SECTION IV-C FLOOD/STORM
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SECTION IV-C FLOOD/STORM

A. THE CALIFORNIA FLOOD THREAT

California has a great history of both floods and droughts throughout its history. When in a major drought like in 2015, we must never forget to continue our planning and preparedness for floods, the most common natural disaster in California's history.

California has a massive and complex system of State, Federal and local sponsored dams, canals, pipelines, tunnels, by which water is stored and transferred within 10 hydrologic regions. The three major aqueducts (1) California Aqueduct, (2) Colorado River Aqueduct, and (3) Los Angeles Aqueduct transport water to Southern California and together traverse nearly 1,000 miles.

Figure 1 - California Aqueducts, Canals and Natural Hydrologic Regions

STATE OF CALIFORNIA MULTI-HAZARD MITIGATION PLAN

According to the State of California Multi-Hazard Mitigation Plan, floods represent the second most destructive source of hazard, vulnerability and risk, both in terms of state history and the probability of future destruction at greater magnitudes than previously recorded.

Floods represent a significant concern for the State of California for several reasons. California has a chronic and destructive flood history. Since 1950, 30% of federally declared disasters in California were the result of floods. During this history, flood disasters have claimed 292 lives, resulting in 759 injuries and over $4.8 billion in Cal EMA-administered disaster costs.

California has widespread flood vulnerability as indicated by FEMA Flood Insurance Rate Map (FIRM) designations with their common presence in populated areas.

CALIFORNIA FLOOD HAZARDS

Every county in the state experiences floods, although the nature of these events varies due to the diverse climate and geography. Disparate climate patterns present challenges to flood mitigation planning in California. These patterns include:

- El Niño conditions
- La Niña conditions
- Drought
- Desert monsoons
- Northwest coastal conditions
- Tropical storms
- Gulf of Alaska storms
- Pineapple Express patterns

In addition, California's geographic diversity represents a difficult challenge to planning for flood mitigation. California has a 1,100 mile-long coastline; prominent coastal and inland mountain ranges, including the Sierra Nevada; and extensive and highly varied deserts. These geographical factors combine to create various types of flood hazards:

- Alluvial
- Fan
- Coastal
- Flash
- Fluvial
- Lake
- Levee
- Mudslide
- Riverine
- Seiche
- Tsunami

CALIFORNIA FLOOD HISTORY

Since 1950 the state has had 32 state-proclaimed flood emergencies and 18 federally declared flood disasters. Since 1992, every county in California was declared a federal disaster area at least once for a flooding event.

Table 1 - California Flood Disasters 1992-2010

Disaster #	Date	Scope (# of Counties)	# of Deaths	Damage in $
935-DR-CA	Feb-92	6	5	$123.2 million
979-DR-CA	Jan-93	25	20	$600 million
1044-DR-CA	Jan-95	45	11	$741.4 million
1046-DR-CA	Feb-95	57	17	$1.1 billion
1155-DR-CA	Jan-97	48	8	$1.8 billion
1203-DR-CA	Feb-98	40	17	$550 million
1498-DR-CA	Jun-03	2	16	--[a]
1529-DR-CA	Jun-04	1	0	$57 million
1577-DR-CA	Feb-05	8	24	$573.1 million
1585-DR-CA	Apr-05	7	0	$198.7 million
1628-DR-CA	Feb-06	40	5	$327.8 million
1646-DR-CA	Jun-06	16	1	$129.5 million
1884-DR-CA	Mar-10	6	0	Preliminary Damage Estimate: $50 million

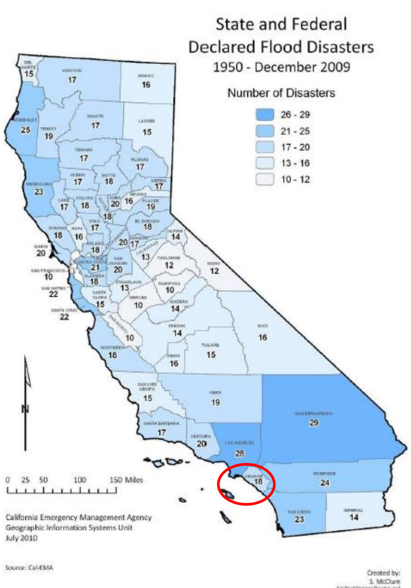
Source: Cal EMA Origins and Development - A Chronology 1917-2010; Cal EMA After Action Reports; FEMA: California Disaster History (www.fema.gov/news/disasters_state.fema)

[a]*DR-1428, 2003 Southern California Fires, caused the elimination of vegetation securing soils to the hillsides. In December 2003, mild flooding caused mudflows and landslides killing 16 people. The costs of the flood damages were not segregated from the fire damages*

STATE OF CALIFORNIA MULTI-HAZARD MITIGATION PLAN

Orange County was included in all disaster declarations highlighted in red above.

Figure 2 - State/Federal Floods 1950-2009



This map shows the distribution of floods leading to disaster declarations from 1950 to 2009 in California. Counties with 21 or more declared disasters during this period include:

Northern California: Humboldt and Mendocino counties

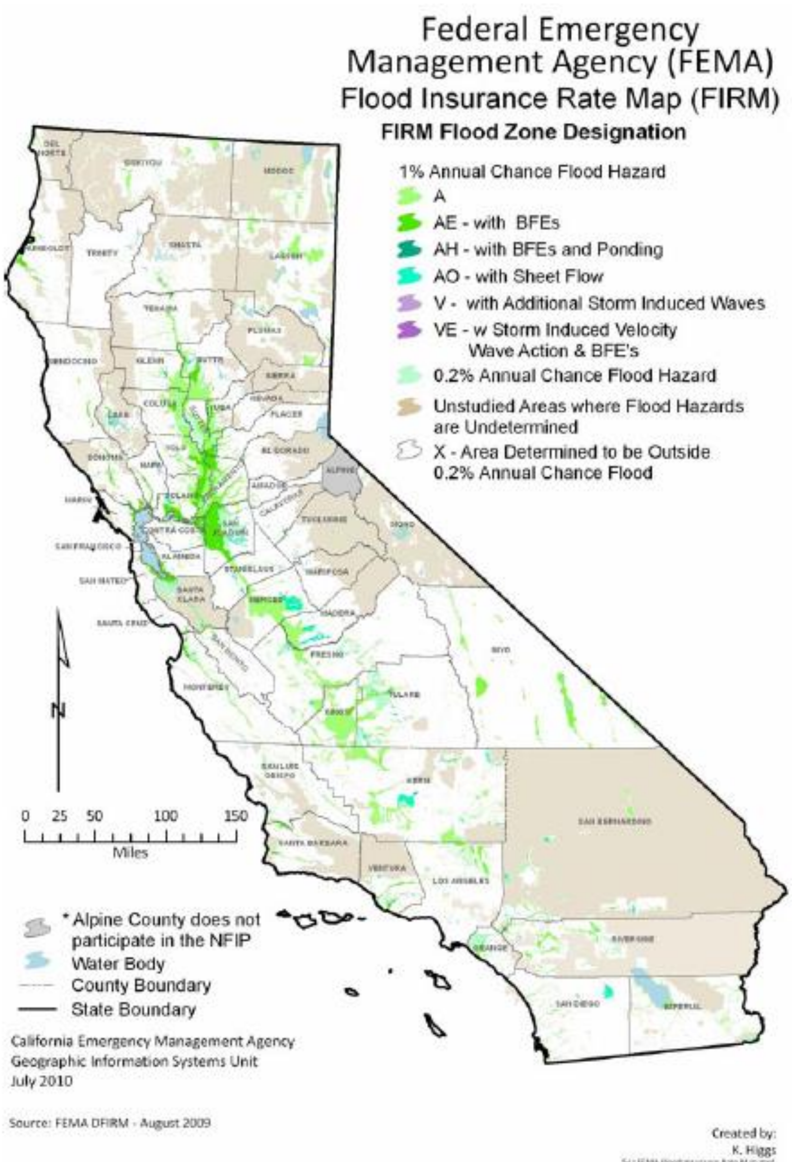
San Francisco Bay Area: Contra Costa, San Mateo and Santa Cruz

Southern California: Los Angles, Riverside, San Bernardino and San Diego.

Orange County had 18 declared flood disasters during his period.

STATE OF CALIFORNIA MULTI-HAZARD MITIGATION PLAN

Figure 3 - FEMA Flood Insurance Rate Map Flood Zone Designation



STATE OF CALIFORNIA MULTI-HAZARD PLAN

This map shows the FEMA-designated 100-Year Flood Zone. High concentrations of 100-Year Flood areas are shown throughout the Central Valley, especially in the Sacramento-San Joaquin Delta region.

Flood zones are areas depicted on a FIRM map defined by FEMA according to levels of risk. Zones with a 1% annual chance of flooding or a 100-Year Flood Zone are part of the Standard Flood Hazard Area (SFHA) and considered to have high risk. In communities that participate in the NFIP, mandatory flood insurance purchase requirements apply to these zones: A, AE, A1-30, AH, AO, AR, A99, V and VE or V1 through 30.

Table 2 - FEMA FIRM Descriptions

ZONE	DESCRIPTION
A	Area with a 1% annual chance of flooding. No depths or Base Flood Elevations (BFEs) are shown.
AE	Base floodplain where BFEs are provided. AE Zones are now used on digital FIRMs instead of A1-A30 Zones.
A1 through 30	Known as numbered A Zones, these are the base floodplains in the old FIRM format where a BFE is shown.
AH	Area with a 1% annual chance of shallow flooding with an average depth ranging from 1 to 3 feet. BFEs are shown at selected intervals.
AO	River or stream flood hazard area, or area with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow with an average depth ranging from 1 to 3 feet. Average flood depths derived from detailed analyses are shown.
AR	Area with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam).
A99	Area with a 1% annual chance of flooding protected by a federal flood control system where construction has reached specified legal requirements. No depths or BFEs are shown.
V	Coastal area with a 1% or greater chance of flooding and an additional hazard associated with storm waves. No BFEs are shown within these zones.
VE or V1 through 30	Coastal area with a 1% or greater chance of flooding and an additional hazard associated with storm waves. BFEs are shown at selected intervals.
B, C, X	Zones considered to have moderate to low risk of flooding, although flood insurance is available to property owners and renters in communities that participate in the NFIP.
D	Area with possible but undetermined flood hazards, where no flood hazard analysis has been conducted.

Studies comparing 2000 U.S. Census data with FIRM maps found that over 5 million Californians (15% of the population) live in FIRM-designated floodplain and nearly 2 million (5.8% of the population) live in the 100-year floodplain. Based on these studies, California would normally expect approximately 20,000 people per year to be affected by a 100-Year Flood and 500-Year Flood annual flooding; however, the state's flood risk is not evenly distributed. Approximately 84% of the 5 million Californians living in a FIRM-designated floodplain were in 13 counties having 100,000 or more people within 100-year and 500-year FIRM designated floodplains. In 2000, the leader by far was Orange County, with almost 1.4 million people at risk.

Table 3 - Counties with 100,000+ People Living in Floodplain, 2000

County	Total Population in FIRM Zone
Orange	1,384,403
Sacramento	490,014
Los Angeles	390,305
Santa Clara	304,511
Riverside	295,081
San Joaquin	287,742
Fresno	205,235
Monterey	198,283
San Bernardino	196,945
Ventura	187,179
San Diego	181,757
Tulare	154,184
Alameda	103,162

Source: U.S. Census; FEMA

Analysis of Damage from Historic Flood Events

Damage data from California's historic flood events are useful for characterizing flood risk and identifying areas that probability-based assessments such as FIRM floodplains may miss. According to a study of population living in floodplains as of 1998, a majority of NFIP flood loss claims occur during flood events that do not rise to the level of a federal disaster declaration. Thus, the event of flood disaster declarations is not a complete measure of vulnerability.

Table 4 - Historic Damage Claims and Repetitive Loss Payments from 1992 to 2002
Individual Assistance (IA), Public Assistance (PA), Repetitive Loss (RL)

IA: County with greatest number of damage locations (accounts for 45% of total state dollar damage claims)	Los Angeles
PA: Counties with greatest dollar damage claims (accounts for 50% of total state dollar damage claims)	Los Angeles
	Santa Barbara
	Monterey
	Ventura
	Orange
	San Mateo
	Santa Clara
	Alameda
	Sonoma
RL: County with greatest dollar payments (accounts for 34% of total state dollar payments)	Sonoma

Source: FEMA; Cal EMA

PARTICIPATION IN THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968. The NFIP is a program administered by FEMA enabling property owners in participating community floodplain management regulations that reduce future flood damages. In California, approximately 97% of the communities participate in the NFIP.

Currently there are 518 NFIP-participating communities throughout the state. With 274,683 flood insurance policies, California has the fourth largest policy count nationwide. Among other activities, the Department of Water Resources provides services in support of the NFIP program.

California Community College Districts are not participants in the National Flood Insurance Program or the Community Rating System programs. However, the cities of Santa Ana, Orange and Tustin as well as the County of Orange are participants.

COMMUNITY RATING SYSTEM PARTICIPATION

The Community Rating System (CRS), part of the NFIP, is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. This is done by providing flood insurance premium discounts to property owners in communities participating in the CRS program. Credit points are earned for a wide range of local floodplain management activities; the total number of points determines the amount of flood insurance premium discounts to policyholders.

In California, there are 164,273 flood insurance policies in CRS communities, representing a total of $111,069,562 in premiums paid by policyholders who realized $12,326,101 in savings from their communities' participating in CRS.

STRATEGY FOR MITIGATING SEVERE REPETITIVE LOSS PROPERTIES

The Flood Insurance Reform Act of 2004 provided a new opportunity for state governments to mitigate the most flood-prone properties by creating the Severe Repetitive Loss (SRL) Pilot Program. In order to qualify for the SRL program, the properties must meet the following criteria based on paid flood losses since 1978:

There must be four or more separate claim payments of more than $5,000 each (building and/or contents), or two or more claim payments (building only) where the total exceeds the current market value of the property. At least two of the referenced claims must have occurred within any 10-year period and must be greater than 10 days apart.

The RSCCD has never made a flood claim to State OES or FEMA and does not have any repetitively flood damaged facilities. One minor flood/mud flow occurred on one of the seven sites. Santiago Canyon College in Orange was hit on 11/25/2008 by rain, flooding and some mud which caused $51,777 in damage to the college. No flood or mudflow incident has occurred since. However, the area has been part of a drought State of Emergency most of that time.

FLOOD MITIGATION ASSISTANCE PROGRAM

The Flood Mitigation Assistance (FMA) program assists states and local communities in implementing flood hazard mitigation measures before a major disaster occurs. The program targets NFIP communities with numerous repetitive loss structures. The program offers two types of grants to local communities; planning and project grants. A community must have a FEMA-approved Floodplain Management Plan (FMP) to be eligible for FMA grant funding.

SOUTH COAST HYDROLOGIC REGION

The RSCCD is located in the South Coast hydrologic region which extends up from the U.S.-Mexico border to the Tehachapi, San Bernardino, San Gabriel and San Jacinto mountains. Nearly one-third of the area is coastal plain. This region contains major urban centers, including the counties of Los Angeles, Orange and San Diego. Much of the flooding is sudden and severe, resulting in massive slides, debris flows and mudflows. Typical of the flooding that occurs in this area are the 1969 winter storms that killed 47 and resulted in $300 million in property damage. During these storms, an alluvial flood and debris flow on Deer Creek in San Bernardino County killed 11.

Orange County consists of:
8-1 Ground Water Basin - Coastal Plain of Orange County, 224,000 acres
9-1 Ground Water Basin - San Juan Valley, 16,700 acres

The RSCCD is all located in the Coastal Plain of Orange County.

LOCAL GOVERNMENTS

Section 201.2 of 44 CFR defines Local Government as:
Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government.

FEMA recognizes that local governance structures vary, and that the authority to implement mitigation strategies (e.g., land use planning and zoning, building code enforcement, infrastructure improvements, floodplain management, etc.) may not reside within a single governmental entity. In addition certain FEMA hazard mitigation assistance programs accept applications from private, non-profit organizations and other quasi-governmental entities that do not necessarily align with traditional geopolitical boundaries. To ensure these potential sub applicants to FEMA mitigation assistance programs met the eligibility requirements for mitigation plans under 44 CFR 201.6 FEMA has identified procedurals of these entities.

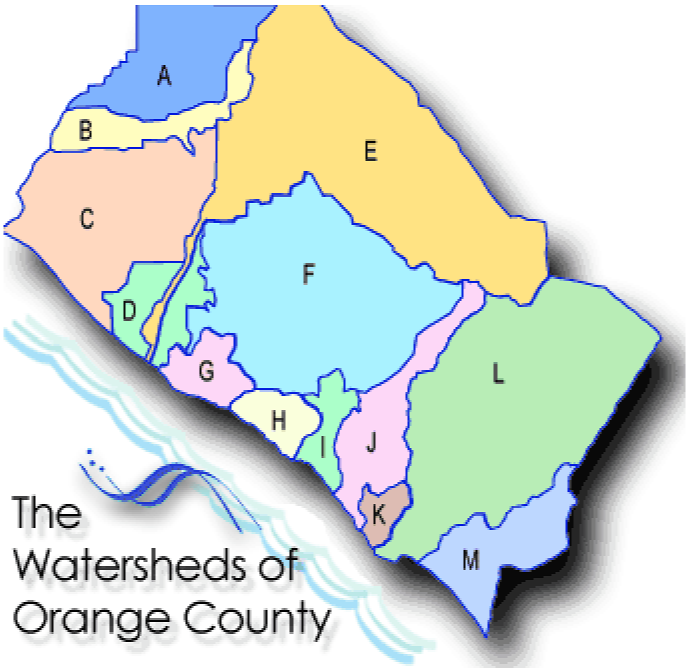
B. THE ORANGE COUNTY FLOOD THREAT

Orange County's 510,000 acres are comprised of mountain terrain (on the northeast and southeast) and floodplain (in the central and western section). The County’s rapid growth and transformation from an agricultural community to an urban community has changed flood control of large flows from mountains and hills to include control of additional runoff produced by development of the plains. Although there is a countywide system of flood control facilities, the majority of these are inadequate for conveying runoff from major storms, such as the Standard Project Flood or the 100-year flood.

The infrequency of very large floods further obscures the County's flood hazard. Storms labeled "severe" have occurred in less than 10 of the past 175 years. In particularly disastrous storms, a false sense of security prevailed following long periods of mild semi-arid years.

The following map provides locations of the various watersheds throughout Orange County.

Figure 4 - Watersheds of Orange County



A = Coyote Creek
B = Carbon Canyon
C = Westminster
D = Talbert
E = Santa Ana River
F = San Diego Creek
G = Newport Bay
H = Los Trancos/Muddy Creek
I = Laguna Canyon
J = Aliso Creek
K = Salt Creek
L = San Juan Creek
M = Prima Deshecha/Segunda Deshecha

COUNTY OF ORANGE AND OCFA HAZARD MITIGATION PLAN

To provide quantitative information for flood warning and detection, Orange County began installing its ALERT (Automated Local Evaluation in Real Time) system in 1983. Operated by the County's Public Works in cooperation with the National Weather Service, ALERT uses remote sensors located in rivers, channels and creeks to transmit environmental data to a central computer in real time. Sensors are installed along the Santa Ana River, San Juan Creek, Arroyo Trabuco Creek, Oso Creek, Aliso Creek, as well as flood control channels and basins. The field sensors transmit hydrologic and other data (e.g., precipitation data, water levels, temperature, wind speed, etc.) to base station computers for display and analysis. In addition, seven pump stations (Huntington Beach, Cypress, Seal Beach, Los Alamitos, Rossmoor, Harbor-Edinger, and South Park) regulating storm water discharge to flood control channels are also instrumented. Their monitoring system includes automated call-out of operations personnel in the event of a crisis.

Activation of the Storm Operations Center operated by the OC Public Works takes place when heavy rainfall occurs or is predicted, and/or when storm runoff conditions indicate probable flood damage. The Center monitors the situation on a 24-hour basis. Response may include patrols of flood control channels and deployment of equipment and personnel to reinforce levees when needed. The Center activation and various emergency response actions are based on the following Emergency Readiness Stages:

Stage I - Mild rainfall (watch stage).

Stage II - Heavy rainfall or potential thereof. OCPW Storm Operations Center activated and surveillance of flood control facilities in effect.

Stage III - Continued heavy rainfall or deterioration of facilities. County OCPW Director in charge. County's personnel assume assigned emergency duties.

Stage IV - Conditions are or are likely to be beyond County control. The Board of Supervisors, or DES when the Board is not in session, proclaims Local Emergency and assumes special powers. Mutual Aid requested.

Stage V - Damage beyond control of all local resources. State forces are required. Governor requested to proclaim State of Emergency.

Stage VI - Damage beyond control of local and State resources. Federal forces are required. President requested to declare Major Disaster.

ORANGE COUNTY FLOOD THREAT

The Santa Ana River, flowing through the heart of Orange County to the Pacific Ocean is the county's greatest flood threat. Research of flooding in Orange County illustrates these flood hazard issues, sighting loss of life as well as damage to personal and public property.

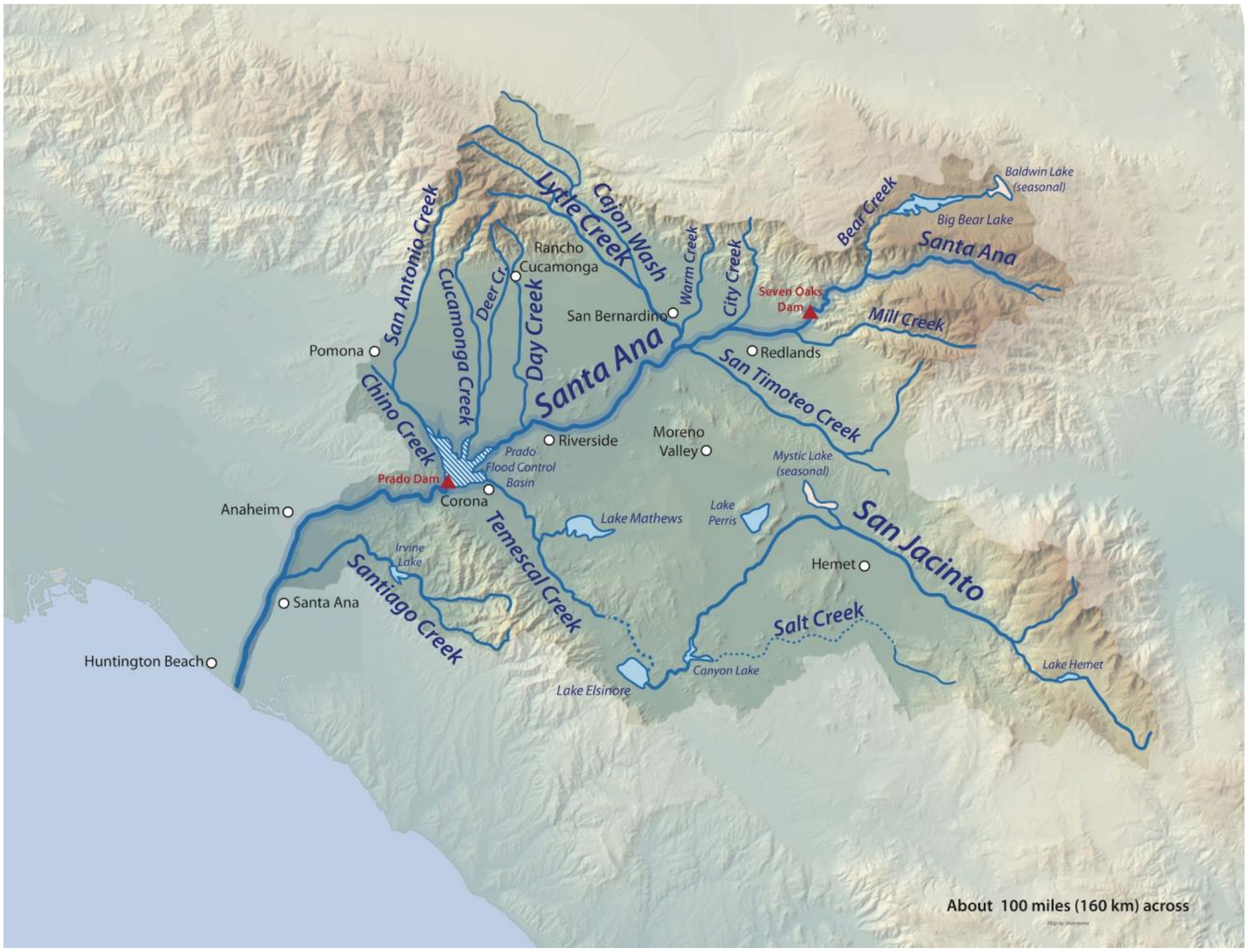
One such flood occurred in 1938, wiping out roads, bridges, and railroads near the river when an 8-foot wall of water swept out of the Santa Ana Canyon. Anaheim, Santa Ana, and Garden Grove were hardest hit and 34 lives were lost because of the flood. The flood and its damage were a catalyst for construction of Prado Dam, developed as part of the Army Corps of Engineers flood control protection plan. Government officials estimated that today without the protection of Prado Dam, a flood of this magnitude would cause as many as 3,000 deaths and top $25 billion in damages. More than 110 acres would be flooded with 3 feet of water and 255,000 structures damaged as documented by S. Gold, in the Los Angeles Times, in 1999.

