Chapter 1

HISTORIC FLOODING IN BERKELEY

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Introduction

Since the 1850's, when it began to be settled by substantial numbers of people, Berkeley has experienced periodic flooding. Present-day flooding stems from both natural and human-induced causes; it seldom results in severe damages, but can cause major inconveniences.

This paper examines several different aspects of flooding in Berkeley: First, topographical, cultural, and climatic factors that contribute to flooding will be explored. Next, the chronology of floods is examined, beginning with the years before records were kept and ending with 1982. A summary will complete the report.

Background to Historic Flooding in Berkeley

The Bay Area is characterized by a Mediterranean climate. The weather is variable, but generally mild. The rainy season usually begins in October and lasts through May. Storms pass through in frontal systems, lasting one to three days. Normally, precipitation falls evenly in such a weather pattern. Rain can fall intensely, however.

Berkeley rainfall is recorded by a United States Weather Service Cooperative Station with instruments located on the roof of the Earth Science Building at the University of California. The daily and hourly records date back to 1886 and 1925, respectively. From 1849 to 1886, Berkeley's rainfall can be estimated from the San Francisco record, since both cities' average rainfall is approximately twenty-two inches, and since both stations derive rainfall from passage of the same frontal systems.

The Berkeley rainfall record shows both long- and short-term variability. The past eleven years have been particularly variable. During that time span, the Berkeley station has recorded its wettest (1982-83), second wettest (1981-82), sixth wettest (1972-73), and seventh wettest (1973-74) seasons, as well as its driest (1975-76) and third driest (1976-77) seasons. December, 1955 holds the record for the wettest month (15.04"), while the most rain in one hour (0.98") fell in December, 1969. The most rain in any 24 hour period is 6.98", recorded on January 4, 1982 (a 24 hour period is from midnight to midnight, whereas a one day period is 24 hours in length but starting at any time) (Figures 1, 2).

Figure 1. Maximum and Minimum Precipitation For Berkeley, California

Rainfall -- Maximum: Monthly and Annual Data

	Historical		Last 30 Years	
January	16.54"	1916	12.47"	1973
February	10.85"	1919	9.14"	1958
March	13.19"	1899	7.06"	1958
April	6.72"	1896	6.06"	1958
May	5.26"	1915	3.56"	1957
June	1.24"	1907	1.21"	1967
July	1.50"	1974	1.50"	1974
August	1.33"	1976	1.33"	1976
September	4.44"	1904	2.62"	1959
October	7.05"	1962	7.05"	1962
November	11.47"	1973	11.47"	1973
December	15.04"	1955	15.04"	1955
Annual	39.81"	1973	39.81"	1973

Rainfall -- Minimum: Monthly and Annual Data

January	0.29"		1976
February	0.00"		1953
March	0.03"		1956
April	0.00"		1970
May through September	0.00"	has been equalled many times	
October	0.00"		1966
November	0.00"		1959
December	0.26"		1956
Annual	9.89"		1929

Rainfall -- Maximum: One Day[1]

January	6.98"	1982	0.1"	1974
February	3.10"	1940	1.0"	1976
March	2.54"	1940	Tr.	1975
April	2.43"	1957	0	
May	1.99"	1957		
June	1.04"	1929		
July	1.40"	1973		
August	0.62"	1976		
Seprember	2.52"	1959		
October	2.39"	1962		
November	3.41"	1977	0	
December	2.96"	1969	0.1"	1972

[1]For the period 1929 to the present.

Normal Precipitation for Berkeley
(Normal is defined as the 30 year mean for the period 1941-1970)

January	5.05"
February	3.38"
March	2.95"
April	2.00"
May	0.64"
June	0.19"
July	0.01"
August	0.07"
September	0.20"
October	1.31"
November	2.92"
December	4.53"
Annual	23.25"

Maximum Precipitation In Any[2] 24 Hour Period (1955-1982)

January	6.98"	(1982)
February	3.08"	(1962)
March	2.23"	(1968)
April	2.64"	(1958)
May	2.19"	(1957)
June	0.90"	(1967)
July	1.44"	(1974)
August	0.71"	(1976)
September	2.55"	(1959)
October	3.95"	(1962)
November	3.57"	(1973)
December	3.30"	(1955)

Maximum Short Duration Precipitation (1940-1982)

1 hr	0.98"	Dec.	1969
2 hr	1.41"	Dec.	1969
3 hr	1.83"	Dec.	1969
6 hr	2.74"	Dec.	1969
12 hr	4.00"	Jan.	1982
24 hr	6.98"	Jan.	1982

