire - Robinhood. These roses suggest that there are similar fire-weather patterns in the northern portion of the County. While the prevailing winds most often come from the west, strong, dry, fire-season winds tend to come from the northeast and the west. Interestingly, moderate-velocity dry winds also occur from the southeast.

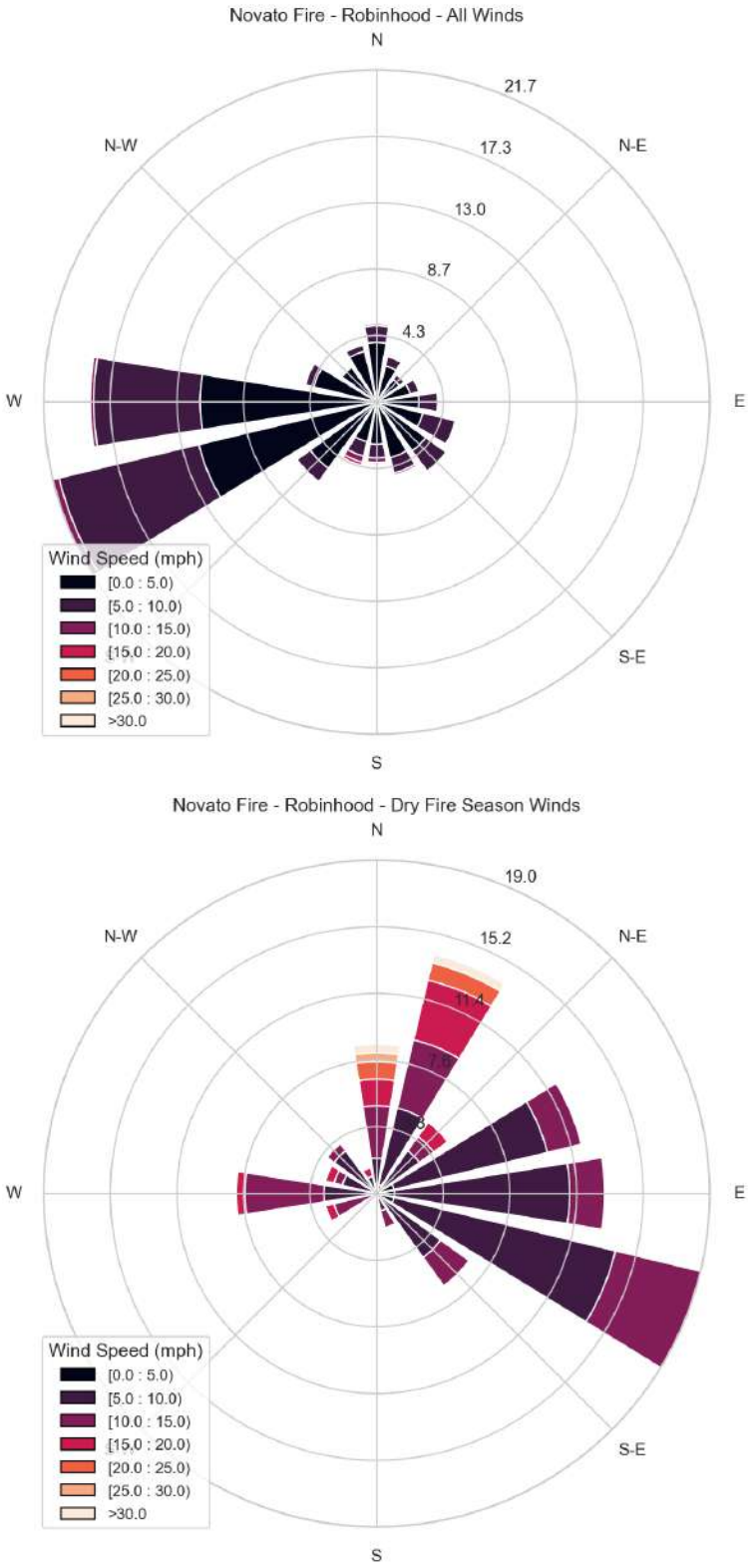


Figure A-11. Wind roses generated from the Novato Fire - Robinhood RAWS station. Top: All weather records. Bottom: Fire season records when relative humidity and fuel moisture are low.

The southeast wind events tend to occur in the fall. As shown in **Figure A-12**, these events usually manifest as moderate increases in wind speed (5-10 mph gusting to 15 mph) after a marked increase in relative humidity. Due to moderate wind speed and above-critical fuel moisture, these events could drive some fire activity but are unlikely to support extreme fire growth and behavior.

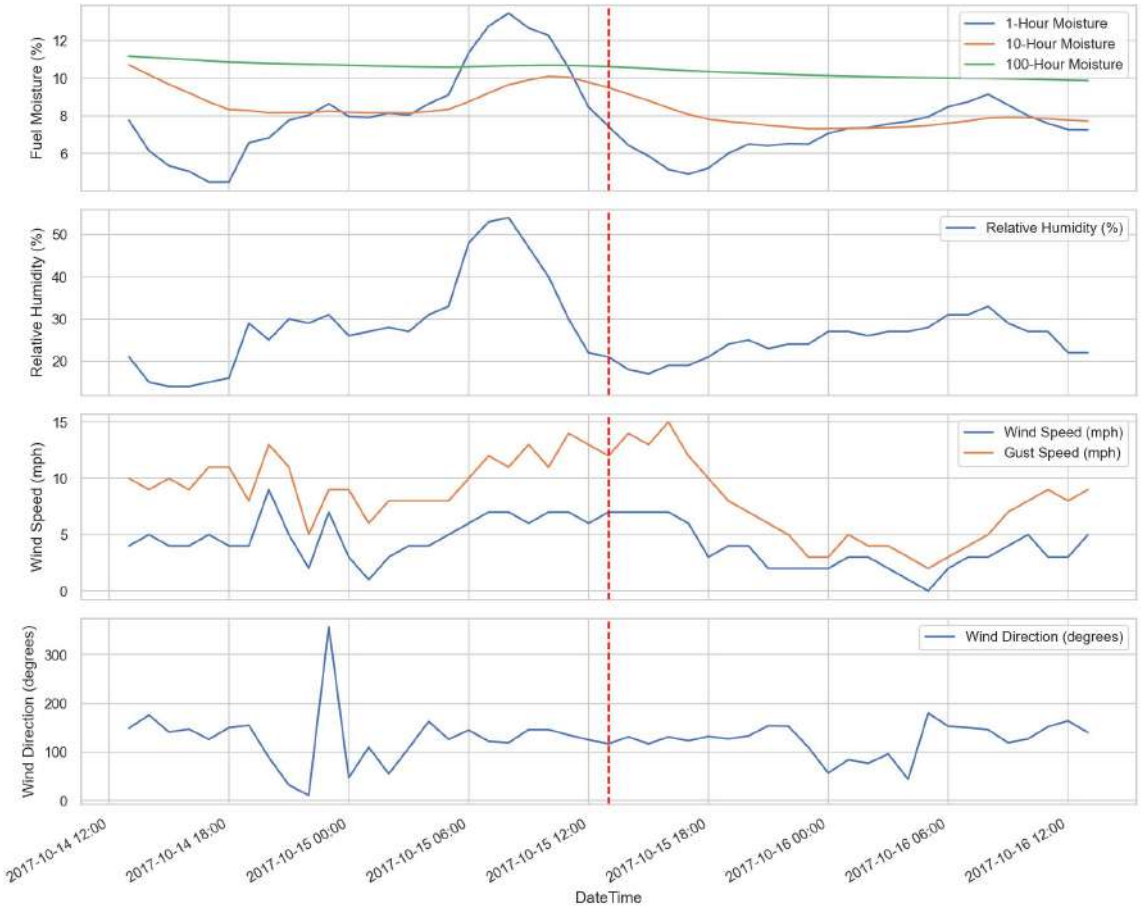


Figure A-12. An example of a southeast wind event recorded at the Novato Fire - Robinhood RAWS station on October 16, 2017.

Barnaby

Figure A-13 shows the wind roses for the Barnaby RAWS station, located near Pt. Reyes Station. This station tends to record a greater north and northwest influence than the two stations discussed above. However, the timing and characteristics of these north and northwest events are similar to those experienced as west and northeast events in other parts of the County.

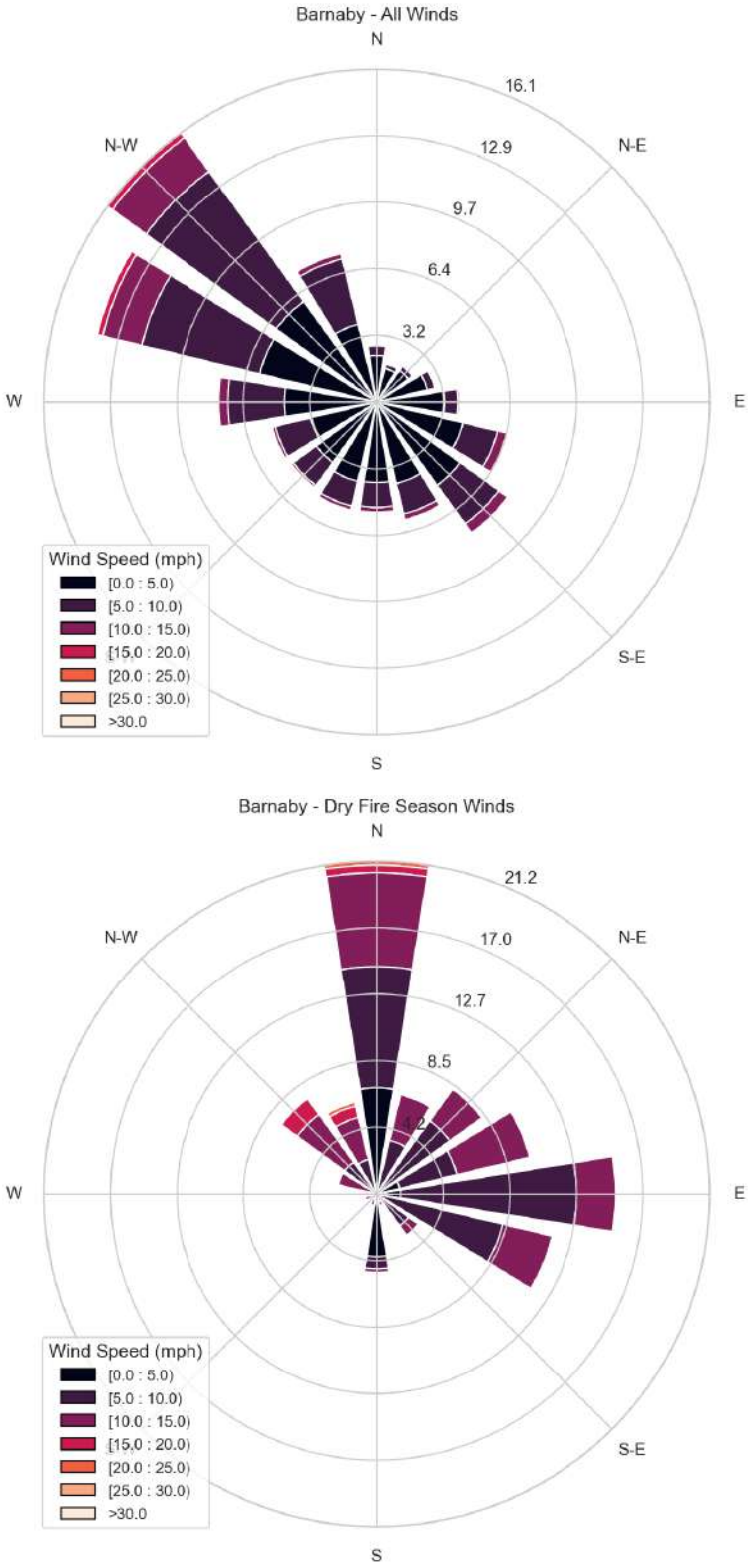


Figure A-13. Wind roses generated from the Barnaby RAWS station. Top: All weather records. Bottom: Fire season records when relative humidity and fuel moisture are low.

Recommendation: While fire-weather events are experienced differently in different parts of the County, the RAWS records do not indicate that alternative fire-weather regimes would significantly contribute to the northeast and west fire-weather scenarios already modeled. We do not recommend adding an additional fire-weather scenario that represents peak fire-weather conditions.

A.6 Out-of-Season Events

City-scale loss fires, including the 2025 Los Angeles fires, the 2021 Marshall Fire, and others, can be associated with out-of-season fire-weather events. These events lead to significant fire activity because very strong winds occur at times of the year when fuels usually have a higher fuel moisture content due to annual growth and seasonal precipitation but in years when precipitation is absent. For example, in many parts of the Southwest, monsoon moisture has recently failed to develop or developed much later than average, resulting in prolonged fire-weather conditions throughout the summer.

In Marin County, it is possible that "normal" winter winds could occur during a period of extreme drying, due to delayed seasonal moisture. In this analysis, we do not address the likelihood of absent moisture since climate change may exacerbate changes in moisture timing. Instead, we investigate whether alternative wind directions and severity may indicate the potential for a high-severity, out-of-season event. We analyze weather patterns in December, January, and February to determine the likelihood of a very high-severity wind event occurring out of phase with annual precipitation.

Figure A-14 illustrates that strong winds in December, January, and February tend to come from the north/northwest or from the southeast.

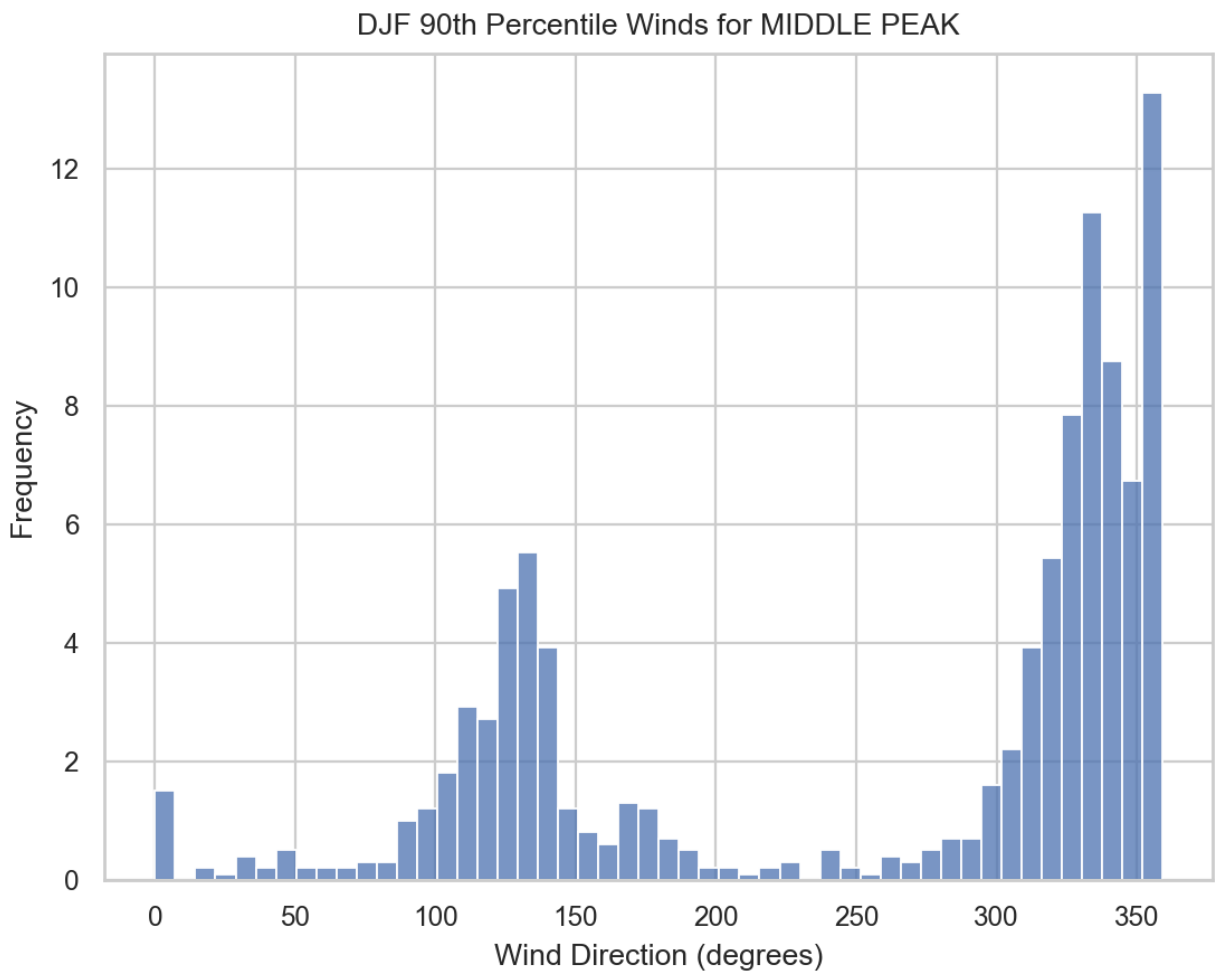


Figure A-14. Distribution of wind directions in December, January, and February when wind speeds are at or above the 90th percentile for this period (i.e., at least 21 mph).

As shown in **Figure A-15**, winds that come from the southeast during the winter tend to be associated with very high atmospheric moisture and precede a significant precipitation event. Figure 16 shows an example of a southeast wind event. While the winds during this event are strong and sustained, the fire danger of this type of event tends to be limited because of the significant precipitation that follows. While precipitation is likely to keep the event duration short, disaster fires, such as the Marshall Fire, have occurred when passing fronts have driven significant fire growth in advance of significant precipitation. **Figure A-16** shows an image from the Marshall Fire, which received over 10 inches of snow the evening following the fire.

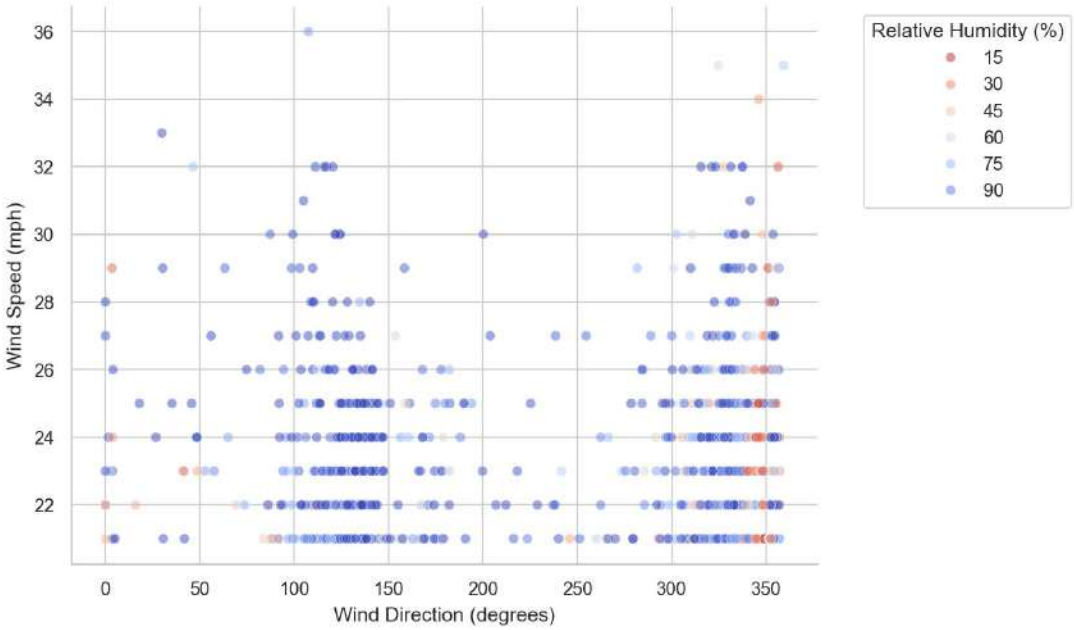


Figure A-15. Distribution of wind speed, wind direction, and relative humidity during winter precipitation events.



Figure A-16. Image of Superior, Colorado the day after the Marshall Fire burned more than 1,000 structures.

Experiencing significant fire growth from a southeast wind event would require many low-probability events to align:

- Delayed annual moisture would be needed such that fuels were still receptive to fire late into the traditional hydrological winter.
- Sustained low relative humidity would be needed to keep fuels critically dry into the wind event.
- An ignition would need to occur quickly after the initiation of the wind event, such that the fire had a sufficient amount of time to develop before precipitation arrived.

The likelihood of these low-probability events occurring simultaneously is very low. **For this reason, we do not recommend including a southeast planning scenario in subsequent analyses. While a high-severity southeast wind event could occur, high-severity events from other directions and at other times of the year are more meaningful planning scenarios.**

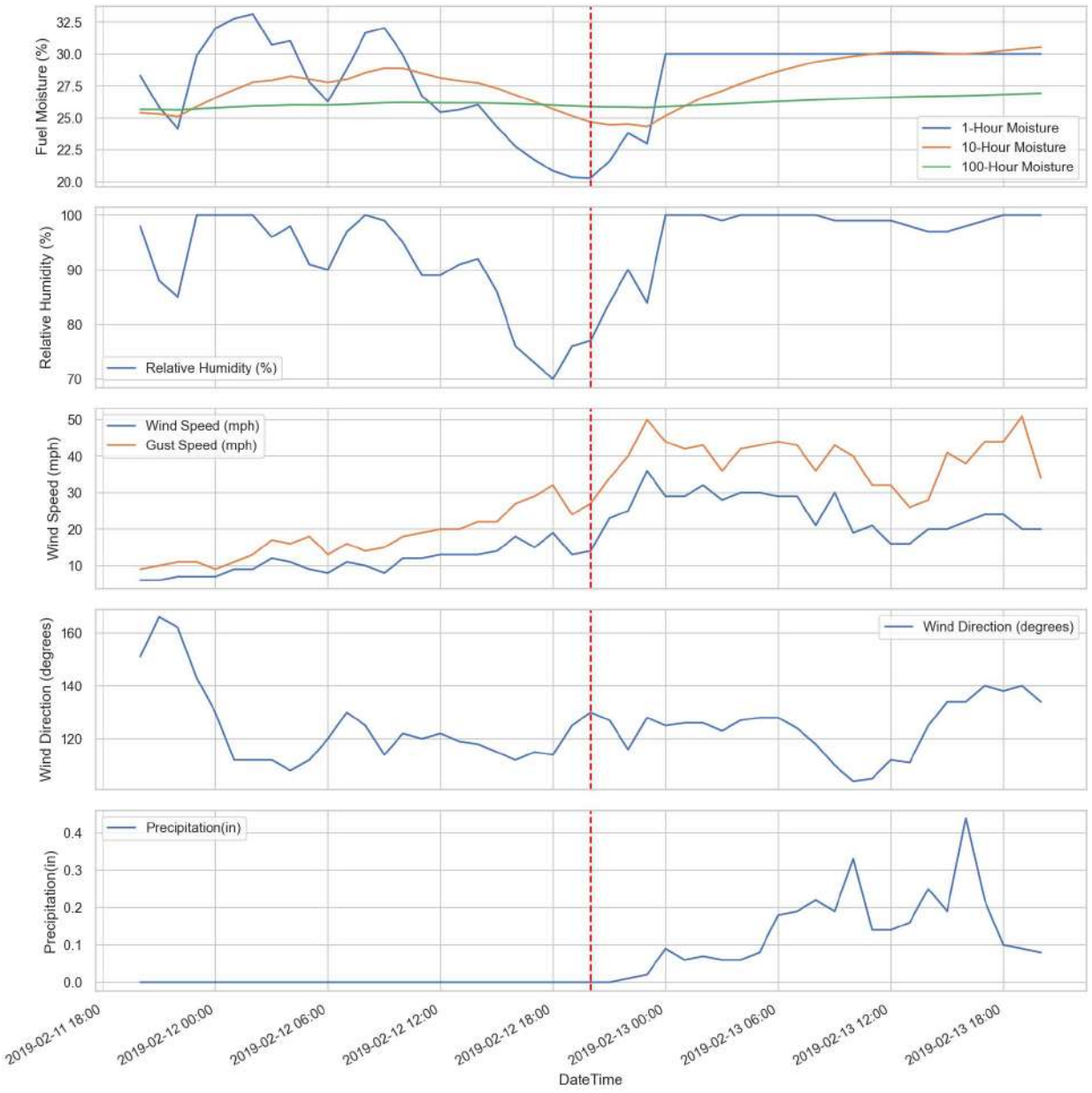


Figure A-17. Example of a southeast wind event during the month of February.

As shown in Figure A-17, the driest out-of-season events are Diablo-type events that occur with north and northeast winds. Wind events from the north with relative humidity below 30% occur about three times per year. An example from 2017 is shown in **Figure A-18**. While this event was preceded by high relative humidity, raising the fine fuel moisture, such an event could lead to significant rapid fire growth if the preceding conditions were drier and heavy fuels were critically dry due to minimal fall and winter precipitation. Historically, these types of events occur in January and February, with February having the greatest frequency of very dry strong wind events.

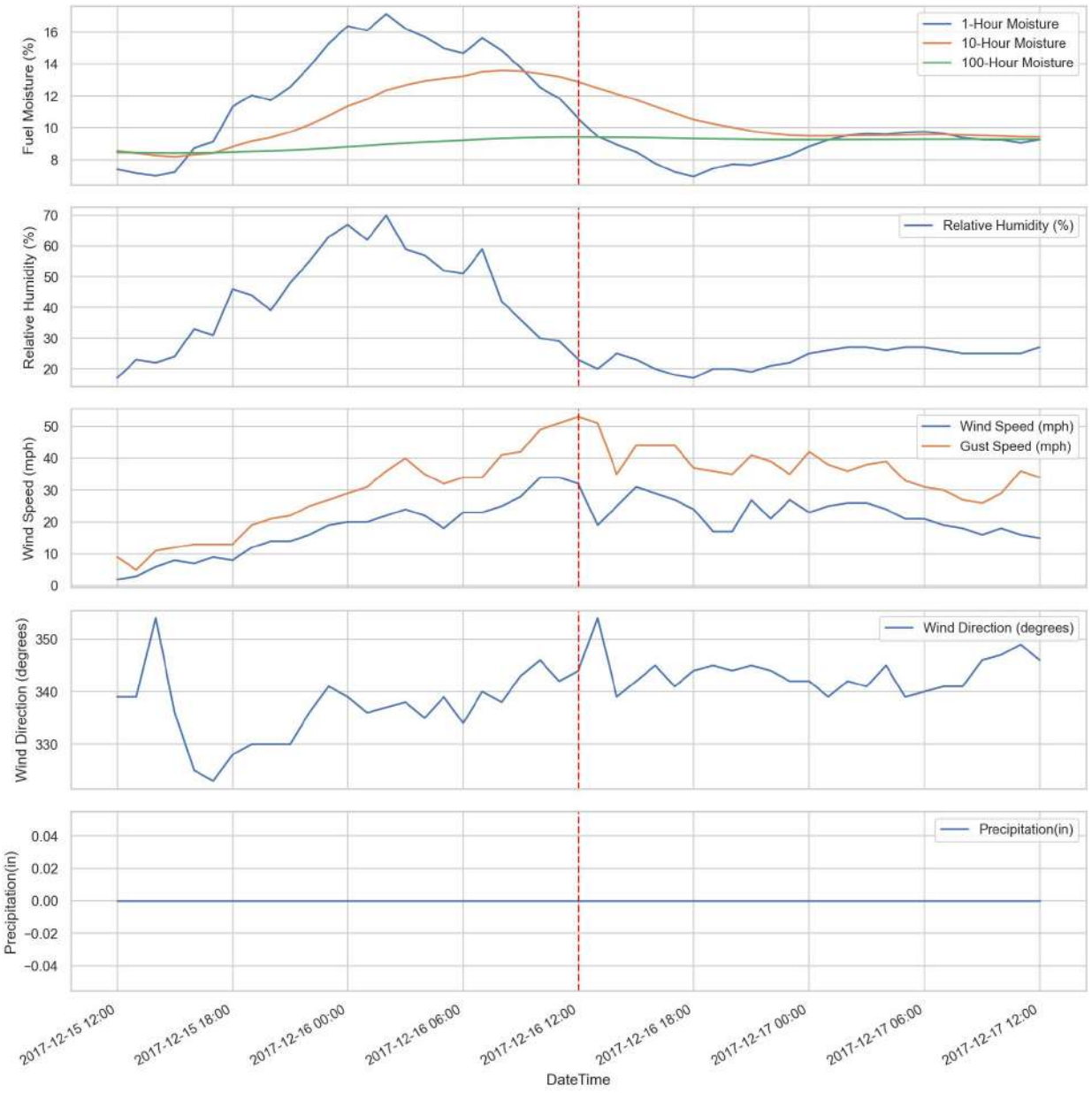


Figure A-18. An example of a sustained dry wind event in December.

Recommendation: Based on the historical record, out-of-season fire-weather events are most likely to manifest similarly to Diablo wind events. While the existing Diablo fire-planning scenario captures these conditions, fire managers should consider the potential for an out-of-season event to occur into February if climate-change-driven changes to the precipitation regime alter the timing of annual seasonality. Because a Diablo fire-weather scenario is already captured in Marin County's fire-behavior analyses, no additional scenario is recommended.

Appendix B. Marin County Fire Weather and Climate Change Assessment

B.1 Executive Summary

As part of the 2026 Marin County CWPP update, this quantitative analysis utilizes downscaled climate model projections to identify likely changes to fire weather anticipated by 2050. The goal of this analysis is to identify the potential differences that Marin County will experience in the near future, focusing on timing, duration, and intensity of precipitation; timing and duration of periods of low atmospheric moisture; and severity of dry-wind events. It is clear that climate change will bring significant changes to the region in the next several decades, and that changes are already underway compared to a 20th-century baseline.

Key Findings

- Fire seasons will become longer. While overall precipitation is projected to *increase* in the next several decades, the seasonality of this precipitation is likely to create longer periods with limited precipitation. Marin County will experience fewer days in the spring with appreciable precipitation and season-ending events in the fall will be delayed.
- Increased winter precipitation during intense atmospheric river events will drive increased vegetation growth and result in elevated fire behavior the following year.
- Fire season months are projected to become drier, and consecutive dry periods will lengthen. Increases in the duration of low-moisture periods will increase by up to 30%. Sustained drying will drive increased fire behavior and create elevated fire-weather conditions for a greater portion of the fire season.
- Overall wind speeds are projected to remain similar until mid-century. However, wind speeds experienced during dry periods will increase substantially. An increase in the number of consecutive dry and windy days, paired with an increase in wind velocity, will drive increased fire activity throughout the summer and fall.

Key Recommendations

Plan for increased grass crops: Due to increased winter moisture in the form of atmospheric rivers, we project an increase in annual grass growth. Wet winters and atmospheric rivers are a common denominator of recent WUI disaster fires. Fire managers and planners should consider increased herbaceous growth as a risk factor and consider increasing investments in grazing and mowing

programs. Risk modelers should incorporate increased herbaceous fuel loading into risk assessments and project prioritization.

Prepare for increases in severity of autumn fire weather: While winter precipitation is projected to increase, October precipitation is projected to decline. Fewer season-ending precipitation events are projected in October by the middle of the 21st century; when they do occur, they are likely to happen later in the month. Because October often coincides with peak Diablo wind conditions, we anticipate an increase in the likelihood of Diablo wind events occurring before the arrival of seasonal moisture. We recommend preparing for the increased severity of these events through enhanced planning, vegetation management, and fire response staffing.

Prepare for an increase in the frequency of moderate fire weather: Models do not indicate an increase in the frequency or characteristics of the highest-severity fire-weather events. However, they do indicate a substantial increase in the number of days with low relative humidity and moderate wind speeds. These "average" fire-weather days may double by the middle of the 21st century. Furthermore, climate models suggest that Marin County will experience an increase of at least 20% in the number of consecutive low-humidity, moderate wind days. We recommend that fire managers plan for an increased number of dry, moderately windy days through increased resident awareness and education, vegetation management, and fire response staffing. We recommend that risk modeling assessments continue to track progress in risk reduction using the highest-severity fire-weather conditions; however, additional modeling to reflect average conditions may be appropriate in some circumstances.

Please also see **Appendix A. Marin County Fire Weather Assessment.**

B.2 Background

Climate change is underway. Changes in fire-weather patterns, the timing and duration of annual precipitation, and wind regimes are already occurring in Marin County. While predicting the exact timing of specific weather events is impossible, predicting multi-annual shifts in humidity, precipitation, temperature, and wind is possible using downscaled global climate model data.

This analysis uses data from several leading climate change models to assess the differences expected in Marin County by the middle of the 21st century. Dynamically downscaled data were obtained from the CalAdapt[44] project, which provides access to numerous climate change tools and datasets.[45] The datasets used in this study include daily climate projections for Marin County at a resolution of about 6 km (3.7 miles). The data were bias corrected and downscaled using the Localized Constructed Analogues (LOCA) statistical method and cover the time period from 2006 to

[44] **https://cal-adapt.org/**

[45] Thomas, N., Mukhtyar, S., Galey, B., Kelly, M. (University of California Berkeley). 2018. Cal-Adapt: Linking Climate Science with Energy Sector Resilience and Practitioner Need. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CCCA4-CEC-2018-015.

2100.[46,47] The RCP8.5 emissions scenario was used to represent continued GHG emissions and more severe climate change impacts. To facilitate comparison, the period between 2005 and 2025 was used as the baseline, and the period between 2030 and 2059 was used as the estimate of mid-century climate.

B.3 Precipitation

While the number of days with precipitation is projected to decrease significantly by 2100, most models indicate that this decrease is not anticipated to occur until the second half of the century. No statistically significant changes in the number of days with more than 0.25" of rain compared with the historical baseline are projected between 2030 and 2060.

The primary near-term impacts to precipitation are changes in its timing, frequency, and intensity. As shown in **Figure B-1** and **Table B-1**, two primary differences in the amount of total precipitation are projected:

- **Decreased Precipitation in October.** This decrease in fall precipitation is indicative of the delayed precipitation described in the preceding section. Such delayed precipitation could increase the severity of Diablo wind events and increase the season during which fuels are receptive to such events.
- **Increased Winter Precipitation.** While climate change is often associated with warmer, drier weather, there is strong evidence from multiple climate models that winter precipitation will increase in the coming decades. This increase in winter precipitation is anticipated to have significant implications for the growth of herbaceous vegetation. As winter moisture increases, annual vegetation growth is expected to increase as well, potentially increasing the availability of fine annual grasses and shrubs. Fine fuels drive rapid rates of fire spread, particularly during wind-driven fires.

[46] Pierce et al. (2018). Climate, drought, and sea level rise scenarios for California's fourth climate change assessment. California's Fourth Climate Change Assessment, California Energy Commission. Publication Number: CNRA-CEC-2018-006.
[47] Climate models include CanESM2, CNRM-CM5, CCSM4, GFDL-CM3, HadGEM2-CC, CESM1-BGC, HadGEM2-ES, MIROC5, CMCC-CMS, ACCESS-1.

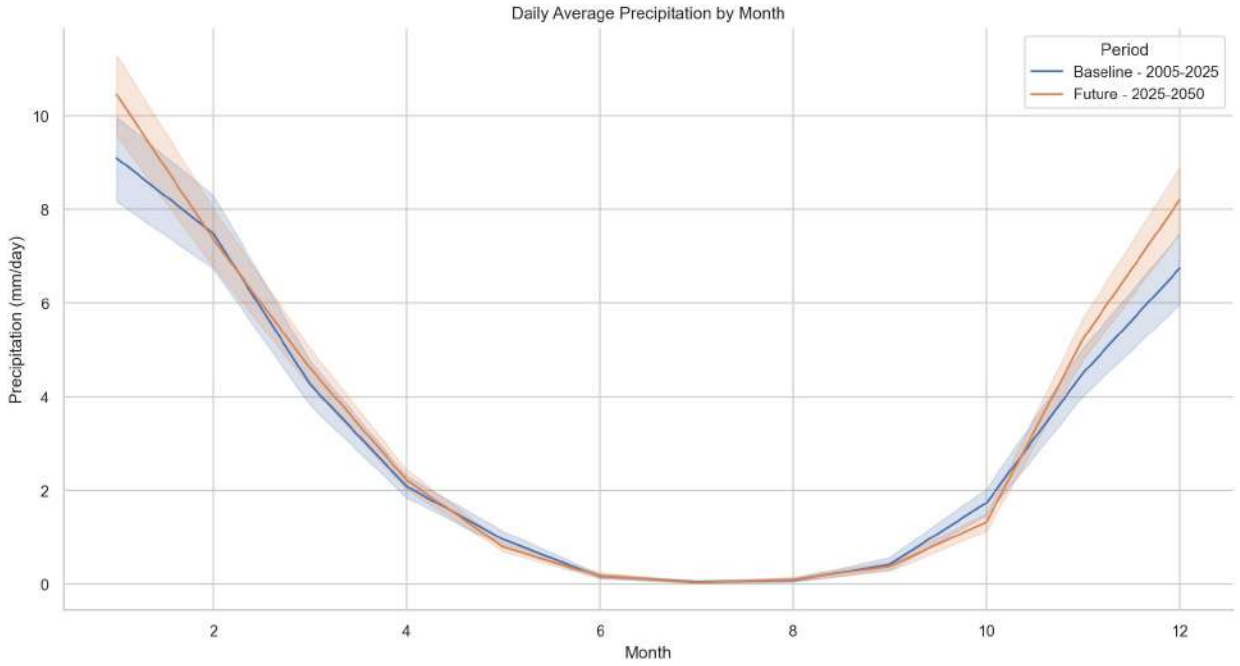


Figure B-1. Changes in the average daily precipitation for each month between the baseline and the 2025-2050 period.

Table B-1. Statistical analysis of projected monthly average precipitation from 10 different downscaled climate projection models.

Month	2005-2025 Average (mm)	2025-2050 Average (mm)	Change (mm)	Interpretation	p Value
January	9.094	10.448	1.354	Significantly Wetter	0.039
February	7.485	7.363	-0.122	No Change	0.808
March	4.269	4.611	0.342	No Change	0.285
April	2.086	2.221	0.135	No Change	0.396
May	0.954	0.792	-0.162	No Change	0.069
June	0.161	0.171	0.010	No Change	0.804
July	0.046	0.030	-0.016	No Change	0.257
August	0.078	0.094	0.017	No Change	0.593
September	0.424	0.385	-0.039	No Change	0.655

Month	2005-2025 Average (mm)	2025-2050 Average (mm)	Change (mm)	Interpretation	p Value
October	1.735	1.324	-0.410	Significantly Drier	0.013
November	4.505	5.234	0.729	Significantly Wetter	0.041
December	6.738	8.198	1.460	Significantly Wetter	0.006

As shown in **Figures B-2 and B-3**, additional changes are projected in the seasonality of rainfall events; such changes will affect the length of the fire season. The number of days with significant precipitation in October is projected to decrease from an average of 5.9 days to 5.2 days by 2060. Significant changes in November and December precipitation days are not projected until later in the century. April and May precipitation days are also anticipated to decrease by about 0.4 and 1.2 days per month, respectively. These changes suggest that climate change will drive longer fire seasons by limiting the green up period and faster curing of spring annual growth and extending the fall fire season and reducing the likelihood of season-ending moisture in October.

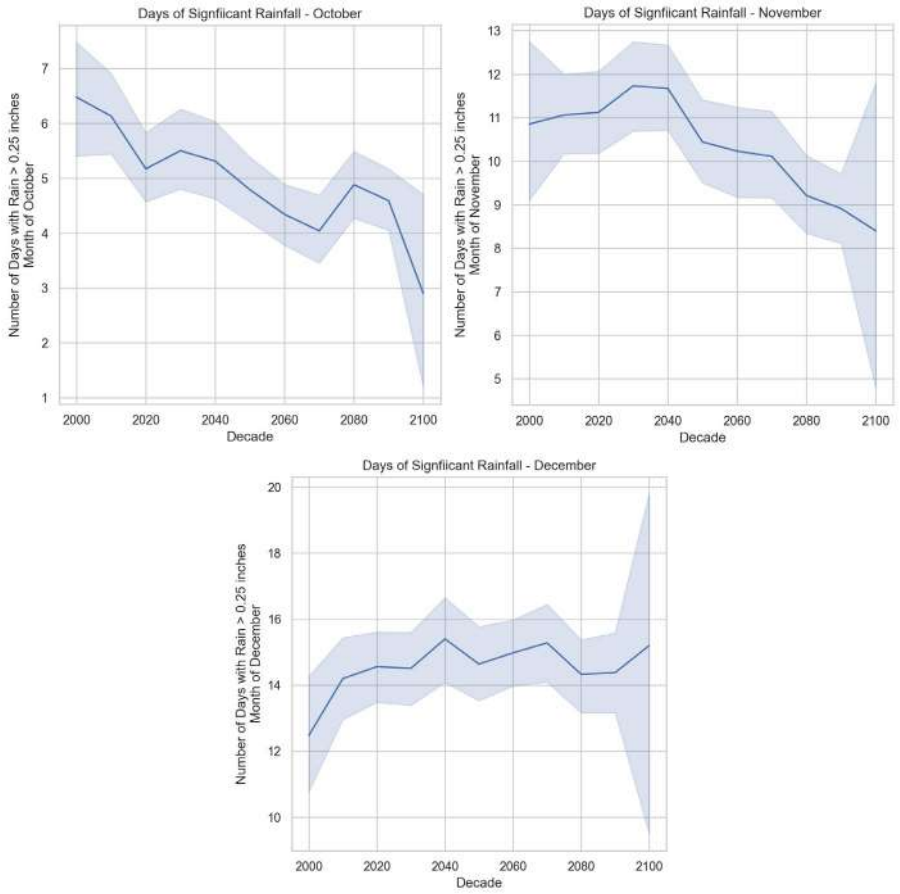


Figure B-2. Projected changes in the number of days with more than 0.25" of rain by month. From left to right: October, November, December.

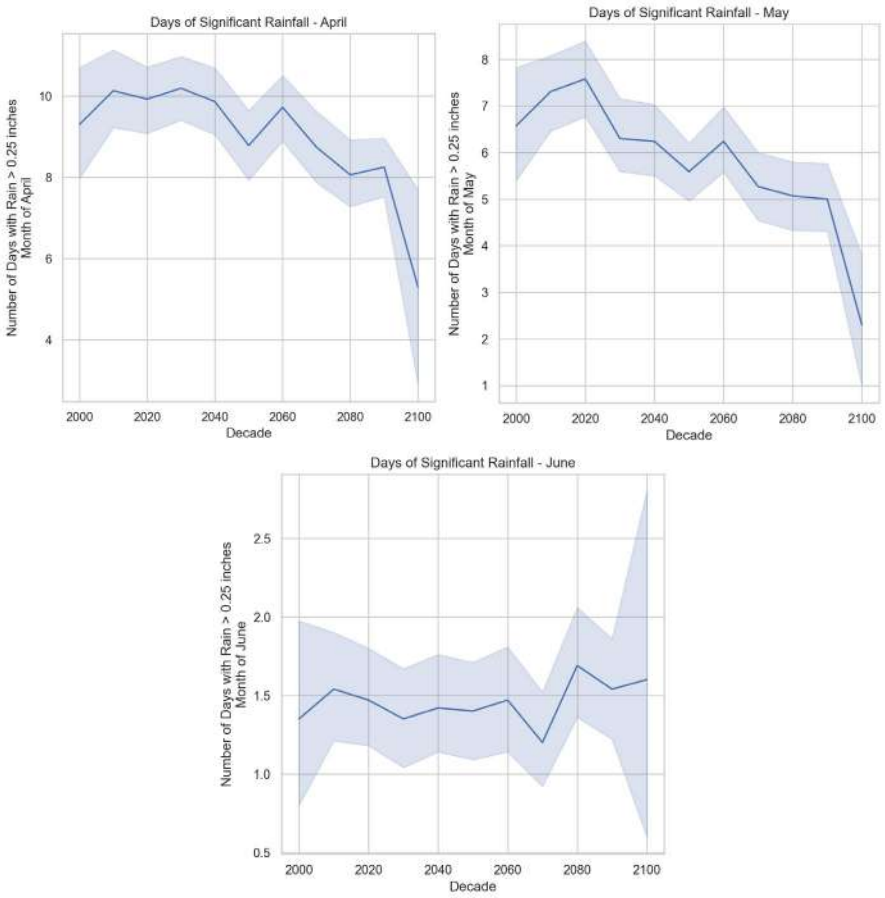


Figure B-3. Projected changes in the number of days with more than 0.25" of rain by month. From left to right: April, May, June.

Figure B-4 shows the cumulative precipitation totals for May and October. Across all climate change models, these months are likely to have less precipitation throughout the month, leading to increased drying of larger-diameter fuels.

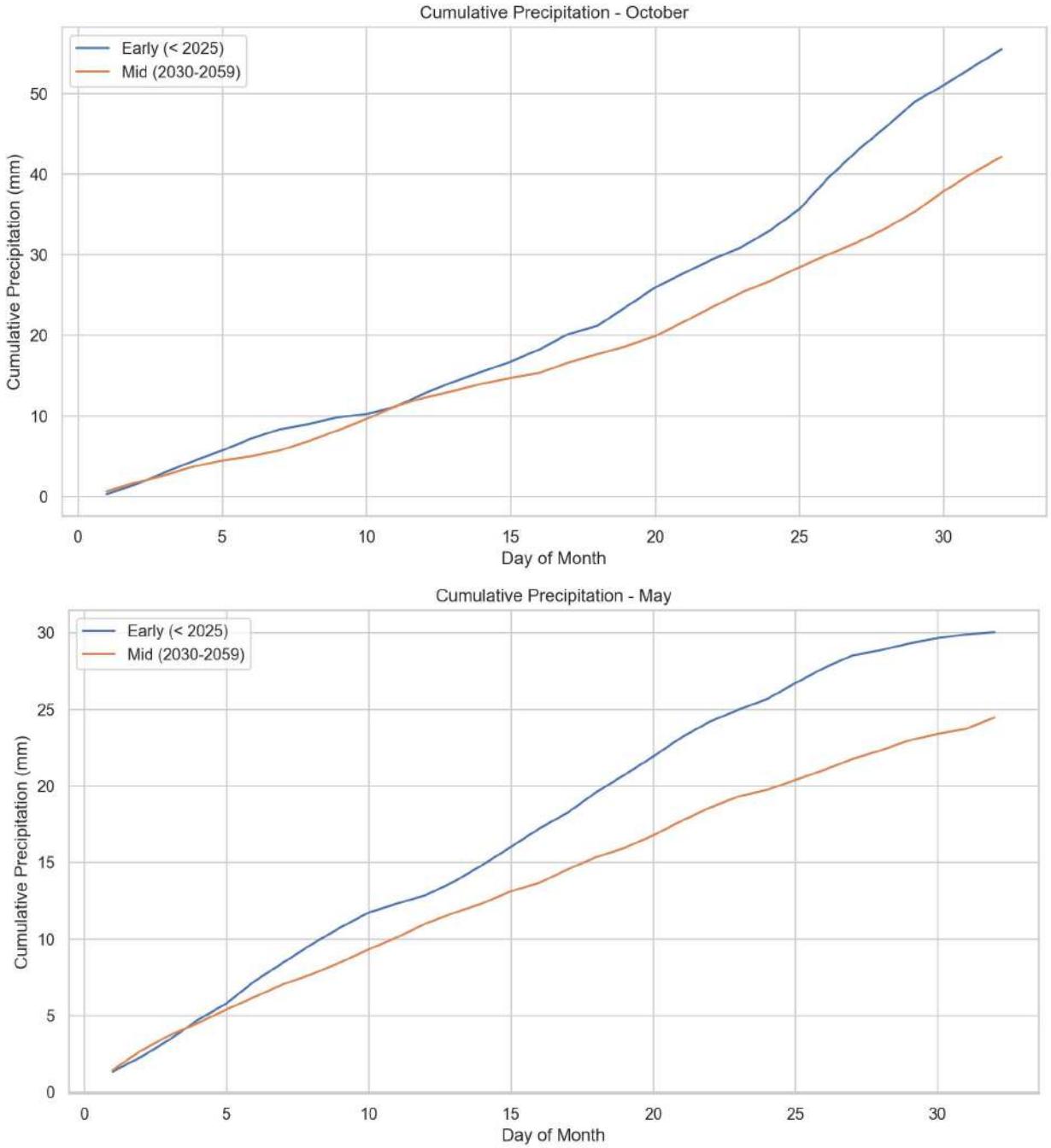


Figure B-4. Average cumulative rainfall for October (top) and May (bottom) for the baseline and mid-century periods.

Precipitation events are also projected to become more intense. Most models agree that extreme precipitation will increase in frequency and intensity by mid-century, with significant further increases by the end of the century. **Figure B-5** shows the daily precipitation of the 1-in-5-year precipitation event (i.e., 20% annual probability). These models show good agreement that the daily rainfall total

of this event is likely to increase from about 2.9 inches to between 3.5 and 3.8 inches, a relative increase of up to 30%. This trend reflects the increased prevalence of atmospheric rivers capable of bringing frequent, high-intensity precipitation to Marin County.

There is limited evidence that 1-in-100-year precipitation events will increase in severity as well. While the most extreme storms may increase slightly, the severity of more frequent storms increases significantly.

