Chapter 2 Flood

Mitigation Rationale

Flooding is the most serious, devastating, and costly of natural hazards and can occur virtually anywhere. Most Idaho residents live near rivers which are subject to periodic flooding. Floods in Idaho frequently damage roads, farmlands, and structures, often disrupt lives and businesses, and occasionally cause loss of lives. A few streams in Idaho are subject to almost annual flooding, but in most areas damaging floods are much less frequent. Historically, the greatest impact has been to the northern and north central parts of the State where communities are vulnerable to flooding from the many rivers, lakes, creeks, and canals in the area. The steep, mountainous terrain creates a flood-prone environment and development is often confined to areas adjacent to stream channels.

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 damage due to prolonged inundation (e.g., crop damage).
- Bank Stability - Bank erosion can alter channel paths and result in substantial loss 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.
- Secondary Hazards - Secondary hazards associated with flooding include land sliding, structural fires, hazardous materials releases, the spread of pollution, and disease.

Generally, flash floods and dam failures represent the greatest risks to life and limb due to the rapid onset, the potentially high velocity of water, and the huge debris load carried by floodwaters. While dam failures are a very rare event they represent an extreme threat to life and property. When conditions allow, flash floods and dam failures may arrive as fast moving walls of debris, mud, and water.

Flash floods from a series of fast moving storms may produce more than one flood crest and the sudden destruction of structures and the washout of access routes may result in the loss of life. Flash floods due to heavy precipitation are generally of a smaller scale than dam failures, but happen somewhere in Idaho almost every year. Flash floods are a major cause of weather-related fatalities in the United States each year.

The possibility for injury and death from flash floods is heightened because they are so uncommon that people do not recognize the danger. For example, the rapid rise in water level and force may cause motorists to underestimate the depth and velocity of floodwaters, causing stalled and flooded vehicles and drowning; fifty percent of all flash-flood fatalities are vehicle related, usually arising when motorists attempt to drive through flood waters.

In general, human hazards during flooding include drowning, electrocution due to downed power lines, leaking gas lines, fires and explosions, hazardous chemicals, and displaced wildlife. Economic loss and disruption of social systems are often enormous. Floods may destroy or damage structures, furnishings, business assets including records, crops, livestock, roads and highways, and railways. They often deprive large areas of electric service, potable water supplies, wastewater treatment, communications, and many other community services including medical care, and may do so for long periods of time.

Hazard Description/Definition

Flooding is a dynamic natural process. Along rivers, streams, and coastal bluffs a cycle of erosion and deposition is continuously rearranging and rejuvenating the aquatic and terrestrial systems. Although many plants, animals, and insects have evolved to accommodate and take advantage of these ever-changing environments, property and infrastructure damage often occurs when people develop coastal areas and floodplains and natural processes are altered or ignored.

Flooding can also threaten life, safety and health and often results in substantial damage to infrastructure, homes, and other property. The extent of damage caused by a flood depends on the topography, soils and vegetation in an area, the depth and duration of flooding, velocity of flow, rate of rise, and the amount and type of development in the floodplain.

Types of Flooding

Flooding can occur in a number of ways, and many times are not independent of each other and can occur simultaneously during a flood event: The types of flooding considered for this Plan include:

- Heavy rainfall
- Urban storm water overflow
- Rapid snowmelt
- Rising ground-water (generally in conjunction with heavy prolonged rainfall and saturated conditions)
- Riverine ice jams
- Flash floods
- Fluctuating lake levels
- Alluvial fan flooding

Flood events may be classified under four general categories:

- Riverine Flooding
- Flash Flooding
- Ice/Debris Jam Flooding
- Dam Failure

Riverine flooding includes those events that are classically thought of as flooding; i.e., a gradual rise of volume of a stream until that stream exceeds its normal channel and spills onto adjacent lands. Such events are generally associated with major meteorological events: spring runoff, winter rain/snowmelt events, and ice jams. Riverine floods typically have low velocities, affect large land areas, and persist for a prolonged period.

In contrast, flash floods may have a higher velocity in a smaller area and may recede relatively quickly. Such floods are caused by the introduction of a large amount of water into a limited area (e.g., extreme precipitation events in watersheds less than 50 square miles), crest quickly (e.g., eight hours or less), and generally occur in hilly or otherwise confined terrain. Steep mountainous terrain in Idaho is particularly susceptible to flash floods and debris flows which can occur within thirty (30) minutes of the onset of heavy rain. Flash floods occur in both urban and rural settings, principally along smaller rivers and drainage ways that do not typically carry large amounts of water.

Occasionally, floating ice or debris can accumulate at a natural or man-made obstruction and restrict the flow of water. Ice and debris jams can result in two types of flooding:

- Water held back by the ice jam or debris dam can cause flooding upstream, inundating a large area and often depositing ice or other debris which remains after the waters have receded. This inundation may occur well outside of the normal floodplain.
- High velocity flooding can occur downstream when the jam breaks. These flood waters can have additional destructive potential due to the ice and debris load that they may carry.

Factors Contributing to Riverine Flooding

Simply put, riverine flooding occurs when water leaves the channels, lakes, ponds, and other confinements where we expect it to stay; flooding-related disasters occur when human property and lives are impacted by that water. An understanding of the roles of weather (precipitation, runoff, and riverine ice formation), landscape, and human development in the floodplain is therefore the key to understanding and controlling flood-related disasters.

Meteorological Factors: Idaho experiences riverine flooding from two distinct types of meteorological events: spring runoff and winter rain/snowmelt events.

The major source of floodwaters in Idaho is normal spring snowmelt. As spring melt is a “natural” condition, the features established during the average spring high flow define the stream channel. 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 stream and river channels. Such floods are the ones that lead to widespread damage and disasters. Floods caused by spring snowmelt 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, such as occurred along the Weiser River in 1997 and again in 2006 and in Owyhee County in 2006, or rainfall associated with a warm, regional frontal system that rapidly melts snow at low and intermediate altitudes, 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 (a weather pattern known as the “Pineapple Express”) moves into the region. Most winter floods develop under these conditions (as was the case with the northern Idaho floods of 1997). La Niña conditions arising from sea surface temperature across the equatorial Eastern Central Pacific Ocean being lower than normal by 0.5 °C or more for a period of at least 5 months of La Niña conditions also increase the probability of above average precipitation in Idaho.

Weather and long-term climate forecasting can help foresee the likelihood of unusual precipitation patterns and temperature regimes (leading to snowmelt or ice formation). 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.

***Landscape Factors*:** 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, and land use and land management practices. Precipitation and snowmelt, 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 influences the relative allocation of the runoff and affects the hydrologic response.

For example, a parking lot has an impervious (nonporous) surface so the entire precipitation landing on this surface leaves as overland flow. Such flows result in a rapid and complete delivery of the runoff to the destination. In contrast, an area with vegetation and well-developed soils offers a highly porous surface and a significant portion of the runoff enters a deep subsurface flow path. Such flow is characteristically slow and some of the runoff may be intercepted (such as through uptake by plants). These two surfaces – paved and forested – are radically different in hydrologic response; consequently, landscape changes will modify the hydrologic response of an area, especially if they occur over a wide region.

As with meteorological factors, a water balance analysis can forecast the capacity of the landscape to accommodate additional water by comparing rainfall and snow pack, stream flow, and reservoir storage data. Although forecasters understand the processes, forecasting can be difficult and margins of safety are required to respond to the unforeseen.

Unlike precipitation and ice formation, steps can be taken to mitigate flooding through manipulation or maintenance of these factors. 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. Revegetation of burned slopes diverts overland flow (fast and flood producing) to subsurface flow (slower and flood moderating).

Mitigation measures often align with environmental concerns but mitigation is not the only public goal affecting the landscape and may find it at odds with other pressing socio-economic concerns.

Development Factors:[1] A good deal is known concerning the mechanisms behind flooding; consequently, 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 damages continue.

In many cases, 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 inundated on a regular basis. Most streams overflow what are commonly regarded as their channels at least once every one and one-half to two years. 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 occupation 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

---

[1] Development, as defined by 46-1021(1), Idaho Code, is: "Any man-made change to improved or unimproved real estate, including, but not limited to, the construction of buildings, structures or accessory structures, or the construction of additions or substantial improvements to buildings, structures, or accessory structures; the placement of mobile homes; mining, dredging, filling, grading, paving, excavation or drilling operations; and the deposition or extraction of materials; specifically including the construction of dikes, berms and levees."

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.

Factors Contributing to Flash Flooding

There are three types of flash flooding:

- Extreme precipitation and runoff events
- Inadequate urban drainage systems overwhelmed by small intense rainstorms
- Dam failures

Debris flows are hazards that are closely related to flash floods, triggered by heavy rainfall, are more commonly considered as a type of earth movement (a "geological" hazard).

Extreme Precipitation and Runoff Events: Events that may lead to flash flooding include:

- Significant rainfall and/or snowmelt on frozen ground in the winter and early spring months.
- High intensity thunderstorms, usually during the summer months.
- Rainfall onto burn areas (such as those affected by wildfire) where high heat has caused the soil to become hydrophobic or water repellent which dramatically increases runoff potential during rain. The 2007 fire season saw approximately 2 million acres burn in Idaho. Much of the burned terrain will have water repellent soils for the next 2 to 4 years and higher probability of experiencing flash floods and debris flows than it normally would.

Flash floods from thunderstorms do not occur as frequently as those from general rain and snowmelt conditions but are far more severe.

The onset of these flash floods varies from slow to very quick and is dependent on the intensity and duration of the precipitation and the soil types, vegetation, topography, and slope of the basin. When intensive rainfall occurs immediately above developed areas, the flooding may occur in a matter of minutes. Sandy soils and sparse vegetation, especially recently burned areas, are conducive to flash flooding. Mountainous areas are especially susceptible to damaging flash floods, as steep topography may stall thunderstorms in a limited area and may also funnel runoff into narrow canyons, intensifying flow. A flash flood can, however, occur on any terrain when extreme amounts of precipitation accumulate more rapidly than the terrain can allow runoff. Flash floods are most common in Idaho in the spring and summer months due to thunderstorm activity.

Inadequate Urban Drainage Systems: Flash flooding in urban environments is an increasingly serious problem. Urban areas are susceptible to flash floods because a high percentage of the surface area is composed of impervious streets, roofs, and parking lots where runoff occurs very rapidly. This rapid runoff allows for an intense concentration in the storm water drainage system. When the system is overwhelmed (i.e., the amount of runoff exceeds the capacity of the system), excessive runoff travels through the streets and open spaces of the area. Typically, this surface runoff will be concentrated by the terrain with streets and other paved areas between buildings functioned much as canyons in mountainous areas. Development in urban/wildland interface areas pose unique risks as flash floods may originate in the mountainous terrain and grow in intensity and severity as they enter the urban environment where vegetation has been removed, where bridges and culverts constrict flow, and where buildings and paving have greatly expanded impermeable surfaces.

Flash floods on alluvial fans are attracting greater attention as the population living in hazardous areas continues to rise. FEMA defines an alluvial fan as, "a sedimentary deposit located at a topographic break such as the base of a mountain front, escarpment, or valley side, that is composed of streamflow and/or debris flow sediments and has the shape of a fan, either fully or partially extended." (FEMA document: "Guidelines for Determining Flood Hazards on Alluvial Fans" (http://www.fema.gov/plan/prevent/fhm/dl_alfan.shtm). Flooding on alluvial fans is characterized by rapid onset, fast flow, unpredictable path, and large amounts of sediment and debris. Thus, while flood depths are generally relatively shallow, this kind of flooding can be highly destructive. There are numerous developments built on flat, alluvial fans adjacent to mountains and foothills in Idaho. One example is the Harris Ranch Subdivision in Ada County. Alluvial fans are a geological feature created by repeated flash floods over hundreds of years and indicate preferred locations of flash floods and debris flows in the future.

Dam Failure*:* Like the flash floods described above, floods resulting from dam failures are characterized by sudden onset, unpredictable nature, high flow velocity, and potentially large debris load. Dam failures may result from design or construction errors or omissions, overfilling/overtopping, and damage resulting from landslides, earthquakes, or other large forces.

