CHAPTER 7

BASIN FLOODING CHARACTERISTICS

INTRODUCTION

Historical flood-related information was gathered for this section on flood generating mechanisms and routing of floods within the basin.

FLOOD PEAKS

The flooding characteristics of Ahtanum and Wide Hollow basins are a function of the topography of the basin as a whole, meteorologic characteristics (rainfall and temperature), and characteristics of the channels and floodplains in the watershed. With the relative absence of Wide Hollow peak gage data it's runoff peaks are inferred from similarities and differences from the Ahtanum basin characteristics, including vegetation, plus resident anecdotes. The Wide Hollow reports indicate less frequent floods than Ahtanum with slightly different timing, as discussed below.

Investigation of longer term gages on the Yakima, Naches and Ahtanum rivers in Figure 7-1 reveals that the eleven largest recorded floods in Yakima Basin were, in order of magnitude: 1933, 1906, 1996, 1917, 1896, 1974, 1948, 1904, 1977, 1980, and 1990. Except for 1948, these floods were winter rain on snow storms. The peak floods of record on the Ahtanum basin, namely 1974, 1996, 1977, 1995, 1910, 1948 and 1933, were also experienced on the Yakima basin, even though the Ahtanum basin is small in comparison. A more extensive recorded peaks comparison is prevented by gaps in the Ahtanum gage data record.

In addition, the time to peak in the Ahtanum basin is in the order of several days and occurs about the same time as the Naches river gages which have very large drainage areas, so the gage data indicates a snowmelt dominated hydrograph on Ahtanum Creek for peak events. The runoff hydrographs for the small size Ahtanum basin show similar long drawn out peaks and this is attributed to the basin shape and presence of snow in the higher rainfall western end.

Of particular interest is that most of the top ten floods on the upstream North Fork gage are snowmelt flood events in the late spring months, which differs from all the other Yakima basin gages listed in Figure 7-1, even though they come from larger contributing areas. This infers less penetration of rain into the Ahtanum basin. This is significant in that the North and South Forks of the Ahtanum contribute most of the Ahtanum peak flows. Unfortunately, the gage near the mouth of Ahtanum was not in operation during the four largest of these snowmelt events: 1948, 1951, 1956 and 1916.

Figure 7-1 Yakima Basin Peak Floods of Record

Yakima River at Kiona (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	5615	Dec-23-1933	67,000
Period of Record	1878-1914,	Nov-17-1906	66,000
	1933-2007	Feb-11-1996	49,400
		Jan-18-1974	39,700
		Nov-18-1896	38,000
		May-31-1948	37,900
		Apr-17-1904	32,000
		Nov-26-1909	30,600
Missing Flood Data		Dec-28-1980	27,600
1917, 1921		Dec-4-1977	27,000

Yakima River at Umtanum (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	1594	Nov-14-1906	41,000
Period of Record	1907-2007	Dec-23-1933	32,200
		May-29-1948	27,800
		Feb-9-1996	27,200
		Nov-25-1909	22,900
		Nov-25-1990	22,800
		Dec-2-1977	21,500
		Nov-23-1959	19,100
Missing Flood Data		Dec-26-1980	16,800
1904, 1906		Dec-3-1975	16,600

Naches River below Tieton (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	941	Dec-22-1933	32,200
Period of Record	1909-1979	Feb-8-1996	20,924
		Nov-24-1909	19,400
Naches River at Naches (BOR)		Dec-2-1977	18,000
		Dec-30-1917	16,800
Area (sq mi)	941	Nov-20-1995	16,434
Period of Record	1979-2007	Dec-13-1921	14,500
		Dec-4-1975	14,100
		Jun-1-1956	13,300
		Jun-17-1974	12,800
Missing Flood Data		May-25-1948	12,600
1904, 1906		Jun-18-1916	11,700

North Fork Ahtanum near Tampico (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	78.9	Jan-15-1974	1,580
Period of Record	1908-1921,	Dec-2-1977	1,080
	1932-1979	May-20-1956	823
North Fork Ahtanum near Tampico (AID)		May-27-1948	770
		Mar-1-1910	766
Area (sq mi)	78.9	Dec-22-1933	755
Period of Record	1997-2006	Jun-18-1916	728
		May-11-1951	655
Missing Flood Data		May-20-1912	629
1904, 1906, 1980, 1990, 1996		Jun-10-1972	593

