



THE TOWN OF
Corte Madera
California



Draft Climate Adaptation Plan

November 19, 2020


Zoom Orientation

- Please mute yourself
- Under "Participant" select "Raise Hand" to ask a question or comment during discussion sections
- Use the "Chat" function to add comments and ask questions during other parts of the conversation
- Breakout rooms will also be used today



Agenda

- | | | |
|------|---|--------|
| I. | Welcome | 5 min |
| II. | Introductions and Meeting Objectives | 10 min |
| III. | Near-term Resilience Actions | 80 min |
| | Town-wide | |
| | Central | |
| | Hillside | |
| | Shoreline | |
| IV. | Wrap-up and Next Steps | 10 min |



Tell us what
you think!

Providing Feedback . . .

*Download the Draft Report
From the Project Website:*

www.cortemaderaadapts.org



The Corte Madera
Climate Change Adaptation Plan

November 2020

About You!

Tell us:

- What part of the Town you are from?
- What is the biggest potential opportunity to enhance community resilience?



Adaptation Plan Process

2019



Laying the
Foundation

2020



Engaging on
Adaptation



Exploring
Adaptation
Options



Refining
Adaptation
Approaches

2021



Draft and Finalize
Adaptation Plan



Community Workshop #3



Community Engagement



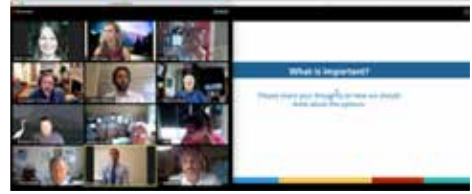
- Two Workshops
- Community Survey
- Flood Control Meetings
- City Council Meetings
- Compilation of Existing Conditions

Resilience Advisory Committee & Analysis



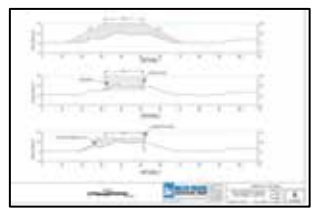
- 5 Advisory Committee Meetings
- 10 Partner Meetings
- GIS & Other Technical Analysis

Community Workshop #2



- Virtual Workshop
- Storymap and Survey

Additional Design



- Near Term Actions
- Shoreline and Hillside
- Preliminary Costs



Values Driven and Science Based



Vision: One Town, One Region, Resilient Together



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.

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.



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.