Five Wettest Seasons		Five Driest Seasons	
(Rainfall Season Runs July 1 - June 30)			
46.00"	1888-89	10.41"	1975-76
39.01"	1894-95	11.57"	1923-24
37.15"	1957-58	12.02"	1976-77
36.98"	1972-73	12.20"	1931-32
35.60"	1973-74	12.32"	1958-59

Maximum Precipitation in One Hour by Month (1955-81)

January	0.55"	1970
February	0.59"	1962
March	0.66"	1975
April	0.88"	1958
May	0.42"	1957
June	0.10"	1972
July	0.06"	1974
August	0.24"	1976
September	0.47"	1959
October	0.48"	1962
November	0.60"	1981
December	0.98"	1969

[2]24-hour period from midnight to midnight. Maximum rainfall for any 24-hour period is currently being calculated.

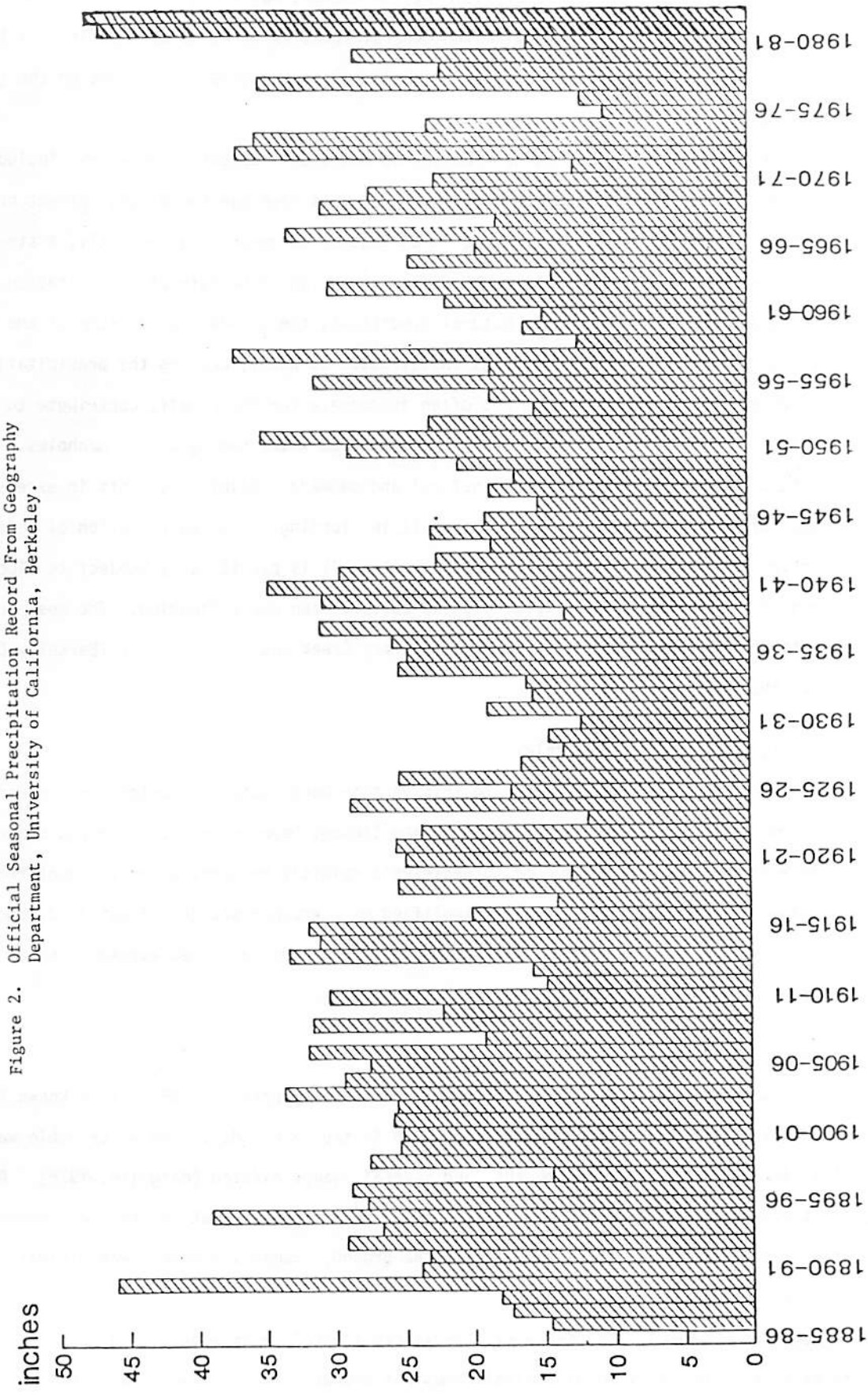

Figure 2. Official Seasonal Precipitation Record From Geography Department, University of California, Berkeley.

