Chapter 4

4 Floods

Floods have been a serious and costly natural hazard affecting Washington. Floods damage roads, farmlands, and structures, often disrupting lives and businesses. Simply put, flooding occurs when water leaves the river channels, lakes, ponds, and other confinements where we expect it to stay. Flood-related disasters occur when human property and lives are impacted by that flooding water. An understanding of the role of weather, runoff, landscape, and human development in the floodplain is therefore the key to understanding and controlling flood-related disasters.

Natural flood events are grouped into three general categories:

- **Riverine Flooding**: a rise in the volume of a stream until that stream exceeds its normal channel and spills onto adjacent lands.
- **Flash Flooding**: results from high water velocity in a small area but may recede relatively quickly.
- **Ice/Debris Jam Flooding**: floating debris or ice accumulates at a natural or man-made obstruction and restricts the flow of water.

The most commonly reported flood magnitude measure is the “base flood.” This is the magnitude of a flood having a one-percent chance of being equaled or exceeded in any given year. Although unlikely, “base floods” can occur in any year, even successive ones. This magnitude is also referred to as the “100-year Flood” or “Regulatory Flood” by State government. Floods are usually described in terms of their statistical frequency. A "100-year flood" or "100-year floodplain" describes an event or an area subject to a 1% probability of a certain size flood occurring in any given year. This concept does not mean such a flood will occur only once in one hundred years. Whether or not it occurs in a given year has no bearing on the fact that there is still a 1% chance of a similar occurrence in the following year. Since floodplains can be mapped, the boundary of the 100-year flood is commonly used in floodplain mitigation programs to identify areas where the risk of flooding is significant. Any other statistical frequency of a flood event may be chosen depending on the degree of risk that is selected for evaluation, e.g., 5-year, 20-year, 50-year, 500-year floodplain.

The areas adjacent to the channel that normally carry water are referred to as the floodplain. In practical terms, the floodplain is the area that is inundated by flood waters.

In regulatory terms, the floodplain is the area that is under the control of floodplain regulations and programs (such as the National Flood Insurance Program which publishes the Flood Insurance Rate Maps (FIRM)). FEMA defines the floodplain as:

>“Any land area susceptible to being inundated by water from any source.”

The nature and magnitude of flood-related damages are dependent on:

- **Flow Volume and Velocity** – High volume and/or velocity flows carry huge mechanical forces and are capable of damaging even substantial structures.
- **Duration** - Long duration floods of even low volume can cause great damages due to prolonged inundation (e.g., crop damage).
- **Bank Stability** - Bank erosion can alter channel paths and result in substantial losses of property.
• Sediment Load and In-stream Debris - Siltation from sediment transport and deposition may decrease the carrying capacity of the channel exacerbating the current and future flood events. Siltation may also decrease reservoir storage capacity, degrade fish and wildlife habitat, change the course of a stream, or introduce chemicals into the stream. In-stream debris increases the likelihood of mechanical damage and may raise flood levels when jams form.

4.1 Weather

The overall weather patterns that affect Stevens County are prevalent throughout Eastern Washington. This section of the State is part of the large inland basin between the Cascade and Rocky Mountains. In an easterly and northerly direction, the Rocky Mountains shield the inland basin from the winter season’s cold air masses traveling southward across Canada. In a westerly direction, the Cascade Range forms a barrier to the easterly movement of moist and comparatively mild air in winter and cool air in summer. Some of the air from each of these source regions reaches this section of the State and produces a climate which has some of the characteristics of both continental and marine types. Most of the air masses and weather systems crossing eastern Washington are traveling under the influence of the prevailing westerly winds. Infrequently, dry continental air masses enter the inland basin from the north or east. In the summer season, this air from over the continent results in low relative humidity and high temperatures, while in winter clear, cold weather prevails. Extremes in both summer and winter temperatures generally occur when the inland basin is under the influence of air from over the continent.

East of the Cascades, summers are warmer, winters are colder and precipitation is less than in western Washington. Annual precipitation ranges from seven to nine inches near the confluence of the Snake and Columbia Rivers, 15 to 30 inches along the eastern border and 75 to 90 inches near the summit of the Cascade Mountains. During July and August, it is not unusual for four to eight weeks to pass with only a few scattered showers. Thunderstorms can be expected on one to three days each month from April through September. Most thunderstorms in the warmest months occur as isolated cells covering only a few square miles. A few damaging hailstorms are reported each summer. Maximum rainfall intensities to expect in one out of ten years are .6 of an inch in one hour; 1.0 inch in three hours; 1.0 to 1.5 inches in six hours; and 1.2 to 2.0 inches in 12 hours.

During the coldest months, a loss of heat by radiation at night and moist air crossing the Cascades and mixing with the colder air in the inland basin results in cloudiness, and occasional freezing drizzle. A “chinook” wind which produces a rapid rise in temperature occurs a few times each winter. Frost penetration in the soil depends to some extent on the vegetative cover, snow cover and the duration of low temperatures. In an average winter, frost in the soil can be expected to reach a depth of 10 to 20 inches. During a few of the colder winters with little or no snow cover, frost has reached a depth of 25 to 35 inches.

Winter season snowfall in the valleys varies from 40 to 80 inches. Both rainfall and snowfall increase along the slopes of the mountains. Snow can be expected in the higher elevations in October and in the lower valleys by the last of November. In the lower elevations, snow reaches a depth of 15 to 30 inches and remains on the ground most of the time from the first of December until March. The few snow survey reports available for elevation above 5,000 feet indicate six to eight feet of snow on the ground the first of April and four to five feet the first of May.

Cold continental air moving southward through Canada will occasionally cross the higher mountains and follow the north-south valleys into the Columbia Basin. On clear, calm winter nights, the loss of heat by radiation from over a snow cover produces ideal conditions for low temperatures. The lowest temperature in the State, -48° F, was recorded December 30, 1965, at Mazama and Winthrop. In January, the average maximum temperature is near 30° F and the minimum temperature is 15° F. Minimum temperatures from -10° to -20° F are recorded almost
every winter and temperatures ranging from -25° to -42° F have been recorded in the colder valleys. In July, the average maximum temperature is 85° to 90° and the minimum temperature 45° to 50° F. Maximum temperatures reach 100° F on a few afternoons each summer and temperatures between 105° to 110° F have been recorded. The record high temperature of 118° F was recorded at Ice Harbor Dam on August 5, 1961. Temperatures in the mountains decrease three to five degrees Fahrenheit with each 1,000 feet increase in elevation. The average date of the freezing temperatures can be expected in the colder valleys by the first of September and before mid-October in the warmer areas.

Winter weather conditions are the main driving force in determining where and when base floods will occur. The type of precipitation that a winter storm produces is dependent on the vertical temperature profile of the atmosphere over a given area. Washington experiences riverine flooding from two distinct types of meteorological events:

- spring runoff and
- winter rain/snowmelt events

The major source of flood waters in Washington is normal spring snow melt. As spring melt is a “natural” condition, the stream channel is defined by the features established during the average spring high flow (bank-full width). Small flow peaks exceeding this level and the stream’s occupation of the floodplain are common events.

Unusually heavy snow packs or unusual spring temperature regimes (e.g., prolonged warmth) may result in the generation of runoff volumes significantly greater than can be conveyed by the confines of the stream and river channels. Such floods are often the ones that lead to widespread damage and disasters. Floods caused by spring snow melt tend to last for a period of several days to several weeks, longer than the floods caused by other meteorological sources.

Floods that result from rainfall on frozen ground in the winter, or rainfall associated with a warm, regional frontal system that rapidly melts snow at low and intermediate altitudes (rain-on-snow) can be the most severe. Both of these situations quickly introduce large quantities of water into the stream channel system, easily overloading its capacity.

