CITY OF GRAND TERRACE

DRAFT LOCAL HAZARD MITIGATION 2017 PLAN UPDATE

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Section 1. Introduction

Natural disasters cause death and injuries, as well as significant damage to our communities, businesses, public infrastructure, and environment. The impacts of these damages result in the displacement of people and tremendous costs due to response and recovery dollars, economic loss, and burden. The City of Grand Terrace Hazard Mitigation Plan is an effort undertaken by the City to mitigate the effects of natural hazards and return to "the norm" sooner with fewer impacts to people and infrastructure.

Hazard mitigation planning is the process through which hazards are identified, likely impacts determined, mitigation goals set, and appropriate mitigation strategies determined, prioritized, and implemented. While natural disasters cannot be prevented from occurring, the effects of natural disasters can be reduced or eliminated through a well-organized public education and awareness effort, preparedness activities and mitigation actions.

After disasters, repairs and reconstruction are often completed in such a way as to simply restore to pre-disaster conditions. Such efforts expedite a return to normalcy; however, the replication of pre-disaster conditions results in a cycle of damage, reconstruction, and repeated damage. Hazard mitigation ensures that such cycles are broken and that post-disaster repairs and reconstruction result in increased resiliency for the City of Grand Terrace residents, business owners and city officials.

The HMP update is a "living document" that should be reviewed, monitored, and updated to reflect changing conditions and new information. As required, the HMP must be updated every five (5) years to remain in compliance with regulations and Federal mitigation grant conditions. In that spirit, this Hazard Mitigation Plan (HMP) is an update of the 2011 City of Grand Terrace Hazard Mitigation Plan Update draft. This HMP presents updated information regarding hazards being faced by the City of Grand Terrace.

1.1 The City of Grand Terrace

The City of Grand Terrace was incorporated on November 30, 1978. (City of Grand Terrace General Plan, 2010) Grand Terrace is located in San Bernardino County between the city of Colton and the community of Highgrove in Riverside County. This 3.6 square mile community has an average elevation of 1,065 feet.

City of Grand Terrace is located in the Santa Ana River watershed, which includes much of Orange County, the north western corner of Riverside County, the southwestern corner of San Bernardino County, and a small portion of Los Angeles County. The Santa Ana River bisects the City of Colton, just to the northwest of the City limits. It enters Colton in the Northeast corner and exits Colton in the Southwest corner. (City of Grand Terrace 2011 Hazard Mitigation Plan Update DRAFT, 2011)

1.2 Purpose of the Plan

The intent of hazard mitigation is to reduce and/or eliminate loss of life and property. Hazard mitigation is defined by FEMA as "*any action taken to reduce or eliminate the long-term risk to human life and property from natural hazards*." A "hazard" is defined by FEMA as "*any event or condition with the potential to cause fatalities, injuries, property damage, infrastructure damage, agricultural loss, environmental damage, business interruption, or other loss*."

The purpose of the Hazard Mitigation Plan (HMP) is to demonstrate the plan for reducing and/or eliminating risk in The City of Grand Terrace. The HMP process encourages communities to develop goals and projects that will reduce risk and build a more disaster resilient community by analyzing potential hazards.

Mitigation is one of the primary phases of emergency management specifically dedicated to breaking the cycle of damage. Hazard mitigation is distinguished from other disaster management functions by measures that make the City of Grand Terrace development and the natural environment safer and more disaster resilient. Mitigation generally involves alteration of physical environments, significantly reducing risks and vulnerability to hazards by altering the built environment so that life and property losses can be avoided or reduced.

Mitigation also makes it easier and less expensive to respond to and recover from disasters. With an approved (and adopted) HMP, the City of Grand Terrace will be eligible for federal disaster mitigation funds/grants (Hazard Mitigation Grant Program, Pre-Disaster Mitigation, and Flood Management Assistance) aimed to reduce and/or eliminate risk.

1.3 Authority

In 2000, FEMA adopted revisions to the Code of Federal Regulations. This revision is known as "Disaster Mitigation Act (DMA)." DMA 2000, Section 322 (a-d) requires that local governments, as a condition of receiving federal disaster mitigation funds, have a Hazard Mitigation Plan (HMP) that describes the process for assessing hazards, risks and vulnerabilities, identifying and prioritizing mitigation actions, and engaging/soliciting input from the community (public), key stakeholders, and adjacent jurisdictions/agencies.

Senate Bill No. 379 will, upon the next revision of a local hazard mitigation plan on or after January 1, 2017, or, if the local jurisdiction has not adopted a local hazard mitigation plan, beginning on or before January 1, 2022, require the safety element to be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to that city or county.

1.4 What's New

This 2017 HMP will become the first approved and adopted *update* to the 2005 Hazard Mitigation Plan. The City completed an update to the 2005 HMP in 2011, but the document was not submitted to the State and FEMA for approval.

For this 2017 HMP Update, some changes were made in the document to reflect changes in development and priorities.

1.4.1 New Hazard Profiles

In addition to the hazards profiled in the 2011 HMP (Earthquake and Wildfire) this update also recognizes Landslide, Flood and Climate Change as being significant hazards to the City of Grand Terrace. This decision was based on changes in priorities and development that were acknowledged during the hazard prioritization process performed by the Planning Committee during Planning Committee Meeting #1 and is explained in detail in Section 4.

1.4.2 Identifying the Problem

Before mitigation goals, objectives and actions were formulated, problem statements were created for this 2017 HMP Update by the Planning Committee. Problem statements are an important step in accessing the changing priorities of the City. Problem statements can be found in Section 5.2.

1.4.3 Updated Mitigation Strategies

In order to reflect the progress in local mitigation efforts made since the 2005 HMP and the unapproved 2011 HMP Update, the mitigation actions from the 2011 HMP were reviewed to address if they have been completed, deleted, or deferred. New mitigation actions were developed to reflect changes in priorities and development and this process is explained in Section 5.5.3.

1.5 Community Profile

1.5.1 Physical Setting

The City of Grand Terrace is located along the southern border of San Bernardino County adjacent to Riverside County in a region known as the "East Valley" area of the County. As seen in Figure 1-1 the City is bounded to the north, east, and west by the City of Colton and to the south by the unincorporated community of Highgrove in Riverside County. The City encompasses approximately 3.6 square miles and has no external sphere of influence. (City of Grand Terrace General Plan, 2010)

Figure 1-1: Location of the City of Grand Terrace, CA

Grand Terrace consists of three distinct topographic regions. The majority of the city is located on a broad alluvial fan extending east from Blue Mountain. The second area is the steep slope of Blue Mountain, while a third area in the northwest portion of the City is located within the Santa Ana River floodplain. Elevations in the City range from 900 above sea level to 2,428 feet at the top of Blue Mountain. (City of Grand Terrace General Plan, 2010)

1.5.2 History

Grand Terrace's roots date back to Mexican land grants from the period between 1830 and 1840. According to the Riverside Press Enterprise newspaper, in 1876 there were nine buildings in the Terrace-Colton area. The development of Grand Terrace, or East Riverside as the Grand Terrace/Highgrove area was then called, became a reality with the construction of the Gage Canal. This 22.5 mile irrigation canal was built at a cost of $2,000,000 and brought water from the Santa Ana River marshlands below “The Terrace”. With plenty of irrigation water, Grand Terrace rapidly became an agricultural community featuring quality citrus. However, a severe "freeze" in 1913 destroyed many citrus groves. Walnuts, a hardier tree, were planted as replacements along with peaches, as quick-profit crops. (City of Grand Terrace General Plan, 2010)

The social activities in the early 1900's centered around the Farm Bureau Extension Service and the Women's Club established in 1908, followed by the P.T.A. in the 1930's. Since there were no local churches, people traveled to surrounding communities for worship and other church activities. (City of Grand Terrace 2011 Hazard Mitigation Plan Update DRAFT, 2011)

Grand Terrace was originally called "The Terrace" because of its higher ground above neighboring communities. Later, the name "Grand" was added referring to the area's hillside view. By the time the Riverside-Highland Water Company was formed in 1898, the community was known as Grand Terrace.

In 1962, the Grand Terrace Chamber of Commerce was organized. From the very beginning, the Chamber was interested in preserving the local identity of the area, and therefore, was a strong supporter of cityhood. This group did much of the groundwork, which led to the formation of a local governing body in 1976, which was called the Municipal Advisory Council or M.A.C. Two years later, the City incorporated on November 30, 1978, becoming the sixteenth incorporated city in San Bernardino County. (City of Grand Terrace General Plan, 2010)

1.5.3 Climate

Grand Terrace receives 13 inches of rain per year with an average snowfall of 0 inches. Rainfall in is evenly distributed throughout the year with January being the wettest month (with an average rainfall around 2.7 inches). The number of days with any measurable precipitation is 42. (Sperling's Best Places, n.d.) On average, there are 282 sunny days per year in Grand Terrace. The July high temperature is around 95 degrees Fahrenheit and the January low is 40 degrees Fahrenheit. During the summer months, temperatures can vary up to 32 degrees between day and night. (City-Data.com, n.d.)

1.5.4 Demographics

The population, economic, and housing factors of the City of Grand Terrace are described in this section. Understanding these socioeconomic factors is imperative to determining the potential impacts a natural hazard event can have on the City’s population and economy.

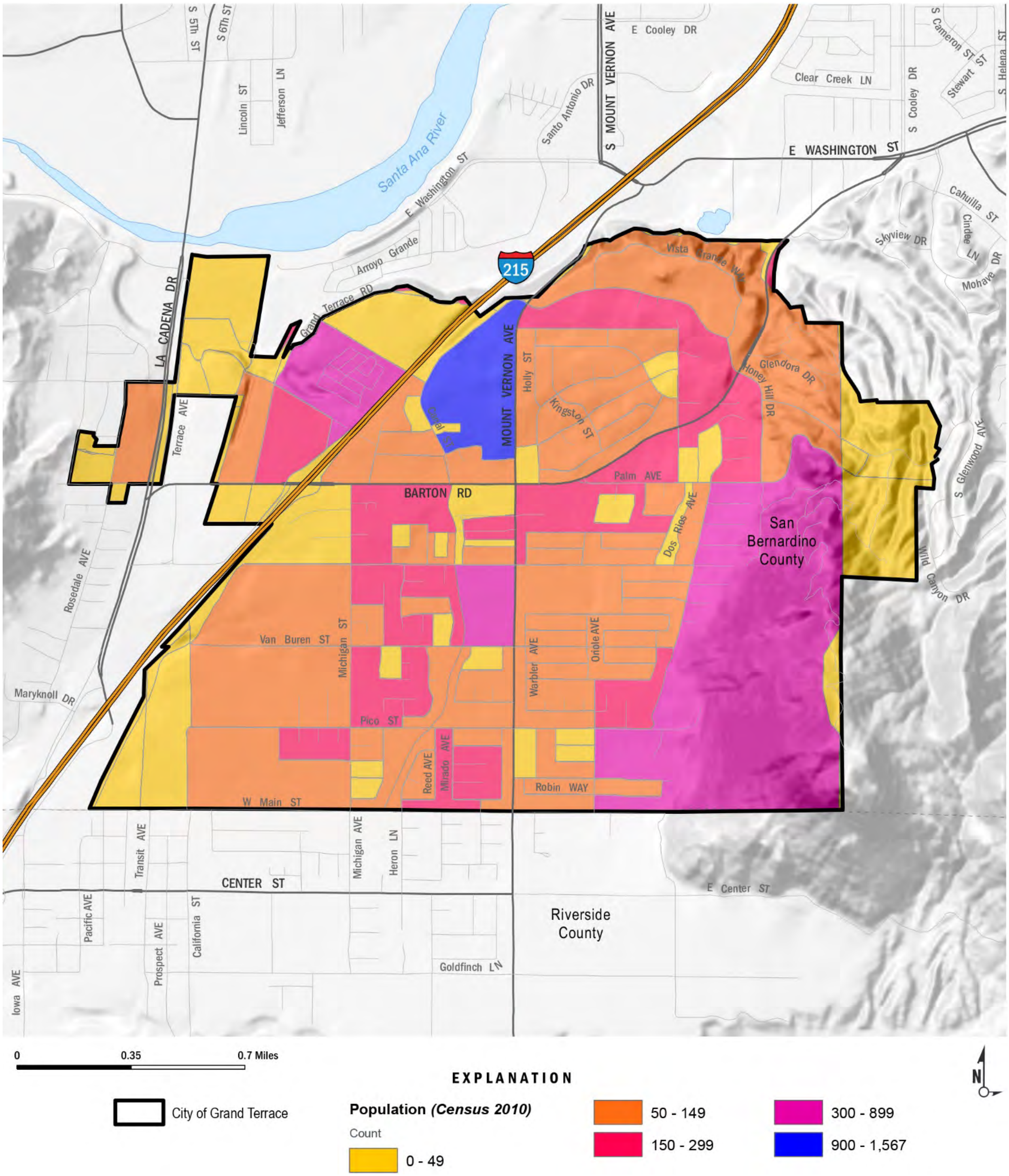

Figure 1-2: Population Density of Grand Terrace

1.5.4.1 Population

According to the 2010 US Census, the population of Grand Terrace was 12,040. The City of Grand Terrace has 3,438 people per square mile; fourteen times the state average of 239.1 people per square mile. According to the US Census population estimates, the City's population has grown by 3.5% from 2010 to July 1st, 2015. The population is the densest along Mount Vernon Ave, north of Barton Rd as shown in Figure 1-2.

The racial makeup of Grand Terrace is primarily White (65.7%). Hispanic or Latinos account for 39.1% percent of the population, followed by Asians at 6.5% and Black or African American at 5.6%. Mixed race persons make up 5.2% of the City. Native Americans constitute only 1% of the population and Native Hawaiian and Other Pacific Islanders make up .3%. (United States Census Bureau, n.d.)

1.5.4.2 Employment

The US Census Bureau reports that 65.2% of the population makes up the civilian labor force (percent of population 16 years or older, between 2010-2014). From 2010-2014 the median income (in 2014 dollars) was $64,140. (United States Census Bureau, n.d.) The most common industries in 2013 were retail trade (18%), health care and social assistance (11%), transportation and warehousing (11%), manufacturing (9%), construction (9%), public administration (6%) and administrative and support and waste management services (5%). (City-Data.com, n.d.) Table 1-1 lists the top employers in Grand Terrace (in alphabetical order).

Table 1-1: Major Employers in Grand Terrace

Major Employers in Grand Terrace (Listed in alphabetical order)	
Auto Zone (retail store)	Riverside Winnelson (plumbing & electrical supplier)
Bank of America (financial institution)	Stater Bros. Market (grocery-retailer)
CVS Pharmacy (pharmacy and retail store)	Superior Pool Products (manufacturer-distributor)
Essco Wholesale Electrical (electrical distributor- supplier)	Walgreens Pharmacy (pharmacy & retail store)
Miguel's Jr. Mexican Restaurant (fast-casual restaurant)	Wilden Pump & Engineering Company (manufacturer)
One Source Distribution (plumbing & electrical supplier)	

Source: http://www.grandterrace-ca.gov/market-area-and-business-profile.html

1.5.5 Existing Land Use

Grand Terrace is predominantly a residential community. The City was formerly an unincorporated bedroom community surrounded by the City of Colton. Predominant commercial and industrial activities focused along regional transportation corridors in other areas of Colton leaving Grand Terrace to primarily develop as a single family residential community. Since the majority of the community is located on the west side of Blue Mountain, the terrain offered scenic views that attracted residents while making large scale development of commercial and industrial uses more difficult.

The majority of the remaining undeveloped land is located on Blue Mountain, in the Santa Ana River floodplain, or adjacent to the I-215 Freeway. Table 1-2 summarizes existing land use categories, by acreage, as noted in the existing City General Plan. As illustrated, 54 percent of all land within the City limits is designated for residential uses. (City of Grand Terrace General Plan, 2010)

Table 1-2: 2010 General Plan Land Use Categories

Land Use Type	Acres	% of Total
Hillside Low Density Residential	125	5%
Low Density Residential	885.2	39%
Medium Density Residential	182.9	8%
Medium/High Density Residential	11.6	0.5%
General Commercial	88.4	4%
Office Commercial	32.9	1%
Industrial	107	5%
Floodplain Industrial	40.1	2%
Public	158.9	7%
Hillside Open Space	189.1	8%
Street & Railroad R/W	353.0	16%
Total	**2,255.1**	**100.00%**

Source: City of Grand Terrace 2010 General Plan, Amended 9/27/2016

1.5.6 Development Trends

Strategically located in the heart of the Inland Empire between the County of Riverside and City of Colton, development within the City of Grand Terrace consists mainly of infill projects in both the commercial and residential areas. The majority of the community is located on the west side of Blue Mountain, the terrain offered scenic views that attracted residents while making large scale development of commercial and industrial uses more difficult. The majority of the remaining undeveloped land is located on Blue Mountain, in the Santa Ana River floodplain, or adjacent to the I-215 Freeway. (City of Grand Terrace 2011 Hazard Mitigation Plan Update DRAFT, 2011)

There have been no changes in development in hazard prone areas in the City of Grand Terrace since the 2011 Hazard Mitigation Plan Draft. All future development that will take place is planned to occur in accordance with the General Plan Land Use Zones and will consider all potential hazards identified within this plan. Additionally, all development will be in compliance with all Fire, Flood, and Seismic codes of the County and State at the time of development.

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Section 2. Plan Adoption

2.1 Adoption by Local Governing Body

A Resolution of the City Council of the City of Grand Terrace, California, adopting the Local Hazard Mitigation Plan as required by the Disaster Mitigation Act of 2000 was adopted on Month Day, 2017 (Resolution is located in Appendix A). The Resolution will include support for the 2013 California State Hazard Mitigation Plan.

2.2 Promulgation Authority

This Hazard Mitigation Plan was reviewed and approved by the following Promulgation Authorities:

Organization: Grand Terrace City Council

Darcy McNaboe – Mayor

Sylvia Robles – Mayor Pro-Team

Brian Reinarz – Council Member

Doug Wilson – Council Member

Bill Hussey – Council Member

2.3 Primary Point of Contact

The Point of Contact for information regarding this HMP is:

Haide Aguirre
Planning and Development Services
Assistant Planner
22795 Barton Road
Grand Terrace, CA 92313
Phone: 909 824-6621, Ext. 247
Fax: 909 824-6624

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Section 3. Planning Process

3.1 Preparing for the Plan

This section describes each stage of the planning process used to develop the 2017 LHMP. The 2017 LHMP planning process provides a framework for document development and follows the FEMA recommended steps. The 2017 LHMP follows a prescribed series of planning steps which includes organizing resources, assessing risk, developing the mitigation plan, drafting the plan, reviewing and revising the plan, and adopting and submitting the plan for approval. Each is described in this section.

3.1.1 The Planning Process

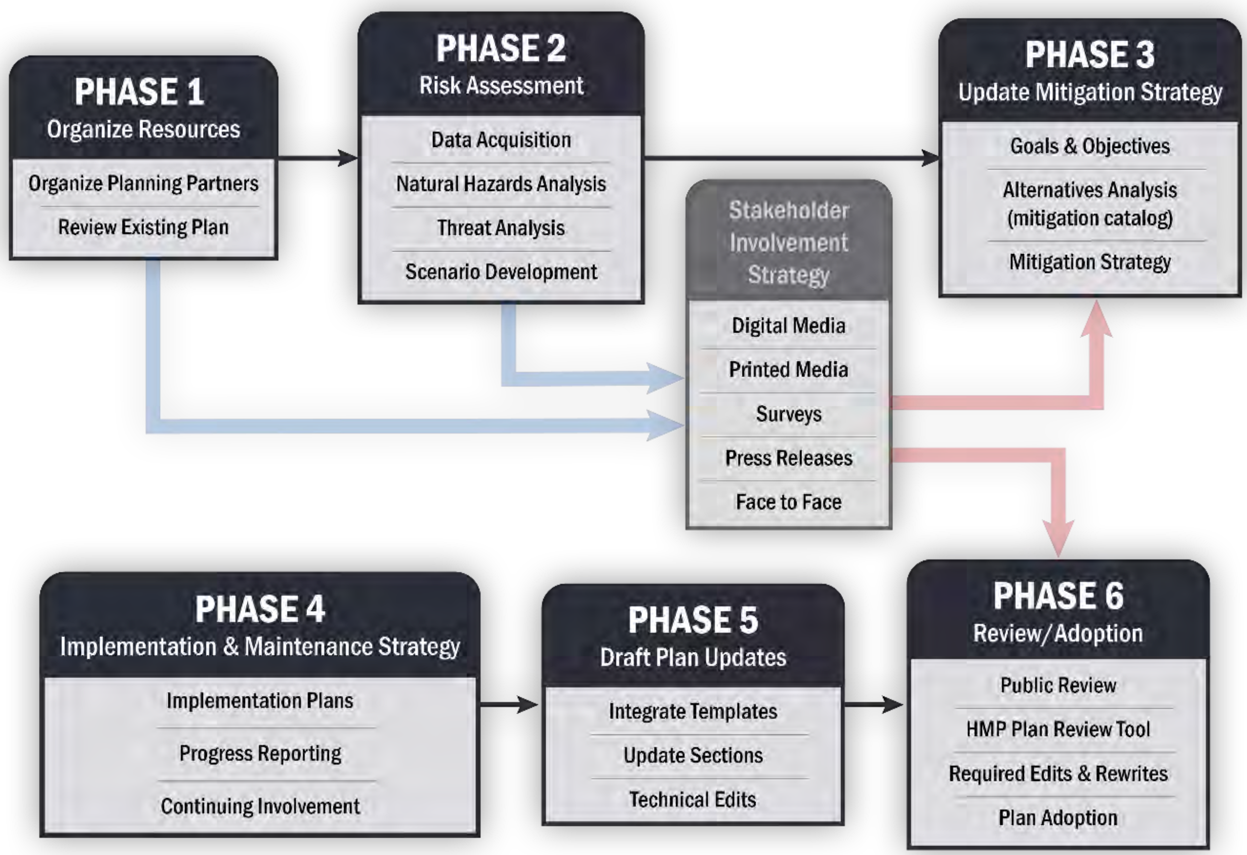
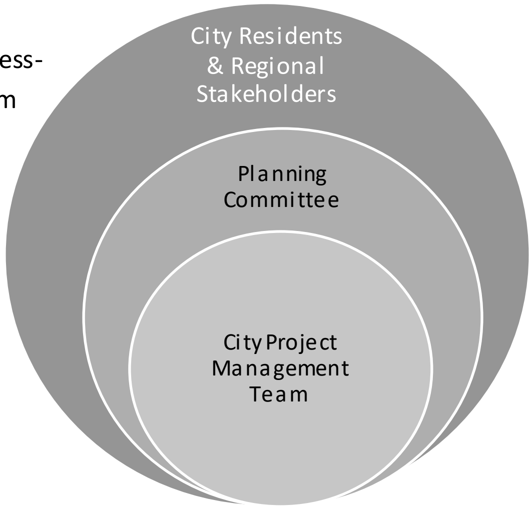


Figure 3-1: City of Grand Terrace Planning Process

3.2 Organize Resources

This section describes the first step of the 2017 HMP planning process- Organizing Resources. Organizing the resources consists of planning team development and document review tasks.



3.2.1 Building the Planning Team

The Planning Team, key to the back bone of the planning process, was critical for the development of the 2017 HMP. The Planning Team consisted of a City Planning Committee, engaged City Residents and Regional Stakeholders and a HMP consultant used for plan development and facilitation.

3.2.1.1 Project Management Team

At the core of the 2017 HMP planning process is the Planning Team. The Planning Team was integral in ensuring the success of the planning process, its implementation, and future maintenance. The City developed a professional services agreement with a HMP consultant (Dynamic Planning + Science) to provide direction for the development of the 2017 update. Members of the project management team were also a part of the LHMP Planning Committee discussed below.

3.2.1.2 Planning Committee

Table 3-1: 2017 LHMP Planning Committee

Planning Committee Members	Title / Role
Planning Team	
G. Harold Duffey	City Manager
Sandra Molina	Planning and Development Services Director
Yanni Demitri	Former Public Works Director
Alan French	Public Works Director, up to January 26, 2017
Barrie Owens	Senior Code Enforcement Officer
Richard Shields	Building Official Consultant
Doug Wolfe	Lieutenant, San Bernardino County Sheriff's Dept.
Dan Wooters	Battalion Chief, San Bernardino County Fire
Haide Aguirre	Assistant Planner
Stakeholders	
Cynthia Fortune	Assistant City Manager
Pat Nares	Former City Clerk, up to February 14, 2017
Debra Thomas	City Clerk
Linda Phillips	Child Care Services Director

Planning Committee Members	Title / Role
City Council	
Darcy McNaboe	Mayor
Sylvia Robles	Mayor Pro Tem
Brian Reinarz	Council Member
Doug Wilson	Council Member
Bill Hussey	Council Member
Planning Commission	
Tom Comstock	Chairman
Tara Cesena	Vice Chairman
Jeffrey Allen	Commissioner
Edward Giroux	Commissioner
Gregory A. Goatcher	Commissioner

Table 3-2: 2017 LHMP Stakeholder List (Invite to review draft plan sent)

Planning Committee / Stakeholder Members	Title / Role
Partner Agencies	
Special Districts and Authorities	
Trans Authority	
Flood Control District	
Tax Assessor	
Colton Joint Unified District	
James Western Principal	
Owen Chay	
Schools	
Grand Terrace Elementary School	
Terrace View Elementary School	
Terrace Hills Middle School	
Utilities	
Southern California Edison	
Riverside Highland Water Company	
Southern California Gas Co.	
City of Colton Water and Wastewater Department	
Community/ Faith Organizations	
Azure Church	Alger Keough
Loma Linda Korean Church	
First Baptist	
Kingdom Life Fellowship,	Garry Donesky

Planning Committee / Stakeholder Members	Title / Role
Christ the Redeemer	Mike Auld
Calvary Deaf Church	
Neighborhood/ Community Organizations	
The Lions Club	Jim McNaboe
Foundation of Grand Terrace	Sally Holt
Grand Terrace Chamber of Commerce	Sally McGuire
Grand Terrace Senior Center	JoAnn Johnson
Major Employers and Businesses	
Wilden Pump/PSG	
Emergency Operation Volunteers	
Paul Tickner	Chairman
Susan Taylor	Secretary
Vic Pfennighausen	Volunteer
Hanni Bennett	Volunteer
Connie Parsons	Volunteer
Pete Parsons	Volunteer
Joe Ramos	Volunteer
Additional	
Loma Linda	Shannon Kendall
Neighboring Jurisdictions	
City of Colton	
Riverside County	
State Agencies	
State Department of Transportation CALTRANS	
State Water Resources Agency	
State Fire and Forestry Agency	
State National Flood Insurance Program Coordinator	
Cal OES (Hazard Mitigation Pre-Disaster & Flood Mitigation)	
Grants Administration / Emergency Services Coordinator	
Senior Emergency Services Coordinator	

3.2.1.3 HMP Consultant Team

To provide assistance to the HMP Planning Committee, the City enlisted Dynamic Planning + Science due to its expertise in assisting public sector entities with developing hazard mitigation plans and strategies for particular hazard prone areas. Dynamic Planning + Science supported the City through facilitation of the planning process, data collection, and meeting material and document development. The HMP Consultant Team, as shown in Table 3-3, consists of a variety of hazard mitigation and certified urban planning professionals.

Table 3-3: HMP Consultant Team

HMP Update Project Team	HMP Update Project Team Role
Ethan Mobley, AICP	Project Manager
Brian Greer	GIS Specialist/Spatial Analyst
Tammy Kulpa	Hazard Mitigation Planner

3.2.1.4 Planning Committee Meetings

The HMP Planning Committee met throughout the development of the updated HMP document. Table 3-4 provides a summary of the meetings conducted throughout the planning process, including meeting date, type, and topics discussed. Meeting documentation, including agendas, hazard maps, PowerPoint presentations, minutes, sign-in sheets, and other relevant handouts, are provided in Appendix B.

Table 3-4: Meeting Summary

Date	Meeting Type	Topics
November 21st, 2016	Planning Committee Meeting #1	*Part 1:* ▪ *Welcome and Introductions* ▪ *Mitigation Planning Defined* ▪ *Background* ▪ *Local Hazard Mitigation Planning Process* ▪ *Overall Objectives* ▪ *Project Schedule* *Part 2:* ▪ *Hazard Identification and Risk Assessment (HIRA) process* ▪ *Local Hazard Initial Review* ▪ *Critical Infrastructure / Essential Facility Review* ▪ *Next Steps* ▪ *Wrap UP*
December 12th, 2016	Planning Committee Meeting #2 (informal)	▪ *Tour of mitigatehazards.com* ▪ *Accessing stakeholder resources* ▪ *Explanation of problem statements*
January 25th, 2017	Planning Committee Meeting #3	*Part I:* ▪ *Mitigation Alternatives* ▪ *Problem Statement Review* ▪ *Assigning Mitigation Alternatives to Problems* *Part 2:* ▪ *Explain goals and objectives* ▪ *Exercise: Review/ Develop / Finalize Create Goals and Objectives*

Date	Meeting Type	Topics
February 22nd, 2017	Planning Committee Meeting #4	*Meeting Objectives:* ▪ *Goals and Objectives Review (See notes below)* ▪ *Review Capabilities Assessment* ▪ *Mitigation Alternative Review* ▪ *Draft Mitigation Action Review* ▪ *Mitigation Actions Prioritization*
March 27th, 2017	Planning Committee Meeting #5	▪ *Review Mitigation Actions* ▪ *Review Community Survey Results* ▪ *Prioritize Mitigation Actions based on Community Response* ▪ *Develop Implementation Measures for Priority Mitigation Actions*

3.3 Public Involvement/Outreach

Public involvement is a major and required component of any HMP update. The Grand Terrace 2017 HMP Update Public Outreach Strategy was developed to maximize public involvement throughout the planning process. The HMP Public Outreach Strategy details the utilization of websites, local media, and community-based services and establishments to engage the public throughout the HMP planning process.

Figure 3-2: Photo of outreach table for Blue Mountain Walk

A 21 question community survey was distributed via the City's Hazard Mitigation Plan website, Facebook page and e-mail blasts as well as in person at the Blue Mountain Walk on March 5th. A total of 104 survey responses were collected. The responses were used to determine the incentives needed for home owners to protect their homes from natural disasters, which were integrated into the mitigation actions. The survey results can be found in Appendix B.

3.4 Assess the Hazard

In accordance with FEMA requirements, the 2017 LHMP Planning Committee identified and prioritized the natural hazards affecting Grand Terrace and assessed the vulnerability from them. Results from this phase of the HMP planning process aided subsequent identification of appropriate mitigation actions to reduce risk in specific locations from hazards. This phase of the HMP planning process is detailed in Section 4.

3.4.1.1 Identify/Profile Hazards

Based on a review of past hazards, as well as a review of the existing plans, reports, and other technical studies/data/information, the 2017 HMP Planning Committee determined if the existing hazards were still valid, and identified new hazards that could affect the City. Updated content for each hazard profile is provided in Section 4.2.

3.4.1.2 Assess Vulnerabilities

Hazard profiling exposes the unique characteristics of individual hazards and begins the process of determining which areas within Grand Terrace are vulnerable to specific hazard events. The vulnerability assessment included field visits and a GIS overlaying method for hazard risk assessments. Using these methodologies, vulnerable populations, infrastructure, and potential loss estimates impacted by natural hazards were determined. Detailed information on the vulnerability assessment for each hazard is provided in Section 4.3.

3.5 Develop Mitigation Plan

The 2017 HMP was prepared in accordance with DMA 2000, the California Office of Planning and Research (OPR) and FEMA's HMP guidance documents. This document provides an explicit strategy and blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and Grand Terrace's ability to expand on and improve these existing tools. Developing the mitigation plan involved identifying goals, assessing existing capabilities, reviewing the 2011 HMP goals, and identifying new mitigation actions. This step of the HMP planning process is detailed in Section 5 and summarized below.

3.5.1.1 Identify Goals

To meet FEMA requirements, the Planning Committee reviewed the 2011 HMP goals and determined current day validity. Due to changes in City priorities, the goals and objectives have been updated to meet the current hazard environments. The Goals and Objectives are presented in Section 5.5.

3.5.1.2 Develop Capabilities Assessment

A capabilities assessment is a comprehensive review of all the various mitigation capabilities and tools currently available to the City to implement the mitigation actions that are prescribed in the 2017 HMP. The HMP Planning Committee identified the technical, financial, and administrative capabilities to implement mitigation actions, as detailed in Section 5.3.

3.5.1.3 Identify Mitigation Actions

As part of the 2017 LHMP planning process, the HMP Planning Committee reviewed and analyzed the status of the mitigation actions identified in the 2011 HMP and provided data and information on the status of the existing mitigation actions. Once the review and analysis of the 2011 HMP mitigation actions was complete, the HMP Consultant Team and HMP Planning Committee worked together to identify and develop new mitigation actions with implementation elements. Mitigation actions were prioritized and detailed implementation strategies were developed during Planning Committee Meeting #4. A detailed approach of the review of the existing mitigation actions, identification, and prioritization of new mitigation actions, and the creation of the implementation strategy is provided in Section 5.5.4.

3.5.1.4 Draft HMP Update

Once the risk assessment and mitigation strategy were completed, information, data, and associated narratives were compiled into the 2017 HMP. Section 1.4 provides detailed information on "what's new" and updated as part of the 2017 HMP.

3.5.1.5 Plan Review and Revision

Once the "Draft" 2017 HMP was completed, a public and government review period was established for official review and revision. Public comments were accepted, reviewed, and incorporated into this update. Applicable comments from the public have been received and addressed prior to the *"authorization to submit"* to FEMA and Cal OES review parties.

3.5.1.6 Plan Adoption and Submittal

This plan has been submitted and approved by FEMA and adopted by the City. A copy of the resolution is provided in Appendix A. ***This section will be completed after approval by Cal OES and FEMA.***

3.5.1.7 Plan Maintenance

Updated plan maintenance procedures, found in Section 6, include the measures Grand Terrace and participating agencies will take to ensure the HMP's continuous long-term implementation. The procedures also include the manner in which the HMP will be regularly monitored, reported upon, evaluated, and updated to remain a current and meaningful planning document.

Section 4. Risk Assessment

The risk assessment is the process of measuring the potential impact to life, property and economic impacts resulting from natural hazards. The intent of the Risk Assessment is to identify, as much as practicable given existing/available data, the qualitative and quantitative vulnerabilities of a community. The results of the risk assessment allow for a better understanding of the impacts of natural hazards to the community and provides a foundation in which to develop and prioritize mitigation actions to reduce damage from natural disasters through increased preparedness and response times and the better allocation of resources to areas of greatest vulnerability.

This Risk Assessment Section evaluates the potential loss from a hazard event by assessing the vulnerability of buildings, infrastructure, and people. It identifies the characteristics and potential consequences of hazards, how much of the City could be affected by a hazard, and the impact on City assets. The Risk Assessment approach consists of three (3) components:

- Hazard Identification – Identification and screening of hazards (Section 4.1)
- Hazard Profiles – Review of historic occurrences and assessment of the potential for future events (Section 4.2)
- Vulnerability Assessment – Determination of potential losses or impacts to buildings, infrastructure and population (Section 4.3)

4.1 Hazard Identification

4.1.1 Hazard Screening Criteria

Per FEMA Guidance, the first step in developing the Risk Assessment is identifying the hazards. The City's HMP Planning Team reviewed a number of previously prepared hazard mitigation plans and other relevant documents to determine the universe of natural hazards that have the potential to affect the City and the nearby region. Table 4-1 provides a crosswalk of hazards identified in the 2011 Grand Terrace Hazard Mitigation Plan Draft, 2010 Grand Terrace General Plan, 2016 San Bernardino County Hazard Mitigation Plan and 2013 CA State Hazard Mitigation Plan. Twelve different hazards were identified based on a thorough document review. The crosswalk was used to develop a preliminary hazards list providing a framework for City HMP Planning Team members to evaluate which hazards were truly relevant to the City and which ones are not. For example, volcanic activity was considered to have no relevance to the City, while earthquake/ geologic hazards and wildfire were indicated in every hazard documentation.

Table 4-1: Document Review Crosswalk

Hazards	2005/11 Grand Terrace Hazard Mitigation Plan	2010 Grand Terrace General Plan	2016 San Bernardino County Multijurisdictional Hazard Mitigation Plan	2013 California State Hazard Mitigation Plan
Climate Change			■	■
Dam inundation				■
Drought			■	■
Earthquake/ Geologic Hazards	■	■	■	■
Extreme Heat				■
Extreme Cold				■
Flood		■	■	■
Hazardous Material		■		■
Terrorism			■	■
Volcanic Activity				■
Wildfire	■	■	■	■
Winter Storm				■

4.1.2 Hazard Prioritization

The Planning Committee's hazard prioritization process combines historical data, local knowledge, and consensus opinions to produce numerical values that allow identified hazards to be ranked against one another. These criteria are used to evaluate hazards and identify the highest risk hazard in Grand Terrace.

