City of Bellflower
2017 Safety Element

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1.0 INTRODUCTION

The Safety Element is included in the General Plan. It must be prepared and adopted by cities, in accordance with California State law Government Code Section 65302(g), to identify and plan for potential future natural and human-caused safety issues, which could affect the residents of the City of Bellflower. The California State Legislature has placed specific responsibilities on local governments for identification and evaluation of seismic and other hazards and the formation of programs and regulations to reduce risk. The Safety Element of the Bellflower General Plan is designed to meet these responsibilities. This document is an update to the 1994 Bellflower General Plan Safety Element.

In essence, the Safety Element aims at reducing deaths, injuries, property damage, and economic and social dislocation resulting from natural, technological and human-caused hazards. The Safety Element evaluates potential risks associated with the effects of seismically induced surface fault rupture, co-seismic ground deformation, ground shaking, ground failure, and dam failure; slope instability leading to mudslides and landslides; subsidence and other known geologic hazards; flooding; fires; crime; terrorism; and hazardous materials. The Element also addresses evacuation routes, peak load water supply requirements, and minimum road widths and clearances around structures. Recent California legislation requires the inclusion of information on climate change. The climate change information in the updated Safety Element is drawn from the City's Climate Action Plan.

2.0 EXISTING CONDITIONS

COMMUNITY ADVANTAGES

The City of Bellflower has several existing conditions that provide the public with a safe living environment. Although the potential for damage resulting from future earthquakes cannot be ignored, Bellflower is characterized by a number of factors that tend to reduce earthquake hazards. Foremost among these are the relatively low density character of the community and the comparatively high level of seismic hazard awareness on the part of residents of the community and public officials.

Low density reduces the chances that any one fire would affect large numbers of people. The relative newness and low density form of the community are definite assets when perceived in terms of seismic susceptibility. Future intensification trends will benefit from modern seismic design strict adherence to the 2016 California Building Code, including Seismic Zone 4 structural requirements, setbacks, clearance and fire preventive devices, and construction technology, creating a positive environment for the total community.

Two other positives relating to the character of the City include near complete buildout of the City and its location on a generally level floodplain. For these reasons, the City is not susceptible to the dangers from brush fires, slope instability, general subsidence, differential settling, or erosion.

Two other advantages are the quality of the local fire control agency (Los Angeles County Fire Department) and the existence of many disaster response agencies that serve the City. The Fire Department is very highly rated and is willing to take advantage of new methods and equipment. They are also tied into a countywide response program that allows them to handle most emergencies. Mutual aid agreements combine the disaster response capabilities of many agencies and jurisdictions, including neighboring cities and counties enabling adequate responses to most foreseeable emergencies. The existing emergency response plans (Los Angeles County Operational Area Emergency Response Plan and the City's Emergency Operations Plan) provide the tools to coordinate the disaster response operations for response agencies and governments. During a major emergency when evacuation of residents is required, the City's contracted law enforcement provider, County of Los Angeles Sheriff Department, serves as the Lead Agency.

Public awareness of earthquake and fire hazards is another important consideration. The citizens are most cooperative in adhering to regulations and this awareness and cooperation contributes to understanding and cooperation during an actual emergency.

Approximately 98 percent of Bellflower, or 5.9 square miles has been committed to urban uses, including streets and highways. Local development patterns have historically been accompanied by gradual aging and intensification of uses in the older areas of the community. This trend is demonstrated by the fact that 93 percent of the total net additions to the City's housing inventory since the 1970 census have been multiple units. Like any urbanized area, the City is susceptible to a variety of seismic and fire-related hazards.

PEAKLOAD WATER SUPPLY

A related factor which could significantly affect response and recovery operations includes loss of adequate water for fire control purposes. The City maintains a 2,000,000-gallon water storage tank beneath the City Maintenance Yard. This water could be used in the event of an emergency. In addition, the City imposes peak load water supply requirements on various types of land uses in the City which are served by four (4) water companies, including Bellflower Municipal Water System, Bellflower Somerset Mutual Water Company, Bellflower Home Garden and Liberty Utilities. The peak load requirements are summarized in **Table 1**.

TABLE 1 – PEAKLOAD WATER SUPPLY REQUIREMENTS
SOURCE: BELLFLOWER DEPARTMENT OF PUBLIC SAFETY, 2015

LAND USE DESIGNATION	FIRE FLOW REQUIRED (GPM)	DURATION REQUIRED	FIRE HYDRANT SPACING
Low Density Residential (1-2 units)	1250-1500	2 hours	600 feet
Medium Density Residential (3 or more units)	2000-maximum based on size of development	2 hours	300 feet
High Density Residential 3 or more units	2000-maximum based on size of development	2 hours	300 feet
Commercial	2000-5000 hours	2 hours	300 feet
Industrial	2000-5000 hours	2 hours	300 feet
Institutional	2000-5000 hours	2 hours	300 feet

SCHOOLS

After the Long Beach Earthquake of 1933, the California State Legislature passed the Field Act, requiring all school structures to be earthquake resistant. There are no schools built prior to 1933 in operation in Bellflower.

Other considerations include the concentration of large student bodies within single structures, problems related to the supervision of younger children during post-disaster, and difficulties in reuniting children with their parents. The Bellflower Unified School District currently has a disaster plan that varies from resuming classes and sending children home on regular bus routes to holding children in schoolyards for parent pickup. The specific post-disaster action depends on the extent of area damage.

PRE-DISASTER RECOVERY PLANNING

The City's ultimate post-disaster survival will depend not only on the effectiveness of hazard mitigation and disaster response programs, but also on how quickly and how well the City is rebuilt after a major disaster. Without pre-planning, effective programs and options for rapid reconstruction will not be available in the immediate aftermath of an earthquake, fire, or other disaster.

A damaging disaster presents both problems and opportunities in urban land use management. For example, if there are larger areas of substantial damage, there may be need for short-term development. This would also provide opportunities for upgrading of the City through such measures as revised street and traffic patterns, parking, architectural and landscape design, and general land use compatibility. It would also provide an opportunity to mitigate specific hazards discovered in the disaster.

MANAGEMENT OF FUTURE DEVELOPMENT

Pursuant to the Bellflower Municipal Code, structures for human occupancy and otherwise must be designed and built to meet or exceed California Building Code (CBC) standards. The CBC provides minimum standards to protect property and public safety by regulating the design and construction of excavations, foundations, building frames, retaining walls, and other features to help mitigate the effects of seismic hazards. The CBC also provides additional seismic safety standards for schools, hospitals, infrastructure and critical facilities.

3.0 STATUTES AND REGULATIONS

CALIFORNIA BUILDING CODE

Building regulations are specified in Chapter 15.04 of the Bellflower Municipal Code, including adoption of the 2016 California Building Code (CBC). The 2016 CBC has been adopted by the City as Ordinance No. 1325 (City of Bellflower, 2016). Standard residential, commercial, and light industrial construction is governed by the CBC, which the city has amended and provided additions to. Due to the type, quality, and age of some of the city buildings, the 2016 State Historical Building Code (SHBC; is defined in CCR Part 8 of Title 24) applies to the strengthening of unreinforced historic structures, while the 1986 Unreinforced Masonry Law (Section 8875 et seq., of California's Government Code) applies to the identification, reporting, and retrofit of non-historic unreinforced masonry (URM) buildings. The CBC is included in Title 24 of the California Administrative Code and applies to all occupancies in California except for modifications adopted by state agencies and local governing bodies.

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONING ACT

The 1972 Alquist-Priolo Special Studies Zones Act resulted from the consequences of the Sylmar-San Fernando earthquake in 1971 and sought to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. The Act was renamed in 1994 to the Alquist-Priolo Earthquake Fault Zoning (APEFZ) Act. The Sylmar-San Fernando earthquake produced surface fault rupture damage along a zone that might have been identified in advance of the earthquake had the proper studies been mandated.
Lead agencies are responsible to regulate most development projects within the Earthquake Fault Zones as described in the Act, but may enact more stringent regulations. Certain smaller residential developments can be exempt. Bellflower currently has no APEFZ within the City or projecting toward the City from nearby. The leading edge of the Puente Hills buried thrust fault is just within the northern portion of the City. This buried thrust fault has been the subject of studies to assess its location and potential to cause co-seismic uplift and deformation of near surface materials that could damage overlying structures in ways that are similar to surface fault rupture.

SEISMIC HAZARDS MAPPING ACT

California's 1990 Seismic Hazards Mapping Act (SHMA; http://www.consrv.ca.gov/cgs/shzp) requires the State Geologist (CGS) to compile maps identifying and describing seismic hazard zones in California, with emphasis given to the urbanized areas in Los Angeles, Ventura and Orange counties in southern California, and Alameda, San Francisco, San Mateo and Santa Clara counties in northern California. As with the APEFZ Act, CGS is the primary State agency charged with implementing the SHMA, and CGS provides local jurisdictions with the 1 inch equals 2,000 feet scale seismic hazard zone maps that identify areas susceptible to a) liquefaction, b) earthquake-induced landslides, and c) in some areas amplified ground shaking.

Guidelines prepared by the State Mining and Geology Board identify the responsibilities of State and local agencies in the review of development within seismic hazard zones. Development on a site that has been designated as a seismic hazard zone requires a geotechnical report and local agency consideration of the policies and criteria established by the Mining and Geology Board. The overall goal is to protect the public by minimizing property damage and the loss of life.

The City of Bellflower has been mapped pursuant to the SHMA and there is required investigation for liquefaction hazard throughout the City of Bellflower (South Gate, Whittier, Long Beach, and Los Alamitos 7.5-minute USGS Quadrangles, 1998).

UNREINFORCED MASONRY BUILDING LAW

In 1986, California enacted a law that required local governments in Seismic Zone 4 to 1) inventory unreinforced masonry (URM) buildings, 2) establish a URM loss reduction program, and 3) report progress to the California Seismic Safety Commission (CSSC) by 1990. The CSSC monitors local government efforts to comply with this law and provides periodic status reports to the state's Legislature. This law can be found in Section 8875 *et sea,* of California's Government Code (1986). It allows each local government to choose its own type of loss reduction program. This leeway is, in part, intended to allow for each jurisdiction to take political, economic, and social priorities into account.

Most unreinforced masonry (URM) buildings possess features that can threaten lives during earthquakes. These include unbraced parapets, walls and roofs that are not well attached to each other, and when an earthquake occurs, masonry can fall, floors and roofs can collapse, and lives are put at risk. The law recommends that local governments:

- Adopt mandatory strengthening programs by ordinance.
- Establish seismic retrofit standards.
- Enact measures to reduce the number of occupants in URM buildings.

The City of Bellflower adopted the mandatory strengthening program by Ordinance, where eighteen of twenty-two URMs were strengthened to California Building Codes standards and four URMs were demolished. The City is in compliance with mitigation requirements.

CALIFORNIA ENVIRONMENTAL QUALITY ACT

The 1970 California Environmental Quality Act (CEQA) ensures that local agencies consider and review the environmental impacts of development projects within their jurisdictions. CEQA requires that an environmental document (e.g., Environmental Impact Report [EIR], Mitigated Negative Declaration [MND]) be prepared for projects that are judged in an Initial Study (IS) to have potentially significant effects on the environment. Environmental documents (IS, MND, EIR) must consider, and analyze as deemed appropriate, geologic, soils, and seismic hazards. If impacts are considered potentially significant, recommendation for mitigation measures are made to reduce geologic and seismic hazards to less than significant. This allows early public review of proposed development projects and provides lead agencies the authority to regulate development projects in the early stages of planning.

NATIONAL FLOOD INSURANCE PROGRAM

The Federal Emergency Management Agency (FEMA) administers the National Flood Insurance Program (NFIP). Participating jurisdictions must exercise land use controls and purchase flood insurance as a prerequisite for receiving funds to purchase or build a structure in a flood hazard area.

The City of Bellflower has participated in the program since 1979 and as of 2007, no special flood hazard areas have been identified in the City. The NFIP provides federal flood insurance subsidies and federally financed loans for eligible property owners in flood-prone areas. Bellflower is identified on the NFIP's Flood Insurance Rate Maps as being within Zone X, and thus subject to minimal flooding when a 100-year storm occurs.

NATURAL HAZARDS DISCLOSURE ACT

The Natural Hazards Disclosure Act (effective June 1, 1998), requires:

> *"that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone."*

The SHMA specifies two ways in which this disclosure can be made:

> *"c. In all transactions that are subject to Section 1103 of the Civil Code, the disclosure required by subdivision (a) of this section shall be provided by either of the following means:*
>
> *1. The Local Option Real Estate Transfer Disclosure Statement as provided in Section 1102.6a of the Civil Code.*
>
> *2. The Natural Hazard Disclosure Statement as provided in Section 1103.2 of the Civil Code."*

The Local Option Real Estate Disclosure Statement can be substituted for the Natural Hazards Disclosure Statement if it contains substantially the same information and substantially the same warning as the Natural Hazards Disclosure Statement. Both the APEFZ Act and the SHMA require that real estate agents or sellers of real estate acting without an agent disclose to prospective buyers that the property is located in an APEFZ or SHMZ One can determine if a property is within a SHMZ by going to the California Department of Conservation website, http://www.conservation.ca.gov/cgs/shzp/Pages/affected.aspx) (CGS, 2014).

4.0 CITY PLANS, PROGRAMS, AND SERVICES

CAPITAL IMPROVEMENT PLAN

The City of Bellflower conducts an annual review and update of its Capital Improvement Program (CIP). The Capital Improvement Program provides the primary planning and budget mechanism for improvement projects throughout the City. The CIP must provide consistency with City policies as set forth in the City's General Plan. Projects within the CIP typically include water, recycled water, sewer, storm drains and public right-of-way improvements.

HAZARD MITIGATION PLAN

The City of Bellflower Hazard Mitigation Plan provides a set of action items to reduce risks from hazards through education and outreach programs and foster the development of partnerships.

The resources and information within the Mitigation Plan:

- ✓ Establish a basis for coordination and collaboration among agencies and the public of City of Bellflower;
- ✓ Identify and prioritize future mitigation projects; and
- ✓ Assist in meeting the requirements of federal assistance programs.

EMERGENCY OPERATIONS PLAN

The emergency response capability within the City is geared primarily to non-disaster incidents, as such, law enforcement, fire, and public works capabilities will be overwhelmed in a large disaster.

Effective implementation of seismic policies will help reduce the magnitude of damage in an earthquake, but a variety of damage should still be anticipated. Effective response to a disaster or to a warning of disaster is essential to life saving and the reduction of subsequent property damage and social dislocation.

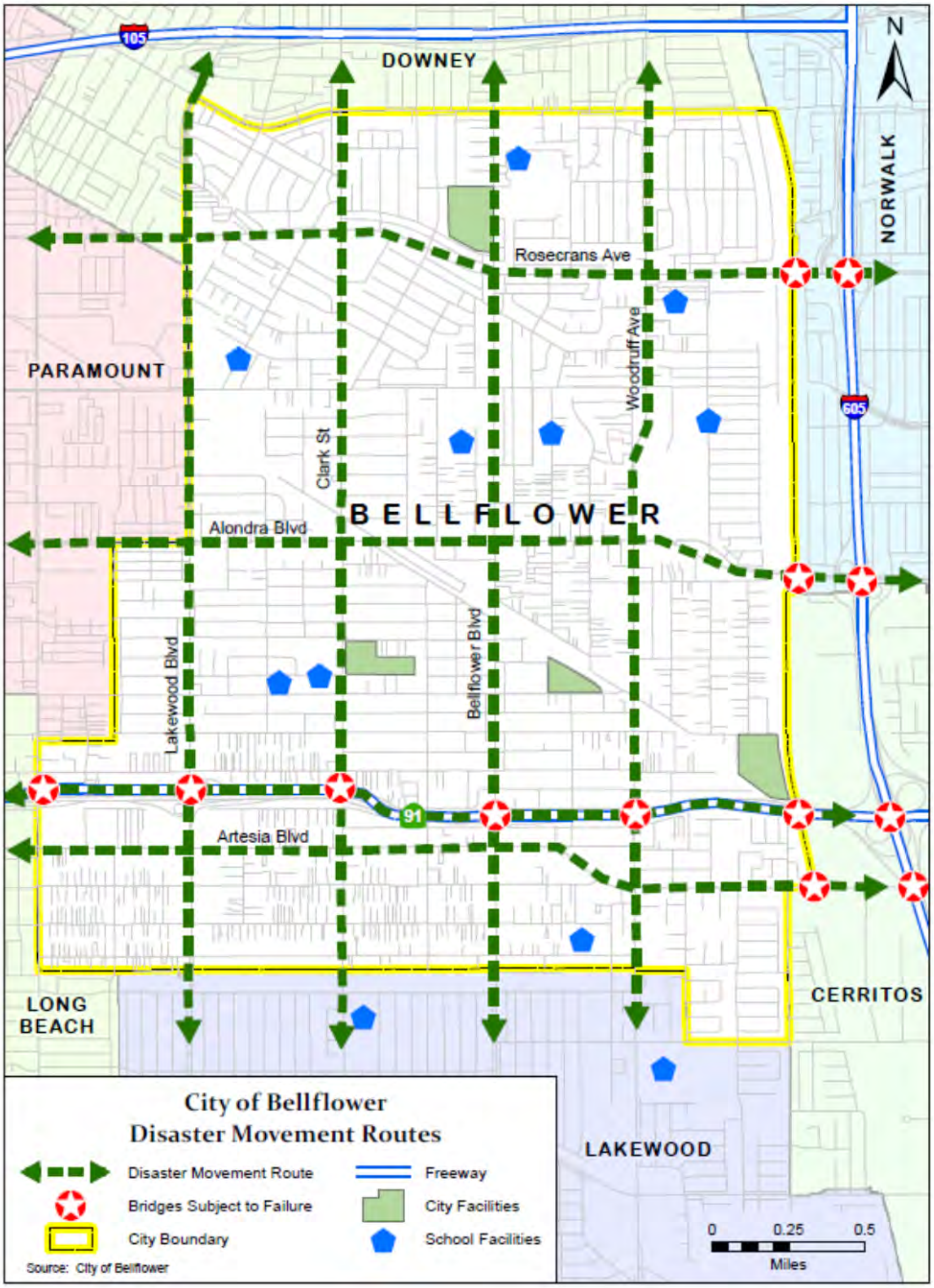
The field of emergency management has changed considerably since the early 1970's. In the mid-1990's following the devastating Tunnel Fire in the Oakland East Bay Hills, California passed legislation establishing statewide standards for emergency plans, training, and exercises. The Standardized Emergency Management System (SEMS) established standards now practiced by public jurisdictions throughout the State. More recently following the tragic events of September 11, 2001, the federal government developed the National Incident Management System (NIMS), which established SEMS-like standards for all jurisdictions in the United States.

The City of Bellflower's Emergency Operations Plan (EOP) updated in 2017, is a document which addresses the jurisdiction's planned response to extraordinary emergency situations associated with natural disasters, technological incidents, and human-caused events. The plan does not apply to normal day-to-day emergencies and the well-established and routine procedures used in coping with such emergencies. Instead, the operational concepts reflected in the plan focus on potential large-scale disasters that may generate unique situations requiring unusual responses. Such disasters pose major threats to life and property and can impact the well-being of large numbers of people.

The EOP is placed into effect immediately upon the existence or declaration of a state of emergency for the state or nation. It may also be placed into effect in case of local disaster by action of City officials. The Plan provides overall organizational and operational concepts for responding to various types of identified hazards. Included are listings of responsible response agencies, emergency action checklists for hazard specific responses, and operational data such as listings of resources, key personnel, and essential facilities. The Plan is updated on a periodic basis to improve disaster response and recovery operations.

In a major disaster, mutual aid sources in adjacent jurisdictions are likely to be fully committed to their own needs, and there may be substantial delays in the request and transport of assistance from more distant locations. Access to and egress from the City is likely to be inhibited by damage caused by the disaster and related congestion and accidents. Major problems can develop if adequate plans have not been made for emergency evacuation. This involves the identification of areas or structures requiring evacuation, determination of available evacuation routes and modes, and establishment of assembly points for displaced persons. The potential for widespread damage resulting from a major quake complicates evacuation efforts. Disaster Movement Route Map (also known as Evacuation Map) is shown on **Map 1**.

MAP 1 – DISASTER MOVEMENT ROUTES
SOURCE: EMERGENCY PLANNING CONSULTANTS



MINIMUM ROADWAY WIDTHS

The blockage of transportation corridors could result in the isolation of critically damaged areas. To ensure that emergency vehicles can gain access during emergency situations, minimum road widths must be established for each street classification identified in the General Plan Circulation Element (1994). Enforcing these standards prevents a street from becoming impassable for emergency vehicles, due to cars being parked too closely on a street. For these reasons, these standards should not be waived, and, any changes to these standards should be reviewed and approved by the Fire Department. These standards are listed in **Table 2**.

TABLE 2 – MINIMUM ROADWAY WIDTHS
SOURCE: BELLFLOWER CIRCULATION ELEMENT

STREET CLASSIFICATION	RIGHT-OF-WAY	ROADWAY WIDTH
Major Highway	82-100 feet	62-84 feet
Secondary Highway	70-80 feet	50-64 feet
Collector	60-64 feet	30-40 feet
Local	50-60 feet	30-40 feet

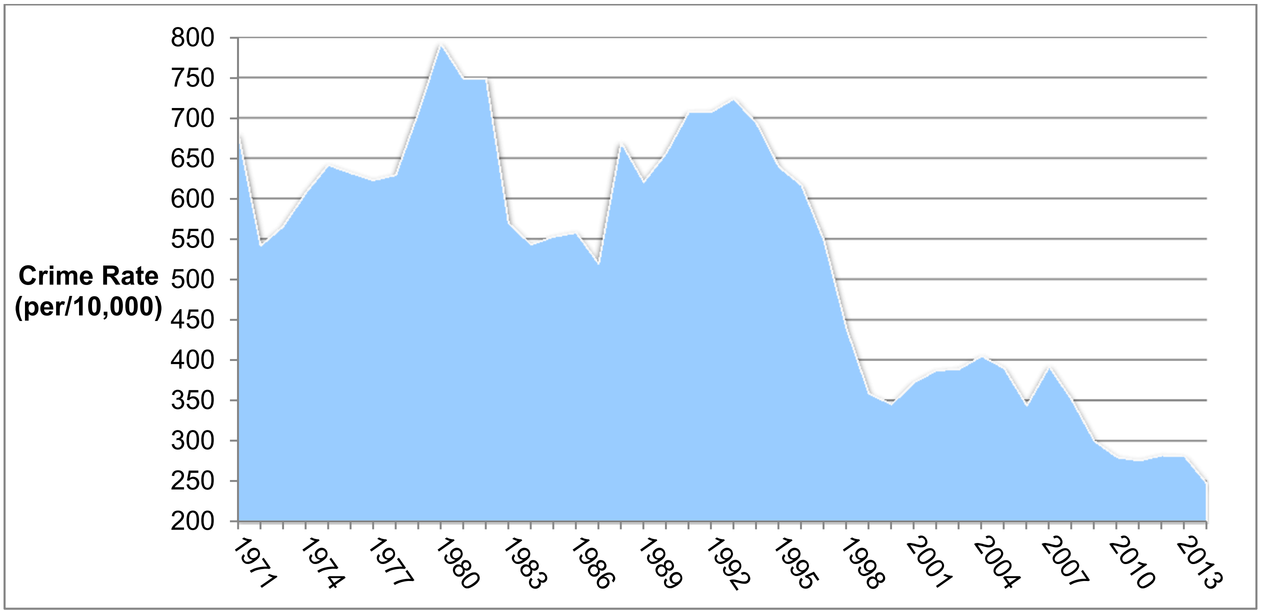
COMMUNITY SERVICES

Public Safety

Bellflower residents and businesses enjoy a very safe community. Under the direction of the Director of Public Safety, the City's Public Safety Department is responsible for management of the City's public safety and community policing programs. These include Bellflower's law enforcement services contract with the Los Angeles County Sheriff's Department and contracts for law enforcement support services, including patrol helicopter, animal control, district attorney, probation, crossing guard, and special legal services. The mission of the Public Safety Department is to "protect and serve the Bellflower community by providing timely, efficient and effective law enforcement and law enforcement support services."

Since the incorporation of the City of Bellflower in 1957, the City has contracted with the Sheriff's Department for law enforcement services. Historically, these services were provided with little or no participation by the City in the determination of the manner, means, quantity or quality of the service. During the next 35 years, the City's population increased significantly from approximately 45,909 in 1960 to 61,815 in 1990. Along with population increase, crime rates also increased not just in Bellflower but nationwide. From 1984 to 1993, the Part 1 Crime Rate (the index of the most serious crimes against persons and property) increased by more than 35%. From 1986 to 1987 alone, the Crime Rate increased by 29%.

FIGURE 1 – BELLFLOWER PART I CRIME RATE 1971 – 2014 (44 YEAR TREND)
SOURCE: BELLFLOWER DEPARTMENT OF PUBLIC SAFETY



In 1991, a local resident and his fiancée were driving home at midnight when their car was hit by rocks being thrown by a group of young people. The driver, a lifelong Bellflower resident, got out of his car to confront the rock throwers and was shot and killed. The 29-year-old victim, a respected member of our community, had no history of criminal activity or gang involvement.

The subsequent investigation identified two individuals, both active gang members, with criminal records, as the probable killers. Due to a lack of sufficient evidence, they escaped prosecution. This random act of violence became the catalyst that brought the community, its government and its Sheriff's Department together to redefine our approach to crime and crime prevention.

In 1993, the City and Sheriff's Department began our transition to a community policing approach to public safety. Significant additional resources were committed and the City assumed an active role in our partnership with the Sheriff's Department. From the 1992-93 fiscal year to 1993-94, the City's budget for public safety and community policing increased by 33%. In the following years, the City and Sheriff Department's commitment to community policing and the safety and welfare of our community has continued to grow.

Community Policing

Community policing is the foundation of Bellflower's entire public safety program. Research over the past twenty-five years has shown the need to look for long-term solutions in resolving persistent and recurring community problems. Studies indicate that in many communities, 30 percent of the calls for service emanate from 10 percent of the locations in the City. Because a good portion of a deputy's time is spent responding to the same locations repeatedly, a problem oriented approach is necessary.

Using this approach, deputies assigned to the City of Bellflower look beyond the individual call for service and address the underlying problems that create them. For example, a particular location may be experiencing a narcotics use problem, but the underlying cause is that the building has been allowed to fall into disrepair, inviting criminal activity. Once the underlying cause is identified, deputies are expected to look for and apply tailor-made solutions to the problem. At times the solution to a problem may not be found in the realm of the criminal justice system. Because of this, they are not only encouraged to utilize the wide range of City resources available, but also those found throughout the community. These community resources include schools, churches, service clubs, non-profit organizations, and local businesses.

Community Policing is based on the cooperative resolution of community safety problems, when the root cause has been identified. Citizens and deputies will participate in, and be responsible for, strategy design and problem solving that emphasizes comprehensive responses to public safety issues. The key to problem solving is a joint effort by deputies and citizens using both public and private resources. These resources are dictated by the uniqueness of the problem and its most effective resolution. Essential to this process are deputies with good interpersonal skills who take a sincere interest in, and are sensitive to the needs of the citizens of the City of Bellflower.

In order for the needs of the City to be met effectively, communication between City and Sheriff's personnel and members of the community is essential. Through their combined efforts, it is expected that crime within the City will decrease. This can only be achieved by having dedicated, efficient personnel working toward the same goals. It is very important that the deputies feel that this is their City, and in return the citizens must feel as if the Sheriff's personnel are in fact the City's “Police Department”.

Neighborhood Watch

Neighborhood Watch is a national crime prevention program that enlists the active participation of citizens in cooperation with law enforcement and municipal authorities. In Bellflower, the program has taken the form of a partnership among the City's residents, businesses, staff, and the deputies of the Los Angeles County Sheriff's Department. For many years, Neighborhood Watch has been a cornerstone of Bellflower's Community Policing Program.

Neighborhood Watch involves neighbors getting to know each other, which does not happen as easily in these busy times as it did in the past. Without the trust built by close acquaintance, the communication and cooperation essential to an effective program probably will not occur. When neighbors are comfortable with each other, they are much more likely to share information, work together to improve conditions on their block, and look out for their neighbors' families and property. Neighborhood Watch encourages regular meetings, as well as get-togethers such as seasonal block parties to help build this closeness and trust.

Neighborhood Watch involves communication, both among neighbors and with law enforcement. There will always be a limited number of deputies patrolling Bellflower, and most of the time they are answering calls for service, one after the other, with little time left over for random patrol. Therefore, the best information about what is happening on a given block will always come from the residents. For Neighborhood Watch to work, there must be a resolution among neighbors to share this information, and to call law enforcement whenever there is a need.

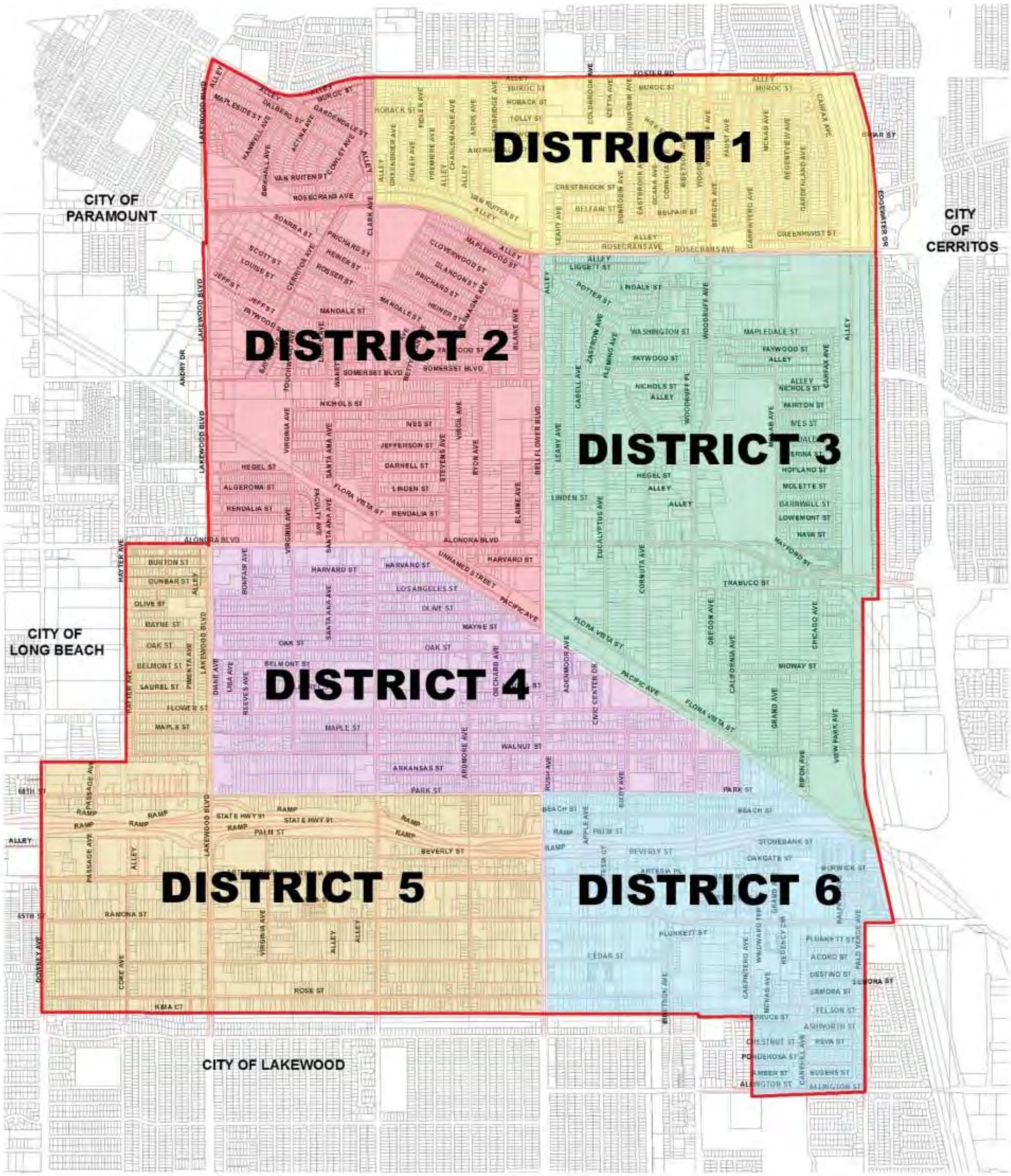
Neighborhood Watch involves education. In addition to motivating participants to observe and report criminal activity, the program teaches them how to be most effective in doing so. In Bellflower, there are a number of resources besides the Sheriff's Department available to aid residents in preventing crime and eliminating unwanted conditions in their area, and many people only learn about these through participation in Neighborhood Watch. The program teaches people strategies for more effective personal, vehicle, and home security. Many of these could be labeled as just common sense, for example reminding drivers to lock their passenger-side doors when driving alone. It certainly is common sense, but an occasional reminder can serve to shake people out of their complacency and possibly prevent them from becoming victims.

