2021

BINGHAM COUNTY MULTI-JURISDICTION ALL HAZARD MITIGATION PLAN

Hazard Identification and Risk Assessment Section

Contents

Section 2: Hazard Identification and Risk Assessment

Hazards that pose a threat to human life, health, and well-being are myriad and no attempt is made here to compile an exhaustive list. Those that are addressed in disaster planning are generally categorized as “natural” or “technological”. FEMA contains a thorough discussion of hazards in the section entitled “FEMA's Multi-Hazard Identification and Risk Assessment (MHIRA)”[1]. Hazards that have been identified as significant in this County and that are considered in this Plan are:

Natural Hazards

Severe Weather:	Drought
	Extreme Heat
	Lightning
	Hail
	Tornado
	Straight Line Wind
	Severe Winter Storm
	Extreme Cold
Flooding:	Flash Flood
	River Flooding
	Dam Failure
Geologic:	Earthquake
	Landslide/Mudslide
Other:	Wildfire
	Biological
	Vector Borne Disease
	Bird Flu
	West Nile
	Human Borne Disease (Communicable Disease)
	SARs
	Swine Flu (H1N1)
	Covid-19

Technological (Manmade) Hazards

Structural Fire
Nuclear Event

[1] http://www.fema.gov/plan/prevent/fhm/ft_mhira.shtm

Hazardous Material Event
Riot/Demonstration/Civil
Disorder Terrorism

Natural Hazards

Weather Hazards

The impact of weather hazards may be widespread (drought) or more localized (lightning), but all have the potential to be severe and directly life-threatening. Historical weather data is generally available in good detail over long time periods, allowing for reasonably accurate risk assessment for planning purposes.

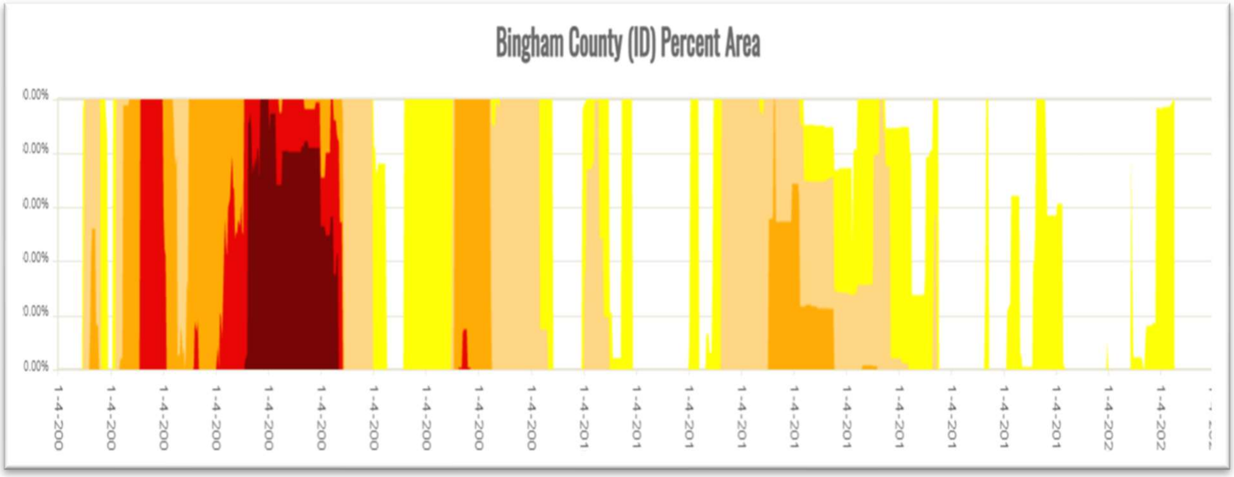
Drought

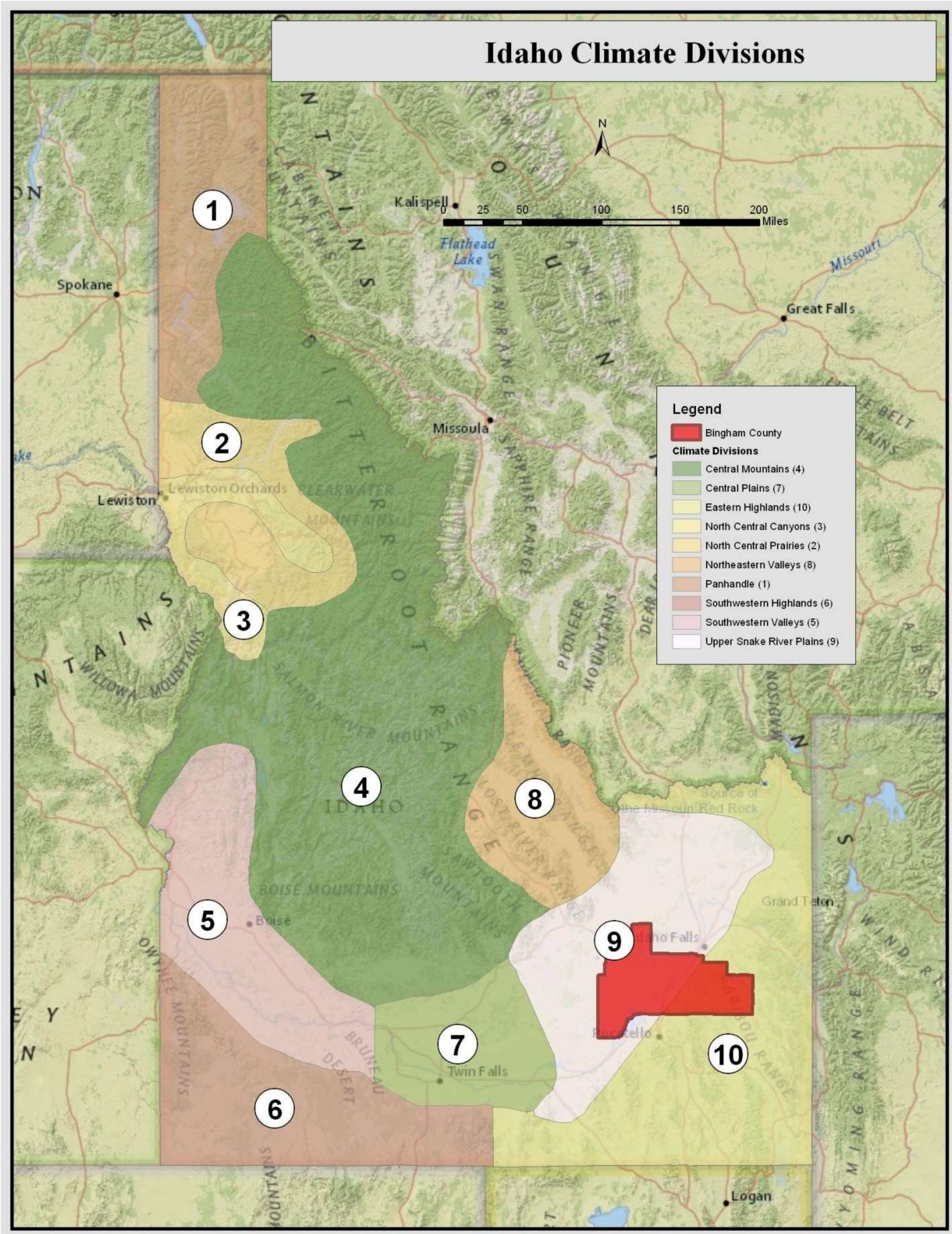
Description

Drought is an expected phase in the climactic cycle of almost any geographical region. Certainly, that is the case in the State of Idaho. Objective, quantitative definitions for drought exist but, most authorities agree that because of the many factors contributing to it, and because its onset and relief are slow and indistinct, none is entirely satisfactory. According to the National Drought Mitigation Center, drought "originates from a deficiency of precipitation over an extended period of time, usually a season or more. This deficiency results in a water shortage for some activity, group, or environmental sector." What is clear is that a condition perceived as "drought" in a given location is the result of a significant decrease in water supply relative to what is "normal" in that area.

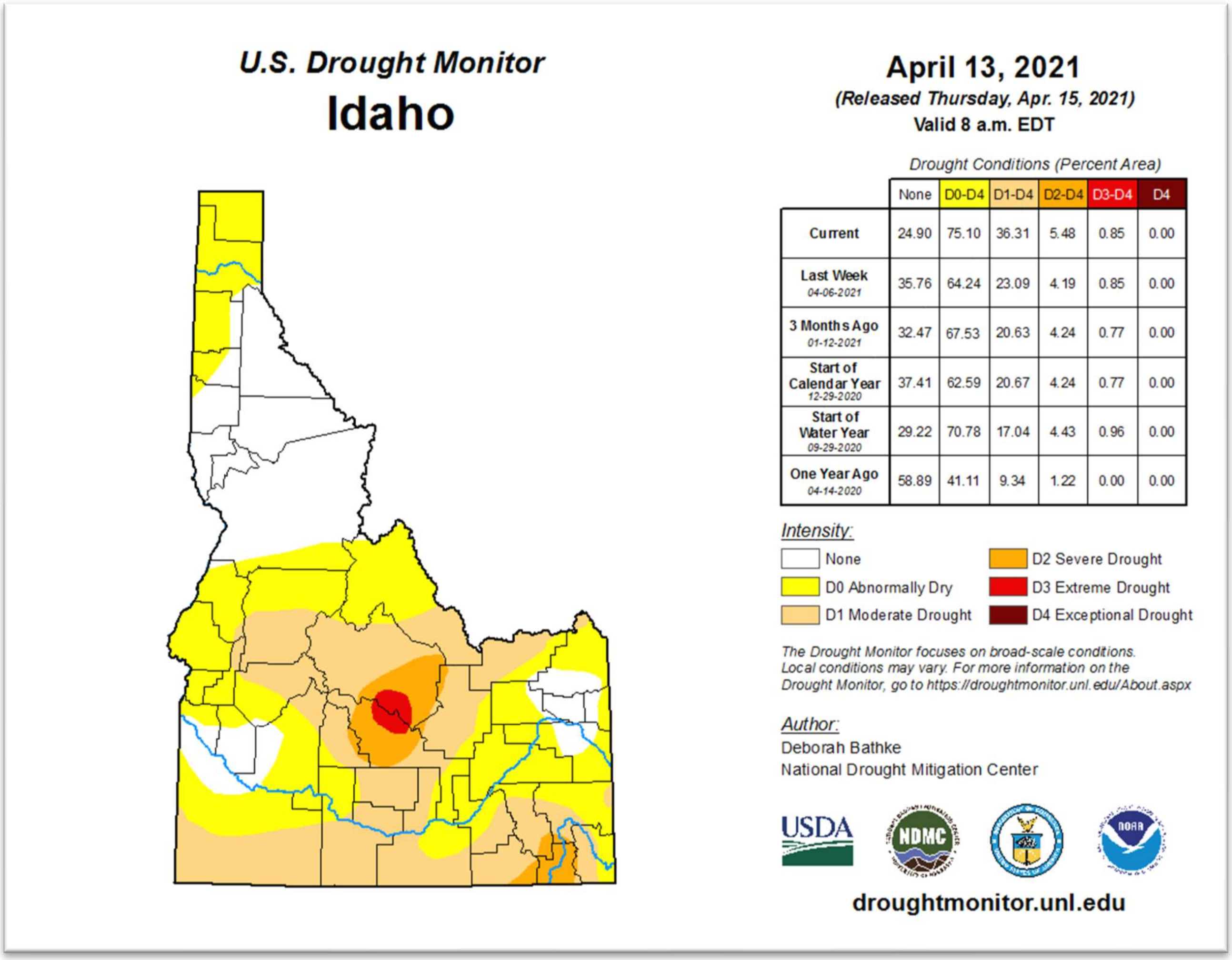
It should be noted that water supply is not only controlled by precipitation (amount, frequency, and intensity), but also by other factors including evaporation (which is increased by higher-than-normal heat and winds), transpiration, and human use. According to the NOAA National Climactic Data Center, much of the State of Idaho most recently experienced moderate to extreme drought conditions from the years 2000 through 2013. Drought Emergency Declarations were issued for various counties by the Idaho Department of Water Resources in the years 2002 through 20012. Idaho's only Federal Drought Emergency Declaration was issued in 1977.

The following figures illustrate the drought conditions for Bingham County. Bingham County is split between two climate divisions, the Upper Snake River Plains (Zone 9) and the Eastern Highlands (Zone 10) divisions.


Bingham County (ID) Percent Area



Idaho Climate Divisions Map



	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	24.90	75.10	36.31	5.48	0.85	0.00
Last Week 04-06-2021	35.76	64.24	23.09	4.19	0.85	0.00
3 Months Ago 01-12-2021	32.47	67.53	20.63	4.24	0.77	0.00
Start of Calendar Year 12-29-2020	37.41	62.59	20.67	4.24	0.77	0.00
Start of Water Year 09-29-2020	29.22	70.78	17.04	4.43	0.96	0.00
One Year Ago 04-14-2020	58.89	41.11	9.34	1.22	0.00	0.00

Historical Frequencies

The Idaho Department of Water Resources reports that meteorological drought conditions (a period of low precipitation) existed in the State approximately 30% of the time during the period 1931-1982. Principal drought in Idaho, indicated by stream flow records, occurred during 192941, 1944-45, 1959-61, 1977, and 1987-92. The most prolonged drought in Idaho was during the 1930s. For most of the State, that drought lasted for 11 years (1929-41) despite greater than average stream flows in 1932 and 1938. In 1977, the worst single year on record, a severe water shortage occurred throughout Idaho and the West. Stream flows were below normal from1979 to 1981. A Federal Declaration was issued in 1977 for the State of Idaho as well as Bingham County.

According to the Idaho Department of Water Resources (IDWR) the following Drought Emergency Declarations were issued for Bingham County.

- May 15, 2001
- May 23, 2002

- April 29, 2003
- May 25, 2004
- April 15, 2005
- June 29, 2007
- June 17, 2013

Bingham County did not have any drought declarations during the years 2014-2020.

Impacts

Drought is agriculture's most expensive, frequent, and widespread form of natural disaster. The current drought in the interior West is part of a multi-year drought that began in 1999, worsened in 2000. As a result, the drought in the West was slow to develop, and likewise, will be slow to recede.

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services.

Impacts are commonly referred to as direct or indirect. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of direct impacts. The consequences of these impacts illustrate indirect impacts. For example, a reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues because of reduced expenditures, increased crime, foreclosures on bank loans to farmers and businesses, migration, and disaster relief programs. Direct or primary impacts are usually biophysical. Conceptually speaking, the more removed the impact from the cause, the more complex the link to the cause. In fact, the web of impacts becomes so diffuse that it is very difficult to come up with financial estimates of damages. The impacts of drought can be categorized as economic, environmental, or social.

Many economic impacts occur in agricultural and related sectors because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

Category	Impact
D0	Irrigation demand is higher than normal
	Ski areas open later, visitation is lower, snowpack is lower
D1	Dryland hay and grain crop yields are low; other crops and pasture are in poor condition
	Well levels decline; reservoir levels are low; water shortages occur; water conservation programs are in place
	Fire risk is elevated, fires spread easily
	Deer are scrawny; bird population suffers due to loss of food and habitat; trees are stressed
D2	Grazing season is shortened, vegetation is sparse; crops are left unharvested; feedlots are not profitable
	River levels are very low
	Hydroelectric power is down; irrigation water allotments are significantly curtailed
D3	Dryland farms are left fallow; forage is limited; cattle herds are cut
	Spring snowpack is very low
	Number of fires increase
D4	Ski resorts lose revenue
	Fire danger is high
	Hydropower generation is affected; power companies may raise rates and/or purchase alternative power
	Crop production is down
	Trees are stressed and threatened by insect infestation
	Fish and wildlife populations decrease; habitats are degraded

Loss Estimates and Vulnerability

All of Bingham County is vulnerable to the effects of drought. Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect. Retailers and others who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue for local, State, and Federal government. Less discretionary income affects the recreation and tourism industries. Prices for food, energy, and other products increase as supplies are reduced. In some cases, local shortages of certain goods result in the need to import these goods from outside the stricken region. Reduced water supply impairs the navigability of rivers and results in increased transportation costs because products must be transported by rail or truck. Hydropower production may also be curtailed significantly.

Hazard Evaluation

Drought risk is based on a combination of the frequency, severity, and spatial extent of drought (the physical nature of drought), and the degree to which a population or activity is vulnerable to the effects of drought. The degree of a region's vulnerability depends on the environmental and social characteristics of the region and is measured by their ability to anticipate, cope with, resist, and recover from drought.

Society's vulnerability to drought is determined by a wide range of factors, both physical and social, such as demographic trends and geographic characteristics.

The Bingham County Agricultural Land Map shows that a relatively large amount of land would be affected by drought conditions. Bingham County's economy is heavily dependent upon agriculture.

Repetitive Loss

Bingham County experiences repetitive loss due to drought. Losses are related primarily to the crop production loss and the associated economics. Other losses are linked to a loss of grazing capacity in public lands.

Drought		
Profile Category	**Rating**	**Description**
Historical Occurrence	2	Medium
Probability	4	High
Vulnerability	3	Critical
Spatial Extent	4	Catastrophic
Magnitude	2	Limited
Total	**15**	**High**

Extreme Heat

Description

The term "extreme heat," sometimes called "heat wave," is to some extent a relative one describing a period when weather conditions include temperatures and humidity significantly higher than those usual for a particular geographic area. The National Weather Service (NWS) issues alerts to the public based on its Heat Index which takes both temperature and humidity into account.

NOAA's National Weather Service Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

National Weather Service Heat Index Chart

The NWS will initiate alert procedures when the High is expected to exceed 105°- 110°F (depending on local climate) for at least two consecutive days. The effects of extreme heat are often exacerbated in large urban areas due to the heat island effect and because stagnant atmospheric conditions may trap pollutants. Extreme heat conditions are not common to Idaho where, in general, humidity is low and weather patterns vary.

Historical Frequencies

There have been no recorded days in which the temperature has reached or exceeded 105 degrees Fahrenheit from 1948-2020. Because of the lack of humidity in the air in Bingham County, the Heat Index temperature is lower than the actual temperature.

Using data from the NWS COOP weather station #USC00100915 located in Blackfoot, the return interval of actual annual maximum temperatures was calculated using the Log-Pearson III method using data from the past 100 years. The results are found in the following table.

Return Period (Years)	Probability (%)	Annual Maximum Temperature (Degrees F)
1.05	95.2	93
1.11	90.1	94
1.25	80	95
2	50	97

5	20	99
10	10	100
25	4	102
50	2	103
100	1	104
200	0.5	104

Extreme Heat Event Return Intervals

Impacts

The primary impact of extreme heat is on human health causing such disorders as sunstroke, heat exhaustion, and heat cramps. Particularly susceptible are the elderly, small children, and persons with chronic illnesses. There are also undoubtedly indirect and chronic health effects from extreme heat, the magnitude of which are difficult or impossible to estimate. Environmental effects can include loss of wildlife and vegetation and increased probability of wildfires.

Loss Estimates and Vulnerability

Bingham County has limited direct exposure to Extreme Heat events. Extreme heat places high demands on electrical power supplies that can lead to blackouts or brownouts. Economic impacts result from such factors as increased energy prices, loss of business as people avoid leaving their homes to avoid the heat, and agricultural losses. The magnitude of these and other more indirect impacts is, again, difficult to assess.

Hazard Evaluation

The magnitude of the effects of extreme heat is centered on the individual citizen. Shelters might be opened for the elderly and/or homeless who do not have a means of relief from the heat. Heat related illnesses could cause death if shelter and hydration are not provided. Because the higher elevations are typically five to ten degrees cooler than the valley, extreme heat would most likely affect only that portion of the County at the lower elevations. Economic loss would primarily be related to the cost of energy consumption and to agricultural impacts. Extreme heat would exacerbate drought conditions and make response to wildfire more hazardous.

Extreme Heat		
Profile Category	**Rating**	**Description**
Historical Occurrence	0	Never
Probability	1	Rare
Vulnerability	1	Negligible
Spatial Extent	2	Limited
Magnitude	1	Negligible
Total	**5**	**Low**

Lightning

Description

Lightning is defined by the NWS as, "A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground, or between the ground and a cloud." A lightning discharge may be over five miles in length, generate temperatures upwards of 50,000°F, and carry 50,000 volts of electrical potential. Lightning is most often associated with thunderstorm clouds but lightning can strike as far as five to ten miles from a storm. Thunder is caused by the rapid expansion of air heated by a lightning strike. Cloud-to-ground lightning strikes occur with much less frequency in the northwestern U.S. than in other parts of the country.

Historical Frequencies

There are thousands of lightning strikes that occur in Bingham County in any given year, but only small percentages cause damage. From 1950 to 2020 there have been reported 7 lightning events that have caused either property damage or casualties.

Impacts

Lightning is the second most deadly weather phenomenon in the U.S., being second only to floods. On average, sixty to seventy deaths per year are attributed to lightning nationally, and in Idaho the average is less than one per year. Despite the enormous energy carried by lightning, only about 10% of strikes are fatal. Injuries include central nervous system damage, burns, cardiac effects, hearing loss, and trauma. The effects of central nervous system injuries tend to be long-lasting and severe, leading to such disorders as depression, alcoholism, and chronic fatigue, and in some cases to suicide. Lightning also strikes structures causing fires and damaging electrical equipment. Wildland fires are often initiated by lightning strikes, as are petroleum storage tank fires. About one third of all power outages are lightning-related.

Loss Estimates and Vulnerability

All of Bingham County is subject to Lightning Strikes. Few injuries or deaths have been reported and the magnitude of economic losses is difficult to estimate.

Hazard Evaluation

Lightning		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	2	Limited
Total	**11**	**Medium**

Hail

Description

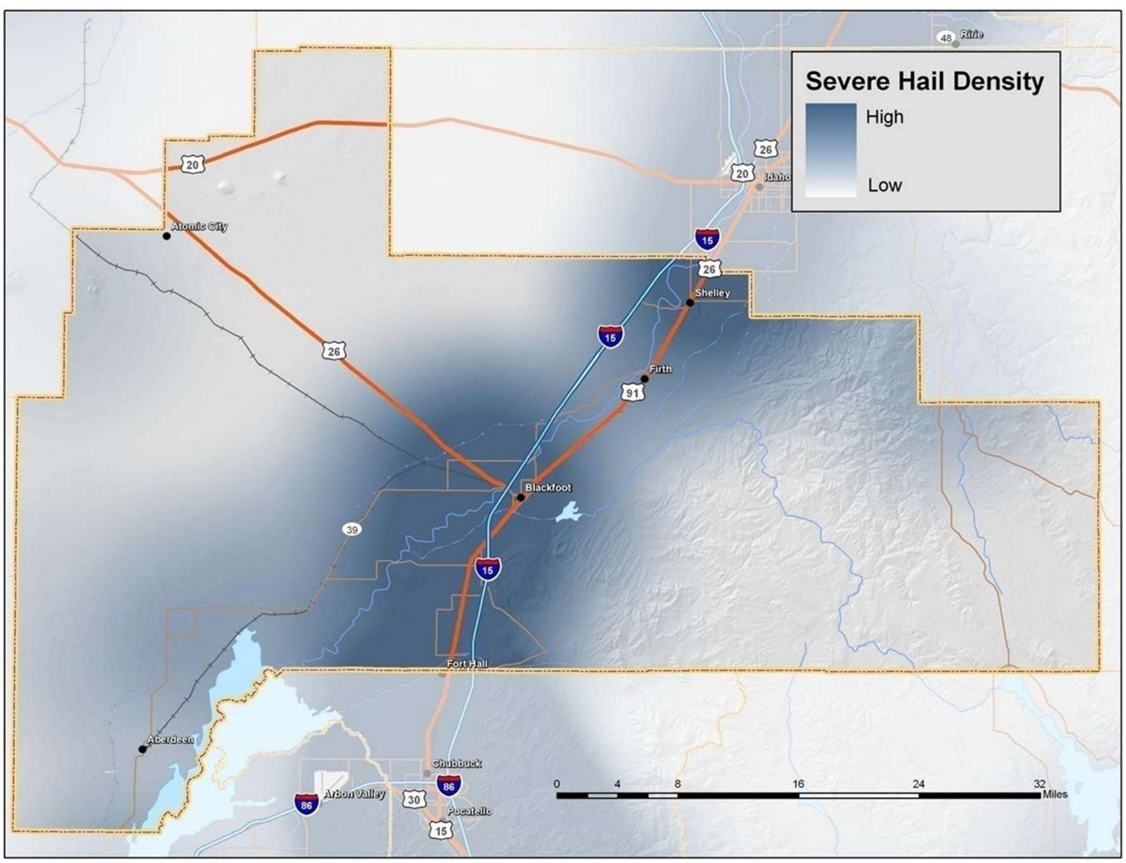
The NWS definition of “hail” is: Showery precipitation, in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud. Its size can vary from the defined minimum, a little over a quarter of an inch, up to 4.5 inches or larger. “Severe hail” is defined as being 0.75 inches or more in diameter. The largest hailstones are formed in supercell thunderstorms because of their sustained updrafts and long duration. Hail and severe hail are relatively uncommon in Idaho

Historical Frequencies

The Storm Event Database from the National Centers for Environmental Information reports 41 hail events from 1950 – 2020. The following table shows the frequency of damaging hail events in Bingham County. There is a 50.9% chance that in a given year there will be a damaging hail event, or 1 event every 1-2 years.

Location	No. of Years	No. of Events	Reoccurrence Interval
Bingham County	70	41	1.7

Frequency of Severe Hail Events



Bingham County Severe Hail Density Map

Impacts

Deaths and injuries are possible but are rare.

Loss Estimates and Vulnerability

All of Bingham County is vulnerable to Hail, with the highest vulnerability being in the populated valley areas of the county. Economic loss can be extensive, especially to agricultural based economies. Hail is very damaging to crops. Severe hail may cause extensive property damage including damage to vehicle paint and bodywork, glass, shingles and roofs, plastic surfaces, etc. Hail loss nationally is estimated at over one billion dollars annually.

Over the past 70 years there has been over $1 million in reported crop loss due to severe hail events, averaging $41,893 per event. There have been no recorded casualties and only minor property damage reported.