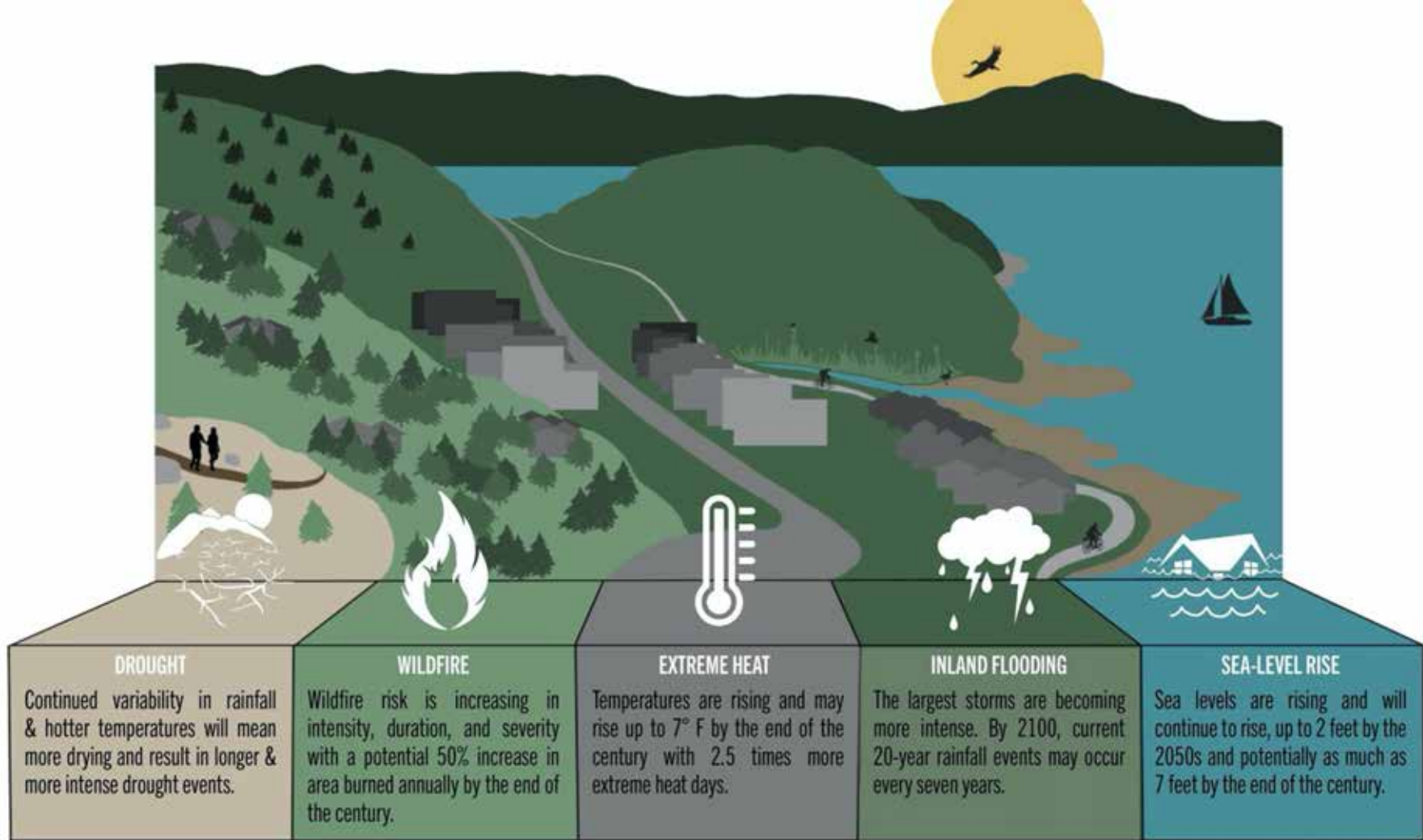
GOAL 4

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.









Cortez Madera in 1926. © Cortez Madera Memories



Cortez Madera in 2019

Projected sea-level rise in San Francisco

Source: State of California Sea-Level Rise Guidance: 2018 Update

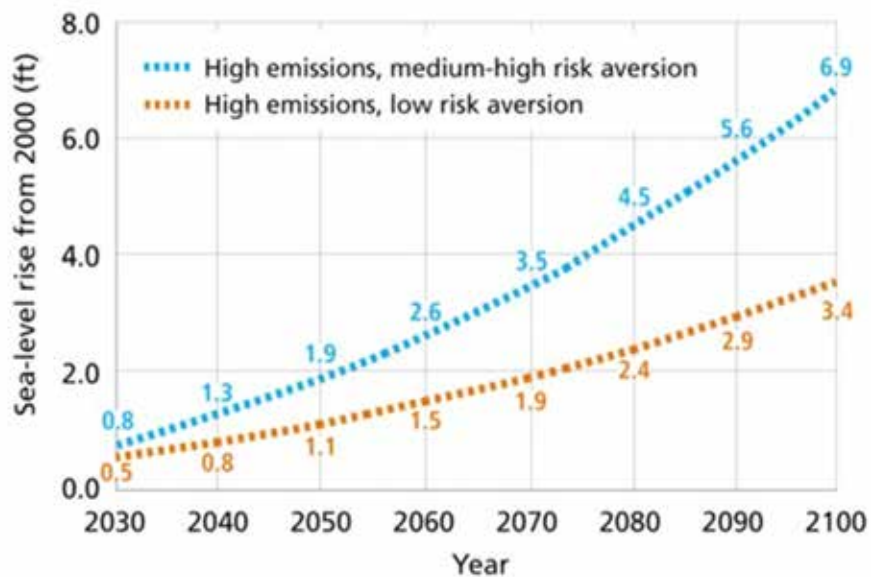


Figure 1.15. Flood inundation map of Corte Madera depicting a water inundation scenario of three feet above mean higher high water (MHHW).

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 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.