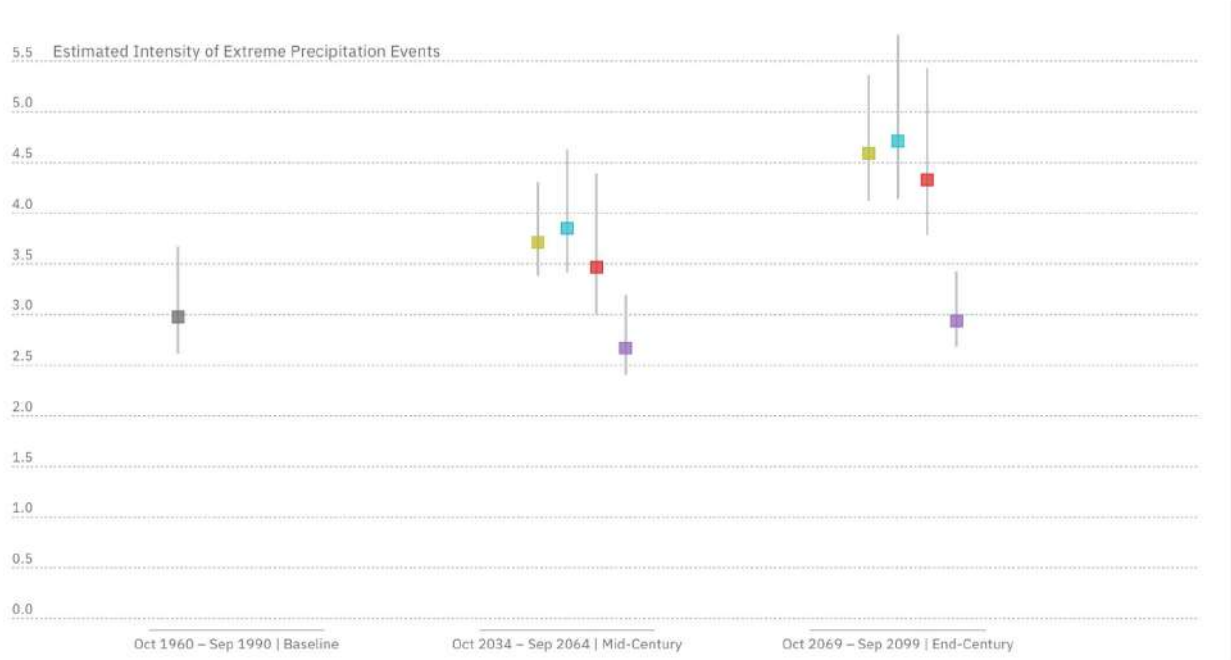


Figure B-5. Daily rainfall totals projected for the 1-in-5 year precipitation event during the historical baseline (left), mid-century (center), and late-century (right).

B.4 Implications for Fire Behavior by Mid-Century:

- Increased winter precipitation is anticipated to increase the loading of fine fuels (grasses, forbs, and shrubs).[48,49] Increases in fine fuels will increase wildfire behavior by creating faster rates of fire spread.
- Decreases in the number of days with precipitation in the spring and fall will extend fire seasons. Fuels will be more available for longer. Curing of herbaceous fuels will begin earlier

[48] Lenihan, James M., et al. (2003) Climate change effects on vegetation distribution, carbon, and fire in California. *Ecological Applications*, 13.6, 1667-1681.
[49] Pilliod, D. S., Welty, J. L., & Arkle, R. S. (2017). Refining the cheatgrass–fire cycle in the Great Basin: Precipitation timing and fine fuel composition predict wildfire trends. *Ecology and Evolution*, *7*(19), 8126-8151.

and season-ending precipitation will come later in the year. Delayed moisture in October will align with Diablo wind events, increasing the risk of high-severity wildfires into late October.

- Increases in the frequency of atmospheric rivers will result in increased biomass production and elevated fire behavior.[50]

B.5 Humidity and Vapor Pressure Deficit

Atmospheric moisture content drives fire behavior by drying fuels. Climate change models indicate potential changes in the seasonality of atmospheric moisture by mid-century:

- Statistically significant decreases in relative humidity are projected throughout the fire season (June through October), as shown in **Table B-2**. Sustained periods of lower atmospheric moisture will lead to decreased fuel moisture and increased fire behavior.
- Statistically significant increases in the number of sustained dry periods. Figure 6 shows the relative change (percent) in the number of days per month where the rolling 3-day relative humidity is less than 25%. Substantial increases are projected in February,[51] June, July, and August. December and January are projected to have increased atmospheric moisture in the future, corresponding to the higher precipitation levels in these months. The sustained drying during the summer months, however, is anticipated to result in lower fuel moisture and greater availability of large-diameter fuels.
- Decreases in relative humidity in June may accelerate the curing of live herbaceous fuels.

[50] Albano, C. M., Dettinger, M. D., & Soulard, C. E. (2017). Influence of atmospheric rivers on vegetation productivity and fire patterns in the southwestern US. *Journal of Geophysical Research: Biogeosciences*, 122(2), 308-323.
[51] While the relative increase in February is very high (117%), sustained drying periods are projected to occur infrequently (i.e., 0.02 times per month). Therefore, there are few fire behavior implications of this change.

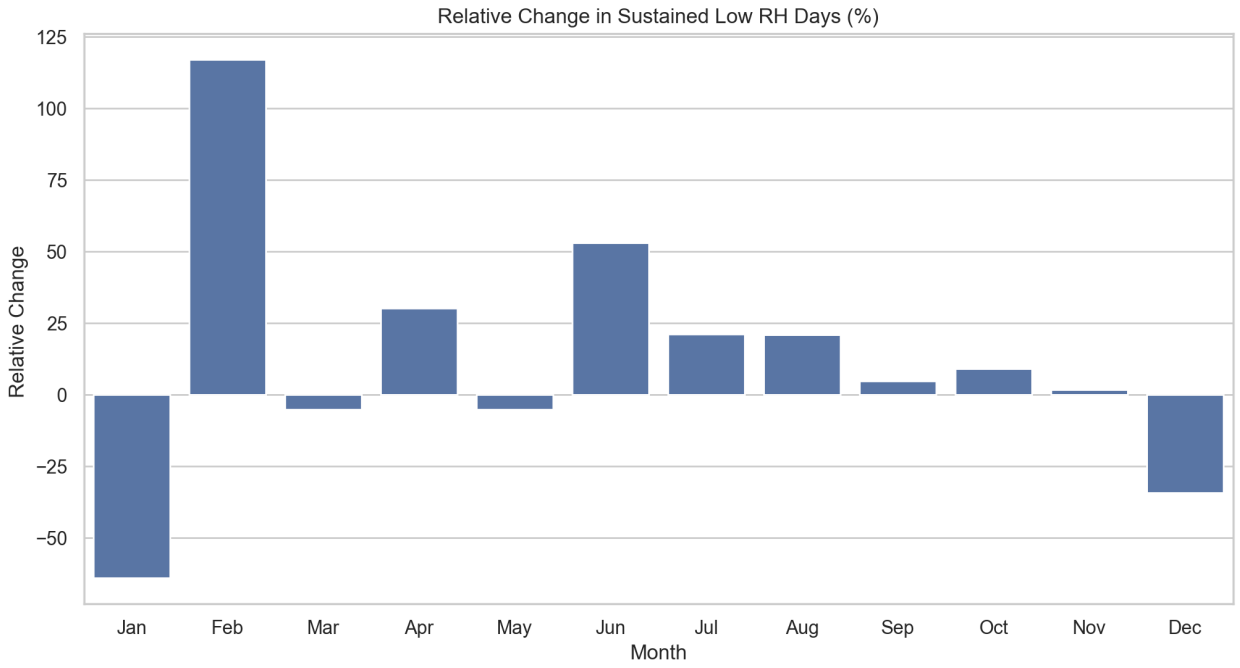


Figure B-6. Percent change in prevalence of 3-day periods with relative humidity below 25% by mid-century.

Table B-2. Projected changes in monthly average relative humidity for Marin County.

Month	Daily Average Relative Humidity (%)		Projected Average Change	Interpretation	p Value
	2005-2025	2030-2059			
January	59.9	62.0	2.09	Significantly Increase	0.00
February	54.2	53.1	-1.11	Significantly Decrease	0.00
March	49.5	49.4	-0.10	No Change	0.65
April	45.9	45.8	-0.14	No Change	0.52
May	43.5	43.1	-0.33	No Change	0.10
June	38.2	37.7	-0.55	Significantly Decrease	0.01
July	34.4	33.9	-0.54	Significantly Decrease	0.00
August	33.7	33.3	-0.43	Significantly Decrease	0.00
September	31.0	30.6	-0.42	Significantly Decrease	0.02
October	31.6	31.0	-0.62	Significantly Decrease	0.02
November	46.3	46.8	0.57	No Change	0.14
December	53.5	54.9	1.42	Significantly Increase	0.00

As shown in **Figure B-7**, the likelihood of sustained low-moisture periods will increase by mid-century. While the likelihood of any single day reaching fire-weather moisture conditions will remain about the same, the likelihood of a three-day stretch with daily average relative humidity below 30% will increase by about 14%. Perhaps more importantly, the likelihood of a nine-day stretch will increase by over 31%. Although these events are rare (estimated frequency: 0.16 times per month at mid-century), the increase in sustained dry periods is likely to result in elevated fire-weather conditions for a longer portion of the fire season.

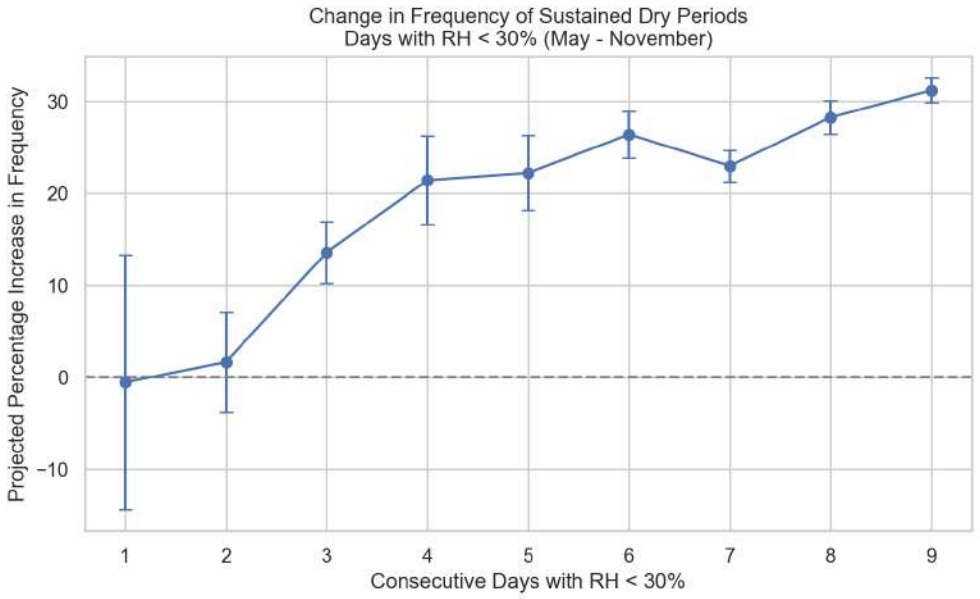


Figure B-7. Relative increase in sustained low-moisture events by duration between the baseline and mid-century periods.

B.6 Implications for Fire Behavior

- Decreased relative humidity throughout the fire-season months will exacerbate fire behavior.
- Increased prevalence of sustained dry periods will increase the availability of larger-diameter fuels and create elevated fire-weather conditions more frequently.

B.7 Wind Speed

No statistically significant changes in average wind speed are projected in the near future. As shown in **Figure B-8**, average wind speeds are projected to remain similar throughout the analysis period. While some models indicate a slight increase in high-wind-speed events, the majority of climate models reflect few statistically significant changes in wind speed.

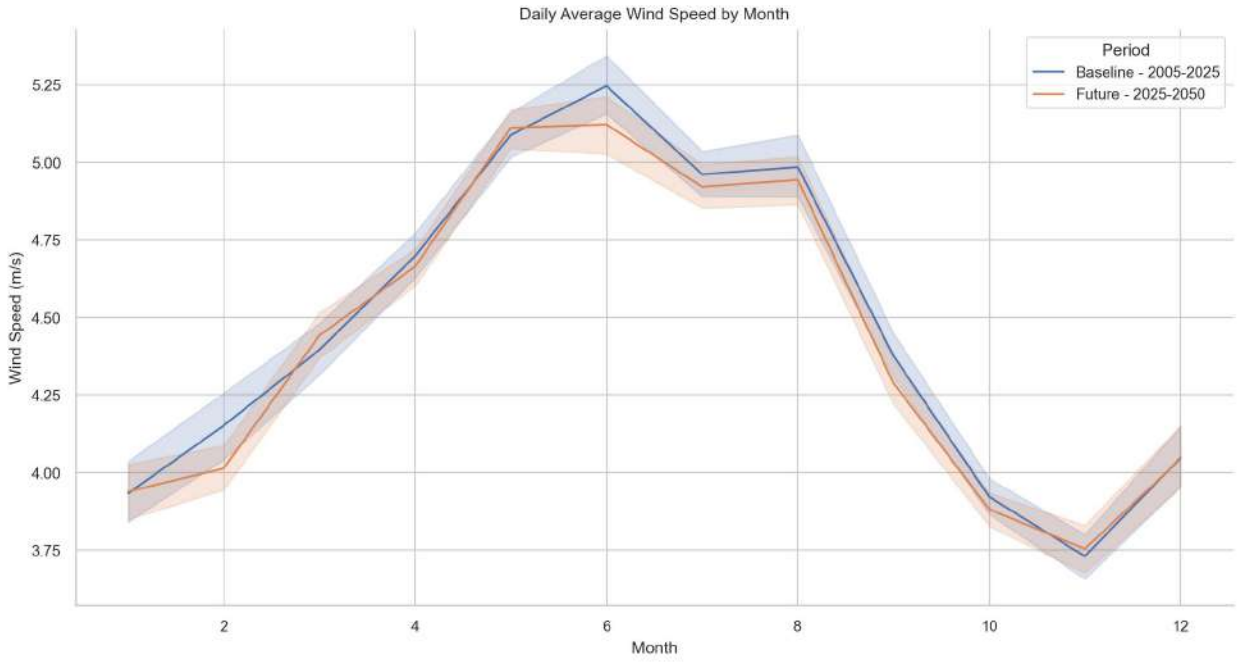


Figure B-8. Changes in the average daily wind speed by month between the baseline and 2025-2050 periods.

While wind speed is unlikely to change significantly, its relationship with other fire-weather variables, such as relative humidity, is likely to result in more elevated fire-weather conditions by mid-century. **Figure B-9** illustrates that the likelihood of consecutive fire-weather days will increase substantially over the next several decades. Here, fire weather is defined as a wind speed equal to or above the 50th percentile (i.e., 4.4 mps or 9.8 mph) and daily average relative humidity less than or equal to the 50th percentile (i.e., 35%) for the fire season months of June-October. The likelihood of four consecutive days of these conditions is projected to increase by about 20%. The likelihood of a week or more of these conditions may increase by as much as 32%.

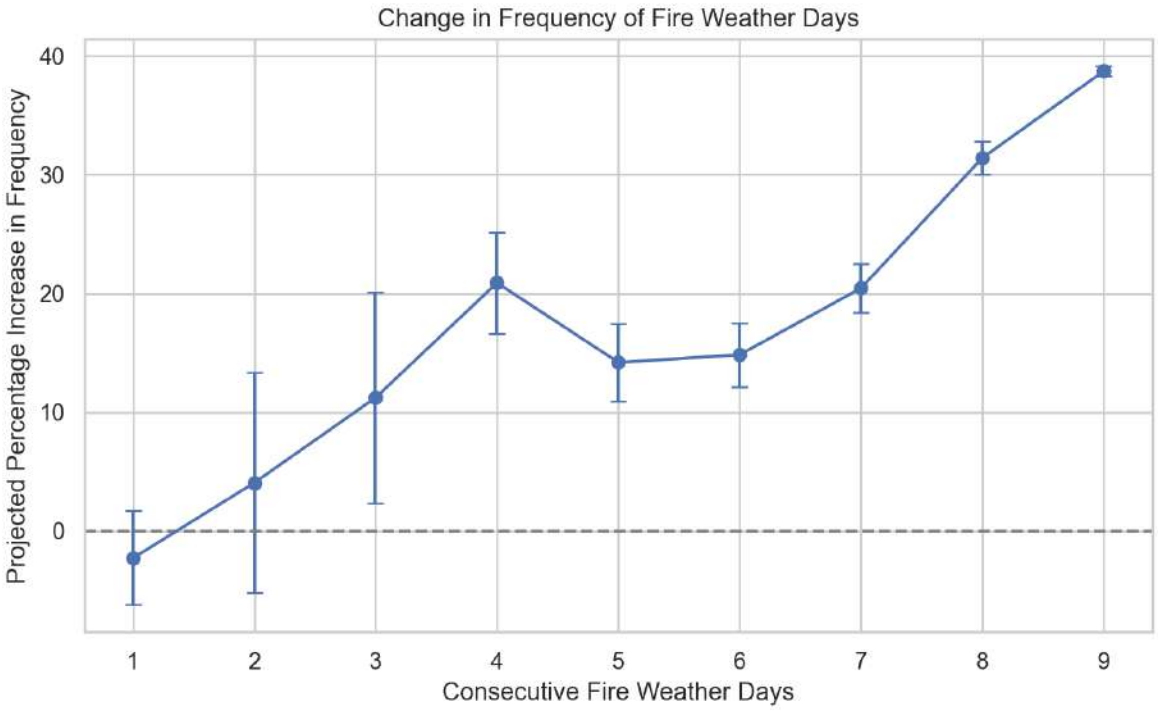


Figure B-9. Change in frequency of consecutive fire-weather days projected by mid-century.

This analysis also suggests an increase in wind speed when relative humidity is low. **Figure B-10** shows a cumulative distribution plot of daily average wind speeds for days when relative humidity is below 30% during the fire-season months. Parameter space in which the orange line is to the right of the blue line corresponds to a greater likelihood of higher wind speeds. While the highest wind speeds during dry periods are not projected to change, there is evidence that wind speeds on moderate fire-weather days may increase.

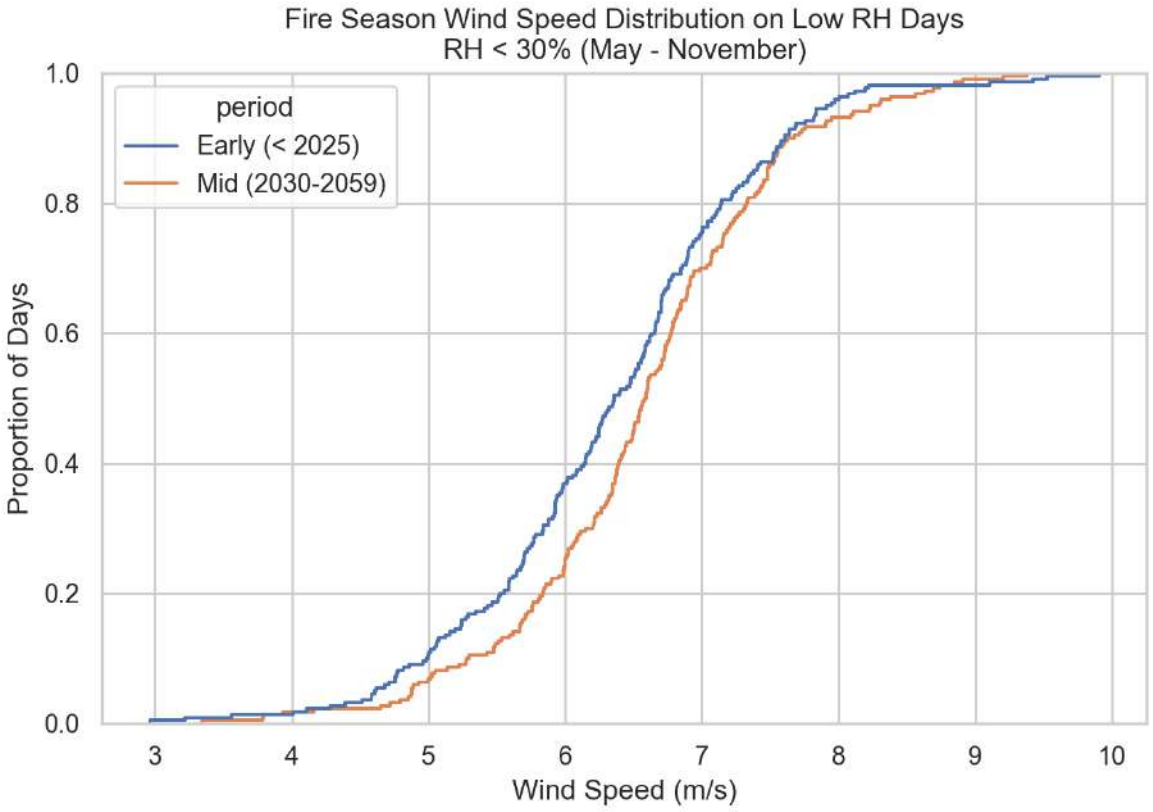


Figure B-10. Cumulative distribution plot of maximum daily wind speeds on days when the relative humidity is below 30% for the baseline and mid-century periods.

As shown in **Figure B-11**, while the number of days with very high wind speeds (above 6 mps or 13.4 mph) is not projected to increase substantially, the number of days with lower wind speeds during dry periods is likely to increase. Significant fire conditions can develop during periods of daily average wind speed above 4 mps (9 mph) with low relative humidity.

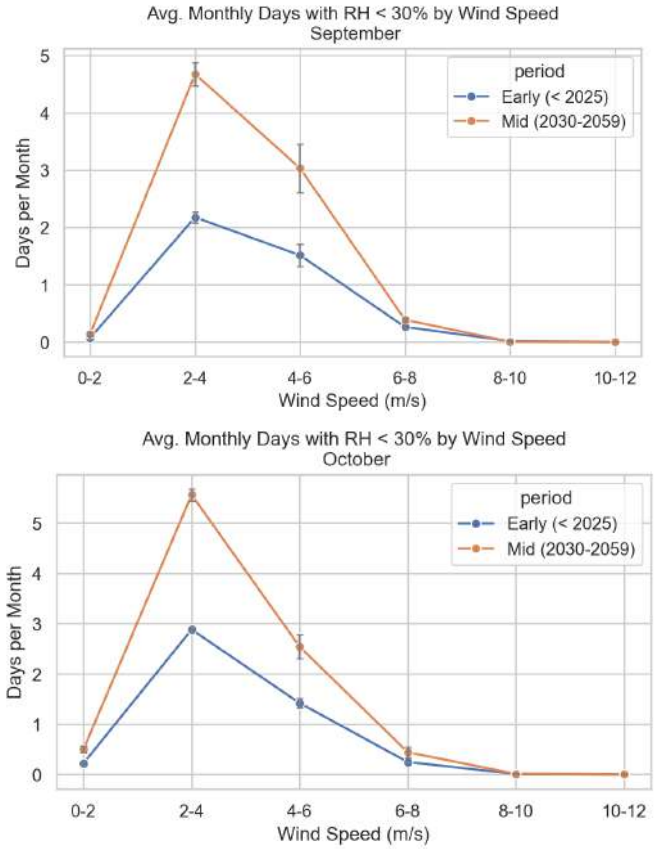


Figure B-11. Projected number of days with relative humidity below 30% by wind speed.

B.8 Implications for Fire Behavior

- Consecutive fire-weather days will result in elevated fire danger more often by mid-century. Consecutive dry and windy days will result in more difficult suppression and more active fire behavior.
- Wind speeds during dry periods may elevate average fire-weather conditions. An increase in the frequency of dry and moderately wind days will increase the likelihood of significant (if not catastrophic) fire activity.

Appendix C. Marin County Social Vulnerability Assessment

C.1 Executive Summary

Social vulnerability captures how the characteristics of certain groups make them more likely to suffer from the adverse impacts of natural disasters. Recognizing the social determinants of risk is essential for equitable hazard mitigation and resilience planning and can ensure that vulnerable groups are prepared to anticipate, respond to, and recover from a natural hazard such as a wildfire.

While Marin County in California is one of the most affluent counties in the United States, with more than 37% of residents earning more than $200,000 annually[52] Marin County is also home to many lower-income and traditionally underrepresented residents. These populations have fewer resources and face structural and linguistic barriers to wildfire preparedness. The objective of this brief technical report is to identify the areas of the county where the social vulnerability is greatest. These areas can be prioritized for additional risk reduction activity, alternative funding mechanisms, and language-specific education and outreach programs.

Note that this assessment intentionally does not explicitly evaluate mixed-status or undocumented households. Eligibility for county outreach, education, and assistance programs does not depend on immigration or documentation status as a condition of participation.

Key Findings

- This analysis applied three census-based social vulnerability indices to identify residents who face heightened risk due to socioeconomic conditions, language and minority status, and demographic characteristics. Datasets include the Centers for Disease Control and Prevention's (CDC's) SVI, the California Climate Investment's Priority Populations dataset, and the California Environmental Protection Agency's (CalEPA's) CalEnviroScreen tool. Marin Wildfire's recent Wildfire Risk Perceptions Survey was also integrated to understand how these factors relate to wildfire preparedness.
- Approximately 47% of Marin County's population resides in low-income areas (as identified by the California Climate Investments screening process; <80% of the statewide median income).

[52] https://censusreporter.org/data/map/?table=B19001&geo_ids=050|04000US06&primary_geo_id=04000US06#column|B19001017,sumlev|050

  - Roughly 10% of people in Marin County live below the poverty line. Several areas of the county, including the Canal area of San Rafael, central Novato, and Bolinas, are home to relatively large populations of residents living below the poverty line.
  - When additional socioeconomic factors, such as housing burden (percent of income spent on housing) and unemployment, are considered in addition to income, the Spinnaker Point and Canal areas of San Rafael, Rowland and Davison areas of Novato, and neighborhoods in Marin City are identified as the communities with the greatest social vulnerability. Prioritizing funding and direct assistance in these neighborhoods may be appropriate.

- Approximately one fifth of the population of Marin County is estimated to live in households that speak English less than well.
  - Near-poverty populations are much more likely to face linguistic barriers than high-income populations.
  - The most common non-English language is Spanish.
- People of color face structural barriers that can limit access to emergency preparedness resources and services.
  - About 65% of Marin County's population is white. Roughly one in five residents is Hispanic.
  - When minority status and linguistic barriers are considered together, the Canal and Spinnaker Point areas of eastern San Rafael, the Davison and Rowland areas of Novato, and Marin City are again identified as the most vulnerable areas of the county. Increased wildfire focus by community-based organizations and Spanish bilingual materials may be appropriate in these areas.
- Respondents to the Risk Perception Survey (RPS) expressed significant concern over wildfires (3.7/5.0).
  - Many residents expressed extreme concern about traffic preventing a safe evacuation. Residents are more concerned about this issue than almost any other issue.
  - Cost is a significant barrier to residential risk reduction (home hardening and defensible space), particularly in low-income communities. Other barriers include a lack of perception of on-parcel vegetation as a risk factor and not being responsible for the exterior of their building or landscaping.
  - Emergency alerts are often received and usually understood by socially vulnerable communities. While there is a perception that residents will miss an alert due to poor cell service or other issues, the vast majority of residents have received alerts in the past.

Key Recommendations

- Develop outreach and education programs designed to meet the needs of socially vulnerable people in Marin County. Work with community-based organizations to deliver these messages and ensure that messaging is available in English and Spanish.
- Implement a needs-based grants program that helps low-income residents with defensible space and home hardening. Such a program should also include an education component so that recipients become more familiar with how defensible space reduces fire risk in their communities.
- Create targeted evacuation planning materials for socially vulnerable groups. There is significant concern that residents will become trapped on a roadway during an evacuation; furthermore, most residents are not prepared to evacuate and/or do not know where to go when an order is issued. Education, outreach, and messaging to help residents understand the evacuation process and the location of nearby safe areas could assuage some of these concerns.
- Consider issuing "test alerts" that allow residents to become more familiar with the emergency alerting infrastructure and build confidence that they will receive an alert during a wildfire emergency.
- Provide materials for renters to help educate their landlords on fire risks. Because many socially vulnerable residents are renting, improved outreach materials that help these residents communicate with the landlords, who may not live in Marin County, could be useful in facilitating action in these communities.
- Develop dedicated evacuation and fire preparedness guidance for people with disabilities and older adults. Of populations with access and functional needs, these groups have the largest exposure in areas with limited alerting and evacuation planning capabilities. Materials should be specific and targeted, and should be comparable in specificity to other materials for other communities, such as renters.

C.2 Datasets

Several datasets are available to evaluate social vulnerability to wildfire in Marin County.

- **Centers for Disease Control and Prevention (CDC) – Social Vulnerability Index (SVI):** A comprehensive index describing the demographic and socioeconomic factors that adversely affect communities that encounter hazards, natural disasters, and other community-level stressors. The SVI is based on more than 50 data layers from the American Community Survey (ACS), and is used by emergency planners, public health officials, and local and state health departments to guide planning and preparedness initiatives nationwide. This analysis

is based on 2022 ACS data and is available at the US Census block-group resolution. The SVI is composed of four themes:

  - **Socioeconomic Status:** Percent of residents below 150% of the poverty level, unemployment, per-capita income, lack of health insurance, and housing cost burden.
  - **Household Composition and Disability:** Elderly population, youth population, single-parent households, and persons with a disability.
  - **Minority Status and Language:** Percent of residents who are racial and/or ethnic minorities and populations who have difficulty with the English language.
  - **Housing and Transportation:** Populations living in mobile homes, apartments, households without vehicle access, and households with more people than rooms.

- **California Climate Investments – Priority Populations (CCI-PP):** Communities identified by the California Environmental Protection Agency (CalEPA) as disadvantaged or low-income communities. Communities can be identified as disadvantaged for a variety of reasons, including disproportionate levels of pollution, environmental degradation, and public health conditions; however, this analysis uses the CCI-PP low-income community data layer to identify communities at or below 80% of the statewide median income level. Priority populations are receiving the bulk (>70%) of California Climate Investments project funding and are prioritized because they are likely to be the hardest hit by climate change. CCI-PP determinations are made at the level of census tracts.
- **CalEnviroScreen:** A statewide analysis of socioeconomic and public health conditions, produced by the California Office of Environmental Health Hazard Assessment. This tool helps identify California communities most affected by pollution and where people are most vulnerable to the effects of pollution. CalEnviroScreen data are based on ACS data from 2015-2019 and are calculated on the census-tract level. While the CalEnviroScreen dataset includes a variety of data themes, this analysis uses population characteristics themes, including linguistic isolation, poverty, and unemployment.

In addition to these census-based datasets, this analysis also integrated the 2023 Wildfire Risk Perceptions Community Survey. This survey was a collaborative effort between Marin Wildfire and community-based organizations in Marin County that serve low-income residents, residents of color, and residents with access and functional needs. The survey was designed to capture the views of traditionally underrepresented groups in Marin County. Through partnerships with local organizations, the survey resulted in more than 1,000 responses. Questions were designed to identify gaps in services and guide communication and outreach efforts.

C.3 Socioeconomic Vulnerability and Poverty

While Marin County is an affluent county with many residents making well above the median income in California, it is home to economically challenged populations as well. As shown in **Figure C-1**,

about 47% of the population in Marin County is classified as a low-income priority population by the CCI-PP. These populations are located throughout Marin County, but are especially prevalent in San Rafael, Novato, Fairfax, Sausalito, and in many areas of West Marin.

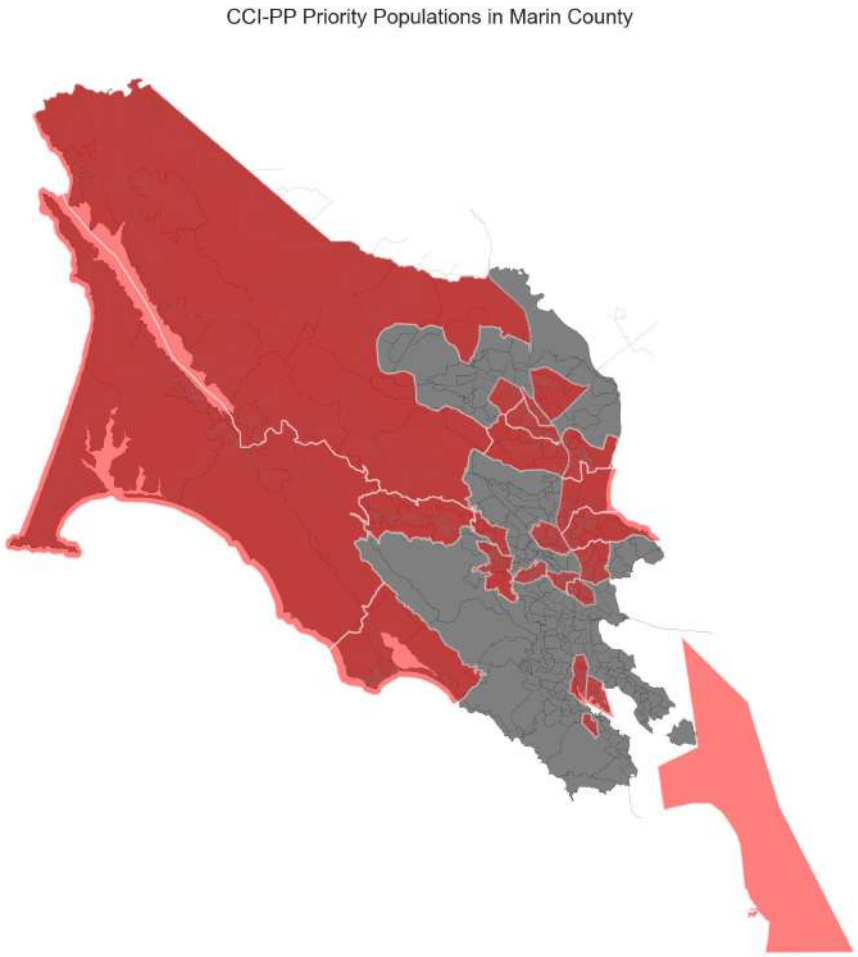


Figure C-1. Low-income priority populations in Marin County.

Figure C-2 shows evacuation zones by the estimated percentage of residents at or below the poverty level, using data from the CalEnviroScreen tool. In 2023, the poverty level was about $43,990 for a family of four. Figure C-2 highlights the high relative poverty rates in eastern San Rafael, central Novato, and the Stinson Beach and Bolinas communities.

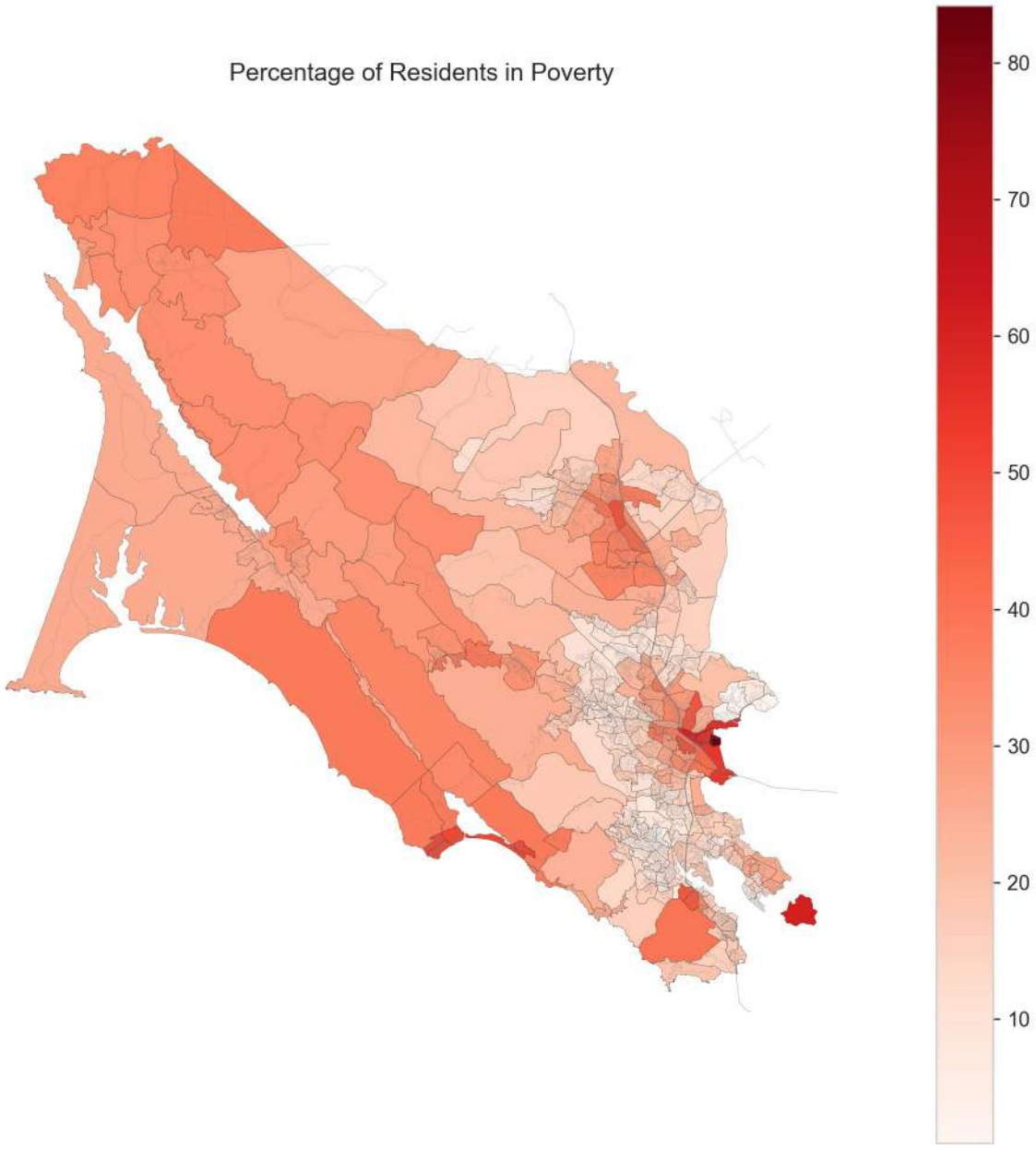


Figure C-2. Estimated percentage of residents in poverty within each block group.

The CDC's Socioeconomic Vulnerability Index (SVI) incorporates several additional indicators of socioeconomic status beyond income. These indicators, including housing burden and unemployment, may paint a more complete picture of the ability of residents to prepare for and respond to natural disasters like wildfires. These factors also reflect the difficulties these communities will have recovering from a disaster. **Figure C-3** shows the SVI for Marin County by evacuation zone. As shown in **Table C-1**, areas of eastern San Rafael, Marin City, and central Novato have the greatest socioeconomic vulnerability. Portions of West Marin, including the areas around Olema and Point Reyes Station, also have high vulnerability.

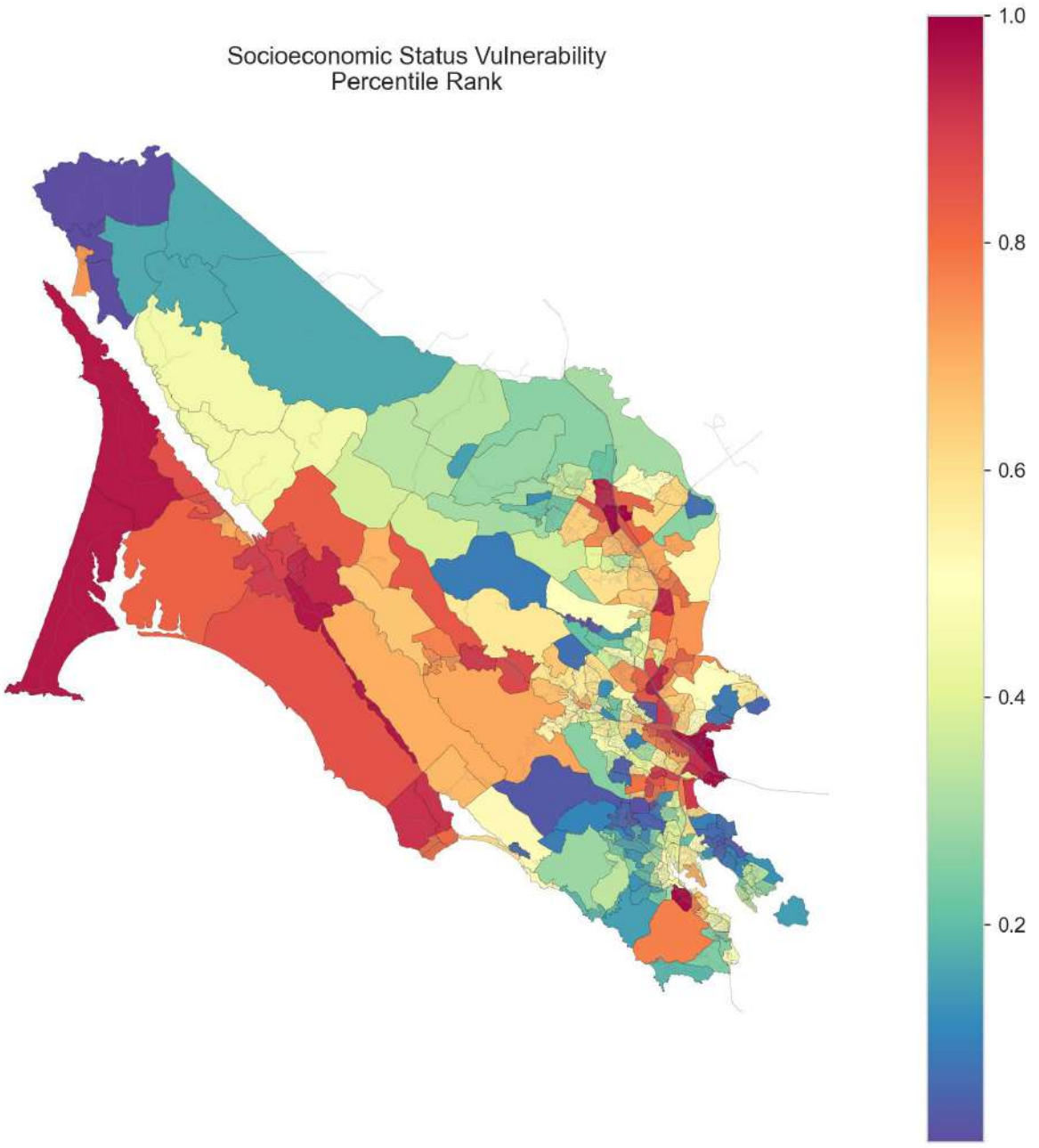


Figure C-3. SVI Theme (Theme 1) for Marin County by evacuation zone.

Table C-1. Evacuation zones with the greatest Socioeconomic Vulnerability Index.

Zone ID	Zone Name	Estimated Population	Average Socioeconomic Vulnerability
US-CA-XMR-SNR-E542	Spinnaker Point/Bay Point Lagoons	2,669	0.84
US-CA-XMR-SNR-E543	Canal/Pickleweed	7,768	0.78
US-CA-XMR-NOV-E022	Rowland	1,784	0.65
US-CA-XMR-NOV-E006	Davidson	199	0.60
US-CA-XMR-SNR-E541	Shoreline Path	41	0.60
US-CA-XMR-MRN-E008	Marin City South	825	0.54
US-CA-XMR-MRN-E014	Marin City North	2,365	0.54
US-CA-XMR-MRN-E134	San Quentin Village	88	0.53
US-CA-XMR-MRN-E079	San Quentin	4,671	0.53
US-CA-XMR-SNR-E521	Canal/Waterfront	2,064	0.53

C.4 Language and Ethnicity

According to the CalEnviroScreenTool, about 18% of the population of Marin County is linguistically isolated. Linguistic isolation is defined as populations with limited English-speaking households, where no one over the age of 14 speaks English well or very well. Spanish is the primary non-English language in the county. In the Risk Perceptions Survey, less than 0.5% of respondents indicated a preferred language for emergency alerts other than English or Spanish. 24% of respondents indicated a preference for Spanish emergency alerts.

As shown in **Figure C-4**, there is a very strong correlation between the areas with high linguistic isolation and high poverty. Areas with high linguistic isolation include communities in San Rafael, Point Reyes Station, Novato, and Marin City. **Figure C-5** shows a map of the estimated percentage of residents in linguistic isolation by evacuation zone.

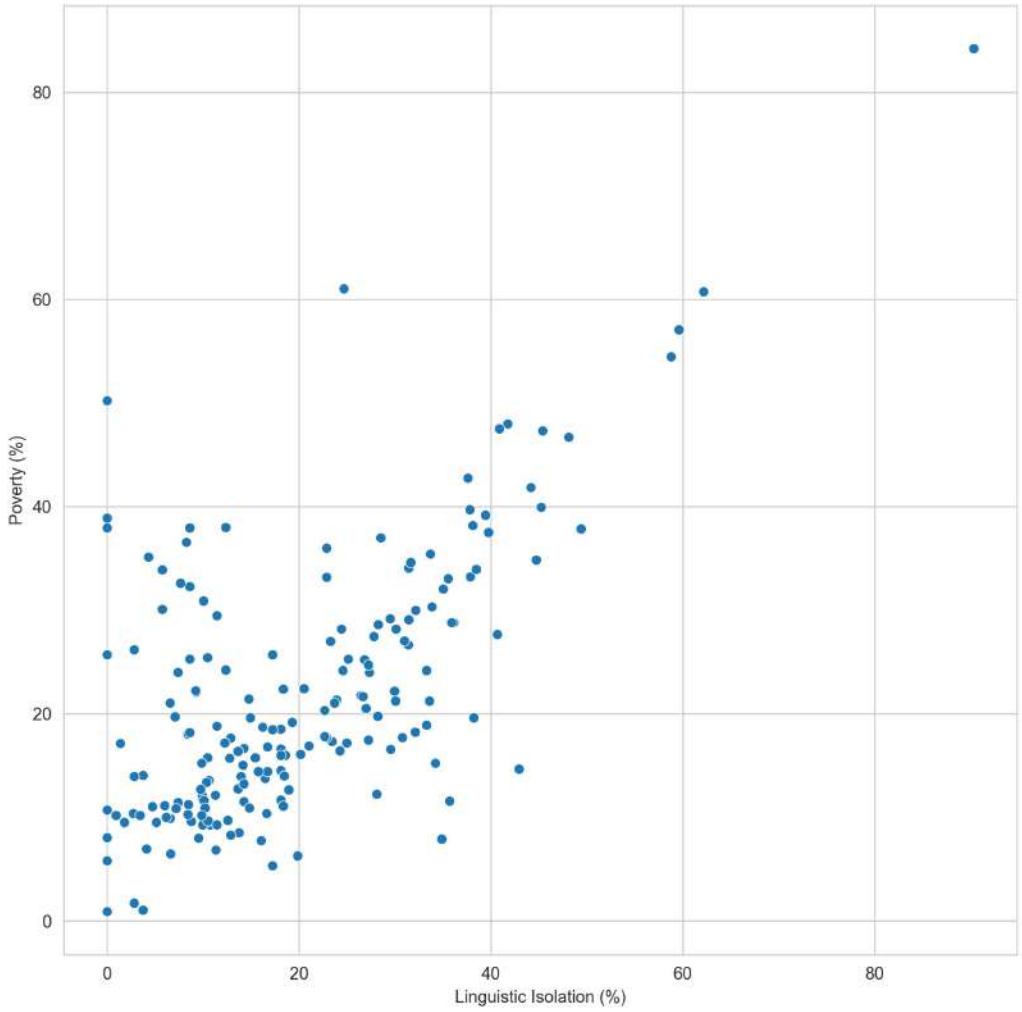


Figure C-4. Correlation between poverty rate and linguistic isolation rate by evacuation zone.

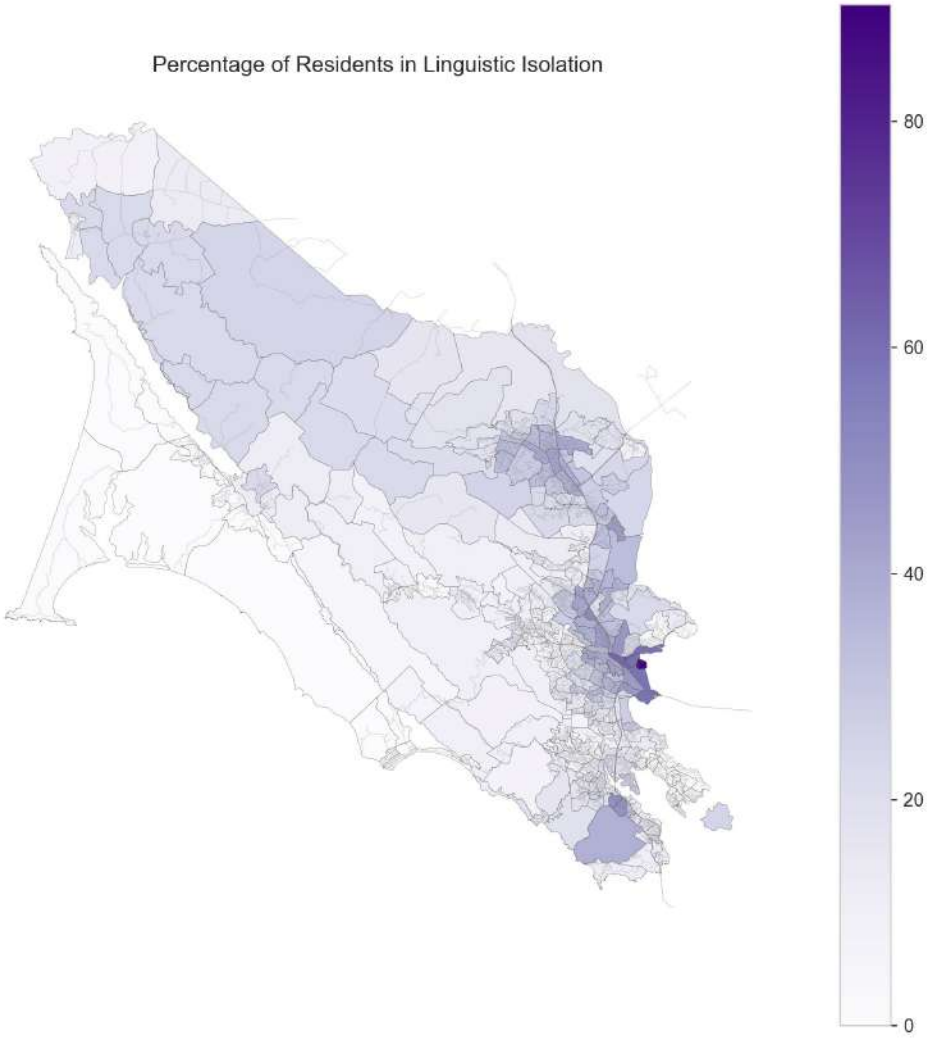


Figure C-5. Estimated percentage of residents in linguistic isolation by evacuation zone.

In addition to language, the SVI includes race and ethnicity to capture how systemic racism, inequities in exposure to hazards, and limited access to community services affect population vulnerability. It recognizes that people of color often face significant structural burdens that increase social vulnerability and reduce the ability to plan for and respond to natural disasters. **Figure C-6** shows the estimated percentage of non-white residents in each evacuation zone. ACS data show that roughly one in five Marin County residents is Hispanic.