On small drainages, the most severe floods are usually a result of rainfall on frozen ground but moderate quantities of warm rainfall on a snow pack, especially for one or more days, can also result in rapid runoff and flooding in streams and small rivers. Although meteorological conditions favorable for short-duration warm rainfall are common, conditions for long-duration warm rainfall are relatively rare. Occasionally, however, the polar front becomes situated along a line from Hawaii through Oregon, and warm, moist, unstable air moves into the region.

In general, the meteorological factors leading to flooding are well understood. They are also out of human control, so flood mitigation must address the other contributing factors.

4.2 Topography

The nature and extent of a flood event is the result of the hydrologic response of the landscape. Factors that affect this hydrologic response include soil texture and permeability, land cover and vegetation, land use and land management practices. Precipitation and snow melt, known collectively as runoff, follow one of three paths, or a combination of these paths, from the point of origin to a stream or depression: overland flow, shallow subsurface flow, or deep subsurface (“ground water”) flow. Each of these paths delivers water in differing quantities and rates. The character of the landscape will influence the relative allocation of the runoff and will, accordingly, affect the hydrologic response.

Unlike precipitation and ice formation, steps can be taken to mitigate flooding through manipulation or maintenance of the floodplain. Insufficient natural water storage capacity and changes to the
landscape can be offset through water storage and conveyance systems that run the gamut from highly engineered structures to constructed wetlands.

Careful planning of land use can build on the natural strengths of the hydrologic response. Re-vegetation of burned slopes diverts overland flow (fast and flood producing) to subsurface flow (slower and flood moderating). Details on rehabilitating burned areas to reduce flash floods, debris flows and landslides can be found in the Landslide chapter of this document.

4.3 Development

Floods generally come with warnings and flood waters rarely go where they are totally unexpected by experts. Those warnings are not always heeded, though, and despite the predictability, flood damage continues.

The failure to recognize or acknowledge the extent of the natural hydrologic forces in an area has led to development and occupation of areas that can clearly be expected to be flooded on a regular basis. Despite this, communities are often surprised when the stream leaves its channel to occupy its floodplain. A past reliance on structural means to control floodwaters and “reclaim” portions of the floodplain has also contributed to inappropriate development and continued flood-related damages.

Unlike the weather and the landscape, this flood-contributing factor can be controlled. Development and occupation of the floodplain places individuals and property at risk. Such use can also increase the probability and severity of flood events (and consequent damage) downstream by reducing the water storage capacity of the floodplain, or by pushing the water further from the channel or in larger quantities downstream.

4.4 Flood Hazards and Risk

4.4.1 Flood Profile in Washington

There have been 28 Presidential Disaster Declarations for floods in Washington State from 1956 through October 2003. Every county has received a Presidential Disaster Declaration since 1970. Since 1980, federal, state, and local governments have invested more than $522 million to repair public facilities, help individuals recover from flood disasters, and pay for measures to prevent future flood damage. This is nearly 40% of the more than 1.37 billion amount spent on disaster relief and hazard mitigation during this time.

The magnitude of most floods in Washington depend on the particular combinations of intensity and duration of rainfall, pre-existing soil conditions, area of a basin, elevation of the rain or snow level, and amount of snow pack. Man-made changes to a basin also can affect the size of floods. Although floods can happen at any time during the year, there are typical seasonal patterns for flooding in Washington State, based on the variety of natural processes that cause floods:

- Heavy rainfall on wet or frozen ground, before a snow pack has accumulated, typically cause fall and early winter floods
- Rainfall combined with melting of the low elevation snow pack typically cause winter and early spring floods
- Late spring floods in Eastern Washington result primarily from melting of the snow pack
- Thunderstorms typically cause flash floods during the summer in eastern Washington; on rare occasions, thunderstorms embedded in winter-like rainstorms cause flash floods in western Washington
Several rivers in eastern Washington flood every two to five years, including the Spokane, Okanogan, Methow, Yakima, Walla Walla, and Klickitat, but damaging events occur less frequently. Flooding on rivers east of the Cascades usually results from periods of heavy rainfall on wet or frozen ground, mild temperatures, and from the spring runoff of mountain snow pack. Eastern Washington is also prone to flash flooding. Thunderstorms, combined with steep ravines, alluvial fans, dry or frozen ground, and lightly vegetated ground that does not absorb water, can cause flooding.

Occasionally, communities experience surface water flooding due to high groundwater tables or inadequate urban storm drainage. This occurred during the 1996-97 winter storms. In many communities, residents outside the flood plain had several inches of water in basements due to groundwater seepage. These floods contaminated domestic water supplies, fouled septic systems, and inundated electrical and heating systems. Firefighting access was restricted, leaving homes vulnerable to fire. Lake levels were the highest in recent history, and virtually every county had areas of ponding not previously seen.

Floodplains make up about 2.5 percent of the state’s total land area. These areas contain an estimated 100,000 households. All the homes and people who live in them are vulnerable to flood damage. Only about 20 to 30 percent of the homes in floodplains have insurance for flood losses. Uninsured homeowners face greater financial liability than they realize. During a typical 30-year mortgage period, a home in a mapped floodplain has 26 percent chance of damage by flood.

Development in or near floodplains increases the likelihood of flood damage in two ways. First, new developments near a floodplain add structures and people in flood areas. Secondly, new construction alters surface water flows by diverting water to new courses or increases the amount of water that runs off impervious pavement and roof surfaces. This second effect diverts waters to places previously safe from flooding.

4.4.2 Stevens County Flood Profile

The Columbia River forms much of the western border of the County; however, due to several downstream dams and the backwater storage of Lake Roosevelt, the Columbia River is not a significant risk of causing flood damage along the Stevens County shoreline. The Spokane River along much of Stevens County’s southern border also does not cause significant flood damage due to the regulation of water flow by dams. The Colville River comprises the major drainage system in the County forming the Colville Valley in which most of Stevens County’s population occurs. Numerous smaller tributaries empty into the Colville River beginning at its headwaters near Springdale and continuing north to its confluence with the Columbia River near Kettle Falls. Other significant drainages in the County include the Deep Creek drainage, the Chamokane Creek drainage, and Sheep Creek drainage.

Stevens County experiences all types of flooding, but riverine floods in several of the Colville River tributaries have the most prolonged impact on the County. Erosion and transported sediment are major secondary hazards of flooding. Erosion of stream channels leads to deposition of sediment in river and creek beds, decreasing their capacity to transport water. The intense runoff can strip away topsoil and deposit it elsewhere, usually where flow is impeded, such as bridge abutments and culverts, or where stream velocity slows as occurs throughout the Colville Valley. Much of the wide Colville Valley floor historically worked as a large wetlands area with frequent low velocity flood events. Hundreds of years of sediment deposit and channel migration has resulted in highly fertile soils, which originally attracted settlement. Now, many of these settlements such as Orin, Arden, Addy, and Valley are at risk to flood damage.

Flash flooding can and has occurred on smaller streams, particularly those in narrow canyons such as the Sheep Creek drainage. Severe flash flooding of the rivers and streams occur, by definition, very rapidly usually following a heavy rainfall event. Ice jams and plugged or undersized culverts...
can exacerbate the impact of this type of flooding. Although infrequent, flash flooding typically causes more damage and loss of life than normal high water events because they happen very quickly and often catch communities unprepared. Due to the high density of structures and, therefore, people in the 100 year floodplain, there is a high probability of significant damage and potential loss of life due to flashflooding.

Stevens County has been assessed by FEMA’s National Flood Insurance Program. There are approximately 20,889 assessed buildings in Stevens County; 886 or about 4% of these (59,650 acres) are in the FEMA identified floodplain. A 100 year flood is calculated to be the maximum level of flood water expected to occur in a 100 year period. The 100 year flood is sometimes referred to as the 1% flood because there is a 1% chance of it occurring in any year. A 500 year flood has a 0.2% chance of occurring in any year (100 divided by 500).

