CHAPTER 4.
YAKIMA RIVER FLOODING CHARACTERISTICS

Flooding is common in Yakima County. Since 1894, the flow in the Yakima River has exceeded flood stage 48 times. Yakima County has been declared a federal disaster area eight times since 1970, most recently in 1990, 1995, 1996 and 1997. However, historical flood events and associated damage are often forgotten over time. Extended mild weather or construction of flood control facilities can provide a false sense of security. Floodplain residents should realize that neither the construction of flood-control facilities nor the lack of recent flood damage guarantees safety from future flood damage. Lessons learned from past floods should not be forgotten; flooding will occur again and it could be worse than even the most severe historical floods.

COMMON FLOOD CHARACTERISTICS

A variety of flood characteristics determine the extent of flood damage within Yakima County. Some flood problems are obvious, such as damage to homes and inundation of farmland. However, many other flood problems are less obvious or are indirect results of flooding: forced evacuations, erosion and loss of property, contaminated water supplies, diversion of public resources, loss of public utilities and facilities, etc. Together, these problems cost property owners and taxpayers money (whether they live in the floodplain or not), disrupt lives and commerce, and burden governments with continual maintenance and emergency services problems.

Flood problems are typically addressed by modifying historical flooding patterns. For example, floodwater inundation can be addressed by confining flood flows between levees to change floodplain conveyance and storage capacity. However, modifying one flooding pattern generally results in negative effects elsewhere. Therefore, the impact of flood control facilities should be examined comprehensively before such facilities are installed. This requires an understanding of the key characteristics of floods: flood magnitude, flood duration, channel migration, sediment transport and deposition, the effect of levees, the effect of roads and bridges, and the effects of storage reservoirs.

Flood Magnitude

Flood magnitude is the peak flow during a flood event, and is highly dependent on weather and runoff conditions. Higher flood flows (flood magnitude) typically inundate more of the floodplain and cause greater damage. However, lower magnitude floods can also cause heavy flood damage. The January 1974 flood on the Yakima River produced greater damage than the December 1977 flood because of ice jams and ice debris, even though the 1974 flood magnitude was less.

The importance of flood magnitude varies among the different reaches of the river. In leveed river reaches, flood damage increases substantially when the flood magnitude exceeds the protection provided by the levee. However, if the flood magnitude is contained within levee reaches and the levees are structurally sound, damage will be limited and independent of the magnitude of the flood.

Flood Duration

Flood duration is the total time flood flows are experienced. The total volume of water in a flood is directly related to flood duration—longer floods produce a greater volume of floodwater. Floodplains act as storage areas to absorb or detain floodwater. During short floods, floodplain storage may significantly reduce the magnitude of the flood as it travels downstream. When floodplain storage is filled because the flood lasts longer or because of development in the floodplain, the flood peak is not reduced with movement downstream, and greater downstream flooding results. Most of the floodplain storage in the CFHMP study area is upstream of Selah Gap and directly above Union Gap. The construction of levees has reduced the amount of storage between Valley Mall Boulevard and Selah Gap.

The bed and banks of a river will begin to move or erode when the flow reaches a certain level, called the entrainment threshold. At flows above the entrainment threshold, the bed and banks of the river or stream are in a state of motion, with larger sediments (sand and larger) bouncing down the river channel as bedload. The duration of the flood above this threshold directly effects the amount of total bedload movement, channel migration, and bank erosion. In the Gap-to-Gap reach, this entrainment threshold is estimated at 7,500 cfs (Dunne, 1976). Floods with long durations tend to damage infrastructure such as roads, bridges, levees and irrigation diversions. For example, the 1997 flood was only approximately a 5-year flood when evaluated from the standpoint of peak flow, but was the longest flood on record. The flood hydrograph for this flood is shown in Figure 4-1. This flood was a very large "energy" event, 86 days of flow above the entrainment threshold, more than any other recorded flood event. Damage from this flood was more related to bridge pier and abutment failure (Donald-Wapato Bridge piers), and levee failure (Yakima WWTP levee).

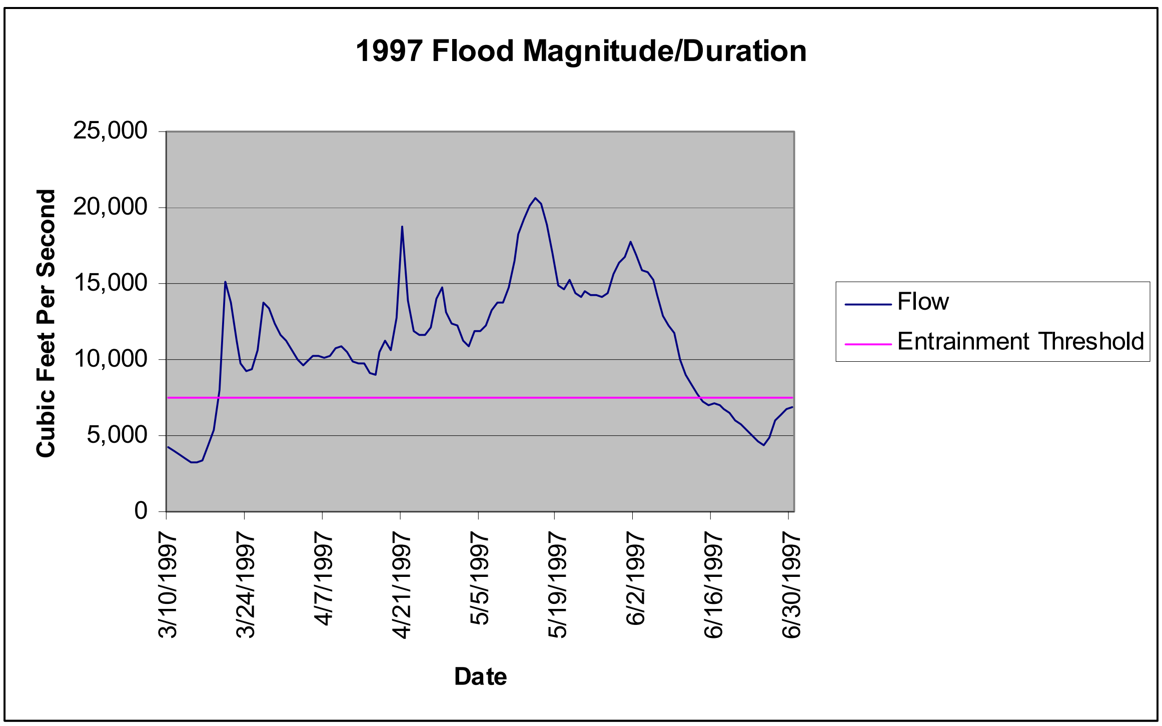

Figure 4-1. 1997 Flood Hydrograph for Yakima River at Union Gap.

The flow values portrayed in Figure 4-2 for the 1996 flood are daily means. The instantaneous peak flow on February 11th was over 53,000 cfs. The 1996 flood approached the 100-year flood within the plan river reach. The 1996 flood hydrograph shown in Figure 4-2 shows the duration of the flood above the entrained threshold to be 25 days.

