



The Corte Madera
Climate Change Adaptation Plan

November 2020





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The Town of Corte Madera is surrounded by scenic and idyllic natural beauty and nestled between the baylands of the Corte Madera Marsh – which include one of the oldest and least disturbed marshes in the Bay – and Mount Tamalpais – a forested reserve that provides unique biodiversity and supplies water for the region. Hillside and shoreline neighborhoods are connected by a thriving economic core anchored by the historic old town area and two shopping malls that service the region. Home to many long-term residents, Corte Maderans care deeply about their community and its future.

The town's way of life and future is at risk from climate change. Much of the hillside region of the town is located in the Wildland Urban Interface (WUI), and recent wildfire seasons have demonstrated that no areas are truly safe from wildfires and smoke. Catastrophic wildfires can occur in the region at any time, putting the health, safety, homes, and infrastructure of the community at risk. The shoreline neighborhoods, built post-WWII on bay fill, are subsiding, facing rising sea levels, and experiencing king-tide and storm-drive flooding. Extreme rainfall from atmospheric rivers dump water faster than stormwater systems can direct it to the Bay. Town-wide, extreme heat – especially when combined with public safety power shut-offs – poses risks to older residents and those with chronic health conditions. As the climate changes, all of these risks are increasing.

Yet, despite these risks, Corte Madera is also presented with opportunity; the Town is on the forefront of adaptation planning in Marin county and the North Bay region. It is building on the extensive foundation of climate change science and risk studies and is taking action based on best practices. A town that faces real and serious challenges in ensuring the near- and long-term health and safety of all its community members, it recognizes that for the next generation of Corte Maderans, the community will likely look very different from today.

Building climate resilience is a process and not the outcome of a single project. It will require ongoing collaborations, partnerships, and investment.

The time for taking action is now! Thinking holistically about the risks of climate change and the opportunities for action is critical if the Town and the region are going to develop solutions that meet the scale of the challenge. Corte Maderans, Town Staff, and the Town Council all know this and have begun discussing, understanding, planning for, and taking action to adapt to climate change. By being proactive and investing now, the Town can help build community resilience and support the physical, mental, and social health of its residents. This goes beyond being prepared for future events and includes making investments in the everyday quality of life for residents, non-resident workers, and visitors. If done well, this effort can also provide extensive environmental and economic benefits to the community.

This plan serves as a roadmap for the Town and community; it lays out the steps necessary to address ever increasing climate challenges. However, the completion of this plan does not mean the Town has accomplished its resilience goals. ***Building climate resilience is a process and not the outcome of a single project. It will require ongoing collaborations, partnerships, and investment.*** By bringing people together, breaking down silos between sectors and departments, thinking creatively and boldly about solutions, and prioritizing near-term collaboration and early investments, the Town can continue to be a regional leader in developing and implementing flexible, robust, and equitable climate adaptation strategies.

CORTE MADERA IN CONTEXT

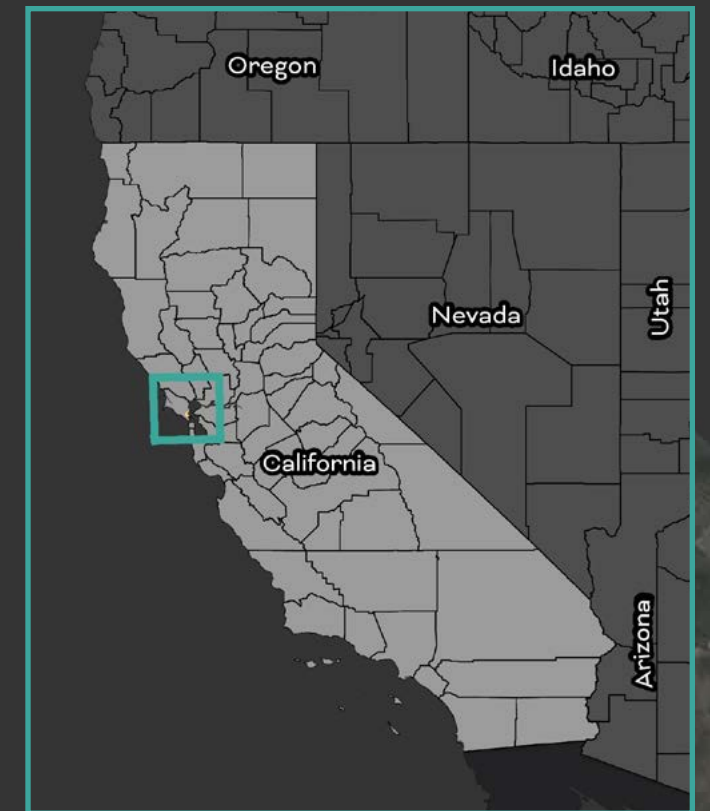
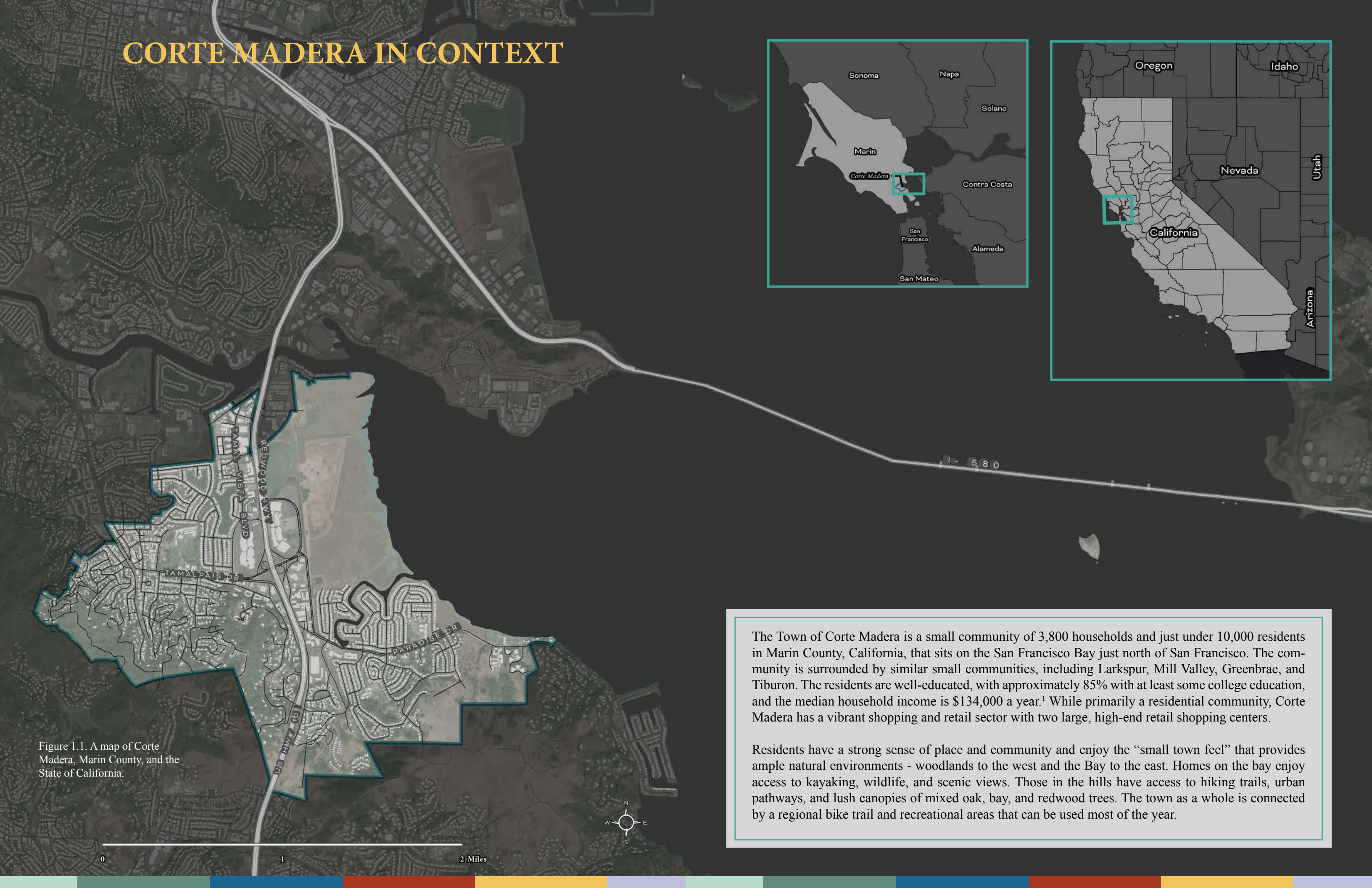


Figure 1.1. A map of Corte Madera, Marin County, and the State of California.

The Town of Corte Madera is a small community of 3,800 households and just under 10,000 residents in Marin County, California, that sits on the San Francisco Bay just north of San Francisco. The community is surrounded by similar small communities, including Larkspur, Mill Valley, Greenbrae, and Tiburon. The residents are well-educated, with approximately 85% with at least some college education, and the median household income is \$134,000 a year.¹ While primarily a residential community, Corte Madera has a vibrant shopping and retail sector with two large, high-end retail shopping centers.

Residents have a strong sense of place and community and enjoy the “small town feel” that provides ample natural environments - woodlands to the west and the Bay to the east. Homes on the bay enjoy access to kayaking, wildlife, and scenic views. Those in the hills have access to hiking trails, urban pathways, and lush canopies of mixed oak, bay, and redwood trees. The town as a whole is connected by a regional bike trail and recreational areas that can be used most of the year.



