# Section 6:
# Flooding Hazards in the City of Carson

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**Why are Floods a Threat to the City of Carson?**
According to the City's General Plan, the Dominguez Channel runs northwest to southeast through the center of the City of Carson. The Dominguez Channel is part of the Los Angeles River Flood Control System which makes it vulnerable when the Los Angeles River Floods. The area surrounding the Dominguez Channel is designated as a 100-year flood zone. Flooding poses a threat to life and safety, and can cause severe damage to public and private property.

The City of Carson was most recently affected by flooding in 1998 when localized flooding occurred in parts of the City.

**History of Flooding in the City of Carson**

There are a number of rivers in the Southern California region, but the river with the best recorded history is the Los Angeles River. The flood history of the Los Angeles River is generally indicative of the flood history of much of Southern California.

**Historic Flooding in Los Angeles County**
Records show that since 1811, the Los Angeles River has flooded 30 times, on average once every 6.1 years. But averages are deceiving, for the Los Angeles basin goes through periods of drought and then periods of above average rainfall. Between 1889 and 1891 the river flooded every year, and from 1941 to 1945, the river flooded 5 times. Conversely, from 1896 to 1914, a period of 18 years, and again from 1944 to 1969, a period of 25 years, the river did not have serious floods.[1]

**Table 6-1: Major Floods of the Los Angeles River**

| **Major Floods of the Los Angeles River** | |
|---|---|
| 1811 | Flooding |
| 1815 | Flooding |
| 1825 | L.A. River changed its course back from the Ballona wetlands to San Pedro |
| 1832 | Heavy flooding |
| 1861-62 | Heavy flooding. Fifty inches of rain falls during December and January. |
| 1867 | Floods create a large, temporary lake out to Ballona Creek. |
| 1876 | The Novician Deluge |
| 1884 | Heavy flooding causes the river to change course again, turning east to Vernon and then southward to San Pedro. |
| 1888-1891 | Annual floods |
| 1914 | Heavy flooding. Great damage to the harbor. |
| 1921 | Flooding |
| 1927 | Moderate flood |

| | |
|---|---|
| 1934 | Moderate flood starting January 1. Forty dead in La Canada. |
| 1938 | Great County-wide flood with 4 days of rain. Most rain on day 4. |
| 1941-44 | L.A. River floods five times. |
| 1952 | Moderate flooding |
| 1969 | One heavy flood after 9 day storm. One moderate flood. |
| 1978 | Two moderate floods |
| 1979 | Los Angeles experiences severe flooding and mudslides. |
| 1980 | Flood tops banks of river in Long Beach. Sepulveda Basin spillway almost opened. |
| 1983 | Flooding kills six people. |
| 1992 | 15 year flood. Motorists trapped in Sepulveda basin. Six people dead. |
| 1994 | Heavy flooding |
| Sources: http://www.lalc.k12.ca.us/target/units/river/tour/hist.html and (http://www.losangelesalmanac.com/topics/History/hi01i.htm) | |

While the City of Carson is sixteen miles south of downtown Los Angeles, it is not so far away as to not be affected by the heavy rains that brought flooding to Los Angeles. In addition, the towering mountains that give the Los Angeles region its spectacular views also wring a great deal of rain out of the storm clouds that pass through. Because the mountains are so steep, the rainwater moves rapidly down the slopes and across the coastal plains on its way to the ocean.

> "The Santa Monica, Santa Susana and Verdugo Mountains, which surround three sides of the valley, seldom reach heights above three thousand feet. The Western San Gabriel Mountains, in contrast, have elevations of more than seven thousand feet. These higher ridges often trap eastern-moving winter storms. Although downtown Los Angeles averages just fifteen inches of rain a year, some mountain peaks in the San Gabriels receive more than forty inches of precipitation annually"[2]

Naturally, this rainfall moves rapidly down stream, often with severe consequences for anything in its path. In extreme cases, flood-generated debris flows will roar down a canyon at speeds near 40 miles per hour with a wall of mud, debris and water tens of feet high.

In Southern California, stories of floods, debris flows, persons buried alive under tons of mud and rock and persons swept away to their death in a river flowing at thirty-five miles an hour are without end.