Yakima River near Parker (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	3660	Dec-23-1933	65,000
Period of Record	1908-1977	Feb-9-1996	58,150
		Dec-30-1917	52,900
Yakima River near Parker (BOR)		Dec-27-1980	47,337
		May-29-1948	37,700
Area (sq mi)	3660	Nov-30-1995	36,504
Period of Record	1979-2007	Nov-26-1990	35,620
		Dec-13-1921	35,800
		Dec-3-1977	35,090
		Jan-8-2009	32,630
		Jan-16-1974	28,800
Missing Flood Data		Nov-23-1959	27,400
1904, 1906		Dec-4-1975	26,500

Yakima River at Cle Elum (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	502	Nov-14-1906	25,600
Period of Record	1907-1990	Dec-30-1917	19,900
		Dec-13-1921	19,500
		Dec-2-1977	17,600
		Dec-24-1909	17,300
		May-29-1948	16,700
		Nov-23-1959	14,000
		Jun-3-1913	11,300
Missing Flood Data		Dec-13-1928	10,600
1904, 1906, 1990		May-30-1917	10,100

American River near Nile (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	78.9	Dec-26-1980	6,280
Period of Record	1940-2006	Dec-4-1975	4,860
		Jan-16-1974	4,310
		Feb-9-1996	4,050
		Jan-2-1968	3,440
		May-27-1948	3,420
		Nov-2-2006	3,130
		Dec-21977	3,020
Missing Flood Data		May-20-1956	2,870
1904, 1906, 1909, 1917, 1921		Nov-27-1949	2,530

Ahtanum Creek at Union Gap (USGS)		Date of Event	Flow (cfs)
Area (sq mi)	173	Jan-16-1974	3,100
Period of Record	1910-1914,	Feb-9-1996	2,660
	1960-2007	Feb-2-1995	1,700
		Mar-3-1910	1,530
		Feb-5-1963	1,340
		Mar-13-1983	1,240
		Feb-21-1982	1,110
Missing Flood Data		Feb-29-1980	1,020
1904, 1906, 1909, 1916, 1917,		Feb-1-2003	1,010
1921, 1933, 1948, 1951, 1956		Dec-3-1977	882

Largest Basin Floods in order: 1933, 1906, 1996 1917, 1974, 1896, 1948, 1977, 1904, 1980, 1990, 1909

Largest Spring Floods in order: 1948, 1904, 1956, 1974

The largest Ahtanum flood in mid January 1974 impacted the Ahtanum basin more severely than the Yakima basin. The 1974 flood was not a major flood on the Yakima River, and did not affect the Kittitas Valley or other portions of the Upper Yakima. The weather events that trigger major flooding in the Ahtanum and Wide Hollow Creeks are established below by examining the 1974, 1996 and 1933 floods. Rain data for the floods are only available at Yakima Airport.

The 1974 event was a snowmelt event associated with a chinook wind. As the Ahtanum basin experienced relatively higher flood peaks than elsewhere it is suspected that a rain cell may have stalled in the Cascades near the Ahtanum headwaters in 1974. Alternatively, there were very high rates of snowmelt.

Weather conditions leading up to the 1974 flood (at the Yakima Airport Weather Station) include an existing water equivalent snow depth of approximately 9 inches and 20 days of below freezing weather, with most nightly low temperatures below zero. This was followed by rapid warming, increased southern wind, and precipitation (at the Yakima Airport Weather Station) totaling ½ an inch over 3 days. By the 14^{th} of January – 2 days before the flood peak – 7 inches of snow remained on the ground. The temperatures overnight remained in the 50s, with 20 mile per hour winds and an additional ½ inch of rain; by the end of the day all the low elevation snow had melted. Temperatures and wind remained high that night and snowmelt must have also continued at a rapid rate at higher elevations in the watershed. On the 16^{th} of January, the South Fork Gage reported a peak of 1210 cfs (currently estimated in excess of a 500 year flow) indicating rapid snowmelt at higher elevations. The peak on the North Fork was 1580 cfs. The downstream peak flow of 3100 cfs that occurred on that date at the Union Gap gage is currently estimated to exceed the 200 year flow. Even after the flood peak, weather remained warm and an additional ½ an inch of rain fell.

