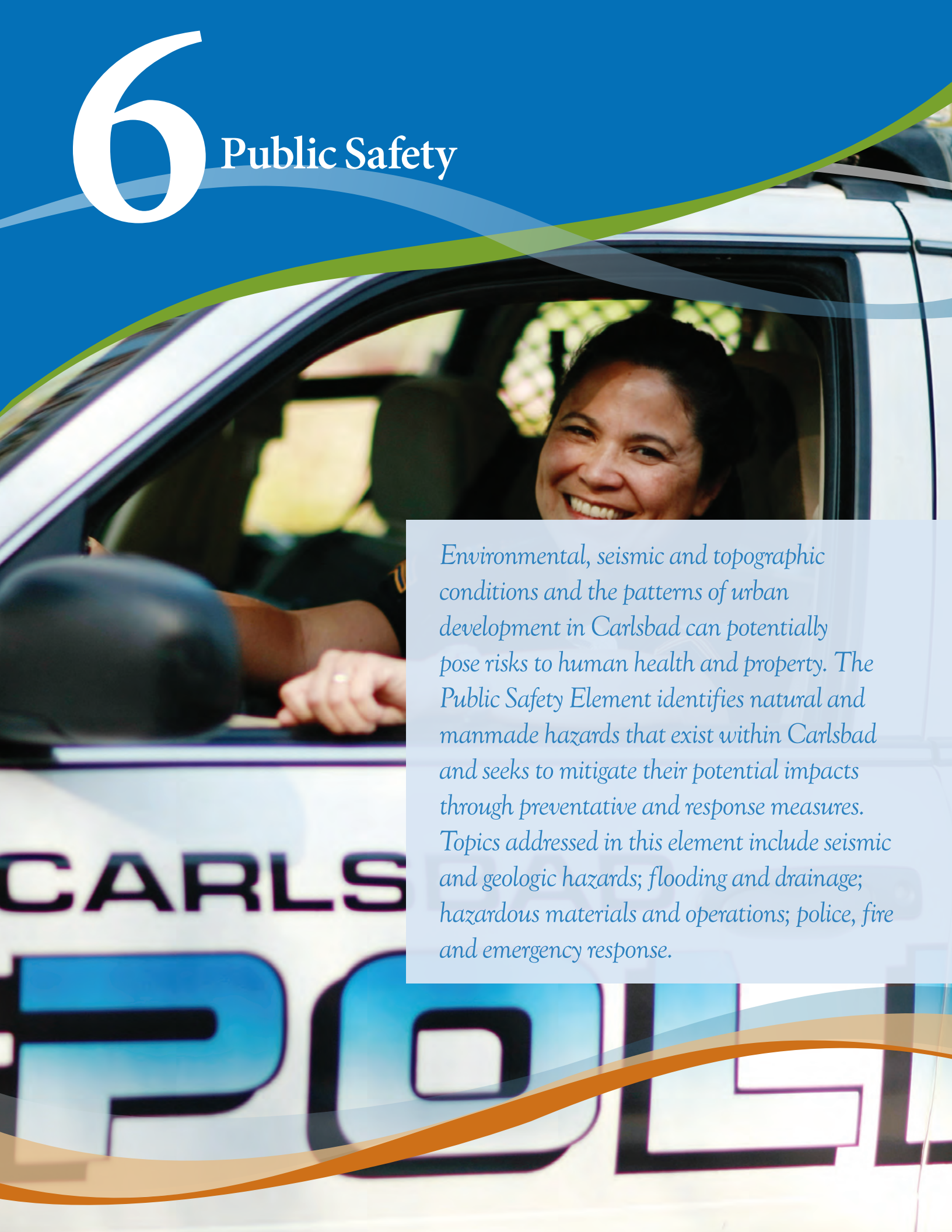


# 6 Public Safety

A photograph of a woman with dark hair, smiling broadly from the driver's seat of a white car. The car has 'CARLSBAD POLICE' written on its side in large, bold letters. The background is slightly blurred, showing greenery. The image is overlaid with a semi-transparent text box.

*Environmental, seismic and topographic conditions and the patterns of urban development in Carlsbad can potentially pose risks to human health and property. The Public Safety Element identifies natural and manmade hazards that exist within Carlsbad and seeks to mitigate their potential impacts through preventative and response measures. Topics addressed in this element include seismic and geologic hazards; flooding and drainage; hazardous materials and operations; police, fire and emergency response.*

6  
Public Safety

## 6.1 Introduction

### Background and Purpose

The purpose of this element is to acknowledge the risk posed by hazards, and to reduce the risk of injury, loss of life, property damage, and economic and social dislocation resulting from natural and manmade hazards. The proposed overall development pattern in the Land Use and Community Design Element incorporates consideration of flooding risk, seismic safety and other hazards. The Public Safety Element contains the city's goals and policies to reduce the risks associated with identified hazards and integrate mitigating measures into the city's development process.

### Relationship to State Law

Government Code Section 65302(g) requires each California city and county to include within its general plan a public safety element that addresses the protection of the community from any unreasonable risks associated with the effects of seismic and other geologically-induced hazards, flooding, and fires. The Public Safety Element is required to include mapping of known seismic and other geological hazards. Where applicable, it must also address evacuation routes, peak load water supply requirements, minimum road widths and clearances around structures.

State law also allows cities to address any other locally relevant issues in its public safety element. In addition to those mentioned above, Carlsbad's Public Safety Element also addresses disaster preparedness and the protection from other local health and safety hazards, such as fire, hazardous materials and airport hazards.

### Relationship to Community Vision

The Public Safety Element is most closely tied to the following objective in the Community Vision:

*Core Value 8: Support quality, comprehensive education and life-long learning opportunities, provide housing and community services for a changing population, and maintain a high standard for citywide public safety.*

### Relationship to Other General Plan Elements

The Public Safety Element is strongly correlated to the Land Use and Community Design Element and the Open Space, Conservation and Recreation Element. The Land Use and Community Design Element includes consideration of fire, seismic, flooding and other hazards in land use designations and their intensity. Through restrictions on the development of hazardous areas, identified by

careful investigation as proposed in the Public Safety Element, the Land Use and Community Design Element supplements the policies of this element.

Related to the Open Space, Conservation and Recreation Element, areas subject to severe hazards, especially those related to seismic or flood-prone conditions, are designated for a reduced level of development or open space, or development is required to be set back from areas impacted by these factors.

Additionally, the Public Safety Element is related to the Mobility Element in that good street design and accessibility of the transportation system is vitally important in providing emergency services.

Finally, the Public Safety Element is related to the Housing Element and the Arts, History, Culture, and Education Element in that it identifies areas that may present hazardous conditions for residential structures and proposes precautionary measures related to older existing structures that may have historic or cultural significance.