**What Factors Create Flood Risk?**

Flooding occurs when climate, geology, and hydrology combine to create conditions where water flows outside of its usual course. According to the City's General Plan, the city is mostly flat however the areas at the base of the Dominguez Hills are more susceptible to flooding.

**Winter Rainfall**

Over the last 125 years, the average annual rainfall in Los Angeles is 14.9 inches. But the term "average" means very little as the annual rainfall during this time period has ranged from only 4.35 inches in 2001-2002 to 38.2 inches in 1883-1884. In fact, in only fifteen of the past 125 years, has the annual rainfall been within plus or minus 10% of the 14.9 inch average. And in only 38 years has the annual rainfall been within plus or minus 20% of the 14.9 inch average. This makes the Los Angeles basin a land of extremes in terms of annual precipitation.

As stated in the General Plan, the City of Carson is located in the northern section of the Los Angeles Basin. It is up against the Dominguez Hills, which increases the collection of rainwater.

**Monsoons**

Another relatively regular source for heavy rainfall, particularly in the mountains and adjoining cities is from summer tropical storms. Table 6-2 lists tropical storms that have had significant rainfall in the past century, and the general areas affected by these storms. These tropical storms usually coincide with El Niño years.

**Table 6-2: Tropical Cyclones of Southern California**

| **Tropical cyclones that have affected Southern California during the 20th Century** | | | |
|---|---|---|---|
| **Month-Year** | **Date(s)** | **Area(s) Affected** | **Rainfall** |
| July 1902 | 20th & 21st | Deserts & Southern Mountains | up to 2" |
| Aug. 1906 | 18th & 19th | Deserts & Southern Mountains | up to 5" |
| Sept. 1910 | 15th | Mountains of Santa Barbara County | 2" |
| Aug. 1921 | 20th & 21st | Deserts & Southern Mountains | up to 2" |
| Sept. 1921 | 30th | Deserts | up to 4" |
| Sept. 1929 | 18th | Southern Mountains & Deserts | up to 4" |
| Sept. 1932 | 28th - Oct 1st | Mountains & Deserts, 15 Fatalities | up to 7 |
| Aug. 1935 | 25th | Southern Valleys, Mountains & Deserts | up to 2" |
| Sept. 1939 | 4th - 7th | Southern Mountains, Southern & Eastern Deserts | up to 7 |
| | 11th & 12th | Deserts, Central & Southern Mountains | up to 4" |
| | 19th - 21st | Deserts, Central & Southern Mountains | up to 3" |
| | 25th | Long Beach, W/ Sustained Winds of 50 Mph | 5" |
| | | Surrounding Mountains | 6 to 12" |

| Tropical cyclones that have affected Southern California during the 20th Century | | | |
|---|---|---|---|
| Sept. 1945 | 9th & 10th | Central & Southern Mountains | up to 2” |
| Sept. 1946 | 30th - Oct 1st | Southern Mountains | up to 4" |
| Aug. 1951 | 27th - 29th | Southern Mountains & Deserts | 2 to 5" |
| Sept. 1952 | 19th - 21st | Central & Southern Mountains | up to 2" |
| July 1954 | 17th - 19th | Deserts & Southern Mountains | up to 2" |
| July 1958 | 28th & 29th | Deserts & Southern Mountains | up to 2" |
| Sept. 1960 | 9th & 10th | Julian | 3.40" |
| Sept. 1963 | 17th - 19th | Central & Southern Mountains | up to 7" |
| Sept. 1967 | 1st - 3rd | Southern Mountains & Deserts | 2" |
| Oct. 1972 | 6th | Southeast Deserts | up to 2" |
| Sept. 1976 | 10th & 11th | Central & Southern Mountains. Ocotillo, CA was Destroyed 3 Fatalities | 6 to 12" |
| Aug. 1977 | n/a | Los Angeles | 2" |
| | | Mountains | up to 8" |
| Oct. 1977 | 6th & 7th | Southern Mountains & Deserts | up to 2 |
| Sept. 1978 | 5th & 6th | Mountains | 3" |
| Sept. 1982 | 24th - 26th | Mountains | up to 4" |
| Sept. 1983 | 20th & 21st | Southern Mountains & Deserts | up to 3" |
| http://www.fema.gov/nwz97/eln_scal.shtm | | | |