The Army Corp of Engineers is tasked with the project of increasing the level of protection at Prado Dam from the current 70-year level to a 190-year level of protection. This project was recently completed. Further, portions of the County not inundated by river overflow during a 100-year event could be subject to flooding from overflow of water drainage facilities currently inadequate for carrying the 100-year discharge.

Other areas subject to flooding during severe storms include areas adjacent to Atwood Channel, Brea Creek Channel, Fullerton Creek Channel, Carbon Creek Channel, San Juan Creek Channel, and East Garden Grove-Wintersburg Channel. Areas adjacent to Santiago Creek and Collins Channel in the central portion of the County and large portions of the San Diego Creek watershed in the City of Irvine and unincorporated areas of the County are also subject to inundation. In the southern portion of the county, canyon areas are subject to flooding. However, with increase in development in these areas the flood hazard becomes even greater.

The RSCCD has reviewed the **Orange County Flood Control Project Seven-Year Plan** which heavily impacts the district's facilities and supports this document and its concepts. These projects will provide additional flood protection for five sites threatened by flood and listed in Table 19.

Figure 5: Orange County Rivers and Creeks



Historic Data for Orange County

Residents reported damaging floods caused by the Santa Ana River, known as the "Great Floods," as early as 1770. A massive flood recorded on January 7, 1770 is in the Notes of Father John Crespi. Major floods in Orange County on the Santa Ana River have occurred in 1810, 1815, 1825, 1884, 1891, 1916, 1927, 1938, 1969, 1983, 1993 and 1997. The greatest flood in terms of water flow was in 1862 with an estimated flow rate of 317,000 cubic feet per second (cfs). This was three times greater than the Great Flood of 1938 estimated at 110,000 cfs. The most damaging flood in terms of cost was the Great Flood of 1969. The County's population had significantly increased by this time creating greater potential for loss.

Great Flood of 1862- The storm and flood of January 1862, called the NOACHIAN deluge of California, were unusual in two ways: 1) the storm occurred during the very severe drought of 1856-1864 and 2) the flooding was extremely long, lasting 20 days. Under normal circumstances, major floods last no longer than a few days. The only structure left standing was a chapel called Aqua Mansa on high ground above the river. The priest rang the chapel bell and the settlers fled the rising waters. Small villages along the Santa Ana River were completely destroyed. Miraculously, there were no recorded deaths.

Great Flood of 1916 – The flood on January 27, 1916 inundated a large area in Santa Ana, flooding Main Street with water 3 feet deep. The farming area, today known as City of Westminster, was also flooded. A total of six bridges, three traffic bridges and three railroad bridges washed away and four people drowned.

Great Flood of 1938 – The flood of 1938 considered the most devastating of all County floods in the 20th Century, affected all of Southern California. The storm began on February 27 lasting until March 3. In the Santa Ana Basin, 34 people died and 182,300 acres were flooded. All buildings in Anaheim were damaged or destroyed. Two major railroad bridges, seven traffic bridges, and the little town of Atwood were completely destroyed. As the Santa Ana River inundated the northwestern portion of Orange County, train service to and from Santa Ana was cancelled and communication with the outside world was essentially nonexistent. Damage exceeded $50 million.

Great Flood of 1969 – The floods of January and February were the most destructive on record in Orange County. Previous floods had greater potential for destruction, but the County was then relatively undeveloped. The intensity of the 1938 flood was greater, however, of shorter duration. A drought that began in 1945 was relieved by only two wet years until the floods in 1969. An annual overdraft of 100,000 acre-feet brought the average groundwater level to 15 feet below sea level, and ocean water moved into the aquifers. Some wells along the coast began producing brackish water and had to be abandoned.

Rainfall was continuous from January 18-25 resulting in widespread flooding January 25-26. Orange County was declared a national disaster area on February 5. A storm on February 21-25 once again brought rain to the already saturated ground, culminating in a disastrous flood on February 25. The largest peak outflow from Santiago Reservoir since its inception in 1933 occurred in February. On February 25, the reservoir at Villa Park Dam reached its capacity. This was the first time since its construction in 1963 with a maximum outlet inflow of 11,000 cfs. Even though the outlet conduit was discharging up to 4,000 cfs, spillway overflow occurred at 1:30 p.m. on February 25 and continued 36 hours. The maximum peak outflow from the dam reached 6,000 cfs. The safety of the dam was never threatened. However, the outflow caused serious erosion downstream in Orange and Santa Ana and in portions of parks and golf courses. Trees and debris inundated the streambed. Houses, apartments, gardens, swimming pools, and bridges eroded away. Numerous residents and volunteers, worked around the clock to remove debris, sandbag eroding embankments, cordon off danger zones, issue warnings, and make temporary repairs. U.S. Marine Corps helicopters dropped junked cars along the banks of the creek below Bristol Street in an effort to prevent further undermining of homes. A Southern Pacific Railroad bridge, water and sewer lines, a pedestrian over crossing, and three roads washed out. Approximately 2,000 Orange and Santa Ana residents were evacuated from houses bordering Santiago Creek.

Great Flood of 1983 – The presence of El Niño spawned the flood of 1983. The intense downpour concentrated in a local area and the highest waves to crest on shore in 10 years. Meanwhile, the Santa Ana River crested at the mouth of the ocean; creating a disaster for the low-lying areas of Huntington Beach with floodwaters three to five feet deep. In addition, the pounding surf destroyed a section of the Huntington Beach Pier, resulting in a complete renovation of the pier.

A city owned and operated dirt lined flood channel was destroyed causing flooding in the South end of Huntington Beach. Over 3,000 persons in Huntington Beach had to be evacuated and sheltered.

Great Floods of 1993 – In 1993, El Niño spawned a storm and flood. This storm was concentrated in the Laguna Canyon Channel area from Lake Forest to downtown Laguna Beach. In spite of a valiant effort to save downtown merchants by sandbagging, the stores were flooded anyway. Laguna Canyon Road was damaged extensively as well as homes and small businesses in the Laguna Canyon Channel. There were no fatalities reported.

Flood of 1995 – In 1995, the Edinger Flood Channel overflowed into the streets and residential areas. Golden West Community College was located just a block from the severe flooding.

Flooding of 1997 & 1998 – From December 1997 through March 1998 an El Niño condition pounded the north west Orange County. On December 7, 1997, three senior mobile home parks in Huntington Beach were flooded. Due to the age of the residents, they had to be helped in evacuating and moved to shelters. This heavy rain pattern continued into March1998 where flood channels reached capacity on numerous occasions.

Flooding during the 1997/1998 El Niño Storm season affected Orange County. Extensive storm damage to private property and public infrastructure (County and cities) reached approximately $50 million. Storm conditions caused numerous countywide mudslides, road closures, and channel erosion. Hillside erosion and mudslides forced continual clearing of County roads of fallen trees and debris. Protective measures, such as stabilizing hillside road slopes with rock or K-rail at the toe of slopes, were taken to keep the normal flow of transportation on the County's road system. County harbors, beaches, parks, and trails also sustained substantial storm damage.

High ocean waves and storm activity forced the closure of Aliso Beach Pier when it was declared unsafe to the public and as a result, eventually required demolition. The high ocean waves also severely damaged the Laguna Beach boardwalk. Flooding occurred in the city, causing injuries and two deaths as a result of water and mudflow. Lateral erosion occurred to the natural banks of Serrano Creek and Aliso Creek. Storm flows destroyed portions of San Juan Creek and Trabuco Creek levees and channel linings. The U.S. Army Corps of Engineers assumed responsibility for the channel restoration following initial emergency response repairs made by the County. Substantial silt and sedimentation deposits at Santa Ana-Delhi and San Diego Creek Channels contributed to severe dredging problems at the Upper Newport Bay Regional Park, with costs estimated in excess of $2 million. Major landslides in Laguna Niguel caused millions of dollars in damage. Deterioration and collapse of a culvert 25 feet beneath the asphalt forced closure of Santiago Canyon Road for three weeks.

Assistance from resources such as the Army Corps of Engineers and the Federal Highway Administration minimized the overall reimbursement from FEMA (P.L. 93-288, Stafford Act for Public Assistance). Still, the FEMA/NDAA reimbursement to the County unincorporated area alone still reached approximately $4 million.

Although the 1997/1998 floods resulted in substantial damage to Orange County, it was not unprecedented. In January 1995, a disaster was declared in the County as extremely heavy and intense rains quickly exceeded the storm runoff capacity of local drainage systems in many Orange County cities and regional Flood Control District systems. As a result, widespread flooding of homes and businesses occurred throughout these cities. There were approximately 1000 people evacuated and extensive damage sustained to both private and public property. Unincorporated areas of the county received $12.5 million in reimbursement through Public

Assistance programs.

Orange County is in close proximity to Los Angeles, San Bernardino, Riverside, and San Diego Counties. Heavy rain affecting any one of these counties can easily affect Orange County. In addition, the towering mountains trap eastern-moving winter storms and draw out the rain. The rainwater moves rapidly down the steep slopes and across the coastal plains on its way to the ocean. Orange County averages about thirteen inches of rain a year, yet some mountain peaks in the County receive more than forty inches of precipitation annually.

Naturally, this rainfall moves rapidly downstream, often with severe consequences for anything in its path. Flood-generated debris flows roar down canyons at speeds near 40 miles per hour carrying with it a wall of mud, debris, and water ten feet high.

In Southern California, stories of floods, debris flows, and persons swept away by the Santa Ana River flowing at thirty-five miles an hour are without end. The good news is that through the Main Stem Project (Santa Ana River and Prado Dam), much of the flooding has been mitigated in the late 1990s and early 2000s. Orange County and its cities have taken flood mitigation seriously and considerable improvements have been made. These improvements are due to the excellent working relationship between the federal, state, counties and cities.

SANTA ANA RIVER IMPROVEMENTS

The Santa Ana River Mainstem Project (SARP) was initiated in 1964, in partial response to a resolution of the House Committee on Public Works adopted May 8, 1964. A survey report was completed by the District in 1975. The report was reviewed, and then submitted to Congress in September 1978.

To protect both upper and lower Mainstem project communities, Seven Oaks Dam, a 550-foot-high and 2,980-foot long rockfill dam with a gross capacity of 145,600 acre feet, has been constructed in the upper Santa Ana Canyon. The dam reduce the Reservoir Design Flood inflow of 85,000 cfs, to a controlled outflow of 7,000 cfs, to provide 350-year flood protection. The project is operated in tandem with Prado Dam, also located on the Santa Ana River 38 miles (61.1 km) downstream, to provide flood protection to Orange County, California.

Congress authorized Santa Ana River Mainstem Project for construction in 1986 under new guidelines for cost sharing of water resources projects between Federal and local governments. The local sponsors must pay between 25% and 50% of total cost of the project with the remaining cost provided by the Federal government.

In September 1980, the Army Corps of Engineers completed the Phase I. The General Design Memorandum (GDM) for the Santa Ana Mainstem. Construction of the SARP was authorized by Section 401(a) of the Water Resources Development Act of 1986. Construction of SARP was initiated in 1989, and completion scheduled for 2014.

On December 14, 1989, the U.S. Army Corps of Engineers (COE) and the County Flood Control District of Orange, Riverside and San Bernardino as Local Sponsors, entered into a four-party Local Cooperation Agreement (LCA) defining the responsibilities and cost-sharing of each party for each feature.

The Local Sponsors are to acquire all lands, easements, rights-of-way and perform relocations required to make way for construction of the Mainstem Project. The Army Corps of Engineers constructed the improvements. On completion, the Local Sponsors are responsible for the operation and maintenance of the Project features; except for Prado Dam where Orange County is responsible to pay for incremental operations/maintenance costs and the Corps of Engineers will continue to operate the Dam.

In 2003, a new agreement was entered between the Corps of Engineers and Orange County Flood Control District where the Prado Dam feature of the Santa Ana Mainstem Project were separated and Orange County was the sole local sponsor for Prado Dam. The project was designed to prevent flooding of 110,000 acres and causing 3,000 fatalities and more than $15 billion in property damage. The project featured constructing 23 miles of the Lower Santa Ana River from the Pacific Ocean to Prado Dam; raising Prado Dam elevation and reservoir capacity and construction of Seven Oaks Dam, the 6th tallest earth dam in the United States.

Implementer: Orange County Flood Control District/Orange County Public Works Flood Control Section

Estimated Cost: $1,890,000,000

Time Period: 25 years

Funding Source: Federal and local sponsorship

Source and Date: Orange County Strategic Financial Plan (2009)

Adopted Plan Number: Local Cooperation Agreement

Initiative and Implementation Status:
The U.S. Army Corps of Engineers has completed construction of the Lower Santa Ana River from the Pacific Ocean to Prado Dam to convey the 190-year storm event and the Seven Oaks Dam. The next step was Orange County Flood Control District acquiring land necessary to accommodate the increase in reservoir capacity with the Prado Dam spillway elevation being raised by the US Army Corps of Engineers.

FACTORS CREATING FLOOD RISK

Flooding occurs when climate, geology, and hydrology combine to create conditions of water flow outside its usual course.

WINTER RAINFALL

Over the last 100-Years, the average annual rainfall in Orange County was 13.03 inches. However, the term “average” means very little as the annual rainfall during this period has ranged from 4.35 inches in 2001-2002 to 38.2 inches in 1883-1884. This makes Orange County a land of extremes in terms of annual precipitation. Orange County is in the southern section of the Los Angeles Basin fringing the border of the Saddleback Range on the east increasing the possibility collection of rainwater within the county.

Another relatively regular source for heavy rainfall, particularly in the mountains and adjoining cities is from summer tropical storms. Tropical storms usually coincide with El Niño year and cause heavy rain and flooding.

EL NIÑO

Like many weather patterns, El Niño is one of those systems that nearly everyone has heard of, but whose origins are not so widely known. An elixir of unusual trade wind patterns and warming waters, the weather event can dominate climatic conditions across the world. El Niño is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

Nineteenth century anglers coined the name "El Niño.” Anglers plying the waters off the coast of Peru in the late 1800s were the first to notice an occasional seasonal invasion of warm, southward ocean current that displaced the north-flowing, cold stream in which they normally fished. Typically, it happened around Christmas, or the first of the year – hence the name "El Niño," which means "little boy" or "Christ Child" in Spanish.

El Niño is falsely linked to global warming, unfairly blamed for hurricanes in the Atlantic, but properly takes credit for droughts in Australia and floods in California. It also is responsible for regional depletion of fish stocks and fluctuations in seasonal temperatures.

An El Niño occurs when the ocean-atmosphere system in the tropical Pacific Ocean is disrupted. Normally, trade winds blow toward the west across the tropical Pacific Ocean, piling up warm surface water in the western Pacific. In a classic El Niño, the trade winds relax in the central and western Pacific, leaving warm water in the eastern Pacific. Heavy rainfall follows the warm water eastward, leading to flooding in Peru and California. Meanwhile, areas farther west, such as Indonesia and Australia, suffer droughts.

Displacing heat in the eastern Pacific prompts changes in the global atmospheric circulation, bringing changes in weather in regions far removed from the Pacific. The alteration in water temperature also affects fish reproduction, which has repercussions in the aquatic food chain. The most recent El Niño event occurred in 1997-98. The 1983-84 El Niño is considered the strongest and most devastating on record, responsible for more than 1,000 deaths, causing weather-related disasters on nearly every continent and totaling $10 billion in damages to property and livestock. El Niño conditions typically last one or two years, and are followed by "La Niña," or "little girl," in which a cooling of the same mid-Pacific waters triggers a reverse in climate impacts.

Table 5 - Tropical Storms that Affected Southern California in 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 to 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"
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	In Central and Southern Mountains. Ocotillo, CA was destroyed and there were 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"

STATE OF CALIFORNIA MULTI-HAZARD MITIGATION PLAN

GEOGRAPHY AND GEOLOGY

Southern California is the product of rainstorms and erosion for millennia. Most of the mountains surrounding the valleys and coastal plain are deeply fractured faults. As the mountains grew taller, their brittle slopes eroded. Rivers and streams carried boulders, rocks, gravel, sand, and silt down these slopes to the valleys and coastal plain. Today, much of the coastal plain rests on the ancient rock debris and sediment washed down from the mountains.

This sediment acts like a sponge, absorbing vast quantities of rain in years when heavy rains follow a dry period. Like a sponge near saturation, the same soil fills up rapidly when heavy rain follows a period of relatively wet weather. Even so, in some years of heavy rain, flooding is minimal because the ground is relatively dry, yet the same amount of rain following a wet period can cause extensive flooding.

Essentially all of Orange County is built out leaving little open land to absorb rainfall. The lack of open land forces water to remain on the surface rapidly accumulating. If it were not for the massive flood control system with its concrete lined river and streambeds, flooding would be a much more common occurrence. In addition, the tendency is toward less and less open land. In-fill building is becoming a much more common practice in many areas. Developers tear down an older home, typically covering up to 40% of the lot, replacing the single home with three or four town homes or apartments covering 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. When water leaves property and accumulates in the street, it is directed toward 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 resurfacing streets, a one to two inch layer of asphalt is laid 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.

BRIDGES

In flood events, bridges are key points of concern because of their importance in the transportation network for the movement of goods, travel, and emergency services. During flood events, scouring of bed material supporting their foundation can occur. Historically, this is the most common cause of bridge failures. Bridges in and of themselves may also be obstructions in a watercourse, restrict flows, and cause stream instability.

Bridges in the County are Federal, State, County, Flood Control District, City, or privately owned property. County owned bridges that are on the public roadway system are inspected by Caltrans in accordance with National Bridge Inspection Standards. Inspections are performed at regular intervals not to exceed two years unless justification to do otherwise is approved by the Federal Highway Administration. Bridges, which are not a part of the public roadway system or listed in the States Inventory of Bridges, will not be subject to inspection and are consequently a reason for concern.

In the last 20 years, the following bridges owned and maintained by the County have been retrofitted to address scour and/or seismic concerns:

- Hamilton Street-Victoria Street at Santa Ana River Channel (Bridge No. 55C-0103)
- Adams Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0344)
- Edinger Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0154)
- Warner Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0148)
- Harbor Boulevard Bridge at Santa Ana River Channel (Bridge No. 55C-0631)
- Lincoln Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0017)
- Glassell Street Bridge at Santa Ana River Channel (Bridge No. 55C-0130)
- Santiago Canyon Road Bridge at Santiago Creek (Bridge No. 55C-0049)
- Island Way Bridge at Harbor Waterway (Bridge No. 55C-0561)
- Brea Boulevard Bridge at Brea Creek (Bridge No. 55C-0122)
- Brea Boulevard Bridge at Brea Creek (Bridge No. 55C-0123)
- Santa Margarita Parkway Bridge at Arroyo Trabuco (Bridge No. 55C-0520)
- Slater Avenue-Segerstrom Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0371)

FLOOD TERMINOLOGY

100-Year Flood

A 100-year flooding event is a 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. Figure 6 bellow illustrates the 100-year floodplain in Orange County.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the expected elevation (normally measured in feet above sea level) of a base flood. Base flood elevations can be set at levels other than a 100-year flood. Some communities choose to use higher frequency flood events as a 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 a 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Development

For floodplain ordinance purposes, development is broadly defined as "any human caused 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.

Uses permitted within the FP-1 District include agriculture, public flood control facilities and devices, public utility facilities, public parks and recreation areas. Specifically prohibited within all Floodplain Zones (FP-1, FP-2, and FP-3) are structures and uses increasing flood elevations during the course of a base flood discharge. Prohibited are landfills, excavations and grading or the storage of materials and equipment resulting in the diversion or increase in erosion, flood elevations, or related hazards to people or property and storage or disposal of floatable substances and materials or of chemicals, explosives, and toxic materials. The "Base Flood" is defined in the Zoning Code as "the flood having a one percent chance of being equaled or exceeded in any given year, a.k.a. 100-year flood."

Dry Floodproofing

A dry flood proofed structure is made of water tight below the level that needs water protection to prevent flood waters from entering. Making the structure water tight requires sealing the walls with water proof coatings, impermeable water membranes, or a supplemental layer of masonry or concrete.

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, stores excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

Floodway

The floodway is one of two main sections creating the floodplain. Regulatory purposes require floodways be defined. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the over bank areas adjacent to the channel. The Orange County Zoning Code defines a “Floodway” as “the channel of a river or other watercourse and that part of the floodplain reasonably required to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.”

The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require the floodway be open and free from development or other structures that can obstruct or divert flood flows.

Flood Fringe

The flood fringe refers to outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. It is generally 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 must be taken. In Section 7-9-113-1 of the Orange County Zoning Code (Zoning Ordinance), the flood fringe encompasses the FP-2 and FP-3 Districts.

The FP-2 is intended to be applied to areas shown as "A," "A1" through "A30," "AO," "AE," "AH," "A99," and "M," on the September 15, 1989 or most current federal Flood Insurance Rate Maps and areas in which Orange County has determined to be a "Special Flood Hazard Area" (SFHA).

The FP-3 is intended to be applied to areas shown as "V," "V1" through "V30," and "VE," "AH," "A99," and "M," on the September 15, 1989 or most current federal Flood Insurance Rate Maps and areas in which the County has determined to be a coastal high hazard area.

Wet Floodproofing

Wet Floodproofing includes permanent or contingent measures applied to a structure or its contents that prevent or provide resistance to damage from flooding while allowing floodwaters to enter the structure or area. Generally, this includes properly anchoring the structure, using flood resistant materials below the Base Flood Elevation (BFE), protection of mechanical and utility equipment, and use of openings or breakaway walls.

CHARACTERISTICS OF FLOODING

Two types of flooding primarily affect Orange County: 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 over bank flooding of rivers and streams. The natural process of riverine flooding adds sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems generating prolonged rainfall over a wide geographic area. Flooding occurs in hundreds of smaller streams, which then drain into the major rivers.

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 floodwaters that rise very rapidly peaking with violent force.

Dam Failure Flooding

Loss of life and damage to structures, roads, and utilities may be the result of a dam failure. Economic loss can result in a lowered tax base and lack of utility profits. The failure of one of the major dams in Orange County would certainly have this effect. FEMA requires all dam owners to develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions, because dam failure can have severe consequences. 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. For more detailed information regarding dam failure flooding, refer to Section III-D of this plan.

Water Tank Failure

In September of 1998, a smaller version of a municipal water storage unit in the City of Westminster failed collapsing about 12 feet of the 100,000 gallon tank. The flow of water from the tank destroyed most of the facility and inundated approximately 30 homes with water and silt. Through the Public Works Mutual Aid Agreement, the Orange County Public Works Department assisted in the clean-up and temporary repair of the streets.

This is an example of one of many water tanks that could cause flooding in Orange County.

This 31-year-old storage tank ruptured in Westminster, California, sending a 6-foot wave of water through the city that damaged or destroyed about 50 buildings and over a dozen vehicles. Storage tanks should be replaced or periodically rehabilitated to preserve their structural integrity.

County of Orange and OCFA-Hazard Mitigation Plan

Dams

Since the 19th century, 45 dam failures have occurred in California. The two most significant dam failures are St. Francis Dam in 1928 and the Baldwin Hills Dam in 1963.

Debris Flows

Another flood related hazard that can affect certain parts of the Southern California region are debris flows. Typically, debris flows occur in mountain canyons and the foothills. 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. They usually start on steep hillsides as shallow landslides that liquefy, accelerating to speeds that are typically about 10 miles per hour, but can exceed 35 miles per hour. The consistency of debris flows range from watery mud to thick, rocky mud and can carry items as large as boulders, trees, and cars. Debris flows from many different sources can combine in channels, greatly increasing their destructive power. As the flow reaches flatter ground, debris spreads causing damage in developed areas."

Coastal Flooding

Low-lying coastal communities of Southern California also contend with coastal flooding. This occurs most often during storms with higher than normal tides. Storms, the time of year, and the tidal cycle can bring much higher than normal tides, causing flooding in low-lying coastal areas. This hazard however is limited to those areas.

EFFECT OF DEVELOPMENT ON FLOODS

Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. Serious problems arise with structures or a material added to floodways or floodplains and there is no removal of fill to compensate. Flood waters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels. 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 occurring within the floodway to ensure 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. Consideration taken in the development and the implementation of storm-water management systems ensures effective displacement of runoff waters.