Hazard Evaluation

Hail		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	2	Limited
Spatial Extent	2	Limited
Magnitude	2	Limited
Total	**13**	**Medium**

Tornado

Description

The NWS describes tornado as, “a violently rotating column of air, usually pendant to a cumulonimbus, with circulation reaching the ground. It nearly always starts as a funnel cloud and may be accompanied by a loud roaring noise. On a local scale, it is the most destructive of all atmospheric phenomena.” Like hail, most tornadoes are spawned by supercell thunderstorms. They usually last only a few minutes, although some have lasted more than an hour and traveled several miles. Wind speeds within tornadoes are estimated based on the damage caused and expressed using the Enhanced Fujita (EF) Scale

F scale	Class	Wind speed mph	Wind speed km/h	Description
F0	weak	65-85	105-137	Gale
F1	weak	86-110	138-177	Moderate
F2	strong	111-135	178-217	Significant
F3	strong	136-165	218-266	Severe
F4	violent	166-200	267-322	Devastating
F5	violent	> 200	> 322	Incredible

Enhanced Fujita (EF) Scale for Estimation of Tornado Wind Speeds[1]

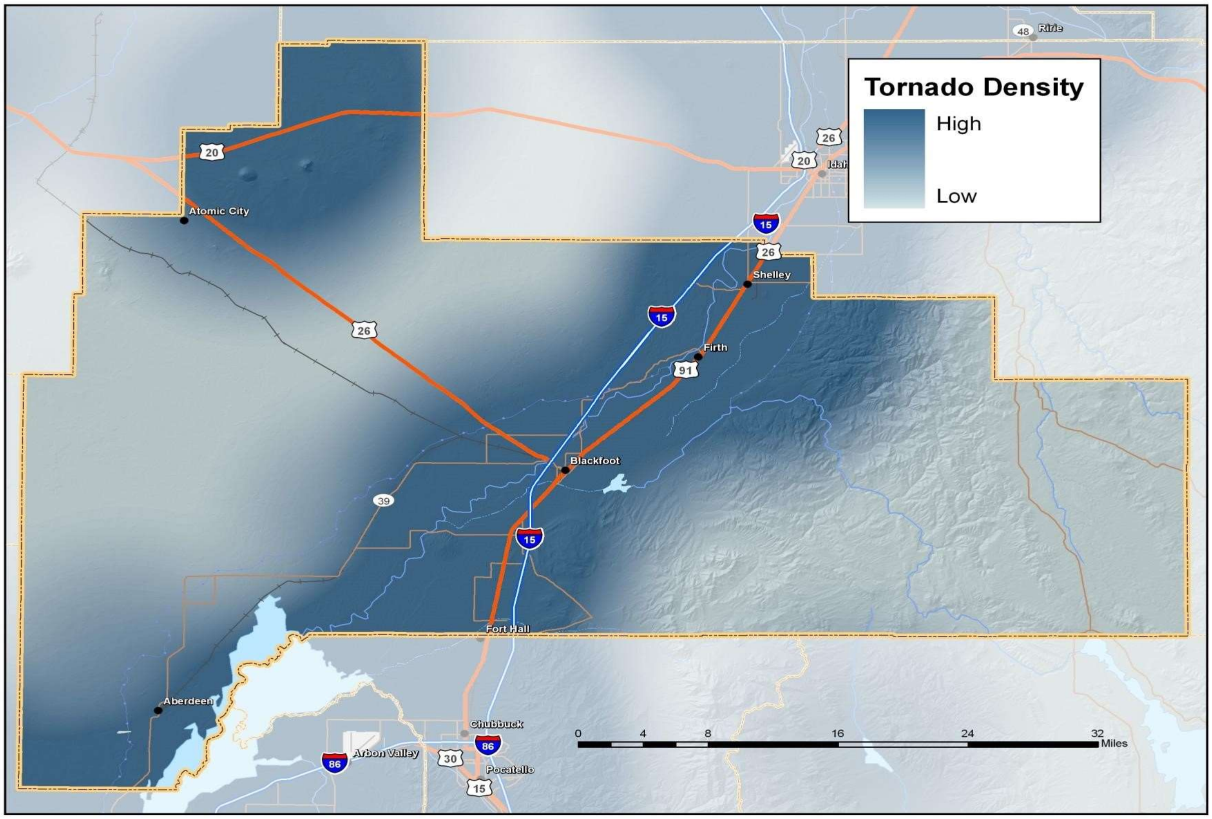
Historical Frequencies

The table below lists recorded Tornado and funnel cloud events in Bingham County. There have been 20 recorded tornado, or funnel cloud, events in Bingham County from 1950-2020. The probability of a tornado event in any given year is 28.7 % or one tornado every 3.5 years.

Location	No. of Years	No. of Events	Reoccurrence Interval
Bingham County	70	20	3.5

Bingham County Tornado Events

Funnel Clouds are associated with a rotating column of air extending from the base of a cloud. If a funnel could touches the ground, it becomes a tornado. For this reason, funnel cloud events were included in the frequency table. The following map in the following figure shows the density of reported tornadoes.



Bingham County Tornado Density Map

Impacts

Loss of utilities (primarily due to fallen trees) is common following tornadoes and, depending on circumstances, communities might be deprived of almost any kind of goods and services including food, water, and medical care. Agriculturally, crop and livestock loss is also possible.

Loss Estimates and Vulnerability

All of Bingham County is vulnerable to Tornados, with the highest vulnerability being in the populated valley areas of the county. Over the past 70 years 2 casualties have been reported caused by tornado events. Recorded losses due to tornados in Bingham County totals ~ $3.64 million over the past 70 years, or $182,000 per event.

Hazard Evaluation

Tornado		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	2	Limited

Total	**11**	**Medium**

Straight Line Winds

Description

The term "straight line wind" is used to describe any wind not associated with rotation, particularly tornadoes. Of concern is "high wind," defined by the NWS as, "Sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration." Like tornadoes, strong, straight line winds are generated by thunderstorms and they can cause similar damage. Straight line wind speeds can approach 150 mph, equivalent to those in an F3 tornado.

Historical Frequencies

The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, 55 damaging wind events were reported. The following table shows the frequency and return interval of these events. According to the National Weather Service office in Pocatello, a damaging wind event can be expected to occur every year in Bingham County. That differs from the following table because straight line wind damage is the most under reported hazard event in the County.

Location	No. of Years	No. of Events	Reoccurrence Interval
Bingham County	70	55	1.2 Years

Bingham County Damaging Wind Event Frequency

Impacts

The impacts of straight-line winds are virtually the same as those from tornadoes with similar wind speeds. The damage is distinguishable from that of a tornado only in that the debris is generally deposited in nearly parallel rows. Downbursts are particularly hazardous to aircraft in flight.

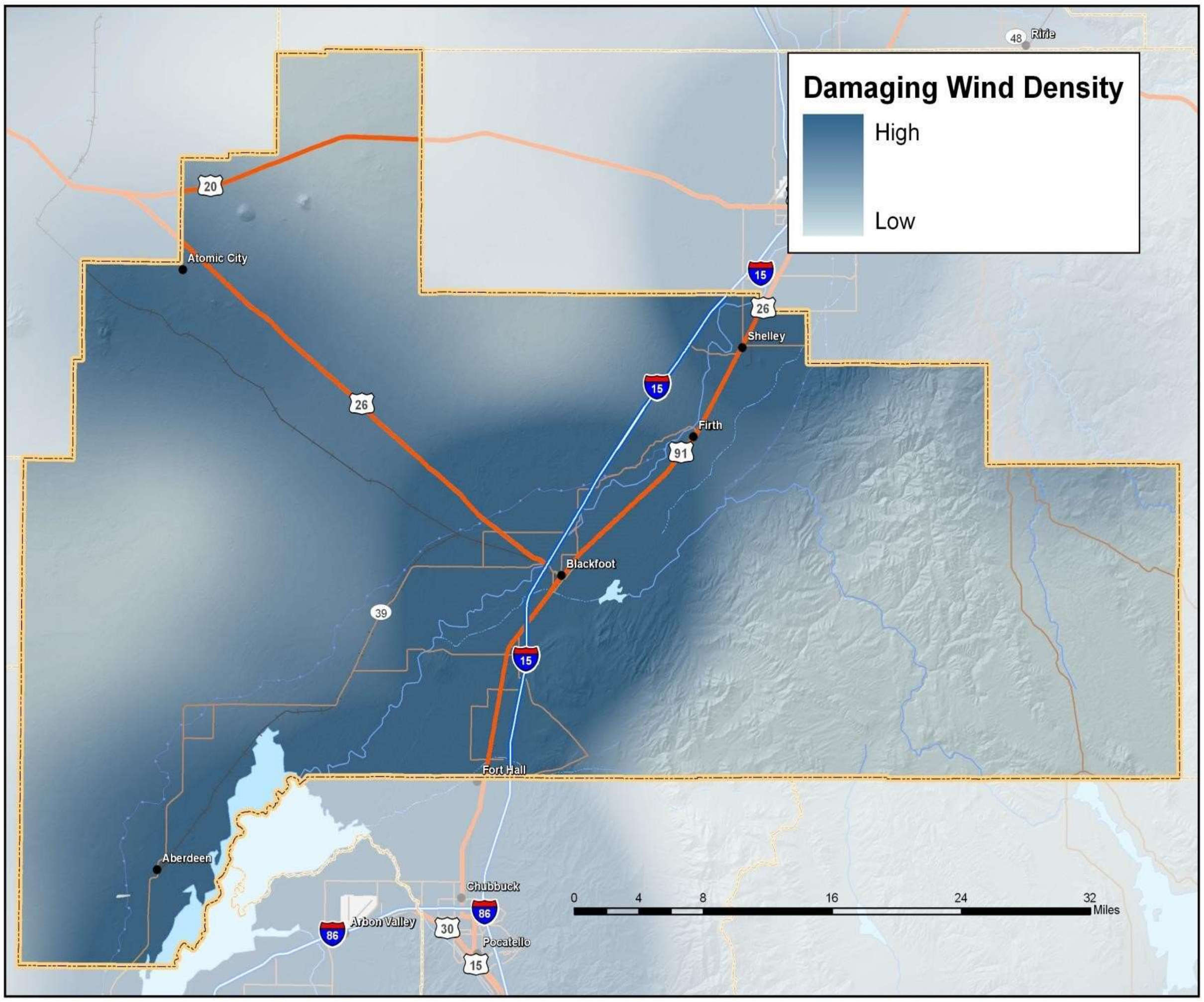
Loss Estimates and Vulnerability

All of Bingham County is vulnerable to Wind, with the highest vulnerability being in the populated valley areas of the county. Since 1950 there has been $4,066,000 of reported damage caused by straight line winds in Bingham County, or over $73,927 per event. There have been 3 injuries reported in the past 70 years.

Hazard Evaluation

Straight Line Wind		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High

Probability	4	High
Vulnerability	2	Limited
Spatial Extent	3	Critical
Magnitude	2	Limited
Total	**14**	**Medium**



Damaging Winds

Severe Weather Hazard Evaluation

Severe Weather occurs frequently in Bingham County, and it is assumed that there are repetitive losses especially caused by Straight Line Wind damage; however, this type of loss is not reported to a single point and thus is hard to track and quantify.

Hazard	Historical Occurrence	Probability	Vulnerability	Spatial Extent	Magnitude	Total	Rank
Extreme Heat	0	1	1	2	1	**5**	**L**
Lightning	3	4	1	1	2	**11**	**M**
Hail	3	4	2	2	2	**13**	**M**
Tornado	3	4	1	1	2	**11**	**M**
Straight Line Wind	3	4	2	3	2	**14**	**M**
Composite Ranking							
Severe Weather	3	4	2	2	2	**11**	**M**

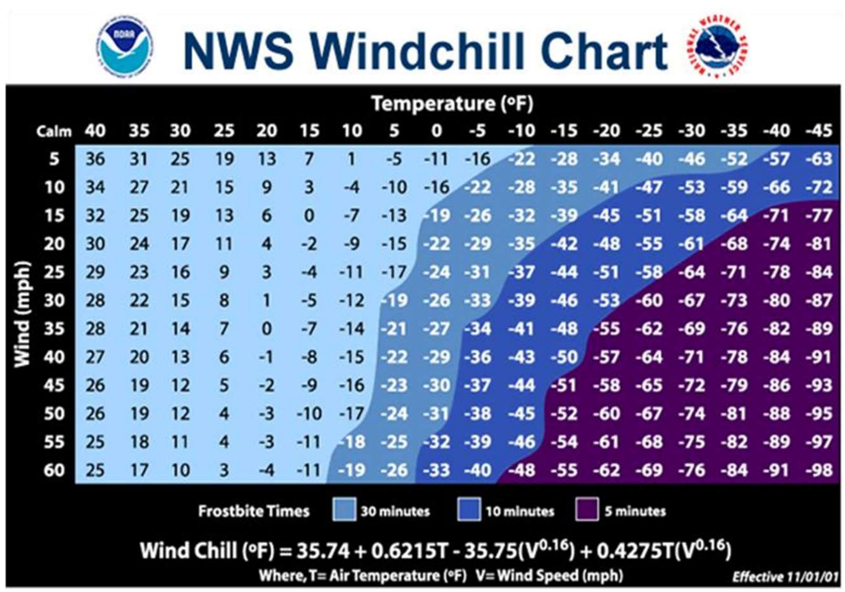
Severe Winter Storms

The Severe Winter Storms category includes extreme cold and winter storms. It should be noted that Straight Line Wind is also associated with Severe Winter Storms, commonly referred to as Blizzard Conditions where snow is driven by wind causing drifting.

Extreme Cold

Description

"Extreme cold" is another of the terms describing hazards that must be defined relative to what is considered normal in a given locale. What might be considered extreme cold varies considerably in the State of Idaho where normal winter temperatures in the southwest are appreciably more moderate than those in the northwest and far north. Very cold temperatures become a particular hazard when accompanied by winds of 10 mph or greater.



NWS Windchill Chart

Wind (mph) \ Temperature (°F)	Calm 40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

The NWS has developed a formula for calculating "wind chill" based on temperature and wind speed and in this region issues wind chill advisories when the wind chill temperatures are predicted to be -10ºF or less with winds of 10 mph or higher for one hour or more. Wind chill warnings are issued when wind chill temperatures will be -20ºF or less with winds of 10 mph or higher for one hour or more. As with extreme heat, extreme cold is of greatest concern when the condition persists for an extended period of time.

Historical Frequencies

Temperatures in Bingham County historically have reached -40 degrees. Using weather records from the NWS COOP weather station in Blackfoot, 100 years of annual low temperatures were analyzed to identify the return period of extreme cold events. The results are found in the table below.

Return Period (Years)	Probability (%)	Annual Minimum Temperature (Degrees F)
1.05	95.2	-3
1.11	90.1	-4
1.25	80	-7
2	50	-15
5	20	-25
10	10	-30
25	4	-35
50	2	-38
100	1	-40
200	0.5	-41

Frequency of Extreme Cold Events

Extreme cold events happen on nearly every other year in Bingham County. There is a 42% chance that an extreme cold event will occur in any given year. The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, 30 Extreme Cold events were reported.

Impacts

Health effects of exposure to extreme cold include hypothermia and frostbite, both of which can be life-threatening. Infants and the elderly are most susceptible. In the United States, nearly 700 deaths are directly attributed to hypothermia annually.

Loss Estimates and Vulnerability

All of Bingham County is vulnerable to Extreme Cold Events, with the highest vulnerability being in the populated valley areas of the county. Extreme cold may cause loss of wildlife and vegetation, and kill livestock and other domestic animals. Economic loss may result from flooding due to burst pipes, large demands on energy resources, and diminished business activity. River flooding may take place as a result of the formation of ice jams.

Hazard Evaluation

Extreme cold affects the individual, families, cities, and the County. Damage typically occurs to individual properties; however, city water systems are usually vulnerable to extreme cold. Repairs to water line freeze ups and breaks generally require the roadways to be excavated necessitating additional maintenance and repairs during the warmer months.

Extreme Cold can cause death and injury, especially to those working or stranded outside for prolonged periods. Economic loss is related to private individuals, businesses, and government agencies in heating of homes and facilities. Additional losses can be expected to the livestock industry. During extreme cold periods, the schools are closed to protect children traveling to and from school.

During the spring, summer, and fall, temperatures can drop low enough to produce frost. While such temperatures are not low enough to damage infrastructure or require extra heating costs, it can be devastating to crops.

Warning lead times in Bingham County usually are a day or two based on forecasts made by the National Weather Service in Pocatello.

Repetitive Loss

Bingham County does experience repetitive loss related to extreme cold events. The losses are primarily associated with freezing and breaking municipal water lines. While there is some repetitive flooding caused by ice jams along the Snake River, economic losses are not repetitive.

Extreme Cold		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	2	Limited
Spatial Extent	4	Catastrophic
Magnitude	2	Limited
Total	**15**	**High**

Winter Storm

Description

The NWS describes "Winter Storm" as weather conditions that produce heavy snow or significant ice accumulations. For purposes of this analysis, Severe Winter Storm is defined as any winter condition where the potential exists for a blizzard (winds >= 35mph and falling/drifting snow frequently reduce visibility < ¼ mile, for 2 hrs. or more), heavy snowfall (valleys 6 inches or more snowfall in 24 hrs., mountains 9 inches or more snowfall in 24 hrs.), ice storm, and/or strong winds.

Historical Frequencies

The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, 110 damaging Winter Storm events were reported. Historic frequencies of winter storm events were calculated using 100 years of 24-hour snowfall data from the NWS COOP weather station in Blackfoot. The results of the analysis are found below.

Return Period (Years)	Probability (%)	24 Hour Annual Maximum Snowfall (Inches)
1.05	95.2	1.7
1.11	90.1	2.23
1.25	80	2.98
2	50	4.72
5	20	6.63
10	10	7.59
25	4	8.51
50	2	9.04
100	1	9.47
200	0.5	9.81

Heavy Snow Event Frequencies

Impacts

The impacts of the very cold temperatures that may accompany a severe winter storm are discussed above. Other life-threatening impacts are numerous. Motorists may be stranded by road closures or may be trapped in their automobiles in heavy snow and/or low visibility conditions. Bad road conditions may cause automobiles to go out of control. People can be trapped in homes or buildings for long periods of time without food, heat, and utilities. Those who are ill may be deprived of medical care by being stranded, or through loss of utilities and lack of personnel at care facilities. Use of heaters in automobiles and buildings by those who are stranded may result in fires or carbon monoxide poisoning. Fires during winter storm conditions are a particular hazard because fire service response is hindered or prevented by road conditions and because water supplies may be frozen. Emergency Services may also not be available if telephone service is lost. People who attempt to walk to safety through winter storm conditions often become disoriented and lost. Downed power lines not only deprive the community of electricity for heat and light, but pose an electrocution hazard. Death and injury may also occur if heavy snow accumulation causes roofs to collapse. Fatalities in Bingham County due to winter storms are somewhat unusual, with four being reported during the ten-year period from 1995 through 2020.

Loss Estimates and Vulnerability

All of Bingham County is vulnerable to Winter Storm Events, with the highest vulnerability being in the populated valley areas of the county. Economic impacts arise from numerous sources including: hindered transportation of goods and services, flooding due to burst water pipes, forced closing of businesses, inability of employees to reach the workplace, damage to homes and structures, automobiles, and other belongings by downed trees and branches, loss of livestock and vegetation, and many others. The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, $223,000 in losses were reported.

Hazard Evaluation

Severe Winter Storms		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	3	Critical
Spatial Extent	4	Catastrophic
Magnitude	2	Limited
Total	**16**	**High**

Severe Winter Storm Hazard Evaluation

Severe Winter Storms occur almost annually in Bingham County, and it is assumed that there are repetitive losses especially caused by Straight Line Wind damage; however, this type of loss is not reported to a single point and thus is hard to track and quantify.

Hazard	Historical Occurrence	Probability	Vulnerability	Spatial Extent	Magnitude	Total	Rank
Extreme Cold	2	4	2	4	2	**14**	**M**
Winter Storm	3	4	3	4	2	**16**	**H**
Composite Ranking							
Severe Winter Storms	3	4	3	4	2	**16**	**H**

Flooding

Flooding is defined by the 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. 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 (NIFP) 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. In the forty-five years from 1976 to 2020 there were five Federal and twenty-eight 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.

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.

Flood Terminology

A number of flood-related terms are frequently used in this plan and are defined below.

Flood Insurance Study (FIS): A *Flood Insurance Study* is the official report provided by the Federal Insurance Administration, which provides flood profiles, the flood boundary-floodway map, and the water surface elevation of the estimated 100-year base flood.

Flood Insurance Rate Map (FIRM): The Flood Insurance Rate Map (FIRM) is the official map on which the Federal Insurance Administration has delineated both the areas of special flood hazards and the risk premium zones applicable to the community.

100-year Base Flood: Base Flood means the flood having a 1% chance of being equaled or exceeded in any given year. It is also referred to as the "100-year flood".

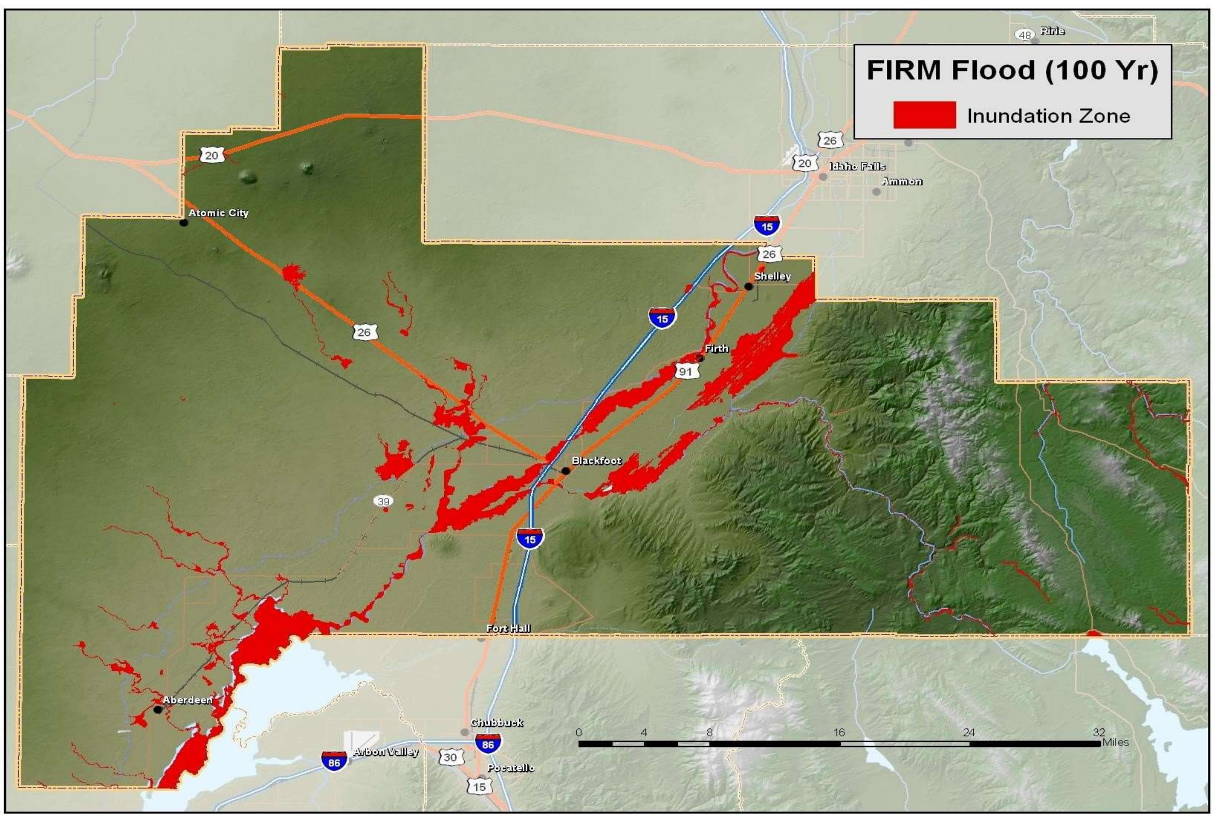
Floodplain: A floodplain is land adjacent to a lake, river, stream, estuary, or other water body that is subject to flooding. If left undisturbed, the floodplain serves to store and discharge excess floodwater. In riverine systems, the floodplain includes the floodway.

Floodway: "Floodway" means the channel of a river or other watercourse and the adjacent areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

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



HAZUS Floodplain

River or Stream Flooding

Description

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.

Historical Frequencies

The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, 23 Flood events were reported. The National Weather Service recognized flood level for the Snake River at Blackfoot is 21,600 cubic feet per second (cfs.). The USGS stream gauge at that location has recorded 3 events in which the flow has reached or exceeded flood stage from 2000 to 2020.

Flood Events			
Location	**No. of Events**	**No. of Years**	**Return Interval**
Snake River @ Blackfoot	23	70	3 Years

Flood Event Frequency

The year 1997 was probably the worst flood year on record. Rapid melt of a record snowmelt led to flooded rivers throughout southern Idaho. The Snake River Basin received significant snowfall during the winter of 1996-97, and in higher elevations the snow pack exceeded 250% of normal, causing above normal runoff during the spring melt. Reservoir flows were increased to allow storage capacity, producing the highest flows on the Snake River in 70 years. During June, the spring snowmelt caused extensive flooding along 225 miles of the Snake River and many of its tributaries, from Roberts to Blackfoot. In places, floodwaters ran as far as a mile away from the river and 5' deep. Damage was extensive to numerous roads, canals, farmland, and over 300 homes.

A Federal Disaster was declared on July 7, 1997 in Bingham County. Approximately 500 people were evacuated in Jefferson and Bingham counties; more than 50,000 acres of agricultural land was flooded; and over $1.3 million in grants and loans were distributed[2].

The following narratives describe recent flooding events in Bingham County as reported by the National Weather Service.

May 10, 2011 – May 31, 2011

"The Snake River at Blackfoot reached flood stage of 10 feet on May 10th and remained over flood stage the remainder of the month peaking at 12.04 feet on May 29th. The Riverton area had widespread flooding resulting in the closure of

[2] http://www.bhs.idaho.gov/local/counties/Bingham.htm

Riverton Road with several homes threatened. The Rose Levee broke on May 27th resulting in the washout of about 200 feet of levee structure. Flows occurred through the Rose Ponds recreation area flooding campgrounds and a walking path. The Archery Range Road was flooded causing the evacuation of a resident from their property. In Blackfoot, sub-water seepage into Jensen's Grove caused minor flooding of the park and an industrial storage lot behind the Super 8 Motel and Blackfoot Medical Center. Flooding of lowlands and agricultural fields occurred adjacent to the river between Rose and Tilden Bridge. The Snake River at Shelley reached flood stage on May 16th at 12 feet and peaked at 13.15 feet on May 28th which was major flood stage. County Road 700 North southwest of Firth was closed. In Firth, the Riverview Arena was partially underwater and extensive flooding of lowlands and agricultural fields occurred adjacent to the river between Firth and Rose.[3]"

June 1, 2011 – June 12, 2011

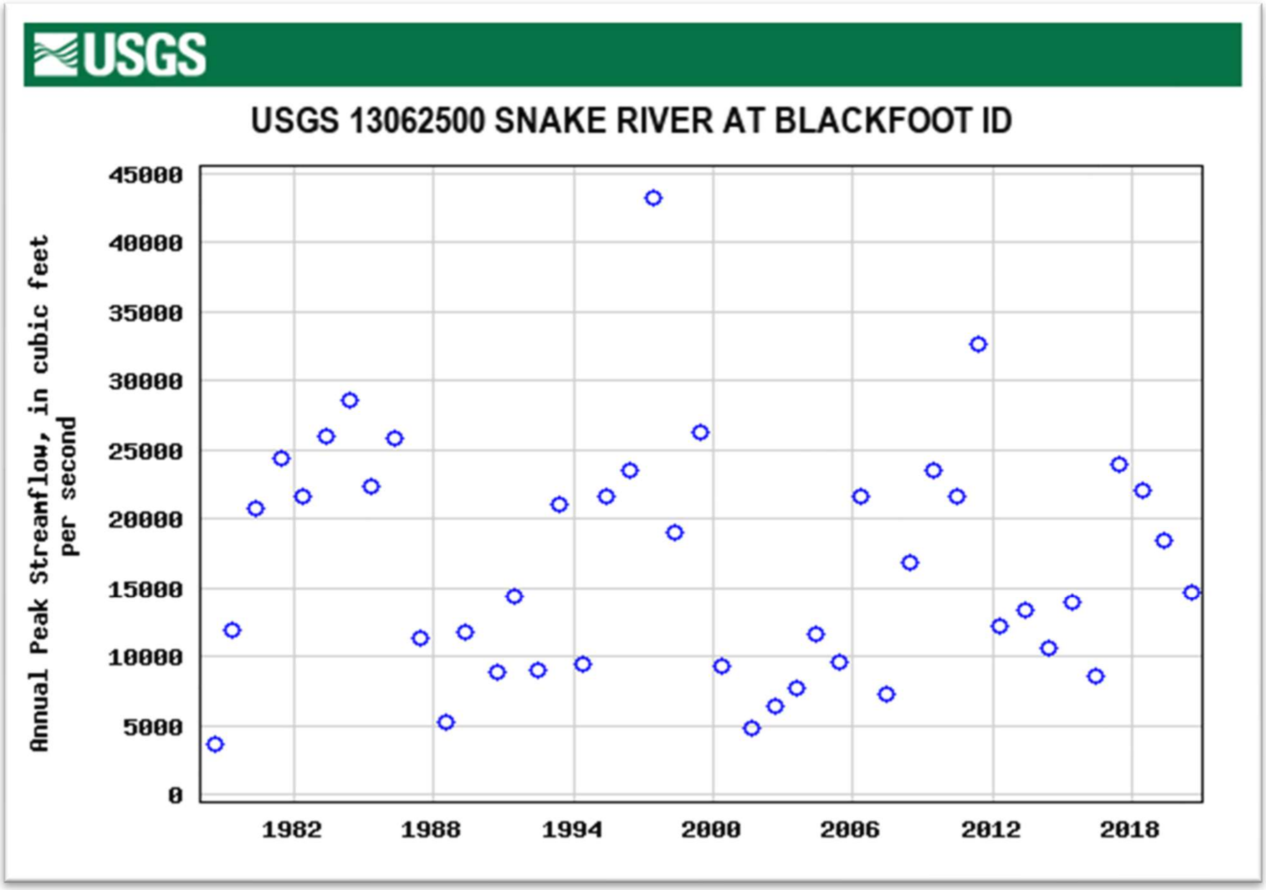
"The Snake River near Shelley was above flood stage from June 1st through June 12th at 12 feet, peaking at 13 feet on June 10th, which was major flood stage. County Road 700 North southwest of Firth was closed. Homes on that road were surrounded by water with yards and outbuildings flooded. In Firth, the Riverview Arena was partially underwater, and extensive flooding of lowland and agricultural fields occurred between Firth and Rose.[4]"

June 1, 2011 – June 19, 2011

"The Snake River at Blackfoot was above flood stage from June 1st through June 19th. It was below flood stage from June 13th through June 16th. Water levels reached moderate flood stage and crested at 11.79 feet on the evening of June 10th. There was widespread flooding in the Riverton area resulting in the closure of Riverton Road with several homes threatened. A number of homes and access roads were threatened in the Thomas area near Riverbend Road and Wilson Road. Berm construction and sandbagging appeared to have been successful in those areas. Archery Range Road near the Rose Overpass was submerged and impassable for a period. In Blackfoot, sub-water seepage into Jensen's Grove caused minor flooding of the park. Flooding of lowland and agricultural fields occurred adjacent to the river between Rose and Tilden Bridge."