**Geography and Geology**

The greater Los Angeles Basin is the product of rainstorms and erosion for millennia. “Most of the mountains that ring the valleys and coastal plain are deeply fractured faults and, as they (the mountains) grew taller, their brittle slopes were continually eroded. Rivers and streams carried boulders, rocks, gravel, sand, and silt down these slopes to the valleys and coastal plain....In places these sediments are as much as twenty thousand feet thick”[3]

Much of the coastal plain rests on the ancient rock debris and sediment washed down from the mountains. This sediment can act as a sponge, absorbing vast quantities of rain in those years when heavy rains follow a dry period. But like a sponge that is near saturation, the same soil fills up rapidly when a heavy rain follows a period of relatively wet weather. So even in some years of heavy rain, flooding is minimal because the ground is relatively dry. The same amount of rain following a wet period of time can cause extensive flooding.

The greater Los Angeles basin is for all intents and purposes developed. This leaves precious little open land to absorb rainfall. This lack of open ground forces water to remain on the surface and rapidly accumulate. If it were not for the massive flood control system with its concrete lined river and stream beds, flooding would be a much more common occurrence. And the tendency is towards even less and less open land. In-fill building is becoming a much more common practice in many areas. Developers tear down an older home which typically covers up to 40% of the lot size and replacing it with three or four town homes or apartments which may cover 90-95% of the lot.

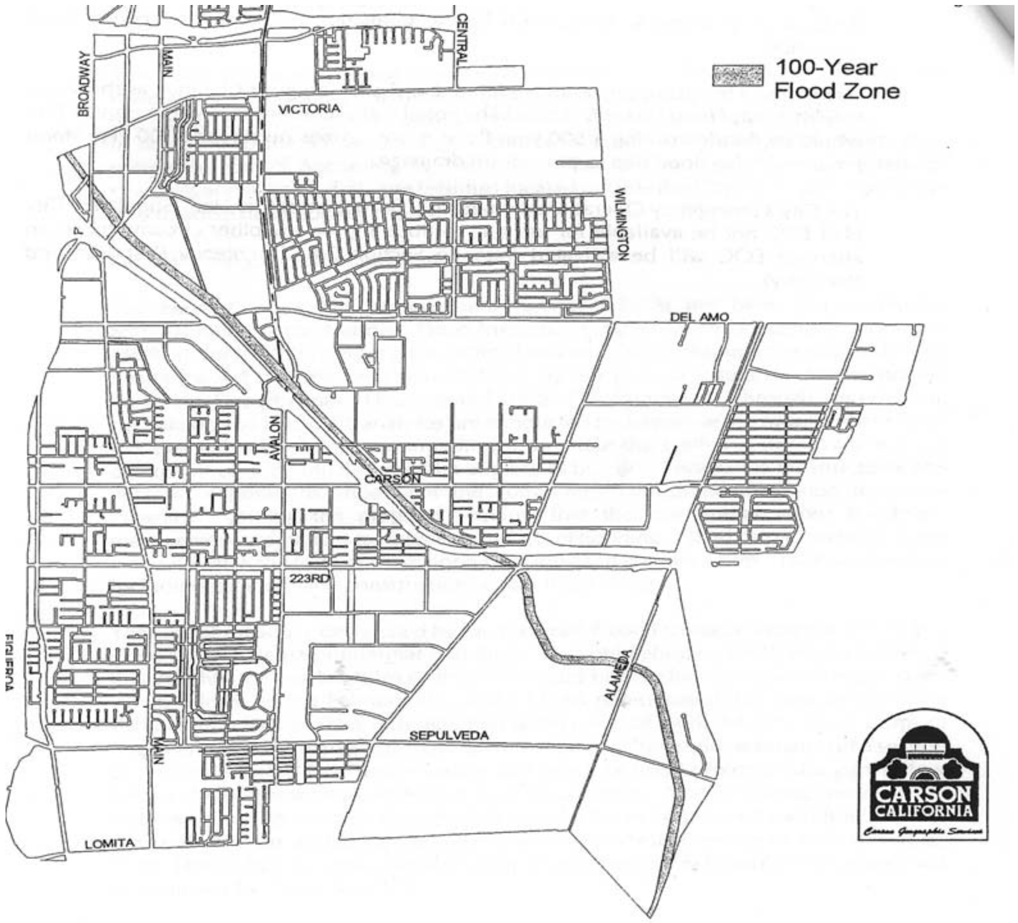
Another potential source of flooding is "asphalt creep." The street space between the curbs of a street is a part of the flood control system. Water leaves property and accumulates in the streets, where it is directed towards the underground portion of the flood control system. The carrying capacity of the street is determined by the width of the street and the height of the curbs along the street. Often, when streets are being resurfaced, a one to two inch layer of asphalt is laid down over the existing asphalt. This added layer of asphalt subtracts from the rated capacity of the street to carry water. Thus the original engineered capacity of the entire storm drain system is marginally reduced over time. Subsequent re-paving of the street will further reduce the engineered capacity even more.