C. ORANGE COUNTY FLOOD CONTROL DISTRICT (OCFCD)

Around the turn of the 20th century, farming interest began development of the land today known as Orange County. Farms and factories were soon established and as farming intensified and prospered, a better drainage system was required. The Orange County Board of Supervisors formed several "drainage districts". Eventually the drainage districts merged and the Orange County Flood Control District (OCFCD), was established May 23rd, 1927 under authorization of the Orange County Flood Control Act. The state statute was created to provide control of flood and storm waters of the district and streams flowing into the district (such as: the Santa Ana River, San Juan Creek, East Garden Grove-Wintersburg Channel and Santa Ana Delhi Channel); to mitigate the effects of tides and waves; and to protect the harbors, waterways, public highways and property in the district from such waterways.

It is the mission of the Orange County Flood Control District to "protect Orange County areas from the threat and damage of flooding".

During the 1950's and 1960's and fueled by the "Baby Boomers", urban sprawl began and suburbs were developed over agricultural fields. The infrastructure of drainage ditches once used for agriculture now needed improvement to the level of, flood control channels.

In 1968, the US Congress created the National Flood Insurance Program (NFIP). The criterion was established to provide 100-year flood protection. In 1972, the first Flood Insurance Rate Map (FIRM) was distributed; <u>a majority of Orange County was in a flood zone</u>. Since the creation of NFIP, OCFCD goal is to completely reduce the floodplain within OCFCD infrastructure by constructing flood control channels that convey 100-year flood protection,

constructing retarding basins, pump stations and dams throughout the County. Over several decades, OCFCD has reduced and removed several homes from the floodplains. OCFCD continues to remove more floodplains.

Hydrologic and hydraulic data are obtained for specific floodplains; these floodplains are analyzed for elimination or reduction to containment within the flood control facility. Strategic planning, including preliminary engineering analysis and engineering reports, for the construction of channel segments for entire channel systems is developed; these channel segments are at the infancy stage of becoming a project.

Projects are nominated before the City Engineers Flood Control Advisory Committee (CEFCAC). The committee composed of the OCFCD and cities decide the best deployment of money and manpower to accomplish conservation of water and protection of existing public and private property from floods. Selected projects are slated into the **Flood Control Project Seven-Year Plan.**

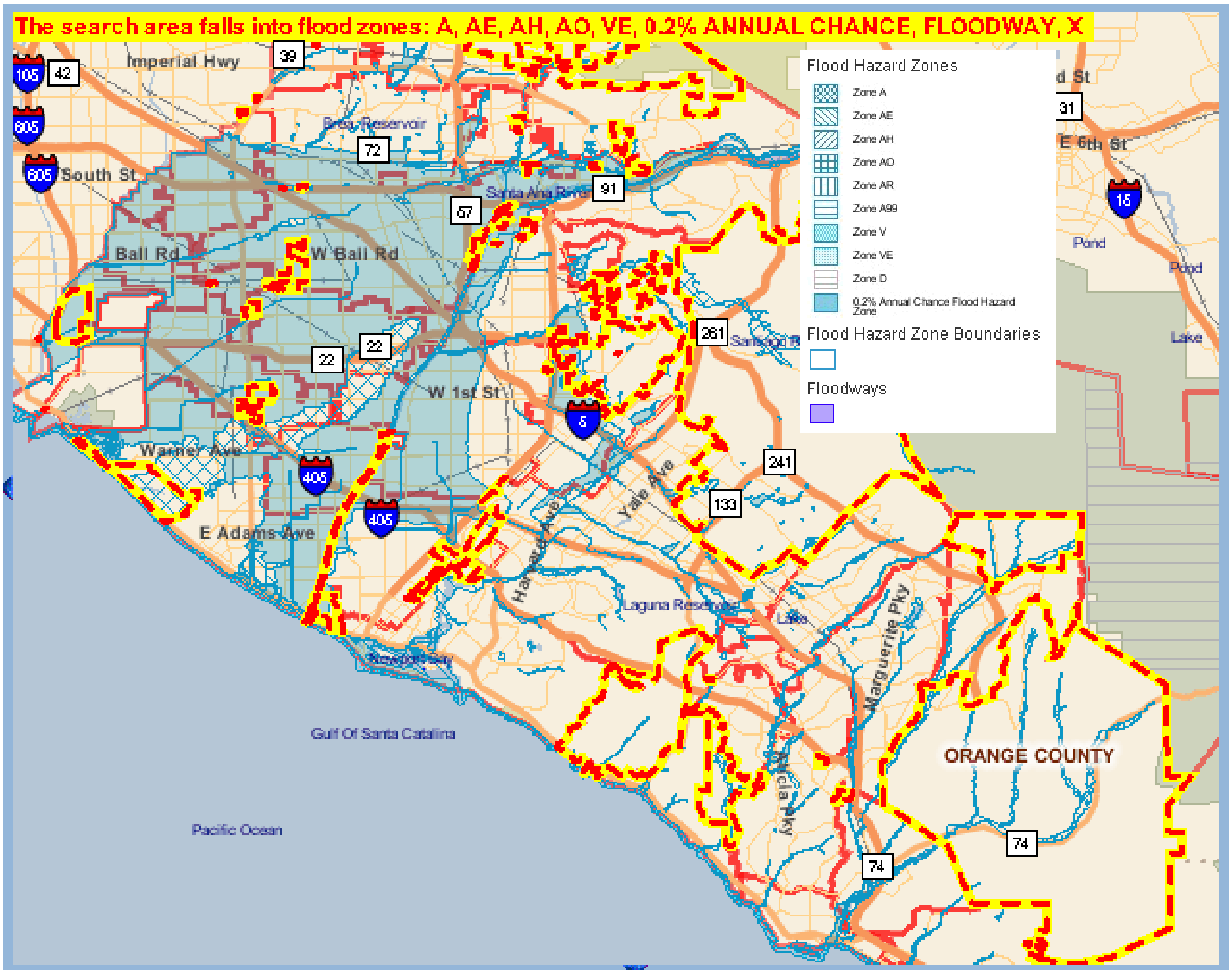
IDENTIFICATION OF ORANGE COUNTY FLOOD-PRONE AREAS

Flood maps and Flood Insurance Studies are often used to identify flood-prone areas. The NFIP was established in 1968 to provide low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations focusing on building codes and sound floodplain management. NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60, 3) require all new construction in floodplains be elevated at or above the 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 delineating Standard Flood Hazard Area (SFHA) in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine flood insurance requirements and applicable rates.

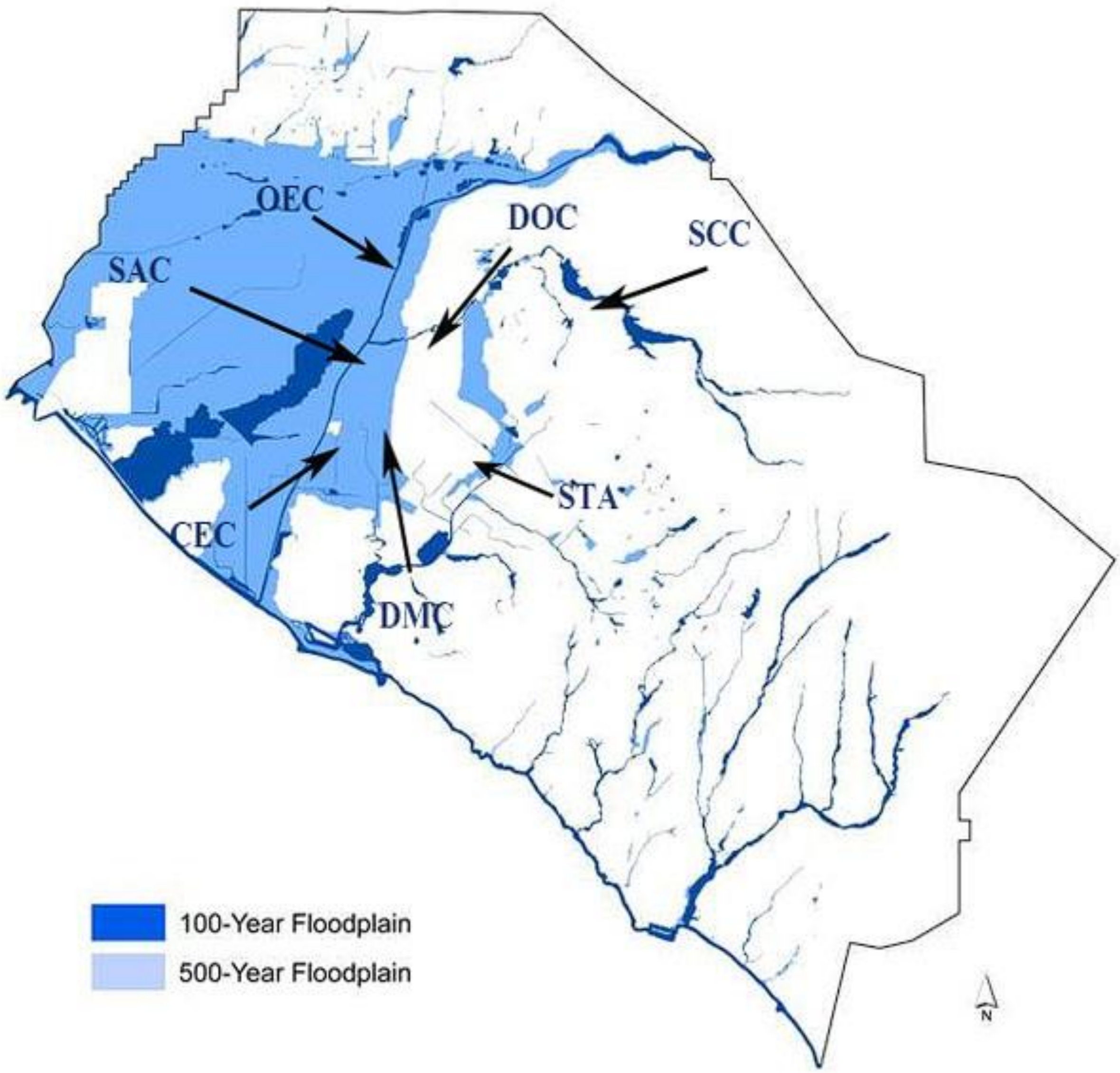
FIRMs are developed by combining water surface elevations with topographic data. Information derived through this process illustrates areas with the potential for inundation during a 100-year flood. They may also include base flood elevations (BFEs) and areas located within the 500-year floodplain. Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding in a specific location. Flood Insurance Studies conducted in the late 1970's and early 1980's by FEMA show flood risk in specific areas. However, FEMA has not mapped all 100-year or 500-year floodplains and does not incorporate planning for floodplain changes in the future due to new development. Although FEMA is considering changing this policy, it is optional for local communities. Human caused and natural changes to the environment continue to change the dynamics of storm water run-off.

Figure 6 - 100-Year Floodplain in Orange County



COUNTY OF ORANGE AND OCFA HAZARD MITIGATION PLAN

Figure 7 - FEMA Q3 Flood Data for Orange County



COUNTY OF ORANGE & OCFA HAZARD MITIGATION PLAN

FLOOD MAPPING METHODS AND TECHNIQUES

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, some flood-prone areas are unmapped, but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and human caused flooding. To address this lack of data, Orange County, as well as other jurisdictions, has taken efforts to develop more localized flood hazard maps. One method 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. Orange County and most of the larger Orange County cities are now using GIS.

Flood hazard areas on tax assessment parcel maps are particularly useful to communities, allowing evaluation of the flood hazard risk for specific parcels during review of a development request. Coordination between FEMA and local planning jurisdictions is key to making a strong connection with GIS technology for flood hazard mapping.

FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership providing multi-hazard maps and information to the public via the Internet. The ESRI web site has information on GIS technology and downloadable maps.

FLOOD COMMUNITY IMPACT

SUSCEPTIBILITY TO DAMAGE DURING A FLOOD EVENT

The largest impact to communities in a flood event is the loss of life and property to both private and public entities. Development in the floodplains of Orange County increases the risk of extensive property loss resulting flooding and flood damage.

PROPERTY LOSS RESULTING FROM FLOODING EVENTS

The type of property damage resulting from flood events is dependent upon the depth and velocity of the floodwaters. Fast moving floodwaters can wash buildings off their foundations and sweep cars downstream. High waters combined with flood debris can damage infrastructure, pipelines, and bridges. Landslide damage related to soil saturation can cause extensive damage. Water saturation of materials susceptible to loss (i.e., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances), in many cases, renders a home unlivable.

SCHOOLS AND BUSINESSES

Flooding impacts schools and businesses when damaged property interrupts operation, forcing closure for repairs, and students and customer's access is cut off. A community maintains economic vitality in the face of flood damage with quick response to the needs of businesses affected by the flood. Response to business damages can include funding to assist owners in elevating or relocating flood-prone business structures. The same with schools; getting students back to schools then allows parents to get back to work and gets the community on to recovery. Public school districts are eligible for recovery funding through FEMA Public Assistance program.

PUBLIC INFRASTRUCTURE

Publicly owned facilities are a key component to the daily life of all residents. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices hinder the government in delivering services. By taking action to create public policy, government can reduce risk to public infrastructure and private property resulting from flood events.

ROADS

During a natural hazard event, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. Orange County road systems often traverse floodplain and floodway areas. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding. In the 1990's when severe floods hit the coastal Orange County over five times, potholes became a constant problem.

Bridges

Bridges are key points of concern during flood events. They are important links in road networks and river crossings and can be obstructions in watercourses, inhibiting the flow of water. A state-designated inspector must inspect all public bridges every two years, looking at everything from seismic capability to erosion and scour. Private bridges, not inspected, can be very dangerous. Five of the highest priority bridges in Orange County are currently being upgraded by replacing earthquake resistant bearing pads.

Storm Water Systems

Local drainage problems are common throughout Orange County. There is a drainage master plan. The Orange County Public Works staff and Orange County cities are aware of local drainage threats. The problems are often present where storm water runoff enters culverts or goes underground into storm sewers. Inadequate maintenance also contributes to the flood hazard in urban areas.

Water/Wastewater Treatment Facilities

There are six sanitary districts in Orange County with sewage treatment facilities located in local jurisdictions. There are 31 water service districts in the County.

Water Quality

Environmental quality problems include bacteria, toxins, and pollution. In early 2002, the California Regional Water Quality Control Board, Santa Ana, and San Diego Regions issued orders under the National Pollution Discharge and Elimination System (NPDES) regarding the regulation of urban storm water. Each jurisdiction, including Orange County must comply. Procedures established assist Orange County Public Works and city staff in implementing NPDES requirements designed for reducing or eliminating the discharge of pollutants into the waters of Orange County because of construction activity. Orange County has invested heavily in efforts to implement a watershed approach to improve known water quality deficiencies. This comprehensive but lengthy planning tool addresses water quality as well as habitat restoration, recreation, and flood control.

Existing Flood Mitigation Activities

Flood mitigation activities include current mitigation programs and activities that are being implemented by Orange County agencies or organizations. County and city engineers work closely together to coordinate mitigation projects.

Orange County Codes

Orange County and Orange County cities use building codes, zoning codes, and various planning strategies to address the goals aimed at restricting development in areas of known hazards, and applying the appropriate safeguards.

Acquisition and Protection of Open Space in the Floodplain

Current efforts to increase public open space in Orange County coupled with the need to restore and preserve natural systems providing a wildlife habitat also help to mitigate flood events. Publicly owned parks and open spaces provide a buffer linking flood hazards and private property.

Riparian Areas
Riparian areas are important transitional areas linking water and land ecosystems. Vegetation in riparian areas is dependent on stream processes and is composed of plants requiring large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion during flood events normally affected by the high water.

Wetlands
Many floodplain and stream-associated wetlands absorb and store storm water flows reducing flood velocities and stream bank erosion. Preserving the wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective in removing nitrogen, phosphorous, heavy metals, and other pollutants from the water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater.

Storm Water Systems
Orange County, the Orange County Flood Control District, and the Cities of Orange County (collectively referred to as Permittees) received their first National Pollutant Discharge Elimination System (NPDES) Permit in 1990 from the Santa Ana Regional Water Quality Control Board. This Permit authorized the discharge of runoff to the municipally owned and operated storm drain system provided pollutants be prevented or minimized to the Maximum Extent Practicable (MEP). Each subsequent NPDES Permit renewal has increased the responsibility of Orange County Permittees to manage runoff entering the storm drain system.

To achieve compliance with NPDES requirements, Orange County Permittees drafted a Drainage Area Management Plan (DAMP) in 1993. The DAMP is updated periodically reflecting the increased requirements of the NPDES Permits. The main objectives of the DAMP are to present a plan that satisfies NPDES permit requirements and to evaluate the impacts of urban storm water discharges on receiving waters.

The DAMP is the principal policy; guidance and reporting document for Orange County Permittees, implemented within each Permittee's jurisdiction as documented within its Local Implementation Plan (LIP).

Flood Management Projects
Flood management structures assist in regulating flood levels by adjusting water flows upstream of flood-prone areas. There are 32 dams in Orange County holding millions of gallons of water in reservoirs. Release of reservoir water is designed to protect the County from floods.

Community Issues Summary
Orange County, it's 34 cities and special districts work to mitigate flood issues as they arise. However, funding, time, and personnel are often unavailable, causing unresolved problems. Areas within the county are more susceptible to flooding issues than others are and have incurred repetitive loss. The Orange County Emergency Management Bureau has documented the problem areas in the community.

The US Army Corps of Engineers (USACE) is engaged in helping Orange County identify problem areas, partnered with property owners to mitigate flooding and associated stream bank issues. However, as the USACE moves away from in-stream stabilization projects, many projects are not maintained. The USACE will continue to assist Orange County in appropriate mitigation projects.

SANTA ANA RIVER HAZARD MITIGATION PROJECT

The Santa Ana River Mainstem Project was designed to provide flood protection to the growing urban communities in Orange, Riverside and San Bernardino Counties. The improvements to the system covered 75 miles, from the headwater of Santa Ana River east of the city of San Bernardino to the mouth of the river at the Pacific Ocean between the cities of Newport Beach and Huntington Beach.

The project increased levels of flood protection to more than 3.35 million people within the three county areas. The project includes seven independent features: Seven Oaks Dam, Mill Creek Levee, San Timoteo Creek, Oak Street Drain, Prado Dam, Santiago Creek and Lower Santa Ana River.

Seven Oaks Dam accounts for about $534 million of the total new estimate $2.09 billion project cost. The Dam is made of 38 million cubic yards of soil, rock and clay that will form ten mostly vertical zones. These zones will help control the water while protecting the integrity of the dam. The pervious material acts as drain-channeling water out of the dam, while zones of impervious material keeps the water out. The Dam is designed to resist an earthquake measuring 8.0 on the Richter

The rapid growth and development of Southern California has decreased effectiveness of the present flood control system. Areas that would absorb rainfall runoff have been reduced as well as the water holding capacities of reservoirs. Today, the most severe flood likely to occur along the river would cover more than 110,000 acres to a depth of three feet and would amount to more than $15 billion in economic losses.

The Santa Ana River Mainstem project is designed to provide flood protection for residences and business in the Southern California communities of Orange, Riverside, and San Bernardino counties. All three counties, collectively, worked closely with the U.S. Army Corps of Engineers to design and construct the project.

The Santa Ana River Mainstem Project (SARP) was initiated in 1964, in partial response to a resolution of the U.S. House Committee on Public Works adopted May 8, 1964. A survey report was completed by the District in 1975. The report was reviewed and then submitted to Congress in September 1978.

In September 1980, the Corps of Engineers completed the Phase I General Design Memorandum (GDM) for the Santa Ana Mainstem. Construction of the SARP was authorized by Section 401(a) of the Water Resources Development Act of 1986. Construction of SARP was initiated in 1989, and completion is scheduled for 2010.

LOWER SANTA ANA RIVER SECTION

The Lower Santa Ana River project cost $367 million dollars, was started in 1991 and completed in 2006. The Federal Government paid 70%; Orange County 27%; San Bernardino County 1.71%; and Riverside County .73% of the three part project (Seven Oaks Dam, Prado

Dam and Lower Santa Ana River).

Improvements to 23 miles of existing channel from Weir Canyon Road to the Pacific Ocean include channel widening, improvement to the existing Greenville-Banning Channel located parallel to the river near the coast, relocation of Talbert Channel ocean outlet and construction of rock jetties and derrick stone jetties at the mouth of the river, and bridge modifications to accommodate the widened channel. In the Santa Ana Canyon area, construction will be limited to levee extension and a dike to protect a mobile home park.

The construction in the Santa Ana Canyon Area also include the bank protection on the south side along the SR-91 (upstream of SAVI Ranch) and on the north side upstream of Weir Canyon Road.

Lower Santa Ana River Project Features

- Improve 23 mile channel from Prado Dam to the Pacific Ocean
- Restore/Enhance 92 acre (8-acre mitigation) wetlands
- Estimated Cost: $367 million
- Acquire 1,123 acres of canyon lands to ensure safe releases from Prado Dam and provide open space habitat
- Relocate 60 various utility lines and 15 oil wells/lines
- Modify 37 bridges
- Landscaping and esthetic treatment
- Sucker Fish Conservation Program
- Habitat Management Plan
- Cooperation with the SARI proponents

Local Cooperation Agreement

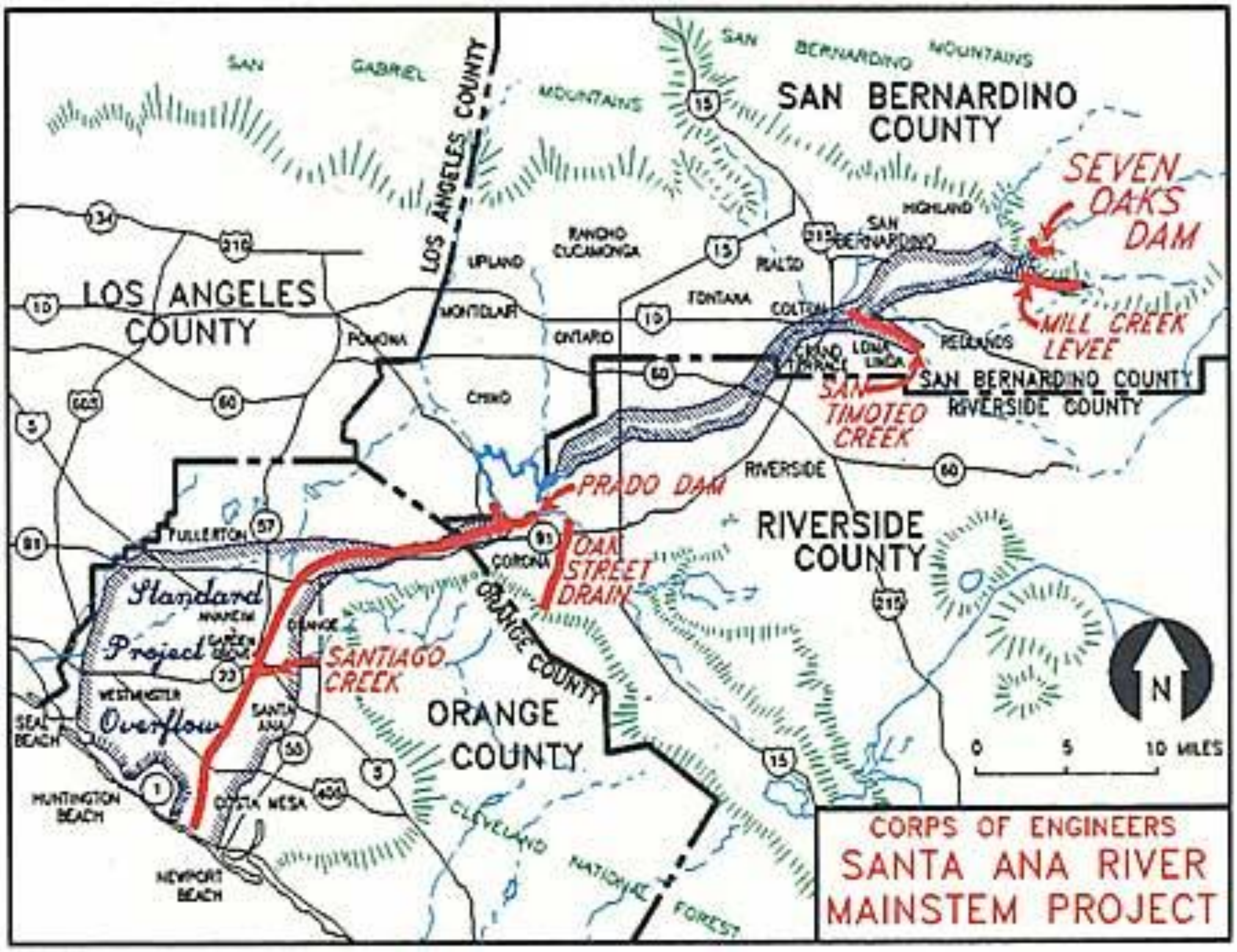
On December 14, 1989, the U.S. Army Corps of Engineers (COE) and the County Flood Control District of Orange, Riverside and San Bernardino as Local Sponsors, entered into a four party Local Cooperation Agreement (LCA) defining the responsibilities and cost-sharing of each party for each feature.