The HMP Planning Committee assigned risk factors for each hazard profiled through a facilitated group exercise. During the group exercise, risk factor (RF) criteria worksheets were used to examine each identified hazard for potential risk. This methodology produces RF numerical values that allow identified hazards to be ranked against one another (the higher the RF value, the greater the hazard risk). Final RF values are obtained by assigning numerical criteria index values to five risk assessment categories. Risk assessment categories include *probability, impact, spatial extent, warning time,* and *duration*.

To obtain RF for each hazard the Planning Committee assigned a numerical range (1-4) to each risk assessment category. Based upon unique concerns for the planning area, a weighting factor can be agreed upon for each RF category. The RF weighting scheme is used to establish a higher degree of importance to selected risk assessment categories. To calculate the RF value for a given hazard the Planning Committee developed the RF weighting scheme below:

RF Value = [(Probability x .30) + (Impact x .30) +

(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

The sum of all five categories shown in the equation above equals the RF final risk factor values presented in Table. Table provides a summary of the RF criteria the Planning Committee used to assign *criteria index values* during a group exercise. This RF approach uses hazard data, local knowledge, and consensus opinions to produce numerical values that allow identified hazards to be ranked against one another. The final RF developed can be used to evaluate hazards and classify perceived hazard risk in the City.

Table 4-2: Risk Factor Criteria

Risk Assessment Category	Degree of Risk	Level	Criteria Index	Weight Value
PROBABILITY What is the likelihood of a hazard event occurring in a given year?	UNLIKELY	Less Than 1% Annual Probability	1	30%
	POSSIBLE	Between 1 & 10% Annual Probability	2	
	LIKELY	Between 10 &100% Annual Probability	3	
	HIGHLY LIKELY	100% Annual Probability	4	
IMPACT In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?	MINOR	Very Few Injuries, If Any. Only Minor Property Damage & Minimal Disruption on Quality of Life. Temporary Shutdown of Critical Facilities.	1	30%
	LIMITED	Minor Injuries Only. More Than 10% Of Property in Affected Area Damaged Or Destroyed. Complete Shutdown of Critical Facilities for More Than One Day.	2	
	CRITICAL	Multiple Deaths / Injuries Possible. More Than 25% Of Property in Affected Area Damaged Or Destroyed. Complete Shutdown of Critical Facilities for More Than One Week.	3	
	CATASTROPHIC	High Number of Deaths / Injuries Possible. More Than 50% Of Property in Affected Area Damaged or Destroyed. Complete Shutdown of Critical Facilities For 30 Days or More.	4	
SPATIAL EXTENT How large of an area could be impacted by a hazard event? Are impacts localized or regional?	NEGLIGIBLE	Less Than 1% Of Area Affected	1	20%
	SMALL	Between 1 & 10% Of Area Affected	2	
	MODERATE	Between 10 & 50% Of Area Affected	3	
	LARGE	Between 50 & 100% Of Area Affected	4	
WARNING TIME Is there usually some lead time associated with the hazard event? Have warning measures been implemented?	MORE THAN 24 HRS.	Self-Defined	1	10%
	12 TO 24 HRS.	Self-Defined	2	
	6 TO 12 HRS.	Self-Defined	3	
	LESS THAN 6 HRS.	Self-Defined	4	
DURATION How long does the hazard event usually last?	LESS THAN 6 HRS.	Self-Defined	1	10%
	LESS THAN 24 HRS.	Self-Defined	2	
	LESS THAN 1 WEEK	Self-Defined	3	
	MORE THAN 1 WEEK	Self-Defined	4	

Table 5-19 displays RF index criteria and weighting determinations from the HMP Planning Committee. Final RF scores determine *High*, *Moderate,* or *Low* risk designations based upon the conclusion index. It should be noted that although some hazards are classified as posing "Low Risk", their occurrence of varying or unprecedented magnitudes is still possible and will continue to be re-evaluated during future updates of this plan. Due to the inherent errors possible in any disaster risk assessment, the results of the risk assessment should only be used for planning purposes and in developing projects to mitigate potential losses.

4.1.3 Hazard Risk Factor

Table 4-3: Risk Factor Results Table

Rank	Natural Hazards	Probability Index	Wt. Value 1	Impact Index	Wt. Value 2	Spatial Extent Index	Wt. Value 3	Warning Time Index	Wt. Value 4	Duration Index	Wt. Value 5	RF Factor
1	EQ	4	1.2	3	0.9	4	0.8	4	0.4	2	0.2	3.5
2	Landslide	3	0.9	2	0.6	3	0.6	4	0.4	1	0.1	2.6
4	Flooding	3	0.9	2	0.6	3	0.6	2	0.2	2	0.2	2.5
3	Fire	2	0.5	2	0.6	3	0.6	4	0.4	3	0.3	2.4

Risk Factor Conclusion	
HIGH RISK (3.0 – 4.0)	EQ
MODERATE RISK (2.0 – 2.9)	Landslide, Flooding, Fire
LOW RISK (0.1 – 1.9)	

Wt. Value = Wt. Value 1 = PROBABILITY INDEX x .30
Wt. Value 2 = IMPACT INDEX x .30
Wt. Value 3 = SPATIAL EXTENT INDEX x .20
Wt. Value 4 = WARNING TIME INDEX x .10
Wt. Value 5 = DURATION INDEX x .10
RF Value = (Wt. Value 1) + (Wt. Value 2) + (Wt. Value 3) + (Wt. Value 4) + (Wt. Value 5)

Low Risk—Minimal potential impact. The occurrence and potential cost of damage to life and property is minimal.

Moderate Risk —Moderate potential impact. This ranking carries a moderate threat level to the general population and/or built environment. Here the potential damage is more isolated and less costly than a more widespread disaster.

High Risk—Widespread potential impact. This ranking carries a high threat to the general population and/or built environment. The potential for damage is widespread. Hazards in this category may have occurred in the past.

4.2 Hazard Profiles

The natural hazard profiles in this section provide a baseline definition and description in relation to the City. The hazards symbolized below are profiled individually in this section and are in order by priority. For reference, each hazard symbol is placed at the beginning of each profile. The hazard profiles in this section provide a baseline for the Vulnerability Assessment, where the vulnerability is quantified in terms of population and assets affected for each of the priority hazards.


Earthquake


Flood


Landslides


Climate Change


Wildfire

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4.2.1 Earthquake Hazard Profile

An earthquake is both the sudden slip on an active fault and the resulting shaking and radiated seismic energy caused by the slip (USGS, 2009). Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. When the accumulated energy grows strong enough, the plates break free causing the ground to shake. Most earthquakes occur at the boundaries where the plates meet; however, some earthquakes occur in the middle of plates.

Ground shaking from earthquakes can collapse buildings and bridges; disrupt gas, electric, and phone service; and sometimes trigger landslides, avalanches, flash floods, fires, and huge, destructive ocean waves (tsunamis). Buildings with foundations resting on unconsolidated landfill and other unstable soil, and trailers and homes not tied to their foundations are at risk because they can be shaken off their mountings during an earthquake. When an earthquake occurs in a populated area, it may cause deaths and injuries and extensive property damage. Earthquakes strike suddenly, without warning. Earthquakes can occur at any time of the year and at any time of the day or night. On a yearly basis, 70 to 75 damaging earthquakes occur throughout the world. Estimates of losses from a future earthquake in the United States approach $200 billion.

Earthquakes are a significant concern to the City. The City of Grand Terrace is located near three major zones; the San Andreas Fault Zone, the San Jacinto Fault Zone, and the Elsinore Fault Zone. (City of Grand Terrace General Plan, 2010) The San Andreas Fault runs along the northern border of the San Bernardino Valley, within 15 miles from the City of Grand Terrace. The San Jacinto fault is approximately 6 miles to the northeast from Grand Terrace and runs in a northwest-southwest direction extending from San Bernardino Valley College, through the area of the Guthrie Interchange (I-10 and I-215) and out through the Reche Canyon area. This fault has had a higher level of moderate to large earthquakes over the past 50 to 100 years, although the rate of slip has been low, causing a great deal of concern. Both faults present a significant natural hazard to the City of Grand Terrace. Comparing these two faults in the San Bernardino Valley, the probability of a major earthquake Magnitude 6.7 or larger during the next 30 years is 51% on the San Andreas fault and 31% on the San Jacinto Fault. (City of Grand Terrace 2011 Hazard Mitigation Plan Update Draft, 2011) The Chino-Elsinore Fault is 20-miles southwest of the City. (City of Grand Terrace General Plan, 2010)

4.2.1.1 Regulatory Environment

Numerous building and zoning codes exist at a state and local level to decrease the impact of an earthquake event and resulting liquefaction on residents and infrastructure. Building and zoning codes include the Alquist-Priolo Earthquake Fault Zoning Act of 1972, Seismic Hazards Mapping Act of 1990, 2016 California Standards Building Code (CSBC), and the 2010 City of Grand Terrace General Plan. To protect lives and infrastructure in the City, the following building and zoning codes are used.

The 1971 San Fernando Earthquake resulted in the destruction of numerous structures built across its path. This led to passage of the Alquist-Priolo Earthquake Fault Zoning Act. This Act prohibits the construction of buildings for human occupancy across active faults in the State of California. Similarly, extensive damage caused by ground failures during the 1989 Loma Prieta Earthquake focused attention on decreasing the impacts of landslides and liquefaction. This led to the creation of the Seismic Hazards Mapping Act. This Act increases construction standards at locations where ground failures are probable during earthquakes.

The 2016 CSBC is based on the International Building Codes (IBC), which is widely used throughout the United States. CSBC was modified for California’s conditions to include more detailed and stringent building requirements. **The City of Grand Terrace has adopted California Building Code 2016 Edition, Volumes 1 and 2.**

The 2010 City of Grand Terrace General Plan (General Plan) includes the following policies for minimizing the risk to public health and safety, social and economic welfare of the City resulting from geologic and seismic hazards:

- All new development shall comply with current seismic design standards.
- All proposed developments shall be evaluated for impacts associated with geologic and seismic hazards.
- Existing structures which are seismically unsound shall be identified and programmed for mitigation or removal where necessary to protect the public safety. Cultural and historic significance of buildings shall be considered in this program.
- Grading plans for development projects shall include an approved drainage and erosion control plan to minimize the impacts from erosion and sedimentation during grading.

4.2.1.2 Past Occurrences

The earthquakes of California are caused by the movement of huge blocks of the earth's crust- the Pacific and North American plates. The Pacific plate is moving northwest, scraping horizontally past North America at a rate of about 50 millimeters (2 inches) per year. About two-thirds of this movement occurs on the San Andreas Fault and some parallel faults- the San Jacinto, Elsinore, and Imperial faults. Over time, these faults produce about half of the significant earthquakes of our region, as well as many minor earthquakes.

The last significant earthquake on the Southern California stretch of the San Andreas Fault was in 1857, and there has not been a rupture of the fault along its southern end from San Bernardino to the Salton Sea since 1690. It is still storing energy for some future earthquake. Southern California has thousands of smaller earthquakes every year. A few may cause damage, but most are not even felt. And most of these are not on the major faults listed above. Earthquakes can occur almost everywhere in the region, on more than 300 additional faults that can cause damaging earthquakes, and countless other small faults.

This is mostly due to the "big bend" of the San Andreas fault, from the southern end of the San Joaquin Valley to the eastern end of the San Bernardino mountains. Where the fault bends, the Pacific and North American plates push into each other, compressing the earth's crust into the mountains of Southern California and creating hundreds of additional faults. These faults produce thousands of small earthquakes each year, and the other half of our significant earthquakes. Examples include the 1994 Northridge and 1987 Whittier Narrows earthquakes.

Table 4-4 shows the earthquakes greater than magnitude 4.0 that have been felt within the San Bernardino County area in the last five years.

Table 4-4: Earthquakes in San Bernardino County 2010-2017

Date	Name
9/14/2011	Calimesa 4.1
1/15/2014	Fontana 4.4
7/5/2014	Running Springs 4.6
3/29/2014	Brea 5.1
7/25/2015	Fontana 4.2
9/16/2015	Big Bear Lake 4.0
12/30/2015	Muscoy 4.4
1/6/2016	Banning 4.4

Source: 2016 San Bernardino Multi-Jurisdiction Hazard Mitigation Plan

4.2.1.3 Location/ Geographic Extent

Although there are no faults running directly through the City of Grand Terrace (see Figure 4-2), there are seven known fault zones located near the City that could result in a seismic hazard to the City (see Figure 4-2). These include:

- Chino-Elsinore Fault – 20 miles southwest
- Cucamonga Fault – 13.5 miles north
- San Andreas Fault – 9 miles north
- Loma Linda Fault – 2.4 miles north
- San Jacinto Fault – 0.75 miles north
- Rialto-Colton Fault – 0.65 miles northeast
- An unnamed fault – 0.47 miles northeast

The Alquist-Priolo Special Study Zone for the San Jacinto Fault lies approximately 2,800 feet north east of the City. Earthquakes along any active fault in Southern California are capable of causing damage within the City of Grand Terrace. Primary hazards result directly from ground motion including ground rupture and ground shaking. Secondary hazards result from the interaction of the ground shaking with existing ground instabilities. Seismic activity may result in landslides on steep, unstable slopes and liquefaction in areas of high groundwater and loose soils. (City of Grand Terrace General Plan, 2010)

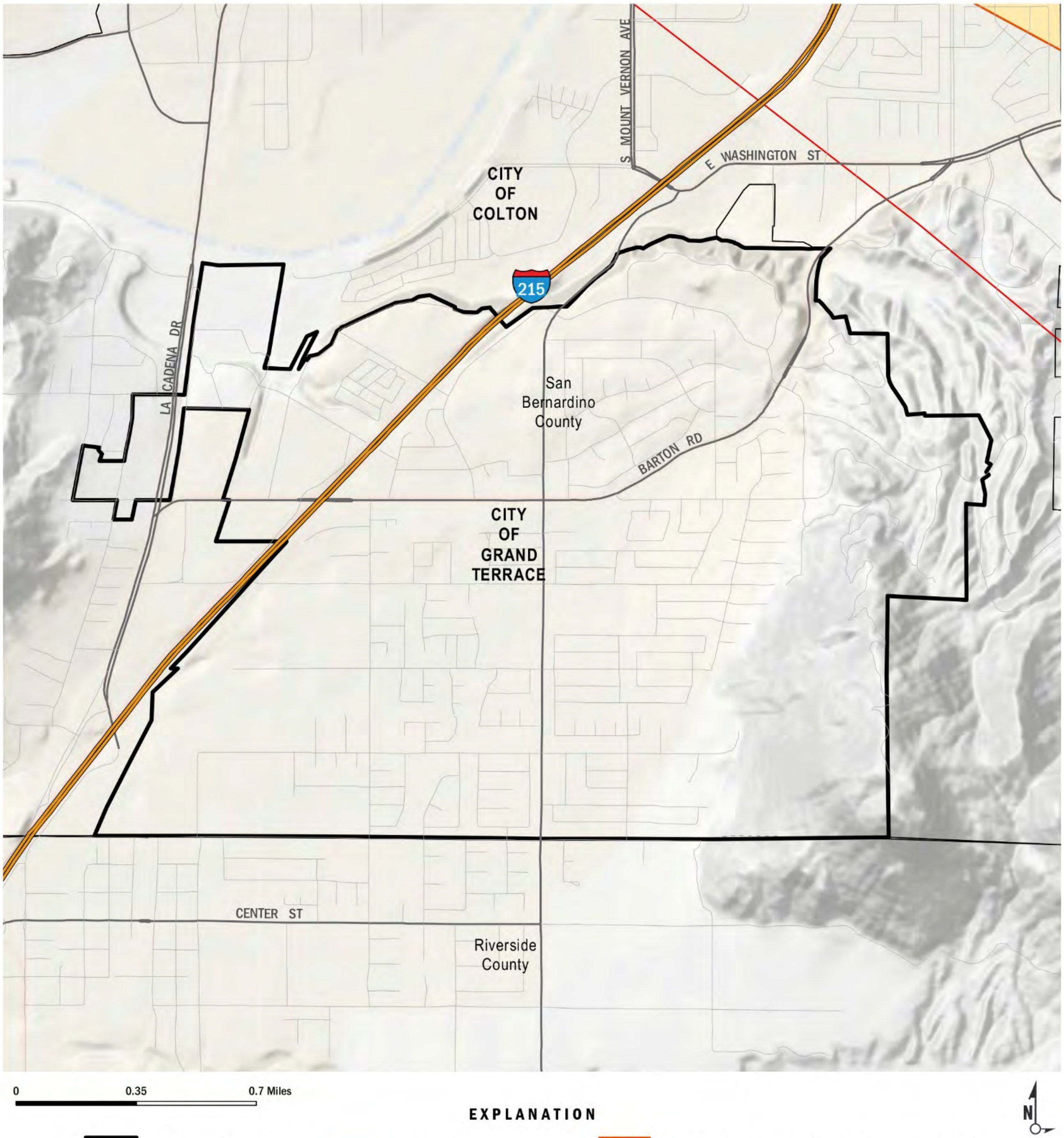


Figure 4-1: USGS Quaternary Faults

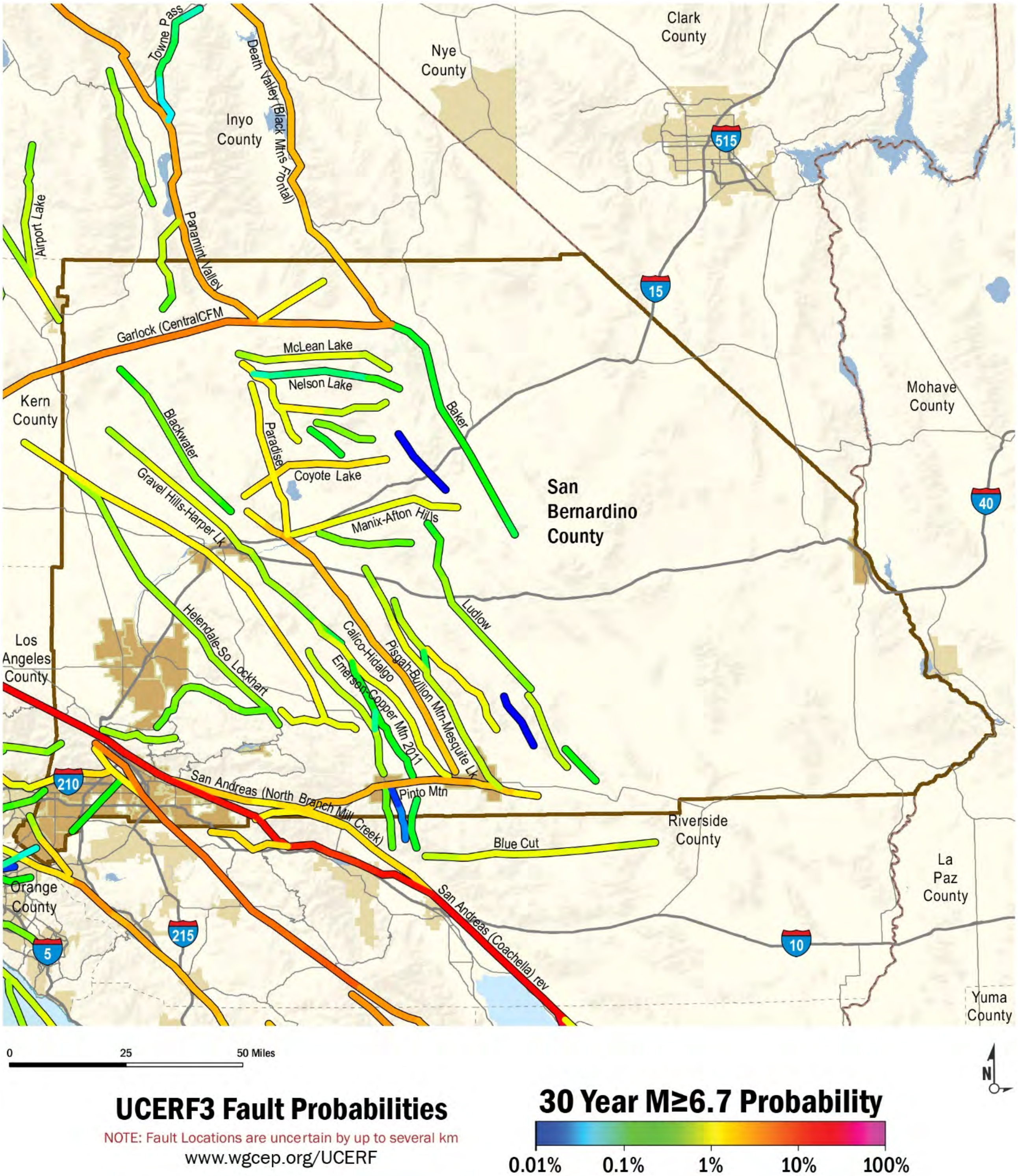


Figure 4-2: San Bernardino County Region Earthquake Probability

4.2.1.4 Magnitude/ Severity

The most common method for measuring earthquakes is magnitude, which measures the strengths of earthquake. Although the Richter scale is known as the measurement for magnitude, the majority of scientists currently use either the

Mw Scale or Modified Mercalli Intensity (MMI) Scale. The effects of an earthquake in a particular location are measured by intensity. Earthquake intensity decreases with increasing distance from the epicenter of the earthquake.

The magnitude of an earthquake is related to the total area of the fault that ruptured, as well as the amount of offset (displacement) across the fault. As shown in Table 4-5, there are seven earthquake magnitude classes, ranging from great to micro. A magnitude class of great can cause tremendous damage to infrastructure in Grand Terrace, compared to a micro class, which results in minor damage to infrastructure.

Table 4-5: Moment Magnitude Scale

Earthquake Magnitude Classes		
Magnitude Class	Magnitude Range (M = Magnitude)	Description
Great	M > 8	Tremendous damage
Major	7 <= M < 7.9	Widespread heavy damage
Strong	6 <= M < 6.9	Severe damage
Moderate	5 <= M < 5.9	Considerable damage
Light	4 <= M < 4.9	Moderate damage
Minor	3 <= M < 3.9	Rarely causes damage.
Micro	M < 3	Minor damage

The MMI Scale measures earthquake intensity as shown in Table 4-6. The MMI Scale has 12 intensity levels. Each level is defined by a group of observable earthquake effects, such as ground shaking and/or damage to infrastructure. Levels I through VI describe what people see and feel during a small to moderate earthquake. Levels VII through XII describe damage to infrastructure during a moderate to catastrophic earthquake.

Table 4-6: Modified Mercalli Scale

Earthquake Magnitude and Intensity		
Magnitude (Mw)	Intensity (Modified Mercalli Scale)	Description
1.0 – 3.0	I	I. Not felt except by very few people under especially favorable conditions.
3.0 – 3.9	II – III	II. Felt by a few people, especially those on upper floors of buildings. Suspended objects may swing.

Earthquake Magnitude and Intensity		
Magnitude (Mw)	Intensity (Modified Mercalli Scale)	Description
		III. Felt quite noticeably indoors. Many do not recognize it as an earthquake. Standing motorcars may rock slightly.
4.0 – 4.9	IV – V	IV. Felt by many who are indoors; felt by a few outdoors. At night, some awakened. Dishes, windows and doors rattle.
		V. Felt by nearly everyone; many awakened. Some dishes and windows broken; some cracked plaster; unstable objects overturned.
5.0 – 5.9	VI – VII	VI. Felt by everyone; many frightened and run outdoors. Some heavy furniture moved; some fallen plaster or damaged chimneys.
		VII. Most people alarmed and run outside. Damage negligible in well-constructed buildings; considerable damage in poorly constructed buildings.
6.0 – 6.9	VII – IX	VIII. Damage slight in special designed structures; considerable in ordinary buildings; great in poorly built structures. Heavy furniture overturned. Chimneys, monuments, etc. may topple.
		IX. Damage considerable in specially designed structures. Buildings shift from foundations and collapse. Ground cracked. Underground pipes broken.
7.0 and Higher	VIII and Higher	X. Some well-built wooden structures destroyed. Most masonry structures destroyed. Ground badly cracked. Landslides on steep slopes.
		XI. Few, if any, masonry structures remain standing. Railroad rails bent; bridges destroyed. Broad fissure in ground.
		XII. Virtually total destruction. Waves seen on ground. Objects thrown into the air.

Since the effects of liquefaction are derived from earthquake shaking, it can be assumed that as earthquake shaking intensifies, so do the risks from liquefaction.

An earthquake scenario represents one realization of a potential future earthquake by assuming a particular magnitude, location, and fault-rupture geometry and estimating shaking using a variety of strategies. In planning and coordinating emergency response, utilities, local government, and other organizations are best served by conducting training exercises based on realistic earthquake situations—ones similar to those they are most likely to face.

ShakeMap Scenario earthquakes can fill this role. They can also be used to examine exposure of structures, lifelines, utilities, and transportation corridors to specified potential earthquakes. In the Great Shakeout scenario, almost the entire City of Grand Terrace is in the violent shake zone. The southwestern corner of the City and a small area in the foothills on the western edge of the City are in the severe shake zones. **Figure 4-3 shows the full results from the Shakeout Scenario.**

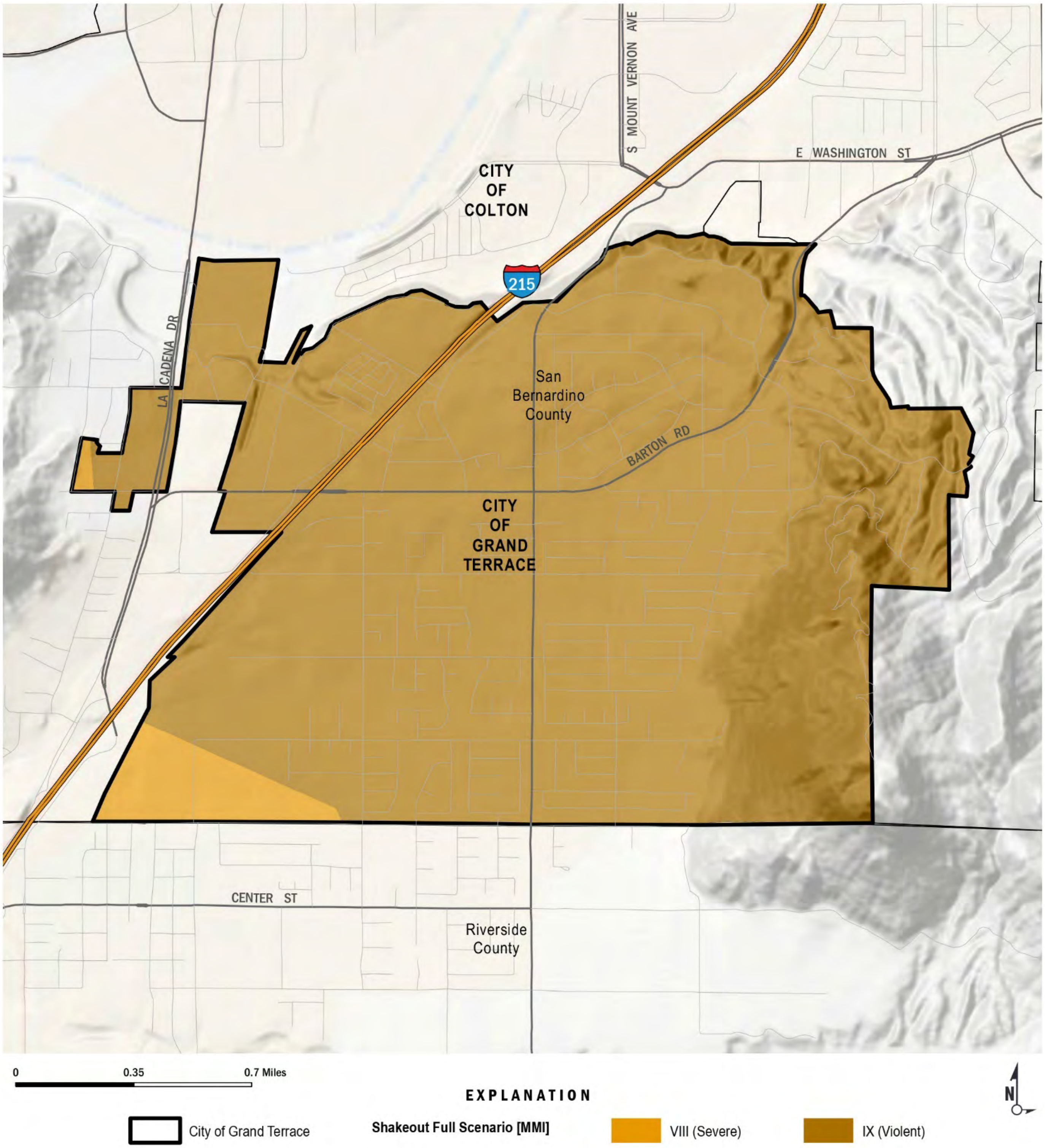


Figure 4-3: Full Shakeout Scenario Results

4.2.1.5 Frequency/ Probability of Future Events

Several of the major Southern California faults have a high probability of experiencing a Magnitude 6.7 or greater earthquake within the next 30 years (Figure 4-2); 59% probability of a M6.7 or greater on the Southern San Andreas Fault, 31% probability on the San Jacinto Fault, and 11% probability on the Elsinore Fault. These probabilities were determined by the USGS and CGS in a 2008 study (2007 Working Group on California Earthquake Probabilities, 2008, The Uniform California Earthquake Rupture Forecast, Version 2 (UCERF 2): U.S. Geological Survey Open-File Report 2007-1437 and California Geological Survey Special Report 203 http://pubs.usgs.gov/of/2007/1437/).

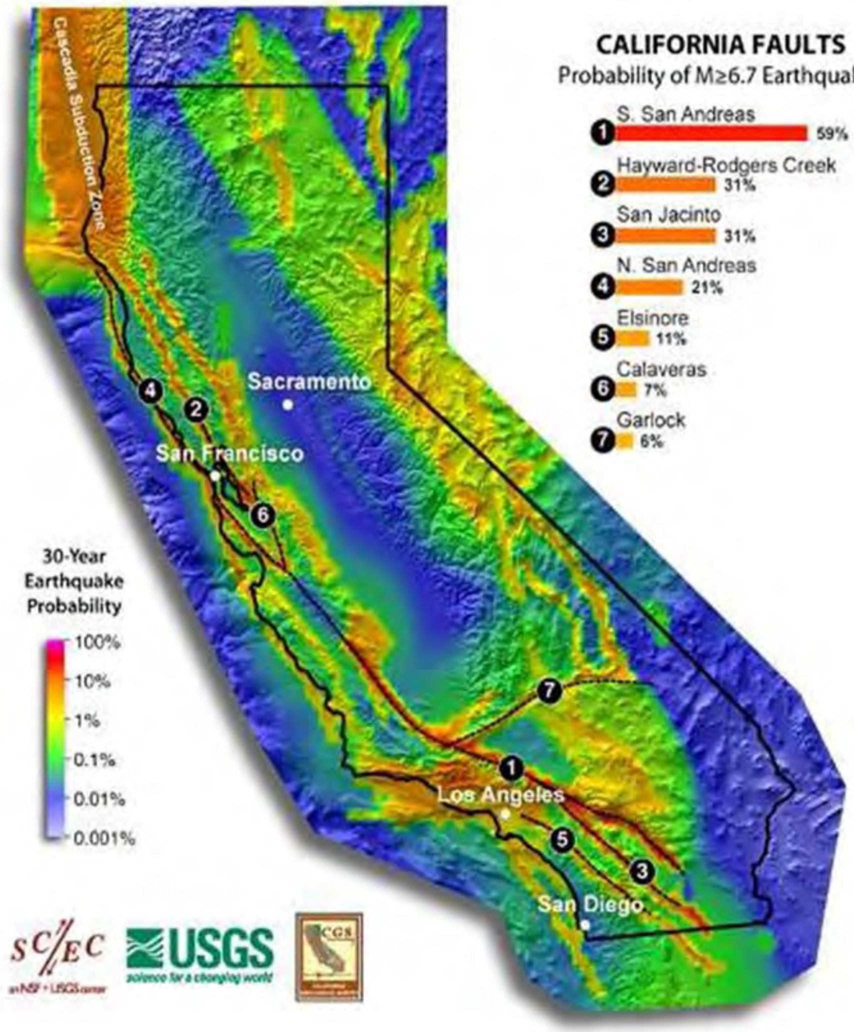


Figure 4-4: California Faults Probability of ≥ M 6.7 Earthquake

As shown in Figure 4-4 the probability of an earthquake with a Magnitude 6.7 or greater occurring somewhere in Southern California within the next 30 years is estimated to be 97% (2007 Working Group on California Earthquake Probabilities, 2008).

4.2.2 Landslide Hazard Profile

Landslides occur when the force pulling the material on the slope in a downward direction under gravitational influence exceeds the strength of the earth materials that compose the slope (USGS, 2004). These materials may move by falling, toppling, sliding, spreading, and/or flowing. Strength of rock and soil, steepness of slope, and weight of the hillside material all play an important role in the stability of hillside areas. Weathering and absorption of water can weaken slopes, while the added weight of saturated materials or overlying construction can increase the chances of slope failure. Sudden failure can be triggered by earthquake shaking, excavation of weak slopes, and heavy rainfall.

Landslides are primarily associated with mountainous regions. Additionally, landslides can occur in areas of low relief. Landslides can occur due to geological, morphological, or human causes. These include weak and sheared materials, thawing, shrink swell, and deforestation. Because portions of eastern Grand Terrace include Blue Mountain, there is a potential for landslides throughout this area. Landslides often accompany other natural hazard events, such as earthquakes, flooding, and wildfire.

4.2.2.1 Regulatory Environment

The City of Grand Terrace has adopted California Building Code (CBC) 2016 Edition, Volumes 1 and 2 which establish the minimum requirements to safeguard the public health, safety and general welfare through structural strength, means of egress facilities, stability, access to persons with disabilities, sanitation, safety to life and property from fire and other hazards attributed to the built environment, and to provide safety to fire fighters and emergency responders during emergency operations.

Chapter 18- Soils and Foundations Section 1804 of the CBC sets the requirements for Excavation, Grading and Fill. Section 1804.4 Site Grading states the ground immediately adjacent to the foundation shall be sloped away from the building at a slope of not less than one unit vertical in 20 units horizontal (5-percent slope) for a minimum distance of 10 feet (3048 mm) measured perpendicular to the face of the wall. (City of Grand Terrace Code of Ordinances , n.d.)

The 2010 General Plan also includes the following policies for protecting humans and property from hazards associated with slope instability:

- The City shall continue to enforce hillside development standards for proposed developments in areas on or near areas of potential slope instability.
- All new developments in areas of slope instability shall be required to perform adequate geotechnical analysis and provide an engineered design to assure that slope instability will not impact the development.

4.2.2.2 Past Occurrences

Many areas of the City have experienced landslides, mudslides, rockslides and washouts. The following incidents were mentioned during a “discovery meeting” with stakeholders on February 2nd, 2017:

- There was a washout at the intersection of Vivienda Avenue and Terrace Avenue in 2009.
- Sloughing has occurred along the north side of Vivienda Avenue between Maple Avenue and Burns Ave.