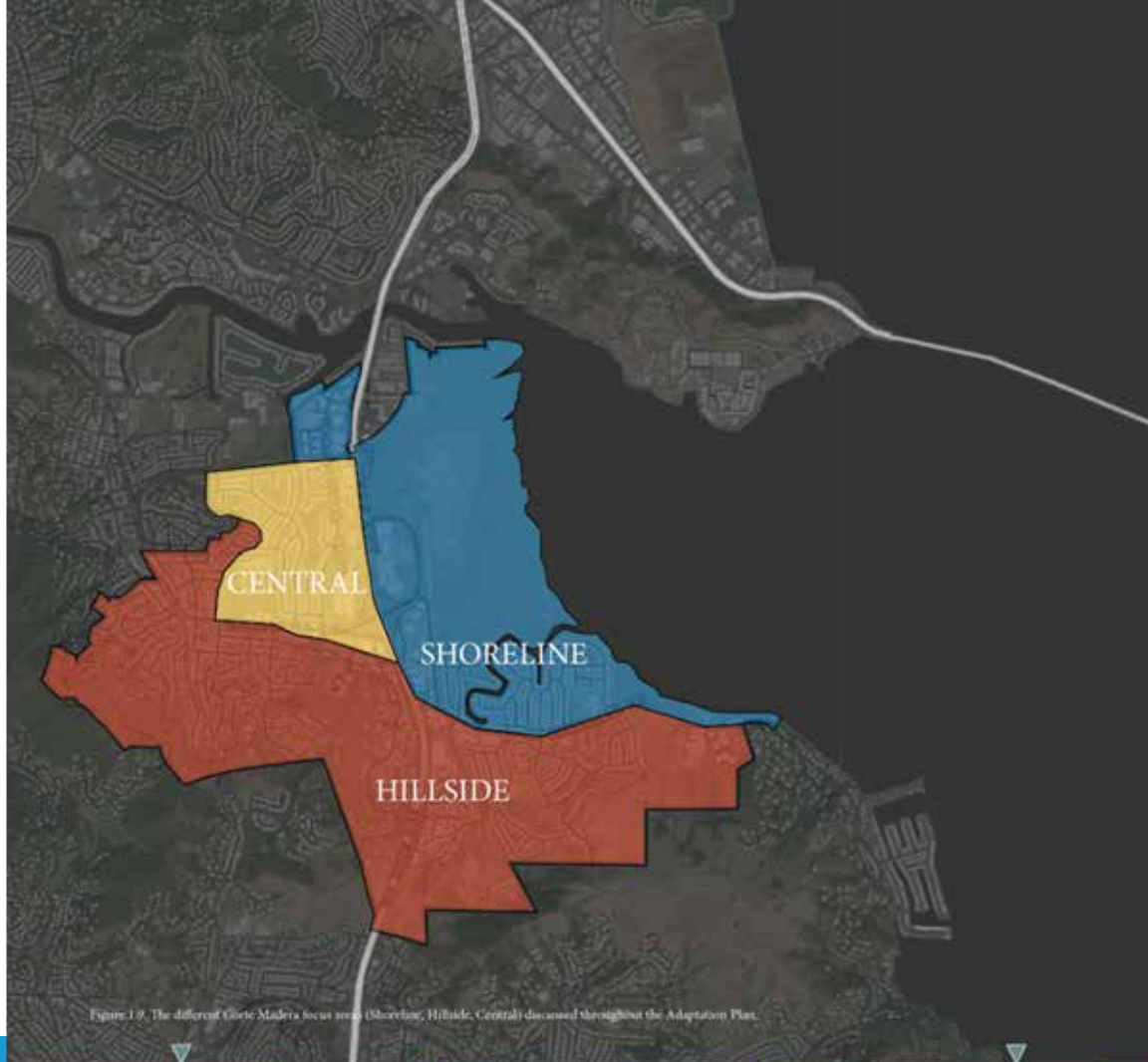


Figure 1.9. The different Corte Madera focus areas (Shoreline, Hillside, Central) discussed throughout the Adaptation Plan.

ADAPTATION PATHWAY

MARINER COVE & MARINA VILLAGE

This adaptation pathway diagram provides a visual depiction of the various decision points associated with adaptation planning for the neighborhoods, as well as a sense of how long various adaptation actions can be expected to provide protection. Continued coordination with stakeholders in the near term will help inform decisions regarding construction of a levee/sheet pile wall with a tide gate and nature-based infrastructure (coarse beach, ecotone levee) to protect the Mariner Cove and Marina Village neighborhoods. At the same time, stakeholders can contribute to the development of the Town's stormwater master plan and the development of a shallow groundwater monitoring program. As environmental conditions reach predetermined thresholds, (e.g. sea levels nearing "freeboard" elevation, or the safety margin included as a buffer in the design of a levee) decisions must be made about next steps. For example, replenishing material on the coarse beach fronting a levee or sheet pile wall may reduce erosion for a certain amount of time, but eventually a decision needs to be made about raising the levee or moving toward a managed retreat strategy. This decision is likely to be dependent on the feasibility of continuing to manage stormwater and groundwater conditions on the landward side of the levee.