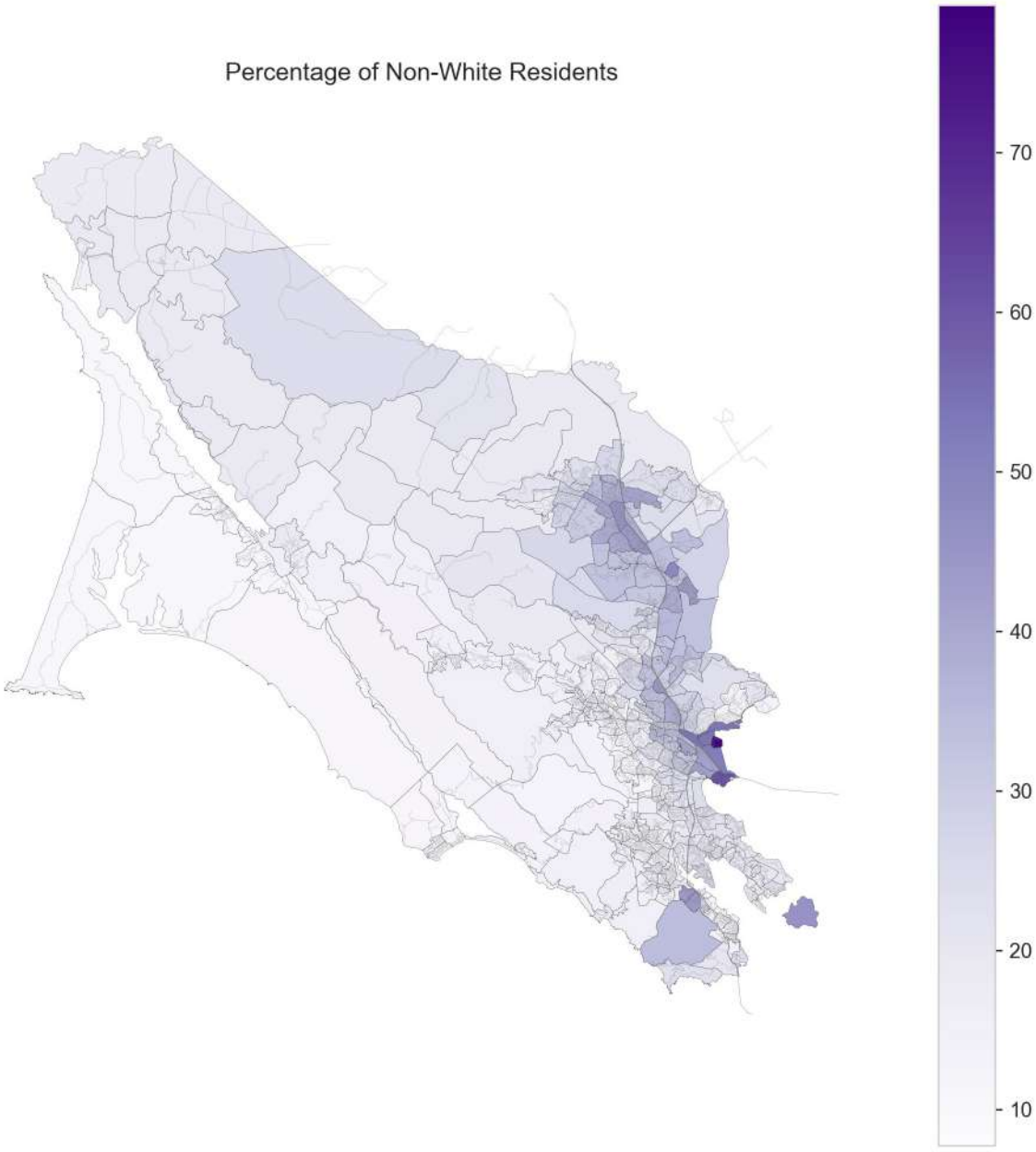


Figure C-6. Estimated percentage of non-white residents in each evacuation zone.

The SVI's composite Minority and Language vulnerability theme is highest in communities along the Highway 101 corridor. As shown in **Table C-2**, there is a large amount of overlap between the zones with high socioeconomic vulnerability and high language minority status vulnerability. The zones with the greatest vulnerability include the communities in eastern San Rafael, Marin City, and Larkspur Landing.

Table C-2. Minority Status and Language Vulnerability Index by evacuation zone.

Zone ID	Zone Name	Estimated Population	Minority and Language Theme
US-CA-XMR-SNR-E542	Spinnaker Point/Bay Point Lagoons	2,669	0.90
US-CA-XMR-SNR-E543	Canal/Pickleweed	7,768	0.86
US-CA-XMR-MRN-E134	San Quentin Village	88	0.79
US-CA-XMR-MRN-E079	San Quentin	4,671	0.79
US-CA-XMR-SNR-E541	Shoreline Path	41	0.77
US-CA-XMR-NOV-E022	Rowland	1,784	0.73
US-CA-XMR-LAR-E003	Larkspur Landing	1,132	0.68
US-CA-XMR-MRN-E008	Marin City South	825	0.67
US-CA-XMR-MRN-E014	Marin City North	2,365	0.67
US-CA-XMR-NOV-E006	Davidson	199	0.67

C.5 Demographics and Housing Characteristics

Vulnerable Population Demographics

SVI's Household Characteristics theme identifies communities with large populations of elderly people, children, and people with disabilities. These populations may face significant barriers during evacuation and may require additional assistance from the fire service to evacuate safely. **Figure C-7** shows the estimated percentage of the population aged 65 and older in each evacuation zone. More than 23% of the county's population is over the age of 65. Projections indicate that this segment of the population will continue to grow in the coming years.

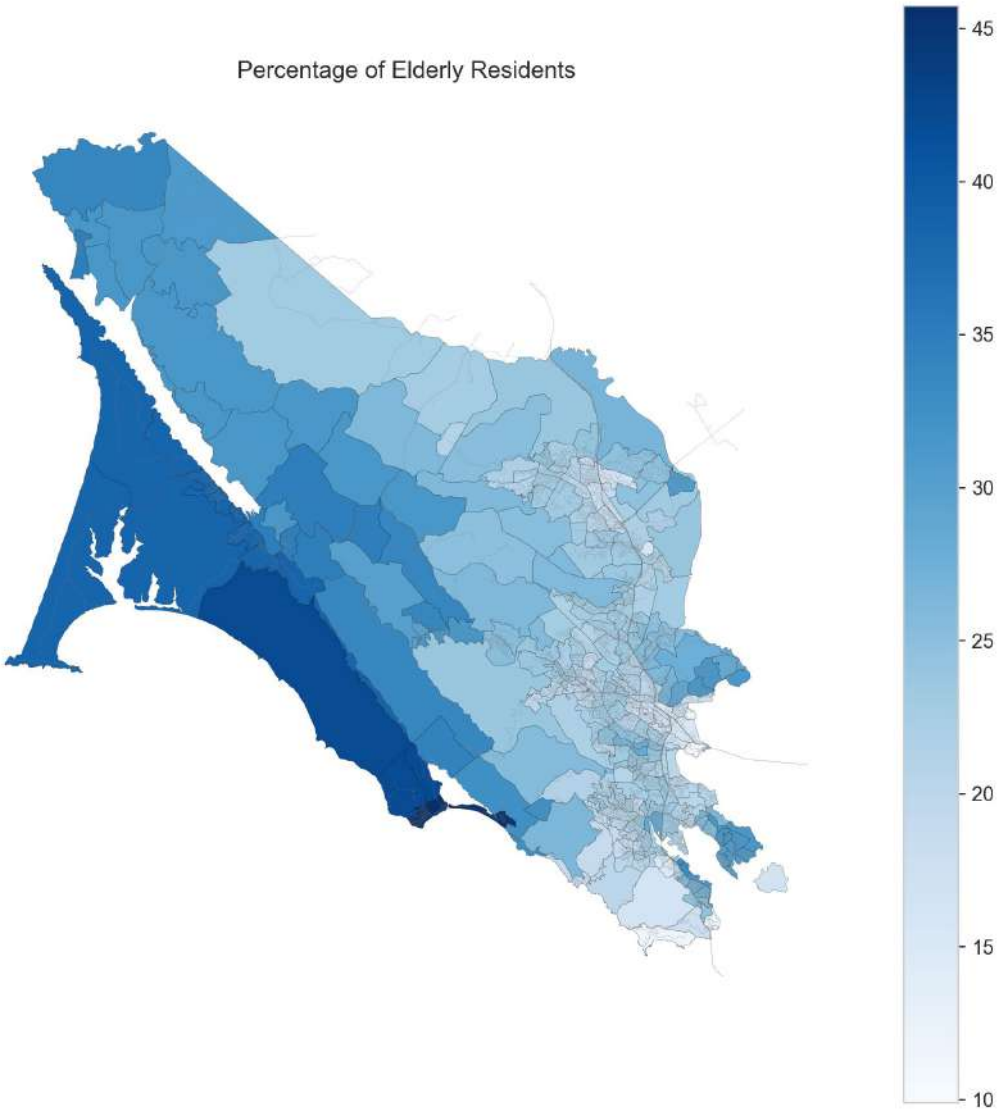


Figure C-7. Percentage of population over the age of 65 by evacuation zone.

As shown in **Figure C-8**, when factoring in additional demographic characteristics, such as youth population, single-family households, and persons with disabilities, the overall vulnerability for this theme follows similar spatial patterns to the economic and language/minority vulnerability themes. While studies of evacuation behavior have shown "households with children were more likely to evacuate immediately," households with these characteristics may face barriers to wildfire preparedness, such as lack of time and resources to perform defensible space. The areas with the greatest vulnerability include the Canal area in San Rafael and portions of central Novato. Other regions, not identified in the previous themes, include the Santalina neighborhood and the Eliseo area in Kentfield. Evacuation zones with the greatest household characteristics/demographics vulnerability are shown in **Table C-3**.

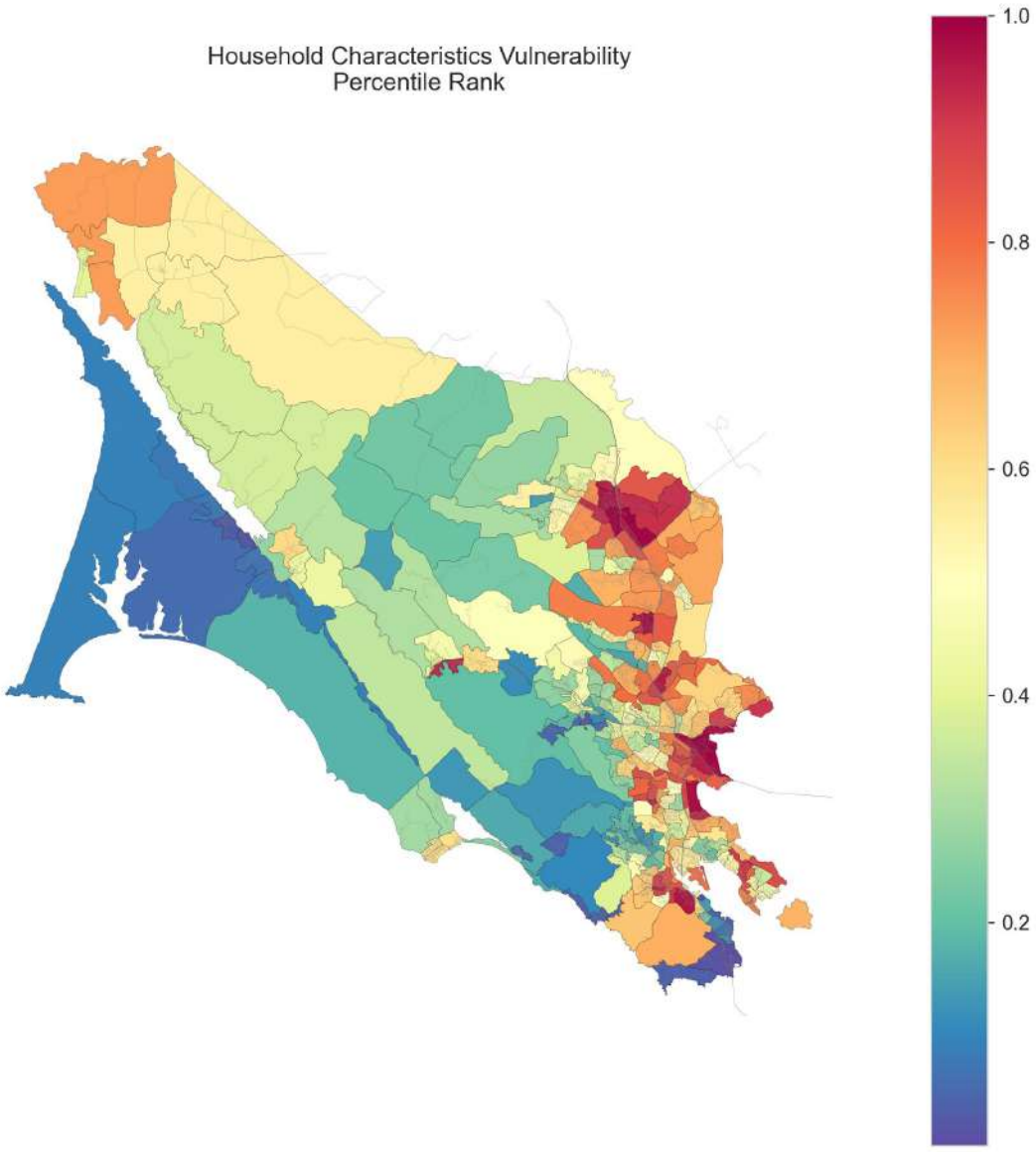


Figure C-8. Household characteristics vulnerability from the SVI dataset.

Table C-3. Evacuation zones with the greatest household characteristics/demographics vulnerability.

Zone ID	Zone Name	Estimated Population	Household Characteristics Vulnerability
US-CA-XMR-SNR-E543	Canal/Pickleweed	7,768	0.79
US-CA-XMR-SNR-E542	Spinnaker Point/Bay Point Lagoons	2,669	0.73
US-CA-XMR-MRN-E008	Marin City South	825	0.73
US-CA-XMR-MRN-E014	Marin City North	2,365	0.73
US-CA-XMR-LAR-E005	Spyglass Hill	698	0.72
US-CA-XMR-SNR-E541	Shoreline Path	41	0.70
US-CA-XMR-SNR-E575	Civic Center	1,014	0.68
US-CA-XMR-NOV-E022	Rowland	1,784	0.66
US-CA-XMR-LAR-E006	South Eliseo	2,437	0.64
US-CA-XMR-NOV-E033	Santolina	714	0.63

C.6 What Support do Vulnerable Communities Need?

The RPS was performed to provide program staff with actionable insights into the types of support needed by vulnerable populations in Marin County. The survey was specifically designed to capture the perceptions of traditionally underrepresented groups about wildfire risk. In total, more than 1,000 respondents completed the survey; the respondents represented nearly all from areas identified as socially vulnerable in the above analysis. Because the survey was not designed to provide a statistically significant comparison between different areas of Marin County, the results from the RPS are used here to provide a narrative about overall perceptions by vulnerable populations as a whole and the specific risk reduction strategies that could provide the greatest benefit.

This analysis provides a brief overview of the survey results; more detailed information is available in the project report and associated dashboard tools.

Results and Discussion

In general, socially vulnerable residents are quite concerned about wildfires. On average, respondents ranked wildfire at a concern of 3.7 out of 5.0, where 5.0 indicated extreme concern. Over 40% of respondents reported that they were "extremely concerned," and just 8% reported no concern at all.

Evacuation

A significant source of concern to these residents is safe evacuation. More than 46% of respondents indicated "extreme concern" that traffic would prevent them from safely leaving their neighborhood during an evacuation. Moreover, the number of respondents indicating extreme concern was highest in the lowest-income bracket included in the study (i.e., households making less than $44,750 per year) and among Hispanic and Latino residents. About 30% of respondents indicated that traffic could prevent them from following an evacuation order.

Residents are more concerned about traveling on crowded roads than leaving their home on time. The concern about being trapped on a roadway due to excessive traffic was approximately 5% higher than the concern over not being able to leave the house quickly enough. Furthermore, approximately 25% fewer residents were "extremely concerned" about being able to leave their home quickly enough compared with being "extremely concerned" about traffic during an evacuation. However, more than half of the survey respondents indicated that they had not prepared for an evacuation. The remaining respondents indicated that they had either made an evacuation plan or prepared a go-bag.

Only approximately 36% of survey respondents indicated they knew where to go for temporary refuge during a wildfire evacuation. This figure was lowest among the lowest-income respondents. Indeed, more than 68% of respondents in the lowest income bracket did not know where to go for refuge. About 68% of survey respondents indicated that they would likely go to the nearest church, community center, or school.

The vast majority of respondents (>80%) have received emergency alerts before, and more than 96% said they understood the message that they received. 37% of respondents indicated that the biggest reason for not evacuating was not receiving the emergency alert, and many residents expressed concern about network/cell coverage preventing them from receiving an emergency alert.

The concern over safe evacuation points towards several potentially effective programming initiatives:

- Outreach campaigns that facilitate the formation of evacuation pre-plans for socially vulnerable groups. These plans should help residents understand where they should go during an evacuation, the services that will be available to them during an evacuation, and

how to plan for evacuating children, elderly relatives, and people with disabilities. These planning efforts should specifically target low-income residents and Hispanic/Latino residents. Ensure that residents know to leave the area, not to simply go to the nearest school or community center.

- Education campaigns that help residents understand safe evacuation and potential evacuation scenarios in their communities. These educational resources should include instructions on how to quickly leave one's house or apartment and how to safely travel on roads during an evacuation. These materials should enforce the "stay in your car" messaging and help residents understand that evacuations are likely to be quite safe.
- Consider issuing "test alerts" that allow residents to become more familiar with the emergency alerting infrastructure and build confidence that they will receive an alert during a wildfire emergency.
- Consider neighborhood evacuation drills to ensure residents are prepared to leave and know where to go.

Defensible Space and Home Hardening

Most survey respondents are not responsible for maintenance outside their homes, making it difficult to create defensible space and undertake structural hardening activities. Just 33% of respondents indicated that they are responsible for exterior maintenance of the building they live in, and 37% said they are responsible for the landscaping around their home. Other than cost, this issue was the greatest barrier to on-parcel risk reduction in vulnerable communities: about 40% of survey respondents said that lack of responsibility for buildings and landscaping was a significant barrier to reducing fire hazards around their place of residence.

In general, socially vulnerable populations are more likely to perceive neighborhood and community landscaping as posing a greater risk than the vegetation on their own properties. 46% of respondents indicated that they thought the vegetation in their neighborhood posed a fire risk, while just 32% believed their own yard or landscaping was a fire risk. An even greater percentage, 49%, indicated they thought that the vegetation in the public open space near them was a fire risk. In each of these cases, however, about 20% of survey respondents indicated they did not know whether the vegetation was a risk.

These findings point towards a significant knowledge gap around defensible space and home hardening in socially vulnerable communities. Residents of these communities may not realize the importance of on-parcel risk reduction and may instead look to public land managers to reduce the perceived fire risk of vegetation on open spaces. Nearly two-thirds of respondents indicated they were unfamiliar with defensible space evaluation programs in Marin County, and many residents thought these programs were only available to homeowners or were not free.

Cost is a significant barrier to on-parcel risk reduction in these communities. More than 60% of survey respondents said they were not able to spend anything on defensible space and home hardening; an additional 20% said they could be able to spend less than $800. As might be expected, the amount residents said they were willing to pay corresponded to their income bracket, with higher earners saying they would be able to spend more on defensible space and home hardening. Younger respondents (less than 50 years old) tended to indicate they could afford less than older respondents. Despite being a major initiative of Marin Wildfire, more than half of survey respondents did not know that public financial assistance was available to help with defensible space, and more than 36% of respondents indicated they thought there was no funding available. Just 11% of respondents said there was funding available to help reduce fire hazards on the exterior of their residence and in the surrounding yard.

These findings suggest that the following programming initiatives could be beneficial in supporting socially vulnerable populations:

- Materials for renters to help educate their landlords on fire risks. Because many socially vulnerable residents are renting, improved outreach materials that help these residents communicate with their landlords, who may not live in Marin County, could be useful in facilitating action in the communities.
- Enhanced education and outreach programs designed to help educate low-income residents on the importance of defensible space. These programs could focus on very low- and no-cost defensible space strategies and highlight the relative importance of on-parcel vegetation maintenance compared with neighborhood and community vegetation.
- Enhanced needs-based grants programs that provide financial resources and/or physical assistance to low-income communities where residents are not able to afford any type of defensible space or home hardening retrofits. These programs should be accompanied by additional education campaigns to help residents understand why these activities are necessary and the role of Marin County fire agencies in promoting a fire-adapted community. These programs could be promoted through community-based organizations; materials should be available in Spanish as well as English.

C.7 Which Populations with Access and Functional Needs are at the Most Risk?

In order to help design specific programs for high-risk populations that face significant evacuation challenges, American Community Survey data (2024) was overlaid with the CWPP recommended priority areas for evacuation planning and alerting. This provides a prioritized list of population demographics in areas that may have difficulty receiving or responding to evacuation communications. As shown in **Table C-4**, older adults are particularly located in areas where evacuation planning and alerting capabilities could be improved. Nearly 30% of these adults live

alone. People with disabilities are also commonly located in these high-risk zones (about 10,000 people). Improved evacuation planning and alerting should address these populations first, given their prevalence in the at-risk areas. Other access and functional needs, such as planning for people with no internet or households with no vehicles, are also important, but will be less impactful than focusing on these larger groups to begin with.

Table C-4. American Community Survey data reflecting the number of people in each demographic category. This shows the population within areas at or above the 70th percentile for the alerting and evacuation planning themes.

Group	Alerting	Evacuation Planning
Older adults (65+)	24,082	25,069
Children (under 10)	11,685	9,218
Poverty below 100% of Federal Poverty Line	4,491	4,457
Low income below 200% of Federal Poverty Line	13,892	9,207
Limited English households	3,149	1,526
Unemployed	3,264	3,787
People with disabilities	11,729	10,798
Households with no vehicle	2,931	1,654
Older adults living alone	7,199	6,880
Households with no internet	1,739	1,120
Crowded housing (more people than rooms)	3,453	1,305

Appendix D. Alerting and Warning Systems

D.1 Alerting and Warning Systems

Emergency alert and warning systems are a core life-safety function during disasters, providing situational awareness and clear guidance to people at risk. County of Marin and its Operational Area partners (cities, towns, and special districts) operate a coordinated, redundant, multi-modal alerting system to communicate imminent threats such as wildfires, floods, and other emergencies.

Marin County's layered alerting system is:

- Governed by federal and state frameworks (IPAWS, CalOES guidelines, and the California Public Alert and Warning System [CalPAWS]).
- Primarily operated by the Marin County OEM, with participation from local agencies.
- Centered on AlertMarin for place-based, action-oriented alerts; IPAWS/WEA/Emergency Alert System (EAS) for rapid, wide-area reach; and SB821 data from PG&E.
- Nixle for local situational awareness and ongoing updates.

Public participation is a critical component of system effectiveness. Enrollment in AlertMarin and use of local information channels all improve the speed, clarity, and reach of emergency communications.

D.2 Governance, Authority, and Roles

OEM serves as the primary alerting authority for the Marin Operational Area. OEM Emergency Management Coordinators are trained and authorized alert originators for the County's systems, including AlertMarin and IPAWS.

OEM maintains a 24/7 on-call Duty Officer responsible for monitoring emerging incidents and, when criteria are met, issuing time-critical notifications in coordination with responding fire agencies, law enforcement agencies, and local jurisdictions. As the Operational Area lead, OEM may issue alerts for countywide incidents or on behalf of cities, towns, and special districts when assistance or coordinated messaging is needed.

Some jurisdictions maintain independent alerting authority. The City of Novato, for example, is authorized to issue Wireless Emergency Alerts (WEA) directly via IPAWS, and several cities and law enforcement agencies operate Nixle for local public safety messaging.

D.3 Legal and Policy Framework

Marin County's alert and warning program operates within federal and state guidance.

At the federal level, the County participates in FEMA's IPAWS, which connects local alert originators to:

- WEA to mobile devices
- EAS for television and radio
- NOAA Weather Radio and other Common Alerting Protocol- (CAP)-enabled systems

Using IPAWS-compliant software, OEM can author a single message and distribute it across these channels simultaneously.

At the state level, California Government Code and CalOES Alert & Warning Guidelines establish expectations for redundant communications, access and functional needs, multilingual messaging where feasible, and training and exercises. OEM coordinates with the California State Warning Center and participates in the CalPAWS framework, particularly during multi-county or statewide incidents.

D.4 Core Systems: AlertMarin and IPAWS

Marin's alerting capability is built around the integrated use of AlertMarin and IPAWS (including WEA and EAS).

AlertMarin is the county's primary platform for action-oriented notifications, including evacuation warnings and orders, major flooding, and other life-threatening events. Using a GIS-based interface, authorized staff can define precise impact areas and issue voice calls, text messages, emails, and IPAWS alerts from a single system. AlertMarin is intentionally reserved for situations requiring specific protective actions such as "evacuate," "prepare to evacuate," or "shelter in place."

Community members are encouraged to register for AlertMarin and customize their profiles. The system allows users to register multiple addresses and multiple contact methods, which is particularly important in wildfire scenarios where people may need to receive alerts for both home and work locations or for vulnerable family members.

AlertMarin is fully integrated with IPAWS. From the same interface, OEM can issue a single CAP-compliant message to both registered users and the public via WEA and EAS.

WEAs use cell broadcast technology rather than phone numbers or subscription lists. Any compatible device within the targeted geographic area can receive the alert, accompanied by a distinctive attention signal. This makes WEA especially important for reaching visitors, commuters, and residents who are not enrolled in AlertMarin.

Marin also uses PG&E data to deliver alerts through calls and texts in the affected area. This provides additional coverage for people who are not registered in AlertMarin, though it has known limitations where the account holder is not the occupant.

D.5 Informational and Jurisdictional Messaging: Nixle

Several Marin jurisdictions use Nixle for broader public information and situational awareness, including:

- Law enforcement and fire activity updates
- Road closures and traffic impacts
- Informational wildfire and smoke updates
- Community advisories and recovery messaging

While AlertMarin and IPAWS are reserved for targeted, action-oriented warnings, Nixle is typically used for broader, ZIP code–level updates and follow-on information.

Appendix E. Marin County Vegetation Management Assessment

E.1 Executive Summary

Vegetation management is an important aspect of fire preparedness and prevention and a core element of Marin County's holistic approach to wildfire risk reduction. This brief technical analysis identifies the recently completed vegetation management projects in Marin County, reviews the ways vegetation management projects are evaluated for effectiveness, and provides an assessment of the estimated effectiveness of the recently completed projects.

Measure C has funded numerous vegetation management projects. In total, approximately 2,200 acres of vegetation have been treated, primarily through near-community shaded fuel breaks. Thousands of additional acres have been proposed, approved, and moved through the regulatory process. Furthermore, member and land management agencies have completed numerous additional vegetation management projects that focus either completely or partially on wildfire risk reduction.

There are several ways to evaluate the effectiveness of vegetation management projects in reducing risk. Marin Wildfire has developed strategic metrics for several of these approaches; others are effective for planning and prioritization. Strategic prioritization measures include composite fire behavior reduction, flame length reduction, increased areas suitable for direct attack by ground-based firefighters, and acres treated. Other, more detailed metrics can include measures such as rate of spread change, change in fire probability within the treated unit and in downwind communities, and spatial relationships with fire pathways.

Key Findings

- Modeling studies show substantial benefits from vegetation management, including significant reductions in flame lengths, decreased rate of spread, and lower probability of canopy fire. While benefits are specific to each project area, an average reduction of over 50% in composite fire behavior is anticipated.
- Marin Wildfire and member agencies have completed thousands of acres of strategically placed vegetation management, focusing on shaded fuel breaks, invasive species removal, and ladder fuel removal.

- Marin Wildfire has established several metrics as Strategic Measures, which are useful for tracking annual progress towards risk reduction through vegetation management. These metrics are updated regularly and are published on the Marin Wildfire website.

Key Recommendations

- Integrate fire behavior modeling as a key phase in the project planning process. Repeat modeling regularly to evaluate when projects should be re-treated.
- Prioritize projects that reduce flame length and rate of spread, particularly those near structures and those located on fire pathways.

E.2 Introduction

Wildfire-risk reduction-focused projects in Marin are anticipated to be highly effective at reducing fire risk within the treated units. Additionally, using fire spread modeling, these projects have been shown to reduce risk to adjacent downwind communities by interrupting fire pathways, reducing the likelihood of fire spread through the treated area, and increasing the probability of success for firefighting activities within and adjacent to the treatment projects.

On average across Marin Wildfire vegetation management projects, modeling studies highlight the anticipated benefits of the fuel reduction. Within the project areas, modeling indicates the following:

- A 55% average reduction in composite fire behavior[53], a metric which incorporates rate of spread, flame length, canopy fire activity, and firefighter access
- A 78% average reduction in the area with flame lengths greater than four feet, a commonly used threshold to determine the effectiveness and safety of ground-based firefighters engaging the fire
- A 61% average reduction in flame length, a key indicator of fire intensity
- A 77% reduction in the likelihood of canopy fire activity within the treated areas (Canopy fire activity indicates very active fire behavior and can pose dangers to firefighters and the public.)

Other vegetation management projects, such as those completed by County Fire, Marin Water, and Marin County Parks and Open Space, are also highly effective at reducing fire behavior in key areas and have demonstrable benefits to community safety.

[53] See **Section E.10 Composite Fire Behavior Index**.

E.3 What is Vegetation Management in Marin?

A century of wildfire suppression, the loss of frequent, low-intensity fire, expanded development, and the spread of invasive plants have significantly altered vegetation across Marin County. These changes have increased wildfire risk to communities and degraded ecosystem resilience. Vegetation management is a primary tool to address both of these challenges. Vegetation management projects, such as those shown in **Figure E-1**, reduce wildfire intensity and spread while improving ecological conditions and supporting wildfire-adapted landscapes.

Marin Wildfire member agencies implement vegetation management in coordination with environmental partners and technical experts, including land management agencies, residents, and subject matter experts. All projects are planned and executed in accordance with established best management practices developed collaboratively with these partners and documented through environmental compliance.

Most vegetation management is carried out by small crews working on foot with hand tools. Typical activities may include the following:

- **Fuel Reduction:** removal of excessive dead and down woody material while retaining some habitat features (e.g., non-hazardous snags) for wildlife
- **Invasive Species Removal:** targeted removal of non-native, fire-hazardous species, particularly broom and gorse
- **Ladder Fuel Reduction:** pruning lower branches of trees to reduce fire spread into the canopy
- **Selective Thinning:** limited thinning of fire-hazardous native vegetation, such as small-diameter, tightly packed, or diseased trees, where conditions warrant

Removal of large, healthy, native trees is not the objective of these projects.

The width of fuel treatments varies based on site conditions and risk. Projects may range from approximately 10 to 200 feet wide and, in specific locations, up to 300 feet wide. Steeper terrain and areas where fire behavior poses a greater risk to uphill homes, roads, or other infrastructure may require wider treatment zones. Each project's approved width is defined in its environmental compliance documentation. As a general principle, treatment intensity decreases with distance from homes and infrastructure, with lighter treatments applied farther from structures.

Occasionally, pile burning or broadcast burning will be used to dispose of natural debris and return fire to the landscape. Prescribed burns are carried out in collaboration with Marin County Fire and CAL FIRE. These fires are highly regulated and go through a comprehensive planning process to ensure that they are safe and effective.



Figure E-1. Examples of vegetation management in Marin County.

E.4 Methods for Evaluating Vegetation Management Effectiveness

The Vegetation Management Risk Assessment evaluates how fuel reduction and vegetation management projects improve community safety across Marin County. The assessment focuses on how common treatment types (e.g., thinning, mastication, grazing, and prescribed fire) change surface and canopy fuels and, in turn, alter expected fire behavior.

Using fire behavior modeling, the assessment estimates how these treatments are likely to reduce fire intensity, rate of spread, and crown fire potential under future fire conditions. The analysis produces clear, map-based indicators that support project prioritization, operational planning, and communication with decisionmakers and the public.

Key outputs include a spatially explicit assessment of current wildfire threat, a quantitative comparison of fire behavior before and after treatment, and an evaluation of how long treatment benefits are expected to persist before maintenance is required. Together, these results provide a defensible basis for targeting vegetation management investments where they are most likely to reduce wildfire risk to communities.

E.5 Vegetation Management Metrics

A variety of metrics are available to characterize vegetation management projects in Marin County. Several metrics have been approved by the Marin Wildfire Board of Directors for use as strategic measures and for tracking risk reduction progress over time. Other metrics provide more detailed

guidance on the performance of particular projects or fuel treatment activities. Metrics are shown in **Table E-1**.

Table E-1. Different methods for evaluating the change in fire behavior and risk attributable to vegetation management activities.

Metric	Strategic Measure	Definition	Notes
Acres Approved for Treatment	Yes	Acres approved for treatment through regulatory processes like CEQA within a given timeframe	A useful measure to evaluate the efficiency of project planning and identify regulatory bottlenecks. A map of Measure C approved projects is available at https://marinwildfire.maps.arcgis.com/apps/instant/sidebar/index.html?appid=c02ee6853d7a43978d84a949d868495e&center=-122.5981%3B38.122&level=11
Acres of Treatment Implemented	Yes	Acres of strategic fuel reduction completed within a given timeframe	Can be useful as a high-level indicator; however, not all acres are equally beneficial at reducing community wildfire risk. Implementation acres should be carefully compared with project effectiveness measures (below) to ensure that treated acres are effectively reducing risk.
Composite Fire Behavior Reduction	Yes	Average change in the composite fire behavior metric, which includes flame length, rate of spread, canopy fire activity, safe working areas for firefighters, and ember flight distance within a treatment area	This composite metric is useful in showing the many ways that vegetation management can reduce fire activity. A description of the composite index is provided in Section E.10.
Flame Length Reduction	Yes	Average change in flame length within a treatment area	Flame length is a clearly understood visual indicator of fire intensity. While there is mixed evidence that higher flame lengths lead to greater structural damage within communities, higher flame lengths make it significantly more difficult for firefighters to safely engage the fire and are associated with higher tree mortality and greater loss of ecosystem services after a fire.

Metric	Strategic Measure	Definition	Notes
Attackable Area Increase	Yes	Change in the area within a treatment project with flame lengths less than 4 feet	Ground-based firefighting personnel are likely capable of using direct attack tactics on flame lengths less than four feet. As fire intensity exceeds this threshold, heavy equipment and dozers are more likely to be required. Safe and effective firefighting conditions are more likely to result in fire suppression prior to the fire's arrival within the community.
Rate of Spread (ROS) Decrease	No	Change in the fire's forward rate of spread within a treatment area	High rate of spread "Fast Fires" are associated with a majority of the structure loss in the western United States in recent years.[54] Reducing rate of spread within the treatment units increases the likelihood that firefighters can engage the fire before it reaches the community.
Canopy Fire Activity Decrease	No	Change in the fire's likelihood of burning in the canopy within the treatment area	Fires in the canopy are more difficult to suppress, more dangerous to firefighters, and more likely to cast embers long distances ahead of the flaming front. Reducing canopy fire activity within treatment units increases the likelihood of safe and effective suppression and reduces the likelihood of ember deposition ahead of the main fire.

[54] Jennifer K. Balch et al., The fastest-growing and most destructive fires in the US (2001 to 2020). Science 386,425-431(2024). DOI: 10.1126/science.adk5737

Metric	Strategic Measure	Definition	Notes
Intersection with fire pathway	No	Whether the treatment area disrupts a fire pathway	Fire pathways show the trajectories of fastest fire spread, where fuel, terrain, and wind align to produce rapid fire growth. Treatment units located along fire pathways, particularly those that reduce rate of spread, can have significantly higher benefits to community safety than those located off fire pathways. Fire pathways tend to be located in fine fuels, steep slopes, and ridgetops.
Change in Arrival Time at Community	No	Change in fire arrival time at community assets or structures after a treatment is completed	Fire pathways can be used to identify whether the treatment is anticipated to materially change the fire's arrival time at the community. Treatments that reduce rate of spread, but don't effectively change the fire's arrival time at the community, have only marginal benefits for community safety. Strategically located treatment areas along fire pathways can increase fire arrival time by many hours, enabling the aggregation of a sufficient firefighting response before structures become involved.
Fire Probability Decrease	No	Change in the modeled fire probability after a treatment is completed	Using an ensemble of fire simulations, fuel treatments can be shown to alter the pattern of fire probability both within the modified area and downwind, where fire is less likely to reach due to changes in the upstream fuel conditions.

E.6 Recent Vegetation Management Projects

Measure-C Funded Projects

Measure C has supported nearly 2,200 acres of vegetation management over the past five years. As shown in **Table E-2**, projects across the county have been implemented with Measure C funding.

Table E-2. Measure C-funded vegetation management projects.

Project Name	Agency	Acres
Marin City Fuel Reduction Zone Project	Marin County Fire	20.6
Ridgecrest Fuel Reduction Project - Throckmorton Ridge Vegetation Management Zone	Marin County Fire	24.4
Greater Novato Shaded Fuel Break	Marin County Open Space District	13.3
Greater Ross Valley Shaded Fuel Break	Marin County Open Space District	31.2
Greater Novato Shaded Fuel Break	Marin County Open Space District and Marin County Parks	46.3
Greater Ross Valley Shaded Fuel Break	Marin Wildfire	4.2
Greater Ross Valley Shaded Fuel Break	Marin Wildfire	381.4
Bahia Fuel Break	Novato Fire District	51.9
Demo Gardens	Novato Fire District	0.2
Eucalyptus Removal	Novato Fire District	2.4
Greater Novato Shaded Fuel Break	Novato Fire District	430.2
IVFB	Novato Fire District	103.5
MHFB	Novato Fire District	42.3
MVGG	Novato Fire District	51.5
Northeast Novato Evacuation Route Clearance	Novato Fire District	66.3
Novato Evacuation Route Clearance	Novato Fire District	206.4
Novato HOA Lands	Novato Fire District	86.2

Project Name	Agency	Acres
Greater Ross Valley Shaded Fuel Break	Ross Valley Fire	10.3
Marinwood & San Rafael Open Space Prescribed Herbivory	San Rafael Fire Department	17.8
Prescribed Herbivory on San Rafael Open Space - San Rafael Zone Core 05	San Rafael Fire Department	5.1
San Rafael - San Anselmo Fuel Reduction Zone Project	San Rafael Fire Department	1.3
San Rafael - San Anselmo Fuel Reduction Zone Project	San Rafael Fire Department	10.2
San Rafael West San Pedro Fuel Reduction Project	San Rafael Fire Department	4.9
San Rafael Zone Evacuation Route Core Project	San Rafael Fire Department	0.4
San Rafael Zone North Lucas Valley Fuel Reduction Project	San Rafael Fire Department	10.1
San Rafael Zone Open Space Management Projects	San Rafael Fire Department	77.8
San Rafael Zone Open Space Prescribed Herbivory Expansion Project	San Rafael Fire Department	187.7
San Rafael Zone South San Pedro Mountain Fuel Reduction Zone Project	San Rafael Fire Department	26.8
San Rafael Zone South San Rafael Hill Fuel Reduction Project	San Rafael Fire Department	7.0
San Rafael Zone Terra Linda/Sleepy Hollow Divide Fuel Reduction Project	San Rafael Fire Department	15.9
Mill Valley Shaded Fuel Break Project	Southern Marin Fire	22.6
Mill Valley Shaded Fuel Break Project	Southern Marin Fire	4.1
Mill Valley Summit & Ralston Fuel Break	Southern Marin Fire	4.8
Ring Mountain Fuel Break	Southern Marin Fire	2.5
Ring Mountain Fuel Break Project	Southern Marin Fire	11.4
Southern Marin Zone Southern Marin Fire District Fuel Break Project	Southern Marin Fire	137.2

Project Name	Agency	Acres
Southern Marin Zone Tamalpais Valley/Homestead Fuel Break Project	Southern Marin Fire	6.5
Summit-Ralston Forest Health Restoration	Southern Marin Fire	64.2
Tamalpais Valley/Homestead Fuel Break	Southern Marin Fire	16.1

E.7 Non-Marin Wildfire Projects

Non-Measure C projects were sourced from the Landscape Fire and Resource Management Planning Tools (LANDFIRE) Public Events Geodatabase. This database aggregates disturbance and treatment records from federal, state, local, and private partners.

For this assessment, the most recent 10 years of reported activities were cleaned and processed into a standardized Fuel Disturbance raster that classifies both treatment type and severity. The dataset was then reviewed and filtered to remove any overlap with Measure C–funded projects to prevent double counting. This dataset includes planned disturbances (such as fuel reduction projects and prescribed burns) and unplanned disturbances (like tree mortality, insect infestations, and wildfires).

The resulting dataset represents a consolidated disturbance layer used in current-condition fuel modeling. **Figure E-2** summarizes the spatial extent and distribution of these mapped disturbances.

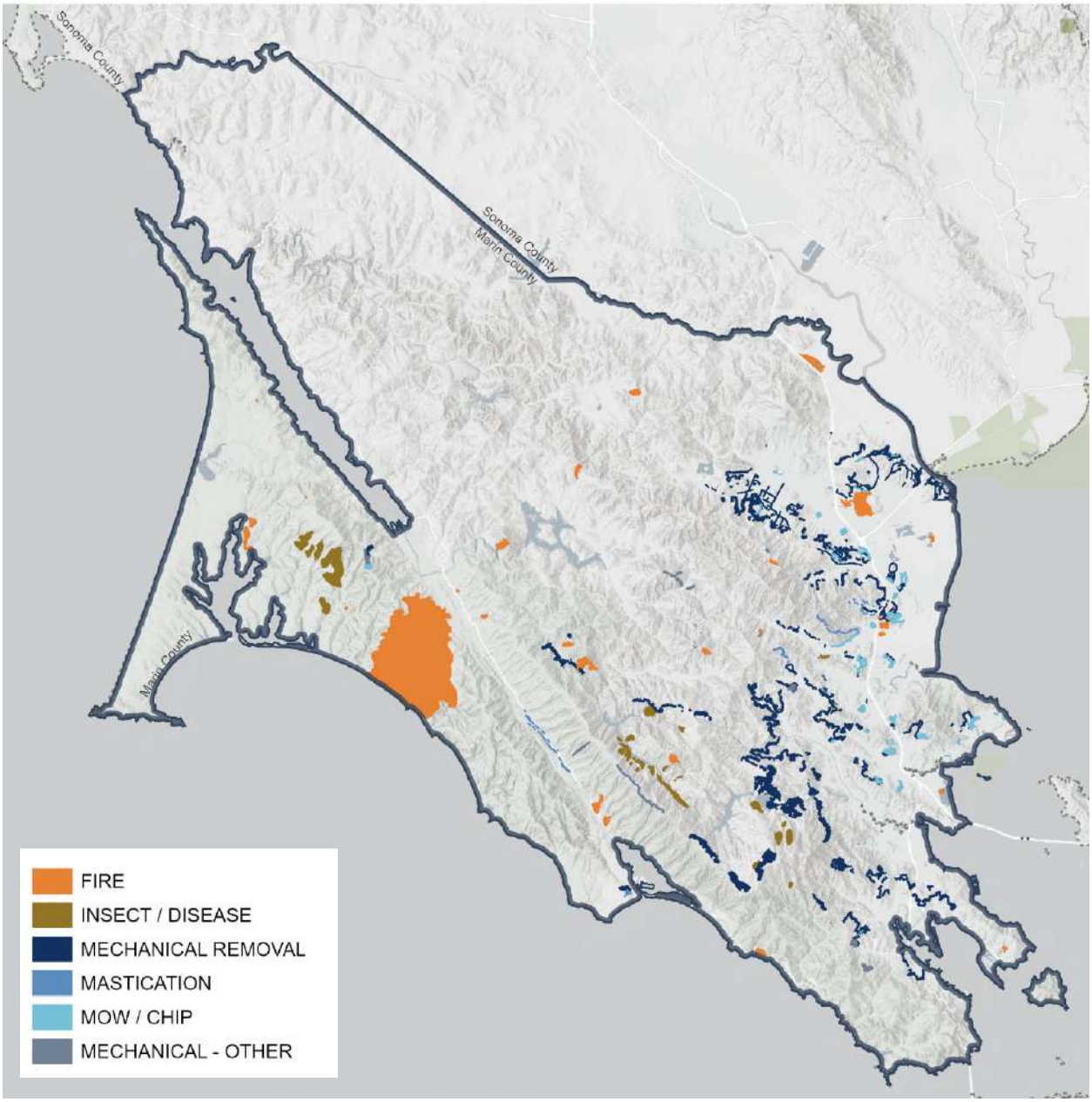


Figure E-2. Landfire disturbance data.

E.8 Evaluating Vegetation Management Project Effectiveness

Table E-3 summarizes modeled changes in wildfire behavior attributable to completed vegetation management projects across Marin County.[55] Sliced by project and agency, results show the estimated reduction from pre-treatment conditions in several key operational fire behavior metrics, including flame length, rate of spread, composite fire behavior, and attackable area. Together, these indicators provide a consistent, quantitative basis for comparing project effectiveness and understanding how individual treatments contribute to improved suppression opportunities and reduced wildfire risk in Marin County.

[55] Please note that project names were provided by agency staff and there may be inconsistencies in the data collection and reporting methods.

Table E-3. Fuel treatment effectiveness metrics for recent Measure C-funded vegetation management projects.

Project Name	Agency	Change in Flame Length (feet)	Change in Rate of Spread (chains/hour)	Change in Composite Fire Behavior	Change in Attackable Area
Greater Ross Valley Shaded Fuel Break	Marin Wildfire	-0.9	-1.3	-38.2%	0.6%
Marin City Fuel Reduction Zone Project	Marin County Fire	-2.4	-4.4	-69.6%	19.0%
Ridgecrest Fuel Reduction Project (Throckmorton Ridge Vegetation Management Zone)	Marin County Fire	-5.5	-11.7	-48.9%	31.2%
Greater Novato Shaded Fuel Break	Marin County Open Space District	-2.4	-5.9	-58.1%	12.5%
Greater Ross Valley Shaded Fuel Break	Marin County Open Space District	-1.8	-4.5	-66.3%	8.4%
Greater Novato Shaded Fuel Break	Marin County Open Space District and Marin County Parks	-1.9	-4.2	-51.0%	7.9%
Greater Ross Valley Shaded Fuel Break	Marin Wildfire	-1.8	-5.0	-46.1%	9.9%
Bahia Fuel Break	Novato Fire District	-1.5	-5.7	-62.0%	7.0%
Greater Novato Shaded Fuel Break	Novato Fire District	-1.8	-6.5	-44.8%	11.3%
IVFB	Novato Fire District	-3.2	-13.2	-63.5%	21.0%
MHFB	Novato Fire District	-2.7	-14.4	-67.6%	19.6%
MVGG	Novato Fire District	-4.7	-15.0	-65.6%	31.7%
Northeast Novato Evacuation Route Clearance	Novato Fire District	-2.5	-12.3	-62.2%	24.0%
Novato HOA Lands	Novato Fire District	-4.2	-14.5	-64.5%	30.6%

Project Name	Agency	Change in Flame Length (feet)	Change in Rate of Spread (chains/hour)	Change in Composite Fire Behavior	Change in Attackable Area
Novato Evacuation Route Clearance	Novato Fire District	-2.7	-9.8	-61.2%	21.6%
Eucalyptus Removal	Novato Fire District	-0.9	-1.4	-71.2%	1.7%
Greater Ross Valley Shaded Fuel Break	Ross Valley Fire	-2.0	-3.5	-67.5%	13.6%
Mill Valley Shaded Fuel Break Project	Southern Marin Fire	-1.1	-2.1	-31.4%	4.1%
Mill Valley Summit & Ralston Fuel Break	Southern Marin Fire	-2.4	-3.0	-73.8%	24.1%
Ring Mountain Fuel Break Project	Southern Marin Fire	-3.9	-10.9	-56.0%	28.9%
Mill Valley Shaded Fuel Break Project	Southern Marin Fire	-0.4	-0.8	-23.4%	0.3%
Ring Mountain Fuel Break	Southern Marin Fire	-3.0	-4.5	-62.5%	21.2%
Southern Marin Zone Southern Marin Fire District Fuel Break Project	Southern Marin Fire	-1.7	-3.0	-54.2%	9.4%
Southern Marin Zone Tamalpais Valley/Homestead Fuel Break Project	Southern Marin Fire	-4.7	-16.9	-82.1%	33.8%
Summit-Ralston Forest Health Restoration	Southern Marin Fire	-2.3	-3.4	-70.2%	20.2%
Tamalpais Valley/Homestead Fuel Break	Southern Marin Fire	-4.1	-9.8	-78.9%	30.9%
Marinwood & San Rafael Open Space Prescribed Herbivory	San Rafael Fire Department	-1.5	-6.3	-42.6%	12.6%
Prescribed Herbivory on San Rafael Open Space - San Rafael Zone Core 05	San Rafael Fire Department	-7.6	-34.7	-61.3%	51.0%
SRSAFRZ	San Rafael Fire Department	-1.9	-3.2	-51.5%	8.7%
San Rafael - San Anselmo Fuel Reduction Zone Project	San Rafael Fire Department	-2.0	-3.5	-39.9%	8.7%

Project Name	Agency	Change in Flame Length (feet)	Change in Rate of Spread (chains/hour)	Change in Composite Fire Behavior	Change in Attackable Area
San Rafael West San Pedro Fuel Reduction Project	San Rafael Fire Department	-1.1	-1.1	-21.6%	2.0%
San Rafael Zone Evacuation Route Core Project	San Rafael Fire Department	-0.5	-0.5	-41.4%	0.0%
San Rafael Zone North Lucas Valley Fuel Reduction Project	San Rafael Fire Department	-1.3	-3.0	-39.4%	7.1%
San Rafael Zone Open Space Management Projects	San Rafael Fire Department	-2.3	-5.5	-60.2%	14.1%
San Rafael Zone Open Space Prescribed Herbivory Expansion Project	San Rafael Fire Department	-2.0	-7.4	-47.8%	14.6%
San Rafael Zone South San Pedro Mountain Fuel Reduction Zone Project	San Rafael Fire Department	-2.1	-4.6	-56.7%	12.8%
San Rafael Zone South San Rafael Hill Fuel Reduction Project	San Rafael Fire Department	-6.3	-28.3	-63.1%	37.1%
San Rafael Zone Terra Linda/Sleepy Hollow Divide Fuel Reduction Project	San Rafael Fire Department	-2.2	-3.3	-42.9%	13.1%

E.9 Publicly Available Resources

Marin Wildfire has worked to promote vegetation management and educate the public about the benefits of these projects. Public resources include:

- **Vegetation Management Storymap (https://storymaps.arcgis.com/stories/04c665cdc6464c93ade25e278ec423d9)**
- **Vegetation Management Dashboard (https://marinwildfire.maps.arcgis.com/apps/dashboards/9e2ed6e8d3a54ff180b04896f2008b0f)**

E.10 Composite Fire Behavior Index

The Composite Fire Behavior Index (CFBI) score produced by Willow Labs is designed to provide a comprehensive measure of fire behavior in a single metric. CFBI is a composite sum of the following metrics.