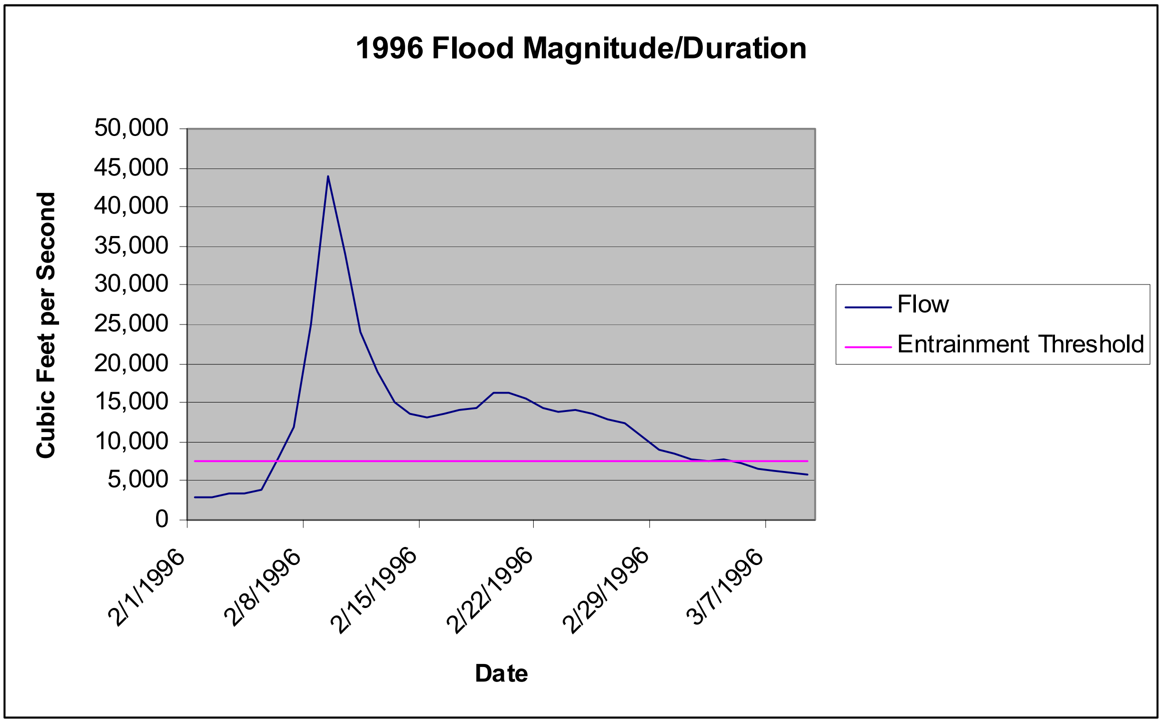

Figure 4-2. 1996 Flood Hydrograph for Yakima River at Terrace Heights.

In the Yakima Basin there is a modified relationship between flood magnitude and flood duration due to flood storage regulation. The US Bureau of Reclamation has 5 irrigation storage reservoirs in the upper basin that are also managed for flood control during late winter and spring. Flood control at the reservoirs is managed to maintain a flow of less than 12,000 cfs at Parker, just downstream from the Union Gap and 17,000 cfs in the upper Yakima Reach. In order to reduce flood magnitude, the reservoirs are used for storage, and release (generally) after the natural flood peak has past, this stored water is released in a manner to maintain flows at these levels. As this is generally above the entrainment threshold of 7500 cfs, it generally results in longer flood duration in most cases. Floods with lower peaks may cause less damage due to inundation of the floodplain, but the lengthened duration of floods may also increased damage to infrastructure such as bridges, levees, and irrigation diversions, as well as increased rates and duration of bank erosion.

Channel Migration

River channel migration is the natural process of a river channel moving across the river valley over time. A river dissipates its energy by migrating across the floodplain. Diverting or confining the river along one reach will focus the river's energy on another, unconfined reach, where the rate of channel migration may increase.

The Yakima River's steep gradient and easily erodible alluvial channel bed promote channel migration in the Yakima Valley. Historical aerial photographs show a significant number of abandoned channels (Figure 4-3). Areas historically occupied by the river are now occupied by human development. The historical aerial photographs show rapid channel shifting, with lateral (side-to-side) migration averaging 30 feet per year and ranging up to 75 feet per year (Dunne 1988). Figure 4-4 shows relative migration rates for floodplain areas between Selah and Union Gap. Lateral activity is greatest below the SR 24 bridge and in three areas above SR 24. This movement must be considered when siting structures or flood control facilities.

The Yakima River has also exhibited *channel avulsion* – a sudden breach of the riverbank that develops a new channel. The new channel may take a completely different course than the original channel, or may re-occupy an old side channel. This new channel may eventually convey most of the river flow. Channel avulsion presents a significant flood hazard because it can divert floodwaters into areas that historically experienced only minor flooding. They also happen suddenly and are hard to predict, posing a constant threat to any structures in the floodplain.

Along the Yakima River, the potential for channel avulsion has been accentuated by gravel mining. Deep gravel pits have at times been excavated within the floodplain with only gravel levees separating the river channel from the gravel pit. During a large flood, floodwaters may often cause these levees to fail and redirect flow away from the main channel. The channel may stabilize a significant distance away from its previous location and isolate businesses, homes, or farmland. In 1972, a gravel pit near Union Gap was captured by the river; the abandoned State Highway pit upstream of Terrace Heights Boulevard has also been captured, the Selah ponds were temporarily captured in 1996, and the Edler Ponds, near Valley Mall Boulevard have also been captured.

Sediment Transport and Deposition

Gravel and sand and gravel bars deposited in the river channel promote channel migration and reduce the channel's capacity for floodwaters. Large quantities of sediment in the bed can be moved over short periods during flood events. Sediment deposition occurs where the river becomes flatter or wider, reducing the energy of its flow, and thus its *sediment transport capacity*, or its ability to carry sediment downstream. Sediment transport capacity increases through velocity increases at channel constrictions or steeper areas, which in turn lead to erosion or scour of the river bed.

Sand and Gravel enter the Yakima River from erosion of surrounding mountains, glacial sediment deposits in the Upper Yakima and Naches basins, and extensive sand and gravel supplies already located on the valley floor. Most of the fine sediment is carried in suspension by the river. The estimated average annual transport of suspended sediment is 183,000 tons per year at the Parker gauging station (Dunne 1976). Coarser sediments transported by rolling along the channel bed are called *sediment bed load*. Bed load at the Parker station is estimated to be 57,000 tons per year (Dunne 1976). For a river the size of the Yakima, the total sediment load (suspended load plus bed load) at Parker is not excessive; however, it is high enough that a flow obstruction or channel avulsion would result in sediment deposition and possible channel shifting.

Figure 15.--MAY 1948 FLOOD DAMAGE TO RESIDENCE ON KEYES ROAD

Residence of Mr. Tymboeck downstream of Terrace Heights Bridge on Keyes Road. Many residences suffered damage in this district. (Photo courtesy of Bureau of Reclamation.)

Figure 4-3a. Keyes Road, May 1948.
Photo from "Flood Plain Information" Prepared by Washington State Department of Water Resources and the U.S. Army Corps of Engineers, 1970.

Figure 5.--AERIAL VIEW OF MAY 1948 FLOOD AT SELAH GAP

Aerial view looking upstream from twin U.S. Highway 99 bridges north of Yakima.

Figure 4-3b. Selah Gap, Looking Upstream.
Photo from "Flood Plain Information" Prepared by Washington State Department of Water Resources and the U.S. Army Corps of Engineers, 1970.

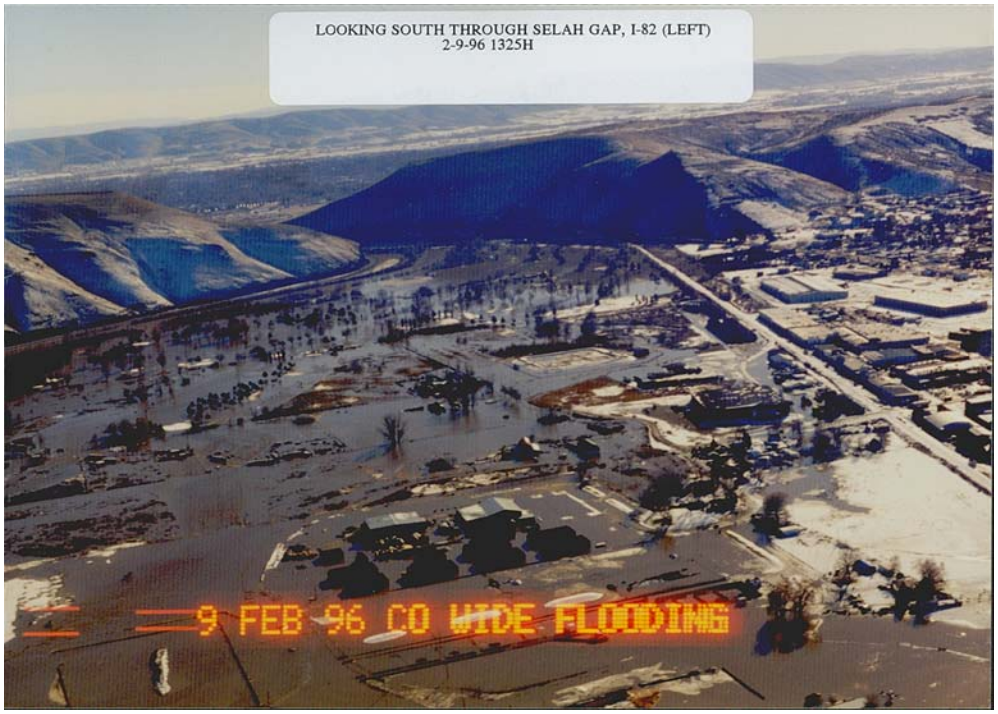

Figure 4-3c. Selah, Looking Downstream to Selah Gap, February 1996.