Rainfall is a primary cause of flooding, of course, but there are other factors. For instance, Berkeley's topography helps determine the general location of flooding. Berkeley's topography consists of hills, a piedmont and an alluvial plain. Flooding generally occurs on the gentle slopes of the piedmont or the flat alluvial lands.

Another factor contributing to flooding is man's development in Berkeley, including construction of culverts, paved streets and storm drains. Culverts have had the biggest effect on flooding, by filling or becoming blocked with debris in an intense downpour. Consequently, a stream may be diverted, causing much damage along its new course. Increased runoff because of concentration of flow due to paving is another problem. Under natural conditions, the ground absorbs some of the rainfall, storing it as groundwater. Pavement prohibits infiltration of water, causing the precipitation to run off all at once. Storm drains, which are often inadequate for the runoff, contribute to flooding, especially in the streets. Traffic tie-ups result from water coming out of manholes.

The causes of flooding are both natural and manmade. Rainfall amounts in excess of 1.5 inches per day, or .7 inches per hour usually result in flooding. The low elevation of West Berkeley makes it perhaps the most flood-prone area of the city. It is particularly subject to flood damage during periods of high tides. Undersized, clogged culverts can cause flooding. The most common overflowing culverts are found on Strawberry Creek, at Oxford Creek and Harwood CReek (Berkeley Daily Gazette, October 15, 1962).

A Chronology of Floods in Berkeley

All accounts of flooding given in this section were found by examining old newspapers in the Newspaper Room at Doe Library. Geography Graduate Student Dave Larsen, the current University of California Weather Observer, guided me to Berkeley's rainfall records, where I pinpointed the periods of most intense rainfall. This greatly simplified my newspaper search. I obtained some flood damage information from Glenn Carlos, a City of Berkeley engineer, and Fred Warnke, Manager of Grounds Services for the University of California Facilities Management.

The Early Years

Though it is unclear how much rain fell on Berkeley prior to 1886, it is known that much more surfacewater and groundwater existed then than is the case today. The water table was higher, large deltas formed at the streams' mouths, and several swamps existed (Margolin, 1978). A lake was located near the junction of Ashby, Adeline and Grove. This suggests that pre-record flooding could have been serious at times, given the saturation of the ground. Damage, however, was minimal or nonexistent, since development was so limited.

Between 1849 and 1886, Berkeley experienced several major storms. In fact, the wettest season experienced by Berkeley in historical times was probably 1861-62, when 49 inches of precipitation fell

in San Francisco. This is around 225% of San Francisco's and Berkeley's normal rainfall. Eight other seasons between 1849 and 1886 had at least 150% of average precipitation. Intense rains in December, 1871, when it rained for 60 hours continuously, produced widespread damage. Torrential rains flooded streets and halted trains in San Francisco.

The Floods of 1904

The first major flood damage of the twentieth century occurred on February 12, 1904, when approximately five inches of rain fell on Berkeley in 24 hours (Berkeley Daily Gazette, February 12, 1904). The storm, which brought some of the most intense rainfall in Berkeley's recorded history, disrupted public transportation and produced major flooding in the western part of the city. Several feet of water stood at many intersections in the lowlands.

The north fork of Strawberry Creek also overran its banks, sweeping down Euclid Avenue in a torrent. After crossing Hearst Street, it regained its channel, swelling until it flowed over the bridges in its path.

The Flood of January 2, 1916

Twelve years later, the Berkeley City Engineer stated in his storm damage report of January 2, 1916 that "the greatest rainfall in history" had occurred, dropping 1.15 inches in one hour, possibly a record to this day. It was estimated that for a few minutes rain fell at the rate of 10 inches an hour (Berkeley Daily Gazette, January 13, 1916). Considering the storm's intensity, Berkeley's damage was relatively light. Cost to the city was several hundred dollars, not including the expense of replacing the screenings and sand washed off the streets. The city's storm system performed well under the extreme conditions with only the streets east of Shattuck Avenue taking a beating.