Finally, Neighborhood Watch involves a change of attitude. Regardless of how many crime stories appear in the newspaper or on television, the attitude persists that crime only happens to the other person. Almost certainly, the victims in these stories felt the same way, at least they did until it happened to them. To be effective, citizens must admit to themselves that there will always be victimizers out there, that they are just as likely to be the target of these people as anyone else is, and that they can largely prevent themselves from becoming victims, by paying attention and taking a few relatively simple steps. There is no desire to create widespread paranoia within our community, but it is an established fact that criminals seek out those who are unprepared for them. Neighborhood Watch helps people to become better prepared.

Citywide participation in Neighborhood Watch is perhaps the best means of sending a message to criminals that Bellflower's residents are informed, prepared, and committed to a safe and crime-free community.

The City of Bellflower is divided into six Neighborhood Watch Districts as shown on **Map 2**.

MAP 2 – NEIGHBORHOOD WATCH DISTRICTS
SOURCE: BELLFLOWER DEPARTMENT OF PUBLIC SAFETY



Crime Statistics

The majority of crimes within the City are property crimes, the largest occurring property crime being larceny, followed by grand theft auto. Only a small percentage of crimes in Bellflower are violent crimes as shown in **Table 3**.

The City of Bellflower is divided into seven Crime Reporting Districts (**Map 3**). As of April 2016, two Special Assignment Officers were assigned to each District. They are responsible for the individual concerns and problems in their Reporting District and work closely with Neighborhood Watch groups. **Table 4** depicts the 2013 crime rates for each of Bellflower's seven Crime Reporting Districts. For 2013, Reporting District 1335 had the highest percentage (24 percent) of reported Part I Crimes, Reporting District 1336 had the lowest percentage (7 percent) of reported Part I Crimes.

TABLE 3 – SUMMARY OF PART I CRIMES
SOURCE: BELLFLOWER DEPARTMENT OF PUBLIC SAFETY

Crime	1993	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016 YTD Feb.	2016 Est	Percent Change	
																	15-16	93-16
Criminal Homicide	4	6	2	7	5	5	7	3	1	4	5	1	2	1	1	6	500.0%	50.0%
Forcible Rape	29	22	21	13	14	25	11	15	23	14	11	9	8	21	5	30	42.9%	3.4%
Robbery	385	217	218	245	236	241	228	232	172	115	138	105	97	152	25	150	-1.3%	-61.0%
Aggravated Assault	731	222	228	262	211	224	261	271	197	151	149	164	186	199	24	144	-27.6%	-80.3%
Burglary, Residential	424	288	315	259	218	349	253	279	282	361	313	271	289	248	27	162	-34.7%	-61.8%
Burglary, Non-Resid.	486	191	232	201	246	175	179	115	124	123	137	156	122	204	30	180	-11.8%	-63.0%
Burglary, Vehicle	503	590	586	505	425	583	491	336	366	356	333	303	244	283	62	372	31.4%	-26.0%
Larceny/Theft	965	711	675	623	589	698	593	436	520	536	562	665	585	533	103	618	15.9%	-36.0%
Grand Theft Auto	1,138	710	821	883	695	718	665	620	475	453	516	487	384	557	102	612	9.9%	-46.2%
Arson	22	20	21	11	12	13	20	12	7	9	10	13	6	13	6	36	176.9%	63.6%
Total Part I Crimes	**4,687**	**2,977**	**3,119**	**3,009**	**2,651**	**3,031**	**2,708**	**2,319**	**2,167**	**2,122**	**2,174**	**2,174**	**1,923**	**2,211**	**385**	**2,310**	4.5%	**-50.7%**
Bellflower Population	**64,700**	**76,449**	**76,996**	**77,252**	**77,141**	**77,189**	**77,110**	**77,194**	**77,312**	**76,840**	**76,907**	**77,289**	**77,741**	**78,106**	**78,106**	**78,106**	**0.0%**	**20.7%**
Crime Rate per 10,000	**724.42**	**389.41**	**405.09**	**389.50**	**343.66**	**392.67**	**351.19**	**300.41**	**280.29**	**276.16**	**282.68**	**281.28**	**247.36**	**283.08**	**N/A**	**295.75**	**4.5%**	**-59.2%**

Key to Classifications	
Classification	**Definition and/or Examples**
Part I Crimes	
Criminal Homicide	The willful (non-negligent) killing of one human being by another. Excludes attempts, fetal deaths, and traffic fatalities.
Forcible Rape	The act of a man having sexual intercourse with a woman forcibly and against her will. Excludes sexual attacks on males, statutory rape, incest, forcible sodomy, sexual assault with an object, etc.
Robbery	The taking of anything of value from the care, custody, or control of a person or persons by force or threat of force or violence and /or by putting the victim in fear.
Aggravated Assault	An unlawful attack by one person upon another for the purpose of inflicting severe or aggravated bodily injury. This type of assault usually is accompanied by the use of a weapon or by means likely to produce death or great bodily harm.
Burglary	The unlawful entry or attempted entry of a structure to commit a felony or theft. Includes apartment, barn, house trailer or houseboat when used as a permanent dwelling, office, railroad car (but not automobile), stable, and vessel (i.e., ship).
Larceny Theft	The unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another. Excludes automobile theft, embezzlement, fraud, counterfeiting, check fraud, etc.
Grand Theft Auto	The theft or attempted theft of a motor vehicle.
Arson	Any willful or malicious burning or attempt to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.
SOURCE: LOS ANGELES COUNTY SHERIFF'S DEPARTMENT	

MAP 3 – BELLFLOWER CRIME REPORTING DISTRICTS
SOURCE: BELLFLOWER DEPARTMENT OF PUBLIC SAFETY

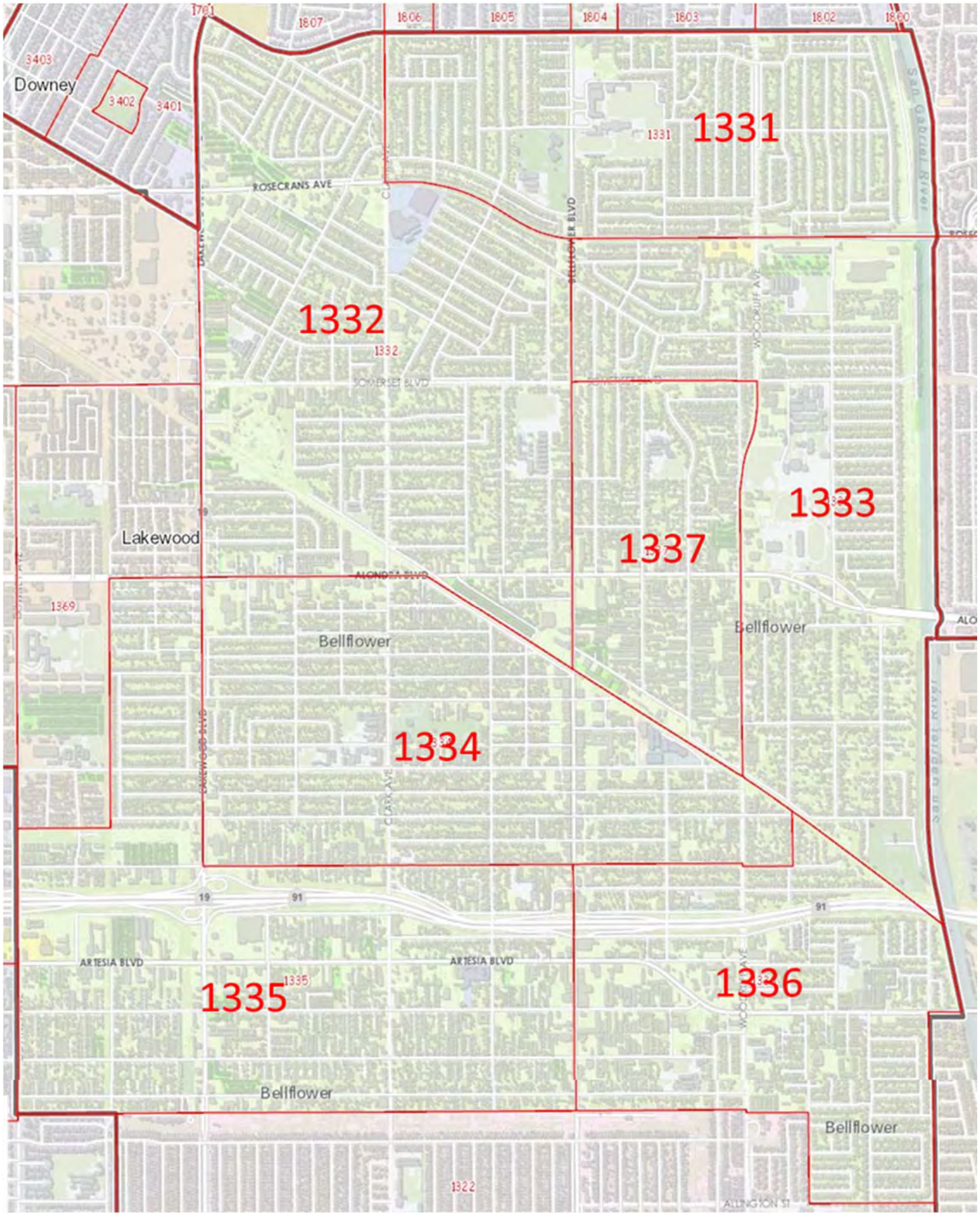


TABLE 4 – BELLFLOWER INCIDENTS BY CRIME REPORTING DISTRICT - 2013
SOURCE: LOS ANGELES COUNTY SHERIFF'S DEPARTMENT

REPORTING DISTRICTS:	1331	1332	1333	1334	1335	1336	1337	8597	8836	Total
PART I CRIMES										
Criminal Homicide	0	1	1	0	0	0	0	0	0	2
Forcible Rape	1	1	1	1	3	0	2	0	0	9
Robbery	7	17	7	25	30	4	15	0	0	105
Aggravated Assault	7	30	13	26	60	10	22	0	0	168
Burglary	47	77	44	86	92	39	42	0	0	427
Larceny Theft	124	197	122	176	210	69	71	0	0	969
Grand Theft Auto	48	80	50	96	133	37	45	0	0	489
Arson	0	4	2	1	3	0	3	0	0	13
SUBTOTAL	**234**	**407**	**240**	**411**	**531**	**159**	**200**	**0**	**0**	**2,182**

REPORTING DISTRICTS:	1331	1332	1333	1334	1335	1336	1337	8597	8836	Total
PART II CRIMES										
Forgery	4	6	5	15	24	3	9	0	0	66
Fraud and NSF Checks	17	27	19	44	46	14	22	0	0	189
Sex Offense, Felony	6	5	5	2	15	5	7	0	0	45
Sex Offense, Misdemeanor	1	4	4	4	7	5	1	0	0	26
Non-aggravated Assault	34	43	26	62	95	36	52	0	0	348
Weapon	7	9	5	16	18	3	5	0	0	63
Offense Against Family	5	4	2	9	12	2	3	0	0	37
Narcotic	71	109	60	133	231	65	51	0	0	720
Liquor/Tobacco	0	0	1	0	0	0	0	0	0	1
Drunk - Alcohol/Drug	6	7	2	12	31	7	8	0	0	73
Disorderly Conduct	1	3	2	4	6	1	4	0	0	21
Vagrancy/Quality of Life	0	0	0	0	0	0	0	0	0	0
Gambling	0	0	0	0	0	0	0	0	0	0
Drunk Driving - Vehicle/Boat	7	23	19	9	39	2	7	0	0	106
Vehicle/Boating	43	84	66	165	217	43	44	0	0	662
Vandalism	25	34	42	65	86	26	40	0	0	318
Warrant	0	0	0	0	0	1	0	0	0	1
Receiving Stolen Property	0	2	1	4	2	1	1	0	0	11
Federal Offense Without Money	0	0	0	0	0	0	0	0	0	0
Federal Offense With Money	1	0	1	2	5	1	0	0	0	10
Felony, Miscellaneous	9	9	6	12	20	7	14	0	0	77
Misdemeanor, Miscellaneous	6	8	4	10	15	7	10	0	0	60
SUBTOTAL	**243**	**377**	**270**	**568**	**869**	**229**	**278**	**0**	**0**	**2,834**

REPORTING DISTRICTS:	1331	1332	1333	1334	1335	1336	1337	8597	8836	Total
NONCRIMINAL INCIDENTS										
Person Missing or Found	9	41	20	40	58	12	37	0	0	217
Juvenile, Noncriminal	32	63	40	57	103	27	61	0	0	383
Commitment	0	0	0	0	0	0	0	0	0	0
Miscellaneous, Noncriminal	165	401	299	619	633	272	240	0	0	2,629
Suicide and Attempt	0	2	2	1	6	1	3	0	0	15
Mentally Ill	3	10	6	8	17	1	5	0	0	50
Accident, Traffic - Vehicle/Boat	57	116	60	103	186	61	50	0	0	633
Accident, Miscellaneous	3	9	7	8	7	4	2	0	0	40
Person Dead	4	6	3	2	12	2	4	0	0	33
SUBTOTAL	**273**	**648**	**437**	**838**	**1,022**	**380**	**402**	**0**	**0**	**4,000**

TOTAL	**750**	**1,432**	**947**	**1,817**	**2,422**	**768**	**880**	**0**	**0**	**9,016**

Fire

The Los Angeles County Fire Department (LACoFD) provides fire protection and emergency medical services for the unincorporated parts of Los Angeles County, California as well as 58 cities, including the City of Bellflower. Fire stations 23 (fire engine) and 98 (fire engine and paramedic squad) are located within City limits.

TABLE 5 – BELLFLOWER THREE-YEAR FIRE STATISTICAL SUMMARY 2013-2015
SOURCE: LOS ANGELES COUNTY FIRE DEPARTMENT

COUNTY OF LOS ANGELES FIRE DEPARTMENT
CITY OF BELLFLOWER
THREE-YEAR STATISTICAL SUMMARY

	2013	2014	2015
FIRE INCIDENTS			
Structures	36	52	61
Vehicles	26	18	28
Rubbish	54	41	37
Brush/Grass	11	10	8
Miscellaneous Property	11	13	13
Total Fire Incidents	138	134	147
Average Response Time	4:35	4:19	4:23
EMERGENCY MEDICAL SERVICES			
Total EMS Incidents	4,556	4,843	5,387
Average Response Time	4:34	4:37	4:32
OTHER INCIDENTS			
False Alarms	426	363	350
Misc. Incidents	358	398	497
Total Other Incidents	784	761	847
TOTAL INCIDENTS	5,478	5,738	6,381
HEALTH HAZ MAT			
Total Emergency Responses	2	4	1

FIRE LOSS IN DOLLARS	2013		2014		2015	
	Property Loss	Content Loss	Property Loss	Content Loss	Property Loss	Content Loss
Structure	$ 37,450	$ 7,100	$ 451,350	$ 159,900	$ 155,050	$ 81,210
Vehicle	$ 45,000	$ 10,300	$ 59,850	$ 450	$ 143,200	$ 12,850
Miscellaneous	$ 5,040	$ -	$ 100	$ 30	$ 4,400	$ 1,150
Total Dollar Loss	$ 87,490	$ 17,400	$ 511,300	$ 160,380	$ 302,650	$ 95,210

PERSONNEL SERVING THE CITY

1 Deputy Fire Chief
1 Assistant Fire Chief
3 Battalion Chiefs
1 Community Services Rep.

City Stations	Apparatus	Daily On-Duty Staffing
23	Engine 23	1 Captain, 1 Fire Fighter Specialist, 2 Fire Fighters
98	Engine 98	1 Captain, 1 Fire Fighter Specialist, 1 Fire Fighter Paramedic
	Paramedic Squad 98	2 Fire Fighter Paramedics

Animal Control

The City of Bellflower contracts with the Southeast Area Animal Control Authority (SEAACA), an animal care agency providing effective and comprehensive animal directed programs for the animals and citizens in the communities served.

The objective of SEAACA's Field Operations is to promote public safety through the control of the animal population and to reduce the risk of human exposure to rabies or other animal transmitted diseases. The Field Operations Division is also charged with encouraging Responsible Pet Ownership through public education and enforcement of state and local laws or ordinances.

Animal Control Officers service the communities on a patrol, response or on-call emergency basis twenty-four hours a day. While on duty, the officers perform many services ranging from the impoundment of stray animals to investigating violation of laws pertaining to animal welfare. The SEAACA receives an average of 200-300 requests for service per month within the City.

Emergency Medical

Emergency Medical Services are provided through the contract with Los Angeles County Fire Department.

Hospitals

Bellflower residents are served by several hospitals located outside the City. The closest major hospitals include: Lakewood Regional Medical Center and Kaiser Permanente Downey Medical Center.

Kaiser Permanente Downey Medical Center
The Kaiser Permanente Downey Medical Center, opened in 2009, is the newest hospital in the area in more than four decades. The six-story hospital compromises 342-beds in an approximately 70,000 square foot leading edge facility.

Lakewood Regional Medical Center
Lakewood Regional Medical Center is a general medical and surgical hospital in Lakewood, CA, with 153 beds.

Patient populations are commonly characterized by physical or mental disabilities. Such disabilities inhibit the patient's capacity to react during a crisis. In instances where there is a large population of dependent individuals, the number of supervisory or custodial personnel is usually inadequate to provide sufficient aid and guidance in times of emergency.

5.0 HAZARDS

Hazards were prioritized utilizing FEMA's Calculated Priority Risk Index (CPRI) hazard ranking technique. The hazard ranking system is described in **Table 6**, while the actual rankings are shown in **Table 7**.

Prioritizing Hazards

- The CPRI value is obtained by assigning varying degrees of risk to four categories for each hazard, and then calculating an index value based on a weighting scheme.
- The four criteria in the CPRI are Probability (45%), Magnitude/Severity (30%), Warning Time (15%) and Duration (10%).
- For each of the criteria, there are four (4) options from which to choose: 1,2,3,4. Zero (0) is the value taken when an option is not assigned.

CPRI Example:

CPRI: Earthquake - Puente Hills Fault M7.1

- **Probability** = Likely = 3
- **Magnitude/Severity** = Critical = 4
- **Warning Time** = Less than 6 hours = 4
- **Duration** = Less than 6 hours = 1

Here's how to calculate the CPRI for an earthquake occurring on the Puente Hills Fault for the City of Bellflower:

CPRI = [(3 x 0.45) + (4 x 0.30) + (4 x 0.15) + (1 x 0.10)] = 3.25

TABLE 6 – CALCULATED PRIORITY RISK INDEX RANKING
SOURCE: FEDERAL EMERGENCY MANAGEMENT AGENCY

CPRI Category	Degree of Risk			
	Level ID	Description	Index Value	Assigned Weight Factor
Probability	Unlikely	Extremely rare with no documented history of occurrences or events. Annual probability of less than 1 in 1,000 (<0.1%)	1	**45%**
	Possibly	Rare occurrences. Annual probability between 1 in 1,000 and 1 in 100 (0.1%-1%)	2	
	Likely	Periodic occurrences with at least 2 or more documented historic events. Annual probability of between 1 in 100 and 1 in 10 (1%-10%)	3	
	Highly Likely	Frequent events with a well-documented history of occurrence. Annual probability of greater than 1 in 10 (>10%)	4	
Magnitude/ Severity	Negligible	Negligible property damages (less than 5% of critical and non-critical facilities and infrastructure owned by the Jurisdiction). Injuries or illnesses are treatable with first aid and there are no deaths. Negligible loss of quality of life. Shut down of critical public facilities for less than 24 hours.	1	**30%**
	Limited	Slight property damage (greater than 5% and less than 25% of critical and non-critical facilities and infrastructure owned by the Jurisdiction). Injuries or illnesses do not result in permanent disability, and there are no deaths. Moderate loss of quality of life. Shut down of critical public facilities for more than 1 day and less than 1 week.	2	
	Critical	Moderate property damage (greater than 25% and less than 50% of critical and non-critical facilities and infrastructure owned by the Jurisdiction). Injuries or illnesses result in permanent disability and at least 1 death. Shut down of critical public facilities for more than 1 week and less than 1 month.	3	
	Catastrophic	Severe property damage (greater than 50% of critical and non-critical facilities and infrastructure owned by the Jurisdiction). Injuries and illnesses result in permanent disability and multiple deaths. Shut down of critical public facilities for more than 1 month.	4	
Warning Time	> 24 hours	Population will receive greater than 24 hours of warning.	1	**15%**
	12–24 hours	Population will receive between 12-24 hours of warning.	2	
	6-12 hours	Population will receive between 6-12 hours of warning.	3	
	< 6 hours	Population will receive less than 6 hours of warning.	4	
Duration	< 6 hours	Disaster event will last less than 6 hours.	1	**10%**
	< 24 hours	Disaster event will last less than 6-24 hours.	2	
	< 1 week	Disaster event will last between 24 hours and 1 week.	3	
	> 1 week	Disaster event will last more than 1 week	4	

TABLE 7 – CALCULATED PRIORITY RISK INDEX RANKING
SOURCE: EMERGENCY PLANNING CONSULTANTS

Hazard	Probability	Weighted 45% (x.45)	Magnitude Severity	Weighted 30% (x.3)	Warning Time	Weighted 15% (x.15)	Duration	Weighted 10% (x.1)	CPRI Totals
EQ - Puente Hills Fault M7.1	3	1.35	4	1.2	4	0.6	1	0.1	3.25
EQ - Newport-Inglewood M6.9	3	1.35	4	1.2	4	0.6	1	0.1	3.25
EQ - Whittier-Elsinore M6.8	3	1.35	3	0.9	4	0.6	1	0.1	2.95
Residential Fires	4	1.80	1	0.3	4	0.6	2	0.2	2.90
Drinking Water Contamination	2	.90	3	0.9	4	0.6	3	0.3	2.70
Commercial Fires	3	1.35	1	0.3	4	0.6	2	0.2	2.45
Industrial Fires	3	1.35	1	0.3	4	0.6	2	0.2	2.45
Dam Failure	1	.45	4	1.2	2	0.3	4	0.4	2.35
Terrorism	2	.90	2	0.6	4	0.6	2	0.2	2.30
Hazardous Materials	1	.45	3	0.9	4	0.6	2	0.2	2.15
Power Line Failure	2	.90	1	0.3	4	0.6	3	0.3	2.10
Flood	2	.90	2	0.6	2	0.3	2	0.2	2.00
Gas Pipeline Explosion	1	.45	2	0.6	4	0.6	3	0.3	1.95
Wildland and Urban Fires	1	.45	3	0.9	1	0.15	2	0.2	1.70

GEOLOGIC, SEISMIC, AND SOIL CONDITIONS

The geologic, seismic, soils, and flooding conditions within and adjacent to the City of Bellflower (City) are summarized in this section. Information is derived from readily available technical documents detailed in Diaz•Yourman & Associates/Wilson Geosciences Inc. (2014). Specifically, hazards arising from the geologic, seismic, and dam failure-induced flooding conditions are discussed in this section. The occurrence of these events within or near the City, have the potential to significantly affect the population and property in the City. These events and their potential impacts are the basis for establishing the goals, policies, and implementation actions located later in the Safety Element.

The technical issues identified should be taken into account as the City of Bellflower expands, fills in, and redevelops. Existing building codes and land use planning requirements can address most of the hazards inherent in the geologic setting of the City. As newer, more accurate geologic, soils, and seismic information was developed since the last General Plan update, it is now possible to identify additional areas in the City which may be vulnerable to natural hazards, and account for the hazards in future development. Sources for information provided range from generalized regional reports and maps to City project-specific geotechnical, engineering geology, and environmental remediation reports.

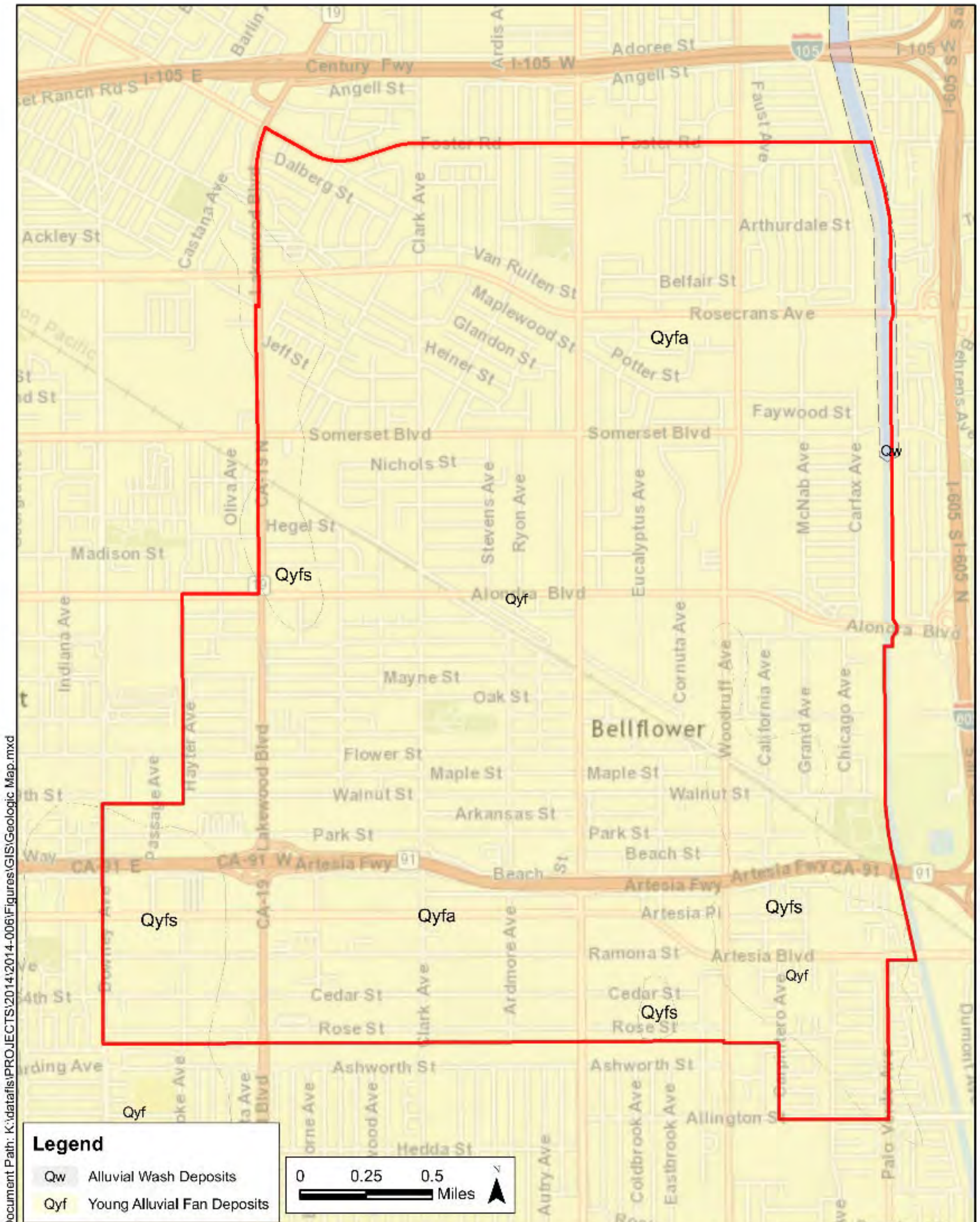
Specific issues included in the geology, seismic, soils, and flooding analysis are generally limited to the boundaries of Bellflower except for elements of seismicity which have a much broader effect on the scope of the study, including:

- A discussion of the general stratigraphy (rock type and age), and the structural geology (earth structure, faults and folds).
- The classification and location of active and potentially active faults throughout Southern California which may affect Bellflower.
- An assessment of the major seismic parameters for ground and surface motion.
- An evaluation of the potential for ground failure or other seismically induced damage to the ground surface.
- A review of historic earthquakes (historic seismicity) for Southern California as they affect Bellflower.

Geology and Soils

The distribution of surficial units on **Map 4** shows the three identified units based on California Geotechnical Survey ([CGS], formerly California Division of Mines & Geology [CDMG], 1998a, 1998b, 1998c, and 1998d) and Saucedo and others (2003). The youngest unit (map symbol Qw) has a limited distribution associated with most recent deposition from the San Gabriel River along the northeastern edge of the City. The next oldest unit (Qyfa) will underlie most of the City at shallower depths. The third, and oldest, unit exposed is Qyfs having relatively limited map distribution as isolated patches in the northwestern, southwestern, and southeastern portions of the City. The older Qfys deposits were uplifted due to fault movements, or broader regional uplift, and the younger Qyfa sediments were deposited on alluvial fans and within stream courses cutting through and around these slightly more elevated areas (Diaz•Yourman & Associates/Wilson Geosciences, 2014).