## 6.2 Regulatory Setting

Public safety is a topic that is subject to extensive federal, state, and local regulations that span a variety of safety topics. Some of the key regulations and regulatory agencies are summarized below. The city is not responsible for administering all of the regulations; rather, the following discussion provides examples of how public safety in Carlsbad is a shared responsibility among various government agencies. For a fuller discussion of the regulatory setting pertaining to safety, the Environmental Impact Report for the General Plan should be consulted.

### Federal Programs and Regulations

#### Environmental Protection Agency

The United States Environmental Protection Agency (U.S. EPA) enforces the Federal Toxic Substances Control Act (1976) and the Resource Conservation and Recovery Act of 1976 (RCRA), which regulates the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA was amended in 1984 by the Hazardous and Solid Waste Act (HSWA), which affirmed and extended the “cradle to grave” system of regulating hazardous wastes (controlling hazardous waste from the time it is generated until its ultimate disposal). The use of certain techniques for the disposal of some hazardous wastes was specifically prohibited by the HSWA.

The 1980 Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as Superfund, provides broad federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment.

#### United States Department of Transportation

Transportation of chemicals and hazardous materials are governed by the United States Department of Transportation (DOT), which stipulates the types of containers, labeling, and other restrictions to be used in the movement of such material on interstate highways.

#### Federal Emergency Management Agency

The primary mission of the Federal Emergency Management Agency (FEMA) is to reduce the loss of life and property and to protect the nation from all hazards, including natural disasters, acts of terrorism, and other manmade disasters, by leading and supporting a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation. FEMA maps floodplains, and is currently (2013) in the process of preparing new floodplain mapping along much of the California coastline, including Carlsbad.

## Disaster Mitigation Act

The Disaster Mitigation Act of 2000 requires a state mitigation plan as a condition of disaster assistance, adding incentives for increased coordination and integration of mitigation activities at the state level.

## State Regulations

### California Environmental Protection Agency

The management of hazardous materials and waste within California is under the jurisdiction of the California Environmental Protection Agency (Cal EPA). Cal EPA is responsible for developing, implementing and enforcing the state's environmental protection laws that ensure clean air, clean water, clean soil, safe pesticides and waste recycling and reduction. Within Cal EPA are various departments, three of which are described as follows:

#### Office of Environmental Health Hazard Assessment

The California Office of Environmental Health Hazard Assessment oversees implementation of the Safe Drinking Water and Toxic Enforcement Act of 1986 (commonly known as Proposition 65), which aims to protect California citizens and the state's drinking water sources from chemicals known to cause cancer, birth defects, or other reproductive harm and to inform citizens about exposures to such chemicals.

#### The California Department of Toxic Substances Control

The California Department of Toxic Substances Control (DTSC) implements California Code of Regulations Title 22, Division 4.5, which provides standards for the management of hazardous waste. The DTSC has the authority to delegate enforcement of the state's hazardous waste regulations to local jurisdictions.

#### State Water Resources Control Board

The State Water Resources Control Board (SWRCB), as well as nine regional water quality control boards, implements various laws related to the protection of water quality. The state and regional boards regulate wastewater discharges to surface and ground water; storm water discharges from construction, industrial, and municipal activities; discharges from irrigated agriculture; dredge and fill activities; alteration of federal water bodies; and other activities that could degrade water quality.

#### The California Department of Transportation

The California Department of Transportation (Caltrans) manages more than 50,000 miles of California's highway and freeway lanes, provides inter-city rail services, permits more than 400 public-use airports and special-use hospital heliports and works with local agencies. Caltrans is also the first responder for hazardous material spills and releases that occur on those highway and freeway lanes and inter-city rail services.

## California Emergency Management Agency

The California Emergency Management Agency (Cal EMA) is responsible for assuring the state's readiness to respond to and recover from all hazards - natural, manmade, war-caused emergencies and disasters. Cal EMA assists local governments in developing their own emergency preparedness and response plans, in accordance with the Standardized Emergency Management System and the State Emergency Plan, for earthquakes, floods, fires, hazardous material incidents, nuclear power plant emergencies, dam breaks, and acts of terrorism. Cal EMA also administers the State of California Multi-Hazard Mitigation Plan (SHMP), which presents goals, strategies, and actions for reducing future disaster losses throughout the state. The SHMP is a federal requirement under the Disaster Mitigation Act of 2000 in order for the state to receive federal funds for disaster assistance.

## Safe School Plan (California Education Code Sections 32280 et seq.)

This statute requires public schools to prepare a school safety plan that identifies strategies and programs that will ensure a high level of school safety related to: child abuse reporting; disaster procedures; on-campus violence; discrimination and harassment; safe ingress and egress to and from school; safe and orderly environment conducive to learning; and school discipline.

## Local Regulations

### County of San Diego Department of Environmental Health

The County of San Diego Department of Environmental Health (DEH) protects public health and environmental quality and implements and enforces local, state, and federal environmental laws. The DEH regulates the following: retail food safety; public housing; public swimming pools; small drinking water systems; mobile-home parks; onsite wastewater systems; recreational water; aboveground and underground storage tanks and cleanup oversight; and medical and hazardous materials and waste. In addition, DEH serves as the Solid Waste Local Enforcement Agency and prevents disease carried by rats and mosquitoes.

### California Environmental Protection Agency's Unified Program

Cal EPA oversees a unified hazardous waste and hazardous materials management and regulatory program, commonly referred to as the Unified Program. The purpose of this program is to consolidate and coordinate six different hazardous materials and hazardous waste programs, and to ensure that they are consistently implemented throughout the state. State law requires local agencies to implement the Unified Program. The County of San Diego DEH, Hazardous

Materials Division is the local agency in charge of implementing the program in the county.

### San Diego County Multi-Jurisdictional Hazard Mitigation Plan

Long-term prevention, mitigation efforts and risk-based preparedness related to specific hazards within the city are addressed in the 2010 San Diego County Multi-Jurisdictional Hazard Mitigation Plan (HAZMIT Plan). The HAZMIT Plan identifies specific risks for San Diego County and provides methods to help minimize damage caused by natural and manmade disasters. The final list of hazards profiled for San Diego County was determined as wildfire/structure fire, flood, coastal storms/erosion/tsunami, earthquake/liquefaction, rain-induced landslide, dam failure, hazardous materials incidents, nuclear materials release, and terrorism. Currently, the city is in the process of updating its mitigation strategies and action programs within the HAZMIT Plan. The County of San Diego Office of Emergency Services is responsible for coordinating with local jurisdictions and participating agencies to monitor, evaluate, and update the San Diego County Multi-Jurisdictional Hazard Mitigation Plan as necessary.