Stream Gauge data from the Snake River at Blackfoot was analyzed for the years 1976 to 2020. The following figure shows the peak stream flow at that stream gauge for approximately 44 years.

[3] http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=315349
[4] http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=328225



The Snake River, at Blackfoot, annual peak flows roughly following the same highs and lows as the drought cycle as described in section 2.1. The flow has been regulated by the Palisades Dam that was completed in 1957. During low water years, less water is released from the dam at a more regulated pace. During high snow pack years, water is released at a higher level which can cause major flooding downstream, especially in Bingham County.

Not only does flooding occur during high flow years, but erosion and sediment transport also occur. The photographs below show the movement of gravel bars in the Snake River in the engineered channel to the northwest of Blackfoot.

The photos below show the channel and its change over time.

June 26, 1987 Flow Rate: 1,650 cfs

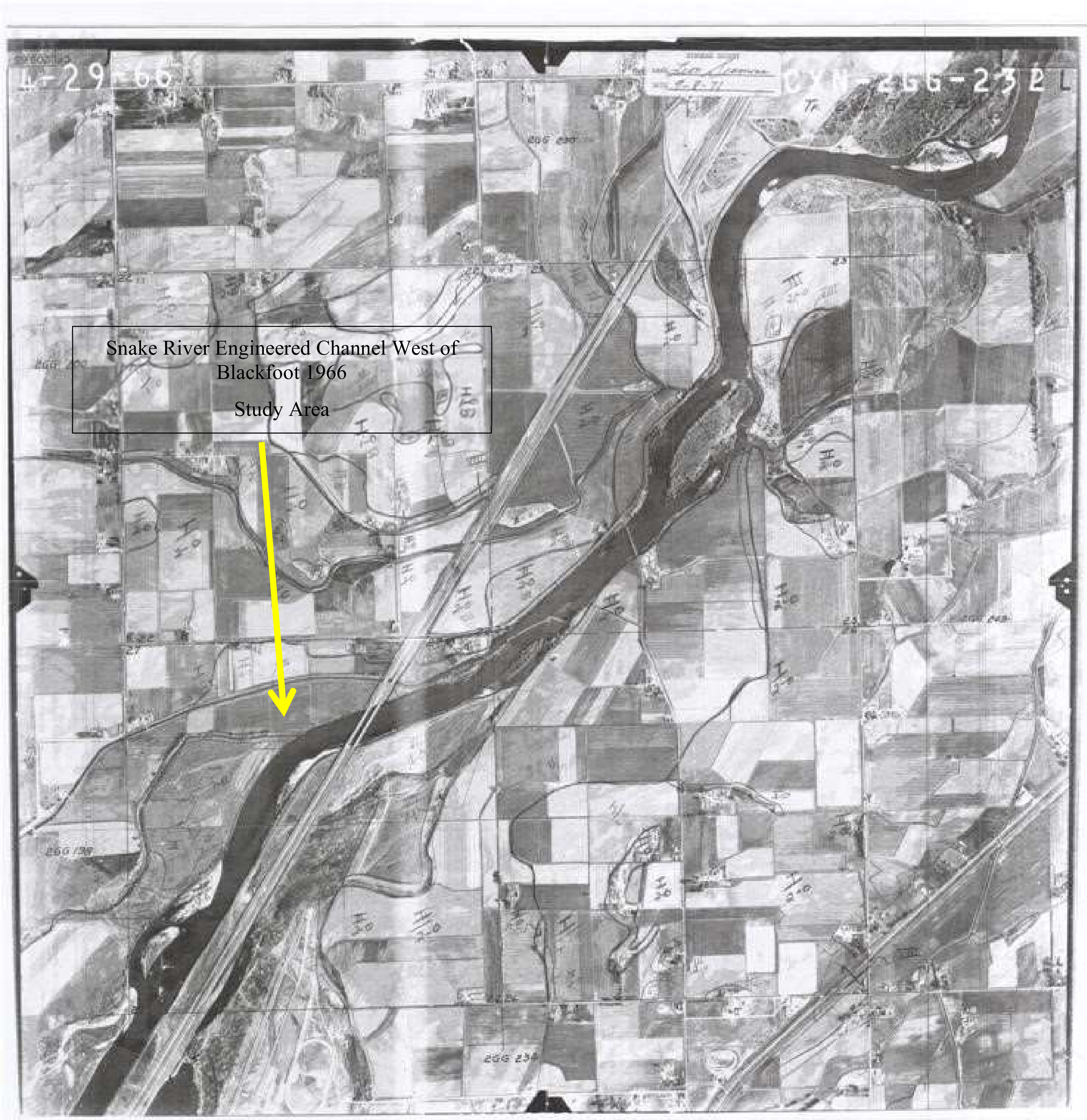
June 7, 1992 Flow Rate: 2,990 cfs

May 28, 1998   Flow Rate: 19,500 cfs

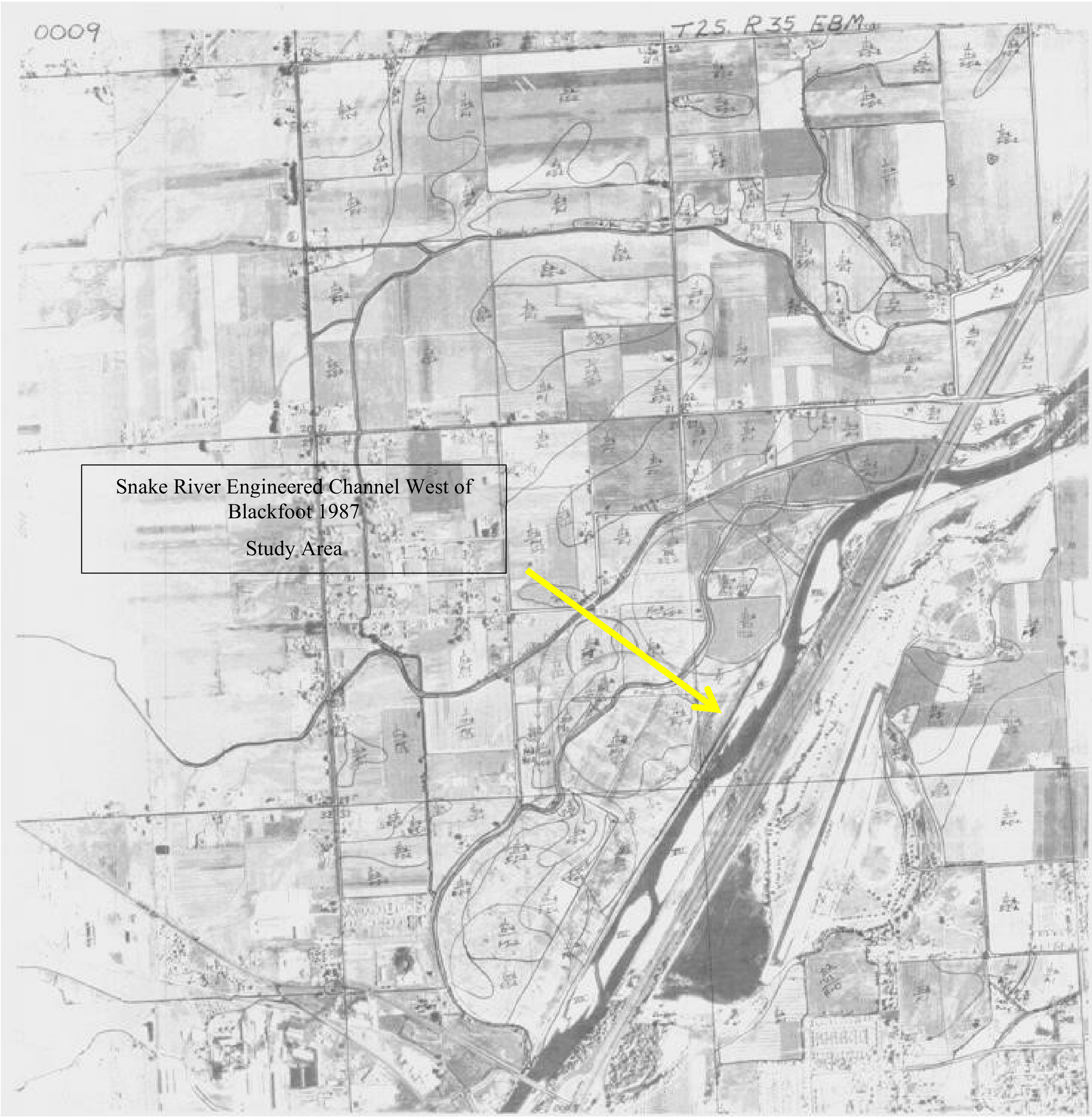
It is difficult to determine the exact change of gravel and sediment in the channel from the above pictures and other aerial photographs, but it is evident that sediment and gravel are moving through the channel.

Snake River Engineered Channel West of Blackfoot

There is a general consensus that water in the Snake River has increased over time. The commercial subdivision near the northeast corner of the State Highway 26 interchange at Interstate-15 reportedly experiences shallow groundwater conditions that may be related to conditions in the Snake River. Bingham County personnel have observed water leaking laterally through the east side of I-15 road embankment and flowing toward the City of Blackfoot. A study of the area was conducted by T-O Engineering, Whisper Mountain Professional Services, Inc., and Environmental Planning Group. A letter report outlining the findings is contained in Attachment 1. The following are excerpts from the report and additional information gathered during the May 9, 2013 stakeholder meeting.




Snake River Engineered Channel West of Blackfoot 1966
Study Area



History

The Snake River was channelized in 1962 as part of the Interstate-90 roadway construction. Prior to that time, the River flowed, or had flood channels, on both sides of I-15. The 1962 construction, between the Twin Bridges and SH-26, channelized the River to the west side of I15 and included a levee on the east bank of the River. Upstream of the Twin Bridges on I-15, a levee was constructed along the golf course to close off the historic channels on the east side of I-15. Near the Rose Road overpass, the River was channelized east of I-15 and the east side of the overpass, along with a levee on the west bank of the constructed channel.

Jensen's Pond was constructed (after 1962) to the east of I-15 in the historic river channel area. A diversion from the River provides inflow to the north end of the Pond. A diversion from the south end of the Pond connects to the lowland area between the River and I-15, and a pipe through the 1962 levee connects to the River.

FEMA conducted a flood insurance study on the Snake River using survey data circa 1974. Initial FEMA maps were published in 1979. In the area between SH-26 and the Twin Bridges, the FEMA maps delineated a floodway along the River with an easterly boundary contained by the 1962 levee and a westerly boundary that extended beyond the west bank of the River. The current 1998 FEMA maps appear to be based on the 1974 study but do not show a floodway west of the River. Also, of note is that 100-year flood elevations in the published FEMA maps account for the effects of ice jams that were estimated by FEMA to increase 100-year water elevations near Blackfoot by an average of approximately 1.6 feet.

According to the FEMA flood insurance study, the Teton dam failure in 1976 washed out a portion of the 1962 levee that was later re-constructed. FEMA estimates the Teton flood discharge at Blackfoot to have been approximately 60,000 cfs and would be comparable to a natural flood event with a 1000-year return interval.

A shoulder levee along the west side of I-15 was constructed/improved on or about 2001.

The improvements included a drain trench inside the shoulder levee.[5]

Preliminary Data Review

Site inspection conducted December 13, 2012 and review of aerial photographs from 1993 to 2011 reveal the presence of gravel bars in the Snake River in the study area. The aerial photographs appear to indicate consistent locations and extent of the gravel bars over the time span of the aerials. Note the time span of the aerials reviewed and consistency of gravel bars therein includes a 100-year flood event (2011) and a 500-year flood event (1997). The gravel bars were not part of the 1962 channelization project.

Analysis of data from the USGS gauging station at Collins Siding Road (old SH-26 alignment) indicates water levels in the Snake River at the gauge site have increased over time at comparable flow rates. The gauge data spans from 1978 to present and indicates water levels in the river have increased roughly 1.5 ft from 1982 to 2006 at approximately equal flows of 21,600 cfs, which is comparable to the 22,500 cfs, developed by the Federal Emergency Management Agency (FEMA) for a 10-year flood event. Gauge data also shows water levels have increased roughly 0.7 ft from 1994 to 2005 at approximately equal flows of 9,500 cfs, which appears to be common for a spring runoff event. Specific causes of the increased gauge height readings are not conclusively defined and no coordination with the UGSG was conducted to investigate conditions of the gauge. The higher gauge readings may be related to reduction of channel capacity.

A limited hydraulic analysis of the Snake River was conducted using a reproduction of the existing FEMA flood study including the circa 1974 survey data. The FEMA survey data includes gravel bars that were not part of the 1962 channel design. A brief visual comparison of

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[5] Letter to Bingham County Emergency Services, Conceptual Overview Reported Flooding Concerns, Possible Causes, Potential Mitigation Snake River and Blackfoot Area, Steve Holt, PhD, February 6, 2013, page 1

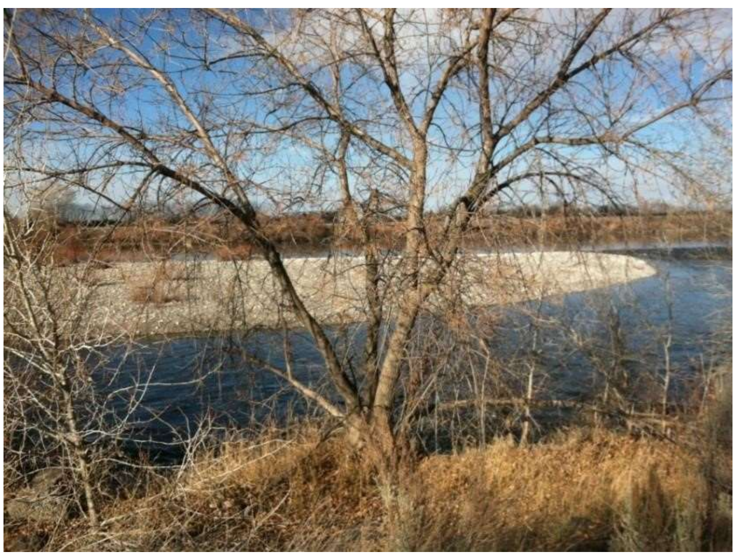
the 1974 cross-sections to current aerial photographs reveals similarities in gravel bar locations in the channel at some cross-sections and differences at other cross-sections.

The limited hydraulic analysis investigated water levels in the River from the SH-26 Bridge and upstream approximately 1 mile. The analysis predicted increased water levels in the River in the range of 0.5 feet to 2 feet when comparing the 1962 channel design to the 1974 survey data with gravel bars. The low-end of the range at 0.5 feet occurs near the SH-26 Bridge where the 1962 channelization begins. The upper end of the range occurs in the middle of the study range. Comparison of water elevations at the upstream end of the hydraulic study is not meaningful because the 1962 design channel invert is almost 4 feet higher than the 1974 invert, and the 1962 invert is higher than the 1974 invert at the Twin Bridges. It is not known if the high invert on the 1962 channel design was constructed.[6]

Areas of Concern Include:

Gravel Accumulation

A reduction in river channel capacity due to gravel accumulation in the constructed 1962 channel would tend to raise water surface elevations in the River. Higher river elevations could induce the reported higher ground water at the commercial development area by way of what is presumed to be subsurface river gravels in the historic river channel and meanders.



Higher water elevations in the river may also cause increased water levels in the lowland area between the 1962 levee and I-15, thereby contributing to the reported lateral flow through the east shoulder of I-15. The functionality of the seepage trench in the I-15 shoulder levee is not known and may also be a contributing factor to lateral seepage.

[6] Letter to Bingham County Emergency Services, Conceptual Overview Reported Flooding Concerns, Possible Causes, Potential Mitigation Snake River and Blackfoot Area, Steve Holt, PhD, February 6, 2013, page 2-3

With respect to the Rose Road washout, gravel accumulation in the River channel may have also increased water elevations that contributed to overtopping of the 1962 levee on the west bank of the relocated River. With overtopping of the levee and overbank flow east of the River, the excavated gravel pits east of the River and upstream of the Rose Road approach probably increased overbank velocity and erosion potential.

Review of 2009 aerial photography indicates the tops of gravel bars were roughly as high as the 10-year water surface elevation. The gravel bars may exacerbate the effects of ice jams that typically occur near the water surface.

A mitigation concept to remedy the apparent effects of gravel accumulation is to remove gravel from the river channel to restore the river channel capacity toward the 1962 design section and presumably lower water elevations in the River.

Piped Connections to the River

An existing 4-foot diameter pipe connects the north end of Jensen's Pond to the River and appears to be used for inflow into the pond in combination with a diversion dam in the River. An existing 4-foot diameter pipe connects the south end of Jensen's Pond to the lowland area between I-15 and the 1962 level, along with a piped connection to the River that presumably allows for outflow from the Pond. Canal gates are also present on the piped connections and appear to be used for regulating flow.

Connections to the River could create conditions where inflow of water from the River to the north end of the Pond, without a balanced outflow back to the River, may cause pond water elevations to trend toward the river elevation at the north (upstream) end and raise the pond relative to the river elevation on south (downstream) end. If these conditions occur, the increased pond elevation could induce higher local shallow ground water as reported at the commercial development area. Outflow from the Pond into the wetland area between the 1962 levee and I-15 may also contribute to the reported lateral seepage across I-15.

A potential mitigation concept is to investigate and document operation of the Pond, piped connections and gates, and consider modification to operations as may be warranted, particularly during high river levels.

It should also be noted that Jensen's Pond by itself, without any influence of connections to the River, will trend toward a level water surface elevation. At the south end of the Pond, the pond level could be higher than ambient groundwater levels and contribute to reported shallow groundwater at the commercial development area.

Development

Increased impervious area that accompanies development typically increases runoff volume following storm events or snowmelt, and could contribute to the reported higher groundwater in the commercial area depending on the ultimate method of disposal. Accumulation of storm water into infiltration basins may increase groundwater levels. Disposal of storm water into the remnant slough near the commercial area may also induce higher groundwater. It is not known from a limited data review whether the remnant slough has a piped connection to the River.

A mitigation concept includes review of storm water management, investigation as to any influence on reported shallow groundwater, and development of site-specific mitigation.

Site inspection on December 13, 2012 provided indication of fill or improvements to the west bank of the River beginning near the SH-26 Bridge and upstream approximately 1 mile.

Based on the limited data review, it is not known how the existing west bank compares to the original 1962 channel construction or pre-1962 existing grade. Therefore, it is not known if the apparent improvements on the west bank may be a contributing factor to reported flooding concerns.

A mitigation concept is to better define existing conditions of the west bank and 1962 levee and investigate relocating either the west bank and/or 1962 levee to increase channel capacity.

SH-26 Bridge Crossing

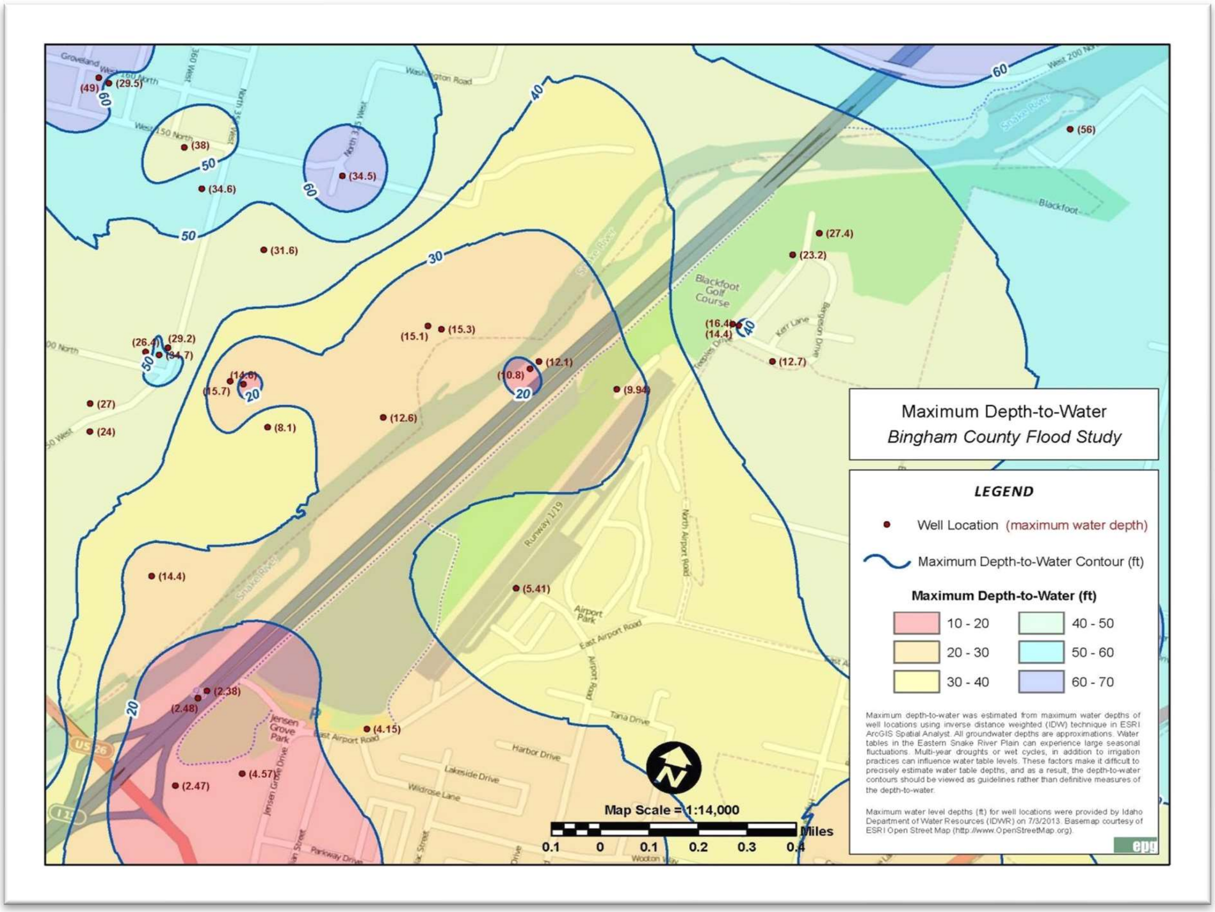
High water levels and flooding conditions were reported at the SH-26 Bridge during the spring runoff of 2011. Date of the observation is not known. Gauge data at the USGS gauging station near Blackfoot showed a peak annual discharge of 32,700 cfs on May 29, 2011. The peak flow is higher than the FEMA defined 100-year event at 29,900 cfs.

Design requirements and design capacity of bridges across the River in the study area were not reviewed. The FEMA flood insurance study profiles indicate the SH-26 Bridge should pass the FEMA predicted 100-year water elevations approximately 0.5 feet under the low chord of the bridge, including the FEMA estimated effects of ice jams.

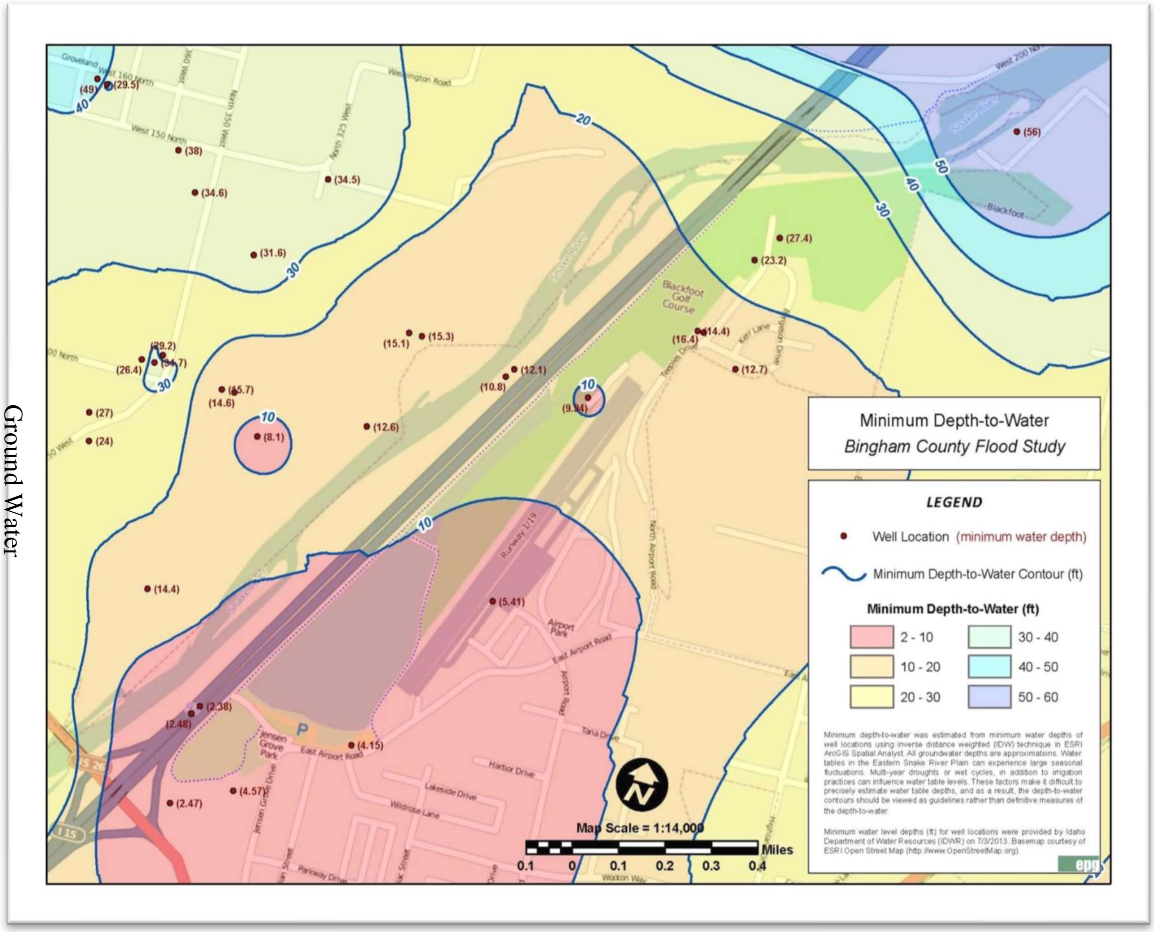
Reported high water observations at the SH-26 Bridge in 2011 include verbal accounts of driftwood and fallen trees that constricted the bridge opening. Debris effects are not included in the FEMA study and are expected to increase upstream water heights.