Figure 1.2. Early development in Cortes Madera in 1926. © Cortes Madera Memories

The history of development within the town is also a story of increasing climate vulnerability. Early development in the area occurred at the base of the hills on the drier, upland edges of the marsh. The railroad at the time roughly corresponds to what is now Highway 101, crossing the marshes and Cortes Madera Creek. With the development of the Golden Gate Bridge and the post-WWII housing boom, there was a dramatic increase in homes and businesses in Cortes Madera within the next few decades. Without strategic planning or strong policies in place to address this increased level of development, homes were built in the hillsides to accommodate the town's growth. As Mariner Cove and Marina Village were developed east of the railroad, levees were constructed to protect low-lying areas from flooding, and in other areas, fill was placed to raise the ground elevation under homes (see Figure 1.3).



Figure 1.3. Low-fill (A) and high-level fill development (B) progression from the 1960's in Cortes Madera. © Cortes Madera Memories

DEVELOPMENT IN CORTE MADERA



Today, Cortes Madera has a mix of neighborhoods both built up and into the hillsides and out along the bay. A legacy of preserved marshland is a significant asset for the community. Highway 101 passes through the center of the town, making it a key piece in the regional transportation network and providing easy access to the two shopping centers.



1

planning for climate change

THE PLAN

Plan Phases

The Corte Madera Climate Change Adaptation and Resilience Plan was completed over two years (January 2019 - February 2021). Over the course of those 25 months, Town staff, the Resilience Advisory Group (RAC), and community members progressed through five key phases to develop the adaptation roadmap and actions highlighted in this plan.



Figure 1.4 - The five phases of the Corte Madera Adaptation and Resilience Plan.

Plan Vision

One Town. One Region. Resilient Together.

The project envisions “*One Town. One Region. Resilient Together.*” The Town, surrounding communities, Marin County, and the entire region must work together to enhance resilience and successfully adapt to climate change. Climate change exposures and risks do not respect jurisdictional boundaries. Similarly, people move between home, work, and leisure, many traversing Highway 101, which connects the Town to the North Bay and San Francisco. Building resilience requires incorporating the interconnectedness of the region in local planning and action.

Guiding Principles

Resilience planning requires a broad-based, holistic, and interdisciplinary perspective that considers people, the environment, and local infrastructure. The health, vitality, and wellbeing of the community depends on all of these components seamlessly working together. Five guiding principles have helped inform the development of this plan.

- *Now is the time for action.* While investments likely need to be phased in over time, it is critical to start taking action now. This plan provides the details on an adaptation program for the next five years and a roadmap for the next few decades that can be used to guide the Town’s actions and investments to support resilience.
- *Collaboration, networking, and learning are critical.* Adaptation is a process, not the outcome of a single project. Bringing together local and regional partners to develop solutions and learn from each other is critical to success. Having the right partners at the table will help design, fund, and implement solutions. This paradigm of collaboration permeates all aspects of this plan and the work that the Town intends to do over the next three decades.
- *Investments in resilience should be cost effective and provide multiple benefits.* When balancing where and when to make investments, the Town will identify benefits provided by each investment. Ideally, these investments will be cost effective, and the values provided will be commensurate with the scale of the challenge and will enhance the resilience of the community as a whole, especially for those who have been historically marginalized and have fewer resources.
- *Flexible, nature-based solutions are preferred.* It is important to explore nature-based or hybrid adaptation solutions that both provide multiple benefits and can adapt (or be adapted) to changing conditions over time. These flexible solutions can be more cost-effective and scalable over time.
- *Taking the Long View.* Continued investments, attention, and commitment to the vision, goals, and actions of this plan are needed to achieve success. This plan should be reviewed and updated regularly, especially when conditions and scientific understanding changes or improves. The Corte Madera of the future may not look like it does today, and decisions made now will determine whether the Town will remain a vibrant and thriving community.



GOAL 1

Protect the health, safety, and wellbeing of all town residents, visitors, and workers by focusing on preparedness and prevention.

Protecting the health and safety of people, both now and in the future, includes supporting risk reduction, emergency preparedness, response, recovery, and improvements to everyday quality of life.



GOAL 2

Incorporate resilience and equity into all of the Town's plans, policies, and projects.

Historically disadvantaged and underserved front-line members of the community experience the first and worst impacts of climate change. To successfully build resilience, actions must meet the needs of community members who face the greatest climate impacts with the least resources. Normalizing consideration of both climate change and equity in Town planning and actions is a crucial component of enhancing resilience.



GOAL 3

Increase community awareness about the urgent need to take action and prepare for climate change.

An informed community can help create and implement strategic and effective solutions.



GOAL 4

Bring the community, neighboring towns, and the region together to plan and fund actions to build resilience.

Multi-jurisdictional collaboration requires effort and attention. This collaboration is critical to the success of the broader resilience initiatives.

Plan Goals

Building on the Guiding Principles, the goals were established through community engagement and refined over the course of the project to reflect the Town's values and interests.

PLANNING APPROACH

Local and State Policy Context

The Town of Corte Madera's goals and efforts to address climate change align closely with various state adaptation and resilience policies. First and foremost, the Town of Corte Madera's Adaptation Plan aligns with the Executive Order (EO) B-30-15, a major backdrop for state and regional adaptation planning.² EO B-30-15 directs and provides guidance to state agencies to integrate climate change into all planning and investment, including accounting for current and future climate conditions in infrastructure investment and suggests local governments develop climate plans that address climate change adaptation.³ California state law also requires each municipality and county to adopt a comprehensive, long-term general plan to guide development, and in October 2015, the governor signed Senate Bill 379 into law, which went into effect January 1, 2017. SB 379 adds a safety element requirement to the general plan that addresses "climate adaptation and resiliency strategies" and states that the updates must include a "set of adaptation and resilience goals, policies, and objectives" and "a set of feasible implementation measures designed to carry out the goals, policies, and objectives."⁴ The safety element of the Town's current general plan (2009) will need to be on before January 1st, 2022.^{5,6} Through this Adaptation Plan, the town meets SB 379 requirements in advance of that date by housing the prescribed climate adaptation and resilience elements in a stand alone document that can be incorporated into the next general plan.⁷

This Climate Adaptation Plan should be incorporated into the Town's next general plan by reference to satisfy the requirements of Senate Bill 379.

The plan also aligns with the mandates of Senate Bill (SB) 264, which brings together state and local government, non-profit and private sector practitioners, scientists, and community leaders to develop and help coordinate holistic strategies that better prepare California for the impacts of a changing climate at state, regional, and local levels.^{8,9} The Adaptation Plan also bolsters the Town's adherence SB 1035 which, similar to SB 379, requires local cities and counties include and regularly update climate adaptation and resilience and new information relating to flood and fire hazards in the housing elements of their general plans including a vulnerability assessment, a set of goals, policies, and objectives for the protection of the community, and a set of feasible implementation strategies.¹⁰ Drafted in 2015 and updated every 8 years, Corte Madera's current housing element addresses planning through the year 2023 and is drafted to be consistent with all other elements of the 2009 general plan.¹¹

Further, the Adaptation Plan's goals align with SB 2800 which provides support for climate-smart infrastructure. Through July 1, 2020, this policy required state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure.^{12,13} It also aligns with SB 1, an infrastructure bill that includes provisions for improving environmental outcomes for state infrastructure projects.¹⁴

Several state policies provide guidance on how local jurisdictions can continually consider all aspects of adaptation and resilience, including social equity and environmental justice. A unique state policy, California's SB 1000 requires environmental justice to be addressed in local government planning, and the California Environmental Justice Alliance (CEJA) and PlaceWorks' "SB 1000 Implementation Toolkit" provides best practices for promoting meaningful community engagement.^{15,16}

Building on Regional and County Assessments and Planning

This plan has been informed by broader regional and county-wide work on climate change. It expands upon the Town's involvement in the Marin Bay Waterfront Adaptation Vulnerability Evaluation (BayWAVE). BayWAVE is a major collaborative effort among county, cities, special districts, and others to provide a detailed vulnerability assessment that evaluates the extent of impacted assets and work with local cities and towns to plan implementation of adaptation strategies.¹⁷ As a part of the BayWAVE project, the Town of Corte Madera also participated in drafting the Adaptation Land Use Planning: Guidance for Marin County Local Governments which explored cross-jurisdictional sea level rise impacts and appropriate adaptation land use planning approaches that could be considered by multiple local governments and unincorporated areas.¹⁸ This plan also aligns with the update to the Marin County Multi-jurisdictional Local Hazard Mitigation Plan that includes all of the towns and cities within Marin County.¹⁹

The Plan's focus on the vulnerability and adaptive capacity of local transportation systems complements the Marin County Department of Public Works' Highway 1 Corridor project that examines adaptation options addressing sea level rise and current flooding at Highway 1 and on the Mill Valley-Sausalito Trail in Southern Marin. It also complements Caltrans and North Bay partner's State Route (SR) 37 Corridor Plan that proactively identifies possible adaptation opportunities for transportation networks and natural ecosystems for the SR 37 corridor.^{20,21}

For more detailed information on adaptation projects happening in the Bay area, check out the Bay Area Climate Adaptation Network (BayCAN) website where you can learn about the hundreds of projects and programs being spearheaded by BayCAN members to address sea level rise, wildfires, extreme heat, drought, and other climate impacts.²²

Regional Collaboration

The complex nature of land jurisdiction and ownership in and around Corte Madera highlights the need to focus on collaborative approaches to monitoring, implementing, and evaluating any and all adaptation work. Often-times, different areas are governed by overlapping regulatory jurisdictions and require coordination for project planning, permitting, and development.