The Local Sponsors are to acquire all lands, easements, rights-of-way and perform relocations required to make way for construction of the Mainstem Project. The COE will construct the improvements. On completion, the Local Sponsors are responsible for the operation and maintenance of the Project features; except for Prado Dam where Orange County is responsible to pay for incremental operations/maintenance costs and the COE will continue to operate the Dam.

Congress authorized Santa Ana River Mainstem Project for construction in 1986 under new guidelines for cost sharing of water resources projects between Federal and local governments. The local sponsors must pay between 25% and 50% of total cost of the project with the remaining cost provided by the Federal government.

In 2003, a new agreement was entered between the Corps of Engineers and Orange County Flood Control District where Prado Dam feature of the Santa Ana Mainstem Project was separated and Orange County was a sole local sponsor for Prado Dam.

Figure 8 - Santa Ana River Mainstem Project

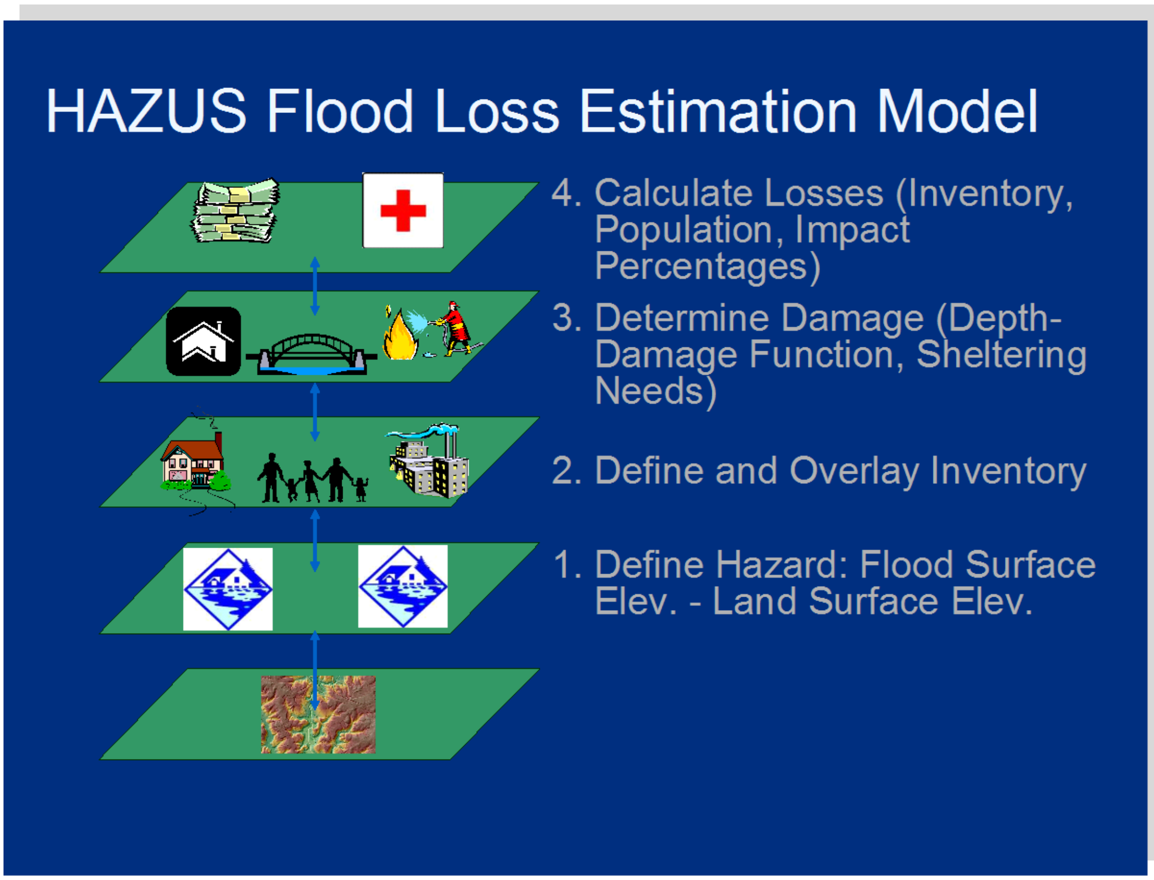


COUNTY OF ORANGE & OCFA HAZARD MITIGATION PLAN

D. Orange County Hazus Flood Study

HAZUS FLOOD LOSS ESTIMATION MODEL

Orange County completed a HAZUS Flood Loss Estimate to help define the potential flood loss in Orange County from both 100 and 500 year floods. . The flood risk assessment has been conducted using HAZUS - FEMA's GIS-based nationally applicable hazard risk assessment software.



FEMA

GENERAL BUILDING STOCK

HAZUS estimates that there are 738,000 buildings in the region which have an aggregate total replacement value of 247,000 million (2006 dollars). The tables below present the relative distribution of the value with respect to the general occupancies by Orange County Study Region and Scenario respectively.

Table 6 – Building Exposure by Occupancy Type for Study Region & Scenario

Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	189,774,227	76.7%
Commercial	41,092,855	16.6%
Industrial	11,227,549	4.5%
Agricultural	401,767	0.2%
Religion	2,370,944	1.0%
Government	602,072	0.2%
Education	1,835,325	0.7%
Total	**247,304,739**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Scenario

Occupancy	Exposure ($1000)	Percent of Total
Residential	41,132,313	74.6%
Commercial	9,712,308	17.6%
Industrial	3,135,431	5.7%
Agricultural	95,599	0.2%
Religion	528,509	1.0%
Government	157,241	0.3%
Education	407,177	0.7%
Total	**55,168,578**	**100.00%**

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

The "education" buildings are 0.7% of the building stock. For the Study Region there is $1.8 billion in exposure and for the Flood Scenarios there is just over $400 million exposure.

Essential Facility Inventory (including schools):
For essential facilities, there are 157 hospitals in the region with a total bed capacity of 6,317 beds. There are 5,733 schools, 139 fire stations, 67 police stations and 38 emergency operations centers.

HAZUS estimates that about 9,719 buildings will be at least moderately damaged. This is over 28% of the total number of buildings in the scenario. There are an estimated 211 buildings that will be completely destroyed. The table below summarizes the expected damage by general building type.

Table 7 - Expected Building Damage by Occupancy and Building Type

Table 3: Expected Building Damage by Occupancy

Occupancy	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	45	39.13	52	45.22	17	14.78	0	0.00	1	0.87	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	9	75.00	1	8.33	1	8.33	0	0.00	0	0.00	1	8.33
Religion	1	50.00	1	50.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	116	1.19	1,909	19.56	5,473	56.07	241	2.47	1,812	18.56	210	2.15
Total	**173**		**1,963**		**5,491**		**241**		**1,813**		**211**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10 Count	1-10 (%)	11-20 Count	11-20 (%)	21-30 Count	21-30 (%)	31-40 Count	31-40 (%)	41-50 Count	41-50 (%)	Substantially Count	Substantially (%)
Concrete	14	37.84	18	48.65	4	10.81	0	0.00	1	2.70	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	1,003	85.65	168	14.35
Masonry	11	26.83	23	56.10	5	12.20	0	0.00	2	4.88	0	0.00
Steel	10	37.04	12	44.44	4	14.81	0	0.00	1	3.70	0	0.00
Wood	116	1.36	1,861	21.84	5,464	64.12	239	2.80	800	9.39	42	0.49

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities: At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	139	5	0	4
Hospitals	157	1	0	0
Police Stations	67	4	0	2
Schools	5,733	148	0	69

If this report displays all zeros or is blank, two possibilities can explain this.

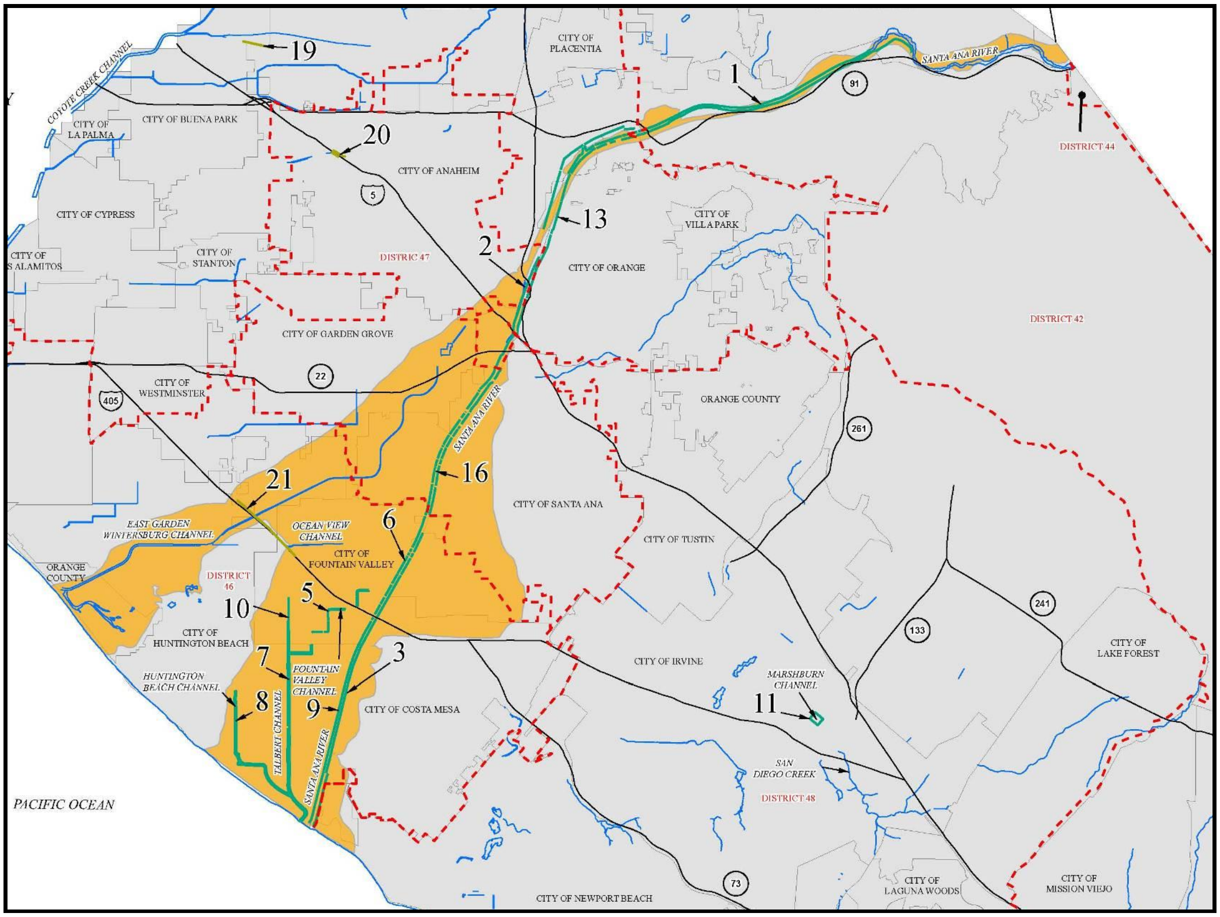
(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Out of the 5,733 school buildings in Orange County, 148 are expected to have at least moderate damage. None are expected to have substantial damage.

Figure 9 - Orange County Levee System Protected Areas



COUNTY OF ORANGE AND OCFA HAZARD MITIGATION PLAN

HAZUS estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. HAZUS also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 52,692 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these 144,893 people will seek temporary shelter in public shelters.

This is a double hit to schools since their sites are utilized as public shelters. School Districts have to deal with both the repairs of their sites as well as the up to 144,893 people living in the schools because they have no other place to go. Typically 10% of the population relies on public shelters. Others go to family, friends and hotels or out of the area. That means that schools should plan for 14,400 individuals. With an average high school gymnasium holding around 400 people, RSCCD may be needed to shelter these victims.

Orange County Hazard Mitigation Committee conducted a study with three different scenarios. The following scenarios will help the reader understand the flood impact on Orange County.

SCENARIO #1 - 100-YEAR FLOOD (LEVEES INTACT)

Table 8 - Summary of Impacts due to 100-Year Flood (Levees Intact)

Impact Category	HAZUS®MH-Estimated Impact
Economic Loss due to Building Damage Total Building-related Direct Economic Loss	\$1.1 B \$2.3 B
# Buildings in Complete Damage State	211
Debris Generated (million tons)	0.24
Displaced Households People Needing Short-term Shelter	52,692 Households 144,893 People
# Highway Bridges w/ at least Moderate Damage (potentially closed)	0

County of Orange and OCFA Hazard Mitigation Plan

In a 1% annual chance flood event (100-year flood) in the county, direct economic losses due to building damage are estimated to reach \$1.1 billion and total building direct economic losses are expected to reach \$2.3 billion. The geographic distribution of total direct economic loss is mapped below. Note that while the total direct economic losses for this flood scenario are roughly 3.6 to 6 times lower that the earthquake scenarios examined, the recurrence period for this flood hazard is 10 to 25 more frequent.

Of the approximately 738,000 buildings modeled within the general building stock for Orange County, much less than 1% (211) are expected to suffer “Complete” damage in the 1% annual chance flood event (100-year flood) scenario. These building would be considered “red-tagged” or unsafe for continued occupancy. Almost three-fourths of the 211 buildings are manufactured housing (i.e., mobile homes). Approximately 7,700 buildings (1%) are expected to suffer more than 20% damage or more, while about 2,100 buildings are estimated to suffer flood damage of less than 20%. As much as 0.24 million tons of debris may result from these damaged buildings and 25% is expected to be heavy debris (concrete and steel), requiring heavy equipment to break down and remove, while 75% is expected to be light debris (wood, brick, drywall and other debris).

Damage to single family and multi-family dwellings is expected to result in the displacement of almost 53,000 households. While many of the displaced may find shelter with friends and family, or in available hotels, as many as 145,000 people are expected to seek short-term public shelter. This large number of people could tax the emergency sheltering capacity of the county. Displaced populace should be able to move to safe locations without too much difficulty. While 4 bridges in the county’s transportation system are expected to suffer minor flood damage, the bridges are expected to remain operational.

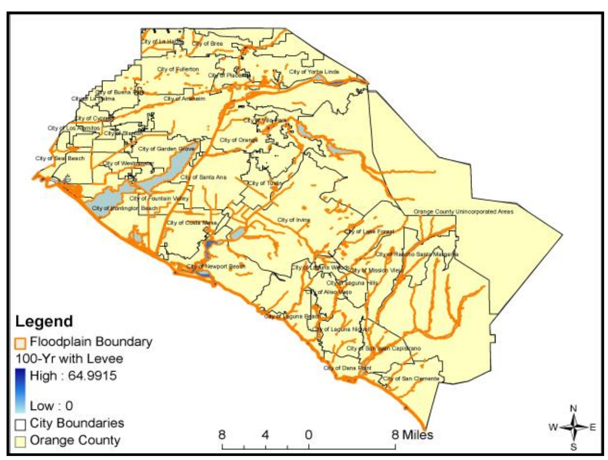


Figure 10 – 100-Year Flood Event Floodplain and Depth Grid

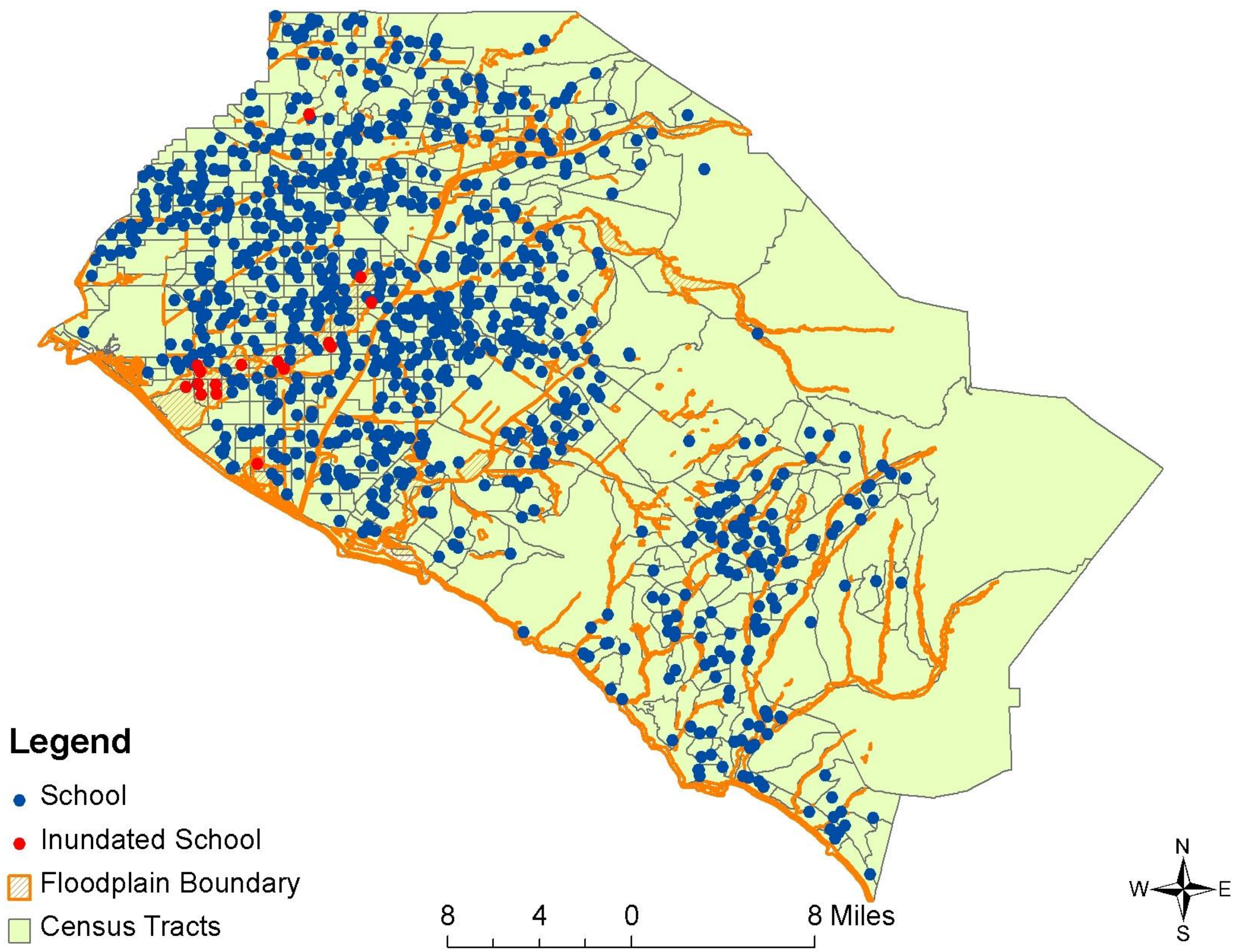
Table 9 - Impacts OC School Districts 100-Year Flood (Levees Intact)

Category	District Name	Number of Facilities/ Sites*	No. of Buildings	Replacement Cost ($1,000)	# Buildings w/ replacement cost data	# Non-Functional Buildings	Restoration Time (Days)	Mean Damage	Economic Loss ($1,000)
K-12 (default data)		560	569	$335,710	569	0	480	5.0%	$207
K-12 (providing data)	Brea Olinda USD	11	118	$83,802	117	0	0	0.0%	$0
	Capistrano USD	60	1,035	$387,399	1,029	0	0	0.0%	$0
	Fullerton Joint UHSD	12	156	$219,752	156	0	480	7.0%	$2,222
	Fullerton SD	22	267	$121,646	267	0	0	0.0%	$0
	Huntington Bch SD	15	176	$115,876	176	11	360-480	5.0%	$407
	Huntington Bch UHSD	9	163	$237,697	163	0	0	0.0%	$0
	Laguna Beach USD	7	54	$60,212	54	0	0	0.0%	$0
	Newport-Mesa USD	36	518	$402,503	518	0	0	0.0%	$0
	Ocean View SD	24	238	$149,274	238	58	360-480	5.0%	$2,973
	Orange Co DOE	33	180	$54,255	75	0	0	0.0%	$0
	Plac-Yorba Linda USD	30	641	$292,554	641	0	0	0.0%	$0
	Santa Ana USD	57	1,046	$623,817	1,046	0	0	0.0%	$0
	Tustin USD	30	360	$234,841	360	0	0	0.0%	$0
CCD (providing data)	North Orange Co CCD	7	90	$304,134	90	0	0	0.0%	$0
	Rancho Santiago CCD	15	122	$157,542	117	0	0	0.0%	$0
TOTALS		**928**	**5,733**	**$3,781,014**	**5,616**	**69**	**360-480**	**5.5%**	**$5,809**

COUNTY OF ORANGE AND OCFA HAZARD MITIGATION PLAN

Note: the RSCCD data displayed on this table was from a previous Insurance Report

Figure 11 - OC School Districts Functionality – 100-Year Flood (Levees Intact)



SCENARIO 2 – 100-YEAR (WITHOUT LEVEES)

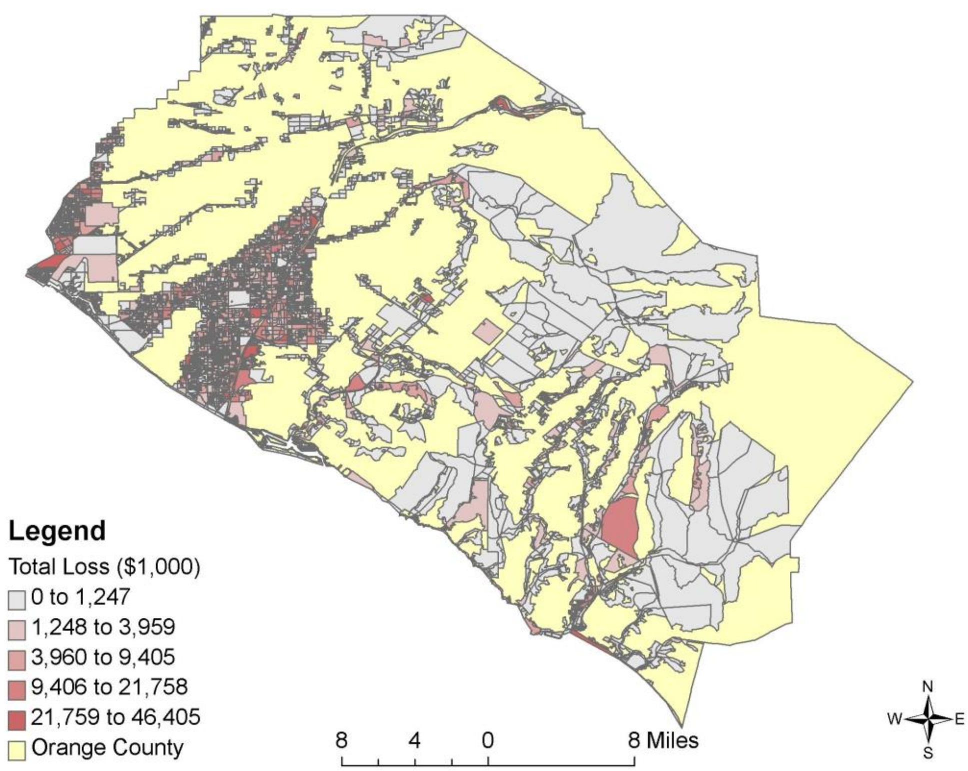
Table 10 - Summary Impacts for OC due to a 100-Year Flood

Impact Category	HAZUS®MH-Estimated Impact
Economic Loss due to Building Damage Total Building-related Direct Economic Loss	\$3.3 B \$6.9 B
# Buildings in Complete Damage State	1,394
Debris Generated (million tons)	0.76
Displaced Households People Needing Short-term Shelter	160,653 Households 463,751 People
# Highway Bridges w/ at least Moderate Damage (potentially closed)	0

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

In a 100-year flood in the county, direct economic losses due to flood building damage are estimated to reach \$3.3 billion and total building direct economic losses are expected to reach \$6.9 billion. The geographic distribution of total direct economic loss is mapped in Figure 12. In this more severe flooding scenario, total direct economic flood losses are much on par with the earthquake scenario losses estimated (roughly 30% to 80% lower).

Figure 12 - Total Direct Economic Loss – 100-Year Flood



ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Of the approximately 738,000 buildings modeled within the general building stock for Orange County, about 0.2% (1394) are expected to suffer "Complete" damage in the 100-Year without levee flood scenario. These building would be considered "red-tagged" or unsafe for continued occupancy. Almost three-fourths of the 1,394 buildings are manufactured housing (i.e., mobile homes). Approximately 27,000 buildings (3.6%) are expected to suffer more than 20% damage or more while about 8,100 buildings are estimated to suffer flood damage of less than 20%. As much as 0.76 million tons of debris may result from these damaged buildings – 21% is expected to be heavy debris (concrete and steel), requiring heavy equipment to break down and remove, while 79% is expected to be light debris (wood, brick, drywall and other debris).