Factors Contributing to Ice/Debris Jam Flooding

Flooding from ice jams is relatively common in Idaho. Ice jam formation depends on air temperature and physical conditions in the river channel. Ice cover on a river (a precursor to the ice jam) is formed when water reaches the freezing point and air temperature is sub-freezing; large quantities of ice are produced, flow downstream, and consolidate.

Ice forms in freshwater bodies when the surface water cools to 0ºC (32ºF) or a fraction of a degree lower. There are many types of ice, depending on the precise mode of formation and evolution, including:

Sheet Ice: The ice that forms in calm water, such as lakes or reservoirs, or in slow-moving rivers where the flow velocity is less than 0.5 m/s (1.5 ft/s), is termed sheet ice. Ice crystals formed at the water surface freeze together into skim ice that gradually thickens downward as heat is transferred from the water to the air through the ice layer. Sheet ice usually originates first along the banks and expands toward the center of the water body. In slow rivers, the sheet ice cover may also be created by the juxtaposition of incoming frazil pans generated in faster reaches upstream. Sheet ice that grows statically in place is often called black ice because of its appearance. An ice cover may also thicken at the top surface when water-soaked snow freezes to form snow ice that has a milky white appearance because of small air bubbles.

Frazil Ice: Frazil Ice consists of small particles of ice formed in highly turbulent, supercooled water, such as river rapids or riffles, during cold, clear winter nights when the heat loss from the water to the atmosphere is very high. As the frazil particles are transported downstream, they join together to form flocs that eventually rise to the surface where they form frazil pans or floes. Frazil is often described as slush ice because of its appearance.

Fragmented Ice: This type of ice is made up of ice pieces that originated as consolidated frazil ice pans or from the breakup of sheet ice growing at the surface of slow-moving water.

Brash Ice: Brash ice is an accumulation of ice pieces up to about 2 meters (6 feet) in maximum dimension, resulting from the breakup of an ice cover by increasing water flow or by vessel passage. It is of particular concern in navigation channels and lock approaches.

Types of Ice Jams

An ice jam is a stationary accumulation of ice that restricts flow. Ice jams can cause considerable increases in upstream water levels, while at the same time downstream water levels may drop, exposing water intakes for power plants or municipal water supplies. Types of ice jams include freezeup jams, made primarily of frazil ice; breakup jams, made primarily of fragmented ice pieces; and combinations of both.

***Freezeup Jams*:** Freezeup jams are composed primarily of frazil ice, with some fragmented ice included. They occur during early winter to midwinter. The floating frazil may slow or stop because of a change in water slope from steep to mild, because it reaches an obstruction to movement such as a sheet ice cover, or because some other hydraulic occurrence slows the movement of the frazil. Jams are formed when floating frazil ice stops moving downstream, make the characteristic "arch" across the river channel, and begins to accumulate. Freezeup jams are characterized by low air and water temperatures, fairly steady water and ice discharges, and a consolidated top layer of ice.

Breakup Jams: Breakup jams happen during periods of thaw, generally in late winter and early spring, and are composed primarily of fragmented ice formed by the breakup of an ice cover or freezeup jams. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge attributable to a significant rainfall event or snowmelt. Late season breakup is often accelerated by increased air temperatures and solar radiation.

Combination Jams: Combination jams involve both freezeup and breakup jams. For example, a small freezeup jam forms in a location that causes no immediate damage. Before the thaw, the jam may provide a collecting point for fragmented ice that floats downstream. On the other hand, it could break up at the same time as the remainder of the river. Since the jam is usually much thicker than sheet ice, it significantly increases the volume of ice available to jam downstream.

Other Factors: In some rivers, frazil ice does not cause freezeup jams; instead, it deposits beneath sheet ice in reaches of slow water velocities. These frazil ice deposits, called hanging dams, are many times thicker than the surrounding sheet ice growth, and will tend to break up more slowly than thinner ice. Such a frazil deposit could also provide an initiation point for a later breakup jam, as well as increase the volume of ice available to jam downstream.

Causes of Ice Jams

River geometries, weather characteristics, and floodplain land-use practices contribute to the ice jam flooding threat at a particular location. Ice jams initiate at a location in the river where the ice transport capacity or ice conveyance of the river is exceeded by the ice transported to that location by the river's flow.

Change in Slope: The most common location for an ice jam to form is in an area where the river slope changes from relatively steep to mild. Since gravity is the driving force for an ice run, when the ice reaches the milder slope, it loses its momentum and can stall or arch across the river and initiate an ice jam. Water levels in reservoirs often affect the locations of ice jams upstream as a result of a change in water slope where reservoir water backs up into the river. Islands, sandbars, and gravel deposits often form at a change in water slope for the same reasons that ice tends to slow and stop. Because such deposits form in areas conducive to ice jamming, they are often mistakenly identified as the cause of ice jams. While these deposits may affect the river hydraulics enough to cause or exacerbate an ice jam, the presence of gravel deposits is usually an indication that the transport capacity of the river is reduced for both ice and sediment. Ice jams located near gravel deposits should be carefully studied to determine whether the gravel deposit is the cause of the jam or a symptom of the actual cause.

Confluences: Ice jams also commonly form where a tributary stream enters a larger river, lake, or reservoir. Smaller rivers normally respond to increased runoff more quickly than larger rivers, and their ice covers may break up sooner as a result of more rapid increases in water stage. Ice covers on smaller rivers will typically break up and run until the broken ice reaches the strong, intact ice cover on the larger river or lake, where the slope is generally milder. The ice run stalls at the confluence, forming a jam, and backing up water and ice on the tributary stream.

Channel Features: Natural and constructed features in a river channel may play a role in the locations of ice jams. River bends are frequently cited as ice jam instigators. While river bends may contribute to jamming by forcing the moving ice to change its direction and by causing the ice to hit the outer shoreline, water slope is often a factor in these jams as well (Wuebben and Gagnon 1995, Urroz and Ettema 1994). Obstructions to ice movement, such as closely spaced bridge or dam piers, can cause ice jams. In high runoff situations, a partially submerged bridge superstructure obstructs ice movement and may initiate a jam. In smaller rivers, trees along the bank sometimes fall across the river causing an ice jam. Removing or building a dam may cause problems. In many parts of the country, small dams that once functioned for hydropower have fallen into disrepair. Communities may remove them as part of a beautification scheme or to improve fish habitat. However, the effects of an existing dam on ice conditions should be considered before removing or substantially altering it. It is possible that the old dams control ice by delaying ice breakup or by providing storage for ice debris. Dam construction can also affect ice conditions in a river by creating a jam initiation point. On the other hand, the presence of a dam and its pool may be beneficial if frazil ice production and transport decrease as a result of ice cover growth on the pool.

Operational Factors: Some structural or operational changes in reservoir regulation may lead to ice jams. For example, changes in hydropower operations can inadvertently cause ice jam flooding. Sudden releases of water, such as those characteristic of peaking plants, may initiate ice breakup and subsequent jamming. On the other hand, careful reservoir regulation during freezeup or breakup periods can reduce ice jam flood risks.[2]

Flooding Definitions

Flooding is defined by NWS as “the inundation of normally dry areas as a result of increased water levels in an established water course.” River flooding, the condition where the river rises to overflow its natural banks, may occur due to a number of causes including prolonged, general rainfall, locally intense thunderstorms, snowmelt, and ice jams. In addition to these natural events, there are a number of factors controlled by human activity that may cause or contribute to flooding. These include dam failure, levee failure, and activities that increase the rate and amount of runoff such as paving, reducing ground cover, and clearing forested areas.

NOAA/NWS defines flood stage for river forecast points in the State of Idaho. Flood stage is the river height or flow which poses a definite hazard to life or property near river. Roads, infrastructure, and property near the river will be inundated when the river exceeds flood stage. The flood stage defined by the NWS is different than the regulatory flood because flood impacts generally begin to occur at the much lower stages than those which represent a 100 year flood event.

Flooding is a periodic event along most rivers with the frequency depending on local conditions and controls such as dams and levees. The land along rivers that is identified as being susceptible to flooding is called the floodplain. The Federal standard for floodplain management under the National Flood Insurance Plan (NFIP) is the “100-year floodplain.” This area is chosen using historical data such that in any given year there is a one percent chance of a “Base Flood” (also known as “100-year Flood” or “Regulatory Flood”).

A Base Flood is one that covers or exceeds the 100-year floodplain. In Idaho, flooding most commonly occurs in the spring of the year and is caused by snowmelt. Floods occur in Idaho every one to two years and are considered the most serious and costly natural hazard affecting the State. From 1976 to 2007 there were six Federal and 26 State disaster declarations due to flooding. The amount of damage caused by a flood is influenced by the speed and volume of the water flow, the length of time the impacted area is inundated, the amount of sediment and debris carried and deposited, and the amount of erosion that may take place.

[2] http://www.usace.army.mil/publications/eng-manuals/em1110-2-1612/c-11.pdf

Floods vary greatly in frequency and magnitude. Small flood events occur much more frequently than large, devastating events. Statistical analysis of past flood events can be used to establish the likely magnitude and recurrence intervals (period between similar events) of future events. As discussed above, the most commonly reported flood magnitude measure is the "base flood." In any given year, there is a 1% or 1 in 100 probability that water levels will exceed this magnitude. 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.

The floodplain is the area that normally carries water adjacent to the channel. Like "disaster," this term has two meanings, practical and regulatory. In practical terms, the floodplain is the area inundated by floodwaters and is obviously a somewhat fluid concept based on the magnitude of the flood. Where the surface of the land is relatively undisturbed, flood-prone areas can be recognized by a well-defined natural flat "floodplain", by natural levees along stream banks, by alluvial fans, abandoned channel meanders, or by soil types that are associated with the floodplains. In altered or urbanized areas, these features will be less distinct; they may be obscured or removed by development. Further, where structures have been placed in the floodplain, the processes may have been so altered that these features no longer accurately define the floodplain.

In regulatory terms, the floodplain is the area that is under the control of floodplain regulations and programs (such as the NFIP). Idaho Code defines the floodplain as:

"…land that has been or may be covered by floodwaters, or is surrounded by floodwater and inaccessible, during the occurrence of the regulatory flood."[3]

The floodway, a subdivision of the floodplain, is of special regulatory interest. More stringent regulations are often imposed in the floodway as changes here can have greater impact on the overall flood regime than in the remainder of the floodplain (the "flood fringe"). The floodway is defined as:

The channel of the river or stream and those portions of the floodplain adjoining the channel required to discharge and store the floodwater or flood flows associated with the regulatory flood.[4]

Application of these terms and concepts to flash and ice/debris jam break floods can be difficult. The term "inundation zone" may be used in place of floodplain and should be considered analogous. Like floodplains, inundation zones may be determined by projection of the anticipated volume of water (e.g., runoff from the "base" storm, storage capacity of the dam that may fail, or excess runoff not conducted by a storm water system). Historical inundation zones may be observed through field study of terrain features and vegetation, but, although they may be associated with recognizable terrain features such as canyons or gulches, areas subject to these floods are often less obvious than those located on a typical riverine floodplain.

Idaho Flooding History

Disasters in Idaho as determined by the U.S. Geological Survey and the Federal Emergency Management Agency are listed in Table 2.1. It lists the major riverine flood events and declared Flood Disasters. Additional details regarding the Declarations are provided below.

[3] §46-1201(4), Idaho Code.
[4] §46-1021(8), Idaho Code.