Figure 4-3d. City of Yakima Sewage Treatment Plant, February 1996.

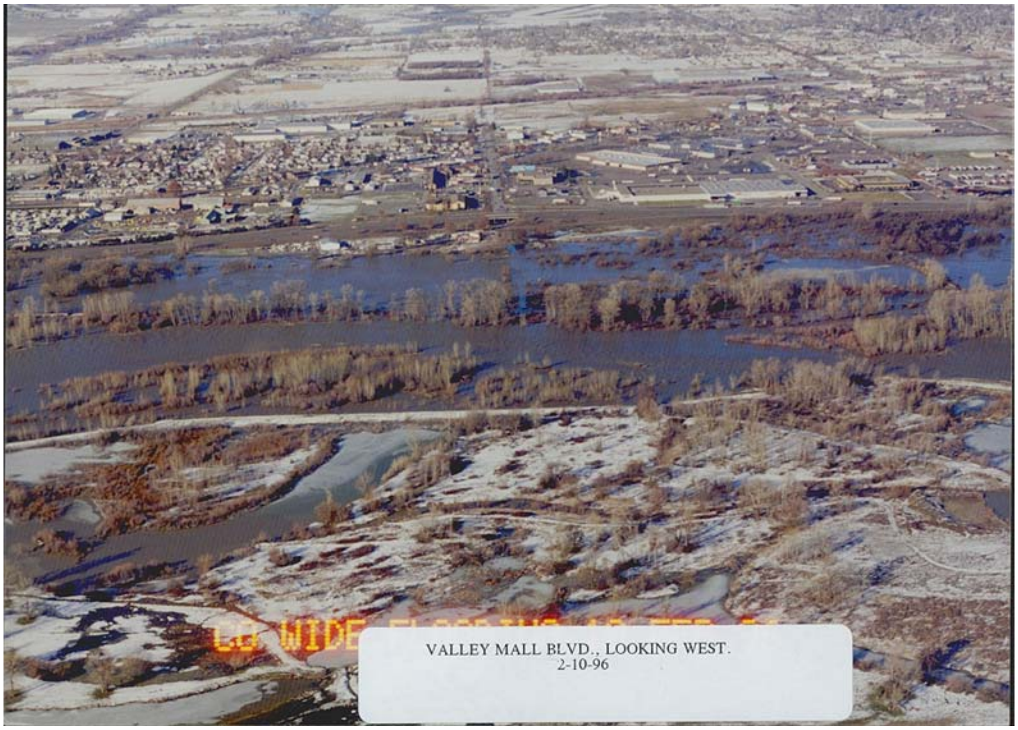

Figure 4-3e. Yakima River at Union Gap, Looking West. February 1996.

Figure 4-3f. Yakima River Capturing Edler Pond, near I-82 East of Union Gap, May 18th, 2006.

The effects of sediment transport along the Yakima River on flooding has been examined in the past (COE 1977), and more recently by Lorang in the Reaches Report (Stanford et. al. 2003). Decreases in levee protection from reduced flood freeboard have been attributed to sediment deposition and decreased channel capacity. Dredging of sediments has been proposed to increase flow capacity of the Yakima River near the City of Yakima wastewater treatment plant.

Effects of Levees

Levees attempt to keep floodwaters within a designated channel by confining them instead of allowing them to spill over into the floodplain. Levees provide a level of protection to floodplain residents; however, they can raise floodwater elevations upstream by creating a backwater effect, increase flow velocities on the levees, reduce side channel fish habitat, increase channel migration, and reduce the storage of floodwaters in the floodplain, leading to greater flood magnitudes downstream.

All levees and berms provide some level of flood protection. Many protect only during low-level, high-frequency floods, such as 1- to 10-year events. Small levees typically fail during significant flood events. Many farmers and businesses construct levees to prevent small frequent floods from causing damage such as killing crops, eroding banks, and depositing unwanted silt.

The Yakima River is lined with some form of low berms or levees throughout the CFHMP study area. Levees originally built following the 1933 flood from the mouth of the Naches River to the SR 24 bridge, as part of an extensive federal levee system, provide the highest level of protection. Portions of those levees that were not certified were upgraded in the 1990's to provide protection from the 100-year flood. Many non-federal levees are also located along the Yakima and Naches Rives. Diking District No. 1 has upgraded levees near SR 24, while the County maintains some riverbank levees along the Naches River; US 12 is certified as a levee along the lower Naches, and some private levees protect gravel pits and businesses.

Effects of Roads and Bridges

Road embankments and bridges in the floodplain can significantly affect flooding because they constrict floodwaters to narrow passages and therefore reduce conveyance capacity. Constrictions cause higher floodwater elevations upstream and higher flow velocities through the constriction. This can result in increased upstream inundation and increased scour in the high-velocity areas. The bridge structures also reduce velocities upstream resulting in large scale deposition of sediment bed-load. The improvement during floods through this sediment increases lateral movement of the river and attack on the river banks.

Several man-made and natural constrictions exist along the Yakima River. In the CFHMP study area, Selah Gap and Union Gap act as natural constrictions, eight bridges cross the Yakima River, and two cross the Naches River. Yakima River bridges include two Burlington Northern Railroad crossings, Harrison Road, Selah Highway, I-82, Terrace Heights Boulevard, and SR 24. Naches River bridges include the Twin Bridges just upstream of the confluence with the Yakima River.

Past Yakima River flooding has damaged several highway bridges. Bridges have been washed out, approaches eroded, and roadways overtopped with floodwaters. SR24 is being replaced due to its "scour critical nature" and the previous SR 24 bridge at what is now Birchfield road was replaced after scour damage that occurred in the 1948 flood. Terrace Heights, Old Moxee, and the Naches River bridges have all been replaced because of flooding. The February 1995 flood caused the Pom Pom bridge to fail and fall into Toppenish Creek.

Effects of Reservoir Storage

Six storage reservoirs exist in the Upper Yakima basin. They were originally constructed to provide irrigation storage for downstream farmland. However, since the 1933 flood they have been operated to reduce flood peak flows where practical and to provide irrigation storage. Since 1972 the Bureau has used a set of "Flood control rule curves" developed by the Corps as guidelines for operation of these reservoirs for flood control. (IOP, 2003)

Multi-purpose management of storage reservoirs is a complicated process. The effect of probable flood flows must be weighed against maximizing water storage for irrigation. When a flood occurs, a portion of the water is held in storage reservoirs to reduce peak flows. If storage capacity is available during a flood, peak flows can be greatly reduced. If storage capacity is not available, there will be little effect on peak flow, but if water levels are lowered in anticipation of a flood that does not occur, irrigation water supply is lost.

The effectiveness of reservoir storage is also influenced by storm location and conditions. If a significant storm is concentrated upstream of the storage reservoirs, downstream flooding will be limited. If a significant storm covers the entire Yakima basin, the storage reservoirs will have minimal impact on downstream flooding because they are located high in the basin.