Flame Length: the average flame length within the treatment segment, rescaled to between 0 and 1. Flame lengths greater than 8′ receive the maximum score of 1. Flame lengths greater than 4′ can be challenging for hand crews and other ground-based firefighters to engage directly (Andrews 1982). Flame lengths between 4′ and 8′ may be more appropriate to engage with engines and heavy equipment, or using indirect tactics. Flame lengths greater than 8 feet indicate severe wildfire behavior and suppression actions may not be effective.

Rate of Spread: the average rate of spread within the treatment segment, rescaled to between 0 and 1. Rates greater than 60 chains/hour (20 m/min) receive the maximum score of 1.

Torching Probability: The proportion of area within the unit likely to torch or transition into a passive or active crown fire.

Ember Flight Distance: The mean maximum ember flight distance (MEFD) within the unit, rescaled to between 0 and 1. Units with a mean MEFD of greater than 500 m receive the maximum value of 1.

The composite CFBI ranges between 0 and 100. A segment unit with a score of 100 indicates a unit that is likely to exhibit very high flame lengths, very high rates of spread, little opportunity for firefighters to engage the fire, and almost certain torching with long-distance spotting. In contrast, a score of zero would indicate very low flame lengths, very low rates of spread, low or no probability of torching and spotting, with a distinct corridor where fire can transition from the canopy to the surface and be safely engaged.

Appendix F. Marin County Fire Structure Vulnerability Assessment

F.1 Executive Summary

This analysis assesses residential exposure to wildland fire and examines the vulnerabilities in home hardening and defensible space in Marin County. Wildfire fire behavior models were used to evaluate the likelihood and characteristics of fire at each structure in Marin County. Subsequently, data from Marin Wildfire's Defensible Space Home Evaluation (DSI) program were used in conjunction with board-approved metrics and parcel-specific wildfire risk modeling to identify the most common risk factors in Marin County. As part of the CWPP, the objective of this technical brief is to identify areas with the greatest concentration of on-parcel vulnerabilities and external hazard.

Specifically, this brief analysis addresses the following research questions:

1. Which areas are most likely to be exposed to fire? What characteristics will that fire have?
2. Which neighborhoods have the highest concentrations of on-parcel risk factors?
3. Which types of on-parcel risk factors are most common and most hazardous in Marin County?
4. Which areas of the community have small structure separation distances that create the potential for structure-to-structure fire spread?

The results of this analysis can be used to inform the prioritization of inspection, mitigation, and education efforts, targeting the most at-risk areas to reduce vulnerabilities.

Key Points

- Very active fire behavior is anticipated in the vicinity of structures. Very large flame lengths and significant ember deposition loads are likely to create risks to structures in Marin County. Fire behavior is anticipated to exceed the capacity for firefighters to safely engage, even when equipped with aircraft and heavy equipment.
- About 40% of structures in Marin County are located within an entry point, where a fire pathway intersects the built environment. These entry points are strong candidates for on-parcel risk reduction and extended defensible space.
- DSI provides thousands of on-parcel inspections per year. These inspections are a valuable touchpoint with Marin County residents, who receive a personalized online risk report after

each visit. Additionally, the program supplies data that can be used to prioritize areas of concern.

- Marin Wildfire has established goals that create a framework for measuring progress toward fire adaptation on private parcels in Marin County. These metrics include home evaluation coverage (117% of target, 30% year-over-year [YoY] change), resident engagement (43%, +2% YoY), resolution of defensible space violations (25%, +4% YoY), parcels with high-risk findings (60%, -3% YoY), and parcels with large flame lengths (28%, +6% YoY). These metrics indicate that inspection coverage has increased significantly; however, these increases have not yet resulted in significant increases in resident engagement or action.
- The most common findings during DSI evaluations in Marin County are vegetation in zone zero, metal gutters, attached combustible fences, and vents with mesh sizes ⅛" or smaller. Countywide, the greatest hazard reductions can be achieved by removing vegetation in zone zero and removing or replacing combustible fences attached to structures. Replacing vent mesh screens is a very-high-return-on-investment action that residents can take for little cost.
- Terra Linda, parts of Corte Madera, and neighborhoods in Stinson Beach have the greatest countywide concentration of defensible space and home hardening vulnerabilities.
- Overall structure vulnerability, which includes the likelihood of fire exposure and fire behavior in adjacent open spaces, is greatest in southern Marin County and areas adjacent to the Mount Tamalpais watershed.
- While modeling is not currently available to characterize structure-to-structure fire spread, neighborhoods with small structure separation distances (SSD) may be subject to urban fire spread, when radiant and convective heating contribute to cascading structure ignitions. In Marin County, the agencies with the greatest exposure to small SSD developments are County Fire CSA 13 (County Service Area, CSA) (Upper Lucas Valley, 88%), Marinwood (87%), and central Marin County (79%). In central Marin County, just 7% of structures are located more than 100 feet from the nearest adjacent structure.

Key Recommendations

- Identify ways to increase resident engagement with defensible space and home hardening. Data indicate that, while evaluation coverage has increased significantly, the tendency to engage with the online wildfire risk report or take action to remove on-parcel vulnerabilities has not. Focusing on the logical gap between inspection and engagement can help to unlock large-scale action by residents across the community. Increasing resident engagement may take the form of incentives, enforcement, or different or more frequent communication via direct mail, email, or other forms.

- Create campaigns that target the greatest risk factors across Marin County. Focusing education and incentive activities on vegetation in zone zero, vent screens, and combustible fences is likely to lead to the greatest risk reductions countywide.
- Prioritize on-parcel risk reduction activities in areas that have high concentrations of on-parcel risk factors and could be exposed to frequent, high-severity wildfire. These areas include Throckmorton Ridge and West Edgewood in southern Marin County, Marina Vista/Wiltshire in Corte Madera, and Goodhill Rd/Crown Road in the Kent Woodlands.
- Consider prioritizing areas with small SSD, particularly those with high concentrations of structures with less than 30 feet of separation to their nearest neighbor, because these areas may be susceptible to structure-to-structure fire spread.
- In areas where structures are likely to be exposed to flame lengths greater than 4 feet, consider implementing extended defensible space and other vegetation management activities that enable firefighters to operate more safely around vulnerable structures.
- In areas with structures exposed to high rates of ember deposition, consider emphasizing the importance of ember resistance to residents and encourage zone zero, ember-resistant vents, and Class A fire-resistant roofing materials as high-impact mitigations against this form of exposure.

F.2 Introduction

Marin Wildfire and Member Agency Defensible Space Program

Marin Wildfire provides funding and staff support for DSI programs across its 17-member agency jurisdictions. During these visits, inspectors evaluate residential properties, assess whether they meet WUI defensible space, vegetation management, and fire-resilient construction standards. At the conclusion of each evaluation, homeowners are provided with a comprehensive online report that includes specific recommendations for improving the home's ability to survive a wildfire. Guidance around a home's compliance with state and local defensible space standards is also provided.

During each home evaluation, individual risk factors ("discoveries") are identified and communicated to the resident. Risk factors are geolocated and very specific. Over the past four years, the DSI program has generated over 750,000 records detailing the type, location, and relative size of potential home hardening and defensible space risk factors on nearly 50,000 parcels in Marin County. During inspections, trained inspectors note the presence (or, in some cases, absence) of nearly 150 different risk factors on the parcel, recording defensible space issues (e.g., dead vegetation, live vegetation, combustible materials) as well as structural hardening issues (e.g., roofs, siding, vents, eaves, decks). After each inspection, a summary of the identified discoveries is provided to the resident to assist in promoting the creation of defensible space, home hardening, and a more fire-adapted community.

The On-Parcel Wildfire Risk Assessment analysis created by Willow Labs provides an objective, quantitative risk assessment of each DSI discovery. Scores are generated using high-resolution environmental data, geospatial analysis, and science-based wildfire behavior models that evaluate a discovery's potential to cause the ignition of surrounding structures. Small variations in discovery location, structure density, topography, and weather conditions change a discovery's risk profile and alter the risks it poses to community safety. The modeling approach and its outputs provide quantitative, data-driven evidence that can inform a variety of fire prevention and preparedness programs.

Tiburon Fire District

The Tiburon Fire District conducts approximately 1,000 defensible space and home evaluations annually. All of the parcels in the WUI are inspected annually. Additionally, all residents may request parcel inspections. Results are communicated to residents through a written inspection report by email or are mailed to residents with the goal of providing education and information for compliance. If a property is not in compliance, a follow-up re-inspection is scheduled. Per California Fire Code, citations can be issued for violations. However, the compliance upon re-inspections has been effective in mitigating fire code violations and hazard concerns, and few citations are issued.

Scale and Resident Privacy

Data collected during home evaluations are considered personal information by Marin Wildfire. While parcel-level information may be used by Marin Wildfire staff to create tactical plans and objectives, this strategic plan uses aggregated data to avoid identifying particular parcels with high-risk characteristics. In this analysis, the finest resolution of analysis is at the evacuation zone scale; each zone contains at least several blocks of homes. Individual parcel-level information is not necessary for countywide planning and will not be released.

Evaluating External Fire Risk

Fire risk from adjacent wildlands and open spaces is evaluated using wildland fire models that estimate the fire likelihood and fire behavior at each pixel on the landscape.

Layers include both potential fire behavior characteristics and dynamic fire spread modeling. Potential fire behavior characteristics include:

- **Fire Probability:** The likelihood, in frequency per decade, that a given pixel is expected to burn. This metric is generated from thousands of simulated wildfires burning under a suite of wind and weather conditions representative of Marin County's climate. This metric highlights areas of Marin County where fire is more likely to occur and is helpful for prioritizing areas where mitigation is most likely to be in the path of a fire.

- **Flame Length:** The conditional flame length at each pixel, if a fire were to occur. Flame length (i.e., length from base to tip of the flame) is a clearly observed operational measure of fire intensity. Vibrant Planet's flame length measure is an estimate of the 95th percentile flame length that incorporates a variety of wind/weather conditions representative of Marin County's climate and is biased towards flame lengths under conditions that are more frequent. Areas with high flame lengths are expected to exhibit intense fire conditions, may exceed the capabilities of ground-based fire suppression resources, and may increase the risk of structure ignition.
- **Rate of Spread:** The projected forward rate of spread at each pixel, if a fire were to occur. Rate of spread is an important measure for evaluating the potential for fire growth and the likelihood of a fire exceeding fire response capabilities. Like flame length, Vibrant Planet's rate of spread calculation estimates the 95th percentile rate of spread incorporating many weather conditions representative of Marin County's climate. Areas with high rates of spread may have increased rates of structure ignition due to rapid fire growth and the potential for fire to reach structures before fire resources can arrive.
- **Ember Deposition:** A primary ignition mechanism for structures in WUI fires is ember deposition. The ember deposition dataset evaluates ember trajectories from ember-producing fuel sources under representative wind patterns. Areas with high rates of ember deposition are at an increased likelihood of ignition during a fire due to the potential for ember showers.

Fire pathways and community entry points were used in conjunction with potential fire behavior layers to identify areas where structures are most vulnerable to exposure from contiguous wildland fuels. Fire pathways are generated from minimum travel time fire growth simulations, showing where wind, fuel, and terrain align to produce the most rapid spread towards the built environment. The fire pathways are produced for two wind scenarios, as identified in the Marin County Fire Weather Analysis (a product of the CWPP update):

- **Northeast:** a sustained Diablo wind event, with strong, dry winds from the northeast. Winds exceed 30 mph with single-digit relative humidity; this scenario occurs once to several times per year.
- **West:** a reversal day when dry air is pushed back onshore, typically after a Diablo wind event. This scenario occurs rarely, but can be extremely hazardous due to low relative humidity, high wind speeds, and an abrupt change in wind direction.

The areas of the community where the fire pathways intersect the built environment are entry points. These areas are where fire is most likely to outpace the fire response due to rapid fire growth and contiguous fuels. If these areas are of sufficient structural density, structure ignition may cause an urban fire to develop. These areas are suitable for prioritizing risk reduction activities on private parcels and corresponding vegetation management activities because these activities will reduce the likelihood of fire becoming established in the built environment and leading to subsequent urban losses.

Evaluating On-Parcel Risk

Wildland fire risk accounts for only a portion of the total fire risk to each structure. Also important is the risk created by vulnerabilities in defensible space and home hardening. To evaluate these vulnerabilities, the On-Parcel Risk Assessment Score is used to assess parcel-level risk.

Using data from the DSI program, each geolocated discovery's risk score is calculated using the following four-component framework that characterizes its contribution to common modes of fire spread and structure ignition in the WUI:

1. **Intensity:** Measures the potential for radiant heating and flame contact with adjacent structures
2. **Embers:** Assesses the potential for the discovery to deposit burning embers of nearby structures
3. **Structure Vulnerability:** Evaluates how specific design elements and construction materials contribute to the survivability of a structure during a wildfire
4. **Continuity:** Assesses the risk for the discovery to serve as a receptive fuel bed with the potential to contribute to fire spread towards adjacent structures

Each risk factor is evaluated under several high-severity fire weather scenarios to evaluate its potential contribution to structure ignition during a wildfire event.

F.3 Fire Probability and Fire Pathways

Fire Probability

Areas where fire is likely to occur are good places to prioritize risk reduction activities, because there is a greater likelihood that those mitigations will be subjected to fire and therefore have a chance to provide a meaningful impact. To generate burn probability, thousands of fire simulations were conducted under a wide variety of wind and weather conditions. Each pixel was assigned a burn probability based on the number of simulations in which it burned. This analysis assumes that ignitions are distributed across the landscape according to ignition risk, which incorporates patterns of human land use and activity, as well as natural fire starts.

For this analysis, the burn probability within 200 feet of structures was used to evaluate the likelihood of fire occurrence near a community. As shown in **Figure F-1**, modeled burn probability is greatest in the northeastern portions of the county, including the areas around Novato. While fires are possible in other parts of the county, they are significantly less likely. The areas around Novato

are almost twice as likely to burn as parts of Mount Tamalpais and three times more likely to burn than most of Point Reyes.

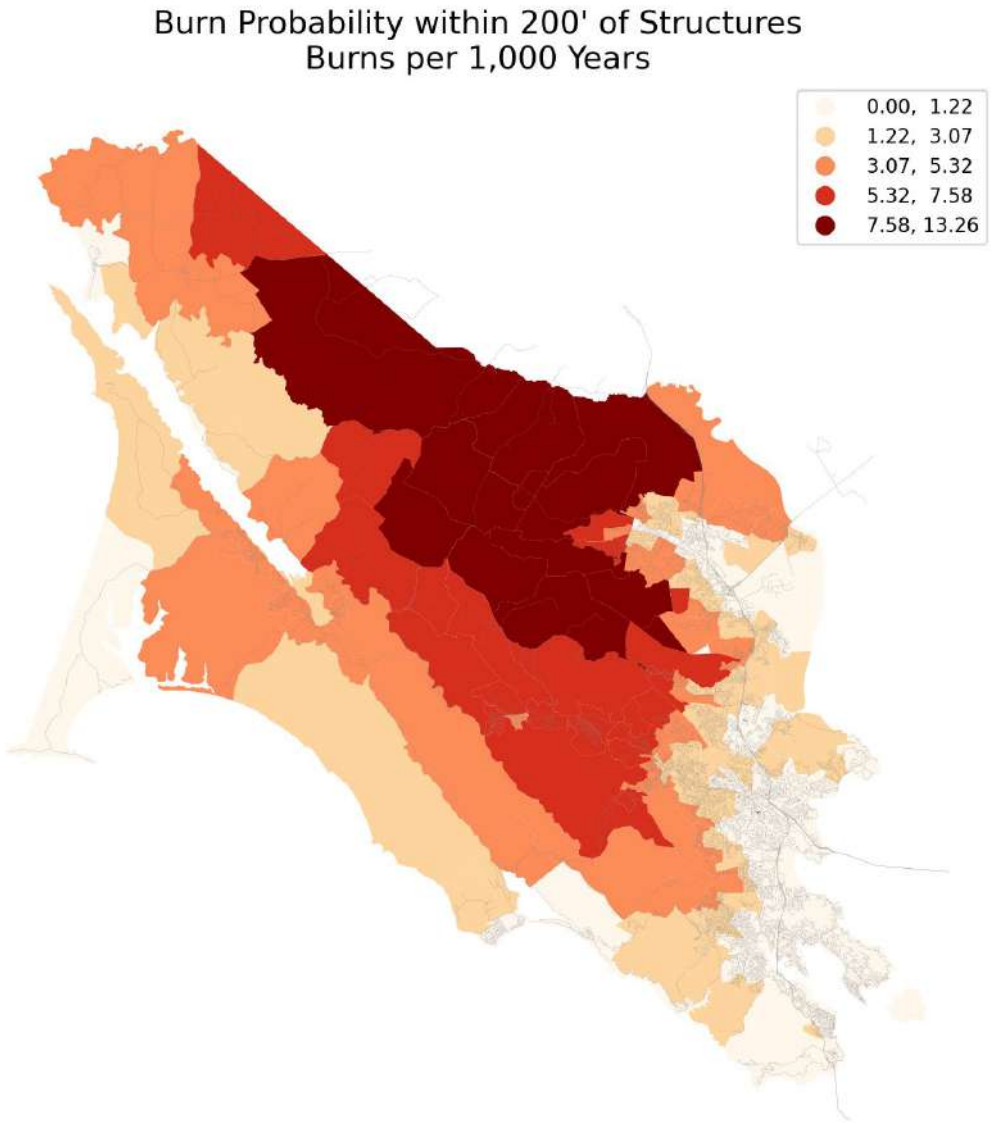


Figure F-1. Fire probability within 200 feet of structures.

Table F-1 lists the average near-structure burn probability in evacuation zones with more than 100 residential parcels. Niscasio, Wildhorse Valley, and zones in the San Geronimo Valley have the greatest likelihood of substantial concentrations of residential structures being exposed to wildfire.

Table F-1. Average burn probability in zones with more than 100 residential parcels.

Zone ID	Burn probability (×1,000)	Residential Parcel Count	Zone Name
US-CA-XMR-MRN-E118	8.8	156	
US-CA-XMR-MRN-E073	7.5	114	Nicasio
US-CA-XMR-NOV-E028	7.3	354	Wildhorse Valley
US-CA-XMR-MRN-E112	7.2	154	Margarita
US-CA-XMR-MRN-E087	6.6	569	Woodacre West
US-CA-XMR-MRN-E062	6.6	118	Meadow Club
US-CA-XMR-MRN-E063	6.4	288	San Geronimo
US-CA-XMR-MRN-E587	6.1	210	
US-CA-XMR-FAI-E002	6.1	391	Baywood/Glenn
US-CA-XMR-MRN-E089	6.0	134	Lagunitas South

Flame Length

Flame length is a measure of fire intensity. Ground-based fire suppression resources may not be capable of safely engaging flame lengths greater than 4 feet; flame lengths greater than 12 feet may resist control even using aerial resources and heavy equipment. Large flame lengths near structures may increase the risk to these structures, both due to the high radiant heating from large flames and the limited capacity for fire suppression. As shown in **Figure F-2**, flame lengths near structures can be very significant, particularly in areas in central Marin County and around Mount Tamalpais. As shown in **Table F-2**, the zones with the highest near-structure flame lengths are West Edgewood, Upper Edgewood, and Blithedale Summit.

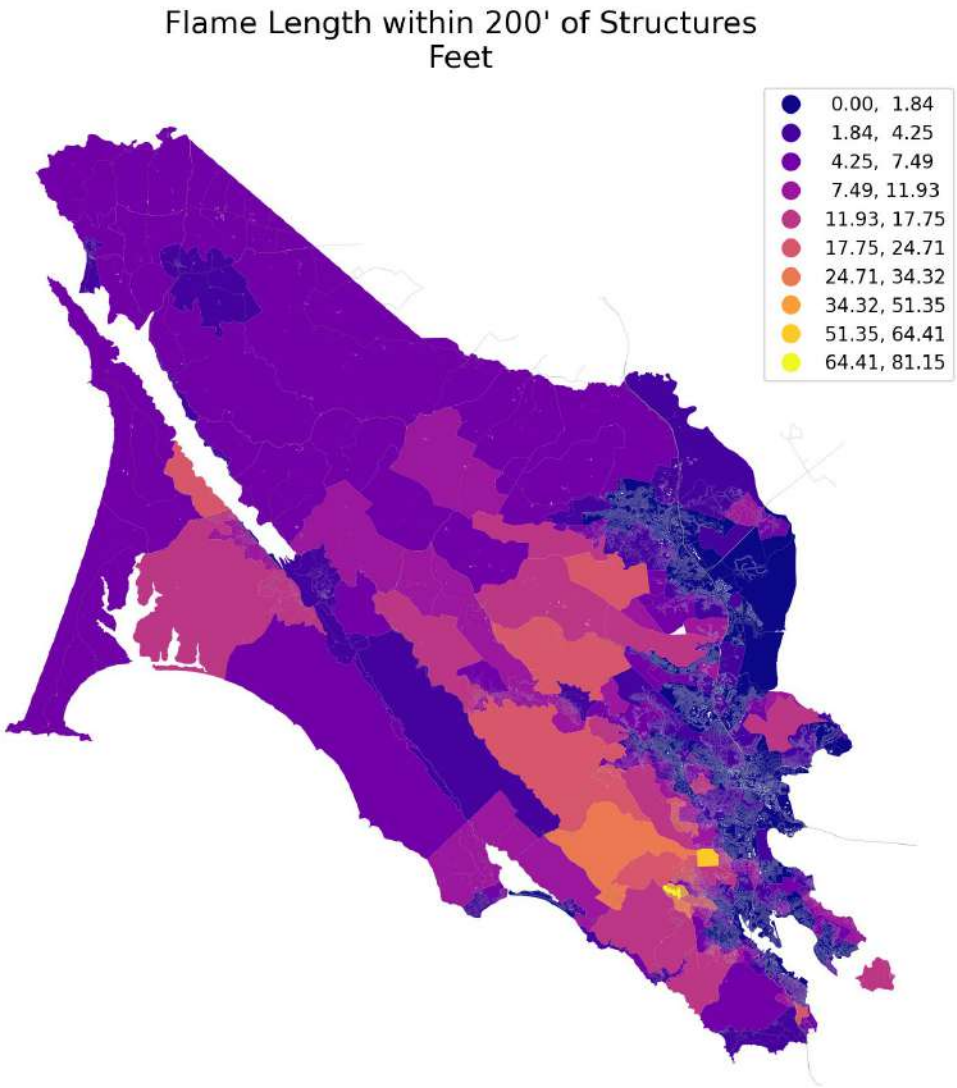


Figure F-2. Average flame length within 200 feet of structures.

Table F-2. Flame length statistics within 200 feet of structures by evacuation zone.

Zone ID	Zone Name	Average Flame Length within 200' of Structures	Number of Structures
US-CA-XMR-MIL-E005	West Edgewood	81	161
US-CA-XMR-LAR-E016	Blithedale Summit	64	151
US-CA-XMR-MIL-E007	Edgewood (Upper)	51	216
US-CA-XMR-MRN-E096	Watershed South	34	38
US-CA-XMR-MRN-E132	Throckmorton Ridge	33	607
US-CA-XMR-MRN-E027	Pantoll	33	11
US-CA-XMR-MRN-E093	East Peak	25	70
US-CA-XMR-MRN-E062	Meadow Club	24	206
US-CA-XMR-MIL-E017	Summit (Upper)	23	451
US-CA-XMR-MRN-E120	Watershed North	21	268

Recommendation: In areas where structures are likely to be exposed to flame lengths greater than 4 feet, consider implementing extended defensible space and other vegetation-management activities that enable firefighters to operate more safely around vulnerable structures.

Ember Deposition

The primary mechanism for structure ignition in WUI fires is ember deposition. Embers capable of igniting structures are usually generated by heavier wildland fuels (e.g., timber and sometimes mature shrubs). As shown in **Figure F-3**, most of the urban core of Marin County along the Highway 101 corridor is out of range of ember deposition from wildland fuels. While some very-long-distance ember deposition may carry embers into these areas, significant rates of deposition are unlikely. In contrast, areas along the WUI boundary, and particularly areas of the boundary dominated by timber fuels, are much more likely to be exposed to embers generated by wildland fuels.

As shown in **Table F-3**, the areas around Mill Valley are among the most at-risk of ember deposition. West Edgewood, East Peak, and Throckmorton Ridge are all likely to be exposed to significant loads of ember deposition.

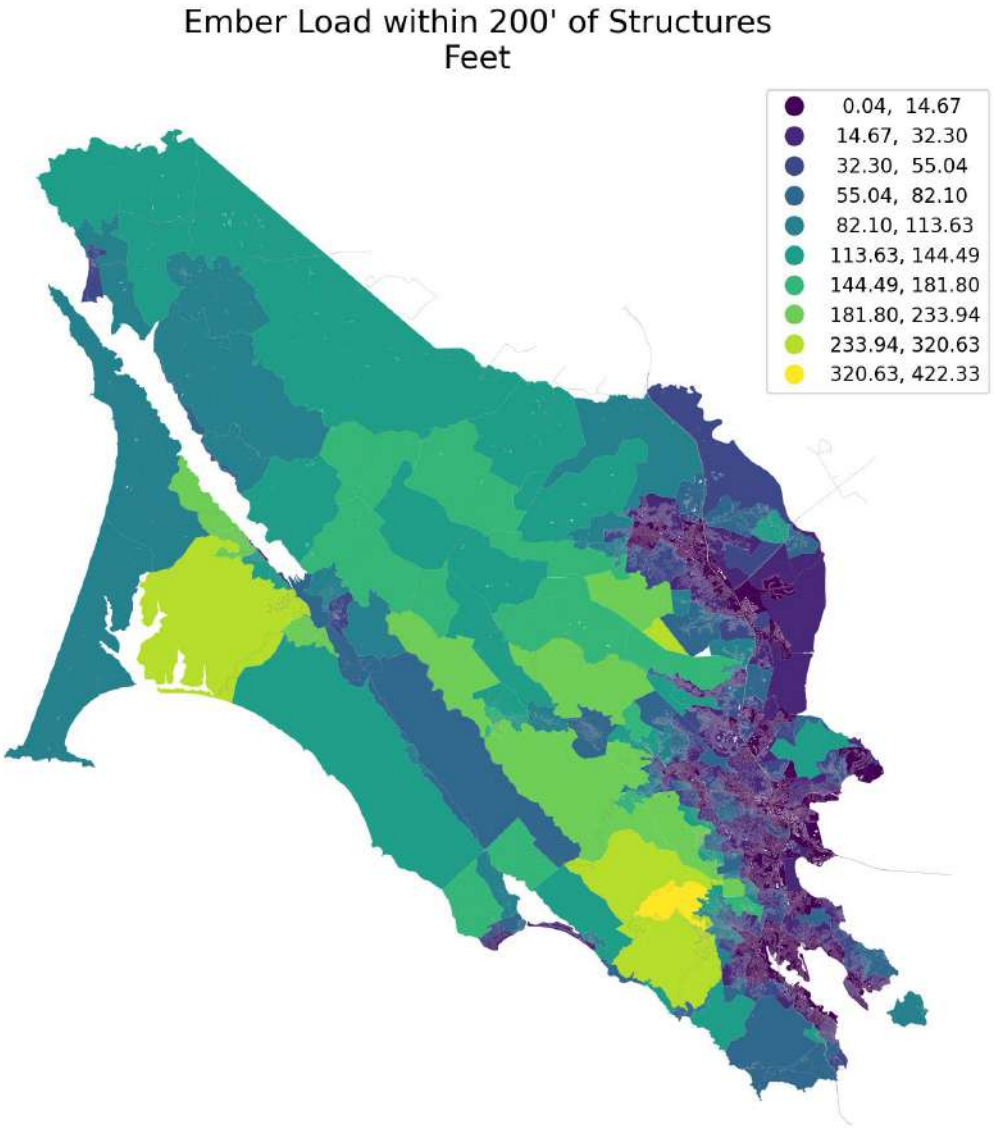


Figure F-3. Conditional ember deposition patterns in Marin County by evacuation zone.

Table F-3. Projected ember deposition within 200 feet of structures by evacuation zone.

Zone ID	Zone Name	Structure Ember Load Index	Number of Structures
US-CA-XMR-MIL-E005	West Edgewood	422	161
US-CA-XMR-MRN-E093	East Peak	358	70
US-CA-XMR-MRN-E099	Muir Woods	321	280
US-CA-XMR-MRN-E132	Throckmorton Ridge	320	607
US-CA-XMR-MRN-E096	Watershed South	309	38
US-CA-XMR-MRN-E151	-	292	6
US-CA-XMR-MRN-E105	-	284	199
US-CA-XMR-MRN-E019	-	275	375
US-CA-XMR-MRN-E098	Diaz Ridge	262	95
US-CA-XMR-MRN-E027	Pantoll	257	11

Recommendation: In areas with structures exposed to high rates of ember deposition, consider emphasizing the importance of ember resistance to residents and encourage zone zero, ember-resistant vents, and Class A fire-resistant roofing materials as high-impact mitigations against this form of exposure.

Structure Exposure Score

The SES is an estimate of the external wildfire conditions a structure may face. It is a combination of fire probability, flame length, and ember deposition. This metric can be used to highlight the structures most likely to experience a fire with active fire behavior characteristics. As shown in **Figure F-4**, the SES illustrates a similar pattern to the fire behavior metrics discussed above. As indicated in **Table F-4**, the zones with the highest scores include the Edgewood areas of southern Marin County (as highlighted above for both high flame length and high rates of ember deposition), Throckmorton Ridge, the Mount Tamalpais watershed, and US-CA-XMR-MRN-E019 (Inverness Park).

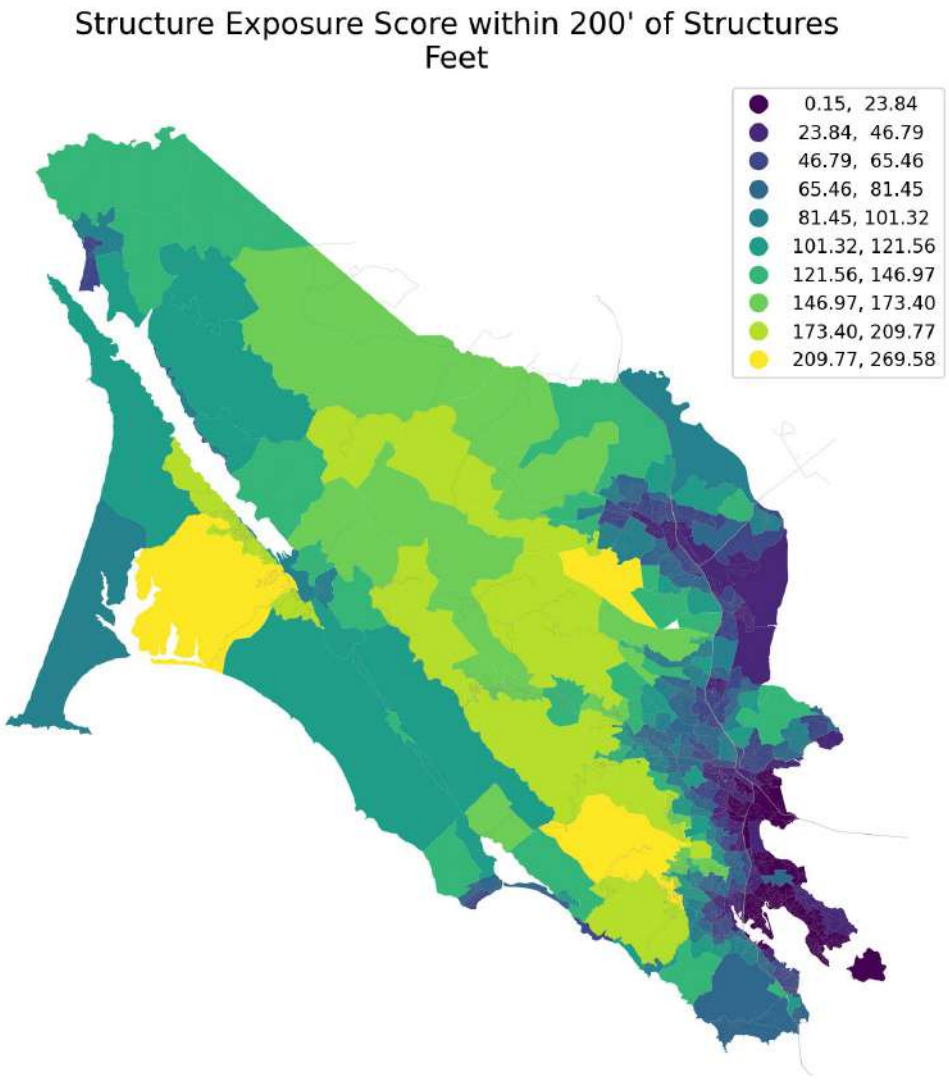


Figure F-4. Distribution of the SES by evacuation zone.

Table F-4. Average SES within each evacuation zone.

Zone ID	Zone Name	Structure Exposure Score	Structure Count
US-CA-XMR-MRN-E093	East Peak	270	70
US-CA-XMR-MIL-E005	West Edgewood	250	161
US-CA-XMR-MRN-E096	Watershed South	248	38
US-CA-XMR-MRN-E019	-	237	375
US-CA-XMR-MRN-E151	-	225	6
US-CA-XMR-MRN-E105	-	222	199
US-CA-XMR-MRN-E132	Throckmorton Ridge	221	607
US-CA-XMR-MRN-E131	-	216	76
US-CA-XMR-MRN-E024	Taylor	210	104
US-CA-XMR-MRN-E120	Watershed North	208	268

Fire Pathways

Low-probability fires can cause tremendous damage. Almost by definition, the fires that cause the greatest damage are those that occur under exceptional circumstances, such as high-severity wind events and seasonal and multi-annual droughts. These fires may not be captured in the fire probability mapping because high-severity events are poorly represented in the distribution of wind and weather conditions used to simulate fire growth patterns.

To address this gap, the fire pathways framework evaluates risk under extreme conditions. Fire pathways assume a fire occurs on a high-severity wind event with no suppression intervention; the goal of this tool is not to identify the likelihood of a fire occurring, but the consequence when it does. Fire pathways provide a useful method for identifying the greatest threat vector for each community and provide a data-driven means for prioritizing the creation of extended defensible space and other vegetation-management activities with the greatest benefit.

Figure F-5 shows the fire pathways from two different wind directions (i.e., northeast and west) and the corresponding entry points. **Figure F-6** evaluates the density of entry points by evacuation zone.

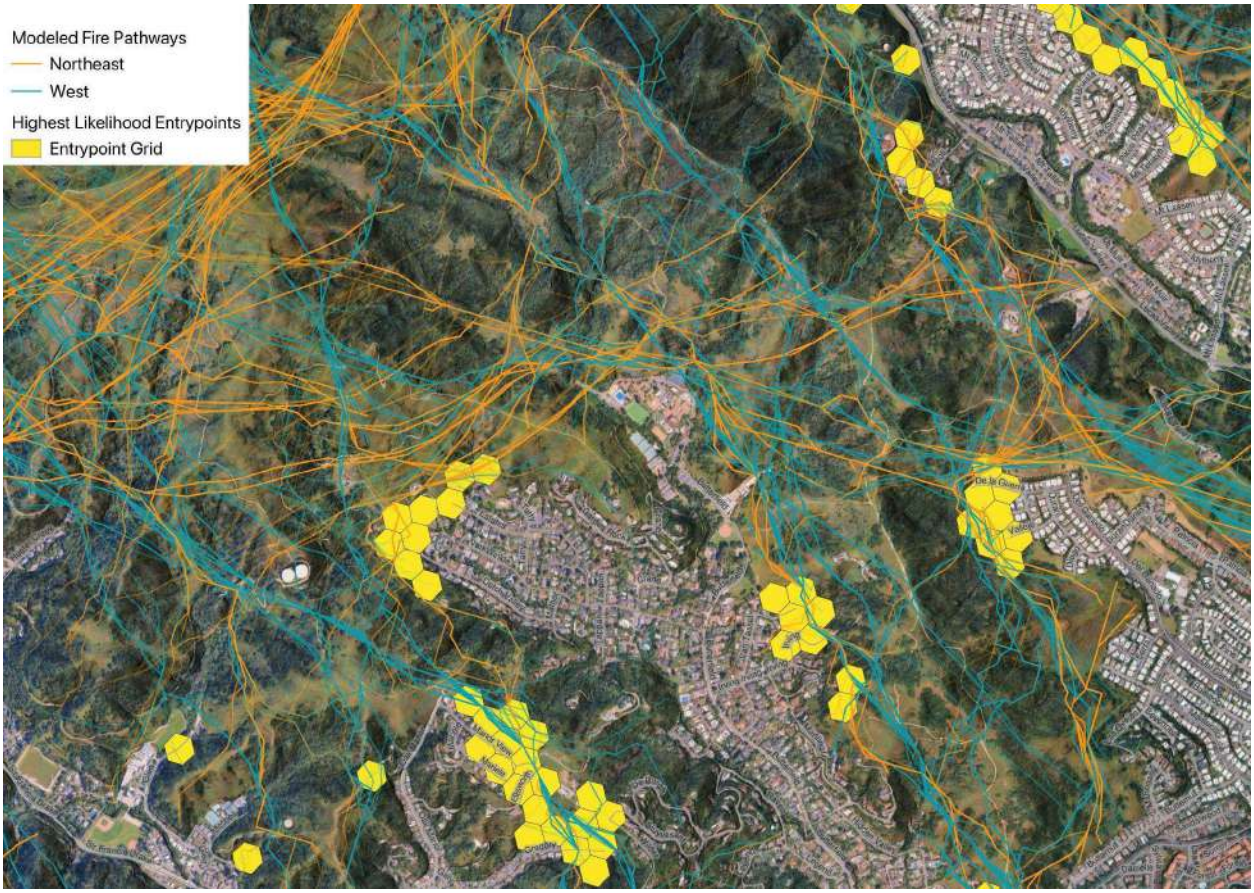


Figure F-5. Entry points and fire pathways in Sleepy Hollow.

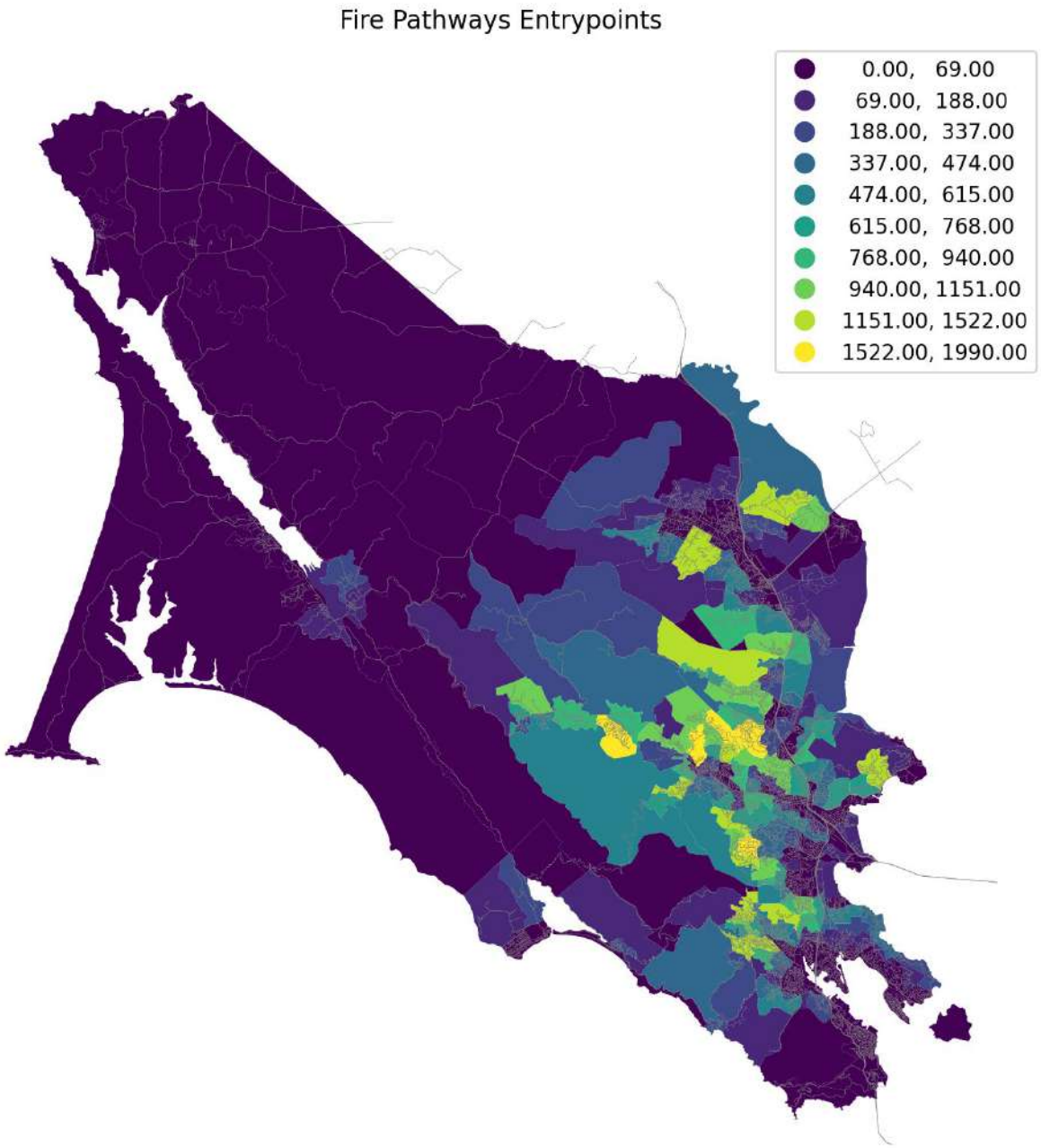


Figure F-6. Fire pathway entry point density by evacuation zone.

F.4 Measuring Progress for Defensible Space and Home Hardening

Marin Wildfire has established several high-level reporting goals that characterize the community's success towards defensible space and home hardening. These measures track the progression from parcel inspection (5A), to resident engagement with wildfire risk (5B), to mitigation (5C), to risk reduction (5D and 5E). JPA zone metrics are listed in **Table F-5**. Tiburon and Belvedere are not included due to lack of data.

Goal 5A – Evaluation Progress: Evaluation and the identification of fire hazards are the first steps towards fire adaptation. This measure tracks the number of evaluations of residential parcels. Each agency or zone sets its own target number of parcels to evaluate annually. This process provides agencies with flexibility regarding their evaluation rollout strategy. Usually, zones set their target at one-third of all residential parcels, so that each parcel is evaluated at least once every three years. In high-risk areas, repeat inspections might occur (but they are not included in this measure). A measure of 100% on Measure 5A does not mean that all residential parcels were evaluated; rather, it means that 100% of the parcels the fire department determined were a priority have been evaluated at least once. Residents can also make an appointment to receive a free evaluation.

Goal 5B – Resident Engagement: After each evaluation, inspectors leave a door hanger with a code that residents can use to access their personalized online Wildfire Risk Report. The objective of this goal is to measure the degree to which Marin County residents are engaging with their on-parcel risk factors. The Wildfire Risk Report contains information about home hardening and defensible space violations that should be addressed within 30 days. It also contains resources and information about available grants. Goal 5B tracks the number of residents who open their Wildfire Risk Report within 15 days of receiving an evaluation. Reminders and follow-ups are sent by email and regular mail.

Goal 5C – Mitigation Progress: Goal 5C tracks progress towards the mitigation of defensible space violations. As an initial step towards meaningful fire adaptation, Marin Wildfire believes residents need to mitigate at least 50% of all defensible space violations found on their parcel. After a fire code violation is identified during an evaluation, the resident can indicate it has been resolved through the online Wildfire Risk Report by submitting a photo.

Goal 5D – Reducing Risk on Private Parcels: Goal 5D assesses whether residents are resolving the most hazardous risk factors on their property and whether Marin County communities are becoming more fire resilient. Each fire hazard is evaluated using the four-component framework described previously to create a score that indicates each discovery's potential to generate embers, expose surrounding parcels to radiant heat and flames, create a continuous path for fire to travel closer to a structure, and contribute to structure ignition. High-risk issues are those in the top 20% of risk across Marin County. This measure calculates the number of evaluated parcels with at least one unresolved high-risk issue.

Goal 5E – Reducing Flame Length: Flame length is a measure of fire intensity; larger flames are harder to control and may result in greater structure damage. Flame lengths of 4 feet or less, particularly within 0 to 30 feet of structures, reflect fires that are low to the ground that have a limited potential to spread to structures and nearby vegetation. Goal 5E counts the number of evaluated parcels for which all remaining fire hazards have a projected flame length of 4 feet or less.

Table F-5. Progress towards Marin Wildfire Goal 5 metrics. Data as of the end of 2024.

Region	Goal 5A: Percent of Target Parcels Evaluated	Goal 5B: Percent of Residents Who Open Reports Within 15 Days	Goal 5C: Percent of Parcels That Mitigate More Than 50% of Defensible Space Violations	Goal 5D: Percent of Parcels with High-Risk Issues	Goal 5E: Percent of Parcels with a Maximum Projected Flame Length of 4' or More
Central Marin	113%	21%	2%	18%	8%
Novato	106%	61%	27%	82%	41%
San Rafael	83%	58%	40%	70%	43%
Southern Marin	78%	56%	36%	57%	40%
West Marin	147%	36%	15%	70%	23%
Total Marin Wildfire JPA	117%	43%	25%	60%	28%

As shown in **Figure F-7**, significant progress has been made towards improving the coverage of inspections between 2023 and 2024. Year over year, the 5A metric increased to include nearly 30% more parcels. On average, Marin Wildfire JPA zones now inspect more than their annual goal. Other metrics have changed by a substantially smaller margin, indicating a need for increased resident incentives to implement the findings in the wildfire risk report.

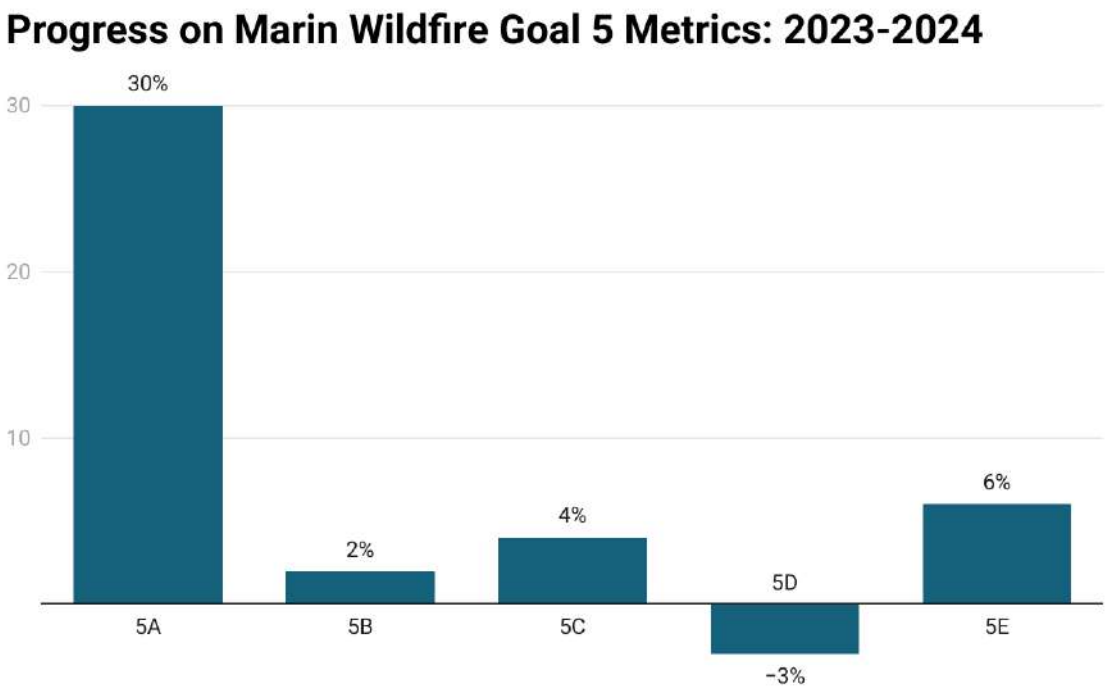


Figure F-7. Annual change for Marin Wildfire Goal 5 metrics between 2023 and 2024.

Prevalent Hazards

Data from the DSI program indicate that the most common hazards identified by inspectors are vegetation in zone zero, metal gutters that may lack gutter guards, combustible fences attached to structures, unenclosed eaves, and structures with vent mesh larger than ⅛". As shown in **Table F-6**, vegetation in zone zero is found on nearly two-thirds of the 83,000 inspectable parcels in the Marin Wildfire jurisdiction.

Table F-6. Frequency of unresolved on-parcel discoveries as of July 2025.

Discovery Type	Number of Unresolved Issues
Vegetation In Zone Zero	52,150
Structure Gutters Metal	43,143
Combustible Fence Attached To Structure	39,753
Structure Eaves Unenclosed	35,163
Structure Vents ≥ 1/8"	33,105
Structure Siding Wood Plank	32,854
Exterior Door Wood	26,868
Structure Deck Softwood	19,157
Structure Window Panes Single	18,093
Vegetation Overhanging Structure	15,502
Structure Under Deck Exposed	15,219
Vegetation Ladder Fuel	12,797
Structure Gutters No Guards	12,150
Structure Siding Wood Shingles	10,463
Structure Roof Complex	10,346
Vegetation Tree Requires Limbing	8,921
Vegetation Hazardous Rosemary	8,828
Combustible Mulch	8,776
Combustible Doormats	8,770
Structure Attached Trellis Pergola Arbor	8,530
Dead Vegetation Litter On Ground	7,972
Dead Vegetation Grasses Weeds	7,640
Structure Deck Elevated	7,488
Skylights Flat Glass	7,298
Outdoor Furniture Cushions	6,767

Based on the On-Parcel Risk Assessment modeling, some of these discoveries are identified as relatively high risk compared with other findings across the county. **Table F-7** lists the number of unresolved issues at or above the 80th percentile in overall risk compared with other risks in the county. Combustible fences are among the most important and most common risks in the county. Other common high-risk discoveries include wood plank and wood shingle siding, attachments such as arbors, trellises, and pergolas, vegetation in zone zero, and fire-hazardous species, such as bamboo, juniper, and cypress.