Below is a list of agencies and municipalities who will likely need to be consulted or involved in future adaptation planning:

- Larkspur
- Mill Valley
- Greenbrae
- Sonoma-Marin Rail Transit (SMART) District
- San Francisco Bay Conservation and Development Commission (BCDC)
- Marin Audubon Society
- Transport Authority of Marin (TAM)
- Golden Gate Bridge, Highway, and Transportation District (GGBHTD)
- California Department of Fish and Wildlife (CDFW)
- Association of Bay Area Governments (ABAG)
- Marin County Parks and Open Space
- Ross Valley Watershed District
- San Francisco Bay Regional Water Quality Control Board
- United States Army Corps of Engineers (USACE)
- National Marine Fisheries Service (NMFS)

Stakeholder Engagement Process

Stakeholder engagement was a central component of developing the Town’s Climate Adaptation Plan, and participants included a range of the municipal departments, local and regional organizations, environmental stakeholder groups, businesses, and homeowners. There were three levels of engagement:

- Community-wide activities appropriate for all members of the general public and other stakeholders;
- Partner meetings designed to gather and vet ideas with special interest groups and invested stakeholders such as CalTrans and the County of Marin; and, a
- Representative community and technical advisory committee with individuals from the Town, businesses, the school district, and county and regional agencies known as the Resilience Advisory Committee (RAC).

The Town developed an outreach and engagement plan to ensure the broadest possible level of participation in the planning process. The Outreach Plan outlined a range of activities and timeframe for stakeholder engagement activities. To help increase engagement, the Town offered multiple methods of feedback and learning opportunities for community members. It should be noted that the COVID-19 pandemic significantly impacted these planned activities, and all engagement after March of 2020 was held virtually. The process graphic below illustrates the general timeline and type of activities that were held. In all, there were over 1,000 various touches with the community.

- **Community-wide activities** included 4 workshops, two of which were online due to COVID-19, a project website (www.cortemaderaadapts.org), an online survey, newsletter and media outreach, a “storymap” detailing existing plans and projects (700+ views), and a community feedback survey.
- The **Resilience Advisory Committee** met six times throughout the project to review technical information and refine questions and materials designed to collect effective community feedback.
- The **Town Staff and Partners** met at several key junctions to inform the existing social, environmental, economic conditions within the town and provide feedback on and recommendations for potential projects and strategies.
- Town Staff presented to **Marin BayWAVE** and **Town of Corte Madera Flood Board**.
- The **Town Council** was updated on progress throughout the process.

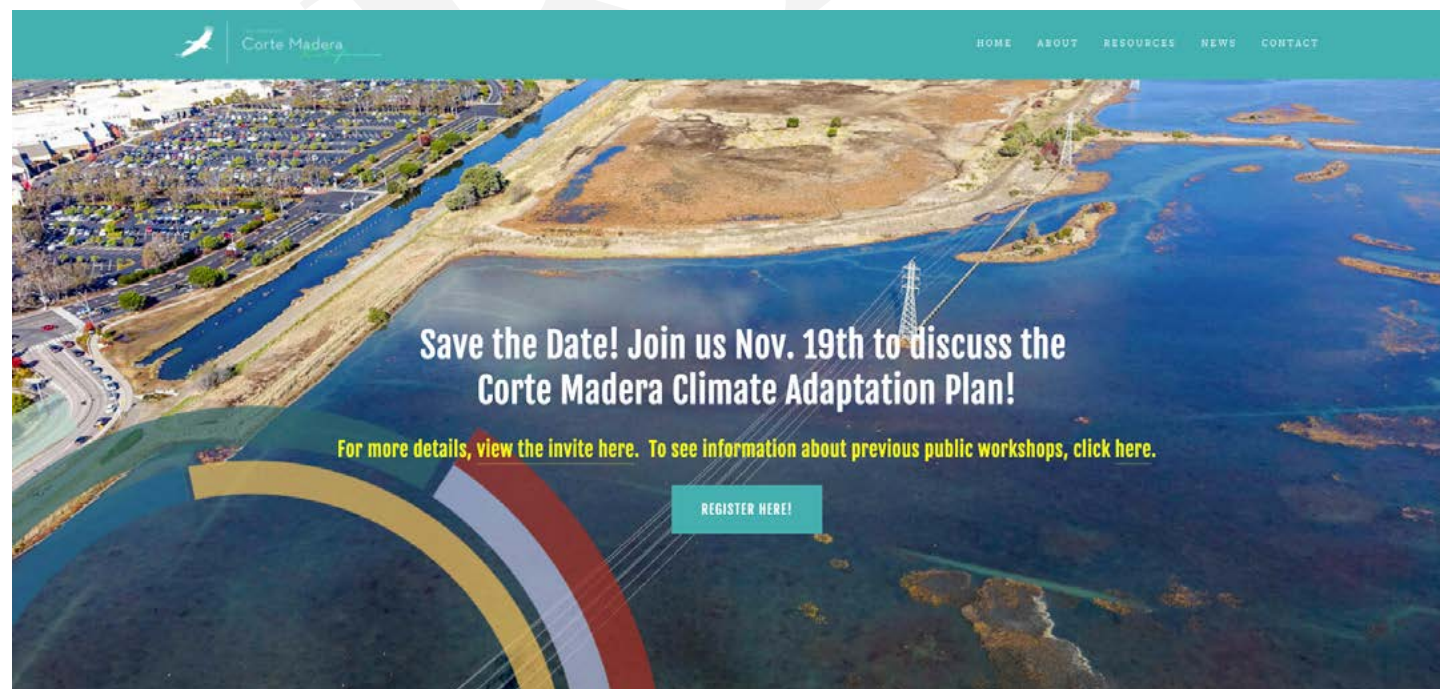


Figure 1.5 - A screenshot of the landing page on the Corte Madera Adapts website.

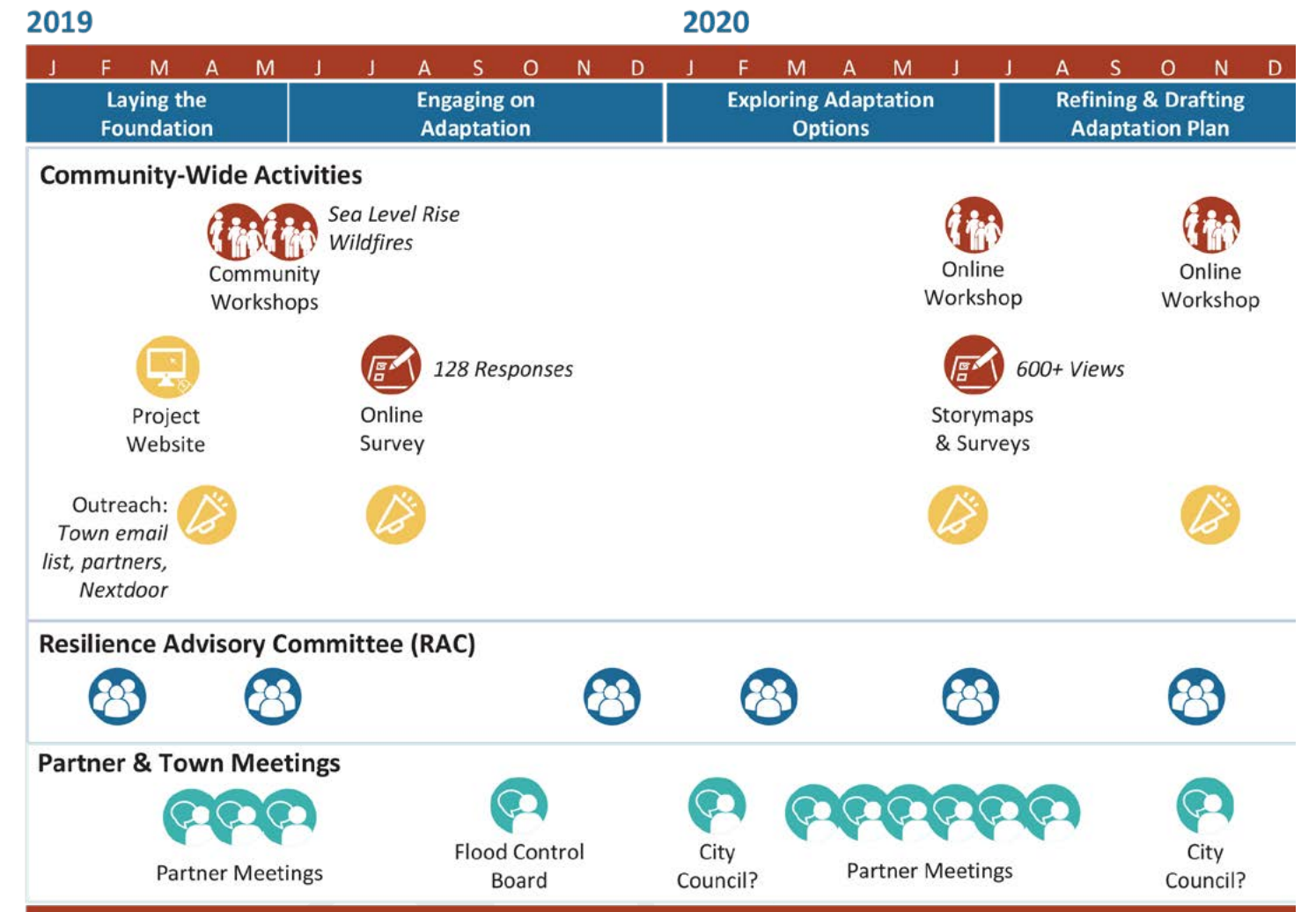


Figure 1.6 - A high-level overview of the stakeholder engagement activities and timeline for the Corte Madera Plan.