FLOOD HISTORY

The Yakima River basin typically produces winter and spring floods. Spring floods are caused by snowmelt aggravated by periods of unusually warm weather and rainstorms. The magnitude of spring floods is generally moderate, but they can last 10 or more weeks, resulting in very large total volumes of runoff and river erosion. The more frequent winter floods are caused by rain on snow and warm winds that produce runoff from snowmelt and rain. They typically follow precipitation periods that have saturated the soil and replenished groundwater reserves, or extended periods of below freezing temperatures, which freezes the soil surface and causes even minor amounts of snowmelt to generate high rates of runoff. Historically, winter floods are the largest in magnitude, but their durations are typically less than one week, so the total volume of runoff is not as high as that of spring floods. The largest flood of record, the flood of December 1933, was the result of a winter rain-on-snow event. Upper basin reservoir storage typically reduces the magnitude of winter floods, which occur after the irrigation season when reservoir storage is available.

Conditions that cause winter and spring floods on the Yakima River also produce flooding in smaller tributary basins. Mid-valley creeks are susceptible to flooding during Chinook weather (snow accumulation followed by a period of warming temperatures, high winds, and heavy rainfall) due to their location and the limited number of trees in their drainage areas. Eastern tributary basins are susceptible to flash flooding caused by thunderstorms. Flood damage is frequent along the Wenas, Cowiche, Wide Hollow, Ahtanum, Toppenish, and Satus creeks.

The largest historical floods are summarized in Table 4-1 and documented flood damage is summarized in Table 4-2. Photographs of historical flood damage are included in Figure 4-3. The return periods for this table are probably an overestimate due to the occurrences of three of the 6 greatest floods after the USGS gage record period.

Major floods have been recorded in 1894, 1906, 1909, 1917, 1919, 1921, 1933, 1948, 1952, 1956, 1959, 1974, 1975, 1980, 1990, 1995, 1996 and 1997. For the CFHMP study, information on past floods was obtained from previous flood studies, newspaper accounts, disaster survey reports prepared for FEMA, and USGS and Bureau of Reclamation flow records. Yakima County Public Works and the Yakima Herald-Republic provided photographs.

The most recent significant floods in Yakima County are described below to examine present flooding conditions. The 1933 and 1948 floods are also briefly described for a comparison between recent flooding characteristics and historical flooding conditions. The floods described are typical for the study area and help identify areas susceptible to flood damage.

February 9, 1996, Flood

The February 9, 1996, flood was the second largest flood of record. Flow crested on the Yakima River at Parker at 57,500 cfs, which exceeded the predicted 100-year event of 56,300 cfs. Water elevations exceeded flood stage by over 6 feet at Parker. This flood was a typical winter event caused by unseasonably warm weather and rainfall on a significant snow pack. Weather conditions produced flood flows from snowmelt combined with rainfall runoff. Keechelus Reservoir reported over 11 inches of precipitation within a three-day period; 5 inches of rain fell in 24 hours on Wednesday, February 7. Flooding conditions were aggravated by ice jams on the Yakima River near Selah Gap and along tributary creeks.

Flood damage was region-wide, occurring both along the Yakima mainstem and tributary creeks. Areas receiving the greatest damage included the Upper Naches, Selah, Ahtanum Creek, Wapato, White Swan, and Toppenish. Within the study area, several million dollars of flood damage occurred. Damage was primarily associated with roads, Yakima Greenway facilities, levees, wastewater treatment facilities, and residential property in Selah. More significant damage occurred outside the study area. The flood required the rescue of 30 people in Selah stranded at the Elks Golf Course lodge; an airlift of 20 people in White Swan by the National Guard; and evacuation of 30 residents in Ramblers Park near Gleed, 200 residents near Nile, and residents near Keys Road, due to a threat of a levee failure.

TABLE 4-1.
LARGEST YAKIMA RIVER FLOODS

Date	Measured at Parker Dam: Flow (cfs)	Measured at Parker Dam: Stage[a] (feet)	Return Period[b] (years)	Comments
December 23, 1933	65,000	17.7	200	Largest flood of record. Resulted in construction of extensive federal levee system.
February 9, 1996	57,500[c]	16.2	100	Yakima Co. declared a fed disaster area.
December 1917	52,900	16.8	95	
May 29, 1948	37,700	15.0	30	
November 30, 1995	36,000[c]	14.6	25	Yakima Co. declared a fed disaster area January 3, 1996.
December 13, 1921	35,800	14.7	25	
November 26, 1990	35,620[c]	14.5	25	Yakima Co. declared a fed disaster area.
November 25, 1909	35,000	14.6	22	
December 2, 1977	34,320	14.0	20	Yakima Co. declared a fed disaster area.
December 27, 1980	31,675	13.4	18	
January 16, 1974	27,700	13.3	11	Yakima Co. declared a fed disaster area.
December 4, 1975	27,600[c]	13.3	11	Yakima Co. declared a fed disaster area.
November 24, 1959	27,400	13.2	10	Yakima Co. declared a fed disaster area.
June 16, 1916	24,800	12.7	9	
February 21, 1982	23,414	11.6	7	
January 31, 1965	22,900	12.3	7	Yakima Co. declared a fed disaster area in December 1964.
June 3, 1913	22,600	12.2	5	
February 1, 2003	22,322[c]	Not Available	5	
January 23, 1919	20,600	11.8	5	
March 14, 1972	20,200	Not Available	5	
May 30, 1917	19,800	Not Available	5	
January 17, 1928 January 26, 1935 May 20, 1956	19,600 19,600 19,600	Not Available Not Available Not Available	5 5 5	
February 21, 1995	19,486[c]	11.3	5	
April 21, 1997	19,448	Not Available	5	Yakima Co. declared a fed disaster area in January 1997.

a. Flood stage equals 10 feet.
b. Based on flood for the Yakima River at Parker frequency curve for the period 1908-1976. (excludes recent events)
c. From BOR gage.

TABLE 4-2.
DOCUMENTED FLOOD DAMAGE IN YAKIMA COUNTY

Flood Event	Damage Type	Total Damage	Year of Estimate	Source
February 9, 1996	Private	$5,000,000	1996	Lacey 1996 p.c.
	Public	$5,349,861		Lacey 1996 p.c.
	COE levees	$376,000		COE 1996
	State Roads	$6,845,000		WSDOT 1996
	Emergency Shelters	$150,000		Scofield 1996 p.c.
	Total	**$17,720,861**		
February 21, 1995	Debris Clearance	$271,000	1995	Yakima County
	Road Systems	$230,000		
	Pom Pom Bridge	$150,000		
	Emergency Response	$54,000		
	Total	**$705,000**		
November 26, 1990	Debris Clearance	$3,116	1990	Yakima County
	Protective Measures	$2,000		
	Road Systems	$22,257		
	Water Control Facilities	$21,855		
	Parks	$38,110		
	Total	**$87,338**		
December 27, 1980	County roads and dikes	$50,000	1980	Yakima Herald-Republic
December 2, 1977	Private homes	$1,300,000	1977	Yakima Herald-Republic
	Dikes and Levees	$280,000		
	Local business	$147,500		
	Roads and Bridges	$45,000		
	Other	$90,000		
	Total	**$1,862,500**		
December 4, 1975	Public facilities	$400,000	1975	FEMA (1994)
January 16, 1974	Homes in Yakima County	$5,400,000	1974	Yakima Herald-Republic
	Agricultural Damage	$3,000,000		
	State Highways	$2,000,000		
	Indian Res. Roads, Bridges	$1,500,000		
	County Roads	$1,000,000		
	Total	**$12,900,000**		
January 31, 1965	County Roads in West and Upper Valleys	$30,000	1965	Yakima Daily Republic
December 23, 1933	Unknown	$1,000,000	1933	Yakima Daily Republic

Significant damage includes the following:

- Damage to the Yakima Greenway exceeded $800,000 (Foundation 1996). The Plath and Jewett Pathways were hit hardest.
- Over $8.8 million damage was associated with County and State Roads (Lacey, E., 1 March 1996, personal communication; WSDOT 1996). The most extensive road damage was in the Ahtanum, Toppenish, and Yakima River drainages.

