
8.0 HAZARDS

8.1 Seismic and Geologic Hazards

Geologic Hazards

The major geologic and related soils hazards in Corte Madera are hill slope failure and static settlement of soils. Potential for hill slope failure depends upon the geologic composition of a slope. Certain combinations of rocks and soils are more stable than others, and hill slope failure can occur without an earthquake. Landslides involve the down slope movement of soil and rock; earthquake-induced landslides will most likely occur in the same areas where landslides are caused by other conditions. Unstable slopes and soils subject to static settlement can become more acute during an earthquake. The slopes of the Tiburon Peninsula Ridge are among the least stable areas. Changes made by man may also induce land sliding. Excavating too steeply, undercutting slopes, or placing fills or structures on unstable slopes can potentially be causes. A large landslide was induced west of U.S. Highway 101 by excavating Alto Hill during construction of the freeway. Scattered landslides have also occurred in the upland areas west of Highway 101.

Regional landslide mapping has indicated the presence of extensive slope stability hazards in Corte Madera, with the hazard typically more pronounced on steeper slopes. The hazards can include relatively large, loose debris flows.

Static settlement, or subsidence, is a safety hazard in the lowland areas of Corte Madera. Much of Corte Madera was built on fill deposited on Bay lands, such as marsh or tidelands (see **Figure 2.2.1**). Bay Mud, soft unconsolidated and water-saturated clay that becomes more compact underneath the weight of fill and urban development, underlie these areas. Bay Mud has severe stability problems because the mud is highly compressible. It reacts by compaction to loads placed on it causing settlement of fill (differential settlement). When fills are placed over thick Bay Mud deposits, large amounts of settlement can take place over long periods of time (100 years). Subsidence of Bay Mud is an on-going condition. This subsidence can subject low-lying areas to frequent flooding. In fact, subsidence is one of the major contributing factors to the steadily increasing flood hazard in Corte Madera.

The primary influence on the amount of subsidence at a given location is the thickness of the underlying Bay Mud. The thicker the Bay Mud layer, the longer consolidation will take place with a greater amount of subsidence. The greater the load compressing the mud, the larger the settlement. Bay Mud varies in thickness so the amount of settlement varies between those areas. When this differential settlement occurs, it can result in tilted buildings, cracked walls, broken streets, etc. The Town of Corte Madera has experienced problems caused by differential settlement and has responded with reconstruction of streets, sidewalks, storm sewers, sanitary sewers, and periodic maintenance of sewers and streets. Flooding of some businesses has been caused by past subsidence; ponding of water at curbs during storms is another consequence.

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Seismic Hazards

Corte Madera is relatively close to known active earthquake faults, including the San Andreas, Hayward, and Calaveras Faults. The Town is approximately eight miles northeast of the San Andreas Fault zone and eleven miles southwest of the Hayward Fault zone. Earthquakes of high magnitude can be felt and cause damage, however there are no direct reports of damage incurred in Corte Madera as a result of major quakes. There are no known active faults in Corte Madera making ground rupture an unlikely hazard. On the other hand, the intensity from ground shaking poses a real threat, as shown on **Figure 8.1.1**.

A critical factor affecting the intensity of ground shaking is the geologic material underneath a site. Deep, loose soils will amplify and prolong the shaking, such the clays and Bay muds prevalent in the Town. The type of rock that least amplifies ground shaking is granite. Ground shaking can be several times greater on sites underlain by weak sediments, like Bay Mud, than on bedrock. Losses from shaking can occur where tall structures are built on thick, soft sediments. Damage from shaking is also influenced by the structural integrity of buildings before an earthquake. Damage to buildings and utilities in the Town of Corte Madera is likely to be greatest on those sites underlain by deep, loose, compressible deposits such as Bay Mud. These areas include the lowland residential neighborhoods built on fill.

The Town typically requires geotechnical investigations for new development, including single-family residences. Mitigation for new construction often includes installation of deep foundation support piers (anchored to bedrock), installation of appropriate drainage improvements around a structure, and seismic design pursuant to the Uniform Building Code.