## Flood Terminology

### Floodplain
A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess flood water. The floodplain is made up of two sections: the floodway and the flood fringe.

### 100-Year Flood
The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood. As stated in the city's General Plan, the City of Carson is primarily designated as zone C, or area of minimal flooding, however the zone bordering the Dominguez Channel is categorized as zone AR. Map 6-1 illustrates the 100-year floodplain in the City of Carson.

**Map 6-1: Floodplains in the City of Carson**
**(Source: Carson City General Plan)**




**Floodway**
The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For NFIP purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the flood water downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties.

The City of Carson regulations prohibit all development in the floodway. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

**Flood Fringe**
The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the

floodway and continuing outward. *In Section xxx of the City of Carson Zoning and Development Ordinance (Zoning Ordinance), the flood fringe is defined as "the land area, which is outside of the stream flood way, but is subject to periodic inundation by regular flooding."  This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.*

**Development**
*For floodplain ordinance purposes, development is broadly defined by the City of Carson Zoning Ordinance to mean "any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.*

**Base Flood Elevation (BFE)**
The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level) that the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation; while the 500-year flood event may serve as base flood elevation for the tie down of mobilehomes. The regulations of the NFIP focus on development in the 100-year floodplain.

**Characteristics of Flooding**
Two types of flooding primarily affect the City of Carson: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

**Riverine Flooding**
Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Map 6-1 shows the various river basins (or flood zones) in the City of Carson.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.

**Urban Flooding**
As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the

basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in flood waters that rise very rapidly and peak with violent force.

The City's General Plan states that 80% of the City is developed and the remaining open areas are dispersed throughout the city. Due to the high percentage of development, the City of Carson has a high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

**Dam Failure Flooding**

Loss of life and damage to structures, roads, and utilities may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of one of the major dams in the City of Carson. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there may be coordination with county officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner. The City's General Plan states that inundation due to dam failure is not a threat to the City of Carson.

There have been a total of 45 dam failures in California, since the 19th century. The significant dam failures in Southern California are listed in Table 6-3.

**Table 6-3: Dam Failures in Southern California**

| **Dam Failures in Southern California** | | | |
|---|---|---|---|
| Sheffield | Santa Barbara | 1925 | Earthquake slide |
| Puddingstone | Pomona | 1926 | Overtopping during construction |
| Lake Hemet | Palm Springs | 1927 | Overtopping |
| Saint Francis | San Francisquito Canyon | 1928 | Sudden failure at full capacity through foundation, 426 deaths |
| Cogswell | Monrovia | 1934 | Breaching of concrete cover |
| Baldwin Hills | Los Angeles | 1963 | Leak through embankment turned into washout, 3 deaths |
| http://cee.engr.ucdavis.edu/faculty/lund/dams/Dam_History_Page/Failures.htm | | | |

The two most significant dam failures are the St. Francis Dam in 1928 and the Baldwin Hills Dam in 1963.

“The failure of the St. Francis Dam, and the resulting loss of over 500 lives in the path of a roaring wall of water, was a scandal that resulted in the almost complete destruction of the reputation of its builder, William Mulholland.

Mulholland was an immigrant from Ireland who rose up through the ranks of the city's water department to the position of chief engineer. It was he who proposed, designed, and supervised the construction of the Los Angeles Aqueduct, which brought water from the Owens Valley to the city. The St. Francis Dam, built in 1926, was 180 feet high and 600 feet long; it was located near Saugus in the San Francisquito Canyon.