Actual stream flooding took place at various locations in northeast Berkeley. A small creek flowing out of "the old quarry" overflowed when its intake became blocked, damaging property on Shasta Road and Tamalpais and Leroy Avenues. Public and private property were covered with debris.

Flooding took place on Codornices Creek, north of Spruce Street, a location that regularly flooded historically (Berkeley Daily Gazette, January 13, 1916). The damage to adjoining property was caused by overflowing sewers. Upstream, bulkheads were undermined and had to be repaired. Downstream flooding caused even more damage. The bridge over Codornices Creek at Stannage had to be repaired due to the loss of several supporting posts. A northern branch of Codornices Creek became clogged, causing flooding which heavily damaged the slope on the west side of the street. The Engineer's Report concluded that "it has been necessary to stop all other work and confine our efforts to taking care of these emergency conditions and will claim the attention of the regular force of the department for several weeks" (Berkeley Daily Gazette, January 13, 1916).

The Floods of 1925 and 1927

In 1925 and 1927 there occurred three floods which did minor damage to the University. On the 12th and 15th of February, 1925, Strawberry Creek rose enough to do considerable damage (The Berkeleyan, February 13, 1925). On the 12th, the swollen creek washed out a protecting wall. As a result, the stream straightened itself, steepening its gradient. On February 16, a headline in the University newspaper read: "Strawberry Creek Carries Soil at the Rate of 30 Tons Per Hour." The Creek became a river and "tore huge rocks away" from its banks. On February 24, 1927, the foundation of a campus building was washed away by another powerful flood, although the building itself was not endangered (The Berkeleyan, February 24, 1927). The foundation was repaired, and the building survived a number of later floods.

The 1940 Floods

During 1940, a record-setting storm passed through the San Francisco Bay Area, wreaking havoc in its path. The Sacramento-San Joaquin River Delta, Russian River Valley, and Sacramento Valley all suffered major damage from flooding and levee breakage. The Sacramento River overflowed, flooding farm lands (Berkeley Daily Gazette, February 29, 1940). By March 5 of that year, the flooding had caused nine deaths, 15 million dollars in damage and left epidemic disease in its wake. Berkeley was not spared from floods, which hit local merchants with $200,000-$250,000 in damages (Berkeley Daily Gazette, February 28, 1940).

February 1940 became the wettest February ever, due to this storm, which dropped seven inches of rain in 48 hours on the 27th and 28th of the month. Flooding was especially bad on the north side of town. The culvert carrying Strawberry Creek, which passed directly under Reid's Pharmacy at Hearst and Euclid Avenue, exploded there after being clogged by a fallen tree or a tree stump. The raging creek tore right through the store, destroying most of the merchandise. Damage was estimated at $20,000. Three adjacent stores had silt marks three feet high on their walls.

After breaking out of the pharmacy (Figure 3) the renegade creek raced down Hearst, turned on Shattuck, and finally went down University Avenue. A 17-block area was covered with several inches of a yellow mud.

Some of the other stores affected by this incident were the Euclid Food Store, whose plate glass windows were taken out by the torrent, and a laundry shop which had more than 100 bundles of cleaned laundry soaked in the mud.

Some of the flow from the North Fork of Strawberry Creek continued across Hearst to its usual channel, tearing up a fence and the chancellor's garden on its way. The creek ran onto Center Street due to a blocked culvert, and continued to the bay on Addison Street and Allston Way. Merchandise from Northside shops--heads of lettuce, cameras, candles, decks of cards, and a thousand other items--