Ground failure is a secondary effect of ground shaking and can include landslides, liquefaction, lurching, and differential settlement. Liquefaction occurs when saturated and poorly consolidated granular material is shaken during an earthquake and is transformed into a fluid-like state. Buildings can tilt or sink, utility lines can rise to the surface, and levees can fail. If soils are poorly consolidated, the ground can subside. Corte Madera faces the hazardous potential for liquefaction of man-placed fill, bay mud sediments, and alluvium. Neighborhoods built on filled Bay Mud are the most susceptible.

8.2 Flooding Hazards

Flooding within Corte Madera occurs infrequently and when it does occur, it is gradual and generally not life threatening from flooding directly. However, indirectly, access by emergency vehicles could be restricted, which could cause a life-threatening situation for an individual needing emergency care. Accordingly, emergency preparedness from an evacuation standpoint is important whereas rescue operations are not related to flooding components of Corte Madera's flood preparedness program.

Figure 8.1.1

Corte Madera personnel monitor low-lying areas and storm runoff. The Corte Madera Fire Department (Fire Department) is responsible for monitoring and responding to imminent/actual flooding. The Director of Emergency Services organizes the Emergency Operating Center (EOC) staff and emergency procedures, search and rescue teams, and provides emergency instructions through local radio stations, such as the Corte Madera Emergency Broadcast (1330 AM). The Department of Public Works is in charge of initiating sandbagging, levee reinforcement, utility shutoff, and flood fighting activities. Emergency situations are reported to the Office of Emergency Services (OES) Mutual Aid Region Office. Evacuation is ordered by the Twin Cities Police Department (e.g., dispatching volunteer Community Emergency Response Teams [CERTS] to inform residents of flood danger and evacuation methods). The Fire Department provides CERT classes to the public to train volunteers on ways to assist Corte Madera in case of a major disaster. There are emergency action checklists to which the Fire Department and other responsible agencies refer in response to imminent/actual flooding.

According to the Fire Department's Flood Emergency Plan, floods are generally classified as either slow-rise or flash floods. Slow-rise floods may be preceded by a warning time lasting from hours, to days, or possibly weeks. Evacuating and sandbagging for a slow-rise flood may lessen damage. Fortunately, Corte Madera is not confronted with damaging flash floods.

Corte Madera and the Corps of Engineers are currently working on a plan to identify options to address the tidal flooding issues of San Clemente Creek and Shorebird Marsh associated with Watersheds No. 4, No. 5, and No. 6. Some of the proposed mitigation suggestions include implementing levees or other on-shore floodwalls or barriers, raising houses immediately adjacent to San Clement Creek, and improving the drainage infrastructure.

Many residents have raised and reinforced the foundations of their houses when remodeling, which has served to protect them from tidal flooding and seepage. Dredging of San Clemente Creek would not, without other measures, significantly reduce any of the flooding problems, since the water storage capacity of the creek could not be increased enough to serve that purpose. Improving the drainage infrastructure would reduce street ponding, but would not stop the flooding from rainwater runoff during high tides or end the seepage problems. Street sweepers regularly keep the streets clean of leaves and debris that could clog drain inlets.

On November 25, 1986, the Corte Madera Town Council established the Flood Control Board, which is the successor to the Flood Control Committee, appointed in 1986. The purpose of the Flood Control Board is to advise the Town Council on all matters affecting flooding in Corte Madera and to recommend ways to provide flood protection for the town.

Corte Madera has adopted an Ordinance that requires all new buildings in Special Flood Hazard Areas to be built with finished floors one foot above flood elevations required by

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FEMA. Since the majority of the area has base flood elevations of 6 feet msl, this requires building elevations of approximately 7 feet msl.

Mitigation Measure HYDRO-1 of the ordinance states that individual development projects are required to complete a detailed hydrologic study prior to issuing development permits. These studies are aimed at identifying downstream areas that experience localized flooding, detailing potential impacts that proposed projects could create on these area, and identifying both on- and off-site mitigation measures that would be required to prevent these impacts. Incorporating appropriate flood hazard reduction measures, as outlined in Title 16 of the Corte Madera Municipal Code, is required for new development in the Paradise/San Clemente area.