The dam gave way on March 12, 1928, three minutes before midnight. Its waters swept through the Santa Clara Valley toward the Pacific Ocean, about 54 miles away. 65 miles of valley was devastated before the water finally made its way into the ocean between Oxnard and Ventura. At its peak the wall of water was said to be 78 feet high; by the time it hit Santa Paula, 42 miles south of the dam, the water was estimated to be 25 feet deep. Almost everything in its path was destroyed: livestock, structures, railways, bridges, and orchards. By the time it was over, parts of Ventura County lay under 70 feet of mud and debris. Over 500 people were killed and damage estimates topped $20 million.”[4]

The Baldwin Hills dam failed during the daylight hours, and was one of the first disaster events documented a live helicopter broadcast.

“The Baldwin Hills Dam collapsed with the fury of a thousand cloudbursts, sending a 50-foot wall of water down Cloverdale Avenue and slamming into homes and cars on Dec. 14, 1963.

Five people were killed. Sixty-five hillside houses were ripped apart, and 210 homes and apartments were damaged. The flood swept northward in a V-shaped path roughly bounded by La Brea Avenue and Jefferson and La Cienega boulevards.

**Photo 6-1: Baldwin Hills Dam**

Baldwin Hills Dam - Dark spot in upper right hand quadrant shows the beginning of the break in the dam.

> The earthen dam that created a 19-acre reservoir to supply drinking water for West Los Angeles residents ruptured at 3:38 p.m. As a pencil-thin crack widened to a 75-foot gash, 292 million gallons surged out. It took 77 minutes for the lake to empty. But it took a generation for the neighborhood below to recover. And two decades passed before the Baldwin Hills ridge top was reborn.
>
> The cascade caused an unexpected ripple effect that is still being felt in Los Angeles and beyond. It foreshadowed the end of urban-area earthen dams as a major element of the Department of Water and Power's water storage system. It prompted a tightening of Division of Safety of Dams control over reservoirs throughout the state.
>
> The live telecast of the collapse from a KTLA-TV helicopter is considered the precursor to airborne news coverage that is now routine everywhere."[5]

**Debris Flows**

Another flood related hazard that can affect certain parts of the Southern California region are debris flows. Most typically debris flows occur in mountain canyons and the foothills against the San Gabriel Mountains. However, any hilly or mountainous area with intense rainfall and the proper geologic conditions may experience one of these very sudden and devastating events.

> "Debris flows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides. These flows generally occur during periods of intense rainfall or rapid snow melt. They usually start on steep hillsides as shallow landslides that

> liquefy and accelerate to speeds that are typically about 10 miles per hour, but can exceed 35 miles per hour. The consistency of debris flow ranges from watery mud to thick, rocky mud that can carry large items such as boulders, trees, and cars. Debris flows from many different sources can combine in channels, and their destructive power may be greatly increased. They continue flowing down hills and through channels, growing in volume with the addition of water, sand, mud, boulders, trees, and other materials. When the flows reach flatter ground, the debris spreads over a broad area, sometimes accumulating in thick deposits that can wreak havoc in developed areas."[6]

**Coastal Flooding**
Low lying coastal communities of Southern California have one other source of flooding, coastal flooding. This occurs most often during storms which bring higher than normal tides. Storms, the time of year and the tidal cycle can sometimes work to bring much higher than normal tides which cause flooding in low lying coastal areas. This hazard however is limited to those areas.

**What is the Effect of Development on Floods?**
When structures or fill are placed in the floodway or floodplain water is displaced. Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and no fill is removed to compensate, serious problems can arise. Flood waters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience flood waters that rise above historic levels. Local governments must require engineer certification to ensure that proposed developments will not adversely affect the flood carrying capacity of the Special Flood Hazard Area (SFHA). Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events. In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.

**How are Flood-Prone Areas Identified?**
Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. The NFIP was established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and sound floodplain management. *In the City of Carson, the NFIP and related building code regulations went into effect on March 1, 1978.* NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60, 3) require that all new construction in floodplains must be elevated at or above base flood level.