### McClellan-Palomar Airport Land Use Compatibility Plan

The McClellan-Palomar Airport Land Use Compatibility Plan (ALUCP) is prepared by the San Diego County Regional Airport Authority to protect the safety of the public from airport related hazards. The ALUCP promotes compatibility between McClellan-Palomar Airport and the land uses that surround it by addressing noise, overflight, safety, and airspace protection concerns. The ALUCP prevents exposure to excessive noise and safety hazards within the airport influence area (AIA), provides for the orderly growth of the airport and the area surrounding the airport, and safeguards the general welfare of the inhabitants within the vicinity of the airport and the public in general.

### Carlsbad Municipal Code

Chapter 6.03 of the Carlsbad Municipal Code incorporates by reference Chapters 9 and 11 of Division 8 of Title 6 of the San Diego County Code of Regulatory Ordinances, which designates the County of San Diego DEH as the local agency responsible for implementing the state's Unified Program and specifies reporting, disclosure and monitoring requirements for hazardous materials and hazardous waste establishments.

## 6.3 Flooding and Coastal Hazards

### Surface Hydrology

The San Diego Region is divided into 11 hydrologic units that flow from elevated regions in the east toward coastal lagoons, estuaries, or bays in the west. Carlsbad is located within the Carlsbad Hydrologic Unit (HU), also referred to as the Carlsbad Watershed Management Area, which is approximately 210 square miles in area, extending from the headwaters above Lake Wohlford in the east to the Pacific Ocean in the west, and from Vista and Oceanside in the north to Solana Beach, Encinitas, and the community of Rancho Santa Fe to the south. The cities of Carlsbad, San Marcos, and Encinitas are entirely within this HU. There are numerous important surface hydrologic features within the Carlsbad HU including four unique coastal lagoons, three major creeks, and two large water storage reservoirs. Approximately 48% of the Carlsbad HU is urbanized. The dominant land uses are residential (29%), commercial/industrial (6%), freeways and roads (12%), agriculture (12%), and vacant/undeveloped (32%).<sup>1</sup>

### Buena Vista Lagoon

Buena Vista Lagoon is a 350-acre fresh water lagoon owned by the State of California and managed by the California Department of Fish and Wildlife (CDFW) as a nature reserve. Located on the border between Carlsbad and Oceanside, it became California's first ecological reserve in 1969. CDFW is the major property owner of the lagoon; however, a number of adjacent residential property owners have control of small portions of their property adjacent to the lagoon's wetland boundary. Although the lagoon itself is maintained as a nature reserve, much of the Buena Vista hydrologic area is already developed.

### Agua Hedionda Lagoon

Agua Hedionda Lagoon is situated between Tamarack Avenue and Cannon Road and is comprised of three inter-connected lagoons, divided by the Interstate-5 freeway and a railroad bridge. Cabrillo Power LLC owns the three lagoon sections; the 66-acre outer lagoon adjacent to the Pacific Ocean, which primarily provides cooling water for the electric producing generators at the Encina Power Plant; the 27-acre middle lagoon is home to the North Coast YMCA Aquatic Park; and the 295-acre inner lagoon extends approximately 1,800 yards in a southeasterly direction from the Interstate-5 freeway bridge. The inner lagoon may be used for boating – permitted crafts include jet skis and powerboats (western portion) and passive vessels like sailboats and kayaks (eastern portion). At the eastern end of the lagoon is the Agua Hedionda Ecological Reserve, which was acquired in 2000 by the CDFW and consists of 186 acres of wetlands.

<sup>1</sup> Project Clean Water Website 2012, [www.projectcleanwater.org/html/ws\\_carlsbad.html](http://www.projectcleanwater.org/html/ws_carlsbad.html), accessed September 21, 2012



## Batiquitos Lagoon

The Batiquitos Lagoon consists of approximately 561 acres owned by both the CDFW and the California State Lands Commission and is protected as a game sanctuary and bird estuary. The lagoon was originally open to the ocean, but over time the construction of transportation corridors and other development resulted in sediment closing off the lagoon. Then, in the mid-1990s, a significant lagoon restoration and enhancement project, conducted by the City of Carlsbad, Port of Los Angeles and other cooperating agencies, allowed for the lagoon to open to the ocean again, as it exists today.

## Stormwater Drainage

Much of the land area in Carlsbad is developed, resulting in impervious surfaces from the placement of roads, parking lots, buildings and other infrastructure. These facilities reduce the amount of water infiltration into the ground, increase direct runoff into the city's creeks and lagoons, and cause soil erosion and sedimentation, which can result in water quality degradation and flooding concerns.

The City of Carlsbad currently employs a number of measures, including best management practices (BMPs), to prevent pollutants and hazardous materials from entering municipal stormwater conveyance systems. As storm drains are not connected to sanitary sewer infrastructure, water conveyed to these drains is not treated prior to discharging into creeks, lagoons and the ocean. Therefore, pollutants must be reduced and/or removed before entering urban conveyance systems. The city's Storm Water Protection Program covers all phases of development through planning, construction and existing development and educates and monitors developers, businesses, municipal facilities, residents, school children, and the general public to help prevent pollutants and other hazardous materials from entering storm drains.