MAP 4 – GEOLOGIC MAP
SOURCE: DIAZ•YOURMAN & ASSOCIATES



References: Geologic Map of the Long Beach 30' x 60' Quadrangle, California, 2003. Saucedo, G.J. and others. California Geological Survey

TABLE 8 – GEOLOGIC UNITS
SOURCE: CALIFORNIA DEPARTMENT OF CONSERVATION

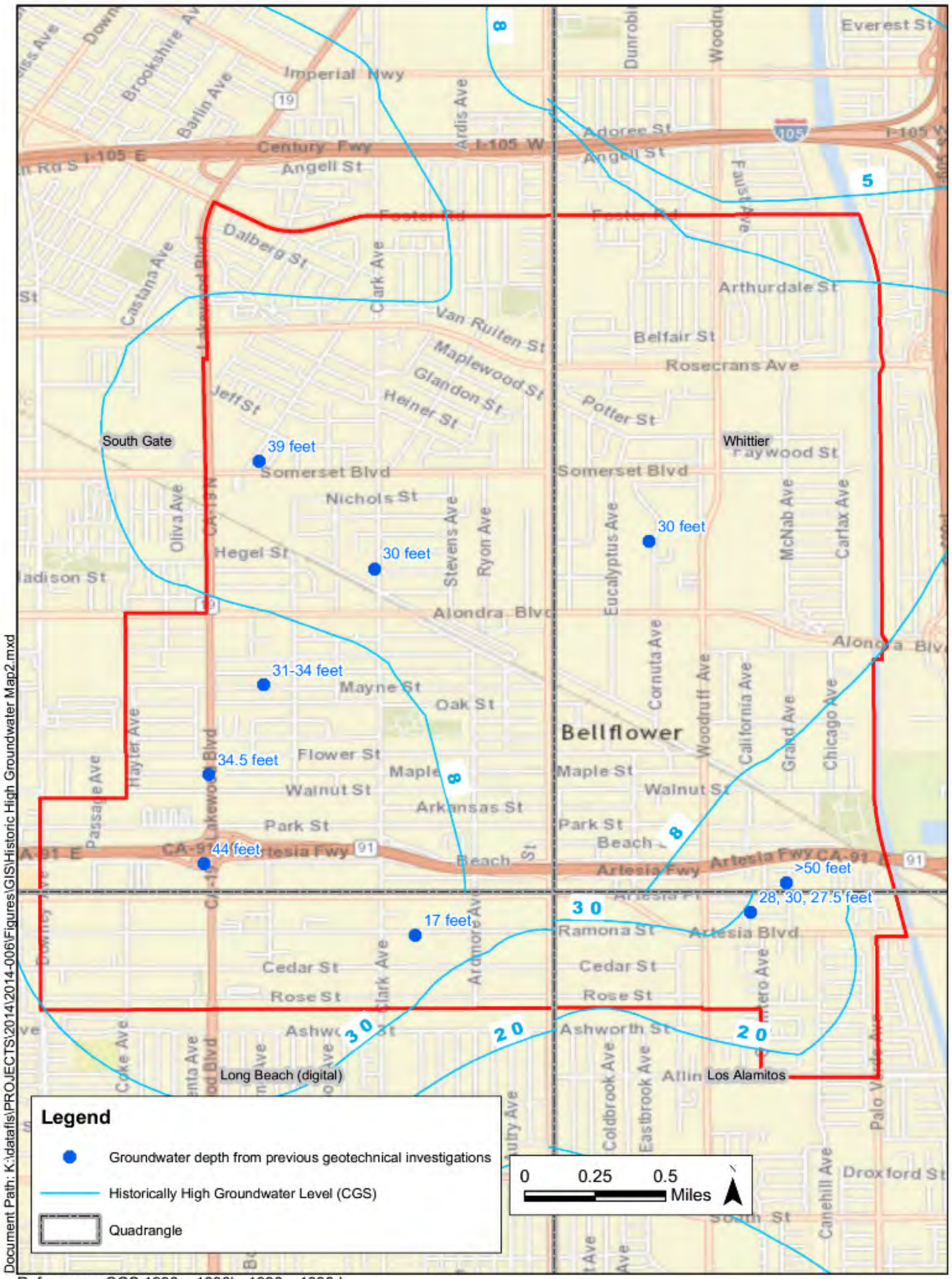
Unit	Description
Qof	**Old Alluvial Fan Deposits** - slightly to moderately consolidated, moderately dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon.
Qyf	**Young Alluvial Fan Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected boulder, cobble, gravel, sand, and silt deposits issued from a confined valley or canyon.
Qyfs	**Young Alluvial Fan and Valley Deposits** - silt
Tss	**Coarse-grained Tertiary age formations** - primarily sandstone and conglomerate.
Qw	**Alluvial Wash Deposits** - unconsolidated sandy and gravelly sediment deposited in recently active channels of streams and rivers; may contain loose to moderately loose sand and silty sand
Qya	**Young Alluvial Valley Deposits** - unconsolidated to slightly consolidated, undissected to slightly dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers
Qoa	**Old Alluvial Valley Deposits** - slightly to moderately consolidated, moderately dissected clay, silt, sand, and gravel along stream valleys and alluvial flats of larger rivers

The entire City consists of alluvial fan and floodplain deposits, of the San Gabriel River. The San Gabriel River along the eastern City boundary was channelized in a straight concrete lined channel. The original naturally wandering channels apparently were filled when the channel was straightened. The locations of the original channels and the quality of the fills are unknown.

Groundwater within the City may be rather shallow (semi-perched aquifer) or deeper for potable groundwater. Studies prepared by CGS provide groundwater depth maps compiled from multiple sources are summarized in **Map 5**. These maps indicate historically highest groundwater levels (shallowest depths) from about 8 feet to over 30 feet in the City. Reports in the City records generally identify shallow groundwater in the range of 12 to 55 feet bgs, with the deepest areas in the north portion of the City based on a well in Downey along Imperial Highway (Diaz•Yourman & Associates/Wilson Geosciences, 2014).

There was some historic oilfield development within the City boundaries. The Department of Oil, Gas and Geothermal Resources (DOGGR) maps indicate there have been at least six idle and abandoned oil wells within the City.

MAP 5 - HISTORICALLY HIGH GROUNDWATER
SOURCE: DIAZ•YOURMAN & ASSOCIATES



References: CGS 1998a, 1998b, 1998c, 1998d

EARTHQUAKE FAULTS, GROUND SHAKING, AND LIQUEFACTION

Faults

Only one documented fault, fault zone, or groundwater barrier is known to directly underlie the City of Bellflower, the Puente Hills Blind Thrust (PHT) Fault Zone. There is limited direct local evidence of different potential impacts, and information regarding degree of activity and damage-generating potential by the PHT. The PHT poses a potential ground surface co-seismic deformation hazard in the northern portion of the City, as shown on **Map 6**. In order of most to least potential damage, the faults of most concern to the City are the following:

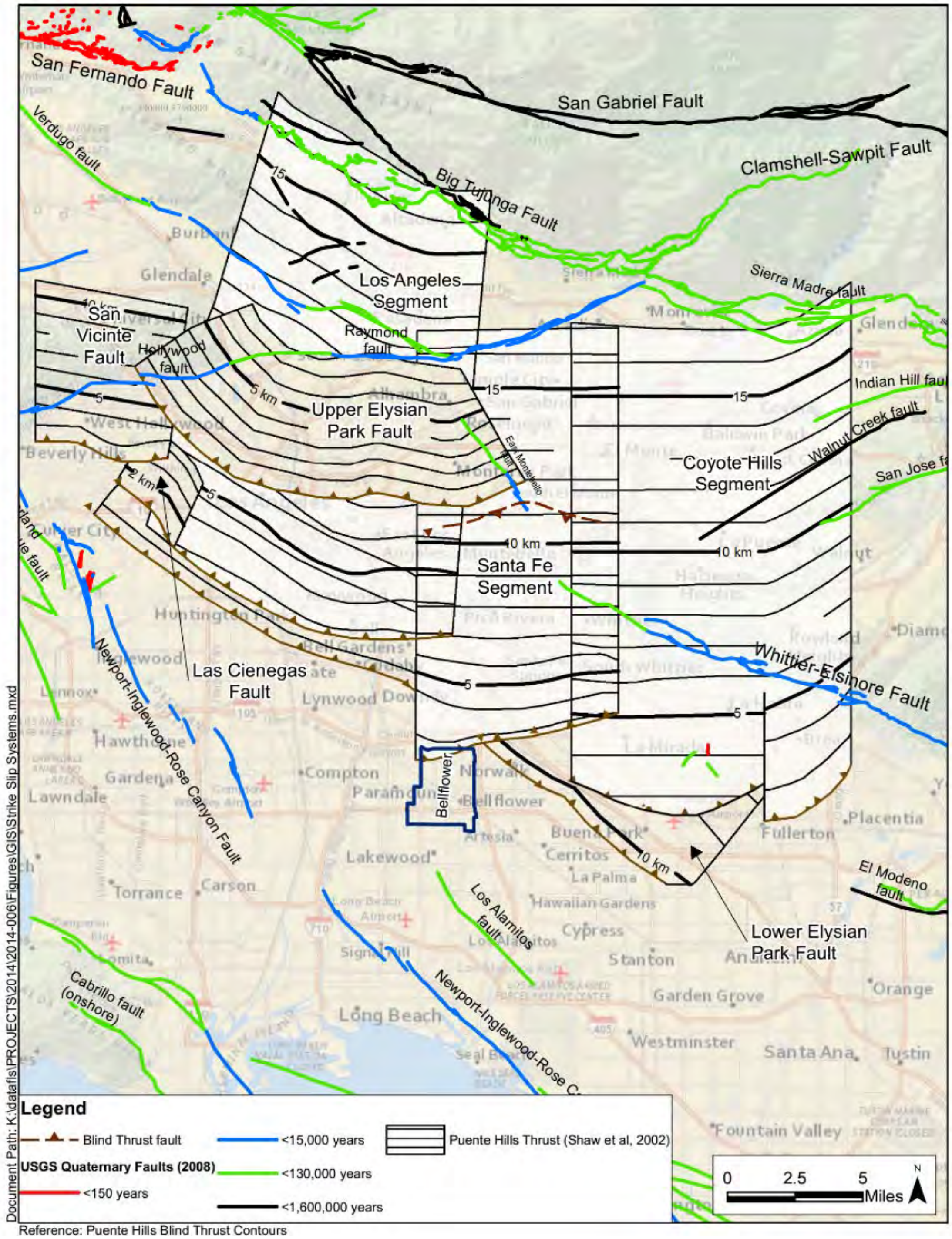
- Puente Hills (blind thrust)
- Newport-Inglewood (strike-slip surface fault)
- Whittier-Elsinore (strike-slip surface fault)

The expected return period for such large earthquake events is very long, probably several thousand years. Various levels of uncertainty relative to the location and the potential for future movement (in a timeframe that may impact planned development in the City) characterize all of the faults identified above (Diaz•Yourman & Associates/Wilson Geosciences, 2014).

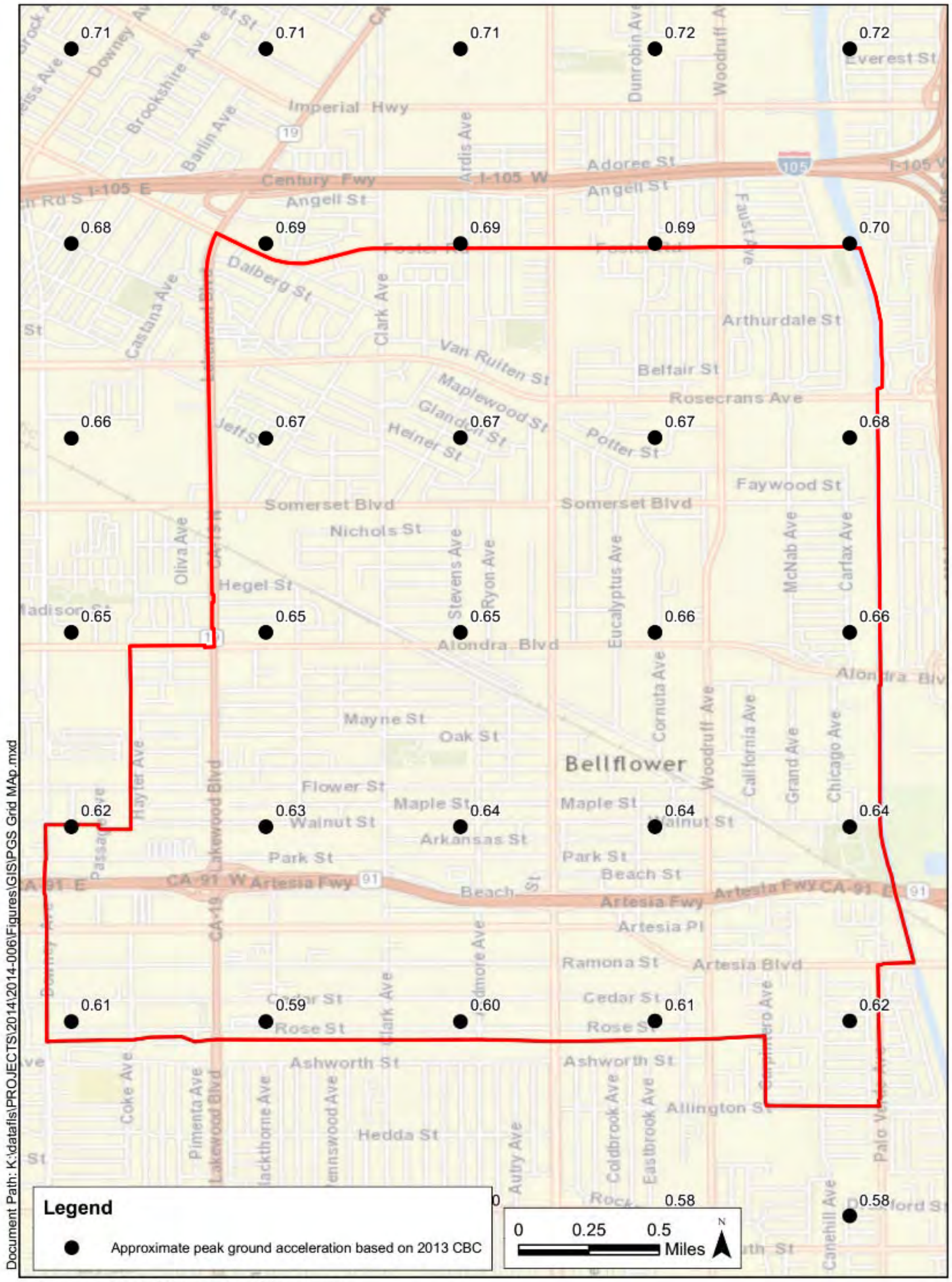
Ground Shaking

Abundant evidence of seismic activity in California is found in the 200 years of records since Gaspar de Portola reported a strong earthquake while camped near the Santa Ana River in Orange County in 1769. The effect of an earthquake is most often presented as the severity of ground shaking, in terms of peak ground acceleration (PGA), which is the recorded spectral acceleration at the ground surface. The PGA is presented as the percentage of the force of gravity, which is termed “1g” for one unit of gravitational force, or 100% gravity. Therefore, 0.50g is 50% the force of gravity. Ground-shaking estimates of peak horizontal acceleration provided in **Map 7** are based on CBC 2013 site class B, but can change based on site specific geological features. Values are estimated and rounded to the nearest 0.01g. This peak horizontal acceleration could result in severe to violent shaking and moderate to heavy damage. The effects of the geology, e.g., “soil sites,” can change the actual ground acceleration for specific locations. Therefore, site-specific geology, geotechnical, and earthquake engineering studies are mandatory for evaluating critical, sensitive, or high-occupancy structures.

MAP 6 - FAULT MAP
SOURCE: DIAZ•YOURMAN & ASSOCIATES



MAP 7 - PGA GRID MAP
SOURCE: DIAZ•YOURMAN & ASSOCIATES



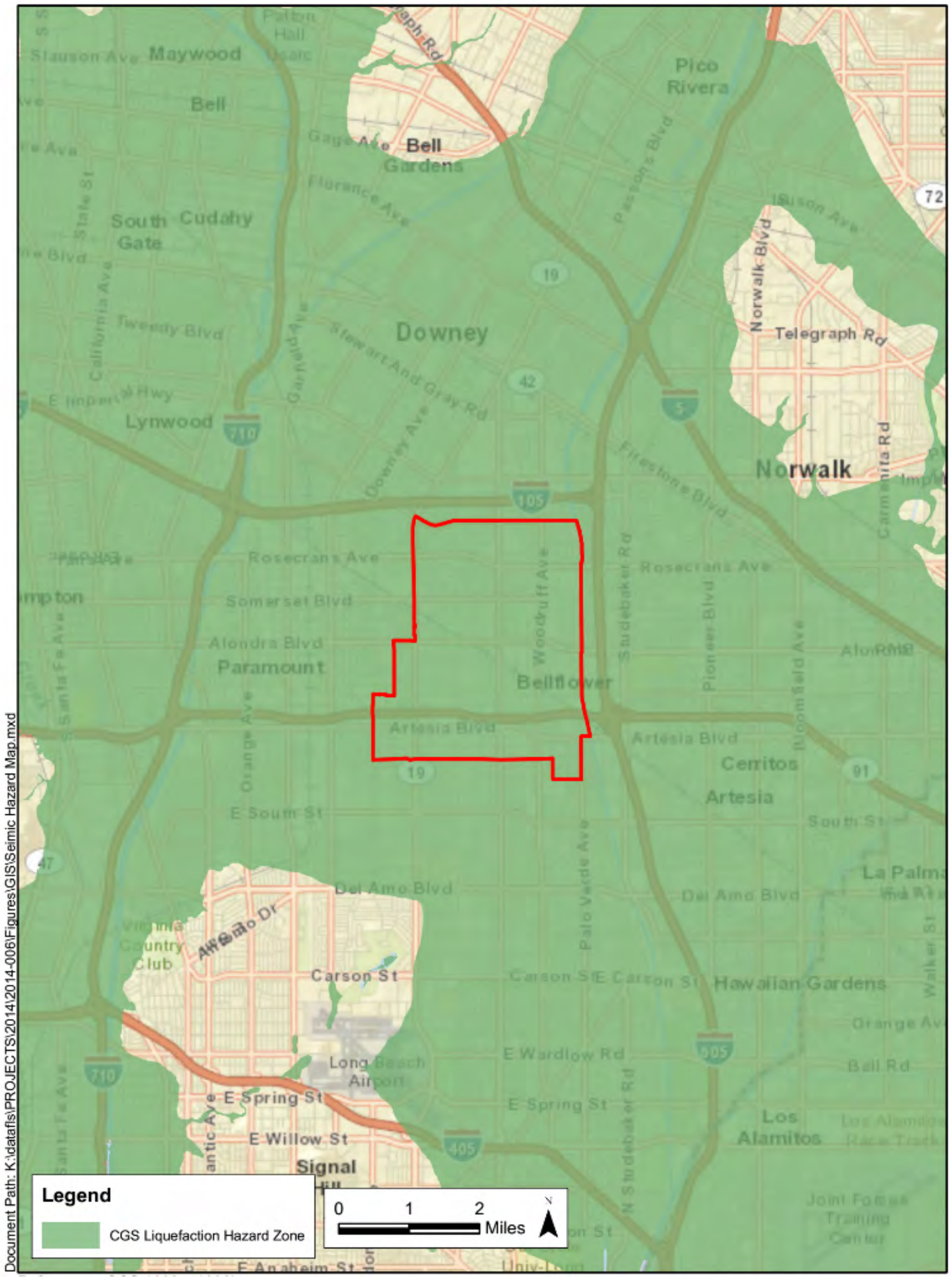
References: CGS 1998a, 1998b, 1998c, 1998d

Liquefaction

All of the City of Bellflower is susceptible to liquefaction, a very destructive secondary effect of strong seismic shaking. Liquefaction occurs primarily in saturate, loose, and fine to medium-grained soils in areas where the ground water table is 50 feet or less below the ground surface. When these sediments are shaken, such as during an earthquake, a sudden increase in pore water pressure causes the soils to lose strength and behave as a liquid. Excess water pressure is vented upward through fissures and soil cracks causing a water-soil slurry to bubble onto the ground surface. The resulting features are called sand boils, sand blows or "sand volcanoes." Liquefaction-related effects include loss of bearing strength, ground oscillations, lateral spreading, and flow failures of slumping (Yerkes, 1985).

Within the City and immediately adjacent areas of influence, the liquefaction areas are identified on **Map 8** corresponding to alluvial deposits Qw, Qyfa, and Qyfs indicated within the City (Map 1) and historically shallow groundwater is illustrated on **Map 5**. These areas with shallowest groundwater (8 to 30 feet bgs) tend to be in the south (higher potential) and deepest (30 to 55 feet bgs) in the north. Although there is some potential for deep liquefaction greater than about 50 below ground surface, liquefaction potential is substantially higher where water is less than 50 feet deep.

MAP 8 – LIQUEFACTION HAZARD ZONES
SOURCE: DIAZ•YOURMAN & ASSOCIATES



FLOODING

The San Gabriel River Channel lies adjacent and east of the City, and is designed to contain a 100-year flood. The Channel is fully operational and is maintained by the U.S. Army Corps of Engineers (USACE) and the Los Angeles County Department of Public Works (County). The construction of San Gabriel River improvements in 1947 reduced the local area's risk of flooding, and LACDA studies performed by the USACE have shown no deficiencies along the San Gabriel River in the vicinity of the City of Bellflower.

The City participates in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The NFIP prepares a Flood Insurance Rate Map (FIRM) that identifies the flooding potential in the City as depicted on **Map 9** (FEMA 2008) for a 100 year flood (1 percent chance of occurring in any year) and a 500 year flood (0.2 percent chance of occurring in any year).

Slope Stability/Flooding

Since the City is relatively flat, no slope stability problems are anticipated. The only major slopes within the City are the engineered fills of the Artesia 91 Freeway.

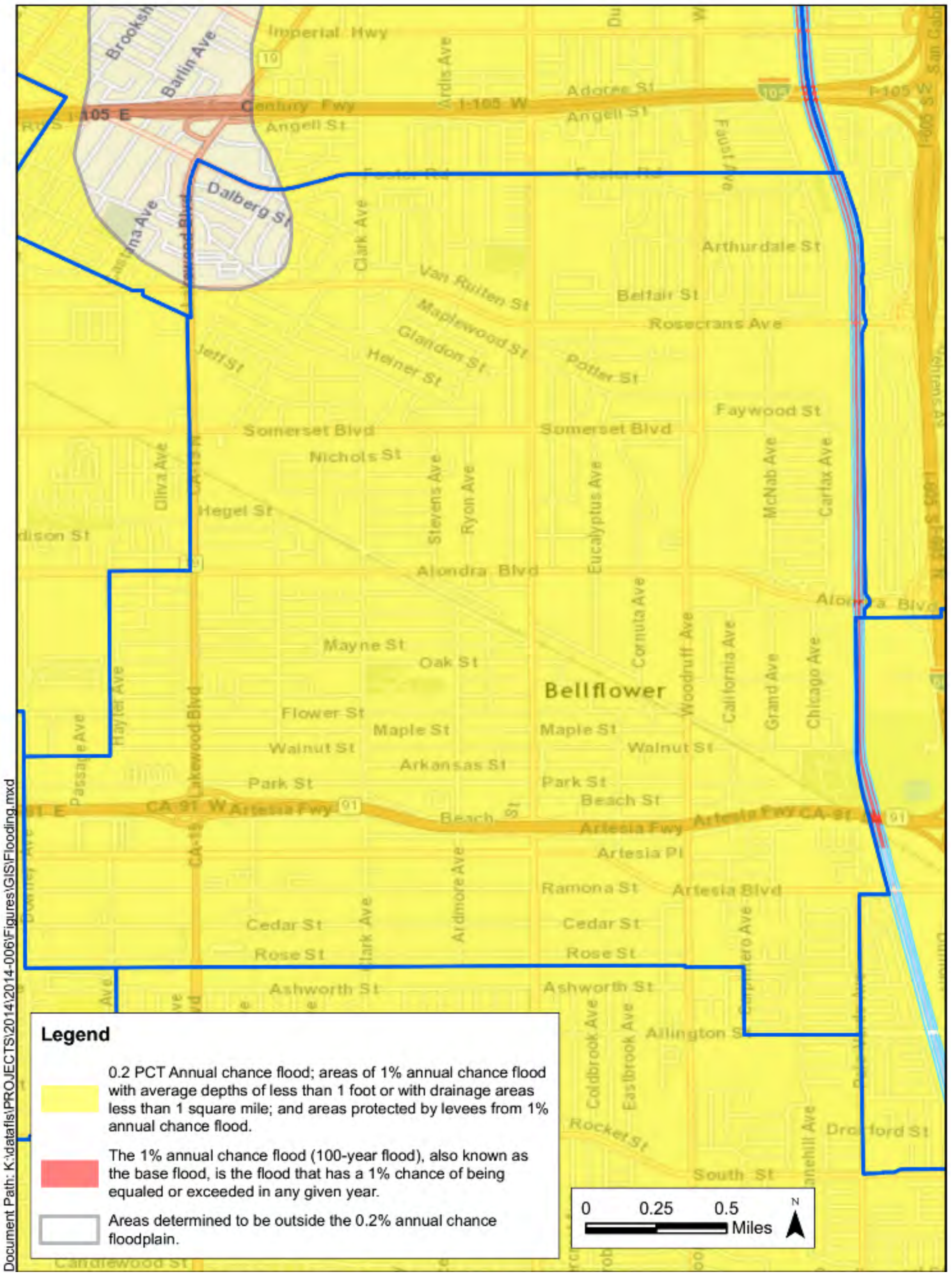
The flow rate within the Los Angeles County Drainage Area (LACDA) flood control channels for a 100-year flood in downtown Los Angeles is 118,000 cubic feet of water per second (cfs) and at the Los Angeles River mouth is 174,000 cfs, the flow rate for a 500-year flood in downtown Los Angeles is 177,000 cfs; and at the Los Angeles River mouth is 227,000 cfs. The flow rate outside the flood control channels is minimal.

According to the "Los Angeles County Drainage Review," prepared by the U.S. Army Corps of Engineers, dated June 1992, Bellflower is within the Los Angeles River's 100-year floodplain. This is due to deficiencies along the Los Angeles River Channel to the west of the City. The study assessed and analyzed the problems facing LACDA and considered design improvements to the LACDA system. A concurrent study was performed by the Federal Emergency Management Agency (FEMA). The City of Bellflower participates in the National Flood Insurance Program providing federal insurance to those structures, both residential and commercial, located within the 100-year floodplain (provided all new structures comply with FEMA regulations).

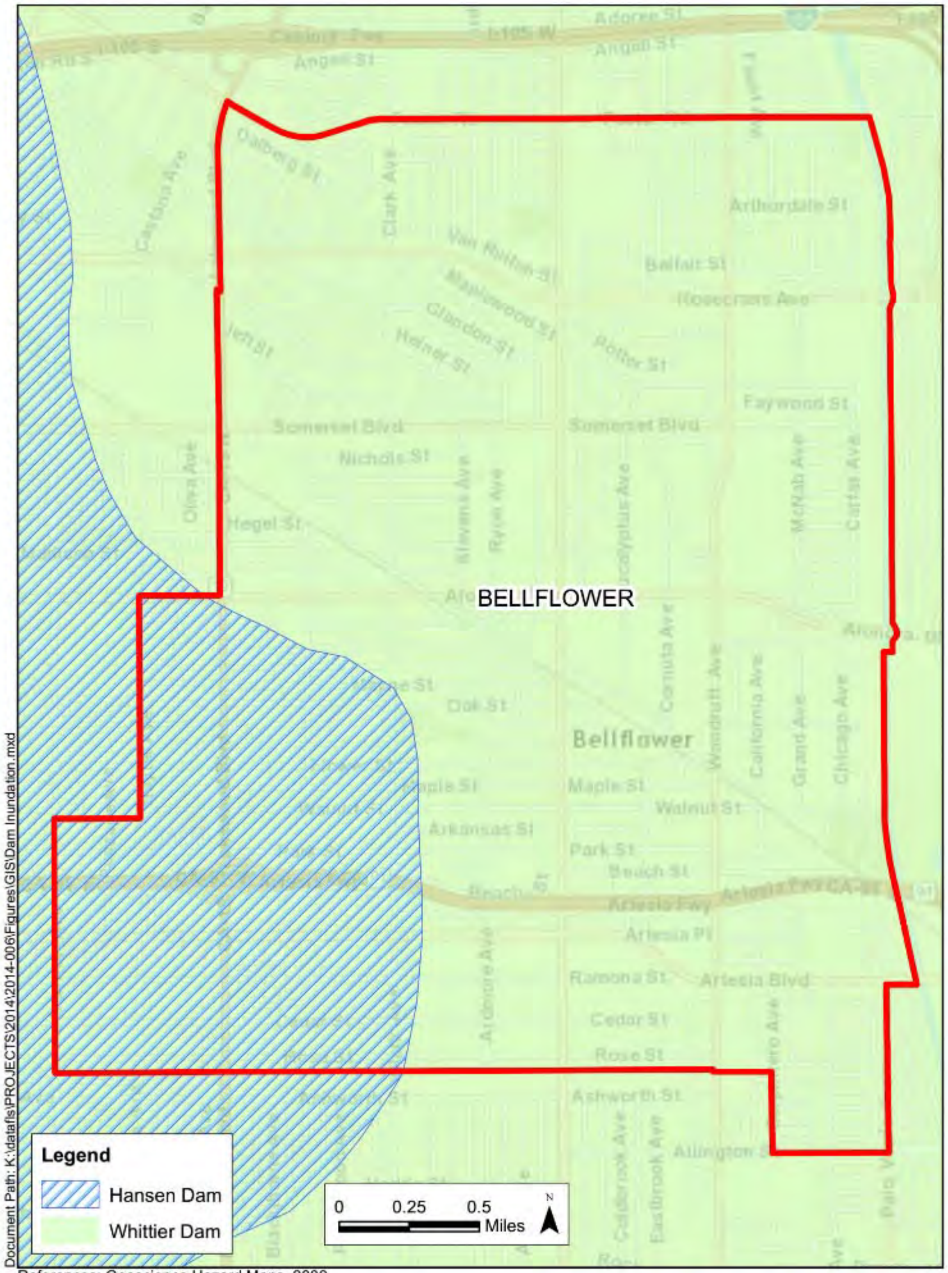
DAM FAILURE INUNDATION

The Whittier Narrows Dam and Hansen Dam could both potentially impact the City of Bellflower. The Whittier Narrows Dam is located on the San Gabriel and Rio Hondo Rivers three miles northwest of the City of Whittier. The entire City of Bellflower is within the dam inundation zone as shown on **Map 10**. If the Whittier Narrows Dam failed, water would reach Bellflower in fifteen hours, and would be four feet deep.

MAP 9 - FLOOD HAZARDS
SOURCE: DIAZ•YOURMAN & ASSOCIATES



MAP 10 – DAM INUNDATION MAP
SOURCE: DIAZ•YOURMAN & ASSOCIATES



References: Geoscience Hazard Maps, 2009

CLIMATE CHANGE

Climate includes patterns of temperature, precipitation, humidity, wind and seasons. Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. “Climate change” refers to seasonal changes over a long period of time. It is generally perceived in the emergency management profession that climate change will have a measurable impact on the occurrence and severity of natural hazards around the world. Impacts include:

- Sea ice and snow cover losses will continue, and declining snowpack will affect snow-dependent water supplies and stream flow levels around the world.
- Sea level is projected to rise 7 to 23 inches during the 21st century due to melting snow and ice on land and thermal expansion of ocean waters.
- The risk of drought and the frequency, intensity, and duration of heat waves are expected to increase.
- More extreme precipitation is likely, increasing the risk of flooding; if the world’s average temperature warms only an additional 2.7ºF to 4.5ºF above pre-industrial levels, an estimated 20 to 30 percent of known plant and animal species would be at increasingly high risk of extinction.

Climate change will affect communities in a variety of ways. Impacts could include an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of existing or new vector-born disease into a community; and increased erosion and inundation of low-lying areas along coastlines. In many cases, communities are already facing these problems to some degree.

Climate change raises the stakes in managing these problems by changing the frequency, intensity, extent, and/or magnitude of the problems. To address that issue, the City’s Hazard Mitigation Plan contains hazard-specific assessments concerning probable impacts of projected climate change on the identified hazards.

Additionally, the City’s Climate Action Plan (CAP) serves as a roadmap for achieving community-wide energy and greenhouse gas emissions reductions that encourages the City to grow smarter and more sustainably.

Impacts of Climate Change in Bellflower

The following content was adapted from the City's Climate Action Plan:

Bellflower and other communities in Southern California will face significant challenges associated with rising temperatures, changes to precipitation patterns, and extreme weather. As indicated in the prior sections, many of the phenomena and impacts are already being observed. These climate changes will affect a number of sectors within the region, resulting in significant social and economic consequences across the region. This section describes the likely impacts of climate change to the following sectors: public health, water resources, and economic systems.

Table 9 - Summary of Climate Change Phenomena by Sector outlines key climate change phenomena and their associated impacts and consequences by sector for Bellflower. Many of the impacts and consequences will be felt across multiple sectors. This summary focuses on climate change impacts to sectors within the purview of the City and does not include those impacts to all sectors.