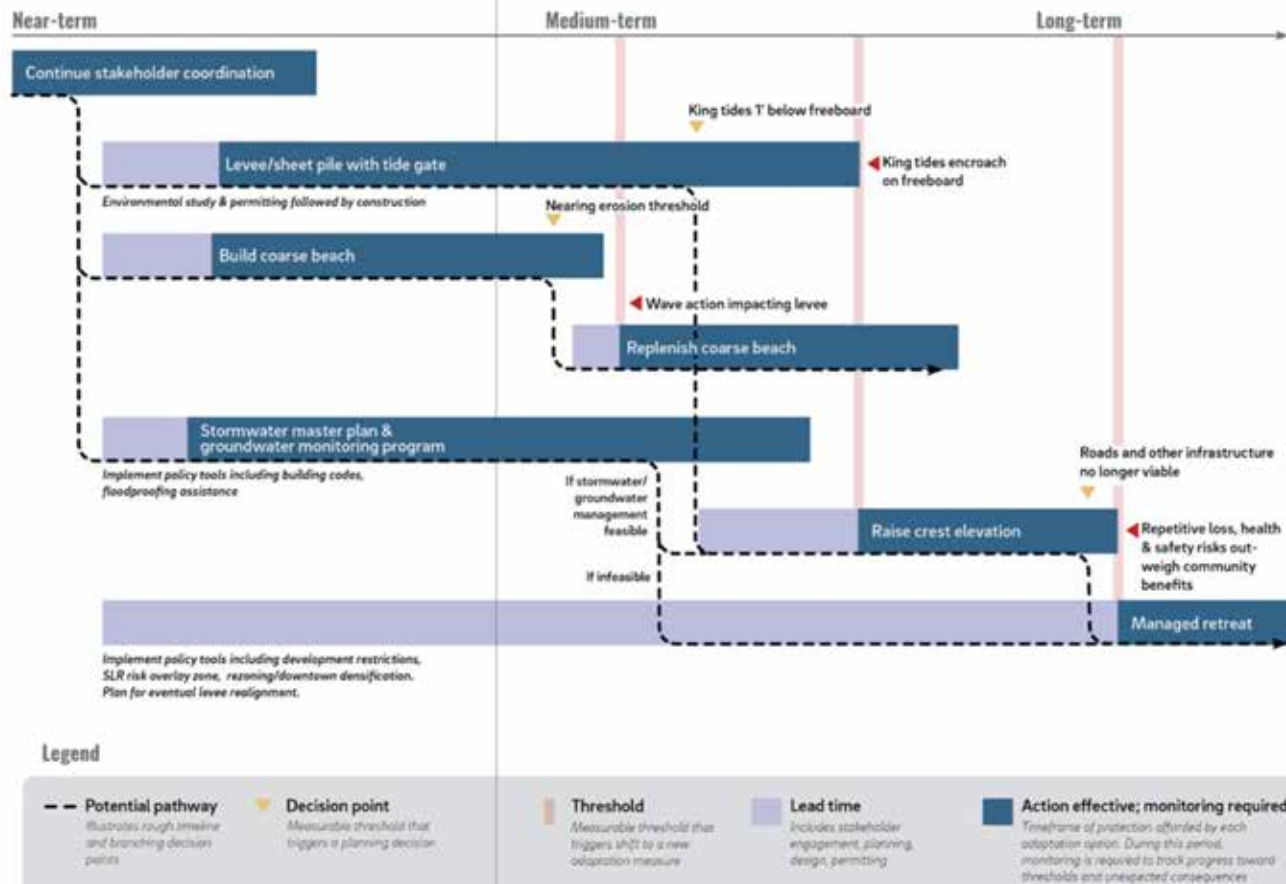
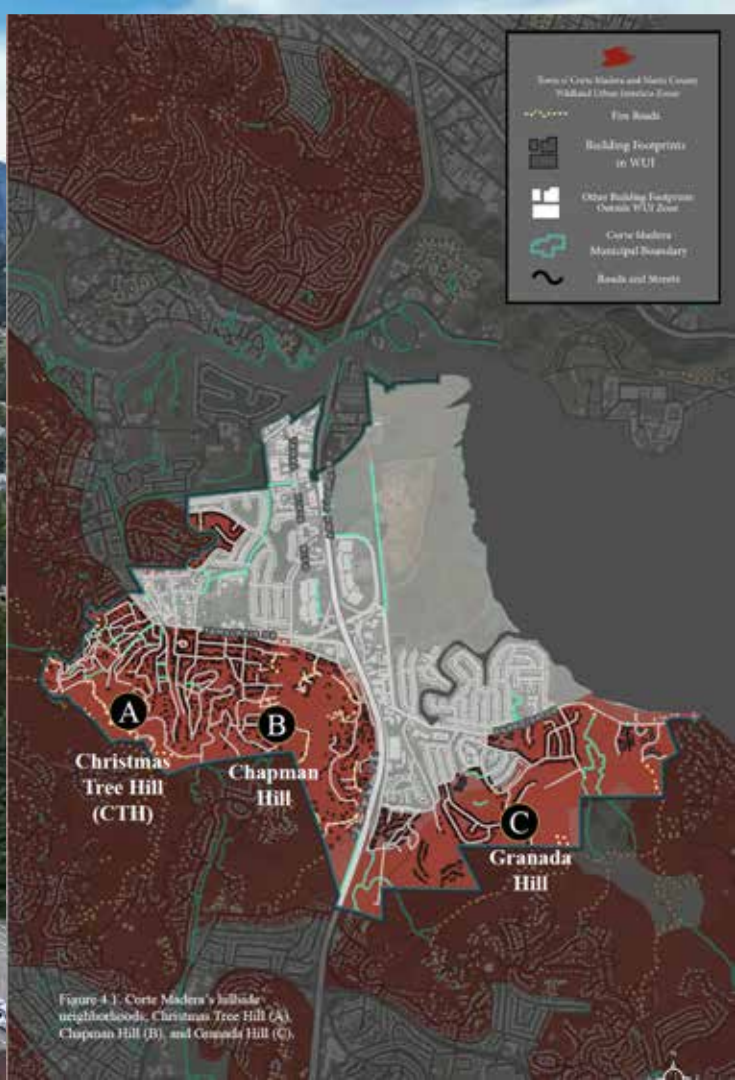


Figure 3.11. Adaptation pathway for Mariner Cove and Marina Village.

An aerial photograph of a coastal town. In the foreground, a school complex with several large buildings and a parking lot is visible. To the right of the school is a large green field. The middle ground shows a dense residential area with houses and streets. In the background, a large body of water, possibly a bay or harbor, is visible under a cloudy sky. The text "Adaptation Actions" is overlaid in the center of the image.