Given the lack of gage data for Wide Hollow Creek, we can only rely on news reports for Wide Hollow plus resident anecdotes that indicate it behaved similarly to Ahtanum during this event but peaked one to two days earlier and was the largest flood. The anecdotes indicate a lesser severity on Wide Hollow.

The 1996 flood, the second largest event on Ahtanum Creek, was similar to both the 1974 and 1933 floods (large amounts of rainfall at higher elevations). In the Ahtanum basin, the 1996 flood, in comparison to the other two events, was preceded by longer duration freezing weather, and a greater maximum snow depth, while the warming was less severe (temperatures remained below freezing at night) and occurred over a much longer time period (5 days) resulting in gradual snowmelt and at least some warming of the soil profile. Like the 1974 flood, a ½ inch of rain fell on the day of the peak in Yakima (Yakima Airport), but there was little or no snow on the ground at the airport when it fell. The peak flow of 2660 cfs is currently estimated as approximately a 70 year flow. Residents report that this was not really as severe an event on Wide Hollow and could be considered the fourth or fifth highest peak behind 1974, 1995, 1983 and 1985. Personal reports indicate peaks occurring several days prior to the Ahtanum.

In 1995, County bridge damage on the much smaller Wide Hollow drainage was 125% of that on the Ahtanum, and residents reported the most localized damage and flooding on Wide Hollow, except for 1974.

The flood of record for most gage stations in the Yakima basin is the flood that occurred on December 22, 1933. The combination of saturated soils, already high streamflows, lack of storage capacity in the reservoirs, and a final rain on snow event resulted in the December 22nd flood. This flood was generated by a series of five Pacific Storms that moved through the state in November and December; many precipitation records for those months were set in western Washington in 1933, and have not been eclipsed since. Prior to the major flood on December 22, two previous floods had occurred in the basin, and the reservoir system (which had just been completed) was "as full as you would ever want to see it" (quote from the BOR administrator) for that time of year. Subsequent to those floods, the next storm event was colder, and deposited approximately 4 feet of relatively wet snow at higher elevations. The storm that caused the flood was again warmer, and melted the snow that had accumulated in the previous storm. It is important to note that this high precipitation event, creating the largest peaks for most gages in the Yakima basin, was less than a ten year event in the Ahtanum basin, according to recent FEMA studies.

The difference between the events on the Ahtanum versus Wide Hollow Creeks appears to be the difference in their distance from the Cascade crest, their protection by mountainous ridges, their orientation and their snow pack retention - the Wide Hollow receives considerably less snow, is largely south facing, has open cover and loses its snowpack more quickly and continually due to sun exposure. There is not a lot of snow falling in Wide Hollow compared to Ahtanum due to its location further from the Cascade ridge. Rain on snow, or rain on ice, are still the prime flood generators for both basins. Wide Hollow peaks arrive within one day of peak rainfalls, while Ahtanum peaks are delayed three days.

In addition, as noted earlier, winter rain generated from Pacific air masses rising over the Cascade crest (orographic rain), do not penetrate to Wide Hollow basin and are often limited in the Ahtanum basin. The Ahtanum receives significant snowfall due to the flatter trajectory of Cascade Crest induced snow. This is not so for the Wide Hollow basin. This is evidenced by the high forest percent in the upper Ahtanum of 94 per cent versus zero per cent in Wide Hollow. The Wide Hollow basin is probably the most sheltered basin in the region, protected topographically to the west by the Cascade Crest and the mountainous Upper Ahtanum basin, including Sedge Mountain, and to the north and south by Cowiche Mountain and Ahtanum Ridge, respectively.

The 100-year 24 hour rainfall for Wide Hollow is 2 inches. Summer rain storms are rare due to the dry desert-like conditions and the basin orographic protection. The 1974 US Corps of Engineers Wide Hollow hydrology study for FEMA recognized the basin sheltering and used mean annual precipitation to reduce peak floods.

FEMA HYDROLOGY

Below in tables 7-1 and 7-2 are the FEMA estimated flood peaks for selected return periods for the two basins. The Ahtanum basin exhibits higher peak runoff.