- The City of Yakima's industrial wastewater spray field had an estimated $830,000 in damage (Lacey, E., 1 March 1996, personal communication).
- An estimated $474,000 was spent by the County for protective measures (Lacey, E., 1 March 1996, personal communication).
- The COE reported damage to the Rambler Park levee ($130,000), City of Yakima Spray Irrigation Field levee ($86,000), City of Yakima Water Treatment Plant levee ($51,000), and authorized federal levees ($109,000) (COE 1996).
- The Eagle Rock and Rattlesnake bridges were washed out.
- The American Red Cross spent approximately $150,000 to operate emergency shelters in Yakima County.

Yakima County was declared a federal disaster area. As of May 23, 1996, FEMA had received over 1,780 applications for disaster assistance. Requests for private assistance were estimated to exceed $5.0 million and requests for public assistance were estimated at over $92 million (Lacey, E., 1 March 1996, personal communication). As of May 23, 1996, FEMA had provided $5.3 million in assistance for public facilities. This figure does not include funding provided by other agencies such as COE and American Red Cross. Protective measures and road systems accounted for the largest portion of requested federal funding assistance (Figure 4-5).

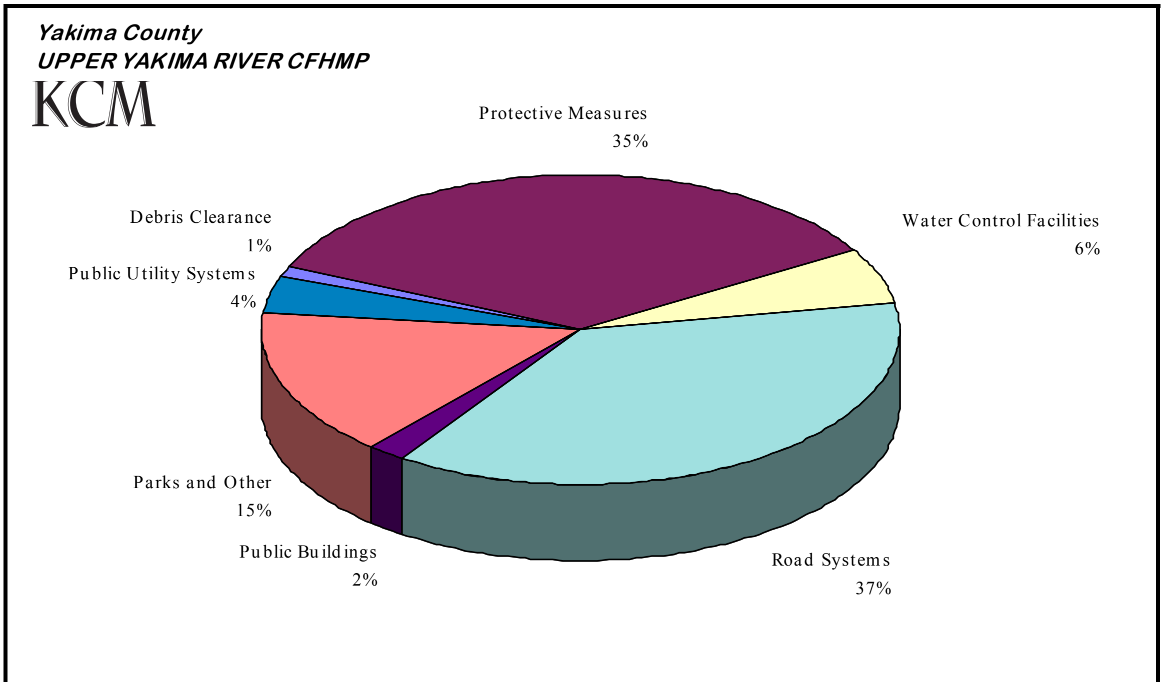

Figure 4-5.
DISTRIBUTION OF PUBLIC ASSISTANCE FOR THE FEBRUARY 1996 FLOOD

Flood data compiled from the February 9, 1996, event is included in the 1998 Upper Yakima River Comprehensive Flood Hazard Management Plan. Data includes FEMA GIS maps showing geographical distributions of disaster applicants, repetitive loss areas, and location of participants in the National Flood Insurance Program. This data also includes a listing of damage survey reports and damaged county roads. County roads damaged during the flood are shown in Figure 4-6.

November 30, 1995, Flood

The "Pineapple Express" brought record high temperatures of up to 66 degrees to the Yakima Valley in late November and early December 1995. Keechelus Reservoir, located at the head of the Yakima River near Snoqualmie Pass, received 10 inches of rain in a 48-hour period, November 29 and 30. Precipitation at Keechelus was 200 percent over normal for the water year. Warm temperatures melted the existing snowpack and, combined with heavy precipitation, resulted in flooding on the Yakima and Naches Rivers. This flood exceeded the levels of both February 1995 events, and was similar in many respects to the 1990 flood. Both floods are estimated to be in the order of 25-year floods.

The winter flood caused the Yakima River at Parker to crest on November 30 with a flow of 36,000 cfs. This flow reached an elevation of 14.61 feet, over 4½ feet above flood stage. Though the flood was primarily a mainstem event, high water was also present on Rattlesnake Creek, which flows into the Naches River near Nile. The hardest hit areas were Nile along the upper Naches River, Selah Gap, and Parker in the lower valley. Several homes near Selah, Parker, and Buena were evacuated. At least 10 County roads (Powerhouse, Craig, Long Lane, Lewis, Nile Loop, Donald, Parker Bridge, East Wapato, and Phillip John) and SR 22 between I-82 and Toppenish were closed at various times over a three-day period preceding and following the flood crest. A total of 60 homes countywide were evacuated.

Preliminary damage assessments found 19 damaged homes in Yakima County, 7 of which sustained major damages. No homes were destroyed. The approach to the bridge over Rattlesnake Creek at Nile Loop Road was destroyed. Damage to county facilities totaled an estimated $174,000 to $200,000. An additional $50,000 to $60,000 damage was sustained by Yakima Greenway facilities, including a section of the Greenway Path at Harlan Landing, damage to Robertson Landing, and minor erosion to portions of the unfinished Plath Pathway. This event resulted in a Presidential disaster declaration; however, damage was minor in the study area.

February 1995 Floods

January 1995 was the wettest January on record in the City of Yakima and the City's third wettest month on record, with a total precipitation of 3.67 inches; the wettest months on record were December 1964, with 4.19 inches, and December 1931, with 3.75 inches. These amounts are very high for an area with average annual precipitation of only 8 inches. Saturated soils, continued precipitation, and unseasonably warm temperatures produced typical winter flooding in February 1995.

Flooding occurred twice in February. The Yakima River at Parker crested on February 1, with a flow of 16,930 cfs, and again on February 25, with a flow of 19,486 cfs. These flows reached elevations 0.8 feet and 1 foot above flood stage, respectively. The Yakima River crested without overflowing its banks during the February 1 flood, and produced minor flooding near Selah and Parker during the late February flood The region's smaller tributary streams produced the primary flood damage. High water was experienced in Wenas, Ahtanum, Cottonwood, Wide

Hollow, Satus, and Toppenish Creeks. The most extensive flooding was experienced in the West and Lower Valleys.