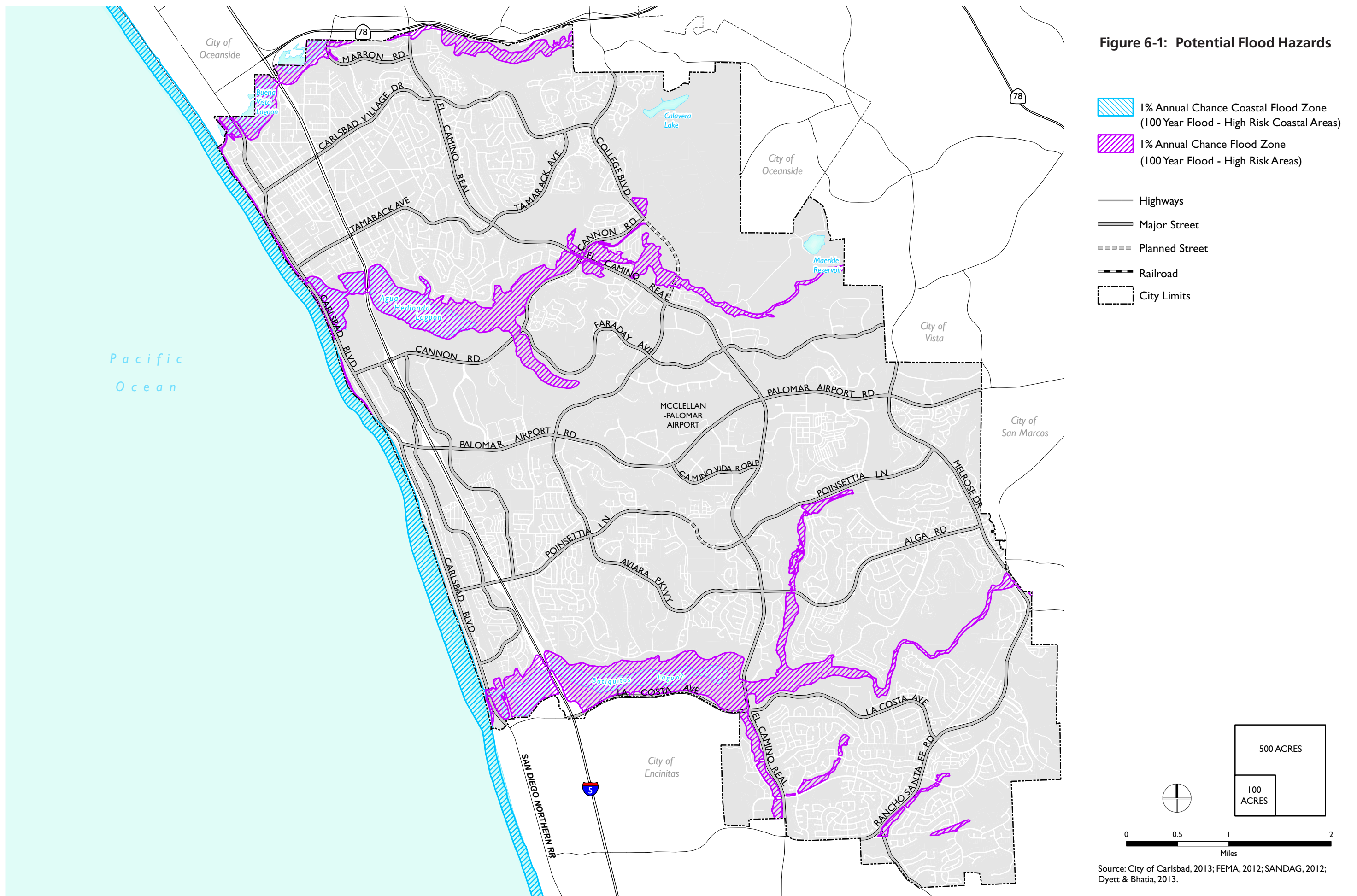
## Flood Zones

Floodplains are areas of land located adjacent to rivers or streams that are subject to recurring inundation, or flooding. Preserving or restoring natural floodplains helps with flood loss reduction benefits and improves water quality and habitat. Floods are typically described in terms of their statistical frequency. For example, a 100-year floodplain describes an area within which there is a one percent probability of a flood occurring in any given year. FEMA prepares Flood Insurance Rate Maps (FIRMs) that identify 100-year and 500-year flood zones. As shown in Figure 6-1, the potential flood hazard areas identified on the FIRM maps in Carlsbad include the entire coastline and the following major drainage basins:

- Buena Vista Creek and Buena Vista Lagoon
- Agua Hedionda Creek, its northern tributary, and the Agua Hedionda Lagoon

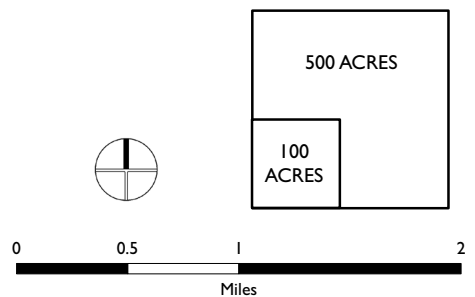


**Figure 6-1: Potential Flood Hazards**



1% Annual Chance Coastal Flood Zone (100 Year Flood - High Risk Coastal Areas)  
 1% Annual Chance Flood Zone (100 Year Flood - High Risk Areas)

Highways  
 Major Street  
 Planned Street  
 Railroad  
 City Limits



Source: City of Carlsbad, 2013; FEMA, 2012; SANDAG, 2012; Dyett & Bhatia, 2013.



- San Marcos Creek and its northern tributary
- Batiquitos Lagoon
- Encinitas Creek

Most jurisdictions within San Diego County, including the City of Carlsbad, participate in the National Flood Insurance Program. Pursuant to the City of Carlsbad's Local Coastal Plan and Carlsbad Municipal Code Title 21 (Zoning), development is restricted within 100-year floodplain areas.

### Dam Inundation

Dam inundation can be caused by the release of impounded water from structural failure or overtopping of a dam. The San Diego County HAZMIT Plan identifies dam-failure risk levels based on dam inundation map data. There are four dams and a reservoir located within or adjacent to the City of Carlsbad, as shown in Figure 6-2: the Calavera, Maerkle, San Marcos, and Bressi dams, and the Stanley A Mahr reservoir. The Calavera and Maerkle dams and Stanley A Mahr reservoir have been assigned high hazard ratings, San Marcos dam has a significant hazard rating, and the Bressi dam has a low hazard rating. All four dams and the reservoir have emergency action plans in place. These facilities are periodically inspected by the State of California Division of Dam Safety.

### Sea Level Rise

In California, sea levels have risen by as much as seven inches along the coast over the last century, resulting in eroded shorelines, deterioration of infrastructure, and depletion of natural resources. In 2009, California adopted a Climate Adaptation Strategy<sup>2</sup>, which summarizes the most recent science in predicting potential climate change impacts and recommends response strategies. The California Energy Commission's 2009 White Paper entitled, *The Impacts of Sea-Level Rise on the California Coast* also describes strategies to address the impacts of sea level rise in California communities. The San Diego County HAZMIT Plan has identified sea level rise as one of Carlsbad's (and other coastal cities) three primary climate change vulnerabilities (the other two being drought and fire). According to Cal-Adapt online tool (developed by the California Natural Resources Agency along with others), the historical average baseline (1961-1990) temperature in the Carlsbad area of 63.0 degrees F could increase by 3.6 to 6.0 degrees by the end of century period (2070-2090), depending on various emissions scenarios. According to the Sea Level Rise Adaptation Strategy for San Diego Bay (south of Carlsbad) prepared in 2012 by a consortium of cities, sea level in the bay could rise by as much as 17 inches by 2050 and five feet by 2100.

<sup>2</sup> 2009 California Climate Adaptation Strategy, California Natural Resources Agency. [http://resources.ca.gov/climate\\_adaptation/docs/Statewide\\_Adaptation\\_Strategy.pdf](http://resources.ca.gov/climate_adaptation/docs/Statewide_Adaptation_Strategy.pdf). As of preparation of this General Plan, a 2013 update of the Adaptation Strategy is underway.

Areas within Carlsbad that are particularly vulnerable to sea level rise are those areas immediately adjacent to the coast and the lagoons, which are similarly vulnerable to coastal storms. Potential strategies to reduce the impacts of sea-level rise on the city may include hard engineering (seawalls, breakwaters, levees) soft engineering (beach nourishment and/or replenishment, wetlands restoration) and restricting or reducing development near the coastal areas.

In 2011, FEMA initiated the California Coastal Analysis and Mapping Project/ Open Pacific Coast Study, which involves over 1,200 miles of new coastal flood hazard mapping and base-flood elevation determinations. Under this initiative, many coastal communities, including Carlsbad, will have coastal flood data and mapping updated for the first time in over 20 years. This study will improve the quality of the coastal data used for both floodplain management and planning purposes.