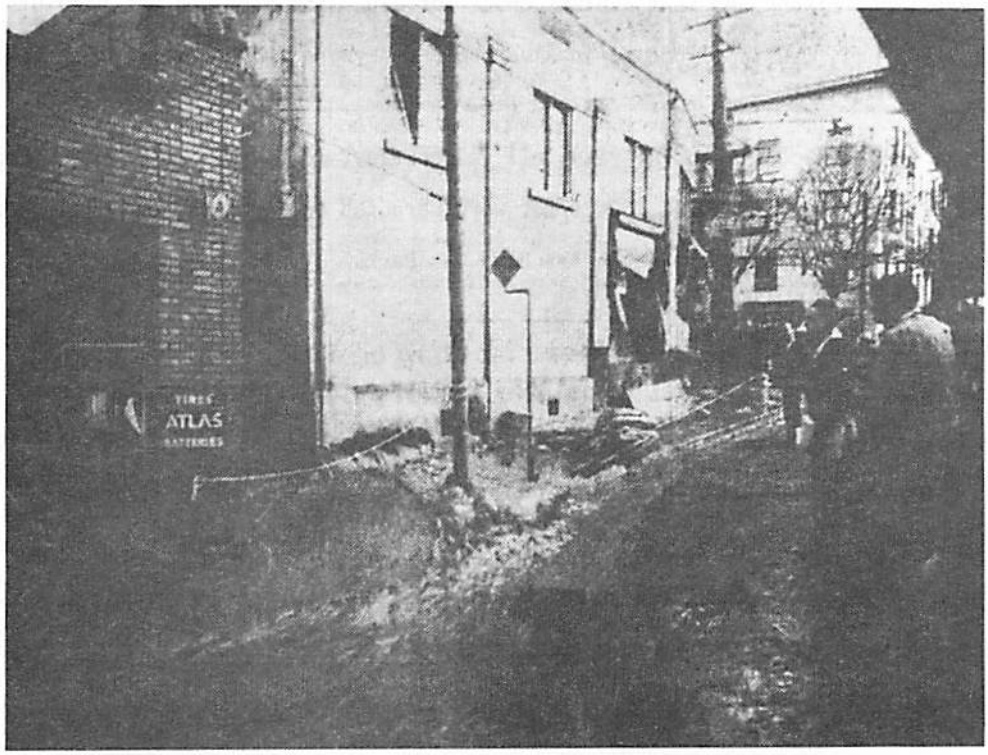

Figure 3. Strawberry Creek pours out of a building in which a culvert exploded.
Source: Berkeley Daily Gazette, February 28, 1940.

flowed down past Shattuck Avenue to Sacramento. Students at the University of California had a good excuse for not taking final exams; 20,000 bluebooks were among the losses. Mud was ankle-deep at Berkeley High School on Milvia. In front of City Hall on Grove Street one could find soap bars, cameras and other items amongst the muddy ooze.

A closed culvert caused Strawberry Creek to jump its banks on Browning Street between Allston and Addison. It raced across the street, barging into a recreation hall, where it displaced a piano.

On March 30, 1940, Reid's Pharmacy was again threatened by a lasting downpour (Berkeley Daily Gazette, March 30, 1940, p. 1). This time, however, the city engineers were forewarned and they relieved the pressure on Strawberry's North Branch culvert by diverting its swollen contents at Le Roy and Ridge Road.

The Storm of 1955

The storm of December 21 to 30, 1955, caused more damage in California than any natural disaster since the 1906 earthquake. Fifty thousand people were rendered homeless and 60 died as a result of major flooding on every river in the northern part of the state. The worst flooding occurred at Yuba City, where the Feather River crested twice, wreaking havoc and necessitating martial law. Twelve thousand acres of farmland were inundated. A war-like mobilization was ordered to aid the

stricken areas and President Eisenhower sent a blank check for aid. The Bay Area was hard hit as well. Levees broke in the South Bay, causing flooding in Alvarado and Hayward and Richmond, that lasted several days.

During December a record 15.04 inches of rain fell in Berkeley, mostly during the last eight days of the month. No major damage was reported, but trees were uprooted on San Luis Road, Telegraph Avenue, Shattuck Avenue, Florence Street, Northampton and at Live Oak Park.

The Storms of September 17, 18 and 19, 1957

May 1957 is the wettest May on record. Helped by a 24 hour total rainfall of 2.19 inches on May 18, that month's rainfall came to over 5 inches (Berkeley Daily Gazette, May 18, 1957). Despite this intense downpour, no flooding was reported.

Later that same year, on the 17, 18th and 19th of September, a heavy storm hit Berkeley. Damage was limited to downed power lines, uprooted trees and some auto accidents. A car was trapped at Bancroft and Browning Street with water up to its window, most likely a victim of Strawberry Creek overflowing its banks (Berkeley Gazette, May 18, 1957).