TABLE 9 - SUMMARY OF CLIMATE CHANGE PHENOMENA, IMPACTS, AND CONSEQUENCES BY SECTOR[1]

CLIMATE CHANGE PHENOMENA	SECTOR AFFECTED	ASSOCIATED IMPACTS	ASSOCIATED CONSEQUENCES
Temperature and extreme heat events	Public Health	Heat-related: heat waves and urban heat island Wildfires	Illnesses, injuries, and loss of life Decline in air quality
	Water Resources	Drought	Decline in quantity and quality of freshwater Increased water demand
	Economy	Drought Heat-related	Energy disruption Economic gains/losses
Precipitation and extreme precipitation events	Public Health	Flooding Drought	Illnesses, injuries, and loss of life
	Water Resources	Flooding Drought Nonpoint source pollution	Illnesses, injuries, and loss of life Decline in quality of freshwater Economic losses
	Economy	Flooding Drought	Loss of agricultural productivity Destruction and damage to property Economic gains/losses

Public Health

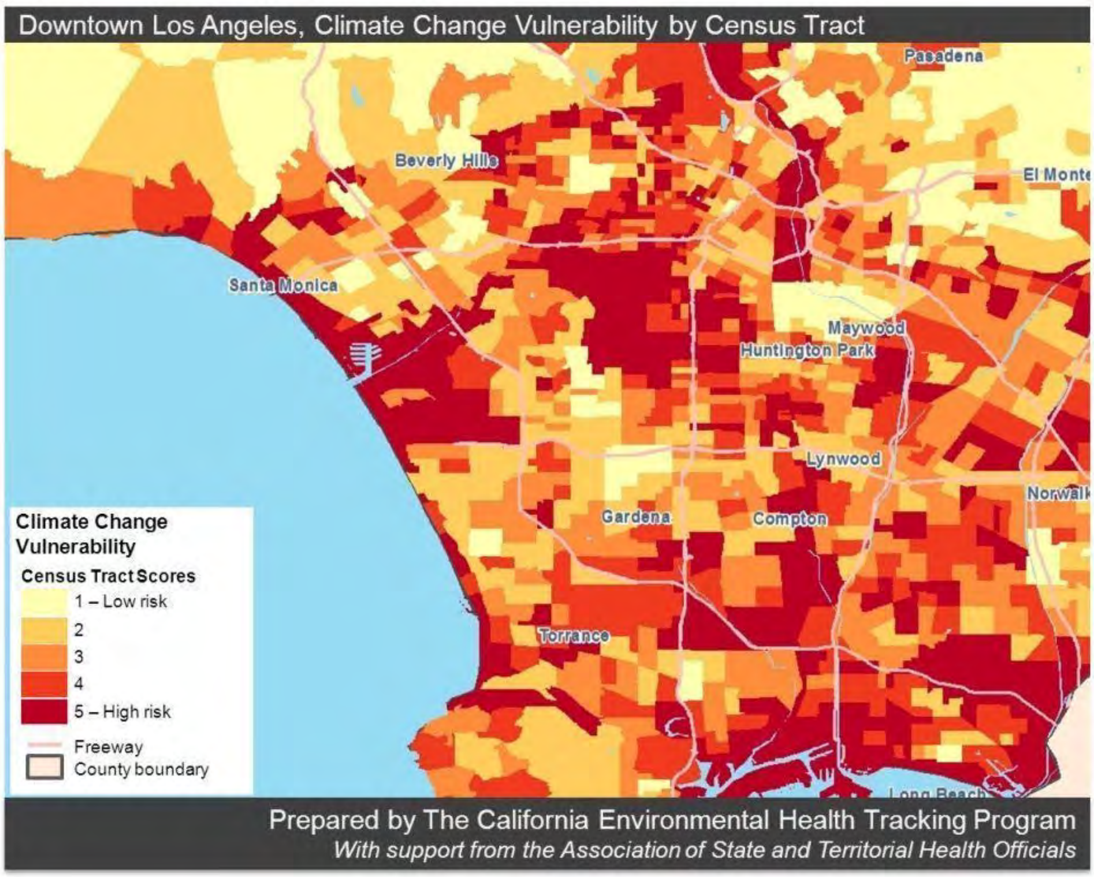
Climate change is expected to affect the health and welfare of people and communities around California and within Bellflower. Climate-related impacts related to heat, drought, and wildfires could have particularly significant health effects within the Bellflower. It is expected that climate

[1] Adapted from the National Oceanic and Atmospheric Administration's *Adapting to Climate Change: A Planning Guide for State Coastal Managers*. 2010.

change will have differential effects on different subpopulations within the region, where biological sensitivity, socioeconomic factors, and geography that will contribute to the heightened risk for climate-sensitive health outcomes. Vulnerable populations include children, pregnant women, older adults, low-income communities, people with chronic diseases and mobility / cognitive constraints, and outdoor workers. Other socioeconomic factors include income, the prices of goods and services, access to vaccines, exposure to pesticides, diet, lifestyles, social networks, and other factors.[2]

The California Environmental Health Tracking Program examined climate change vulnerability among communities in Los Angeles to identify areas most likely to experience substantial climate change impacts (see **Figure 22**). The vulnerability assessment draws on data from a variety of sources and includes information about air conditioning ownership, tree canopy and impervious surfaces, transit and household car access, elderly living alone, flood risk, wildfire risk, and sea level rise.

FIGURE 2 - CLIMATE CHANGE VULNERABILITY BY CENSUS TRACT FOR LOS ANGELES[3]



In Los Angeles County, areas of the highest risk were found along coastal areas, in part because of risks due to sea level rise. Areas in Bellflower ranged from low- to high-risk

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[2] U.S. Climate Change Science Program. 2008. *Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems*. U.S. Environmental Protection Agency, Washington, DC, USA.

[3] California Environmental Health Tracking Program. 2012. Community Vulnerabilities to Climate Change. Received from http://www.ehib.org/page.jsp?page_key=703

depending on the Census tract. The assessment also found clear differences in racial and income disparities. African Americans and Latinos were more likely to live in high-risk areas compared to Whites, and low income households were more likely to live in areas of greater climate change vulnerability.[4]

Heat-related

As discussed earlier, along with seasonal warming, California and Bellflower are likely to experience a larger number of extreme heat days, warm nights, and more prolonged periods of hot weather.[5] Periods of increased high temperatures or extended high temperatures can lead to increased heat-related mortality, cardiovascular-cause mortality, respiratory mortality, heart attacks, and other causes of mortality.[6] Emergency medical services and hospitals also increase during heat waves.[7]

California experienced a similar heat wave during July 2006, which broke temperature records around the state over a ten-day period and caused at least 140 deaths. During the heat wave, hospital and emergency department visits increased statewide, resulting in an estimated 16,166 excess emergency department visits and 1,182 excess hospitalizations. Risk ratios for heat-related illness increased significantly during the heat wave for the South Coast region, which includes Bellflower, but the heat wave also elevated risk ratios for electrolyte imbalance, acute renal failure, and nephritis.[8] In particular, heat-related illnesses impacted people over 65 and Latino and Hispanic persons.[9]

Along with heat-related illness, changes in temperature are expected to worsen air quality, particularly ozone and particulate matter concentrations. Currently, Los Angeles County is ranked as the fourth most polluted county by short-term particle pollution (24-hour $PM_{2.5}$), the third most polluted by year-round particulate pollution (Annual $PM_{2.5}$), and the most ozone-polluted county in the country. Los Angeles County received an F grade for High Ozone Days 2008-2010 with 185 orange days (unhealthy for sensitive populations), 41 red days (unhealthy), and 6 purple days (very unhealthy).[10]
Not only could climate slow California's progress toward attainment of health-based air quality standards and increase pollution control costs, it will increase the risk of incidences of asthma,

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[4] California Environmental Health Tracking Program. 2012. Community Vulnerabilities to Climate Change. Received from http://www.ehib.org/page.jsp?page_key=703

[5] Scripps Institution of Oceanography. 2009. Projected Daily Temperature Data Set. Received from http://cal-adapt.org/temperature/heat/.

[6] U.S. Climate Change Science Program. 2008. Analyses of the Effects of Global Change on Human Health and Welfare and Human Systems. U.S. Environmental Protection Agency, Washington, DC, USA.

[7] Kovats, R.S, and Ebi, K.L. 2006. Heatwaves and Public Health in Europe. European Journal of Public Health 16:592-599.

[8] A risk ratio is a measure of the risk of a certain event happening in one group compared to the risk of the same event happening in another group. National Institutes of Health. 2012.

[9] Knowlton, K., et al. 2009. *The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits*. Environmental Health Perspectives: Volume 117, Number 1.

[10] American Lung Association. 2012. *State of the Air*. Available at http://www.stateoftheair.org/2012/assets/state-of-the-air2012.pdf.

allergies, chronic obstructive pulmonary disease, other cardiovascular and respiratory diseases, skin cancer, and cataracts.[11]

Wildfires

Many ecosystems in California are naturally fire dependent, and therefore, these same forests are prone to wildfire. As California is likely to experience increased temperatures and reduced precipitation, these factors will likely lead to more frequent and intense wildfires and longer fire seasons.[12] For Bellflower, an increase in wildfires will not increase the direct injuries and deaths from fire, but it will likely worsen air quality and negatively impact public health in the Los Angeles basin. The increase in area burned will likely exacerbate eye and respiratory illness, worsening asthma, allergies, chronic obstructive pulmonary disease, and other cardiovascular and respiratory diseases.

Water Resources

Climate change is also expected to affect California's snowpack, precipitation, and, consequently, water supply. There is some uncertainty as to how water supplies will be affected, but even the most conservative models anticipate less stable water supplies and potentially more competition for what are already over-drafted and over-allocated resources. Bellflower's primary sources of water are groundwater production, imported water, and recycled water. The imported water from the State Water Project and Colorado River and local groundwater are likely to be affected by climate change.[13]

In 2010, approximately 35% of Bellflower's water supply was imported, and this water supply will be affected by climate change.[14] An evaluation of climate scenarios on the State Water Project found a 7% - 10% reduction in Sacramento Delta water exports by mid-century and up to a 25% reduction in end of the century. The analysis also found that reservoir storage is likely to decline.[15]

Another important factor to be considered in water supply planning is the occurrence of drought. During periods of drought, water availability decreases and water demand increases. Climate change is expected to increase the frequency and severity of droughts in the region as temperatures rise and precipitation and stream flow decline during the summer.

Along with changes in water supply, demands for water will likely increase with warmer temperatures, higher evapotranspiration, and higher per capita income, straining existing water supplies. Average summer temperatures are a significant factor in water use and Bellflower's

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[11] California Climate Action Team. 2009. *Draft Biennial Climate Action Report*. Available at http://www.energy.ca.gov/2009publications/CAT-1000-2009-003/CAT-1000-2009-003-D.PDF.

[12] California Department of Forestry and Fire Protection. 2012. *CAL FIRE Climate Change Program*.

[13] Bellflower-Somerset Mutual Water Company. 2011. Urban Water Management Plan.

[14] City of Bellflower. 2012. Municipal Water System 2012 Annual Report.

[15] Coachella Valley Water District. 2010. Urban Water Management Plan.

average summer temperature is expected to increase by as much as 7°F.[16] This will increase water demand landscape irrigation and urban water use.[17]

Economy

Each of the impacts of climate change discussed above is likely to impose substantial monetary costs to California. In fact, the California Climate Action Team estimates that climate change will cost California tens of billions of dollars annually. If greenhouse gas emissions begin to be reduced, however, these costs could be lowered.[18] Several potential impacts in the region include:

- Storms and heat waves can disrupt the supply of and increase the demand for energy in California, affecting productivity.
- Extreme heat events and worsening air quality will disproportionately affect low-income residents, particularly those that labor outside, such as construction and outdoor workers.

OTHER HAZARDS

Hazardous Materials

Hazardous materials are any substances that, because of its quantity, concentration, or physical or chemical characteristics, pose a significant present or potential hazard to human health or safety or to the environment. The risks posed by accidental hazardous material releases may include long-term environmental pollution and public health problems. Many types of businesses utilize various chemicals and hazardous materials, and their routine business operations involve chemicals that are manufactured, warehoused, or transported. Currently, there are a variety of existing business operations in the City that use, store, or transport hazardous substances, as well as generate hazardous waste. These sites present risk to both users and adjacent properties.

Transportation routes also present some risks to the release of hazardous materials. The SR-91 Freeway and the I-605 Freeway are heavily traveled routes open to vehicles carrying hazardous materials. Major surface streets in the City of Bellflower providing freeway access include Alondra Boulevard, Rosecrans Avenue, Downey Avenue, Lakewood Boulevard, Clark Avenue, and Bellflower Boulevard. Additionally, a number of underground hazardous material pipelines cross through the City of Bellflower. The lines transport natural gas and oil. Natural gas lines may leak in relatively small quantities from cracks, flaws, or damaged areas of the pipeline, which can typically be repaired. However, rupture of these lines could result in leakage and possible contamination, explosion, and/or fire.

Terrorism

The increased concern over terrorism and the potential for terrorist activity has brought public safety issues into the forefront of our nation. Bellflower is located within Los Angeles County, one of the most target rich population centers in the United States. The City recognizes the

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[16] Scripps Institution of Oceanography. 2009. Projected Temperatures Data Set. Received from http://cal-adapt.org/temperature/century/.

[17] Coachella Valley Water District. 2010. Urban Water Management Plan.

[18] California Climate Action Team. 2009. Draft Biennial Climate Action Report. Available at http://www.energy.ca.gov/2009publications/CAT-1000-2009-003/CAT-1000-2009-003-D.PDF.

need to address terrorism planning and policy issues and maintains an Emergency Operations Plan acknowledging the potential for terrorist activities. The City's approach to terrorism focuses on prevention and adequate response in the event of a terrorist attack through strong coordination with federal, state and local agencies.

Wildland and Urban Fires

Wildfires are those fires of any size that burn in woodland, brushland and grassland areas. Urban fires are those fires which burn in developed urbanized areas and include commercial, industrial and residential fires. At the interface between brush-woodland area and urban areas, wildland fires can become urban fires and vice versa. This vulnerability is especially critical when strong Santa Ana winds are present. Due to the urban nature of Bellflower and surrounding communities, there is very little risk of wildland fire hazards (fires in woodland, brushland, or grassland areas). The primary fire hazard is urban fires, which burn in developed areas and include commercial, industrial and residential structure fires.

Natural Gas

The location of natural gas lines should be recorded and the Los Angeles County Fire Department should be notified of the location of larger, high-pressure lines. Gas lines can fail due to seismic activity, possibly resulting in an explosion. After determining their locations, earthquake evacuation routes should be established that would not cross these areas.

Electrical Power Transmission Lines

Electrical distribution lines are located throughout the City. Since these lines could fall to the ground and create risks of electrocution or fire, their locations should be mapped. The evacuation plan reflects the potential barriers created by downed electrical lines, and new residential development adjacent to these lines should be carefully reviewed.

Petroleum Pipelines

Pipes used to transport oil, gasoline, and crude oil also present risks for explosion and fire. Their locations should also be identified and the evacuation plan should also reflect any potentially hazardous areas.

Drinking Water Contamination

Drinking water supply systems are susceptible to contamination from a variety of sources including bacteriological and chemical. Normal deterioration and use amplifies the vulnerability of these supplies. Disasters such as earthquakes further increase the likelihood of contamination. Periodic and post disaster inspections and sample analysis minimize this danger.

6.0 ISSUES, GOALS, AND POLICIES

Certain human activities and natural conditions discussed in the Safety Element create hazards in Bellflower. These hazards in turn pose risks to individuals and properties that affect how we may develop and use property. Risk from such hazards can be reduced or avoided by recognizing the hazards and adopting and implementing land use and emergency response policies that provide the degree of protection the community desires.

These issues, goals, policies, and implementation actions focus on: (1) reducing risks from natural hazards; (2) preparing for emergency situations; and (3) reducing risks from hazards associated with hazardous materials.

HAZARD-RELATED GOALS AND POLICIES

Underlying all goals and policies is the precept that all buildings and structures in the City of Bellflower should conform to the appropriate building standards in order to protect every citizen to the degree practical. In consideration of certain hazard zones referred to in the Safety Element, the City has considered the category "Important" building or structure in defining new or substantially refurbished existing facilities that should receive increased consideration for geologic, soil, seismic/earthquake, and flood hazard avoidance. An "Important" facility, which would not apply to existing buildings of the types described below unless substantial refurbishment were proposed, would be defined by the City Planning Director, City Engineer, and City Building Official for each case, as appropriate.

In general "Important" would include, but not necessarily be limited to:

(1) One whose function is judged as essential following a severe natural hazard such as an earthquake, e.g., police, fire, City communications center, and hospitals, in order to provide for the safety and well-being of the citizens of Bellflower;

(2) A structure that is critical to the City's recovery following a severe earthquake, i.e., key transportation/evacuation routes, bridges, over/underpasses, electrical substations and towers, natural gas/fuel pipelines;

(3) Structures that may be sensitive to earthquake hazards (e.g., liquefaction and ground shaking), e.g., buildings greater than 2-stories, pre-1971 tilt-ups, non-retrofitted buildings, soft-story construction, non-ductile reinforced concrete, and parking garages; and

(4) Buildings that may have significant populations, and/or high-population densities, i.e., schools/pre-schools, nursing homes, and locations with limited mobility populations.

ISSUE: Bellflower is likely to experience a disaster in the future.

GOAL 1.0: Minimize personal and property damage from such events.

Policy 1.1:	Require all new development and existing retrofitted non-reinforced masonry buildings to comply with established seismic safety standards.
Policy 1.2:	As needed, review and improve Bellflower's disaster response capabilities.
Policy 1.3:	Require that each new development be built incorporating the criteria of safety into the design.
Policy 1.4:	Continue to update the City's Emergency Operations Plan every three years.

Policy 1.5:	Require new or substantially remodeled development located within areas of liquefaction potential to be properly designed and constructed for earthquake safety.
Policy 1.6:	Include earthquake preparedness in all regular inspections.
Policy 1.7:	Request that the Los Angeles County Flood Control District assess all dams upstream from Bellflower for earthquake soundness.

ISSUE: Parts of Bellflower are served by water systems which may not have adequate fire flows.

GOAL 2.0: Provide adequate fire protection to each area of the City.

Policy 2.1:	In accordance with the “City of Bellflower Water Master Plan”, upgrade water lines throughout the City to ensure that they provide adequate fire flows.
Policy 2.2:	Continue to use the development review process to provide project plans to the fire department and other reviewing agencies for fire safety review, including building materials, access and circulation.
Policy 2.3:	Inspect all fire hydrants for operational readiness on an annual basis.
Policy 2.4:	Repair and/or replace all defective hydrants.

ISSUE: In the event of a 100-year flood, Bellflower is potentially at risk of flooding from the Los Angeles River.

GOAL 3.0: Minimize the risks to persons and property from flooding.

Policy 3.1:	Cooperate with the Los Angeles County Flood Control District (LACFD), Federal Emergency Management Agency (FEMA), and other local, state, and federal agencies involved in preparing and implementing flood standards and regulations.
Policy 3.2:	Support public education programs on flood protection, and emergency preparedness and procedures.

ISSUE: Community Safety.

GOAL 4.0: Provide adequate police protection for all residents and businesses in Bellflower.

Policy 4.1:	Expand the City’s Neighborhood Watch Programs
Policy 4.2:	Route development and site plans to the Sheriff’s Department for public safety suggestions.
Policy 4.3:	Utilize site planning mechanisms such as security lighting and well-designed parking lots to minimize crime opportunities.
Policy 4.4:	Continue to work closely with the Sheriff’s Department and community groups to address special crime problems and areas in the City.
Policy 4.5:	Actively remove graffiti and encourage citizens to promptly report incidences of graffiti.

ISSUE: Thorough emergency planning requires regular updates.

GOAL 5.0: The City of Bellflower will act in cooperation with federal, state, and county agencies responsible for the enforcement of planning statutes, environmental laws, and building codes to minimize, to the extent practical, risks to people and property damage, risks related economic and social disruption, and other impacts resulting from 1) geologic and soil hazards, 2) seismic hazards including primary and secondary effects of seismic shaking, fault rupture, and other earthquake-induced ground deformation in Bellflower, and 3) dam failure-induced flood and inundation hazards, while reducing the disaster recovery time due to hazard incidents in Bellflower. The City of Bellflower will update the HAZUS-based loss estimation analysis in the 2016 Hazard Mitigation Plan every five years to more fully quantify potential physical damage, economic loss, and social impacts from these events.

Policy 5.1: **Geology and Soil Hazards**

a) The City will update this element as new information is developed.

b) Assure that all aspects of the geotechnical and engineering geology evaluation process (planning, investigation, analysis, reporting, review, construction, and operations) for new development and redevelopment are conducted, and independently reviewed, by qualified professionals.

Policy 5.2: **Earthquake (Seismic) and Fault Hazards**

a) The City will update this element as new information is developed, such as the current expansion of the Alquist-Priolo Earthquake Fault Zone maps by the California Geological Survey (CGS),

b) Minimize the exposure of people and property to primary and secondary earthquake-related hazards, while allowing properly designed projects to be developed in appropriate locations.

c) Assure that all aspects of the earthquake, fault rupture, liquefaction, and related seismic hazard evaluation process (planning, investigation, analysis, reporting, review, construction, and operations) for new development and redevelopment are conducted, and independently reviewed, by qualified professionals.

d) Require all new development and existing retrofitted unreinforced masonry buildings to comply with established seismic safety standards.

e) Require that each new development be built incorporating the latest criteria of seismic safety into the design.

f) Require new or substantially remodeled development located within areas of liquefaction potential to be properly designed and constructed for earthquake safety.

g) Consider the potential for strong seismic shaking from the Puente Hills Blind Thrust Fault Zone underlying the northern portion of the City.

h) In the northern portion of the City above the projected location of the Puente Hills Blind Thrust Fault Zone, consider the development of potential Co-seismic Hazard Management Zones (CSHMZs) for new construction and redevelopment to evaluate the potential impacts of surface movements such as uplift and ground tilting.

Policy 5.3 **Dam-Inundation Flood Hazards**

a) Minimize development of Important Facilities in flood-prone areas to the extent possible in order to protect public safety and reduce potential property damage due to dam failure-induced flooding.

b) Assure that all aspects of the dam failure flood/inundation evaluation process (planning, investigation, analysis, reporting, review, construction, and operations) for new development and redevelopment are conducted, and independently reviewed, by qualified professionals.

c) Cooperate with the Los Angeles County Flood Control District (LACFD), Federal Emergency Management Agency (FEMA), and other local, state, and federal every five years in preparing and implementing flood standards and regulations.

d) Request that the Los Angeles County Flood Control District assess all dams upstream from Bellflower for earthquake soundness.

e) Support public education programs on flood protection, and emergency preparedness and procedures.

Policy 5.4 **Disaster Preparedness and Communication**

a) Review and improve the City's disaster preparedness and response capabilities. Continue to update the City's Emergency Operations Plan every five years.

b) Create and maintain emergency preparedness and evacuation plans; create public information/education programs to help assure coordinated response, recovery, and mitigation efforts carried out by the City and other governmental agencies.

c) Foster cooperation with neighboring cities and agencies to enhance mutual aid opportunities following natural hazard events.

d) Include earthquake preparedness in all regular inspections by the fire department.

ISSUE: Climate Change, Adaptation and Resilience.

GOAL 6.0: Minimize the potential consequences of climate change through adaptive actions.

Policy 6.1:	Ask the Climate Question - For each project, program, infrastructure investment, and land use decision, City staff and leaders should “ask the climate question” to incorporate climate adaption strategies into planning and decision-making: *What climate change impacts could affect the project and what steps can be taken to minimize these impacts?*
Policy 6.2:	Local Hazard Mitigation - Incorporate increases in extreme heat days, prolonged heat waves, and higher intensity precipitation events into the Local Hazard Mitigation Plan
Policy 6.3:	General Plan - During the next General Plan update, begin to incorporate strategies to reduce climate vulnerability into all elements of the plan
Policy 6.4:	Community vulnerability assessment - Collaborate with state and/or county public health officials to conduct a community-wide assessment of the potential health impacts of climate change on Bellflower residents, identifying the neighborhoods, groups, and individuals most vulnerable to climate change and specific opportunities for the City to reduce vulnerability among specific groups
Policy 6.5:	City website and social media - Make emergency preparedness information more visible on the Bellflower website and use social media to make information more readily available
Policy 6.6:	Energy efficiency and water conservation - Leverage existing programs that promote energy efficiency and water conservation to retrofit the homes of Bellflower’s most-vulnerable residents
Policy 6.7:	Heat island - Target urban heat island programs to increase resilience to climate change
Policy 6.8:	Food security - Improve access to healthy foods in low-income communities increase food security and promote sustainable local food systems to reduce food miles
Policy 6.9:	Transportation to Cooling Centers - Coordinate with regional and county agencies to organize a transportation-assistance program for individuals without access to vehicles
Policy 6.10:	Heat warning systems - Work with state and local organizations to develop a robust heat warning systems
Policy 6.11:	High heat day information - Coordinate with the County Health Department to provide up-to-date information to residents about the health effects of heat and Cooling Center locations throughout the County

Policy 6.12:	Air conditioning - Seek to reduce exposure to extreme heat by seeking grants or opportunities to faciliate access to energy-efficient air conditioning for vulnerable populations
Policy 6.13:	Light-colored, cool roofs - Explore a cool roofs policy for new residential development with air conditioning that applies the voluntary standards established by CalGreen
Policy 6.14:	Light-colored paving - Evaluate on-going pilot programs for cool paving materials (examples include Chula Vista, Chicago) to determine whether the City should establish a cool paving policy
Policy 6.15:	Vegetative cover and planting - Promote the increase in vegetative cover and green roofs to cool the environment through shading and evapotranspiration
Policy 6.16:	South and west side tree planting – Explore opportunities to implement tree planting policies for the planting of shade trees on the south and west facings sides of new residential and commercial development
Policy 6.17:	Commercial energy demand - Work with Southern California Edison to distribute information to businesses about Demand Response Programs in order to reduce energy use during peak demand

IMPLEMENTATION ACTIONS

Implementation Action 1 Review County and special district capital improvement plans for consistency with the seismic safety policies governing the location of critical public facilities.

Implementation Action 2 Inspect critical public facilities for structural integrity, and require correction as necessary.

Implementation Action 3 Require all private roads to conform to the existing City standards concerning safety, movement, and access for emergency vehicles.

Implementation Action 4 Develop a public information program on hazard prevention and disaster response and disseminate information on public safety to all residents and businesses in the City on a regular basis. As funding becomes available, assist lower-income households with the purchase of earthquake safety devices, such as gas turn-off wrenches, and smoke alarms.

Implementation Action 5 Create a website or link on the City of Bellflower website that includes readily available published geologic, soil, and earthquake hazard maps covering the City, and links to the City statutes, plans, and codes governing development and re-development projects. Use the site to communicate to the public information about geologic and soil, seismic, and dam inundation flood hazards and City requirements, including but not limited to a) specify sources to identify licensed professionals such as California Registered Geotechnical Engineers and Certified Engineering Geologists, b) seismic design and construction requirements for individuals and developers applicable to new and existing property improvements, c) City emergency preparedness plans, and d) home- or business-based emergency preparedness procedures and resources.

Implementation Action 6 Identify evacuation routes and update on a regular basis the Emergency Preparedness and Evacuation Plan (as required by Government Code Section 65302) that addresses structural hazards, landslides and slope stability, liquefaction, inundation from dam failure, seismic activity, and other natural disasters.

Implementation Action 7 Avoid grading and development that requires filling natural drainages or changing natural surface water flow patterns.

Implementation Action 8 As required by law and statute, the City shall implement applicable federal, State, and County regulations related to geologic and soils investigations, analyses, designs, and construction, including but not limited to implementing the most up-to-date California Building Code (CBC) provisions regarding lateral forces (Chapter 23) and grading (Chapter 70), and incorporate and adopt CBC as amended by the City of Bellflower.

Implementation Action 9 Require proper geotechnical and engineering geological investigations and reports that address and evaluate necessary analyses of (for example) soil foundation conditions (i.e., expansivity, collapse, seismic settlement), slope stability, surface and subsurface water, and provide necessary design recommendations for grading and site stability, such as excavation, fill placement, and stabilization or remediation measures. These investigations should include review of historical topographic maps and aerial photographs to identify the location man made fills, such as filled-in stream channels, old borrow site quarry pits, and development grading. Such reviews should also include Division of Oil, Gas, and Geothermal Resources (DOGGR) maps of locations of idle and abandoned oil wells.

Implementation Action 10 Require routine inspection of grading operations by properly qualified City representatives to assure site safety and compatibility with approved plans and specifications.

Implementation Action 11 Regularly review the technical data on public safety and seismic safety for use in the planning process and undertake revisions or updates to the Safety Element as needed.

Implementation Action 12 Verify that existing ordinances for the evaluation and abatement of structural hazards (i.e., pre-1971 and URM-type buildings, parapet ordinance and hazardous building ordinance requiring repair, rehabilitation, or demolition of hazardous structures following structural evaluation) are up-to-date. As appropriate, prepare multi-lingual materials that discuss hazardous structures and provide suggestions for the mitigation of structural hazards.

Implementation Action 13 Required geological studies shall be conducted by California Certified Engineering Geologists following the guidelines published by the California Geological Survey and the State Mining and Geology Board, and geotechnical studies shall be conducted by California Registered Geotechnical Engineers.

Implementation Action 14 Require new or substantially remodeled development located within areas of liquefaction potential to be properly designed and constructed for earthquake safety. Required liquefaction assessment studies and/or slope stability analyses shall be conducted in accordance with the California Geological Survey's Special Publication 117A.

Implementation Action 15 As required by law and statute, the City shall implement applicable federal, State, and County regulations related to earthquake hazard investigations, analyses, designs, and construction, including but not limited to the adoption of applicable sections of the current California Building Code and the County of Los Angeles Geotechnical Guidelines, Natural Hazards Mitigation Plan, and compliance with the State Alquist-Priolo Earthquake Fault Zoning Act and the Seismic Hazards Mapping Act requirements.

Implementation Action 16 Ensure that no structure for human occupancy, other than single-family wood-frame and steel-frame dwellings that are less than three stories and are not part of a development of four units or more, shall be permitted within fifty feet of an active fault trace as defined by geologic investigations conducted in accordance with the intent of the Alquist-Priolo Earthquake Fault Zoning Act, and the guidelines contained in the California Geological Survey Notes 48 and 49.

Implementation Action 17 Encourage most new construction in areas with a minimum of identified earthquake-related hazards.

Implementation Action 18 Minimize to the maximum extent practical the construction of important structures (e.g., critical, essential, sensitive, and high-occupancy buildings and critical infrastructure) within known, or suspected earthquake-related hazard zones.

Implementation Action 19 Where construction of important structures (e.g., critical, essential, sensitive, and high-occupancy buildings and critical infrastructure) within known, or suspected earthquake-related hazard zones is proposed, require proper geotechnical and engineering geology investigations and reports that include necessary analyses of (for example) strong ground shaking, fault rupture, liquefaction, lateral spreading, ground subsidence and slope instability, and that provide necessary design recommendations for grading and site stability, such as building setbacks, special foundation considerations, dewatering, ground improvement, and other stabilization or remediation measures.

Implementation Action 20 Require routine and special inspection of investigation sites (e.g., fault exploration trenches) and grading operations by properly qualified consultants to assure scientifically adequate methods, site safety, and compatibility with approved plans and specifications.

Implementation Action 21 The City shall monitor engineering and scientific studies affecting development or re-development in areas of known or suspected earthquake-related hazards that may impact the City, and shall ensure that site-specific data, up-to-date geologic knowledge, and expert peer - (independent third party) review are incorporated into the planning, design, construction, and inspection stages of important project structures (e.g., critical, essential, sensitive, and high-occupancy buildings and critical infrastructure).

Implementation Action 22 As required by law and statute, the City shall implement, where applicable, federal, State, and County regulations related to hydrology and flood investigations, analyses, designs, and construction, including but not limited to continued participation in the National Flood Insurance Program.

Implementation Action 23 Minimize the construction of Important Facilities (e.g., critical, essential, sensitive, and high-occupancy buildings and critical infrastructure) within potential dam failure-induced flood/inundation areas.