Damage to single family and multi-family dwellings is expected to result in the displacement of almost 161,000 households. While many of the displaced may find shelter with friends and family, or in available hotels, as many as 464,000 people are expected to seek short-term public shelter. This large number of people would likely overwhelm the emergency sheltering capacity of the county. Displaced populace should be able to move to safe locations without too much difficulty. While 6 bridges in the county's transportation system are expected to suffer minor flood damage, the bridges are expected to remain functional.

Table 11 - Essential Facility Loss Estimates – 100-Year Flood

Essential Facility	Category	No. of Facilities /Sites	No. of Bldgs	No. of Beds	Replace-ment Cost ($1,000)	# Builds w/ Replace-ment Cost Data	# Non-Function-al Bldgs	Time to Restore Days	Economic Loss ($1,000)
Hospital	Small	2	3	78	$0	0	0	0	$0
	Medium	10	33	1,018	$50,000	7	6	540	$0
	Large	20	121	5,221	$677,998	12	10	360-900	$0
Schools	K-12 (default data)	560	569		$335,710	569	0	480-630	$832
	K-12 (providing data)	346	4,952		$2,983,628	4,840	155	360-720	$29,370
	CCD providing data	22	212		$461,676	207	0	480	$3,432
EOCs		38	38		$368,079	38	5	0-630	$4,015
Police Stations		67	67		$770,105	67	8	0-630	$5,194
Fire Stations		139	139		$316,580	135	8	360-900	$2,044
TOTALS		**1,204**	**6,134**	**6,317**	**$5,963,776**	**5,875**	**192**	**0-900**	**$44,887**

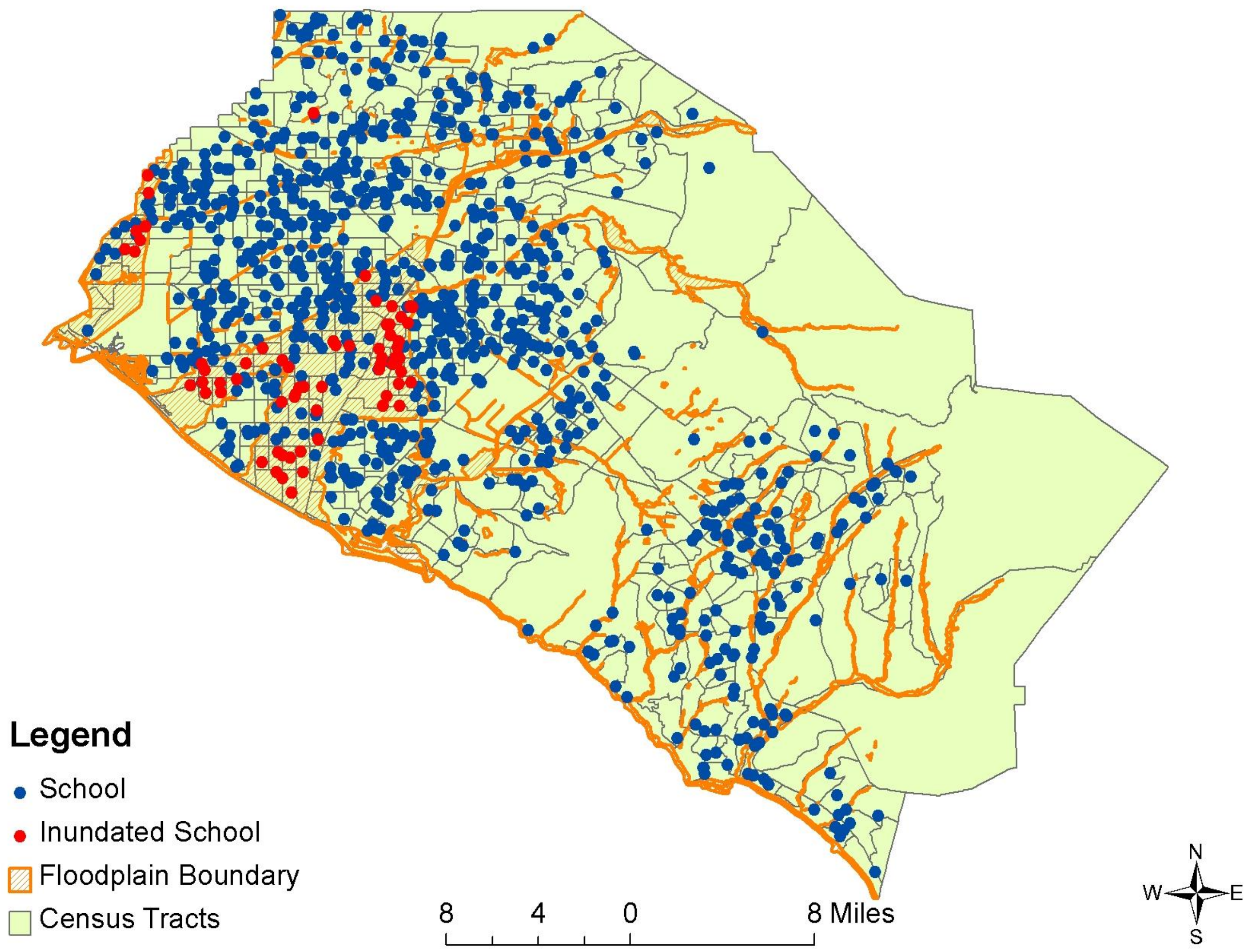
ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Table 12 - Impacts on OC Schools Districts – 100-Year Flood

Category	District Name	Number of Facilities/ Sites*	No. of Buildings	Replacement Cost ($1,000)	# Buildings w/ replacement cost data	# Non-Functional Buildings	Restoration Time (Days)	Mean Damage	Economic Loss ($1,000)
K-12 (default data)		560	569	$335,710	569	0	480-630	5.4%	$832
K-12 (providing data)	Brea Olinda USD	11	118	$83,802	117	0	0	0.0%	$0
	Capistrano USD	60	1,035	$387,399	1,029	0	0	0.0%	$0
	Fullerton Joint UHSD	12	156	$219,752	156	0	480	7.0%	$2,222
	Fullerton SD	22	267	$121,646	267	0	0	0.0%	$0
	Huntington Bch SD	15	176	$115,876	176	64	360-480	5.5%	$3,076
	Huntington Bch UHSD	9	163	$237,697	163	18	360-720	10.4%	$10,947
	Laguna Beach USD	7	54	$60,212	54	0	0	0.0%	$0
	Newport-Mesa USD	36	518	$402,503	518	0	0	0.0%	$0
	Ocean View SD	24	238	$149,274	238	69	360-480	5.3%	$3,238
	Orange Co DOE	33	180	$54,255	75	4	360	0.0%	$0
	Plac-Yorba Linda USD	30	641	$292,554	641	0	0	0.0%	$0
	Santa Ana USD	57	1,046	$623,817	1,046	0	480	5.3%	$9,887
	Tustin USD	30	360	$234,841	360	0	0	0.0%	$0
CCD (providing data)	North Orange Co CCD	7	90	$304,134	90	0	0	0.0%	$0
	Rancho Santiago CCD	15	122	$157,542	117	0	480	6.3%	$3,432
TOTALS		**928**	**5,733**	**$3,781,014**	**5,616**	**155**	**360-720**	**6.5%**	**$33,634**

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Figure 13 - OC School Districts Functionality following – 100-Year Flood



ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

SCENARIO #3 – 500-YEAR FLOOD (WITHOUT LEVEES)

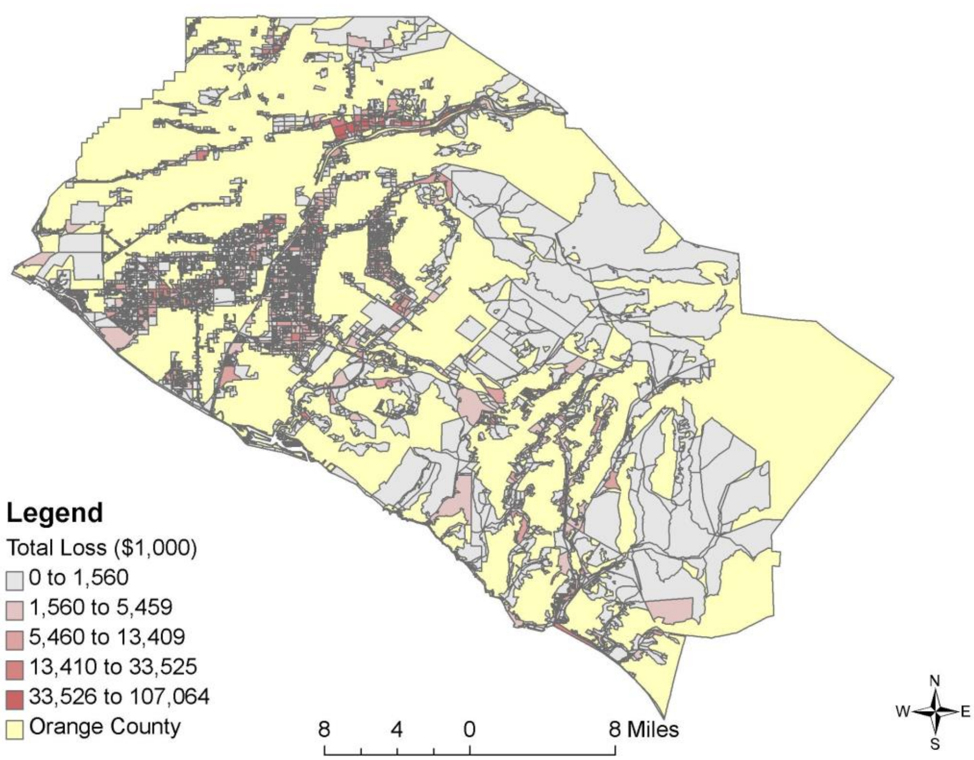
Table 13 - Summary Impacts for 500-Year Flood (Levees Intact)

Impact Category	HAZUS®MH-Estimated Impact
Economic Loss due to Building Damage Total Building-related Direct Economic Loss	\$3.7 B \$8.8 B
# Buildings in Complete Damage State	2,048
Debris Generated (million tons)	0.85
Displaced Households People Needing Short-term Shelter	159,474 Households 458,535 People
# Highway Bridges w/ at least Moderate Damage (potentially closed)	0

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

In a 0.2% annual chance flood event or 500-Year Flood in the county, direct economic losses due to flood building damage are estimated to reach \$3.7 billion and total building direct economic losses are expected to reach \$8.8 billion. The geographic distribution of total direct economic loss is mapped in Figure 13. Note that while the total direct economic losses for this flood scenario are roughly equivalent to the M6.9 Newport-Inglewood Fault Scenario modeled. However, this earthquake has an estimated return interval of 1000 years, twice as long as the return period of this flood.

Figure 14 - Total Direct Economic Loss 500-Year Flood



ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

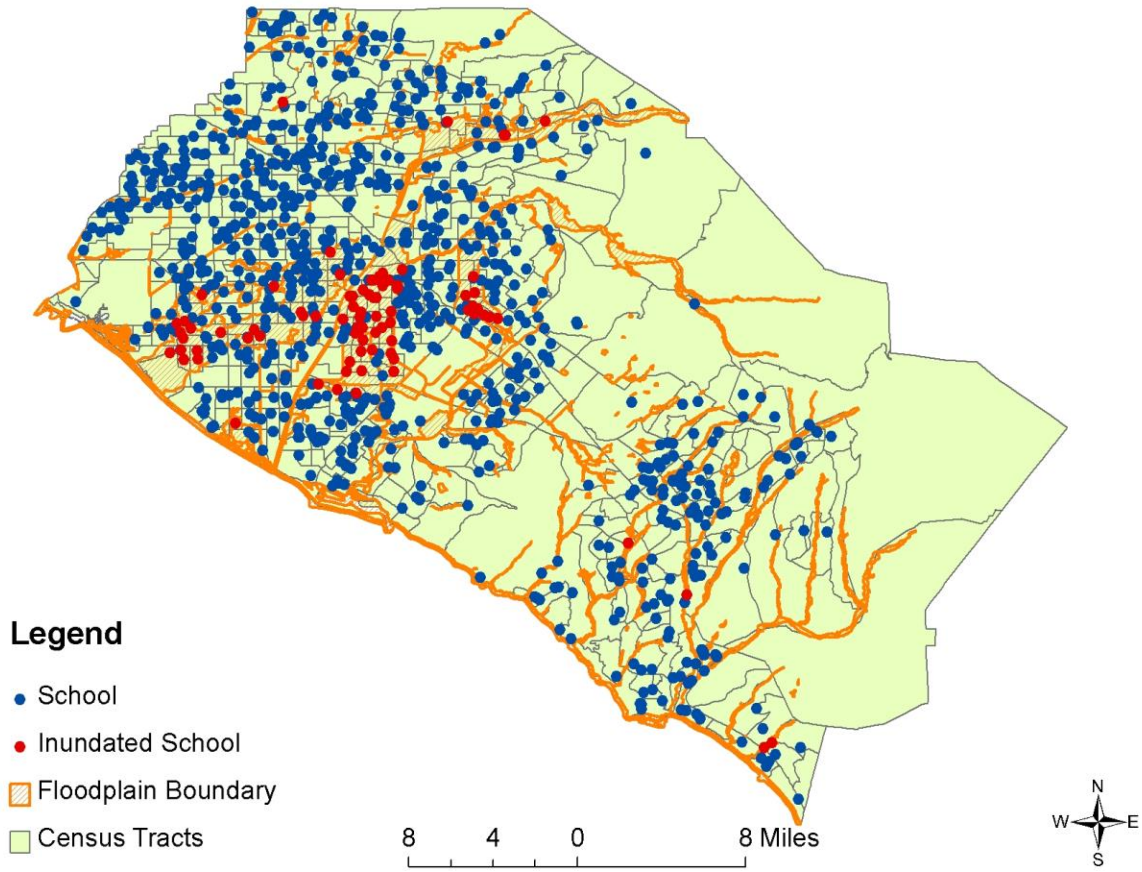
Table 14 - Impacts on OC School Districts - 500-Year Flood (Levees Intact)

Category	District Name	Number of Facilities/ Sites*	No. of Buildings	Replacement Cost ($1,000)	# Buildings w/ replacement cost data	# Non-Functional Buildings	Restoration Time (Days)	Mean Damage	Economic Loss ($1,000)
K-12 (default data)		560	569	$335,710	569	4	480-720	4.7%	$994
K-12 (providing data)	Brea Olinda USD	11	118	$83,802	117	0	0	0.0%	$0
	Capistrano USD	60	1,035	$387,399	1,029	14	360-720	5.2%	$5,065
	Fullerton Joint UHSD	12	156	$219,752	156	0	480	7.0%	$2,222
	Fullerton SD	22	267	$121,646	267	0	0	0.0%	$0
	Huntington Bch SD	15	176	$115,876	176	0	480	4.3%	$778
	Huntington Bch UHSD	9	163	$237,697	163	13	360-630	4.3%	$5,689
	Laguna Beach USD	7	54	$60,212	54	0	0	0.0%	$0
	Newport-Mesa USD	36	518	$402,503	518	25	360-480	5.0%	$625
	Ocean View SD	24	238	$149,274	238	84	360-630	4.3%	$3,247
	Orange Co DOE	33	180	$54,255	75	0	0	0.0%	$0
	Placentia-Yorba Linda USD	30	641	$292,554	641	8	360-720	4.7%	$1,424
	Santa Ana USD	57	1,046	$623,817	1,046	0	480	5.0%	$16,407
	Tustin USD	30	360	$234,841	360	59	360-480	5.0%	$2,750
CCD (providing data)	North Orange Co CCD	7	90	$304,134	90	0	0	0.0%	$0
	Rancho Santiago CCD*	15	122	$157,542	117	0	480	5.0%	$3,060
TOTALS		**928**	**5,733**	**$3,781,014**	**5,616**	**207**	**360-720**	**5.0%**	**$42,261**

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

*Based on past insurance data

Figure 15 - School Districts Functionality following – 500-Year (Levees Intact)



ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

Table 15 - Summary of Impacts on Orange County for Three Flood Scenarios

Impact Category	*100-Year*	*100-Year w/o Levee*	*500-Year*
Economic Loss due to Building Damage Total Building-related Direct Economic Loss	$1.1 B $2.3 B	$3.3 B $6.9 B	$3.7 B $8.8 B
# Buildings in Complete Damage State	211	1,394	2,048
Debris Generated (million tons)	0.24	0.76	0.85
Displaced Households People Needing Short-term Shelter	52,692 Households 144,893 People	160,653 Households 463,751 People	159,474 Households 458,535 People
# Highway Bridges w/ at least Moderate Damage (potentially closed)	0	0	0

ORANGE COUNTY ESSENTIAL FACILITIES RISK ASSESSMENT REPORT PREPARED FOR FEMA

E. THE RSCCD FLOOD THREAT STUDY BY MMI ENGINEERING

The only known flood financial damage to a RSCCD property is the following incident:

Table 16: RSCCD Flood History

Date	Location	Type of Damage	Details (from insurance records)	Costs
11/25/2008	Santiago Canyon College	Rain, flooding and mud	Rain caused flooding and mud at SCC buildings	$51,777

To support the development of a Hazard Mitigation Plan (HMP) for the Rancho Santiago Community College District (RSCCD), MMI Engineering (MMI) conducted a flood risk assessment on District facilities.

Orange County Hazard Mitigation Committee conducted a study with three different scenarios. MMI Engineering conducted a HAZUS study using two scenarios. The data used for the Orange County FEMA study referenced in the County Hazard Mitigation Plan was more detailed than the MMI Engineering default analysis. In that analysis, the DFIRM data was reformatted for use in Hazus. Bearing in mind that the two analyses do not use the exact same input data, and that the MMI Engineering study uses a default Hazus analysis, the closest analog of MMI Engineering study is the Orange County 100 year flood scenario is their Scenario #2, without levees. The losses would change if the levees were intact.

Building data provided by the District that had been categorized and geocoded (i.e., latitude and longitude have been determined) for use in the hazard identification and earthquake risk assessment processes have been re-evaluated for use in the flood risk assessment. The flood risk assessment has been conducted using HAZUS - FEMA's GIS-based nationally applicable earthquake, flood and hurricane risk assessment software. This section describes the facility data used in the flood assessment, discusses the flood hazards as modeled in the risk assessment, and summarizes the flood risk assessment results from the MMI Engineering study.

Table 17: Summary of RSCCD Building Data Considered in the Study

Site	No. of Buildings	Peak Daytime Occupancy (No. of People)	Building Area (Square Feet)	2015 Building Replacement Value ($1,000)	2015 Content Replacement Value ($1,000)
Centennial Education Center (CEC)	15	1,809	49,263	8,008	1,352
Digital Media Center (DMC)	1	283	28,184	6,877	3,049
District Office (DO)	1	399	61,002	14,744	1,895
Orange County Sheriff's Regional Training (OCSRT)	2	305	52,455	13,547	2,121
Orange Education Center (OEC)	1	1,600	84,404	17,609	0
Santa Ana College (SAC)	76	14,925	599,107	136,298	30,010
Santiago Canyon College (SCC)	50	9,513	406,026	103,223	25,323
TOTAL	146	28,834	1,280,441	300,306	63,750

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These building data were used in the hazard identification process, and to execute both the Hazus earthquake and flood risk assessments. The 146 buildings represent more than $300 million in building replacement value, more than $63 million in building contents value, and house more than 28,800 people during peak daytime occupancy.

Flood Hazard Identification

Flood hazard zones are delineated by the Federal Emergency Management Agency (FEMA) and distributed as the National Flood Hazard Layer (NFHL). The NFHL is a digital database that contains flood hazard mapping data from FEMA's National Flood Insurance Program (NFIP). The map data are derived from Flood Insurance Rate Map (FIRM) databases and Letters of Map Revision (LOMRs). The NFHL is GIS data for community officials and community members looking to view effective regulatory flood hazard information. Flood hazard zones for Orange County are shown in Figure 13, and for RSCCD facilities in Figure 14. Table 19 provides a summary of facility exposure, by site, to the regulatory flood hazards as mapped by FEMA.

Areas subject to inundation in the 100-Year Flood are identified on the FEMA maps as "special flood hazard areas". The 100-Year Flood has a 1% chance (one out of 100) of occurring in any given year. Similarly, there is a 0.2% annual chance (one out of 500) of the 500-Year Flood occurring in any given year. As shown in the figures and Tables 17 and 18, one RSCCD site, (the Digital Media Center) is located within the mapped 500-Year) flood zone. Three sites (the District Office, Orange Education Center and Santa Ana College) are located in an area expected to be inundated in the 500-Year flood, but are protected from the 100-Year Flood by levees. One additional site (the Centennial Education Center) is located within a mapped area of undetermined flood hazard.

Figure 16: FEMA Flood Hazard Zones for Orange County

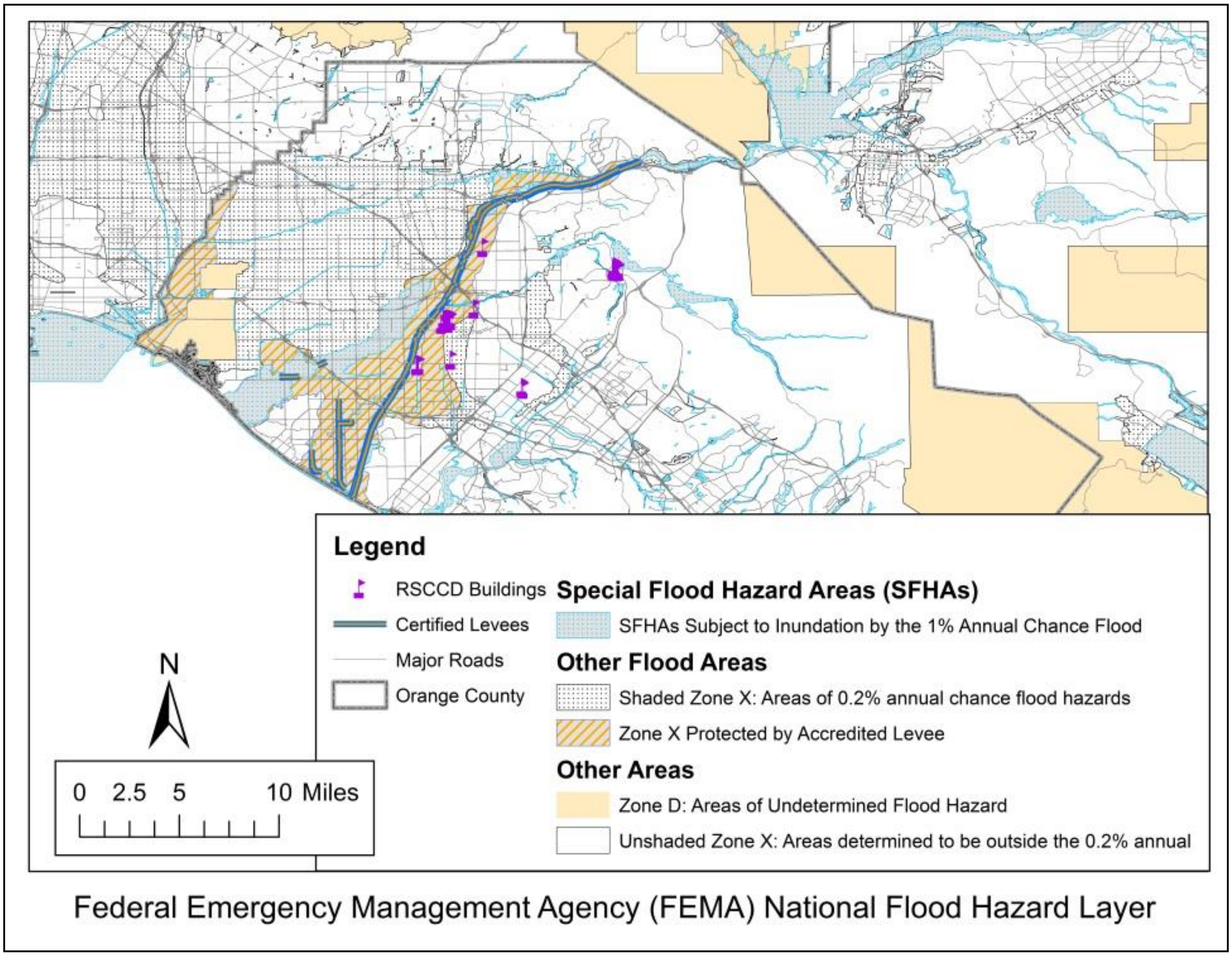
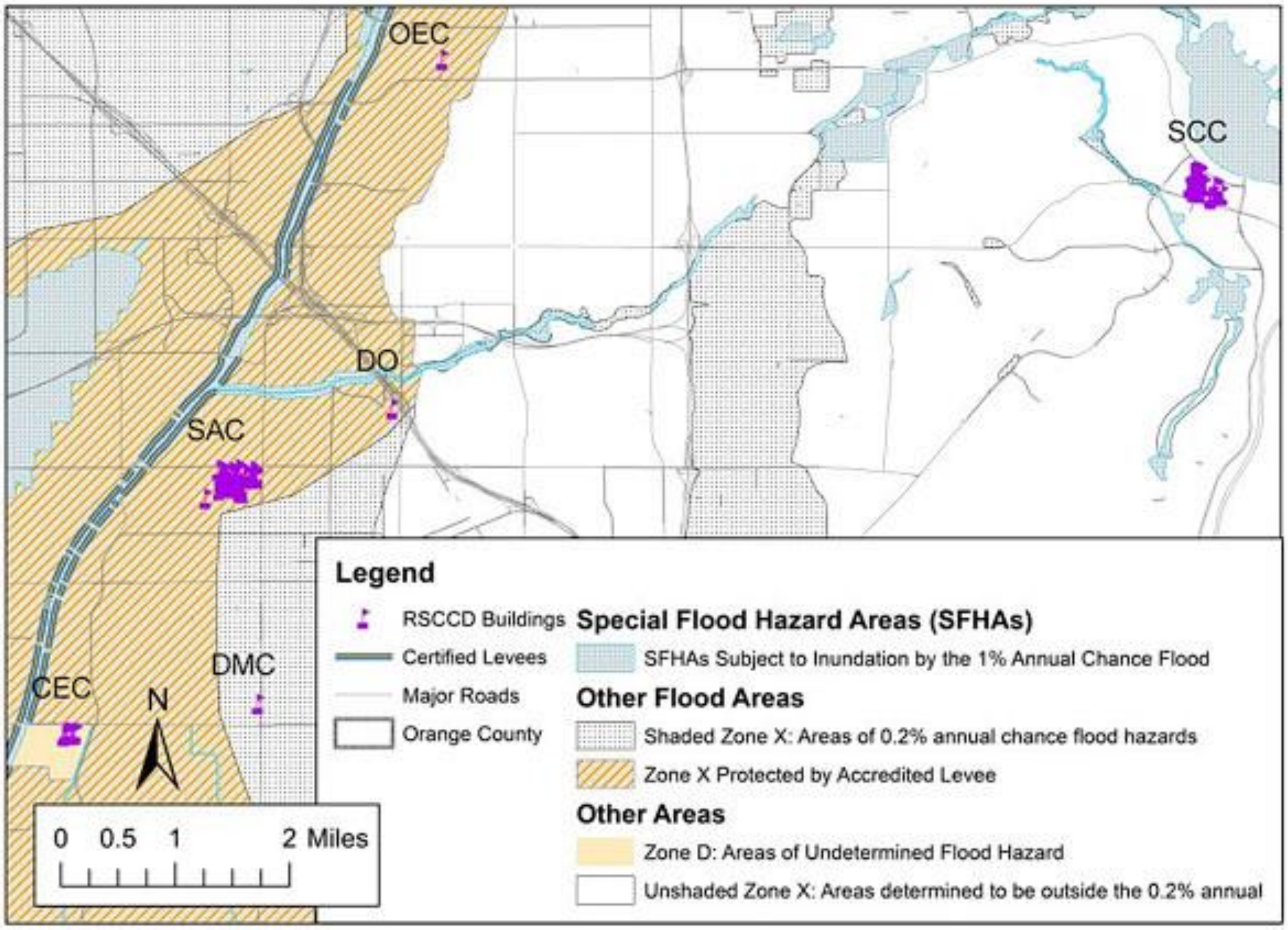