Figure 4-6 shows where County roads were damaged. Damage in each section of the valley was as follows:

- Upper Valley—Road closures and road bank erosion was experienced along Wenas Creek. Homes were flooded in the Selah area.
- West Valley—Wide Hollow Creek overtopped its banks and inundated several businesses and homes and flooded the intersection of 80th Avenue and Wide Hollow Road. Homes along Ahtanum Creek were flooded. French Creek Canyon Reservoir reached its capacity and flowed over the spillway. The reservoir feeds the North Fork of Cowiche Creek, which passes near the communities of Cowiche and Tieton. Sewage lagoons overflowed into Cowiche Creek.
- Mid-Valley—Homes along Ahtanum and Wide Hollow Creeks were flooded. Road bed near South 42nd Street experienced severe erosion.
- East Valley—Minimal damage occurred.
- Lower Valley: Flooding washed out Pom Pom bridge. Water flowed across several roads near White Swan and Brownstown. A large lake formed south of McDonald Road and North Branch Road near Harrah. Satus Creek flooded West Satus Road between SR 22 and Spencer Road. U.S. Highway 97 was closed south of Toppenish. Telephone poles were overturned near North Wapato/Parker area.

From January 28 to February 6, the cost to clean up flood debris and repair damage was estimated at $705,000. As shown in Table 4-2, debris clearance was the County's greatest cost ($271,000), followed by road systems ($230,000) and the replacement of Pom Pom bridge ($150,000). The flood damage was region-wide, though only a small amount of damage was within the study area. Approximately 60 percent of the damage occurred within the Ahtanum, Mid-valley, and Toppenish drainages. Pom Pom bridge alone accounted for 25 percent of the damage. Damage near Wide Hollow, Cottonwood, and Cowiche Creeks contributed approximately 26 percent of the total (Figure 4-7).

Seventeen County roads and U.S. Highway 97 near Toppenish Creek were closed, and 37 County roads were damaged (Table 4-3). Roads were closed from one to nine days. Pom Pom road was closed until the bridge was replaced. The majority of road closures were in the West and Lower Valleys (Table 4-3). Two roads were closed in the Upper Valley.

November 26, 1990, Flood

The 1990 flood was the sixth largest flood on record. Peak flow at Parker dam equaled 35,600 cfs and was estimated as a 25-year flood event. The flood event was short, with peak flow occurring at 12:00 AM and river levels dropping nearly three feet by 7:00 AM the next morning. This typical winter flood was caused by unseasonably warm weather producing snowmelt runoff compounded by significant rainfall. Keechelus Reservoir reported over 10 inches of rain within a four-day period.

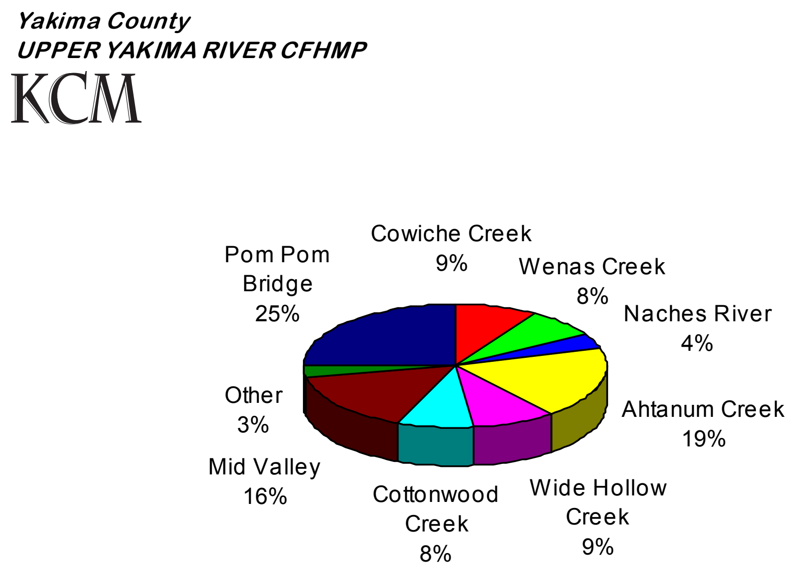

Figure 4-7.
1995 FLOOD DAMAGE BY DRAINAGE AREA

Flooding occurred primarily on the Yakima River, with minimal flooding on tributary streams. Areas hit hardest included eastern Selah and the Parker-Toppenish area. The flood forced 38 people from their homes; 27 in the Parker-Toppenish area and 11 in Selah near the Elks Golf Course. Eleven homes received major damage and there was minor damage to 22 others. According to reports at the time, County officials characterized this flood as more of an inconvenience than a disaster, although Yakima County was declared a federal disaster area.

Reported flood damage was as follows:

- Regional—Yakima Greenway required debris cleanup and path and landing repairs. Areas damaged included north Noel pathway and Century, Robertson, Sarg Hubbard, and Harlan river access landings.
- Upper Valley—Homes near the Elks Golf Course and Harlan Landing received minor flood damage. Elks Golf Course was inundated. Residents near Harrison Road were evacuated. Golf Course Loop was closed. Boise Mill Railroad bridge levee and Weber Auto Wrecking dike were damaged.
- East Valley—Dike south of Terrace Heights Drive was damaged.
- Lower Valley—Homes were damaged between Parker and Toppenish. Donald-Wapato and Thorp roads were closed. Dikes near Wapato-Donald Rd were damaged. Granger's sewage treatment pump house filled with water. County flood damage costs were estimated at $87,000 (Table 4-2). Yakima Greenway contributed the greatest cost ($38,110), followed by water control systems repair ($21,855), which includes bank protection and repair to dikes. The remaining flood damage costs were associated with road systems and clearing debris. Flooding closed 14 roads, and 11 roads experienced minor damage, most of them

in the Lower Valley (Table 4-4). Three roads were closed in the Upper Valley (Figure 4-6).

TABLE 4-3. COUNTY ROADS AFFECTED BY FEBRUARY 1996 FLOODS				
Drainage Area	Road Affected	Debris	Closed	Damaged
Ahtanum Cr.	Carson Rd.			x
Ahtanum Cr.	Emma Lane			x
Ahtanum Cr.	Hazen Rd.			x
Ahtanum Cr.	Lynch Lane	x		
Ahtanum Cr.	North Fork Ahtanum Rd.			x
Ahtanum Cr.	S. Ahtanum Rd.			x
Ahtanum Cr.	S. Fork Ahtanum Rd.			x
Ahtanum Cr.	Stanton Rd.			x
Ahtanum Cr.	W. Slavin Rd.			x
Ahtanum Cr.	Ahtanum Rd.	x		x
Ahtanum Cr.	American Fruit Rd., Rutherford Rd. to S. Ahtanum Rd.		x	x
Ahtanum Cr.	S. 42nd Avenue, S. of Emma Lane to McCullough Rd.		x	x
Ahtanum Cr.	S. Wiley Rd., Rutherford Rd. to S. Ahtanum Rd.		x	x
Cowiche Cr.	Cowiche Mill Rd.			x
Cowiche Cr.	Franklin Rd.			x
Cowiche Cr.	French Canyon Rd.	x		
Cowiche Cr.	Hatton Rd.	x		
Cowiche Cr.	North 72nd Avenue, North of Summitview Avenue		x	
Cowiche Cr.	North Tieton Rd.			x
Cowiche Cr.	North Wenas Rd.		x	
Cowiche Cr.	Summitview Rd., NW of Summitview Extension Rd.			
Cowiche Cr.	Tieton Heights Rd.	x		
Glade Cr.	Glade Rd.	x		
Satus Cr.	West Satus Rd., SR 22 to Spencer Rd.		x	
Toppenish Cr.	Branch Rd.	x		
Toppenish Cr.	Harrah Rd. near Marion Drain		x	
Toppenish Cr.	Hawk Rd.	x		x
Toppenish Cr.	Hinman Rd.			x
Toppenish Cr.	Lateral "C" Rd. at Marion Drain and Pumphouse Rds.		x	x
Toppenish Cr.	Manon Drain Rd.			x
Toppenish Cr.	McDonald Rd., Brownstown Rd. to Harrah Rd.		x	x
Toppenish Cr.	N. White Swan Rd.	x		
Toppenish Cr.	North Stephenson Rd.			x
Toppenish Cr.	Old Goldendale Rd., Jensen Rd. south to Pumphouse Rd.		x	x
Toppenish Cr.	Old Maid Rd.			x
Toppenish Cr.	Pom Pom Rd., South of Marion Drain to Slide Ranch Rd.		x	x
Toppenish Cr.	West Niemeyer Rd.	x		
Wenas Cr.	Audubon Rd.			x
Wenas Cr.	Huntzinger Rd.	x		
Wenas Cr.	Maloy Rd.	x		
Wenas Cr.	Naches Wenas Rd.	x		
Wenas Cr.	North Wenas Rd. at West Huntzinger Rd.		x	x
Wenas Cr.	Old Ellensburg Rd. at Maloy Rd.	x	x	
Wenas Cr.	S. Wenas Rd.			x
Wide Hollow Cr.	80th Avenue			x
Wide Hollow Cr.	Cottonwood Canyon Rd. at North Canyon Rd.		x	x
Wide Hollow Cr.	Olson Rd.			x
Wide Hollow Cr.	Summitview Rd.			x
Wide Hollow Cr.	Tieton Drive			x
Wide Hollow Cr.	Wide Hollow Rd. at Pear Avenue	x	x	x
Wide Hollow Cr.	Wide Hollow Rd. at S. 80th Avenue	x	x	x
Wide Hollow Cr.	Willow Lawn Rd.			x
Wide Hollow Cr..	Burnham Rd.			x
Yakima River	East Selah Rd.			x