- Sloughing and erosion issues have occurred on steep slopes on the north side of Grand Terrace Road north of Newport Avenue down into the City of Colton below.
- Runoff causes undermining and erosion occurs on Canal St requiring improved maintenance of shoulder bed.
- The east side of Mount Vernon Avenue north of Canal Grand Terrace Rd. has experienced sloughing on both sides of the road. (The cut slope on the east side is shared between Grand Terrace and Colton.)
- The off-canter curve of Vista Grande Way causes sheet flow run off to cause undermining, erosion and dirt and water debris buildup.
- Washouts have occurred on Vista Grande Way.
- Major sloughing occurs on the east side of Vista Grande Way East.
- In 2009, a landslide/mudslide made a portion of Barton Road near the border of Grand Terrace and Colton impassible during the floods. There were landslide/mudslide issues on both sides of the road.
- Minor mudslides have occurred at the base of Blue Mountain onto Orangewood Court and Wren Street.
- Super elevation along the curve on Grand Terrace Road washed out in 2015. Guardrail replacement and concrete shoulders were necessary repairs.
- After periods of heavy rain, landslides and erosion occurs along the natural slope/ creek bed behind homes on the north side of Vivienda Avenue between Grand Terrace Road and Highway 215.
- Significant natural erosion occurs at the end of Palm Ave where the road turns private. Three large boulders have ended up in the roadway and needed to be removed.
- On April 23rd, 2013, a landslide swept away part of the hill under a residential hillside structure. There were no injuries or casualties and no other residences needed to be evacuated. (Los Angeles Times, 2013)

4.2.2.3 Location/ Geographic Extent

Virtually the entire City of Grand Terrace sits to the west of Blue Mountain. Low to moderate ratings are generally associated with the river wash and hilly areas. The east side of the City has been found to have a moderate to high susceptibility to landslides, as shown by the slope of the area in Figure 4-4. These areas sit at the foot of Blue Mountain and have had problems from erosion in the past. Drainage canals, retaining walls, and maintenance have prevented the majority of damage to these properties. Two main access points for the city have resulted in closures due to land sliding in heavy rain events. This presents an obstacle in an emergency situation trying to get people and resources in and out of the city. (City of Grand Terrace 2011 Hazard Mitigation Plan Update Draft, 2011)

Parcels zoned Single Family Residential Hillside (RH) are found along the west side of Blue Mountain. The permitted density within the RH zone is one dwelling unit per acre. These parcels are characterized as large rural residential lots on steep hilly terrain and numerous development constraints including steep slopes, landslide potential, high fire hazards, sensitive habitat, excessive grading requirements, limited access, and utility constraints. In consideration of the existing topography and other physical constraints the City requires that development be subject to a specific plan or master plan to establish site development standards such as setbacks, height limits and density, on a project by project basis. Although the specific plan would allow flexibility in design and development standards, these parcels are typically considered too expensive for affordable housing due to the development constraints. Based on an analysis of the properties in the 2010 General Plan, the realistic capacity within the RH zone is 72 additional single family lots.

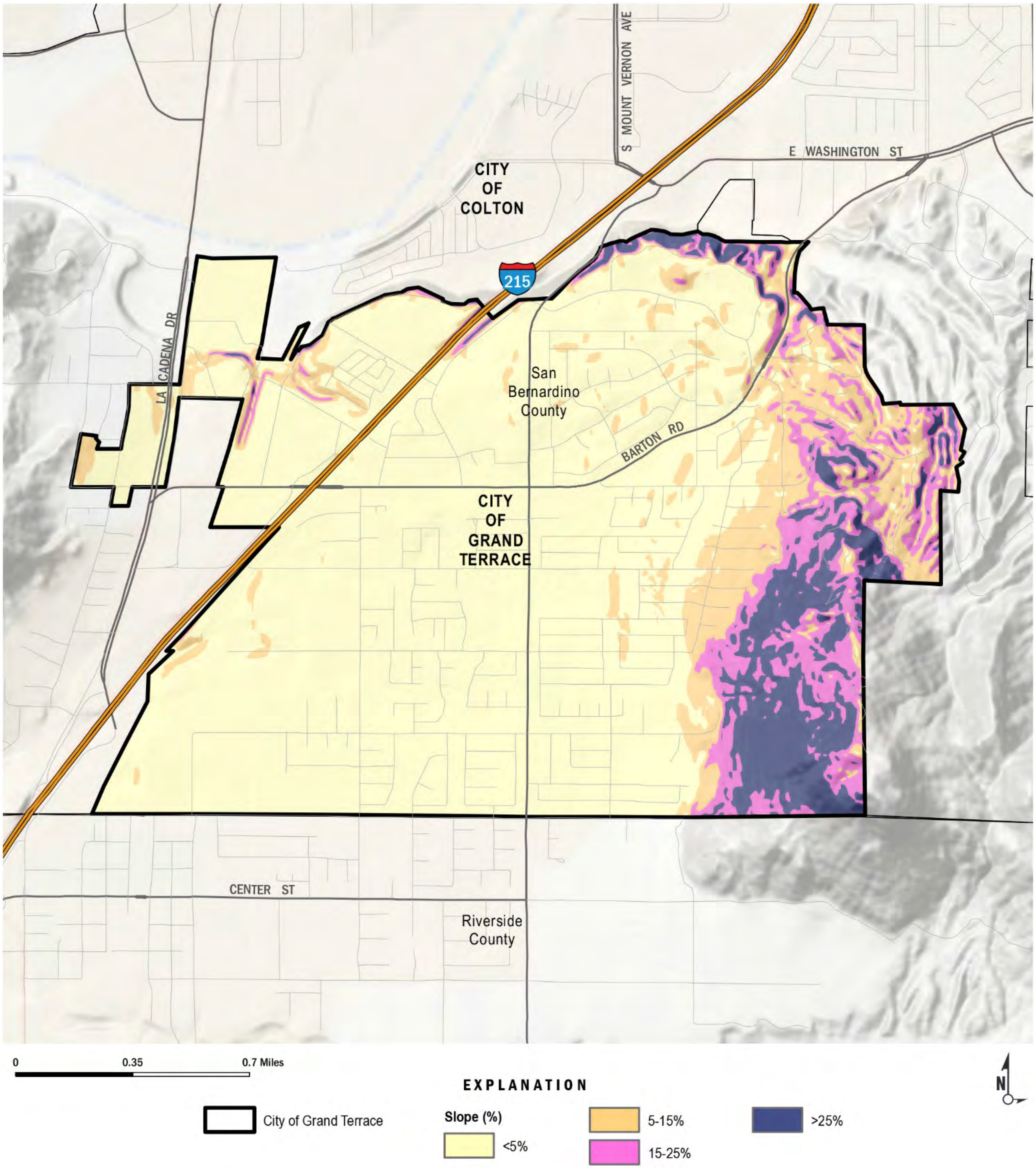


Figure 4-5: City of Grand Terrace Slope Areas at Risk to Landslide

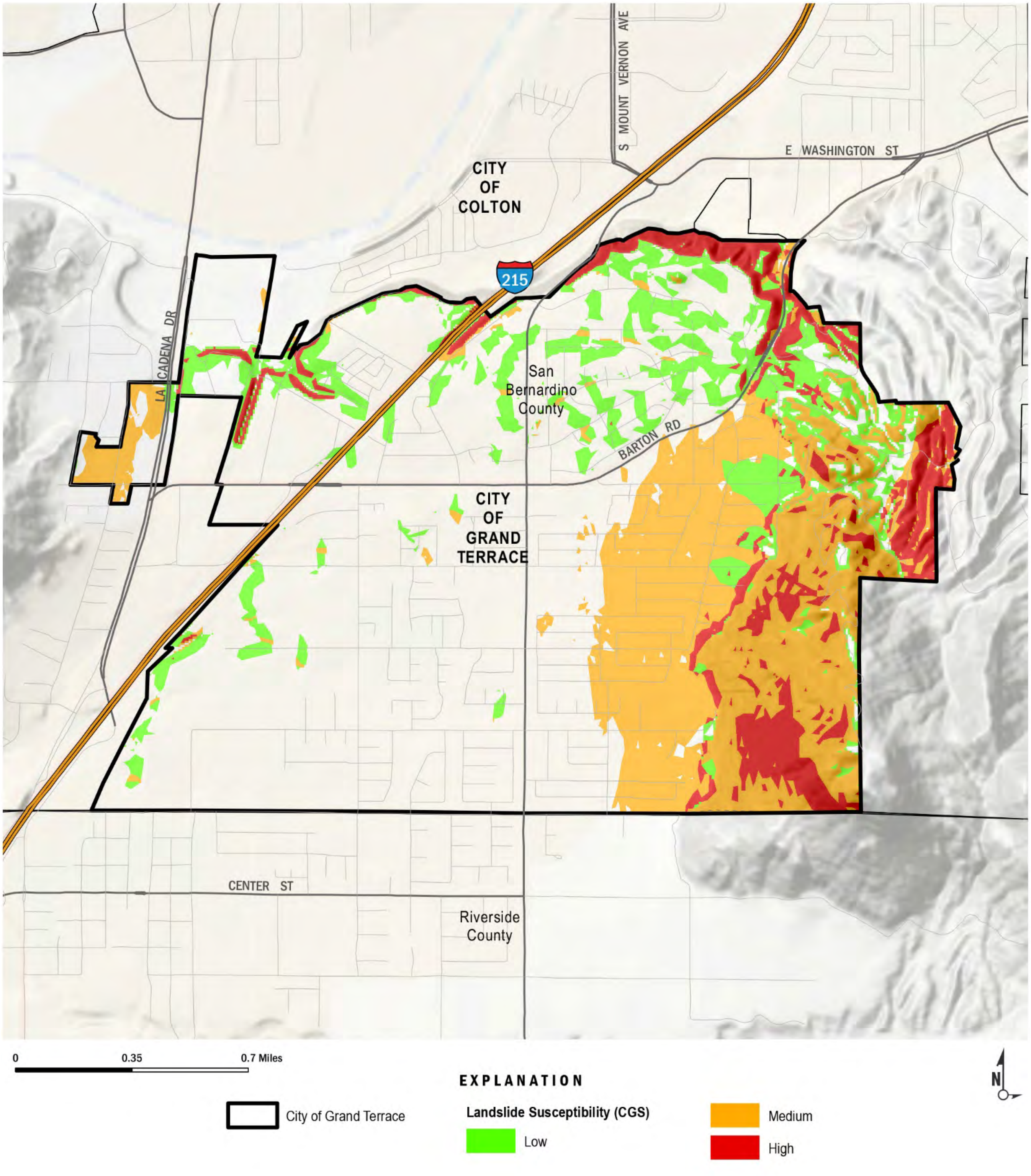


Figure 4-6: Landslide Susceptibility in the City of Grand Terrace

The undeveloped area of Blue Mountain exhibits soils that are classified as unstable and erosive. In addition, the steep slopes of Blue Mountain may also result in a landslide. Development of these slopes could result in a safety hazard. (City of Grand Terrace General Plan, 2010). During a “discovery meeting” with stakeholders from the City of Grand Terrace in February 2017, three main areas of concern for landslides were identified (see Figure 4-6)

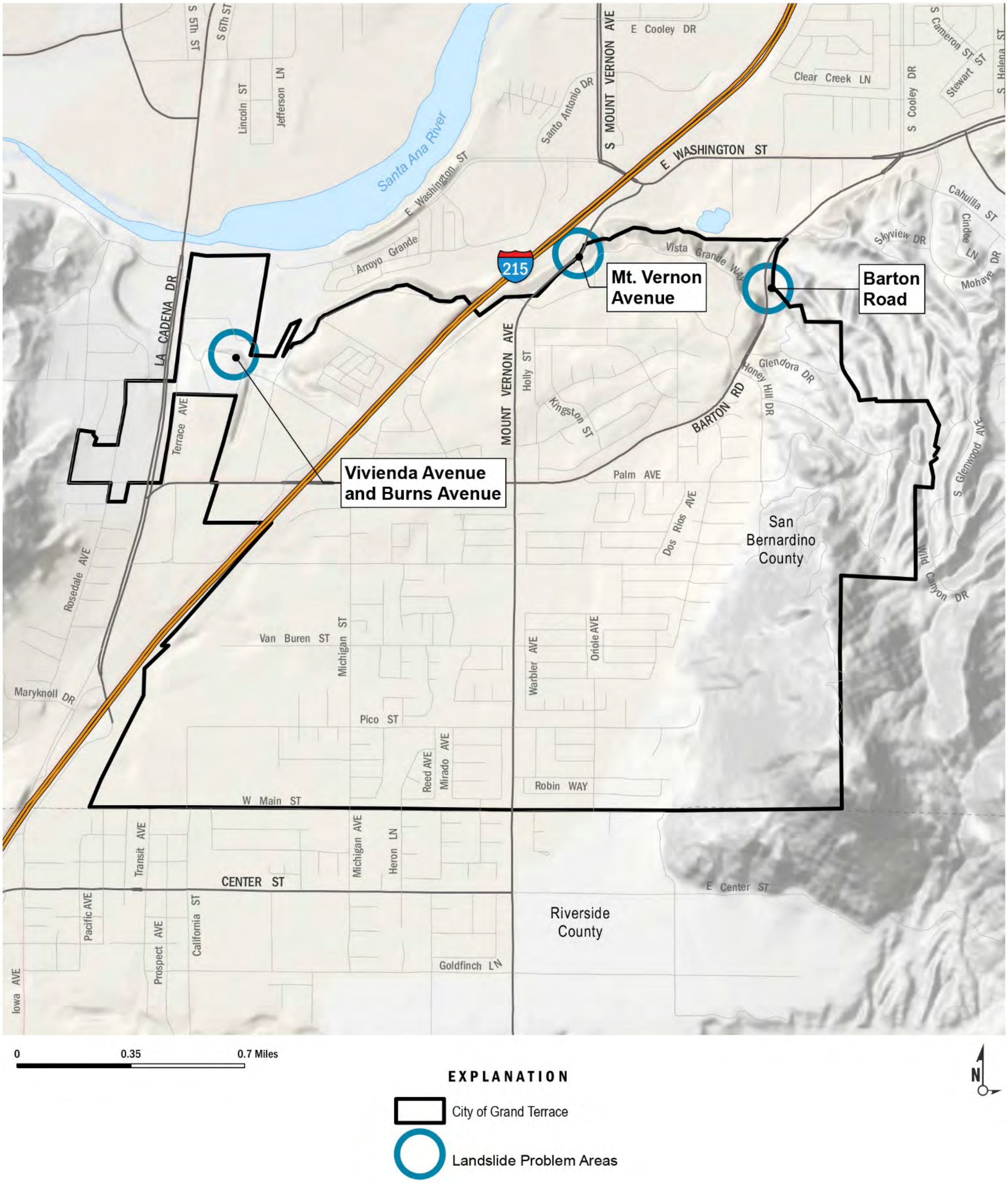


Figure 4-7: Main Landslide Problem Areas

4.2.2.3.1 Slope Stability Problem Area #1

Slope stability along Mount Vernon Avenue from East Canal Street to the end of the slope along Vista Grande Way. (See Figure 4-7**).**

East Canal Street: Undermining is occurring off the road on the west side of Canal Street causing erosion. It was noted that maintenance of the shoulder bed should be improved.

Mount Vernon Avenue: Just north of East Canal Street, sloughing occurs on both sides of Mount Vernon Avenue. The area to the west is the City of Colton and the area on the east side is shared by the City of Grand Terrace and the City of Colton. The cut slope on the western side is unstable and will often cause landslides.

Vista Grande Way: The area along the curve near Grand View Baptist Church (across the street from the future dog park) on Vista Grande Way experiences severe undermining and erosion, resulting in a decrease in roadway stability. Runoff from the church property shoots around the curve on Vista Grande way, undermining the road and sending debris from the dog park into the church parking lot. The shoulder along this curve varies in width from about 25-30 feet to only 2.5 feet. Some of the houses along Vista Grande have experienced erosion.

Figure 4-8: Landslide Problem Area 1: Slope Stability Along Mount Vernon Ave

4.2.2.3.2 Slope Stability Problem Area #2

Mudslides on Barton Rd. at the Colton border could interfere with emergency transportation. (See Figure 4-8)

There have been landslides/ mudslides from both the east and west sides of the road that have blocked Barton Ave. making it impassible and preventing residents from entering or leaving their homes.

Figure 4-9: Landslide Problem Area 2: Mudslides Along Barton Rd

4.2.2.3.3 Slope Stability Problem Area #3

Slope stability at Vivienda Ave. and Burns Ave. (Figure 4-9)

Runoff from the freeway flows into this area affecting slope stability. This area has flooded in the past, making the road impassable.

Figure 4-10: Landslide Problem Area 3: Slope Stability at Vivienda Ave and Burns Ave

4.2.2.4 Magnitude/ Severity

As shown in Figure 4-5, nearly a third of the City has been identified as having medium to high susceptibility to landslides. These areas are generally located along the eastern and northeastern borders of the City, where the land is steep and unstable.

4.2.2.5 Frequency/ Probability of Future Events

As future development occurs near steep slopes, the probability of washouts, sloughing, erosion, rockslides and landslide events occurring in the City becomes more likely. To prevent current problem areas (highlighted in Section 4.2.2.3) from getting worse, the mitigation actions presented in Section 5.5.4 should be completed.

Mismanaged intense residential and recreational development in sloped areas such as Blue Mountain could increase the frequency of damaging landslides occurring in the City. Developing land outside of the medium to high landslide susceptibility areas will be critical to reducing the frequency and probability of future landslide events.

4.2.3 Wildfire Hazard Profile

A wildfire event is an unwanted wildland fire including unauthorized human-caused fires, escaped wildfire use events, escaped prescribed wildfire projects, and all other wildfires.

Wildfire hazard is a significant and recurrent threat in the City and has the potential to destroy buildings, cause damage to vital infrastructure, injure people, and can result in loss of life, agricultural land, and animals. According to the 2010 General Plan Public Health and Safety Element, high summer temperatures, low humidity, and high winds result in dry brush and atmospheric conditions that can accelerate fires through steep terrain. The 2016 San Bernardino County Multi-jurisdictional Hazard Mitigation Plan notes in the County, wildfire season commences in the Summer when temperatures are high, humidity is low, and conditions remain dry. The season continues into the Fall, when the County experiences high velocity, very dry winds coming out of the desert.

The risk of wildland fires is related to a combination of factors, including winds, temperatures, humidity levels, and fuel moisture content. Of these four factors, wind is the most crucial. Steep slopes also contribute to fire hazards by intensifying the effects of wind and making fire suppression difficult. Where there is easy public access to dry vegetation, fire hazards increase due to greater chance of human carelessness. Very high hazard areas in Grand Terrace include the eastern portion of the city at the base of Blue Mountain and the neighborhoods at the foothills in the north west corner of the City. These developments have also moved the urban wildland interface (the area where human development meets undeveloped wildland) closer to higher-risk wildfire hazard areas, increasing the number of people and buildings at risk as illustrated in Figure 4-10.

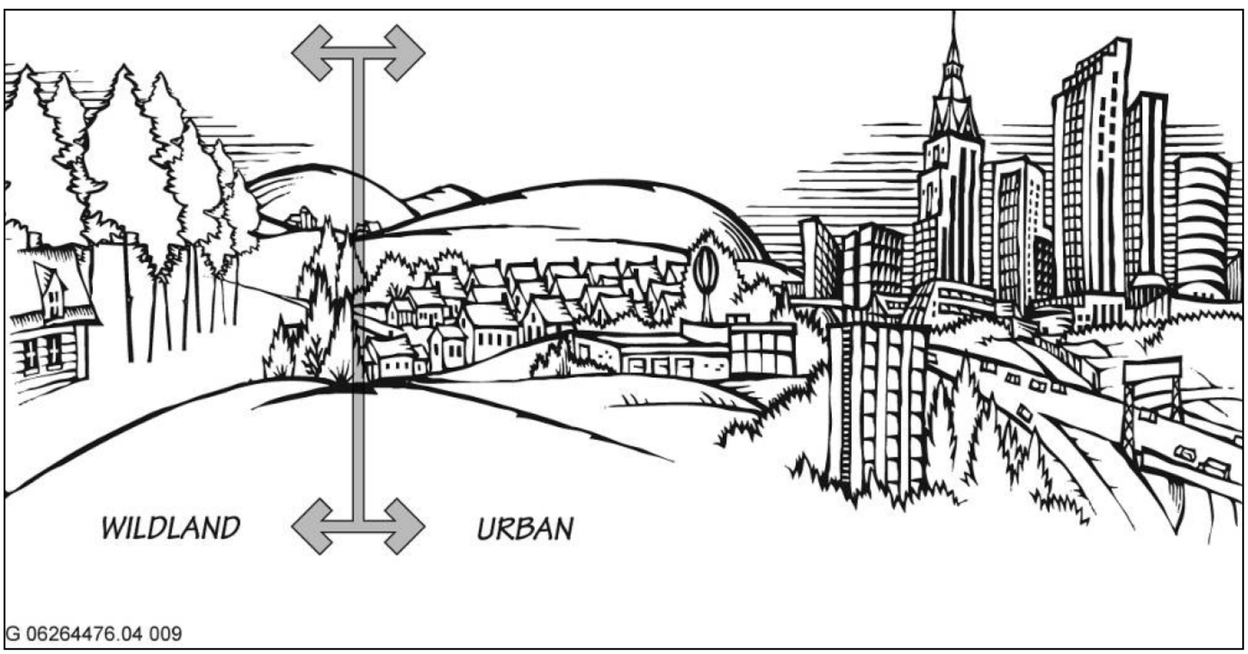


Figure 4-11: Urban Wildland Interface

4.2.3.1 Regulatory Environment

The City of Grand Terrace has adopted the 2007 edition of the California Code as compiled and published by the International Code Council and the San Bernardino County Fire Department Standards. (Grand Terrace, California- Code of Ordinances, n.d.)

The 2016 California Building Code (adopted by the City effective January 1st, 2017) Chapter 7a includes materials and construction methods for exterior wildfire exposure and standards of quality for fire-resistant buildings. (City of Grand Terrace Code of Ordinances , n.d.)

4.2.3.1.1 Fire Hazard Abatement

In an effort to reduce the threat of wild fires, the San Bernardino County Fire Hazard Abatement (FHA) Program enforces the fire hazard requirements outlined in San Bernardino County Code Section 23.0301–23.0319. The primary function of the Fire Hazard Abatement Program is to reduce the risk of fires within communities by pro-actively establishing defensible space and reduction/removal of flammable materials on properties.

The Fire Hazard Abatement Program conducts surveys to identify fire hazards throughout the year. Fire hazards are identified and notices to abate the hazard(s) are mailed to property owners. Property owners are given 30 days to abate the violations. Failure to abate may result in citations, penalties, and/or fees for abatement by the County. The Fire Hazard Abatement Program responds to complaints year round in the unincorporated areas and contracting Cities and Fire Districts. The services are as follows:

- Valley & Desert Regions get two surveys per year during early spring and early fall due to growth cycles of differing types of noxious vegetation.
- Mountain Regions receive one survey in the summer.

4.2.3.1.2 General Plan Policies

The Grand Terrace 2010 General Plan established the following policies to minimize the exposure of residents, business owners, and visitors to the impacts of urban and wildland fires.

- The City shall apply a high fire overlay district to those areas in the City subject to wildland fires such as portions of Blue Mountain.
- Continue the weed abatement program to ensure clearing of dry vegetation areas.
- Encourage the use of fire-resistive construction materials.

The Grand Terrace Code of Ordinances Chapter 8.72 gives the City the authority to remove trees in abandoned orchards if they constitute a fire hazard. (City of Grand Terrace Code of Ordinances , n.d.)

4.2.3.2 Past Occurrences

Table 4-7: Grand Terrace Fires

Date	Event Name	Type
07-06-06	Blue Mountain	Vegetation
05-26-10	I-215 at Barton	Vegetation
07-04-10	Preston St	Vegetation
11-06-10	Scott Fire	Unknown

4.2.3.3 Location/ Geographic Extent

Very High Fire Hazard Severity Zones have been identified along the eastern and northeastern borders of the City as well as the foothills in the western most region of the City. Residential uses have been constructed along these areas that back up to an area of natural vegetation that is highly susceptible to fires. Figure 4-11 illustrates the limits of the Very High, High and Moderate Fire Hazard Severity Zones for the City.

Construction in the Very High Fire Hazard Severity Zone will be required to meet the requirements of Chapter 7A of the California Building Code relating to fire resistant rated construction. (City of Grand Terrace 2011 Hazard Mitigation Plan Update Draft, 2011) Wildland-urban interface fires may occur in areas where urban land uses abut native areas. Under these conditions, wildfires may threaten urban uses.

4.2.3.4 Magnitude/ Severity

The magnitude and severity of a wildfire event is measured by calculating the number of acres burned in a specific wildfire event. A visual of the size of areas burned during wildfire in or near the City is shown in Figure 4-12.

4.2.3.5 Frequency/ Probability of Future Occurrences

CAL FIRE adopted Fire Hazard Severity Zone maps for LRA in June 2008. Fire hazard mapping is a way to measure the physical fire behavior to predict the damage a fire is likely to cause. Fire hazard measurement includes vegetative fuels, probability of speed at which a wildfire moves the amount of heat the fire produces, and most importantly, the burning fire brands that the fire sends ahead of the flaming front.

The model used to develop the information in accounts for topography, especially the steepness of the slopes (fires burn faster as they burn up-slope.). Weather (temperature, humidity, and wind) also has a significant influence on fire behavior. The areas depicted as moderate, high and very high are of particular concern and potential fire risk in these areas are constantly increasing as human development and the wildland urban interface areas expand.

Figure 4-13 shows the fire regime for the City of Grand Terrace. The areas with the highest likelihood to burn within the next 30 years are located along the eastern border of the City in the Blue Mountain region.

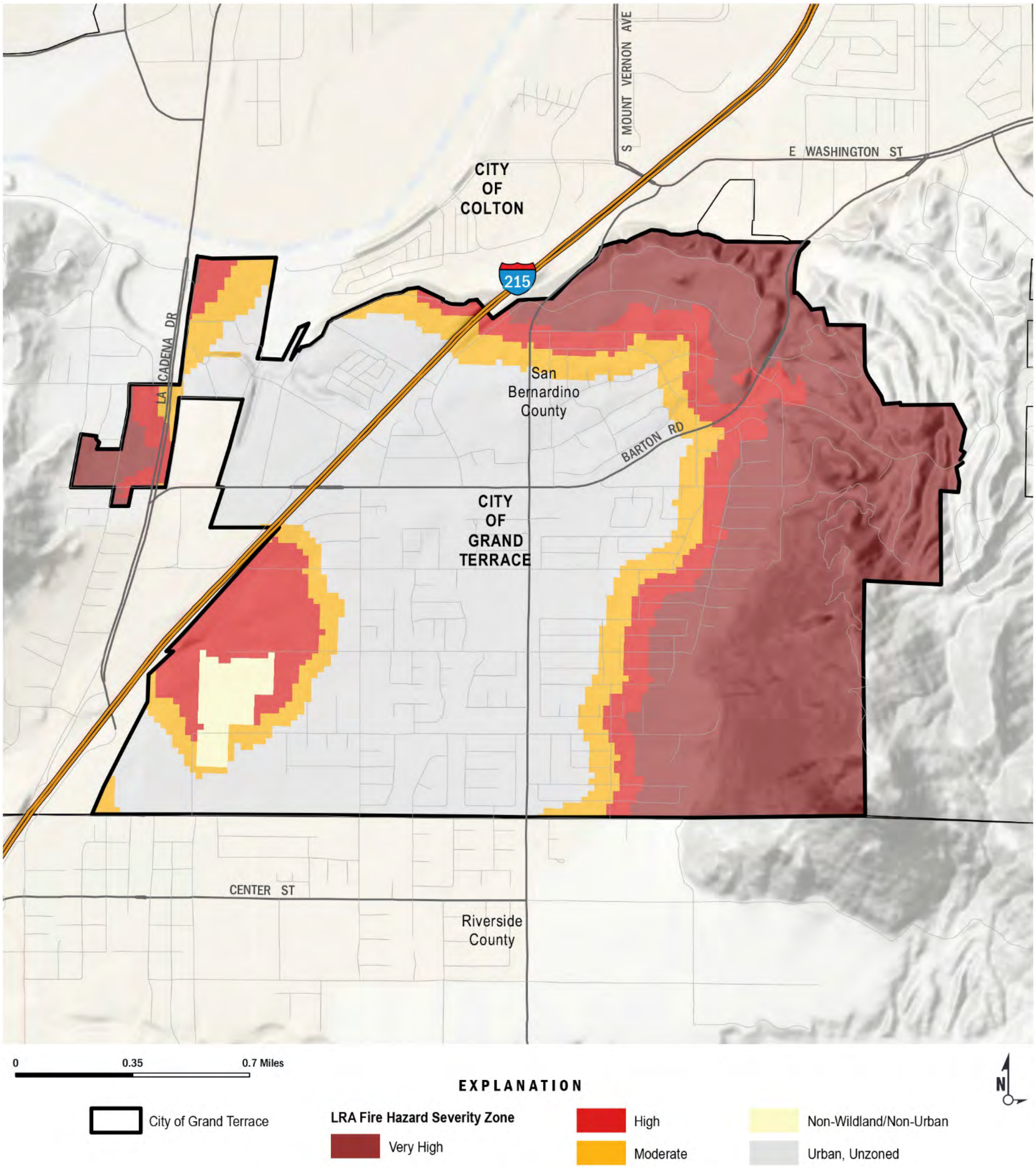


Figure 4-12: Local Responsibility Area Fire Hazard Severity Zones

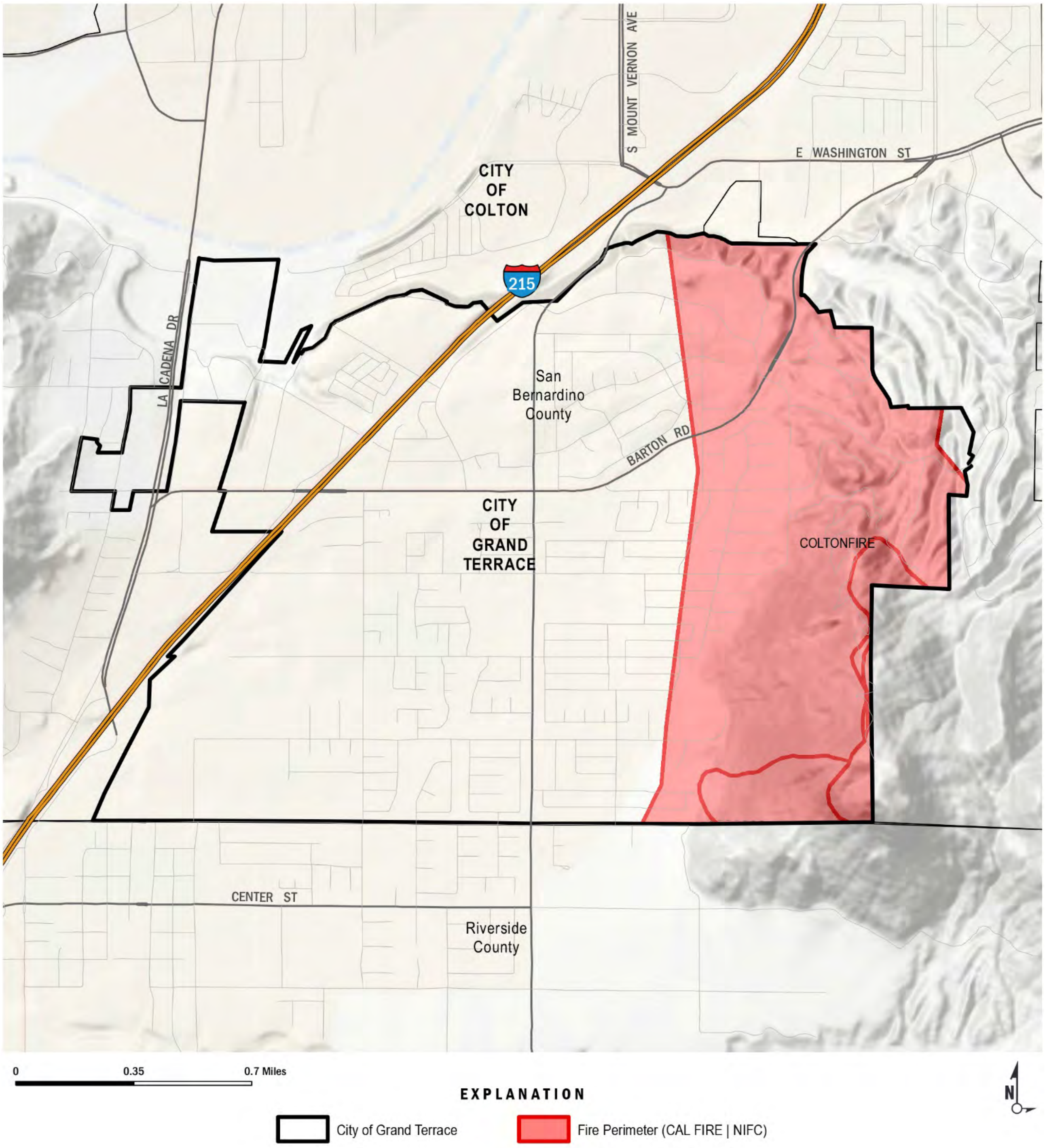


Figure 4-13: Wildfire History in and near Grand Terrace

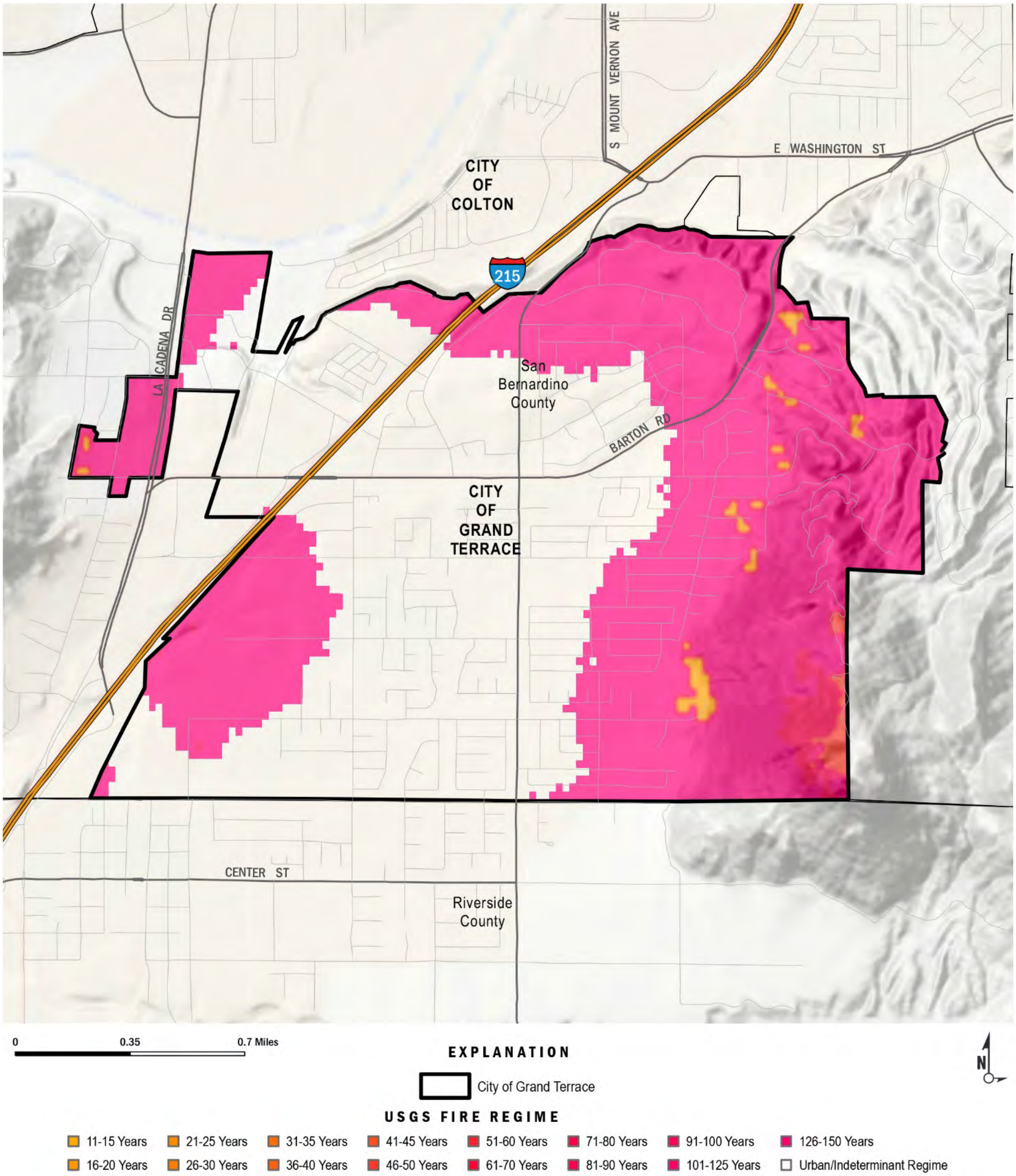


Figure 4-14: USGS Fire Regime for the City of Grand Terrace

4.2.4 Flood Hazard Profile

Floods are the second most common and widespread of all natural disasters faced by the region and cities like Grand Terrace. Most communities in the United States have experienced some kind of flooding during or after spring rains, heavy thunderstorms, winter snow thaws, or summer thunderstorms.

A flood, as defined by FEMA's National Flood Insurance Program (NFIP) is: "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is the policyholder's property) from:

- Overflow of inland or tidal waters, or
- Unusual and rapid accumulation or runoff of surface waters from any source, or
- Mudflow, or
- Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels."

Floods can be slow or fast rising but generally develop over a period of hours or days. Mitigation includes any activities that prevent an emergency, reduce the chance of an emergency happening, or lessen the damaging effects of unavoidable emergencies. Investing in mitigation measures now, such as: engaging in floodplain management activities, constructing barriers such as levees, and purchasing flood insurance will help reduce the amount of structural damage and financial loss from other types of property damage should a flood or flash flood occur.