Major Riverine Flood Events and/or Flood Disaster Declarations	
Year	**Area Affected**
1894	State
1927	Upper Snake River Basin
1933	Spokane River Basin
1943	Boise and Payette Basins
1948	Northern and Western Idaho
1955	Southwest Idaho
1956	Floods
1957	Flooding
1959	Boise River Basin
1962	Southern and Eastern Idaho
1963	Portneuf and Clearwater Basins
1964	State-wide at Low Elevations
1972	Severe Storms Extensive Flooding
1974	Northern and Central Idaho
1976	Teton Dam Failure
1984	Ice Jams and Flooding
1996	Storms and Flooding
1997	Severe Storms and Flooding
1997	Spring Flooding
2006	Severe Storms and Flooding Owyhee County

Table 2.1 - Major Flooding Events and Disaster Declarations

Three of the most notable events occurred in 1933, 1964, and 1974. In 1933, warm rain on low elevation snow led to flooding in the Panhandle region and especially on the Coeur d'Alene River at Coeur d'Alene and the St. Joe River at St. Maries. Railroad tracks were covered with six feet of water, livestock drowned, all the families had to leave their homes, and in many cases, their houses were washed down the river. Levees were destroyed and the entire St. Joe valley became one vast lake (additional flooding occurred in 1946, 1948, 1976, and 1996, despite levee construction by the Army Corps of Engineers in 1942).

At the end of December 1964, warm rains fell on snow causing the Payette, Clearwater, Big and Little Wood Rivers to flood. The Payette River rose to record levels that flooded irrigation ditches and farmland; estimated damage was $21 million and two deaths were reported.

Significant flooding struck the St. Joe River Valley again in January 1974. Damages were estimated at $5.5; $4 million to public facilities (including roads and utilities) and $1.5 million to private property.

Summaries of the last four major flooding declarations are presented below:

Panhandle Floods – 1996*:* A combination of existing snow, 10 inches of new snow, and single-digit temperatures the last week of January 1996, caused ice to form on many rivers. This was followed by a warming pattern the first week of February and resulted in flooding in the northern Panhandle counties beginning on February 6.

On February 11, 1996, the President declared a major disaster in the State of Idaho (designated *DR-1102*). Ten counties and the Nez Perce Indian Reservation were declared eligible for assistance. As of February 1, 2001, assistance included $22,635,325 in public assistance, $71,639 in individual assistance, $301,081 from the Natural Resource Conservation Service (NRCS), and $5,022,353 in hazard mitigation grants.

In Clearwater County, 167 homes were damaged or destroyed; 40 commercial buildings were damaged; one church was destroyed and two were damaged. In the Coeur d'Alene Basin (Kootenai and Shoshone Counties), it was reported that residents were stranded by the flood waters and had to be contacted by boat, ATVs or helicopters.

St. Maries, the county seat of Benewah County, saw heavy damage despite an extensive levee system; over 100 homes and 19 commercial buildings were flooded. At one mill, one million board feet of lumber and a drying kiln were lost. Latah County damage included an estimated $1.6 million of damages to the University of Idaho.

Nez Perce County had damage near the community of Peck where 11 homes were destroyed, six had major damage and two had minor damage. Extensive damage was also reported on the Nez Perce Indian Reservation at Lapwai.

Districts 1 and 2 of the Idaho Transportation Department were hit hard by the disaster. In District 1, major highway damage occurred on U.S. 97 at Carlin Bay; U.S. 2 was closed at Dover where water covered a quarter mile of highway. Idaho 200 and 3 had damage. Interstate 90 was closed temporarily at Pinehurst and Cataldo. Idaho 6 was closed at Harvard Hill where approximately two miles of road was damaged.

In District 2, U.S. 95 had ten miles of damage; it was closed south of Lewiston where the road washed out in many locations. The stretch of road north of Lewiston at the Palouse Bridge was also closed. Damage occurred on U.S. 12 east between Cottonwood Creek and Orofino; Idaho 3 was closed east of Arrow Junction to Juliaetta with a washout area that was 400 feet long and 12 feet deep. Idaho 11 and 162 was closed in areas due to rock and mudslides. Idaho 6, 7, 9, and 64 were also damaged and portions were closed for a period of time.

Northern and Central Floods – 1996-97: During late December 1996, above-normal snowfall occurred in Northern and Central Idaho. This event was quickly followed by a warm, moist current of air from the subtropics that dumped warm rain on melting snow. The melting snow and heavy rains overwhelmed rivers and their tributaries, leading to severe flooding and widespread landslides mainly in the West-Central region of the State. On January 4, 1997 the President declared a Federal disaster (designated as *DR-1154*) in the State of Idaho due to severe winter storms, flooding, mud, and landslides related to the above-normal snowfall and spring runoff. Eighteen counties were declared eligible for Federal assistance. As of February 1, 2001, assistance included $19,404,105 in public assistance, $39,988 in individual assistance, $125,937 from the NRCS, $576,314 from the Army Corps of Engineers, and $5,593,892 in hazard mitigation grants.

Flood damage was widespread. Railroad tracks and trestles were washed out in dozens of locations. Substantial gravel and silt deposits left by flood waters accumulated on agricultural lands; cattle were stranded and farm equipment was submerged and damaged. Pesticide containers and fuel tanks were disturbed by the sudden flooding on the Payette and Weiser Rivers.

In the City of Payette, approximately 120 homes and 30 businesses were flooded; most problems resulted from a levee break that resulted in floodwaters two to three feet above the base flood elevation. In Gem County, 14 levees were damaged, including all three levees in Emmett, which showed large cracks and sections slumped into the river.

On the Weiser River, irrigation canals carried floodwaters to portions of the floodplain that would not have normally been flooded by the river itself; some homes and businesses in Weiser were damaged or destroyed from floodwaters conveyed by these irrigation systems.

U.S. 55 was restricted for one week and U.S. 95 experienced 11 washouts that stranded residents for days. McCall was isolated, suffering severe economic hardship due to disruption of its winter recreation activities. Five fatalities occurred as citizens self-evacuated by private aircraft during extreme weather.

Northern and Southeastern Floods - 1997: In early March 1997, Northern Idaho received 12 to 18 inches of snow on top of an existing snowpack that exceeded 150-170% of average. A rainstorm followed which resulted in a rapid snow melt. Precipitation for the month of March in this area was 187% of normal. The resulting flooding and mudslides lasted for an extended period and damaged many public facilities, including severe impacts to county road systems due to washouts. Additionally, hazardous material contaminants were identified in the Kellogg area. The President issued a Federal Disaster declaration (DR-1177) on June 13, 1997, for Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties.

The Snake River Basin also received a significant amount of snowfall during the winter of 1996-97, with the snowpack exceeding 250% of normal in some higher elevations. By May, the substantial snowpack in the higher elevations along the continental divide started to produce above normal runoff. In order to accommodate the rapid accumulation, the Bureau of Reclamation began increasing its releases from Palisades Reservoir. By June 11, the flows coming out of the reservoir coupled with the high tributary discharges produced the highest flows on the Snake River since 1918.

At its peak, the Snake River flooded as far as a mile from its banks, and many places were under five feet of water. On June 16, flood fights were conducted on the Snake River at Roberts where voluntary evacuations were in effect. River levels were close to overtopping existing flood control levees and flooding of agricultural lands began far from the main channel as irrigation canals overflowed their banks. Numerous closures of county roads and State highways from water and damage to bridges, especially in Jefferson County, had an impact on transportation as well as on response activities. On June 17, flood fighting efforts continued in several small towns, including Menan, Firth, Blackfoot, and Labell. On June 18, Interstate 15 was closed for nearly 20 miles between Shelley and Blackfoot.

On July 7, 1997, six counties in Southeastern Idaho (Bingham, Bonneville, Custer, Fremont, Jefferson, and Madison) were added to the five northern counties already declared under DR-1177. On July 25, Butte County was also declared. As of February 1, 2001, total assistance included $11,365,667 in public assistance, $8,054 in individual assistance, $251,054 from the NRCS, and $1,691,458 in hazard mitigation grants.

The State estimated that approximately 500 people were displaced from their homes in Jefferson and Bingham Counties. Agricultural officials estimated that more than 50,000 acres of farm, pasture, and cropland had been flooded; 30,000 in Bingham County alone.

Flood-related State Disaster Declarations 1976-2007			
Year	**Month**	**Federal**	**Counties Affected**
1979	January		Bingham, Washington
	February		Canyon, Washington
	February		Nez Perce
1980	March		Power, Oneida
1982	February		Bonner, Washington
	April		Blaine
1983	June		Jefferson
1984	May		Cassia
	May		Bannock, Twin Falls
	June		Jefferson
	June		Owyhee
	December		Lemhi, Butte
1985	January		Cassia
1986	January		Canyon, Payette, Washington
	February		Owyhee
	February		Boise
	June		Boise, Custer
1990	September		Elmore
1991	April		Bonner
1994	December		North Idaho
1996	February	X	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce, Shoshone
	May		Payette
	June		Boundary, Kootenai, Latah, Shoshone
1996-1997	November - January	X	Adams, Benewah, Boise, Bonner, Boundary, Clearwater, Elmore, Gem, Idaho, Kootenai, Latah, Nez Perce, Owyhee, Payette, Shoshone, Valley, Washington
1997	March – June	X	Benewah, Bingham, Bonner, Bonneville, Boundary, Butte, Custer, Fremont, Jefferson, Kootenai, Madison, Shoshone
2006	April – February		Camas, Lincoln, Gooding

Table 2.2 - Flood-related State disaster declarations for the period 1976-2007

Extreme Precipitation and Runoff Events: Extreme precipitation and runoff event flash floods occur throughout the State at all times of the year. Many are relatively small and do little damage; these are not well recorded. The National Weather Service did, however, record 121 flash floods during the period of 1982-2000, or an average of seven per year. A Bonner County flash flood in May 1991 received a State Disaster declaration; Federal assistance was denied.

The largest precipitation-related flash flood in recent history occurred August 20, 1959, inundating about 50 blocks in Boise and several hundred acres of farmland with water, rocks, and mud. On August 22, 1995, approximately two inches of rain fell on recently burned mountainous terrain near the North Fork of the Boise River, 45 miles to the northeast of Boise. These heavy rains caused a wall of water, rocks, and mud to flow down several creeks into the North Fork of the Boise River and over roads and campgrounds covering several vehicles.

More recently, warm rain on snow lead to a significant flash flood event near Sandpoint in May 1991. The torrents blew out large sections of the road leading to Schweitzer Basin ski area stranding dozens of people, contaminated the city's primary water supply, and heavily damaged the water treatment facility. The cost to cleanout and repair the water treatment facility ran to several hundred thousand dollars. A State Disaster declaration provided some assistance but without a Federal declaration the costs to the local community were very high.

On Saturday, June 25, 1992, between 4 pm and 5 pm, a severe thunderstorm moving from the southeast towards the northwest struck Boise, Idaho. More than 1 inch of rain fell in less than one hour over the Boise urban area and produced flash flooding. Unofficial storm totals were measured at 1.6 inches in southeast Boise. Many streets in the downtown area were flooded with water one to two feet deep. The storm and flash flood occurred during the Boise River Festival and impacted thousands of people who had gathered in downtown Boise for a parade and other festival activities.

On December 31, 1996 and January 1, 1997, warm heavy rain fell on extensive low elevation snow in Valley, Boise, Gem, Washington, and Adams Counties. The combination of rapid melting snow and the rain caused numerous mudslides and creeks to exceed their banks. Many roads, bridges, and railroads were washed out along with several homes. The community of South Banks was destroyed as mudslides carrying boulders the size of dump trucks and large trees bulldozed homes down to the canyon below.

It is important to remember that even "minor" events can take a toll in terms of loss of life and property. On July 30, 1996, after two hours of heavy rain on the slopes of Black Pine Peak in southeast Cassia County, a flash flood swept across the east bound lanes of Interstate 84, forcing a vehicle off the highway into deep water in a roadside ditch. The vehicle rolled and was carried more than 1,000 feet, and the driver was killed.

On April 14, 2002, flash flooding damaged roads and bridges in Valley and Boise Counties. A debris flow during this event crossed the Banks to Lowman Road near Stair Case rapids. Valley County experienced over 1 million dollars in damage to roads and bridges in the Donnelley area due to small stream flooding.

The road to Atlanta along the Middle Fork of the Boise River was washed out 3 times from 2003 through 2005 due to flash floods and debris flows originating on water repellent soils in the 2003 Hot Creek Fire Burn scar. Vegetation has returned to the burn and the soil is not as water repellent as it was right after the fire, but some increased threat of flash flooding can be expected in this area through 2008.