Effective July 1, 1998, a voter-approved Storm Drainage Tax (Ordinance No. 821, enacted November 4, 1997) was levied on parcels to raise money for storm drainage/flood control improvements and to pay remaining debts. Each residential unit, or 1,000 square feet of floor area of nonresidential use, is assessed \$98 per year for 25 years, providing approximately \$608,000 in revenue. This replaced the Storm Drainage Special Benefit Assessment, which generated \$350,000 per year. Future improvements will focus on protection from tidal flooding, especially in the Lucky Drive area and the Mariner Cove subdivision. The existing conditions will worsen due to settlement and potential sea level rise. Curb ponding in the low-lying subdivisions also needs to be addressed, as it is a considerable inconvenience to homeowners and in some cases can be a traffic hazard. Other improvements will include CMP (corrugated metal pipe) replacement, pump station upgrades (Marquart Lagoon and the Corporation Yard Station), and 100-year protection for the FEMA designated floodplain.

8.3 Wildland Fire Hazards

Wildland fire is a persistent threat to residential neighborhoods in the hillside areas of the Town, including areas on Chapman Hill and Christmas Tree Hill. This problem consists of accumulation of dead or drying vegetation at ground level, steep slopes and summer or early fall fire weather conditions (hot daytime temperatures, low humidity and strong winds). The wildland fire hazard is exacerbated by vehicular access constraints, such as steep, winding and narrow roads. Vigorous vegetation management exists with inter-jurisdictional cooperation and contracted work. The Mt. Tamalpais Vegetation Management Program was completed in 2000 and is operated by the Marin Open Space District. Additionally, the Department of Public Works trains Fire Department personnel on the use of the Town's articulating mower and provides access to the mower during weekends and after business hours. Other contracted work includes the landscape maintenance company Forster & Kroeger, the California Department of Corrections, and the Sonoma County Sheriff's Office for vegetation removal at various locations around the Town. All fire roads within the Town are surveyed annually in the spring, after rains have stopped, in an effort to improve fire protection in the wildland interface.

8.4 Hazardous Materials and Waste

Hazardous materials consist of any substance which has the potential to cause injury, and can include flammable liquids and gases, poisons, corrosives, explosives, radioactive materials, and medical supplies and wastes. They are also commonly transported over highways.

The storage and clean-up (remediation) of hazardous sites is largely regulated by a series of federal, State and local agencies, including the U.S. Environmental Protection Agency, Cal EPA, and the State Department of Toxic Substance Control. The latter maintains a list of hazardous waste and substances list. Because of a general lack of significant industrial operations, the Town does not experience any significant threat from the use or storage of hazardous materials. However, the State has identified over 20 hazardous waste sites in Corte Madera, all of which involve issues of leaking underground storage tanks (LUST's). These sites typically are associated with past automobile-related activities, such as service stations and automobile repair shops, and tend to be located in proximity to Highway 101, including sites on Tamalpais Drive, Paradise Drive and Tamal Vista. The primary risk they pose is leaking of gasoline and diesel fuel hydrocarbons and related compounds into the soil and groundwater. Many of the sites have undergone successful remediation (which usually involves removal of the LUST and any contaminated soil), while the State has indicated that other sites require no further investigation.

The transport of hazardous materials, particularly along the Highway 101 corridor, presents possible hazards in the event of a materials leak or if a transport truck experiences an accident. The Corte Madera Fire Department would respond to any such incidents, utilizing its Hazardous Materials Management Plan. The Plan documents the annual use of any flammable or toxic materials, allowing appropriate Department response to a fire or other emergency.

8.5 Emergency Response Preparedness

As part of its disaster preparedness program, the Department conducts Neighborhood Emergency Response Training (NERT) classes for the general public. The goal of this program is to help the citizens of Corte Madera become self-sufficient in the event of a major disaster. Individuals acquire hands-on disaster training to ensure safer neighborhoods. Training for staff as part of emergency preparedness included earthquake courses, paramedic training, Emergency Medical Technician training, confined space rescue, wild land survival classes, and a multi-agency disaster drill. Vehicle and equipment maintenance, as well as vegetation management and fire road maintenance, remain as a high priority for the Fire Department. Vehicle maintenance repairs include all engines, and rescue and utility vehicles. Equipment repairs and projects consist of installation of and service to all radio equipment, SCBS equipment, the computer system, and suppression and medical equipment. Fire hose in the Department is tested annually, and a fire hydrant maintenance program ensures continual service.