The standard for flooding is the 1% annual chance flood, commonly called the 100-year flood, the benchmark used by the FEMA to establish a standard of flood control in communities throughout the country. The 1% annual chance flood is also referred to as the base flood.

The 1% annual chance flood is the flood that has a 1% chance of being equaled or exceeded in any given year and it could occur more than once in a relatively short period of time. By comparison, the 10% flood (10-year flood) means that there is a 10% chance for a flood of its size to occur in any given year.

Although nearly all of the City of Grand Terrace is elevated along the base of Blue Mountain, the northwest portion of the City lies within a designated flood plain of the Santa Ana River. Levees have been constructed along a portion of the City's riverfront. However, a flood hazard continues to exist that could make certain areas unsuitable for habitable structures. There are also localized flooding issues occurring outside of the floodplain in areas such as Pico St. This is discussed in detail in Section 4.2.4.3

4.2.4.1 Regulatory Environment

The City has adopted codes and regulations to govern development, construction and land use activities. They include construction standards, siting requirements, use limitations, study requirements and mitigation requirements which help directly or indirectly minimize the exposure of people and property to loss or injury resulting from disasters. As such, the City may continue to use these requirements to reduce the amount of damage or harm arising from disasters. This plan provides an opportunity to review existing regulations to determine if they are effective or whether they need to be revised in certain areas to more adequately prevent loss or injury from disasters.

The City of Grand Terrace 2010 General Plan established several policies to reduce the risk to life and property in areas designated as flood hazard areas.

- All development proposed within a designated 100-year floodplain shall be reviewed to assure that all structures designated for human habitation are adequately protected from flood hazards.
- The City shall work with the San Bernardino County Flood Control District and Army Corps of Engineers to provide adequate flood protection along the Santa Ana River.
- The City shall evaluate the flood control system of the City and improve it as required and as funds become available.
- The City shall require all development projects to comply with the National Pollutant Discharge Elimination System (NPDES) and implement appropriate Best Management Practices.
- Open space shall be used to protect public health and safety resulting from flood hazard conditions in the City of Grand Terrace.
- The City shall periodically review the flood hazard maps to identify potential flood hazards.
- Those areas subject to flood hazard shall be placed in a flood hazard overlay zone.
- Areas of the City subject to flood hazard shall be evaluated to determine whether they should be designated as open space.

4.2.4.1.1 National Flood Insurance Program

Effective January 15th, 2016, Grand Terrace is now a participant in The National Flood Insurance Program (NFIP). (City of Grand Terrace, 2016) The NFIP enables property owners to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. (The National Flood Insurance Program, n.d.) Of the 3,346 parcels within the community, .33% (11) are within either the 100 year or 500 year floodplain. There are currently 3 policies held in the City totaling $1,091 in premiums and $980,000 in total coverage. To date there have been no claims filed.

The Privacy Act of 1974 (5 U.S.C. 522a) restricts the release of certain types of data to the public. Flood insurance policy and claims data are included in the list of restricted information. FEMA can only release such data to state and local governments, and only if the data are used for floodplain management, mitigation, or research purposes. Therefore, this plan does not identify the repetitive loss properties or include claims data for any individual property.

4.2.4.1.2 Santa Ana River Integrated Watershed Management Plan

This plan address resources in the Santa Ana River Watershed including hydrogeology, land use, biological resources, water supply, water quality, flood control, and demographics. The plan also presents regional watershed management practices including water storage, water quality improvements, water recycling, flood control, wetlands and sensitive habitat protection, recreational opportunities, and water conservation. (City of Grand Terrace General Plan, 2010)

4.2.4.1.3 Municipal Code of Ordinances Chapter 15.62 Floodplain Management

In order to reduce flood issues this Chapter includes regulations to:

- Restrict or prohibit uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or flood heights or velocities;

- Require that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction;
- Control the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel flood waters;
- Control filling, grading, dredging, and other development which may increase flood damage; and
- Prevent or regulate the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards in other areas.

4.2.4.1.4 Municipal Code of Ordinances Chapter 18.50- FP Floodplain Overlay District

The FP overlay districts limit the permitted uses of land in areas subject to periodic flooding to the following:

- Flood control channels, levees, spreading grounds and basins, roads, bridges and diversion drains, where plans are approved by the San Bernardino County flood control district.
- Agricultural uses (conditional use permits)

All uses and structures must be reviewed subject to the regulations of the Federal Emergency Management Agency (FEMA).

4.2.4.1.5 California Building Code Chapter 18 Section 1804.5

In flood hazards areas established in Section 1612.3, grading, fill, or both shall not be approved:

1. Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of flood water and, as applicable, wave action.
2. In floodways, unless it has been demonstrated through hydrologic ad hydraulic analyses performed by a registered design professional in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in flood levels during the occurrence of the design flood.
3. In coastal high hazard areas, unless such fill is conducted and/or placed to avoid diversion of water and waves toward any building or structure.
4. Where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated that the cumulative effect of the proposed flood hazard area encroachment, when combined with all other existing and anticipated flood hazard area encroachment, will no increase the design flood elevation more than 1 foot (305 mm) at any point.

Appendix G- Flood-Resistant Construction aims to minimize public and private losses due to flood conditions in specific flood hazard areas through the establishment of comprehensive regulations for management of flood hazard areas. This section establishes powers and duties, sets permit and variance standards and the requirements for site improvement, manufactured homes, recreational vehicles, tanks, temporary structures and temporary storage. (City of Grand Terrace Code of Ordinances , n.d.)

4.2.4.2 Past Occurrences

- All of Pico St from east to west City limits and sections of Michigan Street near Pico Street floods often.
- Flooding occurs at Vivienda Avenue and Burns Avenue.
- Runoff from Highway 215 runs into the creek bed running parallel to Vivienda Ave and will flood Grand Terrace Road during extensive periods of rain, making the road impassible.
- The natural basin/creek bed southeast of Thompson Drive floods during heavy rain.

4.2.4.3 Location/ Geographic Extent

The City of Grand Terrace has experienced significant urban development in recent years, predominantly single family subdivisions. A number of the drainage facilities contained in the Grand Terrace Master Plan of Drainage have already been constructed, however these facilitates are 10-year facilities and are undersized to deal with the City's drainage issues at this time. In fact, in the area of Grand Terrace around Pico Street, there are no drainage facilities constructed at all. In this portion of the City, flows are conveyed downstream via street flow. Streets in this area have curbs that go up to 12" in height to ensure proper conveyance of flows. The drainage facilities that do exist in the City of Grand Terrace consist primarily of reinforced concrete pipes (RCP) and trapezoidal channels. (Grand Terrace MPD Update Drainage Study, 2011)

As seen in Table 4-8 most the City is elevated above the flood plain. Apart from a few acres in the northwest corner of the city limits (the undeveloped Santa Ana River floodplain), areas subject to flooding in Grand Terrace are adjacent to the Main, Pico, Van Buren and De Berry Streets due to heavy rainfall. These streets carry the water runoff from Blue Mountain and properties from the East end of the City to the West. Properties adjacent to these Streets may be subject to damage during storm events. Winter storms in the past have caused gutters to overflow City streets on to private property. Properties adjacent to the storm channels have been damaged and road closures have taken place. (City of Grand Terrace 2011 Hazard Mitigation Plan Update Draft, 2011)

Table 4-8: Grand Terrace Flood Hazard Area

Flood Hazard Type	Sum of Acres	Sum of Square Miles
100-Year Flood	34	0.05
100-Year, Floodway	1	0.00
500-Year Flood	8	0.01
Total	**43**	**0.07**

According to the 2010 General Plan, there are 26.1 acres of land designated as Floodplain Industrial in the northwest corner of the City. Properties designated with the Floodplain Industrial designation experience the potential for severe flooding resulting from their proximity to the Santa Ana River. Properties within this designation are planned for ultimate development as light industrial, nonpolluting uses. Proposed developments must demonstrate that adequate measures can be implemented to ensure that the proposed use is effectively protected from identified flood hazards. Presently, parcels within this area are largely undeveloped or developed as rural residential land uses. It is anticipated that buildout of this area will occur over a long period of time. During this buildout period, existing residential uses shall be permitted and regulated under the requirements of the Low Density Residential land use designation. Light agricultural uses shall be permitted including the keeping of animals with the approval of an Agricultural Overlay zoning designation. (City of Grand Terrace General Plan, 2010)

4.2.4.4 Magnitude/ Severity

In urban areas like Grand Terrace, flood problems are intensified because new homes and other structures, and new streets, driveways, parking lots, and other paved areas decrease the amount of open land available to absorb rainfall and runoff, thus increasing the volume of water that must be carried away by waterways.

4.2.4.5 Frequency/ Probability of Future Events

The FIRM maps not only identify the flood hazard zones for insurance and floodplain management purposes, but also provide a statement of probability of future occurrence. As illustrated in Figure 4-14, nearly the entire City is located in the 500-Year flood zone, which means there is a 0.2-percent-annual-chance of flooding. The northwestern most part of the City, located in the Santa Ana River Floodplain, is in a 100-Year flood zone. This means there is a 1-percent annual chance of flooding. Although the recurrence interval represents the long-term average period between floods of specific magnitude, significant floods could occur at shorter intervals or even within the same year.

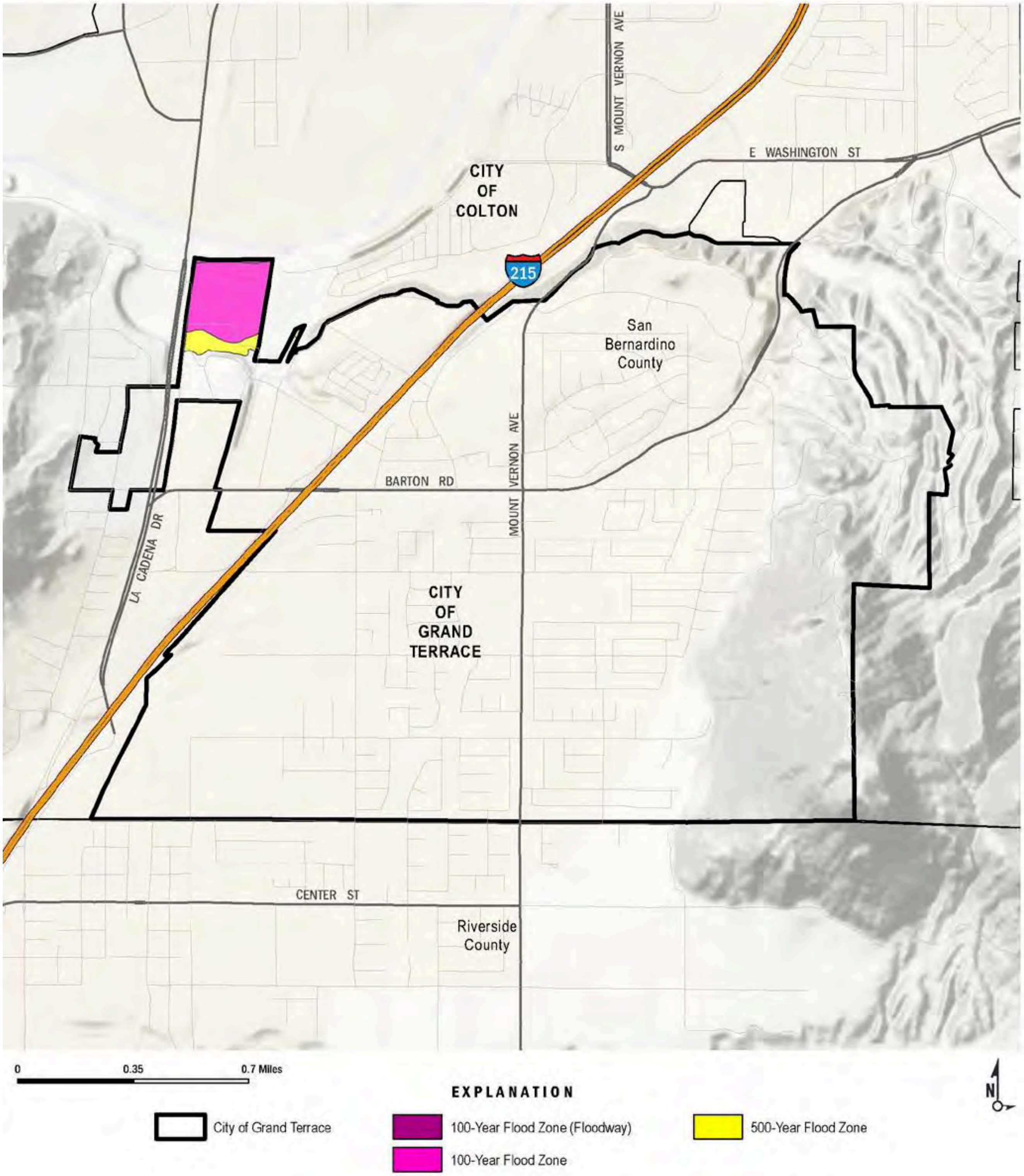


Figure 4-15: 100 and 500- Year Flood Zones in Grand Terrace

4.2.5 Climate Change Hazard Profile

Climate change refers to any distinct change in measures of climate lasting for a long period of time, more specifically major changes in temperature, rainfall, snow, or wind patterns. Climate change may be limited to a specific region, or may occur across the whole Earth. Climate change may result from:

- Natural factors (e.g., changes in the Sun's energy or slow changes in the Earth's orbit around the Sun);
- Natural processes within the climate system (e.g., changes in ocean circulation); and
- Human activities that change the atmosphere's make-up (e.g., burning fossil fuels) and the land surface (e.g., cutting down forests, planting trees, building developments in cities and suburbs, etc.).

The effects of climate change are varied: warmer and more varied weather patterns, melting ice caps, and poor air quality, for example. Thus, climate change impacts a number of natural hazards.

The 2013 State of California Multi-Hazard Mitigation Plan stated that climate change is already affecting California. Sea levels have risen by as much as seven inches along the California coast over the last century, increasing erosion and pressure on the state's infrastructure, water supplies, and natural resources. The State has also seen increased average temperatures, more extreme hot days, fewer cold nights, a lengthening of the growing season, shifts in the water cycle with less winter precipitation falling as snow, and both snowmelt and rainwater running off sooner in the year. In addition to changes in average temperatures, sea level, and precipitation patterns, the intensity of extreme weather events is also changing.

4.2.5.1 Regulatory Environment

California's response to climate change is directed by Legislation and Regulations and by other Mandates such as executive orders.

4.2.5.1.1 2010 City of Grand Terrace General Plan

The 2010 City of Grand Terrace General Plan includes a Sustainable Development Element which includes the concept of Environmental Sustainability. Environmental sustainability is defined as the ability of the environment to continue to properly function indefinitely. The element establishes goals and policies in the categories of energy, waste reduction, urban design, urban nature, transportation, environmental health, water and city buildings and facilities.

4.2.5.1.2 The Sustainable Communities and Climate Protection Act of 2008

The Sustainable Communities and Climate Protection Act of 2008 (Sustainable Communities Act, SB 375, Chapter 728, Statutes of 2008) looks to reduce GHG emissions through coordinated transportation and land use planning with the goal of more sustainable communities. Regional targets are established for GHG emissions reductions from passenger vehicle use by the sustainable communities strategy (SCS) established by each metropolitan planning organization (MPO). The SCS is an integral part of the regional transportation plan (RTP) and contains land use, housing, and transportation strategies to meet GHG reductions targets. In San Bernardino County, the South Coast Air Quality Management District facilitates compliance with the federal Clean Air Act and implements the state's air quality program.

The Office of Planning and Research's General Plan Guidelines and SB 375 builds upon Assembly Bill 162 (flood protection) and Senate Bill 1241 (fire protection) and supports Safeguarding California implementation.

SB 375 also supports Assembly Bill 2140 which requires that a City/County General Plan contains a safety element in addition to a Hazard Mitigation Plan. AB 2140 also requires a vulnerability assessment, adaptation goals, policies and objectives, and a set of feasible implementation measures.

4.2.5.1.3 2015 San Bernardino Valley Regional Urban Water Management Plan

This Urban Water Management Plan provides a summary of anticipated supplies and demands for the years 2015-2040 for the agencies participating in the plan, including Riverside Highland Water Company who services the City of Grand Terrace. The Urban Water Management Plan Act requires evaluation of the following:

- Whether supplies will be sufficient to meet demands during the following hydrologic year types o Normal/average year o Single dry year o Multiple dry year sequence;
- Existing baseline water use in terms of gallons per capita per day (GPCD) (applies only to retail water suppliers);
- Targets for future water use consistent with the Water Conservation Act of 2009 (SB X7-7) which seeks a 20 percent reduction in per capita water use by 2020;
- Demand Management Measures (DMMs) implemented or planned for implementation as well as the methods proposed for achieving future water use targets;
- Water shortage contingency planning; and
- Notification and coordination with other water agencies, land use entities, and the community.

4.2.5.1.4 Water Shortage Contingency Plan

In 1987, Riverside Highland Water Company (RHWC) started and maintained various funds whereby it can respond to emergencies without waiting for funds from outside sources. RHWC has approved a living document known as the "Emergency Preparedness and Response Procedure" in March, 1994 and most recently revised the document in April 2010 and adopted a "Water Shortage Contingency Plan" in July of 2014.

4.2.5.1.5 2016 California Building Efficiency Standards

By adopting the 2016 California Building Code, the City has also adopted the 2016 Building Energy Efficiency Standards Title 24, Part 6. The Standards contain energy and water efficiency requirements (and indoor air quality requirements) for newly constructed buildings, additions to existing buildings, and alterations to existing buildings. Public Resources Code Sections 25402 subdivisions (a)-(b) and 25402.1 emphasize the importance of building design and construction flexibility by requiring the Energy Commission to establish performance standards, in the form of an "energy budget" in terms of the energy consumption per square foot of floor space. For this reason, the Standards include both a prescriptive option, allowing builders to comply by using methods known to be efficient, and a performance option, allowing builders complete freedom in their designs provided the building achieves the same overall efficiency as an equivalent building using the prescriptive option. Reference Appendices are adopted along with the Standards that contain data and other information that helps builders comply with the Standards. (California Energy Commission, 2016)

4.2.5.1.6 California Adaptation Planning Guide (APG)

The State of California has been taking action to address climate change for over 20 years, focusing on both greenhouse gas emissions reduction and adaptation. The California Adaptation Planning Guide (APG) continues the state's effort by providing guidance and support for communities addressing the unavoidable consequences of climate change.

Based on upon specific factors, 11 Climate impact regions were identified. Some of the regions were based on specific factors particularly relevant to the region. As illustrated in Figure 4-15 San Bernardino County is located in the Desert Region.

Figure 4-16: Climate Impact Regions

The Desert is a heavily urbanized inland region (4.3+ million people) made up of sprawling suburban development in the west near the South Coast region and vast stretches of open, largely federally owned desert land to the east. Prominent cities within the desert portion include Palm Springs (44,500+) and El Centro (42,500+). The region's character is defined largely by the San Gabriel Mountains, San Gorgonio Mountains, San Jacinto Mountains, and smaller inland mountains reaching through the desert to the Colorado River, which borders the region on the east. Communities in the Desert region should consider evaluating the following climate change impacts:

- Reduced water supply
- Increased temperature
- Reduced precipitation
- Diminished snowpack
- Wildfire risk
- Public health and social vulnerability
- Stress on special-status species

4.2.5.2 Past Occurrences

Climate change has never been directly responsible for any declared disasters. Past flooding, wildfire, levee failure, and drought disasters may have been exacerbated by climate change, but it is impossible to make direct connections to individual disasters. In addition, unlike earthquake and floods that occur over a finite time period, climate change is an on-going hazard, the effects of which some are already experiencing. Other effects may not be seriously experienced for decades, or may be avoided altogether by mitigation actions taken today.

According to the California State Hazard Mitigation Plan (SHMP), the worst single heat wave event in California occurred in Southern California in 1955, when an eight-day heat wave resulted in 946 deaths. The July 2006 heat wave in California caused approximately 140 deaths over a 13-day period.

4.2.5.3 Location/Geographic Extent

The effects of climate change are not limited by geographical borders. Grand Terrace, San Bernardino County, the State of California, the United States, and the rest of the world are all at risk to climate change. As such, the entire City is at risk to the effects of climate change.

Figure 4-16 and Figure 4-17 provide Cal Adapt[1] modeled decadal July high temperature averages for 2010 and 2090. These figures provide current decade-long July temperature averages and possible annual high heating trends for the remaining portion of the century. The data presented in the figures represent a "projection" of potential future climate scenarios, they are not predictions. These figures illustrate how the climate may change based on a variety of different potential social and economic factors. The visualizations are comprised of average values from Coupled Climate model 2.1 (GFDL), Community Climate System Model Version 3 (CCSM3), Coupled Global Climate Model Version 3 (CNRM) and Parallel Climate Model 1 (PCM1). During the next few decades, scenarios project average temperature to rise between 1° and 2.3°F; however, the projected temperature increases begin to diverge at mid-century so that, by the end of the century, the temperature increases projected in the higher emissions scenario (A2) are approximately twice as high as those projected in the lower emissions scenario (B1). Customizable maps can be viewed at http://cal-adapt.org/temperature/decadal/

[1] Cal-Adapt has been funded to provide access to data and information that has been produced by the State's scientific and research community. The data available in this site offer a view of how climate change might affect California at the local level.

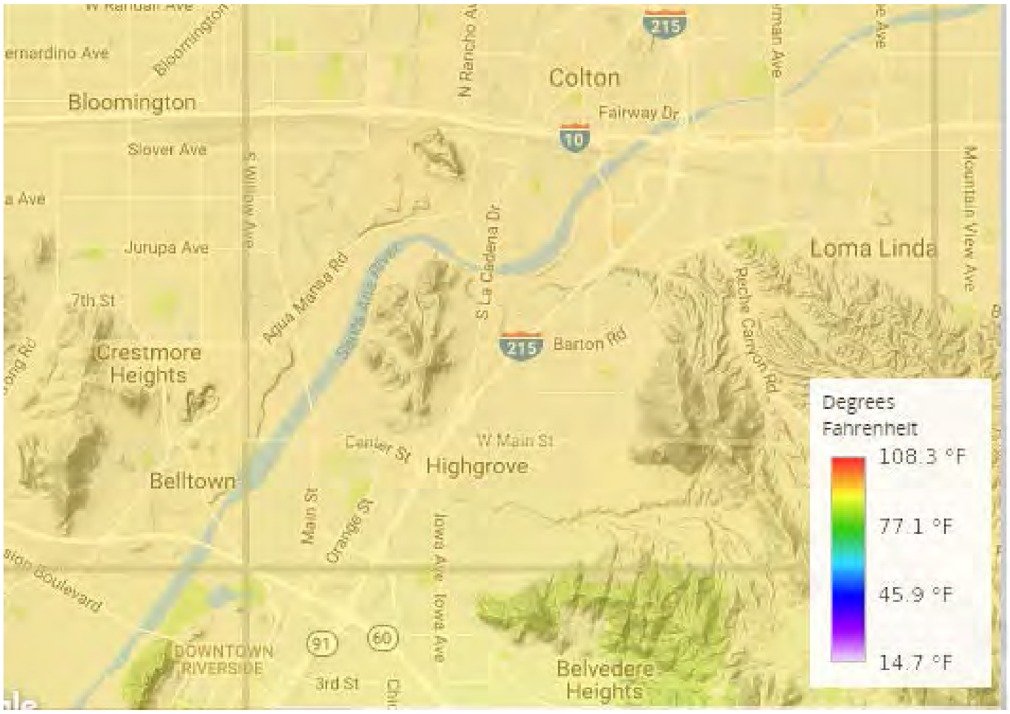


Figure 4-17: July Decadal Average High Temperature Map; 2010

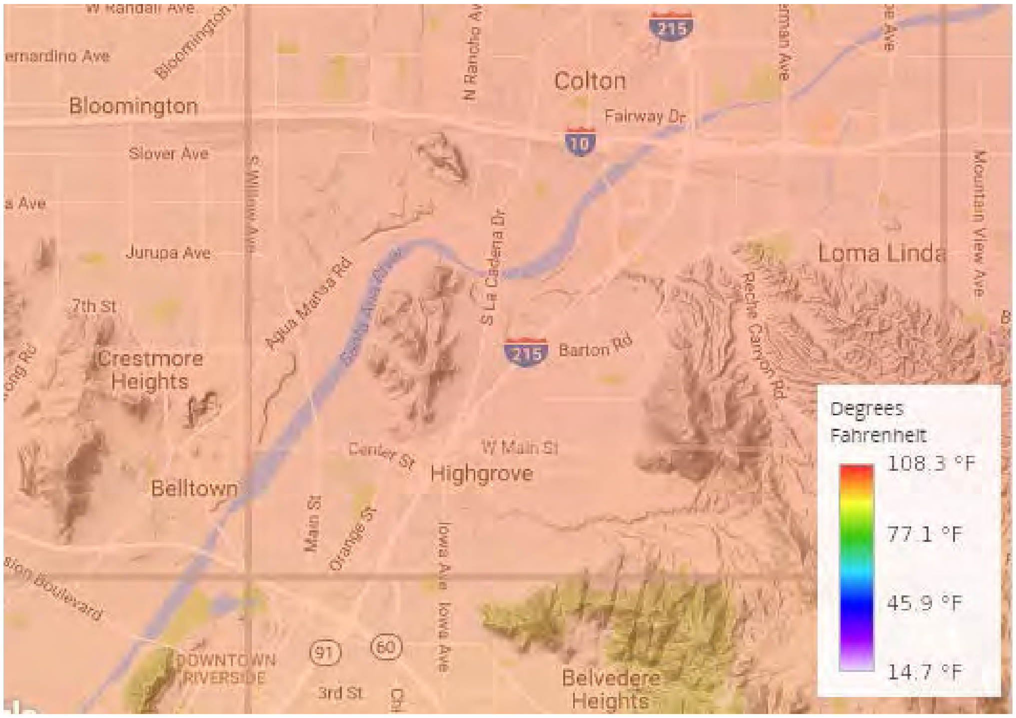


Figure 4-18: July Decadal Average High Temperature Map; 2090

4.2.5.4 Magnitude/Severity

The California Adaptation Planning Guide has calculated projections for changes in temperature, precipitation, heat waves, snowpack and wildfire risk in the desert area, as shown in Table 4-9. Hotter, drier conditions are expected to exist in the desert area, increasing the risk for other natural hazards.

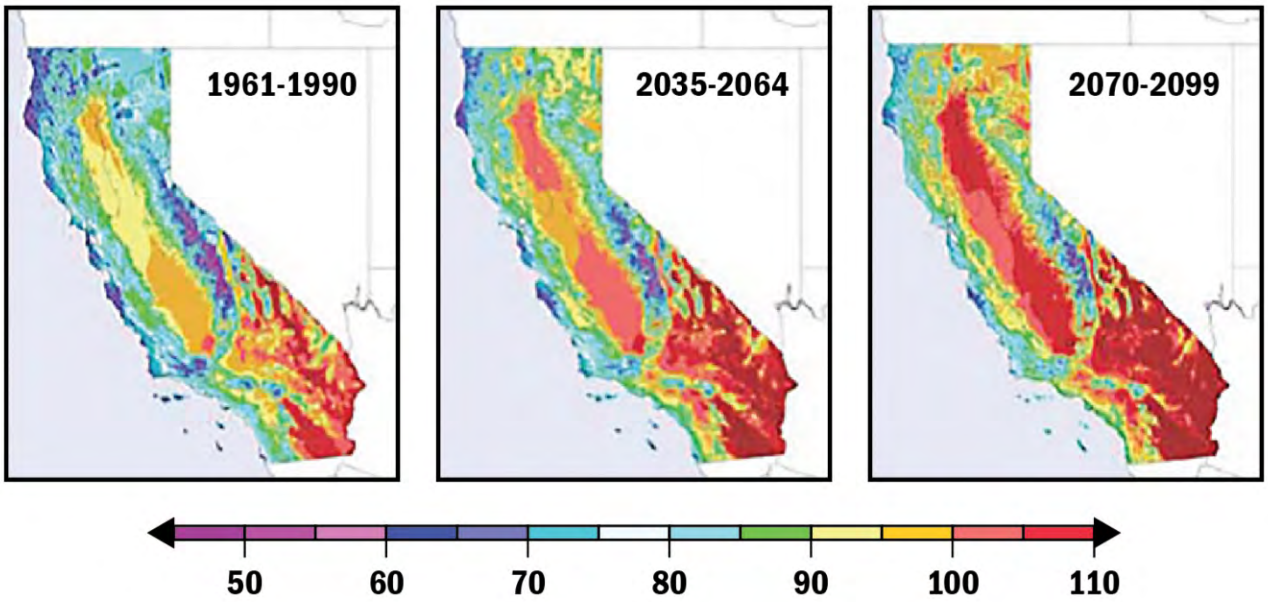
Table 4-9: From APG: Table 41. Summary of Cal-Adapt Climate Projections for the Desert Region

Effect	Ranges
Temperature Change, 1990-2100	January increase in average temperatures: 2°F to 4°F by 2050 and 5°F to 8°F by 2100. July increase in average temperatures: 3°F to 5°F by 2050 and 6°F to 9°F by 2100 (Modeled high temperatures; high carbon emissions scenario)
Precipitation	Generally, annual rainfall will decrease in the most populous areas. Wetter areas like the western part of Riverside and southwestern San Bernardino counties will experience a 2 to 4 inch decline by 2050 and 3.5 to 6 inch decline by the end of the century. Big Bear is expected to lose around 8 inches per year by 2090. Southern Imperial County will have a small decline of about 0.5 inches. The eastern, desert portion of the region will see little to no change in annual rainfall. (CCSM3 climate model; high carbon emissions scenario)
Heat Wave	Heat waves are defined by five consecutive days over temperatures in the 100s over most of the region. Three to five more heat waves will be experienced by 2050, increasing to 12 to 16 in the western parts of the region to more than 18 to 20 in the eastern parts of the region.
Snowpack	March snowpack in the Big Bear area will diminish from the 2.5- inch level of 2010 to 1.4 inches in 2030 and almost zero by 2090. (CCSM3 climate model; high emissions scenario)
Wildfire Risk	Most areas are projected to have the same or slightly increased likelihood of wildfire risk. The major exceptions are the Mecca San Gorgonio and San Jacinto Mountains, where wildfire will be 1.5 and 2.0 times more likely. (GFDL model, high carbon emissions scenario)

[Public Interest Energy Research, 2011. Cal-Adapt. Retrieved from http://cal-adapt.org]

The California Climate Adaptation Strategy (CAS), citing a California Energy Commission study, states that "over the past 15 years, heat waves have claimed more lives in California than all other declared disaster events combined." This study shows that California is getting warmer, leading to an increased frequency, magnitude, and duration of heat waves. These factors may lead to increased mortality from excessive heat, as shown in Figure 4-18.

Figure 4-19: California Historical and Projected Temperature Increases - 1961 to 2099



Source: Dan Cayan; California Climate Adaptation Strategy

4.2.5.5 Frequency/Probability of Future Occurrences

Climate change is one of the few natural hazards where the probability of occurrence is influenced by human action. In addition, unlike earthquake and floods that occur over a finite period of time, climate change is an on-going hazard.

The 2009 Climate Adaptation Strategy (CAS) delineated how climate change may impact and exacerbate natural hazards in the future, including wildfires, extreme heat, floods, drought, and levee failure:

- Climate change is expected to lead to increases in the frequency, intensity, and duration of extreme heat events and heat waves in Grand Terrace, San Bernardino County and the rest of California, which are likely to increase the risk of mortality and morbidity due to heat-related illness and exacerbation of existing chronic health conditions. Those most at risk and vulnerable to climate-related illness are the elderly, individuals with chronic conditions such as heart and lung disease, diabetes, and mental illnesses, infants, the socially or economically disadvantaged, and those who work outdoors.
- The Desert region relies on water from the Colorado River and the State Water Project. Both of these sources begin with mountain snowpack. Climate change will result in drastically reduced supply from these sources. Declining snowpack in the San Gabriel Mountains, San Gorgonio Mountains, and San Jacinto Mountains will lead to permanently diminished local water supply.
- Higher temperatures will melt the snowpack earlier and drive the snowline higher, resulting in less snowpack to supply water to California users.
- Droughts are likely to become more frequent and persistent in the 21st century.

- Intense rainfall events, periodically ones with larger than historical runoff, will continue to affect California with more frequent and/or more extensive flooding.
- Storms and snowmelt may coincide and produce higher winter runoff. Together, these changes will increase the probability of dam and levee failures in the San Bernardino County Flood Control District.
- Warmer weather, reduced snowpack, and earlier snowmelt can be expected to increase wildfire risk through fuel hazards and ignition risks. These changes can also increase plant moisture stress and insect populations, both of which affect forest health and reduce forest resilience to wildfires. An increase in wildfire intensity and extent will increase public safety risks, property damage, fire suppression and emergency response costs to government, watershed and water quality impacts, vegetation conversions and habitat fragmentation.

4.3 Vulnerability Assessment

The information in this section provides an explicit representation of what a community stands to lose in a disaster. This is useful for City Staff and other decision makers who will need to balance the costs of mitigation against the potential harm to residents and damage to property. It provides comparable measurements of community natural hazard exposure [2] and assists in determining which hazards and/or what parts of the City to focus on making resilient to disaster first. Based upon possible assets at risk, hazard mitigation resources can be directed where need be, in-part, by a vulnerability assessment and information presented in this section.

The vulnerability assessment is developed by developing quantitative and qualitative information for each hazard. Through an exposure analysis, quantitative data is developed for each hazard. An exposure analysis provides quantities of people and assets at risk to particular hazards. Qualitative data has been developed and presented in this section for hazards without measurable data. Qualitative data provides information beyond quantities of people and assets at risk, but rather a description of how the hazard could affect the region around Grand Terrace.

Note: The hazard exposure analysis has been developed with best available data and follows methodology described in the FEMA publication "Understanding Your Risks—Identifying Hazards and Estimating Losses".

Note: There are other intangible losses that could result from a natural hazard event, such as losses of historic or cultural integrity or damage to the environment that are difficult to quantify. Other costs, including response and recovery costs, are often unrecoverable and are not addressed in this document**.**

4.3.1 Methodology

A vulnerability assessment was conducted for each of the identified priority hazards. Geospatial data is essential in determining population and assets exposed to particular hazards. Geospatial analysis can be conducted if a natural hazard has a particular spatial footprint that can be overlaid against the locations of people and assets. In Grand Terrace, earthquakes, landslides, flooding and climate change have known geographic extents and corresponding spatial information about each hazard.

Several sources of data are necessary to conduct a vulnerability analysis. Figure 4-19 provides an exhibit of the data inputs and outputs used to create the vulnerability analysis results presented in this section. U.S. Census data is the primary source in determining natural hazard exposure to city residents. Census data has been used to determine the population at risk, which is generally referred to as population exposure. Population exposure is provided for earthquakes, landslides, flooding and climate change as potential hazards later in this section.

Together with the U.S. Census data, City asset data was used to provide a snapshot of how City assets are affected by natural hazards. For purposes of this vulnerability analysis, asset data includes parcels and critical infrastructure within the City boundaries. Critical infrastructure is described as assets that are essential for people and a community to function.

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[2] Elements at risk; Risk inventory; Exposure encompasses all elements, processes, and subjects that might be affected by a hazardous event. Consequently, exposure is the presence of social, economic, environmental or cultural assets in areas that may be impacted by a hazard.

Critical infrastructure includes utilities, city-owned facilities, bridges, schools, and other community facilities that provide essential services to residents.

Critical facilities data was developed from a variety of sources including city owned and maintained data, state and federal government datasets, and private industry datasets. A critical infrastructure spatial database was developed to translate critical facilities information into georeferenced[3] points. Critical facility points are intersected with the spatial hazard layers to develop a list of "at risk" critical facilities. The City critical facilities that intersect with natural hazards are referred to as facilities with hazard "exposure". Exposure results are presented later in this section.