Other factors that may contribute to increased water elevations at the SH-26 Bridge could include gravel accumulation in the river channel or near the bridge piers, tail water effects from potentially higher downstream water elevations, and development on the northwest bank of the River. Determination of the effects, if any, of these factors is beyond the scope of this conceptual analysis.

The mitigation concepts offered in this letter may provide improved hydraulic performance of the bridge as alternatives to bridge replacement. However, further investigation of cause-and-effect relationships is needed.


Maximum Depth-to-Water
Bingham County Flood Study
LEGEND
Well Location (maximum water depth)
Maximum Depth-to-Water Contour (ft)
Maximum Depth-to-Water (ft)
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
Maximum depth-to-water was estimated from maximum water depths of well locations using inverse distance weighted (IDW) technique in ESRI ArcGIS Spatial Analyst. All groundwater depths are approximations. Water tables in the Eastern Snake River Plain can experience large seasonal fluctuations. Multi-year droughts or wet cycles, in addition to irrigation practices can influence water table levels. These factors make it difficult to precisely estimate water table depths, and as a result, the depth-to-water contours should be viewed as guidelines rather than definitive measures of the depth-to-water.
Maximum water level depths (ft) for well locations were provided by Idaho Department of Water Resources (IDWR) on 7/3/2013. Basemap courtesy of ESRI Open Street Map (http://www.OpenStreetMap.org).
Map Scale = 1:14,000
0.1 0 0.1 0.2 0.3 0.4
Miles
Blackfoot Golf Course
Jensen Grove Park
Airport Park
East Airport Road
Tana Drive
Harbor Drive
Lakeside Drive
Washington Road

Ground Water



Stakeholder Input

A meeting was held with all Federal, State, and Local stakeholders on May 9, 2013. The consensus from that meeting identified two primary causes of flooding. There are as follows:

(1) Shallow ground water levels.

This can be contributed to multiple factors. The first factor is development. As a result of development in the Area of Concern, there has been an increase in impervious area, which increases storm-water runoff. If said runoff is disposed by means of the Snake River or under-ground disposal, groundwater levels would increase. Another factor could be the development of Jensen’s Grove. Because the Grove “seeks” to maintain equilibrium, it is common that the surface level may increase groundwater levels.

(2) Gravel accumulation in the River.

This accumulation will tend to reduce the capacity of the River and increase water levels. This could increase groundwater levels throughout the Area of Concern. Mr. Holt stated that he used two different sources of data to return these conclusions. One of these sources was a USGS gauge station below the Highway 26 Bridge. Another source used was the 1974 FEMA hydrology study used to construct the Floodplain. Mr. Holt noted that according to this study, gravel bars are present in 1974. Another study was done to determine the impact of these bars, and it was determined that water levels increase between 0.5ft and 1.5 ft since 1962.

The attendees discussed potential mitigation strategies. Two possible mitigation strategies are to:

(1) Remove the gravel bars

(2) Perform a levee inventory, inspection, maintenance, and/or rehabilitation

Based on input from Mr. Ed Bala, the District Engineer for the Idaho Transportation Department, the County chose to address action 1 by partnering with ITD, the County, and the City of Blackfoot, to apply for a mining permit to remove the gravel from the River in the study area and use the gravel to backfill a State of Idaho owned gravel pit in Moreland, which is approximately 4.5 miles to the west of the River on Highway 26.

Loss Estimates and Vulnerability

HAZUS was used to perform loss estimates for a 100-year flood on rivers and streams countywide. It is noted that the HAZUS floodplain does not cover the Snake River as it flows near Blackfoot, which could be a high loss area. The following loss estimates were taken from the HAZUS Global Summary Report.

HAZUS estimates that about 12 buildings will be at least moderately damaged and there are an estimated 12 buildings that will be completely destroyed, all of which are residential structures.

HAZUS estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.), and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 4,898 tons of debris will be generated. Of the total amount, finishes comprise 15% of the total; structures comprise 41% of the total, and foundations comprise 44% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 196 truckloads (@25 tons/truck) to remove the debris generated by the flood.

HAZUS estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. HAZUS also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 63 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 20 people (out of a total population of 1,735) will seek temporary shelter in public shelters.

The total economic loss estimated for the flood is $10.97 million dollars, which represents 3.67 % of the total replacement value of the scenario buildings. The total building related losses were $10.93 million dollars.

As noted above the area around Blackfoot cannot be analyzed by HAZUS and the losses would be much greater. For the purpose of this study a loss estimate was generated manually using GIS and HEC RES modeling to generate a floodplain for the area east of the Snake River along the

Engineered Channel discussed above. According to the Bingham County Assessor the Area has a total property value of $222,088,864. Using the FEMA Loss Estimate Guide[7] the losses for a 1- and 2-foot flood depth are as follows:

Flood Depth	Structural Damage	Contents Damage	Total
1 foot	$31,092,320	$46,638,480	$77,730,800
2 feet	$48,859,360	$73,289,040	$122,148,400

A picture of the impacted area is presented below. The highlighted area represents the impacted properties.

Hazard Evaluation

Repetitive Loss– There is spring flooding extremely frequently along the Snake River in the riparian areas. The flooding at times becomes an impact to local communities especially in Blackfoot and in the Riverton Area. Economic Loss at times has been significant. There have been no repetitive NFIP Claims however in Bingham County.

[7] FEMA Mitigation Planning "How-To" Guides FEMA 386-2, page 4-13

River Flood		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	3	Critical
Spatial Extent	2	Limited
Magnitude	3	Critical
Total	**15**	**High**

Flash Flood

Description

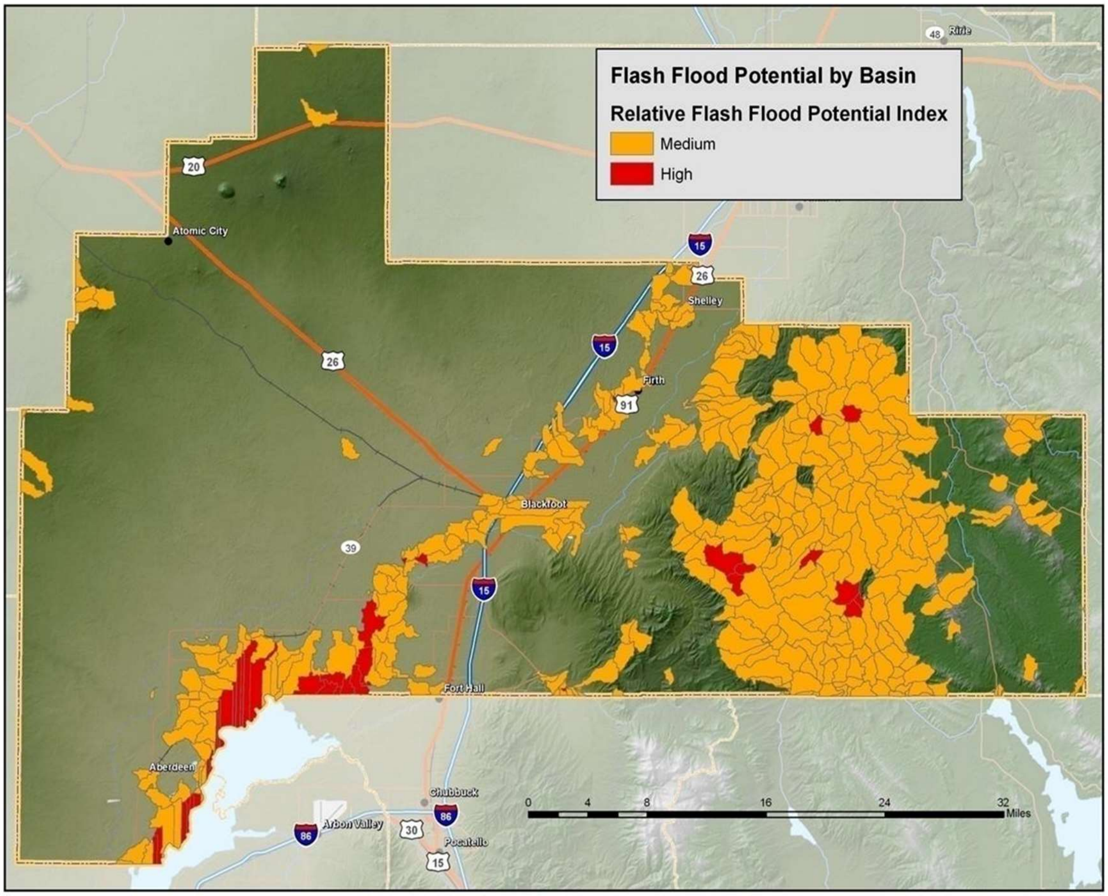
Flash flood is defined by NWS as, "A rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within six hours of the causative event (e.g., intense rainfall, dam failure, ice jam). Ongoing flooding can intensify to flash flooding in cases where intense rainfall results in a rapid surge of rising flood waters." Flash floods differ from floods (discussed below under River Flooding) in the rapidity with which they develop. Floods generally develop over a period of several days, providing more warning time, and time for preparation and evacuation. Flash floods occur with little or no warning. They may occur during thunderstorms due to rapid runoff from steep terrain, from areas where the soil is already saturated, or in urban areas where vegetation has been removed and pavement has replaced exposed soil. Flash floods may also arise as the result of dam failure (discussed below) or the breakup of ice jams.

Historical Frequencies

The Storm Event Database from the National Centers for Environmental Information reports from 1950 to 2020, 5 Flash Flood events were reported. Many times, this is due to localized personal damage, rather than a widespread costly disaster.

There have been five recorded flash flood events in Bingham County since 2000. The events are summarized below.

Location	County/Zone	St.	Date	Time	T.Z.	Type	Mag	Dth	Inj	PrD	CrD
Totals:								0	0	315.00K	2.00K
BLACKFOOT	BINGHAM CO.	ID	08/22/2003	16:00	MST	Flash Flood		0	0	0.00K	0.00K
EAST PORTION	BINGHAM CO.	ID	02/28/2006	10:00	MST	Flash Flood		0	0	15.00K	0.00K
BLACKFOOT	BINGHAM CO.	ID	07/26/2006	16:15	MST	Flash Flood		0	0	0.00K	0.00K
TABER	BINGHAM CO.	ID	08/05/2014	12:30	MST-7	Flash Flood		0	0	0.00K	2.00K
BLACKFOOT	BINGHAM CO.	ID	08/06/2014	14:00	MST-7	Flash Flood		0	0	300.00K	0.00K
Totals:								0	0	315.00K	2.00K



Relative Flash Flood Potential Index

The above figure shows the relative flash flood potential for each basin in Bingham County. This map shows an aggregation of soil infiltration rates, slope, land cover, and canopy density.

Impacts

Because flash floods develop so rapidly, people on foot or in automobiles may be stranded or may be swept away and injured or drowned. They are characterized by high velocity water flow and large amounts of debris, both of which cause damage to, or destroy structures and other objects in their path. Other impacts are discussed below under River Flooding.

Loss Estimates and Vulnerability

A GIS overlay operation was used to determine the number and value of structures that lie within basins with a medium-high to high flash flood potential. Digital parcel data was not available at from the County at the time the Plan was developed. The estimates below are established using the US Census data to calculate the exposure of structures. The following table represents the results of that analysis:

Hazard	No of Residential Structures Affected	Value of Affected Structures

Flash Flood	1959	$148,272,791

Residential Structures Affected by Flash Flood 2019

Hazard Evaluation

Flash Flood		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	2	Limited
Spatial Extent	2	Limited
Magnitude	3	Critical
Total	**14**	**Medium**

Dam Failure

Description

Dam failure is the unintended release of impounded waters. Dams can fail for one or a combination of the following reasons:

- Overtopping caused by floods that exceed the capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Poor design and/or construction methods
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep

Failures may be categorized into two types; component failure of a structure that does not result in a significant reservoir release, and uncontrolled breach failure that leads to a significant release. With an uncontrolled breach failure of a manmade dam, there is a sudden release of the impounded water, sometimes with little warning. The ensuing flood wave and flooding have enormous destructive power. The Idaho Department of Water Resources (IDWR) is responsible for dam safety in this State. The program is described as follows (from the "Dam Safety Program," IDWR web site)[8]:

[8] http://www.idwr.state.id.us/water/stream_dam/dams/dams.htm

Dams 10 feet or higher or, which store more than 50-acre feet of water, are regulated by the Idaho Department of Water Resources (as are mine tailings impoundment structures). Idaho currently has 546 water storage dams and 21 mine tailings structures that are regulated by IDWR for safety. The Dam Safety Section inspects these dams or tailings structures every other year unless one has a particular problem. Copies of all inspection reports for each of the dams and tailings structures are available at the IDWR State Office in Boise. Inspection reports are also available at the four IDWR Regional Offices for dams and tailings structures located in their specific regions.

Dam Classifications

Each dam inspected by Idaho Water Resources is given both a size and risk classification.

Size Classification

Small – 3: Twenty (20) feet high or less and a storage capacity of less than one hundred (100) acre feet of water.

Intermediate – 2: More than twenty (20) but less than forty (40) feet high or with a storage capacity of one hundred (100) to four thousand (4,000) acre feet of water.

Large – 1: Forty (40) feet high or more or with a storage capacity of more than four thousand (4,000) acre feet of water.

Risk Classification

This classification is used by IDWR to classify potential losses and damages anticipated in down-stream areas that could be attributable to failure of a dam during typical flow conditions.

Low Risk – 3: 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 – 2: No concentrated urban development, one (1) or more permanent structures for human habitation which are potentially inundated with flood water at a depth of two (2) ft. or less or at a velocity of two (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 – 1: Urban development, or any permanent structure for human habitation which are potentially inundated with flood water at a depth of more than two (2) ft., or at a velocity of more than two (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.

Purposes Categories:

N-Industrial, B-Mining, O-Other, C-Commercial, P-Power, D-Domestic, Q-Fire Protection, Erosion Control, F-Flood Control, S-Stockwater, G-Wildlife Protection, T-Mine Tailings, H-Fish Propagation, I-Irrigation, J-Stockwater and Irrigation, K-Domestic, Stock and Irrigation, L-Domestic and Irrigation, M-Municipal Supply

Dam Type

Earth- Earth Fill, Rock- Rock Filled, CNGRV- Concrete Gravity, CNAR-Concrete Arch, MCNAR-Multiple Concrete Arch, TMCRB-Timber Crib, SLBT-lab and Buttress, RKMAS-Rock Masonry, Metal-Metal Sheet Pile, AUXDAM-Auxiliary Dam

Name	Stream	Purpose	Risk Category	Size Category	Type	Storage Capacity (Acre Ft.)	Height (Ft.)
Twin Buttes NO 1	Lava Draw	S	3	2	Earth	180	15
Crystal Springs Middle	Crystal Springs	IR	3	3	Earth	99	12
Blackfoot Equalizing	Blackfoot River	O	1	2	Earth	1500	18

: Dams in Bingham County [9]

Historical Frequencies

There have been no recorded dam failures in Bingham County

Impacts

Impacts from dam failures in Bingham County would have a major impact on residents. The major use for dams is irrigation in very rural parts of the County.

Ririe Reservoir

If the Ririe Dam failed catastrophically, either from a natural disaster or a human initiated event, it would reach the first population center, the City of Ucon, in 108 minutes; it would reach the City of Idaho Falls, the major population center of Bonneville County, in 187 minutes; it would arrive in Bingham County at Shelley within 7 hours after the dam failure. The Dam is not manned 24 hours a day and therefore it is anticipated that there would be at least a fifteen (15) minute lag between event initiation and the commencement of the notification of the residents of Bingham County. The Figure below illustrates the inundation zone in Bingham County.

According to the Bureau of Reclamation Flood Plain Mapping, the flood boundary would flow to the south and east along the foothills. According to the 2000 U. S. Census 64,185 people or 22,624 households will need to be evacuated out of the flood zone. Based on the estimated growth rate since the 2000 Census the number could be as high as 90,000 individuals and 31,000 households.

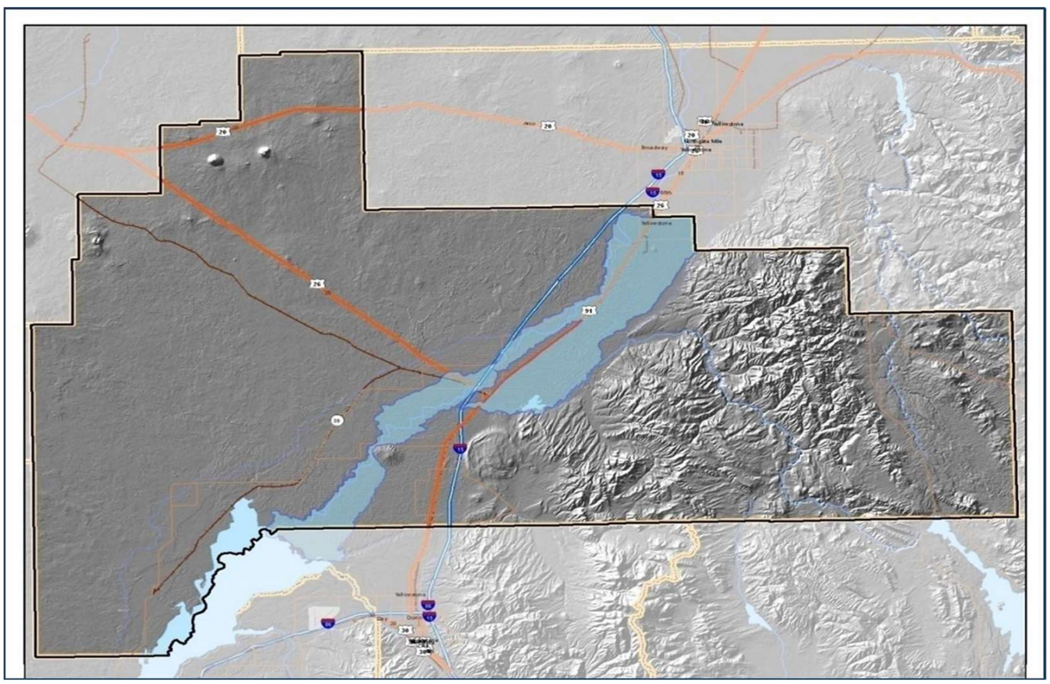
Blackfoot Reservoir

Even though the Blackfoot Reservoir Dam is not physically located in Bingham County, it poses the greatest risk in the event of a dam failure. Water stored in the Blackfoot Reservoir is used to irrigate lands on the Fort Hall Indian Reservation and other lands in the vicinity of Blackfoot. It

[9] http://www.idwr.idaho.gov/water/stream_dam/dams/Dams.pdf

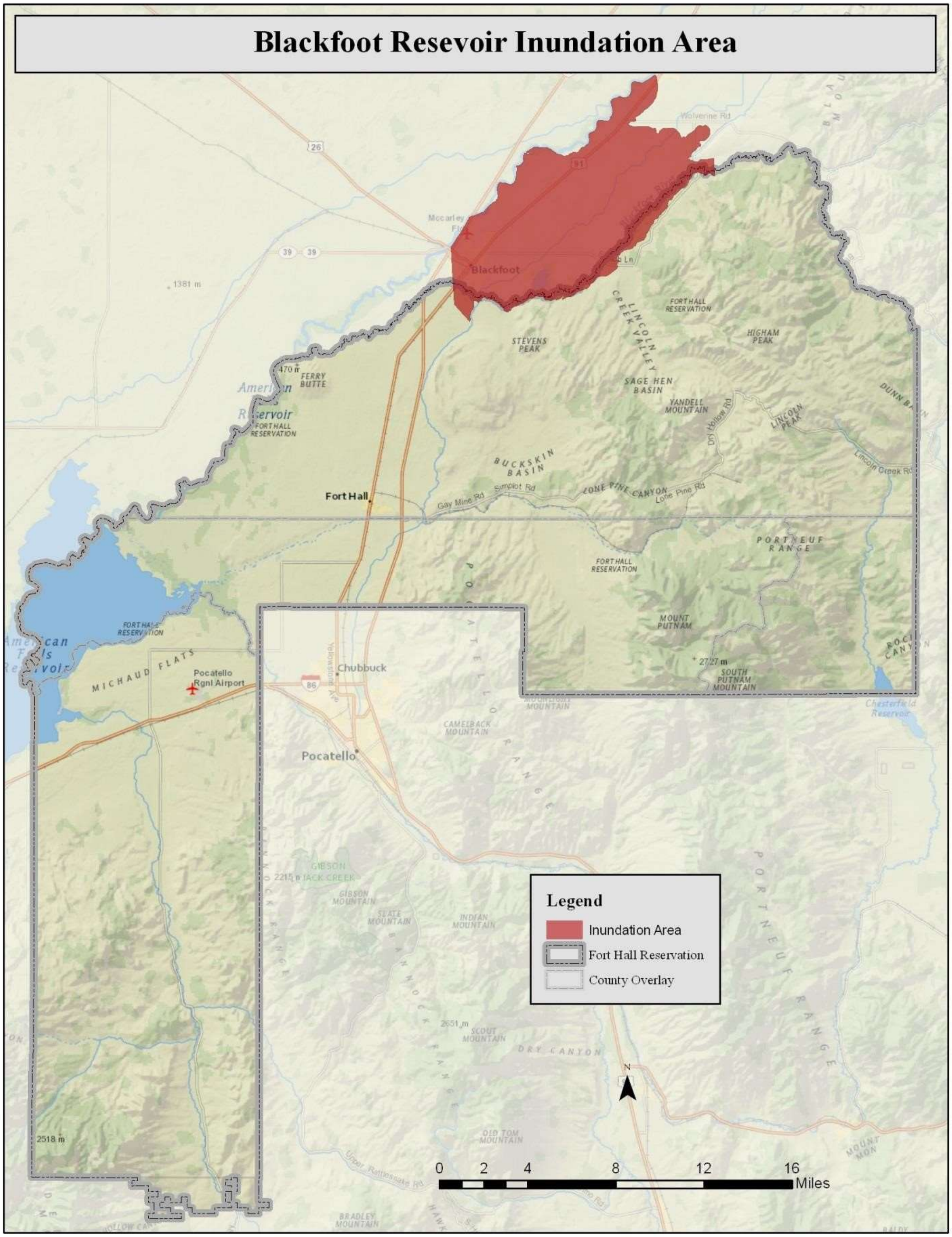
is managed by the Bureau of Indian Affairs (BIA) in Fort Hall.

Blackfoot Reservoir has a very good population of rainbow, cutthroat trout and carp. Its islands are home to pelicans, cormorants, and gulls. Its waters are used by waterfowl, water birds and shore birds. Blackfoot Reservoir covers 18,000 surface acres when full, the second largest reservoir in southeastern Idaho. The main dam was built 55 feet high above the stream bed. Blackfoot Reservoir has a usable storage capacity of 413,000 acre-feet at a design maximum water surface elevation of 6124'.[10]



Ririe Reservoir Inundation Zone

[10] http://www.visitidaho.org/attraction/lakes-rivers/blackfoot-reservoir/



Blackfoot Reservoir Inundation Zone

Loss Estimates and Vulnerability

Losses due to failure of dams in Bingham County could be in the $1,000,000's range. The impacts would affect a large portion of the population. The map on the previous page show inundation areas, areas along rivers would also be at risk.

Hazard Evaluation

Dam Failure		
Profile Category	**Rating**	**Description**
Historical Occurrence	1	Low
Probability	1	Rare
Vulnerability	4	Catastrophic
Spatial Extent	3	Critical
Magnitude	4	Catastrophic
Total	**13**	**Medium**

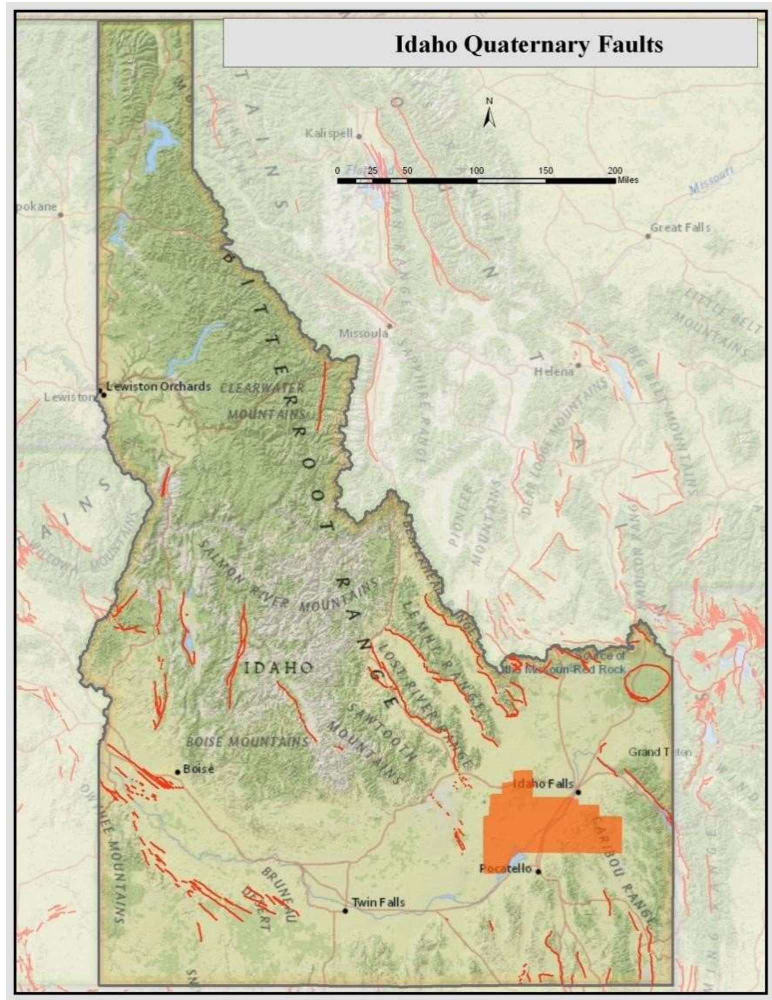
Geologic Hazards

Geologic hazards are adverse conditions capable of causing loss of life and damage to property that involve the movement of geologic features or elements of the surface of the earth. There are a wide variety of such hazards that may be categorized as either sudden or slow phenomena. Slowly developing geologic hazards include soil erosion, sinkholes and other ground subsidence, and migrating sand dunes. Only sudden geologic hazards will be considered in this planning and will be limited to earthquake, landslide/mudslide, and snow avalanche.

Earthquake

Description

The U.S. Geological Survey (USGS) defines earthquake as: "Ground shaking caused by the sudden release of accumulated strain by an abrupt shift of rock along a fracture in the Earth or by volcanic or magmatic activity, or other sudden stress changes in the Earth." The hazards associated with earthquake are essentially secondary to ground shaking (also called seismic waves) which may cause buildings to collapse, displacement or cracking of the earth's surface, flooding as a result of damage to dams or levees, and fires from ruptured gas lines, downed power lines and other sources. Earthquakes cause both vertical and horizontal ground shaking which varies both in amplitude (the amount of displacement of the seismic waves) and frequency (the number of seismic waves per unit time), usually lasting less than thirty seconds. Earthquakes are measured both in terms of their inherent "magnitude" and in terms
of their local "intensity." The magnitude of an earthquake is essentially a relative estimate of the total amount of seismic energy



released and may be expressed using the familiar "Richter Scale" or using the "moment magnitude scale" now favored by most technical authorities. Both the Richter scale and the moment magnitude scale are based on logarithmic formulae, meaning that a difference of one unit on the scales represents about a thirty-fold difference in amount of energy released (and, therefore, potential to do damage). On either scale, significant damage can be expected from earthquakes with a magnitude of about 5.0 or higher. What determines the amount of damage that might occur in any given location, however, is not the magnitude of the earthquake, but the intensity at that particular place. Earthquake intensity decreases with distance from the earthquake's "epicenter" (its focal point) but also depends on local geologic features such as depth of sediment and bedrock layers. Intensity is most commonly expressed using the "Modified Mercalli Intensity Scale." This measure describes earthquake intensity on an arbitrary, descriptive, twelve-degree scale (expressed as Roman numerals from I to XII) with significant damage beginning at around level VII. Mercalli intensity is assigned based on eyewitness accounts. More quantitatively, intensity may be measured in terms of "peak ground acceleration". (PGA) is expressed relative to the acceleration of gravity (g) and determined by seismographic instruments.