SOURCE: Yakima County Flood Damage Assessment Reports.

TABLE 4-4.
COUNTY ROADS AFFECTED BY THE NOVEMBER 1990 FLOOD

Drainage Area	Road	Debris	Closed	Damaged
Cowiche Creek	Naches-Tieton Bridge #35	x		
Harrah Drain	East Jones Road	x	x	x
Naches	Lewis at South Naches		x	
Naches	South Rushmore, Naches Avenue to end		x	x
Naches Creek	Nile Road Bridge #30	x		
Naches Creek	Nile Road Bridge #31	x		
Naches Creek	Nile Road Bridge #32	x		
Yakima Main Stem	East Branch, SR 22 to Wierman		x	x
Yakima Main Stem	East Pomona at SR 821		x	
Yakima Main Stem	East Wapato at "A" Street		x	x
Yakima Main Stem	Golf Course Loop		x	x
Yakima Main Stem	North Camas to Wapato Centerline		x	x
Yakima Main Stem	North Oldenway at Phillip John		x	x
Yakima Main Stem	Phillip John, Oldenway to Winaway		x	x
Yakima Main Stem	Pomona at Harrison		x	
Yakima Main Stem	Slough Road	x		x
Yakima Main Stem	Thorp Road, Birchfield and I-82		x	
Yakima Main Stem	Toppenish—Zillah Bridge #489	x		
Yakima Main Stem	Wapato-Donald, I-82 to Wapato centerline	x	x	x
Yakima Main Stem	Winaway, Phillip John to Mallard		x	x

SOURCE: Yakima County Flood Damage Assessment Report.

December 27, 1980, Flood

The December 1980 flood resulted from unseasonably warm and wet winter weather. Record high temperatures of 67° F combined with rain caused rapid snow melt and runoff. The Yakima River flow peaked at 31,675 cfs at Parker, more than 3 feet above flood stage. Most flooding was adjacent to the Yakima River with minor flooding along Toppenish and Satus Creeks. Flood damage was relatively minor, and disaster relief was not requested.

Flood damage costs to County roads and dikes were estimated at $50,000 (*Yakima Herald-Republic* December 30, 1980). Floodwaters undermined approach abutments at the Wapato-Donald bridge. The Elks Golf Course in Selah was inundated. Two bridges were washed out, one along Bumping River road and another a private bridge on the Naches River. Floodwater was reported in crawlspaces of homes along Ahtanum Creek and Satus Road; County dikes experienced minor damage.

December 2, 1977, Flood

Typical winter flood conditions produced the December 1977 flood. Warm Chinook winds and excessive rainfall resulted in loss of high elevation snow and produced significant runoff. Flow on the Yakima River crested at 13.97 feet (34,320 cfs), 4 feet above flood stage. The Naches River crested at 20.06 feet, 3 feet above flood stage. It was the seventh largest Yakima River flood on record. Reported damage was as follows:

- Upper Basin—Up to 100 people were evacuated from the Ponderosa, Gold Hill, and Eagle Rock areas on Chinook Pass. Floodwaters were over the roadway near Pond Cafe, Squaw Rock, and Upper Nile bridge. Three private bridges washed out near Nile.

- Upper Valley—A debris jam caused water to overtop I-82 near Selah. The Elks Golf Course was inundated and the clubhouse was damaged.
- West Valley—Homes, roads, and dikes were damaged along Ahtanum Creek.
- East Valley—Homes, roads, and dikes were damaged in the Terrace Heights area.
- Lower Valley—Water inundated the Wapato-Donald road north of the River bridge. Extensive damage occurred near Buena. Businesses receiving damage included Evergreen Products near Parker, J&B Meats and McDonald Wrecking Yard near Wapato, and lower valley vineyards.

Private and public flood damage was estimated to be near $2 million. Private homes and public dikes and levees were hardest hit, accounting for 85 percent of the total damage (see Table 4-2). Damage to local businesses contributed $147,000 to the total. Damage was considered low, given the high flood levels. This flood was of greater magnitude than the January 1974 flood, but the January 1974 caused more damage (almost $13 million).

December 4, 1975, Flood

Warm temperatures, rapid snow melt, and heavy rainfall produced the December 1975 flood. The Yakima River crested at 13.1 feet (27,600 cfs), 3 feet above flood stage; the Naches River at 18 feet, 2 feet above flood stage. Significant damage to public facilities allowed the County to be declared a federal disaster area, making it eligible for disaster relief funds (FEMA 1994).

Flood damage associated with the 1975 flood approached $400,000 (FEMA 1994). The Lower Valley was hardest hit. Several roads were inundated: SR 22 between Toppenish and Buena, Donald Road, East Wapato Road, Olden Way Road, Iverson Road, Weyerman Road, Fraley Road, and Blackburn Road, all within the Lower Valley. Homes were evacuated along Donald Road east of Wapato, and 25 homes were threatened in the area of Toppenish and Buena. A private dike near Buena Loop broke, causing flooding in the Buena area. Unprotected land was inundated by the Yakima River west of Moxee and Granger. The Yakima River also breached protective levees and flooded the Granger sewage treatment plan.

Generally, the flood damage was associated with the Yakima River. Wide Hollow and Ahtanum Creeks rose to the top of their banks, but overbank flooding was limited.

January 16, 1974, Flood

The January 16, 1974, flood was a significant winter flood event. Rain showers, rising temperatures, snowmelt, and ice debris in the river produced typical winter flood conditions. The January 1974 event resulted in ice jams near Selah allowing floodwaters to back up until ice debris dislodged. This produced a small flood wave and additional bank erosion along the Yakima River. Peak flow on the Yakima River at Parker reached 27,700 cfs. The Naches River peaked at 10,800 cfs.

Excluding the 1933 flood, the January 1974 flood produced the greatest damage before the February 1996 flood. Yakima County was declared a federal disaster area. Six major bridges were damaged and two were completely washed out. Military helicopters were brought in to assist with evacuations and drop supplies. White Swan could not be reached by road. More than 500 people were forced to leave their homes.

An estimated $13 million of damage was reported, most of it outside the study area. Agricultural damage was estimated at $3 million, and $4 million of damage occurred to roads, highways, and other public facilities. Seventy-seven homes were destroyed and 383 others received major damage; 1,115 families were affected, and two fatalities were reported (FEMA 1994). Damage to private homes was estimated at about $5.4 million.