RAC meeting, February 2019 in the Town of Corte Madera council chambers. © Sascha Petersen

Understanding Town and Community Values

It is clear from conversations with the Resilience Advisory Committee and community members that Corte Madera is proud of their Town, love the “small town feel” and proximity to nature, and recognize their responsibility to be proactive in response to the climate crisis.

In the initial phase of this project, the project team conducted a survey²³ that received 128 responses. Of the total respondents, 72% were very concerned about climate change and 90% thought that climate change was either already affecting the community or would affect the community in the next 10 years. The top three concerns of respondents (identified by the number of people who ranked the issues as something they were “very concerned” or “concerned” about) were wildfires, sea level rise, and flooding from heavy rainfall. More than 50% of respondents felt that it was important to ensure that critical services and community members were resilient.

The Adaptation Library

The adaptation library serves as the foundation for the adaptation plan. In order to create a detailed adaptation program for the Town, actions relevant to local climate exposures were gathered from local, regional, state, national, and international plans as well as adaptation guidance documents, reports, and literature. These actions were then customized to fit Corte Madera’s needs and reviewed by Town staff and local experts. Actions in the library fall into three main categories of Policies, Programs and Projects.

- **Policies:** Locally-adopted regulations, rules and procedures can provide a foundation for a more resilient town. Policies are generally vetted through the Town Council, and require layers of approval before they can be implemented.
- **Programs:** The Town and its partners can develop, maintain, and implement a range of programs that can bring the community together, solidify a commitment to resilience, and offer the critical human component to fighting climate crises.
- **Projects:** Some of the Town’s most critical adaptation solutions will require changes to the physical environment or infrastructure. Often these efforts take more time and investment from the Town and regional partners.

Much like how multiple cords braided together create a stronger rope, braiding programs, policies, and projects together creates a stronger, longer-lasting, and more effective effort to build resilience (see Figure 1.7).



Figure 1.7 - A graphic representing how Policies, Programs, and Projects can be braided together to strengthen the Town’s efforts to build resilience.

Evaluating Adaptation Actions

The evaluation process used to identify high priority actions is based on the United States Agency for International Development (USAID) framework for evaluating adaptation options.²⁴ Figure 1.8 illustrates the evaluation process, different screening “tiers,” and possible outcomes. The Tier 1 screening focuses on a quick assessment of cost, feasibility, and effectiveness of the adaptation options being considered in light of the Town’s goals and needs. Actions that are not discarded based on this screening are reviewed in more depth and rated across three evaluation criteria: effectiveness, efficiency, and feasibility in Tier 2. Actions that score well across all three criteria are particularly relevant and a great fit for the Town. These actions are “expedited” and moved to the final customized library. Adaptation actions, or groups of actions, that need additional detailed evaluation or further comparison are passed through the Tier 3 screening process. This detailed analysis focuses on initial cost estimates, feasibility in specified locations, and the effectiveness of selected alternative investments.

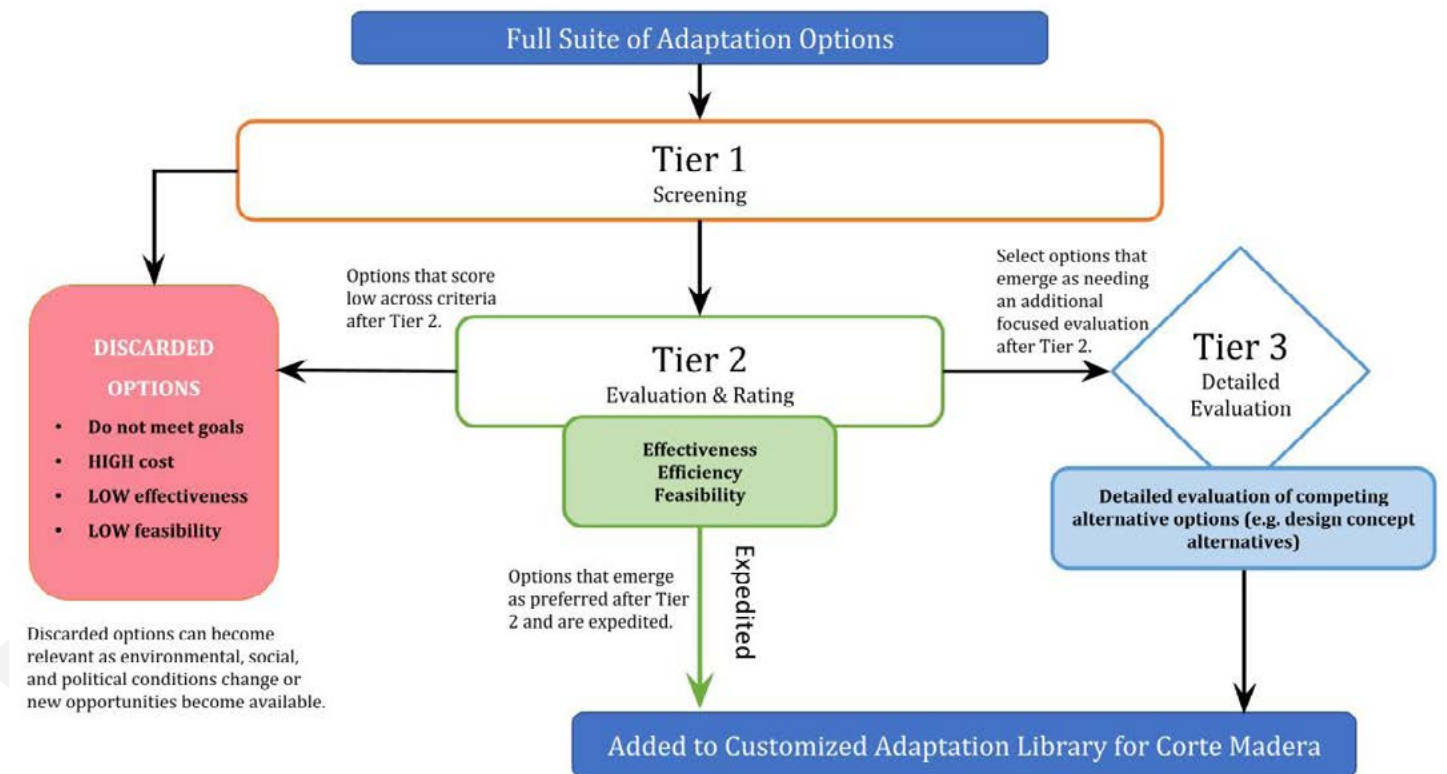


Figure 1.8. This figure illustrates the evaluation process for adaptation actions through Tier 1, Tier 2, and possibly Tier 3 screening.

Evaluation Criteria

In the Tier 2 screening process, each action was scored 1-5 for each of the three main criteria to determine relative rankings for individual actions. These criteria were selected based on the Town's input, published literature, State-wide adaptation and resilience efforts, and leading examples of resilience work in other parts of the world.^{25,26}

Effectiveness: *The extent to which the action achieves the desired outcomes.* The criterion considers how well the actions limits the short- and long-term impacts of climate change, the ability of the action to help meet the Town's goals, how well it prepares the town for the future, and whether it is commensurate with the exposure and the need.

Efficiency: *The extent to which the action makes efficient use of resources including funding, expertise, and staff time.* This criterion considers whether the direct, indirect, and external costs of implementing the action are balanced by the community, social, environmental, and economic benefits and whether it is equitable to all residents.

Feasibility: *The extent to which the action can successfully be implemented.* This criterion considers whether an action can actually be implemented and whether there is the current specific institutional, technical, community, and political setting and characteristics to be successful.

Adaptation Pathways Approach to Planning

Planning for climate change requires a shift in traditional planning approaches and requires the consideration of multiple possible outcomes and pathways to reach them. The adaptation pathway approach to planning can help local governments plan for multiple potential futures with differing environmental, social, and economic conditions. Additionally, the pathways approach helps address uncertainty by exploring the robustness, flexibility, and feasibility of various adaptation alternatives across multiple temporal and spatial scales and environmental conditions. Details on the specific adaptation pathways created for Mariner Cove & Marina Village as well as the Marsh and Railroad Right of Way can be found in the Shoreline section starting on pg. 54.