Figure 17: FEMA Flood Hazard Zones for RSCCD Facilities



Federal Emergency Management Agency (FEMA) National Flood Hazard Layer

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Table 18: Summary of RSCCD Building Exposure to Mapped Flood Hazards

Flood Hazard	Site	Centennial Education Center	Digital Media Center	District Office	Orange County Sheriff's Regional Training	Orange Educ. Center	Santa Ana College	Santiago Canyon College	Total
	Total Number of Buildings	15	1	1	2	1	76	50	146
Special Flood Hazard Areas Subject to Inundation by the 1% Annual Chance (100-year) Flood	Zone A - no base flood elevations determined	0	0	0	0	0	0	0	0
	Zone AE - base flood elevations determined	0	0	0	0	0	0	0	0
	Zone AH - Flood depths of 1 - 3 feet (usually areas of ponding); base flood elevations determined	0	0	0	0	0	0	0	0
	Zone AO - Flood depths of 1 - 3 feet (usually sheet flow on sloping terrain); average depths determined.	0	0	0	0	0	0	0	0
Other flood areas	Zone X (Shaded) - areas of 0.2% annual chance (500 yr.) flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile.	0	1	0	0	0	0	0	1
	Zone X Protected by Levee - areas protected by levees from the 1% annual chance flood	0	0	1	0	1	76	0	78
Other Areas	Zone D - areas in which flood hazards are undetermined, but possible	15	0	0	0	0	0	0	15
	Zone X (Unshaded) - areas determined to be outside the 0.2% annual chance (500-year) floodplain	0	0	0	2	0	0	50	52

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Table 19: RSCCD Site Impact Results

Site	Address	Impact
Digital Media Center	1300 South Bristol SA	500-Year Flood Zone
District Office	2323 N. Broadway SA	500-Year Inundation Area/Protected from the 100-Year Flood by Levees
Orange Education Center	1465 N. Batavia Orange	500-Year Inundation Area/Protected from the 100-Year Flood by Levees
Santa Ana College	1530 W. 17th St. SA	500-Year Inundation Area/Protected from the 100-Year Flood by Levees
Centennial Education Center	2900 W. Edinger SA	Located within a mapped area of undetermined flood hazard

Flood hazards, as determined by Hazus, are developed independently of the FIRM data mapped in the NFHL. Hazus was not intended for regulatory use, but to produce loss and damage estimates for use in planning and preparedness. Further, Hazus does not include data on the location of existing levees and their accreditation. If levees are not captured in the publicly-available Digital Elevation Model (DEM) data used by Hazus to develop flood depth data, the levees will not be explicitly considered in the Hazus flood depth analysis. This is of particular interest for the current study, as the District Office, the Orange Education Center, and Santa Ana College are all located within an area assumed to be protected from the 100-Year flood by levees ("Zone X Protected by Levee - areas protected by levees from the 100-Year Flood see Figure 14). Accordingly, any losses estimated for these facilities by Hazus under the

100-Year flood would be considered worst case (i.e., levee failure) losses.

Hazus' built-in (default) flood modeling capabilities have been utilized to develop maps of potential flood depths for the one percent annual chance (100-Year) flood, shown in Figures 15 and 16 for Orange County and in the vicinity of RSCCD facilities, respectively, and the 0.2 percent annual chance (500-Year) flood, shown in Figures 17 and 18. The most significant differences between the 100 and 500-Year flood depth maps occur along the San Gabriel River and its tributaries in northwestern Orange County. The differences are less noticeable for the Santa Ana River, to which the RSCCD facilities are closer. In some locations, Hazus predicts that the 500-Year flood would have a wider footprint than the 100-Year flood, but shallower predicted flooding. It should be noted that while this default Hazus analysis was conducted using best-available data, damage patterns in an actual flood event will be different. Lack of damage in the two modeled events should not be taken to mean that a facility will not experience some flood damage during its useful lifetime.

Figure 18: HAZUS Estimated Flood Depths for the Orange County 100-Year Flood

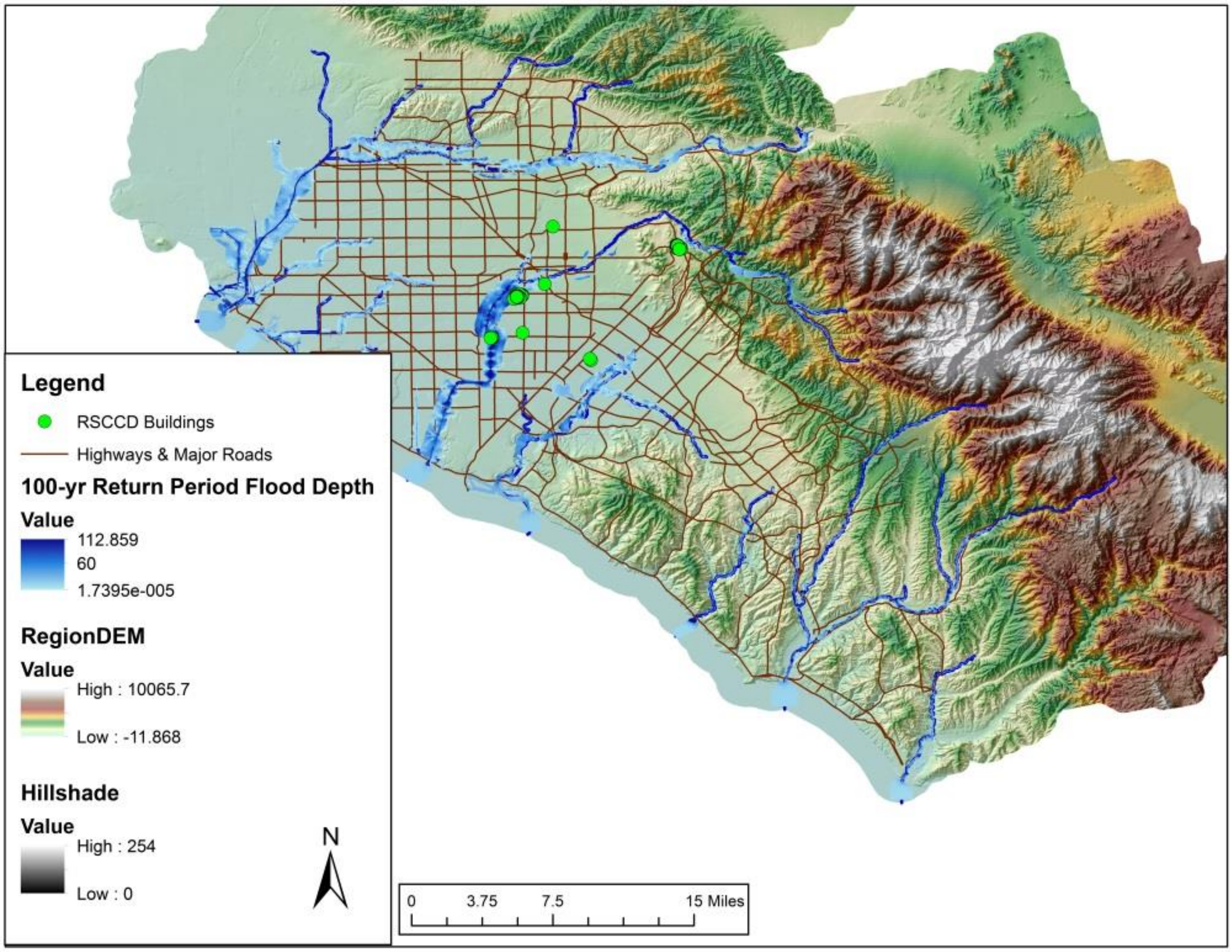

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Figure 19: HAZUS-Estimated Flood Depths for the 100-Year Flood in Vicinity of RSCCD Facilities

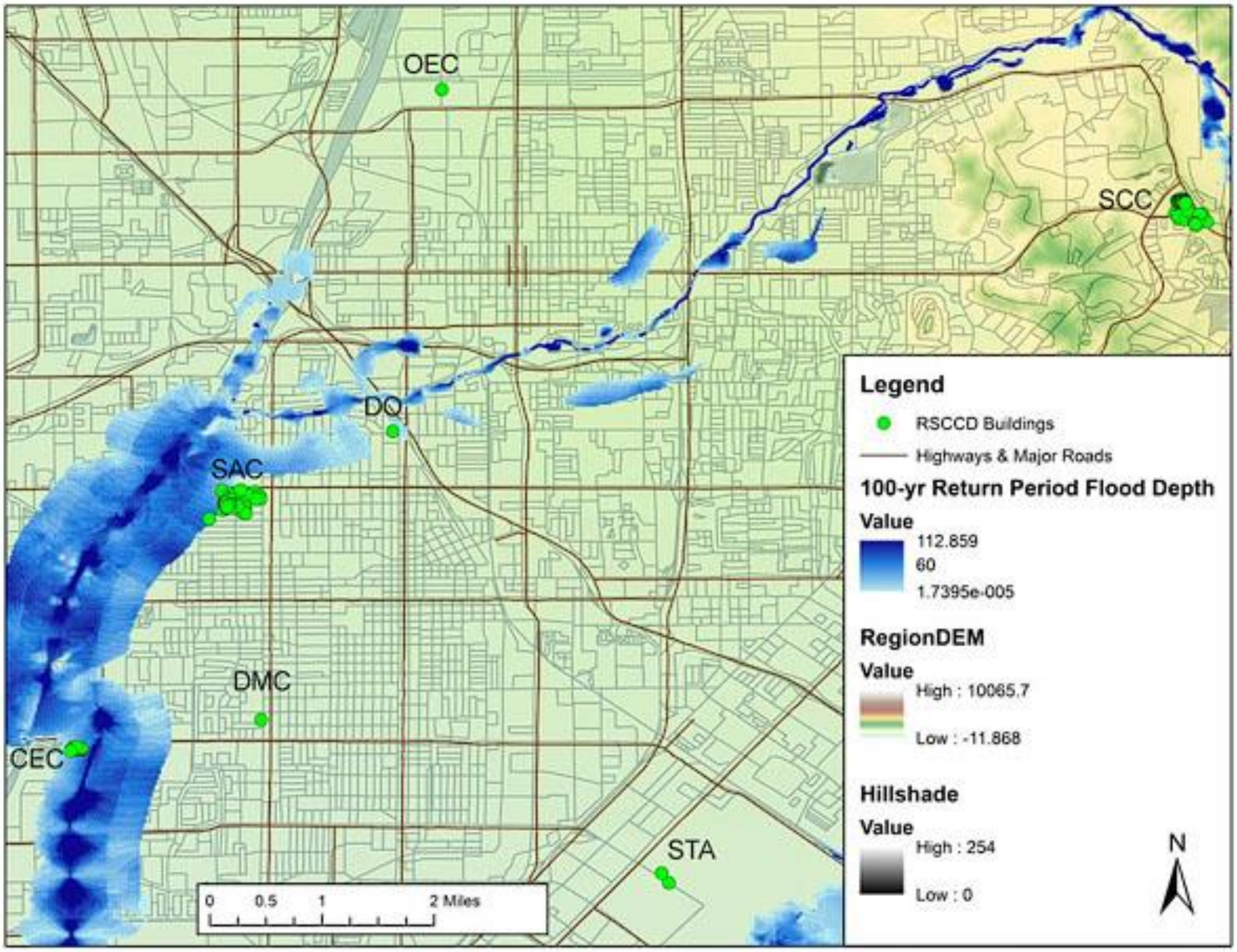

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Figure 20: HAZUS Flood Depths for Orange County for the 500-Year Flood

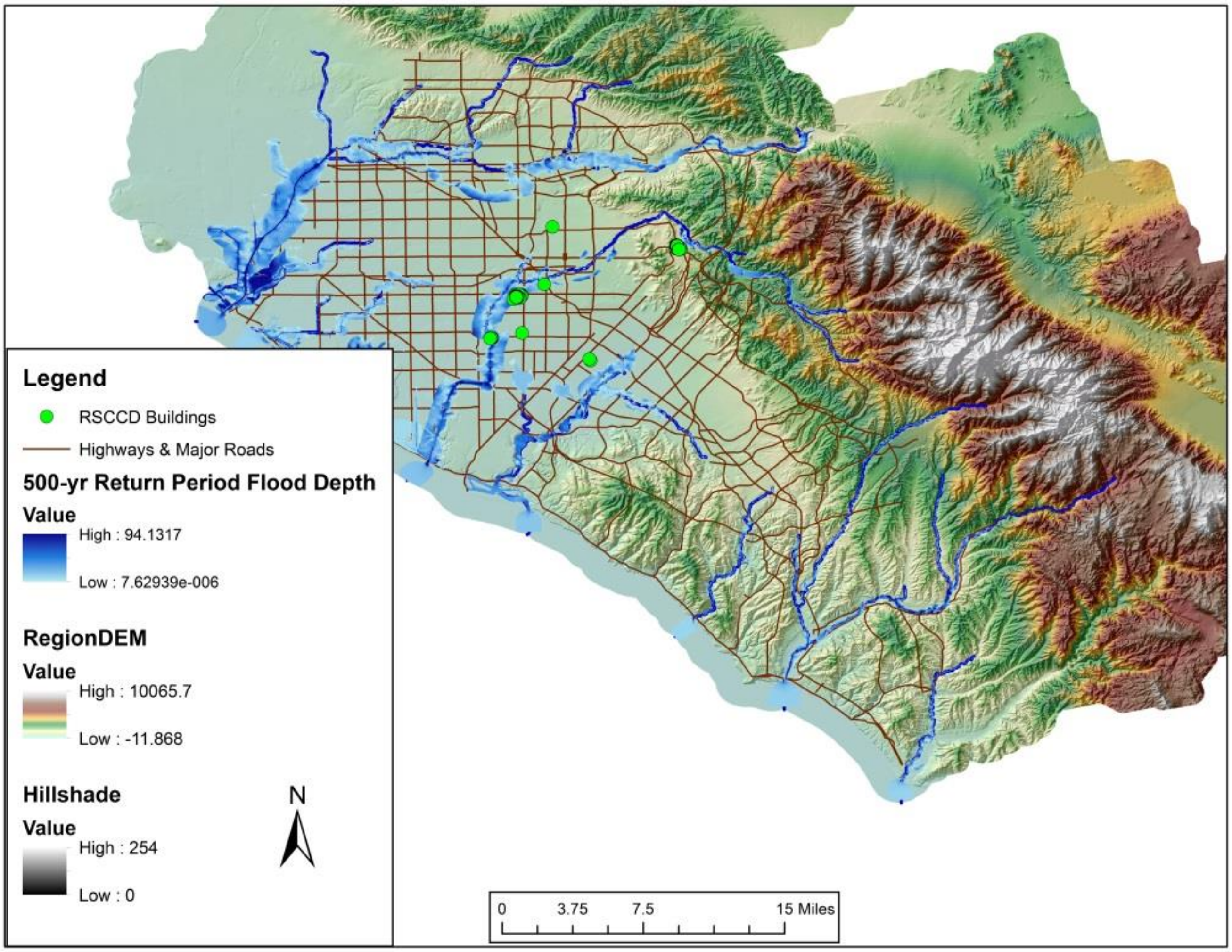

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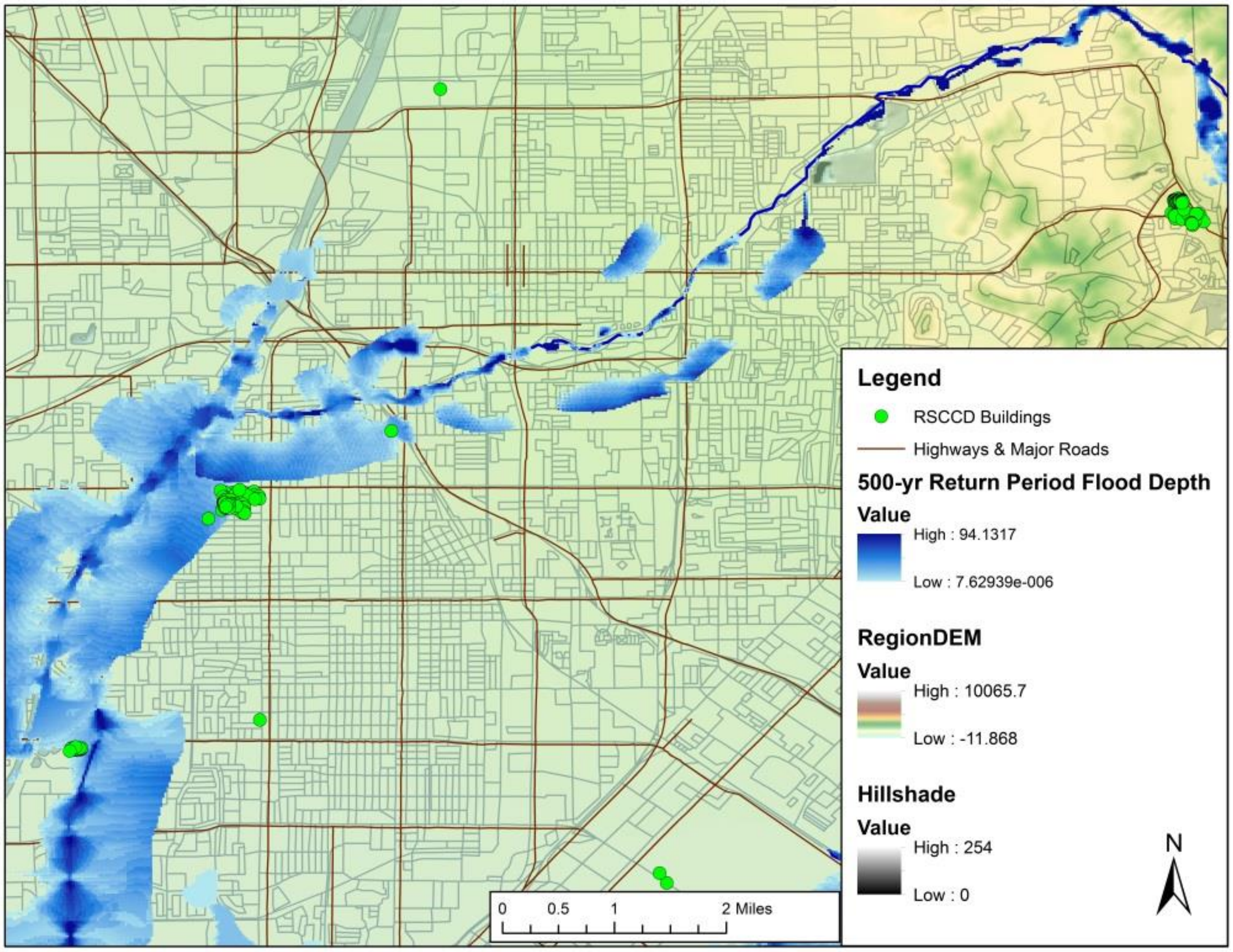
Figure 21: HAZUS-Estimated Flood Depths for 500-Year Flood in the Vicinity of RSCCD Facilities



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BUILDING CLASSIFICATION FOR RISK ASSESSMENT

Using the building inventory data described previously, each building has been assigned Hazus-specific classifications required for analysis in the Hazus Flood *User-Defined Facilities* (UDF) module. These parameters are described below, and are provided for each building in **Appendix A**.

- *Hazus Occupancy classes* have been assigned based on the predominant use of the building, including:
    - COM4 – Office buildings
    - COM8 – Entertainment and recreation (e.g., snack and dining facilities, physical education)
    - EDU2 – Colleges and universities
    - GOV2 – Emergency response facilities (e.g., security facilities)
    - IND2 – Light industrial (e.g., auto shop, maintenance buildings)
    - IND5 – High technology
- Buildings are classified into Hazus flood *Building Types* based on their construction material, i.e., concrete, masonry, steel, wood, etc. Information used to determine *Building Type* was contained in the insurance appraisal reports, in data fields "ISO Class" (providing basic information about a buildings fire-resistance and construction materials), supplemented by data in the "Exterior Wall Type" field. Classifications have been assigned using the same methodology as was implemented for the 2009 OCEFRA Study conducted for FEMA (*FEMA, 2009*), which was incorporated into the Orange County HMP (*County of Orange, 2010*). Relevant examples of *Building Types* common among RSCCD facilities include masonry, steel, concrete and wood, many of which are portable structures. It should be noted that these data are included for completeness of the database, but are not considered by the default Hazus depth-damage functions in use for the current study.
- For the Hazus flood model, *Design Level* is considered to be pre-FIRM (i.e., built prior to the adoption of flood-related building regulations) if the construction date of the building pre-dates the community's first Flood Insurance Rate Map, and post-FIRM if constructed after the initial FIRM was identified. FIRM-related dates are published by FEMA in the state-specific "Community Status Book for California" (*FEMA, 2015*). Relevant FIRM-entry dates for RSCCD communities include:
    - Orange County - 09/14/79
    - City of Orange - 09/30/82
    - City of Santa Ana - 09/14/79
- Data on building foundations were also required. Most RSCCD buildings are built on slab foundations, although a number of portable buildings at Santa Ana College and Santiago Canyon College are elevated. In addition, Dunlap Hall at Santa Ana College has a small basement which houses building equipment.
- The final critical type of data for flood risk assessment is *First Floor Height* (FFH). FFH is the height, in feet, of the top of the finished floor surface for the first floor above ground, relative to the ground outside (i.e., how high the water has to rise to enter the structure). For the current assessment, FFH has been determined from review of building photos included in the insurance appraisal report, internet tools, such as Google Street View, and confirmed by limited site visits conducted by the RSCCD Risk Management Team. The following assumptions have been made:

- Raised portables have been assumed to have a FFH of 18 inches, consistent with assumptions made in the previous Hazus study conducted for Orange County (*FEMA, 2009*), and confirmed by RSCCD site visit. There are 36 such raised portables at Santa Ana College and 4 at Santiago Canyon College.
- When a building has steps at the entrance, a stair height of six inches is assumed. If a building has multiple entrances with differing numbers of steps (e.g., 5 steps at one side, 2 steps at another), the lower height is used to be conservative. Based on available photos, ten buildings were observed to have stairs or ramps at their entrances (other than portables described above); assumed FFH are provided in Table 19 below.
- All other buildings are assumed to have entries at grade with an assumed FFH of 6 inches.