While Mercalli and PGA intensities are arrived at differently, they correlate reasonably well. While the locations most susceptible to earthquakes are known, there is little ability to predict an earthquake in the short term.

Historical Frequencies

The following table lists earthquakes that have been felt in Bingham County from 1900 to 2020. There have been 20 earthquakes 3.4 or larger felt in Bingham County over a period of 120 years. There is a 16% yearly chance of an earthquake felt in Bingham County, and a reoccurrence interval of 6 years.

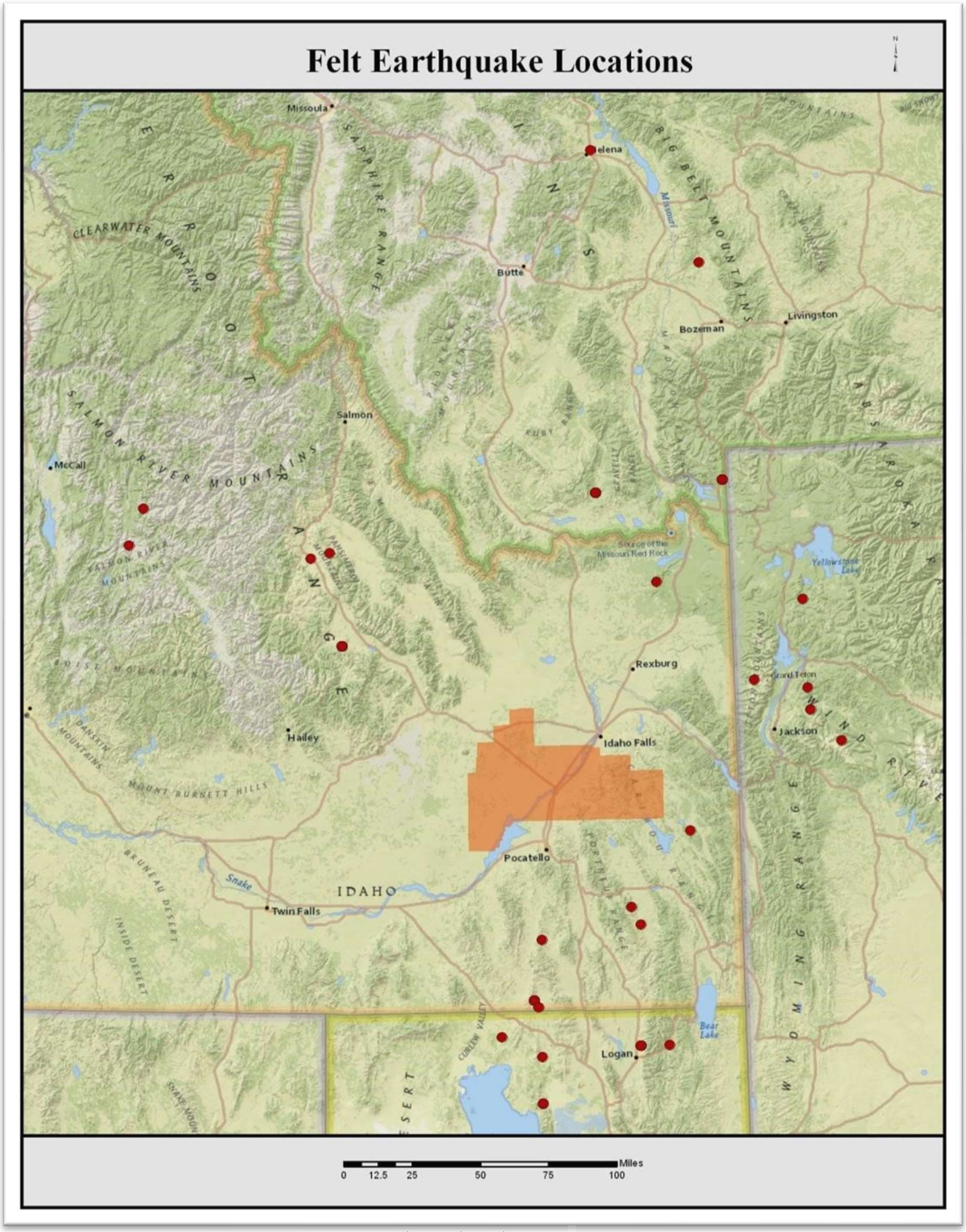
List of the 100 largest quakes in Blackfoot, Bingham County, Idaho, USA since 1900

Hint: Click on Date/Time to show latest first

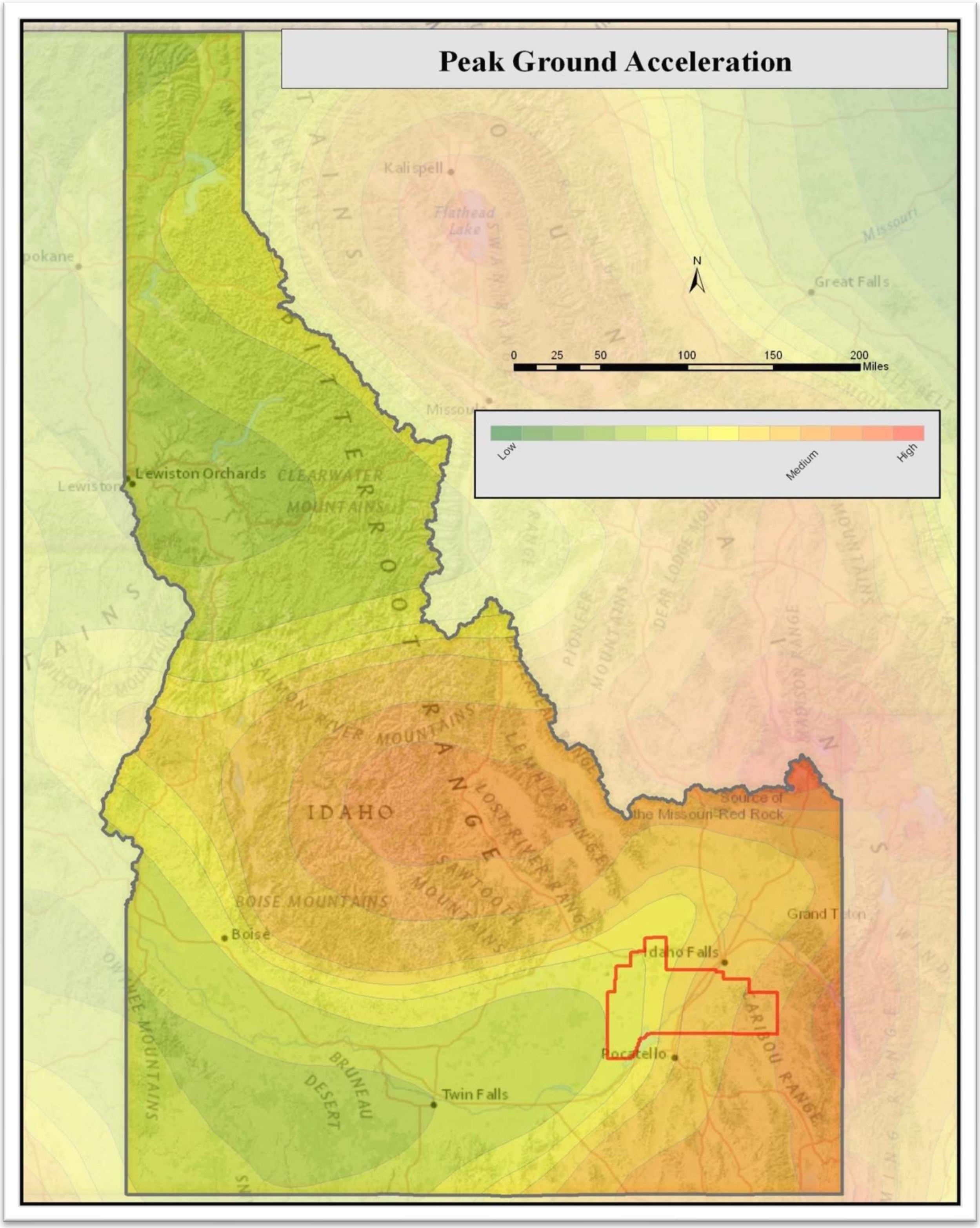
Date / time UTC	Mag	Depth	Age	Details
06 Sep 2017 04:37	**4.5**	5km / 3.1mi	4 years ago	5.3 mi SE of Soda Springs, Caribou County, Idaho, USA
06 May 2013 03:13	**4.2**	11.3km / 7mi	8 years ago	Bannock County, 8.3 mi S of Bancroft, Caribou County, Idaho, USA
11 Nov 1992 18:00	**4.2**	5km / 3.1mi	28 years ago	Caribou County, 43 mi SE of Idaho Falls, Bonneville County, Idaho, USA
11 Nov 1992 12:08	**4.1**	5km / 3.1mi	28 years ago	40 mi SE of Idaho Falls, Bonneville County, Idaho, USA
03 Sep 2017 06:44	3.9	5km / 3.1mi	4 years ago	5.1 mi NE of Soda Springs, Caribou County, Idaho, USA
03 Sep 2017 06:05	3.8	5km / 3.1mi	4 years ago	3.4 mi E of Soda Springs, Caribou County, Idaho, USA
03 Sep 2017 00:17	3.7	5km / 3.1mi	4 years ago	3.9 mi E of Soda Springs, Caribou County, Idaho, USA
03 Sep 2017 16:09	3.6	4km / 2.5mi	4 years ago	6 mi E of Soda Springs, Caribou County, Idaho, USA
06 May 2013 03:20	3.6	4.9km / 3mi	8 years ago	Bannock County, 7.8 mi SW of Bancroft, Caribou County, Idaho, USA
13 Nov 1992 02:01	3.6	5km / 3.1mi	28 years ago	39 mi SE of Idaho Falls, Bonneville County, Idaho, USA
11 Nov 1992 17:36	3.6	5km / 3.1mi	28 years ago	42 mi SE of Idaho Falls, Bonneville County, Idaho, USA
10 Nov 1992 10:45	3.6	10km / 6.2mi	28 years ago	Bingham County, 28 mi SE of Idaho Falls, Bonneville County, Idaho, USA
04 Sep 2017 20:51	3.5	9km / 5.6mi	4 years ago	Bear Lake County, 7.3 mi SE of Soda Springs, Caribou County, Idaho, USA
03 Sep 2017 00:25	3.5	5km / 3.1mi	4 years ago	6.1 mi E of Soda Springs, Caribou County, Idaho, USA
12 Nov 1992 06:32	3.5	5km / 3.1mi	28 years ago	41 mi SE of Idaho Falls, Bonneville County, Idaho, USA
20 Jan 2020 21:12	3.4	5km / 3.1mi	1 year 13 weeks ago	5.6 mi E of Bancroft, Caribou County, Idaho, USA
05 Sep 2017 02:28	3.4	5km / 3.1mi	4 years ago	4.9 mi SE of Soda Springs, Caribou County, Idaho, USA
03 Sep 2017 14:12	3.4	5km / 3.1mi	4 years ago	5.7 mi SE of Soda Springs, Caribou County, Idaho, USA
06 Feb 2017 00:30	3.4	3.6km / 2.2mi	4 years ago	6.6 mi W of Soda Springs, Caribou County, Idaho, USA
16 Nov 1992 02:32	3.4	5km / 3.1mi	28 years ago	Caribou County, 40 mi SE of Idaho Falls, Bonneville County, Idaho, USA

Earthquakes felt in Bingham County 1900-2020

It is noted that the majority of felt earthquakes have caused little or no damage. There has never been significant damage recorded in Bingham County due to an earthquake.



Felt Earthquakes Map


Peak Ground Acceleration
0
25
50
100
150
200
Miles
Low
Medium
High
Kalispell
Flathead Lake
Missouri
Great Falls
Missoula
Lewiston Orchards
Lewiston
CLEARWATER MOUNTAINS
BITTERROOT RANGE
SALMON RIVER MOUNTAINS
LEMHI RANGE
LOST RIVER RANGE
SAWTOOTH MOUNTAINS
IDAHO
BOISE MOUNTAINS
Boise
Source of the Missouri-Red Rock
Idaho Falls
Pocatello
Twin Falls
BRUNEAU DESERT
CARIBOU RANGE
OWYHEE MOUNTAINS
PIONEER MOUNTAINS

County Seismic Potential Map92

Impacts

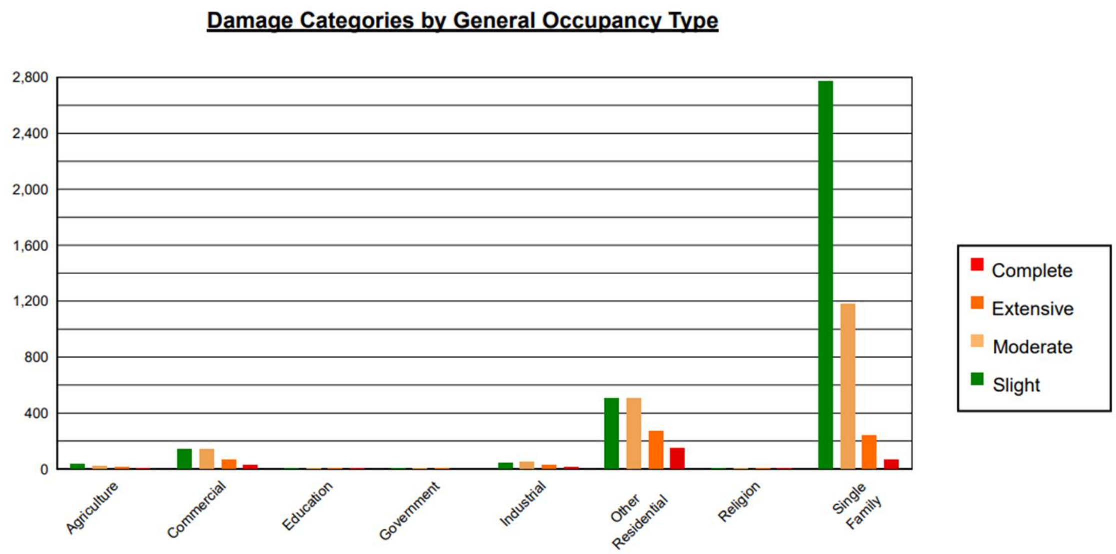
Earthquakes are capable of catastrophic consequences, especially in urban areas. Worldwide, earthquakes have been known to cost thousands of lives and enormous economic and social losses. In minor earthquakes, damage may be done only to household goods, merchandise, and other building's contents, and people are occasionally injured or killed by falling objects. More violent earthquakes may cause the full or partial collapse of buildings, bridges and overpasses, and other structures. Fires due to broken gas lines, downed power lines, and other sources are common following an earthquake, and often account for much of the damage. Economic losses arise from destruction of structures and infrastructure, interruption of business activity, and innumerable other sources. Utilities may be lost for long periods of time and all modes of transportation may be disrupted. Emergency Services including medical may be both disabled and overwhelmed. In addition to broken gas lines, other hazardous materials may be released.

Loss Estimates and Vulnerability

The following loss estimates were generated using HAZUS. The analysis was performed on a probabilistic magnitude 7 earthquake with a 100-year return frequency for the entire area within Bingham County.

Building Damage

Hazus estimates that about 2,797 buildings will be at least moderately damaged. This is over 17.00 % of the buildings in the region. There are an estimated 258 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.



Essential Facility Damage

Before the earthquake, the region had 153 hospital beds available for use. On the day of the earthquake, the model estimates that only 28 hospital beds (18.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 48.00% of the beds will be back in service. By 30 days, 89.00% will be operational.

Debris

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris. The model estimates that a total of 75,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 38.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 3,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Shelter Requirements

HAZUS estimates that 0 households will be displaced and 0 people will seek shelter in public shelters.

Casualties

HAZUS estimates that there will be 1 non-life-threatening injury requiring medical attention in this scenario.

Economic Loss

The total economic loss estimated for the earthquake is 6.67 (millions of dollars), which includes building and lifeline related losses based on the region’s available inventory.

Building Related Economic Loss

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building related losses were $3.88 (millions of dollars); 21 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 63 % of the total loss.

For additional information the complete HAZUS report is included in the appendix.

Hazard Evaluation

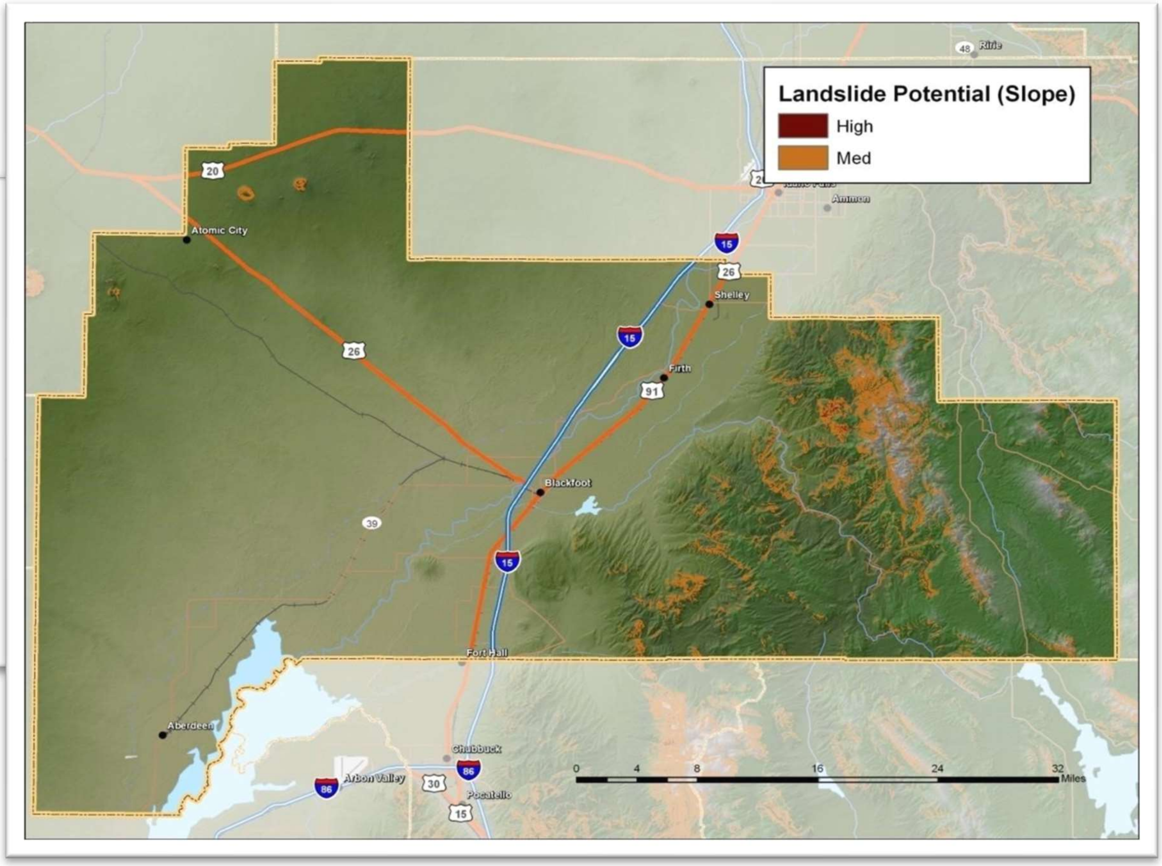
Earthquake		
Profile Category	**Rating**	**Description**
Historical Occurrence	2	Medium
Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	4	Catastrophic
Magnitude	1	Negligible
Total	**12**	**Medium**

Landslide/Mudslide

Description

The term “landslide” encompasses several types of occurrence (including mudslides) in which slope-forming materials such as rock and soil move downward under the influence of gravity. Such downward movement may occur as the result of an increase in the weight of slope-forming materials, an increase in the gradient (angle) of the slope, a decrease in the forces resisting downward motion (friction or material strength), or a combination of these factors. Factors that may trigger a landslide include: weather related events such as heavy rainfall (one of the most common contributors), erosion, and freeze-thaw weakening of geologic structures, human causes such as excavation and mining, deforestation, vibration from explosions or other sources, and such geologic causes as earthquake, volcanic activity, and shearing or fissuring. The speed of descent ranges from sudden and rapid to an almost imperceptibly slow creep where effects are only observable over a period of months or years.

Bingham County Landslide Potential



Historical Frequencies

Although there are no reported landslide events in Bingham County, the landslide potential map indicates that the mountain areas of Bingham County have at least a medium potential. There are no incorporated towns near landslide prone areas.

Impacts

Some of the many direct and indirect impacts of landslides are:

- Human and animal deaths and injuries and resulting productivity losses
- Damage or destruction of structures
- Destruction or blockage of roadways and resulting transportation interruption
- Loss of, or reduced land usage
- Loss of industrial, agricultural, and forest productivity
- Reduced property values in areas threatened by landslide
- Loss of tourist revenues and recreational opportunities
- Damage or destroyed infrastructure and utilities
- Damming or alteration of the course of streams and resulting flooding
- Reduced water quality

Loss Estimate and Vulnerability

Losses due to Landslide events are generally tied to the repair of roadways or the removal of all debris on roadways. There are approximately 335 miles of roadway that run through landslide prone areas; most of these roads are in the back country. The County estimates that back country replacement value is $825,000 per mile. The total vulnerability based on that estimate would be $251,250,000; however, landslides are usually considered a local event and thus it is difficult to predict the actual repair or replacement costs for a single event.

Hazard Evaluation

Landslide		
Profile Category	**Rating**	**Description**
Historical Occurrence	2	Medium
Probability	3	Medium
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	1	Negligible
Total	**8**	**Low**

Snow Avalanche

Description

Snow avalanches are common in mountainous terrain where heavy snowfall accumulates on steep slopes. Avalanches generally occur on slopes between 30 and 45 degrees with 38 degrees being the "ideal" slope for development of avalanche conditions. They are often categorized as either "loose snow" or "slab" types. While the exact moment of an avalanche cannot be predicted, avalanche conditions are readily recognizable, and avalanches tend to recur on the same slopes year after year.

Historical Frequencies

There are no recorded avalanche events in Bingham County; however, many avalanches occur in the back country and go unrecorded. With the growing population, Bingham County could experience an increase in reported avalanches.

Impacts

It is common for avalanche impacts to be somewhat limited. Because avalanches usually occur in remote areas, the most frequent victims are recreational users of the slopes on which they occur. Of those who die in avalanches, approximately one third of the deaths are as a result of trauma, while the remaining two thirds are from suffocation. Trauma may be the result of being carried into obstructions such as boulders and trees or over cliffs, or from rocks, trees or large chunks of snow being carried downward at high speed. Avalanches may also damage or destroy structures, break power lines, block roadways and railroads, and damage trees and vegetation.

Loss Estimates and Vulnerability

Snow Avalanches occur primarily in the back country of Bingham County. As with Landslides, losses from Snow Avalanches come from damage to roadways and the resulting snow and debris removal costs. There are approximately 335 miles of roadway that could be impacted by avalanches. The economic loss caused by an avalanche is primarily related to snow and debris removal and road closures.

Hazard Evaluation

Avalanche		
Profile Category	**Rating**	**Description**
Historical Occurrence	2	Medium
Probability	3	Medium
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	1	Negligible
Total	**8**	**Low**

Other Natural Hazards

Wildfire

Description

Wildfire is defined by the USDA Forest service as, “A fire naturally caused or caused by humans, that is not meeting land management objectives.”[11] It is generally thought of as an uncontrolled fire involving vegetative fuels occurring in wildland areas. Such fires are classified for hazard analysis purposes as either “Wildland” or “Wildland Urban Interface” fires. Wildland fires occur in areas that are undeveloped except for the presence of roads, railroads, and power lines, while Wildland Urban Interface fires occur where structures or other human development meets, or is intermingled with the wildland or vegetative fuels. Wildland fire is currently considered a natural and necessary component of wildland ecology and, as such, is most often allowed to progress to the extent that it does not threaten inhabited areas or human interests and well-being. At the Wildland Urban Interface (WUI), vigorous attempts are made to control fires

[11] http://www.fs.fed.us/fire/fireuse/education/terms/fire_terms_pg5.html

but, this becomes an increasingly difficult challenge as more and more development for recreational and living purposes takes place in wildland areas. Some wildland fires are ignited naturally (almost exclusively by lightning) but, most ignitions are a result of human activities, either careless or intentional. The rapidity with which a wildland fire spreads and the intensity with which it burns is controlled by a number of factors including:

- Weather - wind speed and direction, temperature, precipitation
- Terrain – fires burn most rapidly upslope
- Type of vegetation
- Condition of vegetation - dryness
- Fuel load – the amount and density of vegetation
- Human attempts to suppress

In Idaho, fire was once an integral function of the majority of ecosystems. The seasonal cycling of fire across the landscape was as regular as the July, August, and September lightning storms plying across the canyons and mountains. Depending on the plant community composition, structural configuration, and buildup of plant biomass, fire resulted from ignitions with varying intensities and extent across the landscape. Shorter return intervals between fire events often resulted in less dramatic changes in plant composition[12]. The fires burned from 1 to 47 years apart, with most at 5 – 20-year intervals[13]. With infrequent return intervals, plant communities tended to burn more severely and be replaced by vegetation different in composition, structure, and age[14]. Native plant communities in this region developed under the influence of fire, and adaptations to fire are evident at the species, community, and ecosystem levels. Fire history data (from fire scars and charcoal deposits) suggest fire has played an important role in shaping the vegetation in the Columbia Basin for thousands of years[15].

Historical Frequencies

Between the years 2010 and 2020 there were a total of 67 recorded wildfires in Bingham County. A frequency of wildland fires per year in Bingham County is given in this table. Wildland fires occur every year in the County.