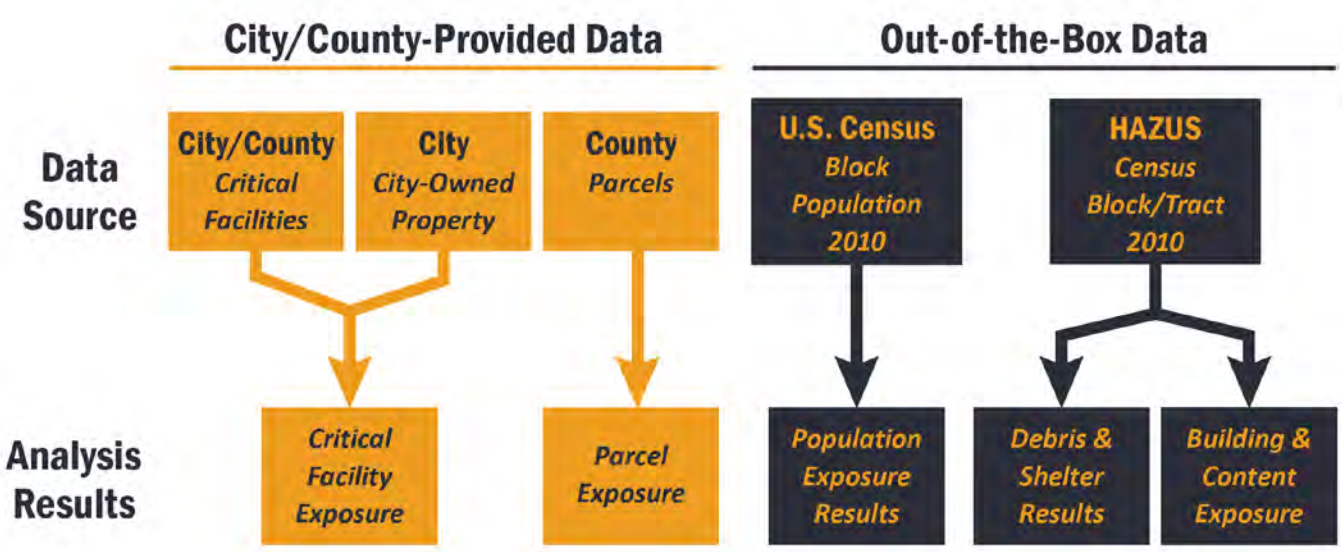


Figure 4-20: Data Source and Methodology

Lastly, FEMA's Hazus-MH MR5 (Hazus) software was implemented to conduct detailed loss estimation for flood and earthquake. Hazus is a nationally applicable standardized methodology that contains models for estimating potential losses from earthquakes, floods, and hurricanes. HAZUS uses Geographic Information Systems (GIS) technology to estimate physical, economic, and social impacts of disasters. For purposes of this planning effort, Hazus was used to graphically illustrate the limits of identified high-risk locations due to possible earthquakes and floods.

4.3.2 Population and Assets

In order to describe vulnerability for each hazard, it is important to understand the "total" population and "total" assets at risk. The exposure for each hazard described in this section will refer to the percent of total population or percent of total assets. This provides the possible significance or vulnerability to people and assets for the natural hazard event and the estimated damage and losses expected during a "worst case scenario" event for each hazard. Sections below provide a description of the total population, critical facilities, and parcel exposure inputs.

[3] To georeference something means to define its existence in physical space. That is, establishing its location in terms of map projections or coordinate systems. The term is used both when establishing the relation between raster or vector images and coordinates, and when determining the spatial location of other geographical features.

4.3.2.1 Population

In order to develop hazard-specific vulnerability assessments, population near natural hazard risks should be determined to understand the total "at risk" population. We can understand how geographically defined hazards may affect the City by analyzing the extent of the hazard in relation to the location of population. For purposes of the vulnerability assessment approximately 12,040[4] (100%) of the City's population is exposed to one or more hazards within or near the City boundaries. Each natural hazard scenario affects the City residents differently depending on the location of the hazard and the population density of where the hazard could occur. Vulnerability assessment sections presented later in this section summarize the population exposure for each natural hazard.

1.1.1.1 Vulnerable Populations

The severity of a disaster depends on both the physical nature of the extreme event and the socioeconomic nature of the populations affected by the event. Important socioeconomic factors tend to influence disaster severity. A core concept in a vulnerability analysis is that different people, even within the same region, have a different vulnerability to natural hazards.

1.1.1.1.1 Income and Housing Condition

Income or wealth is one of the most important factors in natural hazard vulnerability. This economic factor affects vulnerability of low income populations in several ways. Lower income populations are less able to afford housing and other infrastructure that can withstand extreme events. Low income populations are less able to purchase resources needed for disaster response and are less likely to have insurance policies that can contribute to recovery efforts. Lower income elderly populations are less likely to have access to medical care due to financial hardship. Because of these and other factors, when disaster strikes, low income residences are far more likely to be injured or left without food and shelter during and after natural disasters.

Figure 4-20 shows the median household income distribution for the City of Grand Terrace in 2012. The "median" is the value that divides the distribution of household income into two equal parts (e.g., the middle). The average median household income in the City of Grand Terrace between 2010 and 2014 was $64,140, in the United States during the same period the median house household income was $65,443 (US Census Bureau Factfinder, n.d.).

The most vulnerable residents (in terms of income and housing condition) to natural hazards are located northwest of I-215 (Riverside FWY).

1.1.1.1.2 Age

Children and the elderly tend to be more vulnerable during an extreme natural disaster. They have less physical strength to survive disasters and are often more susceptible to certain diseases. The elderly often also have declining vision and hearing and often miss reports of upcoming natural hazard events. Children, especially young children, have the inability to provide for themselves. In many cases, both children and the elderly depend on others to care for them during day to day life.

[4] According to the 2010 U.S. Census, the total population for the City in 2010 was 12,040.

Finally, both children and the elderly have fewer financial resources and are frequently dependent on others for survival. In order for these populations to remain resilient before and after a natural hazard event, it may be necessary to augment city residents with resources provided by the City, state and federal emergency management agencies and organizations.

As seen in Figure 4-21, the block groups with the highest concentration of people under 18 years old are located in the northwestern portion of the City (north west of 1-215) and to the west of Mt. Vernon Ave. and Pico St. Figure 4-22 shows that the highest concentration of people over the age of 65 is in the city center (northeast, southeast and southwest of Barton Rd. and Mt. Vernon Ave.).

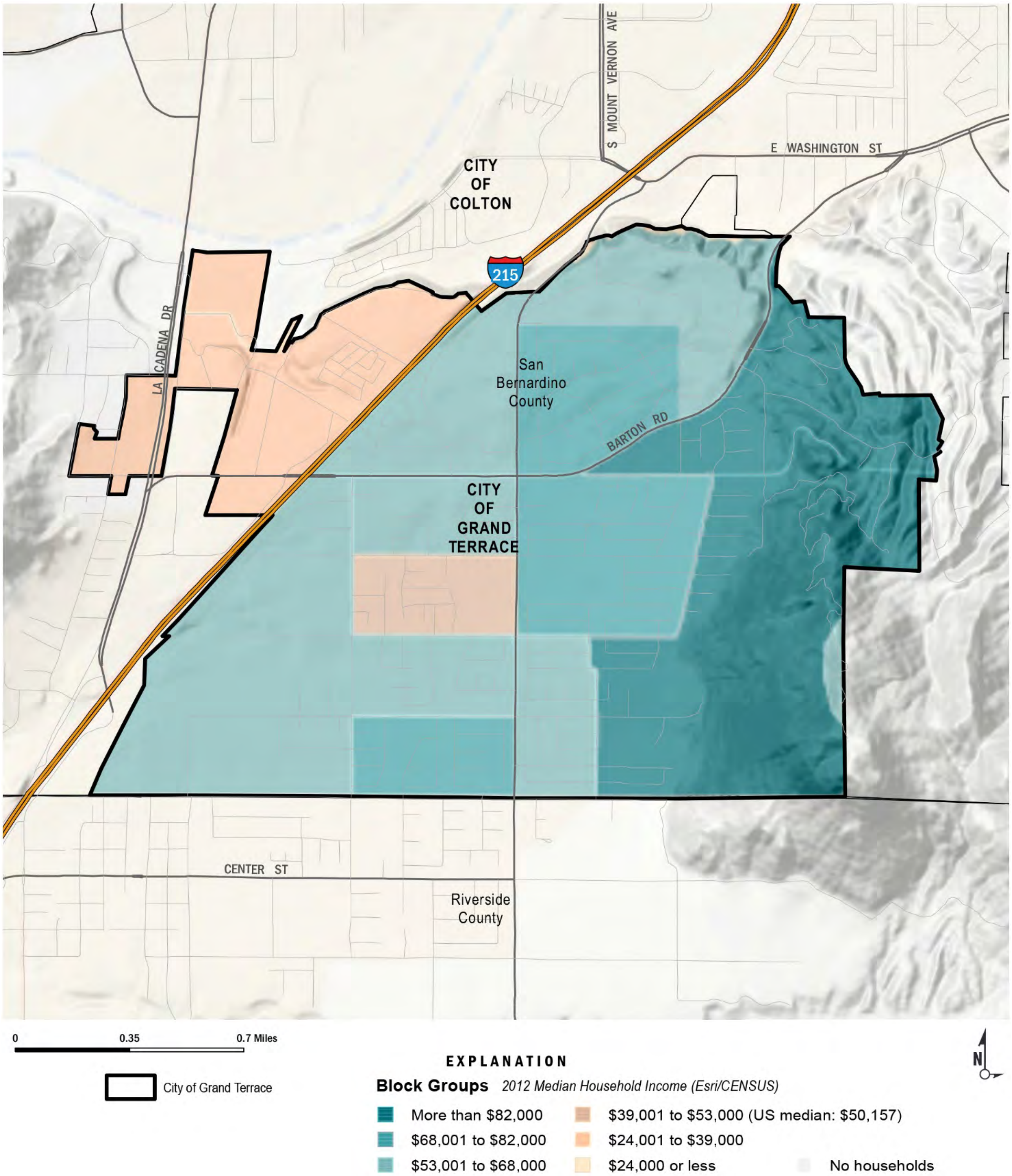


Figure 4-21: Median Household Income Distribution in Grand Terrace

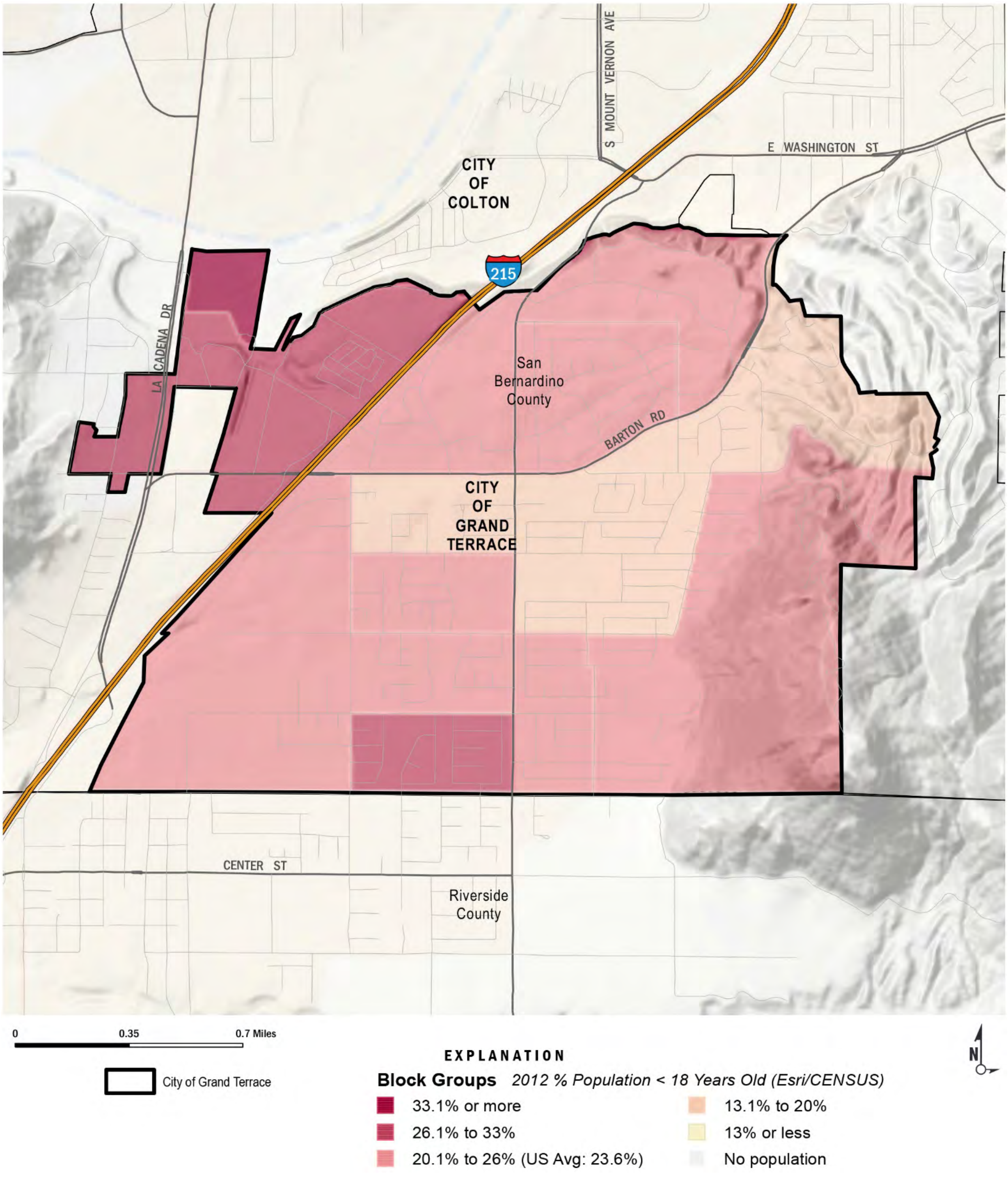


Figure 4-22: 2012 Population Under 18 Years Old in Grand Terrace

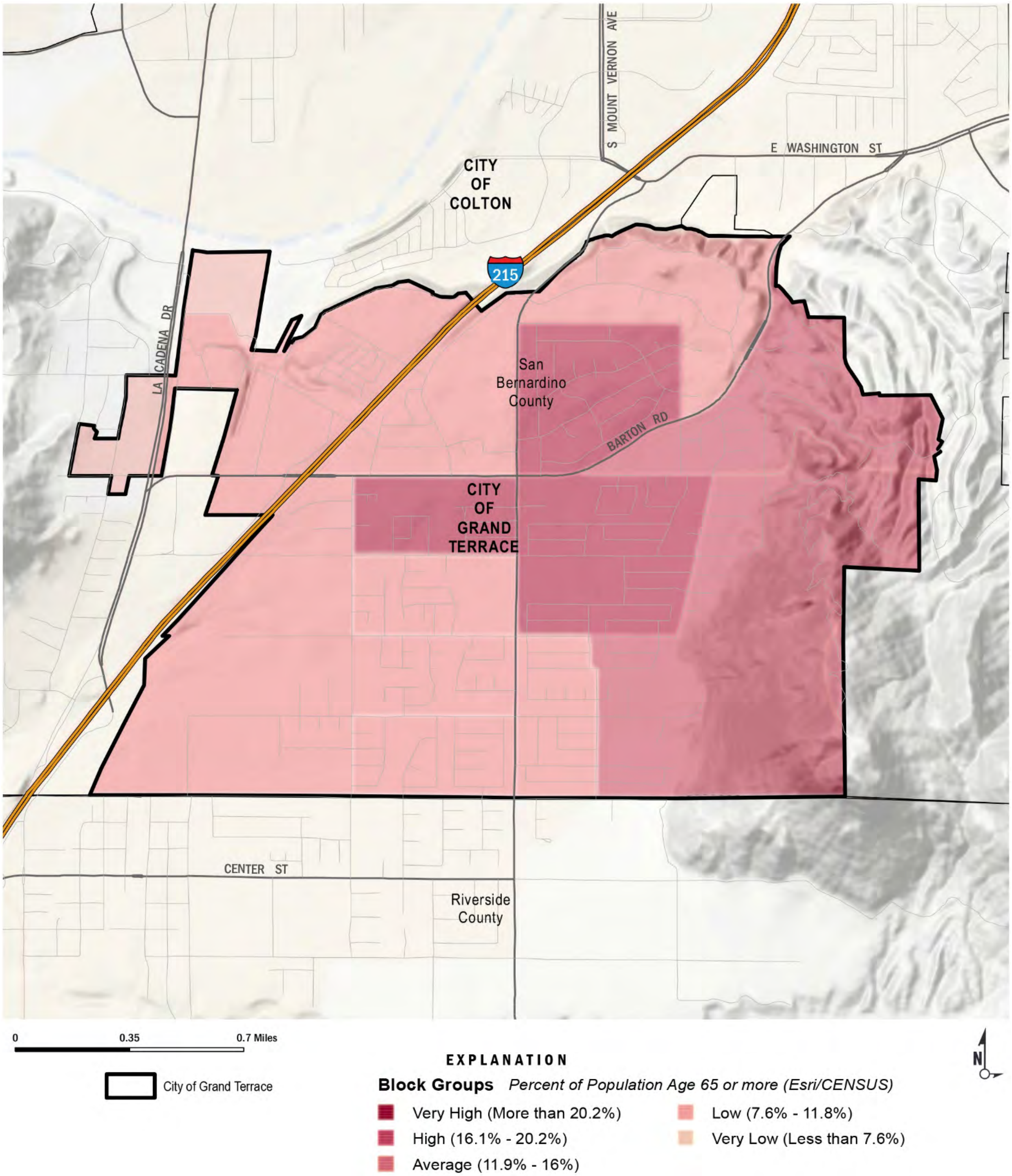


Figure 4-23: 2012 Population Over 65 Years Old in Grand Terrace

1.1.1.2 Parcel Exposure

The total count and value of parcels within the City of Grand Terrace which could be exposed to a hazard event is referred to as parcel exposure in this plan. A standardized hazard overlay was conducted to develop hazard exposure results for improved city parcels presented later in this section. The spatial overlay method identifies improvement value [5], land value, total assessed value, building replacement costs and content replacement costs for a hazard's geographic extents. In the event of a disaster, it is generally the value of the infrastructure or improvements to the land that is of concern or at risk. Generally, the land itself is not a total loss and structures can be rebuilt. The San Bernardino County Assessor's data is pivotal to developing parcel values exposed to each hazard. Replacement cost is the value of both material, labor, and design time to reconstruct a residential building. It is important to note that replacement cost is different than assessed market value for taxation purposes and is not related to housing market conditions. The City parcel information is summed and provided in Table 4-10.

Table 4-10: Parcel Counts and Value (IN THOUSANDS)

Improved Parcel Count	Improvement Value Exposure ($000)	Land Value Exposure ($000)	Total Exposure ($000)
3,346	$ 908,403,159	$ 736,628,523	$ 1,645,031,682

4.3.2.2 Critical Facilities

Critical facilities are of particular concern when conducting hazard mitigation planning. Critical facilities are defined as essential services, and if damaged, would result in severe consequences to the health, safety, and welfare of the public.

An inventory of critical facilities based on data from the City of Grand Terrace and other publicly sourced information were used to develop a comprehensive inventory of facility points and lifelines. Critical facility points include fire stations, buildings containing hazardous materials (HAZMAT), schools, transportation, utilities, and government buildings. Lifelines include communication, electric power, liquid fuel, natural gas, and transportation routes. A current representation of the critical facilities and lifelines are provided in Table 4-11 and Table 4-12. Some critical facility information has been omitted from documentation due to national security purposes. The City of Grand Terrace Public Works Department manages and maintains a complete list of critical facilities.

[5] A long-term asset which indicates the cost of the constructed improvements to land, such as buildings, driveways, walkways, lighting, and parking lots.

Table 4-11: Critical Facility Points

Infrastructure Type	Total Feature Count
Essential Facility	9
EOC	1
Fire Station	1
Government Facility	1
Hospital	1
School	5
High Potential Loss	51
Hazmat	24
Utility-Communication Facility	2
Utility-Electric Power Facility	1
Vulnerable Population-Adult Residential Care	4
Vulnerable Population-Child Care	10
Vulnerable Population-Foster/Home Care	2
Vulnerable Population-Senior Care	8
Transportation and Lifeline	6
Highway Bridge	4
Railway Bridge	2
Grand Total	66

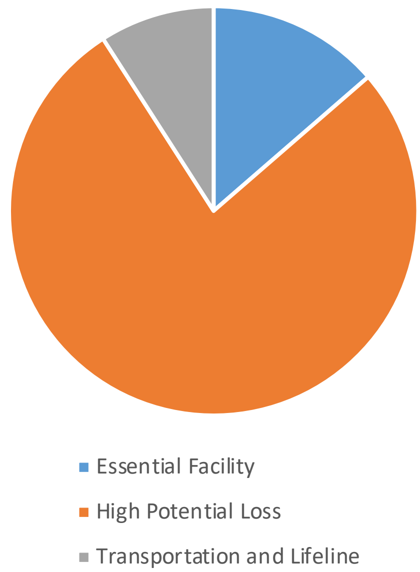


Table 4-12: Linear Utilities

Infrastructure Type	Total Linear Mileage
Transportation and Lifeline	**53**
Railway	**2**
Roads	**51**
Interstate Highway	2
State / County Highway	5
Local Road, Major	1
Local Road	37
Other Minor Road	3
Vehicular Trail	3
Ramp	1
Grand Total	**53**

4.3.3 Hazus-MH Inputs

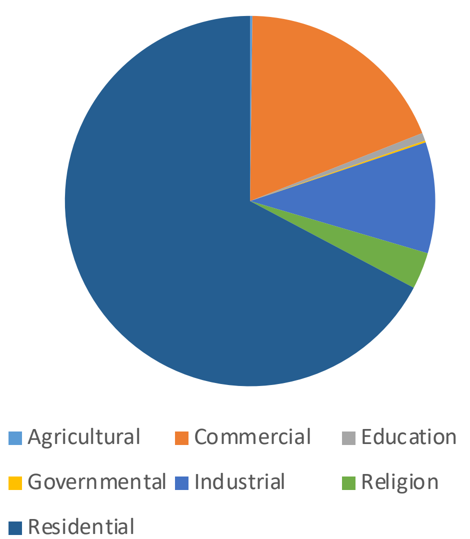
FEMA's loss estimation software, Hazus MH, was used to analyze the City 's building risk to flood and earthquake hazards. Hazus contains a database of economic, demographic, building stock, transportation facilities, local geology, and other information that can be used for several steps in the risk assessment process. Hazus software operates on structure square footage, structure replacement, and content replacement costs aggregated to the census block and tract levels depending on type of hazard analysis. Table 4-13 and Figure 4-23 provide value data for building categories at the census block and census tract levels. Census block and census tracts are used to provide input information for the Hazus analysis presented in this report.

The project team used the San Bernardino County Essential Facilities Risk Assessment (SBEFRA) to incorporate these newly updated DFIRM data into HAZUS to assess potential losses in the mapped 100-year (with and without levee protection) and 500-year flood zones. The City's results are provided in Table 4-13.

Note: The Hazus software utilizes different census level information inputs to develop loss estimates depending on the hazard module. The flood module uses census block information while the earthquake module uses census tract information. It is important to understand the total values of each as estimated damage to the community is presented on a percent of total value basis.

Table 4-13: Hazus Census Block Input Values (Total Community)

Building Type	Building Replacement Costs ($000)	Building Replacement Cost (%)	Content Replacement Cost ($000)	Content Replacement Cost (%)	Total Value ($000)	Total Value (%)
Agricultural	$ 1,063	0.1%	$ 1,063	0.1%	$ 2,126	0%
Commercial	$ 97,090	6.9%	$ 99,975	7.1%	$ 197,065	14%
Education	$ 3,675	0.3%	$ 3,675	0.3%	$ 7,350	1%
Governmental	$ 847	0.1%	$ 847	0.1%	$ 1,694	0%
Industrial	$ 36,828	2.6%	$ 51,465	3.7%	$ 88,293	6%
Religion	$ 17,018	1.2%	$ 17,018	1.2%	$ 34,036	2%
Residential	$ 714,538	51.0%	$ 357,301	25.5%	$ 1,071,839	76%
Total	**$ 871,059**	**62%**	**$ 531,344**	**38%**	**$ 1,402,403.00**	**100%**



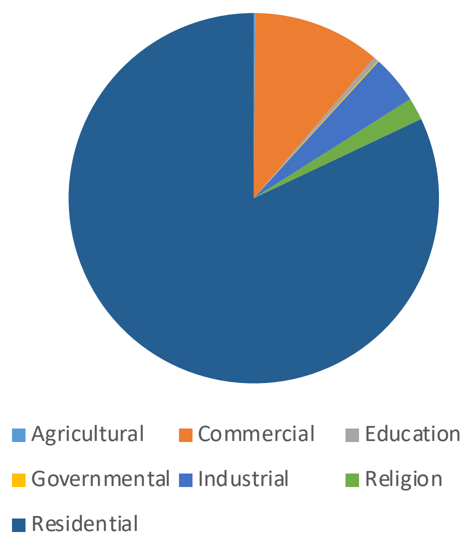


Figure 4-24: Census Block Building and Content Exposure Values

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4.3.4 Hazard Specific Vulnerability

The Disaster Mitigation Act regulations require that the City of Grand Terrace evaluate the risks associated with each of the hazards identified in the planning process. This section summarizes the possible impacts and quantifies, where data permits, the City's vulnerability to each of the priority hazards identified in the hazard profiles. The hazards evaluated as part of this vulnerability assessment include:

- Earthquake
- Flood
- Landslides
- Climate Change
- Wildfire

An estimate of the vulnerability of the City to each identified hazard, in addition to the estimate of risk of future occurrence, is provided in each of the hazard-specific sections that follow. Vulnerability is measured in general, qualitative terms and is a summary of the potential impact based on past occurrences, geographic extent, and damage and casualty potential.

Vulnerability can be quantified in those instances where there is a known, identified hazard area, such as a mapped floodplain. In these instances, the numbers and types of buildings subject to the identified hazard can be inventoried and their values tabulated. Other information can be collected in regard to the hazard area, such as the location of critical community facilities, historic structures, and valued natural resources. Together, this information conveys the vulnerability of that area to a hazard.

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4.3.4.1 Earthquake

Major Impacts from earthquakes are primarily the probable number of casualties and damage to infrastructure occurring from ground movement along a particular fault (USGS, 2009). The degree of infrastructure damage depends on the magnitude, focal depth, distance from fault, duration of shaking, type of surface deposits, presence of high groundwater, topography, and the design, type, and quality of infrastructure construction.

The most recent earthquake (above 4.0 magnitude) in the region was the 4.4 magnitude Banning earthquake. The earthquake was most likely not felt in Grand Terrace, and no damage or injuries were reported.

To analyze the risk to Grand Terrace residents, the Great Shakeout Scenario was performed at a magnitude of 7.8. The hazard foot prints for this scenario were used to develop exposure results for population, critical facilities, and single family residential parcel values. FEMA Hazus analyses was used to conducted loss estimation and include building and content loss estimation results based on peak ground acceleration, peak ground velocity, and peak spectral acceleration.

Building codes provide one of the best methods of addressing natural hazards. When properly designed and constructed according to code, the average building can withstand many of the impacts of natural hazards. Hazard protection standards for all new and improved or repaired buildings can be incorporated into the local building code to reduce future flood losses. It is important to note that the City of Grand Terrace has adopted California's 2016 Building Code standards (Volumes 1, 2).

Manufactured or mobile homes are often not regulated by local building codes. They do have to meet construction standards set by the U.S. Department of Housing and Urban Development that apply uniformly across the country. However local jurisdictions may regulate the location of these structures and their on-site installation.

4.3.4.1.1 Population at Risk

According to the 2010 US Census, the population of Grand Terrace is 12,040. Depending on the time of day (the population differs based on employment opportunities) and exact location of the modeled epicenter, the earthquake scenario performed could be experienced differently. The results from the Great Shakeout scenario are illustrated in Figure 4-24. In this scenario, 53 people would experience severe shaking and 11,979 people would experience violent shaking.

Population Exposure

Population Count by The Great Shakeout EQ Shake Severity Zone

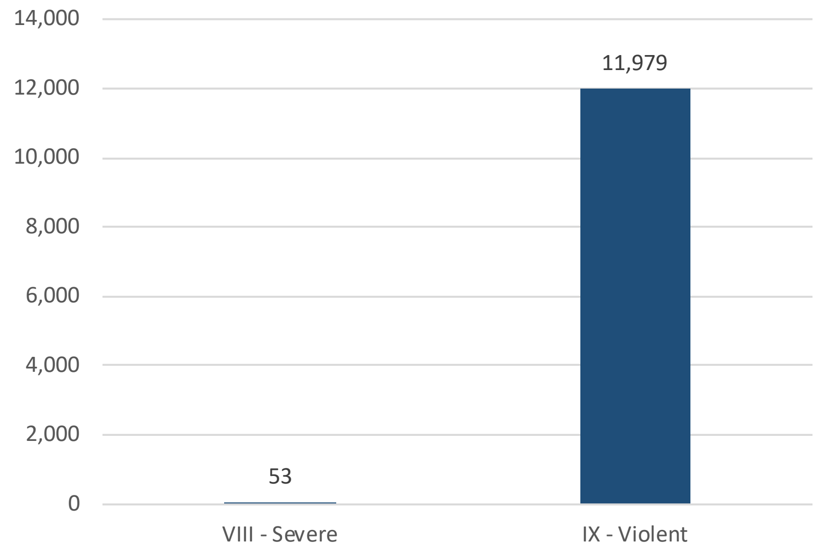


Figure 4-25: Population Exposure to the Great Shakeout EQ Shake Severity Zones

4.3.4.1.2 General Building Vulnerability

One of the key issues that must be addressed in an earthquake vulnerability assessment is the determination of (1) the year in which seismic codes were initially adopted and enforced by the jurisdiction having authority, and (2) the year in which significantly improved seismic codes were adopted and enforced, otherwise known as the benchmark year. The City adheres to the 2016 California Building Code. Table 4-14 provides a listing of code improvements for the City of Grand Terrace. Benchmark years are indicated in bold. For reference, Table 4-15 provides the definitions of the building types listed in Table 4-14.

Table 4-14: Seismic Benchmark Years

Code Edition	Effective Date	Adoption Ordinance (s)	Building Type
(2016 CBC)	January 1, 2016		
(2013 CBC)	January 1, 2014	2013-0048	N/A
(2012 IBC)			
(2010 CBC)	January 1, 2011	2010-0053	N/A
(2009 IBC)			
(2007 CBC)	January 1, 2008	2007-0108	N/A
(2006 IBC)			
(2001 CBC)	November 1, 2002	2002-0076	N/A
(1997 UBC)			
(1998 CBC)	**July 1, 1999**	**99-0040**	**W1a, S2, S2a, RM1, PC1, PC1a**
(1997 UBC)			
(1994 UBC)	**January 7, 1996**	**95-0064**	**S1, S1a, C1, C2, C2a, RM2**
(1991 UBC)	**November 29, 1992**	**92-0114**	**URM**
(1988 UBC)	**April 29, 1990**	**90-0045**	**S2 & S2a**
(1985 UBC)	November 8, 1987	87-0177	N/A

Code Edition	Effective Date	Adoption Ordinance (s)	Building Type
(1982 UBC)	December 9, 1984	84-0211	N/A
(1979 UBC)	June 21, 1981	12340	N/A
(1976 UBC)	**November 1, 1977**	**11574**	**W1 and W2**
(1973 UBC)	April 13, 1975	11095	N/A
(1970 UBC)	August 29, 1971	10323	N/A
(1967 UBC)	July 12, 1968	9541	N/A
(1964 UBC)	July 1, 1965	8809	N/A
(1961 UBC)	August 17, 1962	8242	N/A
(1958 UBC)	October 1, 1958	7384	N/A
(1955 UBC)	January 1, 1956	6768	N/A
(1955 UBC)	January 1, 1956	6768	N/A
(1946 UBC)	June 18, 1948	5119	N/A
(1943 UBC)	July 13, 1944	4367	N/A
(1940 UBC)	April 4, 1941	3787	N/A
(1937 UBC)	September 10, 1937	2966	N/A
(1930 UBC)	March 20, 1933	2225	N/A

Source: ASCE 41-13

Table 4-15: Definitions of FEMA Building Types

FEMA Building Type	Definition
W1	Wood Light Frame
W1A	Wood Light Frame (multi-unit residence)
W2	Wood Frame (commercial and industrial)
S1	Steel Moment Frames
S2	Steel-braced Frames
S3	Steel Light Frames
S4	Steel Frames with concrete shearwalls
S5	Steel Frames with infill masonry walls
C1	Concrete Moment Frames
C3	Concrete Frames with infill masonry shear walls
C2	Concrete Shear Walls
PC1	Tilt-Up Concrete shear walls
PC2	Precast Concrete Frames with shear walls
RM1	Reinforced Masonry Walls with flexible diaphragms
RM2	Reinforced Masonry Walls with stiff diaphragms
URM	Unreinforced Masonry Bearing Walls

4.3.4.1.3 Residential Parcel Value at Risk

The County's parcel layer was used as the basis for the inventory of improved residential parcels. GIS was used to create centroids, or points, to represent the center of each parcel polygon – this is assumed to be the location of the structure for analysis purposes. The centroids were then overlaid with the shake severity zones to determine the at-risk structures. Only improved parcels greater than $20,000 were analyzed. The analysis indicates residential parcels the chosen scenario will experience similar, but different shaking patterns. The type and year of construction will greatly influence damage for structures subject to similar shaking. Table 4-16 shows the count of at-risk structures and their associated improvement and land exposure values.

Table 4-16: Residential Parcel Value Exposure from Southern California Great Shakeout

Shake Severity Zone	Improved Parcel Count	Improvement Value Exposure ($000)	Land Value Exposure ($000)	Total Exposure ($000)	Percentage of Total Value
VIII - Severe	9	$ 2,364	$ 1,960	$ 4,324	.09%
IX - Violent	3,337	$ 906,039	$ 734,669	$ 1,640,708	.01%
Total	**3,346**	**$ 908,403**	**$ 736,629**	**$ 1,645,032**	**.10%**

Notes:
1- Total Value = $1,269,689,711

4.3.4.1.4 Critical Facilities with Damage Potential

Earthquakes pose numerous risks to critical facilities and infrastructure. Seismic risks, or losses, that are likely to result from exposure to seismic hazards include:

- Casualties (fatalities and injuries).
- Utility outages.
- Economic losses for repair and replacement of critical facilities, roads, buildings, etc.
- Indirect economic losses such as income lost during downtime resulting from damage to private property or public infrastructure.

Roads or bridges that are blocked or damaged can prevent access throughout the area and can isolate residents and emergency service providers needing to reach vulnerable populations or to make repairs.

Linear utilities and transportation routes are vulnerable to rupture and damage during and after a significant earthquake event. The cascading impact of a single failure can have affects across multiple systems and utility sectors. Degrading infrastructure systems and future large earthquakes with epicenters near critical regional infrastructure could result in system outages that last weeks for the most reliable systems, and multiple months for others.

Table 4-17 provides an inventory of critical facility locations (points only) with earthquake exposure for the Great ShakeOut Earthquake Scenario. Depending on "year built", each critical facility presented in the tables may have varying damage potential.

Table 4-17: Critical Facilities with EQ Risk

Critical Infrastructure Exposure

Feature Count by Great ShakeOut EQ Scenario

Infrastructure Type	Very Strong (VII)	Strong Shake Zone (VI)	Total Feature Count
Essential Facility	1	8	9
EOC	-	1	1
Fire Station	-	1	1
Government Facility	-	1	1
Hospital	-	1	1
School	1	4	5
High Potential Loss	-	51	51
Hazmat	-	24	24
Utility-Communication Facility	-	2	2
Utility-Electric Power Facility	-	1	1
Adult Residential Care	-	4	4
Child Care	-	10	10
Foster/Home Care	-	2	2
Senior Care	-	8	8
Transportation and Lifeline	-	6	6
Highway Bridge	-	4	4
Railway Bridge	-	2	2
Grand Total	**1**	**65**	**66**

4.3.4.1.5 HazMat Fixed Facilities

Although earthquakes are low probability events, they produce hazardous materials (HazMat) threats at very high levels when they do occur. Depending on the year built and construction of each facility containing HazMat, earthquake initiated hazardous material releases (EIHR) potential will vary. HazMat contained within masonry or concrete structures built before certain benchmark years reflecting code improvements may be of particular vulnerability.

4.3.4.1.6 Transportation

Earthquake events can significantly impact bridges and overpasses which often provide the only access to some neighborhoods. Since soft soil regions generally follow floodplain boundaries, bridges that cross water courses are considered vulnerable. Since all of the bridges just outside the city limits cross the Santa Ana River, they are at least somewhat vulnerable to earthquakes.

Interstate 215 is a 54.5-mile long north–south Interstate highway in the Inland Empire region of Southern California. It is an auxiliary route of Interstate 15, running from Murrieta to northern San Bernardino. While I-215 connects the city centers of both Riverside and San Bernardino, its parent I-15 runs to the west through Corona and Ontario. As shown in Figure 4-25 there are two I-215 overpasses in the City of Grand Terrace, one at Barton Road and one at Newport Avenue. Key factors in the degree of vulnerability are the bridge/ overpass's age and type of construction which indicate the standards to which the structure was built. Table 4-18 provides a detailed inventory of overpasses in the City, which is in Caltrans District 8.