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS) Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA which delineates SFHA in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

Water surface elevations are combined with topographic data to develop FIRMs. FIRMs illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain. Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies. However, it is important to note that not all 100-year or 500-year floodplains have been mapped by FEMA. *It is estimated that the flood maps cover xxx% of the total population in the City of Carson.*

FEMA flood maps are not entirely accurate. These studies and maps represent flood risk at the point in time when FEMA completed the studies, and does not incorporate planning for floodplain changes in the future due to new development. Although FEMA is considering changing that policy, it is optional for local communities. *The FEMA FIRM map for the City of Carson was completed in 1987.* Man-made and natural changes to the environment have changed the dynamics of storm water run-off since then.

**Flood Mapping Methods and Techniques**

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, there are some flood-prone areas that are not mapped but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and areas susceptible to manmade flooding. *About 10% to 20% of all flood-related damage from past floods in the City of Carson is located outside the boundaries of the FEMA's FIRMs.*

*In order to address this lack of data, the City of Carson, as well as other jurisdictions, has taken efforts to develop more localized flood hazard maps. One method that has been employed includes using high-water marks from flood events or aerial photos, in conjunction with the FEMA maps, to better reflect the true flood risk. The use of GIS (Geographic Information System) is becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS, which allows for GIS analysis of flood hazard areas.*

Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request. Coordination between FEMA and local planning jurisdictions is the key to making a strong connection with GIS technology for the purpose of flood hazard mapping.

FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcViewC9 and ArcInfoC9 . The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site are intended to assist communities in evaluating geographic information about natural hazards. Flood information for most communities is available on the ESRI web site. Visit www.esri.com for more information.

**Hazard Assessment**

**Hazard Identification**

Hazard identification is the first phase of flood-hazard assessment. Identification is the process of estimating: (1) the geographic extent of the floodplain (i.e., the area at risk from flooding); (2) the intensity of the flooding that can be expected in specific areas of the floodplain; and (3) the probability of occurrence of flood events. This process usually results in the creation of a floodplain map. Floodplain maps provide detailed information that can assist jurisdictions in making policies and land-use decisions.

**Data Sources**

*FEMA mapped the 100 -year and 500-year floodplains through the Flood Insurance Study (FIS) in conjunction with the United States Army Corps of Engineers (USACE) in August of 1987. There were previous studies done, including a Housing and Urban Development (HUD) study, which mapped the floodplain in March of 1978, this is when the City of Carson initially entered into the NFIP. The county has updated portions of the USACE and FEMA maps through smaller drainage studies in the county since that time.*

**Vulnerability Assessment**

Vulnerability assessment is the second step of flood-hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events. Because site-specific inventory data and inundation levels given for a particular flood event (10-year, 25-year, 50-year, 100-year, and 500-year) are not readily available, calculating a community's vulnerability to flood events is not straightforward. The amount of property in the floodplain, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential flood losses.

**Disruption of Critical Services**

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after a flooding event. Vulnerability of these facilities is indicated on Table 4-2 in Section 4.

**Risk Analysis**
Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessment. A flood risk analysis for the City of Carson should include two components: (1) the life and value of property that may incur losses from a flood event (defined through the vulnerability assessment); and (2) the number and type of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events. Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events. The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event.

Using GIS technology and flow velocity models, it is possible to map the damage that can be expected from flood events over time. It is also possible to pinpoint the effects of certain flood events on individual properties. At the time of publication of this plan, data was insufficient to conduct a risk analysis for flood events in the City of Carson. However, the current mapping projects will result in better data that will assist in understanding risk. This plan includes recommendations for building partnerships that will support the development of a flood risk analysis in the City of Carson.

**Community Flood Issues**

**What is Susceptible to Damage during a Flood Event?**
The largest impact on communities from flood events is the loss of life and property. During certain years, property losses resulting from flood damage are extensive. Development in the floodplains of the City of Carson will continue to be at risk from flooding because flood damage occurs on a regular basis throughout the county. Property loss from floods strikes both private and public property.

**Property Loss Resulting from Flooding Events**
The type of property damage caused by flood events depends on the depth and velocity of the flood waters. Faster moving flood waters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Most flood damage is caused by water saturating materials susceptible to loss (i.e. wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). In many cases, flood damage to homes renders them unlivable.