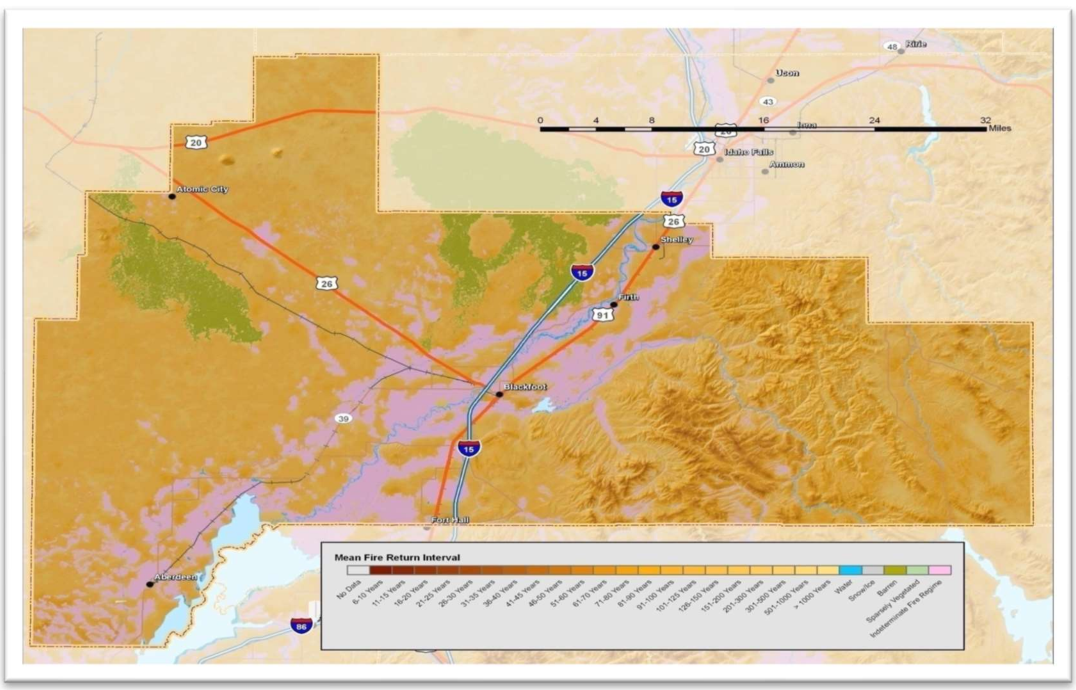
Location	No. of Years	No. of Events	Reoccurrence Interval
Bingham County	10	67	0.15 Years

Wildland Fire Frequency

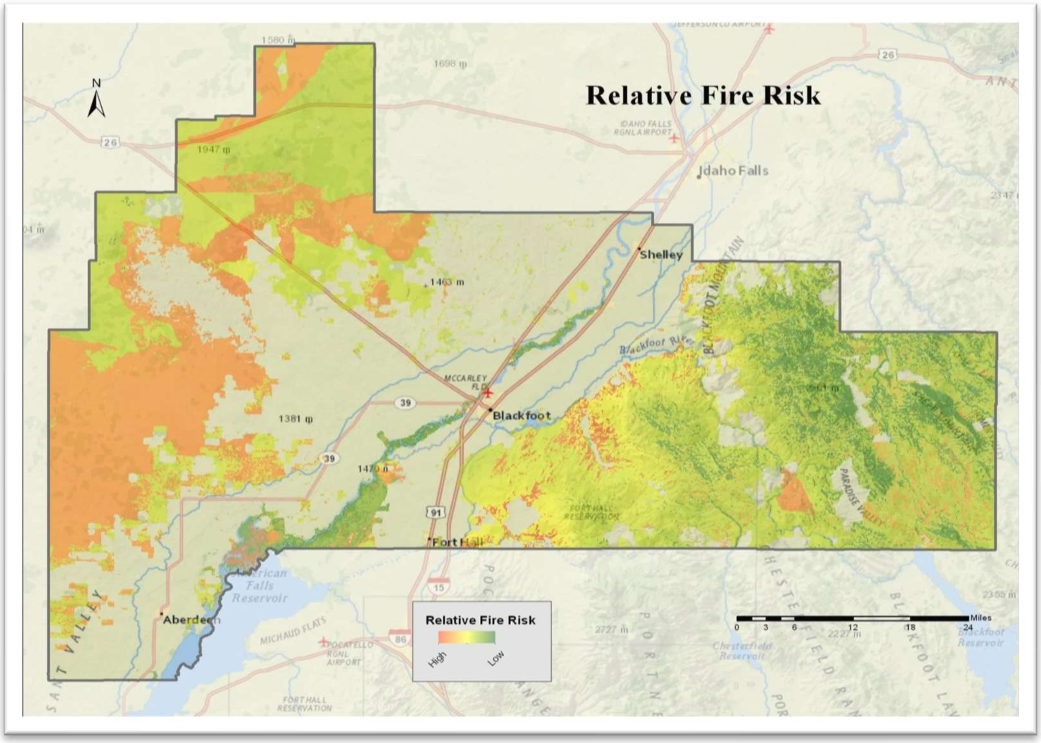
[12] Johnson 1998
[13] Barrett 1979
[14] Johnson *et al.* 1994
[15] Steele *et al.* 1986, Agee 1993

Impact

Wildland fires threaten the lives of anyone in their path including hikers, campers, and other recreational users and, where suppression efforts are made, firefighters. Enormous volumes of smoke and airborne particulate materials are produced that can affect the health of persons for many miles downwind. Nearer to the fire, smoke reduces visibility, disrupting traffic and increasing the likelihood of highway accidents. As a result of wildland fire there may be changes in water quality in the area, and erosion rates may increase along with increased rainfall runoff and flash flood threat, and decreased rainfall interception and infiltration yielding an increased potential for landsides or mudslides in the burn area. Indirect impacts include losses to tourism, recreational and timber interests, and loss of wildlife habitat. Wildland Urban Interface fires have most or all of the above impacts, as well as those of structural fires, including injury and loss of life, and loss of structures and contents. Agricultural losses may also be sustained including livestock, crops, fencing, and equipment.



Bingham County Mean Fire Return Interval Map



Bingham County Relative Fire Risk Map

Loss Estimates and Vulnerability

A GIS overlay operation was used to determine the number and value of structures that lie within the WUI. Because digital parcel data was not available at the time the plan was developed, 2010 US Census data was used to calculate the exposure of structures. The following table represents the results of that analysis:

Hazard	No of Residential Structures Affected	Value of Affected Structures
Wildland Fire	~4,367	~$371,031,720

Wildfire Loss Estimates

Hazard Evaluation

Wildfire

Profile Category	Rating	Description
Historical Occurrence	3	High
Probability	4	High
Vulnerability	3	Critical
Spatial Extent	3	Critical
Magnitude	4	Catastrophic
Total	**17**	**High**

Additional Wildfire information is contained in the County Wildfire Protection Plan (CWPP) Appendix of this plan.

Biological

Communicable Disease

Description

Communicable Disease Outbreaks are usually discussed in two ways; an epidemic and a pandemic. An "epidemic" is defined as a disease that appears as new cases in the human population at a rate, during a given time period and location, that substantially exceeds the number expected. It is thus, a relative term and there is no quantitative criterion for designating a health crisis as an epidemic. In addition to its application to infectious diseases, the term is sometimes used to describe outbreaks of other adverse health effects including those stemming from chemical exposure, sociological problems, and psychological disorders. A "pandemic" is a worldwide epidemic while the term "outbreak" may be applied to more geographically limited medical problems as, for instance, in a single community rather than statewide or nationwide. The term "cluster" is often used with reference to non-communicable diseases.

Three factors combine to produce an epidemic: an "agent" that causes the disease, a "host" that is susceptible to the disease, and an "environment" that permits the host to be exposed to the agent. The spread of an infectious disease depends on the chain of transmission: a source of the agent, a route of exit from the host, a mode of transmission between the susceptible host and the source, and a route of entry into another susceptible host. Modes of spread may involve direct physical contact between the infected host and the new host, or airborne spread, such as coughing or sneezing. Indirect transmission takes place through vehicles such as contaminated water, food, or intravenous fluids; inanimate objects such as bedding, clothes, or surgical instruments; or a biological vector such as a mosquito or flea.

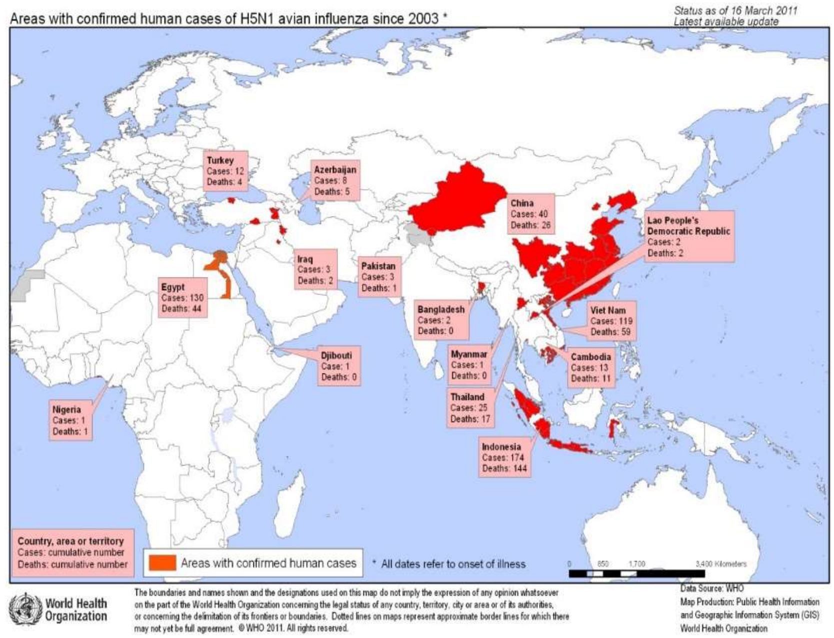
Health agencies closely monitor for diseases with the potential to cause an epidemic and seek to develop immunizations and eliminate vectors. While this effort has been remarkably successful, there are many diseases of concern and the HIV/AIDS pandemic is still not controlled despite more than 40 years of effort since recognition of the disease in 1981.

Pandemic influenza versus annual influenza season

A flu pandemic has little or nothing in common with the annual flu season. Flu pandemic is caused by a new, much more serious and contagious virus to which humans have little or no natural resistance. While in general, a vaccine has been developed in anticipation of the annual flu season, no vaccine would be available at the onset of a pandemic. If such a new, highly contagious strain of influenza began to infect humans, it would probably cause widespread illness and death within a matter of months, and the outbreak could last up to two years. The Centers for Disease Control and Prevention (CDC) predict that as much as 25- 30% of the U.S. population would become ill, that many of these would require hospitalization, and many might die. Eastern Idaho Public Health District is currently working on a plan to limit the spread of a pandemic influenza and to maintain essential health care and community services if an outbreak should occur. In fact, governments all around the world are preparing for the possibility of a pandemic outbreak. Even so, it may not be possible to prevent a pandemic or to halt it once it begins. A person infected with influenza may be contagious for 24 hours before symptoms appear and for seven days thereafter, making it extremely easy for the virus to infect large numbers of people. Although the Federal government is stockpiling large quantities of medical supplies and antiviral drugs, no country in the world has enough antiviral drugs to protect all of their citizens. Antiviral drugs would be used to treat severe cases as long as there was a reasonable chance that the drugs might help save lives. Antiviral drugs might also be reserved for people who work in areas that place them at high risk for exposure in an outbreak, such as health care workers. Other strategies for slowing the spread of a potentially deadly pandemic influenza virus might include temporarily closing schools, sports arenas, theaters, churches, restaurants, taverns, and other public gathering places and facilities.

Vector Borne Disease

H5N1 "Bird Flu"



While it has so far affected few humans, there is the danger that the bird flu virus may mutate into a new form of human flu that would be easily spread person to person. Some migratory waterfowl carry the H5N1 virus with no apparent harm, but transmit the virus to susceptible domestic poultry. The highly lethal H5N1 outbreak among domestic poultry was widespread and uncontrolled and has directly infected a small number of humans.

Impacts

People who have close contact with infected birds or with surfaces that have been contaminated with droppings from infected birds are at risk of becoming infected. In infected countries, poultry consumption has not been shown to be a risk factor if food is thoroughly cooked, nor are travelers in these countries at increased risk of infection provided the person does not visit live poultry markets, farms, or other environments where exposure to diseased birds may occur. More than 200 million birds in affected countries have either died from the disease or were killed in order to try to control the outbreak.

Many Asian countries are currently dealing with bird flu outbreaks. Bird flu continues to spread geographically from its original focus in Asia. Further spread of the virus along migratory routes of wild waterfowl is anticipated. So far, there has been no sustained person to-person spread of the disease, but a few isolated cases of apparent human-to-human spread between family members are currently under investigation.

The reported symptoms of bird flu in humans range from typical influenza-like symptoms (e.g., fever, cough, sore throat, and muscle aches), to eye infections (conjunctivitis), pneumonia, acute respiratory distress, viral pneumonia, and other severe and life-threatening complications. Diarrhea, vomiting, abdominal pain, chest pain, and bleeding from the nose and gums have also been reported as early symptoms in some cases. In many cases, health deteriorates rapidly leading to a high percentage of death in those infected.

Loss Estimates and Vulnerability

Because there have been no reported cases of H5N1 Bird Flu in the United States it is difficult to estimate economic losses. The potential exists for catastrophic loss of life.

Hazard Evaluation

H5N1 Bird Flu		
Profile Category	**Rating**	**Description**
Historical Occurrence	0	High
Probability	1	High
Vulnerability	4	Negligible
Spatial Extent	4	Negligible
Magnitude	4	Critical
Total	**13**	**Medium**

West Nile Virus

Description

West Nile Virus (WNV) is transmitted to people, birds, and other animals by the bite of an infected mosquito. This virus can cause serious illness in people of any age, but especially in people over the age of 50 or those with other underlying medical conditions. The best form of protection is by avoiding mosquito bites.

West Nile virus infections occur in the summer and fall in Idaho, when mosquitoes are active. WNV does not occur in northern states when it is too cool for mosquitoes to survive. In southern states with warmer climates and mosquitoes present year-round, the risk of infection may still be present in the winter months.

Historical Frequencies

Locally-acquired mosquito-borne human infections were first recorded in Idaho in 2004. In 2006, Idaho led the nation in reports of human illness associated with WNV with 996 cases being reported to the State Health Department. In addition to people, WNV was also detected in 338 horses, 127 birds and numerous mosquitoes.

Impacts

West Nile fever may include a fever, headache, body aches, a rash, and swollen glands. The symptoms of West Nile fever may last for days or linger for weeks to months. Serious illness infecting the brain or spinal cord can occur in some individuals, and although anyone can experience the more severe form of the disease, it tends to occur in people over the age of 50, or those with other underlying medical conditions or weakened immune systems. The severe symptoms may include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness, and paralysis. These symptoms may last several weeks or more, and neurological effects may be permanent. Usually, symptoms occur from 5 to 15 days after the bite of an infected mosquito. There is no specific treatment for infection, but hospitalization and treatment of symptoms may improve the chances of recovery for severe infections. There is no vaccine available for humans.

Loss Estimates and Vulnerability

Losses brought about by the effects of West Nile virus are centered on loss of income for those affected by the virus, as well as a loss of productivity by businesses. Death has occurred in Idaho from the West Nile virus both in humans and animals.

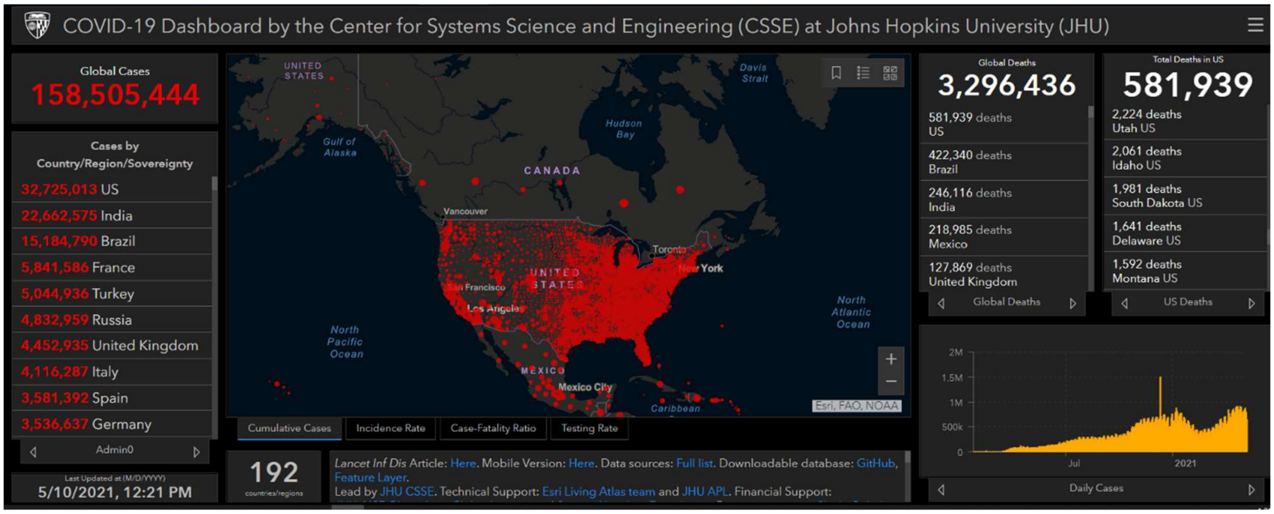
West Nile Virus		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	3	Critical
Total	**12**	**Medium**

Human Borne Disease

Covid-19

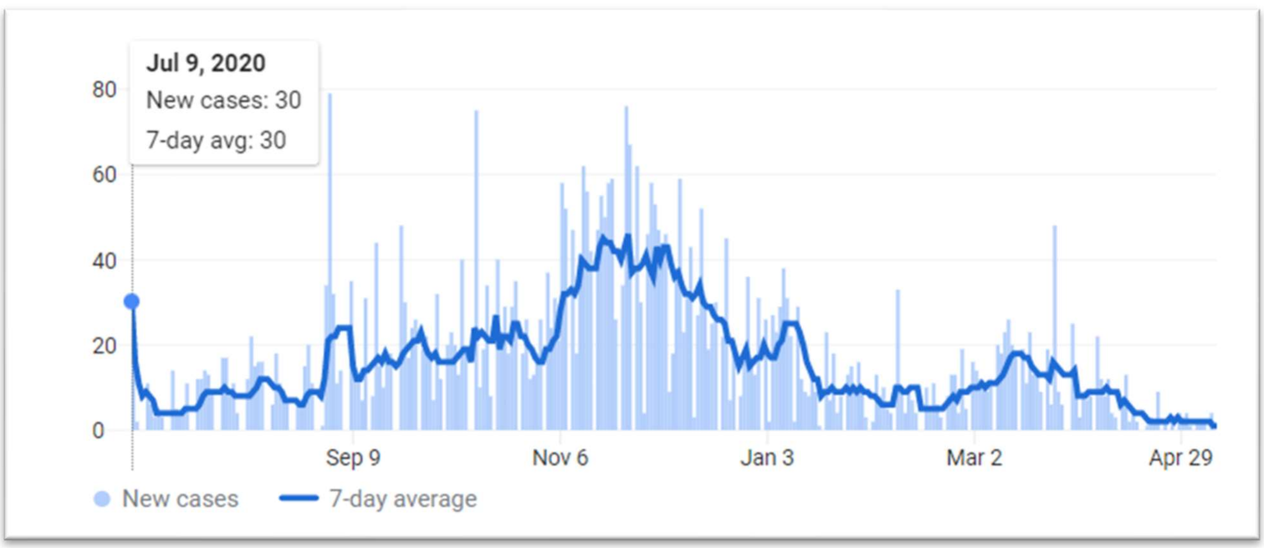
Description

COVID-19 is caused by a coronavirus called SARS-CoV-2. Older adults and people who have severe underlying medical conditions like heart or lung disease or diabetes seem to be at higher risk for developing more serious complications from COVID-19 illness.



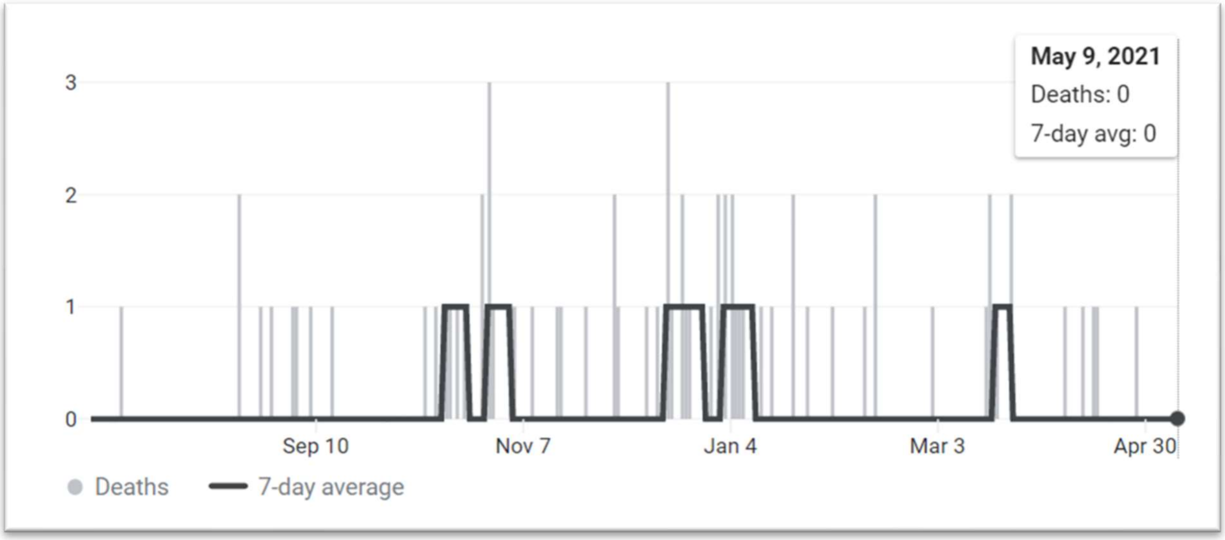
Historical Frequencies

This is a new virus. The following table shows the history to-date in Bingham County.



Impacts

Bingham County was impacted economically, socially increased healthcare and protective actions, but the most devastating are the deaths caused by the virus.



Loss Estimates and Vulnerability

All citizens of Bingham County are at risk as well as all economic sectors. Loss estimates have yet to be calculated.

Hazard Evaluation

Covid-19		
Profile Category	**Rating**	**Description**
Historical Occurrence	1	Low
Probability	3	Medium
Vulnerability	4	Catastrophic
Spatial Extent	4	Catastrophic
Magnitude	4	Catastrophic
Total	**16**	**High**

Severe Acute Respiratory Syndrome (SARS)

Severe acute respiratory syndrome (SARS) is a viral respiratory illness caused by a coronavirus, called SARS-associated coronavirus (SARS-CoV). SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the SARS global outbreak of 2003 was contained. According to the World Health Organization (WHO), a total of 8,098 people worldwide became sick with SARS during the 2003 outbreak. Of these, 774 died. In the United States, only eight people had laboratory evidence of SARS-CoV infection. All of these people had traveled to other parts of the world where there were SARS outbreaks. SARS outbreaks did not occur in the United States.

Historic Communicable Disease Outbreak Events

The 1918 -1920 Spanish Flu:

The first cases of Spanish Flu were reported in Canyon County (northwest of Boise) on September 30, 1918. Within three weeks, the disease was raging all across the State. The numbers of deaths in the State and in Bingham County are unknown, but it is estimated that 675,000 Americans died during the epidemic and that 20 to 40 million died worldwide.

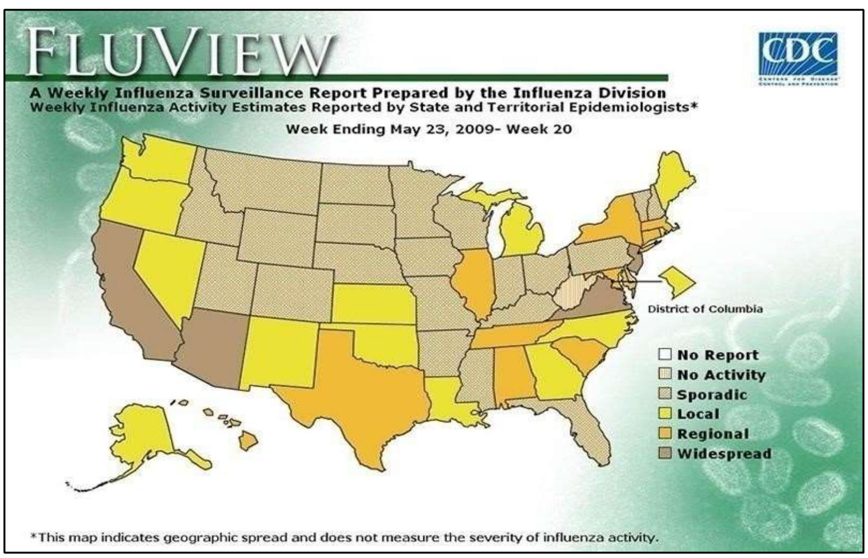
Asian Flu 1957 -1958:

First identified in China, this virus caused roughly 70,000 deaths in the United States during the 1957-58 seasons. Because this strain has not circulated in humans since 1968, no one under 30 years old has immunity to this strain.

Hong Kong Flu 1968-1969:

This was first detected in Hong Kong in early 1968 and spread to the United States later that year. The Hong Kong Flu killed about 34,000 people in the United States and one million people worldwide.

Swine Flu – 2009



Novel influenza A (H1N1) is a new flu virus of swine origin that was first detected in April, 2009. The virus is infecting people and is spreading from person-to-person, sparking a growing outbreak of illness in the United States. An increasing number of cases are being reported internationally as well.

It's thought that novel influenza A (H1N1) flu spreads in the same way that regular seasonal influenza viruses spread; mainly through the cough and sneezing of people who are sick with the virus.

It's uncertain at this time how severe this novel H1N1 outbreak will be in terms of illness and death compared with other influenza viruses. Because this is a new virus, most people will not have immunity to it, and illness may be more severe and widespread as a result. In addition, there is currently no vaccine to protect against this novel H1N1 virus.

Impacts

Characteristics and impacts of a Communicable Disease Outbreak are:

- Rapid Worldwide Spread
- Health Care Systems Overloaded
- Medical Supplies Inadequate
- Economic and Social Disruption

Loss Estimates and Vulnerability

Historically, Communicable Disease Outbreaks have claimed far more lives than any other type of disaster. While modern epidemiology and medical advances make the decimation of populations much less likely, new forms of disease continue to appear. The potential, therefore, exists for Communicable Disease Outbreaks to cause widespread loss of life and disability, overwhelm medical resources, and have tremendous economic impacts.

Hazard Evaluation

Communicable Disease		
Profile Category	**Rating**	**Description**
Historical Occurrence	2	Medium
Probability	2	Low
Vulnerability	4	Catastrophic
Spatial Extent	4	Catastrophic
Magnitude	4	Catastrophic
Total	**16**	**High**

Technological (Manmade) Hazards

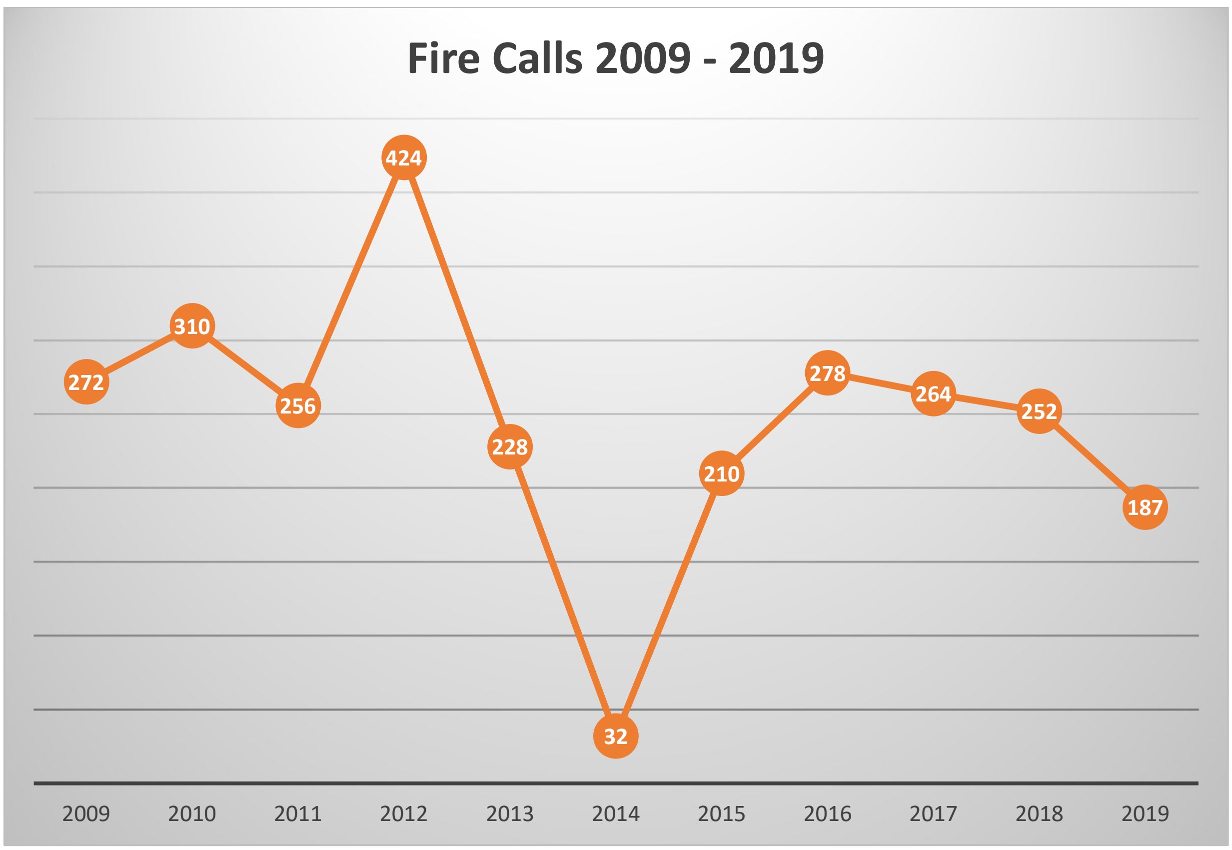
Structural Fire

Description

Structural fires produce high heat, toxic gases, and particulate material as smoke and soot. The heat produced or burning debris can, in turn, cause additional fires. Toxic gases and smoke are extreme hazards in the interior of burning structures and may also be a threat downwind of the structure. Where the building contents include toxic materials, the downwind threat can extend a mile or more. Burning structures may collapse injuring persons inside or nearby and floors or roofs may give way beneath those walking on them. Burning structures present electrical, explosion, and flashover hazards, and partially burned structures may, themselves, be physical hazards even after the fire is extinguished.