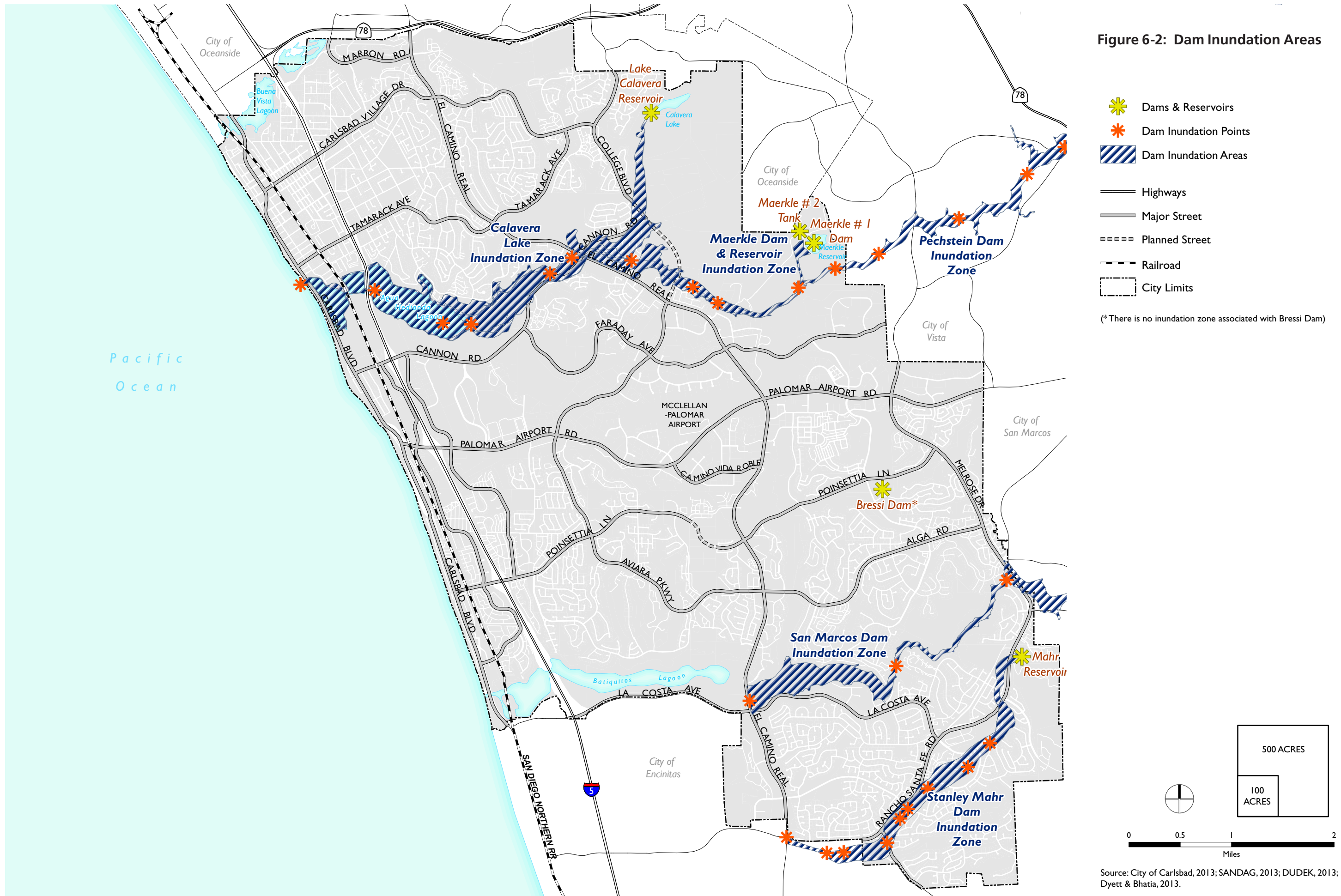
### Tsunamis and Seiches

Tsunamis are long wavelength ocean waves generated by sudden movements of the ocean bottom during events such as earthquakes, volcanic eruptions, or landslides. The County of San Diego maps zones of high risk for tsunami run-up. As shown in Figure 6-3, the only areas identified within the City of Carlsbad as having risk for tsunami run-up are the immediate vicinity of the Buena Vista, Agua Hedionda, and Batiquitos lagoons.

Seiches are defined as wave-like oscillatory movements in enclosed or semi-enclosed bodies of water such as lakes or reservoirs. Potential effects from seiches include flooding damage and related hazards from spilling or sloshing water, as well as increased pressure on containment structures. The County of San Diego maps zones of high risk for dam inundation throughout the county. The high-risk areas are located in other communities upstream in the Carlsbad Watershed Management Area.