On June 29, 2004, between 3:30 pm and 4:30 pm, a severe thunderstorm moving from the southeast towards the northwest struck Boise Idaho. Rainfall accumulations of 1.27 inches in one hour were measured in the north end of Boise that caused flash flooding to develop rapidly. Many streets in the downtown area and in the north end experienced flooding. Minor flood damage occurred to some north end businesses and residential areas. The State Capitol building also sustained some water damage when water entered portions of the basement.

In April 2006, a State disaster was declared and was extended several times to February 2007. The event was caused by above average spring precipitation, heavy runoff, and rapid snowmelt resulting in flooding in Camas, Lincoln, and Gooding Counties. The State costs were as follows; Gooding County - no State monies were paid, Camas County - $454,171.14, and Lincoln County - $21,757.51.

***Inadequate Urban Drainage Systems*:** Minor flooding is a common occurrence in Idaho's cities. Climate, mountainous surroundings, and rapid growth have in some cases resulted in insufficient urban drainage systems. For example, Pocatello is located at the mouth of the Portneuf Canyon with generally mountainous terrain bordering the city on the east and south. Showers and thundershowers in the late spring and summer may result in highly localized precipitation concentrations that overwhelm the urban drainage systems. Some level of flooding occurs in Pocatello nearly annually, typically in underpasses and other areas with limited natural drainage.

Although such flooding is often regarded as a mere inconvenience, significant damage can occur. In September 1998, hundreds of homes in Idaho Falls were damaged when the 1.17 inches of rain that fell in twenty-four hours overwhelmed the drainage system. Most recently, flash flooding from severe thunderstorms resulted in basement-flooding in Pocatello in 1999.

***Dam Failures*:** Dam failure-caused flooding is infrequent but can have significant consequences. Idaho has experienced two major dam failures in recent history, Teton Dam (1976) and Kirby Dam (1991). There have also been a number of "near-miss" incidents where disaster was averted; these are not discussed here.

Teton Dam Failure – 1976: On June 5, 1976, Teton Dam in Fremont County failed. An estimated 80 billion gallons of water were released into the Upper Snake River Valley from the reservoir. Devastating flooding occurred in Wilford, Sugar City, Rexburg, and Roberts; additional significant flooding occurred in Idaho Falls and Blackfoot.

At the time of its failure, Teton Dam was brand new, stood 305 feet high, with a crest length of 3,100 feet and a base width of 1,700 feet. The dam was a zoned earth-fill structure with a volume of approximately ten million cubic yards. The flood waters threatened American Falls Dam downstream on the Snake River. Dam managers opened the outlet works on American Falls full bore to empty the Reservoir and to save American Falls Dam and the string of dams farther down the Snake River.

On June 6, President Gerald Ford declared Bingham, Bonneville, Fremont, Madison, and Jefferson Counties a Federal disaster area. Eleven deaths were attributed to the dam failure and subsequent flood. Estimates of monetary damages ranged as high as $2 billion; the Federal government eventually paid out over $300 million in claims.

Kirby Dam Failure – 1991: During the summer of 1990, it became apparent that the old log crib structure of the Kirby Dam near Atlanta had become unsound and was in jeopardy of failing. The possibility of failure was of special concern due to the large quantity of mine runoff and tailings that had collected behind the dam over the years. A strategy to stabilize the dam was developed by the Idaho Department of Water Resources and the U.S. Forest Service but was unsuccessful. On May 26, 1991, Kirby Dam collapsed, cutting off electrical power and blocking the primary access bridge to Atlanta. Contaminated sediments (containing arsenic, mercury, and cadmium) were released into the Middle Fork of the Boise River.

Ice Jam Floods: Ice jams have played a role in a number of floods in the State. Significant ice jams have occurred on: the Teton, Portneuf, and Snake Rivers in the east; the Little Lost (at Howe), Salmon, and Lemhi Rivers in the central region; the Payette and Weiser Rivers in the west; and the Kootenai (at

Bonners Ferry) and Clearwater (extensive overbank flooding in 1974 and 1996) Rivers in the Panhandle region. The most notable of the ice jam flood was on the Lemhi River near Salmon in 1984, an event that led to a Federal Disaster declaration. Ice jams on the St. Joe River caused significant flooding damage in St. Maries in 1997.

Lemhi Ice Jam Floods – 1984: [5] In January 1984, extensive ice jam formation in the Lemhi River just above the confluence with the Salmon River lead to flooding in and around the town of Salmon. Weather leading to this ice jam flood was typical, nighttime temperatures averaging -20°F and daytime temperatures near 0°F. Although initial ice jam build up began on December 22 in the Salmon River, aggressive ice control and flood fighting had allowed local crews to contain the flood waters prior to January 19. Flood damage occurred on January 19, 21, 23, and 28. After the flood waters receded, ice up to 3 feet thick remained in many homes and ice nearly 5 feet thick remained around homes and along streets. Ice jams are frequent in the area but the flooding was labeled as a base flood event.

President Reagan declared the Lemhi County ice jam, ice and flooding damages a disaster on February 16, 1984 (under the designation of DR-697). The entire county was included in the declaration. Disaster costs included approximately:

- $433,000 of public assistance – flood fight, cleanup, and repair work (including extensive levee reconstruction by the U.S. Army Corps of Engineers).
- $613,000 of private assistance – SBA home and business loans, insurance claims, and grants.

Most of the damage was concentrated in Salmon and adjacent developed agricultural fields. Only minor injuries were reported, but 325 people were displaced and 81 residences were damaged. Much credit was given to local search and rescue teams for avoiding serious injury and loss of life. Businesses, roads, sewers, and levees were also damaged.

Debris Jams: Woody debris commonly piles up in many drainages, especially those that have been logged. Lightning Creek (Pend Oreille), Lawyer Creek, Little Wood River (Ketchum and Hailey) have all experienced flooding from debris jams. Flooding from such events tends to be localized but may cause significant damages.

Flooding Risk Assessment

Rivers and Related Basins

Figure 2.1 shows major riverine flood susceptible areas. River flood forecast point along with expected impacts at different river stages can be viewed on NOAA/NWS web pages.

See:

http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=boi

http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=pih

http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=mso

http://ahps2.wrh.noaa.gov/ahps2/index.php?wfo=otx

Snake River: Only a relatively small portion of the Snake River is susceptible to flooding; however, many of the flood prone areas are intensively populated. Flooding can cause extensive damage to land and buildings, highways, railroads, irrigation facilities, and utilities. Snake River floods will generally occur in the months April through June, primarily from snow melt in the upper watersheds. Late spring or summer snow melt floods typically occur as a series of high flows for periods of days or weeks. They

[5] Idaho Department of Water Resources & Idaho Bureau of Disaster Services, 1985

can be compounded by warm spring rains that increase snow melt rates and contribute directly to runoff. Flood damage along the Snake River, for the most part, will be confined to the floodplain between Heise and American Falls Reservoir. The safe channel capacity of the Snake River in this reach varies from 15,000 cfs to 30,000 cfs.

Regulation of the Snake River and some tributaries can significantly reduce natural flood flows through dams constructed for flood control and other purposes. Reservoirs that function for other purposes can reduce flood flows through informal flood control operation or incidental storage of flood waters. Major dams in this region include Jackson Lake, Palisades, Island Park, and the Ririe Dam located on Willow Creek, a major tributary.

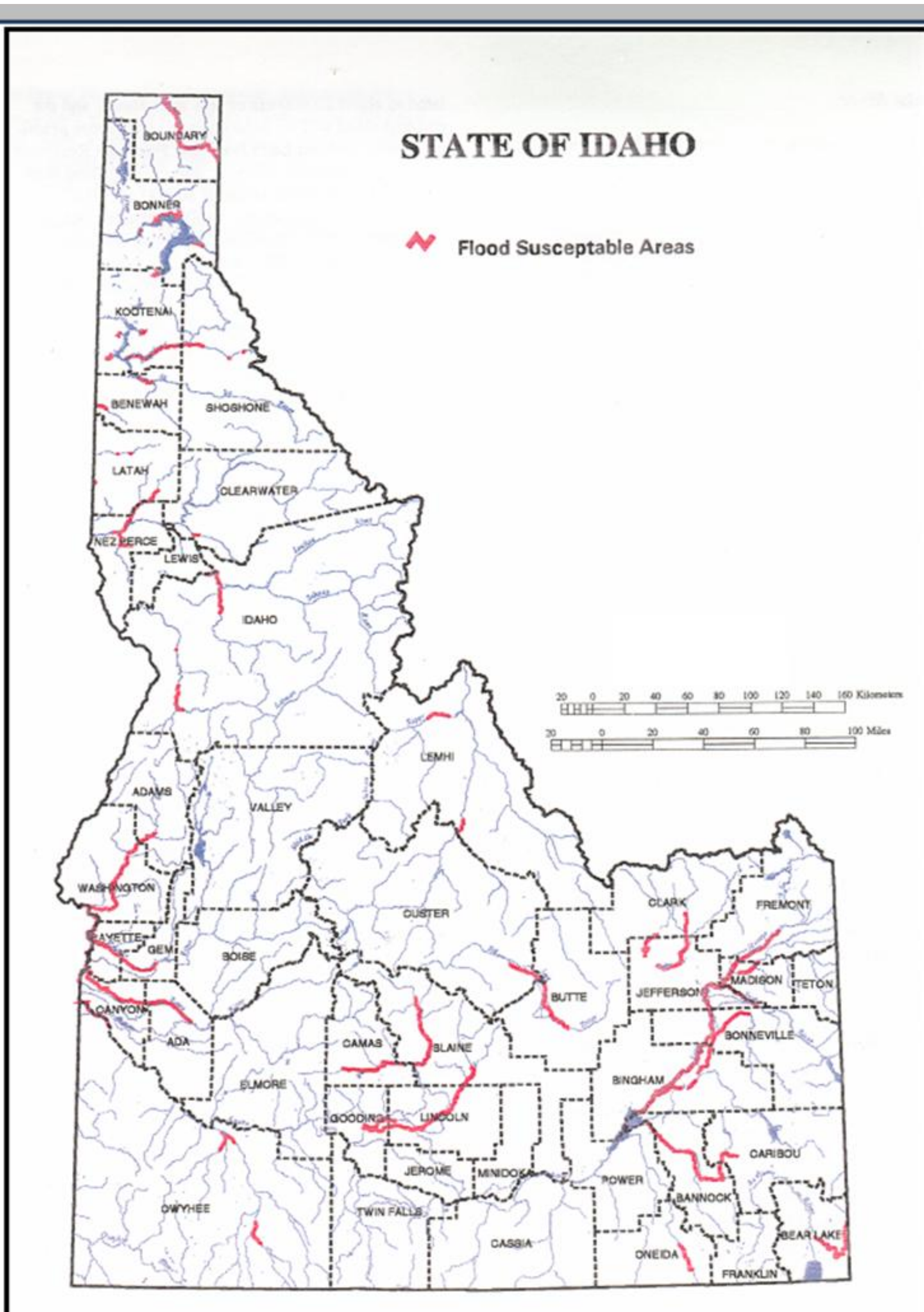

Figure 2.1 - Areas Susceptible to Flooding
Source: Idaho Department of Water Resources, 1997

Levees provide some flood protection in the flood prone land between Heise and Roberts, near Shelley, and near Blackfoot. However, the stream bed materials, low banks, and gradient induce river meanders. Major channel shifts could unpredictably impinge upon the levees.

American Falls affords major regulation of Snake River flood flows, although little flood damage is likely from the dam downstream to Milner. This stretch of the river consists of a series of irrigation diversion pools and canyon reaches. The Snake River, between Milner Dam and King Hill, flows through a deep narrow canyon cut in the Snake River Plain.

Mud Lake: Camas and Beaver Creeks are sources of surface inflow to Mud Lake, which has no effective outlet other than irrigation canals, evaporation, and seepage. Lands along Camas Creek near the lake and along the south side of the lake are susceptible to flooding. If the volume of inflow were to exceed the available storage capacity of the lake, locally constructed dikes around the lake might fail and permit flooding of farm areas south of the lake. The Mud Lake floodplain is principally in crops. Portions of residential and associated developments in the communities of Terreton and Mud Lake, on the fringe of the floodplain, may suffer minor damages under extreme flood conditions.