Historical Frequencies

Structure fires are common in Bingham County as they are across the nation. As an example of frequency, the following table gives the summary of structural fires responded to in Bingham County from 2009 - 2019.



Impacts

Indirect dollar losses, as is often the case, may be much larger than direct losses. Costs also include those for development and enforcement of fire codes and maintaining fire response capabilities. Firefighters are additionally at risk from such hazards as physical exhaustion and cardiac stresses, heat exhaustion or heat stroke, acute and chronic health effects from toxic exposures, hearing damage, and injuries from many sources.

Loss Estimates and Vulnerability

All structures in Bingham County are at risk. Structural fire losses have ranged from $121,000 in 1993 to almost $600,000 a year in 1999. The average annual loss over the 11-year period was $300,066.00.

Structural Fire		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High
Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	4	Catastrophic
Total	**13**	**Medium**

Nuclear Event

Description

A "nuclear event" is defined as an incident involving a nuclear reaction, nuclear fission, or nuclear fusion. Nuclear fusion, at present, only takes place during the detonation of a nuclear weapon (the so-called H-bomb) and is highly improbable. Much more common is nuclear fission which must involve "fissionable" materials, defined as materials containing isotopes with nuclei capable of splitting. Further, the most probable incidents involve "fissile" materials, defined as materials containing isotopes capable of sustaining a nuclear fission chain reaction. Such reactions release heat, radiation, and radioactive contamination in extremely large quantities relative to the amount of material reacting. Examples of nuclear events include nuclear weapons detonations, nuclear reactor incidents, and nuclear (fissile) material production, handling, or transportation incidents. A nuclear detonation as a part of an attack scenario is, perhaps, the ultimate technological disaster. The hazards are well-known and vividly described in FEMA publications[16]. They include shock wave, enormous heat, and the spread of fallout (radioactive contamination). Other nuclear events would not involve a nuclear blast, but still have the potential to produce widespread and long-term consequences as exemplified by the 1986 Chernobyl accident[17]. Of primary concern is the release of radioactive contamination in the form of airborne gases and particulate material. This radioactive material has the potential to travel great distances, and particulate material eventually is deposited in the environment and incorporated into the food chain. Such contamination may remain hazardous for many years.

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[16] http://www.fema.gov/areyouready/nuclear_blast.shtm
[17] http://www.iaea.org/NewsCenter/Focus/Chernobyl/index.html

Direct radiation exposure is also a hazard in relatively close proximity to a nuclear event, as is exposure to high thermal energy. Nuclear events are virtually always caused by intentional or unintentional human actions.

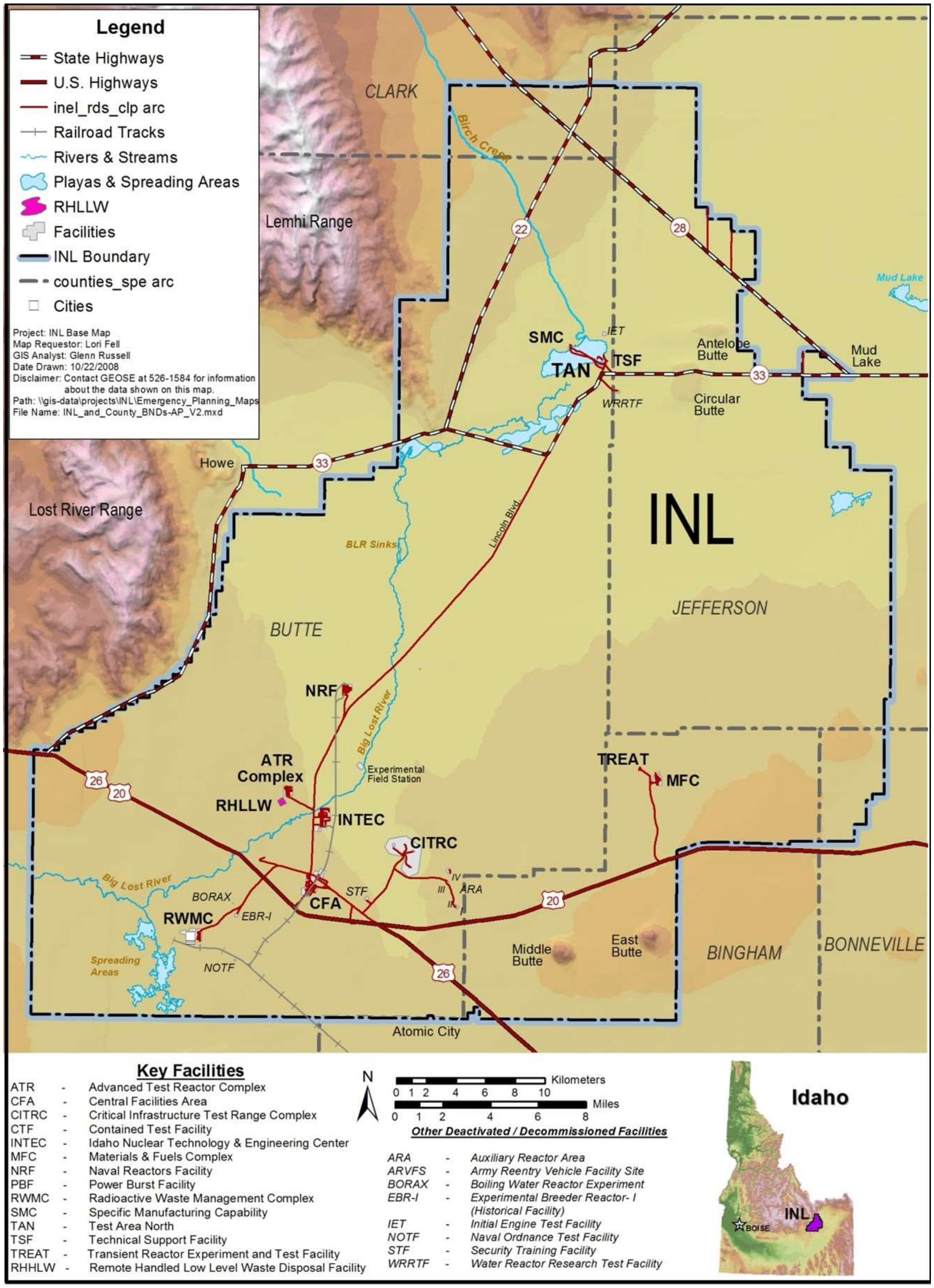
The Idaho National Laboratory poses a credible hazard to Bingham County. The locations of the INL and of the RTC facility within the Site boundary are shown in the map below. As shown in the table below, the Protective Action Distance for a radiological release from the RTC facility is 115 km (approximately 69 miles). This indicates a threat to crops and grazing lands in the western and southwestern portions of Bingham County.

Historical Frequencies

INL Hazards Assessment Maximum Protective Action Distances (PAD)		
Facility	**Non-Rad PAD**	**Rad PAD**
Research Center (IRC)	0.1 km	None
Radioactive Waste Management Complex (RWMC)	None	15 km
Reactor Technology Complex (RTC)	7.8 km	115 km
Idaho Nuclear Technology and Engineering Center (INTEC)	1.6 km	16 km
Central Facilities Area (CFA)	0.5 km	None
Transportation	*	*
Materials and Fuels Complex (MFC)	1.7 km	4.5 km
Area North (TAN)	**	0.03 km

* INL asserts that associated transportation activity is within “normal” limits for highway traffic and uses the DOT ERG for its planning basis.

** Unclear but well within INL Site boundary



There have been no recorded nuclear events in Bingham County

Impacts

A portion of western Bingham County lies within the 69-mile ingestion pathway planning zone of the INL Reactor Technology Complex. In this zone, direct human radiological and contamination exposure is not a serious concern. There is, however, a long-term threat to the food supply because vegetables, fruit, trees, and grains may take up radionuclides from the soil. Radionuclides may also be ingested by livestock, wild game, and fish that may then enter the human food chain. In the event of a serious radiological release from that facility, food production, processing, and marketing facilities within the planning zone could be affected.

There are two types of responses intended to prevent or limit public exposure in the ingestion pathway:[18]

- Preventive protective actions are those taken by farmers to prevent contamination of milk, water, and food products (e.g., sheltering dairy animals and placing them on stored feed and covered water).
- Emergency protective actions are those taken by public officials to address contaminated milk, water, and food products, and divert such products from animal and human consumption (i.e., embargoes).

Loss Estimates and Vulnerability

The eastern part of the county is at greatest risk, but all of the county could be impacted. Indirect costs due to a nuclear event would almost certainly exceed those of clean-up. These would include costs attributable to the stigma associated with radiation and radioactive material in the mind of the public. Because of this stigma, the social and political impacts of a nuclear event may greatly exceed any justifiable limits. There have been instances where the public has avoided radiologically contaminated areas and shunned affected businesses and their products long after any credible health threat has been eliminated.

Hazard Evaluation

Nuclear		
Profile Category	**Rating**	**Description**
Historical Occurrence	0	Never
Probability	1	Rare
Vulnerability	3	Critical
Spatial Extent	3	Critical
Magnitude	3	Critical
Total	**10**	**Low**

[18] http://www.hsem.state.mn.us/uploadedfile/dir_hand/EMDH_C- 13_RadiologicalEmergencyPreparednessProgram.pdf

Hazardous Material Event

Description

Substances that, because of their chemical or physical characteristics are hazardous to humans and living organisms, property, and the environment, are regulated by the U.S. Environmental Protection Agency (EPA) and when transported in, by commerce, and by the U.S. Department of Transportation (DOT). EPA regulations address "hazardous substances" and "extremely hazardous substances".

EPA chooses to specifically list hazardous substances and extremely hazardous substances rather than providing objective definitions. Hazardous substances, as listed, are generally materials that, if released into the environment, tend to persist for long periods and pose long-term health hazards for living organisms. They are primarily chronic, rather than acute health hazards. Regulations require that spills of these materials into the environment in amounts at or above their individual "reportable quantities" must be reported to the EPA. Extremely hazardous substances, on the other hand, while also generally toxic materials, are acute health hazards that, when released, are immediately dangerous to the life of humans and animals, as well as causing serious damage to the environment. There are currently 355 specifically listed extremely hazardous substances listed along with their individual "threshold planning quantities" (TPQ). When facilities have these materials in quantities at or above the TPQ, they must submit "Tier II" information to appropriate State and/or local agencies to facilitate emergency planning.

DOT regulations provide the following definition for the term "hazardous material":

> *Hazardous material* means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions in part 173 of subchapter C of this chapter.

When a substance meets the DOT definition of a hazardous material, it must be transported under safety regulations providing for appropriate packaging, communication of hazards, and proper shipping controls.

In addition to EPA and DOT regulations, the National Fire Protection Association (NFPA) develops codes and standards for the safe storage and use of hazardous materials. These codes and standards are generally adopted locally and include the use of the NFPA 704 standard for communication of chemical hazards in terms of health, fire, instability (previously called "reactivity"), and other special hazards (such as water reactivity and oxidizer characteristics). Diamond-shaped NFPA 704 signs ranking the health, fire, and instability hazards on a numerical scale from zero (least) to four (greatest) along with any special hazards, are usually required to be posted on chemical storage buildings, tanks, and other facilities. Similar NFPA 704 labels may also be required on individual containers stored and/or used inside facilities.

While somewhat differently defined by the above organizations, the term “hazardous material” may be generally understood to encompass substances that have the capability to harm humans and other living organisms, property, and/or the environment. There is also no universally accepted, objective definition of the term “hazardous material event.” A useful working definition, however, might be framed as: any actual or threatened uncontrolled release of a hazardous material, its hazardous reaction products, or the energy released by its reactions that pose a significant risk to human life and health, property and/or the environment.

Hazardous materials are also very commonly stocked and used by businesses in smaller quantities than those required to submit Tier II reports, as well as by private individuals. Thus, it is reasonably safe to consider the entire County and its inhabitants may be exposed to risk from hazardous materials. In spite of their widespread use, however, hazardous materials events are relatively rare and even more rarely cause death, injury, or largescale property damage. To some extent this is due to the fact that such hazards are very effectively addressed by inspections, regulations, codes, and safety procedures, as well as by specialized emergency response training.

Historical Frequencies

The following table lists recent hazardous material events reported by the Idaho Office of Emergency Management for Bingham County.

Event Number	Date	Classification	Description
2009			
H-2009-00262	10/23/2009	1	White Powder
H-2009-00202	8/16/2009	2	Explosive Material
H-2009-00143	6/21/2009	1	Diesel
H-2009-00048	2/27/2009	2	Diesel
2010			
2010-00266	11/23/2010	1	Diesel
2010-00229	10/4/2010	2	Explosive
2010-00217	9/22/2010	1	Caustic Potash
2010-00192	8/9/2010	1	Sodium
2010-00185	8/5/2010	1	Asphalt Oil
2010-00123	6/3/2010	1	Unknown
2010-00087	5/1/2010	2	Explosive
2011			

2011-00209	10/8/11	1	Diesel
2011-00186	8/26/11	2	Drug Lab
2011-00175	8/18/11	2	Explosive
2011-00146	7/14/11	1	Explosive
2011-00127	6/21/11	2	Aviation Fuel
2011-00021	2/5/11	2	Explosive
2012			
2012-00214	10/2/2012	1	Diesel
2012-00129	6/14/2012	1	Nitric Acid
2012-00057	3/24/2012	2	Herbicide
2012-00006	1/13/2012	2	Unknown
2013			
2013-00191	9/3/2013	1	Hydrochloric Acid
2013-00141	7/16/2013	2	White Milky Substance
2013-00105	6/5/2013	1	Oil
2013-00061	3/29/2013	2	Explosive Material
2013-00059	3/27/2013	2	Explosive Material
2013-00002	1/5/2013	1	Ethylene Glycol
2014			
H-2014-00111	6/21/2014	2	White Powder
2015			
H-2015-00190	9/24/2015	3	Explosive Material
H-2015-00102	6/24/2015	2	Gasoline
2016			
H-2016-00177	11/30/2016	2	Improvised Explosive
H-2016-00133	9/5/2016	2	Unknown
H-2016-00069	5/15/2016	3	Pipe Bombs/Explosives
H-2016-00019	2/7/2016	1	Natural Gas
2017			
H-2017-00190	11/11/2017	1	Diesel
H-2017-00102	6/15/2017	2	Nitrogen Phosphate
H-2017-00020	2/12/2017	2	Explosive Material
2018			
2019			
H-2019-00216	11/29/2019	3	German Stick Grenade
2020			
H-2020-00161	8/5/2020	1	Diesel
H-2020-00011	1/15/2020	1	Diesel

2021			
H-2021-00050	3/23/2021	1	Diesel

Impacts

Because hazardous materials are so widely used, stored, and transported, a hazardous material event could take place almost anywhere. Further, many hazardous materials are used, stored, and transported in very large quantities so that the impacts of an event may be widespread and powerful. Regulations and safety practices make such large-scale events unlikely, but smaller scale incidents may have severe impacts.

State of Idaho Hazardous Materials Response Classification Levels

Level I – An incident involving any response, public or private to an incident involving hazardous materials that can be contained, extinguished, and/or abated using resources immediately available to the responders having jurisdiction.

Level II – An incident involving hazardous materials that is beyond the capabilities of the first responders on the scene, and may be beyond the capabilities of the public sector response agency having jurisdiction. Level II incidents may require the services of the State of Idaho Regional Response Team, or other State/Federal Assistance.

Level III – An incident involving weapons of mass destruction/hazardous materials that will require multiple State of Idaho Regional Response Teams or resources that do not exist within the State of Idaho. These incidents may require resources from State and Federal agencies and/or private industry.

Loss Estimates and Vulnerability

All areas of Bingham County are at risk for Hazmat Events. Losses due to the release of Hazardous Materials are linked specifically to two (2) areas; 1) response, including evacuation, and 2) clean up. Bingham County has not had a significant hazardous materials incident; however, releases of hydrocarbon fuels are a constant threat. Clean up of these releases is the responsibility of the spiller. Response to releases is reimbursed to the responding jurisdiction by the Idaho Office of Emergency Management Hazardous Materials Division.

Hazard Evaluation

Hazardous Materials		
Profile Category	**Rating**	**Description**
Historical Occurrence	3	High

Probability	4	High
Vulnerability	1	Negligible
Spatial Extent	1	Negligible
Magnitude	2	Limited
Total	**11**	**Low**

Riot/Demonstration/Civil Disorder

Description

State of Idaho statutes define "riot" as follows (Idaho Statute 18-6401 – RIOT DEFINED):

> Any action, use of force or violence, or threat thereof, is disturbing the public peace, or any threat to use such force or violence, if accompanied by immediate power of execution, by two (2) or more persons acting together, and without authority of law, which results in:
>
> (a) physical injury to any person; or
> (b) damage or destruction to public or private property; or
> (c) a disturbance of the public peace; is a riot.

Also defined in the statutes (Idaho Statute 18-8102 – DEFINITIONS) is "civil disorder":

> "Civil disorder" means any public disturbance involving acts of violence by an assemblage of two (2) or more persons which acts cause an immediate danger to or result in damage or injury to the property or person or any other individual.

The term "demonstration" is not defined in this context in the Idaho statutes, but the following is given for "unlawful assembly" (Idaho Statute 18-6404 - UNLAWFUL ASSEMBLY DEFINED):

> Whenever two or more persons assemble together to do an unlawful act, and separate without doing or advancing toward it, or do a lawful act in a violent, boisterous, or tumultuous manner, such assembly is an unlawful assembly.

Riots are generally thought of as being spontaneous, violent events, whereas demonstrations are usually planned events and are usually intended to be non-violent. Riots seem often to be motivated by frustration and anger, usually over some real or perceived unfair treatment of some group. There are instances, however, where riots have begun during celebrations and other events where the only initiating factor seems to have been the gathering of a crowd of people. The potential for rioting, then, exists any time people gather but, a number of factors are associated with the increased probability one will occur including:

- Drug and alcohol use
- Youth of crowd members
- Low socio-economic status of members
- High level of emotions

- A history of rioting on the same or similar previous occasions
- Initiating event, person, or persons

Once violent or illegal activity is initiated, it escalates, possibly at least partly because of the perception that, because all are acting together, there is little probability that any given individual will be arrested or otherwise suffer consequences. Riots may range in scope from a very few people in a small area to thousands over an entire city. Once initiated, large riots are very difficult to suppress, particularly in the United States, where law enforcement is constrained by constitutional guarantees as well as personnel limits. Early and decisive action by law enforcement may be effective in suppressing a riot, but police actions may also lead to further escalation.

Historical Frequencies

There are no recorded riot events in Bingham County; however, there have been demonstrations at the Idaho National Laboratory within Bingham County during the last 25 years.

Impacts

Riots may result in loss of life, injury, and permanent disability (participants, bystanders, and law enforcement personnel) as well as looting, vandalism, setting of fires, and other property destruction. Law enforcement, emergency medical services, medical facilities and personnel, firefighting, and other community resources may be overwhelmed and unavailable to the community at large. Transportation routes may be closed, infrastructure and utilities damaged or destroyed, and public buildings attacked, damaged, or destroyed. Social and psychological effects may also cause great impacts. Lingering fear and resentment can be long-lasting and can greatly impair the ability of a community to function politically, socially, and economically.

Loss Estimates and Vulnerability

All of Bingham County could be at some level of risk. Losses from Riot/Demonstration/Civil Disobedience come primarily from damage to community and private property. It is difficult to estimate specific losses; however, losses would be consistent with losses due to structure fires and similar incidents.

Hazard Evaluation

Riot/Civil Disobedience		
Profile Category	**Rating**	**Description**
Historical Occurrence	0	None
Probability	1	Low
Vulnerability	2	Limited
Spatial Extent	1	Negligible
Magnitude	2	Limited
Total	**6**	**Low**

Terrorism

Description

Terrorism is an unlawful act under both Federal and State of Idaho statutes. Definitions are as follows:

U.S. Code: Title 18: Section 2331. Definitions

(5) The term "domestic terrorism" means activities that -

(A) Involve acts dangerous to human life that are a violation of the criminal laws of the United States or of any State;

(B) Appear to be intended -

(i) To intimidate or coerce a civilian population;

(ii) To influence the policy of a government by intimidation or coercion; or

(iii) To affect the conduct of a government by mass destruction, assassination, or Kidnapping; and

(C) Occur primarily within the territorial jurisdiction of the United States.

Idaho Statute 18-8102 – DEFINITIONS

(5) "Terrorism" means activities that:

(a) Are a violation of Idaho criminal law; and
(b) Involve acts dangerous to human life that are intended to:

(i) Intimidate or coerce a civilian population;
(ii) Influence the policy of a government by intimidation or coercion; or (iii) Affect the conduct of a government by the use of weapons of mass destruction, as defined in section 18-3322, Idaho Code.

The Federal Emergency Management Agency gives the following as general information on terrorism[19]:

"Terrorism is the use of force or violence against persons or property in violation of the criminal laws of the United States for purposes of intimidation, coercion, or ransom.

Terrorists often use threats to:

- Create fear among the public
- Try to convince citizens that their government is powerless to prevent terrorism

[19] http://www.fema.gov/hazard/terrorism/info.shtm

- Get immediate publicity for their causes

Acts of terrorism include threats of terrorism, assassinations, kidnappings, hijackings, bomb scares and bombings, cyber-attacks (computer-based), and the use of chemical, biological, nuclear, and radiological weapons.

High-risk targets for acts of terrorism include military and civilian government facilities, international airports, large cities, and high-profile landmarks. Terrorists might also target large public gatherings, water and food supplies, utilities, and corporate centers. Further, terrorists are capable of spreading fear by sending explosives or chemical and biological agents through the mail."

Acts of terrorism, then, are essentially the intentional initiation of the sorts of hazard events that have been discussed in previous sections.

Historical Frequencies

There are no recorded terrorism events in Bingham County.

Impacts

Since the events of September 11, 2001, no citizen of the United States is unaware of the enormous potential impacts of terrorist acts. The emotional impacts of fear, dread, anger, outrage, etc. serve to compound the enormous physical, economic, and social damage. The continuing terrorist threat itself has a profound impact on many aspects of everyday life in this country and on the U.S. economy.

Loss Estimates and Vulnerability

All of Bingham County could be at some level of risk, with populated areas at higher risk. Specific loss estimates are not provided due to security policies.

Hazard Evaluation

Terrorism		
Profile Category	**Rating**	**Description**
Historical Occurrence	0	None
Probability	1	Rare
Vulnerability	3	Critical
Spatial Extent	2	Limited
Magnitude	4	Catastrophic
Total	**10**	**Low**

Vulnerability Analysis

Bingham County's largest natural hazard is flooding along the Snake River. The Snake River

Flood Plain extends from the Bonneville County line just north of Woodville, Idaho to the Fort Hall Bottoms located to the south on the Fort Hall Indian Reservation. The River travels through a densely wooded riparian area where flooding occurs annually during the spring run-off. Critical facilities in Bingham County are most generally located outside of the mapped flood plain; however, the County does own recreation facilities along the River west of Shelley and between the Firth River Bridge and the Highway 26 Bridge west of Blackfoot. These recreation facilities have been damaged by flooding several times, including in the years 1997 and 2011.

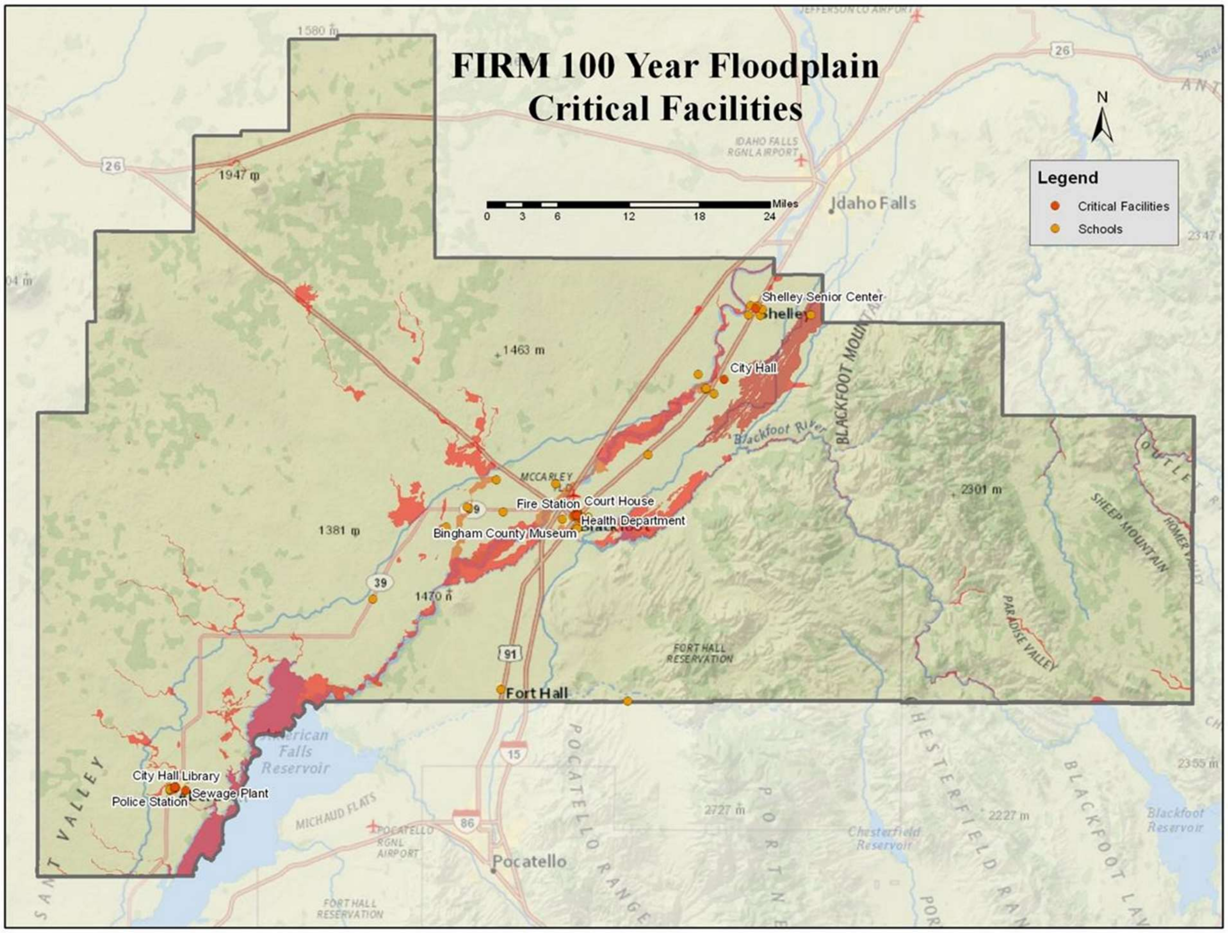
The riparian area surrounding the Snake River is also considered a wildland fire hazard. Small wildland fires have occurred and are easily contained by local fire departments. The recreation facilities owned by the County in the riparian area north of the Blackfoot Golf Course are particularly vulnerable.