Figure 4-26: Highway Overpasses in the City of Grand Terrace

Table 4-18: Freeway Overpass Caltrans Inventory

Post-Mile	Bridge/ Overpass Number	Structure Name	Type	Length (m)	Width (m)	Spans	Clear Height1 (m)	Year Built	Permit Rating
_001.31	54 0528	BARTON ROAD OC	204[2]	78.3	16.1	4	4.42	1959	PPPPP[3]
_001.78	54 1294	NEWPORT AVENUE OC	205[4]	56.4	15.5	2	5.56	2014	PPPPP

Notes:
1 The minimum vertical clearance over the traveled way portion of the route in meters.
2204= Concrete, continuous, Tee Beam
3 PPPPP = permit capacity for 5, 7, 9, 11, and 13 axle vehicles.
4 205= Concrete, continuous, Box Beam or Gliders - Multiple

Freeway overpasses provide throughways to significant regional corridors in San Bernardino County. A single overpass failure can severely disrupt travel and emergency access from County public safety and mutual aid from other neighboring public safety districts. The Newport Avenue overpass has undergone seismic safety upgrades, but the Barton Road Overpass has not.

4.3.4.1.7 Public Schools

The Field Act was enacted on April 10, 1933, one month after the Long Beach Earthquake in which many schools were destroyed or suffered major damage. Public school construction has been governed by the Field Act since 1933 and enforced by the Division of the State Architect. In any community, public schools constructed under the Field Act after 1978 are likely to be among the safest buildings in which to experience a major earthquake. The Field Act requires:

- School building construction plans be prepared by qualified California licensed structural engineers and architects;
- Designs and plans be checked by the Division of the State Architect (DSA) for compliance with the Field Act before a contract for construction can be awarded;
- Qualified inspectors, independent of the contractors and hired by the school districts, continuously inspect construction and verify full compliance with plans;
- The responsible architects and/or structural engineers observe the construction periodically and prepare changes to plans (if needed) subject to approval by DSA;
- Architects, engineers, inspectors and contractors file reports, under penalty of perjury, to verify compliance of the construction with the approved plans emphasizing the importance of testing and inspections to achieve seismically safe construction. Any person who violates the provisions or makes any false statement in any verification report or affidavit required pursuant to the Act, is guilty of a felony.

Private schools are not subject to the Field Act and fall solely under the jurisdiction of the local building departments and their requirements. Private schools are covered under the Private Schools Building Act of 1986, with the legislative intent that children attending private schools be afforded life safety protection similar to that of children attending public schools.

In the late 1960s (Section 15516, Appendix X, Education Code, 1968) regulations were put in place to have pre-Field Act (1933) buildings retrofitted, removed from school use or demolished. The Field Act also prohibits use of unreinforced masonry buildings as school buildings. Seismic building standards in general were greatly strengthened after significant damage to buildings was observed, especially in the 1971 San Fernando earthquake. The Field Act regulations in place since 1978 are considered adequate for most public school buildings in most cases.

4.3.4.1.8 Utilities

Linear utilities and transportation infrastructure would likely suffer considerable damage in the event of an earthquake. Due to the amount of infrastructure and sensitivity of utility data, linear utilities are difficult to analyze without further investigation of individual system components. Table 4-19 provides best available linear utility data and it should be assumed that these systems are exposed to breakage and failure.

Table 4-19: Lifelines with EQ Risk

Critical Infrastructure Exposure

Linear Milage by Great ShakeOut EQ Scenario

Facility Type	Severe (VIII)	Violent (IX)	Total Mileage
Transportation and Lifeline	1	53	53
Railway	0	2	2
Roads	0	51	51
Interstate Highway	0	2	2
State / County Highway	0	5	5
Primary Highway	0	0	0
Local Road, Major	0	1	1
Local Road	0	37	37
Other Minor Road	0	3	3
Vehicular Trail	0	3	3
Cul-de-Sac / Traffic Circle	0	0	0
Ramp	0	1	1
Service Road	0	0	0
Total	**1**	**53**	**53**

Water Supply Utilities

The City of Grand Terrace gets its water supply from one provider- Riverside Highland Water Company (Riverside Highland). The supply for Riverside Highland is from 5 separate groundwater basins, 2 of which are aboveground storage tanks located within the City. The Company has 13 wells constructed in the groundwater basins of which 8 wells produce potable water for domestic use, two (2) wells which produce nonpotable water at this time for irrigation purposes (reason for non-potable classification is nitrate which is in excess of State Drinking Water Standards) and three wells dedicated to pump water from the Bunker Hill Basin to lower the groundwater due to encroachment of the water into structures. (Riverside Highland Water Company Urban Water Management Plan, 2010) Riverside Highland is responsible for the reliability of the City's water transmission systems and the capability of the local water storage to meet water needs if outside sources are interrupted. Riverside Highland has not implemented a "Water Shortage Plan," but, has put into place, programs whereby actions will go into effect if a catastrophic interruption, mandatory prohibition or other causes occur. (Riverside Highland Water Company Urban Water Management Plan, 2010)

The California Aqueduct carries water from the Sacramento-San Joaquin Delta to the San Joaquin Valley and Southern California. The Aqueduct has been designed to "break" at the Devil Canyon Powerplant (approx. 13 miles north of Grand Terrace) in the event of a large earthquake. (Upper Santa Ana Integrated Resources Water Management Plan, 2015).

Natural Gas Utilities

The U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) defines natural gas pipelines under two categories, "Transmission" and "Distribution." Transmission pipelines are primarily used to receive gas from suppliers and move it to distribution load centers or to storage facilities.

High Pressure Distribution lines are used to deliver gas to Grand Terrace customers. These pipelines operate at pressures above 60 psi and deliver gas in smaller volumes to the lower pressure distribution system. (SoCalGas Gas Transmission and High Pressure Distribution Pipeline Interactive Map, n.d.)

Several common characteristics of earthquakes and their impacts on natural gas safety are:

1. Earthquake ground shaking will generally lead to substantially more instances of building damage than fire ignitions.
2. Ground motions that are sufficient enough to damage buildings are the most likely to impact utility and customer gas systems and create a potential for gas-related fire ignitions.
3. The number of post-earthquake fire ignitions related to natural gas can be expected to be 20% to 50% of the total post-earthquake fire ignitions.
4. The consequences of post-earthquake fire ignitions for residential gas customers are largely financial. A fire ignition only becomes a life safety concern when inhabitants are unable to exit the building following earthquakes. Experience in past earthquakes indicates that egress from earthquake damaged single-family homes is generally possible because of the limited structure height, low numbers of occupants, and multiple direct escape paths through doors and windows.
5. The potential life safety dangers from post-earthquake fires are considerably more serious in seismically vulnerable apartment or condominium buildings since they provide a greater chance for damaging the structure and trapping the occupants.

Southern California Gas Company (SoCal Gas), Grand Terrace's natural gas utility, is responsible for designing, constructing, maintaining, and operating the natural gas system safely and efficiently. This includes all the facilities used in the delivery of gas to any customer up to and including the point of delivery to the customers' gas piping system. SoCal Gas provides seismic safety through compliance with existing regulations, coordinating their emergency planning with local governments, and incorporating earthquake-resistant design considerations into their maintenance activities and new construction.

Gas customers and Grand Terrace residents are responsible for using gas safely on their property and within their buildings and other facilities. Customers meet this responsibility by maintaining their gas appliances in good working condition, assuring that only qualified individuals are engaged to modify or maintain their gas service and facility piping, and knowing what to do before and after earthquakes to maintain the safe operation of their natural gas service.

The following conditions, when combined, pose the greatest risk for severe post-earthquake fire damage:

1. Buildings are unoccupied and individuals are not present to mitigate damage to gas systems or control small fires.
2. High building density or dense, fire-prone vegetation.
3. High wind and low humidity weather conditions.
4. Damage to water systems that severely limits firefighting capabilities.
5. Reduced responsiveness of firefighting resulting from impaired communications, numerous requests for assistance, direct damage to fire stations, restricted access because of traffic congestion and damaged roadways, and delays in mutual aid from neighboring fire districts.

4.3.4.1.9 Loss Estimation Results

The Hazus Level 2 analysis was used to assess the risk from and vulnerability to earthquake shaking within Grand Terrace. Hazus buildings data is aggregated to the census tract level for earthquake models, known as the general building stock (GBS), which has a level of accuracy acceptable for planning purposes. The following sections describe risk to and vulnerability of the GBS within the City. Hazus calculates losses to structures from earthquake shaking by considering the amount of ground displacement and type of structure. The software estimates the percentage of damage to structures and their contents by applying established building fragility curves. Damage estimates are then translated to estimated dollar losses.

For the Great Shake Out Scenario ground shaking data (shakemaps) were acquired from CISN and imported into Hazus. The shakemap data consist of peak ground velocity, peak ground acceleration, peak spectral acceleration at 0.3 seconds, and peak spectral acceleration at 1.0 seconds. The earthquake module operates on census tracts that often include population and structures in the incorporated cities and the unincorporated area within a single tract. Due to this fact the results include census tracts that have a substantial portion of land within the incorporated area (loss estimates for some tracts will include structures in incorporated cities).

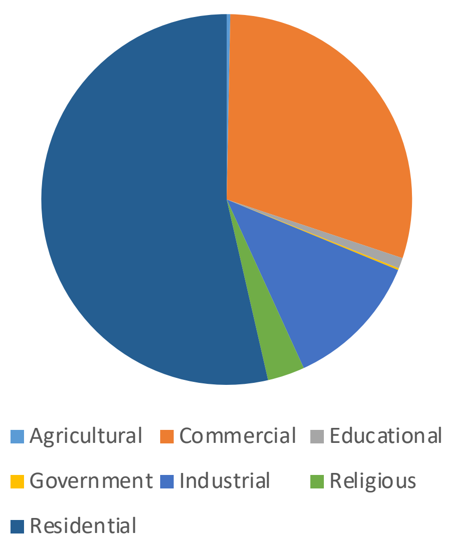
The loss estimation results are summarized in Table 4-20 for the Great Shake Out Scenario. It is important to understand that the Hazus earthquake module uses the census tract as its enumeration unit rather than the more detailed census block. The loss estimation values for earthquakes are much higher than those of the flooding due to this fact. The portions of incorporated areas included within boundary census tracts elevate the values due to the inclusion of additional GBS. Though the difference between census tracts and census blocks are extremely disparate, the most important summary information is the percent of loss estimation against the total value. Reading from Table 4-20, residential building and content loss estimation from the Great Shake Out Scenario is $424,845,000 and 11.4 percent of the total value of the residential buildings. In the Great Shake Out Scenario, residential damage will be the greatest. While there are several limitations to the FEMA Hazus model, it does allow for potential loss estimation. It is important to remember that the replacement costs are well below actual market values, thus, the actual value of assets at risk may be significantly higher than those included herein.

Table 4-20: Earthquake Building and Content Loss Estimation

Building Type	Building Replacement Costs ($000)	Building Replacement Cost (% of Total Value)	Content Replacement Cost ($000)	Content Replacement Cost (% of Total Value)	Total Estimated Loss ($000)	Total Loss Estimation (% of Total Value)	Total Value ($000)
Agricultural	$ 1,048	13.1%	$ 344	4.3%	$ 1,393	17.4%	$ 8,014
Commercial	$ 99,964	14.4%	$ 30,713	4.4%	$ 130,677	18.8%	$ 695,118
Educational	$ 3,130	10.3%	$ 899	3.0%	$ 4,029	13.3%	$ 30,312
Government	$ 518	15.4%	$ 155	4.6%	$ 674	20.0%	$ 3,374
Industrial	$ 40,098	13.8%	$ 19,262	6.6%	$ 59,360	20.4%	$ 291,364
Religious	$ 10,864	12.8%	$ 3,211	3.8%	$ 14,075	16.6%	$ 84,686
Residential	$ 179,648	6.9%	$ 34,990	1.3%	$ 214,638	8.2%	$ 2,605,667
Grand Total	**$ 335,271**	**9.0%**	**$ 89,574**	**2.4%**	**$ 424,845**	**11.4%**	**$ 3,718,535**

Total Building Loss by Occupancy

Census Tract Level



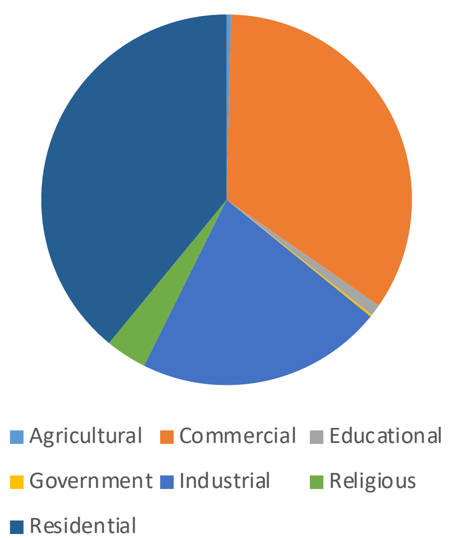


Figure 4-27: Census Tract Building and Content Loss Values by Occupancy Type

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4.3.4.2 Landslide

Both the mountainous eastern portion of the City and the area west of I-215 have a medium to high susceptibility to landslides. The steepest slopes are found to the east and northeast of the City suggesting a greater susceptibility to landslides in these areas.

Human activities that contribute to landslide events include altering the natural slope gradient, increasing soil water content, and removing vegetative cover. The best available predictor of where landsides may occur is the location of previous occurrences. In addition, landslides are most likely to occur during severe weather events. The ground must be saturated prior to the onset of a severe weather event for a significant landslide to occur.

4.3.4.2.1 Population at Risk

Landslide risk is of greatest concern to populations residing in the high landslide susceptibility zones (see Figure 4-27). Blue Mountain, one of the City's most vulnerable areas, was damaged during a fire in the summer of 2006. The resulting loss of vegetation and the migration of debris make this area even more susceptible to landslides. Grand Terrace has 250 residents living in the high susceptibility zone.

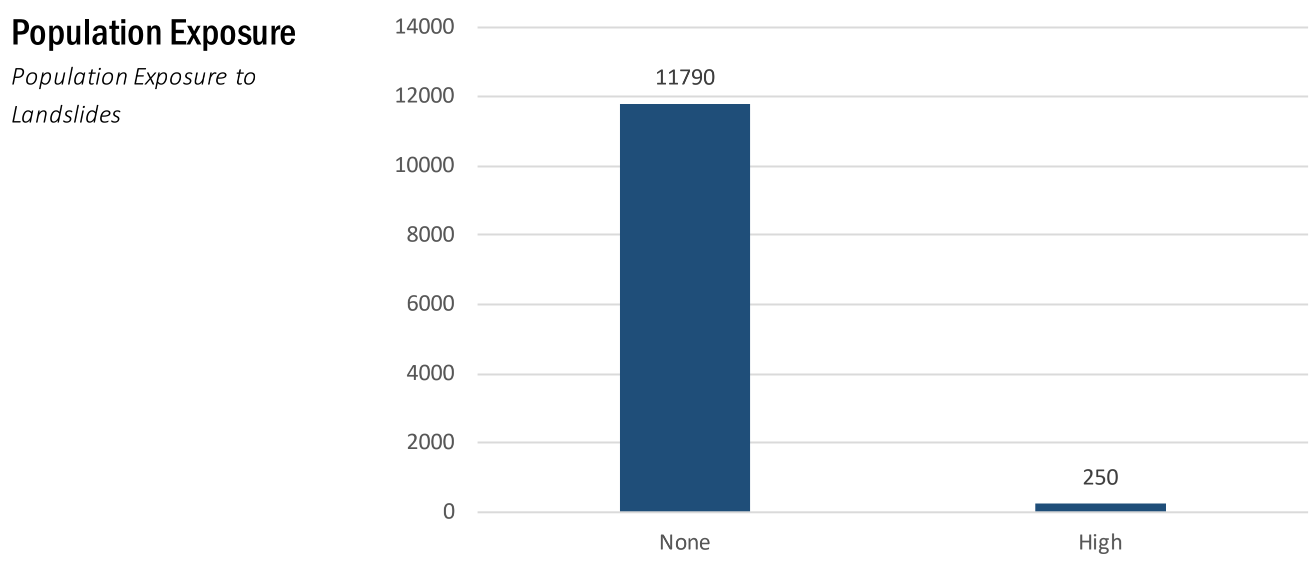

Figure 4-28: Population Exposure to Landslides

4.3.4.2.2 Residential Parcel Value at Risk

The County's parcel layer was used as the basis for the inventory of improved residential parcels. In some cases, a parcel will be within in multiple landslide hazard zones. GIS was used to create centroids, or points, to represent the center of each parcel polygon – this is assumed to be the location of the structure for analysis purposes. The centroids were then overlaid with the landslide threat layer to determine the risk for each structure. The landslide threat zone in which the centroid was located was assigned to the entire parcel. This methodology assumed that every parcel with a square footage value greater than zero was developed or improved with a structure. Only improved parcels were analyzed. Table 4-21 exhibits the improved parcels within Grand Terrace that have significant assets at risk to landslides in the High landslide hazard zone.

Table 4-21: Improved Residential Parcel Exposure

Landslide Risk	Improved Parcel Count	Improvement Value Exposure ($000)	Land Value Exposure ($000)	Total Exposure ($000)	Percentage of Total Value
High	58	$ 10,830	$ 3,822	$ 14,652	.10%

Notes:

1- Total Value = $14,651,847

4.3.4.2.3 Critical Facilities at Risk

Critical facilities data were overlain with landslide hazard severity zone data to determine the type and number of facilities within each risk classification. The City of Grand Terrace does not have any critical facilities (essential facilities and high potential loss) in the High landslide hazard zone. The City has one local road in the High landslide hazard zone, as shown in Table 4-22.

Table 4-22: Transportation and Lifelines with Landslide Risk

Critical Infrastructure Exposure

Linear Mileage of Transportation Infrastructure and Lifelines by Landslide Hazard Zone

Facility Type	Total Mileage
Transportation and Lifeline	1
Railway	0
Roads	1
Interstate Highway	0
State / County Highway	0
Local Road, Major	0
Local Road	1
Other Minor Road	0
Vehicular Trail	0
Grand Total	**1**

4.3.4.3 Wildfire

Risk to the City of Grand Terrace from wildfire is a significant concern. Steep hills and clusters of vegetation bordered by residential zones creates the potential for both natural and human-caused fires that can result in loss of life and property. In addition, high temperatures, low humidity, and clear sunny days characterize summer months. Thunderstorms from July through September can create lightning strikes, erratic high winds and, sometimes, heavy rains.

Potential losses from wildfire include human life, structures and other improvements, natural and cultural resources, quality and quantity of water supplies, cropland, timber, and recreational opportunities. Short and long-term economic losses could also result due to loss of business and other economic drivers. Smoke and air pollution from wildfires can be a severe health hazard. In addition, catastrophic wildfire can create favorable conditions for other hazards such as flooding, landslides, and erosion during the rainy season.

Generally, there are three major factors that sustain wildfires and predict a given area's potential vulnerability to burn. These factors are fuel, topography, and weather.

- Fuel – Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is generally classified by type and volume. Fuel sources are diverse and include everything from dead tree leaves, twigs, and branches, to dead standing trees, live trees, brush, and cured grasses. Manmade structures are also considered a fuel source, such as homes and other associated combustibles. The type of prevalent fuel directly influences the behavior of wildfire. Fuel is the only factor that is under human control. Residential developments in the east, northeast and a small part of the western region (in the mountains and foothills) currently possess the highest vulnerability to wildfire. Great measures have been taken to mitigate wildfire when new development has been constructed. Fire prevention strategies also focus on educating the public and enforcement of fire codes. Nevertheless, these high fuel hazards, coupled with a greater potential for ignitions, increase the susceptibility of the City to a catastrophic wildfire.
- Topography – An area's terrain and slope affect its susceptibility to wildfire spread. Both fire intensity and rate of spread increase as slope increases due to the tendency of heat from a fire to rise via convection. The arrangement of vegetation throughout a hillside can also contribute to increased fire activity on slopes.
- Weather – Weather components such as temperature, relative humidity, wind, and lightning also affect the potential for wildfire. High temperatures and low relative humidity dry out fuels that feed wildfires, creating a situation where fuel will ignite more readily and burn more intensely. Thus, during periods of drought the threat of wildfire increases. Wind is the most treacherous weather factor. The greater the wind, the faster a fire can spread and the more intense it can be. Wind shifts, in addition to wind speed, can occur suddenly due to temperature changes or the interaction of wind with topographical features such as slopes or steep hillsides. As part of a weather system, lightning also ignites wildfires, often in difficult to reach terrain for firefighters.

Factors contributing to the high, widespread wildfire risk in Grand Terrace include:

- Residential landscaping, fencing and outbuildings increase fuel loading, spotting and fire intensity.
- Nature and frequency of ignitions; and increasing population density leading to more ignitions.

- Slope of the foothills;
- Residential development along the foothills;

The City of Grand Terrace contracts with San Bernardino County Fire for fire and rescue services. Fire Station 23 consists of both paid and volunteer staffing. Fire prevention strategies concentrate on free household hazardous waste disposal.

4.3.4.3.1 Population at Risk

Wildfire is of greatest concern to populations residing in the moderate, high and very high fire hazard severity zones. U.S. Census Bureau block data was used to estimate populations within the Cal Fire identified hazard zones. As seen in Figure 4-28 nearly 1,600 residents live in areas considered to be very high risk to wildfires, 1,070 reside in high risk areas and almost 1,200 reside in moderate risk areas.

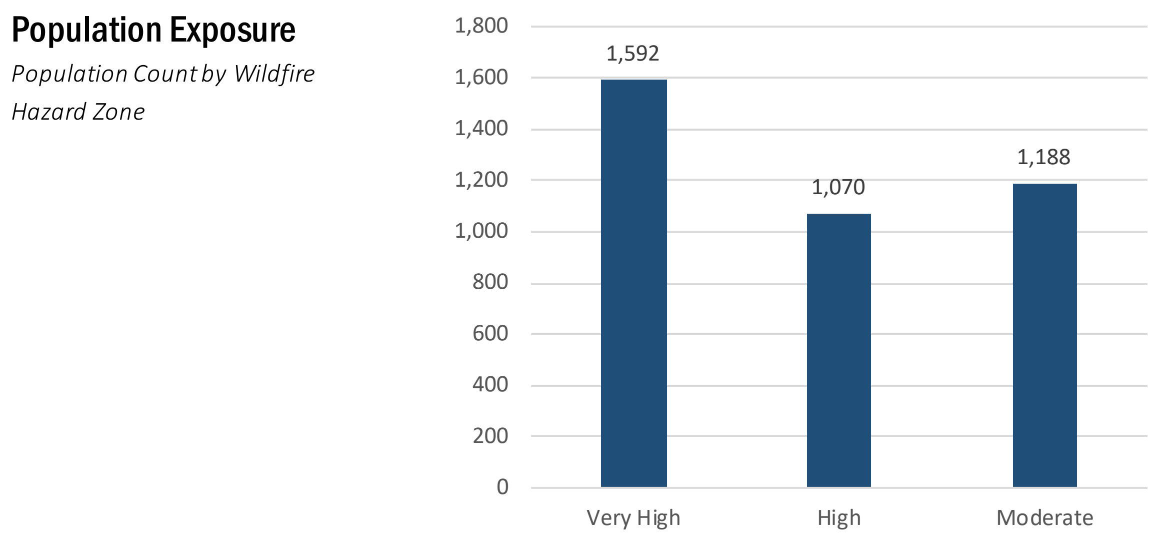

Figure 4-29: Population at risk from wildfire hazards

4.3.4.3.2 Residential Parcel Value at Risk

The County's parcel layer was used as the basis for the inventory of improved residential parcels. In some cases, a parcel will be within in multiple fire threat zones. GIS was used to create centroids, or points, to represent the center of each parcel polygon – this is assumed to be the location of the structure for analysis purposes. The centroids were then overlaid with the fire threat layer to determine the risk for each structure. The fire threat zone in which the centroid was located was assigned to the entire parcel. This methodology assumed that every parcel with a square footage value greater than zero was developed in some way. Only improved parcels were analyzed. Table 4-23 exhibits the portions of Grand Terrace that have significant assets at risk to wildfire in the moderate, high and very high fire severity zones.

Table 4-23: Residential Buildings and Content within Cal Fire Wildfire Severity Zones

Fire Hazard Severity Hazard Zone	Improved Parcel Count	Improvement Value Exposure ($000)	Land Value Exposure ($000)	Total Exposure ($000)	Percentage of Total Value
Very High	497	$ 101,158	$ 35,001	$ 136,158	.01%
High	351	$ 72,383	$ 21,876	$ 94,258	.01%
Moderate	333	$ 73,691	$ 24,795	$ 98,486	.01%
Urban Unzoned	2,165	$ 661,172	$ 654,957	$ 1,316,129	.08%
Total	**3,346**	**$ 908,403**	**$ 736,629**	**$ 1,645,032**	**.10%**

Notes:

1. Total Value= $1,645,031,682

4.3.4.3.3 Critical Facilities at Risk

Critical facilities data were overlain with fire hazard severity zone data to determine the type and number of facilities within each risk classification. Table 4-24 and Table 4-25 list the critical facilities in the high and very high wildfire hazard zones for Grand Terrace.

Table 4-24: Critical Facility Exposure to Wildfire

Critical Infrastructure Exposure

Feature Count by Wildfire Hazard Zone

Infrastructure Type	High	Very High	Total Feature Count
Essential Facility	0	1	1
EOC	0	0	0
Fire Station	0	0	0
Government Facility	0	0	0
Hospital	0	0	0
Police Station	0	0	0
School	0	1	1
High Potential Loss	6	4	10
Dam	0	0	0
Economic Element-Major Employer	0	0	0
Hazardous Material	4	2	6
Historic/Cultural Resource-Historic	0	0	0
Utility-Communication Facility	0	1	1
Utility-Electric Power Facility	0	0	0
Utility-Natural Gas Facility	0	0	0
Utility-Potable Water Facility	0	0	0
Utility-Waste Water Facility	0	0	0
Vulnerable Population-Adult Residential Care	1	0	1
Vulnerable Population-Child Care	0	1	1
Vulnerable Population-Flood Zone	0	0	0
Vulnerable Population-Foster/Home Care	1	0	1
Vulnerable Population-Mobile Home Park	0	0	0
Vulnerable Population-RV Park	0	0	0
Vulnerable Population-Senior Care	0	0	0
Transportation and Lifeline	2	0	2
Highway Bridge	0	0	0
Railway Bridge	2	0	2
Bus Facility	0	0	0
Rail Facility	0	0	0
Airport Facility	0	0	0
Grand Total	**8**	**5**	**13**

Table 4-25: Lifelines with Wildfire Risk

Critical Infrastructure Exposure

Linear Mileage by Wildfire Hazard Zone

Facility Type	High	Very High	Total Mileage
Transportation and Lifeline	6	11	17
Railway	0	**-**	0
Roads	5	**11**	17
Interstate Highway	0	-	0
State / County Highway	1	1	1
Local Road, Major	0	1	1
Local Road	4	6	11
Other Minor Road	0	0	1
Vehicular Trail	-	3	3
Grand Total	**6**	**11**	**17**

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4.3.4.4 Flood

Flooding is a significant problem in Grand Terrace as described in the flood hazard profile. While the majority of the City is elevated above the floodplain, the northwestern portion that borders the Santa Ana River is located in the 100-year flood zone. Localized flooding occurs often throughout the City due to drainage issues. All of Pico St floods frequently during rain events, trapping residents. In urban areas, the increase in paved areas associated with new development decrease the amount of open land available to absorb rainfall and runoff, thus increasing the volume of water that must be carried away from by waterways.

4.3.4.4.1 Population at Risk

Of greatest concern in the event of a flood is the potential for loss of life. Using 2012 population data aggregated by census blocks, an estimate was made of the population exposed to the 100- and 500-year floodplain. To account for census blocks that were partially within the floodplain, a weighted average was employed to calculate the proportion of the population within the floodplain. The results of the population overlay are shown in Figure 4-29. There are 10 people living in the 100-Year Floodplain and 1 living in the 500-Year Floodplain.

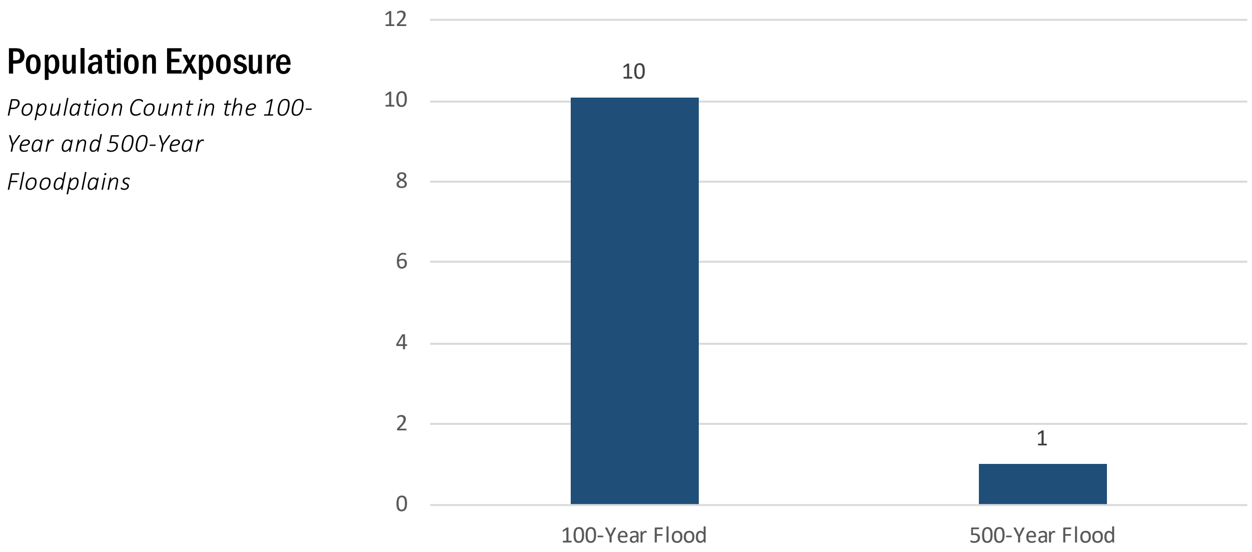


Figure 4-30: Population Exposure to Flood

4.3.4.4.2 Residential Parcel Value at Risk

The County's parcel layer was used as the basis for the inventory of improved residential parcels within the FEMA NFIP flood zones. In some cases, a parcel will be within in multiple flood zones. GIS was used to create centroids, or points, to represent the center of each parcel polygon – this is assumed to be the location of the structure for analysis purposes. The centroids were then overlaid with the floodplain layer to determine the flood risk for each structure. The flood zone in which the centroid was located was assigned to the entire parcel. This methodology assumed that every parcel with a square footage value greater than zero was developed in some way. Only improved parcels greater than $20,000 were analyzed. Table 4-26 shows the count of at-risk parcels and their improvement and land exposure values.

Table 4-26: Parcels Exposed to NFIP Flood Zones

Flood Hazard Zone	Improved Parcel Count	Improvement Value Exposure ($000)	Land Value Exposure ($000)	Total Exposure ($000)	Percentage of Total Value
100-Year Flood	2	$ 94	$ 246	$ 340	.03%
500-Year Flood	1	$ 196	$ 494	$ 690	.07%
Grand Total	**3**	**$ 290**	**$ 740**	**$ 1,030**	**.10%**

Notes:

1- *The table above does not display loss estimation results; the table exhibits total value at risk based upon the hazard overlay and San Bernardino County Assessor data.*
2- *Parcel information is for all county parcels with greater than $20,000 in assess parcel improvement value only. The San Bernardino County Assessor's roles only provide spatial information on assessed improvement and land values.*
3- *Total Value = $1,029,670*

While there are several limitations to this methodology, it does allow for potential loss estimation. It should be noted that the analysis may include structures in the floodplain that are elevated at or above the level of the base flood elevation, which will likely decrease potential flood damage to these particular structures. Also, it is important to remember that the replacement costs are well below actual market values; thus, the actual value of assets at risk may be significantly higher than those included herein.

4.3.4.4.3 Critical Facilities Exposure

Critical facilities data were overlain with flood hazard data to determine the type and number of facilities within the 100- and 500-year floodplain. Flooding poses numerous risks to critical facilities and infrastructure:

- Roads or bridges that are blocked or damaged can prevent access throughout the area and can isolate residents and emergency service providers needing to reach vulnerable populations or to make repairs.
- Creek or river floodwaters can back up drainage systems causing localized flooding.
- Floodwaters can get into drinking water supplies causing contamination.
- Sewer systems can be backed up causing waste to spill into homes, neighborhoods, rivers, and streams.
- Underground utilities can also be damaged.

There are no critical facilities (essential facilities and high potential loss) in the floodplain in Grand Terrace. There is one mile of local road that is in the 100 year flood zone, as seen in Table 4-27.

Table 4-27: Lifeline Exposure to NFIP Flood Zones

Population Exposure

Population Count in the 100-Year and 500-Year Floodplains

Facility Type	100 Year	500 Year Flood Zone	500 Year Flood Zone, Protected by Levee	Total Mileage
Transportation and Lifeline	1	0	0	1
Railway	0	0	0	0
Roads	0	0	0	1
Interstate Highway	0	0	0	0
State / County Highway	0	0	0	0
Primary Highway	0	0	0	0

Local Road, Major	0	0	0	0
Local Road	0	0	0	1
Other Minor Road	0	0	0	0
Vehicular Trail	0	0	0	0
Cul-de-Sac / Traffic Circle	0	0	0	0
Ramp	0	0	0	0
Service Road	0	0	0	0
Total	**1**	**0**	**0**	**1**

4.3.4.4.4 Loss Estimation Results

The Hazus analysis was used to assess the risk from and vulnerability to flooding within the City. Hazus buildings data is aggregated to the census block level, known as the general building stock (GBS), which has a level of accuracy acceptable for hazard mitigation planning purposes. The following sections describe risk to and vulnerability of the GBS within the city's mapped regulatory floodplain. The total value of exposed buildings and content within the city's planning area was generated using Hazus and is previously summarized in Table 4-13.

Hazus calculates losses to structures from flooding by considering the depth of flooding and type of structure. Using historical flood insurance claim data, the software estimates the percentage of damage to structures and their contents by applying established depth-damage curves. Damage estimates are then translated to estimated dollar losses. The results are summarized in Table 4-28 and Table 4-29**.** An estimated $11,185,000 of damage could occur in the city's regulatory floodplain if all flooding sources experienced a 100-year flood event. An all-encompassing event (all tributaries flooding to the NFIP 100-year floodzone) is estimated to cause losses of .8 percent of the total GBS within the City boundaries. An estimated $19,340,000 of damage could occur if all flooding sources experienced a 500-year flood event, representing 1.4 percent of the total GBS within the city boundaries.

While there are several limitations to the FEMA Hazus model, it does allow for potential loss estimation. It should be noted that the analysis may include structures in the floodplain that are elevated at or above the level of the base flood elevation, which will likely mitigate flood damage. Also, it is important to remember that the replacement costs are well below actual market values, thus, the actual value of assets at risk may be significantly higher than those included herein.