Adaptation Actions





9

Total cost (in billions) in damages from Wildfire in California in 2018 alone. (*)

1,943,500,000

The total dollar value of all commercial properties and homes located in the WUI in Corte Madera.

49

Total percentage of Corte Madera structures located in the WUI.

26

Total number of road miles in hillside neighborhoods.

3.5

The total dollar value of damages from wildfires in California in 2018 alone (*).

150

The number of acres in the Christmas Tree Hill neighborhoods.

1,588

The total number of Corte Madera structures located in the Wildland Urban Interface.

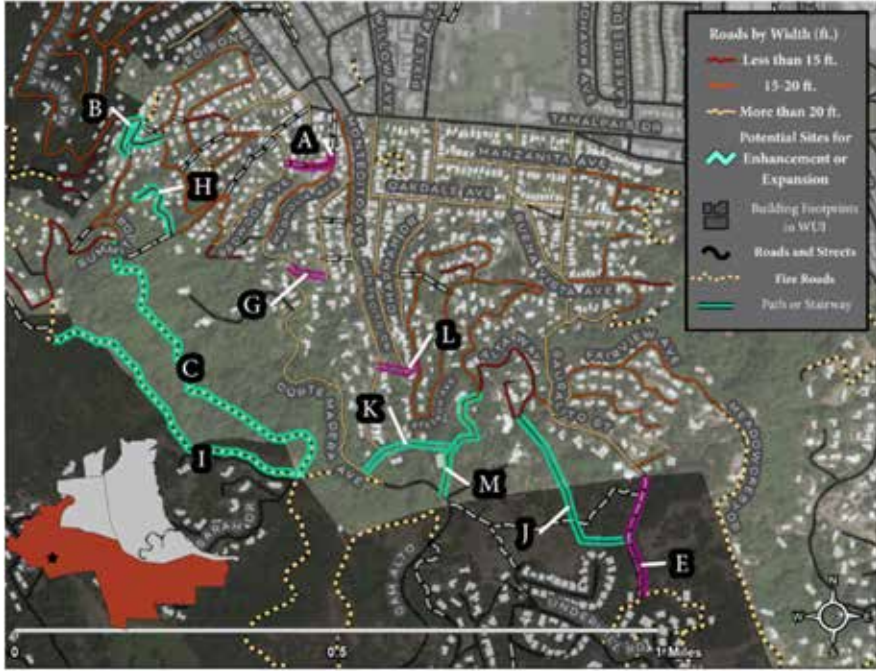
BY THE NUMBERS

Hillside Mobility Actions

- Support other modes of transportation
- Manage on-street parking along evacuation routes
- Create pull-outs
- Widen narrow street sections
- Create new connections
- Enhance wayfinding and lighting

Proposed Infrastructure Improvements

Christmas Tree Hill & Chapman Hill



Granada Hill



Evaluation Framework for Hillside Improvements

Approach/Metric	Status Quo	Policy Changes	Enhanced Network	California Lane (new connection)	Lower Summit Fire Road (new connection)
Multimodal access	Private Vehicle Emergency Vehicle Pedestrian Bike/e-bike	Private Vehicle Emergency Vehicle Pedestrian Bike/e-bike	Private Vehicle Emergency Vehicle Pedestrian Bike/e-bike	Private Vehicle Emergency Vehicle Pedestrian Bike/e-bike	Private Vehicle Emergency Vehicle Pedestrian Bike/e-bike
Streets permitting simultaneous access & egress	Very limited	Limited	Very Limited - More	Most	Most
Households with access to a new primary vehicular route	-	-	0-49	69	16
Downhill access/egress points (to Town)	3	3 (with better two-way operation)	3 (with better two-way operation)	4	3
Uphill access/egress points (over hills)	-	-	0-1	4	1
Infrastructure cost	-	Low-Medium	Low-Medium	High	High

Investing in Infrastructure

Potential Priority Actions

- Analyze and Implement potential connections
 - California Lane
 - Grove Ave connection
 - El Camino Dr and Madera del Presidio Dr
 - Sausalito St to Mill Valley
- Widen and improve Summit Drive
- Improve Town-maintained hill paths and stairs on Christmas Tree Hill
- Improve Lower Summit fire road
- Create strategic pullouts on Christmas Tree Hill
- Widen Redwood Ave where feasible



3



the shoreline



King Tide, 2015

7.4ft NAVD88, 1.5 ft above average high tides



Scenario	Threshold	SLR	"Event"
MHHW + 1 ft.	Episodic Flooding	0	King Tide
		1 ft.	Daily Tide
MHHW + 3 ft.	Levee Overtopping and Significant Flooding	1 ft.	5-yr
		3 ft.	Daily Tide
MHHW + 5.5 ft.	Chronic and Extensive Flooding	2 ft.	100-yr
		5.5 ft.	Daily Tide

257

Total acres of marsh areas located in the Shoreline neighborhoods of Corte Madera.

13

Miles of road vulnerable to flooding at present during king tide (1 ft. above MHHW).