**Mobilehomes**
Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61% were mobilehomes and trailers. Many older mobilehome parks are located in floodplain areas. Mobilehomes have a lower level of structural stability than stick-built homes and must be anchored to provide additional structural stability during flood events. Because of

confusion in the late 1980s resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements. Lack of enforcement of mobilehome construction standards in floodplains can contribute to severe damages from flood events.

According to the City of Carson Planning Division, the mobilehome parks listed below have some portion of their property in the 100-year floodplain. The safety of these parks and their compliance with land use planning and building codes, as well as FEMA NFIP requirements, warrants further investigation.

Bel Aire Mobilehome Park – 21425 S. Avalon Blvd.
Carson Gardens Trailer Lodge – 437 W. Carson St.
Carson Harbor Village Mobilehome Park 17701 S. Avalon Blvd.
Colony Cove Mobile Estates – 17700 S. Avalon Blvd.
Country Estates Mobilehome Park – 1502 E. Carson St.
Dominguez Trailer Park – 2666 Dominguez St.
E&L Trailer Haven – 807 Lincoln St.
Little Dude Trailer Park – 630 E. 220th St.
Ocean Villa Mobilehome Park – 605 W. 228th St.
Ray Mar Trailer Park – 823 E. Realty St.
Nu-Way Mobilehome Park – 401 W. Carson St.
Flamingo Gardens Trailer Park – 520 E. Carson St.
Laco Mobilehome Park – 22325 S. Main St.
Bel-Abbey Mobilehome Park – 200 E. Gardena Blvd.
Paradise Trailer Lodge – 21900 S. Martin St.
Park Granada Trailer Lodge – 218 W. Carson St.
Rancho Dominquez Mobile Estates – 425-435 E. Gardena Blvd.
Shangri Lodge – 21834 S. Grace Ave.
Imperial Avalon Mobile Estates – 21207 S. Avalon Blvd.
Imperial Carson Mobile Estates – 21111 Dolores St.
Park Avalon Mobile Estates – 750 E. Carson St.

**Business/Industry**

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

**Public Infrastructure**

Publicly owned facilities are a key component of daily life for all citizens of the county. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Government can take action to reduce risk to public infrastructure from flood events, as well as craft public policy that reduces risk to private property from flood events.

**Roads**
During natural hazard events, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. Roads systems in the City of Carson are maintained by multiple jurisdictions. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Road networks often traverse floodplain and floodway areas. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

**Bridges**
Bridges are key points of concern during flood events because they are important links in road networks, river crossings, and they can be obstructions in watercourses, inhibiting the flow of water during flood events. The bridges in the City of Carson are state, county, city, or privately owned. A state-designated inspector must inspect all state, county, and city bridges every two years; but private bridges are not inspected, and can be very dangerous. The inspections are rigorous, looking at everything from seismic capability to erosion and scour.

**Storm Water Systems**
The Los Angeles County Department of Public Works (LACDPW) is responsible for flood control protection within Los Angeles County, according to the city's General Plan. The Dominguez Channel is a part of the LACDPW flood control system. There are approximately 130 storm drains throughout the city.

**Water/Wastewater Treatment Facilities**
As stated in the City's General Plan, there are two water companies that serve the City of Carson including the California Water Service Company and the Southern California Water Company. The Los Angeles County Department of Public Works maintains the local sewer lines. The Los Angeles County Sanitation District is responsible for the trunk sewer lines in the city. There are two small lift stations that are located in the City of Carson: the Scottsdale Pump station, and the Belshaw Pump station. The Joint Water Pollution Control Plant is located in the city providing wastewater treatment for seventeen sanitation districts in Los Angeles County. This plant is one of the largest wastewater treatment plants in the world serving approximately 3.5 million people.

**Water Quality**
Environmental quality problems include bacteria, toxins, and pollution.

Flood Endnotes

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1. http://www.lalc.k12.ca.us/target/units/river/tour/hist.html

2. Gumprecht, Blake, 1999, Johns Hopkins University Press, Baltimore, MD.

3. Ibid

4. http://www.usc.edu/isd/archives/la/scandals/st_francis_dam.html

5. http://www.latimes.com/news/local/surroundings/la-me-surround11dec11,0,1754871.story?coll=la-adelphia-right-rail

6. http://www.fema.gov/rrr/talkdiz/landslide.shtm#what