Portneuf River: Flooding can occur in reaches along the entire length of the Portneuf River downstream from Portneuf Reservoir and along Marsh Creek. Protection of the Pocatello area is afforded by a rectangular concrete channel through the city with riveted levees on both ends where development is less extensive. A 1988 Army Corps of Engineers Preliminary Report on the Portneuf River examined constructing multiple purpose storage reservoirs and enlarging the river channel. The study found that these proposals were not economically justified.

Wood River: Flood damage in the Wood River basin is most likely in a reach extending from Ketchum to Bellevue, near Gooding, and at Carey and Shoshone. The agricultural lands subject to flooding in the Big and Little Wood valleys are used primarily for pasture, hay, and grains. This area, however, is experiencing significant population growth, with an accompanying increase in flooding risk from Ketchum to Carrey.

Boise River: In the Lower Boise River Basin, the magnitude of flood flows has been partly diminished by irrigation diversions and storage reservoirs. The upstream reservoirs only provide protection against minor flood events. Boise, Garden City, Eagle, Star, Middleton, and agricultural lands downstream of Boise are still subject to periodic flooding in high runoff. Ada and Canyon Counties are currently seeing increased development along rivers and streams greatly increasing flood hazard exposure.

Weiser River: Major flooding of the Weiser River is also possible. The fairgrounds at the town of Cambridge and a portion of the area south of town are located in the river’s floodplain. The agricultural enterprises in the lower 13 river miles of the Weiser River, from the Galloway Diversion to the mouth of the river near the City of Weiser, are susceptible to flooding. Incidental storage in Crane Creek and Lost Valley reservoirs can reduce peak flows by an estimated 3,600 cfs.

Clearwater River: Flood flows in the Clearwater Basin can be expected to damage residential and commercial buildings in the cities of Orofino, Stites, and Kooskia on the main stem of the Clearwater. Towns on tributary streams are also subject to damages. Highway and railroad bridges and roadbeds can be undercut and washed out. Lumber operations are also at risk.

Flood control is an important function of the Dworshak project on the North Fork Clearwater. The reservoir is managed to alleviate flooding below Ahsahka and is a part of the regional flood control system of the Columbia River Basin. Dworshak regulation is considered essential in limiting flood waters to 150,000 cfs or less through Lewiston.

Bear River: Spring snow melt flooding in the Bear River Basin can exceed stream channel capacity and overflow onto adjacent low lands. More serious damage may be expected when heavy rain falls on frozen ground and/or a heavy snow pack. Thunderstorms are common during the summer and fall months, and these may produce localized cloudburst flooding. The total volume of water produced by this type of storm is relatively small, although the instantaneous runoff rate is high.

PacifiCorp’s regulation of flows at Bear Lake has reduced the impact of flooding virtually every year on the main stem of the Bear River below Bear Lake. Bear Lake is operated to provide an annual pre-runoff storage volume equal to twice the average annual runoff. The Corps of Engineers (1991) estimated average annual damages from flooding and analyzed structural control measures in the basin. Most of the damage from floods can be expected to occur on agricultural land and property.

Panhandle Rivers: Flood prone lands constitute a significant portion of the Panhandle basins. The Spokane, Kootenai, and Pend Oreille Basins have a long history of major flood events. However, the greatest potential damage is usually not along major rivers, but along tributary streams. Minor tributaries have steep gradients and damages are generally the result of flash floods. Placer Creek, a tributary of the South Fork Coeur d'Alene River, places the town of Wallace at risk (flooding has occurred seven times in the last century).

In the Spokane River Basin, flooding is expected mainly along the low lying lands adjacent to tributary streams above Coeur d'Alene Lake in the Coeur d'Alene and St. Joe River valleys. Past property damage around Coeur d'Alene Lake has been negligible, but large areas may be inundated.

The Spokane River Basin above Coeur d'Alene Lake is unregulated by storage structures. About 55 miles of levees along the lower Coeur d'Alene River, the St. Joe River, Pine Creek, and other minor tributaries protect over 4,000 acres of land adjacent to rivers and streams from flood events. However, levees in the vicinity of St. Maries have failed and may do so again. A levee at Coeur d'Alene protects the city against high lake levels.

A melting snow pack is the most likely source for major flooding on the Kootenai River. Libby Dam regulation can control all but about one percent of floods originating from the Kootenai River. A base flood can be controlled by the dam to a 27-foot stage at Bonners Ferry. Levees have been constructed at many locations on both major and minor streams in the basin. Over 95 miles of levees protect 32,000 acres along 51 river miles in the Idaho portion of the basin. Levees protecting Kootenai Flats are effective up to a river stage of 35 feet at Bonners Ferry.

Flooding in the Pend Oreille Basin may occur along the river lowlands and tributaries. Damages would likely be confined largely to grain crops and pasture land, although some low lying road and buildings may be affected around Lake Pend Oreille. Calispell Creek, a tributary of the Pend Oreille, can produce major flooding events.

Table 2.3 below illustrates the flood hazard ranking for Idaho's forty-four (44) Counties.

Impact/Probability	**Low**	**Medium**	**High**
Low	Jerome Nez Perce Teton	Twin Falls	Clearwater
Medium	Bear Lake Caribou Franklin Owyhee	Adams Bannock Boise Clark Custer Lemhi Butte Jefferson Madison Minidoka Oneida Power	Lincoln
High	Bingham	Bonneville Canyon Cassia Elmore Fremont Gooding Idaho Kootenai Valley	Ada Benewah Blaine Bonner Boundary Camas Gem Latah Lewis Payette Shoshone Washington

Table 2.3 - Flood Risk Impact and Probability for Counties in Idaho *(Source: BHS)*

Probability

High: Steep, mountainous terrain, history of flooding events, number of new developments and number of rivers, lakes, creeks in vicinity of flood zones, flood control systems often *overwhelmed*

***Medium**: Geography is moderate; fewer susceptible streams and cree*ks, historically less flood-prone, flood control is normally adequate

Low: Few historical flood events, little or no new development in flood zones, geography is less flood-prone, sufficient flood control operations

Impact

High: Number of new developments, large population centers, vulnerable irrigation systems, sewer and water systems, rivers, lakes and creeks in vicinity, major utility/transportation corridors, number of state facilities

Medium: Few large population centers, few new areas of development, irrigation, sewer and water systems are less vulnerable, state facilities are widely dispersed

Low: Little or no flood exposure to development or population, effective flood controls mitigate flood damage, little or no exposures to state facilities

Flash Flooding

Extreme Precipitation and Runoff Events*:* Winter storm floods generally occur during the months of January through March. Thunderstorms may occur at any time of the year, although they are most common from March through September. Almost all Idaho flash floods occur during the afternoon and evening hours. Flash floods are more difficult to forecast than riverine floods as their likelihood is related to a number of dynamic factors. Precipitation extremes as well as vegetation, soil condition, and development all directly affect the probability of flash flooding. Areas with a history of flash floods or suitable terrain must be considered at-risk, especially after events such as wildland fires that predispose the areas to flash floods.

Inadequate Urban Drainage Systems*:* As Stated above, minor flooding is a common occurrence in Idaho's cities as insufficient urban drainage systems are overwhelmed by intense, concentrated late-spring and summer precipitation. The majority of these events are "nuisances" resulting in traffic delays or detours and minor cleanup costs. On occasion, though, they result in major damage and loss of life. Rapid growth in Idaho's urban areas (with the construction of impervious surfaces) is expected to place continuing pressure on the urban drainage systems and an increase in the frequency and severity of this type of flash flooding may occur.

Dam Failures: Idaho has hundreds of dams located throughout the State, ranging from large government reclamation and private utility hydroelectric facilities to small privately-owned dams for local flood control or irrigation purposes. Between 1905 and 1930, many dams were built in the State to store water, primarily for irrigation. A second spurt of dam construction, primarily for power generation, between 1950 and 1969, significantly increased water storage capacity. A major concern is that the expected life of a dam is 75 years and many dams are either approaching or have exceeded this age. Dams, through either overtopping or outright failure, may pose significant risks to downstream communities.

Dam safety in Idaho is administered by the Idaho Department of Water Resources. Dams 10 feet or higher or which store more than 50 acre feet of water (as well as mining tailings impoundment structures) are regulated by IDWR. Every dam is inspected once every other year unless more frequent inspections are called for by safety concerns. IDWR uses a dam risk classification to identify potential losses and damages anticipated in downstream areas that could be attributable to failure of a dam during typical flow conditions.[6] The risk categories are:

- Low Risk: No permanent structures for human habitation; Minor damage to land, crops, agricultural, commercial or industrial facilities, transportation, utilities or other public facilities or values.
- Significant Risk: No concentrated urban development, 1 or more permanent structures for human habitation which are potentially inundated with flood water at a depth of 2 ft. or less or at a velocity of 2 ft. per second or less. Significant damage to land, crops, agricultural, commercial or industrial facilities, loss of use and/or damage to transportation, utilities or other public facilities or values.
- High Risk: Urban development, or any permanent structure for human habitation which are potentially inundated with flood water at a depth of more than 2 ft. or at a velocity of more than 2 ft. per second. Major damage to land, crops, agricultural, commercial or industrial facilities, loss of use and/or damage to transportation, utilities or other public facilities or values.

High risk dams are located through the State and pose a potential risk to many of Idaho's more densely settled communities. The fact that many dams in Idaho are aging and have not had any significant renovation activities, increases the opportunities for dam problems.

[6] Idaho Administrative Code, IDAPA 37, Title 3, Chapter 6, Section 25: Safety of Dam Rules.

Ice/Debris Jam Flooding

Ice jams are relatively common in Idaho. For example, a study conducted following the Lemhi River ice jam flooding in 1984, revealed that during the period of 1910-1984, ice jams reached the town of Salmon every 25 years, with jams occasionally building up to Salmon twice during a single winter. Elsewhere on the river, significant ice jams were found to have occurred in nine out of every ten winters between 1899 and 1984.

Ice jams can be expected to continue forming on rivers throughout the State. Debris jams may also be expected to continue forming and are directly influenced by human actions and other hazard occurrence (e.g., landslides).

Flooding Mitigation

Policy Framework

Several State-level documents specifically address flood damage policy, building on the general hazard mitigation policy framework established earlier in the Plan.

Idaho Code Regulatory Provisions

Flooding is the one hazard that the State Legislature has seen fit to specifically address. The purpose and findings in §46-1020, Idaho Code establish the State's flood damage reduction policy guidelines:

- The public interest requires that the floodplains of Idaho be managed and regulated in order to minimize flood hazards to life, health and property.
- Local units of government have the primary responsibility for planning, adoption and enforcement of land use regulations to accomplish proper floodplain management. Furthermore, they are best able to adopt and implement comprehensive floodplain management programs that include non-regulatory techniques to accomplish the purposes of this act in cooperation with Federal, State and local agencies.
- Flood damage and the number of people and structures at risk in flood hazard areas should be reduced through proper *floodplain management*[7], including such measures as floodplain zoning ordinances which require structures to be built at a *flood protection elevation*[8] and/or with *floodproofing*[9].

State Water Plan

The Idaho State Water Plan, adopted by Idaho Water Resource Board, is the key active policy Statement regarding water resources and flooding in the State. It is currently under revision with a goal to strengthen the Floodplain Management Program in the State. Specific steps have been listed as part of the Mitigation Action Items.

WATER RESOURCES DEVELOPMENT ACT PROJECTS APPROVED

Washington, DC – The United States Senate has authorized a number of water projects for Idaho in the Water Resources Development Act (WRDA), H.R. 2864.

"Passing this bill for the first time in seven years will finally authorize critical water infrastructure projects for Idaho," [Senator] Crapo said. "These are important projects to both the livelihood of Idahoans and the future of our water resources."

"Without water projects like the ones included here, the West dries up, literally and figuratively," [Senator] Craig said. "It is critical that these needs are met so growing States like Idaho can continue to keep up with ever-increasing water demands."