1181

Total number of buildings vulnerable to flooding at MHHW + 5.5 ft.

36

Percentage of buildings vulnerable to flooding at MHHW + 5.5 ft.

BY THE NUMBERS

25

Miles of road vulnerable to flooding at MHHW +5.5 ft.

368

Number of total structures less than 1 ft. above MHHW.

1,250,000,000

Total value (in dollars) of structures in the FEMA flood zones(*).



Nature-based measures

- Multiple benefits
 - Habitat
 - Flood protection
 - Recreation
- More adaptable over time
- Can be used in combination with other approaches

Photo by
Shira Bezael

NATURE-BASED ADAPTATION

Natural and nature-based measures are physical landscape features that are created and evolve over time through the actions of environmental processes, or features that mimic characteristics of natural features but are created by engineering and construction (in concert with natural processes) to provide coastal protection and other ecosystem services.⁹⁹ Nature-based adaptation measures are only appropriate in certain landscape settings. They can be used in combination with other appropriate nature-based measures, or in hybrid combinations that include both nature-based measures and conventional gray infrastructure measures. Two examples of suites of nature-based adaptation measures working in concert to provide flood protection and habitat benefits are shown in Figure 3.2. Examples of nature-based measures that are suitable in Corte Madera are tidal marshes, ecotone slopes, submerged aquatic vegetation, and coarse beaches, each of which are described in more detail below.

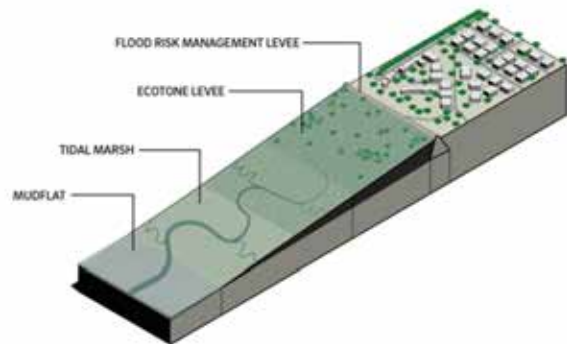


Figure 3.2. Example of multiple “gray” (traditional) and “green” (nature-based) adaptation actions working in concert to provide flood protection and habitat benefits. Illustration by Micaela Bazo, SFEI. Adapted from the SF Bay Adaptation Atlas (SFEI & SPUR 2019).

Tidal Marshes

Protecting, maintaining, and restoring tidal marshes and their associated tidal flats is critical for sustaining their flood risk management services with a changing climate.¹⁰⁰ Specific actions include restoring tidal action to diked baylands to restore marshes, planting native species to accelerate colonization, placing sediment to raise subsided areas, and creating marsh mounds - higher areas within marshes to provide high-tide refuge.¹⁰¹ In existing marshes this measure might also include sediment placement to help maintain marsh elevation with sea level rise. The topography of the marsh and its associated mudflat plays a significant role in wave refraction, shoaling, and breaking. Wide marshes at Corte Madera are an asset in wave attenuation. Stabilizing the outer edge of the marsh by placing coarse beaches can help maintain marsh width by reducing erosion.

Ecotone Slopes

Ecotone slopes are ramps (with a length to height ratio of 10:1 or gentler) bayward of flood risk management levees and landward of a tidal marsh. They can provide wetland-upland transition zone habitat when properly vegetated with native clonal grasses, rushes, and sedges.¹⁰² They can attenuate waves, provide high-tide refuge for marsh wildlife, and allow room for marshes to migrate upslope with sea level rise.¹⁰³ In Corte Madera, there is a unique opportunity to use on-site material (dredge spoils at the Golden Gate Bridge District parcel) to create an ecotone slope along the railroad embankment, connecting a future flood-risk management levee to the marsh.¹⁰⁴

For more information about nature-based sea level rise adaptation strategies, please refer to the [San Francisco Bay Shoreline Adaptation Atlas](#).

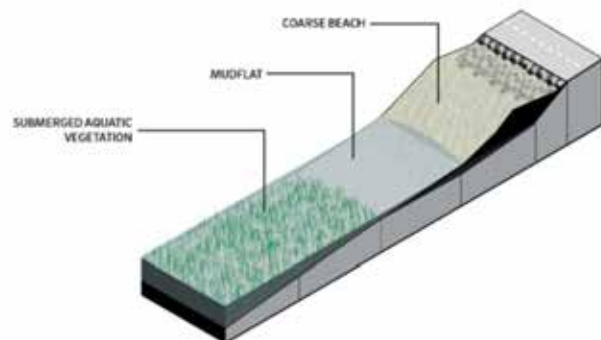


Figure 3.3 - Submerged aquatic vegetation, mudflats, and coarse beaches are natural features that can reduce the impact of wave action on the shoreline. Illustration by Micaela Bazo, SFEI. Adapted from SF Bay Shoreline Adaptation Atlas (SFEI & SPUR 2019).