Implementation Action 24 Require proper hydrology and flooding investigations and reports that include necessary analyses of (for example) pre- and post-development flow characteristics, changes to surface drainage network, potential environmental impacts on existing development down-gradient from new construction in upstream areas, and adequacy of current and proposed culverts, debris basins, and storm drain systems.

Implementation Action 25 Establish procedures for reviewing subdivisions and other development permit applications to ensure safety from seismic and geologic hazards, including liquefaction areas, slope stability, and ground shaking zones.

Implementation Action 26 Consider the latest state-of-knowledge related to the earthquake analysis and considerations for the design of structures and facilities pursuant to the current version of the California Building Code. Knowledge of the sedimentary basin depth and geometry beneath the City of Bellflower are important for the proper estimation of earthquake ground motions. In addition to the amplifications and resonances caused by shallow softer alluvium, there are complex interactions between the three dimensional geometry of the basin and the seismic waves that have been shown to increase the amplitude and duration of shaking during an earthquake. Interactions may focus the wave energy to a surface location from the bottom of the basin leading to a concentration of intensity of shaking in small regions. Likewise, the edges of basins appear to trap incoming seismic waves, thereby increasing the duration of shaking in the basin. Basin depth and geometry can be estimated using tools available through the Southern California Earthquake Center (SCEC) website, which will assist developers and City building officials in ensuring compliance with the current CBC. Other information important to proper code compliance includes consideration of (a) distant large duration/large magnitude earthquakes, (b) recently developed Next Generation Attenuation (NGA) relationships, (c) ongoing updates to U.S. Geological Survey and California Geological Survey databases. The City is committed to assist in providing access to these tools and databases to enhance the public safety in Bellflower.

Implementation Action 27 In accordance with the “City of Bellflower Water Master Plan”, continue to upgrade water lines throughout the City to ensure that they provide adequate fire flows during emergencies.

Implementation Action 28 Cooperate with the Los Angeles County Flood Control District (LACFD), Federal Emergency Management Agency (FEMA), and other local, state, and federal agencies involved in preparing and implementing flood standards and regulations.

Implementation Action 29 Require review of historical topographic maps and aerial photographs be performed to identify potential previous channels from former streambeds or where the San Gabriel River have been filled.

Implementation Action 30 Facilitate voluntary energy efficiency improvements and upgrades in existing residential buildings by expanding participation in and promotion of existing programs. Explore the development of an in-lieu fee for energy efficiency.

Implementation Action 31 Prepare for and adapt to future impacts of changing weather patterns by continuing to implement the City’s adopted Climate Action Plan.

7.0 REFERENCES CITED

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8.0 ATTACHED SEPARATELY

City of Bellflower Hazard Mitigation Plan (2017)
City of Bellflower Climate Action Plan (2012)

City of Bellflower

SAFETY ELEMENT

TECHNICAL BACKGROUND REPORT

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1.0 INTRODUCTION

This report presents geotechnical, seismic, and geological technical background information for use in development of a Hazard Mitigation Plan, and revisions of the Safety Element of the City of Bellflower's General Plan. The Safety Element-Technical Background Report was last updated in 1994.

1.1 STATUTORY REQUIREMENTS AND OVERVIEW

The California State Legislature has placed specific responsibilities on local governments for identification and evaluation of seismic and other hazards and the formation of programs and regulations to reduce risk from these hazards. The Safety Element of the Bellflower General Plan is designed to meet these responsibilities. California State law, Government Code Section 65302(g) requires each city to prepare and adopt a Safety Element as follows:

> *"(g) (1) A safety element for the protection of the community from any unreasonable risks associated with the effects of seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, and dam failure; slope instability leading to mudslides and landslides; subsidence; liquefaction; and other seismic hazards identified pursuant to Chapter 7.8 (commencing with Section 2690) of Division 2 of the Public Resources Code, and other geologic hazards known to the legislative body; flooding; and wildland and urban fires. The safety element shall include mapping of known seismic and other geologic hazards. It shall also address evacuation routes, military installations, peak load water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards."*

Specific issues included in the study are generally limited to the boundaries of Bellflower except for elements of seismicity and flooding, which have a much broader geographic area from which hazard sources may affect the City of Bellflower (City). It is therefore necessary to look at a wide range of potential geology, soils, and seismic related topics in order to comply with State Guidelines for environmental impact reports (EIR) and General Plan documents and to provide a sound understanding of geologic and geotechnical issues affecting land use planning decisions. These topics include the following:

- Ground shaking (strong earthquake ground motions)
- Surface fault rupture
- Co-seismic uplift and folding
- Liquefaction, differential compaction, and settlement
- Ground lurching and cracking, fill mass deformation
- Earthquake-induced landslides
- Subsidence
- Compressible, collapsible, or expansive soils
- Flooding from dam failure
- Flooding from tsunami and seiche
- Landslides and slope instability
- Groundwater depth

This document is an update to the 1994 Technical Background Report and supports the 2017 General Plan Safety Element. The document contains up-to-date information on the seismic and geologic conditions within and around the City, which will potentially affect the persons and property in the City in the event of a local geologic hazard or a major earthquake in Southern California.

Based on past seismic events, no part of the State of California is immune from earthquake damage, including Bellflower. It is important, therefore, that the City adopt public safety goals and policies that recognize the inevitability of future seismic events and plan effectively for them. The technical issues mentioned above must be taken into account as the City undertakes expansion, redevelopment, and in-fill. Existing building codes and land use planning requirements can address most of the hazards inherent in the geologic and seismic setting of the City. Because newer, more accurate geologic, soils, and seismic information has been developed since the last General Plan update, it is possible to better identify the hazard areas and to account for them in future development. Sources for this information range from generalized regional reports and maps to site-specific geotechnical and engineering geology reports for projects in the City. The City should be aware that as new information is developed, such as the current expansion of the Alquist-Priolo Earthquake Fault Zone maps by the California Geological Survey (CGS, formerly the California Division of Mines and Geology [CDMG], additional updates may be required.

1.2 SEISMIC AND GEOLOGIC HAZARD PLANNING CONSIDERATIONS

Geologic and seismic hazards play an important role in the planning process with regard to the selection of development locations, the definition of processes necessary to develop safe projects, and the studies necessary to design a project to avoid or withstand these two types of natural hazards. The General Plan Safety Element provides guidance to accomplish these steps and information useful to begin the development planning process. Seismic hazards result from the primary action of an earthquake (strong ground shaking, co-seismic deformation and surface fault rupture), and the secondary effects caused by the earthquake shaking (liquefaction, induced settlement, lateral spreading, and landslides, ground fissures, tsunamis, seiches). Laws, regulations, and codes are established to ensure that proper precautions are taken in advance of development to prevent unreasonable levels of damage, injuries, or fatalities.

Seismic ground motion (earthquake shaking) hazard concerns increase with the increasing importance of a structure. The importance may relate to high-occupancy (hotel, multi-story office building), essential services (e.g., hospitals, police and fire, 911 capability, traffic management centers), schools, critical lifelines (e.g., pipelines, freeways, aqueducts), or concentrated residential development. The 2016 California Building Code (CBC) uses a maximum considered earthquake (MCE) adjusted for a targeted risk of structural collapse. The targeted risk is adjusted for a more stringent design standard for public schools, hospitals, and other critical facilities (e.g., dams, reservoirs, power plants) based on the importance factor. This design standard in the building code is adopted by State organizations and local jurisdictions for application to a development project considering the importance of a facility and its proposed use, as well as the projected design life. Professionals responsible for the planning, design, construction, and operation of development projects use these (and other) earthquake design levels to provide the necessary margin of safety for the project in question.

Geologic (and soil) hazards and surface fault rupture, in contrast to seismic ground motion hazards, are more susceptible to direct observation and testing to determine the degree of hazard and to specify a remediation or avoidance strategy. These hazards include potentially unstable slopes, landslides, mudflows, severe erosion or flooding, expansive and compressible soils, shallow groundwater, and several secondary seismic hazards arising from geologic conditions.

In summary, geologic and seismic hazards must be considered in all phases of the development cycle from the earliest conceptual planning to the operations and eventual decommissioning of a facility. Building codes and general plan documents provide regulations, specifications, and strategies to cover most hazard conditions, if the proper detailed studies are performed to recognize the hazards, to define their potential severity, and to provide an adequate design that considers the importance, use, and life span of the facility.

1.3 GEOLOGIC AND SEISMIC HAZARD REGULATIONS

1.3.1 Alquist-Priolo Earthquake Fault Zoning Act

The 1972 Alquist-Priolo Special Studies Zones Act resulted from the consequences of the Sylmar-San Fernando earthquake in 1971 and sought to mitigate the hazard of fault rupture by prohibiting the location of structures for human occupancy across the trace of an active fault. The Act was renamed in 1994 to the Alquist-Priolo Earthquake Fault Zoning (APEFZ) Act. The Sylmar-San Fernando earthquake produced surface fault rupture damage along a zone that might have been identified in advance of the earthquake had the proper studies been mandated.

The best and most feasible surface rupture mitigation is avoidance of the causative fault. Thus, the APEFZ Act mandates that cities and counties (lead agencies) require that within an APEFZ, geologic investigations must be performed to demonstrate that potential development sites are not threatened by surface fault displacements from future earthquakes. To aid the various jurisdictions that function as lead agencies for project approvals in California, CGS; to avoid confusion CGS is used for CDMG even for older reports) must delineate Earthquake Fault Zones on standard U. S. Geological Survey (USGS) topographic maps (1-inch equals 2,000-feet scale) along faults that are "sufficiently active and well defined" as defined in the Act. Quoting from the implementation guide, Special Publication 42 (Hart and Bryant, 1997; a 2007 interim revision contains updates to reflect changes in the index map and the listing of additional effected cities):

> *"Zone boundaries on early maps were positioned about 660 feet away from the fault traces to accommodate imprecise locations of the faults and possible existence of active branches. The policy since 1977 is to position the EFZ boundary about 500 feet away from major active faults and about 200 to 300 feet away from well-defined, minor faults. Exceptions to this policy exist where faults are locally complex or where faults are not vertical."*

Lead agencies are responsible to regulate most development projects within the Earthquake Fault Zones as described in the Act, but may enact more stringent regulations. Certain smaller residential developments can be exempt. Bellflower currently has no APEFZ within the City or projecting toward the City from nearby. The Newport-Inglewood fault lies approximately 2 miles to the southwest of the southwestern portion of the City. In addition, the leading edge of the Puente Hills buried thrust fault is just within the northeastern portion of the City. This buried thrust fault (probably the source of the March 26, 2014, 5.1 magnitude (M) La Habra earthquake) has been (in other neighboring cities) the subject of studies to assess its location and potential to cause co-seismic uplift and deformation of near surface materials that could damage overlying structures in ways that are similar to surface fault rupture.

1.3.2 Seismic Hazards Mapping Act

The 1990 Seismic Hazards Mapping Act (SHMA) addresses the primary earthquake hazard, strong ground shaking, as well as potential secondary hazards. As with the APEFZ Act, CGS is the primary State agency charged with implementing the SHMA, and CGS provides local jurisdictions with the 1-inch equals 2,000 feet scale seismic hazard zone maps that identify areas susceptible to a) liquefaction, b) earthquake-induced landslides, and c) in some areas amplified ground shaking. When a development project is located within one of the Seismic Hazard Mapping Zones (SHMZ) defined as a zone of required investigation, site-specific hazard investigations are required by the SHMA.

Lead agencies with the authority to approve projects shall ensure that:

> *"The geotechnical report shall be prepared by a registered civil engineer or certified engineering geologist, having competence in the field of seismic hazard evaluation and mitigation. The geotechnical report shall contain site-specific evaluations of the seismic hazard affecting the project, and shall identify portions of the project site containing seismic hazards. The report shall also identify any known off-site seismic hazards that could adversely affect the site in the event of an earthquake."*

and:

> *"Prior to approving the project, the lead agency shall independently review the geotechnical report to determine the adequacy of the hazard evaluation and proposed mitigation measures and to determine the requirements of Section 3724(a), above, are satisfied. Such reviews shall be conducted by a certified engineering geologist or registered civil engineer, having competence in the field of seismic hazard evaluation and mitigation."*

CGS Special Publication 117A (CGS, 2008a) covers the investigation, analysis, implementation, and review processes for liquefaction and earthquake-induced landslide evaluations, and reports as revised and reauthorized effective September 2008 in order to provide detailed guidance for lead agencies to review SHMA reports. The overall goal is to protect the public by minimizing property damage and the loss of life. The City of Bellflower has been mapped pursuant to the SHMA and there is required investigation for liquefaction hazard throughout the City of Bellflower (South Gate, Whittier, Long Beach, and Los Alamitos 7.5-minute USGS Quadrangles, 1998).

1.3.3 Natural Hazards Disclosure Act

The Natural Hazards Disclosure Act (effective June 1, 1998), requires:

> *"that sellers of real property and their agents provide prospective buyers with a "Natural Hazard Disclosure Statement" when the property being sold lies within one or more state-mapped hazard areas, including a Seismic Hazard Zone."*

The SHMA specifies two ways in which this disclosure can be made:

> *"c. In all transactions that are subject to Section 1103 of the Civil Code, the disclosure required by subdivision (a) of this section shall be provided by either of the following means:*

1. The Local Option Real Estate Transfer Disclosure Statement as provided in Section 1102.6a of the Civil Code.

2. The Natural Hazard Disclosure Statement as provided in Section 1103.2 of the Civil Code."

The Local Option Real Estate Disclosure Statement can be substituted for the Natural Hazards Disclosure Statement if it contains substantially the same information and substantially the same warning as the Natural Hazards Disclosure Statement. Both the APEFZ Act and the SHMA require that real estate agents or sellers of real estate acting without an agent disclose to prospective buyers that the property is located in an APEFZ or SHMZ. One can determine if a property is within a SHMZ by going to the California Department of Conservation website (CGS, 2014).

1.3.4 California Environmental Quality Act (CEQA)

The 1970 California Environmental Quality Act (CEQA) ensures that local agencies consider and review the environmental impacts of development projects within their jurisdictions. CEQA requires that an environmental document (e.g., Environmental Impact Report [EIR], Mitigated Negative Declaration [MND]) be prepared for projects that are judged in an Initial Study (IS) to have potentially significant effects on the environment. Environmental documents (IS, MND, EIR) must consider, and analyze as deemed appropriate, geologic, soils, and seismic hazards. If impacts are considered potentially significant, recommendation for mitigation measures are made to reduce geologic and seismic hazards to less than significant. This allows early public review of proposed development projects and provides lead agencies the authority to regulate development projects in the early stages of planning.

1.3.5 Building Codes

Building regulations are specified in Chapter 15.04 of the Bellflower Municipal Code, including adoption of the 2016 CBC. The 2016 CBC has been adopted by the City as Ordinance No. 1255 (City of Bellflower, 2013). Standard residential, commercial, and light industrial construction is governed by the CBC, which the City has amended and provided additions to. Due to the type, quality, and age of some of the City buildings, the 2013 State Historical Building Code (SHBC; is defined in CCR Part 8 of Title 24) applies to the strengthening of unreinforced historic structures, while the 1986 Unreinforced Masonry Law (Section 8875 et seq, of California's Government Code) applies to the identification, reporting, and retrofit of non-historic unreinforced masonry (URM) buildings. The California Building Standards Code (Title 24, California Code of Regulations) includes the CBC and is a compilation of three types of building standards from three different origins:

- Those adopted by state agencies without change from building standards contained in national model codes (e.g., the IBC).
- Those adopted and adapted from the national model code standards to meet California conditions (e.g., most of California is Seismic Design Categories D and E).
- Those authorized by the California legislature that constitute extensive additions not covered by the model codes that have been adopted to address particular California concerns (e.g., the specification of Certified Engineering Geologist rather than engineering geologist).

International and national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies. Facilities and structures such as power plants, freeways, emergency management centers (e.g., traffic management and 911 centers), and dams are regulated under criteria developed by various California and federal agencies.

2.0 THE GEOLOGIC SETTING

2.1 GENERAL LOCATION AND GEOLOGIC BACKGROUND

The City is located in the southeastern part of Los Angeles County, is an urbanized residential community situated on the Los Angeles Coastal Plain, and is bounded by the cities of Norwalk, Downey, Paramount, Long Beach, Lakewood, and Cerritos. The San Gabriel River forms the eastern boundary of the City. Topographically, the City is on the southerly sloping Los Angeles Coastal Plain and is along the western bank of the San Gabriel River, as shown on Figure 1.

Physiographically, the Los Angeles Coastal Plain of is a southward-sloping alluviated lowland and coastal plain bounded on the far north by the Transverse Ranges (the Santa Monica and San Gabriel Mountains), and more closely by the Elysian, Repetto, and Puente Hills, and on the south by the Pacific Ocean. Farther to the east and southeast are the Peninsular Ranges (the Santa Ana Mountains and San Joaquin Hills) with the local alluvial slopes being interrupted by the Coyote Hills to the east. Locally on the south and west are a line of elongated low hills (e.g., Signal Hill, the Dominguez Hills) and mesas, and the Palos Verdes Peninsula borders the western extremity of the coastal plain.

General geologic conditions in the City (Saucedo and others, 2003) are shared with other cities within the coastal plain bordering and inland from the Pacific Ocean. Millions of years of tectonic activity (uplift and faulting) have occurred causing these mountains and hills to be formed, and causing erosion of the mountains to allow transport of sediment by water and gravity to shape the alluvial plains. This tectonic activity resulted in fault-bounded alluvial basins that store groundwater and in geomorphic surfaces that have recorded younger (<12,000 year old) fault movements. Where groundwater is shallow and sediments are sufficiently loose, earthquakes can cause liquefaction/consolidation of the alluvium and settlement of overlying man-made structures. Man-made water reservoirs near the mountain-valley interface have the potential to fail and release floodwaters toward the City if water is impounded behind them.

The entire City consists of alluvial fan and floodplain deposits, with no bedrock exposed at the surface within the City. The thickness of these deposits is not well constrained, however they are believed to be several hundred to a few thousand feet thick. Bellflower is largely built upon the gently sloping alluvial fan and San Gabriel River floodplain deposits west of the river. Local low hills include Signal Hill to the south, the Dominguez Hills to the west, the West Coyote Hills to the east, and the Puente Hills to the northeast. The steeper San Gabriel Mountains foothills lay approximately 20-miles to the north. Elevations in the City range from approximately 85 to 90 feet above mean sea level (msl) in northwestern Bellflower (near Gardendale Avenue and Lakewood Boulevard) to 55 to 60 feet msl at the southwestern City boundary (near Downey Avenue and Rose Street). Under the alluvial fan and river floodplain surface there are at least a few hundred feet of alluvium composed primarily of silt, sand, gravel, cobbles, and some local clay-rich deposits.

Because of the topography and the nature of the geologic formations present in the City, overall the non-seismic "geologic" hazards are what would be expected in cities with gently sloping terrain. Geologic formations mapped in the City are limited to the three alluvial units discussed below and no bedrock, landslides, or mudslides are found in the City. Large-scale subsidence due to fluid withdrawal (water or oil) is not reported in the study area. Dam failure inundation potential exists, but water is not often stored behind some of the dams located upstream from the City. Some geotechnical issues are present. Taken together, geologic and seismic hazard conditions in the City are similar to many cities in Southern California. The following subsections describe briefly the major seismic and geologic features that may impact the City.

2.2 GEOLOGIC CONDITIONS AFFECTING THE CITY

2.2.1 Physiography

Landforms and topography (physiography) of the City are controlled by the distribution and character of geologic units, by fault movements, and by climate and erosion, all of which contribute to the sculpture of the landscape. Bellflower is located approximately 20 miles west of the Peninsular Ranges' Santa Ana Mountains and 20 miles south of the Transverse Ranges' San Gabriel/Santa Monica Mountains. The entire City is built on the gently sloping alluvial fan and floodplain associated with the San Gabriel River drainage system. The ground slope shows a fairly consistent north-to-south slope of less than 0.5 percent. Under the alluvial fan surface are hundreds to a few thousand feet of alluvium composed primarily of sand, silt, clay, gravel, cobbles, and boulders.

The City is within the San Gabriel River watershed, which covers an area of approximately 640 square miles and is located in eastern Los Angeles County extending from the San Gabriel Mountains to the coast. The watershed's main hydrologic feature is the San Gabriel River, which flows from north to south; the upper part of the San Gabriel River watershed has a West Fork and East Fork. Descending from the mountains, large spreading grounds for groundwater recharge are in operation, while the river in the lower part of the watershed has a concrete-lined channel for the protection of people and property in this heavily urbanized sector. The river along the eastern City boundary has been channelized in a straight concrete lined channel. The original naturally wandering channel apparently was filled when the channel was straightened. The river is once again unlined before entering the Pacific Ocean at the City of Long Beach.

2.2.2 Bedrock Geology

No sedimentary bedrock or crystalline basement rock are exposed in the City. It is estimated that Quaternary deposits are several hundred to a few thousand feet thick, and sedimentary bedrock is approximately 25,000 feet thick before crystalline basement rocks are reached (Yerkes and Campbell, 2005)).

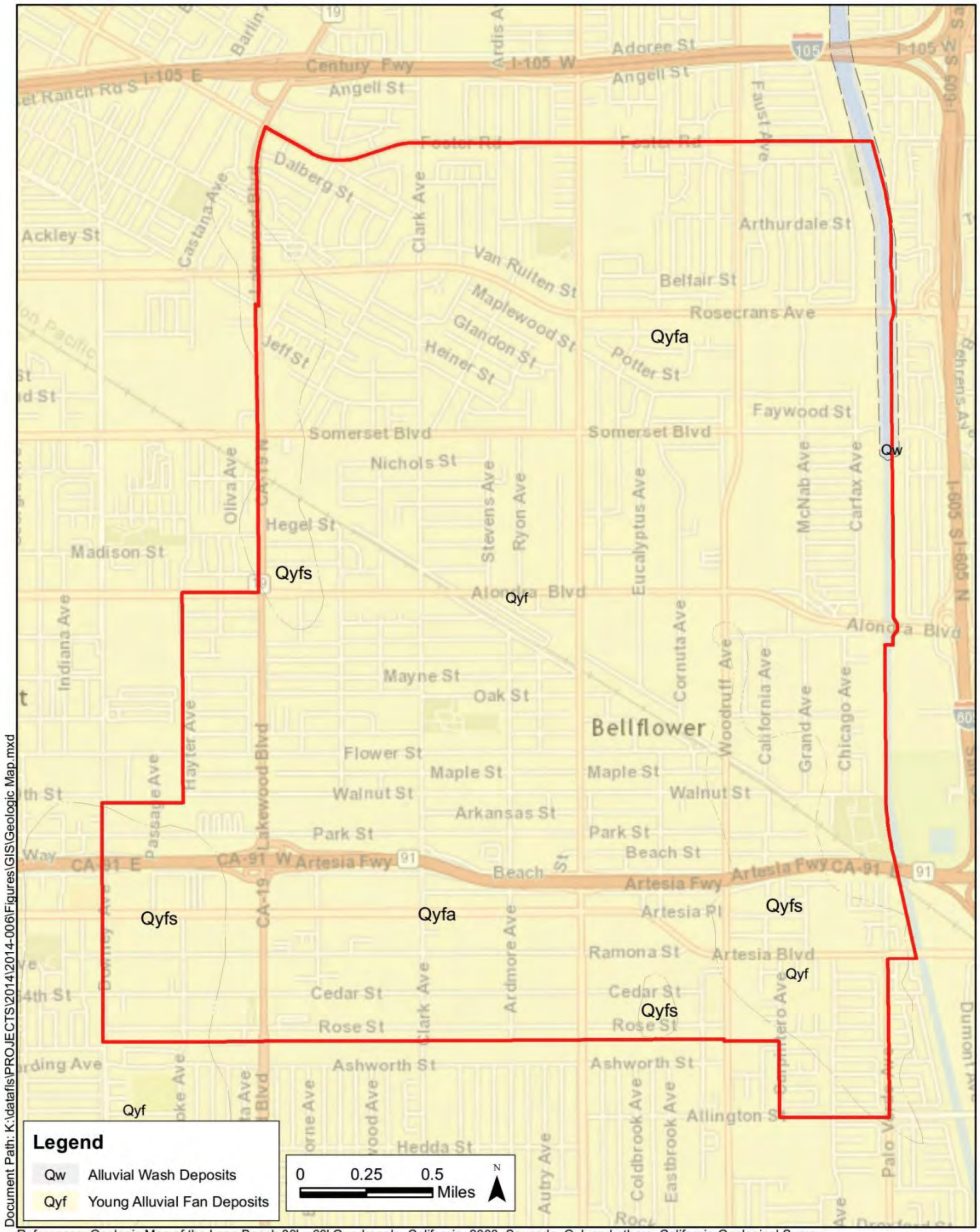
2.2.3 Surficial Deposits

Surficial Mapping

Published geologic maps reviewed for this study include the CGS (1998a, 1998b, 1998c, 1998d, and 2013), and the USGS (Saucedo and others, 2003). The USGS authors compiled geologic maps which provide a reasonably simple view of the distribution of the only three alluvial (surficial, non-bedrock) units as shown on Figure 1. The CGS (1998a, 1998b, 1998c, and 1998d) provides a breakdown of surficial units based on the unpublished work of numerous agencies and consultants and this has been adopted for discussion of surficial mapping in the City because the CGS has related this greater mapping detail to engineering geologic/geotechnical properties as shown in Table 1. This allows potential development project site characteristics (shallow subsurface properties) to be classified on a preliminary planning basis.

Surficial deposits consist of relatively recent (geologically young) sediments formed by alluvial processes in streams, on alluvial fans/basins located, in the case of Bellflower, well south of the Transverse Ranges (San Gabriel Mountains) and southwest of the Peninsular Ranges (Santa Ana Mountains and isolated hills). These deposits have been laid down over a range of geologic time; in general, the uppermost surficial sediments are Holocene (less than 10,000-12,000 years old) to late Quaternary (less than 100,000 years old) in age, although few deposits represented in the City are known to have been age-dated by absolute methods (e.g., radiocarbon).

FIGURE 1 - GEOLOGIC MAP
SOURCE - DIAZ YOURMAN & ASSOCIATES



References: Geologic Map of the Long Beach 30' x 60' Quadrangle, California, 2003. Saucedo, G.J. and others. California Geological Survey

The distribution of surficial units shown on Figure 1 and described in Table 1 comprises only three identified units based on CGS (1998a, 1998b, 1998c, and 1998d) and Saucedo and others (2003). The youngest unit (map symbol Qw) has a limited distribution associated with most recent deposition from the San Gabriel River along the eastern edge of the City. The next oldest unit (Qyfa) will underlie most of the City at shallower depths. The third, and oldest, unit exposed is Qyfs, having relatively limited map distribution as isolated patches in the northwestern, southwestern, and southeastern portions of the City surrounded by Qyfa. The older Qfys deposits were uplifted due to fault movements, or broader regional uplift, and the younger Qyfa sediments were deposited on alluvial fans and within stream courses cutting through and around these slightly more elevated areas. We judge that grading for development and stream course filling has resulted unmapped fill at various locations within the City.

TABLE 1 - ENGINEERING GEOLOGIC UNITS AND UNIT CHARACTERISTICS
SOURCE – DIAZ YOURMAN & ASSOCIATES

Map Unit [f = alluvial fan]	Age	Relative Age and Environment of Deposition	Primary Texture/ Grain Size	General Consistency	Susceptible to Liquefaction? [When saturated]
Qyfa (youngest) and Qyfs (oldest)	Holocene to latest Pleistocene	Young alluvial fans and floodplain deposits	a = sand s = silt	Unconsolidated to slightly consolidated	Yes

Note: Refer to CGS Table 1.1 for details (Saucedo and others, 2003; Bedrossian and others, 2013; and CGS,1998a, 1998b, 1998c, and 1998d). Alluvial unit names indicate "characteristic grain size" (e.g., Qyfa, Qyfs); a = arenaceous (sand), s = silt.

Map Unit [f = alluvial fan]	Mean/Median Group Angle of Internal Friction-phi (degrees)				Mean/Median Group Cohesion-C (pounds per square foot)			
USGS Quadrangle	South Gate	Whittier	Los Alamitos	Long Beach	SG	W	LA	LB
Qyfa and Qyfs	None	29.6/30.5	None	30.2/30	None	380/280	None	186/135

Note: Refer to CGS (1998a, 1998b, 1998c, and 1998d) Table 2.1 for details and the application of these data to slope stability analyses.

Qw (sand and silt), Qyfa (sand-rich), and Qyfs (silt-rich) are classified as young alluvial fan and valley deposits of undivided-Holocene and late Pleistocene age. Collectively, these deposits are mostly poorly consolidated and poorly sorted, undissected to slightly dissected silt, sand, silty sand, and clay sequences, with lesser gravel and cobble deposits, laid down along broad stream valleys and alluvial flats of large rivers. These would be associated with the ancestral San Gabriel River as distal fan/floodplain deposits.

Historically high groundwater (less than 30 feet deep) is believed to be present in almost all areas of the City, and the suitability of the geologic units for construction (e.g., slopes, foundation material) may range from acceptable to poor. Liquefaction and dynamic settlement potential is the highest where these deposits are primarily sand and silty sand with low density, and are at least partially saturated. High ground-shaking intensity (site amplification) potential would be associated with these deposits more so than with otherwise thinner or denser geologic units.

Subsurface Unit Characteristics

The youngest active river deposits (Qw) are found in the San Gabriel River wash where sand layers containing abundant gravel, cobbles, and boulders dominate Quaternary alluvial deposits. During earthquake shaking, the sand-rich layers are potentially liquefiable if the material is loosely packed and water-saturated (CGS, 1998a-d).

Descriptions of subsurface conditions and deposits are summarized from reports and maps published by the California Department of Water Resources (CDWR) and CGS reports mentioned in the previous section. Primary subsurface deposits in the Bellflower area are described by CDWR (1961), CGS (1998a, 1998b, and 1998c), Saucedo and others (2003), and Bedrossian and others (2013) as noted above. A few site-specific geotechnical and groundwater investigation/remediation reports were available from the City to provide limited subsurface information for the Qyfa and Qyfs deposits. Boring depths were limited (less than 60-feet) and it is uncertain if they encountered the underlying older alluvial deposits (Qof).

The ten City reports were from different areas of the City. Due to the heterogeneous nature of the alluvial deposits no specific conclusions were drawn regarding unit correlations or some consistent Qyfa and Qyfs variability by area within the City. In order of predominance the unit descriptions are silty sand, sandy silt, sand, silty clay/clayey silt, and clay. Gravel is noted at one location in the southwest portion of the City. One specific report to confirm soil post-remediation results (Frey, 2012) included several borings to a depth of approximately 40 to 60 feet near the intersection of Alondra Boulevard and Woodruff Avenue in Qyfa. Report cross-sections showed Unified Soil Classification System (USCS) of predominantly SP (poorly sorted sand), SW (well-sorted sand), and SM (silty sand), with ML (silt) and CL (clay) layers making up about 10% to 25% of the materials.

CDWR (1961) describes the deeper units in the Bellflower area as part of a larger technical bulletin for the entire Los Angeles Coastal Plain. The surface geology shows as one formation Recent Alluvium (Qal), which is equivalent to Qyfa and Qyfs. The cross-section interpretations are controlled by numerous logged water wells ranging in depth from a few hundred to over 800 feet. The Qal is composed of shallower aquifers and aquicludes (low permeability layers) including the Gaspur aquifer and the upper Bellflower aquiclude.