Flood Protection Projects Include:

- **Little Wood River** – Rehabilitation of the Gooding Idaho Channel Project for flood control and for ecosystem restoration.
- **Boise River** – Provides for new studies on flood control, ecosystem restoration, and water supply.
- **Port of Lewiston** – Lifts restrictions and allows the use of fill material to raise some (non-wetland) low areas above flood elevation to meet project standards.
- **Fish Creek Dam –** Dam safety improvements at the Fish Creek Dam in Blaine, County. The water in the reservoir is used for irrigation, recreation, flood control, and fish and wildlife habitat.

---

[7] Idaho State Code 46-1021: "The analysis and integration of the entire range of measures that can be used to prevent, reduce or mitigate flood damage in a given location, and that can protect and preserve the natural, environmental, historical, and cultural values of the floodplain."
[8] Ibid.: "An elevation that shall correspond to the elevation of the one percent (1%) chance flood (one hundred (100) year flood) plus any increased flood elevation due to floodway encroachment, plus any required freeboard."
[9] Ibid.: "The modifications of structures, their sites, building contents and water and sanitary facilities, to keep water out or reduce the effects of water entry."

The most recent version of the plan establishes the State's policy to:

- Encourage the protection of floodplains and reliance on management rather than structural alternatives in reducing or preventing flood damages.[10]

Flood damage can be limited by providing sufficient space in the floodplain to accommodate flood waters. Local government is encouraged to plan for floodways and protect floodplains from further development.

Prospective buyers should be made aware of identified flood prone areas. The pressures to develop areas subject to periodic flooding will continue to increase as population increases. Buyers should realize that flood prone areas require special construction provisions to avoid flood losses.

The NFIP should be adopted State-wide. This program requires that local units of government zone and control flood prone areas in order to be eligible for most Federal assistance and prevent damage in the community. Floodplain maps prepared for FEMA are available through IDWR.

- Regulate the construction and maintenance of flood control levees.[11]

The only standards applicable to the construction of flood control levees in Idaho are in the rules governing Stream Channel Alterations. These standards apply only when all or part of the levee will be located below the mean high water mark.

Flood control levees are maintained by local entities. There are no maintenance regulations so the degree of maintenance varies with the capability and diligence of the responsible organization. This situation creates a potential hazard that levees may deteriorate to the point of being unsafe.

All new flood control levees should be required to be built to standards promulgated by the Department of Water Resources. The Department should also be authorized to develop maintenance criteria for flood control levees and to insure compliance with these criteria through an inspection program.

When a levee is scheduled to be rebuilt, a cost/benefit analysis should be conducted to determine if it is prudent to rebuild the levee in question or buy the property which the levee would protect.

The State Water Plan also establishes a number of environmental quality and fish and wildlife habitat policies that are relevant to flood mitigation actions:

- That the public interests be considered when decisions are made to maintain sustainable populations of plant and animal species whose existence is threatened by mankind's actions.[12]
- To cooperate, insofar as allowed by State law, in efforts to conserve and restore plant and animal species listed by the Federal Government as Threatened or Endangered.[13]
- That comprehensive management plans for surface use and water quality protection be developed for lakes and reservoirs in the State.[14]
- That climate variability is considered in planning for and in the management of the State's water resources.[15]
- To have the Idaho Water Resource Board appropriate in-stream flows when it is in the public interest.[16]

---

[10] Idaho Department of Water Resources, 1997; Policy 3I
[11] Ibid.; Policy 3J
[12] Ibid.; Policy 2A
[13] Ibid.; Policy 2B
[14] Ibid.; Policy 2C
[15] Ibid.; Policy 2D

- To protect the ecological viability of riparian habitat and wetlands within the State in the public interest.[17]
- That the costs and benefits of stream channel rehabilitation be evaluated where past activities currently or potentially affect the yield or quality of the State's watersheds.[18]

Catastrophic flooding is often the outcome of heavy run-off combined with human disturbances, and may result in the destruction of stream channels. The functional loss of impacted channels may threaten public safety, private property, and the overall quality and quantity of water produced in the affected watershed. It is appropriate for the State to take action to rehabilitate impacted stream channels where public safety may be threatened, or where the remedial costs are less than the potential damages.

Other

The Flood Damage Reduction Plan (prepared in 1996 by the Bureau of Disaster Services) and the reports produced by the Interagency Hazard Mitigation Teams for three federally declared flood-related disasters (DR-1102, DR-1154, and DR-1177) articulate the State's desire to develop a comprehensive and coordinated approach to flood hazard mitigation. Additionally, the Flood Damage Reduction Plan lists four objectives:

1. Enhance coordination of agencies and consistency of flood damage reduction policy.
2. Increase knowledge of flood hazards, flood hazard mitigation approaches and the impacts of land uses, flood damage and repair, and resource management practices on watershed dynamics, fish and wildlife populations, and flood hazards.
3. Reduce vulnerability to flood damage and environmental impacts through coordination with land planning efforts, improved design and construction standards, and programs that address current at-risk development.
4. Strengthen flood preparedness, response, and education.

Finally, the DR-1154 report reinforces the State's commitment to local level implementation:

Most important in this effort is local government involvement in the examination and implementation of hazard mitigation alternatives to protect residences, businesses, and infrastructure from future damages.[19]

Mitigation Policy Summary

Flooding is recognized as one of the most significant hazards in Idaho. The public interest clearly requires that flood hazards to life, health, and property be minimized. The following are priorities in the effort to accomplish this:

- Manage and regulate the floodplains to include:
    1. Floodplain zoning ordinances and design and construction standards that require structures located in the floodplain be flood-resistant or flood-proofed and programs that address current at-risk development.
    2. Reliance on management (such as coordinated land planning efforts and protection of floodplain functions) rather than structural flood controls.
    3. Balancing conservation and restoration efforts and protection of ecological viability of riparian habitat and wetlands with the public interest.

---

[16] Ibid.; Policy 3A
[17] Ibid.; Policy 3D
[18] Ibid.; Policy 3E
[19] Interagency Hazard Mitigation Team, n.d.; p.5

- Place primary responsibility on local units of government.
- Regulate the construction and maintenance of flood control levees.
- Enhance coordination of agencies and consistency of flood damage reduction policy.
- Increase knowledge of flood hazards, flood hazard mitigation approaches and the impacts of land uses, flood damage and repair, and resource management practices on watershed dynamics, fish and wildlife populations, and flood hazards.
- Strengthen flood preparedness, response, and education.

Existing Mitigation Planning Programs

Flooding is one of the most damaging and visible of the hazards that impact the State. This high priority and profile has given flooding considerable weight in mitigation and mitigation planning activities.

Floodplain Management through the National Flood Insurance Program

The responsibility and authority for floodplain management and the implementation of the NFIP rests with local governments. The Idaho Department of Water Resources coordinates the implementation of the NFIP on a statewide basis by providing technical assistance and education about the NFIP to local officials and property owners.

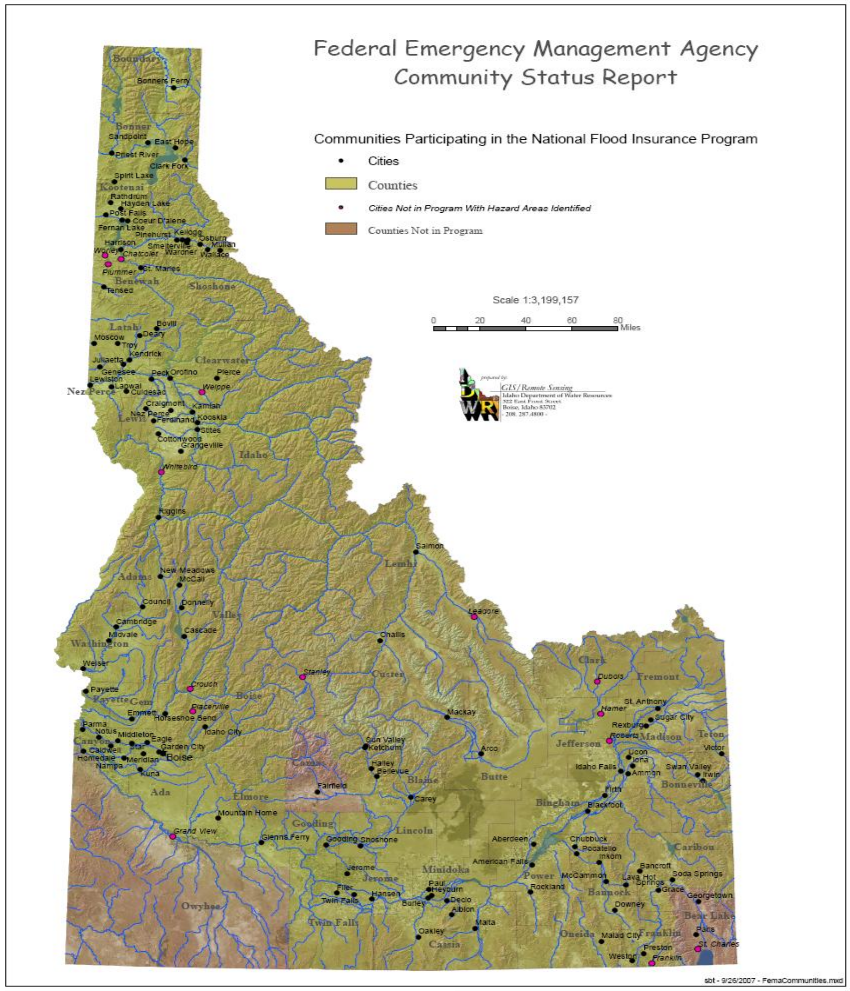

Figure 2.2

Communities that choose to participate in the NFIP must make some effort at managing development in the floodplains that have been identified. This is done though the implementation of local ordinances that meet a minimum of basic requirements established by the NFIP. Communities are allowed and encouraged to adopt floodplain ordinances that go beyond these minimum requirements. Typically, regulations are based on flood hazard areas established by the Flood Insurance Rate Maps (FIRM) provided by FEMA; preparation of the FIRM allows for implementation of floodplain management ordinances in a community. Figure 2.2 provides an overview of those communities that are participating in the NFIP.

Implementation and enforcement of required flood plain ordinances varies greatly among the counties and cities represented. The State of Idaho has no regulatory authority over NFIP compliance issues. The State NFIP Coordinator monitors local compliance with NFIP requirements and reports compliance issues to the FEMA Regional NFIP Program Specialist who is responsible for resolving the compliance issue or imposing sanctions against violating communities.

Although the implementation of the NFIP in Idaho provides a base-line for managing the risk associated with Idaho's mapped floodplains several significant shortcomings and challenges exist. The first of these is that Idaho's risk exposure to floods is not limited to the areas included in the flood hazard areas included on FIRM maps provided by FEMA. This situation gives property owners outside of flood hazard areas identified on FIRM maps a false sense of security. The intense development pressure experienced by Idaho communities creates a situation where many communities are eager to work with developers to use Letters of Map Amendment (LOMA) and Letters of Map Revision (LOMAR) to get hazardous properties out of the floodplain. In most cases, this approach does little to reduce the flood hazard exposure, while providing property owners with a false sense of security. The other major challenge to the effectiveness of the NFIP in Idaho is the maintenance of flood hazard maps. Continued Federal funding for flood map revisions is in question. The statewide development pressure continues to highlight the need for better mapping. Natural processes and development change watercourses and neither local, State, or Federal Agencies have adequate resources to address flood map revision individually.

While structures constructed before community adoption of the FIRMs continue to be at risk, a number of them have been acquired, relocated, or elevated using funds from the Hazard Mitigation Grant Program. These efforts will continue using available funding from the Pre-Disaster Mitigation Grant Program, Flood Mitigation Assistance Grant Program, and Hazard Mitigation Grant Program.