These flood zone maps will serve as the basis for the analysis of assets of risk to flooding in Stevens County.
Figure 4.1. Compilation of FEMA Flood Insurance Rate Maps in Stevens County, Idaho.
4.4.2.1 NFIP Participation

Stevens County (unincorporated) as well as Colville and Chewelah are currently participating in the National Flood Insurance Program (NFIP). FEMA flood maps were last updated in 1990 (partial) and 1996 (partial) for unincorporated areas of the County and 1985 and 1986, respectively, for Colville and Chewelah. Participation in the NFIP is low with only 50 policies in force in the county and only 11 total for Colville and Chewelah. Springdale has a significant number of buildings in the floodplain, but has 0 current policies. The cities of Kettle Falls, Marcus, and Northport do not have any FEMA flood zones identified within city limits.

<table>
<thead>
<tr>
<th>Community Name</th>
<th>Policies In-Force</th>
<th>Insurance In-Force Whole</th>
<th>Written Premium In Force</th>
<th>Total Losses (1978-2007)</th>
<th>Total Payments (1978-2007)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stevens County</td>
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<td>$8,974,500</td>
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<td>$45,526</td>
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<td>City of Colville</td>
<td>4</td>
<td>$113,900</td>
<td>$2,618</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Town of Springdale</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>City of Chewelah</td>
<td>7</td>
<td>$1,363,200</td>
<td>$4116</td>
<td>1</td>
<td>$4,553</td>
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</tbody>
</table>

4.4.2.2 USGS Stream Data in Stevens County

Stream flow histories in the form of gauging stations have been kept by the USGS since the 1920’s. Many of these monitoring sites were discontinued in the early 70’s. A few are still in operation. By looking at the annual peak flow for several of the stations an indication of the size and relative frequency of flood events can be obtained.

Figure 4.2. Peak stream flow of Columbia River, 1939-2006.

Since the construction of the dams on the Columbia and Spokane Rivers water flow has been highly regulated; thus, providing flood protection for communities and shorelines upstream. As
Figures 4.2 and 4.3 show, outliers in the peak streamflow data are uncommon. The Columbia River and Spokane River watersheds drain 59,700 and 6,020, respectively. These drainages are not at significant risk of impact due to riverine or flash flooding. Nevertheless, annual spring runoff and rain on snow events can affect the water level of the reservoirs. It is the responsibility of the dam managers to strike the delicate balance between flood water regulation during peak runoff periods and adequate reservoir storage for irrigation during the summer months. More detailed USGS peak streamflow is given in the individual community assessments section of this chapter.

Figure 4.3. Peak stream flow of Spokane River, 1938-2006.

4.4.2.3 Past Events

Some of the most serious floods on the Colville River occurred in 1904, 1956, and 1974. According to newspaper accounts, each of these floods caused the river to overflow its banks. The 1956 flood resulted from unseasonably warm temperatures which melted a heavy winter snowpack. Temperatures exceeded 65 degrees Fahrenheit for nearly one week and reached 81 degrees at the Colville Airport on April 23rd, 1956 (approximately a 50-year recurrence interval). The most severe flood recorded occurred in 1974 after temperatures slumped nearly 60 degrees Fahrenheit from subzero levels and rain had fallen for about a week. The Colville River at Kettle Falls peaked at 3,440 cfs on January 23rd, 1974 (approximately an 80-year recurrence interval). Ice jams are reported to have formed on many of the Colville River tributaries.

March 1989 - Federal Disaster #822. Stafford Act disaster assistance provided – $3.8 million. Flooding and heavy rainfall affected Douglas, Okanogan, Stevens, and Whitman Counties. Roads and utilities heavily damaged in four rural counties. Mud from flooding impaired the city of Bridgeport’s sewage treatment facility for months. Two million dollars in damage to public facilities.

December 1996 - January 1997 - Federal Disaster #1159. Stafford Act disaster assistance provided – $83 million. Small Business Administration loans approved – $31.7 million. Saturated ground combined with snow, freezing rain, rain, rapid warming and high winds within a five-day
period to cause flooding. Impacted counties – Adams, Asotin, Benton, Chelan, Clallam, Clark, Columbia, Cowlitz, Douglas, Ferry, Franklin, Garfield, Grant, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Klickitat, Lewis, Lincoln, Mason, Okanogan, Pacific, Pend Oreille, Pierce, San Juan, Skagit, Skamania, Snohomish, Spokane, Stevens, Thurston, Walla Walla, Whatcom, Whitman, and Yakima. Significant urban flooding occurred north of Pierce County; significant river flooding occurred south of Pierce County; severe groundwater flooding took place in Pierce and Thurston Counties. Twenty-four deaths; $140 million (est.) in insured losses; 250,000 people lost power.

March 1997 - Federal Disaster #1172. Stafford Act disaster assistance provided – $6.5 million. Small Business Administration disaster loans approved – $2.9 million. Heavy rainfall and low-elevation mountain snowmelt caused flooding in counties of Grays Harbor, Jefferson, King, Kitsap, Lincoln, Mason, Pacific, Pierce, Pend Oreille, and Stevens.

May 1998 - Federal Disaster #1252. Stafford Act disaster assistance provided – $3.6 million. Heavy rainfall caused flooding in Ferry and Stevens Counties.

4.4.2.4 Value of Resource at Risk

The FEMA has assessed the floodplains for all of Stevens County. The Flood Insurance Rate Maps show 100 and/or 500 year floodplains in the cities of Colville and Chewelah and the town of Springdale. In order to more accurately reflect the potential loss due to floods, we have included individual risk assessments for these communities as well as the main drainages of the Colville River, the Kettle River Arm, Deep Creek, Chamokane Creek, and Sheep Creek (near Northport). Although Chewelah has numerous buildings in the floodplain, assets in the unincorporated areas result in the most value of resources at risk.

The building values were determined using the County’s parcel database. According to this data set, there are 1,083 parcels with assessed building values in the Stevens County floodplain. Within these parcels there are approximately 888 buildings equating to a total value of $70,568,433.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Number of Buildings</th>
<th>Total Acres</th>
<th>Total Value of Buildings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stevens County</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Zone A (100 year)</td>
<td>807</td>
<td>58,851</td>
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<td>81</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zone A (100 year)</td>
<td>-</td>
<td>35</td>
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<td>Zone B (100-500 year)</td>
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<td>12</td>
<td>$6,460,765</td>
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<tr>
<td>Chewelah</td>
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<td>Zone A (100 year)</td>
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<td>69</td>
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<td>Zone B (100-500 year)</td>
<td>5</td>
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<td>Springdale</td>
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<td></td>
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<tr>
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<td>14</td>
<td>44</td>
<td>$423,513</td>
</tr>
<tr>
<td>Zone B (100 year)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

There are currently 29 municipal water facilities in the FEMA identified floodplain of Stevens County, 10 of which are associated with Colville. The KCVL communications tower as well as several sections of BPA powerlines and various roadways are also within the county floodplain.
Table 4.3. Municipal Water Sources in the FEMA floodplain.