Table F-7. Frequency of high-risk discoveries in Marin as of July 2024. High-risk discoveries are those with an On-Parcel Risk Score of greater than the 80th percentile, compared with all other discoveries in Marin County.

Discovery Type	Number of Unresolved Discoveries
Combustible Fence Attached To Structure	39,465
Structure Siding Wood Plank	20,495
Structure Attached Trellis Pergola Arbor	8,042
Structure Siding Wood Shingles	6,244
Vegetation Hazardous Bamboo	4,149
Vegetation Hazardous Juniper	3,859
Vegetation In Zone Zero	2,434
Vegetation Hazardous Cypress	1,914
Structure Window Panes Single	1,734
Vegetation Ladder Fuel	1,298
Vegetation Hazardous Broom Plants	1,225
Vegetation Overhanging Structure	1,198
Vegetation Hazardous Acacias	1,023
Dead Vegetation Dead Shrubs	961
Vegetation Hazardous Rosemary	942
Vegetation Hazardous Other	844
Combustible Fence On Property Not Attached	762
Structure Roof Wood	588
Flammable Patio Furniture	485
Combustible Materials Under Deck	457
Dead Vegetation Piles	446
Combustible Lumber Or Building Materials	442
Structure Siding Vinyl	439
Vegetation Spacing Shrub	337
Vegetation Spacing Tree	314

Parcel-level scores are created by evaluating the number and severity of unresolved discoveries on the parcel. This approach yields high scores for the parcels where there are either (a) many unresolved moderate- or high-risk factors, or (b) one or more unresolved very high-risk discoveries. As shown in Figure F-8, the highest on-parcel risk scores are found in Terra Linda (US-CA-XMR-SNR-E564, US-CA-XMR-SNR-E565, and US-CA-XMR-SNR-E563), Mariner Cove in Corte Madera (US-CA-XMR-COR-E010), and Contempo (US-CA-XMR-SNR-E581). Stinson Beach (US-CA-XMR-MRN-E020) also has a high relative on-parcel risk.

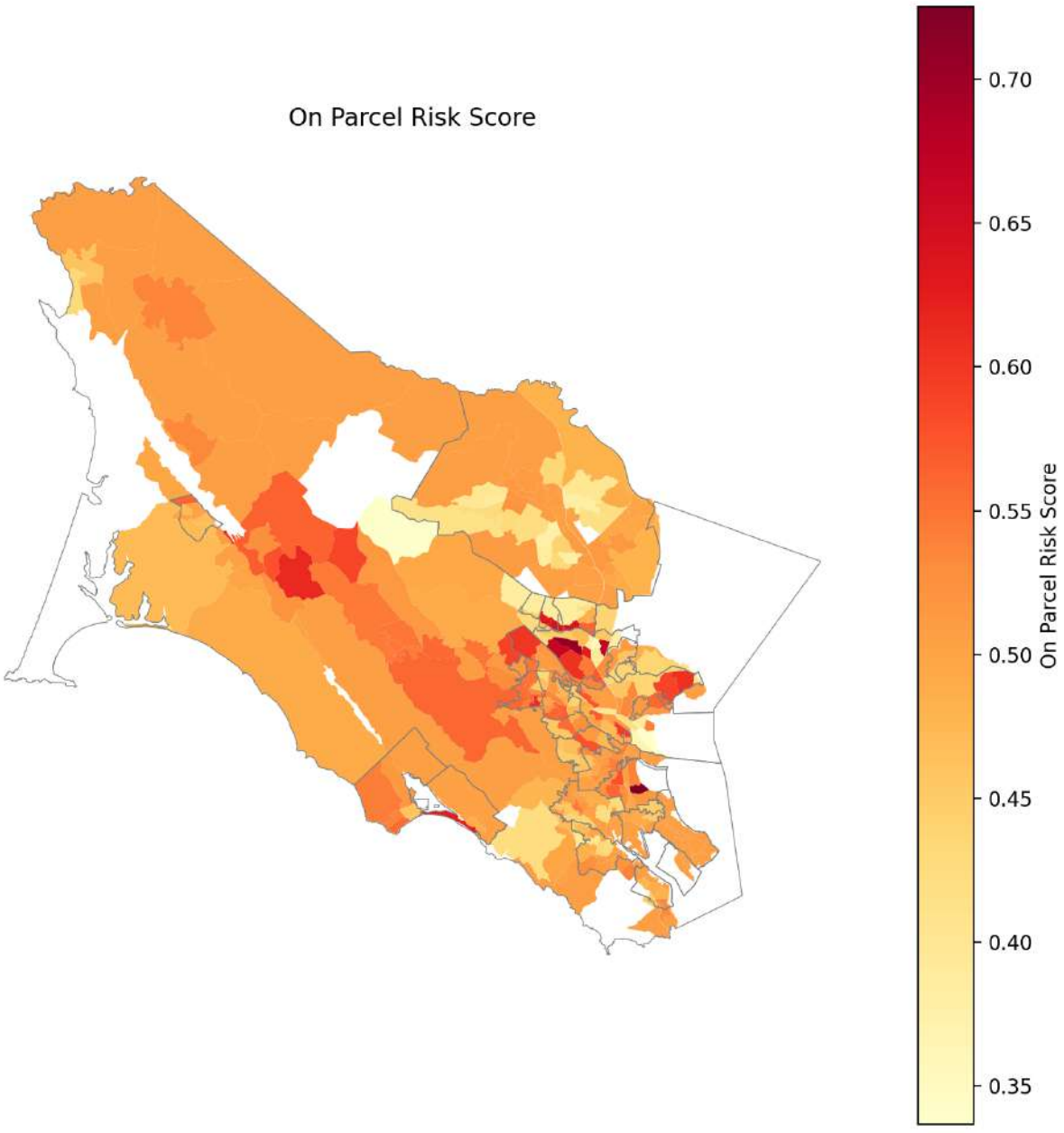


Figure F-8. Average on-parcel risk score for each evacuation zone.

Figure F-9 illustrates the average composite score for each zone. This metric incorporates fire probability, fire behavior (flame length, ember deposition, and rate of spread), fire pathway entry points, and on-parcel risk derived from the On-Parcel Risk Assessment. Table F-8 lists the top 10 zones by composite parcel risk.

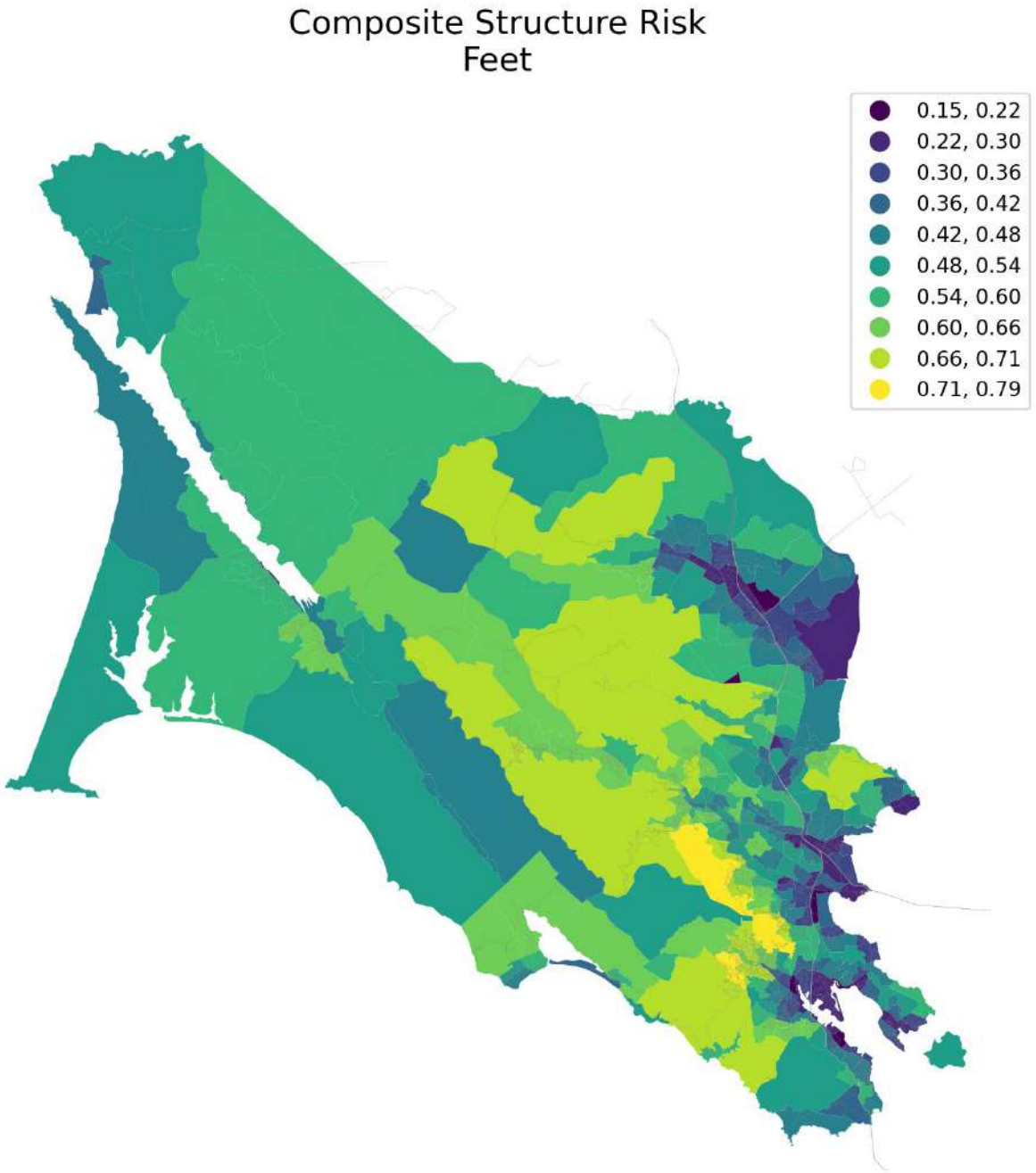


Figure F-9. Average composite parcel risk score for each evacuation zone.

Table F-8. Composite wildfire risk statistics incorporating both on-parcel risk scores and wildfire behavior scores.

Zone ID	Zone Name	Structure Risk Rank	Structure Count
US-CA-XMR-MRN-E132	Throckmorton Ridge	79%	607
US-CA-XMR-MIL-E005	West Edgewood	77%	161
US-CA-XMR-LAR-E016	Blithedale Summit	76%	151
US-CA-XMR-COR-E005	Marina Vista/Wiltshire	74%	342
US-CA-XMR-MIL-E007	Edgewood (Upper)	74%	216
US-CA-XMR-KEN-E006	Goodhill Rd/Crown Rd	73%	195
US-CA-XMR-MIL-E009	Upper Hillside	72%	356
US-CA-XMR-MRN-E100	Phoenix Lake	72%	236
US-CA-XMR-MRN-E062	Meadow Club	71%	206
US-CA-XMR-MRN-E099	Muir Woods	71%	280

F.5 Evaluating Neighborhood Risk

Recent disaster fires have spread through the built environment via structure-to-structure spread, highlighting the importance of structure separation distance and community design in determining fire spread. Studies of urban conflagration are still refining the scientific basis for how fire spreads within the built environment.[56] Modeling studies are integrating these findings into computational models that can accurately reflect the damage and progression of a fire within the community.[57] Marin Wildfire has been working on several pilot projects that explore the potential for large-scale spread within the built environment; however, at the time of writing, those studies are too limited in scope to include in the countywide planning process. Nonetheless, an assessment of structure vulnerability would be incomplete without an assessment of the areas where fire is most likely to spread between adjacent buildings.

Structure separation distances can be used as a proxy for areas where fire could spread by radiant and convective heat between structures. Structures located less than 30 feet from one another are at

[56]Maranghides, Alexander, et al. *Structure Separation Experiments: Shed Burns without Wind*. National Institute of Standards and Technology, US Department of Commerce, 2022.
[57] Mahmoud, Hussam, and Akshat Chulahwat. "Unraveling the complexity of wildland urban interface fires." *Scientific Reports* 8.1 (2018): 9315.

the highest risk of ignition via this mechanism.[58] In this prioritization exercise, we evaluate the distribution of low SSD in communities across the county. Using the official county buildings footprint dataset, this analysis accounts for all structures that are at least 120 square feet; sheds and other outbuildings are also included. Recent analysis suggests that these outlying buildings are important contributors to fire spread within the built environment.

Areas that have low SSD, are contiguous with vegetative fuels, and have on-parcel vulnerabilities are those at the greatest risk of setting a cascade of structure-to-structure ignitions. Defensible space and vegetation management around these communities are recommended.

Parcels with low SSD without connectivity to vegetation may also be at risk of fire when a structure-to-structure cascade occurs. These structures should also be prioritized for defensible space and home hardening, with particular attention to ember resistance. Resisting ignition from ember deposition can interrupt fire spread if initiated.

Figure F-10 shows the percentage of structures in each evacuation zone with less than 30 feet SSD. Many of the urban areas in Marin County have low SSD, indicating the capacity for fire to spread within the built environment given suitable conditions. Countywide, the median SSD is just 16.7 feet. More than 68% of structures are less than 30 feet from their nearest neighbor. Just 12% of structures are located more than 100 feet from their nearest neighbor.

[58] Cohen, Jack D. 1995. Structure ignition assessment model (SIAM)\t. In: Weise, David R.; Martin, Robert E., technical coordinators. The Biswell symposium: fire issues and solutions in urban interface and wildland ecosystems; February 15-17, 1994; Walnut Creek, California. Gen. Tech. Rep. PSW-GTR-158. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; p. 85-92

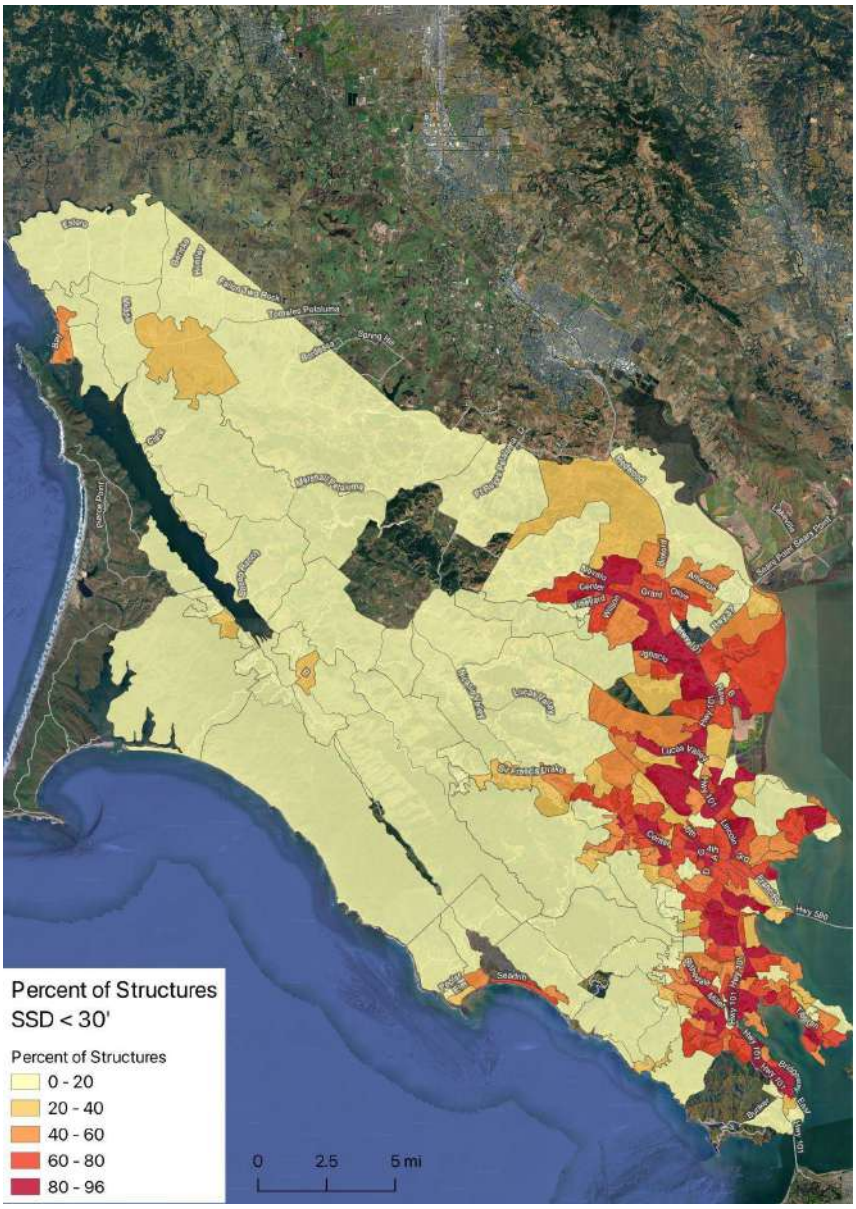


Figure F-10. Percentage of structures in each evacuation zone with an SSD of less than 30 feet.

As shown in **Table F-9**, the agencies with the greatest exposure to low-SSD developments are County Fire CSA 13 (Upper Lucas Valley, 88%), Marinwood (87%), and Central Marin (79%). In Central Marin, just 7% of structures are located more than 100 feet from the nearest adjacent structure. The agencies least exposed to low SSD development are Inverness Public Utility District (PUD) (22%) and Bolinas (27%). On average, parcels in these jurisdictions have SSD of greater than 100 feet.

Table F-9. Structure SSD statistics for each fire agency.

Fire Service Provider	Average SSD (feet)	Percent of Parcels with SSD < 30'	Percent of Structures with SSD 30-50'	Percent of Structures with SSD 50-100'	Percent of Structures with SSD > 100'
Belvedere Fire Department	32.3	78%	11%	5%	6%
Bolinas Fire Protection District	121.9	27%	15%	14%	45%
Central Marin Fire Department	32.9	79%	9%	5%	7%
County Fire (CSA 13)	32.6	88%	4%	0%	9%
County Fire (CSA 19)	48.8	63%	9%	15%	13%
County Fire (CSA 31)	115.6	32%	11%	14%	43%
Inverness Public Utility District	113.7	22%	16%	18%	44%
Kentfield Fire Protection District	48.2	56%	14%	19%	11%
Marinwood Community Services District	29.4	87%	5%	2%	6%
Mill Valley Fire Department	42.5	67%	14%	10%	10%
Novato Fire Protection District	39.2	74%	10%	7%	10%
Ross Fire Department	70.7	39%	18%	21%	22%
Ross Valley Fire Department	35.5	75%	11%	7%	8%
San Rafael Fire Department	34.4	76%	10%	7%	7%
Sleepy Hollow Fire Protection District	60.0	42%	22%	22%	15%
Southern Marin Fire Protection District	39.2	75%	10%	6%	9%
Stinson Beach Fire Protection District	65.7	64%	8%	7%	22%
Tiburon Fire Protection District	52.9	56%	19%	12%	13%

Appendix G. Marin County Assessment of Local Preparedness

Components of the appendix have been integrated into other appendices. This appendix will be updated accordingly in the final CWPP document.

Table G-1 below provides a list of the firefighting resources available to the Marin County fire agencies.

Table G-1. Available fire resources to each Marin County fire agency.

Agency	Type 1 Engines	Type 3 Engines	Type 6 Engines	Water Tender	Dozer	Handcrew	Personnel	Additional equipment
Central Marin	4	2		1			40 full time paid members. 39 suppression / 1 admin	2 type on ambulances 3 Battalion chief pickups 3 utility pickups 2 SUVs.
Southern Marin	5	2				1	100 (11 administrative, 8 fire prevention, 73 fulltime firefighters, 8 Seasonals-Fuels/Hand Crew)	three ALS ambulances one medium rescue one ladder truck four Battalion Chief vehicles (1 reserve) five staff vehicles eight prevention vehicles eight utilities one crew transport One water rescue apparatus one fireboat one IRB two RWC one dive tender unit

Agency	Type 1 Engines	Type 3 Engines	Type 6 Engines	Water Tender	Dozer	Handcrew	Personnel	Additional equipment
San Rafael	5	1	1				74 Line Personnel	1 Ladder Truck + (1 Reserve Ladder Truck) 4 Paramedic Ambulances (2 Cross Staffed) + (2 Reserve Ambulances) Fire Boat RWC 2 ATV's
Marin County	8	13	2	3	2	4	366 (147 full time, 184 seasonal, 35 volunteers)	Five ambulances/medic Two Medium Rescues. Twelve Fire Detection Cameras Two Lookout Towers two excavators One grader one loader One skid steer w/mulching head Five chippers Two crew support vehicles Two chip trucks.
Inverness	2		1				25 firefighters (full-time, part-time, volunteer)	one small rescue two utility/command vehicles
Kentfield	2	1	1				20 firefighters (full-time, part-time, volunteer)	
Marinwood	1	1					9 Line Personnel	
Ross Valley	4	2 (1OES Type 3)					30 Firefighters 4 Battalion Chiefs 2 Prevention 1 Fire Chief 1 Admin Assistant 1 Wildfire Preparedness Coordinator (Fixed Term)	Four command vehicles Air Trailer three Utility vehicles
Stinson Beach	2	1		1			7 personnel (15 volunteers)	one BLS ambulance two command vehicles

Agency	Type 1 Engines	Type 3 Engines	Type 6 Engines	Water Tender	Dozer	Handcrew	Personnel	Additional equipment
Bolinas	2	1					21 firefighters (full-time, part-time, volunteer)	One Mass Casualty Incident (MCI) Trailer Four command/utility vehicles
Novato	7	2		1			82 (65 emergency response personnel, 17 administrative personnel, one fire mechanic)	Four ALS ambulances (two first out, one cross staffed and one reserve) One ALS aerial ladder truck Two Weather stations Thermal imaging cameras One Training tower One Administrative building.
Tiburon	3	2					22 Support/Ops, 6 admin	One rescue One fireboat One medic ambulances One utility vehicle Four staff vehicles Three command vehicles Thermal Imaging cameras emergency siren system

Appendix H. Marin County Fire Evacuation Risk Assessment

H.1 Executive Summary

Marin Wildfire has invested in several quantitative approaches to evaluating evacuation preparedness and evacuation safety in Marin County. Evacuation is an important factor in fire prevention planning. Life safety is always the top priority for first responders; ensuring that residents are effectively alerted and prepared to evacuate quickly, that roadways can carry a sufficient number of vehicles, and that safe locations are identified and communicated increases the likelihood of a safe evacuation. Safe and efficient evacuation also improves the effectiveness of firefighting personnel, allowing them to engage in fire suppression rather than evacuation management.

Evacuation studies in Marin County include:

- **Evacuation Ingress/Egress Difficulty Assessment:** A county-wide, data-driven analysis integrating numerous spatial data layers to assess evacuation preparedness along three axes: communication and alerting, fire behavior, and road condition and travel difficulty. This analysis fuses demographic data with fire behavior modeling and roadway characteristics to identify the areas where populations are likely to have the greatest difficulty evacuating from a wildfire.
- **Fire-Resilient Roadway Analysis:** An assessment of fire behavior along public roadways in Marin County. The objective of this study is to characterize road segments where evacuation during peak fire conditions would be unsafe for the public. Thermodynamic calculations are used to estimate the interior temperature change within a vehicle due to the adjacent fire behavior. Results from this analysis can be used to guide evacuation route clearance projects or inform shelter-in-place or temporary staging area evacuation planning.
- **A comprehensive literature review** describing the state of the science of evacuation planning that was used to evaluate (1) key gaps in evacuation planning and (2) common denominators to failed evacuations.
- The Local Hazard Mitigation Plan (2023)[59] provides a multi-threat assessment for local emergency managers and identifies several WUI communities that may have difficulty evacuating from a wildfire. This plan included a recommendation (MC-74) to identify additional areas with insufficient evacuation opportunities.

[59] https://publicworks.marincounty.gov/documents/marin-county-operational-area-multi-jurisdictional-hazard-mitigation-plan-2023/

Key Findings

- Many areas of Marin County have narrow, steep roads with complex intersections that are likely to be difficult to traverse during an evacuation. Portions of southern Marin County have the greatest concentration of these difficult roadways. Special consideration should be given to road conditions during evacuation planning and incident response.
- Approximately 87% of designated evacuation route miles and 91% of public road miles in Marin County meet the temperature target of less than 3°F/minute interior temperature change during high-severity fire weather conditions. The average heating rate on public roadways is approximately 2.6°F/minute.
- The greatest concentration of evacuation routes that exceed the resilience threshold occurs in west Marin County and southern Marin County. Enhanced pre-planning can help ensure that residents do not attempt to evacuate along these roadways during a fire; vegetation management and evacuation route clearance can reduce the heat that evacuees will be exposed to during evacuation in these locations.

Key Recommendations

- Consider targeted fuel-reduction programs along evacuation routes, focusing on areas with high burn frequency and limited existing fire resilience. Enhanced fuel reduction, including canopy clearance, should be considered along evacuation routes that are narrow, winding, steep, and surrounded by dense fuels.
- Improve evacuation pre-planning to incorporate key factors that change the evacuation dynamics, including the time of fire ignition, resilient evacuation routes, and safety locations/shelters. Plans should consider the time of day at which an evacuation occurs and include strategies and protocols for managing background traffic, especially during afternoon school release times and the evening rush hour. Plans should also include an assessment of where residents will be evacuated to and whether the routes to those locations are fire resilient.
- Designate temporary safe locations and consider plans for sheltering in place. Depending on conditions, designating alternative fire-resilient shelters and temporary staging areas may be more effective, less disruptive, and safer than evacuation. Temporary staging areas are not intended for long-duration sheltering, but could provide locations for evacuees to briefly safely park, make a plan, and avoid roadways that could be dangerous. These areas could also be used by traffic managers to temporarily stage vehicles to reduce roadway congestion along high-traffic evacuation routes.
- About 35 miles of designated evacuation routes should be assessed for vegetation management or other mitigation measures. These segments may not support safe evacuation without mitigation. Vulnerable roadways include Muir Woods Road (46% of miles

exceed the resilience threshold), Bear Valley Road (41.7%), Panoramic Highway (35.6%), Bolinas Road (27.5%), and Marshall-Petaluma Road (26.7%).

- Prioritize fire resilience on designated evacuation routes. Many evacuees will likely use these routes in the event of a fire.

H.2 Introduction

Over the past four years, Marin Wildfire has undertaken multiple evacuation risk assessments to assess evacuation safety, efficiency, and effectiveness across Marin County. In the wake of the 2018 Camp Fire—which resulted in 85 civilian fatalities—and other recent extreme fire events with significant loss of life, evacuation planning has become a critical priority for emergency managers and fire prevention planners. As part of its strategic objectives, Marin Wildfire is focused on measuring progress toward risk reduction through alerting, detection, and evacuation (Goal 2). Working in collaboration with member agencies, Marin Wildfire has commissioned several innovative methods for evaluating and improving the factors that drive evacuation safety in Marin County. These tools provide specific guidance for evacuation planning that addresses the areas with the highest likelihood of an evacuation failure during a wildfire.

1. A state-of-the-science literature review designed to identify commonalities in evacuation failures and civilian fatalities in past wildfire evacuations.[60] This study highlighted the practical implications for Marin County, discussed the characteristics of successful evacuation, and identified potential planning and risk reduction improvements to address Marin County's unique risk factors.
2. The Evacuation Ingress/Egress Risk Assessment study addressed evacuation risk factors in Marin County based on five determinants of evacuation success: fire behavior, alerts and communication, resident decision making, safe travel during the evacuation, and safe arrival at a designated safe location. Numerous spatial datasets were used to evaluate the evacuation difficulty associated with these factors. These datasets were grouped into three overarching themes: fire and fuels, communications and human decision making, and traffic flow. The outcome of this GIS study included a report on current conditions of evacuation difficulty and an **interactive map** tool useful for identifying potential areas of high risk during an evacuation.
3. The Fire-Resilient Roadways study identifies the roads—particularly designated evacuation routes—likely to be compromised during a wildfire evacuation due to severe fire behavior. The literature review identified that "in most cases, evacuation is the safest option for residents even if the roadways used for evacuation are impacted by nearby fire or smoke;" however, "in extreme conditions … [factors] will affect residents' ability to completely avoid danger during evacuation." The objective of the Fire-Resilient Roadways project is to identify

[60] **https://assets-global.website-files.com/6107823cbe8db485b50aa8f8/6362c326bcc34a69b81cc941_MWPA%20Literature%20Review%20-%20FINAL.pdf**

road segments where residents are likely to be able to safely travel through the fire area, even during high-severity fire conditions. The results of this analysis include an **interactive mapping platform** that helps emergency managers identify areas of concern. Marin Wildfire has also established a strategic measure to track the percentage of resilient roadways in each of its administrative zones.

H.3 Evaluating Evacuation Difficulty

The Evacuation Difficulty study used a variety of publicly accessible geospatial datasets to evaluate, among other factors, road segments where road characteristics, such as pavement conditions, geometry, and congestion, may create bottlenecks or otherwise impede a safe evacuation. Additionally, California Assembly Bill 747 was enacted that established a structured, forward-looking framework for evacuation route planning and implementation. Fire Safe Marin, in collaboration with many Marin County fire agencies, cities, towns, and other partners developed and published wildfire evacuation routes and maps for WUI communities within Marin County. Evacuation routes include highways and local arterials, or major collectors as identified in the General Plan Circulation Element of each agency in the county, as well as any other major evacuation routes identified by fire or police chiefs responsible for evacuation management.

The evacuation difficulty study evaluated other components as well, including fire and fuels difficulty (fire behavior) and communication difficulty (demographics). These layers are excluded from the present analysis because newer analytical approaches have been developed and incorporated into the CWPP.

H.4 Road Conditions

The roadway evacuation difficulty score describes the risk to evacuation created by road conditions, design, and accessibility. The score accounts for road characteristics, the designated evacuation routes discussed above, road geometry, the number of structures served by each roadway, and near-road fire behavior. A low difficulty score indicates a roadway is less likely to experience bottlenecks or traffic delays during an evacuation. A high score indicates a roadway with a higher likelihood of congestion, reduced ingress/egress, low access to critical infrastructure, and/or extreme fire behavior during an evacuation. Variable risk factors, including fire behavior adjacent to the road, fire engine accessibility, and roadway conditions, can be more easily mitigated than fixed risk factors, such as slope, elevation, geometry, and number of intersections. These fixed risk factors require significant capital or resources to mitigate, if they can be addressed at all. Areas with high roadway evacuation difficulty should explore mitigation options such as fuel reduction along roadways and improved communication. **Figure H-1** lists roadway evacuation difficulty factors.

Fixed Risk Factors	Variable Risk Factors
Road Slope	Near-Road Flame Length
Road Elevation	High-Collison Roadways
Road Complexity	Key Evacuation Route Intersections
Number of Intersections	Fire Engine Accessibility
Main Evacuation Route	Roadway Condition
Structure Density	
Safe Locations	
Key Infrastructure	
Burn Probability	

Figure H-1. Roadway evacuation difficulty factors.

As shown in **Figure H-2**, the areas with the highest roadway difficulty scores include parts of central and southern Marin County. The zone with the highest roadway difficulty score is the Four Corners area in southern Marin County. This zone has a very high fixed difficulty, as well as high variable difficulty. Other vulnerable areas include the Summit area of Mill Valley, the Greenhill area of southern Marin County, and the Wiltshire area of Corte Madera. Parts of Stinson Beach and Bolinas also score highly in roadway difficulty. **Table H-1** lists the top 15 evacuation zones with the highest roadway difficulty scores.

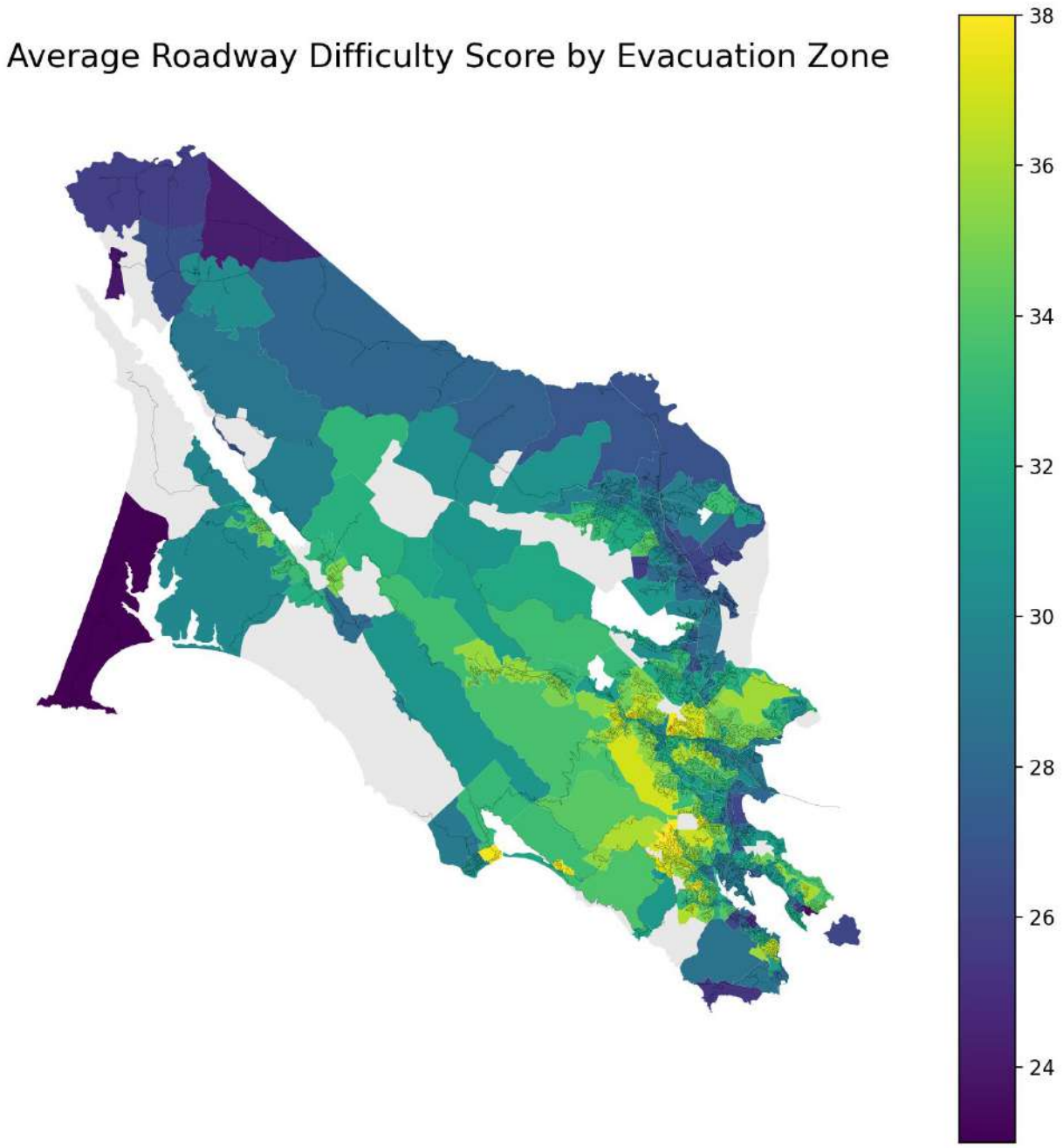


Figure H-2. Roadway difficulty score by evacuation zone. Areas in light grey correspond to regions with insufficient data for aggregation.

Table H-1. Top 15 evacuation zones with the highest roadway difficulty scores.

Zone ID	Evacuation Zone Name	Road Difficulty: Overall	Road Difficulty: Fixed Component	Road Difficulty: Variable Component	Distance to Safety (m)	Road Slope (deg)	Road Curve	Intersection Difficulty
US-CA-XMR-SOM-E078	Four Corners	42.8	25.6	17.2	5635.2	4.3	1.2	24.0
US-CA-XMR-COR-E005	Marina Vista/Wiltshire	38.0	25.9	12.1	1521.3	9.0	1.3	2.9
US-CA-XMR-MIL-E017	Summit (Upper)	37.9	24.6	13.3	3385.7	6.3	1.5	7.2
US-CA-XMR-SOM-E077	Greenhill	37.9	26.3	11.6	5482.2	6.5	1.2	6.0
US-CA-XMR-SNR-E517	Racquet Club/ Mt. Tam	37.8	27.2	10.5	234.6	6.9	1.1	2.7
US-CA-XMR-MRN-E131		37.8	25.5	12.3	3374.0	8.0	1.3	14.5
US-CA-XMR-MIL-E024	Summit (Lower)	37.7	24.5	13.3	3702.3	8.1	1.3	8.8
US-CA-XMR-MRN-E031		37.7	26.6	11.2	778.2	4.5	1.3	5.6
US-CA-XMR-SAN-E008	Sequoia/Forbes	37.7	26.1	11.6	562.8	7.5	1.2	6.1
US-CA-XMR-FAI-E011	Taylor/Willow	37.6	23.8	13.8	3242.7	7.2	1.3	25.0
US-CA-XMR-MRN-E034	Hill/Highlands & Panoramic	37.5	25.3	12.1	341.2	6.8	1.1	23.8
US-CA-XMR-MRN-E132	Throckmorton Ridge	37.1	25.0	12.1	5140.2	9.5	1.2	5.1
US-CA-XMR-MIL-E003	Cascade	37.1	23.7	13.4	4174.2	8.2	1.2	6.5
US-CA-XMR-MIL-E007	Edgewood (Upper)	37.1	22.9	14.2	4403.8	5.7	1.5	10.3
US-CA-XMR-SNR-E518	Fairhills	37.1	25.9	11.2	644.3	6.6	1.2	4.0

H.5 Fire-Resilient Roadways

A complementary assessment of Marin County's roads' capacity to facilitate safe evacuation during a fire is the Fire-Resilient Roadway analysis. This study[61] assesses the evacuation safety of Marin County roads by estimating whether evacuees will be exposed to hazardous levels of radiant and convective heat during peak fire conditions.

Roadway resilience is defined as the ability of a road segment to facilitate safe evacuation without subjecting vehicle occupants to unsafe or dangerous heating. Segments that do not support safe evacuation can be mitigated through targeted roadside vegetation management or incorporated into comprehensive evacuation planning strategies, such as the designation of TFRAs and the development of alternative routing protocols.

Definition: Fire-Resilient Roadway – Road segments that are projected to support an average heating rate of less than 3°F/minute for a modern passenger vehicle during a high-severity wildfire event. 3°F/minute was chosen to reflect the safe limit for brief exposure among vulnerable populations, such as children and the elderly.

This study uses fire behavior analysis to project the heat output of wildland vegetation under high-severity wind and weather conditions. It then uses thermodynamic principles to estimate the heat received by a hypothetical vehicle traveling along each segment of road in Marin County. Finally, assumptions about the model, age, and size of a hypothetical car are used to estimate the rate of cabin temperature increase. Road segments projected to heat by less than 3°F/minute are considered resilient; even under peak fire conditions, passengers inside the vehicle are likely to remain safe from the heat. On roadways where the projected heating rate exceeds this threshold, passengers, particularly children and the elderly, may experience health risks, especially when exposed for sustained periods of time.

As shown in **Table H-2**, west Marin County has the greatest concentration of roadways that do not meet the fire-resilient threshold. Only 81.4% of the designated evacuation route miles in west Marin County meet this threshold. On the other hand, 93 percent of the evacuation route miles in Novato and San Rafael meet the resilient standard.

[61] Willow Labs. More details: **https://docs.google.com/document/d/1I-SnAh95gzfuRCn5-3nfGKOxd5mUDavIjjX72aXzwdg/edit?tab=t.0**

Table H-2. Percentage of resilient roadways in each MWPA zone.

Region	Percent of Evacuation Route Miles Meeting the Resilience Threshold
West Marin	81.4
Central Marin	91.5
San Rafael	93.1
Southern Marin	87.3
Novato	93.0

Figure H-3 shows the percentage of each evacuation zone's designated evacuation route road miles that meet the fire-resilient roadway criteria. The areas with the greatest vulnerabilities are East Peak (18.6 km), Point Reyes (25.8 km), Southern Paradise Drive (3.7 km), and McNear's Beach (3 km). Table H-3 provides the percentage of designated evacuation road miles meeting the 3°F/minute fire resilience threshold in each Zone ID.

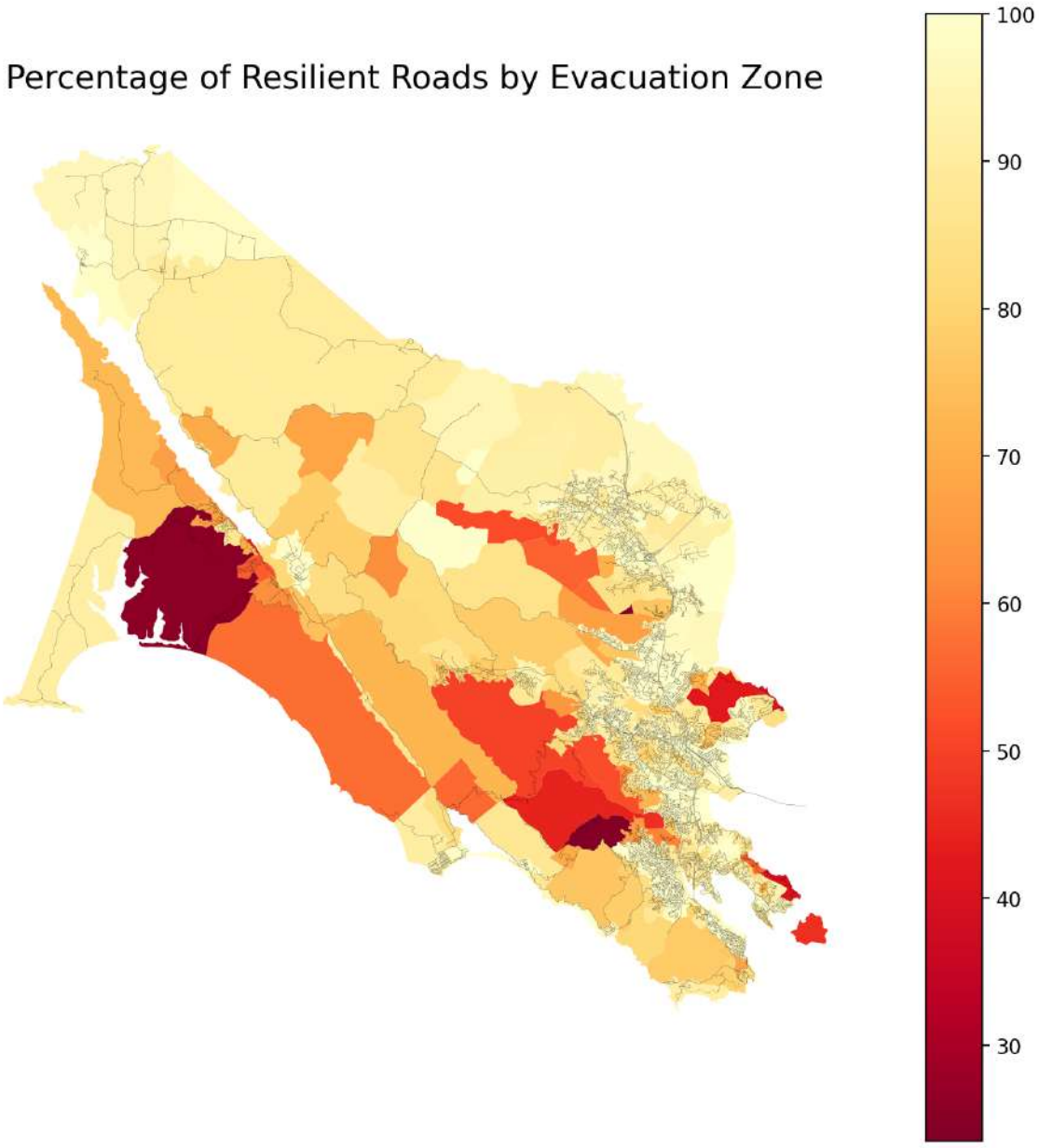


Figure H-3. Percentage of designated evacuation road miles meeting the 3°F/minute fire resilience threshold.

Table H-3. Percentage of designated evacuation road miles meeting the 3°F/minute fire resilience threshold.

Zone ID	Zone Name	Resilient Road Length (m)	NonResilient Length (m)	Total Length (m)	Resilient Roadway Percentage	Non-Resilient Roadway Percentage
US-CA-XMR-MRN-E150		456	1,485	1,941	23.5	76.5
US-CA-XMR-MRN-E093	East Peak	5,929	18,645	24,575	24.1	75.9
US-CA-XMR-MRN-E105		8,895	25,832	34,727	25.6	74.4
US-CA-XMR-TIB-E004	Southern Paradise Dr.	2,524	3,792	6,316	40.0	60.0
US-CA-XMR-SNR-E556	McNear's Beach	2,069	3,014	5,083	40.7	59.3
US-CA-XMR-SNR-E557	China Camp/Open Space	8,352	11,356	19,708	42.4	57.6
US-CA-XMR-MRN-E028		682	916	1,598	42.7	57.3
US-CA-XMR-MRN-E096	Watershed South	15,262	19,283	34,545	44.2	55.8
US-CA-XMR-LAR-E016	Blithedale Summit	2,983	3,424	6,406	46.6	53.4
US-CA-XMR-TIB-E006	Angel Island	4,313	4,930	9,243	46.7	53.3
US-CA-XMR-MRN-E120	Watershed North	38,726	38,897	77,624	49.9	50.1
US-CA-XMR-MRN-E103		960	900	1,859	51.6	48.4
US-CA-XMR-MRN-E100	Phoenix Lake	14,682	13,494	28,176	52.1	47.9
US-CA-XMR-MRN-E019		7,960	6,637	14,596	54.5	45.5
US-CA-XMR-MRN-E131		6,962	5,648	12,609	55.2	44.8

Figure H-4 shows the evacuation routes with the greatest vulnerabilities. Paradise Drive, Muir Woods Road, Bear Valley Road, Panoramic Highway, Marshall-Petaluma Road, Bolinas Road, Lucas Valley Road, and Sir Francis Drake Boulevard all have more than 1 km of vulnerable segments. Other major evacuation routes, including Trestle Glen Boulevard, D Street, and Monte Mar Drive, have shorter segments of vulnerability.

Communities that rely on major evacuation routes that lack fire resilience should:

- Ensure that residents are prepared to leave quickly and that communication and alerting will enable residents to leave before fire impacts the evacuation routes
- Consider targeted vegetation management along roadways, focusing on areas where fire resilience is lacking
- Consider temporary staging areas and phased evacuation to limit residents evacuating on non-resilient roadways during peak fire conditions
- Implement additional traffic management strategies to limit evacuation on non-fire resilient roadways during peak fire conditions.

Table H-4 shows the fire-resilience percentage for designated evacuation routes in Marin County.

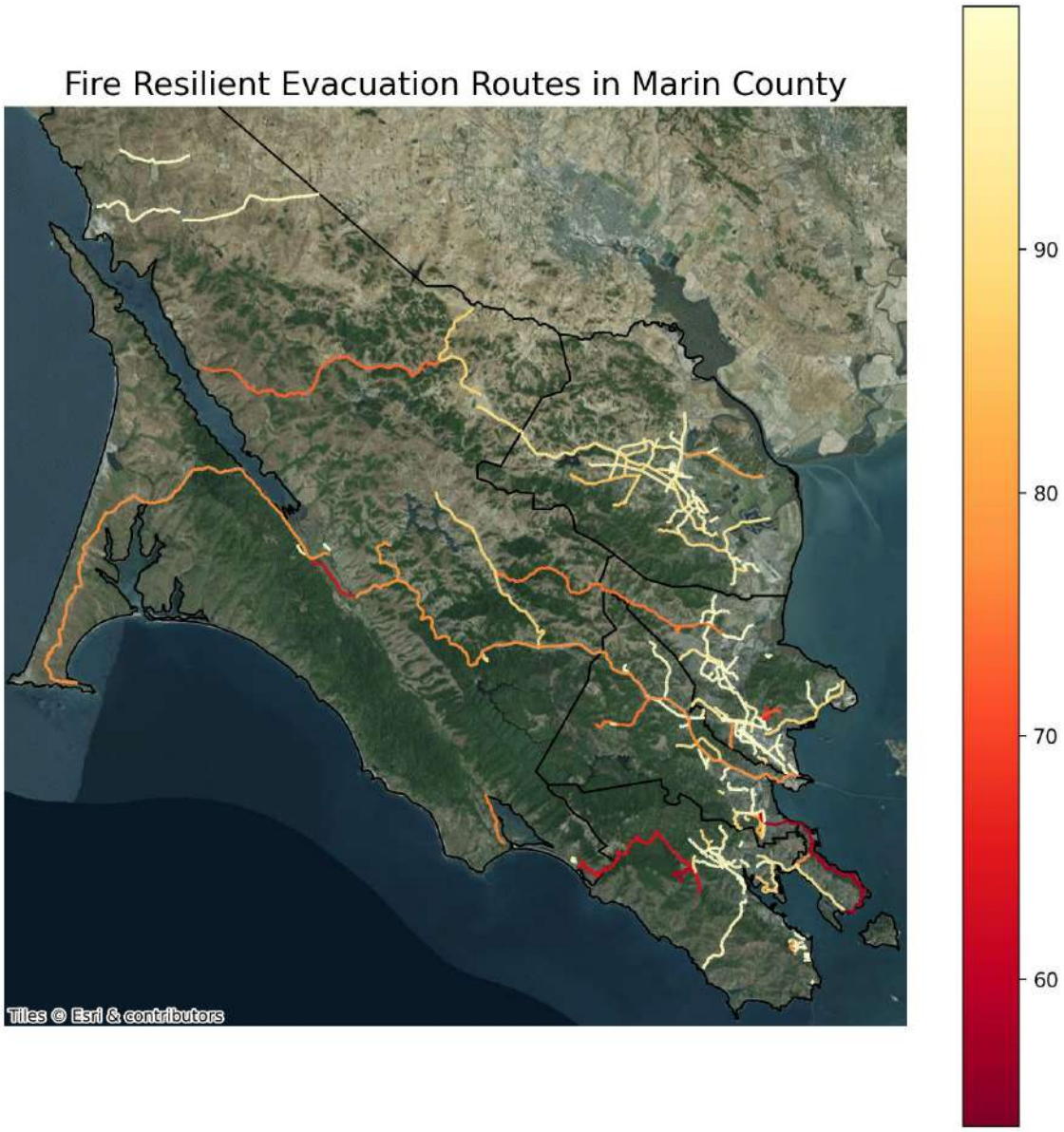


Figure H-4. Evacuation routes symbolized by the proportion of roadway meeting the 3°F/minute resilience threshold.