Figure 6-2: Dam Inundation Areas

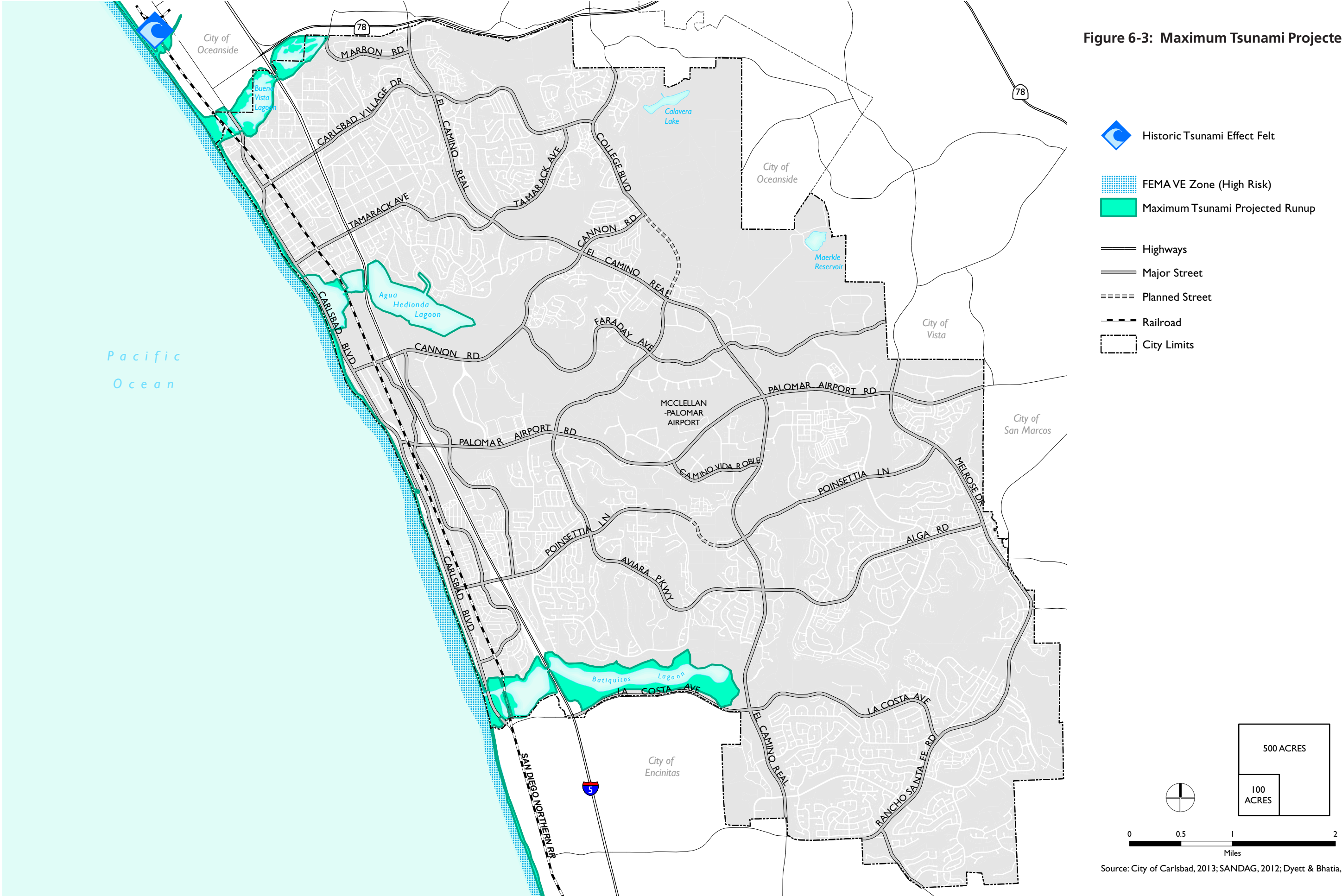


Source: City of Carlsbad, 2013; SANDAG, 2013; DUDEK, 2013; Dyett & Bhatia, 2013.





Figure 6-3: Maximum Tsunami Projected Run-up



Source: City of Carlsbad, 2013; SANDAG, 2012; Dyett & Bhatia, 2013.



## 6.4 Geologic and Seismic Hazards

### Geology and Soils

The City of Carlsbad is within the coastal portion of the Peninsular Ranges Geomorphic Province, a region characterized by northwest-trending structural blocks and intervening fault zones. Topographically, the Peninsular Ranges Province is composed of generally parallel ranges of steep-sloping hills and mountains separated by alluvial valleys. More recent uplift and erosion has produced the characteristic canyon and mesa topography present today in western San Diego County, as well as the deposition of surficial materials including Quaternary-age (less than approximately two million years old) alluvium, colluvium and topsoil.<sup>3</sup> Figure 6-4 shows the local geology of Carlsbad.

### Seismicity

There are no active faults that run directly through Carlsbad. Additionally, the California Geologic Survey does not include the City of Carlsbad on its list of cities affected by Alquist-Priolo Earthquake Fault Zones. The nearest fault to the city is the Newport-Inglewood-Rose Canyon Fault, which runs offshore of the western edge of the city and is considered active. Other faults in the region include the Coronado Bank, La Nacion, Elsinore, Agua Caliente, and San Jacinto.

Fault activity has the potential to result in ground shaking, which can be of varying intensity depending on the intensity of earthquake activity, proximity to that activity, and local soils and geology conditions. Although there are no active faults within Carlsbad, the city is located within a seismically active region and earthquakes have the potential to cause ground shaking of significant magnitude. Figure 6-5 shows the location and extent of the profiled earthquake faults within San Diego County based on a United States Geological Survey earthquake model that shows probabilistic peak ground acceleration. Although located near fault lines, Carlsbad lies within a medium-low probabilistic peak ground acceleration zone.

Historical documents record that an earthquake centered either on the Rose Canyon or Coronado Bank faults struck San Diego on May 27, 1862, damaging buildings in Old Town and causing ground rupture near the San Diego River mouth. This earthquake is believed to have had a magnitude of about 6.0 based on descriptions of the damage it caused. The strongest recorded earthquake in the San Diego area was a magnitude of 5.3 on the Richter scale that struck on July 13, 1986 on the Coronado Bank fault, 25 miles offshore of Solana Beach. There have been several moderate earthquakes recorded within the Rose Canyon Fault Zone as well. On June 17, 1985, three earthquakes hit San Diego measuring

<sup>3</sup> Ibid.

3.9, 4.0, and 3.9, respectively, and on October 28, 1986, a stronger earthquake with a magnitude of 4.7 occurred.<sup>4</sup>

### Seismic Risk to Development

Earthquake damage to structures can be caused by ground rupture, liquefaction, ground shaking, and possibly inundation from tsunami (as discussed above). The level of damage at a location resulting from an earthquake will depend upon the magnitude of the event, the epicenter distance, the response of geologic materials, and the design and construction quality of structures.

During an earthquake, shaking of granular loose soil saturated with water can lead to liquefaction, a condition in which sediments below the water table temporarily lose strength during an earthquake and behave as a viscous liquid rather than a solid. As a result, this can cause structures to lose foundation-bearing capacity. Historically, seismic shaking levels in the San Diego region, including in Carlsbad, have not been sufficient enough to trigger liquefaction, and as such, the city generally has a low liquefaction risk. However, there are areas of the city that have a higher risk of liquefaction due to the presence of hydric soils or soils that are often saturated or characteristic of wetlands. These areas are limited to the immediate vicinity of the Buena Vista, Agua Hedionda, and Batiquitos Lagoons, as shown in Figure 6-6. Additionally, in general, south facing slopes in Carlsbad are gentle grade and not prone to landslides, while north facing slopes are generally steeper and more susceptible to landslides.