Table 20: Assumed First Floor Heights for Selected Buildings

Building Name	Entry Description	Assumed FFH
District Office - Admin Building	2 steps/5 steps	12 inches
SAC - Theater Building	4 steps	24 inches
SAC - Gymnasium	6 steps	36 inches
SAC - Mechanical Pool Building	ramp	18 inches
CEC - Portable Classroom (Building 907)	short ramp	12 inches
SCC - Admin/Office/Classroom Building	4 steps/10 steps	24 inches
SCC - Science Center	5 steps/entry at grade	6 inches
SCC - Humanities Building	3 – 5 steps/entry at grade	6 inches
SCC - PE Building	entries at grade and at the second level	6 inches
SCC - Portable Survey Office	ramp	18 inches

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In addition to the building classification data described above, information taken directly from the insurance appraisal report to build the required Hazus UDF input database included building square footage, building replacement value, contents replacement value, location (latitude and longitude), number of stories and year built. The Hazus UDF also requires data on applicable building and content damage functions, determined from the Hazus default recommendations by occupancy class. No customization has been included; each building is represented by the default damage function associated with the identified occupancy class and foundation type.

FLOOD RISK ASSESSMENT RESULTS

RSCCD facility flood damage and associated losses have been estimated for the 100-Year Flood scenario and 500-Year Flood hazard using Hazus. Damage estimates for the District's buildings, generated using Hazus' User Defined Facilities (UDF) Module, are provided in Table 20 by site and are discussed in more detail below. (Detailed results for individual buildings are provided in the full reports appendix.) For the 100-Year Flood, the results for the three sites located within levee protected areas are shaded in light orange in Table 20. For these sites, the "worst-case" estimates, determined by Hazus assuming no levee protection, are provided in the Table 20. "Best-case" estimates (full levee protection) would show no losses.

As shown in Table 20, just two sites – Santa Ana College and the Centennial Education Center – are expected to suffer damage under 100-Year flood conditions, and Santa Ana College would only be expected to suffer these damages should there be levee failure. Under 500-Year flood conditions, one additional site – the District Office – can also expect to be subject to potential inundation. District-wide losses for the 100-Year flood would exceed $5 million at Centennial Education Center, and could exceed $9 million, if levees protecting Santa Ana College fail. For the 500-Year flood, district-wide losses are actually lower (just under $4.7 million), due to the wider predicted footprint and shallower depths predicted by Hazus for the 500-Year flood. It should be noted that the results presented here are the product of a default Hazus flood analysis conducted using best-available data; damage in an actual flood event will be different. The results of this Hazus analysis are intended to be used for relative-risk assessment and screening for further study. Lack of damage in the modeled events should not be taken to mean the facility will not experience some flood damage during its useful lifetime.

Most of the cost of the expected flood damage will result from damage to building contents, ranging from 58% of the loss at the District Office in the 500-Year flood, to 89% of the loss at Centennial Education Center in both the 100 and 500-Year floods. Accordingly, flood damage mitigation strategies should be considered both for the structure itself, as well as for building contents. For example, vulnerable building contents can be relocated to higher parts of the building (above the anticipated flood height) or protected in place.

A large number of damaged buildings at Centennial Education Center (9 out of 15 in the 100-Year flood) are portable structures with entries at grade, but due to their modest value, damage to these buildings represents just 14% of the total cost of damage to the buildings and their contents. At Santa Ana College, damage to six portables (out of 14 damaged buildings) represents just 2% of the total damage, likely because the buildings are elevated. Accordingly, mitigation of the portable structures is expected to have lower economic benefits, but may have other, non-financial benefits, such as reduced closure times.

The distribution of flood damage by building is mapped in Figure 19 (below) for Santa Ana College for the 100-Year flood; the four maps provided depict percent building damage, building damage in dollars, percent content damage, and content damage in dollars. As shown, flooding impacts the western portion of the campus. Similar maps for Centennial Education Center are provided for the 100-Year flood in Figure 20 and for the 500-Year flood for SAC, CEC and the District Office in Figures 21, 22 and 23, respectively. A list of damaged buildings, by site, is provided in Table 21.

Table 21: Summary of Economic Impacts from Flooding for RSCCD Facilities by Site

(shading indicates sites considered protected by levees in the 100-year flood)

Damage Type	District Office[1]	Santa Ana College[1]	Centennial Education Center	Digital Media Center	Orange Education Center[1]	Santiago Canyon College	OC Sheriff's Regional Training	Total
	RSCCD Sites							
1% Annual Chance (100 year) Flood								
Number of Buildings Within the Inundated Area	0	18	15	0	0	0	0	33
Number of Buildings Within the Inundated Area Suffering Damage	0	14	15	0	0	0	0	29
Number of Portable Buildings Damaged	0	6	9	0	0	0	0	15
Building Damage ($1,000)	$0	$750	$580	$0	$0	$0	$0	$1,330
Contents Damage ($1,000)	$0	$2,850	$4,880	$0	$0	$0	$0	$7,730
Total Building & Contents Damage ($1,000)[2]	*$0*	*$3,600*	*$5,460*	*$0*	*$0*	*$0*	*$0*	*$9,060*
0.2% Annual Chance (500 year) Flood								
Number of Buildings Within the Inundated Area	1	30	14	0	0	0	0	45
Number of Buildings Within the Inundated Area Suffering Damage	1	6	13	0	0	0	0	20
Number of Portable Buildings Damaged	0	0	7	0	0	0	0	7
Building Damage ($1,000)	$560	$430	$170	$0	$0	$0	$0	$1,160
Contents Damage ($1,000)	$760	$1,380	$1,390	$0	$0	$0	$0	$3,530
Total Building & Contents Damage ($1,000)[2]	*$1,320*	*$1,810*	*$1,560*	*$0*	*$0*	*$0*	*$0*	*$4,690*

Notes: 1) The DO, SAC and OEC are all located in FEMA flood zone "Zone X Protected by Levee – areas protected by levees from the 1% annual chance flood"
2) The results presented here are the product of a default Hazus flood analysis conducted using best-available data; damage in an actual flood event will be different. The results of this Hazus analysis are intended to be used for relative-risk assessment and screening for further study. Lack of damage in the modeled events should not be taken to mean the facility will not experience some flood damage during its useful lifetime.

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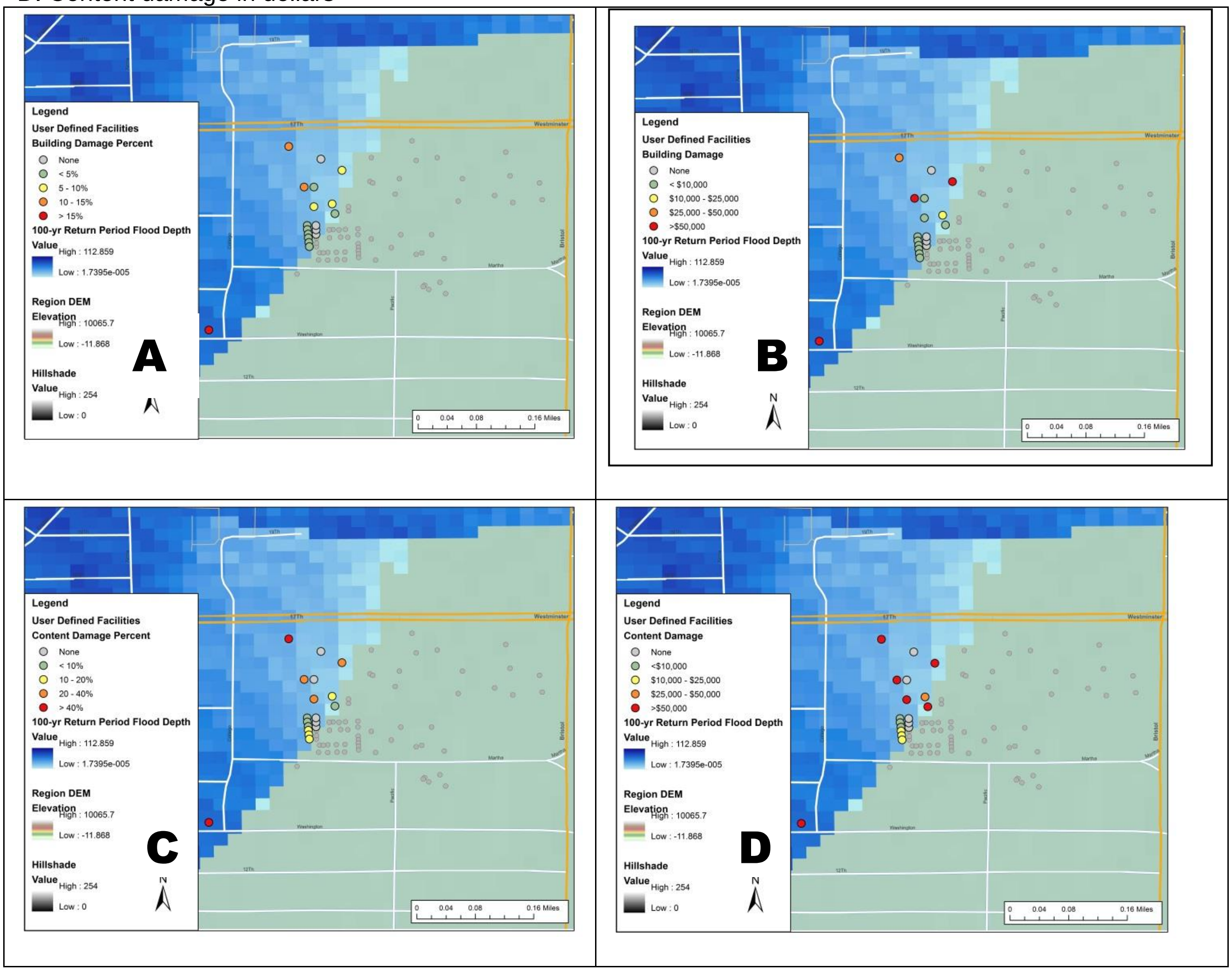
The following five figures show flooding in the RSCCD:

- Figure 21: Santa Ana College for a 100-Year Flood
- Figure 22: Centennial Education Center for a 100-Year Flood
- Figure 23: Santa Ana College for a 500-Year Flood
- Figure 24: Centennial Education Center for a 500-Year Flood
- Figure 25: District Office for a 500-Year Flood

Figure 22: Santa Ana College for 100-Year Flood- Building and Content Damage Distributions

A. Percent building damage
B. Building damage in dollars
C. Percent content damage
D. Content damage in dollars



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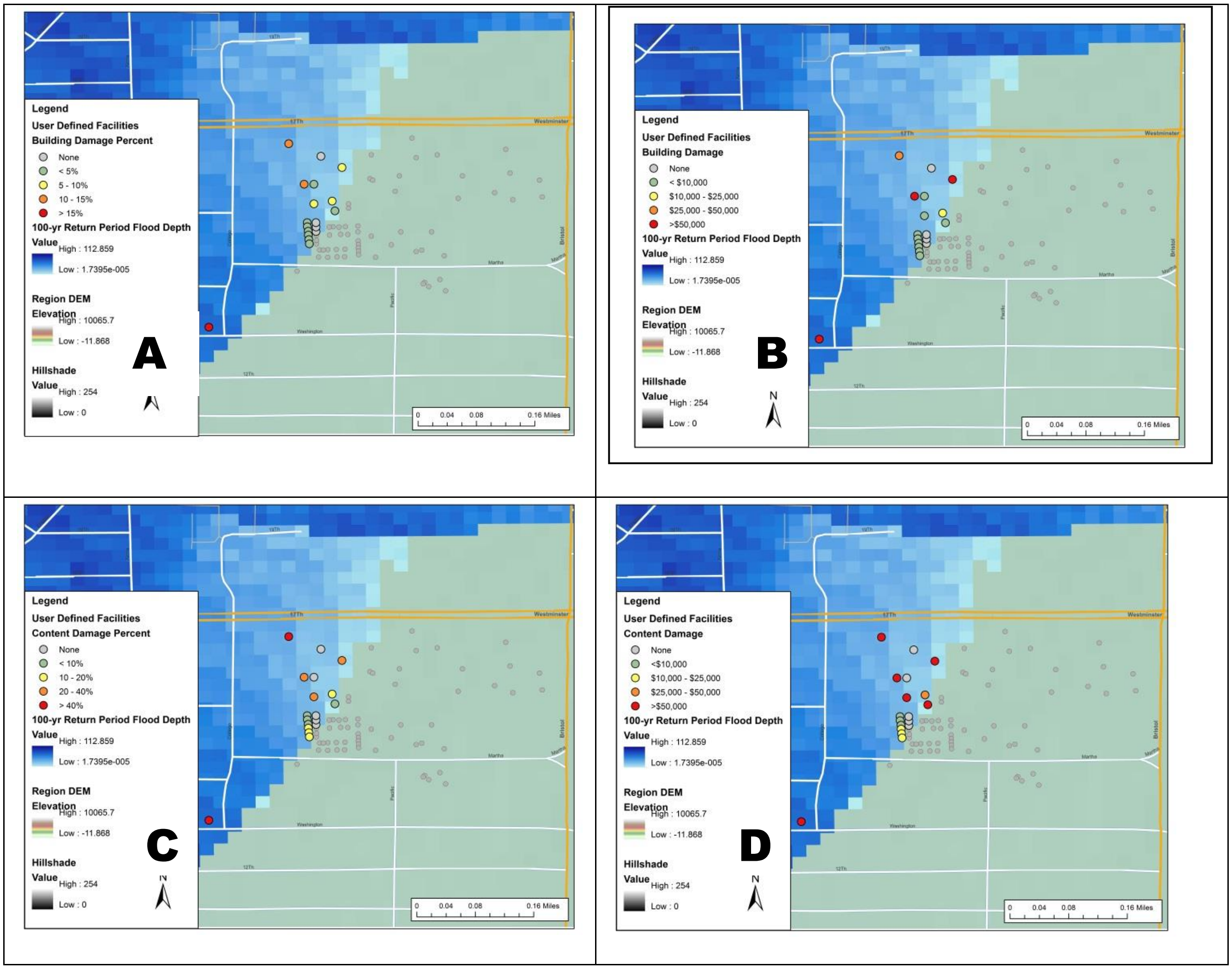
Legend
User Defined Facilities
Building Damage Percent
None
< 5%
5 - 10%
10 - 15%
> 15%
100-yr Return Period Flood Depth
Value
High : 112.859
Low : 1.7395e-005
Region DEM
Elevation
High : 10065.7
Low : -11.868
Hillshade
Value
High : 254
Low : 0
A
0 0.04 0.08 0.16 Miles
Legend
User Defined Facilities
Building Damage
None
< $10,000
$10,000 - $25,000
$25,000 - $50,000
>$50,000
100-yr Return Period Flood Depth
Value
High : 112.859
Low : 1.7395e-005
Region DEM
Elevation
High : 10065.7
Low : -11.868
Hillshade
Value
High : 254
Low : 0
B
N
0 0.04 0.08 0.16 Miles
Legend
User Defined Facilities
Content Damage Percent
None
< 10%
10 - 20%
20 - 40%
> 40%
100-yr Return Period Flood Depth
Value
High : 112.859
Low : 1.7395e-005
Region DEM
Elevation
High : 10065.7
Low : -11.868
Hillshade
Value
High : 254
Low : 0
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0 0.04 0.08 0.16 Miles
Legend
User Defined Facilities
Content Damage
None
<$10,000
$10,000 - $25,000
$25,000 - $50,000
>$50,000
100-yr Return Period Flood Depth
Value
High : 112.859
Low : 1.7395e-005
Region DEM
Elevation
High : 10065.7
Low : -11.868
Hillshade
Value
High : 254
Low : 0
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N
0 0.04 0.08 0.16 Miles

(Enlargement from "D" above Content Damage with building names)

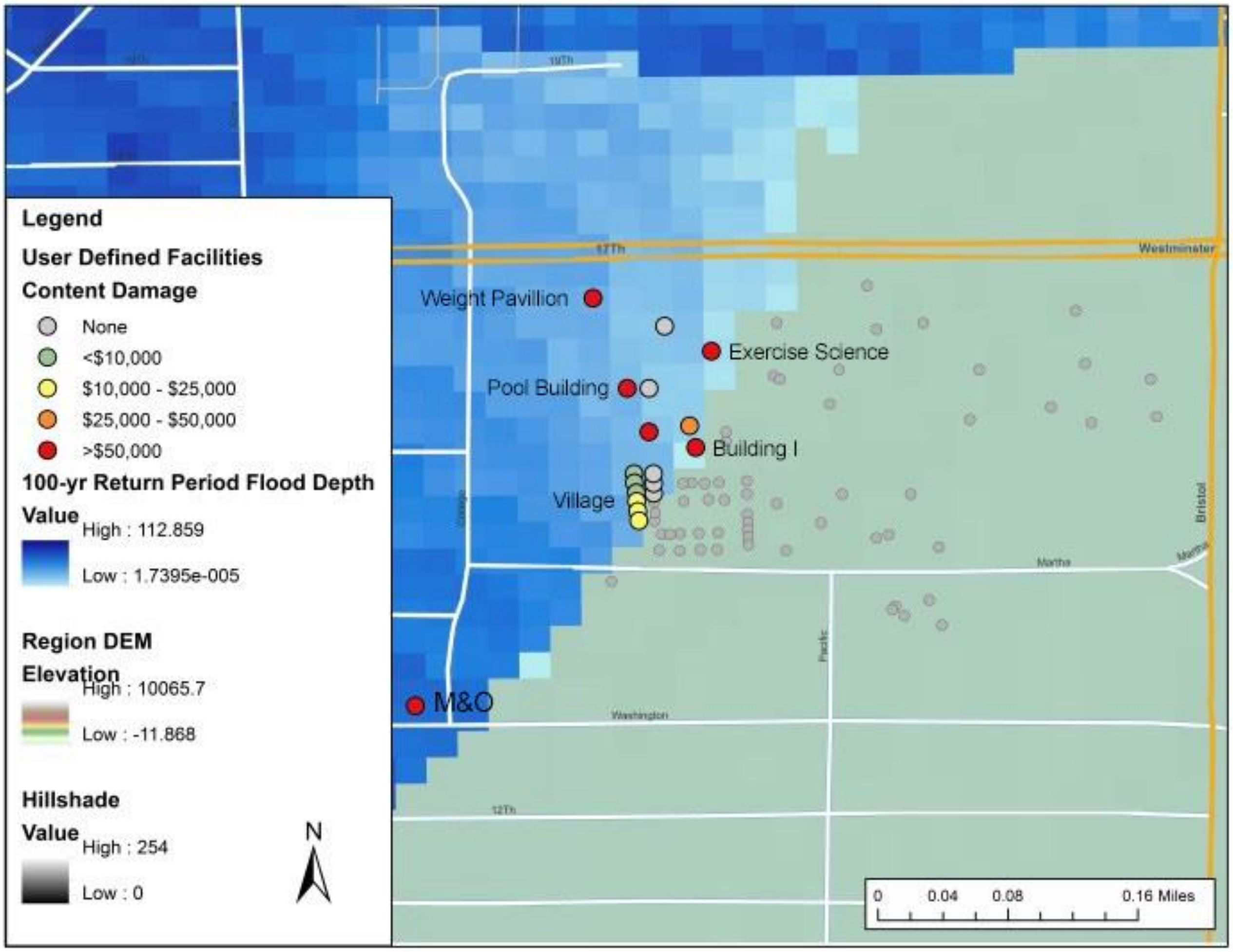

Figure 23: Centennial Ed. Center 100-Year Flood -Building & Content Damage Distributions

A. Percent building damage
B. Building damage in dollars
C. Percent content damage
D. Content damage in dollars

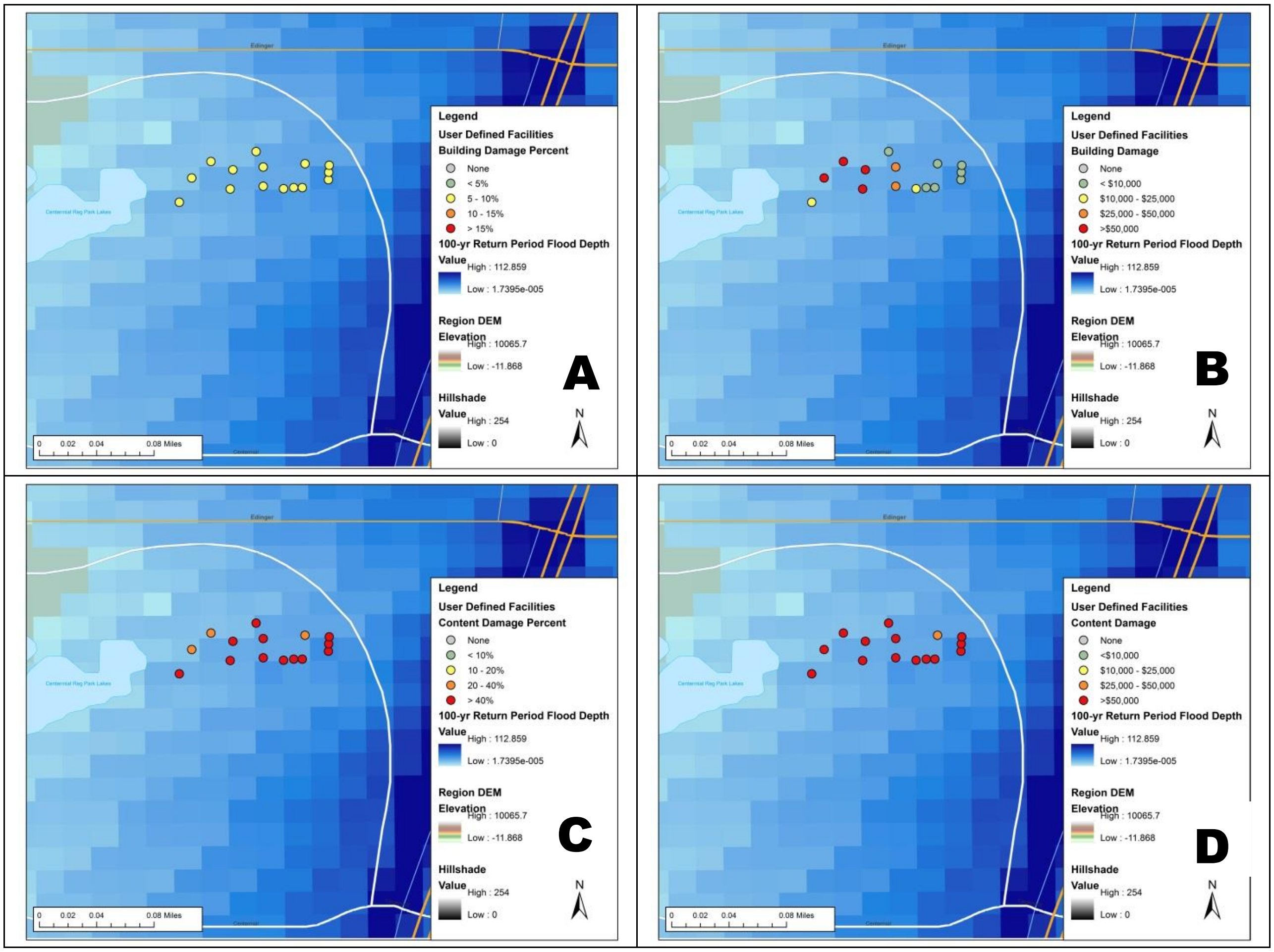

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Figure 24: Santa Ana College for 500-Year Flood - Building and Content Damage Distributions