<table>
<thead>
<tr>
<th>System Name</th>
<th>System Type</th>
<th>Source Name</th>
<th>Source Type</th>
<th>Contact City</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORTHWEST ALLOYS INC</td>
<td>Group B</td>
<td>Well #1</td>
<td>Well in Well Field</td>
<td>Addy</td>
</tr>
<tr>
<td>NORTHWEST ALLOYS INC</td>
<td>Group B</td>
<td>Well #2</td>
<td>Well in Well Field</td>
<td>Addy</td>
</tr>
<tr>
<td>CHEWELAH WATER DEPT SOUTH</td>
<td>Community</td>
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<td>Chewelah</td>
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<tr>
<td>CHEWELAH WATER DEPT SOUTH</td>
<td>Community</td>
<td>Alm Lane 2 (Well 7)</td>
<td>Well Field</td>
<td>Chewelah</td>
</tr>
<tr>
<td>STIMSON LUMBER COMPANY</td>
<td>Non-Transient, Non-Community</td>
<td>South Well AGG010</td>
<td>Well</td>
<td>COEUR DALENE</td>
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<tr>
<td>CROSSROADS BAR AND GRILL</td>
<td>Transient Non-Community</td>
<td>Well #1- AGG489</td>
<td>Well</td>
<td>Colville</td>
</tr>
<tr>
<td>ELM TREE WATER &amp; SEWER ASSN</td>
<td>Community</td>
<td>Well #1 - AGG014</td>
<td>Well</td>
<td>Colville</td>
</tr>
<tr>
<td>ST. CLAIR, CHAN WATER SYSTEM</td>
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<td>WELL 1</td>
<td>Well</td>
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</tr>
<tr>
<td>SHILOH WATER SYSTEM</td>
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<td>Well in Well Field</td>
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</tr>
<tr>
<td>DAVIS, HAL WATER SYSTEM</td>
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<td>DAVIS WELL #1</td>
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<tr>
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<td>Well</td>
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<td>NW Alloys - AGG004</td>
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<td>Well in Well Field</td>
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<td>KETTLE FALLS WATER DEPT</td>
<td>Community</td>
<td>The Falls</td>
<td>Surface</td>
<td>Marcus</td>
</tr>
<tr>
<td>LANDS WATER SYSTEM</td>
<td>Group B</td>
<td>WELL #1</td>
<td>Well</td>
<td>NINE MILE FALLS</td>
</tr>
<tr>
<td>AGMED CHEMICAL CO INC</td>
<td>Group B</td>
<td>WELL 1</td>
<td>Well</td>
<td>SPRINGDALE</td>
</tr>
<tr>
<td>DRAKE S II</td>
<td>Group B</td>
<td>DRAKES WELL 1</td>
<td>Well</td>
<td>TACOMA</td>
</tr>
<tr>
<td>MELVILLE S WATER SYSTEM</td>
<td>Group B</td>
<td>WELL 1</td>
<td>Well</td>
<td>VALLEY</td>
</tr>
<tr>
<td>LANE MOUNTAIN SILICA COMPANY</td>
<td>Group B</td>
<td>WELL 1</td>
<td>Well</td>
<td>VALLEY</td>
</tr>
<tr>
<td>LANE MOUNTAIN SILICA COMPANY</td>
<td>Group B</td>
<td>WELL 2</td>
<td>Well</td>
<td>VALLEY</td>
</tr>
</tbody>
</table>

Roads or railroads that are blocked or damaged can prevent access throughout the County can isolate residents and emergency service providers needing to access vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris from floods also can cause isolation. Culverts can be blocked by debris from flood events causing localized flooding problems. Water and sewer systems can be flooded or backed up, causing further health problems. Flood waters can get into drinking water supplies causing contamination. Underground utilities can also be damaged during flood events. Damage to infrastructural elements, particularly roadways, is the most widely felt impact from floods. After major floods, it may take weeks to repair damaged road surfaces and bridges to restore the County’s ability to import supplies and materials needed by residents. Currently, there is approximately 82 miles of roadway (federal, state, county) in the FEMA identified floodplain. Table 4.4 summarizes significant access routes located in the floodplain.
Table 4.4 Significant Access Routes located in floodplain.

<table>
<thead>
<tr>
<th>Road Name</th>
<th>Length (Miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aladdin Road</td>
<td>4</td>
</tr>
<tr>
<td>BNSF Railroad</td>
<td>16</td>
</tr>
<tr>
<td>State Route 231</td>
<td>1</td>
</tr>
<tr>
<td>State Route 291</td>
<td>2</td>
</tr>
<tr>
<td>Onion Creek Road</td>
<td>1</td>
</tr>
<tr>
<td>State Route 25</td>
<td>5</td>
</tr>
<tr>
<td>U.S. Highway 395</td>
<td>2</td>
</tr>
<tr>
<td>Springdale-Hunters Road</td>
<td>2</td>
</tr>
<tr>
<td>Williams Lake Road</td>
<td>2</td>
</tr>
<tr>
<td>Deep Lake-Boundary Road</td>
<td>1</td>
</tr>
</tbody>
</table>

4.4.2.5 Countywide Mitigation Activities

There is no way to prevent floods. The weather forces and topography of Stevens County will always dictate when and where floods occur. However, flood mitigation strategies should combine both structural and non-structural approaches to alleviating the hazard. Structural approaches include reservoir storage, channel modification, levees and flood walls, pumping stations and other engineering works designed to control floodwaters. Non-structural approaches include both preventive and corrective actions. Preventive actions involve comprehensive floodplain management techniques that prevent unwise and hazardous development of the floodplain. Corrective actions are directed at mitigating flood damages and losses which result from unwise development of flood hazard areas.

There are three areas where action can be taken to reduce the loss of life, property, and infrastructure and business disruption to floods.

- Mitigation
- Readiness/Education
- Building codes

4.4.2.5.1 Mitigation

In the past, mitigation efforts have concentrated on the construction of dams and dikes to control and corral flood waters. Over the decades these efforts have resulted in unexpected and undesirable consequences. Building dikes only moved the problem downstream or across stream. Often subdivisions were constructed in areas behind the dikes, resulting in high losses when dikes are breached. Fish habitat, the natural functions of wetlands, and its associated wildlife habitat have all been found to be negatively effected by these mitigation measures.

Today mitigation of the topographical and hydrological aspects of a floodplain or watershed within Stevens County seems to be meeting most of the socio-economical goals within the County. Some type of mitigation measures have been addressed in impacted communities within the County.

4.4.2.5.2 Readiness and Education

Continued periodic public education measures should be undertaken. When extended periods of time pass between major flood events, both emergency response units and the public tend to forget to review plans and take necessary precautions. Some media and public communication ideas are:
• Publish a special section in your local newspaper with emergency information on floods and flash floods. Localize the information by printing the phone numbers of local emergency services offices, the American Red Cross chapter, and the nearest hospitals.

• Ask the local paper to interview local officials about land use management and building codes in floodplains.

• Periodically inform your community of local public warning systems. Explain the difference between flood watches and warnings. Let them know where to turn for emergency broadcast information should they hear a warning on their radio or television.

• Assist hospitals and other operations that are critically affected by power failure by arranging for auxiliary power supplies; this would include city water and sewer systems, emergency services (including electric dependent phone systems), police and fire.

• Publish emergency evacuation routes for areas prone to flooding.

• Have a ready source of sand, bags and shovels available, stored outside the floodplain.

• Requiring building permits and compliance with building codes. Builders and future homeowners should be made aware of the potential risk of building in the floodplain. Periodic publication of the highlights of these building codes can help to keep up public awareness.

4.4.2.5.3 Building Codes

Participation in the National Flood Insurance Program (NFIP) and subsequent adoption of the Uniform Building Codes, or more stringent local building codes, provide basic guidelines to communities on how to regulate development. When a County participates in the NFIP it enables property owners in the County to insure against flood losses. By employing wise floodplain management, a participating County can protect its citizens against much of the devastating financial loss resulting from flood disasters. Careful local management of development in the floodplains results in construction practices that can reduce flood losses and the high costs associated with flood disasters to all levels of government.

To encourage communities to go beyond the minimum requirements and further prevent and protect against flood damage, the NFIP established the Community Rating System (CRS). To qualify for CRS, communities can do things like make building codes more rigorous, maintain drainage systems, and inform residents of flood risk.