Table 4-28: Flood Loss Estimation (Based on Depth) in NFIP Flood Zones

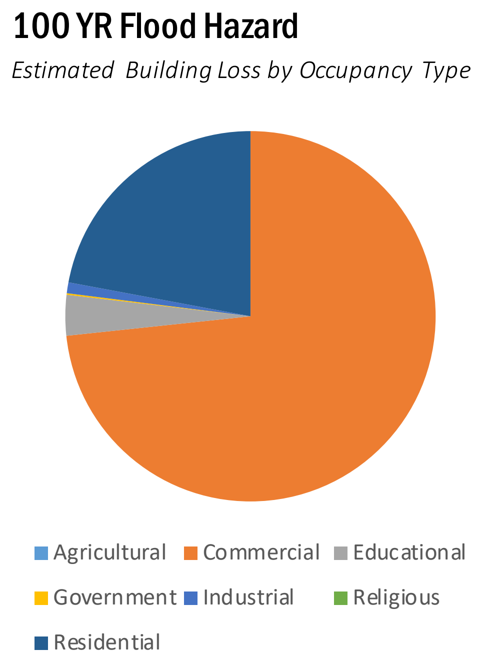
Flood Hazard Zone	Building Loss ($000)	Building Loss (% of Total Value)	Content Loss ($000)	Content Loss (% of Total Value)	Total Estimated Loss ($000)	Total Estimated Loss (% of Total Value)
100-Year	$ 3,703	0.3%	$ 7,159	0.5%	$ 11,185	0.8%
500-Year	$ 5,710	0.4%	$ 13,222	0.9%	$ 19,340	1.4%

*Note: *from Table 4-11 Hazus Census Block Input Values*
1- Hazus Census Block Building Stock Value ($000):
2- Building Replacement Costs = $871,059
3- Content Replacement Cost = $531,344
4- Total Value = $1,402,403

Table 4-29: 100-Year Flood Loss Estimation (Based on Depth) in NFIP Flood Zones by Occupancy Type

Building Type	Building Replacement Costs ($000)	Building Replacement Cost (% of Total Value)	Content Replacement Cost ($000)	Content Replacement Cost (% of Total Value)	Total Estimated Loss ($000)	Total Loss Estimation (% of Total Value)	Total Value ($000)
Agricultural	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ 2,126
Commercial	$ 2,715	1.38%	$ 6,171	3.13%	$ 9,200	4.67%	$ 197,065
Educational	$ 131	1.78%	$ 431	5.86%	$ 566	7.70%	$ 7,350
Government	$ 5	0.30%	$ 16	0.94%	$ 21	1.24%	$ 1,694
Industrial	$ 35	0.04%	$ 62	0.07%	$ 102	0.12%	$ 88,293
Religious	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ 34,036
Residential	$ 817	0.08%	$ 479	0.04%	$ 1,296	0.12%	$ 1,071,839
Grand Total	**$ 3,703**	**0.26%**	**$ 7,159**	**0.51%**	**$ 11,185**	**0.80%**	**$ 1,402,403**

*Note: *from Table 4-11 Hazus Census Block Input Values*
1- Hazus Census Block Building Stock Value ($000):
2- Building Replacement Costs = $871,059
3- Content Replacement Cost = $531,344
4- Total Value = $1,402,403



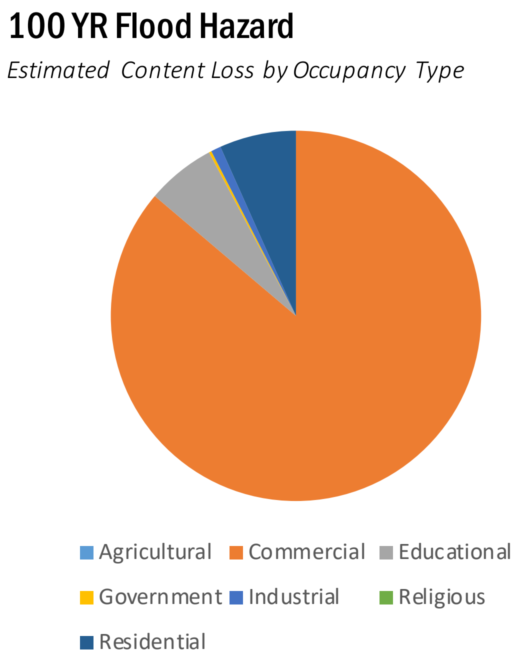
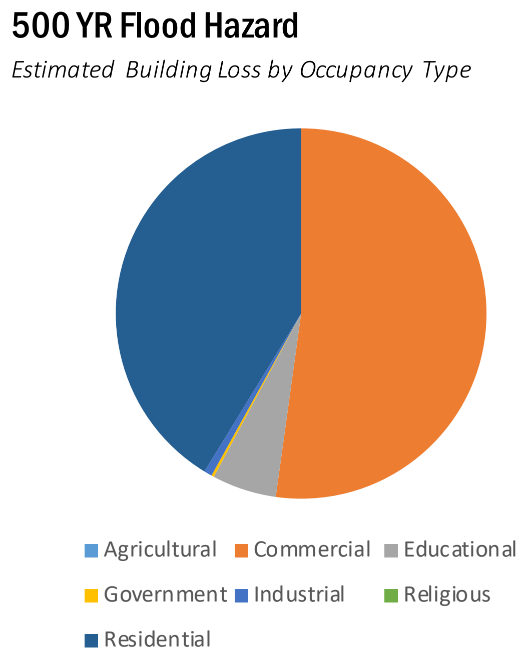


Figure 4-31: Total Building and Content Loss by Occupancy Type

Table 4-30: 500-Year Flood Loss Estimation (Based on Depth) in NFIP Flood Zones by Occupancy Type

Building Type	Building Replacement Costs ($000)	Building Replacement Cost (% of Total Value)	Content Replacement Cost ($000)	Content Replacement Cost (% of Total Value)	Total Estimated Loss ($000)	Total Loss Estimation (% of Total Value)	Total Value ($000)
Agricultural	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ 2,126
Commercial	$ 2980	1.51%	$ 10,245	5.20%	$ 13,591	6.90%	$ 197,065
Educational	$ 321	4.37%	$ 1,430	19.46%	$ 1,781	24.23%	$ 7,350
Government	$ 13	0.77%	$ 62	3.66%	$ 77	4.55%	$ 1,694
Industrial	$ 40	0.05%	$ 105	0.12%	$ 151	0.17%	$ 88,293
Religious	$ -	0.00%	$ -	0.00%	$ -	0.00%	$ 34,036
Residential	$ 2,356	0.22%	$ 1,380	0.13%	$ 3,740	0.35%	$ 1,071,839
Grand Total	**$ 5,710**	**0.00%**	**$ 13,222**	**0.94%**	**$ 19,340**	**1.38%**	**$ 1,402,403**

*Note: *from Table 4-11 Hazus Census Block Input Values*
1- Hazus Census Block Building Stock Value ($000):
2- Building Replacement Costs = $871,059
3- Content Replacement Cost = $531,344
4- Total Value = $1,402,403



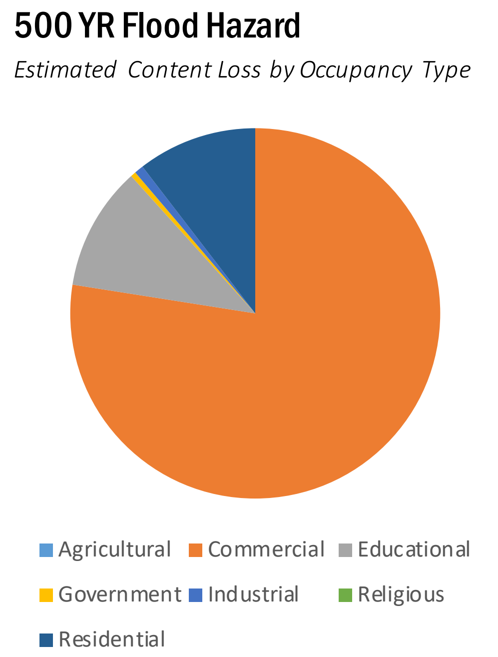


Figure 4-32: Total Building and Content Loss by Occupancy Type

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4.3.4.5 Climate Change

4.3.4.5.1 Population at Risk

The effects of climate change are not limited or defined by geographical borders. Every resident of Grand Terrace is at risk to the impacts of climate change.

Vulnerable populations should receive special attention when assessing the community's vulnerability to climate change. For example, care and sheltering during extreme heat conditions must be provided for vulnerable populations such as the elderly. The City center has the largest concentration of people age 65 or older. According to information provided by FEMA, extreme heat is defined as temperatures that hover 10 degrees or more above the average high temperature for the region and last for several weeks. Heat kills by taxing the human body beyond its abilities. In a normal year, about 175 Americans succumb to the demands of summer heat. According to the National Weather Service (NWS), among natural hazards, only the cold of winter—not lightning, hurricanes, tornados, floods, or earthquakes—takes a greater toll. In the 40-year period from 1936 through 1975, nearly 20,000 people were killed in the United States by the effects of heat and solar radiation. In the heat wave of 1980, more than 1,250 people died.

Since climate change can exacerbate other hazards, consideration should also be given to populations living in high hazard wildfire and flood zones. Drought caused by climate change will also affect the entire population. Agricultural yields will suffer and drier vegetation creates more fuel for wildfires.

4.3.4.5.2 Critical Facilities

The location of infrastructure, its current condition and its susceptibility to climate impacts are important factors to consider when accessing the vulnerability of critical facilities to climate change.

Infrastructure provides the resources and services critical to community function. Roads, rail, water (pipes, canals, and dams), waste (sewer, storm, and solid waste), electricity, gas, and communication systems are all needed for community function. Climate change increases the likelihood of both delays and failures of infrastructure. Delays and failures can result from climate-exacerbated hazards such as flooding, fire, or landslide, as well as increased demand, load, or stress on infrastructure systems that can result from climate change (e.g., heat impacts on roadway durability). Temporary delays or outages can result in inconvenience and economic loss, while larger failures can lead to disastrous economic and social effects. (California Adaptation Planning Guide)

Three to five more heat waves will be experienced by 2050, increasing to 12 to 16 in the western parts of the region to more than 18 to 20 in the eastern parts of the region. The age and construction method of essential facilities, transportation systems, lifeline utility systems, high potential loss facilities and hazardous material facilities will determine how they stand up to the effects of climate change such as extreme heat days.

For example, the City Manager's Office will offer to provide emergency shelter at City Hall and the City Yard during times of extreme weather or hardship. (City of Grand Terrace General Plan, 2010) In the event of a heat wave or extreme heat day, the air conditioning and cooling capability of the building will play a critical role in the facility's ability to act as a cooling center for the community.

4.3.4.5.3 Loss Estimation Results

Climate Change can potentially affect critical infrastructure in a variety of ways.

- **Temperature and heat waves:** Heat can stress infrastructure, altering maintenance needs, particularly for roadways.
- **Precipitation, intense rainstorms, and landslide:** Increased frequency of landslides could be seen throughout the City, especially in areas already identified as high risk (Blue Mountain, La Loma Ridge, Vivienda Ave, Pico Ave and Barton Rd.).
- **Snowpack:** Melting snow on Blue Mountain could cause increased flooding, erosion and landslides.
- **Wildfire:** Dry vegetation as a result of high heat can increase the risk of wildfire on Blue Mountain.

4.4 Summary of Spatial Hazards

Hazards with spatial components can be evaluated with side-by-side comparison. At-risk populations, critical infrastructure, improved parcels, and loss results for each hazard category are provided in this summary section. The side-by-side comparison allows officials to evaluate the impacts of potential hazards to determine what hazards to direct energy and financial resources for mitigation activities.

4.4.1 Population

Figure 4-32 exhibits the amount of Grand Terrace residents living within flood, wildfire, earthquake or landslide hazard areas. For detailed vulnerabilities assessment information on affected populations, see the individual hazard specific sections presented previously in this section.

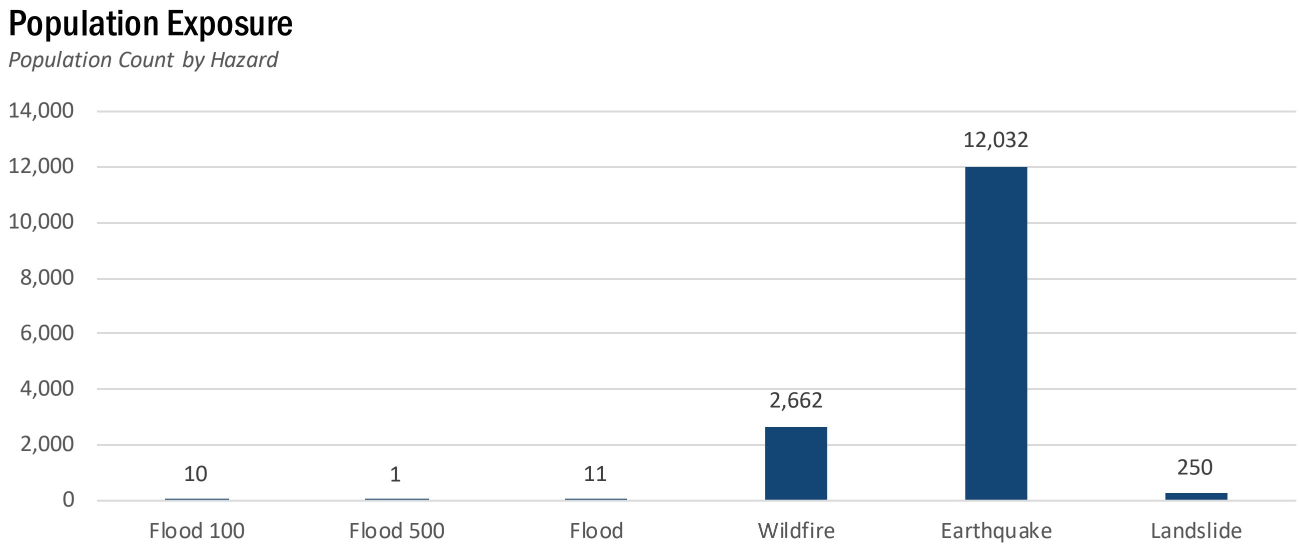


Figure 4-33: Population exposed to flood, wildfire, earthquake, or landslide hazards

Note: The planning team did not estimate or summarize casualties for the other spatial hazards described in this section.

4.4.2 Critical Infrastructure Summary

Critical infrastructure exposure by hazard comparison is provided in Figure 4-33 and Figure 4-34. Figure 4-33 provides a summary of at-risk utilities and transportation routes by miles for each hazard. Figure 4-34 provides a summary of at-risk critical infrastructure points for each hazard. Critical infrastructure points include fire stations, schools, transportation points such as highway bridges, utility points such as communication towers, and facilities that contain HAZMat. For detailed vulnerabilities assessment information on critical infrastructure, see the individual hazard specific sections presented previously in this section.

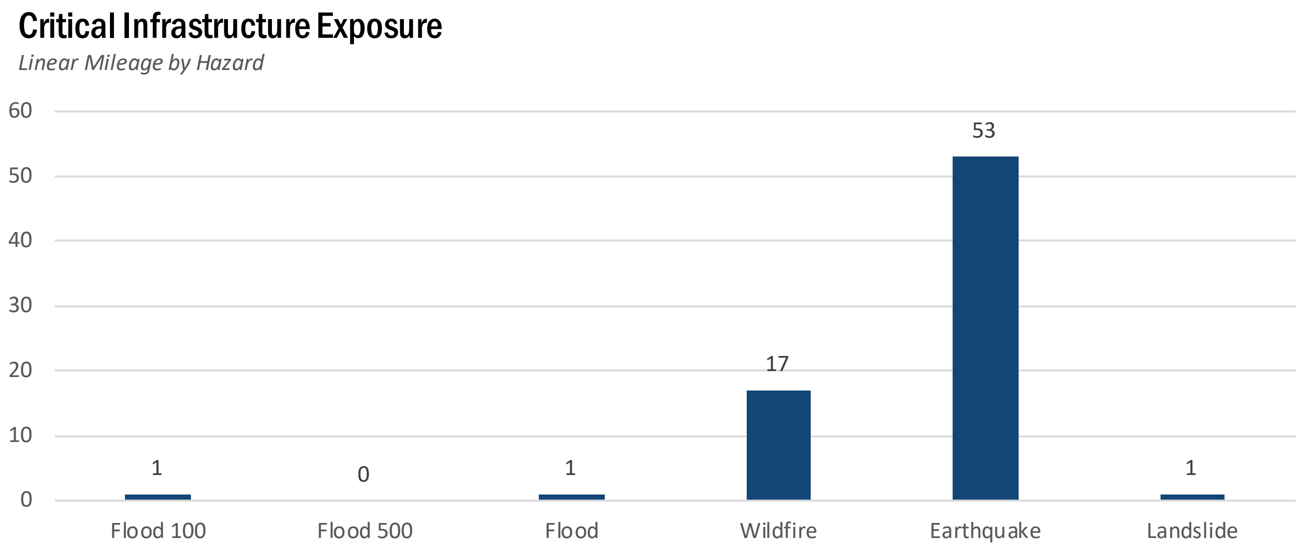
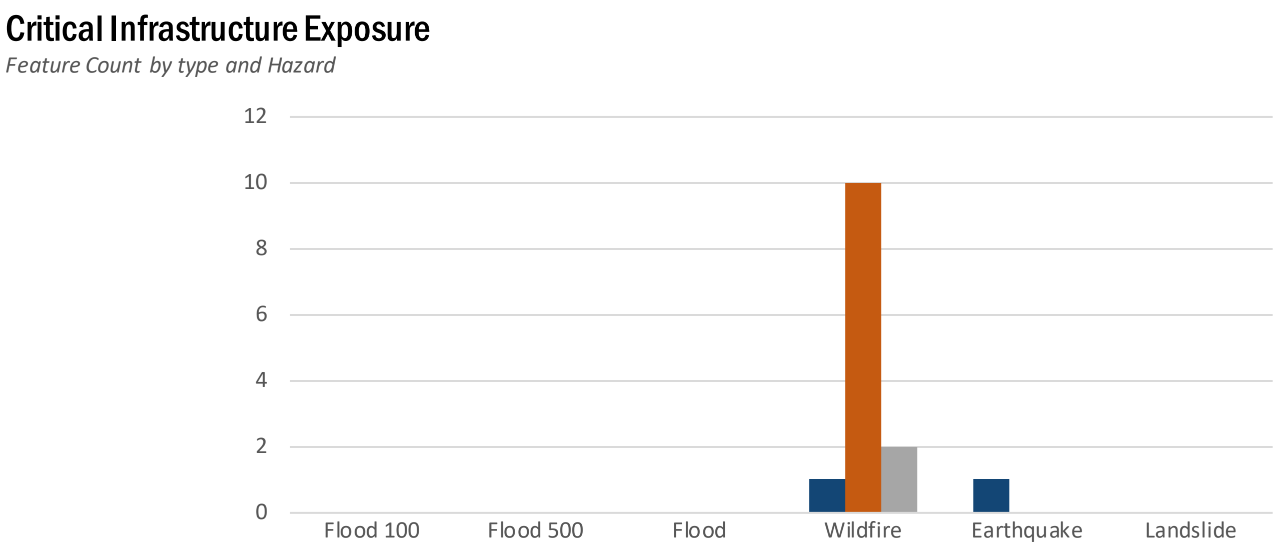


Figure 4-34: Miles of Critical Infrastructure Summary by Hazard



	Flood 100	Flood 500	Flood	Wildfire	Earthquake	Landslide
Essential Facilities	0	0	0	1	1	0
High Potential Loss	0	0	0	10	0	0
Transportation & Lifeline	0	0	0	2	0	0

Figure 4-35: Critical Infrastructure Points Summary by Hazard

4.4.3 Parcel Exposure

Critical infrastructure exposure by hazard comparison is provided in Figure 4-35, Figure 4-36 and Figure 4-37. Figure 4-35 provides a summary of at-risk parcels by hazard. Figure 4-36 provides a summary of at-risk structure and content value based on the parcel information by hazard. Figure 4-37 provides a summary of parcel value exposure by hazard. For detailed vulnerabilities assessment information see the individual hazard specific sections presented previously in this section.

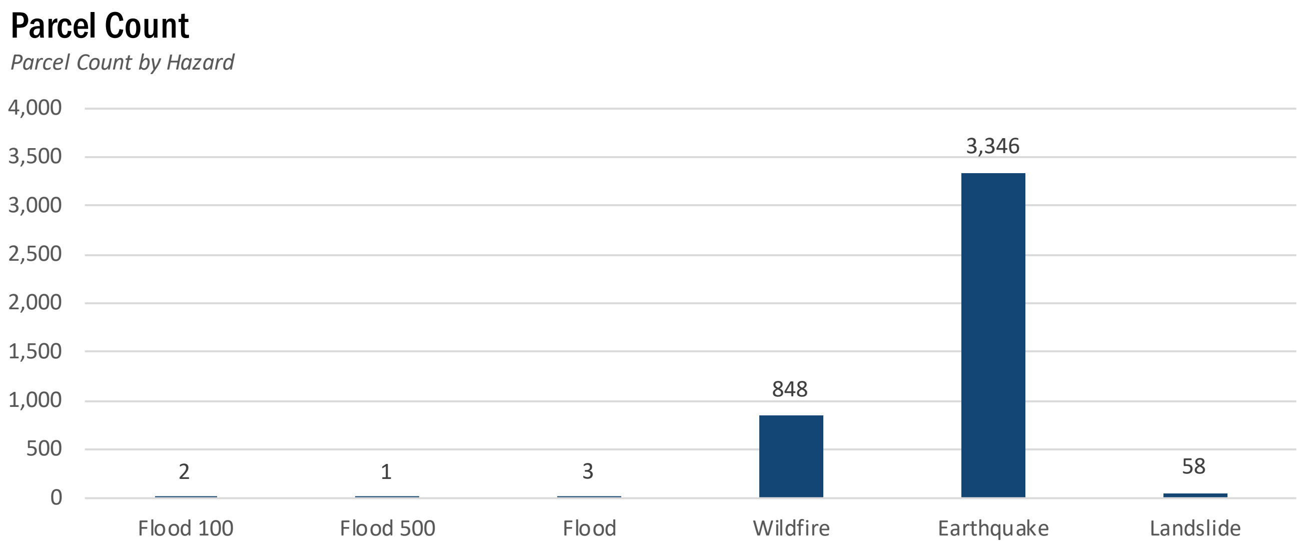


Figure 4-36: Parcels at Risk by Hazard Category

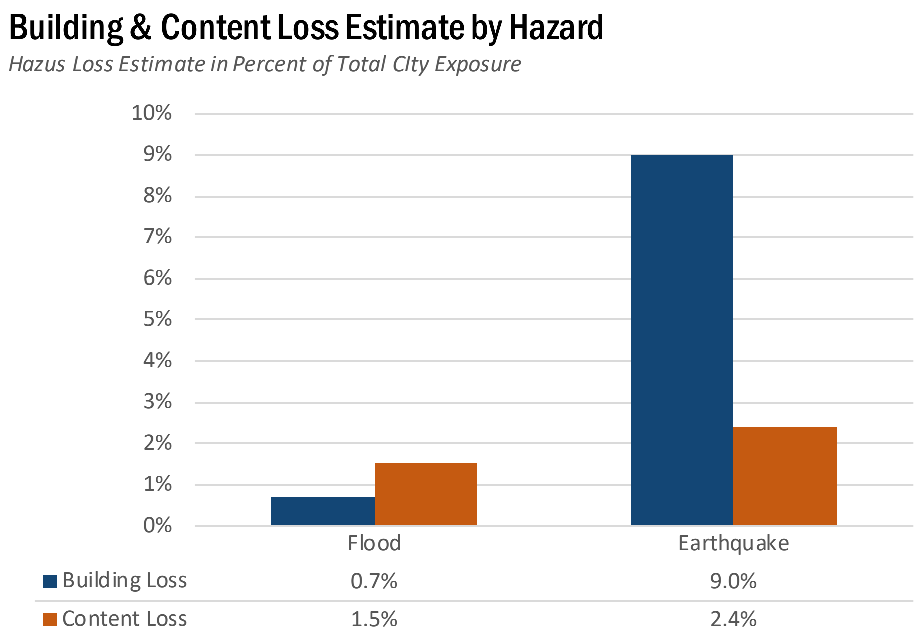
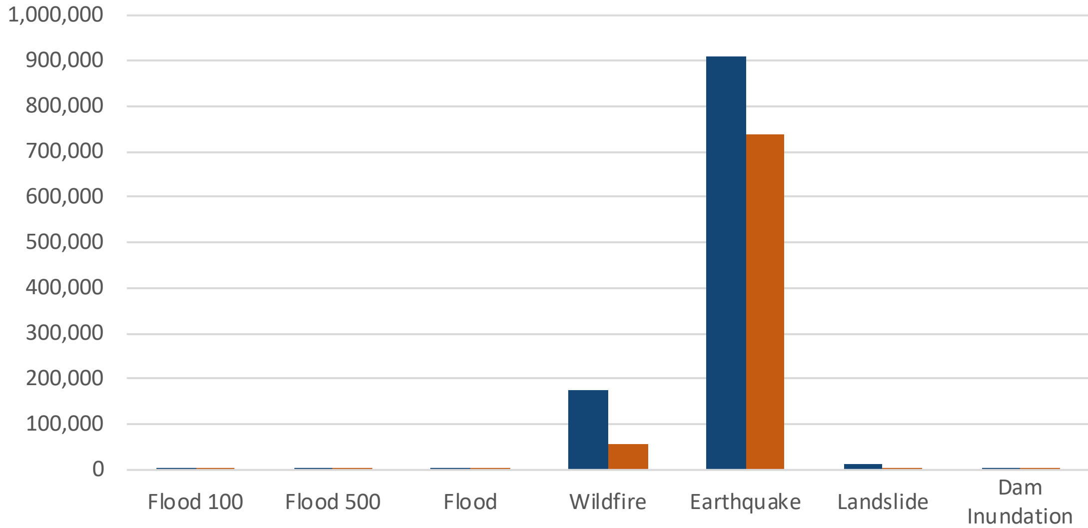


Figure 4-37: Building and Content Loss Estimate Summary by Hazard

Parcel Value Exposure

Parcel Improvement and Land Value Exposure by Hazard



	Flood 100	Flood 500	Flood	Wildfire	Earthquake	Landslide	Dam Inundation
Improvement Value ($000)	94	196	290	173,540	908,403	10,830	464
Land Value ($000)	246	494	740	56,876	736,629	3,822	814

Figure 4-38: Parcel Value Exposure by Hazard Summary

Section 5. Mitigation Strategy

The intent of the mitigation strategy is to provide the City of Grand Terrace with a guidebook to future hazard mitigation administration. The mitigation strategy is intended to reduce vulnerabilities outlined in the previous section with a prescription of policies and physical projects. This will help City staff to achieve compatibility with existing planning mechanisms, and ensures that mitigation activities provide specific roles and resources for implementation success.

5.1 Planning Process for Setting Hazard Mitigation Goals and Objectives

The mitigation strategy represents the key outcomes of the Grand Terrace HMP planning process. The hazard mitigation planning process conducted by the Planning Committee is a typical problem-solving methodology:

- Estimate the impacts the problem could cause (*See Section 4.3, Vulnerability Assessment*);
- Describe the problem (*See Section 5.2, Identifying the Problem*);
- Assess what safeguards and resources exist that could potentially lessen those impacts (See Section, 5.3 *Capabilities Assessment,*);
- Develop Goals and Objectives with current capabilities to address the problems (*See Section 5.5.1 Goals and Objectives*)
- Using this information, determine what can be done, and select those actions that are appropriate for the community (*See Section 5.5.4.3, Goal, Objective and Mitigation Action Matrix*).

5.2 Identifying the Problem

As part of the mitigation actions identification process, the HMP Planning Committee identified issues and/or weaknesses as a result of the risk assessment and vulnerability analysis. By combining common issues and weaknesses developed by the Planning Committee, the realm of resources needed for mitigating each can be understood. Community issues and weaknesses are presented by individual hazard in Table 5-1 through Table 5-3. Projects or actions have been developed to mitigate each problem identified. Actions numbers are indicated in each table. Referenced actions are presented in full detail in Section 6.

Table 5-1: Earthquake Hazard Problem Statements

Problem Description	Problem Type	Action No.
1. Damage to City water supply in the event of an earthquake may present a water supply issue.	Infrastructure	EQ 1.2
2. Potential damage to I-215 overpasses would impede travel. Specifically, the Barton Rd. Overpass, built in 1959.	Infrastructure	EQ 1.2
3. Protecting utility service such as natural gas from earthquake damage.	Infrastructure	EQ 1.2
4. Public facility infrastructure i.e. fire stations with earthquake damage risk.	Infrastructure	EQ 1.2
5. Structural adequacy of city buildings / facilities?	Infrastructure	EQ 1.2

Problem Description	Problem Type	Action No.
6. Content damage in City buildings.	Infrastructure	EQ 1.2
7. ID of buildings (city & other) in need of retrofit work and seismic safety review.	Infrastructure Protection	EQ 1.2
8. It is unknown if Unreinforced Masonry (URM) buildings exist within City boundaries.	Infrastructure	EQ 1.2
9. The majority of residents live in the Violent shake zone in the Great Shakeout Scenario.	Vulnerable Population	EQ 4.1

Table 5-2: Landslide Hazard Problem Statements

Problem Description	Problem Type	Action No.
1. Steep slopes along the northern end of Mt. Vernon (along Grand Terrace/ Colton boundary) experience severe mud slides that could potentially impede traffic in all travel lanes.	Infrastructure	LS 3.1, LS 3.2
2. Residential properties in the eastern part of the City at the foothill of Blue Mountain are vulnerable to mud slides, especially after fires.	Vulnerable Populations/ Public Education	LS 4.1, LS 3.2
3. Landslides/mudslides are likely to occur: • **Along Mt. Vernon Ave. from East Canal St. to Vista Grande Way** • **On Barton Ave. at the Colton border** • **At Vivienda Ave. and Burns Ave.**	Maintenance	LS 1.2, LS 3.2

Table 5-3: Wildfire Hazard Problem Statements

Problem Description	Problem Type	Action No.
1. Residents along the City's east/ northeast and western-most borders of the city are in the Very High fire hazard severity zone.	Vulnerable Populations	WF 2.1
2. City open spaces / vegetative fuels backing up to resident's property/ homes.	Vulnerable Populations	WF 3.1, WF 2.1
3. Lack of public notice to areas of extreme fire danger (clear brush etc.)?	Public Education	WF 2.1

Table 5-4: Flood Hazard Problem Statements

Problem Description	Problem Type	Action No.
1. Several streets are rendered impassable during heavy rain storms, such as all of Pico Street from east to west city limits as well as sections of Michigan Street near Pico Street, trapping residents.	Infrastructure	FL 1.1, FL 1.3
2. The northwestern portion of the City bordering the Santa Ana River is located in the 100-year flood zone.	Vulnerable Populations	FL 3.1
3. Debris buildup near street drain.	Maintenance	FL 4.1

Table 5-5: Climate Change Hazard Problem Statements

Problem Description	Problem Type	Action No.
1. Other natural disasters such as drought, severe weather, flood, and wildfire occurrence intervals can change. I.e. Increased wildfire risk due to a drier climate, in dry years, variability and the frequency/severity of hazard events i.e. El Nino Events in wet years.	Natural Hazards	CC 3.1, CC 3.2, CC 4.1

5.3 Mitigation 5- Year Progress Report

Progress towards the following projects has been achieved since the 2005/2011 HMP was completed or drafted. These projects have contributed to the overall enhancement of the City's capabilities should a natural hazard event occur with the City or Region.

2011 Mitigation Action/ Project	Description	Status
UPRR Bridge rebuild	Grand Terrace Department of Building and Safety/ Public Works is working on a project in correlation with the City of Colton to rebuild the UPRR railroad bridge that links the Barton Road with the City of Colton on the West border of Grand Terrace. This bridge is old and built to outdated standards. Rebuild of the bridge will increase the probability of access greatly.	Plans are being redesigned. No longer requires grade separation.
I-215/Barton Road Interchange	SANBAG is working on a proposed project to reconstruct the I-215 / Barton Road interchange.	Construction to begin in 2017.

2011 Mitigation Action/ Project	Description	Status
Develop Land Use Policies to Mitigate Wildfire	Develop and support land use policies and standards that protect life, property, and natural resources.	Policies can be found in the City of Grand Terrace General Plan.

5.4 Capabilities Assessment

The mitigation strategy includes an assessment of the City's planning and regulatory, administrative/technical, fiscal, and political capabilities to augment known issues and weaknesses from identified natural hazards.

5.4.1 Local Planning and Regulatory Mitigation Capabilities

The information in Table 5-6 is used to construct mitigation actions aligned with existing planning and regulatory capabilities of the City. Planning and regulatory tools typically used by local jurisdictions to implement hazard mitigation activities are building codes, zoning regulations, floodplain management policies, and other municipal planning documents.

Table 5-6: Planning and Regulatory Mitigation Capabilities Summary

Hazard	Plan/Program/ Regulation	Responsible Agency	Comments
Multi-Hazard	Grand Terrace / California Building Code 2016 Edition	Building Dept.	The City has adopted the California Building Code 2016 Edition, Volumes 1 and 2. The California Building codes protect buildings to the extent possible from natural occurring hazards.
Multi-Hazard	City of Grand Terrace General Plan Safety Element	Planning and Development Services	The General Plan was updated in 2010. The safety element is not compliant with recent laws and needs to be updated.
Multi-Hazard	Grand Terrace Capital Improvement Plan	Public Works Dept.	This can be used to catalog and fund capital related hazard mitigation projects throughout the city.
Flood	Grand Terrace MPD Update Drainage Study	Public Works Dept.	Although not formally adopted, this drainage study investigates the lack of drainage facilities in the area of Grand Terrace around Pico St. and provides cost estimates for MPD facilities.

Hazard	Plan/Program/ Regulation	Responsible Agency	Comments
Wildfire	San Bernardino County Fire Hazard Abatement (FHA) Program	San Bernardino County Land Use Services	The FHA enforces the fire hazard requirements outlined in San Bernardino County Code Section 23.0301–23.0319. The primary function of the Fire Hazard Abatement Program is to reduce the risk of fires within communities by pro-actively establishing defensible space and reduction/removal of flammable materials on properties. Two times a year notices go out for abatement. Ability to lien abate through county.
Wildfire	Mountain Area Safety Taskforce (MAST)	MAST/ San Bernardino County and Special Districts	MAST provides a single point of coordination for numerous Federal, State, and local agencies that perform a multitude of tasks related to creating fire safe mountain communities. MAST provides an extensive Fuels Reduction Program.
Wildfire	Grand Terrace Code of Ordinances Chapter 8.72	City of Grand Terrace	Gives the City the authority to remove trees in abandoned orchards if they constitute a fire hazard.
Flood	National Flood Insurance Program (NFIP)	City Manager is the Floodplain Manager.	NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. As a participating member of the NFIP, the City has 3 policy owners. Recently adopted Floodplain ordinances. Mention FloodSmart.gov
Flood	Grand Terrace Code of Ordinances No. 289	Floodplain Administrator (City Manager)	Addition of Chapter 15.62- Floodplain Management. It is the purpose of this Chapter to promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by legally enforceable regulations applied uniformly throughout the community to all publicly and privately owned land within flood prone, mudslide [i.e. mudflow] or flood related erosion areas.
Flood	Santa Ana River Integrated Watershed Management Plan		This plan address resources in the Santa Ana River Watershed including hydrogeology, land use, biological resources, water supply, water quality, flood control, and demographics.

Hazard	Plan/Program/ Regulation	Responsible Agency	Comments
Flood	Municipal Code of Ordinances Chapter 18.50- FP Floodplain Overlay District	Planning and Development Services	The FP overlay districts limit the permitted uses of land in areas subject to periodic flooding to the following: • Flood control channels, levees, spreading grounds and basins, roads, bridges and diversion drains, where plans are approved by the San Bernardino County flood control district. • Agricultural uses (conditional use permits) All uses and structures must be reviewed subject to the regulations of the Federal Emergency Management Agency (FEMA).
Climate Change	2015 San Bernardino Valley Regional Urban Water Management Plan		This Urban Water Management Plan is a tool that provides a summary of anticipated supplies and demands for the years 2015 to 2040.
Multi-Hazard	2014 Water Shortage Contingency Plan	Riverside Highland Water Company	Riverside Highland Water Company has a "Water Shortage Plan," in place, programs whereby actions will go into effect if a catastrophic interruption, mandatory prohibition or other causes occur.
Climate Change	The Sustainable Communities and Climate Protection Act of 2008		Looks to reduce GHG emissions through coordinated transportation and land use planning with the goal of more sustainable communities. Regional targets are established for GHG emissions reductions from passenger vehicle use by the sustainable communities strategy (SCS) established by each metropolitan planning organization (MPO).

5.4.2 Administrative and Technical Capabilities

provides a summary of administrative and technical capabilities organized by staff type and department. It is important to understand current administrative and technical capabilities before developing mitigation activities.

Table 5-7: City Administrative and Technical Mitigation Capabilities

Staff/Personnel Resources	Dept. / Agency	Comments
Planners (with land use / land development knowledge)	Planning and Development Services	Includes Land Use Planning, Planning Commission, Building & Safety, Code Enforcement, and Enforcement Programs.
Planners or engineers (with natural and/or human caused hazards knowledge)	Public Works Dept., Utilities Dept., Planning and Development Services	Fire Prevention can assist as well.
Engineers or professionals trained in building and/or infrastructure construction practices (includes building inspectors)	Public Works Dept.	Registered Professional Engineer on staff.
Floodplain Management	City Manager	The City Manager is the Floodplain Administrator according to FEMA Region IX and NFIP data.
Land / Building surveyors	N/A	City contracts survey services.
Plan Checks	N/A	City Contract for Plan Review Services. Wildan Engineering for Plan Check and inspection services. Survey notes etc…
Personnel skilled in Geographic Information Systems (GIS) and/or FEMA's HAZUS program	N/A	GIS knowledge and software not available to City staff.
Grant writers or fiscal staff to handle large/complex grants	N/A	Numerous types of federal, state, local, and private grants have been administered by City staff. Will contract with consulting firms to grant write.