Table H-4. Fire-resilience percentage for designated evacuation routes in Marin County.

Street Name	Evacuation Route Designation	Resilient Length (m)	Non-Resilient Length (m)	Total Length (m)	Resilient Percentage	Non-Resilient Percentage
Sanford Street	Minor	30	26	56	54.0	46.4
Paradise Drive	Major	8,430	6,326	14,757	57.1	42.9
Muir Woods Road	Minor	1,783	1,226	3,009	59.2	40.8
Panoramic Highway	Major	9,583	5,514	15,097	63.5	36.5
Bear Valley Road	Major	2,334	1,331	3,665	63.7	36.3
Deer Park Avenue	Minor	951	462	1,413	67.3	32.7
Highland Avenue	Minor	1,337	523	1,859	71.9	28.1
Marshall Petaluma Road	Major	13,061	4,734	17,795	73.4	26.6
Bolinas Road	Major	3,528	1,191	4,719	74.8	25.2
Lucas Valley Road	Major	13,582	4,440	18,022	75.4	24.6
Olema Bolinas Road	Minor	2,708	859	3,567	75.9	24.1
Trestle Glen Boulevard	Major	758	226	984	77.0	23.0
D Street	Major	1,355	401	1,755	77.2	22.8
Sir Francis Drake Boulevard	Major	54,054	15,249	69,303	78.0	22.0
Monte Mar Drive	Major	998	268	1,266	78.8	21.2

Appendix I. Marin County Fire Response Assessment

I.1 Executive Summary

This analysis examines the fire response times to communities in Marin County from in-county fire agencies and out-of-county mutual aid. Network analysis is used to evaluate the response time to every structure in Marin County. This analysis helps to illustrate areas where fire-suppression capabilities are most robust and also identify areas where fire resources may be delayed in relation to the fire spread. Areas of thin fire response may be candidates for additional home hardening, defensible space, and vegetation management efforts that can slow fire growth and provide more time to aggregate a sufficient firefighting response.

Key Findings

- On average, fire responders can reach structures in Marin County within 4 minutes of travel time. The 90th percentile travel time is 6.2 minutes.
- Most agencies in the county can reach more than 99% of structures within 10 minutes of travel time. Fire service in unincorporated Marin County reaches fewer structures at this interval (approximately 74%) due to the distributed and rural nature of the district.
- On average, 1.2 different fire stations are capable of reaching every structure in Marin within 5 minutes. Approximately 10 different stations can reach every structure within 15 minutes of travel time.
- The least-accessible areas of the county include Dillon Beach, much of the area on the northern Marin County boundary, and parts of Lagunitas.
- The ratio of fire responses to structures (RS) highlights areas where fire response is likely to be thin compared to the scale of the built environment during a major wildland fire. Districts with the lowest RS include Bolinas, Inverness, and Belvedere. Parts of Novato also have relatively low RS.
- Marin County is well covered by regional aerial firefighting resources. In addition to hosting an exclusive-use firefighting helicopter in Novato, two Firehawk helicopters capable of nighttime operations, two C-130 large air tankers, and nearly a dozen S-2T air tankers are located within about 30 minutes of Marin County.

Key Recommendations

- Prioritize additional fire mitigation activities in areas where fire response with low RS ratios, where there may be fewer firefighters than structures needing defense. Additional home hardening, defensible space, vegetation management, and evacuation initiatives in these areas can slow fire growth and resist transition into the built environment while providing additional time for firefighters to arrive to perform offensive and defensive actions.
- Strive for interoperability and coordination between in-county and out-of-county mutual aid resources. No agency in Marin County is capable of preventing large-scale structure loss alone. Automatic aid and mutual aid resources are important in preventing large-consequence fires in Marin County. Prioritizing initiatives that ensure smooth communication and practicing inter-agency operational tactics and strategies will maximize the effectiveness of mutual aid.

I.2 Introduction

Fire response is an important element of fire preparedness. A timely fire response can ensure that fire personnel and equipment are available to perform offensive and defensive fire suppression actions before the fire becomes large or established within the built environment. Firefighters are highly effective at containing and controlling wildfire spread. Nationally, initial attack efforts control more than 99% of fires at less than one acre in size[62]. Early detection and rapid response is vital to limiting fire growth during high-severity fire conditions. Moreover, detailed post-fire reconstructions indicate that the majority of structures destroyed during a wildfire are undefended by firefighters[63]. When a fire is poised to transition into the built environment, firefighting actions, including firing operations, structure defense, and direct line construction, can be highly effective at reducing structure loss and preventing catastrophic fire spread.

This assessment uses a network analysis to address the following research questions:

1. How long will it take for firefighters to arrive at a fire in different parts of Marin County?
2. Which areas of the county can quickly aggregate many firefighting resources? Which areas take a long time to assemble these resources?
3. Which areas are likely to quickly assemble an adequate amount of resources compared to the housing density? Conversely, which areas are likely to have more assets to protect than firefighters at the early stages of an incident?
4. In what ways are out-of-county responders particularly important in controlling fire spread and protecting structures?

[62] Dale, L. A., & Barrett, K. (2023). Missing the mark: Effectiveness and funding in community wildfire risk reduction.
[63] Maranghides, Alexander, and William Mell. "A case study of a community affected by the Witch and Guejito wildland fires." *Fire Technology* 47.2 (2011): 379-420.

The locations of fire stations were obtained from the official Marin County GIS dataset.[64] In total, 43 fire station locations were retained for analysis. Fire facilities without apparatus staffing were removed (e.g., Mount Tam Fire Lookout). Public roads were obtained from OpenStreetMap.[65] Travel speeds were assigned to each segment based on the mapped speed limit (if available) or the road type classification. Travel times were computed by evaluating each segment's length and speed. Dijkstra's algorithm was used to evaluate the shortest response time from each fire station to each building in Marin County. Approximately 113,000 building footprints were included in the analysis. Not all buildings were accessible by road; 3,318 buildings were excluded.

Figure I-1 illustrates the fire response time assessment for a structure in Novato. Nearby stations can send resources within 10 minutes. While other stations may also send resources, they may not arrive until half an hour or more after they are dispatched.

[64] **https://gisopendata.marincounty.gov/datasets/ede237acbaed478989b69527300a5973_0/explore?location=38.039736%2C-122.683021%2C11.45**. Accessed July 18, 2025.
[65] **https://www.openstreetmap.org**. Accessed July 18, 2025.

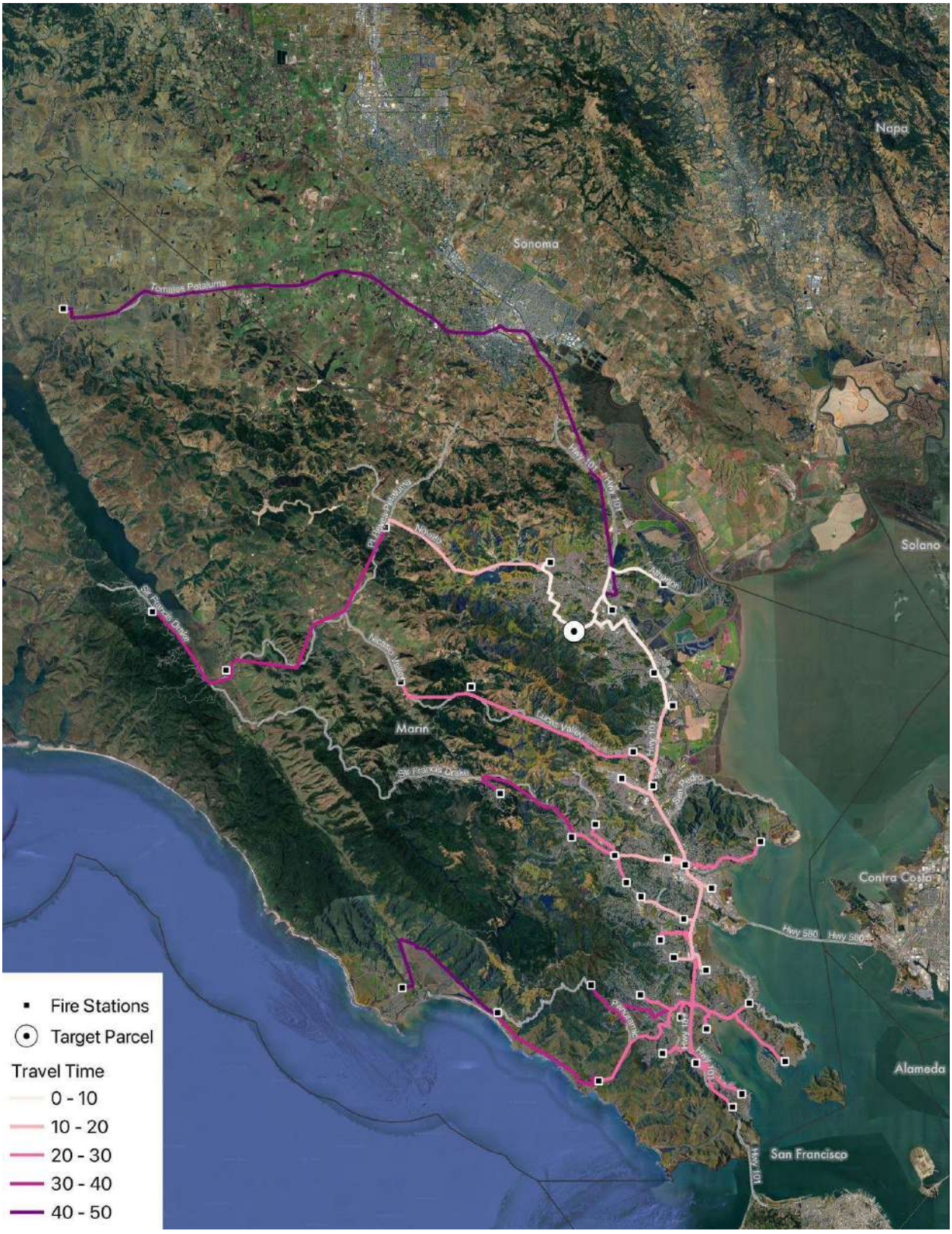


Figure I-1. Fire response from each fire station (square) to a target structure in Novato (circle).

This analysis has several limitations:

1. Turnout time is not included. This analysis therefore underestimates the total response time because firefighters require time to access their apparatus and depart from the station. Data from Southern Marin indicate that most fire and EMS calls have turnout times of less than 2 minutes and 28 seconds (2025).
2. Firefighters and apparatus may not be available at each station. Firefighters may be out of the station working other calls or performing other tasks. This situation may increase or decrease the response time depending on the firefighters' location at the time of dispatch.
3. This analysis does not consider traffic originating from evacuating residents. Additional characteristics of the roadway, such as red lights, turns, and pavement conditions, are also not considered.
4. Multiple apparatuses may be located in a single station; however, this analysis only assesses the response time from the station location to the target building. Cross-staffing and multiple resource deployment are not included in this assessment.
5. This analysis focuses on the response time to buildings, not to each location on the landscape. Depending on access, topography, and fire conditions, engaging the fire in the wildland may take much longer than the time to drive to the nearest building.

Southern Marin Fire Protection District makes several metrics available that help to ground-truth the travel time analysis. In particular, this district publishes 90th percentile travel time statistics from each of its five fire stations on a monthly basis. Comparison against the 2025 year-to-date statistics suggests that this study underestimates actual 90th percentile travel time by about 90 seconds. Approximately 50% of the reporting units (census block groups) exhibited actual 90th percentile response times within 60 seconds of the modeled values. Reasons for this variability include (a) actual call location skews the percentile distribution away from parcels near fire stations, (b) variability in unit dispatching and response areas results, and (c) traffic, difficult-to-navigate roads, and other differences in travel speed compared with those modeled.

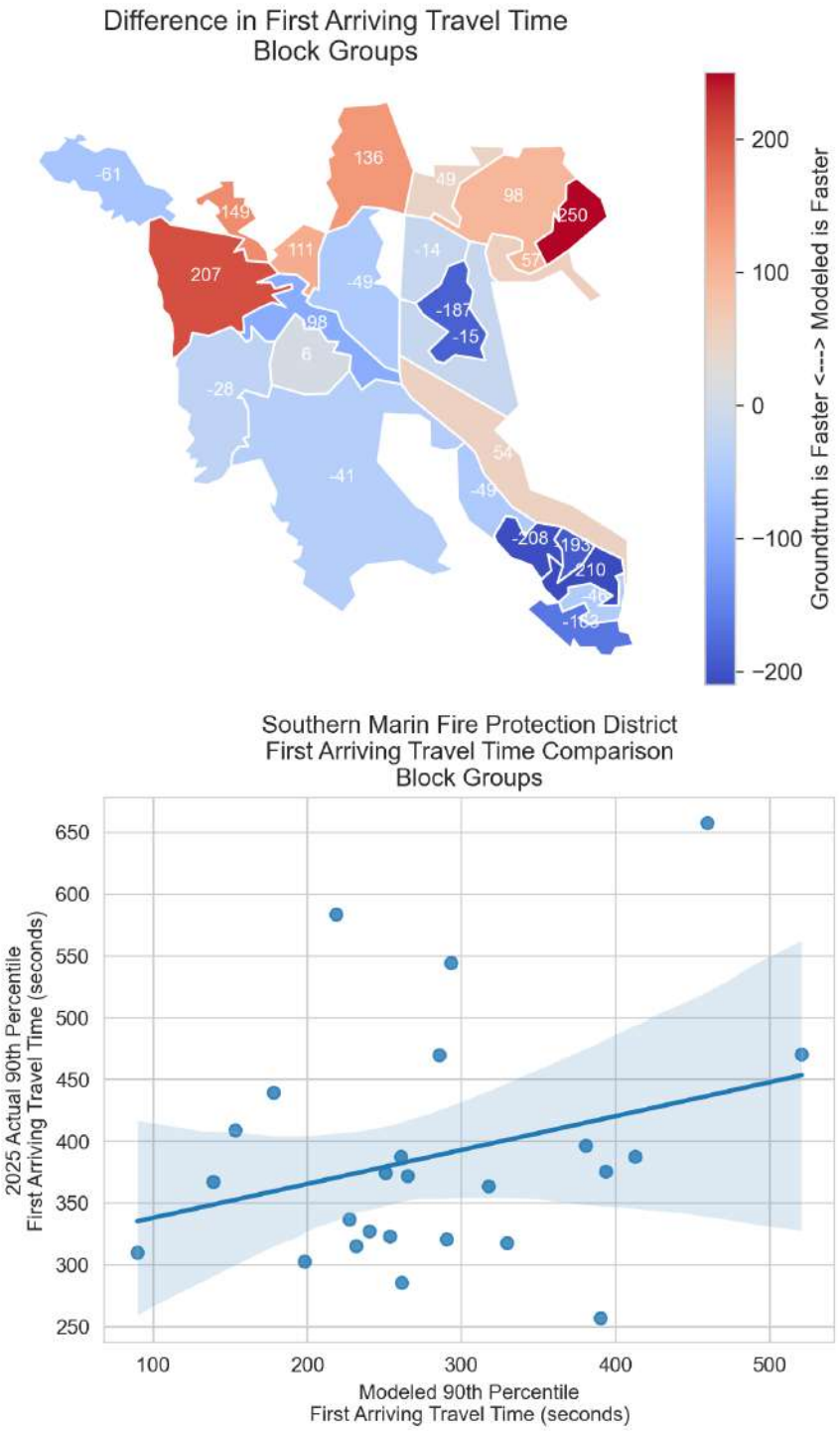


Figure I-2. Comparison with Southern Marin 2025 actual travel time data. Points represent the 90th percentile response time for the first arriving unit within each block group in Southern Marin Fire Protection District's jurisdiction. Calls include medical and fire calls.

I.3 Results and Discussion

Response Time

The average response time from the closest fire station to each building in Marin County is about 4 minutes. While more than 75% of structures can be reached within 4.4 minutes of travel time, some parcels take more than 10 minutes to reach. Firefighters can reach more than 90% of structures within 6.2 minutes of travel time. **Table I-1** provides statistics for fire response travel time across Marin County.

Table I-1. Descriptive statistics for fire response travel time across Marin County.

Statistic	Fastest Arrival Time (minutes)
Mean	3.7
25th Percentile	2.0
Median	3.1
75th Percentile	4.4
90th Percentile	6.2
95th Percentile	8.3
99th Percentile	17.1

As shown in **Figure I-3**, the vast majority of buildings are highly accessible to responding fire resources. Some parcels, particularly those located in west Marin, take much longer to reach, with a small fraction taking 20 minutes or more to reach.

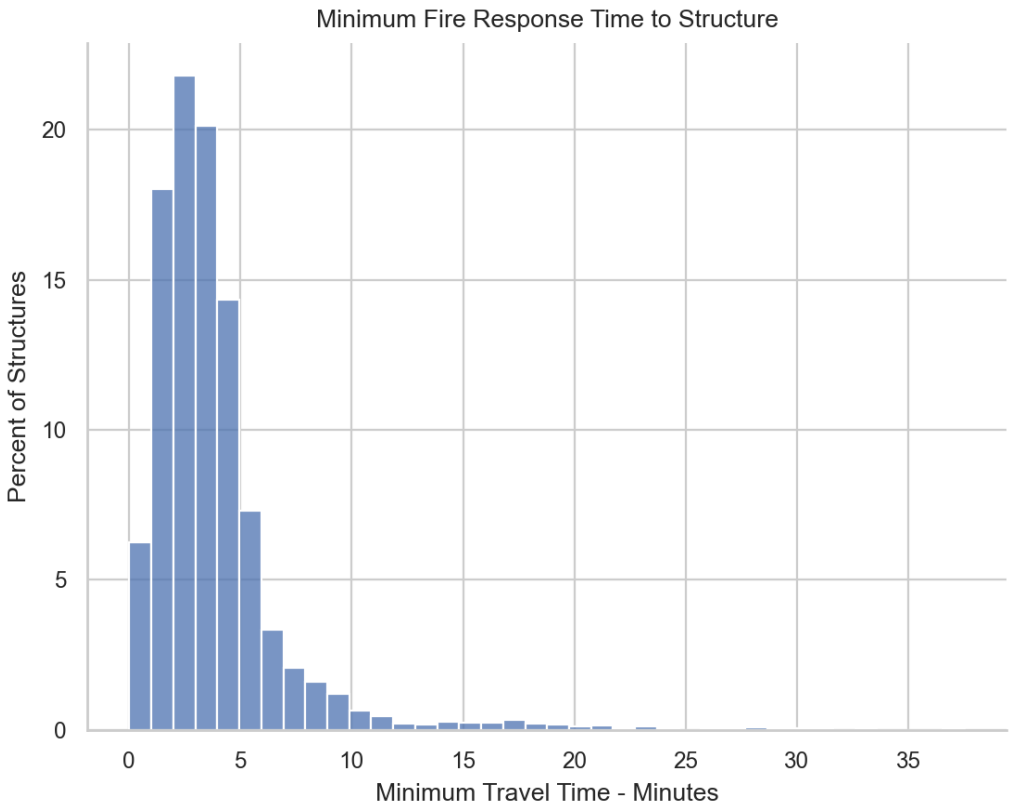


Figure I-3. Distribution of fire response travel times across Marin County.

Table I-2 shows the modeled response travel time statistics for each fire agency in Marin County. This table shows the percentage of structures reachable within 2:30, 5:00, 7:30, 10:00, and 15:00, as well as the average first response time within the agency's geographic area. Automatic mutual aid is assumed; areas on the edge of agency's borders may be serviced by an adjacent agency. Most agencies can reach 100% of structures within 10 minutes of travel time. Tiburon, Novato, and County Fire (CSA 19 - Los Ranchitos and Santa Venetia) can reach 98% or more of the structures within this interval. Within County Fire CSA 31 (Unincorporated Marin), only 74% of structures are reachable within 10 minutes, and about 87% are reachable within 15 minutes of travel time.

Table I-2. Response travel time statistics for fire agencies in Marin County, showing the percentage of reachable parcels within different thresholds and the average initial response time within the agency's geographic area.

Label	Reachable within					Average First Response Travel Time (Minutes)
	2:30	5:00	7:30	10:00	15:00	
Belvedere Fire Department	27.2%	91.9%	100.0%	100.0%	100.0%	3.3
Bolinas Fire Protection District	29.9%	88.0%	99.8%	100.0%	100.0%	3.3
Central Marin Fire Department	67.9%	98.6%	100.0%	100.0%	100.0%	2.1
County Fire (CSA 13) - Lucas Valley	1.4%	91.9%	100.0%	100.0%	100.0%	3.9
County Fire (CSA 19) - Santa Veneta and Los Ranchitos	5.8%	33.1%	67.3%	98.0%	100.0%	6.2
County Fire (CSA 31) - Unincorporated Marin	25.7%	49.1%	62.7%	73.6%	86.9%	7.3
Inverness Public Utility District	42.6%	81.4%	100.0%	100.0%	100.0%	3.1
Kentfield Fire Protection District	55.4%	90.3%	100.0%	100.0%	100.0%	2.5
Marinwood Community Services District	41.3%	88.6%	100.0%	100.0%	100.0%	3.1
Mill Valley Fire Department	39.5%	90.4%	99.6%	100.0%	100.0%	3.0
Novato Fire Protection District	18.6%	73.4%	92.8%	98.9%	99.8%	4.2
Ross Fire Department	67.6%	98.1%	100.0%	100.0%	100.0%	2.2
Ross Valley Fire Department	61.5%	98.2%	100.0%	100.0%	100.0%	2.3
San Rafael Fire Department	38.2%	90.8%	99.9%	100.0%	100.0%	3.1

Label	Reachable within					Average First Response Travel Time (Minutes)
	2:30	5:00	7:30	10:00	15:00	
Sleepy Hollow Fire Protection District	3.2%	40.6%	86.0%	100.0%	100.0%	5.5
Southern Marin Fire Protection District	35.3%	94.4%	100.0%	100.0%	100.0%	3.0
Stinson Beach Fire Protection District	87.8%	100.0%	100.0%	100.0%	100.0%	1.5
Tiburon Fire Protection District	27.8%	87.6%	98.5%	99.5%	100.0%	3.5

Figure I-4 shows a map of the time needed to reach 90% of the structures within each evacuation zone. Evacuation zones are used to highlight the interplay between fire response and evacuation and to create discrete planning units for prioritization when response may be delayed.

Note that mutual aid resources may service some of the areas adjacent to the Sonoma County boundary; however, due to the rural nature of these areas, all responses are likely to be delayed compared with those in central and southern Marin County and Novato.

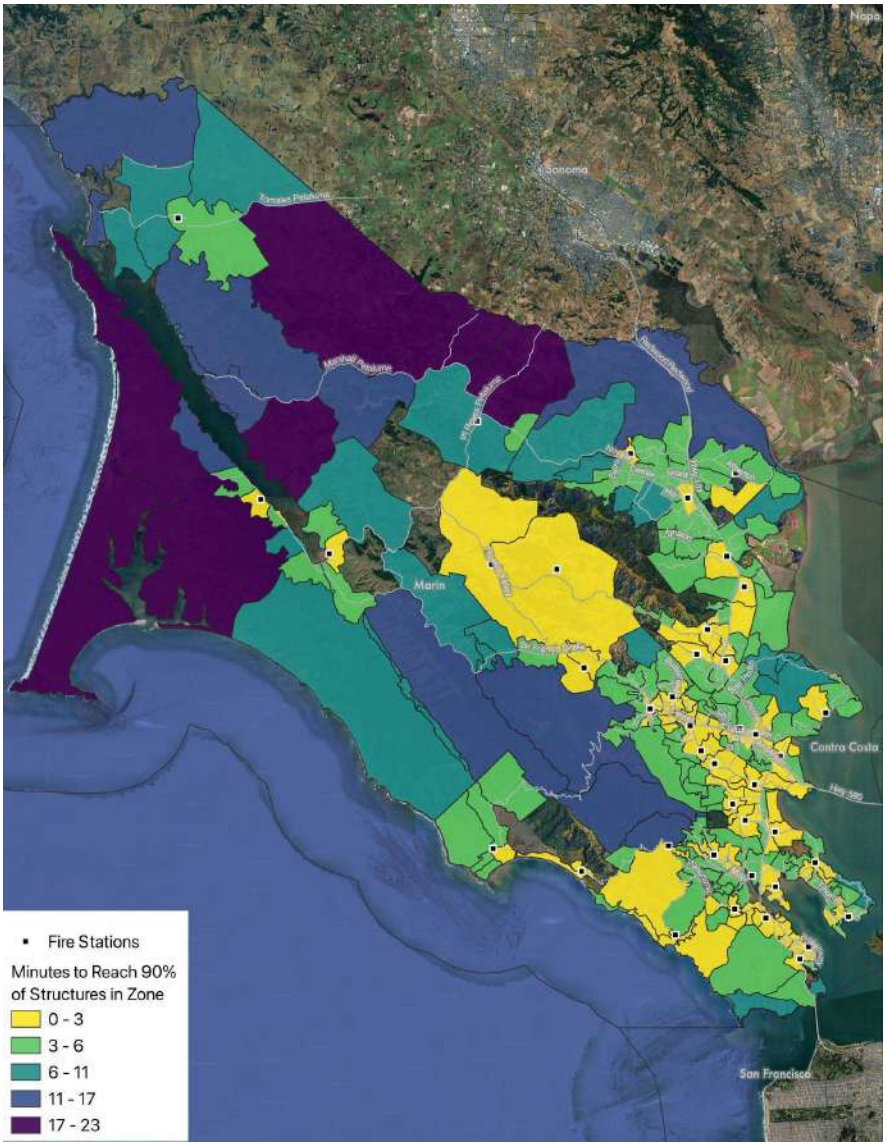


Figure I-4. Minutes to reach 90% of the structures within each evacuation zone.

Response Density

While the timing of the first responding engine is important, most wildland fires require many more resources and multiple mutual aid partners. In a significant wildland fire, the quantity and timing of arriving resources is often more important than the time it takes a single engine to travel to the scene. This section explores the timing of assembling a sufficient number of firefighting resources to engage in offensive and defensive actions in advance of a wildland fire. This section only evaluates within-county fire response density; out-of-county mutual aid is examined in the following sections.

Table I-3 lists the number of fire stations—a proxy for fire engines and personnel—within 5, 10, 15, and 30 minutes. The average parcel in Marin County is reachable by 1.2 stations within a 5-minute travel time. Within a 10-minute travel time, the average parcel is reachable by 4.6 stations. Due to the density of fire stations in populated areas in Marin County and the accessibility of many areas of the county, the average parcel can be reached by over 26 stations within a 30-minute travel time[66]. These metrics highlight the capability of numerous firefighters to reach the scene of a major wildland fire threatening the built environment in Marin County.

Table I-3. Number of fire resources within 5, 10, 15, and 30 minutes of travel time of the average parcel in Marin County.

Arrival Time	Number of Fire Stations within Threshold
Arrival within 5 minutes travel time	1.2
Arrival within 10 minutes travel time	4.6
Arrival within 15 minutes travel time	10.0
Arrival within 30 minutes travel time	26.4

Figure I-5 shows the average number of fire resources within a 10-minute travel time in each evacuation group. The pattern of resource density closely follows the population density. Parts of Corte Madera, San Rafael, and Larkspur are the most accessible in Marin County. These areas can be reached by more than 10 resources within 10 minutes of travel. Other populated areas, including Novato, Mill Valley, Tiburon, and much of the Ross Valley, can be reached by four to eight resources within that interval. In contrast, much of the northern and western areas of Marin County are reachable by only one or two resources within 10 minutes. While these areas are sparsely populated, this map highlights that a major wildland fire developing in these areas may be able to grow significantly before a sufficient firefighting response force is assembled.

[66] It is unlikely that all of these resources would be dispatched to even the most severe fire. Agencies would likely need to ensure minimum staffing requirements.

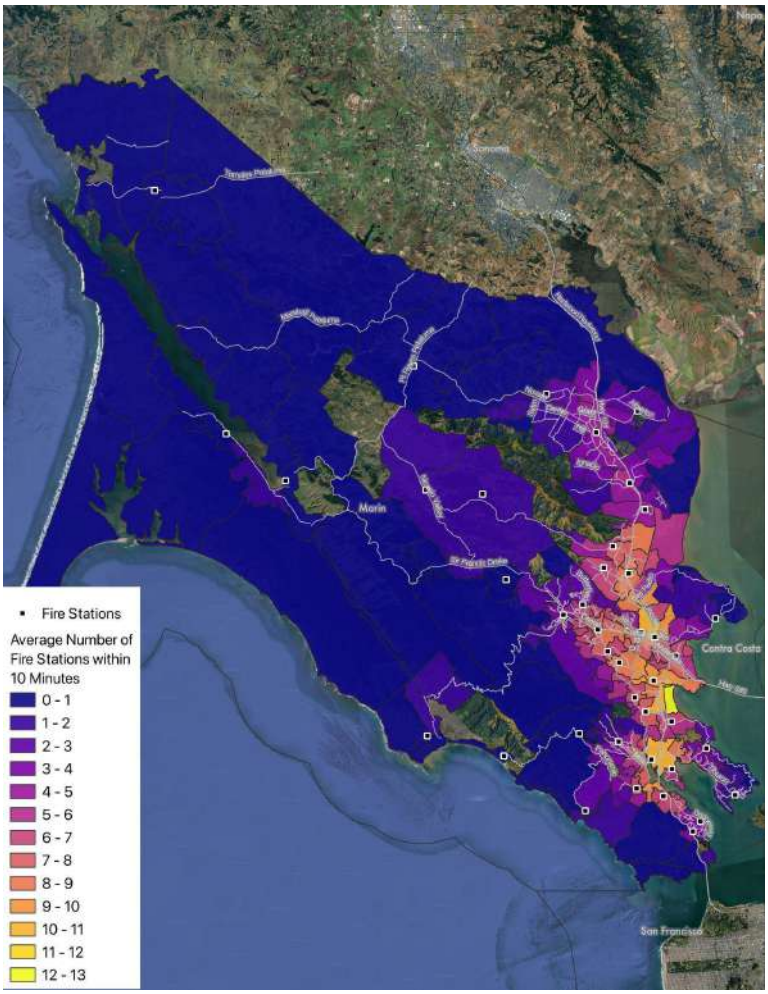


Figure I-5. Number of fire stations within 10 minutes of travel time. Polygons represent evacuation zones.

Figure I-6 further illustrates the relationship between population density and fire resource accessibility. Generally, there is a positive correlation between the number of people within each evacuation zone and the number of resources available to service that area. The most densely populated zone in Marin County is the **Canal/Pickleweed zone i**n San Rafael, with an estimated population density of about 50 people per acre. The most accessible zone is the **Dominican zone** in San Rafael, with over 12 potential responses within 10 minutes of travel time.

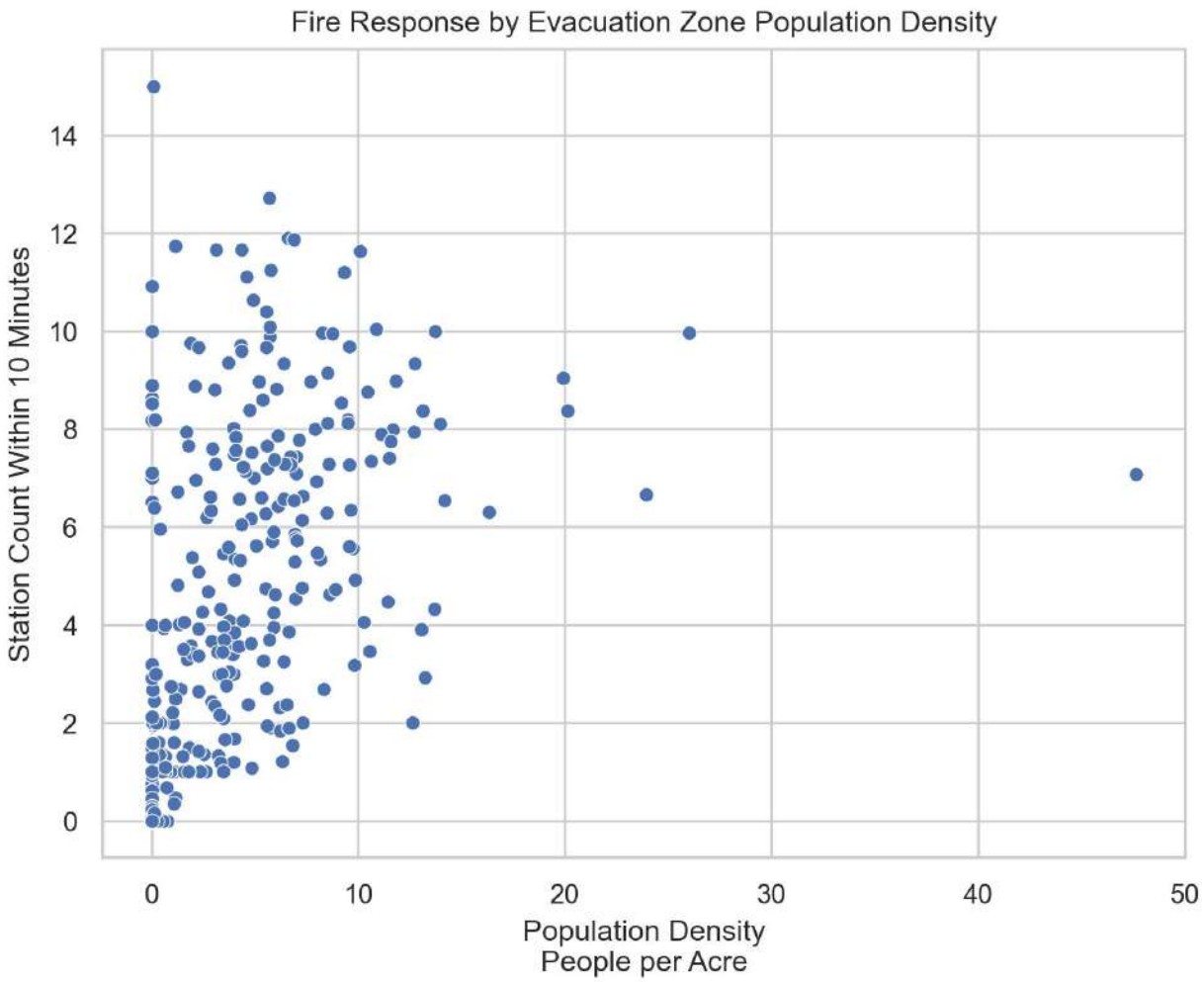


Figure I-6. Relationship between fire response density for a travel time of 10 minutes and evacuation zone estimated population.

Table I-4 provides a list of the 10 least accessible evacuation zones in Marin County. These zones have an estimated population of more than 100 residents but have very few adjacent fire resources. These zones include Dillon Beach, much of the area on the northern Marin County boundary, and parts of Lagunitas. Mutual aid response in the areas of the northern portions of the county is particularly important. Sonoma County resources may be able to more quickly respond to major wildland fires in northern Marin County.

Table I-4. Evacuation zones with the lowest response densities in Marin County. Only zones with an estimated population of more than 100 people are shown.

Zone ID	url	Building Count	Estimated Population	Average Stations Reachable within 5 Minutes	Average Stations Reachable within 10 Minutes	Average Stations Reachable within 30 Minutes	90th Percentile First Arrival Time (minutes)
US-CA-XMR-MRN-E068	https://protect.genasys.com/zones/US-CA-XMR-MRN-E068	700	508	0.0	0.0	1.0	18.8
US-CA-XMR-MRN-E118	https://protect.genasys.com/zones/US-CA-XMR-MRN-E118	465	419	0.0	0.0	0.9	30.6
US-CA-XMR-MRN-E018	https://protect.genasys.com/zones/US-CA-XMR-MRN-E018	152	149	0.0	0.1	1.0	24.2
US-CA-XMR-MRN-E066	https://protect.genasys.com/zones/US-CA-XMR-MRN-E066	236	261	0.0	0.2	11.1	11.4
US-CA-XMR-MRN-E055	https://protect.genasys.com/zones/US-CA-XMR-MRN-E055	110	140	0.1	0.3	1.0	15.4
US-CA-XMR-MRN-E089	https://protect.genasys.com/zones/US-CA-XMR-MRN-E089	154	132	0.0	0.3	11.1	12.0
US-CA-XMR-MRN-E114	https://protect.genasys.com/zones/US-CA-XMR-MRN-E114	413	623	0.0	0.6	11.8	11.5
US-CA-XMR-MRN-E064	https://protect.genasys.com/zones/US-CA-XMR-MRN-E064	109	218	0.2	0.7	4.8	29.6
US-CA-XMR-MRN-E083	https://protect.genasys.com/zones/US-CA-XMR-MRN-E083	386	385	0.0	0.9	12.0	9.8
US-CA-XMR-MRN-E021	https://protect.genasys.com/zones/US-CA-XMR-MRN-E021	72	201	0.0	0.9	9.2	10.0

Perhaps most importantly for evaluating the capabilities of the firefighting response to limit or prevent the spread of a wildland fire into the built environment is the ratio of firefighting resources to structures. When this ratio is high, there are many resources available to perform structure defense, ember patrol, and offensive firefighting actions. When this ratio is low, resources are spread thin and may not be sufficient to prevent fire from becoming established in the community.

Figure I-7 shows the ratio of fire response resources within 10 minutes of travel time to structure count within each evacuation zone (RS ratio at 10 minutes). Note that some densely populated areas of Marin County have relatively low ratios; these areas indicate an elevated possibility of vegetation to structure fire transition. For example, many of the evacuation zones in Novato are in the lowest 20% of RS ratios. While firefighters can quickly reach these areas, it will be difficult for in-county resources to aggregate a sufficient firefighting response to prevent fire transition in the dense neighborhoods in Novato.

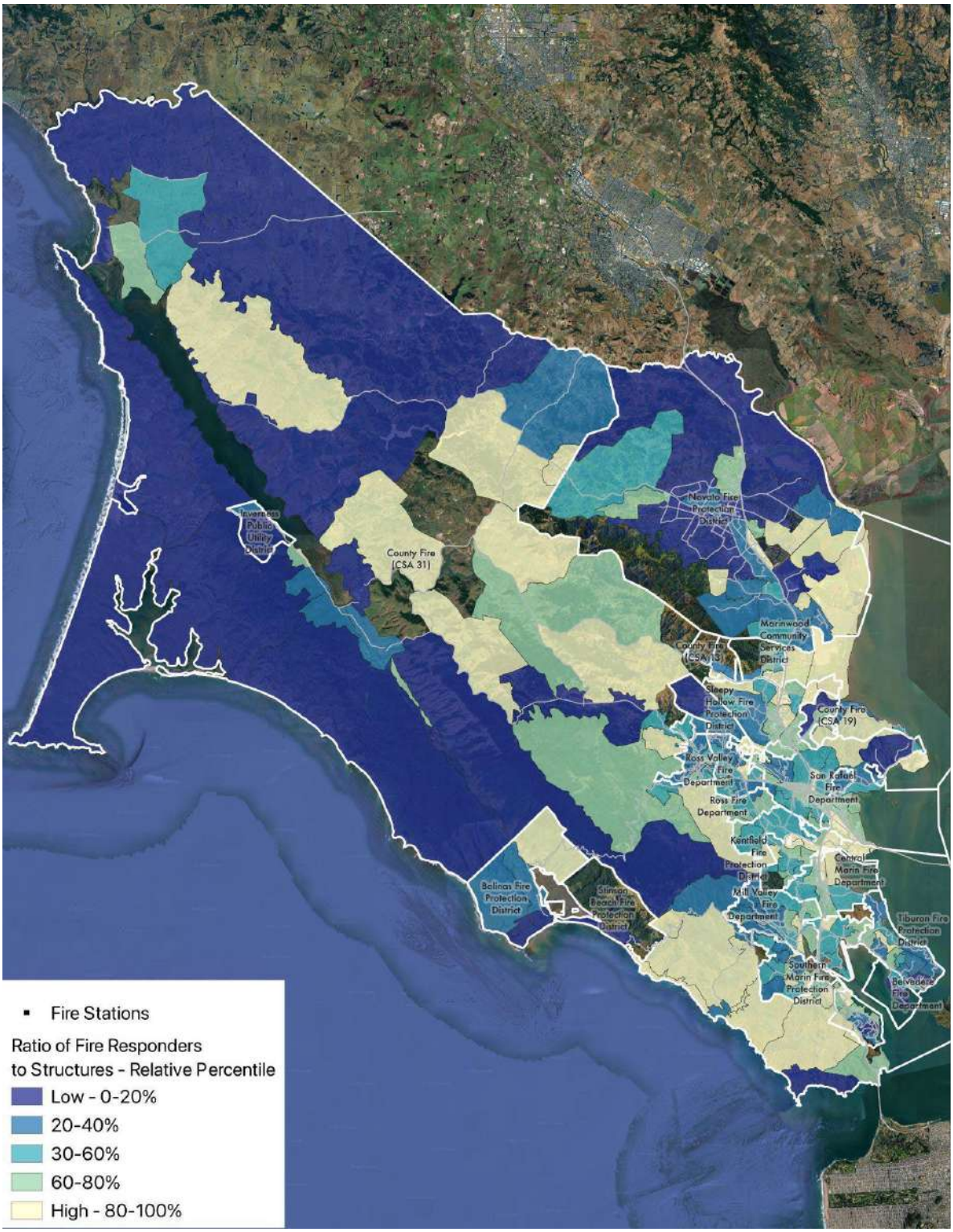


Figure I-7. Relative ratio of firefighters to structures. Low ratios (blue) indicate areas where resources may be insufficient to prevent fires from spreading into the built environment, resulting in large-scale structural loss.

Table I-5 lists density ratios for each fire agency in the county. This analysis assumes that automatic aid will be given from all agencies in the county. This work is not a commentary on the fire response capabilities of each agency; rather, it is an assessment of the areas of the county where initially responding resources may have difficulty preventing structure loss due to location and structure density.

Table I-5. Average response ratios for the fire agencies in Marin County. Higher ratios indicate more responders per structure.

Fire Service Provider	Structure Count	Reachable within 30 Minutes	Responders for Every 100 Structures at 30 Minutes
County Fire (CSA 13)	667	32.6	4.9
Ross Fire Department	1,384	33.4	2.4
Belvedere Fire Department	1,176	26.8	2.3
Sleepy Hollow Fire Protection District	1,401	25.9	1.9
Marinwood Community Services District	1,925	33.0	1.7
Kentfield Fire Protection District	3,065	33.6	1.1
County Fire (CSA 19)	3,552	33.4	0.9
Tiburon Fire Protection District	3,307	27.9	0.8
Stinson Beach Fire Protection District	1,177	7.9	0.7
Mill Valley Fire Department	6,359	32.0	0.5
Central Marin Fire Department	7,984	33.1	0.4
Ross Valley Fire Department	9,760	32.5	0.3
Southern Marin Fire Protection District	11,189	31.5	0.3
Inverness Public Utility District	923	2.5	0.3
San Rafael Fire Department	18,350	33.9	0.2
Bolinas Fire Protection District	1,959	3.3	0.2
Novato Fire Protection District	24,171	23.8	0.1
County Fire (CSA 31)	13,587	13.3	0.1

Adjacent-County Mutual Aid

During large, extended attack incidents in Marin County, firefighters from across the nation will respond within several days. However, recent WUI disaster fires have shown that the majority of the damage is likely to be wrought within a single operational period. Therefore, the capabilities of surrounding counties to quickly aid Marin County in a large fire are very important to preventing large-scale structure loss in Marin County.

This section examines the travel time required for mutual aid resources from outside Marin County to respond to various parts of the county. The Fire and EMS station inventory produced by FEMA's National Geospatial Data Asset (NGDA) program[67] provides a nationwide assessment of emergency response stations. The Mapbox isochrone API was used to assess the reachable area within 60 minutes of each evacuation zone in Marin County. This analysis is designed to be coarser than that in the preceding sections. Fire responders from other counties may take longer to arrive and may arrive with limited coordination compared with responders within the same county, who regularly train together and respond to incidents together. Out-of-county responders will also have longer turnout times due to the need for explicit requests for out-of-county resources rather than seamless automatic aid agreements. **Figure I-8** shows an example of identifying fire stations located within 60 minutes of driving time of the MRN-E055 evacuation zone.

[67] Federal Emergency Management Agency. (2025). Fire Stations & EMS Stations [Dataset]. FEMA Disaster Resilience Hub. Retrieved July 21, 2025, from **https://resilience-fema.hub.arcgis.com/datasets/fedmaps::fire-stations-ems-stations**

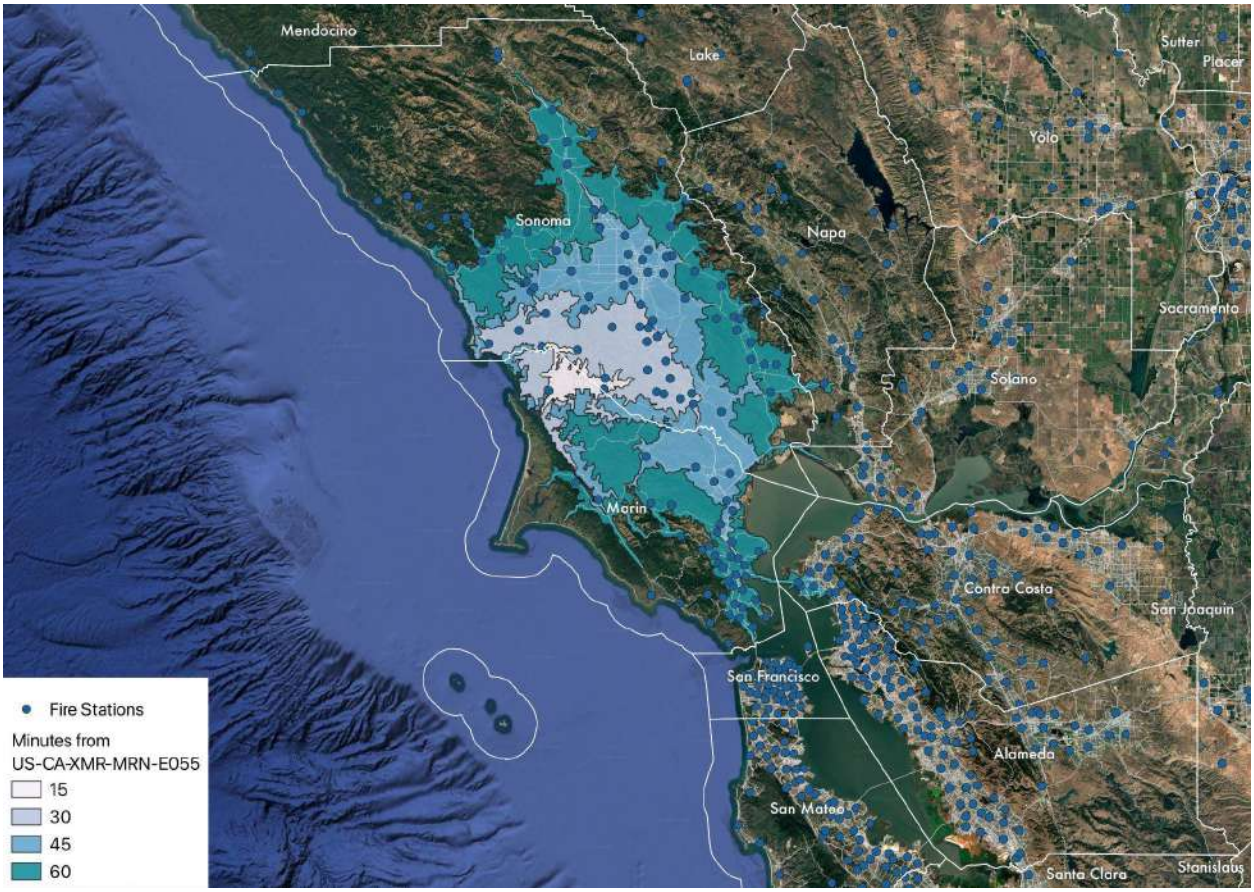


Figure I-8. Example of identifying fire stations located within 60 minutes of driving time of the MRN-E055 evacuation zone.

Figure I-9 shows the fire stations that are within 60 minutes driving time of at least one evacuation zone in Marin County. As tabulated in **Table I-6**, Alameda, Contra Costa, and Sonoma counties are capable of contributing the greatest number of responders within 60 minutes.