In exchange for becoming more flood-ready, the CRS community's residents are offered discounted premium rates. Based on your community's CRS ratings, you can qualify for up to a 45% discount of your annual flood insurance premium. Participation is relatively simple, and with the planning work already in place within the County, little to no additional work would have to be done to start receiving discounted insurance rates. For additional information go to http://www.floodsmart.gov/floodsmart/pages/crs_ratings.jsp.

4.4.3 Individual Community Assessments

The following assessments were written for incorporated communities that have assets at risk within the 100 year or 500 year flood zone (according to the FEMA Flood Insurance Rate Maps) within their city limits.
4.4.3.1 City of Colville

The city of Colville is adjacent to the Colville River with most of its residences and commercial infrastructure located on the Colville Valley floor. Nevertheless, there is only one building located in the 500 year floodplain within the Colville city limits.

Figure 4.4. Compilation of FEMA Flood Insurance Rate Maps at Colville.
4.4.3.1.1 Infrastructure

The city of Colville is impacted not only by floods within city limits, but also by floods within the Colville River drainage throughout the county by restricted access or impairing water or sewer functions. Ten municipal water supplies are either located in Colville’s identified floodplain or outside of the city limits, but serve the Colville population (Table 4.3). Additionally, a small portion of the wastewater treatment facility on the western edge of town lies within the 500 year floodplain. A high water event flooding incident could contaminate water supplies or sewage systems in Colville. This may result in the release of untreated sewage with severe impacts upon the environment.

4.4.3.1.2 Value of Resources At Risk

The only assessed building located in Colville’s floodplain is the Hearth and Home Technologies plant, which only a small section of is located in the 500 year floodplain. Nevertheless, this building’s assessed value is nearly $6.5 million. The operation of the wastewater treatment facility could also be affected by a 500 year flood event. Although, the monetary value of this facility is undetermined, it’s function is critical to the community.

4.4.3.1.3 Mitigation Activities

The city of Colville’s current FIRM maps date back 1985 and have not been updated since. Continued participation in NFIP and enforcement of building codes in the floodplain will help reduce the risk of Colville experiencing costly flood damage. Increased participation in the NFIP should be encouraged for residents of the Colville (and the rest of the county).

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount). The CRS classes for local communities are based on 18 creditable activities, organized under four categories: (i) Public Information, (ii) Mapping and Regulations, (iii) Flood Damage Reduction, and (iv) Flood Preparedness. All of these steps are recommended for the city of Colville.

4.4.3.2 City of Chewelah

The city of Chewelah has a significant number of structures as well as critical infrastructure within both the 100 and 500 year floodplains. According the most recent FIRM maps (1986), there are 151 assessed buildings in the 100 year floodplain and 5 buildings in the 500 year zone.

4.4.3.2.1 Flood Potential

Much of the flood potential in Chewelah is a result of the Colville River to the southwest and the Chewelah Creek drainage to the north. The Colville River does not significantly impact structures within the city limits of Chewelah; however, there are several residences along the river channel outside of the city that could be directly impacted by flood events.
The main channel of Chewelah Creek flows through the middle of town crossing the downtown business district and U.S. 395. The confluence of the North and South Forks of Chewelah Creek occurs directly north of the city limits creating a wide 500 year floodplain encompassing numerous residences. Two other smaller tributaries, Paye Creek and Thomason Creek, also flow through the townsite affecting primarily residences, but some commercial structures as well. Spring high water flows are common during April, May, and June. Swollen streams often cause Chewelah Creek to reach the full capacity of the main channel. Of the 156 assessed buildings in Chewelah’s floodplain (mostly 100 year), there are currently only 7 National Flood Insurance Program policy holders.

Floods in the area are generally the result of three different types of weather events: rain-on-snow, rapid snowmelt, and thunderstorms. Rain-on-snow events that affect Stevens County occur when significant snow pack exists in the upper reaches of the drainage. Warm rains falling on the snow pack result in significantly increased rate of snowmelt. Often this melting occurs while the ground is frozen and the water cannot be absorbed into the soil, resulting in increased overland flows. Flood waters recede slowly as rain-on-snow weather events tend to last for several days. Low velocity flooding occurs near Chewelah almost annually during the spring runoff period.

Loam soils and agricultural vegetation combine to foster flash flooding when intense thunderstorms hit the region. Floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions, but they can be far more severe.

Warm weather or rain after a heavy snowfall is often responsible for high flows in the Colville River, Chewelah Creek, Paye Creek, and Thomason Creek drainages. An increased level of sediment is prevalent during periods of high runoff. This sediment tends to cause a deteriorating condition in streambeds and channels through deposition. Natural obstructions to flood waters include trees, brush, and other vegetation along the stream banks in the floodplain area. Considerable debris is often allowed to accumulate in these channels, plugging culverts and bridges at several locations throughout the area. Debris accumulations in these areas often cause flood waters to exceed the normal capacity of the channel spilling over onto roadways and blocking access routes.

The major impacts of flooding in Chewelah are the restricted use of several streets, commercial properties, and residential areas. Most of the city government buildings are outside of the identified floodplain; however, they are located between the Chewelah Creek and Thomason Creek floodplains (to the east). It is unlikely that the buildings would incur any flood damage; however, access to and from this area may be restricted. Impacts from road closures may include closed city and county services. Flood waters tend to recede very slowly because of the minimal topographic relief in the valley.

Flooding of any public facilities will impact residents of Chewelah as commerce is disrupted and distribution of basic services such as emergency response and postal services are slowed. Electrical service may also be impacted as power is shut off in flooded areas to prevent electric shock. The lack of electricity could become a secondary hazard as the ability of residents to cook or provide heat is halted. Additionally, grocery and petroleum outlets may be closed or contaminated, which may lead to a lack of fresh drinking water and food sources as well as residents’ inability to leave the area. Any amount of flooding typically causes damage to structures. Much of the damage may be cosmetic, but still very costly. More extreme damage may be caused as river and stream channels migrate or infrastructural components, such as a bridge or sections of the railroad, are destroyed.
Chewelah Creek experienced serious flooding in 1956 and 1974. The 1956 event was caused by runoff from snowmelt, which was particularly heavy in the North Fork Chewelah Creek basin. In the city of Chewelah, Chewelah Creek overflowed its banks, washed out two footbridges and threatened the footings of another bridge. Two 42-inch culverts in the town were unable to convey the high flows, and flooding occurred on nearby properties. Two bridges along North Fork Chewelah Creek were also washed out during this event. In 1974, the city of Chewelah experienced flooding, which caused extensive damage to city streets and private homes. During this flood, Chewelah Creek flows peaked at 392 cfs on January 17, 1974 (approximately a 25-year
4.4.3.2 Ingress-Egress

The city of Chewelah is a major transportation thoroughfare for both regional highway travel and railroad lines. U.S. Highway 395, the main intercounty and intracounty transportation route for Stevens County, passes directly through Chewelah and crosses the 100 year floodplain. A section of the roadway from approximately Main Street to the north end of the city park is within the floodplain. Additionally, several other city streets pass through sections of the floodplain resulting in the need for numerous bridge or culvert crossings. It is the responsibility of the city to maintain these crossings keeping them free of debris and silt deposition as well as insuring they are adequately sized to handle high flow events.

Due to the extensive use of these roadways, many water crossings have been adequately built to accommodate 100 year flood events. It is unlikely that every access route into and out of Chewelah would be cut off due to flooding, but floodwaters could result in the isolation of certain areas due to the lack of an additional access route.

4.4.3.2.3 Infrastructure

The city of Chewelah is impacted not only by floods within city limits, but also by floods within the Colville River watershed throughout the county, which could limit access to the city and surrounding communities. Two municipal water supplies are located with Chewelah’s floodzone. The sewer system in Chewelah is located west of town near the Colville River. The lagoons have been built up to raise them out of the floodplain; however, they are directly adjacent to the river. Although unlikely, a high water event could contaminate water supplies or sewage systems in Chewelah. This may result in the release of untreated sewage with severe impacts upon the environment.