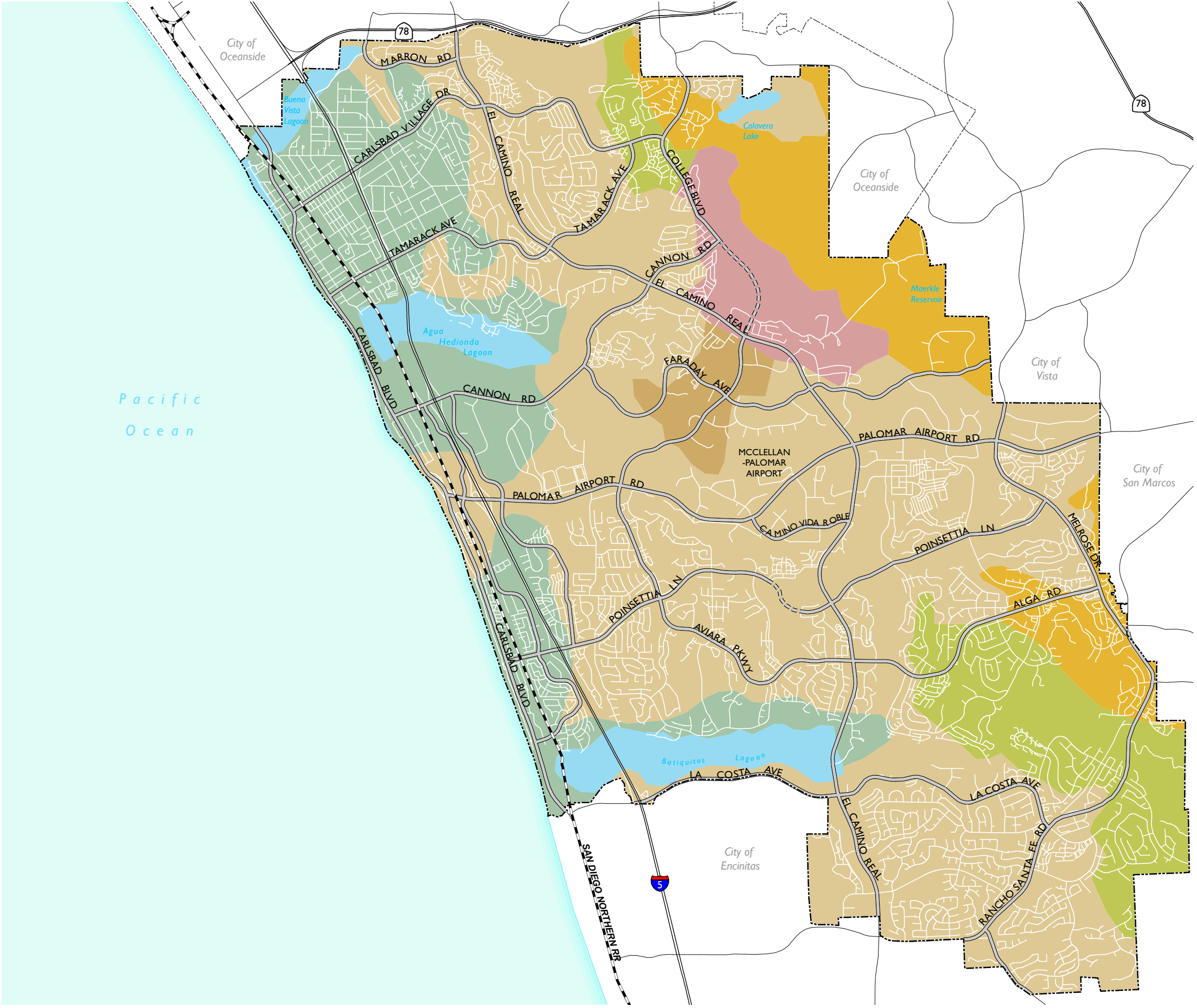
Development in a liquefaction hazard zone requires adherence to the guidelines for evaluating and mitigating seismic hazards as required by California Public Resources Code Section 2695(a). Before a development permit can be granted for a site within a seismic hazard zone, a geotechnical investigation of the site must be conducted and appropriate mitigation measures incorporated into the project design. Mitigation of liquefaction hazards can include edge containment structures (e.g. berms, dikes, retaining walls, etc.), driving piles, removal or treatment of liquefiable soils, or modification of site geometry.

The city's Building Division implements and enforces the Carlsbad Municipal Code and the California Building Code regulations relative to seismic risk to development. Chapter 18.07 of the Carlsbad Municipal Code specifies the need and establishes guidelines for the seismic upgrade of unreinforced masonry buildings.

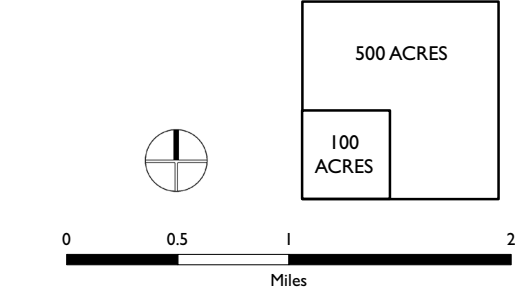
<sup>4</sup> Deméré, Thomas A., Ph.D., San Diego Natural History Museum, Geology of San Diego County, California, <http://www.sdnhm.org/archive/research/paleontology/sdfaults.html>, accessed on September 25, 2012b



Figure 6-4: Geology



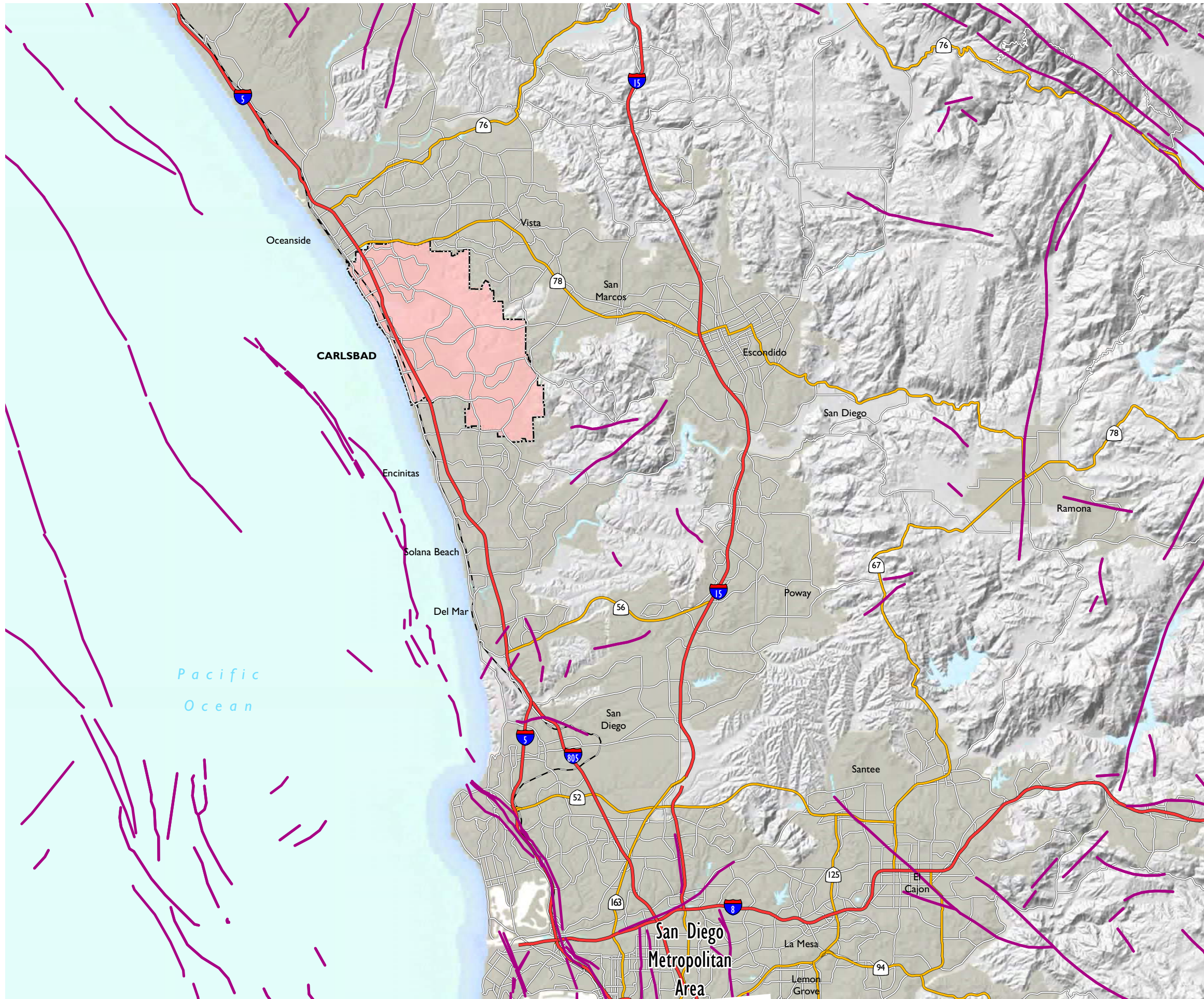
- Alluvium
- Cretaceous marine undivided
- Eocene marine
- Mesozoic granitic rocks
- Upper Cretaceous marine
- Mesozoic volcanic and metavolcanic
- Pliocene marine
- Water
- Highways
- Major Street
- Planned Street
- Railroad
- City Limits