One particular challenge for flood mitigation in Idaho is the middle fork of the Boise River located in the central part of the state. Both normal high-water spring runoff and infrequent flash flooding have had damaging effects on a particular stretch of unpaved road in Elmore County used by local residents, recreationalists and commercial vehicles. In 2003, federal agencies spent $540K to repair and replace water-damaged roadway. In 2004, the Burned Area Debris Flow Risk Assessment field study was conducted, but focused mainly on hillside fire damage. The study did not include the damage-prone roadway. In 2004, the $1.1M in damages was paid by federal emergency relief funds. The damage caused by spring runoff in 2005 cost nearly $750K in federal funds to repair the same stretch of road. Even with all of the resources used to annually repair the roadway, there has been minimal state investment due to full federal reimbursement of repairs and maintenance. Potential mitigation actions would include a feasibility study to consider relocating the road as a prelude towards collaboration with all appropriate partners in order to seek more permanent solutions to this persistent problem.

Flood Mitigation Assistance Program

The Flood Mitigation Assistance (FMA) program is a key proactive mitigation planning tool for local governments in Idaho. Funding for flood mitigation programs under the program is seen by BHS as a catalyst for eventual preparation of all-hazard mitigation plans by all of the counties. The applicant community must be a participant in the NFIP and implement the 2000 or later International Building Code.

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) has been the key funding source for mitigation actions in the State. Building elevations, property acquisitions, and small-scale structural projects have all been completed as a result of HMGP.

State Dam Safety Program

The State Dam Safety Program (DSP) is administered in Idaho by IDWR. This program focuses on inspection, classification, and emergency planning for dam safety.

Other

There are a number of structural and non-structural measures in place to reduce flood caused damages. These measures are undertaken and maintained by Federal, State, and local agencies and private interests.

Thirteen Flood Control Districts exist in the State. Flood Control District goals include:

- Constructing or proposing projects to reduce flooding.
- Protecting and maintaining present flood works as funding allows.
- Discouraging development in the floodplain.

Structural projects for flood damage reduction in Idaho consist of reservoirs, levees, and stream channel alteration. Storage projects and levees in the State have been built throughout the State to protect communities from damage by a base flood event. Structural flood controls range from the major dams to shovel-built berms. Levees in many areas are non-engineered, remnants of previous flood fights. Unclear regulation and ownership has led to continuing levee maintenance problems throughout the State. With ownership uncertain, even some levees constructed by the U.S. Army Corps of Engineers or the Natural Resources Conservation Service have not been maintained.

Nonstructural projects include watershed improvement and land use zoning within floodplains. Land use zoning (often related to NFIP participation) is used to prohibit inappropriate construction within floodplains, allowing local communities to prevent future flood damages. Watershed improvement projects experiment with land management methods and small water projects to reduce surface runoff and slow peak flood flows on rangeland, farmland, and forest land.

Local Capability Assessment

Local governments draw on several strengths for dealing with the risk associated with the flooding hazard. All 44 of Idaho's counties have either begun the development of their multi jurisdiction all-hazard mitigation plans or have expressed an interest in doing so. This is an important first step for communities to foster a mindset of reducing future potential losses from flooding events. Forty-one of Idaho's 44 counties participate in the NFIP which requires them to adopt and enforce minimum standards established by the NFIP regulations (44 CFR Part 60). The primary responsibility for floodplain management is vested with local government. Local governments also have the best knowledge and data about the pattern of flooding events and the risk exposure to these events.

Local governments also face several significant challenges in addressing the risk associated with their flood hazard and vulnerability. Many communities find it difficult to enforce floodplain ordinances for several reasons including low staffing levels, outdated flood hazard maps, lack of technical expertise, political opposition, economic pressure from developers, and lack of public support. Many communities participate in the NFIP with ordinances that only meet the bare minimum standard of acceptance. Many citizens, politicians, and developers have a common misconception about floodplain regulation. This misconception leads them to believe that floodplain ordinances limit individual property rights when the truth is that well written and enforced floodplain ordinances actually protect the property rights of individuals.

Idaho's smaller and rural communities experience significant challenges in implementing flood mitigation activities. Floodplain code enforcement is a major challenge in many smaller jurisdictions since floodplain administration is largely handled by individuals performing other jobs in addition to floodplain management. These jurisdictions also face challenges in developing sound engineering solutions to known vulnerabilities because of expense and limited access to design professionals. These communities are also challenged in finding funds to address potential future losses on shoestring budgets. Many of these communities require significant technical assistance from the State to assist with grant application development and benefit cost analysis once a project has been identified.

Idaho Code (Title 42 Chapter 31) includes provisions for Flood Control Districts at the local government level. These taxing districts have extremely limited staff, resources and equipment. Their role and function is often misunderstood and their limited resources often leave them ill equipped to address any significant flooding.

Idaho Code also includes provisions for the creation and operation of Drainage Districts at the local level of government (Title 42 Chapter 31). These districts have the powers to dike, alter or remove obstructions from any natural water course or river that drains the district to promote drainage. Idaho Code also allows for the creation of Levee Districts at the local level of government (Title 42 Chapter 44) for the maintenance, construction or operation of levees to control irrigation water or prevent flooding. The role of these taxing districts is clearer than that of the Flood Control Districts; however they also have small staffs with very limited budgets.

Flood Mitigation Projects:

The seeking of funding for mitigation projects is just beginning as the counties complete their All Hazard Mitigation Plans. Currently, two flood mitigation projects are underway in Idaho, they include:

- 2005 FMA for Nez Perce County- Federal funds $129,579 - Recipient share $43,193.
- 2007 PDM for Bonners Ferry – Federal funds $53,360 - Recipient share $17,790. Project to strengthen bank around city sewer lagoon and outfall.

General Approaches to Mitigation

Flood mitigation is principally involved with accommodating desired social and economic use while preventing losses to life, health, and property. In general, flood damage may be mitigated by keeping humans and structures separate from floodwaters through controls on land use, actions to increase water storage capacity, removal or elevation of structures and controlling development in the floodplain, structural measures such as levees and dikes, and increasing the understanding of the flood hazard by the public and decision makers. Recommendations for steps to implement each of these approaches are presented in the five categories:

- Hazard Management
- Information/Education
- Infrastructure
- Regulatory
- Mapping and Analysis

A key distinction of flooding when compared to other hazards is the extent to which the actions of others can influence flooding impact on a community. Activities in the upper portions of the basin that generate additional surface water runoff, in-stream debris, or sedimentation may increase flood impacts on downstream communities. It is essential that flood mitigation planning address the entire basin and that communities undertaking local planning efforts coordinate and cooperate with adjacent jurisdictions.

In comparison to riverine flooding, flash flooding comes with little warning and is considerably less predictable. Flash floods are generally triggered by more concentrated events (e.g., focused thunderstorms, overwhelmed infrastructure, and dam failures) that are harder to foresee with any reliability. Certain areas though, due to terrain and precipitation regimes, can be seen as relatively high-risk. Mitigation focuses on controlling the factors that can be controlled and providing for effective evacuation, response, and recovery.

Mitigation for ice and debris jam floods is closely related to riverine and flash flooding mitigation and is not described separately. The obvious additional step is to control the jam-forming material prior to the event.

Hazard Management

Flood hazard management may be accomplished through structural (e.g., levees and dikes) and non-structural (e.g., constructed or enhanced wetlands) means. These means involve manipulation of existing or constructed of new features to compensate for changes that have occurred in the floodplain. Such changes may be the result of development or other land use practices, which either has increased the likelihood or extent of flooding or that has placed residents or businesses within the floodplain.

As with riverine flooding, flash flood hazard management may be accomplished through structural (e.g., retention ponds and dams) and non-structural (e.g., revegetation following wildland fire and stream channel maintenance) means. Although the flash flood may result from any of several causes, in general hazard management is the same:

- Avoid sudden releases of large quantities of water (e.g., improve the watershed's ability to retain precipitation or strengthen and maintain dams).
- Keep the water that cannot be stopped separate from people and properties (e.g., build sufficient storm water facilities, maintain an adequate warning and evacuation system).
- Direct site development away from the apex of alluvial fans and dam failure inundation zones.

Information/Outreach and Public Education

As described above, continued flood damages have been associated with a misunderstanding of the extent of flood hazard areas and/or the potential impacts of flood waters. Public information and education is the first line of defense, not only increasing the knowledge of the problem but also gaining higher compliance with regulatory and voluntary mitigation measures.

In areas that have not seen recent flash flooding, the hazard may be seriously undervalued due to a lack of obvious remainders (such as large river channels). Many residents and property owners may be unaware that their lives and properties lie in high-risk areas. Residents and property owners should be informed of known flash flood inundation zones. When they are aware, residents and property owners can play an important role in mitigation.

Infrastructure

Flood-resistant infrastructure can be built but at a high cost. Roads and other transportation infrastructure are often hit hard by flash floods. In much of the State, the mountainous terrain strongly favors construction of roads and other lifelines through the relatively accessible (and inexpensive) narrow valleys that may be prone to flash floods. Infrastructure that cannot be relocated from high-risk areas must be "flash flood-proofed" or contingencies must be developed to maintain the systems function.

Regulatory

The State has clearly stated the policy that direct legal controls through regulation occur at the local level. Consequently, the State's legislative involvement is confined principally to incentives and assistance. One key regulatory step that can be taken at the State level is mandating full disclosure of flood hazards during real estate transactions.

One of the few effective steps for dam failure-caused floods is careful land use planning that keeps development out of inundation zones. Local governments need to identify and provide for appropriate use of at-risk areas.

Mapping / Analysis / Planning

Accurate mapping of flood-prone areas is the first step in mitigation. This analysis depends on knowledge of the normal hydrologic regime and past flood events through direct observation and inference from other environmental data. Developing a comprehensive database is a key priority of the overall flood mitigation effort.

All mitigation projects approved on or after the date revision of this Plan adoption that are entered into databases must be geocoded using standard datum. For projects approved before the date of this memorandum, existing project data may be geocoded using the street address. The guidance for the standardized datum is available from the State of Idaho Hazard Mitigation Office.

Recommended Statewide Flood Mitigation Actions

Hazard Management

SHMP-HM01	Flood-proof vulnerable State facilities
SHMP-HM02	Protect hazardous materials facilities from flood inundation
SHMP-HM03	Stabilize banks of watercourses to prevent further erosion and protect government facilities
SHMP-HM04	Elevate structures vulnerable to flooding
SHMP-HM05	Acquire properties vulnerable to flooding and create open space to reduce future flood impacts
SHMP-HM06	Enhance drainage in areas prone to flooding
SHMP-HM07	Construct catch basins and drainage control systems in areas prone to flash flooding
SHMP-HM08	Raise HVAC and mechanical systems to avoid flood damage
SHMP-HM09	Construct ice control structures in areas prone to ice jam flooding
SHMP-HM10	Construct thermal discharge system to control ice buildup in areas prone to ice jam flooding
SHMP-HM11	Rehabilitate damaged community watersheds to control run-off
SHMP-HM12	Implement measures to control sediment in areas prone to sediment build-up
SHMP-HM13	Enhance storm water systems in flood prone areas
SHMP-HM14	Increase the number of NFIP communities participating in the CRS program
SHMP-HM15	Improve dam safety
SHMP-HM16	Develop levee safety program and improve levee safety
SHMP-HM17	Increase the number of communities participating in the NFIP: *Specifically the following Counties: Bear Lake, Camas, Owyhee, and Cities: Dubois, Buhl, Franklin, Leadore, Stanley, Roberts, Hamer, Grandview, St. Charles, Crouch, Placerville, Whitebird, Weippe, Plummer, Worley, Chatcolet that have hazards identified*
SHMP-HM18	Install flood alert system and computer monitoring system with flood warning capability In high flood risk areas

Information/Outreach and Public Education

SHMP-IE01	Increase public awareness of flood hazards and mitigation possibilities
SHMP-IE02	Establish a flood awareness week in Idaho

SHMP-IE03	Develop and publish a flood Information web site
SHMP-IE04	Develop and distribute a floodplain conservation toolkit
SHMP-IE05	Encourage the use of NOAA weather alert radios in flash flood high-risk areas
SHMP-IE06	Increase participation in the NFIP through the provision of information and interface with local elected officials
SHMP-IE07	Develop guidance for local governments to use in the “holistic” or integrated management of the flood hazards
SHMP-IE08	Increase public awareness and participation in the National Flood Insurance Program
SHMP-IE09	Increase awareness and participation in the National Flood Insurance Program within the business community