4.4.3.2.4 Value of Resources At Risk

There are currently 151 assessed buildings in the 100 year floodplain with an associated total value of $12,391,206. There are also 5 buildings in the 500 year floodplain with a total value of $706,898. The value the two municipal water sources and affected roadways, particularly U.S. 395, are undetermined, however, their functions are critical to the community.

4.4.3.2.5 Mitigation Activities

The city of Chewelah’s current FIRM maps date back 1986 and have not been updated since. Continued participation in NFIP and enforcement of building codes in the floodplain will help reduce the risk of Chewelah experiencing costly flood damage. Increased participation in the NFIP should be encouraged for residents of the Chewelah (and the rest of the county).

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount).
The CRS classes for local communities are based on 18 creditable activities, organized under four categories: (i) Public Information, (ii) Mapping and Regulations, (iii) Flood Damage Reduction, and (iv) Flood Preparedness. All of these steps are recommended for the city of Chewelah.

4.4.3.3 **Town of Springdale**

In 1999, FEMA issued the town of Springdale a letter of conversion saying that their existing Flood Hazard Boundary Maps were to be converted and used as the official FEMA Flood Insurance Rate Maps. According to these maps, Springdale has 14 assessed buildings with the 100 year floodplain.

4.4.3.3.1 **Flood Potential**

The flood potential within the city limits of Springdale is a result of the Sheep Creek drainage, which has its headwaters in the upper elevations of Bald Mountain north of Deer Lake. The main channel of Sheep Creek flows through the middle of town (east to west) crossing the downtown business district just north of State Route 231. Spring high water flows are common during April, May, and June. Swollen stream capacity often causes Sheep Creek to reach the full capacity of the main channel. Of the 14 assessed buildings in Springdale's floodplain, there are currently no National Flood Insurance Program policy holders.

Floods in the area are generally the result of three different types of weather events: rain-on-snow, rapid snowmelt, and thunderstorms. Rain-on-snow events that affect Stevens County occur when significant snow pack exists in the upper reaches of the drainage. Warm rains falling on the snow pack result in significantly increased rate of snowmelt. Often this melting occurs while the ground is frozen and the water cannot be absorbed into the soil, resulting in increased overland flows. Flood waters recede slowly as rain-on-snow weather events tend to last for several days. Low velocity flooding occurs near Springdale almost annually during the spring runoff period.

Warm weather or rain after a heavy snowfall is often responsible for high flows in the Sheep Creek drainage. An increased level of sediment is prevalent during periods of high runoff. This sediment tends to cause a deteriorating condition in streambeds and channels through deposition. Natural obstructions to flood waters include trees, brush, and other vegetation along the stream banks in the floodplain area. Considerable debris is often allowed to accumulate in these channels, plugging culverts and bridges at several locations throughout the area. Debris accumulations in these areas often cause flood waters to exceed the normal capacity of the channel spilling over onto roadways and blocking access routes.

The major impacts of flooding in Springdale are the restricted use of several streets, commercial properties, and residential areas. Impacts from road closures may include closed city services. Flooding of any public facilities will impact residents of Springdale as commerce is disrupted and distribution of basic services such as emergency response and postal services are slowed. Electrical service may also be impacted as power is shut off in flooded areas to prevent electric shock. The lack of electricity could become a secondary hazard as the ability of residents to cook or provide heat is halted. Additionally, grocery and petroleum outlets may be closed or contaminated, which may lead to a lack of fresh drinking water and food sources as well as residents’ inability to leave the area. Any amount of flooding typically causes damage to structures. Much of the damage may be cosmetic, but still very costly. More extreme damage may be caused as the stream channel migrates or infrastructural components, such as a bridges or culverts, are destroyed.
4.4.3.3.2 Ingress-Egress

The primary access routes to and from Springdale are State Route 231 from the north and south, State Route 292 from the east, and the Springdale-Hunters Road from the west. State Route 231 and the Springdale-Hunters Road have the most significant risk as they cross the floodplain just west of the main townsite. State Route 292 parallels the floodplain as it converges with State Route 231 on the east side of town. Additional city roads that could be affected by flooding of Sheep Creek include West Shaffer Avenue, North Main Street, and North 1st Street.
4.4.3.3 Infrastructure

The town of Springdale has only one municipal water source within the floodplain.

4.4.3.4 Value of Resources At Risk

There are currently 14 assessed buildings and 44 acres in the 100 year floodplain with an associated total building value of $423,513. The value the municipal water source and affected roadways, particularly U.S. 231, are undetermined, however, their functions are critical to the community.

4.4.3.5 Mitigation Activities

Currently, Springdale does participate in the National Flood Insurance Program and has adopted a Flood Damage Prevention Ordinance that dictates development regulations within the Special Flood Hazard Area in compliance with FEMA requirements. Continued participation in this program in addition to the enforcement of building codes in the floodplain will help reduce the risk of Springdale experiencing costly flood damage.

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance.

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount). The CRS classes for local communities are based on 18 creditable activities, organized under four categories: (i) Public Information, (ii) Mapping and Regulations, (iii) Flood Damage Reduction, and (iv) Flood Preparedness. All of these steps are recommended for the Town of Springdale.

4.4.4 Colville River Drainage

There are several unincorporated communities (Orin, Arden, Addy, and Valley) and scattered structures and infrastructure affected by the floodplain associated with the Colville River, whose watershed drains approximately 1,007 square miles. Floodplain areas within the city limits of Colville and Chewelah were considered separately in those city’s assessments. Numerous streets, highways, and power lines cross the identified floodplain. There are commercial, industrial, and residential areas with public utilities in and around the Colville River floodplain.

Floods in this area are the result of two different types of weather events, rain-on-snow and thunderstorms. Rain-on-snow- events that affect the Colville Valley occur when significant snow pack exists in the upper reaches of the foothills and beyond in the Colville National Forest and Huckleberry Mountains. Warm rains falling on the snow pack results in a significantly increased rate of snowmelt. Often this melting occurs while the ground is frozen and the water cannot be absorbed into the soil, resulting in increased overland flows. Flood waters recede slowly as rain-on-snow weather events tend to last for several days. Low velocity flooding occurs in several tributaries to the Colville River almost annually during the spring runoff period.

Steep slopes and sparse vegetation in many Colville River tributaries combine to foster flash flooding when intense thunderstorms hit the valley. Floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions, but can be far more severe. The possibility for injury and death from flash floods is heightened because they are so uncommon that
people do not recognize the potential danger. Water levels in the Colville River are not generally impacted by localized thunderstorms; however, the smaller tributaries such as Mill Creek, the Little Pend Oreille River, and Sheep Creek may breach their banks relatively quickly during an intense thunderstorm. These and other tributaries are more likely to threaten lives and property as a result of thunderstorms and subsequent flash flooding. Thunderstorms generally occur in June to September while late December to February is the worst time for rain on snow events.

Figure 4.7. USGS Peak Streamflow data for the Colville River at Kettle Falls.

The major impacts from both types of flooding in the Colville Valley are the restricted use of several roadways including limited evacuation routes, industrial sites, and extensive residential areas. The USGS peak streamflow data recorded for the Colville River near Kettle Falls show several peak flood events including the 1996-07 rain on snow flood event that significantly impacted and caused severe damages in nearly every county in Washington, Idaho, and western Montana.

Warm weather or rain after a heavy snowfall is usually responsible for high flows in the Colville River drainage. A high level of sediment is prevalent during periods of high runoff. This sediment tends to cause changes in streambeds and channels through deposition. Natural obstructions to flood waters include trees, brush, and other vegetation along the stream banks.