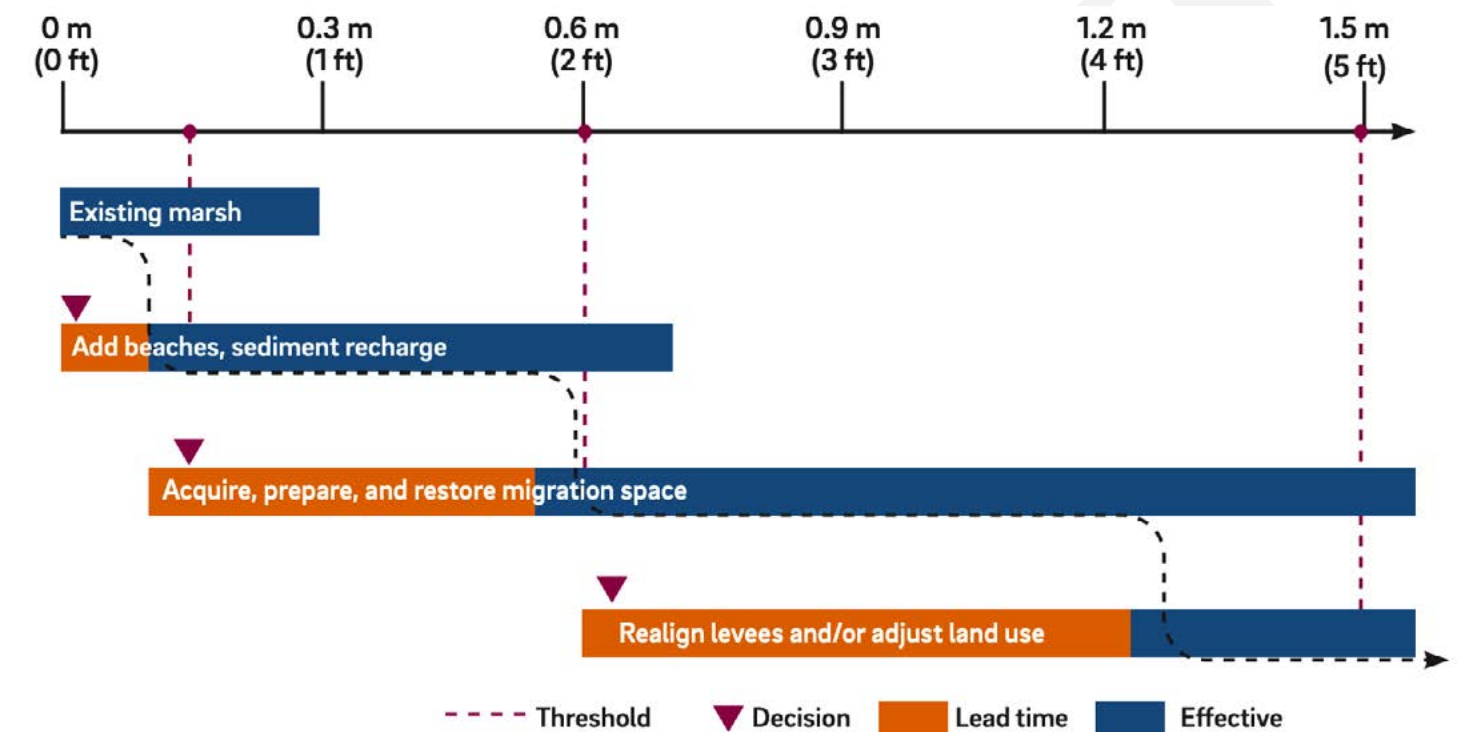


Figure 1.9. This graphic depicts an adaptation pathway approach to planning, which includes the conceptual phasing of actions with certain triggers (SLR in this example) rather than by a chronological timeline. Illustration from SF Bay Shoreline Adaptation Atlas (SFEI & SPUR, 2019).

The timeframe for planning and implementing different adaptation strategies varies greatly across strategies and locations. For example, the time to plan, permit, design, and build a levee takes much longer than it does to implement a change in building code or municipal ordinance. While some adaptation actions highlighted in the plan can stand alone, many of them are most effective when implemented concurrently with other actions. Some actions are contingent on particular decisions and are only effective if implemented before or after other actions. It can be important to identify “triggers” and “thresholds” associated with certain pathways or individual actions that can determine when a policy or project will become ineffective. Certain actions may only be effective for a discrete period of time or until particular environmental conditions are met or exceeded. For example, a levee may protect infrastructure until a particular amount of sea level rise, at which point it may be overtopped during a 100-year storm event.

The main function of the adaptation pathway approach is to develop strategies that are robust for the most likely future scenarios and/or can be modified or adjusted at key junctures in the future. It is essential to identify in advance how these changes would be implemented and when these changes would need to occur.²⁷ This approach can help the Town plan for, prioritize, and stagger investment.

Strategic Planning in Corte Madera

Adaptation and resilience planning in Corte Madera requires a long-term, cross-sectoral, and multi-layered approach. While some actions will need to be taken in specific locations, many others will need to be implemented with the whole community in mind. The subsequent sections of the report focus on specific climate exposures that are particularly relevant to the hillside, shoreline, and central Corte Madera focus areas of the town. These location-hazard pairs (hillside-wildfire, shoreline-coastal flooding, and central-inland flooding) allow for detailed consideration of the exposures and concerns specific to each area. The Town as a whole faces an interrelated mixture of climate exposures (see pages 22-35 for more information), therefore the full suite of adaptation actions in the following actions were chosen to address specific hazards more broadly, and in some cases, help the Town address multiple hazards at the same time.

Adaptation actions highlighted in each focus area (see Figure 1.10 for the three focus areas) are nested within key pillars of action and are described in more detail in the respective sections of the plan.

Town-wide Actions (pages 36-53):

- 1) Health and Wellness
- 2) Emergency Preparedness
- 3) Resilient Infrastructure
- 4) Collaboration

Shoreline Actions (pages 54-95):

- 1) Protect
- 2) Accommodate
- 3) Retreat

Hillside Actions (pages 96-121):

- 1) Evacuation
- 2) Wildfire Mitigation
- 3) Protection
- 4) Education

Central Corte Madera Actions (pages 122-137):

- 1) Collaboration
- 2) Protection

The full suite of high priority actions is extensive, and only some actions can be featured in each section of the report. The featured actions highlighted in each focus area demonstrate the depth and breadth of types of actions the Town can take but are not the only important (or most immediate) actions. The full suite of actions and more detailed information on each action can be found in Appendix X and are referenced throughout the plan.

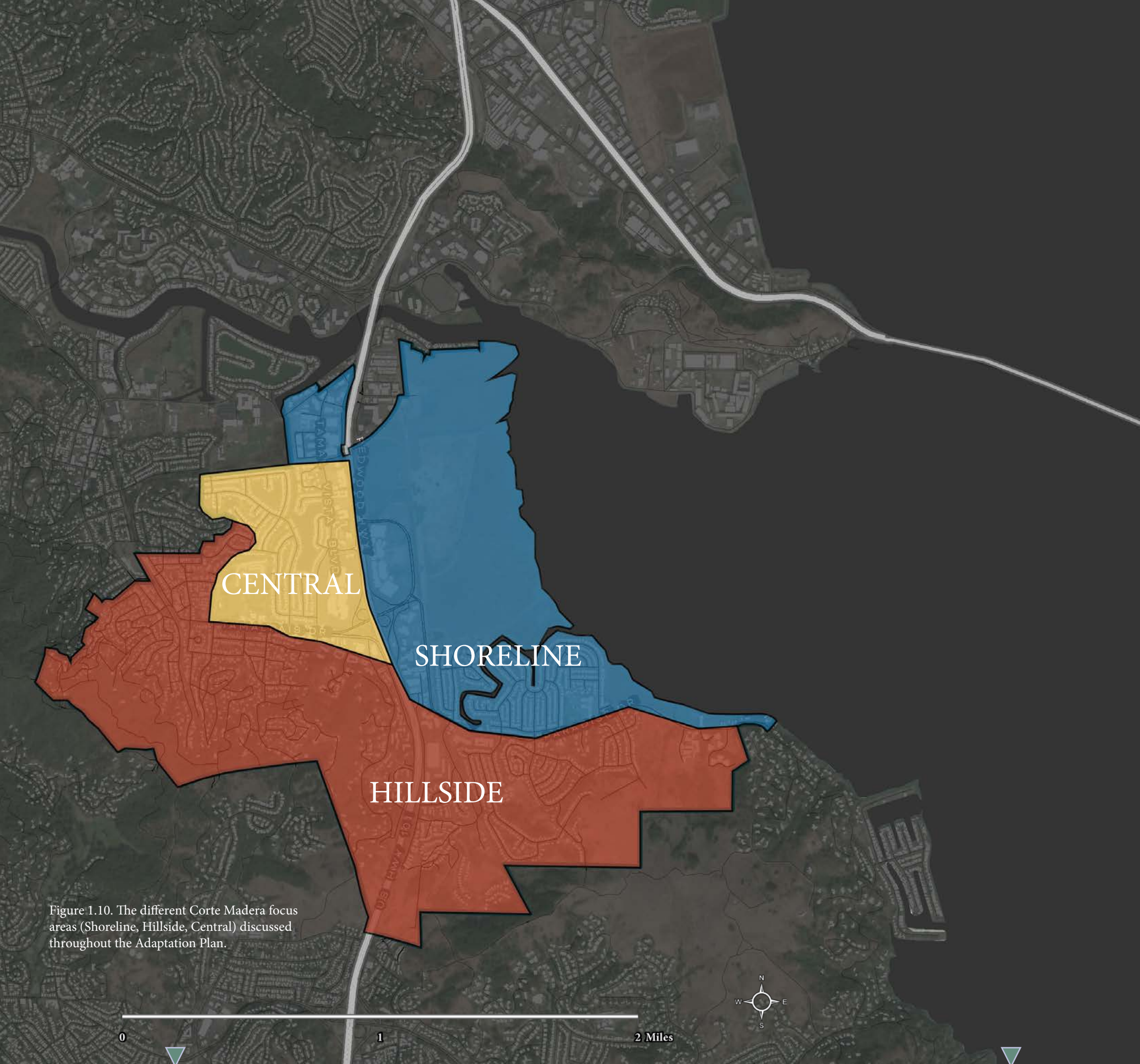


Figure 1.10. The different Corte Madera focus areas (Shoreline, Hillside, Central) discussed throughout the Adaptation Plan.

CLIMATE CHANGE AND CORTE MADERA

The Town of Corte Madera is already experiencing the effects of climate change, and projections indicate that these impacts will continue to worsen throughout the century. This increase in climate impacts poses significant immediate, medium-term, and long-term risks to the community's health, safety, economy, ecosystems, and infrastructure. The Bay Area's average annual maximum temperature has increased by 1.7 degrees Fahrenheit from 1950 to 2005 and will continue to increase creating a cascade of additional impacts that vary in severity, scale, certainty, and timing including the immediate and unpredictable risk of wildfire and the long-term and unavoidable sea level rise.²⁸

Climate vulnerability is dependent on three key factors: climate exposure, sensitivity, and adaptive capacity.^{29,30} The way these components interact determines the vulnerability of the people, assets, and ecosystems at risk.