Submerged Aquatic Vegetation

Submerged aquatic vegetation refers to all underwater flowering plants, and contributes to trapping sediment and slowing shoreline erosion.¹⁰⁵ Eelgrass (*Zostera marina*) is the main species in the lower parts of the San Francisco Estuary, but other submerged vegetation species exist throughout the Bay as well. However, submerged aquatic vegetation cannot grow anywhere; salinity, light, and substrate are limiting factors for eelgrass beds, and they do best where current speeds and wave energy are not excessive. Potential exists to establish eelgrass beds at depths less than 2m in broad swaths along the shores of Corte Madera bayward of the tidal marsh.^{106,107}

Beaches

Coarse or composite estuarine beaches are dynamic features that can consist of a mixture of sand, shell, gravel, or cobble. Coarse gravel and cobble beaches can dissipate wave energy over shorter distances than marshes and therefore may be more suitable within an urbanized estuary and that has limited space.¹⁰⁸ Beaches can be placed in front of levees, roads or other infrastructure vulnerable to wave overtopping, or in front of marshes vulnerable to erosion. These beaches have the potential to be a multi-beneficial soft-shoreline stabilization strategy in San Francisco Bay.¹⁰⁹ In addition, groins or other retention structures (large woody debris is one option) should be considered for beaches implemented along shorelines where the dominant waves tend to transport sediment down the shoreline.

Structure Height Assumptions

Elevations in feet
NAVD88

With natural
outboard edge
(beach or
ecotone slope)

Traditional
levee/wall

SLR	MHHW + SLR	MHHW + SLR + 100 yr storm	MHHW + SLR + 100 yr storm + 2' freeboard	MHHW + SLR + 100 yr storm + 2' freeboard + wave runup
0'	6.1'	9.5'	11.5'	13.9'
1.9'	8.0'	11.4'	13.4'	15.8'
3.5'	9.6'	13.0'	15.0'	17.4'
6.9'	12.9'	16.4'	18.4'	20.8'

*Unofficial "goal"
for 2050 by
California State
Assembly, Sea
Level Rise and
California
Economy
Committee*

Sea Levels from OPC (2020). *Strategic Plan to Protect California's Coast and Oceans 2020-2025*. California Ocean Protection Council. <http://www.opc.ca.gov/2020/02/the-ocean-protection-council-approves-a-bold-plan-to-protect-californias-coast-and-oceans/>

Tides and extreme water levels from AECOM (2016). *San Francisco Bay Tidal Datums and Extreme Tides Study*. Bay Conservation and Development Commission http://www.adaptingtorisingtides.org/wp-content/uploads/2016/05/20160429.SFBay_Tidal-Datums_and_Extreme_Tides_Study.FINAL_.pdf

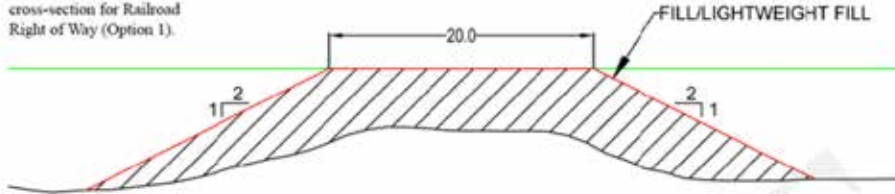


3 ft above current MHHW



Conceptual Cross-Section for Railroad Right of Way

Figure 3.20. Earthen levee cross-section for Railroad Right of Way (Option 1).



Option 1 is a traditional earthen levee built over the existing railroad berm. The 20 ft. width at the top at 15 ft. NAVD88 would protect the central portion of the town from a 100-year storm in the middle of the century and would provide 2 ft. of free board. It could also accommodate an enhanced bike and pedestrian path or a future rail expansion. The weight of the fill may cause differential settlement and require rasing over time. Replacing earthen fill with lightweight fill would reduce settling but be approximately three times more expensive.

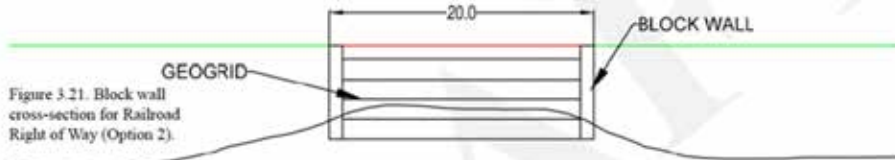


Figure 3.21. Block wall cross-section for Railroad Right of Way (Option 2).

Option 2 is a block wall connected by a geogrid. This option would reduce additional weight on the marsh and reduce settlement rates. The 20 ft. width at the top could still accommodate additional bike and pedestrian facilities or a future rail expansion. The block walls could be hidden or made more visually appealing by adding natural landscaping.

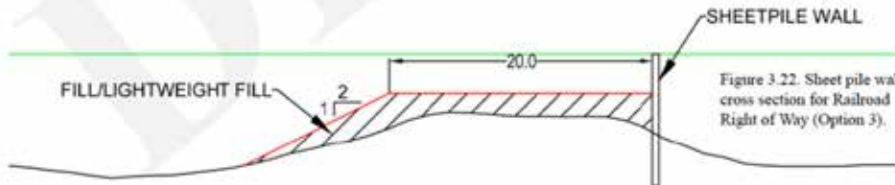


Figure 3.22. Sheet pile wall cross section for Railroad Right of Way (Option 3).