Table 7-1. FEMA Ahtanum Flood Discharges.

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (cfs) 10-Year	50-Year	100-Year	500-Year
Ahtanum Creek					
Near Tampico	119	950	1,750	2,250	4,100
At Union Gap	173	1,100	2,200	2,850	5,200
North Fork Ahtanum Creek					
Near Mouth	68.9	790	1,140	1,290	1,680
South Fork Ahtanum Creek					
Near Mouth	24.8	440	710	840	1,180

Table 7-2. FEMA Flood Discharges for Wide Hollow Creek and Tributaries

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
Wide Hollow Creek					
At mouth	70.5	362	665	817	1,262
Above confluence with Wide Hollow Tributary 3	62.7	343	631	775	1,198
Above confluence with Shaw Creek	41.2	283	521	642	993
Above confluence with Cottonwood Creek	24.6	223	412	509	789
Above confluence with Wide Hollow Tributary 2	14.3	174	322	398	619
Above confluence with Wide Hollow Tributary 1	4.9	106	198	246	384
Wide Hollow Tributary 2					
At confluence with Wide Hollow Creek	7.9	132	246	305	475
Above confluence with Tributary to Wide Hollow Tributary 2	5.6	113	211	261	408
Tributary to Wide Hollow Tributary 2					
At confluence with Wide Hollow Tributary 2	2.2	73	138	172	269
Wide Hollow Tributary 1					
At confluence with Wide Hollow Creek	9.2	142	264	327	509
Shaw Creek					
At confluence with Wide Hollow Creek	11.0	154	286	354	551
Above confluence with Shaw Creek Tributary	2.9	83	156	194	304
Shaw Creek Tributary					
At confluence with Shaw Creek	6.4	120	224	278	433
Cottonwood Creek					
At confluence with Wide Hollow Creek	15.3	179	332	411	638
Above confluence with Cottonwood Creek Tributary 2	11.8	159	295	365	568
Above confluence with Cottonwood Creek Tributary 1	7.5	129	240	298	464

CHANNEL ROUTING OF FLOOD WATERS

The upper portions of the Ahtanum Creek watershed (i.e. above "the narrows") are steep and forested. The tributary and main channels of the upper watershed are generally steep, have some large woody debris or other channel roughness, and naturally high levels of sediment. In general, these channels can convey significant flows due to the high gradient, and it is not unusual to have flood events where there is little evidence of out-of-bank flooding in the upper watershed even though the creek is out-of-bank in the lower watershed.

The high velocities of these channels can cause channel erosion, especially where riparian vegetation has been removed, or where bridges or other constrictions cause a decrease in slope. There are 120 public and private bridges and culverts on Ahtanum drainage streams that were large enough to be included for new FEMA flood map models, and 183 crossings on Wide Hollow drainage creeks. These structures are largely a result of development and urbanization, which can contribute to flooding.

In the lower north fork Ahtanum, an area of relatively frequent out-of-bank flooding occurs where the lower two bridges cross the creek. This area is where a natural change in slope occurs from the steep mountain valley to the broader and gentler valley formation. The bridges and irrigation diversion dam that are located there probably also contribute to the high flood frequency at this location, but historical records indicate this location frequently flooded and changed course prior to construction of these bridges. Flood waters from these locations are can be routed over and along the NF Ahtanum Road, spreading water across the upper portion of the alluvial fan. The recent FEMA flood mapping exercise showed that without the flow diversions caused by these bridges, floodwaters would remain near the current channel of Ahtanum Creek. With these flow diversions, water is routed across a broad area of the alluvial fan, impacting residences and SF Ahtanum Road downstream.

Specific areas of high frequency flood occurrences are described below in the Flooding Issues discussion, but the general channel conditions in Ahtanum Creek below the narrows are low-gradient, naturally incised, have high sinuosity and good to excellent riparian vegetative cover directly adjacent to the stream. This type of channel is very stable, and the sinuosity of the channel also absorbs much of the stream energy of a flood. This creates an "attenuation" of flood peaks – the flood peaks are reduced and lengthened.