Infrastructure

SHMP-IS01	Improve bridge safety
SHMP-IS02	Improve drainage in flood prone areas where streams cross transportation routes
SHMP-IS03	Protect sewer treatment and water treatment facilities from flood damage
SHMP-IS04	Erect wing walls where appropriate to protect bridge abutments
SHMP-IS05	Protect bridge footings from scour

Regulatory

SHMP-RE01	Adopt statewide floodplain management legislation
SHMP-RE02	Revise the State Executive Order on floodplain management
SHMP-RE03	Update highway design standards
SHMP-RE04	Change the State Statue IC 55-2508 to require disclosure to buyers of properties in special flood hazard areas or regulated floodplains, or where flood insurance may be required
SHMP-RE05	Conduct a policy gap analysis to determine if Idaho Statues effectively implement floodplain management in Idaho
SHMP-RE06	Convene a workgroup to analyze the effectiveness of IC Chapter 42 Section 31 and develop appropriate recommendations to clarify the role of flood control districts and make them more effective

Mapping / Analysis / Planning

SHMP-MA01	Improve collection of long-term and real-time Hydrologic Data
SHMP-MA02	Develop and maintain a floodplain hazardous materials inventory
SHMP-MA03	Improve floodplain mapping in Idaho through a partnership with FEMA, IDWR, the State of Idaho Chief Information Officer, and local Governments

SHMP-MA04	Establish a state flood hazard advisory committee
SHMP-MA05	Develop a collaborative approach between local, State, and Federal agencies to address flood hazard mapping shortfalls
SHMP-MA06	Install flood gauges on un-gauged flood prone streams that pose a significant flood hazard to communities
SHMP-MA07	Develop a statewide levee inventory and levee safety program

Recommended Region/County Flood Mitigation Strategies

The following strategies, if observed and adopted by the individual county all hazard mitigation committees, will drive statewide implementation of the Mitigation Projects listed above.

Hazard Management

- Increase Participation in the NFIP
- Increase Participation in the Community Rating System
- Identify and then seek to remediate stabilize disturbed reaches to control sediment in targeted watersheds working with appropriate Federal and State Agencies
- Work with the IDWR to improve dam safety by installing early warning systems for dam failures
- Working with appropriate State and Federal Agencies establish ice flow control mechanisms
- Develop local programs to clear and maintain stream channels
- Develop local programs to ensure canal safety

Information/Outreach and Public Education

- Increase public knowledge regarding safety while building in flood prone areas
- Develop local programs which provide education to local homeowners on the national flood insurance program and the Community Rating System
- Increase elected and appointed official knowledge regarding land use practices in flood prone areas
- Develop a program to use NOAA weather alert radios to provide flood warnings

Infrastructure

- Integrate bridge safety programs in the county transportation plans
- Seek funding through Idaho Transportation Department and other sources to improve bridge safety
- Develop Culvert Maintenance Programs
- Implement practices to protect roadways from flash floods and debris flows

Regulatory

- Implement the recognized floodplains into land use planning and ordinances
- Develop ordinances that adopt the NFIP
- Develop ordinances that adopt the Community Rating System

Mapping / Analysis / Planning

- Develop or enhance Geographical Information System (GIS) mapping of flood prone areas
- Using GIS mapping practices, provide locations of flood mitigation projects
- Link flood mapping GIS layers to hazardous materials layers
- Using GIS to define areas prone to flash flooding, landslides, mudslides, etc.

Appendix 2.1

State of Idaho Stream Gauges

Bear River Basin
Bear River at Border Wyoming
Bear River at Pescadaro, Idaho
Bear River at Idaho-Utah State Border
Cub River near Preston, Idaho
Kootenai River Basin
Kootenai River at Leonia, Idaho
Moyie River at Eastport, Idaho
Kootenai River at Bonners Ferry, Idaho
Kootenai River at Tribal Hatchery near Bonners Ferry, Idaho
Kootenai River at Porthill, Idaho
Pend Oreille River Basin
Lightning Creek at Clark Fork, Idaho
Priest River near Priest River, Idaho
Spokane River Basin
North Fork Coeur D'Alene River above Shoshone Creek near Prichard, Idaho
North Fork Coeur D'Alene River at Enaville, Idaho
Canyon Creek above mouth at Wallace, Idaho
East Fork Pine Creek above Gilbert Creek near Pinehurst, Idaho
East Fork Pine Creek above Nabob Creek near Pinehurst, Idaho
Pine Creek below Amy Gulch near Pinehurst, Idaho
South Fork Coeur D'Alene River near Pinehurst, Idaho
Coeur D'Alene river near Cataldo, Idaho
St. Joe River at Calder, Idaho
St. Marie's River near Santa, Idaho
St. Joe river near Chatcolet, Idaho
Spokane river near Coeur D'Alene Lake outlet at Coeur D'Alene, Idaho
Spokane River near Post Falls, Idaho
Upper Snake River Basin
Snake River above Jackson Lake at Flagg Ranch, Wyoming
Snake River near Morgan, Wyoming
Pacific Creek at Moran, Wyoming
Buffalo Fork above Lava Creek near Moran, Wyoming
Snake River at Moose, Wyoming
Gros Ventre River at Zenith, Wyoming

Snake River below Flat Creek near Jackson, Wyoming
Snake River above Reservoir near Alpine, Wyoming
Grey's River above Reservoir near Alpine, Wyoming
Salt River above Reservoir near Etna, Wyoming
Snake River near Irwin, Idaho
Snake River near Heise, Idaho
Dry Bed Near Ririe, Idaho
Snake River at Lorenzo, Idaho
Henrys Fork Basin
Henry's Lake near Lake, Idaho
Henry's Fork near Island Park, Idaho
Henry's Fork near Ashton, Idaho
Falls River above Yellowstone Canal near Squirrel, Idaho
Falls River near Squirrel, Idaho
Falls River near Ashton, Idaho
Falls River near Chester, Idaho
Henry's Fork at St. Anthony, Idaho
Teton River above South Leigh Creek near Driggs, Idaho
Teton River near St. Anthony, Idaho
North Fork Teton River near Sugar City, Idaho
South Fork Teton River near Rexburg, Idaho
Henry's Fork near Rexburg, Idaho
Middle Snake River Basin
Snake River near Menan, Idaho
Great Western Spillback near Idaho Falls, Idaho
Snake River above Eagle Rock near Idaho Falls, Idaho
Gray's Lake outlet near Herman, Idaho
Willow Creek below Tex Creek near Ririe, Idaho
Sand Creek near Ucon, Idaho
Willow Creek Floodway Channel near Ucon, Idaho
Willow Creek Floodway Channel at mouth near Idaho Falls, Idaho
Willow Creek below Floodway Channel near Ucon, Idaho
Snake River near Shelley, Idaho
Snake River at Blackfoot, Idaho
Blackfoot River above Reservoir near Henry, Idaho
Blackfoot River near Shelley, Idaho
B lackfoot River bypass near Blackfoot, Idaho
Blackfoot River near Blackfoot, Idaho
Snake River near Blackfoot, Idaho
Portneuf River at Topaz, Idaho

Marsh Creek near McCammon, Idaho
Portneuf River at Pocatello, Idaho
Portneuf River near Tyhee, Idaho
Spring Creek at Sheepskin Road near Fort Hall, Idaho
Snake River at Neely, Idaho
Snake River near Minidoka, Idaho (at Howells Ferry)
Milner Lake at Milner Dam, Idaho
Snake River Gaging at Milner, Idaho
Snake River at King Hill, Idaho
McCalley Dam Outflow at Mountain Home Air Force Base, Idaho
CJ Strike Reservoir near Grand View, Idaho
Goose Creek Basin
Goose Creek above Trapper Creek near Oakley, Idaho
Trapper Creek near Oakley, Idaho
Salmon Falls Creek near San Jacinto, Nevada
Mud Lake-Lost Rivers Basins
Little Lost River below Wet Creek near Howe, Idaho
Big Lost River at Howell Ranch near Chilly, Idaho
Big Lost River below Mackay Reservoir near Mackay, Idaho
Big Lost River near Arco, Idaho
INL Diversion at head near Arco, Idaho
INL Diversion at outlet of Spreading Area A near Arco, Idaho
Big Lost River below INL Diversion near Arco, Idaho
Big Lost River at Lincoln Boulevard Bridge near Atomic City, Idaho
Malad River Basin
Big Wood River at Hailey, Idaho total flow
Camas Creek near Blaine, Idaho
Little Wood River above High Five Creek near Carey, Idaho
Little Wood River near Carey, Idaho
Silver Creek at Sportsman Access near Picabo, Idaho
Malad River near Gooding, Idaho
Bruneau River Basin
Bruneau River near Hot Spring, Idaho
Owyhee River Basin
Owyhee River near Rome, Oregon
Owyhee river below Owyhee Dam, Oregon
Boise River Basin
Boise River near Twin Springs, Idaho
South Fork Boise River near Featherville, Idaho
South Fork Boise River at Anderson Ranch Dam, Idaho

Mores Creek above Robie Creek near Arrowrock Dam, Idaho
Cottonwood Creek below Fivemile Creek near Boise, Idaho
Boise River at Glenwood Bridge near Boise, Idaho
Boise River South Channel at Eagle, Idaho
Boise River near Parma, Idaho
Malheur and Harney Lakes Basin - eastern OR
Donner under Blitzen River near Frenchglen, Oregon
Malheur River Basin - eastern OR
Malheur River below Warmsprings Reservoir near Riverside, Oregon
North Fork Malheur River at Beulah, Oregon
Malheur River below Nevada Dam near Vale, Oregon
Payette River Basin
South Fork Payette River at Lownam, Idaho
Deadwood River below Deadwood Reservoir near Lowman, Idaho
Middle Fork Payette River near Crouch, Idaho
Payette Lake at McCall, Idaho
North Fork Payette River at McCall, Idaho
Payette River near Horseshoe Bend, Idaho
Payette River near Emmett, Idaho
Payette River near Letha, Idaho
Payette River near Payette, Idaho
Weiser River Basin
Weiser River near Cambridge, Idaho
Crane Creek at mouth near Weiser, Idaho
Weiser River near Weiser, Idaho
Lower Snake River Basin
Snake River at Nyssa, Oregon
Snake River at Weiser, Idaho
Snake River at Hells Canyon Dam Idaho-Oregon State Line
Snake River below McDuff Rapids at China Gardens, Idaho
Snake River near Anatone, Washington
Palouse River near Potlatch, Idaho
Salmon River Basin
Salmon River below Yankee Fork near Clayton, Idaho
Thompson Creek near Clayton, Idaho
Squaw Creek below Bruno Creek near Clayton, Idaho
Salmon river at Salmon, Idaho
Lemhi River near Lemhi, Idaho
Lemhi River below L5 Diversion near Salmon, Idaho
Salmon River near Shoup, Idaho

Middle Fork Salmon River at Middle Fork Lodge near Yellow Pine, Idaho
Middle Fork Salmon River at mouth near Shoup, Idaho
South Fork Salmon River near Krassel Ranger Station, Idaho
Johnson Creek at Yellow Pine, Idaho
Little Salmon River at Riggins, Idaho
Salmon River at White Bird, Idaho
Clearwater River Basin
Selway River near Lowell, Idaho
Lochsa River near Lowell, Idaho
South Fork Clearwater River near Elk City, Idaho
South Fork Clearwater River at Stites, Idaho
Clearwater River at Orofino, Idaho
North Fork Clearwater River near Canyon Ranger Station, Idaho
Clearwater River near Peck, Idaho
Potlatch River below Little Potlatch Creek near Spalding, Idaho
Webb Creek near Sweetwater, Idaho
Sweetwater Creek at mouth at Sweetwater, Idaho
Lapwai Creek near Lapwai, Idaho
Clearwater River at Spalding, Idaho

Source: http://waterdata.usgs.gov/id/nwis/current?type=flow&group_key=basin_cd&search_site_no_station_nm=