- **Climate Exposure** - an extreme weather event or changing climate condition that can adversely affect people, livelihoods, species, ecosystems, environmental functions, services, resources, infrastructure and economic, social, and cultural assets.
- **Sensitivity** - the degree to which one of these components is affected by a climate exposure.
- **Adaptive Capacity** - the ability to adjust to potential impacts, take advantage of opportunities, and respond to climate exposures.
- **Vulnerability** - the degree to which something is susceptible to the adverse effects of climate change.

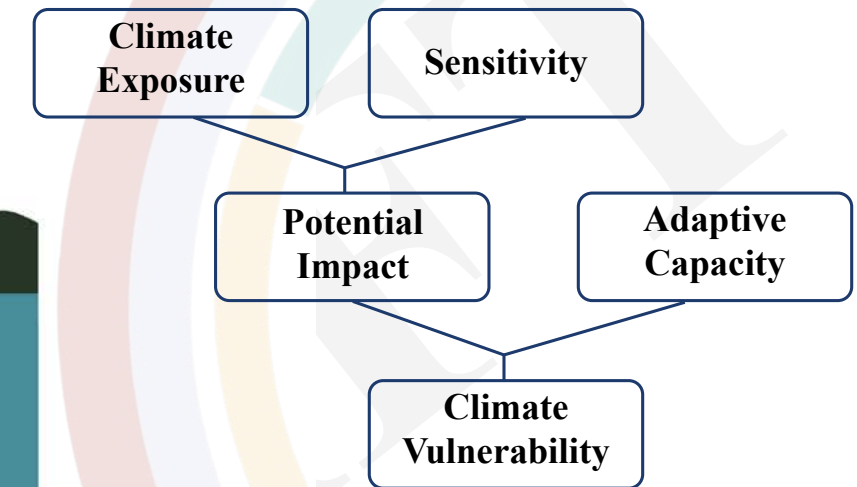
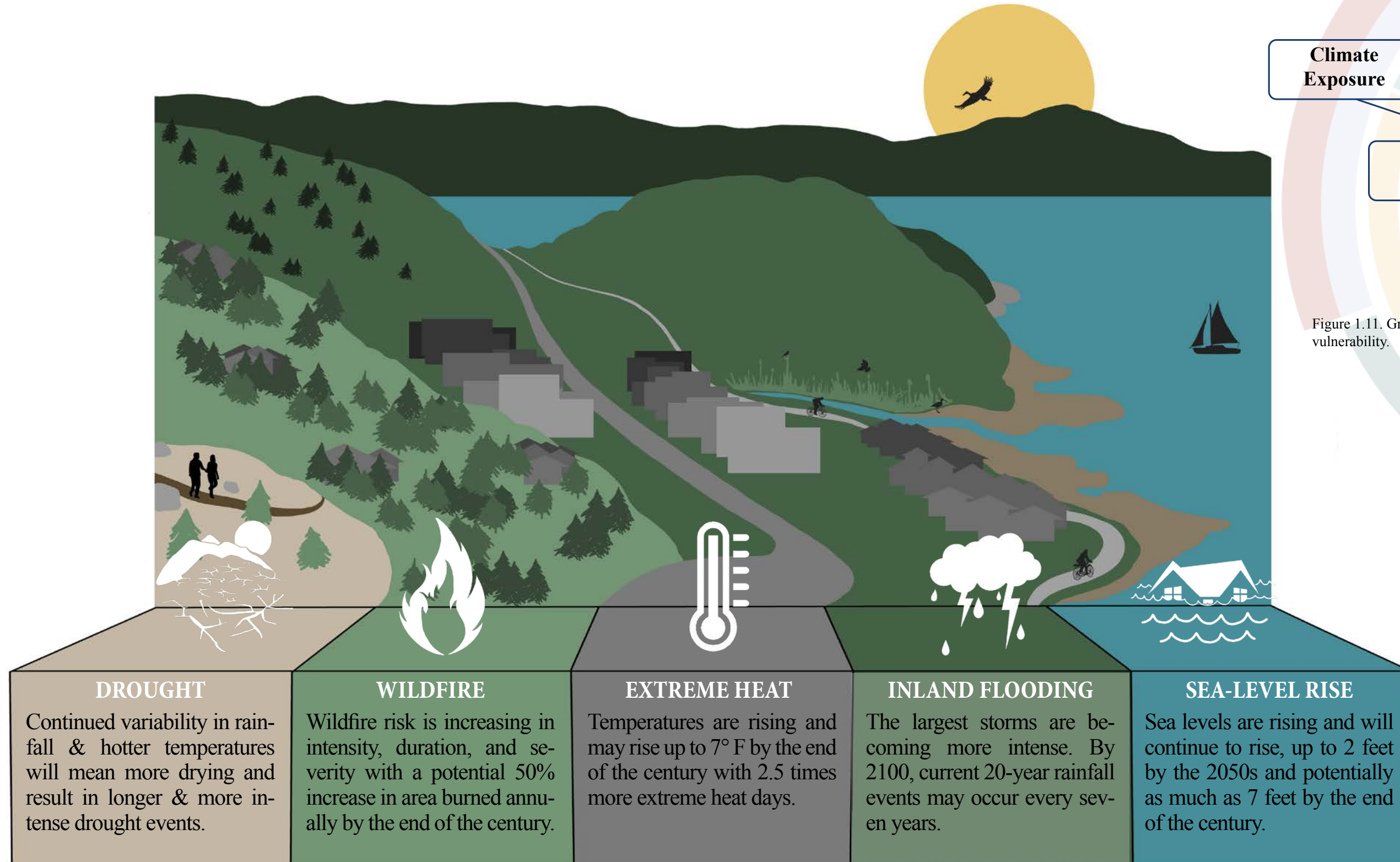
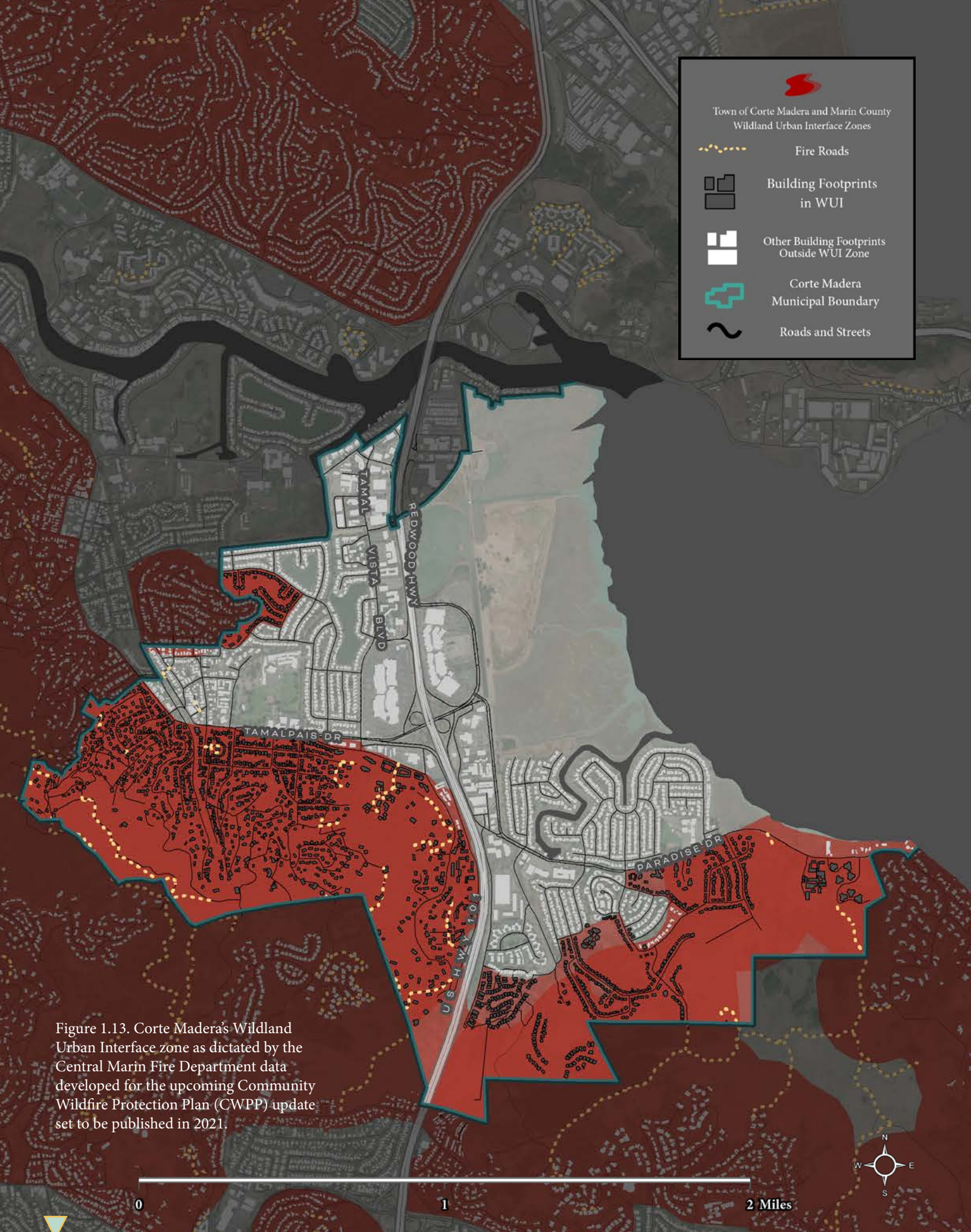


Figure 1.11. Graphic representation of the components of climate vulnerability.

Figure 1.12. Climate exposures summary for Corte Madera. Climate projections are based on the "business-as-usual" scenario (RCP 8.5).