For example in the 2003 flood, which peaked at approximately 900 cfs (a 5 year event) the flood waters peaked on the North and South Forks of the Ahtanum on Thursday evening (February 13) but did not peak at Emma Lane, 18 miles downstream, until Sunday morning (February 16). In the North and South Fork the peak of the flood lasted no more than 2 hours, but the peak at Emma Lane lasted for 3 days and caused significant damage. Given these types of channel conditions, areas such as Emma Lane, which regularly experience overbank flooding, can expect high levels of damage during relatively minor flood events due to the usually longer flood duration. Even large floods, such as 1996 have very long durations in the Ahtanum system. The flood peak of the 1996 flood moved rapidly downstream (lower elevations were also contributing floodwaters due to rain and rapid snowmelt) and remained at elevated flood levels for the next 3 weeks.

Channel conditions in the Wide Hollow drainage are more variable, and have had more direct changes from human activities, as noted in Chapter 4. In its natural state, the upper reaches of Wide Hollow were likely ephemeral streams with wide, coarse channels and relatively sparse riparian vegetation. These channels (i.e. upstream of 96th Avenue) generally retain these characteristics. Flooding in this portion of the basin results in relatively rapid and numerous areas of overbank flooding, and high rates of channel migration where not constrained by bridges, roads or levees. Where bridges or levees are present, gravel accumulations and/or changes in the approach angles result in frequent overbank flood events. Currently, many of channels in the upper portions of the watershed have been straightened, lengthened farther up valley, or moved to a different location to allow for conveyance of irrigation water. Where this has occurred the channels are generally sized and maintained for irrigation conveyance, which can easily be exceed by flood flows, resulting in overbank flooding.

In the middle portion of the watershed, Wide Hollow crosses a large silt fan. Below approximately 40th Avenue the channel would have been, and remains in spots, similar to the Ahtanum Creek channel – sinuous and slightly incised.

In the lower watershed, channels have been straightened and relocated to increase the amount of farmable or developable land, or to act as drains, or, in the City of Union Gap, to convey water used historically to turn a grist mill wheel. In most cases this has resulted in channel incision and bank erosion, especially in urban areas. In the case of the channel in Union Gap, frequent flooding can occur just upstream of the grist mill due to lack of conveyance capacity at the mill itself.

The largest current influence on capacity within the channel and flooding characteristics in the Wide Hollow watershed is the presence of stands of native willows, non-native Silver Willow (*Salix alba*), and hybrids between the two, and the conveyance capacity at bridge crossings where sediment and vegetation accumulates. These trees thrive in areas where the streams hydrograph exhibits higher flows in the summer than in the winter. Most native species are not adapted to these types of water level changes, consequently riparian stands are converted to these Willows and associated non-native plants such as Reed Canary Grass (*Phlaris arundacea*) and Russian Olive (*Elaeagnus angustifolia*).

The Willow trees achieve unusually large size (over 60 feet) and produce large amounts of both litter in the form of leaves and seeds, and also large quantities of small, medium and large pieces of stems and trunks. The large amounts of litter tend to be cohesive and coat the bottom of the channel in layers of muck as they break down, and the woody debris greatly increases channel roughness.

These combined effects often dramatically reduce channel capacity, especially in areas with high concentrations of Reed Canary Grass which further reduces channel capacity. Over time, these channels can become very wide and shallow, further increasing habitat for the willows and other non-native species. This results in an increase in the frequency of overbank flooding events in these areas, often several such events will occur annually.

Routing of Floods Across Floodplain

As mentioned in Chapter 4, these watersheds are in an active geologic region, and the valley itself is warped with differential rates of rise in the ridges to the north and south of the valley. This differential rise has a large influence on flooding patterns during major events in the Ahtanum Valley, but little effect in Wide Hollow Creek.

The complexity of the Ahtanum Valley, combined with channel conditions, can result in long duration floods where floodwaters extend several miles from the creek itself. Even small changes in topography in this wide and complex valley can alter flood patterns from decade to decade or year to year. The frequency with which such large scale, long duration floods occur is generally low, occurring in 1910, 1974 and 1996, with a shorter duration event in 1995. In general, the Ahtanum basin has a large area of floodplain for water storage, consequently damages caused by high energy floodwaters to structures such as bridge or homes is minor, as are dramatic changes in channel location in the lower watershed. The impact of these events is severe in terms of low velocity damage to infrastructure (roads, bridges, and irrigation), disruption of transportation systems, and damage to private property.