Staff/Personnel Resources	Dept. / Agency	Comments
Construction Equipment	Public Works Dept.	Public Works owns and maintains dump truck and front end loader.
Emergency Management Personnel	Planning and Development Services	County OES / County Fire provide much of the emergency management support. However, Planning Services has initiated the development of an EOP.
Care and Sheltering	Regional Red Cross Personal (local office at 6235 River Crest Dr, Riverside, CA 92507)	Care and sheltering during extreme heat conditions, will provide sheltering and support services for fire victims. County OES.

5.4.3 Fiscal Capabilities

This section identifies the financial tools or resources that the City could potentially use to help fund mitigation activities. Fiscal capabilities include City-specific as well as state and federal resources.

5.4.3.1 Local Fiscal Resources

Table 5-8 provides summary local fiscal capabilities. As indicated in Table 5-8, there are several governmental funds and revenue raising activities that can be allocated for hazard mitigation activities.

Table 5-8: Fiscal Capabilities Table

Financial Resources	Dept. / Agency	Comments
General Fund Revenue	Grand Terrace City Council	$1,714,172 *Projected* Fund Balance June 30, 2017
Street Fund (Special Revenue Fund)	Grand Terrace City Council	$1,299,560 *Projected* Fund Balance June 30, 2017

Financial Resources	Dept. / Agency	Comments
Storm Drain Fund (Special Revenue Fund)	Grand Terrace City Council	$91,731 *Projected* Fund Balance June 30, 2017
Facilities Development Fund (Special Revenue Fund)	Grand Terrace City Council	$240,528 *Projected* Fund Balance June 30, 2017
State and County Community Development Dept. Block Grants (CDBG)	California Dept. of Housing and Community Development Dept. (HCD)	Programs Include: Community Development (CD) Economic Development (ED) Disaster Recovery Initiative (DRI) Neighborhood Stabilization Program (NSP) 45k-46k a year to fund public services…. Approximately $2 Million approved by city for 2014/15.
Home Investments Partnership Program	California Dept. of Housing and Community Development	City is a non-entitlement city and must apply competitively for grant funds.

Source: City of Grand Terrace FY 2016-17 Adopted Budget

5.4.3.2 State and Federal Fiscal Resources

To augment local resources, Table 5-9 provides a list of potential funding programs and resources provided by state and federal agencies and programs which can be used for local hazard mitigation activities.

Table 5-9: Potential Funding Programs/Grants from State and Federal Agencies

Agency / Grant Name	Potential Programs/Grants
California DWR Proposition 50/84: **Integrated Regional Water Management (IRWM) Program.**	***DWR has a number of IRWM grant program funding opportunities. Current IRWM grant programs include planning, implementation, and stormwater flood management.*** http://www.water.ca.gov/irwm/grants/index.cfm Proposition 84, the Safe Drinking Water, Water Quality, and Supply, Flood Control, River and Coastal Protection Bond Act, which provides $1,000,000,000 (P.R.C. §75001-75130) for IRWM Planning and Implementation. CA Dept. of Water Resources' Flood Emergency Response Projects are posted on the webpage at: http://www.water.ca.gov/floodmgmt/hafoo/fob/floodER/
California Housing and Community Development (HCD) Emergency Solutions Grant (ESG) Program	***To fund projects that serve homeless individuals and families with supportive services, emergency shelter/transitional housing, assisting persons at risk of becoming homeless with homelessness prevention assistance, and providing permanent housing to the homeless population. The Homeless Emergency Assistance and Rapid Transition to Housing (HEARTH) Act of 2009 places new emphasis on assisting people to quickly regain stability in permanent housing after experiencing a housing crisis and/or homelessness.*** http://www.hcd.ca.gov/fa/esg/index.html
CalTrans Division of Local Assistance / Safe Routes to School Program	California Dept. of Transportation. Federal funding administered via Caltrans. Local 10% match is the minimum requirement. http://www.dot.ca.gov/hq/LocalPrograms/saferoutes/saferoutes.htm Active transportation grant program. Creating mobility and connectivity. Prioritize projects, and preparation of PED for active transportation projects.
Property Assessed Clean Energy (PACE) Programs	PACE financing allows property owners to fund energy efficiency, water efficiency and renewable energy projects with little or no up-front costs. With PACE, residential and commercial property owners living within a participating district can finance up to 100% of their project and pay it back over time as a voluntary property tax assessment through their existing property tax bill.

Agency / Grant Name	Potential Programs/Grants
U.S. Dept. of Energy / Energy Efficiency and Conservation Block Grant Program	***Provides funding for weatherization of structures and development of building codes/ordinances to ensure energy efficiency and restoration of older homes.*** http://www1.eere.energy.gov/wip/eecbg.html
Dept. of Homeland Security (DHS) / FEMA Grants	For more information on current grants visit: http://www.fema.gov/grants Grants Under DHS include: EMPG: Good for Equipment and Back Up Generators Etc… HMPG Notes: Diesel Back-Up Generators at already exist City Building, Public Works not connected to back-up. Unknown if Fire Station has back-up generation. City needs construction equipment for mudslide and shoulder improvements.
Cal OES / Proposition 1B Grants Programs	The Highway Safety, Traffic Reduction, Air Quality and Port Security Bond Act of 2006, approved by the voters as Proposition 1B at the November 7, 2006 general election, authorizes the issuance of nineteen billion nine hundred twenty five million dollars ($19,925,000,000) in general obligation bonds for specified purposes, including grants for transit system safety, security, and disaster response projects. http://www.calema.ca.gov/EMS-HS-HazMat/Pages/Emergency-Management-Homeland-Security-and-Hazard-Mitigation-Grant-Programs.aspx
California Proposition 1: the Water Bond (AB 1471)	Authorize $7.545 billion in general obligation bonds for state water supply infrastructure projects, such as public water system improvements, surface and groundwater storage, drinking water protection, water recycling and advanced water treatment technology, water supply management and conveyance, wastewater treatment, drought relief, emergency water supplies, and ecosystem and watershed protection and restoration.

Agency / Grant Name	Potential Programs/Grants
	The State Water Resources Control Board (State Water Board) will administer Proposition 1 funds for five programs. The estimated implementation schedule for each is outlined in Five Categories: ▪ Small Community Wastewater ▪ Water Recycling ▪ Drinking Water ▪ Stormwater ▪ Groundwater Sustainability http://www.waterboards.ca.gov/water_issues/programs/grants_loans/proposition1.shtml
Assistance to Firefighters Grant Program (AFG); Fire Prevention and Safety (FP&S)	The primary goal of the FP&S Grants is to enhance the safety of the public and firefighters with respect to fire and fire-related hazards. The Grant Programs Directorate administers the FP&S Grants as part of the AFG Program. FP&S Grants are offered to support projects in two activity areas: 1). Fire Prevention and Safety (FP&S) Activity Activities designed to reach high-risk target groups and mitigate the incidence of death and injuries caused by fire and fire-related hazards. 2). Research and Development (R&D) Activity To learn more about how to prepare to apply for a project under this activity, please see the FP&S Research and Development Grant Application Get Ready Guide. https://www.fema.gov/fire-prevention-safety-grants FY 14 Awards: https://www.fema.gov/fire-prevention-safety-grants-award-year-2014
HazMat Emergency Preparedness Grant	The purpose of this grant program is to increase effectiveness in safely and efficiently handling hazardous materials accidents and incidents; enhance implementation of the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA); and encourage a comprehensive approach to emergency training and planning by incorporating the unique challenges of responses to transportation situations. http://www.caloes.ca.gov/cal-oes-divisions/fire-rescue/hazardous-materials/hazmat-emergency-preparedness-grant

Agency / Grant Name	Potential Programs/Grants
CERT Program Manager Course	The purpose of this Community Emergency Response Team (CERT) Program Manager course is to prepare CERT Program Managers for the tasks required to establish and sustain an active local CERT program. http://www.californiavolunteers.org/index.php/CERT/PM/
Sheriff's Explorer Scout Program	The primary mission of the Sheriff's Explorer Scout Program is to educate and mentor youth and provide in-depth firsthand experience in the field of Law Enforcement. The program is intended to interest youth in possible Law Enforcement careers, and to build mutual understanding. Through involvement, this program will establish an awareness of the complexities of law enforcement services. This program is intended for the benefit of youth from age 14 through 20.
Search and Rescue Program	The primary mission of search and rescue volunteers is to search for and rescue persons on behalf of the Sheriff of San Bernardino County. Additional missions may include evidence searches and assignments at the direction of the Department.
Citizen Volunteer Units	Citizen Volunteer Units are utilized throughout the county to assist the San Bernardino County Sheriff's Department in meeting law enforcement objectives during the normal course of operation as well as times of disasters and emergencies. The program encourages community support and understanding of law enforcement through involvement in volunteer units such as Citizen on Patrol, Equestrian on Patrol and many administrative, specialized and support functions.
The California Residential Mitigation Program	The California Residential Mitigation Program (CRMP) was established to carry out mitigation programs to assist California homeowners who wish to seismically retrofit their houses. http://www.californiaresidentialmitigationprogram.com/
Earthquake Brace + Bolt	EBB was developed to help homeowners lessen the potential for damage to their houses during an earthquake by offering eligible homeowners up to a $3,000 incentive to seismically retrofit their homes. https://www.earthquakebracebolt.com/
California Air Resources Board Air Pollution Incentives, Grants and Credit Programs	These programs have hundreds of millions of dollars in grants available over the next several years to reduce emissions from on- and off-road vehicles and equipment. https://www.arb.ca.gov/ba/fininfo.htm

5.5 Mitigation Goals, Objectives and Actions

Goals and objectives discussed in this section help describe what actions should occur, using increasingly narrow descriptors. Long-term goals are developed which can be accomplished by objectives. To achieve the stated objectives "mitigation actions" provide specific measurable descriptors on how to accomplish the objective. The goals, objectives, and actions form the basis for the development of a Mitigation Action Strategy and specific mitigation projects to be considered for implementation.

The process consists of 1) setting goals and objectives, 2) considering mitigation alternatives, 3) identifying strategies or "actions", and 4) developing a prioritized action plan resulting in a mitigation strategy.

5.5.1 Goals and Objectives

The HMP Planning Committee discussed goals and objectives for this plan update at distinct points in the planning process. In January 2017 (Planning Committee Meeting #3), the Planning Committee discussed the results of the risk assessment and the identified issues/weaknesses to be addressed by Mitigation Actions. During that time the HMP Planning Committee opted to develop a new set of goals and objectives as a result of the risk analysis and community priorities. More details of this particular meeting are provided in Appendix B. The following goals and objectives have been developed as part of this planning effort:

ALL HAZARD GOAL: Significantly reduce life loss and injuries resulting from natural hazards. ***(California Multi-Hazard Mitigation Plan, 2013)***

ALL HAZARD OBJECTIVE 1: Continuously improve hazard and vulnerability assessments.

ALL HAZARD OBJECTIVE 2: Evaluate and improve ability to alert and warn residents of natural hazard risk.

ALL HAZARD OBJECTIVE 3: Support mitigation planning in all City Operations.

ALL HAZARD OBJECTIVE 4: Explore ways to increase the City's capability to provide mitigation opportunities for residents.

5.5.2 Considering Mitigation Alternatives

During February 2017, the HMP Planning Committee participated in the development and review of mitigation actions with a wide range of alternatives. To narrow mitigation alternatives for inclusion, FEMA's six broad categories of mitigation alternatives were used. Each FEMA category is described below. The HMP Planning Committee developed several mitigation alternatives for implementation under each mitigation category.

PREVENTION (PRV):

Preventative activities are intended to keep hazard problems from getting worse, and are typically administered through government programs or regulatory actions that influence the way land is developed and buildings are built. They are particularly effective in reducing a community's future vulnerability, especially in areas where development has not occurred or capital improvements have not been substantial. Examples of preventative activities include:

- Planning and zoning ordinances;
- Building codes;
- Open space preservation;
- Floodplain regulations;
- Stormwater management regulations;
- Drainage system maintenance;
- Capital improvements programming; and
- Riverine / fault zone setbacks.

PRV ALTERNATIVES:

1) Evaluate the City's regulations that manage flood risk / stormwater conveyance and consider additional standards to help prevent flood problems from increasing. These include:
    - Practicing Water Sensitive Urban Design such as the incorporation of curb cuts into bioswales to control runoff.
    - Enhanced stormwater regulations to reduce stormwater runoff, especially for new development
2) Consider additional policies and regulations to enhance the preservation of Open Space in flood prone and wild land fire high risk areas.
3) Training for City Staff:
    - Provide Certified Floodplain Manager training and certification to staff
4) Vegetation management in fire prone areas.

PROPERTY PROTECTION (PPRO):

Property protection measures involve the modification of existing buildings and structures to help them better withstand the forces of a hazard, or removal of the structures from hazardous locations. Examples include:

- Critical facilities protection;
- Retrofitting (e.g., seismic design techniques, etc.);
- Insurance.

PPRO ALTERNATIVES:

1) Consider promoting and supporting voluntary property protection measures through several activities, ranging from financial incentives to full funding. Examples include Earthquake Brace + Bolt, The California Residential Mitigation Program and California Air Resources Board Air Pollution Incentives, Grants and Credit Programs.
2) Promote earthquake insurance for properties with a focus on older structures built before 1980.
3) Evaluate public owned facilities and critical facilities for property protection measures.
4) Perform seismic review (both structural and non-structural) on city buildings and city owned critical facilities.
5) Provide automatic shutoff valves for utility infrastructure.
6) Review city owned buildings for seismic risk.
7) Identify and mitigate privately owned unreinforced masonry buildings within the City.

PUBLIC EDUCATION AND AWARENESS (PE&A):

Public education and awareness activities are used to advise residents, elected officials, business owners, potential property buyers, and visitors about hazards, hazardous areas, and mitigation techniques they can use to protect themselves and their property. Examples of measures to educate and inform the public include:

- Outreach projects including neighborhood and community outreach;
- Speaker series / demonstration events;
- Hazard mapping;
- Real estate disclosures;
- Materials Library;
- School children educational programs; and
- Hazard expositions.

PE&A ALTERNATIVES:

1) Enhancing the City's Public Information Program to include both the public and private sectors.

2) Education and outreach measures to ensure the community understands **their** role in protecting **themselves** in a disaster event.

    - Mitigation measures for residents at the home (i.e. stabilizing through vegetation)
    - Safety precautions for all types of hazards, but especially earthquakes, wildfires, and drought.
    - Knowing where emergency evacuation routes and shelters are located.
    - Family and emergency preparedness measures.

3) Enhance public outreach program to include all hazards. Appropriate ways to spread information are:
    - Websites and social media
    - Mailings to everyone, in utility bills or otherwise
    - News releases or newspaper articles
    - Newsletters
    - Displays, particularly at special events
    - Handouts, flyers and other materials, which can be distributed at special events and presentations

NATURAL RESOURCE PROTECTION (NRP):

Natural resource protection activities reduce the impact of natural hazards by preserving or restoring natural areas and their protective functions. Such areas include floodplains, wetlands, steep slopes, and sand dunes. Parks, recreation, or conservation agencies and organizations often implement these protective measures. Examples include:

- Floodplain protection
- Watershed management;
- Vegetation management (e.g., fire resistant landscaping, fuel breaks, etc.);
- Erosion and sediment control;
- Wetland and habitat preservation and restoration;

NRP ALTERNATIVES:

1) Inform City Council about the hazard mitigation benefits of restoring natural drainage features, wetlands and other natural areas.
2) Develop restoration and protection techniques using water sensitive urban design, landslide areas and high risk wild land fire areas.

3) Enhance public education and outreach efforts to inform the public about the need to protect hillsides from erosion. (i.e. stabilizing through vegetation) (City needs to make sure the resources are needed to do this after a fire) Enhance public education and outreach efforts to inform the public about capturing stormwater and using it for landscape features.
4) Work with property owners to replant native vegetation after a fire.
5) Land use and/or other regulatory control of undeveloped properties in flood zones.

EMERGENCY SERVICES (ES):

Although not typically considered a "mitigation" technique, emergency service measures do minimize the impact of a hazard event on people and property. These commonly are actions taken immediately prior to, during, or in response to a hazard event. Examples include:

- Warning systems;
- Construction of evacuation routes;
- Sandbag staging for flood protection; and
- Installing temporary shutters on buildings for wind protection.

ES ALTERNATIVES:

1) Consider StormReady certification.
2) Provide alert and notification to residents for flood risk
3) Training for City Staff

STRUCTURAL PROJECTS (SP):

Structural mitigation projects are intended to lessen the impact of a hazard by modifying the environmental natural progression of the hazard event through construction. They are usually designed by engineers and managed or maintained by public works staff. Examples include:

- Stormwater diversions / detention / retention infrastructure;
- Utility Upgrades
- Seismic Retrofits

SP ALTERNATIVES:

1) The City has previously constructed flood control and drainage facilities that move storm and flood waters more efficiently and reduced potential for overbank flooding. The City should identify and prioritize additional projects in the City.
2) Protecting utilities from EQ damage. Not the City's responsibility but private utility industry.
3) Constructing backup utility infrastructure in the event of a natural disaster.
4) Check the condition of the City's utility infrastructure.
5) Upgrade or seismically retrofit transportation infrastructure including overpasses, underpasses, and other transportation infrastructure vulnerable to seismic events.
6) Identify or construct alternative routes for emergency access to the City. Provide shoring and bank stabilization near roadways to prevent further erosion.
7) Work with private property owners to reduce runoff.
8) Provide City infrastructure to slow the movement of water.

5.5.3 Mitigation Action Development

Based upon planning committee priorities, risk assessment results, and mitigation alternatives, mitigation actions were developed. Most importantly, the newly developed mitigation actions acknowledge updated risk assessment information outlined in Section 4. Mitigation actions presented in Table 5-10 establish 22 possible mitigation actions. Some mitigation actions support ongoing City activities, while other actions are intended to be completed when funding is available. Regardless, mitigation actions will be part of an annual review.

Table 5-10: Mitigation Action Abbreviated List

Action No.	Specific Mitigation Action	Mitigation Type	Priority Rating	Comments
EARTHQUAKE				
EQ 1.1	Evaluate all proposed developments for impacts associated with geologic and seismic hazards. (Grand Terrace General Plan, 2010)	PRV	4	Developer cost / impact fee. Currently no requirements above existing building codes.
EQ 1.2	Perform a seismic review (both structural and non-structural) on city buildings and city owned critical facilities i.e. City Hall, Public Works building and Fire Station.	PRV, PPRO	2	
EQ 3.1	Mitigate unreinforced masonry buildings in the City, starting with gathering facilities.	PPRO	5	
EQ 3.2	Conduct seismic retrofitting on Barton Rd. Overpass.	SP	6	
EQ 4.1	Work with local insurance brokers to encourage earthquake insurance for homeowners.	PE&A, PPRO	N/A	
EQ 4.2	Provide residents the means to seismically retrofit their homes.	SP	1	
EQ 4.3	Provide automatic shutoff valves for gas meters in the Grand Terrace service area.	PPRO	3	

Action No.	Specific Mitigation Action	Mitigation Type	Priority Rating	Comments
LANDSLIDE				
LS 1.2	Develop a feasibility study for slope stabilization for areas of slope failure concern, such as Mt. Vernon, along Barton Ave and at Vivienda and Burns Ave.	PRV	1	
LS 3.1	Plant deep-rooted vegetation on bare slopes.	NRP, PRV	4	
LS 3.2	Perform earth / slope stabilization near landslide / rockslide / mudslide hazard zones, such as along the northern end of Mt. Vernon.	PRV, SP	2	
LS 4.1	Encourage homeowners in high landslide hazard areas to plant native trees and shrubbery.	PE&A, PRV	5	
LS 4.2	Develop public education and awareness material regarding vegetation and erosion control and provide resources for erosion control and slope failure on private properties.	PE&A, NRP	3	
WILDFIRE				
WF 2.1	Improve public education programs for residents to reduce wildfire risk.	PE&A, PRV	4	
WF 3.1	Maintain and improve access to fire prone areas such as Blue Mountain.	SP, PRV	2	

Action No.	Specific Mitigation Action	Mitigation Type	Priority Rating	Comments
WF 3.2	Continue the weed abatement program and fuel management and fuel reduction in open space, creeks, around critical facilities, and urban / wildland interface areas.	PRV, NRP	1	
WF 3.3	Repair/ replant vegetation on slopes after a fire to minimize the risk of landslides, mudslides or slope failure.	NRP, PRV	3	
FLOOD				
FL 1.1	Perform a feasibility study for retention and detention of storm water to include water sensitive urban design.	PRV	2	Already in the process of doing some of this at Pico / Michigan.
FL 1.2	Evaluate public infrastructure (bridges, traffic signals, street lights, etc.) and its ability to withstand localized flood events.	PRV	5	Some of this can be done by Edison. Contract with Siemens for inspections. Sewer line, water lines and connector culverts are inspected by City of Colton annually.
FL 1.3	Perform a feasibility study for stormwater drainage along Pico Ave.	PRV, SP	1	
FL 3.1	Ensure undeveloped properties adhere to General Plan Land Use designations and flood plain preservation and risk reduction methodologies.	PRV	3	
FL 4.1	Implement a Maintain-A-Drain program to keep street drains clear from debris.	PE&A, PRV	4	Street sweeping is conducted on a monthly basis. Once a week on Barton and Mt. Vernon.

Action No.	Specific Mitigation Action	Mitigation Type	Priority Rating	Comments
CLIMATE CHANGE				
CC 3.1	Accrue property and construct parks and open space for every 1,000 residents, reducing the impacts of high heat on urbanized areas. (Grand Terrace General Plan, 2010)	PRV, NRP	3	
CC 3.2	Plant street trees to provide shade on high heat days and reduce the urban heat island effect.	PRV	1	
CC 4.1	Continue working with Southern California Edison to promote energy conservation at residences and businesses. (Grand Terrace General Plan, 2010)	PE&A, PRV, NRP	2	This may include implementing an Air Conditioning Replacement Program or encouraging a reduction in energy consumption on high heat days.

Note: As a living document, project descriptions and actions in Table 5-10 will be modified to reflect current conditions over time.

5.5.3.1 Mitigation Costs

Cost effectiveness of each measure was a primary consideration when developing mitigation actions. Because mitigation is an investment to reduce future damages, it is important to select measures for which the reduced damages over the life of the measure are likely to be greater than the project cost. For structural projects, the level of cost effectiveness is primarily based on the likelihood of damages occurring in the future, the severity of the damages when they occur, and the level of effectiveness of the selected measure.

While a detailed analysis was not conducted during the mitigation action development process, these factors were of primary concern when selecting measures. For measures that do not result in a quantifiable reduction of damages, such as public education and outreach, the relationship of the probable future benefits and the cost of each measure was considered when developing the mitigation actions. Costs are made available in individual Implementation Plans described in Appendix C.

5.5.4 Prioritization of Mitigation Actions

Common failures of a mitigation plan involve the prioritization of mitigation actions for future implementation. Implementing the identified mitigation actions in Table 5-10 can be overwhelming for any community, especially with limited staffing and fiscal resources. To ensure that the City of Grand Terrace's HMP reflects a reality of what the City can do with its available resources, mitigation actions are prioritized with public input, risk factor scores, and HMP Planning Committee agreement. This method assists the City to direct resources appropriately during particular planning windows.

5.5.4.1 Public Input

A 21 question community survey was distributed to the public, yielding 104 survey responses and useful insight into the community's perception of natural hazards affecting the City of Grand Terrace.

Specific question responses heavily influenced the prioritization of mitigation actions, including:

- The majority of respondents (38.5%) weren't sure how much money they would be willing to spend at one time to protect their home, while 23.1% said they would be willing to spend less than $250.
- 47.1% of respondents said they would be willing to spend less than $250 per year on flood or earthquake insurance for their home or business.
- The most popular choices for incentives that would encourage homeowners to protect their homes from natural disasters were: rebate programs (72.1%), property tax break or incentives (65.4%), financial assistance for property upgrades or equipment (59.6%), insurance premium discounts (52.9%) and mortgage discounts or low interest loans (50%).
- The high priority protection methods the City, County, State or Federal agencies could be using in order to reduce damage and disruption from hazard events within the City of Grand Terrace were:
    - Retrofit and strengthen essential facilities such as police and fire facilities, schools and hospitals.
    - Retrofit infrastructure such as roads, bridges, drainage facilities, water supply, waste water and power supply facilities.
    - Strengthen codes and regulations to include higher standards in hazard areas.
    - Assist vulnerable property owners with securing funding for mitigation / property protection.
    - Provide better public information about risk, and the exposure to hazards within Grand Terrace.
    - Carry out projects to restore the natural environments capacity to absorb the impacts from natural hazards.
    - Acquire emergency generators for essential government facilities and buildings identified as care and shelters.
- 67.3% of respondents did not know if their home or business is located in a FEMA designated floodplain.
- 61.5% of respondents did not know if their home or business is located near an earthquake fault.

The complete survey results can be found in Appendix B.

5.5.4.2 Planning Committee Prioritization Process

Using risk factor scores and their historical knowledge and local expertise, the Planning Committee prioritized the mitigation actions during Planning Committee Meeting #4. During Planning Committee Meeting #5, these mitigation actions were compared to the results of the Community Survey to validate the Priority Mitigation Actions. This process is documented in Appendix B.

The benefits of proposed projects were also weighed against estimated costs as part of the project prioritization process. A review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the benefits of these projects.

Benefit ratings were defined as follows:

- High—Project will provide an immediate reduction of risk exposure for life and property.
- Medium—Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- Low—Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios are considered cost-beneficial and are prioritized accordingly.

5.5.4.3 Goal, Objective and Mitigation Action Matrix

Based upon the City's capabilities, Table 5-11 lists each priority mitigation action (listed in order of priority by hazard) and identifies the responsible party, time frame, potential funding source and an implementation plan for each action.

Table 5-11: 2017-2022 Prioritized Mitigation Strategy

Action No.	ACTION	DESCRIPTION / BACKGROUND	RESPONSIBLE PARTY	ACTION TYPE	TIME FRAME	POTENTIAL FUNDING SOURCE	IMPLEMENTATION PLAN
EQ 4.2	Provide residents the means to seismically retrofit their homes.	Most property damage caused by earthquakes ends up being handled and paid for by the homeowner or renter. As a homeowner or renter, you can significantly reduce risk of damage to your home by fixing a number of known and common weaknesses, including interior falling hazards. There are no guarantees of safety during earthquakes, but properly constructed and strengthened homes are far less likely to collapse or be damaged during earthquakes. **Possible Implementation Measures:** • List of resources, programs and inventory list, of vulnerable buildings. • Prepare a list of vulnerable buildings within the City and establish priority. • Update the Building Code to start mitigating all future developments in the City. • Earthquake resident awareness, outreach programs, website information, insurance representatives. • Seek grant opportunities for residents • Retrofit vulnerable structures, provide retrofit information to residents.	Building and Safety	SP	1-2 years	Staff Time to review possible programs. Brace and Bolt Program expansion.	See Appendix C.
EQ 1.2	Perform a seismic review (both structural and non-structural) on city buildings and city owned critical facilities i.e. City Hall, Public Works building and Fire Station.	Essential facilities are those facilities and parts of a community's infrastructure that must remain operational or can be restored quickly after an earthquake for a community to respond effectively. Fire stations, police stations, ambulance services, and emergency/City operation centers must have the ability to provide immediate response during an earthquake or other disaster. Those existing essential facilities which are identified as being potentially non-operable after an earthquake must be strengthened and their equipment secured so they will function after an earthquake. The overall impact and cost of a disaster is strongly influenced by how long it takes to recover. The time needed to recover depends on the level of damage sustained by essential facility buildings, the availability of utilities, and how quickly the City can return to fully functioning status. **Possible Implementation Measures:** • Identify City owned buildings and perform inspections and assessment. • Prepare a list of priority feasibility issues that need to be addressed. • Identify if there are any Grants to be used for City building upgrades. • Coordinate with the School District to obtain evaluations of their facilities. • Update the Building Code to start mitigating future developments within the City • Review and set Inspection and recording process • Prepare/obtain retrofit/seismic repair estimates • Develop retrofit/seismic repair plan; determine priority repairs	Building and Safety, Public Works	PRV, PPRO	3-5 years	City Funded, General Fund, Public Works Budget.	See Appendix C.

Action No.	ACTION	DESCRIPTION / BACKGROUND	RESPONSIBLE PARTY	ACTION TYPE	TIME FRAME	POTENTIAL FUNDING SOURCE	IMPLEMENTATION PLAN
EQ 4.3	Provide automatic shutoff valves for gas meters in the Grand Terrace service area.	Automatic shutoff valves could help prevent fires from starting as a result of an earthquake. **Possible Implementation Measures:** • Educate the public on installation of an Earthquake or Excess flow valve, why is important and how to obtain one, installation requirements. • Coordinate with the School District to make sure they have installed automatic shut off valves. • Install shut off valves on all City owned facilities. • Seek grant opportunities to fund program • Consider ordinance requiring for new construction	Building and Safety, Public Works	PPRO	2-4 years	So. Cal Edison, PDM	See Appendix C.
LS 1.2	Develop a feasibility study for slope stabilization for areas of slope failure concern, such as Mt. Vernon, along Barton Ave and at Vivienda and Burns Ave.	Landslides and rockslides have made roads impassable, trapping residents and preventing emergency service vehicles from getting to their destination as quickly as possible. Undercutting, sloughing, runoff and debris flow are concerns in many areas. **Possible Implementation Measures:** • Identify a consultant to prepare a feasibility study for slope stabilization. • Identify areas vulnerable to Land slide. • Prioritize areas that need to be stabilized.	Public Works/ Engineering	PRV	3-5 years	Grants, City Funding	See Appendix C.
LS 3.2	Perform earth / slope stabilization near landslide / rockslide / mudslide hazard zones, such as along the northern end of Mt. Vernon.	Just north of East Canal Street, sloughing occurs on both sides of Mt. Vernon Avenue. The area to the west is the City of Colton and the area on the east side is shared by the City of Grand Terrace and the City of Colton. The cut slope on the western side is unstable and will often cause landslides. **Possible Implementation Measures:** • Identify areas in Grand Terrace that are vulnerable to landslides. • Prioritize areas that need to be stabilized. • Apply soils stabilization measures, such as planting soil stabilization vegetation on steep slopes. • Establish flow control measures. • Install catch-fall nets for rocks at steep slopes. • Educate the public stabilization measures, types of planting soil and vegetation that can be utilized on their properties. • Seek grant opportunities for identified mitigation work	Public Works / Engineering	PRV, SP	Ongoing	Grants, City Funds	See Appendix C.

Action No.	ACTION	DESCRIPTION / BACKGROUND	RESPONSIBLE PARTY	ACTION TYPE	TIME FRAME	POTENTIAL FUNDING SOURCE	IMPLEMENTATION PLAN
LS 4.2	Develop public education and awareness material regarding vegetation and erosion control and provide resources for erosion control and slope failure on private properties.	Deep rooted vegetation can help prevent erosion, especially after natural disasters such as wildfire. **Possible Implementation Measures:** • Identify areas in Grand Terrace that are vulnerable to landslides. • Prioritize areas that need to be stabilized. • Apply soils stabilization measures, such as planting soil stabilization vegetation on steep slopes. • Establish flow control measures. • Install catch-fall nets for rocks at steep slopes. • Educate the public stabilization measures, types of planting soil and vegetation that can be utilized on their properties. • Provide a plant palette of plants that provides soil stabilization, and planting/spacing recommendations for effectiveness. • Educate via website and social media. Share the plant palette	Public Works/ Engineering	PE&A, NRP	1-2 years	PDM Grants, City Funds	See Appendix C.
WF 3.2	Continue the weed abatement program and fuel management and fuel reduction in open space, creeks, around critical facilities, and urban / wildland interface areas.	MAST provides an extensive Fuels Reduction Program. The Fuels Reduction Program began with removal of dead hazardous trees from areas threatening electrical transmission lines, evacuation routes, and structures within the San Bernardino Mountains. The Grand Terrace Code of Ordinances Chapter 8.72 gives the City the authority to remove trees in abandoned orchards if they constitute a fire hazard. **Possible Implementation Measures:** • San Bernardino has already identified the properties that are problematic. • Notices are sent to property owners with a deadline for cleanup. • Non-compliant properties are cleaned up by the county and the property owners are billed. • Continue to contract with SB County for weed abatement services. • Require fuel reduction as part of new development activities.	San Bernardino County	PRV, NRP	Ongoing	PDM Grants	See Appendix C.

Action No.	ACTION	DESCRIPTION / BACKGROUND	RESPONSIBLE PARTY	ACTION TYPE	TIME FRAME	POTENTIAL FUNDING SOURCE	IMPLEMENTATION PLAN
WF 3.1	Maintain and improve access to fire prone areas such as Blue Mountain.	Appropriate access for firefighting services is a necessary aspect of developing in a fire prone area. California Fire Code (CFC), California Vehicle Code (CVC) dictate standards for emergency access in communities across California. See: http://www.unidocs.org/fire/un-096.pdf The roads off of Observation Dr. heading towards Blue Mountain end in cul-de-sacs, limiting access for emergency vehicles. Access to Blue Mountain is currently limited to Blue Mountain Road. **Possible Implementation Measures:** • Identify property owners of the Blue Mountain. • Conduct quarterly inspections. • Conduct cleanup/maintenance regularly. • Annually inspect Blue Mountain Road to ensure access. • Annually contact responsible party to ensure road maintenance.	Public Works	SP, PRV	Ongoing	City funds, grants	See Appendix C.
WF 3.3	Repair/ replant vegetation on slopes after a fire to minimize the risk of landslides, mudslides or slope failure.	Vegetative cover, root depth, and root strength affect the extent to which landslides occur. Slope failures are much less common with deep-rooted vegetation than with grasses, and with dry soils than with soils that have been saturated by winter storms or overwatering. Deep rooted plants pump water out of the soil, leaving it free to absorb winter rains. Deep rooted vegetation such as California lilac, toyon, oak trees and sugar bush. **Possible Implementation Measures:** • Tracking and maintaining documents of areas vulnerability to wildfire. • Implement a City program to clean dead vegetation and plant fire resistant vegetation. • Where the City owns and controls property, implement erosion control measures on slopes after a wildfire. • Utilize code enforcement on private properties.	Public Works and County Fire Community Development	NRP, PRV	Varies	Private Property Owner	See Appendix C.
FL 1.3	Perform a feasibility study for stormwater drainage along Pico Ave.	Pico Ave. often floods, becoming impassable. A Drainage Study was performed in 2011 as part of the Grand Terrace Master Drainage Study. **Possible Implementation Measures:** • Review the 2011 Drainage Study • Prepare feasibility study, and prioritize recommendations. • Seek funding opportunities to phase improvements. • Require development to construct fair share of storm improvements.	Public Works/ Engineering	PRV, SP	Ongoing	PDM Grants	See Appendix C.

Action No.	ACTION	DESCRIPTION / BACKGROUND	RESPONSIBLE PARTY	ACTION TYPE	TIME FRAME	POTENTIAL FUNDING SOURCE	IMPLEMENTATION PLAN
FL 1.1	Perform a feasibility study for retention and detention of storm water to include water sensitive urban design.	Water-sensitive urban design (WSUD) is a land planning and engineering design approach which integrates the urban water cycle, including storm water, groundwater and wastewater management and water supply, into urban design to minimize environmental degradation and improve aesthetic and recreational appeal. **Possible Implementation Measures:** • Identify consultants • Identify areas vulnerable. • Enforce Building and Safety codes and Development Standards • Prepare feasibility study, and prioritize recommendations. • Seek funding opportunities to phase improvements. • Require development to construct fair share of storm improvements.	Public Works/ Engineering	PRV	3-5 years?	PDM Grants, City Funds	See Appendix C.
FL 3.1	Ensure undeveloped properties adhere to General Plan Land Use designations and flood plain preservation and risk reduction methodologies.	In urban areas like Grand Terrace, flood problems are intensified because new homes and other structures, and new streets, driveways, parking lots, and other paved areas decrease the amount of open land available to absorb rainfall and runoff, thus increasing the volume of water that must be carried away by waterways. Typical violations occur when private property owners or developers begin clearing vegetation on slopes, have large equipment on site that is altering the landform and/or impacting existing drainage conditions, and/or when soil is being deposited or excavated on site. Limiting future development in high hazard zones is crucial to mitigating the effects of flooding and preserving flood plains. **Possible Implementation Measures:** • Adopt and enforce Planning Development Standards and Building Codes. • Avoid/restrict/limit development on vulnerable floodplain areas. • Identify high flood risk areas in the City. • Encourage flood proof techniques on new and existing high vulnerable locations.	Planning, Building and Safety	PRV	Ongoing	City Funds	See Appendix C.

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