Source: City of Carlsbad, 2013; DUDEK, 2013; SANDAG, 2013; Dyett & Bhatia, 2013.

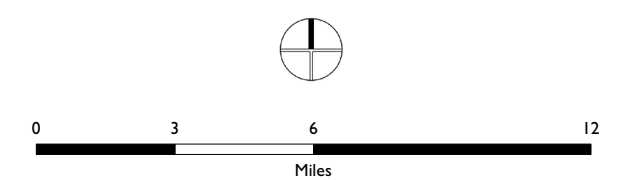






**Figure 6-5: Earthquake Faults**

- Earthquake Fault Lines
- Freeway
- Major Highway
- Minor Highway/Major Street
- Passenger Rail Lines
- County Lines
- City of Carlsbad
- Urban Areas

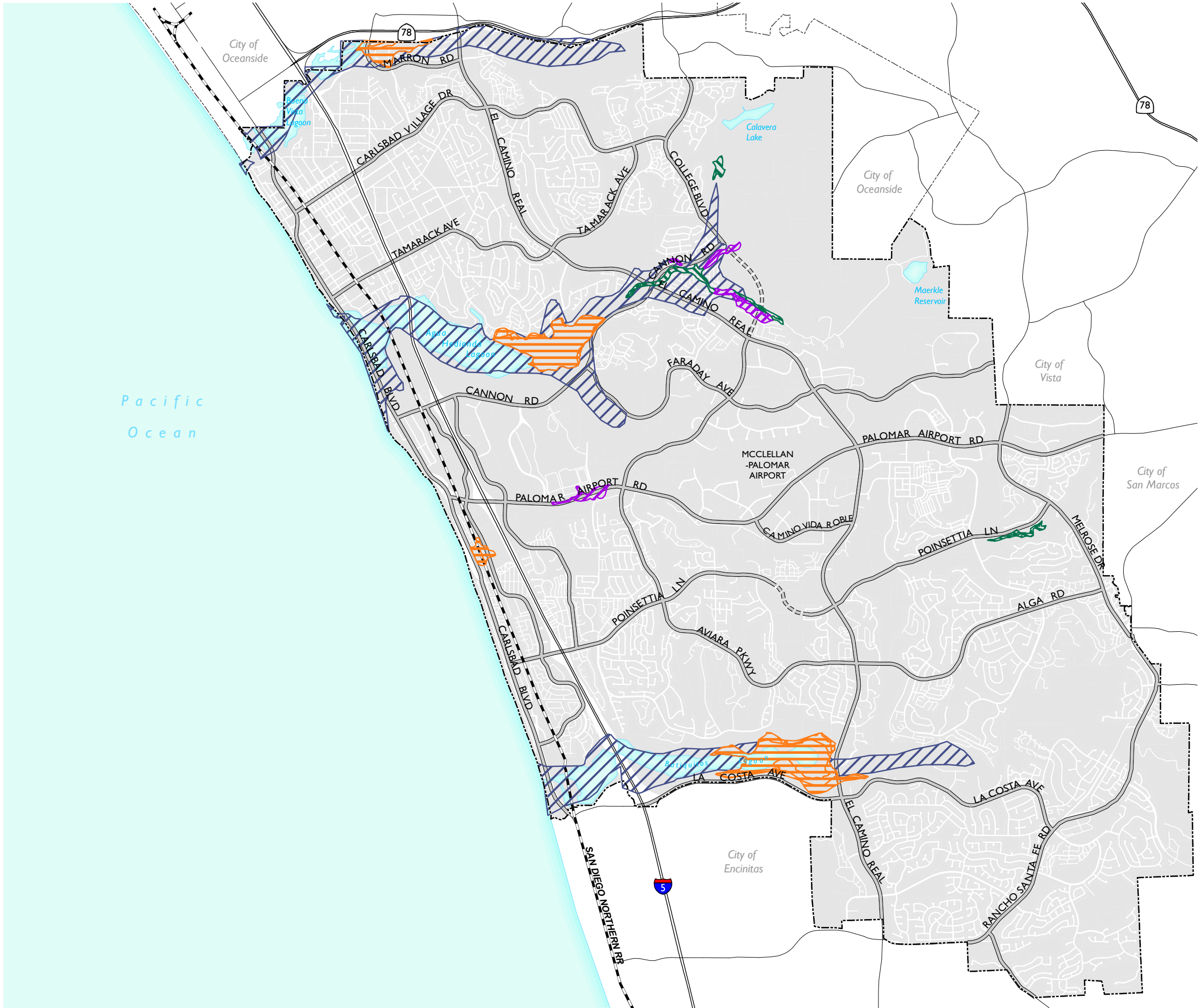


Source: ESRI, 2009; City of Carlsbad, 2013; DUDEK, 2013; USGS, 2002; Dyett & Bhatia, 2013.





Figure 6-6: Liquefaction Hazards



**Potential Liquefaction**

- Riverwash
- Tidal flats
- Tujunga sand, 0 to 5 percent slopes
- Other Hazard

Highways  
 Major Street  
 Planned Street  
 Railroad  
 City Limits

Source: City of Carlsbad, 2013; DUDEK, 2013; SANDAG, 2013; Dyett & Bhatia, 2013.