The primary access routes through the Colville Valley are U.S. 395 and State Route 231. These highways roughly parallel the Colville River and could be threatened by flood waters in several locations. Bridge crossings are especially prone to damage due to bank failure, ice or debris jams, or high water overtopping the structure.

There are only a few critical facilities located in the floodplain of the Colville River that are outside of an incorporated city’s limits. Major city and County services, office buildings, emergency response equipment and communications equipment are generally located outside of the floodplain and are not at direct risk of damage.
Roads and bridges are the major infrastructural element that is affected by flooding. Alternative routes to all parts of County are limited during most major flood events. Bridges and culverts have been repeatedly compromised by past flood events causing long term damage to road systems.

Local power distribution systems may be compromised when power poles are undermined by flood waters; however, this is not a common occurrence.

In the Colville River watershed including the Mill Creek, Sheep Creek (near Springdale), and Little Pend Oreille River drainages, there are 405 assessed buildings located in the floodplain with an associated value of $40,326,694.

Increased participation in the NFIP (currently only 52 policies in the unincorporated county) and enforcement of building codes in the floodplain will help keep the risk of the County incurring costly flood damage low.

4.4.5 Chamokane Creek Drainage

There are two unincorporated communities (Ford and Camas) and numerous scattered structures affected by the floodplain associated with the Chamokane Creek drainage. The North, Middle, and South Forks of Chamokane Creek have their headwaters in the Huckleberry Mountains east and northeast of the Camas Valley. The main channel of Chamokane Creek flows through Camas Valley eastward towards Springdale before turning south and paralleling the Spokane Indian Reservation boundary through Ford and finally to empty into the Little Falls Reservoir (Spokane River).

Floods in this drainage are the result of two different types of weather events, rain-on-snow and thunderstorms. Rain-on-snow- events that affect Chamokane watershed occur when significant snow pack exists in the upper reaches of the foothills and beyond in the Huckleberry Mountains, Scoop Mountain, Godfrey Mountain, and Round Top Mountain. Warm rains falling on the snow pack results in a significantly increased rate of snowmelt. Often this melting occurs while the ground is frozen and the water cannot be absorbed into the soil, resulting in increased overland flows. Flood waters recede slowly as rain-on-snow weather events tend to last for several days. Low velocity flooding occurs in several tributaries of Chamokane Creek almost annually during the spring runoff period.

Steep slopes and sparse vegetation in many Chamokan watershed tributaries combine to foster flash flooding during intense thunderstorms. Floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions, but can be far more severe. The possibility for injury and death from flash floods is heightened because they are so uncommon that people do not recognize the potential danger. Water levels in the Chamokane Creek drainage can be significantly impacted by localized thunderstorms; especially many of the smaller tributaries such as Swamp Creek, Rail Creek, and Moses Creek. These and other tributaries are more likely to threaten lives and property as a result of thunderstorms and subsequent flash flooding. Thunderstorms generally occur in June to September while late December to February is the worst time for rain on snow events.
The USGS peak streamflow data for Chamokane Creek is incomplete; however, the major flood events of 1996-97 and 1975 are prevalent.

State Route 231 and the Springdale-Hunters Road are the primary access routes in this area. These paved routes roughly parallel Chamokane Creek and could be threatened by flood waters in several locations. Bridge and culvert crossings are especially prone to damage due to bank failure, ice or debris jams, or high water overtopping the structure.

In the Chamokane Creek watershed, there are 31 assessed buildings located in the floodplain with an associated value of $955,760.

Increased participation in the NFIP (currently only 52 policies in the unincorporated county) and enforcement of building codes in the floodplain will help keep the risk of the County incurring costly flood damage low.

4.4.6 Deep Creek Drainage

There are numerous scattered residences and other structures affected by the floodplain associated within the Deep Creek watershed including the main Deep Creek channel and the north and south forks. The South Fork Deep Creek has its headwaters near Rabbit Mountain in the Colville National Forest and flows in a northerly direction towards its confluence with the North Fork near Spirit. The North Fork’s headwaters are in the Red Mountain area from which it flows southward pooling to form Deep Lake about three miles from the confluence. The main channel of Deep Creek flows northwesterly to eventually empty into the Columbia River near Northport. This area is very rural, populated only be private residences.

Floods in this area are the result of two different types of weather events, rain-on-snow and thunderstorms. Rain-on-snow- events that affect the Deep Creek drainage occur when significant snow pack exists in the upper reaches of the Colville National Forest and Lime Creek and Stoddard Mountains. Warm rains falling on the snow pack results in a significantly increased rate
of snowmelt. Often this melting occurs while the ground is frozen and the water cannot be absorbed into the soil, resulting in increased overland flows. Flood waters recede slowly as rain-on-snow weather events tend to last for several days. Low velocity flooding occurs in several tributaries Deep Creek almost annually during the spring runoff period.

Steep slopes and sparse vegetation in many of the Deep Creek watershed tributaries combine to foster flash flooding during intense thunderstorms. Floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions, but can be far more severe. The possibility for injury and death from flash floods is heightened because they are so uncommon that people do not recognize the potential danger. Water levels in the Deep Creek watershed are significantly impacted by localized thunderstorms; especially the smaller tributaries such as Meadow Creek, Smackout Creek, Currant Creek, Republican Creek, Silver Creek, and O’Hare Creek. These and other tributaries are more likely to threaten lives and property as a result of thunderstorms and subsequent flash flooding. Thunderstorms generally occur in June to September while late December to February is the worst time for rain on snow events.

The primary routes accessing the Deep Creek watershed are Aladdin Road and Deep Lake – Boundary Road. These paved, county roads roughly parallel the stream channels and could be at risk in several locations. Bridge and culvert crossings are especially prone to damage due to bank failure, ice or debris jams, or high water overtopping the structure.

In the Deep Creek watershed, there are 43 assessed buildings located in the floodplain with an associated value of $2,141,740.

Increased participation in the NFIP (currently only 52 policies in the unincorporated county) and enforcement of building codes in the floodplain will help keep the risk of the County incurring costly flood damage low.

4.5 Flood Inundation Due to Dam Failure or Malfunction

Water is one of the most powerful natural forces to shape the American landscape and one of our most precious resources. To ensure continued benefits from our rivers, dams and other water control structures have been built to manage water and keep rivers in their channels, rather than let them wander at the whim of nature. Without dams and other water control structures, the rivers we rely on can change course during times of flood, with severe economic and social consequences. Today, dams are a critical and vital part of the American infrastructure. They provide a range of benefits, including hydroelectric power, river navigation, water supply, wildlife habitat, waste management, flood control, and recreation. Although the federal government owns or regulates only about 5 percent of the dams in the United States, many of these dams are significant in terms of size, function, benefit to the public, and their hazard potential.

Under FEMA’s leadership, the National Dam Safety Program (NDSP) is dedicated to protecting the lives of American citizens and their property from the risks associated with the development, operation, and maintenance of America's dams. The NDSP, which is led by FEMA, is a partnership of the states, federal agencies, and other stakeholders to encourage individual and community responsibility for dam safety.

Throughout history, in all parts of the world, dams built to store water have occasionally failed and discharged the stored waters to inflict sometimes incalculable damage in the loss of lives and great damage to property. Failures have involved dams built without application of engineering principles, but have also involved dams built to, at the time, accepted engineering standards of design and construction. The technology of dams has improved with the increased knowledge of design principles and of the characteristics of foundation and dam materials, and it is generally agreed that safe dams can be built and existing dams can be safely maintained with proper application of current technology.
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In the National Inventory of Dams maintained by the US Army Corps of Engineers, each dam is given a Downstream Hazard Potential of Low, Significant, or High. Dams assigned the low hazard potential classification are those where failure or misoperation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner’s property. Dams assigned the significant hazard classification are those dams where failure or misoperation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas, but could be located in areas with population and significant infrastructure. Dams assigned the high hazard potential classification are those were failure or misoperation will probably cause loss of human life (US Army Corp of Engineers 2005).