Flood damage was region-wide, with concentrations in the Lower Valley. Flooding affected properties along the Yakima River, in addition to smaller tributaries, as follows:

- Upper Valley—East Selah and the golf course were inundated. North Wenas Road was covered with floodwaters near Gibson Road.
- Mid-valley—Yakima Air Terminal was closed due to floodwaters covering half the runway. Citizens dug a drainage channel through South 47th Avenue to divert floodwaters away from homes.
- West Valley—All West Valley school districts were closed due to flooded roads. Many homes were flooded along Wide Hollow and Ahtanum Creeks. Lynch Road bridge on Ahtanum Creek washed out. Downed electrical poles caused a power outage near the North Fork of Ahtanum Creek. The entire Ahtanum Road was undercut.
- Lower Valley—White Swan was completely isolated by floodwaters from Toppenish Creek. Twenty-five homes were evacuated along Satus Creek. U.S. Highway 97 (Toppenish to Goldendale), SR 22 (Toppenish to Prosser and Toppenish to Buena), and SR 220 experienced flooding and structural damage. The U.S. Highway 97 bridge and dirt roads and bridges from Lateral A east were washed out along Toppenish Creek. Several families were stranded in Granger. Granger’s sewage treatment plant was surrounded by floodwaters. Numerous roads were closed, including Sunnyside-Mabton Road, all roads in the White Swan Area, roads along Satus Creek, and Mabton-Bickleton Road.

March 14, 1972, Flood

The March 1972 flood, a moderate winter flood, was a result of heavy rainfall coupled with above-average snow pack, warm temperatures, and rapid snow melt. The flood was further aggravated by large releases from upper basin reservoirs. The Yakima River crested at 20,200 cfs. The reported flood damage was primarily in the Lower Valley. Several roads were closed, including SR 22 between Toppenish and Buena, Donald Road, Iverson Road, Fraley Road, and McCoy Road. Other reported flood damage areas involved serious erosion along the east bank of the Yakima River near the Moxee Bridge on SR 24 and failure of the east bank levee south of SR 24.

May 29, 1948, Flood

The 1948 flood, the fourth largest on record, is one of the few significant spring floods. Unseasonably warm weather followed a winter with above-average snow pack. Warm temperatures and rain produced excessive high elevation snowmelt and runoff. On May 27 and 28, over 3 inches of rain fell in the Cascades, and May temperatures reached the high 80s. Flow on the Yakima at Parker peaked at 37,700 cfs, 5 feet above flood stage. The Bureau of

Reclamation reported that the peak flow could have been reduced to 22,000 cfs if snow pack information had been available. At the time of the flood, upstream reservoir storage was inadequate to greatly reduce the peak flow.

Brief newspaper accounts report region-wide damage. In the Upper Valley, several families were driven from their homes in East Selah, the golf course was inundated, the river cut new channels through farmlands upstream of Selah, Selah Bridge was inundated, and a Naches River levee near its mouth experienced serious erosion. Additional reported damage included settlement of the Terrace Heights Bridge caused by scour of a mid-span pier, washout of 100 feet of the Moxee highway, loss of numerous dikes between Selah Gap and Union Gap, major levee breaks between Moxee highway and Terrace Heights Bridge, water over Moxee Bridge, and flooding in the Toppenish/Buena area. Many of the levee failures were subsequently repaired by the COE.

December 23, 1933, Flood

The 1933 flood was a winter flood caused by rain on snow in the lower valley; it is the largest flood on record. Precipitation in the upper watershed was 500 percent above normal. Approximately 3 inches of rain per day fell in the upper watershed prior to peak flow. Over 16.5 inches of rain was reported at Keechelus Lake from December 17 through 22. Flow in the Yakima River at Parker peaked at 65,000 cfs and was estimated as approximately a 200-year flood event (see Table 4-1).

The flood caused extensive damage in the Yakima Valley, estimated at over $1 million. Newspaper accounts report water rushing over both approaches to the Terrace Heights Bridge, Naches Bridge being washed out, loss of the Union Gap bridge approach, and isolation of the City of Yakima due to loss of train and highway service for 36 hours.

The high level of damage provided the incentive to construct an extensive federal levee system of approximately 25,000 feet of right bank levees, 10,700 feet of left bank levees, and associated closure structures and culverts between Selah Gap and the Moxee bridge. Construction began in July 1947 and the primary system was completed in March 1948.

Summary of Historical Floods

Review of historical floods reveal common problems and general trends. Historical flood accounts indicate the following flood problems within Yakima County:

- Major flood damage is typically caused by high-magnitude winter floods. Eighteen of the 24 largest Yakima River floods were winter floods.
- Excessive damage from earlier floods was concentrated in the Mid-valley area. Damage from recent floods has been concentrated more in the Lower Valley and along tributary streams.
- Tributary streams have consistently caused significant flood damage in the past. Most damage is contributed by the Upper Naches River, and Ahtanum, Wide Hollow, and Toppenish creeks.
- Flood problems that have occurred repeatedly include the following:
  - Inundation of the Elk Golf Course near Selah
  - Lower Valley closure of U.S. 97, SR 22, and Wapato/Donald Road
  - Excessive erosion to roads along tributary creeks

  - Floodwaters encroaching on homes and inundating roads within East Selah, Toppenish, Parker, White Swan, Buena, Union Gap, and Granger.
- The extensive levee system has protected much of the mid-valley from flooding since 1948. Damage would have been much greater without the levees.
- Damage within the study area is concentrated in Selah, Pomona, along existing levees, along state and county roads, and within the Yakima Greenway. Since construction of the levees within the study area, damage has been significantly reduced in the areas protected.

HISTORICAL FLOOD IMPROVEMENT PROJECTS

Historical river improvement projects were also examined to determine locations and extent of historical flood damage in Yakima County. County files were reviewed and available information compiled into a database. County files documented river improvement projects along the Yakima and Naches Rivers for the years 1976 to 1988. County files include information on project locations, type of projects, estimated costs, and project qualification for different funding sources. Several projects listed were never completed.

Table 4-5 summarizes project costs (in 1995 dollars) by location. Additional information is included in the 1998 Upper Yakima River Comprehensive Flood Hazard Management Plan. Between 1976 and 1985, total costs for river improvement projects equaled $1.3 million along the Yakima River and $1.0 million along the Naches River. The largest expenditures occurred in 1978 as a result of the December 1977 flood. River improvement projects consisted primarily of riprap replacement and dike repair. Repetitive expenditures along Yakima River were concentrated along the Moxee Hubbard Irrigation Canal dikes near SR 24 and dikes south of Terrace Heights Boulevard. Repetitive expenditures along the Naches River were concentrated near the cities of Nile, Naches, and Gleed, and near Eschbach Park and Rock Creek.

TABLE 4-5
SUMMARY OF HISTORICAL RIVER IMPROVEMENT PROJECTS
(1976-1985)

Location	# of Projects	Cost (1995 $s)	Project Descriptions
Yakima River			
Moxee Hubbard Irrigation Canal [b]	9	$367,739[a]	riprap, dike repair
Below Union Gap [b]	2	$13,202	bank protection and armor dike
Toppenish	2	$43,680[a]	river channel realignment, riprap
Near SR 24 [b]	7	$327,155	dike repair, riprap, gravel scalping
Donald-Wapato	2	$4,229	dike repair, riprap
Terrace Heights [b]	2	$127,703	riprap, flood gauge
Selah Moxee Canal [b]	2	$5,943[a]	replace and repair berm
Sunnyside Dam	1	$91,540	riprap
Buena	1	$179,108	dike repair
Spring Creek [b]	1	$3,900	flood gate
Unknown locations	4	$120,269	flood rehabilitation
Total	**33**	**$1,297,334**	
Naches River			
Eschbach Park	5	$72,522[a]	riprap, dike repair
Gleed	5	$211,818	riprap, dike repair
Naches	6	$330,342	riprap, dike repair
Nile	6	$300,020[a]	riprap, replace road, dike repair
Rock Creek	3	$10,576[a]	riprap, dike repair
Gauging Station	2	$14,615[a]	gauge installation, riprap
Elks Ridge Lodge	1	$15,115	dike repair
Unknown location	1	$147,576	flood rehabilitation
Total	**29**	**$969,981**	

a. Some projects in this area did not have cost figures.
b. Within study area.