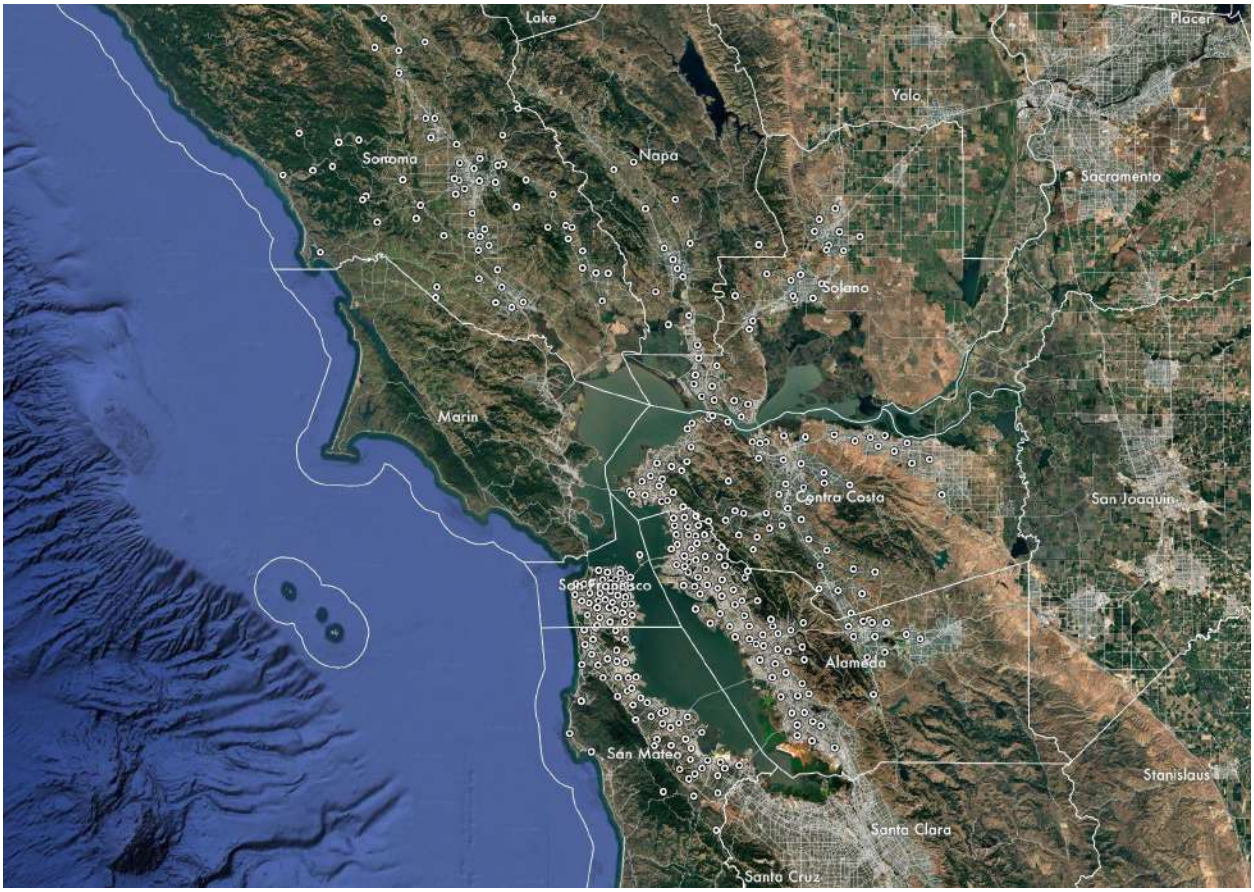


Figure I-9. Fire stations located within 60 minutes of driving time of at least one evacuation zone in Marin County.

Table I-6. Number of fire stations in each county capable of responding to an incident in Marin County within 60 minutes of driving time.

County	Response Stations within 60 Minutes
Alameda	88
Contra Costa	70
Sonoma	64
San Mateo	54
San Francisco	45
Solano	28
Napa	14

Figure I-10 shows the density of fire stations in adjacent counties that could respond to a fire within 60 minutes. In many parts of central Marin, close to 300 fire resources could arrive in less than 60 minutes of travel time. In areas along the Sonoma County border, adjacent county mutual aid plays an important role in the initial fire response. Within 30 minutes, Sonoma County could mobilize additional resources to rural parts of western Marin County where the in-county response may be thin.

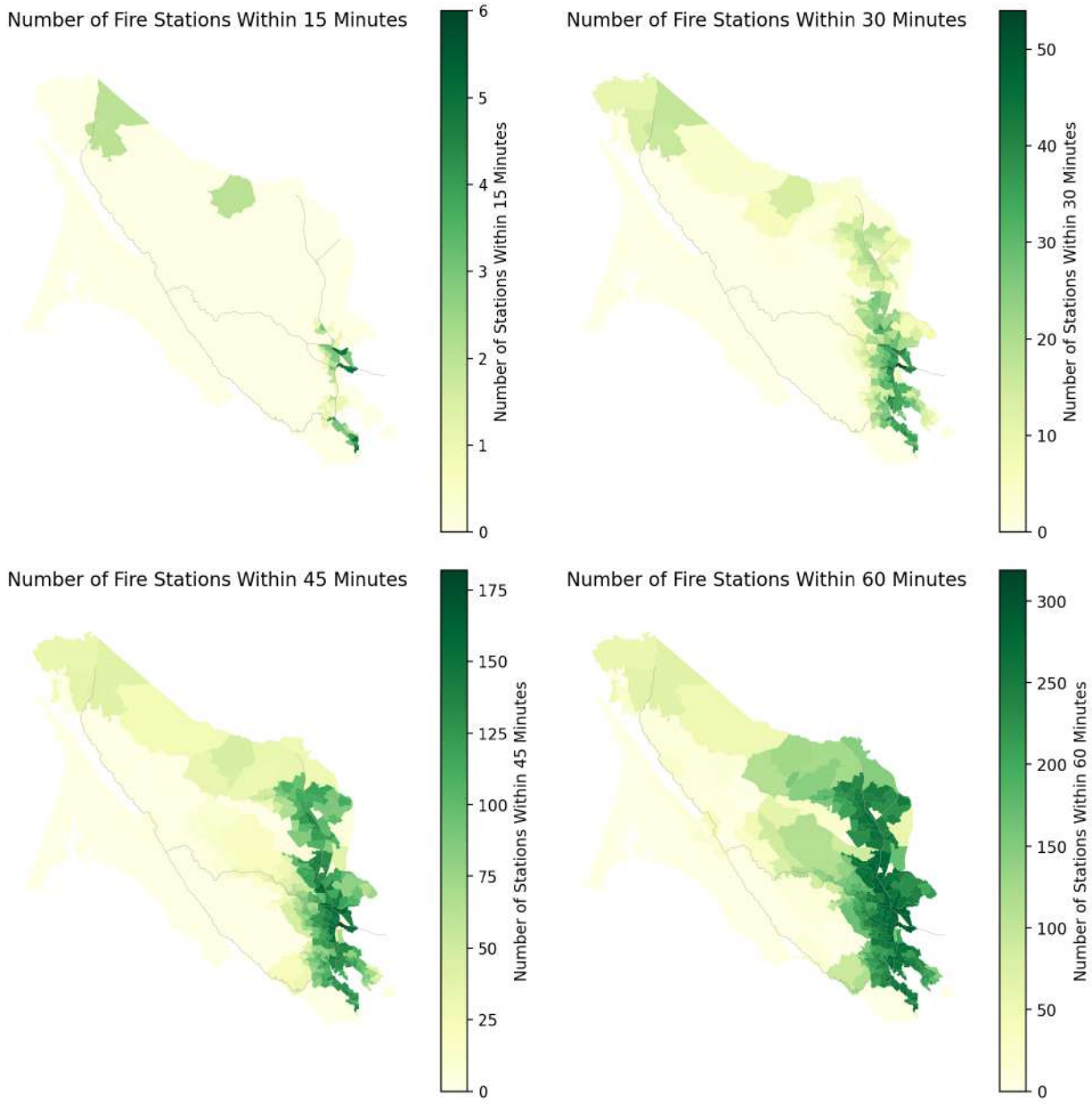


Figure I-10. Density of out-of-county mutual aid at different travel times.

Aerial Firefighting Response

Aerial firefighting resources play a vital role in helping to contain a fire, particularly during the early stages of the incident. These resources, including helicopters and airtankers, drop water and retardant on the fire, slowing fire growth and supporting ground-based firefighting operations and line constructions.

During the peak of fire season, many fires compete for limited aerial firefighting resources. The availability of these resources in Marin County is not guaranteed; if many fires are burning across the western United States, helicopters and airtankers available to support an initial attack in the county may be limited. However, the location of the helitack and air bases can provide a rough assessment of the capacity for aircraft to support wildland fire operations in Marin County.

Using data from CAL FIRE,[68] this analysis uses a 100-km buffer around helicopter bases and a 200-km buffer around fixed-wing air bases to identify relevant regional air resources. While aircraft speeds vary significantly based on type, model, and weight, these buffers typically reflect a flight time of about 30 minutes. As shown in **Table I-6**, three helicopter bases and seven air attack bases are within these thresholds.

Table I-6. Aerial firefighting resources within range of Marin County for an initial attack.

Base Name	City	Type
McClellan Reload Base	McClellan	Air Attack Base
Hollister Air Base	Hollister	Air Attack Base
Chico Air Base	Chico	Air Attack Base
Sonoma Air Base	Santa Rosa	Air Attack Base
Ukiah Air Base	Ukiah	Air Attack Base
Grass Valley Air Attack Base	Grass Valley	Air Attack Base
Columbia Air Base	Columbia	Air Attack Base
Boggs Mountain Helibase	Cobb	Helibase
Gnoss Field	Novato	Helibase
Alma Helitack Base Fire Station 33	Los Gatos	Helibase

[68] **https://data.ca.gov/dataset/facilities-for-wildland-fire-protection**

Figure I-11 shows the location of nearby helibases. The Gnoss Field Airport is a vital resource for fire suppression in Marin County. Through a partnership with Marin County Fire and PG&E, a Sikorsky Black Hawk helicopter is stationed at the Novato Airport with exclusive use for fire suppression in Marin County and surrounding Bay Area communities.[69]

The Boggs Mountain Helitack Base in Cobb and the Alma Helitack Base at Moffett Field in Mountain View both host Sikorsky S70i Firehawk helicopters.[70] These helicopters are able to perform water drops, insert a seven-person firefighting crew into difficult-to-access terrain,[71] and perform nighttime operations.[72]

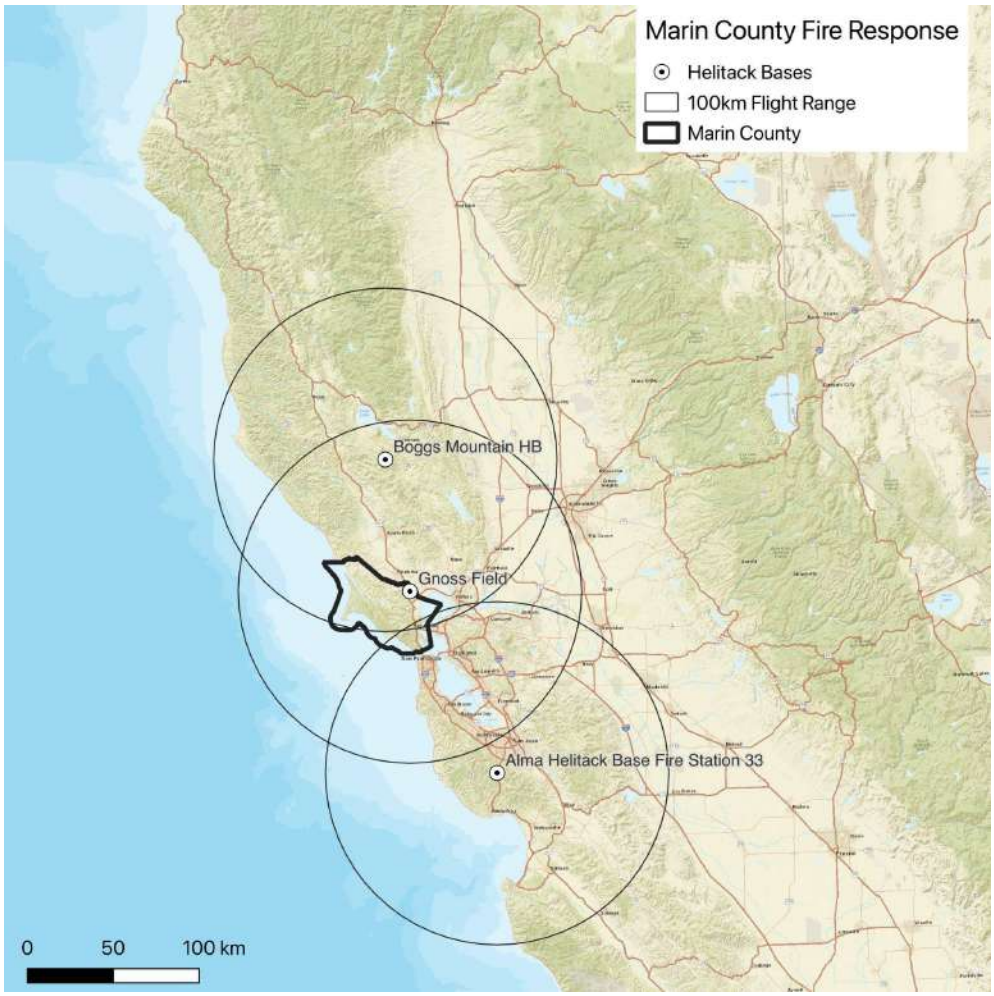


Figure I-11. Helibases within 100 km of Marin County.

[69] https://patch.com/california/sanrafael/black-hawk-helicopter-help-fight-marin-county-wildfires
[70] https://calfirehistory.com/wp-content/uploads/2022/06/aviation-guide-2022.pdf
[71] https://boggsmountain.org/boggs-activities/cal-fire-helipad/
[72] https://www.lockheedmartin.com/en-us/products/sikorsky-firehawk.html

Figure I-12 shows the air attack bases within 200 km of Marin County. These bases host fixed-wing aircraft that can support firefighting operations through retardant drops. Many bases are also home to Air Tactical Aircraft ("Air Attack Platforms") that support command and control operations fires with multiple aerial resources.[73] As shown in Table 7, regional firefighting resources include at least two C130 Hercules large airtankers, seven air attack platforms, and nearly a dozen S-2T airtankers.

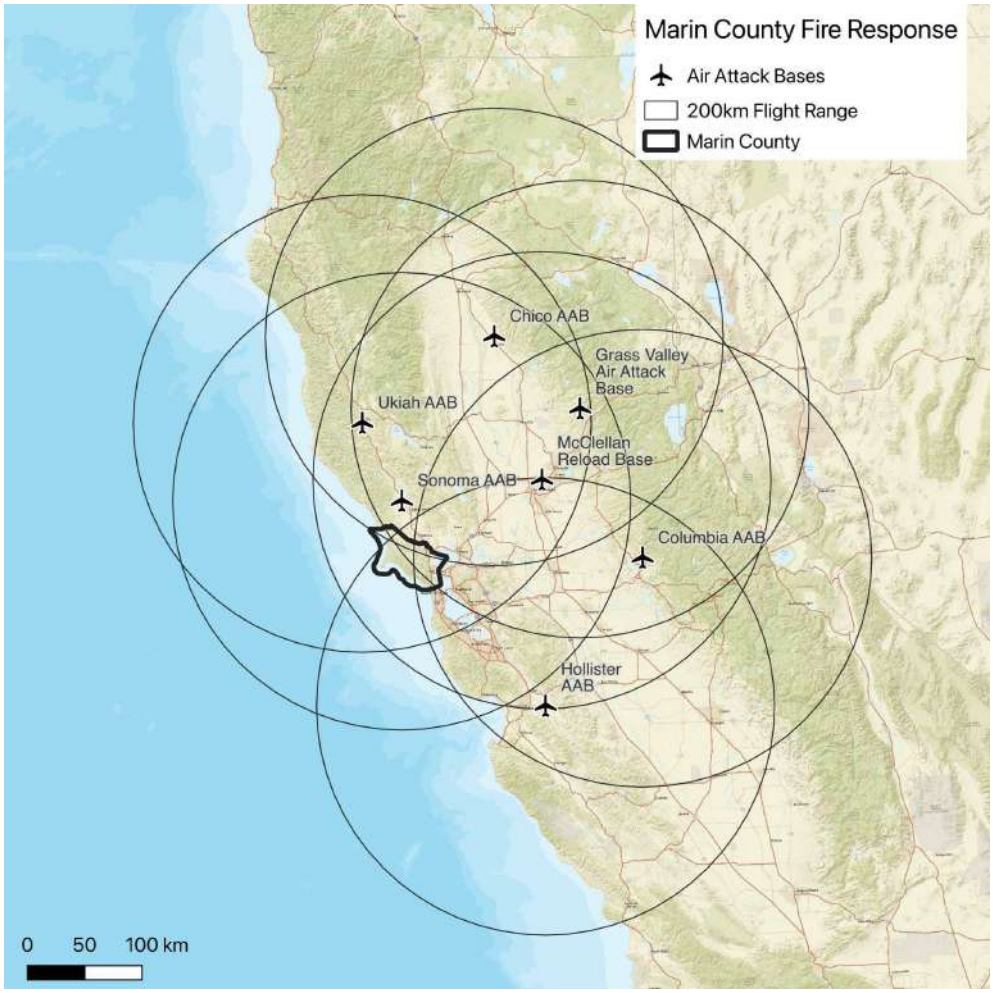


Figure I-12. CAL FIRE air attack bases within 200 km of Marin County.

[73] https://34c031f8-c9fd-4018-8c5a-4159cdff6b0d-cdn-endpoint.azureedge.net/-/media/calfire-website/what-we-do/fire-protection/aviation-program/ov-10.pdf?rev=25750cbd9f674f5bb4fd7a0347926837&hash=5E657387D5B97DB9755CBA0BDEED0031

Table I-7. Regional aircraft within initial attack range of Marin County.

Aircraft Type	Count
C-130 Hercules Large Airtanker	2
OV-10 Air Tactical Aircraft	7
S-2T Airtanker	11
Total	20

Table I-8 provides the structure coverage by each station.

Table I-8. Structure coverage by station.

Station Name	Station Address	District Name	Structures Reached within 5 minutes	Structures Reached within 10 Minutes	Structures Reached within 30 Minutes
Bolinas	100 Mesa Rd	Bolinas Fire Protection District	1,508	1,752	3,710
Station 13	5600 Paradise Dr	Central Marin Fire Department	2,515	16,997	88,887
Station 14	342 Tamalpais Dr	Central Marin Fire Department	4,233	18,796	88,339
Station 15	420 Magnolia Ave	Central Marin Fire Department	4,031	12,013	84,893
Station 16	15 Barry Way	Central Marin Fire Department	4,792	27,158	94,507
Hicks Valley	7330 Redhill Rd	County Fire (CSA 31)	56	181	19,177
Marin City	850 Drake Ave	County Fire (CSA 31)	1,626	13,032	76,133
Muir Beach Volunteer Fire	1716 Shoreline Hwy	County Fire (CSA 31)	288	3,957	50,565
Nicasio Valley Volunteer Fire	1 Old Rancheria Rd	County Fire (CSA 31)	144	330	23,373

Station Name	Station Address	District Name	Structures Reached within 5 minutes	Structures Reached within 10 Minutes	Structures Reached within 30 Minutes
Pt Reyes Station	401 B St	County Fire (CSA 31)	1,048	1,517	6,274
Skywalker Ranch Fire Brigade	5888 Lucas Valley Rd	County Fire (CSA 31)	39	173	41,399
Throckmorton	816 Panoramic Hwy	County Fire (CSA 31)	401	1,001	38,408
Tomales	599 Tomales-Dillon Beach Rd	County Fire (CSA 31)	346	497	2,515
Woodacre	33 Castle Rock Dr	County Fire (CSA 31)	1,116	2,349	29,096
Inverness	50 Inverness Way	Inverness Public Utility District	789	1,271	2,846
Station 17	1004 Sir Francis Drake Blvd	Kentfield Fire Protection District	5,150	23,085	90,838
Marinwood	777 Miller Creek Rd	Marinwood Community Services District	3,576	14,732	92,909
Station 6	26 Corte Madera	Mill Valley Fire Department	5,420	12,858	75,006
Station 7	1 Hamilton Dr	Mill Valley Fire Department	3,303	17,740	82,254
Station 1	7205 Redwood Blvd	Novato Fire Protection District	6,035	17,159	77,463
Station 2	450 Atherton Ave	Novato Fire Protection District	2,105	11,124	66,881
Station 3	65 San Ramon Way	Novato Fire Protection District	3,734	11,236	48,060
Station 4	319 Enfrente Rd	Novato Fire Protection District	3,944	20,936	90,441

Station Name	Station Address	District Name	Structures Reached within 5 minutes	Structures Reached within 10 Minutes	Structures Reached within 30 Minutes
Station 5	5 Bolling Dr	Novato Fire Protection District	2,652	16,735	90,659
Station 18	33 Sir Francis Drake Blvd	Ross Fire Department	5,801	20,781	89,615
Station 19	777 San Anselmo Ave	Ross Valley Fire Department	7,675	21,571	91,488
Station 20	150 Butterfield Rd	Ross Valley Fire Department	5,624	14,844	81,209
Station 21	10 Park Rd	Ross Valley Fire Department	5,673	12,419	76,782
Station 1	1151 C St	San Rafael Fire Department	7,538	27,335	96,804
Station 2	519 4Th St	San Rafael Fire Department	7,594	30,086	96,562
Station 3	650 Del Ganado Rd	San Rafael Fire Department	3,139	11,811	92,882
Station 4	46 Castro St	San Rafael Fire Department	2,870	19,545	94,989
Station 5	955 Point San Pedro Rd	San Rafael Fire Department	2,126	4,233	82,941
Station 6	650 Del Ganado Rd	San Rafael Fire Department	3,121	11,518	92,722
Station 7	30 Joseph Ct	San Rafael Fire Department	1,994	16,203	93,592
Station 1	333 Johnson St	Southern Marin Fire Protection District	2,925	5,904	68,357
Station 2	300 Spencer Ave	Southern Marin Fire Protection District	3,237	9,336	72,444
Station 4	309 Poplar Ave	Southern Marin Fire Protection District	4,226	14,620	74,413

Station Name	Station Address	District Name	Structures Reached within 5 minutes	Structures Reached within 10 Minutes	Structures Reached within 30 Minutes
Station 9	308 Reed Blvd	Southern Marin Fire Protection District	1,912	12,280	80,023
Station 2	3410 Shoreline Hwy	Stinson Beach Fire Protection District	709	746	14,597
Station 10	4301 Paradise Dr	Tiburon Fire Protection District	1,914	8,707	75,164
Station 11	1679 Tiburon Blvd	Tiburon Fire Protection District	2,223	3,965	62,471

Appendix J. Infrastructure Exposure Assessment

Exposure of critical infrastructure is evaluated by the Wildfire Exposure Score (WES), which provides an index of wildfire exposure to resources or assets at a given location. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel and exposure from direct flame front—and is calculated for all parts of the landscape. Wildfire Exposure Score calculations are applied broadly across the landscape regardless of whether a structure is present (see the Wildfire Exposure Score map sheet in Figure J-1). It serves as a relative index of wildfire impacts based on landscape characteristics and does not incorporate the specific building materials of individual structures or other infrastructure.

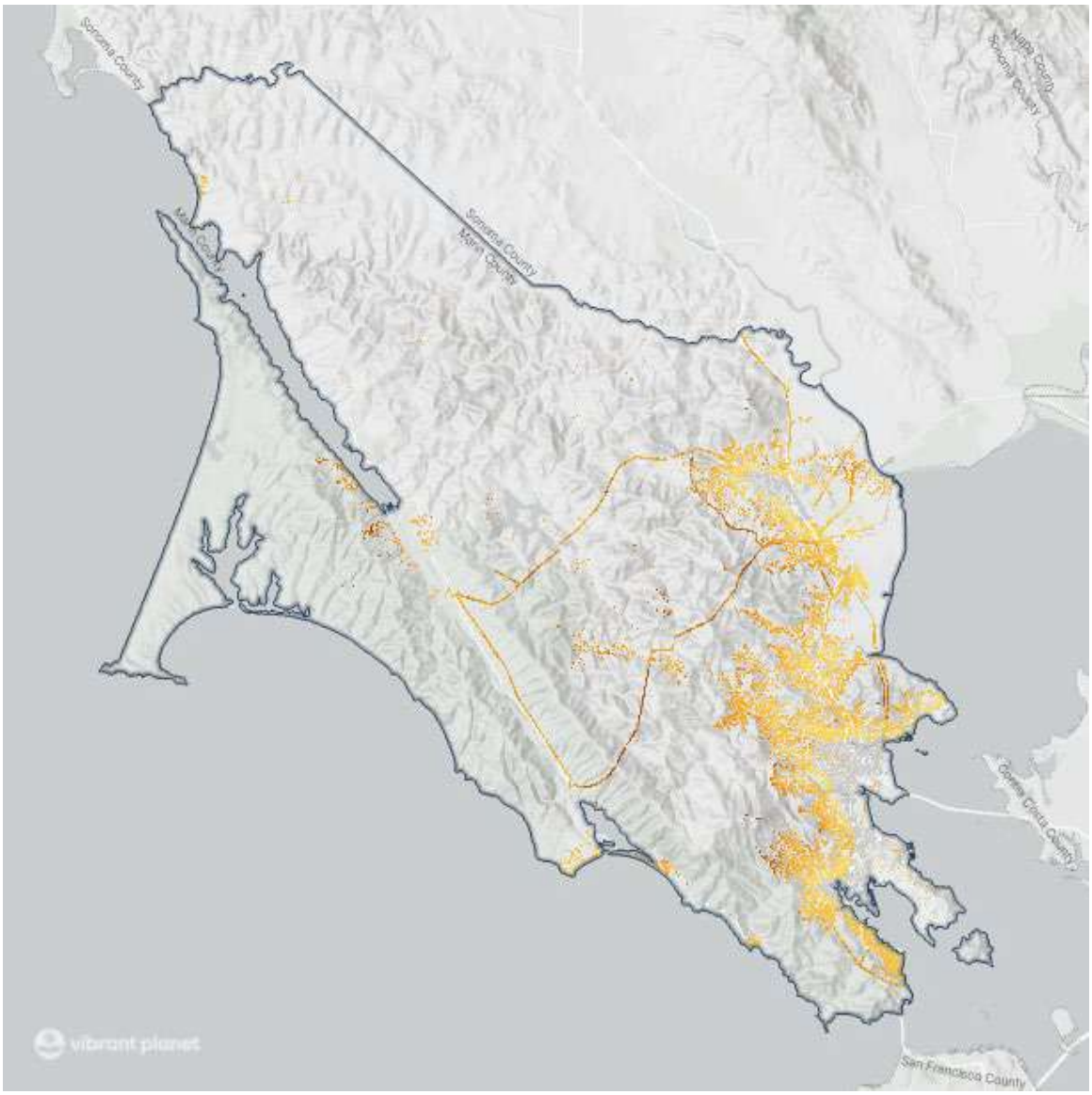


Figure J-1. Wildfire Exposure Score Map

J.1 Infrastructure Assessment and Methodology

In order to assess exposure to specific infrastructure a combination of public and locally provided data was collated for various infrastructure supporting regional public works, emergency response, communication and other public utility. The spatial datasets were then buffered by 200 ft to assess potential exposure in the direct defense zone of a given feature and intersected with the WES layer.

J.2 Risk Patterns and Decision Support

The resulting decision support information can be used to identify critical infrastructure most at risk, and can help to identify patterns of exposure throughout the county. Generally speaking, across this landscape, features have higher levels of exposure outside of the urban core where fire behavior is more extreme, and lower exposure in developed areas where the threat of wildfire hazard is lower.

Appendix K. Wildfire Hazard Assessment

K.1 Area of Interest

This analysis and the associated data layers cover Marin County, the area of interest (AOI) shown in the following maps. The AOI is depicted by a navy blue outline. Summary tables and statistics represent the full data layer extent, which typically align with the AOI, or with features that intersect the AOI.

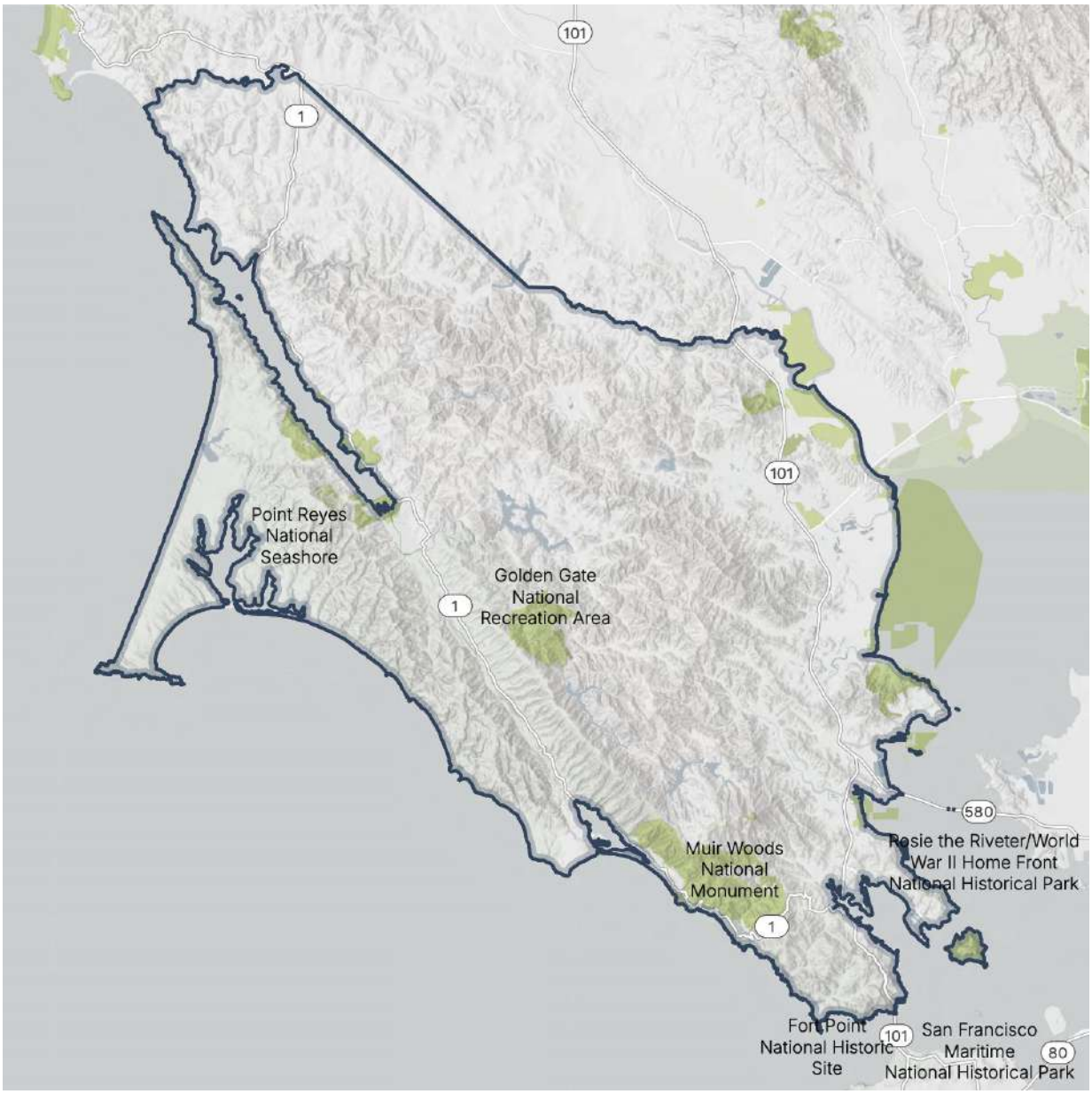


Figure K-1. Marin County (area of interest).

These map sheets and associated datasets represent wildfire hazards produced and modeled by Pyrologix. These maps are intended to provide a quantitative foundation for wildfire risk mitigation planning efforts.

This data presents a picture of current conditions as it relates to wildfire hazard. Unless otherwise noted, all data and maps within this report reflect hazard conditions that have incorporated natural disturbance data through 2024 and treatment data through Q2 of 2025.

K.2 Burn Probability – Annual

Burn probability (BP) shows the probability of an area burning at any time during a single calendar year. A higher BP means wildfire is more likely to occur in an area.

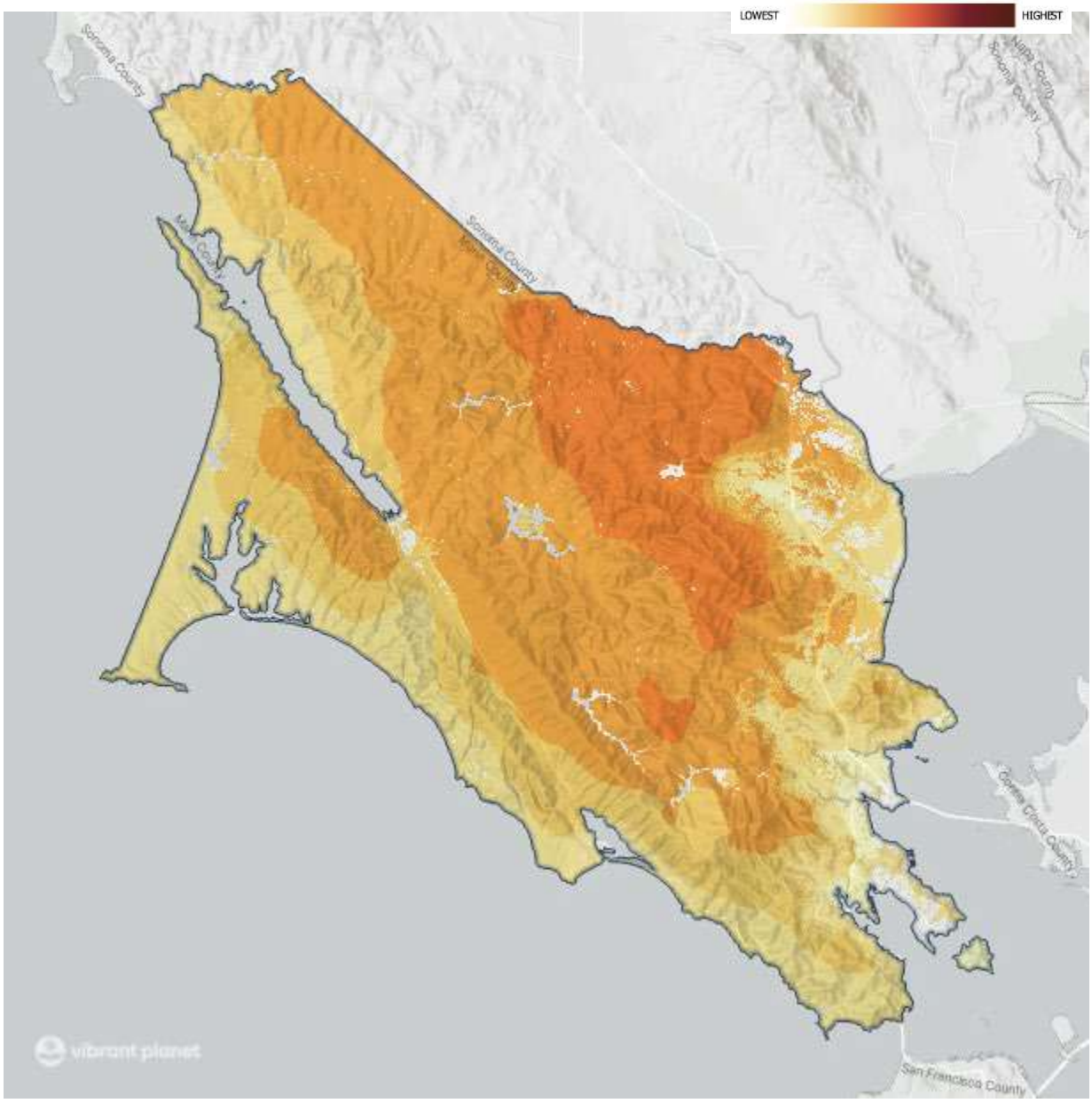


Figure K-2. Burn probability – annual.

The FSim large-fire simulator (by the United States Forest Service [USFS] Missoula Fire Sciences Lab) is used to quantify wildfire likelihood. FSim is a comprehensive fire occurrence, growth, behavior, and

suppression simulation system that uses locally relevant fuel, weather, topography, and historical fire occurrence information to make a spatially resolved estimate of the contemporary likelihood and intensity of wildfire across the landscape (Finney et al. 2011).[74]

FSim focuses on the relatively small fraction of wildfires that escape initial attack and become "large" (greater than 247 acres). Since the occurrence of large fires is relatively rare, FSim generates many thousands of simulated iterations to capture a sample size large enough to generate burn probabilities for the entire landscape.

A given FSim iteration spans one entire year. There is no temporal component to FSim beyond a single wildfire season consisting of up to 365 days. FSim performs independent (and varying) iterations of one year, defined by the fuel, weather, topography, and wildfire occurrence inputs provided. FSim does not account for a simulated wildfire's potential influence on the likelihood or intensity of future wildfires (even within the same simulation year). FSim integrates all simulated iterations into a probabilistic representation of wildfire likelihood. Each year represents an independent realization of how fires might burn given the current fuelscape and historical weather conditions.

K.3 Ignition Frequency Density Grid

Fire ignition frequency density is the number of fire ignitions per unit time per unit area (ignitions per year per sq km). Wildfire ignition probability data provides spatially explicit estimates of the likelihood that a wildfire will start in a given location and can include either human or natural ignitions or both.

[74] Finney, M. A., McHugh, C. W., Grenfell, I. C., Riley, K. L., & Short, K. C. (2011). A simulation of probabilistic wildfire risk components for the continental United States. Stochastic Environmental Research and Risk Assessment, 25(7), 973–1000.

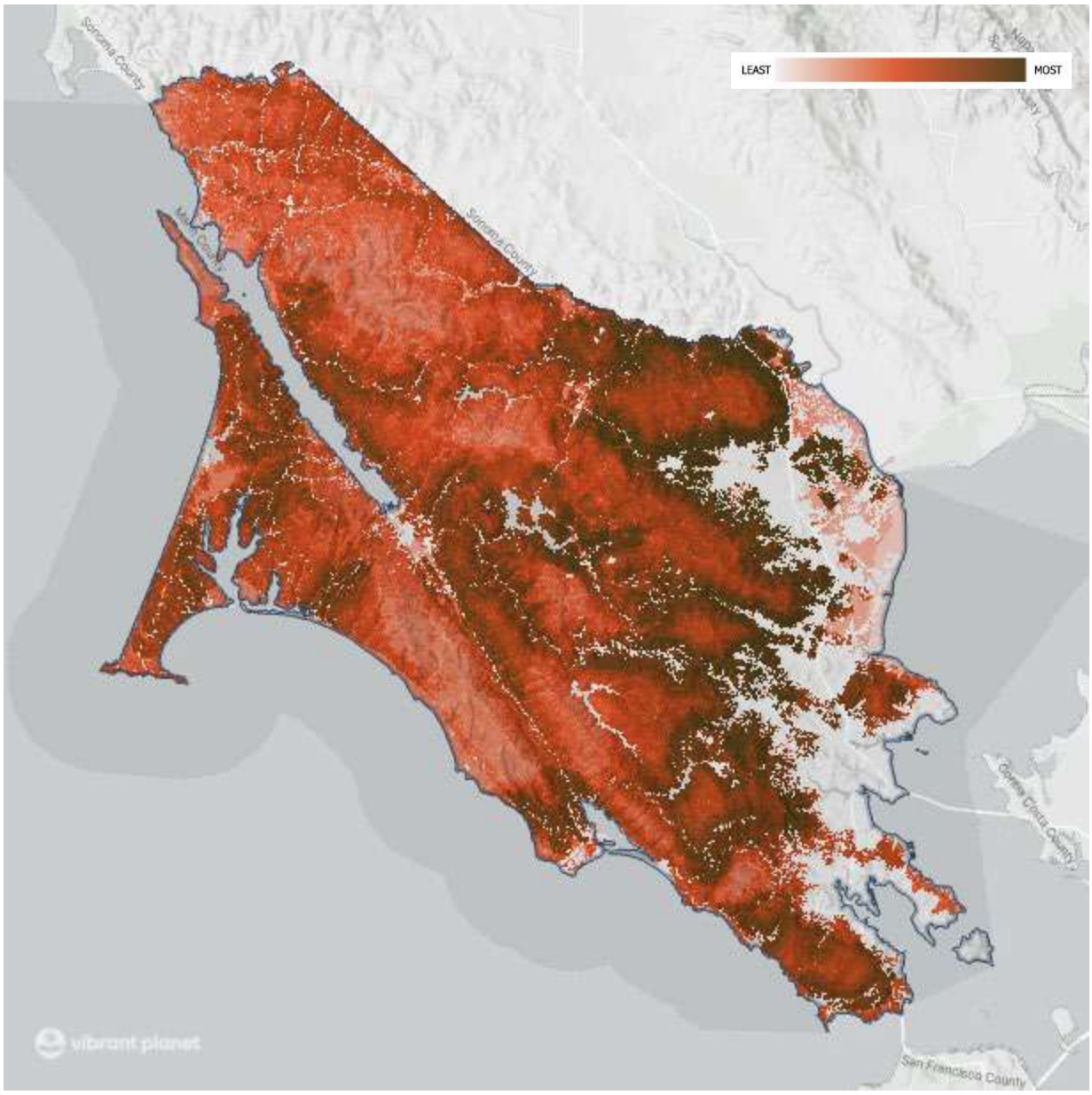


Figure K-3. Ignition frequency density grid.

The Ignition Frequency Density grid indicates where fires are likely to originate as the annual relative frequency per sq km (number of fires per sq km per year) with emphasis placed on fires with significant growth potential. It is derived from historical data and can be a useful metric to identify areas where fires are likely to start, such as along roads due to human-caused ignitions, or ridgetops for lightning-caused ignitions. This layer represents only human-caused ignitions, which typically display a pattern showing decreasing ignitions moving away from roads and population centers.

The annual ignition probabilities reflect the conditions recorded in 2022, as observed in the Fire Occurrence Database (FOD), which was used for model training. Climate change, vegetation shifts,

and evolving social factors could alter ignition patterns over time. This dataset does not characterize the dynamic intra-annual variability observed in ignition probability and the input features. For more information on this dataset please visit Vibrant Planet Data Commons (**https://www.vpdatacommons.org/datasets/human-ignition-probability-west**).

K.4 Characteristic Flame Length

Characteristic Flame Length represents the season-long mean flame length expressed in feet. Flame lengths are grouped into six classes.

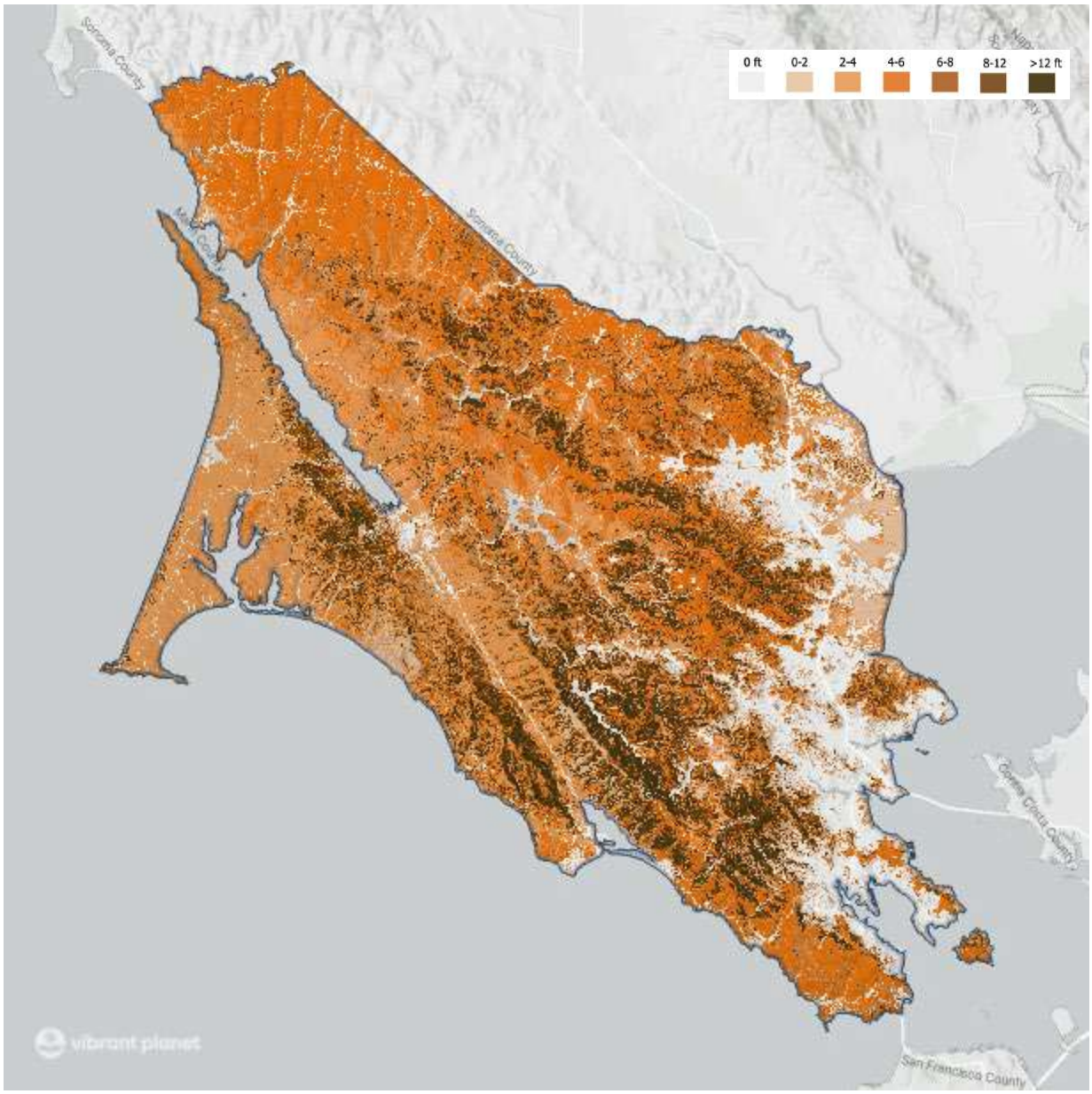


Figure K-4. Characteristic flame length.

Characteristic Flame Length (CFL) represents the mean fire-season flame length expressed in feet. Flame lengths are grouped into the following classes: >0-2 ft, >2-4 ft, >4-6 ft, >6-8 ft, >8-12 ft, and greater than 12 ft flame lengths. CFL can be expressed for any set of fire hazard weather conditions. Here, it is calculated using heading-only fire behavior and is weighted according to weather-type probabilities across the full season, incorporating both temporal frequencies and the influence of high-spread conditions from the fire modeling process WildEST (the Wildfire Exposure Simulation Tool).

K.5 95th Percentile Flame Length

The "Average Worst" or 95th Percentile Flame Length represents the average of the top 5% of flame lengths, weighted by weather probability occurrence. This metric can inform fire behavior potential for the near-worst weather conditions.

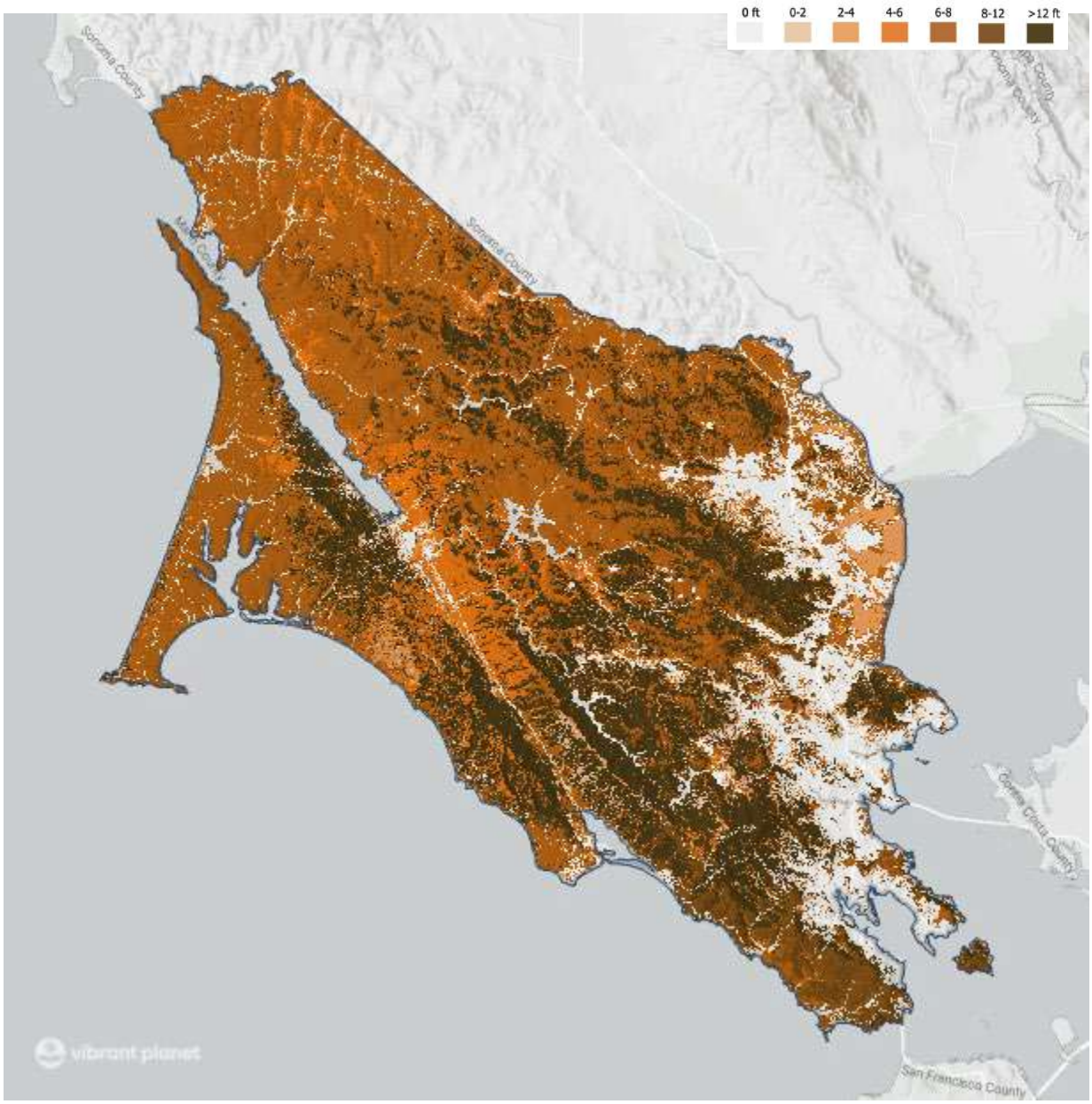


Figure K-5. 95th percentile flame length.

The 95th Percentile Flame Length is calculated using weather-type probabilities from the worst 5% of flame lengths rather than the entire fire season. Some wildfire-safety applications require knowledge

of fire behavior potential for the near-worst weather conditions. In the past, this was accomplished by separately finding the near-worst wind speed and near-worst moisture content— typically the 95th, 97th, or 98th percentiles of those measures at a weather station. However, those two variables are not necessarily independent, so the 95th percentile wind speed may not ever occur at the 95th percentile moisture content. Moreover, wind direction is not typically used in such an analysis.

To avoid those challenges of addressing wind speed, wind direction, and moisture content together in one measure of the "95th percentile," WildEST computes the 95th percentile flame length value for a pixel as the weighted average of the weather types and flame length values that comprise the highest 5% of modeled results.