Town of Cortez Madera and Marin County
Wildland Urban Interface Zones

-  Fire Roads
-  Building Footprints in WUI
-  Other Building Footprints Outside WUI Zone
-  Cortez Madera Municipal Boundary
-  Roads and Streets



Wildfire

In the past few decades, there has been a significant increase in the number of wildfire ignitions, acres burned, and harmful impacts to humans and ecosystems in California.³¹ Fires are becoming hotter, more severe, and more deadly.³² Recent studies suggest that climate change has rendered the concept of a “fire season” in California obsolete — major wildfires can happen at any time throughout the year and areas previously considered to be low-risk can experience major wildfires. A 2019 study³³ showed that, due to changes in the North Pacific jet stream, the correlation between winter rainfall and the severity of the fire season can no longer be made.³⁴ In addition, according to the California Climate Assessment, the average area burned statewide could increase 77% by 2100 if greenhouse emissions continue to rise.³⁵

Wildfire risk in Cortez Madera is significant due to several important factors: its unique climatic, topographic, and geologic attributes; ongoing longer and more

severe droughts; current and historical fire-suppression policy in California; County-level environmental policies that support vegetation growth in Marin County;³⁶ population growth in the Wildland Urban Interface (WUI); and, the exacerbation of the frequency, intensity, and severity of wildfires across California due to climate change.³⁷ Wildfires are also exacerbated by factors such as a reduction in annual snowpack, decreasing water supply, and rising temperatures across the region. A wildfire in the Cortez Madera community would put lives at risk and likely destroy homes and other infrastructure. Additional adverse impacts to the Town include poor to hazardous air quality, public safety power shutoffs (PSPS), and economic impacts from reduced retail visits. Research shows that there is a limited projected increase in the fire risk for Cortez Madera until 2050 but a large increase in fire risk between 2050 and 2085. In addition to hotter and drier conditions, offshore winds (especially in the fall) drive even more dangerous and persistent wildfire conditions.

Figure 1.13. Cortez Madera's Wildland Urban Interface zone as dictated by the Central Marin Fire Department data developed for the upcoming Community Wildfire Protection Plan (CWPP) update set to be published in 2021.





Sea Level Rise

There is no doubt that over time sea level rise (SLR) will greatly impact the lives of Corte Maderans. Without action, daily high tides will eventually inundate major thoroughfares, schools, retirement communities, private homes, shopping areas, bike paths, protected wetland areas, and stormwater detention ponds. Increases in bay water levels will also intensify wave action on levees and marsh edges, speeding up the rate of erosion. Erosion of the marsh edge will reduce the width of marshes and result in the loss of wetland habitat and reduction in wave attenuation.³⁸ Eventually, rising seas will overtop the Bay levees causing significant damage and disruption to homes and infrastructure. The relative sea level rise (the amount of sea level rise relative to a fixed point on land) varies due to differential rates of sediment compaction, marsh accretion, and tectonic movement. Much of the Corte Madera shoreline infrastructure is settling because it was built on Bay fill over very deep bay mud that is compacting; this is causing land subsidence and accelerating the pace of relative sea level rise for neighborhoods such as Mariner Cove and Marina Village.³⁹ With rising seas, what used to be a 1% annual chance of a storm-driven flood event (100-year storm) has the potential to become the daily high tide water levels by the 2060s. Coastal flooding is determined by the water level above today's mean higher high water (MHHW), and is the sum of mean sea level, sea level rise, tides, and storm surges (which can be as much as 3 feet). A specific water surface elevation can be reached by combinations of sea level rise and extreme water level events. The sea level in the San Francisco Bay Area has risen eight inches in the past century and could rise up to 70 more inches by the end of the century (see Figure 1.14).⁴⁰

Sea level rise projections are probabilistic, meaning that for each scenario, a set of probabilities describe the likelihood that sea level will meet or exceed a particular amount of sea level rise within a given time frame. Selecting what level of sea level rise to plan for is generally done based on risk tolerance. The larger the potential consequences from a flooding or overtopping event, the more risk averse the planners should be and the more they should consider lower likelihood (but higher magnitude) events (i.e. 0.5%) in planning and design. Where the potential impacts of flooding are less serious, planners can be less risk averse and use a lower amounts of sea level rise for planning. The graph provides a summary of low risk aversion (orange line - 17% chance per year) and medium-high risk aversion (blue line - 0.5% chance per year) scenarios for sea level rise through the end of the century.

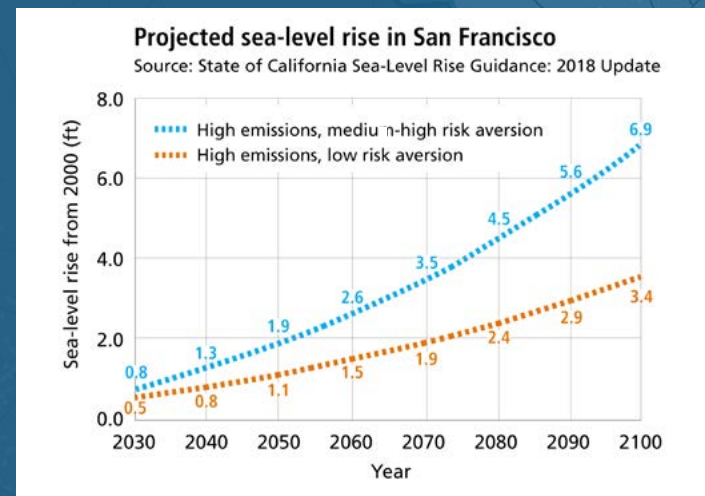


Figure 1.14. San Francisco Bay Area sea level rise projections.



Figure 1.15. Flood inundation map of Corte Madera depicting a water inundation scenario of three feet above mean higher high water (MHHW).



Impacts of Sea Level Rise on Groundwater

Groundwater levels in Corte Madera fluctuate over time due to variations in rainfall and water levels in the Bay, nearby lagoons, and channels. Groundwater is not pumped for potable water within the Town limits, and when groundwater levels are high, the ground becomes saturated and groundwater seepage can enter foundations, causing property damage.⁴¹ Saline conditions or salt water intrusion can further complicate problems from groundwater seepage, impacting buried infrastructure and vegetation. Groundwater seepage is a common occurrence in the residential bayside area, and many residents do not have sump pumps to remove standing water from around their houses. How sea level rise will affect groundwater seepage and salt water intrusion has not been widely assessed and planned for across the state, though pilot investigations have shown that local impacts can be severe in some communities including low-lying coastal areas.^{42,43}

Information on SLR-driven groundwater inundation in California is also limited by the lack of data on shallow coastal aquifers, which are not commonly studied because they are not suited for domestic or agricultural use. However, initial regional studies have found that Corte Madera is one of many urban areas around the Bay with very shallow coastal groundwater.^{44,45} In relatively permeable substrates, groundwater levels respond to tidal forcing.⁴⁶ Chronically-higher sea levels

may cause groundwater tables to rise even in areas with less-permeable substrates that do not show a tidal signal today. Discharge of rising groundwater to creeks, lagoons, and stormwater channels may reduce stormwater conveyance capacity and increase fluvial flood risk. But even before emergence flooding becomes an issue, groundwater at shallow and intermediate depths (e.g., <6 ft. depth) will present significant challenges to the maintenance of existing and new infrastructure (including foundations, basements, and buried utilities) and can affect human health due to mobilization of buried contaminants.⁴⁷

Engineering approaches to mitigate flooding (e.g. levees) usually do not address groundwater inundation, so assessment of this risk is an essential step Corte Madera and neighboring communities should take to be able to plan for the full impacts of climate change.⁴⁸

When a levee is constructed, rising groundwater levels landward of the levee increase the level of pumping required to protect local infrastructure. As a consequence, pumping groundwater from former wetland soils can increase the rate of subsidence in already-subsiding areas. A localized groundwater monitoring program specifically focused on the shallow coastal aquifer will help the Town collect the data needed to develop adaptation plans that thoroughly address this threat.

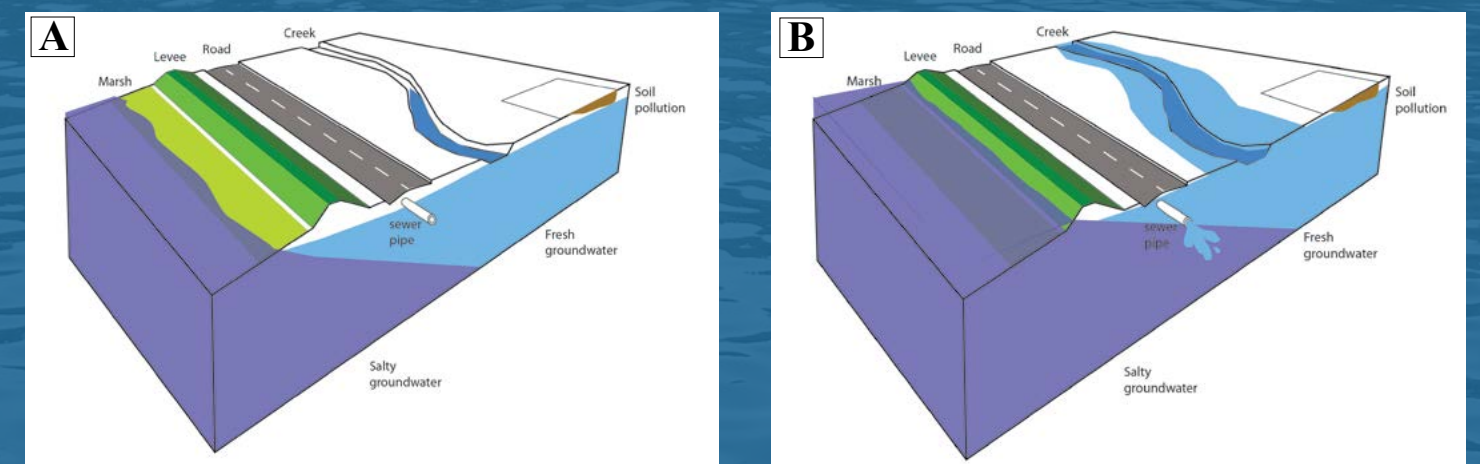


Figure 1.16. A schematic depicting groundwater inundation before (A) and after SLR and tidal forcing (B). Illustrations: Kristina Hill.