In general based on the CDWR report the shallower aquifers and aquicludes above the Gaspur vary in thickness from approximately 50 feet to 150 feet. This would be the materials most encountered related to development in the City. As summarized by the CDWR, the recent alluvium is primarily stream-deposited gravel, sand, silt, and clay with the upper approximately 150 feet composed of the semi-perched aquifer and upper Bellflower aquiclude. The semi-perched aquifer is often coarse sands and gravels found on or near the surface with a variation in thickness from zero to 60 feet and may contain significant amounts of unconfined groundwater more than 20 feet thick. The semi-perched aquifer is generally separated from the lower aquifers by silts and clays of relatively low permeability in the Bellflower aquiclude. The Bellflower aquiclude inhibits downward percolation of water to the underlying Gaspur aquifer. Older Pleistocene-age alluvial deposits of the Lakewood Formation underlie the recent alluvium and Gaspur aquifer. In the southeast corner of the City, the Gaspur is not present and the recent alluvium lies directly on the Artesia aquifer with the Lakewood Formation. The Lakewood Formation is exposed outside the City in the hills to the northeast (Coyote Hills) and southwest (Signal Hill).
The CBC was updated and revised in 2013. As with past revisions, the geologic subgrade classification system (S_A through S_F) is used to classify soil profiles according to their physical properties. Under this subgrade classification, the upper less dense units (Qw/Qa, Qyfa, and Qyfs) would likely be classified as S_D or S_E, which is a stiff to soft soil profile. These

classifications will affect seismic coefficients for earthquake design as shown by geotechnical design reports.

2.2.4 Groundwater Depth

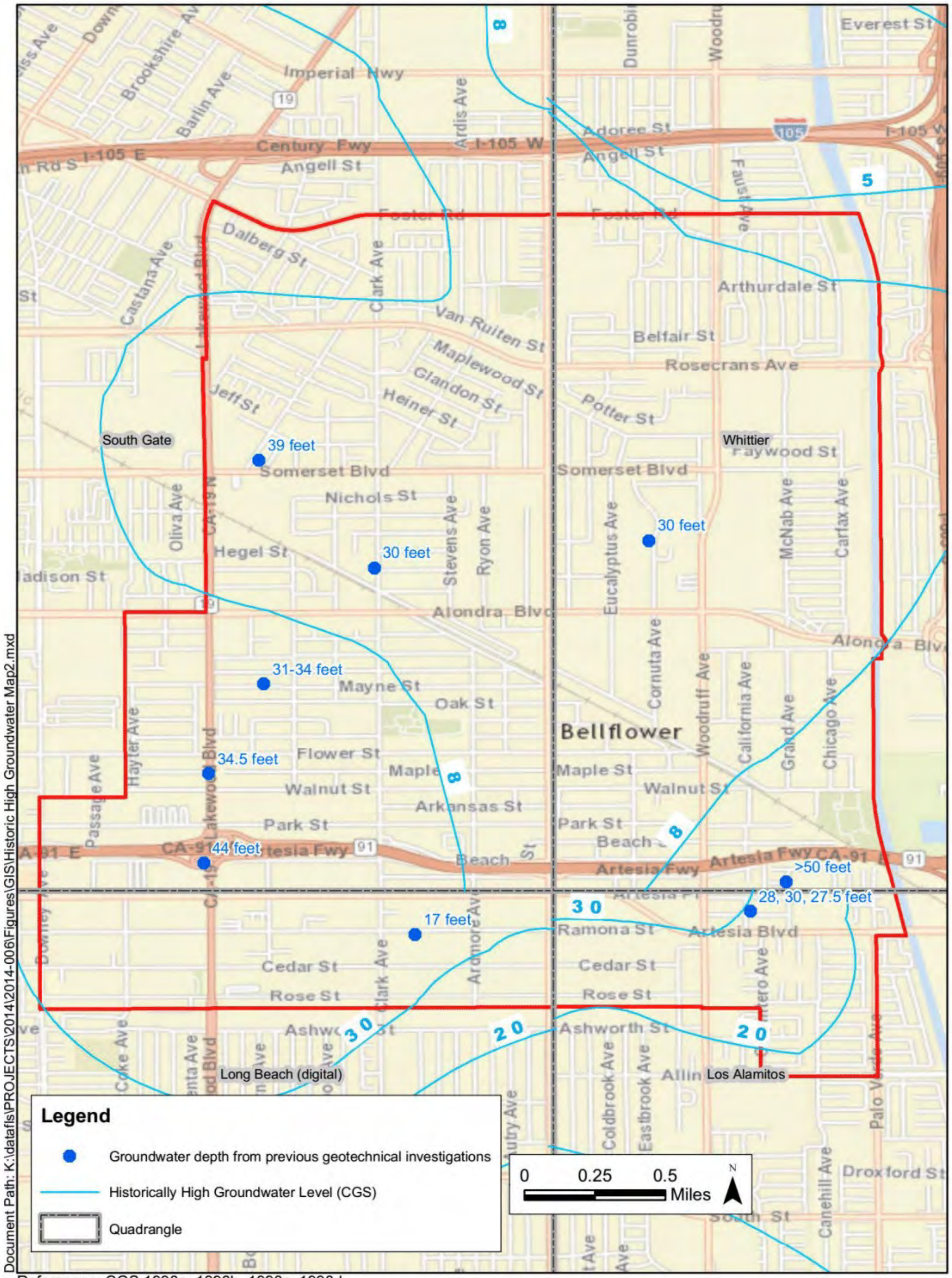
Groundwater within the City may be rather shallow (semi-perched aquifer) or deeper for potable groundwater. Groundwater records for potable water wells from the Los Angeles County Department of Public Works (LACDPW, 2014) were used to determine groundwater depths within the City, and the GeoTracker database for the State Water Resources Control Board (SWRCB, 2014) for environmental contaminate/remediation projects was used for shallower (non-potable) groundwater depths. In general, the LACDPW wells show water depths greater than 50 feet below ground surface (bgs), meaning liquefaction potential would be low. However, the SWRCB data indicates perched water at depths ranging from approximately 12 feet bgs to approximately 55 feet bgs. Shallow groundwater, as defined for this report, is any area within the City with groundwater within 50 feet of the ground surface. Groundwater elevations are a necessary part of any seismic evaluation because they are directly related to the potential for both liquefaction and consolidation of soils materials.

Studies prepared by the CGS (1998a, 1998b, 1998c, and 1998d) provide groundwater depth maps compiled from multiple sources are summarized in
Figure 2. These maps indicate historically highest groundwater levels (shallowest depths) from about 8 feet to over 30 feet in the City. These groundwater depths are based on data from somewhat different eras for the Long Beach and Los Alamitos southerly quadrangles versus the South Gate and Whittier northerly quadrangles; therefore, groundwater level contours do not match at the common east-west boundary. North of the boundary, water levels are approximately 8 feet bgs and south of the boundary approximately 20 to 30 feet bgs.

The SWRCB GeoTracker data provides previous environmental reports, which include scattered well points as mentioned above. These data support shallow groundwater in the range of 12 to 55 feet bgs, with the deepest areas in the north portion of the City based on a well in Downey along Imperial Highway (SWRCB, 2014). It appears that the bulk of the City from the San Gabriel River west is in the 20 to 35 feet bgs range. Individual assessments would be required to verify the water depth at any given location. For example, the aforementioned work plan report at Alondra Boulevard and Woodruff Avenue indicate groundwater levels in the recent alluvium at a depth of approximately 20 feet. The effect of shallow groundwater is discussed in the section on liquefaction hazards. The City-provided reports generally confirm the data in the previous reports available on GeoTracker and the water depths below ground surface are shown at the report sites on
Figure 2. Reported depths range between 17- and 44-feet with one location greater than 50-feet.

Safety Element – Technical Background Report

FIGURE 2 - HISTORICALLY HIGHEST GROUNDWATER
SOURCE - DIAZ YOURMAN & ASSOCIATES



References: CGS 1998a, 1998b, 1998c, 1998d

3.0 SEISMIC SETTING

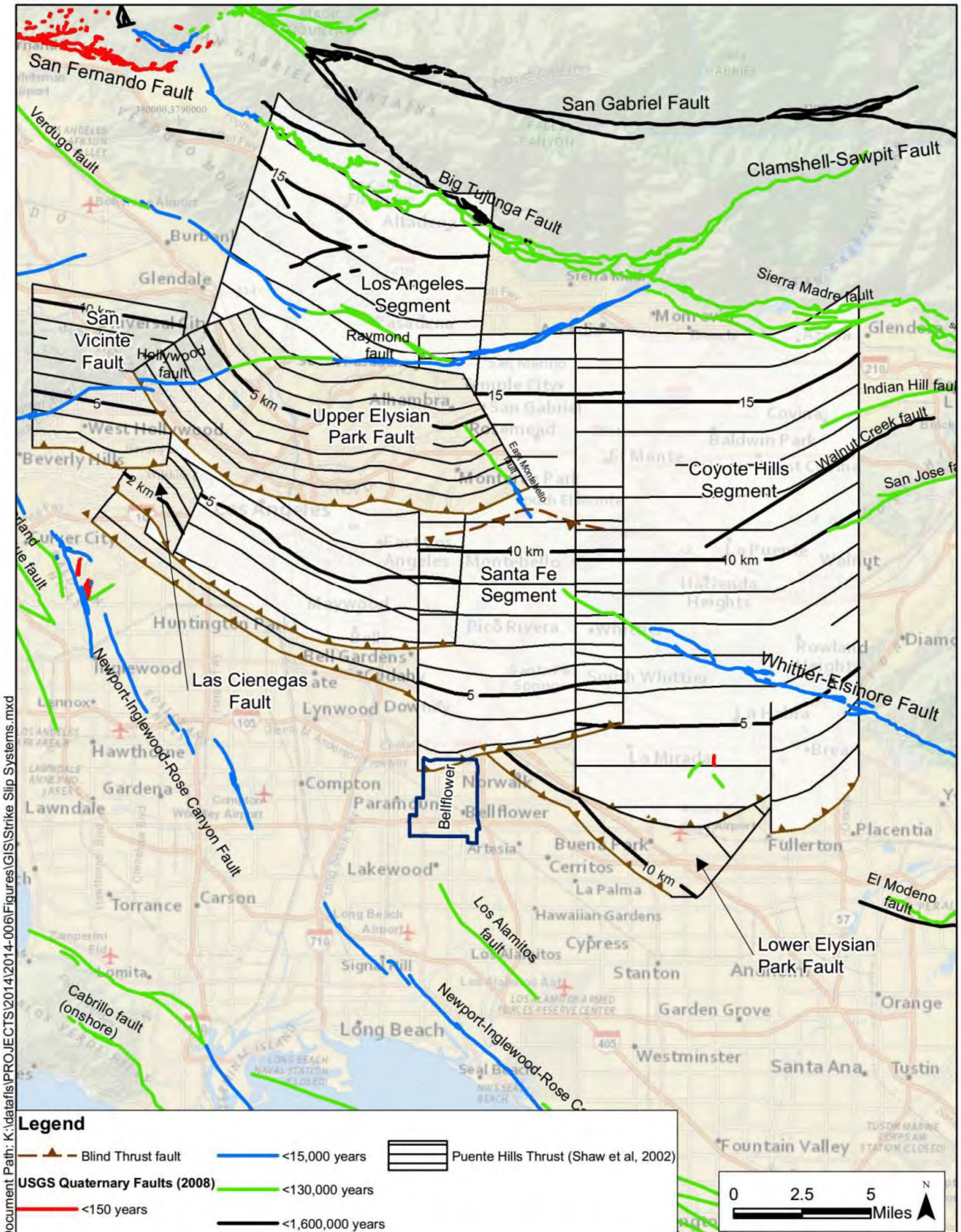
California is seismically active. Recorded and historically reported epicenters of southern California earthquakes that have occurred within and surrounding Los Angeles County are shown on Figure 4. These epicenters represent recorded seismic activity above Magnitude (M) 5 during the past 80 years and reported earthquakes for the past 200 years. Their frequency, in addition to the hundreds of lower magnitude earthquakes in the vicinity, indicates that the Los Angeles region is very prone to earthquakes.

Abundant evidence of seismic activity in California is found in the 200 years of records since Gaspar de Portola reported a strong earthquake while camped near the Santa Ana River in Orange County in 1769. Of the thousands of earthquakes felt in California since that time, three (Fort Tejon 1857, Owens Valley 1872, San Francisco 1906) were truly great earthquakes (over 7.75 magnitude); 12 were major earthquakes (magnitude 7.0 to 7.7), such as the Arvin-Tehachapi 1952, and El Centro 1940; and over 60 were moderate shocks (magnitude 6.0 to 6.9), such as Santa Barbara 1925, Long Beach 1933, San Fernando 1971, and Northridge 1994. About 200 earthquakes of magnitude 4.0 to 5.9 occur within the State every 10 years. These quakes are felt locally and have caused minimal to substantial structural damage.

Historic earthquake records are of a relatively short time span when compared to geologic time. Consequently, methods for the prediction of seismicity must be based not only on statistical data from historic records, but more importantly, on the extensive geologic evidence of faulting during the past millions of years. These data suggest that California should anticipate a great earthquake (over magnitude 7.75) approximately every 60 to 100 years, a major quake about every 20 years, and a moderate quake about every eight to 10 years. However, no regular periodicity has been established by the data, and short-term, fault-specific prediction of earthquakes is not yet possible.

As mentioned, the City has experienced both severe to mild earthquake shaking in the historic past, some events occurring within the recent memories of many citizens. Events centered some distance from the City (e.g., Landers, Big Bear, Northridge, and San Fernando) were unsettling but caused only minor local disruptions. The 2014 5.1 M La Habra (approximately 11 miles to the east), the 1987 5.9 magnitude Whittier Narrows earthquake (approximately 12 miles to the north), the 1994 M6.7 Northridge earthquake (approximately 32 miles to the northwest), the 1971 M6.4 San Fernando (approximately 39 miles to the north), and the 1933 Long Beach M6.3 (approximately 16 miles to the southeast) were strongly felt in Bellflower. Substantial disruption to the City and surrounding communities reminded Southern California residents that every several years another area of Southern California is vulnerable to a "direct hit." With earthquake prediction still a distant goal, it is important that each City and citizen do what is within its means and power to create policies that will maximize the protection to lives and property.

FIGURE 3 - FAULT MAP
SOURCE - DIAZ YOURMAN & ASSOCIATES



Reference: Puente Hills Blind Thrust Contours

Earthquake conditions for the City are typical of most Southern California cities in that the severe local earthquakes mentioned above may occur within a relatively short distance, for example less than 30 miles. Such earthquakes would most likely occur more or less aligned with major reverse or strike-slip faults having recognizable surface features (e.g., the Newport-Inglewood, Whittier, Elsinore, San Jacinto, and San Andreas faults), but possibly on more recently discovered "blind" thrust faults (e.g., Puente Hills 1987 M5.9, Whittier Narrows and Northridge 1994 M6.7) having no, or very subtle, surface expressions. There are three known and documented "blind" thrust faults (Puente Hills Lower Elysian Park, and Compton-Alamitos) in the immediate vicinity of the City. Depending upon the type of source fault, the depth of the energy release, and the magnitude of the earthquake, the affected area may experience surface fault rupture, uplift, co-seismic folding, and/or ground tilting and deformation within the near-surface geologic and soil formations.

3.1.1 Active and Potentially Active Faults

Faults classified as active and potentially active are considered the most significant in relation to the seismicity of the County of Los Angeles. The classification of the faults discussed below is coincident with the classification by CGS (Hart and Bryant, 1997). Active and potentially active faults are shown on

Figure 3 3. An active fault demonstrates offset of Holocene materials (less than 10,000-12,000 years ago) or significant seismic activity. The potentially active fault demonstrates Pleistocene materials (greater than 12,000 but less than 1,600,000 years ago).

The City is located between the Whittier-Elsinore Fault Zone on the northeast and the Newport-Inglewood Fault to the southwest and in part overlies the leading edge of the Santa Fe Springs segment of the Puente Hills blind thrust fault, as shown on Figure 3. This is an area of active crustal compression and will experience shaking due to a seismic event. The fault characteristics are presented in Table 2 for active and for potentially active faults, which may have a significant effect on the City within the foreseeable future. It is emphasized and should be noted that for purposes of consistency the distances in Table 2 are taken from a single location, Bellflower City Hall (latitude 33.8836°, longitude 118.1221°), as the reference point. Table 2 includes magnitudes, which are generally expressed as M for Richter magnitude [equals M_L for local magnitude]); M_W for moment magnitude that may be used in some instances. These values are suitable for general planning purposes, but should not be used for site-specific design. The Puente Hills, Newport-Inglewood, and Whittier-Elsinore faults are the closest faults and considered to have the potential to cause significant impact to the City. These three faults are discussed in more detail below.

TABLE 2 - MAJOR FAULTS WITHIN APPROXIMATELY 50-MILE RADIUS OF BELLFLOWER CITY HALL
SOURCE – DIAZ YOURMAN & ASSOCIATES

Fault Name (in order of nearest distance from the site)	Approx. Distance from Site (miles)	Fault Dip	Slip rate (mm/yr.)	Type of Fault (sense of slip)	Magnitude (mw)	Age and Evidence of Latest Surface Faulting
Puente Hills (Santa Fe Springs)	1.8	29° N	0.7	Thrust	6.7	No documented surface faulting
Puente Hills (Coyote Hills)	4.5	26° N	0.7	Thrust	6.9	No documented surface faulting
Puente Hills (Los Angeles)	5.9	27° N	0.7	Thrust	7	No documented surface faulting
Newport-Inglewood	5.9	90°	0.3	Strike Slip	7.5	Historic (1933 Long Beach EQ)
Whittier-Elsinore	8.8	84° NE	2.5	Strike Slip	7.8	Late Quaternary; Holocene
Palos Verdes	12	90°	3	Strike Slip	7.3	Holocene
Elysian Park (Upper)	12	50° NE	1.3	Reverse	6.7	Historic (1987 Whittier Narrows EQ)
Raymond	16	79° N	1.5	Strike Slip	6.8	Historic (1988 M4.9 Pasadena EQ)
San Joaquin Hills	17	23° SW	0.5	Thrust	7.1	Late Quaternary uplift San Joaquin Hills
Verdugo	17	55° NE	0.5	Reverse	6.9	Holocene
Hollywood	17	70° N	1	Strike Slip	6.7	
San Jose	18	74° NW	0.5	Strike Slip	6.7	Late Quaternary
Santa Monica	18	44°	2.4	Strike Slip	7.4	Late Quaternary; Holocene
Sierra Madre	20	51° N	2	Reverse	7.3	Holocene and Late Quaternary
Clamshell-Sawpit	21	50° NW	0.5	Reverse	6.7	Recent seismicity
Chino	24	65° SW	1	Strike Slip	6.8	Late Quaternary
Malibu Coast	25	74° N	0.3	Strike Slip	7	Late Quaternary
Anacapa-Dume	26	41° N	3	Reverse	7.2	
Cucamonga	28	45° N	5	Reverse	6.7	Late Quaternary; Historic
San Gabriel	31	61° N	1	Strike Slip	7.3	Late Quaternary
Northridge	33	35° S	1.5	Thrust	6.9	Historic (1994 Northridge Earthquake)
Santa Susana	37	55° N	5	Reverse	6.9	Late Quaternary
San Andreas	41	90°	29	Strike Slip	8.2	
San Jacinto	42	90°	6	Strike Slip	7.8	

Fault Name (in order of nearest distance from the site)	Approx. Distance from Site (miles)	Fault Dip	Slip rate (mm/yr.)	Type of Fault (sense of slip)	Magnitude (mw)	Age and Evidence of Latest Surface Faulting
Coronado Bank	43	90°	3	Strike Slip	7.4	
Simi-Santa Rosa	44	60°	1	Strike Slip	6.9	
Holser	44	58° S	0.4	Reverse	6.8	
Cleghorn	48	90°	3	Strike Slip	6.8	
Oak Ridge (Onshore)	49	65° S	4	Reverse	7.4	

Source: USGS 2008 National Seismic Hazards Maps .

- **Puente Hills Blind Thrust** - The east-northeast to west-southwest trending Santa Fe Springs segment of the Puente Hills blind thrust fault dips to the north and appears to underlie the northern portion of the City; it is considered to be a thrust fault up on the north side. Due to its buried nature and past uncertainties regarding blind thrust faults, the Puente Hills blind thrust fault is not shown as a buried feature by Saucedo and others (2003). The Puente Hills blind thrust fault was named by Shaw and Shearer (1999), and they initially indicated that this was the source for the 1987 Whittier earthquake rather than the "lower" Elysian Park where it had been attributed. The lower Elysian Park blind thrust (also shown southeast of the City) is deeply buried and does not pose a risk of surface deformation. Portions of the three segments of the Puente Hills blind thrust fault shown on

- Figure 3 3 have been studied using various techniques to view the subsurface characteristics.

  Leon and others (2007) provide an up-to-date summary and compilation of detailed information regarding the data supporting the Puente Hills blind thrust fault characteristics in the City. This paper describes extensive field work and analysis of the Puente Hills blind thrust fault Santa Fe Springs segment within the City (the Carfax site) along Gardendale and Carfax Avenues near Arthurdale Street adjacent to the San Gabriel River. The results of this work and the application to the City are presented below.
  The primary conclusions from Leon and others (2007) regarding the Puente Hills blind thrust fault Santa Fe Springs segment are summarized as follows:

  - Geophysical seismic reflection surveys, drilling, and cone penetration testing data above the Santa Fe Springs segment of the Puente Hills fault provide evidence of incremental folding during several large Puente Hills fault earthquakes in the Holocene (past 10,000 to 12,000 years).
  - Borehole data indicate that the three youngest growth folds in the uppermost 65 feet bgs are characterized by southward thickening sedimentary strata that are separated by three sedimentary layers of roughly equal thickness deposited between large earthquake events.
  - The three equal thickness intervals are interpreted to have occurred after the formation of the buried paleo-fold scarps formed during three large-magnitude M>7 Puente Hills fault earthquakes in the past 8,000 years with the most recent 200 to 2,200 years ago.
  - The surface fold scarps were estimated to be 3.5 to 5.5 high over a 200-foot-wide zone indicating minimum thrust displacements (along the buried fault plane) of 8 to 15 feet and a minimum Holocene slip rate of 0.9 to 1.6 millimeters/year [mm/year].

- **Newport-Inglewood Fault Zone** - The Newport-Inglewood Fault Zone (NIFZ), including its offshore and onshore extensions with the Rose Canyon fault zone to the south. The primary section of interest to the City is the south Los Angeles Basin segment extending from the Santa Monica Mountains on the north to the Newport Beach area on the south. The NIFZ was the source for the 1933 M6.6 Long Beach earthquake. The fault zone section of interest is a right-lateral strike-slip fault, which is comprised of five different faults, is a series of en echelon (parallel structural features that are offset like the edge of shingles on a roof when viewed from the side) northwest-trending, vertically dipping faults extending from the southern edge of the Santa Monica Mountains southeastward to the offshore area near Newport Beach. The fault is considered active based on its seismicity record, the youthful geomorphic features along the fault, and evidence of Holocene-age surface ruptures documented in Orange County by various investigators (Guptil and Heath, 1981; Medal, Aragon, Worswick, and Associates, 1981; CGS, 1986).

- **Whittier-Elsinore Fault Zone** - The Whittier-Elsinore fault zone is a right-lateral strike-slip fault located northeast of the City. This northwest-trending fault extends from Whittier Narrows southeast across the Santa Ana River, past Lake Elsinore, into western Imperial County, and then into Mexico. Fault segments northwest of the Santa Ana

River that were demonstrably involved in the October 1 and 4, 1987, Whittier Narrows earthquakes (magnitude 5.9 and 5.3) are, for the most part, northeast-dipping reverse faults along which bedrock of the late Miocene Puente Formation, making up most of the Puente Hills, have been uplifted. "Right-handed" en echelon folds along the Whittier fault within rocks of the Puente Formation indicate long-term right lateral offset.

Local active or potentially active faults that do not appear in Table 2 are the Norwalk and Compton-Alamitos, which have much less known about their earthquake potential or they are part of a larger zone, which was previously discussed. In either case, the likely upper bounds of their earthquake risk potential are accommodated in the potential of the larger, better-studied adjacent faults (e.g., Puente Hills, Newport-Inglewood, Whittier-Elsinore). The Norwalk and Compton-Alamitos faults are discussed in more detail below.

- **Norwalk Fault -** The Norwalk Fault is approximately 3.5 miles northeast of the City. This fault strikes 65 to 85 degrees to the northwest and dips steeply to the northeast. This fault is noted as a possible source of a damaging earthquake (magnitude 4.7) occurring on July 8, 1929 (Ziony and Yerkes, 1985), which caused significant damage in Whittier and Norwalk. The fault is approximately 9 miles long and has an arcuate trace between Buena Park and Tustin. Microseismic activity along the Norwalk Fault is high, and Joyner (1985) suggests that the fault may be capable of generating a magnitude 6.3 earthquake.

- **Compton-Alamitos Fault** - The potentially active Compton-Los Alamitos fault running north-south is located approximately 2.2 miles south of the City in the City of Lakewood. This 7.5-mile long single strand fault running parallel to the Newport-Inglewood fault zone is considered (Ziony and Jones, 1989) to be either an upward verging ramp of a lower buried thrust or an inward segment of the Newport-Inglewood fault zone.

Other active faults, which could induce large ground shaking in Southern California in the future, but have less potential to significantly impact the City than the Puente Hills, Newport-Inglewood, and Whittier-Elsinore faults, are discussed below.

- **San Andreas Fault Zone** - The City is south and west of the San Andreas fault zone. This fault zone extends from the Gulf of California northward to the Cape Mendocino area, where it continues northward along the ocean floor. The fault plain is essentially vertical and has a right lateral sense of movement. In 1857, a magnitude 7.9 earthquake occurred along a 225-mile length of this fault between Cholame and San Bernardino. This seismic event is the most significant historic earthquake in Southern California history. The length of this right lateral fault and its active seismic history indicate that it has a very high potential for large-scale movement in the near future (magnitude 8.0+) and should be considered important in land-use planning for most cities in California.

- **San Fernando Fault Zone** - The San Fernando fault (the western segment of the Sierra Madre fault zone) is north of the City. Fault segments that were demonstrably involved in the February 9, 1971, San Fernando Earthquake (magnitude 6.4) are, for the most part, east-west trending thrust faults with associated left lateral movement. The ground surface ruptures occurred on little known pre-existing faults in an area of low seismicity and previously unknown historic ground displacement. The zone of displacement was approximately 9 miles long and had a maximum of 3 feet vertical movement. The earthquake epicenter of the February 9, 1971, seismic event was near the community of Newhall. The recurrence interval for the San Fernando Fault Zone is estimated to be approximately 200 years.

- **Malibu Coast Fault Zone** - The Malibu Coast fault is northwest of the City. The onshore Malibu Coast fault consists of several subparallel strands trending east-west along the southern margin of the western Santa Monica Mountains. The onshore fault zone is composed of reverse faults. The latest movement on this fault was believed to have been more than 11,000 years ago, but Converse Consultants (1993) found evidence of Holocene displacement within colluvial soils determined to be 5,000 to 6,000 years old at a location in the City of Malibu. Based on this evidence, the fault is considered to be active.

- **Verdugo Fault Zone** - The Verdugo fault is north of the City. This fault bounds the south flank of the Verdugo Mountains and appears to merge with the Eagle Rock-San Rafael Fault System in the vicinity of Verdugo Wash. The northwest-trending north-dipping Verdugo fault has thrust Cretaceous basement rocks southward several hundreds of feet over terrace and alluvial deposits of Pleistocene and possible Holocene Age (less than 10,000 years). The fault is a low-angle reverse fault (thrust fault). Groundwater cascades and surface scarps are evidence of recent activity along the fault. The Verdugo fault has a high potential for future activity. It is not considered to have had seismic activity during historic time.

- **San Gabriel Fault Zone** - The San Gabriel fault zone is north of the City. This fault extends from Frazier Park to Mount Baldy Village. This fault displays a complex range of movement that appears to change from one section of the fault to another. Stratigraphic evidence (sequence of sediment deposition) suggests approximately 35 miles of right lateral offset since Miocene (Ehlig, 1973) time. Sections of the fault show Quaternary and Holocene offset, and because of its length and its ancestral relationship with the San Andreas Fault, its potential future activity must be considered.

- **Santa Monica Fault Zone** - The City is located southeast of the Santa Monica fault. The Santa Monica fault is currently designated as potentially active; however, ongoing and future studies may redefine this fault system as active. No detailed information is available on the exact location of this southwest-northeast trending fault at the ground surface (fault trace), or on its geometric orientation. From the inferred trace on geologic maps and some oil well data, the fault has been described as a northwest-dipping thrust fault bordering the south flank of the Santa Monica Mountains. This fault, the Malibu Coast fault, the Hollywood fault, and the Raymond fault belong to one large fault system (Lamar, 1965).

3.1.2 Historical Ground Shaking

Earthquakes generally occur along faults, which are the planar features within the earth. Numerous regional and local faults are capable of producing severe earthquakes, those of M of 6.0 or greater (SCEC, 2014). The top 10 reported or recorded historical earthquakes that produced the highest shaking intensity at the City and having magnitude of 5 or greater and within 100 miles radius of the City is summarized in Table 3 specifically distance from the City Hall, the PGA, and felt intensity (Modified Mercalli Intensity [MMI]). The Modified Mercalli

Intensity (MMI) is used to document how an earthquake was felt by inhabitants who experienced the seismic event with values ranging from I to XII as described in Table 4. This summary information was obtained from EQSEARCH computer program for the estimation of PGA from historical California earthquake catalogs. In addition to the summary table, the date, magnitude and locations of the historical earthquakes are shown on Figure 4. Earthquake epicenters in the region with a magnitude of 5.0 or greater are shown on Figure 4, and significant earthquakes within 100 miles of the City center through the end of 2013 are also shown in Table 3.

No historic earthquakes of magnitude greater than 6.0 have occurred in the City. General background seismicity is considered low for faults that pass through or near the City, with the exception of the 1987 Whittier Narrows and 1933 Long Beach earthquakes, which caused moderate to heavy ground shaking within the City.

TABLE 3 - TOP TEN EARTHQUAKES WITHIN 100 MILES OF BELLFLOWER CITY HALL: 1800-2001 SORTED BY MMI
SOURCE: EQSEARCH, 2011

Earthquake	Estimated Site MMI	Latitude North	Longitude West	Date	Approximate Magnitude	Acceleration At Site (%g)	Approximate Distance (miles)
Los Angeles	VIII	34.1	118.1	07/11/1855	6.3	0.147	15
Mainshock Whittier Narrows	VIII	34.061	118.079	10/1/1987	5.9[2]	0.13	12.5
Long Beach aftershock	VIII	33.783	118.133	10/2/1933	5.4[1]	0.151	7
Norwalk	VIII	33.9	118.1	7/8/1929	4.7[2]	0.218	1.7
Unknown	VII	34	117.5	12/16/1858	7	0.089	36.5
Wrightwood	VII	34.37	117.65	12/08/1812	7[1]	0.073	43
Mainshock Northridge	VII	34.213	118.537	1/17/1994	6.7[1]	0.082	33
Long Beach Mainshock	VII	33.617	117.967	3/11/1933	6.3[1]	0.106	20.5
Long Beach Aftershock	VII	33.683	118.05	3/11/1933	5.5[1]	0.081	14.5

1. Moment magnitude
2. Richter magnitude

.