The long floodplain of Ahtanum Creek which begins near Tampico and ends at the confluence with the Yakima River is warped in different directions along its course. From Tampico to the area upstream of the Mission, the valley tilts to the south and the stream and flooding pattern are along the southern valley wall. Just upstream of the Mission the valley flattens and large floods may occupy the entire valley floor. In large floods, much of the floodwaters will not return to Ahtanum Creek, but flow down the Bachelor Creek Channel on the north valley wall. For approximately ¼ mile on the Mission property, near the beginning of Hatton Creek, the valley tilts to the north. This location allows large amount of floodwaters to be routed to the Middle and northern parts of the valley, and is the location of a potential avulsion of Ahtanum Creek.

Further downstream the valley is again tilted to the South for several miles until the vicinity of Wiley City. At that point Ahtanum Creek, on the south valley wall, is somewhat incised in the valley floor and floodwaters remain in the south. Floodwaters that have already exited Ahtanum Creek and are in Hatton and Bachelor creeks are routed farther to the North, and can become essentially impounded in the vicinity of the town of Ahtanum and areas to the east. These impounded floodwaters then slowly travel eastward in a variety of swales where they enter the head of Spring Creek West, which flows into the Yakima Regional Airport. As these floodwaters move northward, they can become diverted by roads and routed down valley. Rutherford Road and Meadowbrook Roads in several places act as interceptors, causing damage to the roadways, adjacent road ditches and private driveways, and further increasing floodplain storage.

The valley below Wiley City once again tilts toward the South and a portion of the floodwaters from Hatton Creek return to Ahtanum at 72nd Avenue. For the next several miles flooding is along the south valley wall from Ahtanum Creek, and the north valley wall from Bachelor and Hatton Creeks. Near 52nd Avenue, the gradient of the valley as a whole reduces, and the valley is once again level, spreading floodwaters across the valley as a whole.

Near 42nd (Emma Lane) the valley tilts strongly toward the north, overbank flood waters travel north from Ahtanum into floodplain swales and the already swollen Bachelor Creek. All of these overland flow paths (overbank from Ahtanum, overbank and channel from Bachelor, and overbank and channel from Spring Creek West) meet on and near the Airport, and flow in a variety of paths, including some contribution to lower Wide Hollow Creek. The valley then again tilts to the south, with most of the floodwaters from Bachelor and its tributary Spring Creek, returning to Ahtanum at Goodman Road. At this point flooding is confined once again to the southern valley wall. Near the confluence with the Yakima, the gradient of the channel decreases and the floodplain is nearly level. This area is frequently flooded but flood damage is minor as most of this area is managed as a Park (Fulbright) by the City of Union Gap.

Arial photographs of the 1996 flood are shown in Figures 7-2 and 7-3

Figure 7-2

1996 Ahtanum Flooding

Emma Lane & 42nd – looking Southeast

Rutherford Road – looking Northeast

Figure 7-3

1996 Ahtanum Flooding

Community of Ahtanum- looking East

Wiley City – looking North

Wide Hollow Routing of Floods in Floodplain

Wide Hollow Creek has 3 major floodplain landforms – hollows, low gradient alluvial fans, and Missoula flood Deposits, each has unique flood routing characteristics.

Hollows are relatively broad valleys with very flat valley floors. Infrequent flood events, usually snowmelt over frozen soil, result in flows being routed across the width of the valley floor. The flatness of the floor causes water to spread, so flood events in hollows are generally shallow and of short duration. Changes to the valley floor due to roads, fences, houses, etc can cause changes to routing of flood waters in the Hollows. More intense levels of residential development in Hollows can cause dramatic changes in flood routing and increase the duration of the flood due to the increased roughness of the floodplain and increased impervious surfaces. Even though the valley floors of the Hollows are floodplains, very few of them have been mapped as floodplains in the past, or are planned for mapping in the future.