A. Percent building damage
B. Building damage in dollars
C. Percent content damage
D. Content damage in dollars

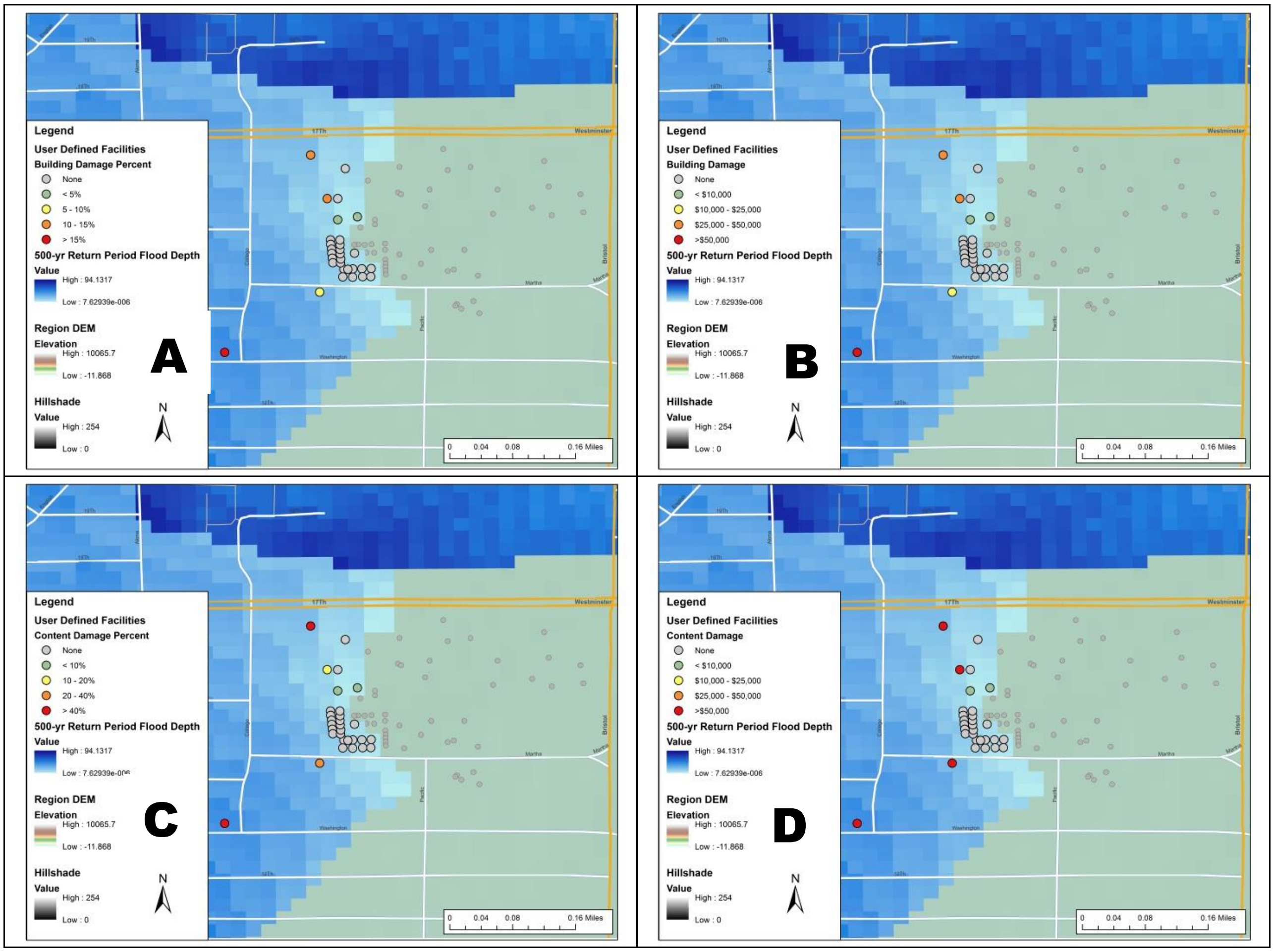

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Figure 25: A Centennial Ed. Center 500-Year Flood-Building and Content Damage Distributions

A. Percent building damage
B. Building damage in dollars
C. Percent content damage
D. Content damage in dollars

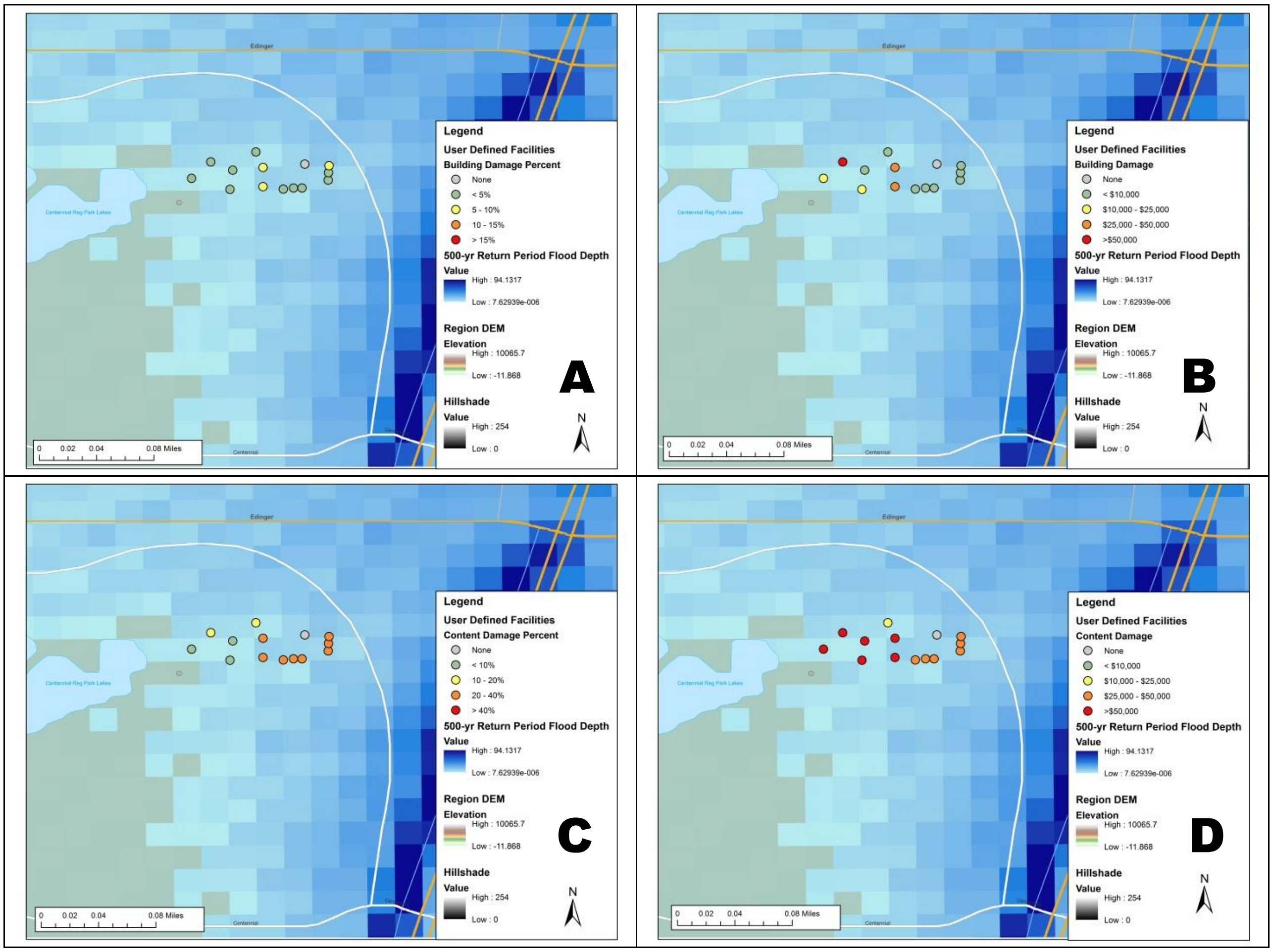

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Figure 26: District Office for the 500-Year Flood - Building and Content Damage Distributions

A. Percent building damage
B. Building damage in dollars
C. Percent content damage
D. Content damage in dollars

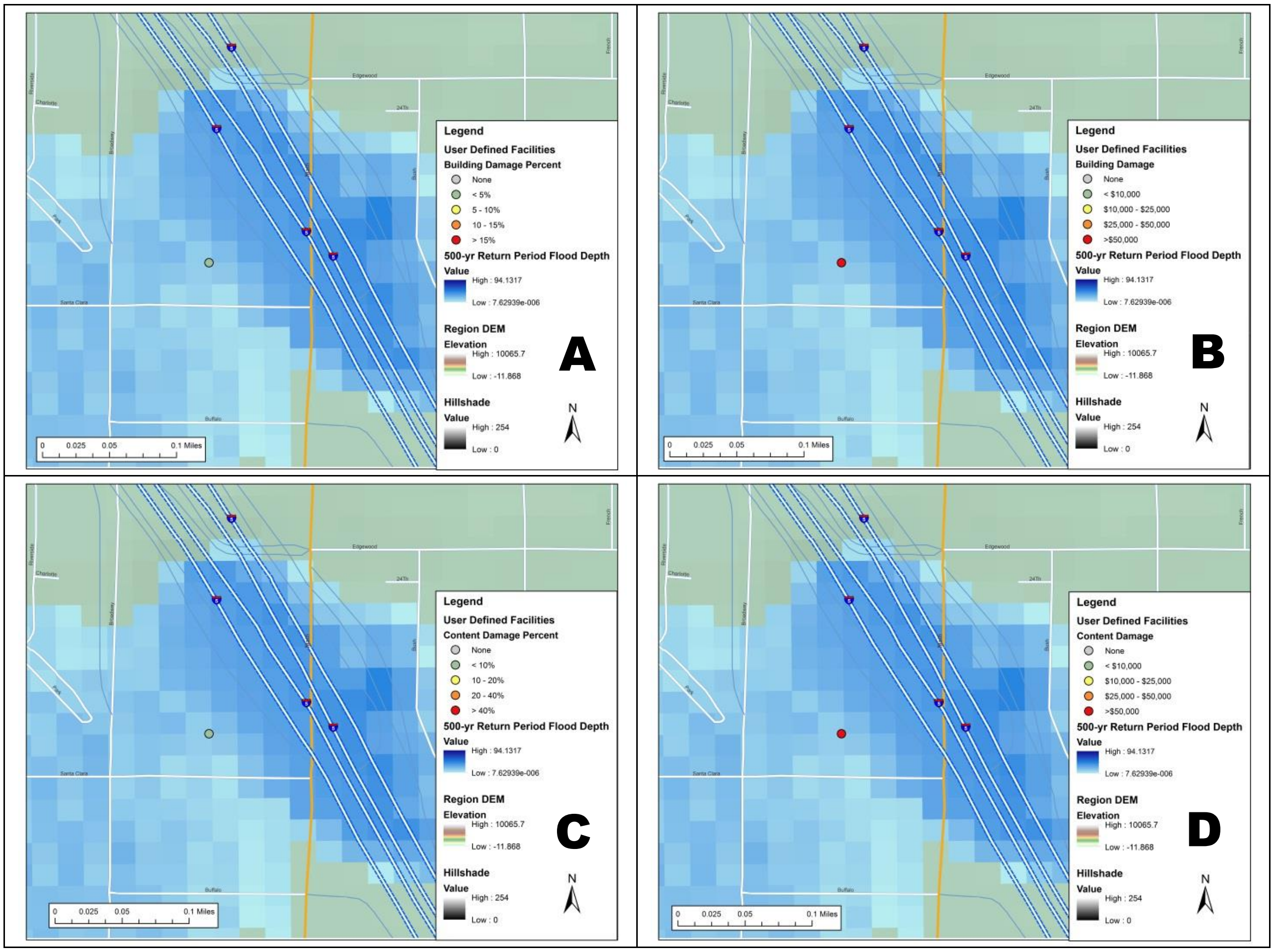

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Table 22: Buildings Predicted by HAZUS to Suffer Damage in 100-Year or 500-Year Flood

Building Name	Damaged in the 1% Annual Chance Flood[1]	Damaged in the 0.2% Annual Chance Flood[1]
District Office – Admin Building		☑
SAC – Exercise Science - Building-W	☑	
SAC – Baseball Office/Restroom Building		☑
SAC - Classroom Building-I	☑	
SAC - Weight Pavilion	☑	☑
SAC - Mechanical Pool Building	☑	
SAC - PE Offices – Building-F	☑	☑
SAC - Storage Building (Old Soccer Scoreboard)	☑	☑
SAC - Maintenance and Operation Buildings	☑	☑
SAC - Pool Equipment Storage Building	☑	☑
SAC - Village Classroom Rm 301	☑	
SAC - Village Classroom Rm 302	☑	
SAC - Village Classroom Rm 303	☑	
SAC - Village Classroom Rm 304	☑	
SAC - Village Classroom Rm 305	☑	
SAC - Village Classroom Rm 306	☑	
CEC - Building A	☑	☑
CEC - Building B	☑	☑
CEC - Child Development Center Building C	☑	☑
CEC - Building D	☑	☑
CEC - Building E	☑	☑
CEC - Building F	☑	☑
CEC - Portable Classroom D107 D106	☑	☑
CEC - Portable Classroom D108	☑	☑
CEC - Portable Classroom D109	☑	☑
CEC - Portable Classroom 110	☑	☑
CEC - Portable Classroom D111	☑	☑
CEC - Portable Classroom D112	☑	☑
CEC –Child Development Center C-110	☑	
CEC - Child Development Center C-111	☑	☑
CEC – F-115/F-1116	☑	

MMI ENGINEERING

Notes: 1) The results presented here are the product of a default Hazus flood analysis conducted using best-available data; damage in an actual flood event will be different. The results of this Hazus analysis are intended to be used for relative-risk assessment and screening for further study. Lack of damage in the modeled events should not be taken to mean the facility will not experience some flood damage during its useful lifetime.
2) Some building names have been updated from the original insurance report, as of 9/17/2015

MMI ENGINEERING STUDY CONCLUSIONS AND RECOMMENDATIONS

As described in this report, the Rancho Santiago Community College District's facilities could suffer more than $5 million in damage to the buildings and their contents at the Centennial Education Center in a100-Year Flood, increasing to as much as $9 million if the levees protecting Santa Ana College fail to provide adequate flood protection. In a 500-Year Flood as modeled by Hazus, losses may exceed $4.6 million, including damage at the District Office, Santa Ana College and the Centennial Education Center. As noted previously, the results presented here are the product of a default Hazus flood analysis conducted using best-available data; damage in an actual flood event will be different. The results of this Hazus analysis are intended to be used for relative-risk assessment and screening for further study. Lack of damage in the modeled events should not be taken to mean the facility will not experience some flood damage during its useful lifetime

While much of the predicted economic loss is a result of flood damage to building contents, damage to the inundated buildings themselves also occurs. To minimize this type of damage and its effects on operations, the District could conduct detailed flood risk reviews of their potentially flooded facilities (Table 21), in order to confirm flood risk and identify approaches to mitigate damage to both the buildings and their contents. Various strategies are available to reduce the risk of flood damage. Mitigation of potential flood damage can be accomplished by elevation, relocation, wet floodproofing (e.g., raising utilities and building contents, or configuring electrical and mechanical systems to minimize disruptions), dry floodproofing (e.g., making the building more watertight), or construction of barrier systems, such as a floodwall. A more detailed flood risk analysis would be required to assess the most cost-effective strategies for the District. A good general discussion of various flood mitigation techniques may be found in FEMA's "Homeowner's Guide to Retrofitting: Six Ways to Protect your Home from Flooding" (FEMA, 2014)

Detailed building level results are provided in the MMI Engineering Report on Flood, **Appendix B**. Every effort has been made to accurately classify each building's structural type and first floor height from available data (see MMI Engineering Report on Flood, **Appendix A**). For buildings where the current categorization differs from user expectations, sensitivity studies or "what-if" analyses could be conducted to shed further light on the potential variations in performance resulting from a range of categorizations, or a more detailed engineering review could be implemented to fine-tune the categorization. Further, a similar analytical approach could be used to assess the potential improvement in performance associated with selected physical mitigation strategies, such as building elevation.

F. THE LOCALIZED FLOODING ISSUES

Localized flood problems sometimes do not get the remedial attention they need, partly because they are not the subject of dramatic headlines or stories on the nightly news, and partly because they fall outside the scope of many local flood protection ordinances, which are geared toward the Special Flood Hazard Area (SFHA) depicted on the community's Flood Insurance Rate Map (FIRM). However, as local officials, technical staff, and residents of those areas know, this flooding is a significant—and often a recurring—problem.

Localized flooding can result from even minor storms. Runoff overloads the drainage-ways and flows into the streets and low-lying areas. Sewers back up can cause inundation. Homes and businesses are flooded, especially basements and the lower part of first floors. Localized flooding poses most of the same problems caused by larger floods, but because it typically has an impact on fewer people and affects small areas, it tends to bring less State or Federal involvement such as funding, technical help, or disaster assistance. As a result, the community and the affected residents, business owners and schools are left to cope with the problems on their own. Finally, flooding of this type tends to recur; small impacts accumulated over time can become major problems.

The RSCCD is made up of:

- Seven sites
- 146 buildings
- Daytime peak occupancy 28,834
- The district facilities affected by flood are "Moderate" or about 50% of the district's sites

Finding the elevation of each RSCCD site helped the Hazard Mitigation Committee determine the localized flooding threat.

Table 23: RSCCD Elevation by Site

Item	District Location	Address	Elevation Feet Above Sea Level
1	District Operations Center	2323 North Broadway, Santa Ana 92706	147 feet
2	Santa Ana College (SAC)	1530 West 17th Street, Santa Ana 92706	106 feet
3	Santiago Canyon College (SCC)	8045 East Chapman Avenue, Orange 92869	557 feet
4	Centennial Education Center (CEC)	2900 West Edinger Avenue, Santa Ana 92704	91 feet
5	Orange Education Center (OEC)	1465 North Batavia Street, Orange 92867	176 feet
7	Orange County Sheriff's Regional Training Academy (OCSRTA)	115991 Armstrong Avenue, Tustin 92782	57 feet
8	Digital Media Center (DMC)	1300 South Bristol Street, Santa Ana 92704	71 feet

Note: Site 6 is the Regional Fire Training Center; land not owned by RSCCD; lease terminated May 2015

The RSCCD has one recorded incident of a flood that caused damage to its facilities.

Date	Location	Type of Damage	Details (from insurance records)	Costs
11/25/2008	Santiago Canyon College	Rain, flooding and mud	Rain caused flooding and mud at SCC buildings	$51,777

G. Flood Probability of Future Occurrences

Based on history, a flood is the most common type of disaster in the US, California and Orange County. Flooding situations have occurred in all 50 states and all 58 California counties including Orange County. Land along rivers, like the Santa Ana River, are particularly susceptible to flooding.

Some flooding occurs on an average of every four years in Orange County with severe floods occurring approximately every ten years, often during an El Niño. The Santa Ana River Mainstem mitigation project has lessened the probability and the impact. Floods resulting from heavy rains and storms are the most common disaster affecting the RSCCD which is why extra effort has been made to prepare for flood emergencies.

Table 24: Probability for Flood Scenarios

Scenario	Probability of Future Events*
100-Year Flood	Likely
500-Year Flood	Occasional
Localized Flooding	Likely

*Based on the consensus of the Hazard Mitigation Committee
Not-Likely, Occasional or Likely

In summary, flood probability is ranked "likely" for the 100-Year floods, "occasional" for the 500-Year scenario and "likely" for localized flooding.

H. FLOOD/STORM HAZARD MITIGATION STRATEGIES

SHORT TERM MITIGATION STRATEGIES

Hazard	FLOOD ACTIVITY #1 – SHORT TERM
Action Item	**Identify and mitigate potentially vulnerable non-structural components and systems from flooding as well as conducting a structural engineering evaluation of RSCCD facilities to determine if they meet today's flood building codes and are structural retrofits needed in older facilities. (See List of Facilities Recommended by the Hazard Mitigation Team below)**
Coordinating Organization	Facilities Managers and Director of District Construction
Ideas for Implementation	▪ Determine if a Facilities Safety Committee needs to be formed. It could include RSCCD Facilities, City Building Officials and a representative from the Department of State Architect ▪ Work with contractors to provide cost estimates for this project. ▪ Write a FEMA Hazard Mitigation project grant to develop a complete Non-Structural and structural engineering evaluation ▪ As part of the grant, research what steps have already been taken by the district; determine steps still needed to prepare all sites for their sites worst case scenario ▪ Develop a long-term maintenance plan for the program
Time Line	3 years and ongoing
Constraints	Grant approval by Cal EMA and FEMA
Funding Sources	25% General Fund and 75% FEMA Maintenance costs are 100% RSCCD
Cost Estimate	$7-8 million
Benefits: Losses Avoided	Life Safety and reduced injuries; reduced property damage from floods; in older and critical facilities such as the campus EOCs, it will allow for continued emergency management operations during a disaster
Priority	Extremely High

Plan Goals Addressed	
	Promote Public Awareness
X	Create Partnerships and Implementation
X	Protect Life and Property
	Protect Natural Systems
X	Strengthen Emergency Services

Buildings Predicted by HAZUS to Suffer Damage in 100-Year or 500-Year Flood

Building Name	Damaged in the 1% Annual Chance Flood[1]	Damaged in the 0.2% Annual Chance Flood[1]
District Office – Admin Building		☑
SAC – Exercise Science - Building-W	☑	
SAC – Baseball Office/Restroom Building		☑
SAC - Classroom Building-I	☑	
SAC - Weight Pavilion	☑	☑
SAC - Mechanical Pool Building	☑	
SAC - PE Offices – Building-F	☑	☑
SAC - Storage Building (Old Soccer Scoreboard)	☑	☑
SAC - Maintenance and Operation Buildings	☑	☑
SAC - Pool Equipment Storage Building	☑	☑
SAC - Village Classroom Rm 301	☑	
SAC - Village Classroom Rm 302	☑	
SAC - Village Classroom Rm 303	☑	
SAC - Village Classroom Rm 304	☑	
SAC - Village Classroom Rm 305	☑	
SAC - Village Classroom Rm 306	☑	
CEC - Building A	☑	☑
CEC - Building B	☑	☑
CEC - Child Development Center Building C	☑	☑
CEC - Building D	☑	☑
CEC - Building E	☑	☑
CEC - Building F	☑	☑
CEC - Portable Classroom D107 D106	☑	☑
CEC - Portable Classroom D108	☑	☑
CEC - Portable Classroom D109	☑	☑
CEC - Portable Classroom 110	☑	☑
CEC - Portable Classroom D111	☑	☑
CEC - Portable Classroom D112	☑	☑
CEC –Child Development Center C-110	☑	
CEC - Child Development Center C-111	☑	☑
CEC – F-115/F-1116	☑	

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Hazard		**FLOOD ACTIVITY #2 – SHORT TERM**
Action Item		**Increase Flood Risk Awareness and Education**
Coordinating Organization		Risk Manager and Chief District Safety & Security
Ideas for Implementation		▪ As part of the planning process for this plan, present the RSCCD Flood Hazard Mitigation Plan to as many RSCCD staff, faculty, students and the public as possible ▪ Every occasion the districts emergency preparedness program is presented, include information on the RSCCD Hazard Mitigation Plan and ask for input into future projects. ▪ Utilize the maps in the plan for employee and public education ▪ Include an overview of the plan, its goals, maps and lists of at risk buildings when training Building Captains. Discuss which buildings are more vulnerable to flooding and should not be used during a flood.
Time Line		Ongoing
Constraints		Chief District Safety & Security can only offer the training; attendance is voluntary
Funding Sources		General Fund
Cost Estimate		Staff Time
Benefits: Losses Avoided		Sustained mitigation outreach programs have minimal cost and will help build and support district-wide capacity. This type of activity enables the district faculty, students and the public to better prepare for, respond to and recover from disasters.
Priority		High
Plan Goals Addressed		
X	Promote Public and College Community Awareness	
X	Create Partnerships and Implementation	
X	Protect Life and Property	
	Protect Natural Systems	
X	Strengthen Emergency Services	

LONG TERM MITIGATION STRATEGIES

Hazard:	FLOOD/STORM ACTIVITY #3 – LONG TERM
Action Item	**Conduct the flood-proofing measures to vulnerable facilities starting with critical facilities (Phase 2 - Phase 1 is Flood/Storm Short Term #1)**
Coordinating Organization	Vice Chancellor of Administrative Services and Facility Director
Description	▪ Flood-proof critical facilities identified in the assessment ▪ Flood-proof all other facilities identified in the assessment ▪ Flood proofing includes but is not limited to: o Dry Floodproofing – making a building water tight below the level that needs water protection o Wet Floodproofing - providing resistance to damage from flooding while allowing floodwaters to enter the structure or area o Flood walls or small berms o Installing/upgrading storm water pump stations o Increasing draining capacities; Increasing dimensions of drainage culverts; o Using vegetative management
Time Line	7 Years
Constraints	Time, Expertise and Budget
Plan Goals	Protect Life and Property
Funding Sources	California Community College Schedule Maintenance Program, California Community College Capital Outlay Fund, FEMA Hazard Mitigation Grant and partnerships with other agencies
Cost Estimate	Costing out the project is done in phase 1, short term action item
Benefits: Losses Avoided	Life safety, reduction in property losses, potential for reduced loss of life and injury due to flooding.
Priority	Extremely High

Plan Goals Addressed	
	Promote Public/College Community Awareness
	Create Partnerships and Implementation
X	Protect Life and Property
	Protect Natural Systems
	Strengthen Emergency Services