K.6 Wildfire Exposure Score

The WES dataset provides an index of wildfire exposure to structures. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel—and is calculated for all parts of the landscape.

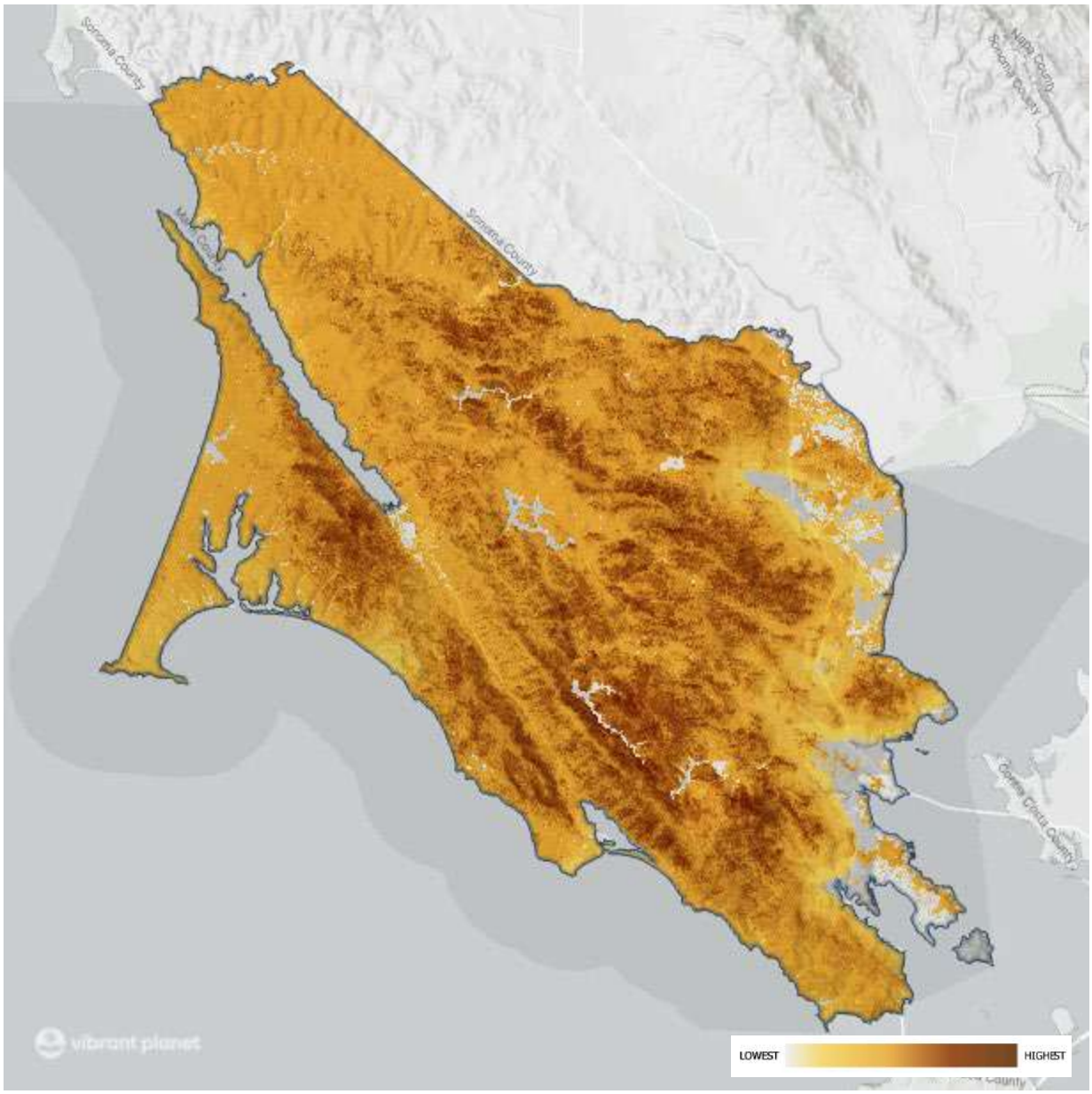


Figure K-6. Wildfire exposure score.

Wildfire Exposure Score (WES) is an integrated measure combining the likelihood of wildfire (Burn Probability) with potential consequences of wildfire to resources or asset at a given location (Damage Potential, DP). In this dataset, consequence is modeled using a response function that accounts for potential loss to structures as a function of flame length, along with ember exposure from nearby vegetation. Together, these factors provide a general estimate of potential wildfire damage to homes.

WES calculations are applied broadly across the landscape regardless of whether a structure is present. It serves as a relative index of wildfire impacts based on landscape characteristics and does not incorporate the specific building materials of individual structures. Although WES offers an estimate of exposure relevant to homes, it does not include data on the actual presence or locations of structures. WES maps can be paired with additional data on structure locations and assets of interest.

WES uses a geometric-interval classification to define ten exposure classes where each class break is 1.5 times larger than the previous break. A location in Class 7 is 1.5 times more exposed than one in Class 6, and so on. This classification supports meaningful grouping of structures by exposure class to inform inspection, risk assessment, and hardening strategies.

K.7 Ember Load + Production Indexes

The Conditional Ember Load Index (cELI) shows where embers may land on a landscape, which is helpful for identifying where to harden buildings against ember ignition. The Conditional Ember Production index (cEPI) rates the potential for ember production if a fire were to occur. Ember characteristics are useful for proactive fuels management, response planning, and structural hardening.



Figure K-7. Conditional Ember Load Index.



Figure K-8. Conditional Ember Production Index

The cELI is an index of the relative number of embers that land at a given landscape location, including embers that land on non-burnable pixels that do not produce embers. The cELI does not account for burn probability and can be used to identify where on the landscape hardening buildings to resist ember ignition may be needed.

The cEPI is an index of the relative number of embers lofted at a given landscape pixel, if a fire were to occur. The cEPI does not account for variation in burn probability across the landscape and can be used to highlight areas that would benefit from fuel-reduction efforts to reduce ember generation.

K.8 Damage Potential

Damage Potential (DP) is a relative measure of the potential consequences of wildfire to a resource or asset at a given location, if a fire were to occur. DP incorporates both fire intensity and ember load (cELI).

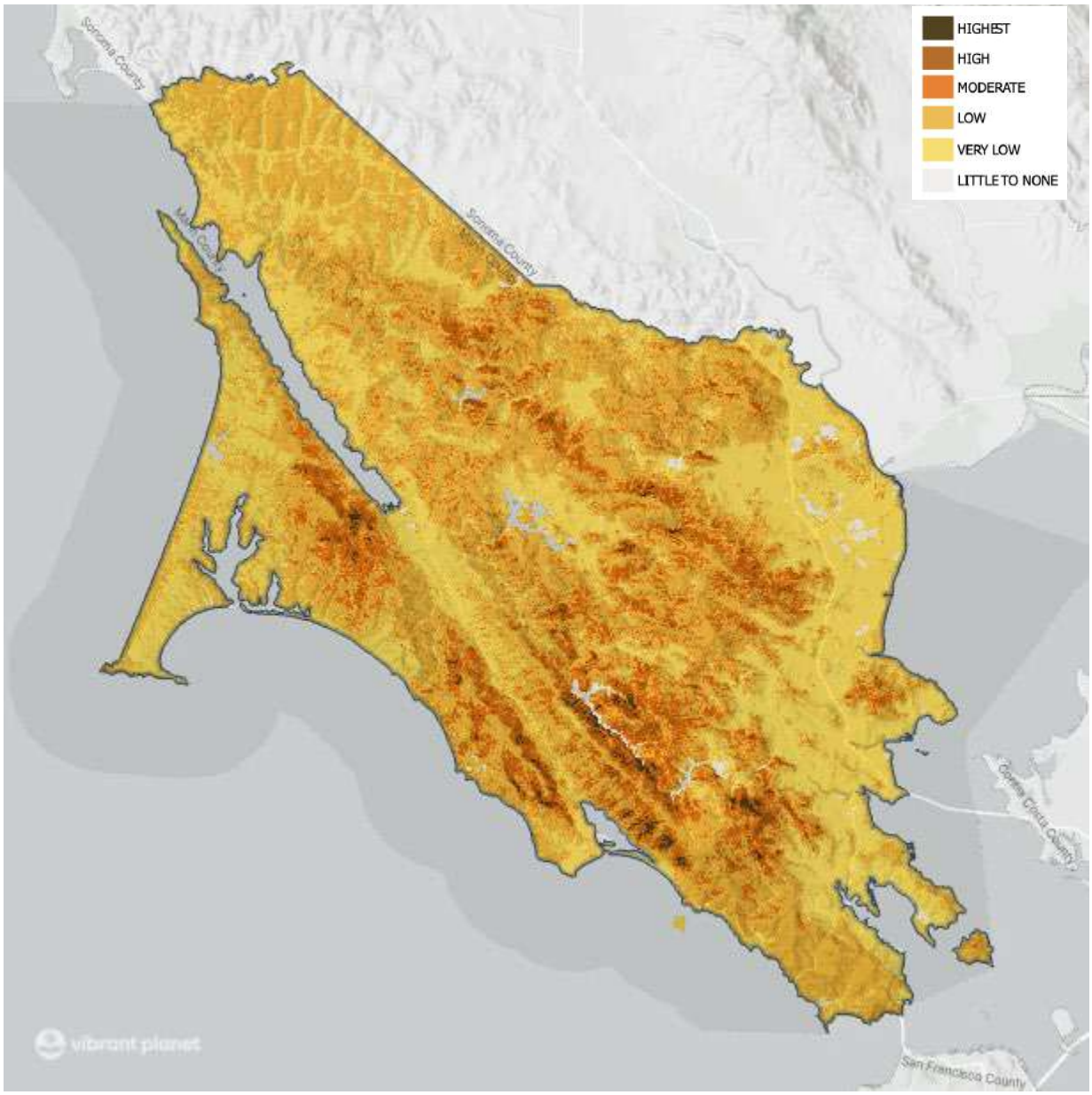


Figure K-9. Damage Potential.

The fire intensity portion of DP is an extension of the Conditional Risk to Potential Structures (cRPS) dataset. The cRPS portion of DP is calculated from WildEST, non-heading fire-intensity results, which are analogous to FSim's intensity results but are calculated using separate response functions using lifeform fuel type groups.

The cRPS response functions, characterizing potential consequences to an exposed structure, are applied to all burnable fuel types on the landscape regardless of whether a structure is actually present there. The response function does not consider building materials of structures and is meant as a general measure of the effect of fire intensity on buildings. This can be useful for informing structural inspection and hardening efforts. The cRPS response functions are provided in the table.

These results are calculated using 30 m “fire-effects” flame-length probabilities from the WildEST wildfire behavior results and then smoothed into non-burnable areas to match the extent of the burn probability raster. A cRPS value of 0 means no exposure of a structure, and a value of 100 represents a complete loss.

Although DP offers an estimate of exposure relevant to homes, it does not include data on the actual presence or locations of structures. DP maps can be paired with additional data on structure locations and assets of interest.

K.9 Rate of Spread + 95th Percentile Rate of Spread

Rate of Spread (ROS) represents the season-long tendency for rate of spread at a pixel given the fuel, weather, and topography at that pixel. It can also be represented at the 95th percentile to represent potential spread during near worst weather conditions.

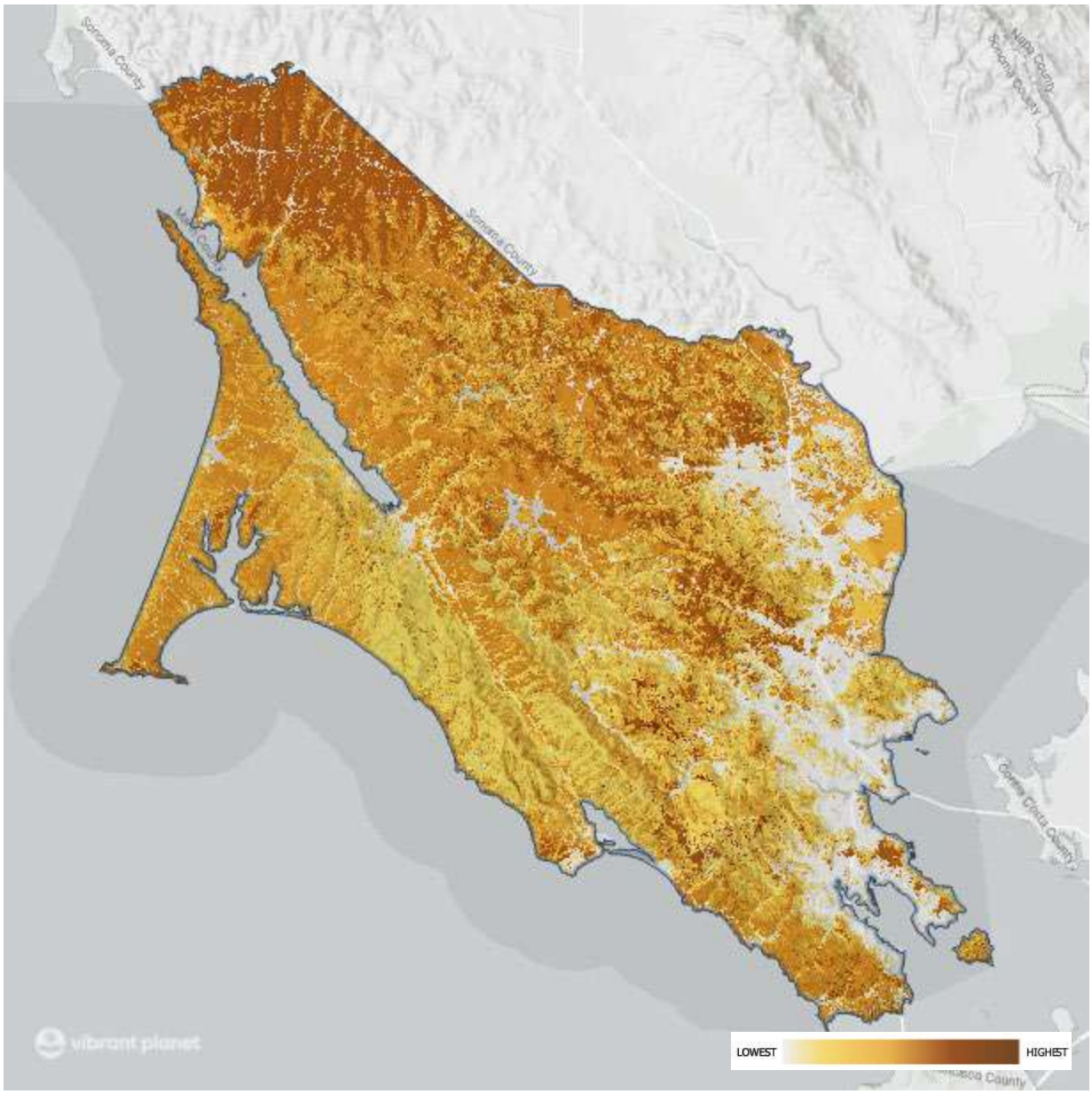


Figure K-10. Rate of spread.

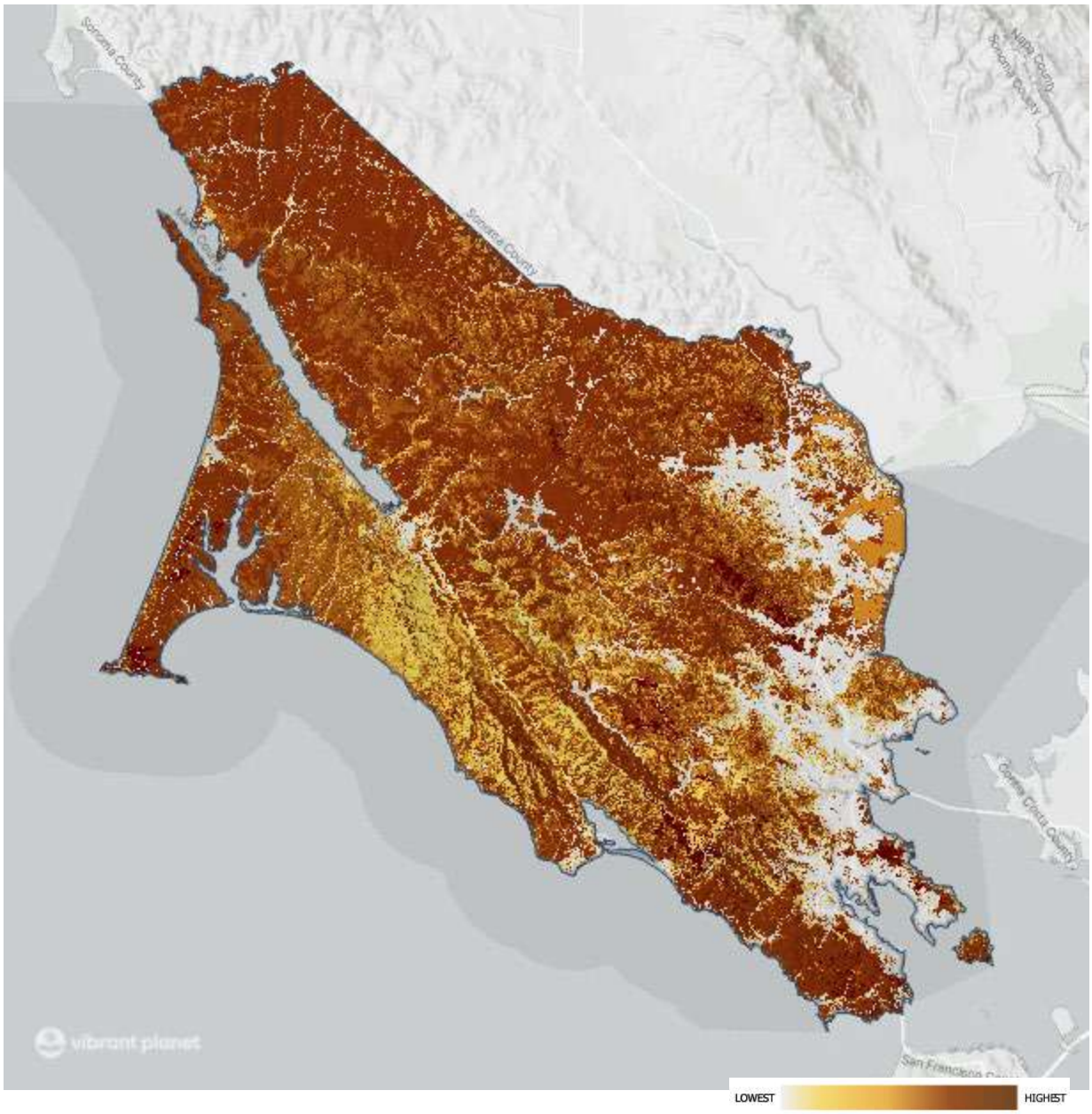


Figure K-11. 95th percentile rate of spread.

Characteristic ROS is the weighted-average rate of spread for a given pixel in the fuelscape, including any contributions of crown fire spread. Characteristic ROS is calculated using heading-only fire behavior and is weighted according to weather-type probabilities across the full season, incorporating both temporal frequencies and the influence of high-spread conditions from the fire modeling process WildEST. It is best used as a relative measure for comparison with other pixels on the landscape rather than for its nominal value.

The 95th Percentile ROS represents the average of the worst 5% of results, rather than the entire fire season. This metric can inform fire behavior potential for the near-worst weather conditions.

K.10 Data Dictionary

Table K-1. Data dictionary.

Title	File Name	File Type	Units	Summary	Legend Description
Burn Probability - Annual	burn_probability.tif	Raster	Fractional 0-1 (%)	Burn probability (BP) shows the probability of an area burning at any time during a single calendar year. A higher BP means wildfire is more likely to occur in an area.	Standard, logarithmic (breaks: 0, 0.0001, 0.0022, 0.0046, 0.01, 0.215, 0.046, 0.1, 0.215, 0.464, 1)
Ignition Frequency Density Grid	Pyrome_514_IDG.tif	Raster	Number of fires/sq km/yr	Fire ignition frequency density is the number of fire ignitions per unit time per unit area (ignitions per year per sq km). Wildfire ignition probability data provides spatially explicit estimates of the likelihood that a wildfire will start in a given location, and can include either human or natural ignitions or both. This layer indicates if an area has a history of human caused ignitions.	Natural jenks, calculated in a GIS.
Characteristic Flame Length	wfl.tif	Raster	Feet	Characteristic Flame Length represents the season-long mean flame length expressed in feet. Flame lengths are grouped into six classes.	Standard, categorical (>0-2 ft, >2-4 ft, >4-6 ft, >6-8 ft, >8-12 ft, >12 ft).

Title	File Name	File Type	Units	Summary	Legend Description
95th Percentile Flame Length	qfl.tif	Raster	Feet	The "Average Worst" or 95th Percentile Flame Length represents the average of the top 5% of flame lengths, weighted by weather probability occurrence. This metric can inform fire behavior potential for the near-worst weather conditions.	Standard, categorical (>0-2 ft, >2-4 ft, >4-6 ft, >6-8 ft, >8-12 ft, >12 ft).
Wildfire Exposure Score	ses.tif	Raster	Relative score	The Wildfire Exposure Score (WES) dataset provides an index of wildfire exposure to structures. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel—and is calculated for all parts of the landscape.	A standard geometric-interval classification, where each class break is 1.5 times larger than the previous break (breaks: 0, 50, 75, 113, 169, 253, 380, 570, 854, 1500).
Ember Load + Production Indexes	cELI.tif, cEPI.tif	Raster	Relative score	The Conditional Ember Load Index (cELI) shows where embers may land on a landscape, which is helpful for identifying where to harden buildings against ember ignition. The Conditional Ember Production index (cEPI) rates the potential for ember production if a fire were to occur. Ember characteristics are useful for proactive fuels management, response planning, and structural hardening.	Custom logarithmic scale (breaks: 0, 31.62, 56.62, 100, 177.8, 316.2, 1000, 1778, 9999).

Title	File Name	File Type	Units	Summary	Legend Description
Damage Potential	DPs.tif	Raster	Relative score	DP is a relative measure of the potential consequences of wildfire to a resource or asset at a given location, if a fire were to occur. DP incorporates both fire intensity and ember load (cELI).	A cRPS value of 0 means no exposure of a structure, and a value of 100 represents a complete loss.
Rate of Spread + 95th Percentile Rate of Spread	qros.tif, wros.tif	Raster	Chains/hr	ROS represents the season-long tendency for rate of spread at a pixel given the fuel, weather, and topography at that pixel. It can also be represented at the 95th percentile to represent potential spread during near worst weather conditions.	Standard, categorical (0 chains/hr, >0-5, 5-10, 10-20, 20-30, 30-50, 50-100, >100 chains/hr).

Appendix L. Detailed Prioritization Logic

Table L-1. Detailed prioritization logic per theme.

Theme	Data Source	Theme 1: Near-Community Vegetation Management	Theme 2: Open-Space Vegetation Management	Theme 3: Detection	Theme 4: Alerting	Theme 5: Evacuation Planning	Theme 6: Roadside Clearance	Theme 7: Residential Risk Reduction
Fire Pathways	Simulated fire pathways run using the fuel model produced for the 2026 CWPP	Within 200' of structures	Relative density of pathways leading to downstream structures					
Entrypoints	Intersections between fire pathways and the built environment, scored according to relative frequency of fire pathways and community density	Within 200' of structures			Within 200' of structures	Within 100' of roads Within 200' of residential structures	Within 100' of roads	Within 200' of residential structures
Burn Probability	Simulated probability of large fire growth using the fuel model produced for the 2025 CWPP	Within 200' of structures	Within 100' of utility assets Average within zone		Within 200' of structures	Within 100' of roads Within 200' of residential structures	Within 100' of roads	

Theme	Data Source	Theme 1: Near-Community Vegetation Management	Theme 2: Open-Space Vegetation Management	Theme 3: Detection	Theme 4: Alerting	Theme 5: Evacuation Planning	Theme 6: Roadside Clearance	Theme 7: Residential Risk Reduction
Flame Length	Simulated 95th percentile flame length using the fuel model produced for the 2025 CWPP	Within 200' of structures	Within 100' of utility assets Within drinking water source areas Average within zone				Within 100' of roads	
Rate of Spread	Simulated 95th percentile rate of spread using the fuel model produced for the 2025 CWPP		Within 100' of utility assets Average within zone	Within detection network blind spots Within roadless areas	Within 200' of structures			Within 200' of residential structures
Canopy Fire Activity	Likelihood of passive canopy fire activity under 95th percentile weather conditions using the fuel model produced for the 2025 CWPP	Within 200' of structures	Within 100' of utility assets Within drinking water source areas Average within zone				Within 100' of roads	
Fire Response Density	Number of fire resources within 10 minutes of travel time		Average within zone			Average within zone		Average within zone

Theme	Data Source	Theme 1: Near-Community Vegetation Management	Theme 2: Open-Space Vegetation Management	Theme 3: Detection	Theme 4: Alerting	Theme 5: Evacuation Planning	Theme 6: Roadside Clearance	Theme 7: Residential Risk Reduction
Ignition Risk	Modeled likelihood of wildfire ignitions with the potential to grow beyond 250 acres		Within 100' of utility assets Average within zone	Within detection network blind spots Within roadless areas				
Viewshed Percentage	Percentage of zone visible from more than one wildfire camera, computed using the AlertWildfire camera locations and a digital elevation model, assuming a 50' smoke column			Percentage within zone				
Structure Separation Distance	Distance between each structure and its nearest neighbor, calculated using the Marin County Building Footprints dataset							Median within zone
AlertMarin Subscription Frequency	Percentage of parcels with at least one active AlertMarin subscription			Percentage within zone				

Theme	Data Source	Theme 1: Near-Community Vegetation Management	Theme 2: Open-Space Vegetation Management	Theme 3: Detection	Theme 4: Alerting	Theme 5: Evacuation Planning	Theme 6: Roadside Clearance	Theme 7: Residential Risk Reduction
Household Characteristics / Access and Functional Needs	SVI - Theme 2 produced using 2022 American Community Survey data at the block group resolution			Average within zone				
Fire-Resilient Roads	Indicator of whether peak fire conditions would exceed tolerance for safe evacuation, produced using the 2020 finescale fuel model data, updated to reflect treatments through Q2 2025						Within 100' of roads	
Structure Exposure Score	A combined index reflecting fire probability, ember deposition, and flame length, produced using the 2025 CWPP Fuels Dataset							Within 200' of residential structures

Theme	Data Source	Theme 1: Near-Community Vegetation Management	Theme 2: Open-Space Vegetation Management	Theme 3: Detection	Theme 4: Alerting	Theme 5: Evacuation Planning	Theme 6: Roadside Clearance	Theme 7: Residential Risk Reduction
Roadway Difficulty	Anticipated difficulty of travelling a roadway during evacuation, including road curve geometry, intersection complexity, and other factors; derived from the Marin County Roads dataset					Average within zone		
On-Parcel Risk Score	Score indicating relative severity of defensible space and home hardening vulnerabilities; data from Marin Wildfire DSI programs							Average within zone

Appendix M. Wildfire Risk Assessments and Modeling Tools

M.1 Fire Probability

Burn probability (BP) shows the probability of an area burning at any time during a single calendar year. A higher BP means a wildfire is more likely to occur in an area.

The FSim large-fire simulator – produced by the USFS Missoula Fire Sciences Lab – is used to estimate where wildfires are most likely to occur. It does this by running many thousands of simulations using locally relevant fuels, weather, topography, and historical fire data to understand how fires that escape initial attack and grow large (over about 250 acres) tend to behave. Each simulation represents one possible fire season under current conditions, and by repeating this process many times, FSim builds a probabilistic picture of wildfire likelihood and potential fire behavior across the entire area. The result is a data-driven assessment of where large fires are most likely to start, spread, and cause impacts, given today's fuels and typical weather patterns.

M.2 Fire Growth Potential Ignition Risk Assessment

Fire ignition frequency density is the number of fire ignitions per unit time per unit area (ignitions per year per sq km). Wildfire ignition probability data provides spatially explicit estimates of the likelihood that a wildfire will start in a given location and is based on the history of both human-caused and natural ignitions resulting in fires greater than about 250 acres. This provides insights into ignition likelihood and growth potential.

M.3 Fire Pathways and Community Entry Points

Low-probability fires can cause tremendous damage. Almost by definition, the fires that cause the greatest damage are those that occur under exceptional circumstances, such as high-severity wind events and seasonal and multi-annual droughts. These fires may not be captured in the fire probability mapping because low-frequency, high-severity events are poorly represented in the distribution of wind and weather conditions used to simulate fire growth patterns.

To address this gap, the fire pathways framework evaluates risk under extreme conditions. Fire pathways assume a fire occurs on a high-severity wind event with no suppression intervention; the goal of this tool is not to identify the likelihood of a fire occurring, but to assess the consequences

when it does. Fire pathways provide a useful method for identifying the areas of the landscape where wind, topography, and fuels align to produce rapid fire spread towards communities and community assets.

The areas of a community where the fire pathways intersect the built environment are labeled as entry points. These areas are where a fire is most likely to outpace the fire response due to rapid fire growth and contiguous fuels. If these areas are of sufficient structural density, structure ignition may cause an urban fire to develop.

M.4 Potential Wildland Fire Behavior

Potential fire behavior analysis describes the anticipated characteristics of a fire at every location on the landscape. This form of risk assessment helps to identify the portions of the landscape that will experience the highest severity fire, where canopy fire is most likely to occur, and where ember deposition may affect the built environment. In this suite of assessments, fire behavior is simulated under numerous wind and weather conditions; the 95th percentile is selected for rate of spread and flame length to represent high-severity characteristics and retained for planning and prioritization. The all-weather scenario is selected for the remainder of the analysis.

M.5 Rate of Spread

ROS is an important measure for evaluating the potential for fire growth and the likelihood of a fire exceeding fire response capabilities. Areas with high rates of spread may have increased rates of structure ignition due to rapid fire growth and the potential for fires to reach structures before fire resources can arrive.

Rate of spread is also an important factor in determining fire intensity, which is a product of the fuel's energy and the speed at which the fire is moving.

M.6 Flame Length

Flame length is a measure of fire intensity and is the standard benchmark for determining operational control thresholds. Ground-based fire suppression resources may not be capable of safely engaging flame lengths greater than four feet; flame lengths greater than twelve feet may resist control even using aerial resources and heavy equipment. High flame lengths near structures may increase the risk to these structures, both due to the high radiant heating from large flames and the limited capacity for fire suppression. As such, this metric is a useful component in determining the importance of structural hardening and defensible space.

M.7 Canopy Fire Activity

Canopy fire activity is an indicator of fire severity and the potential for extreme fire behavior. Fire behavior is classified into categories from underburning to an active crown fire. Mapping these areas allows managers to identify where fire is likely to reach the canopy, which is often the precursor to "stand-replacing" events and/or substantial ember production. Active crown fires loft more embers than surface fires, which are then transported downwind to ignite secondary fires or buildings. Identifying areas prone to crown fires is therefore essential for mitigating "aerial" threats to communities, as these events can carry embers across nonburnable barriers and jump established containment lines. Canopy fire activity is also hazardous to firefighters and can reduce the effectiveness of fire control activities.

M.8 Ember Production

Ember production, represented by the Conditional Ember Production Index (cEPI), is a measure of the relative number of embers lofted at a given landscape pixel if a fire were to occur. This is based on multiple factors, such as vegetation type, structure, and fire intensity. This metric is important for proactive fuels management because it identifies production areas that have the potential to launch embers into communities. By undertaking vegetation management in these high-production zones, land managers can effectively reduce the volume of embers that a fire sends downwind toward vulnerable assets.

M.9 Ember Deposition

One important mechanism for structure ignition in WUI fires is ember deposition. The Conditional Ember Load Index (cELI) shows where embers may land on a landscape. This is based on a combination of ember production and transport models. The assessment considers multiple factors, including wind speed, wind direction, surface fuel moisture content, surface and canopy fuel characteristics, and topography. Ember deposition and load are important factors in identifying where to harden buildings against ember ignition, especially in cases of likely ember accumulation.

M.10 Fire Resilient Roads

The Fire Resilient Roads analysis is an assessment of fire behavior along all public roadways in Marin County. The objective of this risk assessment is to identify the road segments where evacuation would be unsafe for the general public during peak fire conditions. Thermodynamic calculations were used to estimate the interior temperature change within a vehicle due to the adjacent fire

behavior. Results from this analysis are used to guide evacuation route clearance projects and to inform shelter-in-place or temporary staging area evacuation planning.

M.11 Roadway Difficulty

The roadway evacuation difficulty score describes the risk to evacuations created by road conditions, design, and accessibility. The score accounts for road characteristics, designated evacuation routes, road geometry, the number of structures served by each roadway, and near-road fire behavior. A low difficulty score indicates a roadway is less likely to experience bottlenecks or traffic delays during an evacuation. A high score indicates a roadway with a higher likelihood of congestion, reduced ingress/egress, low access to critical infrastructure, and/or extreme fire behavior during an evacuation. This analysis was completed as part of the Evacuation Ingress/Egress Risk Assessment.[75]

M.12 On-Parcel Risk Assessment

Wildland fire risk accounts for only a portion of the total fire risk to each structure. The risk created by vulnerabilities in defensible space and home hardening is also important to consider. To evaluate these vulnerabilities, the On-Parcel Risk Assessment Score assesses parcel-level risk created by hazardous plants, building materials, and other factors on and around homes.

Using data from the DSI program, each finding is evaluated against a four-component risk model that characterizes the potential to contribute to fire spread and structure ignition in the WUI. Each risk factor is evaluated under several high-severity fire weather scenarios to evaluate its potential contribution to structure ignition during a wildfire event.

M.13 Structure Exposure Score

The SES dataset provides an index of wildfire exposure to structures from direct flame front and ember deposition. It combines wildfire likelihood with potential damage to homes—including ember exposure from nearby fuel—and is calculated for all parts of the landscape. SES is an integrated measure combining the likelihood of wildfire (Burn Probability) with potential consequences of wildfire to resources or assets at a given location (Damage Potential). In this dataset, consequence is modeled using a response function that accounts for potential loss to structures as a function of flame length, along with ember exposure from nearby vegetation. Together, these factors provide a general estimate of potential wildfire damage to homes. It serves as a relative index of wildfire impacts based on landscape characteristics and does not incorporate the specific building materials of individual structures. Although SES offers an estimate of exposure relevant to homes, it does not

[75] https://www.marinwildfire.org/project/evacuation-ingress-egress-risk-assessment

include data on the actual presence or locations of structures. SES maps can be paired with additional data on structure locations and assets of interest to identify level of wildfire exposure.

M.14 Fire Response Time Assessment

Fire response is an important element of fire preparedness. A timely fire response can ensure that fire personnel and equipment are available to perform offensive and defensive fire suppression actions before the fire becomes large or established within the built environment. The Fire Response Time analysis examines the fire response times to communities in Marin County from in-county fire agencies and out-of-county mutual aid. Network analysis is used to evaluate the response time to every structure in Marin County. This analysis helps to illustrate areas where the fire suppression capabilities are greatest and identify areas where fire resources may be delayed in relation to the fire spread.

Appendix N. Fuel Model Details

Surface fuel models are a wildfire behavior analysis-specific tool for characterizing the type, arrangement, and density of wildland vegetation. Fuel models are distinct from vegetation type or species alliance and other land-cover characteristics. Because fuel models are designed to characterize the fuel most likely to carry a fire, there is not a one-to-one relationship between fuel models and vegetation types. That is, a single vegetation type can be represented by multiple fuel models (for example, depending on the load and arrangement of dead and down material); conversely, a single fuel model can represent multiple vegetation types (e.g., lodgepole pine, jeffery pine, and mixed conifer forest types may all be represented with conifer litter surface fuel models). Therefore, determining the accuracy of a surface fuels dataset cannot be achieved by simply making a comparison with a vegetation type map or land-cover dataset. While certain vegetation types tend to correlate with certain fuel models, the specific conditions in a particular pixel will dictate the specific choice of fuel models.

A "fuels dataset" is a suite of overlapping geospatial layers used as inputs into standard fire behavior models, such as Flammap or Elmfire. While surface fuel classification is an important component of fire behavior analysis, canopy layers, including canopy base height, canopy cover, and canopy density, as well as topography layers such as slope, aspect, and elevation, also play a role in the analysis. These layers all work together to produce an anticipated fire behavior; combining these layers can result in nonlinear effects. For example, decreases in canopy cover can increase the midflame wind speed that the surface fuels experience.

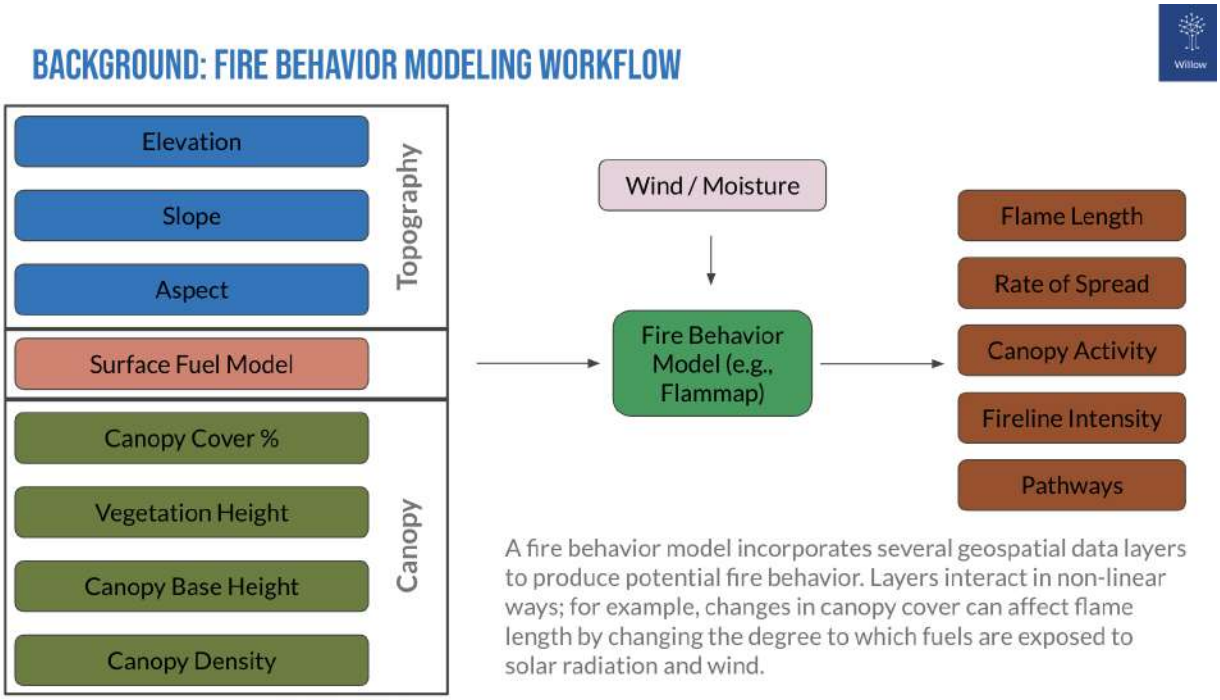


Figure N-1. Fire behavior modeling workflow. Geospatial data, including topographic, surface fuels, and canopy fuels layers are input into the fire behavior models along with a wind and moisture scenario to yield projected fire behavior characteristics. Input layers work in concert to yield accurate fire behavior assessments.

As part of the CWPP process, a new fuel model dataset was built and calibrated to reflect Marin County's landscape in 2025.

Following a detailed comparison of different fuel modeling and mapping approaches, the CWPP project team designed a framework for efficiently creating a new, Marin County-specific fuel model, leveraging local knowledge and county-specific datasets wherever possible. The new dataset was developed in four phases:

- **Landfire Base Dataset:** The new dataset uses Landfire as a base dataset. The Landfire project produces nationally consistent fuel model and vegetation structure datasets at 30-m resolution. These datasets are based on remote sensing and algorithms to characterize the fuels present in each pixel.
- **California Calibration:** The fuel model was calibrated for California using a series of expert workshops that included land and fire managers throughout the state. At these workshops, the fuel models were adjusted to better reflect the anticipated fire behavior for different vegetation assemblages in the state.
- **Local Data Integration:** The dataset was further refined to Marin County by integrating local fine-scale vegetation data. The Marin County Finescale Vegetation Map was used to provide

very detailed insights into specific vegetation types and lifeforms across Marin County. This dataset was used to adjust the fuel model to reflect local knowledge.

- **Staff Review:** Finally, the dataset was reviewed by fire agency staff and CWPP stakeholders to evaluate whether the anticipated fire behavior accurately represents anticipated conditions. A variety of comments were received, and systematic and point-specific updates were implemented to refine the dataset.

Comments and responses to the fuel model dataset are provided in **Appendix O. Homework Questions, Comments, and Responses**.

Appendix O. Homework Questions, Comments, and Responses

Table O-1 provides the list of fuel model comments and responses to the fuel model dataset provided in **Appendix N. Fuel Model Details**.

Table O-1. Comments and responses to the fuel model dataset.

Zone	Question / Comment	Answer
West Marin	Can we consider removing the data points from the lagoon area that has no vegetation? I'm concerned they could give the wrong impression and undermine public confidence in the program.	We are masking out water pixels based on United States Geological Survey (USGS) National Hydrography Dataset (NHD) data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: Feature Type (FTYPE) = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
San Rafael	Do the flame length models include canopy layer ignition, or is this just surface fuels?	Yes, flame lengths reflect any contribution of crown fire produced in the full set of weather scenarios used to run fire behavior modeling.
Novato	Please describe how the treatment layers were incorporated, and how the flame length and rate of spread values reflect those treatments. Should we include the treatment layers in tis initial pass through of the data?	Treatments typically reflect a change in surface fuel model and a reduction in canopy fuel - if it is present in the fuel mapping. The degree to which treatments change/reduce fire behavior has to do with the fuel type, treatment type, age of treatment, and severity of the treatment.
Novato	Which weather scenario was incorporated in the fuel model?	The flame length and rate of spread layers here are based on the weighted average fire weather for each location. The weighting reflects the probability of various fire weather conditions, emphasizing those that lead to high-spread fires. The result is a single value representing the season-long fire behavior tendency for that area. We'll be using this weighted average weather scenario for the CWPP outputs. The two weather scenarios traditionally included in MWPA modeling will still be available when looking at project or program planning.
Novato	Current conditions are not captured in either layer. This area is not dredged anymore, and the vegetation dries out relatively quickly.	Most of this area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.

Zone	Question / Comment	Answer
Central Marin	This located in an irrigated park	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated".
Central Marin	Located in the middle of the creek	We are masking out water pixels based on NHD data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: FTYPE = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
Central Marin	Located in the middle of the water	We are masking out water pixels based on NHD data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: FTYPE = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
Central Marin	This area is all irrigated grass	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated" and appears quite dry in available Environmental Systems Research Institute (ESRI) imagery too.
Central Marin	this area is all in the water and should not have flame lengths associated.	We are masking out water pixels based on NHD data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: FTYPE = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
Central Marin	This is a park with irrigated grass	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated" and appears quite dry in available ESRI imagery too.
Central Marin	This is located in the water. No flame lengths needed.	We are masking out water pixels based on NHD data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: FTYPE = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
Central Marin	Entire area located in the water.	We are masking out water pixels based on NHD data. NHDArea is used for ocean pixels and NHDWaterbody for freshwater. NHDWaterbody is filtered with the following query: FTYPE = SeaOcean. NHDWaterbody is filtered with the following query: FTYPE = Lake/Pond OR Reservoir.
Central Marin	Area located in a paved parking lot	This is a data limitation. Most of it was mapped as nonburnable apart from 4 pixels that were mapped as Urban Shrubland.
Central Marin	This area is located in a park with irrigated grass	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated".
Central Marin	Located in an irrigated park	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated" and appears quite dry in available ESRI imagery too.

Zone	Question / Comment	Answer
Central Marin	Mall Paved Parking lot	This is a data limitation. Most of it was mapped as nonburnable apart from 4 pixels that were mapped as Urban Shrubland.
Central Marin	Irrigated lawn at a park	Data limitation. These two pixels were mapped as "urban burnable"
Central Marin	100 Acre Undeveloped lot	The fire modeling shows potential for these fuels to threaten nearby structures
Central Marin	Redwood High Baseball and football fields	Data limitation. These 5 pixels are misclassified as burnable fuel.
Central Marin	High school baseball playing field	This is a data limitation. Most of it was mapped as nonburnable apart from a handful of pixels that were mapped as burnable.
Tiburon / Belvedere	Why is the flame length so high here?	This pixel is mapped as a Oak Woodland and Savanna vegetation type, with high cover according to the OneTam Vegetation inputs. It is capable of transitioning to crown fire under higher wind speeds/drier conditions/ steeper slopes.
South Marin	This area in 2025 has shown a few years of overgrowth with broom, grasses, and dense tree canopy. The is a bowl and would likely generate some significate fire growth potential. Why very limited flame lengths in the model?	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This area in 2025 has shown a few years of overgrowth with broom, grasses, and dense tree canopy. The is a bowl and would likely generate some significate fire growth potential. Why very limited flame lengths in the model?	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	Same as other point. Needed to add a smaller photo.	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	Why is this a large void area of DATA? Not sure what is here, but it looks like a gap in data.	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This area is mostly listed as 1' flame length, yet the lower 2/3s of this area of the freeway have been heavily overgrown for years with broom, grasses, dying pines, and coyote brush. these ladder into a spaced oak canopy upslope.	The 1-2' flame length area is mapped as vegetation type "Developed-Upland Evergreen Forest" with fuel characteristics that reflect a more "manicured" understory - mostly producing surface fires/underburn.

Zone	Question / Comment	Answer
South Marin	This is a steep area with a blend of light flashy fuels and shrubs that have been historically treated late in the year since 2020. Although partially treated annually, portions of the year have been reported to be overgrown. Why nothing?	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This is a steep area with a blend of light flashy fuels and shrubs that have been historically treated late in the year since 2020. Although partially treated annually, portions of the year have been reported to be overgrown. Why nothing?	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This area in 2025 has shown a few years of overgrowth with broom, grasses, and dense tree canopy. The is a bowl and would likely generate some significate fire growth potential. Why very limited flame lengths in the model?	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	These specific areas are mostly well-maintained green golf course lands. I don't see how this can have a flame length in a model. This is also an area the City of Mill Valley has determined to be a "TRA".	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated".
South Marin	This area is full annually of seasonal grasses (3-10") between a spaced mosaic of coyote brush (2-4'). I would image it to give a 3-8 foot flame length.	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This looks very accurate to the conditions of this area for the past two years. It was only just recently treated.	
South Marin	This area has had become heavily overgrown with broom, grasses, shrubs, and pampas since 2019. It was recently partially treated mid 2025.	
South Marin	This area is a green park field all year long. Does it need to be triggered by this model?	Despite efforts to identify and correct irrigated parks and fields as part of our methodology, this area persisted as "not irrigated" and appears quite dry in available ESRI imagery too.

Zone	Question / Comment	Answer
South Marin	This area is steep and has had a mix of seasonal grasses and French broom overgrowing for the past few years. Last treated in early 2024, it should likely show flame length.	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.
South Marin	This area is a hillside that has historically been untreated, grasses mixed with young oaks and coyote brush. Only ever treated on the perimeter.	
South Marin	Hillside community with limited adjoining fences. The hillside is mostly pampas and seasonal grasses with mixed shrubs. Gets high in the off season. We wonder why there is no flame length indicated here.	This area is mapped as "developed" in the vegetation maps, which is a non-burnable fuel type. We spread burn probability into this area but cannot show expected flame length/fire behavior for areas mapped without a burnable fuel model.

Appendix P. Data Sources

Table P-1 provides a list of all data sources used in the hazard and risk assessment analyses.

Table P-1. Data sources for the hazard and risk assessment analyses.

Dataset	CWPP Role	Category	Source Dataset(s)
Residential Structures	Values at Risk		Marin County Building Footprints Dataset, Marin County Assessor Parcels Dataset
Hazardous Materials Facilities	Values at Risk		California State Hazardous Waste Tracking System
Electric Substations	Values at Risk	Energy Facilities	Pacific Gas and Electric
Solar Footprints	Values at Risk	Energy Facilities	California Energy Commission
Transmission Lines	Values at Risk	Energy Facilities	U.S. Department of Homeland Security
Wastewater Treatment Plants	Values at Risk	Water Facilities	MarinMap, Marin Water
Water Pump Stations	Values at Risk	Water Facilities	Marin County GIS
Fire Hydrants	Values at Risk		MarinMap
Dams	Values at Risk	Water Facilities	U.S. Army Corps of Engineers

Dataset	CWPP Role	Category	Source Dataset(s)
Communication Infrastructure (cellular transmission, AM and FM transmission; broadband radio service and educational broadband service; digital television transmitters; paging transmission; mobile commercial transmission; microwave service; and other antenna structures and broadcast towers)	Values at Risk	Communications Facilities	U.S. Department of Homeland Security
Evacuation Routes	Values at Risk		Marin County AB747-Designated Evacuation Routes
Bridges	Values at Risk		CalTrans Bridges Dataset
Economically Vulnerable Communities	Values at Risk		California Climate Investments Priority Populations
Schools	Values at Risk		Marin County Schools Dataset
Medical Facilities	Values at Risk	Community Facilities	Marin County GIS
Fire Stations	Values at Risk	Community Facilities	Marin County GIS (Updated by OEM, 2026)
Linguistically Isolated Areas	Values at Risk		CalEnviroScreen
Historic Ignitions	Contextual Data		National Interagency Fire Center
Standing Dead Trees	Contextual Data		Marin Regional Forest Health Strategy
Firewise Neighborhoods	Contextual Data		Fire Safe Marin
Trails	Contextual Data		Marin County GIS
Fire Observation Cameras	Contextual Data		AlertWildfire
Rivers	Contextual Data		National Hydrology Datasets (NHD)

Dataset	CWPP Role	Category	Source Dataset(s)
Fire Return Interval Departure	Contextual Data		Marin Regional Forest Health Strategy
Lader Fuels	Contextual Data		Marin Regional Forest Health Strategy
Parks	Contextual Data		Marin County GIS
Roadless Areas	Evaluation Area		Marin County Roads Dataset
Blind Spots	Evaluation Area		AlertWildfire Camera Locations, USGS Digital Elevation Model
Drinking Water Headwaters	Evaluation Area		The Nature Conservancy California Drinking Water Source Watersheds