The low gradient alluvial fans of Wide Hollow Creek should tend to route shallow floodwaters across a wide area, with areas of deeper flood waters against the valley walls. This type of shallow flood should and does occur with greatest frequency near the upper portions of the fans. The area of the confluence of Wide Hollow and Cottonwood Creeks is the beginning of the first major fan, Shaw Creek is another fan that enters the valley just downstream, and the fan landform extends downstream to approximately 48th Avenue. Flooding in the vicinity of 96th Avenue for both Wide Hollow and Shaw Creeks exhibits this shallow broad flooding behavior with historical floods known to cover the majority of the fan. Where the Wide Hollow and Shaw Creek fans join, there is a broad swale that can route floodwaters from either fan downstream, this swale is best depicted on the Wide Hollow only flooding maps in the Shaw Creek area. This swale ends at the intersection of 80th and Wide Hollow Road, an area of frequent shallow inundation. Downstream of 72nd, the Wide Hollow Fan buts up against the Ahtanum Creek watershed. This forms another broad swale that can route floodwaters from either Wide Hollow or Ahtanum watershed, this area generally lies just to the North of Washington Avenue, and has numerous irrigation ditches, drains and Spring Creek West, all of which can become active during flood events.

Spring Creek (Chambers) **East flood Routing**

Unlike the remainder of the watershed, Spring Creek (Chambers) East is a side channel of the Yakima River. When the Yakima River is in flood, floodwaters travel upstream into Lower Spring Creek (Chambers), Wide Hollow, and during large events, Ahtanum Creek. LiDAR data and other information sources indicate that the bed of the Yakima River is rising in this reach, which in turn, should cause flood levels in the river and in these backwater areas, and the local groundwater table, to rise as well. Recent studies by WSDOT for the Valley Mall Boulevard exit also indicate that flood levels have risen since the original flood studies from the early 1970s. If the bed of the Yakima River continues to rise, the potential exists for the freeway to be overtopped, which would bring a large area of the City of Union Gap into the floodplain, or at much higher flood risk than currently on the Flood Insurance Rate Panels. See Figure 7-4.

Figure 7-4 1996 Flood Extent in Union Gap

Impacts of Roads and Bridges on Flood Routing

Both watersheds are prone to large areas of shallow flooding due to the characteristics of the land forms – low gradient alluvial fans, Missoula flood deposits, warping of the valley floors and farming practices taking advantage of these opportunities. A large common factor in the development of flow paths and subsequent routing of floodwaters across the floodplains of both watersheds is the effect of roadways, bridges and irrigation diversion structures.

Historically, due to the flat floodplains bridges were built to span the active channel, resulting in under-sizing of the bridges to pass flood flows and causing sediment accumulations in the channels upstream of bridges. Private parties and public agencies found it necessary to periodically "clean out" the bridge approaches to maintain conveyance capacity for annual flood events. With the increasing regulation of activities in stream channels, this maintenance activity has decreased for both public and private bridges. This in turn results in more frequent out of bank flooding associated with bridge crossings, especially the larger public bridges. In addition, the FEMA remapping has shown that the improvement of arterial roads with large amounts of fill, when orientated east-west parallel to the streams, has blocked the north south alignment of historic flow paths and redirected flows onto previously unaffected land.

During large flood events, floodwaters can be distributed across a large area of the floodplain. Construction of bridges to efficiently convey these floodwaters across the road, or constructing the road and bridge to concentrate all of the flood flows at a single bridge crossing is difficult at best, and not economically feasible in many locations due to the flat configuration of the floodplain. Channeling all flood flows to one bridge location can have the effect of raising the flood level upstream of the bridge with consequences to local private properties and infrastructure. Maintaining a spread flow across the wide areas of floodplain can make roads impassable or unsafe. Providing overflow culverts or other structures along the roadway tends to concentrate flow into several streams, which can in turn change the flooding characteristics – depth and velocity of floodwaters – downstream. Given the large amounts of woody and other debris that is generated in large floods, these culverts can also plug and lose their effectiveness, raising upstream flood elevations further, or causing further changes in flooding characteristics downstream.

The large amount of vegetation, noted in Chapter 4, contributes to reduced channel conveyance at the bridges and within their approaches further exacerbating the crossing flood issue.

Figure 7-5 Example of a bridge constriction - Cottonwood Creek

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