TABLE 4 - MODIFIED MERCALLI INTENSITY (MMI) SCALE (ABRIDGED VERSION)[1]

Average Peak Velocity (cm/sec)		Intensity Value and Description	Average Peak Acceleration (% gravity)
<0.1	I.	Not felt except by a very few under especially favorable circumstances (I Rossi-Forel scale).	<0.17
0.1 – 1.1	II.	Felt only by a few persons at rest, especially on upper floors of high-rise buildings. Delicately suspended objects may swing. (I to II Rossi-Forel scale).	0.17 – 1.4
0.1 – 1.1	III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel scale).	0.17 – 1.4
1.1 – 3.4	IV.	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like a heavy truck striking building. Standing automobiles rocked noticeably. (IV to V Rossi-Forel scale).	1.4 – 3.9
3.4 – 8.1	V.	Felt by nearly everyone, many awakened. Some dishes, windows, and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel scale).	3.9 – 9.2
8.1 - 16	VI.	Felt by all, many frightened and run outdoors. Some heavy furniture moved, few instances of fallen plaster and damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale).	9.2 - 18
16 - 31	VII.	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars. (VIII Rossi-Forel scale).	18 - 34
31 - 60	VIII.	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed. (VIII+ to IX Rossi-Forel scale).	34 - 65
60 - 116	IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel scale).	65 – 124
> 116	X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. (X Rossi-Forel scale).	> 124
> 116	XI.	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.	> 124
> 116	XII.	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into air.	> 124

1. Middle column Bolt (1993); outer columns Wald et al. (1999).

FIGURE 4 - EARTHQUAKE EPICENTER MAP FOR EVENTS MAGNITUDE 5 AND GREATER
SOURCE - DIAZ YOURMAN & ASSOCIATES

The list of select historic earthquakes felt in the City, summarized in Table 3, and the statistical distribution of earthquakes by magnitude during the same period, summarized in Table 5 illustrate that Bellflower has experienced strong ground motions (MMI of VII to IX) from past local and distant earthquakes, but only the M = 6.3 Long Beach earthquake in 1933 constitutes a large local, historic earthquake. If such a major earthquake were generated closer to the City, ground motion would be severe. Brief summaries of the 1855, 1929, 1933, 1941, 1987, and 1994 earthquakes are presented below. In addition, the recent 2014 La Habra earthquake is summarized below, because of its close proximity to the City of Bellflower. Due to the small size, greater distance, and/or poorly recorded nature of the 1812 and 1858 earthquakes, no details of actual ground shaking or damage in the City beyond those in Table 3 are known.

TABLE 5 - STATISTICAL DISTRIBUTION OF EARTHQUAKES BY MAGNITUDE WITHIN 100 MILES OF BELLFLOWER CITY HALL IN THE PERIOD 1800-2001
SOURCE – DIAZ YOURMAN & ASSOCIATES

Equal to or Greater Than Earthquake Magnitude	Number of Times Exceeded	Cumulative Number of Earthquakes per Year
4.0	1119	5.2
4.5	417	1.9
5.0	150	0.69
5.5	51	0.24
6.0	26	0.12
6.5	13	0.06
7.0	7	0.03
7.5	2	0.009

1) For magnitudes equal to or greater than those in the corresponding column 1.

Several large historic/pre-instrumental (i.e., before modern seismographs) earthquakes are reported to have occurred within the selected 100-mile radius. The epicenter locations of each of these events are considered very uncertain because they are based on damage reports and the felt intensity of shaking. Damage and intensity can be highly affected by local geology and not just distance to the epicenter.

1855 Los Angeles Area Earthquake - On 11 July 1855 a moderate earthquake of estimated magnitude 6.3 earthquake occurred, which reportedly consisted of shaking over a 12-second span and damaged buildings in the Los Angeles, including damaged the bell tower at the Mission San Gabriel about 8 miles east-northeast of Los Angeles. The epicenter location is not known, but generally suspected locations are on the Raymond Fault, beneath what is now metropolitan Los Angeles, and possibly offshore since there was a tsunami sighting.

1929 Norwalk Earthquake - The 1929 Whittier earthquake occurred on July 8 with a local magnitude of 4.7 and maximum intensity of VII (very strong) on the MMI. The shock occurred west of Bellflower at a depth of 8 miles. Reportedly, homes and a school in the immediate epicentral area suffered heavy damage, and in Santa Fe Springs, oil towers were damaged and some short cracks appeared in the ground (Stover & Coffman 1993). Damage in the area of East Whittier was estimated at $50,000 to $350,000. In the Santa Fe Springs area reportedly four people were injured. It was thought that this earthquake was located on the Norwalk fault (Richter, 1935), but may have been located on the Puente Hills blind thrust Santa Fe Springs segment or Coyote Hills (CHS) segment

1933 Long Beach Earthquake - In 1933, at 5:54 p.m. on March 10th, Southern California experienced its deadliest seismic disaster in recorded history when an earthquake struck the Long Beach area. The magnitude (M_w) 6.4 Long Beach earthquake occurred along the

Newport-Inglewood fault zone offshore of Newport Beach at a depth of 10 kilometers. It is estimated that maximum slip along the fault was on the order of one meter, and the total rupture length along the fault was about 15 kilometers. Earthquake ground shaking lasted about 20 seconds, and some 17 miles away, the maximum recorded ground acceleration was 0.22g. The earthquake killed over 120 people and caused property losses in 1933 dollars estimated at $50 million. Many of the buildings severely damaged or destroyed were schools in and around Long Beach. This led to passage of the Field Act, a state law mandating improved building codes for new public schools and direct state review of public school design.

1941 Torrance-Gardena Earthquakes - Two relatively small earthquakes struck the southern Los Angeles basin, causing damage to nearby communities and oil fields, the first on October 21, 1941 and the second November 14, 1941. The earthquakes were both M_L 4.8 and felt at MMI levels of VII and VIII, respectively. As far south as Signal Hill plaster and walls were cracked, and chimneys were damaged. The November event was felt throughout the Los Angeles area and as far away as San Diego. No injuries or deaths were reported from either event. The second event caused more damage, with gas and water mains burst, a ruptured oil tank, oil well casings and other equipment were damaged, and store fronts in the business districts of Torrance and Gardena collapsed. Probably the damage from the second event was greater because the first event had substantially weakened building materials.

1987 Whittier Narrows Earthquake - The Whittier Narrows earthquake (M5.9) and several moderate aftershocks occurred on the Puente Hills blind thrust (the Santa Fe Springs and Coyote Hills segments), a previously unknown concealed fault located beneath the City and the area to the north. There were eight fatalities, hundreds of injuries, and approximately $358 million in property damage mainly to communities near the epicenter east of Los Angeles (e.g., Whittier, Montebello, El Monte, and San Gabriel). The most severe damage occurred in the old downtown sections of Whittier, Alhambra, and Pasadena where there were high concentrations of unreinforced masonry buildings. Many chimneys collapsed some falling into the homes; primary residence damage was to masonry structures, homes not fully anchored to foundations, and houses/apartments built over garages/carports with large openings. In general wood frame residences sustained relatively little damage.

1994 Northridge Earthquake - The Northridge earthquake struck on January 17, 1994, beneath the highly urbanized San Fernando Valley centered on a previously unknown blind thrust fault. Damage was widespread, reportedly exceeding $12 billion. As with the San Fernando earthquake 13 years before, sections of major freeways collapsed, parking structures and office buildings collapsed, and numerous apartment buildings were unsalvageable. Damage to wood-frame apartment houses, typically those with a soft first floor or lower-level parking garages, was very widespread in the San Fernando Valley and Santa Monica areas. The high accelerations, both vertical and horizontal, in the epicentral area lifted structures off their foundations and/or shifted walls laterally.

2014 La Habra Earthquake - In addition, a recent earthquake is the La Habra earthquake M5.1, which occurred on March 29, 2014, beneath the urban area of La Habra/Brea apparently on the Coyote Hills segment of the Puente Hills blind thrust. Bellflower reports generally confirmed an MMI of IV; the City was approximately 11 miles from the epicenter, which was approximately 4.5 miles deep.

4.0 ANALYSIS OF HAZARDS AFFECTING THE CITY

Potential hazards have been divided into two categories, seismic and geologic (non-seismic including geotechnical/soil hazards). Seismic hazards require an earthquake. The magnitude of an earthquake should be at least 5.0 for some significant effects to be triggered, although lesser magnitude earthquakes have activated hazards and caused damage. Geologic hazards are those that may be activated with or without an earthquake due to the nature of the geologic materials or the hydrogeologic regime. In the City, seismic hazards carry with them the most risk to property and population.

The occurrence of several active/potentially active faults adjacent to or partly under the City and the subdued topography and presence of alluvial formations across the City indicate that seismic hazards will predominate, as shown on Figure 4. Geotechnical issues related to weak soils and unstable slopes are present. Large-scale subsidence due to fluid withdrawal (water or oil) is not reported, though the City does overlie known groundwater aquifers and has had oil drilling (The Department of Oil, Gas, and Geothermal Resources [DOGGR] indicates six idle or abandoned oil wells within the City); no large-scale subsidence has been reported. Dam and water tank failure inundation/flooding potential exists from several sources including large (e.g., Whittier Narrows, Santa Fe, and Santa Anita Dams) and small reservoirs within and outside the City. Taken together, geologic and seismic hazard conditions in the City are about average for cities in Southern California. The following subsections describe in more detail the seismic and geologic hazards that may impact the City.

4.1 SEISMIC HAZARDS

For the seismic component of the Safety Element, the minimum list of potential hazards that must be considered is:

- Primary
  - Ground shaking (strong earthquake ground motion
  - Surface fault rupture (primary and subsidiary)
  - Co-seismic uplift and folding
- Secondary
  - Liquefaction, differential compaction and settlement
  - Ground lurching and cracking, fill mass deformation
  - Earthquake-induced landslides
  - Flooding from earthquake-induced dam failure
  - Flooding from tsunami and seiche

4.1.1 Potential Future Ground Shaking

Data

There are several local and regional faults that have a higher potential to impact the future seismicity of the City and the surrounding region. The effects of an earthquake originating on any given fault will depend primarily upon its distance from the City and the magnitude of the earthquake (amount of energy release) that the fault is likely to generate. The effect is most often presented as the severity of ground shaking, in terms of peak ground acceleration (PGA), which is the recorded spectral acceleration at the ground surface. The PGA is presented as the percentage of the force of gravity, which is termed "1g" for one unit of gravitational force, or 100% gravity. Therefore, 0.50g is 50% the force of gravity. Both deterministic and probabilistic estimates of future ground motion parameters are used to determine the potential for ground shaking within the City.

In general, the more distant the fault and the smaller the potential earthquake, the less potential for ground-shaking at a given location. However, local geology (e.g., thick alluvium versus shallow bedrock) and sedimentary basin geometry can have dramatic effects on seismic waves that are more extensive than amplifications and resonances caused by near-surface soft alluvium alone. Interactions between the structure of the basin and earthquake waves can increase the amplitude and duration of shaking during an earthquake and can focus the waves from the bottom of the basin. This can increase the intensity of strong shaking in small regions at the surface and diminish it in others, as well as increase the duration of shaking at the edges of basins (USGS, 1996).

Alluvial thickness in the City is in the range of approximately 100 to a few thousand feet within the City based on descriptions of the groundwater basins (CDWR, 1961; San Gabriel Basin Watermaster, 2006). Depending upon the source (direction and distance), and magnitude of a large earthquake, and the presence of groundwater and site-specific geologic subgrade, thick alluvium may have a positive or negative effect on overlying structures.

Generally Expected Effects

The effects of severe ground shaking can be envisioned given the experience of many citizens with recent earthquakes in Southern California. The 1971 San Fernando earthquake (M6.6) and 1994 Northridge earthquake (M6.7) occurred on faults bordering or beneath the San Fernando Valley. They caused significant structural damage, injury, and loss of life. Peak horizontal and vertical ground accelerations exceeded 1g in a few locations. Ground-shaking estimates of peak horizontal acceleration provided in

Figure 5 are based on CBC 2013 site class B, but can change based on site specific geological features. The effects of the geology, e.g., "soil sites," can change the actual ground acceleration for specific locations. Therefore, site-specific geology, geotechnical, and earthquake engineering studies are mandatory for evaluating critical, sensitive, or high-occupancy structures.

4.1.2 Surface Fault Rupture (Including Co-Seismic Deformation)

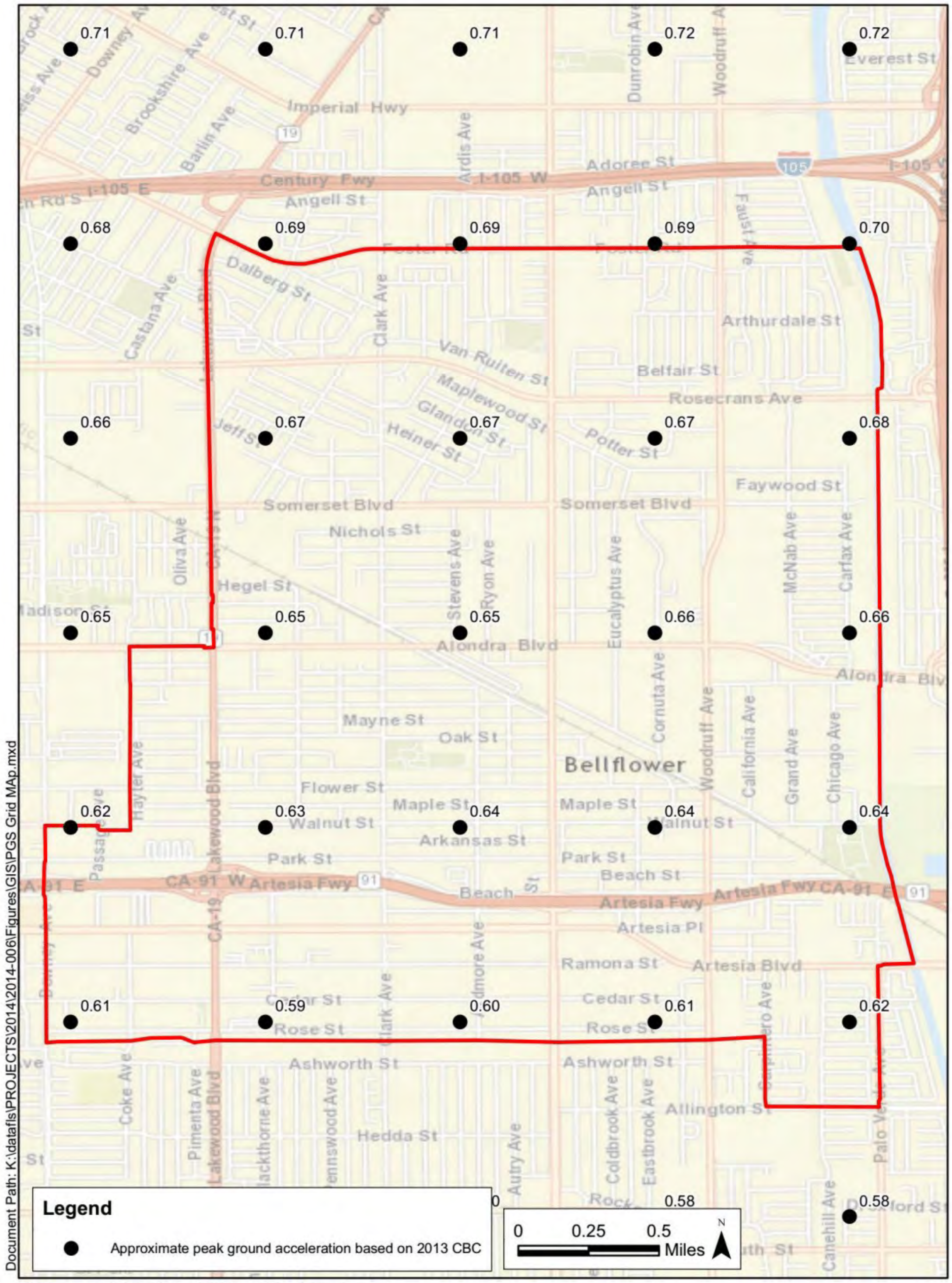
Data

In cases where earthquakes are large or hypocenters are shallow, movement along the source fault plane can cause ground disturbance where the fault is close to the ground surface. While the potential for ground surface fault disturbance is considered low in the City, it cannot be fully discounted. Active faults and potentially active faults (as defined by the CGS) must be considered as potential sources for fault rupture. In general, the younger the last movement is on a fault, the higher the potential for future movement on that fault.

Fault rupture through a structure will very likely cause irreparable damage and may cause collapse of walls and ceilings. Normal foundations would be dislocated and rendered unusable. Combined with strong ground shaking, this is a very serious hazard.

There is limited direct local evidence of different potential impacts and information regarding degree of activity and damage-generating potential by the Puente Hills blind thrust fault. The Puente Hills blind thrust fault poses a potential ground-surface deformation hazard in the northern portion of the City, as shown on Figure 3 for locations of the Puente Hills blind thrust fault and regional faults.

FIGURE 5 - SEISMIC GRID PGA
SOURCE - DIAZ YOURMAN & ASSOCIATES



References: CGS 1998a, 1998b, 1998c, 1998d

Generally Expected Effects and Mitigation Methods

No Alquist-Priolo Earthquake Fault Zones located within the City (Hart and Bryant, 2007); therefore, surface rupture is unlikely to occur in or adjacent to the City boundaries. Such surface faulting features such as scarps (small cliffs), grabens (trenches), fractures, and "mole tracks" or pressure ridges are very unlikely. Scientific evidence suggests that the City is far more likely to be impacted by blind thrust faults, such as the Puente Hills and Compton-Alamitos blind thrusts located beneath and southwest of the City.

We believe these conclusions as applied to the location of the Santa Fe Springs segment of the Puente Hills blind thrust fault, shown on Figure 3, suggest the potential for subsurface and ground-surface uplift of approximately 3.5 to 5.5 feet with associated ground deformation and tilting in the area above the leading edge ("upper tip line of the Puente Hills blind thrust fault ramp") of the Santa Fe Springs segment.

Considering the location of the Puente Hills blind thrust fault, two types of fault impacts are important to consider in Bellflower. Fault-generated earthquake ground shaking is the most critical impact due to its widespread effects and to the severe damage resulting in economic losses and the injury to or death of people. Earthquake shaking is a prime consideration for the City, and its impacts are discussed in subsequent sections. The other important impact relates to ground movement, e.g., co-seismic uplift, ground tilting, ground lurching, and ground cracking particularly in the area of the leading edge of the Puente Hills blind thrust. While these effects are more limited in extent (over or near active or potentially active faults) than strong ground shaking, the impacts on structures and the public can be severe.

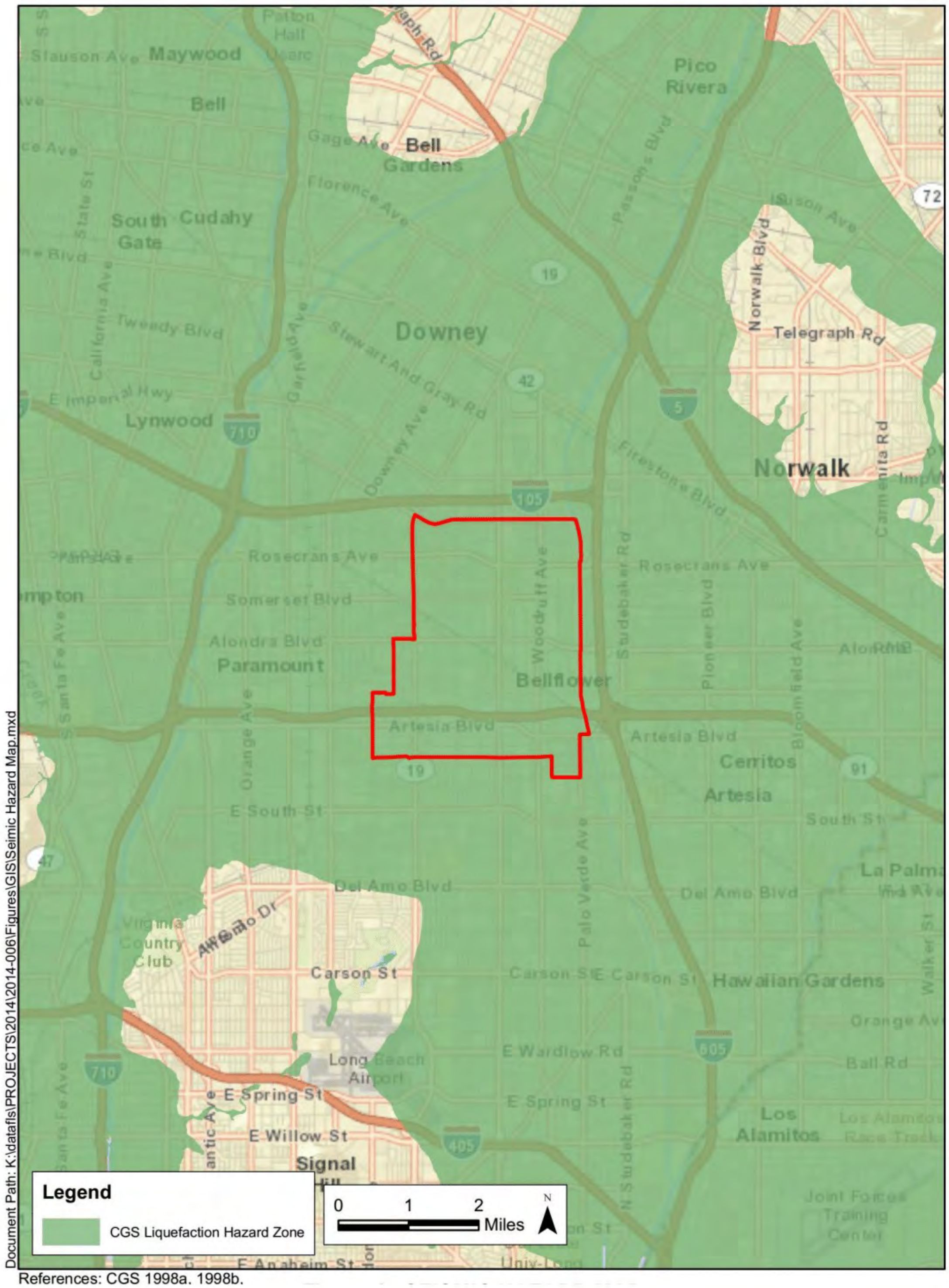
Only one documented fault, fault zone, or groundwater barrier is known to directly underlie the City, the Santa Fe Springs segment of the Puente Hills thrust. There is limited direct local evidence of different potential impacts and information regarding degree of activity and damage-generating potential by the Puente Hills blind thrust fault. The Puente Hills blind thrust fault poses a potential ground-surface deformation hazard in the northern portion of the City, see Figure 3 for locations of the Puente Hills blind thrust fault and regional faults.

4.1.3 Earthquake-Induced Landslides

Data

The Seismic Hazard Mapping Program delineates the approximate boundaries of areas susceptible to earthquake-induced landslides and other slope failures (e.g., rock falls). Figure 6 shows areas susceptible to earthquake-induced landslides. However, there are no areas designated in Bellflower since hillside terrain is not present (CDMG, 1998a-d). There may be some potential for earthquake induced slope failures along the San Gabriel River engineered slopes. To distinguish the level of susceptibility, project-specific geologic and geotechnical study is needed.

FIGURE 6 – SEISMIC HAZARD MAP
SOURCE - DIAZ YOURMAN & ASSOCIATES



References: CGS 1998a, 1998b.

Generally Expected Effects and Potential Mitigation Methods

Earthquake-induced landslides along the San Gabriel River adjacent to the City could travel into the river and affect structures, roadways, utilities, and the general population located in these potential hazard areas. In areas of concern, appropriate engineering geology and geotechnical investigation, including field data collection, laboratory testing, and slope stability analysis, should be conducted considering both static and dynamic (earthquake) forces.

4.1.4 Liquefaction

The entire City has been mapped pursuant to the SHMA in a liquefaction hazard zone and therefore is required investigation for liquefaction hazard throughout the City (South Gate, Whittier, Long Beach, and Los Alamitos 7.5-minute USGS Quadrangles, 1998), as shown on Figure 6 Seismic Hazard Map. A degree of potential (high to low) will increase with shallower groundwater depths and areas of predominantly low-density sand and silty sand. Ground failures associated with saturated deposits (liquefaction) can include an entire suite of effects ranging from simple ground cracking to complex lateral-spreading landslides.

Data

The three key factors that indicate whether an area is potentially susceptible to liquefaction are severe ground shaking, shallow groundwater and low-density sands. In addition to having ground shaking parameters, quantitative estimates of liquefaction potential require specific data from geotechnical borings, laboratory testing, and groundwater level information. The CGS Seismic Hazard Zones maps (CDMG, 1998a, 1998b, 1998c, and 1998d) delineate the entire City and adjacent areas that are susceptible to liquefaction, as shown on Figure 6; a prime consideration is whether historically highest groundwater levels have been within 50 feet of the ground surface. These are areas where alluvium is sufficiently loose and groundwater is sufficiently shallow that strong earthquake shaking could cause sediments to lose bearing capacity (CDMG, 1998a, 1998b, 1998c, and 1998d). This could result in severe settlement of surface facilities and in some cases uplift of buried structures (e.g., large pipelines).

Within the City and immediately adjacent areas of influence, the liquefaction areas identified on Figure 6 correspond to alluvial deposits Qw, Qyfa, and Qyfs indicated within the City (Figure 1) and historically shallow groundwater (illustrated on Figure 2). Areas with the shallowest groundwater (8 to 30 feet bgs) tend to be in the south (higher potential) and deepest (30 to 55 feet bgs) in the north. Although there is some potential for deep liquefaction greater than about 50 below ground surface, liquefaction potential is substantially higher where water is less than 50 feet deep. CGS maps use the historically highest groundwater depth of 50 feet or less in their evaluation and do not separate potentially liquefiable sediments into susceptibility categories based on groundwater depth or sediment type. All other factors being equal (same earthquake, same geologic formation) susceptibility levels may be higher where groundwater is shallower, but such estimates would not have a high degree of precision.

Liquefaction areas are considered to have potential land use constraints. Liquefaction assessments must be made for important projects. The depth and intensity of study will naturally vary depending on the location, type, and importance of the project. It should be a goal to compile such data as it might exist in City, State, or County files, and to update groundwater depth data so that an ongoing assessment is possible. Due to the lack of specific geologic and engineering properties and groundwater depth data across the City, relative severity of liquefaction potential (not differentiated on Figure 6) mentioned above based on groundwater depth should be considered approximate. This could be used as general, not absolute, planning guidelines to indicate where various levels of assessment are needed for planned structures or possibly for existing critical, essential, and high occupancy facilities.

Generally Expected Effects and Mitigation Methods

Liquefaction-induced ground failure can involve a complex interaction among seismic, geologic, soil, topographic, and groundwater factors. Failures can include ground fissures, sand boils, ground settlement, loss of bearing strength, buoyancy effects, ground oscillation, flow failure, and lateral spread (Bartlett and Youd, 1992). These, in turn, can have effects on surface and subsurface structures. *Ground fissures* may be reflected as linear tensional features that open to widths of a few to several inches, but that may or may not exhibit differential vertical movement. *Sand boils* are built-up sand accumulations often up to three feet across that result from ejected sand and water forced from the subsurface under pressure. *Ground settlement* often occurs as liquefied sand deposits reconsolidate following ejection of the water and sand. A *loss of bearing strength* can cause surface structures to settle, either evenly or differentially, causing tilting. *Buoyancy* caused by rapid upward movement of water through sandy soils can cause buried structures to rise (float) when they are founded in the liquefied layer. *Ground oscillation* may not cause permanent ground displacement, but may damage rigid structures in a non-liquefied zone. *Flow failure* is found in steeper terrain where liquefied soils near the ground surface flow as a viscous mass down slope similar to a mudflow in rain-saturated soils. *Lateral spread* is a liquefaction-induced landslide of a fairly coherent block of soil and sediment deposits that moves laterally (along the liquefied zone) by gravitational force, sometimes on the order of 10 feet, often toward a topographic low such as a depression, or a channel area.

Each type of liquefaction failure can cause damage to surface and subsurface structures, with the severity dependent upon the type and magnitude of failure and the relative location of the structures. For planning purposes, it is only possible to designate areas where the likelihood of these ground failures, as a group, is greatest; presently that includes the entire City. Existing and future groundwater and liquefaction studies may provide additional information to subdivide the single liquefaction area designated in Figure 6. In addition, since liquefaction-induced lateral spread failures are more prevalent adjacent to topographic depressions or valley areas that form unsupported slopes or “free faces”, it is possible to conclude for Bellflower that slopes adjacent to the San Gabriel River would be the most susceptible to a lateral spread landslide failure. These failures have occurred in areas with very low slope gradients; at Juvenile Hall and the Sylmar Converter Station in Sylmar (1971), the average ground surface gradient was 1.5 degrees and the maximum was 3 degrees (O'Rourke, Roth and Hamada, 1992). Lateral spreads in the San Francisco earthquake of 1906 occurred associated with surface gradients of 0.4 to 2.10 percent, or about 0.2 to 1 degree (O'Rourke, Beaujon, and Scawthorn, 1992). In the latter case, the slope of the liquefied subsurface layer may have been as low as zero degrees. This suggests, but does not demonstrate, that lateral spreads could occur away from the river as well.

The Seismic Hazards Mapping Program (SHMP) provides published guidelines and implementation procedures for the evaluation and mitigation of liquefaction conditions within a designated liquefaction hazard zone. These guidelines and procedures require registered professionals (California Registered Civil Engineer or Certified Engineering Geologist) to conduct the evaluations, establish the site-specific mitigation, and participate in the implementation process. The evaluation determines the controlling earthquake parameters, liquefaction depth, thickness and lateral extent of the liquefiable layer affecting the proposed development, and type and estimated amount of vertical and horizontal ground deformation.

Ground improvement (densification and hardening) and structural (foundation) design are the two classes of liquefaction mitigation. Ground densification methods include vibro-compaction, vibro-replacement (also known as vibro-stone columns), deep dynamic compaction, and compaction (pressure) grouting. Hardening methods reduce the void space in the liquefiable soil by introducing grout materials either through permeation grouting, mechanical soil mixing, or jet grouting. Structural mitigation may have little or no effect on strengthening the soil itself. For heavy structures, mitigation can include deep caissons or pile foundations to penetrate through the liquefiable material, or a mat foundation may be feasible. For lighter structures, continuous spread footings having isolated footings interconnected with grade beams, mat foundations, and post-tensioned slabs may be appropriate. Dewatering and drainage systems may be part of the mitigation process. Lateral spread hazards are not as readily mitigated with structural solutions and may require removal or treatment of liquefiable soils, modification of site geometry, or drainage to lower the groundwater table. Whether a single type of mitigation technique or a combination of techniques is needed will depend on size and scope of the project and the site-specific geotechnical conditions.

4.1.5 Dynamic Consolidation and Subsidence

Data

Dry to partially saturated sediments not susceptible to liquefaction may be susceptible to dynamic consolidation/densification and local ground subsidence. This consolidation or densification occurs in loose cohesionless sediments as the void spaces are diminished due to intense seismic shaking. Hazard maps are not normally created for this condition, and there are no specific data in the City that allow prediction of the locations or magnitudes of potential consolidation and subsidence.

In general, the youngest alluvium (Qw, Qyfa) would be the most susceptible to dynamic consolidation effects. Young alluvium (Qyfs) could be less susceptible, because of the higher in-place density and presence of some cementation. The artificial fill (map symbol Qaf) is not formally mapped within the City, but where present, is susceptible to dynamic consolidation particularly where it may have been placed without proper compaction, engineering controls, and inspections. This may be a concern in areas where thick artificial fill masses have been placed along the San Gabriel River banks, and where channels have been filled.

Generally Expected Effects and Mitigation Methods

Due to the heterogeneous nature of the alluvial deposits in the City, the amount of dynamic consolidation and subsidence will not be consistent from location to location. Variations in vertical subsidence (and resulting settlement) may occur within a small area such as an individual lot or beneath an individual structure. This may cause differential settlement of the structure and substantially more damage than if the structure were to settle evenly throughout. Sections of the City with young alluvial deposits and thick artificial fill masses are potentially susceptible to subsidence, although no specific areas of documented past subsidence are identified.

Observations reported in the other areas of Southern California suggest that earthquake-induced consolidation, ground subsidence, and building settlement may reach 3 feet or more; however, settlements of 2 to 12 inches are common. The resultant ground failures are manifest as ground cracks with relative vertical displacements as indicated above. When structures overlie these local subsidence areas, ground cracking may be translated through foundations and slabs causing severe structural damage.