Extreme Heat

Projections for the San Francisco Bay area show an average annual warming of approximately 4.4 degrees Fahrenheit by mid-century, with an increase in up to 7.2 degrees Fahrenheit by the end of the century.⁴⁹ Extreme heat days in Corte Madera (temperatures above 94.7°F) historically averaged four days per year (1961-1990). If greenhouse gas emissions continue unchecked, there are projected to be 20 extreme heat days a year by the end of the century.⁵⁰ Rising heat days are a substantial concern due to the lack of air conditioning in most homes in the Bay Area. Extreme heat events can greatly impact physical and mental health by exacerbating existing and underlying conditions and causing heat stress and stroke in generally healthy popula-

tions. These impacts can be particularly acute for the very young, the elderly, those without adequate access to cooling areas, individuals who work outdoors, and the unhoused. Extreme heat may also damage transportation infrastructure through pavement rutting and heave, warping railroad lines, and construction and maintenance challenges.⁵¹ The increased frequency of extreme heat events impact the frequency and severity of drought and wildfires; this cascade effect leads to an increase in energy consumption through higher demand for air conditioning, further adding to greenhouse gas (GHG) emissions, and could increase the number of PSPS events.



Drought

Droughts are projected to increase in duration and intensity across the state.⁵² The Marin Municipal Water District (MMWD) supplies Corte Madera and the eastern corridor of Marin County with surface water sourced from seven local reservoirs, augmented by supplies from the Sonoma County Water Agency (SCWA).⁵³ The water supply comes from local runoff and the Russian River. Historically, during periods of extreme drought, MMWD has been able to successfully meet water demands through a combination of rationing, conservation, and additional supply from SCWA.⁵⁴ However,

more pervasive and sustained drought periods will likely limit the ability of MMWD to meet demands. Droughts also reduce the amount of water available to fight wildfires and increase the exposure of residents to extreme heat events, flash flooding, and degraded water quality. Further, increasingly intense and longer periods of droughts can stress natural systems, including the trees that cover the Corte Madera hillside, creating opportunities for disease, infestation, and drier, wildfire-prone landscapes.



A composite image of two images through the Corte Madera marsh, taken 5 months apart. © Roger Johnson, Flickr.com.



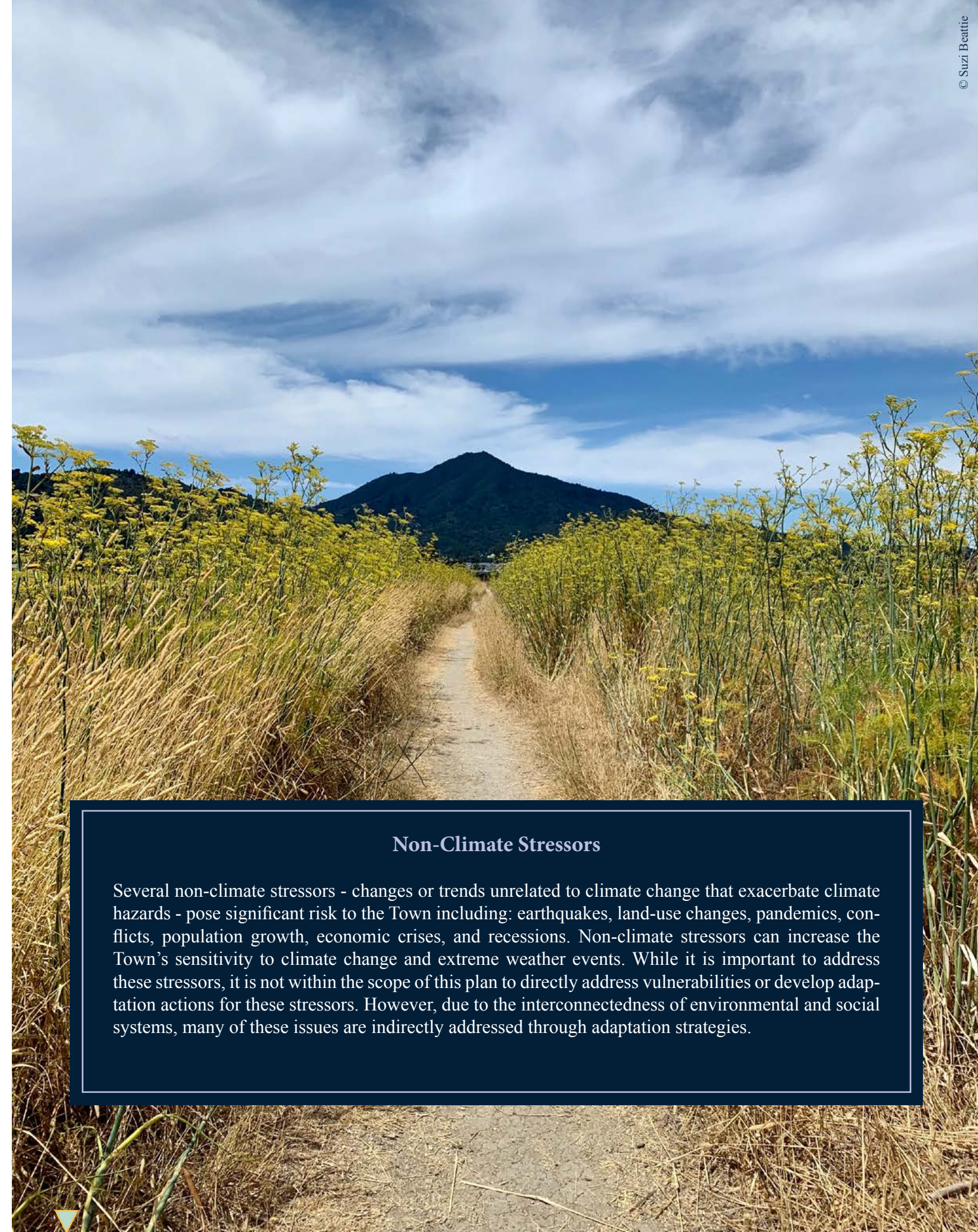
Inland Flooding

Increasingly intense and frequent extreme precipitation events,⁵⁵ altered drainage patterns, and increased development with impermeable surfaces are likely to increase the frequency and intensity of inland flooding in Corte Madera. This is not a surprise to residents as larger storm events coupled with king tide events already cause extensive inundation and the temporary closure of major streets. Additional factors that affect flooding in Corte Madera include fluvial hydrology, precipitation, tides, sea level rise, sedimentation, and

land subsidence. Inland flooding is exacerbated when the Town's experience simultaneous high tides and severe storms or a heavy amount of upland watershed runoff. Heavy precipitation events, such as atmospheric rivers,⁵⁶ not only cause inland flooding in low lying areas, but also can lead to landslides and other damaging events. Some uncertainty remains in future projections for total precipitation; however, understanding the general trend in increased heavy precipitation events is important for decision making and planning purposes.



Flooding from an extreme precipitation event on Casa Buena drive on February 12, 2019 in central Corte Madera. © Leslie Regan



© Suzi Beatrice

Non-Climate Stressors

Several non-climate stressors - changes or trends unrelated to climate change that exacerbate climate hazards - pose significant risk to the Town including: earthquakes, land-use changes, pandemics, conflicts, population growth, economic crises, and recessions. Non-climate stressors can increase the Town's sensitivity to climate change and extreme weather events. While it is important to address these stressors, it is not within the scope of this plan to directly address vulnerabilities or develop adaptation actions for these stressors. However, due to the interconnectedness of environmental and social systems, many of these issues are indirectly addressed through adaptation strategies.

The Town, Climate Change, and Public Health

Climate change will affect all Corte Maderans. Extreme weather events, such as heat waves and flooding, and wildfires can affect the direct health and safety of residents and visitors. Disruptions to the transportation network from flooding or wildfire events limit the ability of people to evacuate and move away from danger, decrease access to hospitals and medical care facilities, and reduce the ability of emergency first responders to protect residents. Indirect effects, such as degraded air quality from regional wildfire smoke and ash also threaten the health and wellness of Corte Maderans. Climate-related events that require people to remain indoors more often can also affect mental health and strain social relationships that bind families and the community.^{57,58} While all residents of Corte Madera are at risk, these changes can be particularly impactful for frontline community members that have chronic health conditions or other underlying disease burdens.

Figure 1.17. A composite map showing the combined Wildland Urban Interface (in red with black building outlines) and the FEMA 1% Annual Chance Flood Zone (in blue, with yellow building footprints).

FEMA Flood Zones

- Coastal Flood Risk Zone (VE, 100 yr. + Waves)
- 100 yr. Flood Hazard Zone (AE, 1% Annual Chance)

Buildings by FEMA Flood Zone Designation

- AE
- VE

Town of Corte Madera and Marin County Wildland Urban Interface Zones

- Building Footprints in WUI
- Other Building Footprints Outside WUI Zone

Corte Madera Municipal Boundary

- Roads and Streets
- Fire Roads