Corte Madera Marsh & Railroad Right of Way

Preliminary Construction Costs	\$5.0 million
Preliminary Engineering, Public Outreach, & Environmental Document	\$1.0 million
Environmental Permitting & Mitigation	\$1.5 million
Design (15% of construction)	\$0.8 million
Construction Management (15% of construction)	\$0.8 million
Subtotal	\$9.1 million
Contingency (20% of total)	\$1.8 million
Maintenance (25 years)	\$3.5 million
Total	\$14.4 million

3 ft above current MHHW



Inner Alignment



Outer Alignment



- Hardened Structure
- Tide Gate Location
- Alternative Levee Alignment
- Ecotone Slope
- Marsh Mounds
- Coarse Beach



Conceptual Cross-Section for Inner Alignment and Mariner Cove

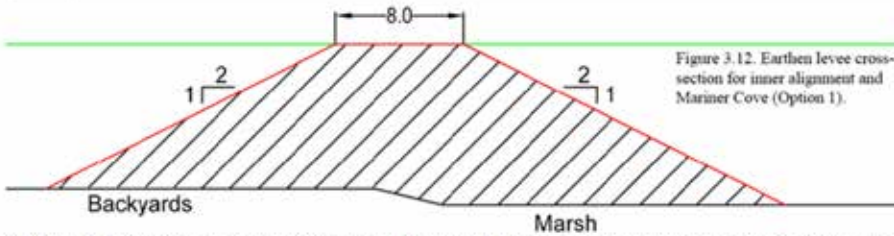


Figure 3.12. Earthen levee cross-section for inner alignment and Mariner Cove (Option 1).

Option 1 is a traditional earthen or light weight fill levee built in or near homeowners' backyards. While this is the least expensive option, it is likely infeasible due to space limitations, the net weight of the levee, and the associated settlement in areas built over bay mud.

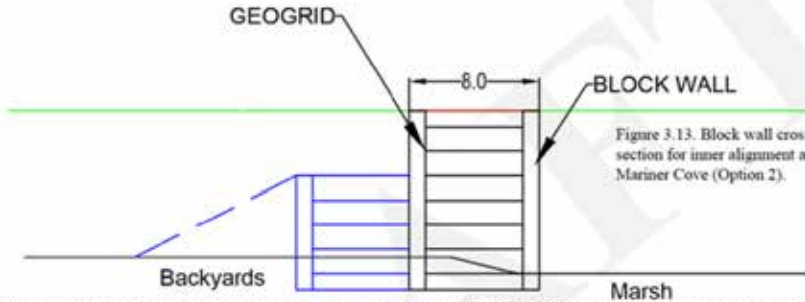


Figure 3.13. Block wall cross-section for inner alignment and Mariner Cove (Option 2).

Option 2 is a block wall connected by a geogrid. This option would reduce additional weight on marsh and significantly reduce the width of the levee; however, this option would reduce visibility of the Bay, as it would extend eight or nine feet above the current ground level to provide adequate flood protection through the middle of the century. The block walls could be modified on the inside to provide a set-up design (see blue lines in figure 3.13), be hidden by landscaping, or allow homeowners to build steps and decks connected to the wall.

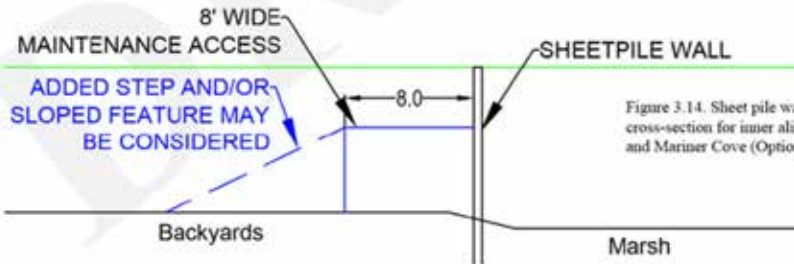


Figure 3.14. Sheet pile wall cross-section for inner alignment and Mariner Cove (Option 3).

Marina Village & Mariner Cove

Preliminary Construction Costs	\$21.5 million
Preliminary Engineering, Public Outreach, & Environmental Document	\$1.5 million
Environmental Permitting & Mitigation	\$4.0 million
Design (15% of construction)	\$3.2 million
Construction Management (15% of construction)	\$3.2 million
Subtotal	\$33.4 million
Contingency (20% of total)	\$6.6 million
Maintenance (25 years)	\$4.0 million
Total	\$44 million



Wrap up and Next Steps

Providing Feedback . . .

Download the Report

Project Website:

www.cortemaderaadapts.org

Add comments

www.cortemaderaadapts.org/draft-plan



The Corte Madera
Climate Change Adaptation Plan

November 2020



THANK YOU!

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