Table 4.5. US Army Corp of Engineers National Inventory of Dams.

<table>
<thead>
<tr>
<th>Dam Name</th>
<th>Stream Name</th>
<th>Owner</th>
<th>Built Date</th>
<th>Hazard Rating</th>
<th>Regulation</th>
<th>Latitude</th>
<th>Longitude</th>
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<tbody>
<tr>
<td>Beitey Lake Dam</td>
<td>Colville River</td>
<td>1934 Washington, Dept of Ecology</td>
<td>Low</td>
<td>48.168333</td>
<td>117.631667</td>
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<td>Blue Gulch Reservoir Dam</td>
<td>Columbia River</td>
<td>1926 Significant Washington, Dept of Ecology</td>
<td>48.590000</td>
<td>118.098333</td>
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<tr>
<td>Browns Lake Dam</td>
<td>Wrights Creek</td>
<td>1928 Low Washington, Dept of Ecology</td>
<td>48.233333</td>
<td>117.805000</td>
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<tr>
<td>Dawn Mines Tailings Pond No. 4</td>
<td>Chumuckane Creek-Offstream</td>
<td>Dawn Mining Company</td>
<td>1981 Low Washington, Dept of Ecology</td>
<td>47.898333</td>
<td>117.840000</td>
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<td>D'Hondt Dam</td>
<td>Stensgar Creek</td>
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<td>Fletcher Dam</td>
<td>South Fork Harvey Creek</td>
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<td>118.026667</td>
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<tr>
<td>Garvey Dam</td>
<td>Truman Wood Creek</td>
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<tr>
<td>Hill Lake Dam</td>
<td>Pinston Creek</td>
<td>1984 Low Washington, Dept of Ecology</td>
<td>48.646667</td>
<td>118.050000</td>
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<tr>
<td>Jumpoff Jim Lake Dam</td>
<td>Tr-Colville River</td>
<td>1972 Low Washington, Dept of Ecology</td>
<td>48.153333</td>
<td>117.655000</td>
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<tr>
<td>Keystone Dam</td>
<td>Tr-Cedar Creek</td>
<td>1920 Low Washington, Dept of Ecology</td>
<td>48.201667</td>
<td>117.896667</td>
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<tr>
<td>Little Sweden Dam</td>
<td>Tr-Colville River</td>
<td>1986 Low Washington, Dept of Ecology</td>
<td>48.151667</td>
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<td>Little Twin Lakes</td>
<td>Camp Creek</td>
<td>Dept. of Agriculture, Forest Servic</td>
<td>1964 Low Washington, Dept of Ecology</td>
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<td>Long Lake Dam</td>
<td>Spokane River</td>
<td>Washington Water Power Company</td>
<td>1914 High Federal Energy Regulatory C</td>
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<td>Loon Lake Aeration Lagoon</td>
<td>Loon Lake-Offstream</td>
<td>Loon Lake Sewer District No. 4</td>
<td>1986 Significant Washington, Dept of Ecology</td>
<td>48.070000</td>
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<tr>
<td>Loon Lake Polishing Lagoon</td>
<td>Loon Lake-Offstream</td>
<td>Loon Lake Sewer District No. 4</td>
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<td>Madre Mine</td>
<td>Alder Creek</td>
<td>Cortez International Ltd.</td>
<td>1985 Low Washington,</td>
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</table>
Peak flows of the Columbia River at the international boundary are regulated by 28,633,000 acre-feet of flood control storage. The operating authority for 20,492,000 acre-feet of the total is the Columbia River treaty because of its location in Canada. The U.S. Army Corps of Engineers (COE), North Pacific Division (NPD) serves (along with the Bonneville Power Administration) as the U.S. entity in the implementation of the treaty, through which three Canadian storage projects have been planned and are operated by the U.S. for flood control. NPD is also responsible for regulating the 8,141,000 acre-feet located in the U.S. at Libby and Hungry Horse. After treaty ratification in 1964, system-wide flood control operating studies were made by NPD to develop the interim “Columbia River Treaty Flood Control Operating Plan.” These studies featured detailed daily routings for the record from 1929 to 1958 using the computer program “SSARR” (Streamflow Synthesis and Reservoir Regulation) and assumed 1975 storage conditions and estimated 1985 irrigation depletions. Output from the final routings were used by the COE, Seattle District, to develop frequency curves for natural and regulated conditions for the Columbia River at Grand Coulee, and by NPD to develop similar curves for the Columbia River at the Dalles. The curves for Grand Coulee were adjusted to reflect the longer record, 1958 to 1970, available at the Dalles (FEMA 1996).
4.6 Secondary Hazards

4.6.1 Bank Erosion and Channel Migration

The most problematic secondary hazards resulting from high water events (and time) in Stevens County is bank erosion and subsequent channel migration. The channels of some streams, particularly larger streams and rivers in broad, alluvial valleys, may migrate across the valley as a result of natural erosional and depositional processes; the area over which the channel is expected to migrate is called the channel migration zone or CMZ. Although erosion is natural, erosion levels can be accelerated above natural rates because of human-caused activities, such as removal of riparian vegetation, bank stabilization, or upstream manipulation of stream channels.

In the past, many rivers in the Pacific Northwest have seen extensive bank stabilization and channel control efforts enacted as a means of "protecting" the adjacent lands from river encroachment. As more bank stabilization structures are built, both short-term and long-term consequences arise. In the short-term, stabilization measures tend to physically stabilize one local stretch of riverbank or divert flows away from one bank to another. This can trigger increases in river flow velocities, exacerbate downstream bank erosion, and lead to further instabilities downstream. In other words, preventing natural erosion at one location can significantly increase erosion downstream of the project. Therefore the "problem" is neither controlled nor solved, but merely relocated from one spot to another, negatively impacting downstream landowners. Increased downstream erosion often causes affected landowners to put in structures to protect their property—and the cycle repeats itself over and over again. Over the long-term, bank stabilization can cause the channelization of our rivers and streams as floodplains narrow or disappear, natural stream migration is prevented, and, ultimately, riparian vegetation does not regenerate. Channelization also impacts the health of rivers and streams by: exacerbating the severity, duration, and frequency of local flooding events and erosion downstream; preventing the maintenance and formation of sandbars and backwater areas; and degrading critical fish and other habitat required in aquatic systems (Montana Audubon 2006).

As property values increase along our streams, the demand for bank stabilization projects is increasing. The solutions to reverse this trend are complicated and not always obvious:

- Set buildings back away from streams—and support land-use planning that requires all structures to be built a set distance from a stream. Setbacks should incorporate floodplains and channel migration zones as well as non-floodplain areas. A common problem arises when homes are built overlooking a river, then landowners stabilize the bank below to prevent their homes from eventually falling into the water.

- When bridges are built or reconstructed, advocate increasing their span or relocating them so that bank stabilization is not needed to protect either end of the bridge. (When bridges are constructed too narrowly, streambanks are lined with riprap.)

- Avoid projects that remove native shrubs and other woody plants from the streambank and adjacent floodplain. If vegetation is disturbed by a project, insist that native riparian plants are planted (and established) when the project is complete. Don’t plant lawns or other non-native vegetation along stream banks.

- Support programs that restore the ability for natural stream processes to function, including easements purchased that allow flooding and stream meandering, and programs that remove old bank stabilization structures.

- If bank stabilization is deemed necessary, confine it to the shortest possible length of stream and use techniques that fit the stream type and have the least impact (Montana Audubon 2006).
• Develop channel migration studies for all rivers in Stevens County similar to the one already completed for the Methow River.
• Reassess activities allowed under county-declared disaster or state of emergency