Most of the City is underlain by younger alluvium and, therefore, the subgrade soils can be assumed to be composed of loose, unconsolidated granular alluvium. In an area with 50 feet of young alluvium, the dynamic consolidation may range from 12 to 36 inches. In areas overlain by thick non-engineered fill, the amount of settlement could be proportionately greater. Even in areas where fill is engineered and properly compacted, the cut/fill contact line (engineered fill against native material) is a primary location where differential dynamic consolidation can occur that can impact structures.

Earthquake-induced consolidation and structure settlements are normally less severe than liquefaction ground deformations; however the previously described remediation measures for liquefaction could apply. Based on a thorough geotechnical investigation by licensed professionals, recommendations are provided, with the most common being over-excavation of the loose soils and replacement by compacted soils meeting standard geotechnical specifications. The depth of over-excavation will depend on the nature and thickness of the loose soils, but critical areas are the contacts between formations of varying density where differential settlement is most common. For example, where alluvium and bedrock or artificial fill and a denser geologic formation are in contact, over-excavation is used to provide a uniform surface for recompacted soils or foundations.

4.1.6 Ground Cracking, Fill Slope Deformation, and Ridgetop Spreading

Data and Generally Expected Effects and Mitigation Methods

Strong seismic shaking can cause general ground cracking, ridge-top spreading, and deformation of fill slopes. Ground cracking may be widespread depending upon the surface materials and is not a cause for significant earthquake damage. Ridgetop spreading is not an issue in the City except possibly along the banks of the San Gabriel River where artificial fill is present. Fill slopes could permanently deform during seismic shaking causing slope bulges, surface settlement cracks, and differential settlement cracks along contacts between dissimilar materials. Possibly susceptible areas are the engineered fill embankments of the SR-91 freeway. Although the exact mechanism for the failures is not completely understood, it appears that seismic shaking induces lateral movement and differential settlement of rock masses, and in other cases, topographic amplification of the shaking occurs because of the tall and narrow shape of the ridge. Mitigation of effects may be obtained by reducing the height and increasing the width of the ridge to limit amplification; by removing loose, fractured materials that may be subject to lateral movement and settlement; constructing deeper foundations below the affected zone; avoiding new construction on these ridges; and protecting structures downslope from existing facilities such as water tanks or electrical towers.

4.1.7 Dam Failure Inundation/Flooding--Includes Large Reservoirs and Seiche Effects

Flooding

Analysts describe floods of different sizes in terms of their statistically projected frequency. For example, a 100-year flood is the size flood which has a 1.0% chance of occurring in a given year, while a 500-year flood is one which has a 0.2% chance of happening in any year. A 500-year flood would be slightly deeper and cover a greater area than a 100-year flood.

The San Gabriel River Channel lies adjacent and east of the City, and is designed to contain a 100-year flood. The Channel is fully operational and is maintained by the U.S. Army Corps of Engineers (USACE) and the Los Angeles County Department of Public Works (County). The construction of San Gabriel River improvements in 1947 reduced the local area's risk of flooding, and LACDA studies performed by the USACE have shown no deficiencies along the San Gabriel River in the vicinity of the City (City of Bellflower, 1996).

The City participates in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP). The NFIP prepares a Flood Insurance Rate Map (FIRM) that identifies the flooding potential in the City and Los Angeles County as depicted on Figure 7. The corridor crosses a 100-year flood plain at the Los Angeles River and a 500-year floodplain. These maps consider specific flood depths for small areas in order to make certain that the insurance rate one pays is consistent with the flood damage risks faced.

The USACE and the County built the existing flood control system to maintain the largest possible flood to strike the Los Angeles Basin, based on information available in the 1930s. Since then, data has been accumulated relating to flood size and frequency. Major portions of the storm drain system in Los Angeles County were upgraded to their current capacity in the 1960s, which contributes to the flooding problems along LACDA mainstream channels (City of Bellflower, 1996).

Seismic Sea Waves and Seiches

A seismic sea wave, or tsunami, is a wave that moves at velocities of 300-400 miles per hour and may be many miles long in deep open water. Tsunamis will not affect the City of Bellflower because of its inland setting and surface elevations above 60 feet. Seiches, or periodic oscillations ("sloshing") of bodies of water such as ponds, lakes, and bays, usually occur in moderate to great earthquakes. Seiches may raise and lower a water surface from a few inches to several feet and may occur several thousand miles away from the earthquake epicenter. Seiches within its City limits will not affect the City because there are no significant bodies of water. However, seiches may occur in tanks and reservoirs during an earthquake and should be evaluated individually.

Local Flooding Induced by Seismic Activity

Two dam failures have occurred (St. Francis and Baldwin Hills) within the County of Los Angeles, followed by the near failure of the Van Norman Dam during the 1971 San Fernando earthquake. The failure of any large reservoir or flood control basin during peak storage could cause significant flooding in large urban areas near significant drainages. Most of the City is within the Whittier Narrows Dam flood control and inundation boundaries and may be significantly impacted if a catastrophic failure of the reservoir occurs. Flooding could possibly be caused by a failure of the Santa Fe Dam upstream from Whittier Narrows. It should be noted, however, that all dams in California are monitored for seismic safety by the California Division of Safety of Dams (DSOD).

Data

The past failures (Baldwin Hills and St. Francis) and near failures (Van Norman) of Southern California dams point out the importance of considering dam safety. Dams may fail for seismic or geologic reasons, either of which could lead to the results described in this section. Sections 8589.5 of the California Government Code requires dam owners to provide the Governor's Office of Emergency Services with an inundation map showing the extent of damage to life and property that would occur, given a complete and sudden dam failure at full capacity. The City lies downstream from dams, reservoirs, and debris basins whose drainages ultimately flow across portions of the City (City of Bellflower, 2004). Inundation hazards range from high to low with increasing distance away from these water containment structures. Some of the larger structures are Whittier Narrows Dam and Santa Fe Dam (on the San Gabriel River). In addition, reservoirs located in the City could produce flooding that would affect local areas.

A failure of the Whittier Narrows Dam forms the largest inundation area that would affect the City. If Whittier Narrows Dam were impounding water to its capacity and failed catastrophically, floodwaters would travel down the San Gabriel River drainage and then spread across the entire City. For purposes of complying with State dam safety regulations, the water level behind Whittier Narrows Dam is restricted to no higher than what is allowed by DSOD's seismic safety requirements and reducing the potential magnitude of downstream flooding.

Generally Expected Effects and Mitigation Methods

Whittier Narrows Dam (located in Montebello) and Santa Fe Dam and Reservoir (located in Irwindale) are flood control projects and water conservation facilities constructed and operated by the U.S. Army Corps of Engineers (USACE), Los Angeles District. Santa Fe Dam is a 1949 earth-filled USACE dam. In the unlikely event of a Santa Fe Dam and Whittier Narrows Dam failure with the reservoirs near capacity, the inundation risk to Bellflower is considered significant. Probabilistically, the risk is relatively low due to the low percentage of time that these dams/reservoirs contain large volumes of water. The entire area of the City is within the inundation footprints of these two structures.

FIGURE 7 - FLOOD HAZARD MAP
SOURCE - DIAZ YOURMAN & ASSOCIATES

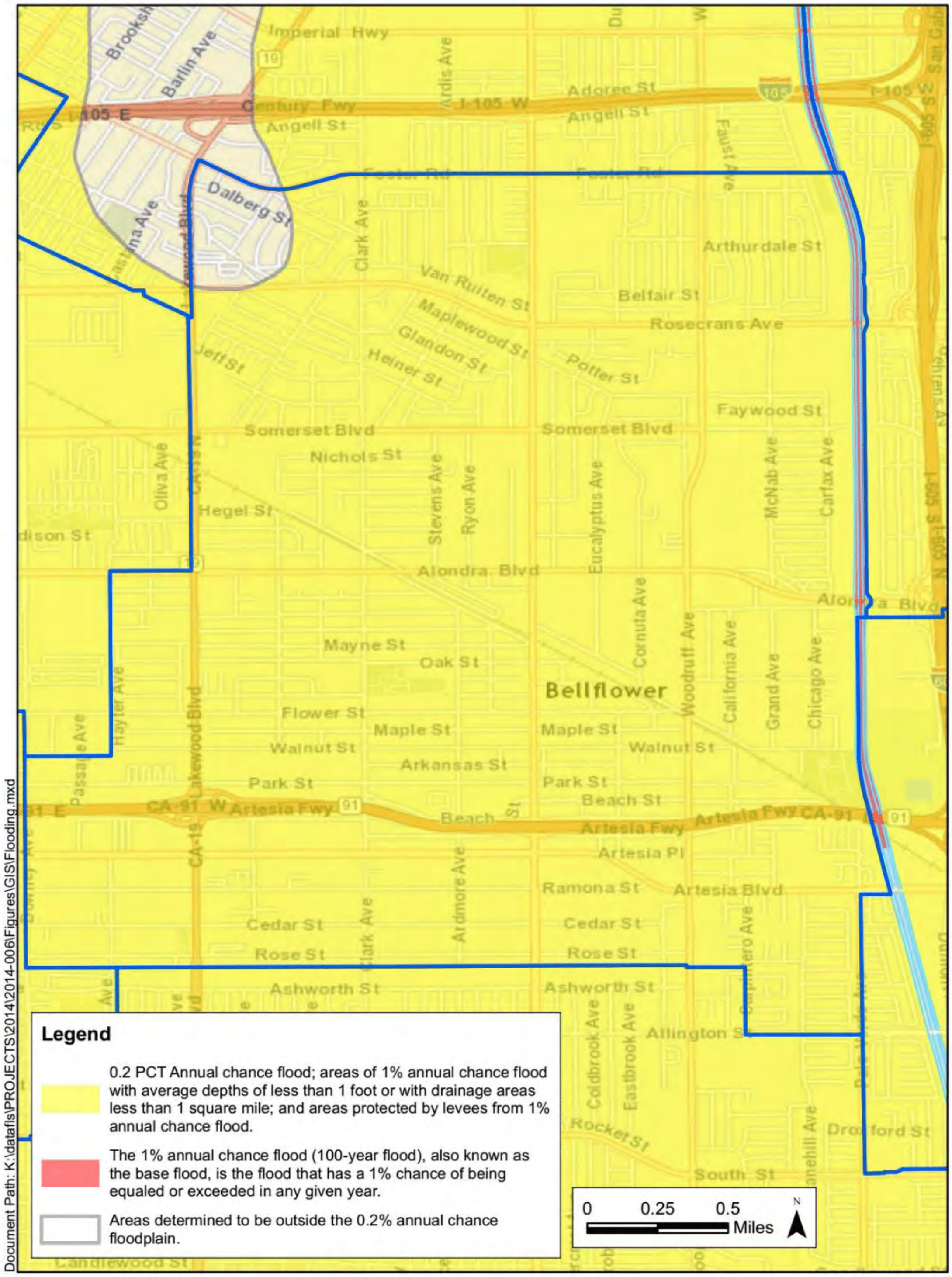
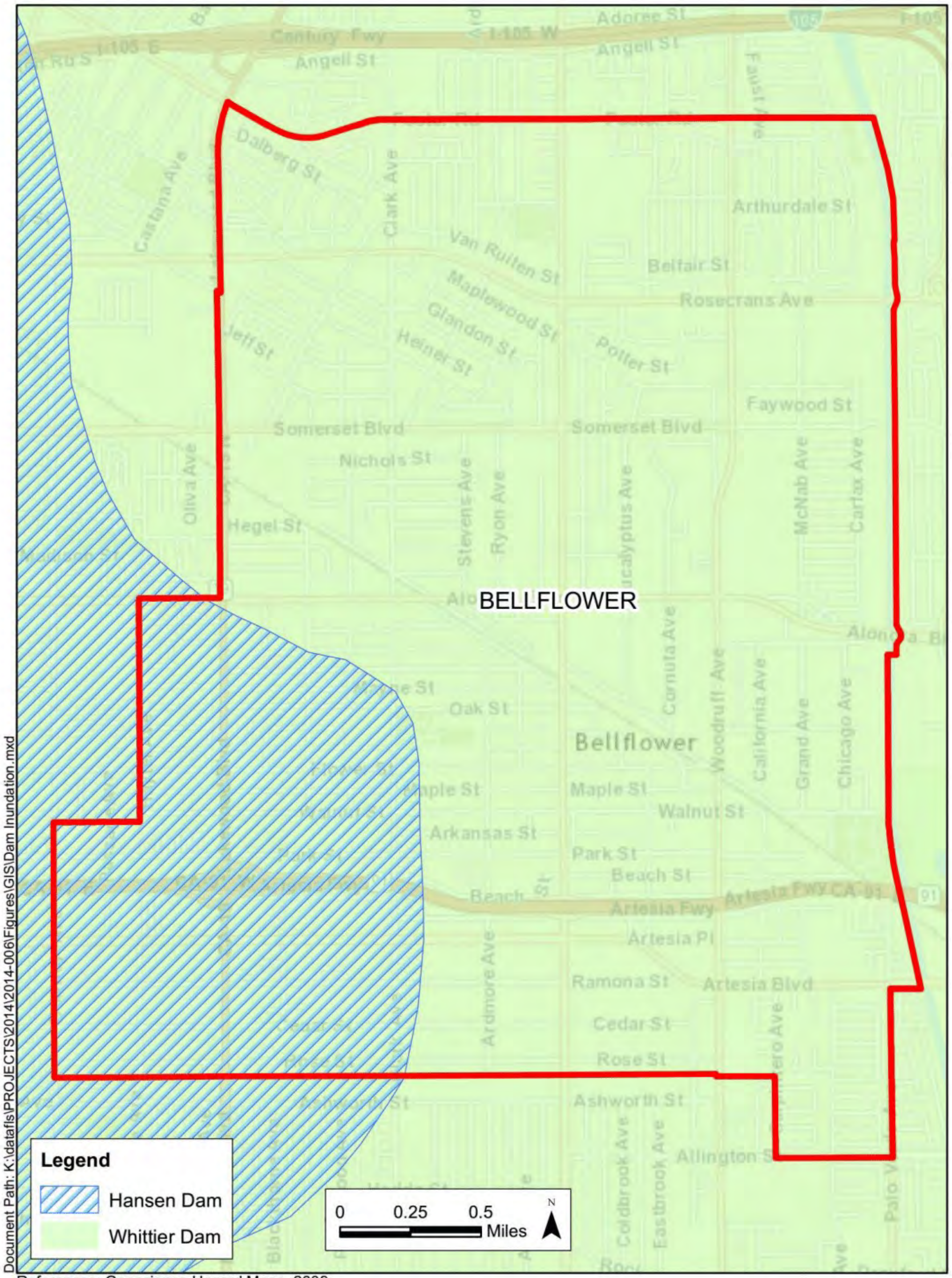


FIGURE 8 – INUNDATION MAP
SOURCE - DIAZ YOURMAN & ASSOCIATES



References: Geoscience Hazard Maps, 2009

A catastrophic failure of Whittier Narrows Dam (approximately 8 miles north of the City) as modeled by the USACE would inundate the City. However, the USACE analysis was conducted prior to construction of the Interstate (I) 105 and SR-91 freeways through this area, which could mitigate predicted effects south of I-105 and worsen effects north of SR-91. It is likely that the most extensive damage would be expected for structures and facilities located along natural low areas in close proximity to the San Gabriel River. Farther from the river, less flood damage is expected as water spreads across the City beginning several minutes after the rupture in the north and reaching the southern extremes of the city in about one hour. Specific arrival times and flood levels are not predicted.

Areas immediately along the natural drainage courses would be the most susceptible to damage from rapidly flowing water, severe erosion, and associated floating debris. Higher areas and those farthest from the existing flood channels would suffer more from sheet flow and rising water. Man-made barriers, such as I-105 and SR-91 freeways east-to-west highways and railroads, would locally deflect sheet flow in ways not anticipated by the USACE modeling. Because other reservoirs are relatively small compared to the area behind Whittier Narrows Dam or would be unlikely to be holding substantial water (e.g., Santa Fe Dam), failure of Whittier Narrows Dam should represent the worst-case inundation scenario for the City.

All of the dams mentioned are regulated and monitored for structural safety by the CDWR Division of Safety of Dams (DSOD) in accordance with Division 3 of the California State Water Code. This is due to the dam height of greater than 25 feet or storage capacity of more than 50 acre-feet. The regulation of these dams reduces substantially the chance of catastrophic failure; however, under the most severe scenario earthquake on the Puente Hills, Sierra Madre, and Whittier faults, these dams would be in danger of damage that could cause a release of water. For severe flooding to result, the earthquake and the high water levels would have to occur simultaneously, which makes the chance very remote. Mitigation of flooding realistically would consist of evacuation planning for most areas of the City and elevating new critical facilities above the predicted flood level for their location. Of course, upgrading the structural integrity of the dams (as is proposed for the Whittier Narrows Dam, would also provide an added safety margin for all but the most severe earthquake events.

4.2 GEOLOGIC AND SOIL HAZARDS

4.2.1 Overview

For the geologic component of the Safety Element, the minimum list of geology and soils (non-seismic) potential hazards that must be considered are:

- Slope Instability (landslides, mudslides, and debris flows)
- Subsidence
- Groundwater Depth (also discussed under liquefaction above)

Subsidence due to groundwater withdrawal is possible due to substantial pumping; however, there are no known records of such an occurrence in the City. No subsidence within the City was noted in references reviewed. Landslides, collapsible/expansive soils, and shallow groundwater are discussed below.

4.2.2 Landslides, Mudslides, and Debris Flows

Data

Slope instability under non-earthquake (static) conditions is considered to be a potentially significant hazard in hillside and mountainous areas. The only significant slope areas are along the San Gabriel River, and because the remaining City topography is nearly flat and no bedded formations are exposed, earthquake-induced landslide hazards are only a concern as related to liquefaction as discussed in Section 4.1.4.

Generally Expected Effects and Mitigation Methods

Due to the geologic formations exposed and the very low ground surface slopes in the City, no landslide impacts are expected.

4.2.3 Collapsible and Expansive Soil Hazards

Data, Generally Expected Effects, and Mitigation Methods

Collapsible and expansive soil issues are recognized in standard geotechnical investigations mandated by the City and other regulatory bodies. Expansive soils are found associated with soils, alluvium, and bedrock formations that contain clay minerals susceptible to expansion under wetting conditions and contraction under drying conditions. Depending upon the type and amount of clay present in a geologic deposit, these volume changes (shrink and swell) can cause severe damage to slabs, foundations, and concrete flatwork. Due to the generally fine-grained nature of the Qyfa and Qyfs alluvium, and some site-specific boring information within the City, expansive clays are likely present associated with past low areas and low gradient portions of the ancestral San Gabriel River.

Collapsible soils undergo a volume reduction when the pore spaces become saturated, causing loss of grain-to-grain contact and possibly dissolving of interstitial cement holding the grains apart. The weight of overlying structures can cause uniform or differential damage to foundations and walls. The most likely locations for collapsible soils are the current and pre-development washes and drainage channels, which may cover much of the City.
Expansive and collapsible soil damage can be mitigated by delineating the soils during a geotechnical investigation, over-excavating the subject soils and re-compacting on new engineered fill material, possibly pre-saturating the subject soils, and providing proper surface drainage away from structures and building foundations.

4.2.4 Shallow Groundwater

Data, Generally Expected Effects, and Mitigation Methods

Data on shallow groundwater are discussed in an earlier section. The concern in this section is the potential to intercept shallow or perched groundwater in subsurface excavations, such a basements, utility trenches, deep foundations, or tunnels. Shallow groundwater within the City, as shown on
Figure 2, may be present at depths ranging from 8 to 30 feet, and in times of high precipitation or excessive surface water spreading, the groundwater may reach the ground surface. In areas where shallow groundwater is indicated on these maps, planning for each project should

consider shallow water levels in determining how to best implement construction or exploration programs.

Surface (open cuts and pits) or underground (tunnels, vertical large-diameter borings) excavations can encounter shallow groundwater inflows, which may be perched and local or widespread in extent. This will affect excavation stability, and therefore short- and long-term safety for workers, as well as post-construction stability of structures associated with these excavation areas. The degree of hazard for the City is generally very low, but should be determined on a case-by-case basis if projects requiring deep excavations are proposed.

It is important to recognize that shallow groundwater data discussed above are depth estimates based on a "snapshot" in time; the historically highest levels should be considered for planning purposes. Depths to water of less than 15 feet are considered a high hazard because water may be encountered even in routine project excavations; depths of 15 to 30 feet are considered a moderate hazard because only the more significant excavations (e.g., subterranean parking garages) for larger project structures would likely extend to these depths. For water greater than 30 feet deep, the hazard is considered insignificant, although for some projects (e.g., deep tunnel or a major high-rise building), this will remain a design issue; it is assumed that such structures will be very carefully studied and with liquefaction as an issue will call attention to the shallow water depths.

5.0 POTENTIAL EARTHQUAKE EFFECTS AND HAZARD REDUCTION

Hazards discussed in previous sections indicate the potential for serious damage, injury, and death if the seismic event is large enough to generate short-duration high peak ground accelerations or long-duration moderate to high ground accelerations. Examples of the types of structures of concern are linear lifelines (i.e., streets, freeways, pipelines, high voltage lines, utilities lines) and many types of important and essential facilities that become more critical in emergencies and natural disasters. The earthquake effects on structures and facilities will depend upon the size and location of the earthquake being considered for specific facility locations within the City.

5.1 SCHOOLS

Schools are located throughout the City, including private and public, pre-school through high school. Some of these are susceptible to various hazards identified above. Age of construction and relative seismic stability of the schools are known by the City. In general, schools located in a zone of liquefaction and dynamic settlement potential would have more damage in a given earthquake than schools outside these areas. Since schools are often used as evacuation shelters following an earthquake, the northern locations are more at risk and will be generally less suitable for sheltering (from a planning viewpoint) than the more southern locations. It appears that some schools may be crossed by a previously unmapped strand of the Santa Fe Springs segment of the Puente Hills blind thrust giving it a higher potential damage profile should this fault experience an earthquake that develops surface deformation, ground cracking, and tilting of the ground surface.

5.2 MEDICAL AND SKILLED NURSING FACILITIES

Several medical and skilled nursing facilities are located in the City and surrounding region. These facilities are critically important for the concentration of individuals not able to care for themselves in an emergency. It is important to understand whether construction of these facilities has accounted for geologic and seismic risk, as they are now understood within the City. The hospital owners in conjunction with the City should undertake an evaluation of these factors and conditions. All medical and skilled nursing facilities should include an assessment of the earthquake preparedness of the staff and the vulnerability of the contents and fixtures. In addition, there may be other dependent care facilities (e.g., convalescent, day care, social services, and retirement facilities) or medical offices in the City that should be identified and evaluated for earthquake safety.

Kaiser Permanente Bellflower Medical Offices is located at 9400 E. Rosecrans Avenue in Bellflower however no emergency services are located onsite. Several hospitals are located nearby but outside the City including: Lakewood Regional Medical Center and Downey Medical Center Hospital.

Kaiser Permanente Downey Medical Center
The Kaiser Permanente Downey Medical Center opened in 2009 is the newest hospital in the area in more than four decades. The six-story hospital compromises 342-beds in an approximately 70,000 square foot leading edge facility.

Lakewood Regional Medical Center
Lakewood Regional Medical Center is a general medical and surgical hospital in Lakewood, CA, with 153 beds.

Patient populations are commonly characterized by physical or mental disabilities. Such disabilities inhibit the patient's capacity to react during a crisis. In instances where there is a large population of dependent individuals, the number of supervisory or custodial personnel is usually inadequate to provide sufficient aid and guidance in times of emergency.

5.3 POTENTIALLY HAZARDOUS BUILDINGS

5.3.1 Earthquake-Hazardous Pre-1933 Buildings

Some buildings in Bellflower were erected prior to enactment of the 1933 Building Code requirements for seismic resistance. As a result, these buildings were constructed with little or no regard for the effects of earthquakes. The majority of these structures were located in and around the downtown area. Many of the pre-1933 buildings in the City were damaged at the time of the Long Beach earthquake and when rebuilt were constructed under the new standards adopted for seismic resistance. Based on the 2006 Seismic Safety Commission report, all 22 identified unreinforced masonry buildings (URMs) have been satisfactorily dealt with. It appears that 18 buildings were brought to CBC requirements and 4 were demolished. The following discussion is presented as it may be related to future issues with the retrofitted structures.

The social and economic ramifications concerning strengthening or demolishing these buildings are tremendous. Complex problems must be resolved concerning occupant safety and welfare. Many of those persons residing in pre-1933 hazardous buildings are elderly or economically disadvantaged. Such individuals have a limited number of adequate housing alternatives, and some may not be physically able to withstand the stress of relocation. The same may be true of businesses that could not economically survive relocation.

An ill-conceived or improperly administered hazard abatement program could have a severe impact on the community tax base. Other concerns include equitable treatment of building owners, minimization of adverse effects on the general business community, and provision of adequate relocation service when required. However, public safety is paramount considering the potential seismic hazard and compliance with UBC Chapter 96, Earthquake Retrofit Requirements will be accomplished in the near future.

It is beyond the scope of this study to comment on specific facilities and structures. Generally this includes residences, small apartments and condominiums, businesses, and public facilities such as libraries, agency offices, meeting rooms, theaters, and churches. Many buildings in the City were constructed prior to 1971, before more stringent seismic design codes were enacted based on the San Fernando earthquake and on later technology studies.

Potentially hazardous buildings consist of: dilapidated structures regardless of age; pre-1971 concrete tilt-up construction; non-ductile concrete frame buildings; multi-story buildings with a soft story; buildings with a complex design/floor plan; and homes with unbolted foundations including mobile homes. Also potentially hazardous are non-structural building components (e.g., contents, facades, fixtures) and buildings storing hazardous materials. The City should do whatever it can to educate and persuade City residents, business owners, and owners of buildings within the City that fall into these categories to perform seismic strengthening and engage in earthquake-preparedness programs.

5.3.2 Infrastructure

The City is dependent on a complex web of linear systems for a variety of vital support functions. Such functions include the importation and distribution of water supplies, collection and disposal of sewage, channeling of storm runoff, provision of natural gas and electrical power, communications, and transportation. Seismic interruption of such functions would, in varying degrees, impact the safety and welfare of City residents.

5.4 LAND USE AND DEVELOPMENT

Land use constraints identified are strong ground shaking, liquefaction, potential co-seismic deformation, and earthquake-induced dam inundation flooding. While the City is more likely to experience the higher ground shaking levels further southwest and northeast in the City, this is not considered a constraint to land use because engineering design measures exist to minimize ground shaking damage, particularly for essential facilities. Liquefaction areas underlie parks/open space, residential areas, and business/commercial districts. Future critical and emergency facilities, high-population buildings, medical care facilities, and schools should not be planned for these areas if other acceptable sites are available; siting such facilities in these areas requires more specialized investigations and design precautions. Because of the Puente Hills blind thrust fault zone potentially affecting the northern portion of the City, consideration of potential co-seismic fault hazard zones is recommended. The consideration of Co-seismic Hazard Management Zones (CSHMZs) that would have an impact on new construction and redevelopment are suggested due to potential Santa Fe Springs segment activity levels and the uncertainly of the segment location.

Sites susceptible to high levels of ground shaking and those in potential liquefaction-prone areas require site-specific geotechnical evaluations and analysis. All recommended engineering design measures included in these studies should be incorporated into building design and construction. When possible, liquefaction hazard areas and areas susceptible to the higher PHGA levels should be avoided for essential/critical facilities. Potential surface fault rupture areas will require site-specific investigation and may warrant a special City-sponsored investigation project to better define the activity and location of faults now suspected of having some surface rupture potential. Despite these conditions, it is technically feasible to develop the land in the City if precautions are taken, including the proper geologic and geotechnical investigations, analyses, and project design considerations.

5.5 IDLE AND ABANDONED OIL WELLS

Six abandoned or idle oil wells were identified on the DOGGR map. Former oil wells should be located in the field and care should be exercised to insure that no buildings are constructed over former oil wells.

5.6 HAZARD REDUCTION

Seismic and geologic hazard reduction will mainly be attained through the proper implementation of existing building codes and regulations related to natural hazards (e.g., Seismic Hazards Mapping Act, California Building Code). Certain of the natural hazards that have previously been either unrecognized or not risen to prominence (e.g., co-seismic deformation and liquefaction) may require special City zoning and land-use policies. Potentially hazardous buildings, beyond URMs, can be identified and depending upon their quality and use (e.g., medical or nursing home care), may be suitable for retrofit.

5.6.1 Building Codes

Adoption of the most rigorous building codes governing seismic safety and structural design will be the most effective means to mitigate future earthquake damage from strong ground shaking. The most recent 2013 CBC incorporates lessons from the most severe earthquakes to impact California in the past 24 years, in particular San Fernando-Sylmar (1971), Loma Prieta (1989), and Northridge (1994), and has been adopted by the City. Use of the 2013 State Historic Building Code for historic structure seismic retrofit and the CBC for retrofit of other potentially hazardous structures will continue the trend of reduction in the loss of life in future earthquakes. In addition, as population pressures lead to development in more hazard-prone areas of the City and as the existing building inventory ages, the active implementation of these codes will reduce the earthquake hazard risk for the City.

5.6.2 Special Hazard Zones

CGS creates maps for the use of cities and other jurisdictions that define hazardous areas for " active" faults, liquefaction, and earthquake-induced landslides. In addition, CGS and USGS create maps that define the potential levels of seismic ground shaking that can be expected. Together these represent "special hazard zones" that have regulatory meaning and require certain studies and precautions before development can be approved. The City is not crossed by active or potentially active faults, but is underlain in part by concealed fault traces (blind thrusts) that are not extremely well studied or located so that the degree of activity is not completely understood. It is suggested that the City carefully consider and explore the possibility of creating the recommended Co-seismic Deformation Hazard Management Zones (CDHMZs) for each of the faults in question as shown on Figure 3. The goal would be to refine the hazard zone location and fault activity database for the buried Santa Fe Springs segment Puente Hills thrust fault under the northern portion of the City.

5.6.3 Building Retrofit

The City should consider programs to identify potentially hazardous buildings (generally pre-1971 in age and not yet seismically retrofitted) and potential funding sources to rehabilitate and strengthen these structures as redevelopment, infill, and new development proceed. Upgrades should be made that will ensure the survivability and function of these facilities in such an earthquake event.

5.6.4 Disaster Response

In a review of disaster response efforts after the 1971 San Fernando earthquake, the Los Angeles County Earthquake Commission determined that, while most agencies responded well and the problems encountered were within their capabilities to solve, there were inadequacies. One problem that must be dealt with is the initial assessment of damage. Despite immediate reconnaissance operations launched by police and fire officials, some areas heaviest hit by the 1971 earthquake were not discovered until well after the event.

A problem related directly to that of damage assessment is the loss of communications. Communications systems are an essential element in the conduct of emergency operations. It seems clear that any communication system dependent on land lines and commercial power is susceptible to earthquake damage.

Another major problem of disaster response and recovery operations is that of evacuation. This involves identifying areas or structures requiring evacuation, determining available evacuation routes and modes, and establishing assembly points for displaced persons. The potential for widespread damage resulting from a major quake complicates evacuation efforts.

The City has prepared the "City of Bellflower Natural Hazards Mitigation Plan," dated August 2006, to address emergency situations within the City. In addition, each City employee should be trained to handle emergency events. In the event of an emergency, the City's "Natural Hazards Mitigation Plan" should be followed.

5.6.5 Peak-Load Water Supply

A related factor that could significantly affect response and recovery operations includes loss of adequate water for fire control purposes. It is understood that the Bellflower-Somerset Water Company purchased and maintains a former City 2,000,000-gallon water storage tank beneath the City Maintenance Yard at 9944 Flora Vista. This water could be used in the event of an emergency. In addition, the City imposes peak load water supply requirements on various types of land uses in the City, which are served by five water companies (City of Bellflower, 2014).

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