The Columbus Day Storm of 1962

The most damaging storm ever to hit Berkeley began on Friday, October 12, 1962, and lasted three days. On the 12th, 0.48 inches dropped in one hour and 3.95 inches fell in a 24 hour period. Berkeley's rainfall hit record-breaking highs, damaging the University considerably. The incredible amount of rainfall of Friday the 12th and Saturday the 13th caused Chicken Creek, a tributary of Strawberry Creek in Strawberry CAnyon, to overflow at the culvert above Haas Club House (Lennert and Associates, 1963). THis overflow from Chicken Creek, combined with mud from slides in the canyon, flooded the entire Strawberry Canyon Recreation Area. The muddy torrent went right through Haas Club House and filled the swimming pool with mud and debris. At Rimway Road, the mud river split in two directions, part heading for Cowell Hospital, deluging that building with mud and water, while the other part passed through the International House. It broke the ground floor window, entered the lobby as a wall of mud and debris several feet wide and six inches deep and exited through the main doors. After pouring down the stairs, it followed a downhill course on the Berkeley streets. As much as three feet of mud covered some areas of the canyon. Actually, the Chicken Creek outflow had been diverted purposely by the University engineers to avoid greater damage by the overflow of Strawberry Creek.

Strawberry Creek overflowed its banks above Sather Gate, flooding the ASUC offices and basement. Even the garage was not spared, as water poured down through the drains. Below Dwinelle Hall in the Eucalyptus Grove, Strawberry Creek was 20 feet wide; over five times its normal width. The culvert at Oxford and Center Street overflowed, sending water down Center Street.

Mud from construction sites at Etcheverry Hall, Wurster Hall, Barrows Hall and the Biochemistry Building added to the damage. Etcheverry's construction was set back several months. Damage to the University came to $100,000. A 40-man crew worked from Friday, October 12, until Tuesday the 16th in Strawberry Canyon, clearing away the mud and debris.

Elsewhere in the city, many roads and buildings were flooded. A school had to be closed due to a flooded cafeteria (Berkeley Daily Gazette, October 15, p. 3). Accumulation of rainwater on the roof of a sporting goods store on Telegraph Avenue caused the building to collapse. Both KPFA and KRE, whose buildings flooded, had to go off the air for six hours. The biggest worry, however, was a broken sewer line near the Oakland border that poured raw sewage into the neighborhood.

This, the "Columbus Day Storm," had a colossal 1100 mile front wreaking havoc from California to Canada. Six deaths occurred in Northern California. In the Bay Area, the Nimitz and the Eastshore freeways had to be closed for the first time in their histories. The Caldecott Tunnel was closed for weeks after mud and water knocked out its generators.

The Storm of December 22, 1969

The next major storm of note hit Berkeley on December 22, 1969, when 0.98 inches fell in one hour and 2.96 inches fell in a day, setting two records. Flooding occurred at Spenger's and throughout much of West Berkeley as a result of high tides coinciding with the storm. A retaining wall at Codornices Tennis Courts crumbled under the weight of the adjoining hill.

One month later, on January 20, 1970, a record 4.37 inches of rain fell in a 24 hour period. Longfellow School was seriously flooded. Rain water backing up the sewer created a reverse flow of water and effluent from the basement toilets, necessitating its evaculation (Berkeley Daily Gazette, January 22, 1970).

The 1981-1982 Season

The record-setting season of 1981 to 1982 will long be remembered for the torrential downpour of January 4, 1982, when 6.98 inches of rain fell, setting an impressive one day and 24 hour record. Damage in Berkeley was widespread. Two hundred homes, several schools, and seemingly every intersection were flooded. The Berkeley Support Services Hotel at Fourth and Harrison Streets closed when water backed up through the sewers and seeped through the walls. Occupants had to be put up at the Red Cross Shelter in Albany at the high school gymnasium (Berkeley Daily Gazette, January 5, 1982). King Jr. High had standing water in the cafeteria, as well as in the counseling complex. Flood waters extinguished the furnace at Longfellow, Franklin and Cragmont Schools (Berkeley Daily Gazette, January 6, 1982). Water damaged books at Columbus School by seeping in through the walls. A lake formed in the Columbus parking lot, much to the satisfaction of the students, who were hoping for a new swimming pool anyway. Fortunately for PG&E, only minor power outages occurred for short periods of time.

Summary

This paper describes the nature and cause of flooding in Berkeley, and provides a chronicle of flood events. Timing of floods coincides with intense rainfall, usually of two inches or greater during a 24 hour period. High tides, coinciding with the storm, often intensify floods in West Berkeley. The basic underlying factors contributing to flooding include man's construction, topography and precipitation. The most common cause for flooding stems from culverts clogging up, either from debris or too much water.

The most outstanding floods took place in February, 1940 and October, 1962. In both cases, culverts unable to carry all the storm runoff caused serious flooding. Therefore, to alleviate the problem, larger culverts need to be put in the trouble spots, which have been identified previously as various locations on Strawberry and Harwood Creek. With these preventive measures, flooding as a recurring problem should lessen.

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