The remaining critical facilities owned by the County are located within populated areas outside of the floodplain and the wildland urban interface area.

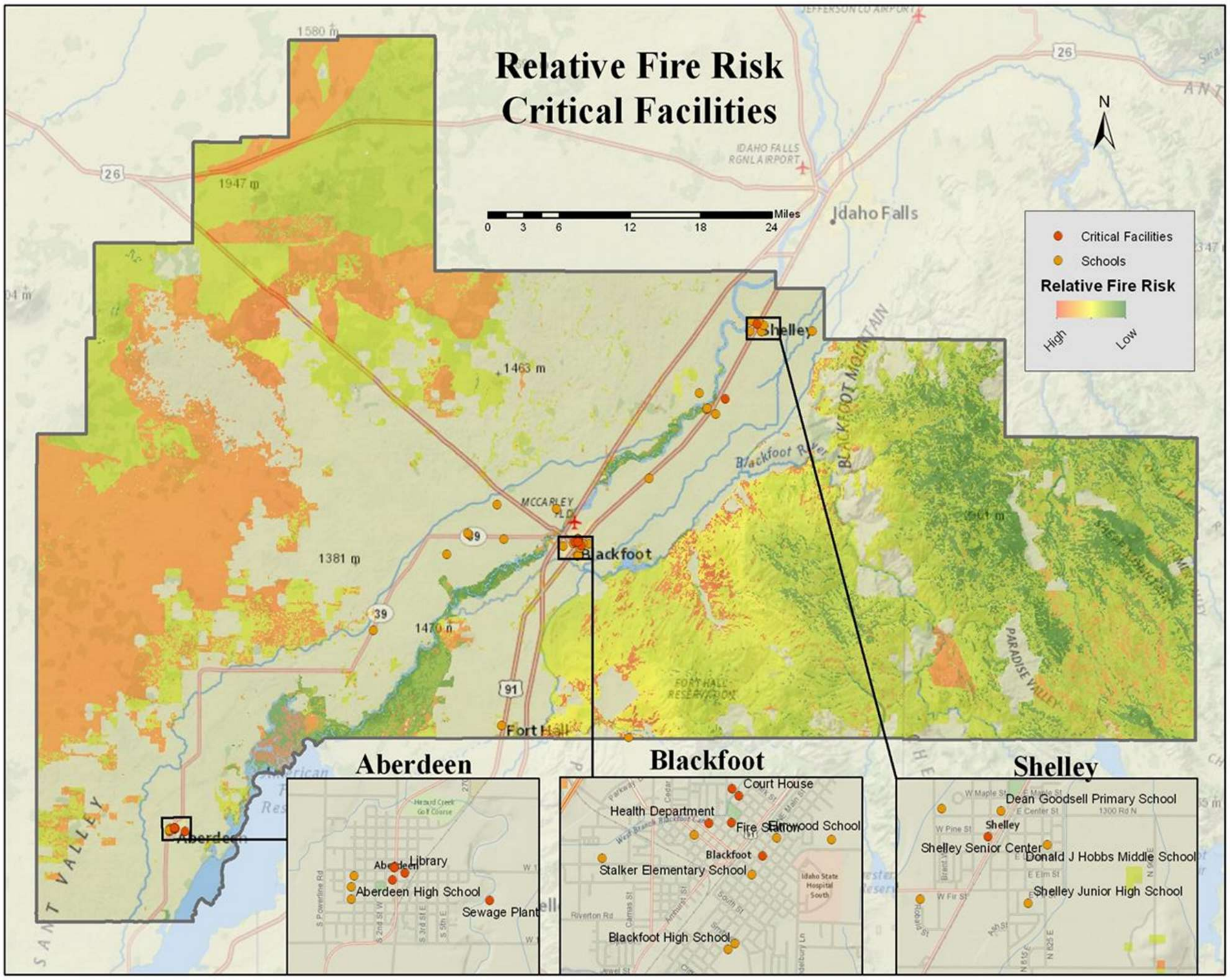
Bingham County has a unique geological composition with mountains along the eastern border and a high mountain desert to the west, divided in the center by the Snake River. Both the eastern and western reaches of the County are vulnerable to wildfires. While the fuels are significantly different, the economic risk to ranchers on either side of the County is substantial. Ranchers in Bingham County rely heavily upon grazing allotments on both public and private lands which are located within these wildland areas.

Bingham County experiences severe weather events both in summer and winter. All severe weather events are accompanied with strong straight-line winds causing the blowing and drifting of light soils and sands and snow. These conditions cause damage to private structures and produce extremely hazardous driving conditions.

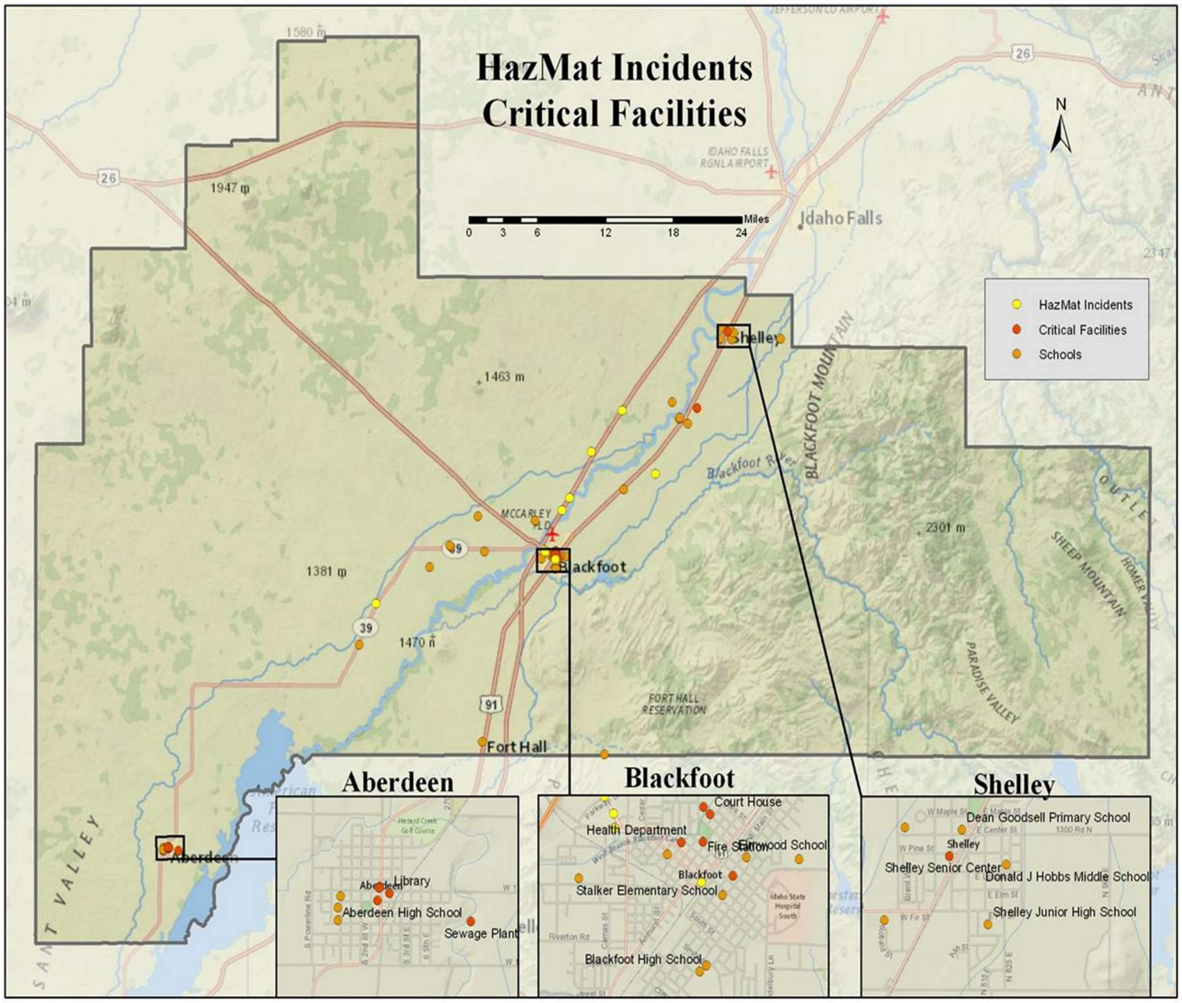
The Bingham County community as a whole is vulnerable to the release of hazardous chemicals from transportation incidents occurring along Interstate 15, US Highway 91, US Highway 26, and other minor State highways. The Union Pacific Rail Road main line from Pocatello to Butte, Montana transects Bingham County running north and south. The rail poses a hazardous material transportation risk to cities and populations located on either side of the rail lines.



FIRM 100 Year Floodplain / Critical



Relative Fire Risk / Critical Facilities



HazMat Incidents / Critical Facilities

Risk Ranking Changes from the 2013 and 2021 Updates

The following tables show the differences between hazard ranking in the 2013 Plan and this 2021 Plan can be accounted for by the difference in historic hazard event data, and the scoring methodology.

2013 Risk Rankings – Bingham County

Hazard	Historical Occurrence	Probability	Vulnerability	Spatial Extent	Magnitude	Total	Rank
Wildfire	3	4	3	3	4	**17**	**H**
River Flooding	3	4	3	3	4	**17**	**H**
Severe Winter Storms	3	4	3	4	2	**16**	**H**
Hazardous Materials	3	4	2	2	4	**15**	**H**
Flash Flooding	3	4	2	2	3	**14**	**M**
Drought	2	4	3	3	2	**14**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Structure Fire	3	4	1	1	4	**13**	**M**
Communicable Disease	1	2	4	3	3	**13**	**M**
Dam Failure	1	1	4	3	4	**13**	**M**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Nuclear Event	0	1	4	4	4	**13**	**M**
West Nile Virus	3	4	1	1	3	**12**	**M**
Earthquake	2	4	1	4	1	**12**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Landsides	0	1	2	1	2	**6**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Avalanche	0	1	1	1	1	**4**	**L**

2021 Risk Rankings - Bingham County

Hazard	Historical Occurrence	Probability	Vulnerability	Spatial Extent	Magnitude	Total	Rank
Wildfire	3	4	3	3	4	**17**	**H**
Communicable Disease	2	2	4	4	4	**16**	**H**
River Flooding	3	4	3	3	3	**16**	**H**
Severe Winter Storms	3	4	3	4	2	**16**	**H**
Drought	2	4	3	4	2	**15**	**H**
Dam Failure	1	1	4	3	4	**13**	**M**
Flash Flooding	3	4	1	2	3	**13**	**M**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Structure Fire	3	4	1	1	4	**13**	**M**
Earthquake	2	4	1	4	1	**12**	**M**
Hazardous Materials	3	4	2	1	2	**12**	**M**
West Nile Virus	3	4	1	1	3	**12**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Nuclear Event	0	1	2	3	3	**9**	**L**
Avalanche	2	3	1	1	1	**8**	**L**
Landsides	2	3	1	1	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**

Individual Jurisdictional Vulnerability Analysis and Risk Rankings

Blackfoot

Blackfoot is a city in Bingham County, Idaho, United States. The population was 11,899 at the 2010 census. The city is the county seat of Bingham County. Blackfoot is the "Potato Capital of the World", because it has the largest potato industry in the world. It is the site of the Idaho Potato Museum (a museum and gift shop that displays and explains the history of Idaho's potato industry), which has the world's largest baked potato and potato chip. Blackfoot is also the location of the Eastern Idaho State Fair, which operates between Labor Day weekend and the following weekend.

The first general store was built in 1874 by Fredrick S. Stevens and Major Danilson after learning that a railroad was to be built in the area. They were hoping that a station would be built there because it was just outside the Fort Hall Indian Reservation, which speculation paid off four years later. On October 10, 1878, a post office was established with Theo T. Danilson as Postmaster. On November 10, 1878, track was laid through town, with the track running right up behind the Stevens Store to take advantage of the store's loading platform (which was originally used to unload freight wagons). Originally called Grove City, the name of the town was changed to Blackfoot on March 20, 1879.

On January 13, 1885, Bingham County was established with Blackfoot as its county seat. Originally, the county seat was to be Eagle Rock (now called Idaho Falls). However, on the night before its legal appointment, men from Blackfoot bribed a clerk to erase Eagle Rock and write in Blackfoot. The measure went through without opposition and was signed by the governor.

Blackfoot was incorporated as a town in 1907.

According to the United States Census Bureau, the city has a total area of 6.07 square miles (15.72 km^2), of which 5.83 square miles (15.10 km^2) is land and 0.24 square miles (0.62 km^2) is water. Blackfoot has a semi-arid climate with cold winters and hot, dry summers.

Vulnerability Analysis

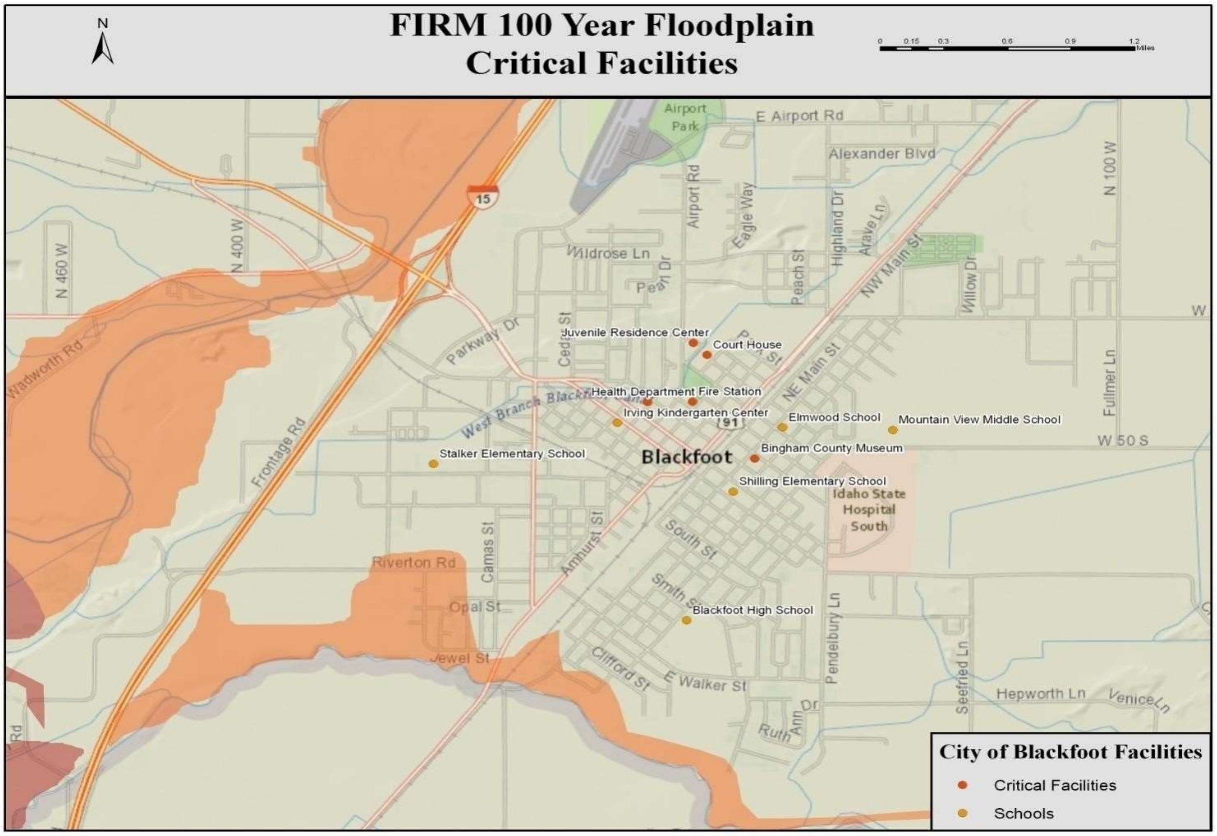
The City of Blackfoot is extremely vulnerable to flooding from both the Snake and Blackfoot Rivers, as indicated by the map below. Of special concern is the engineered channel that was constructed in the early 1960s to facilitate the routing of Interstate 15 west of Blackfoot. The Snake River originally ran through the west boundary of the City, but was relocated further west. The engineered channel forms the northern boundary of Rose Road and Interstate 15 and extends along the west side of the City. Since construction, the channel has accumulated large amounts of gravel, which have traveled from the upper reaches of the Snake River. During the 1976 Teton Dam failure, the accumulation has been significant with the current capacity 60% of design. This condition is causing frequent flooding in the business district adjacent to Interstate 15 during high water flows. It is occurring more frequently as time passes. This problem is exacerbated by development on the west side of the River as historic floodways have been filled in.

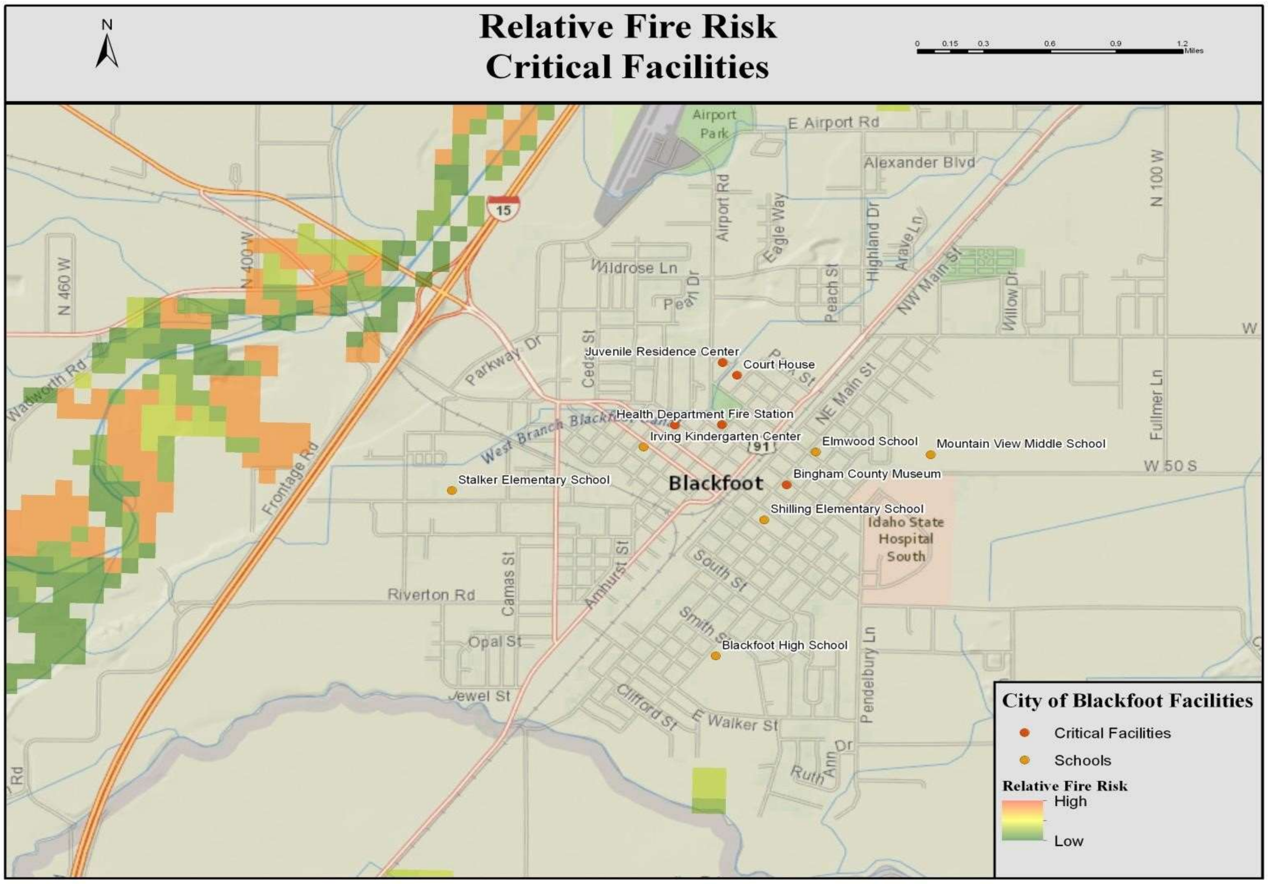
The flooding hazard described does not affect the City of Blackfoot's critical facilities, with the exception of the sewage treatment plant, which is located along the Snake River south and west of Blackfoot. The entire city's storm water drainage system empties to the River in the same general vicinity as the sewage plant.

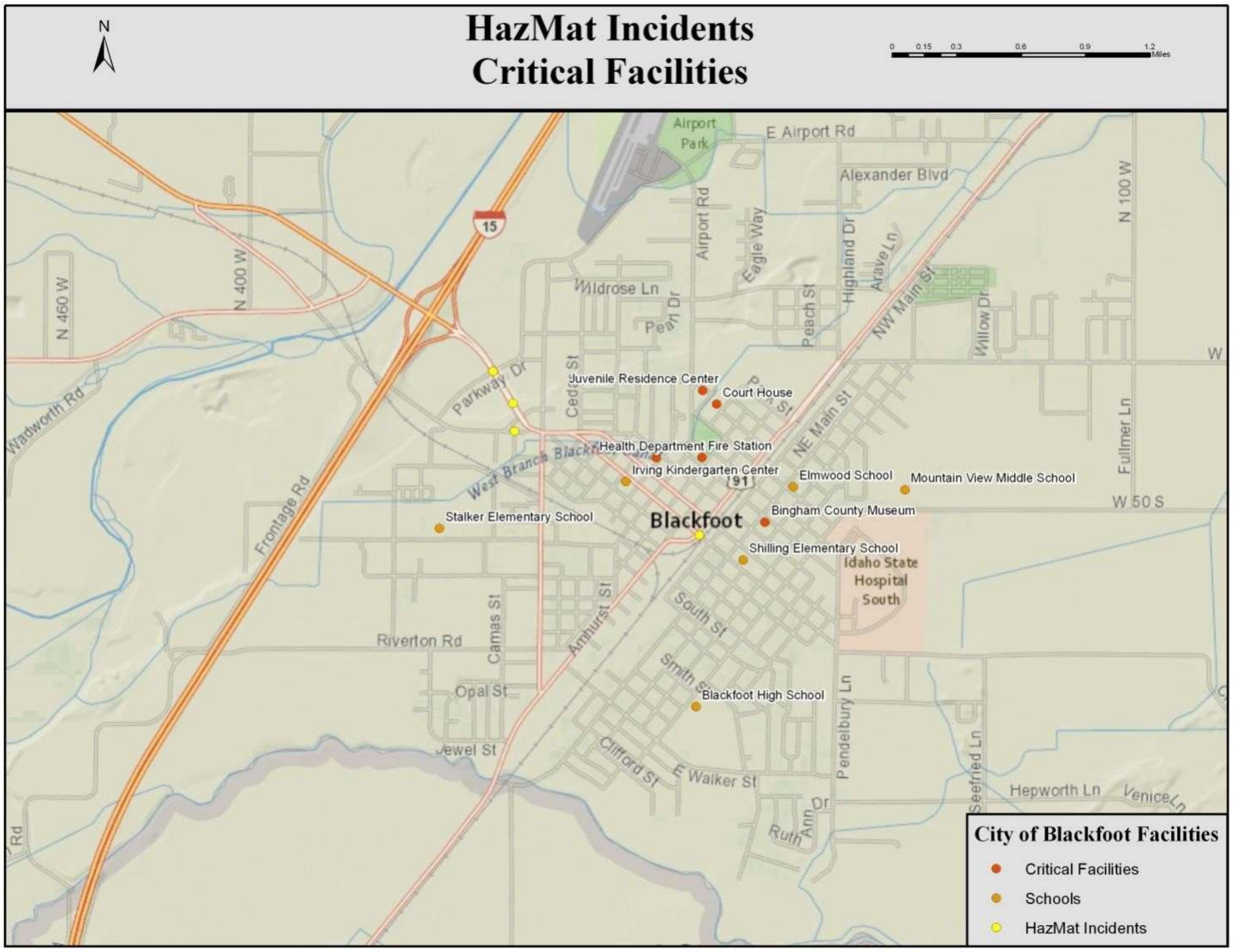
There is a small wildfire risk to the City from the riparian area along the Snake River. Most of the "river bottom" vegetation has been removed to facilitate commercial and agricultural development along the River, thus reducing wildland fuels.

As with all cities in Bingham County, Blackfoot is vulnerable to severe weather events in summer and winter. Much of the damage experienced by severe weather is caused by straight-line wind.

The City is vulnerable to hazardous material releases from transportation routes which bisect the City, including Union Pacific Railroad and US Highway 91. Most fixed hazardous material facilities are not located within the city limits, but rather to the west. The risk summary for the City of Blackfoot follows the maps below.


FIRM 100 Year Floodplain
Critical Facilities
N
0 0.15 0.3 0.6 0.9 1.2 Miles
Juvenile Residence Center
Court House
Health Department
Fire Station
Irving Kindergarten Center
Elmwood School
Mountain View Middle School
Stalker Elementary School
Blackfoot
Bingham County Museum
Shilling Elementary School
Idaho State Hospital South
Blackfoot High School
City of Blackfoot Facilities
Critical Facilities
Schools


Relative Fire Risk
Critical Facilities
N
0 0.15 0.3 0.6 0.9 1.2 Miles
Juvenile Residence Center
Court House
Health Department Fire Station
Irving Kindergarten Center
Elmwood School
Mountain View Middle School
Stalker Elementary School
Blackfoot
Bingham County Museum
Shilling Elementary School
Idaho State Hospital South
Blackfoot High School
E Airport Rd
Alexander Blvd
Airport Park
Wildrose Ln
Parkway Dr
Riverton Rd
Opal St
Jewel St
Frontage Rd
Wadworth Rd
NW Main St
NE Main St
South St
Smith St
Clifford St
E Walker St
Amhurst St
Camas St
Pendelbury Ln
Fullmer Ln
W 50 S
N 100 W
N 400 W
N 460 W
City of Blackfoot Facilities
Critical Facilities
Schools
Relative Fire Risk
High
Low


HazMat Incidents
Critical Facilities
City of Blackfoot Facilities
Critical Facilities
Schools
HazMat Incidents
Juvenile Residence Center
Court House
Health Department
Fire Station
Irving Kindergarten Center
Elmwood School
Mountain View Middle School
Stalker Elementary School
Blackfoot
Bingham County Museum
Shilling Elementary School
Idaho State Hospital South
Blackfoot High School

2021 Risk Rankings - Blackfoot							
Hazard	**Historical Occurrence**	**Probability**	**Vulnerability**	**Spatial Extent**	**Magnitude**	**Total**	**Rank**
Communicable Disease	2	2	4	4	4	**16**	**H**
River Flooding	3	4	3	3	3	**16**	**H**
Structure Fire	3	4	2	2	4	**15**	**H**
Earthquake	2	4	2	4	2	**14**	**H**
Severe Winter Storms	3	4	3	2	2	**14**	**H**
Dam Failure	1	1	4	3	4	**13**	**M**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Flash Flooding	2	3	2	2	3	**12**	**M**
Hazardous Materials	3	4	2	1	2	**12**	**M**
West Nile Virus	3	4	1	1	3	**12**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Nuclear Event	0	1	2	3	3	**9**	**L**
Drought	2	3	1	1	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Wildfire	0	1	1	1	2	**5**	**L**
Avalanche	0	1	1	1	1	**4**	**L**
Landsides	0	1	1	1	1	**4**	**L**

Aberdeen

Aberdeen is a friendly agricultural community that sits 20 miles west of Pocatello. Since its beginnings as a dry land farming area in the early 1900s, Aberdeen has grown to become an important producer of potatoes, sugar beets, grains, and other agricultural commodities in southeastern Idaho. It has also become known worldwide as an important area for agricultural research and development.

According to the United States Census Bureau, the City has a total area of 1.03 square miles (2.67 km^2), all of it land.

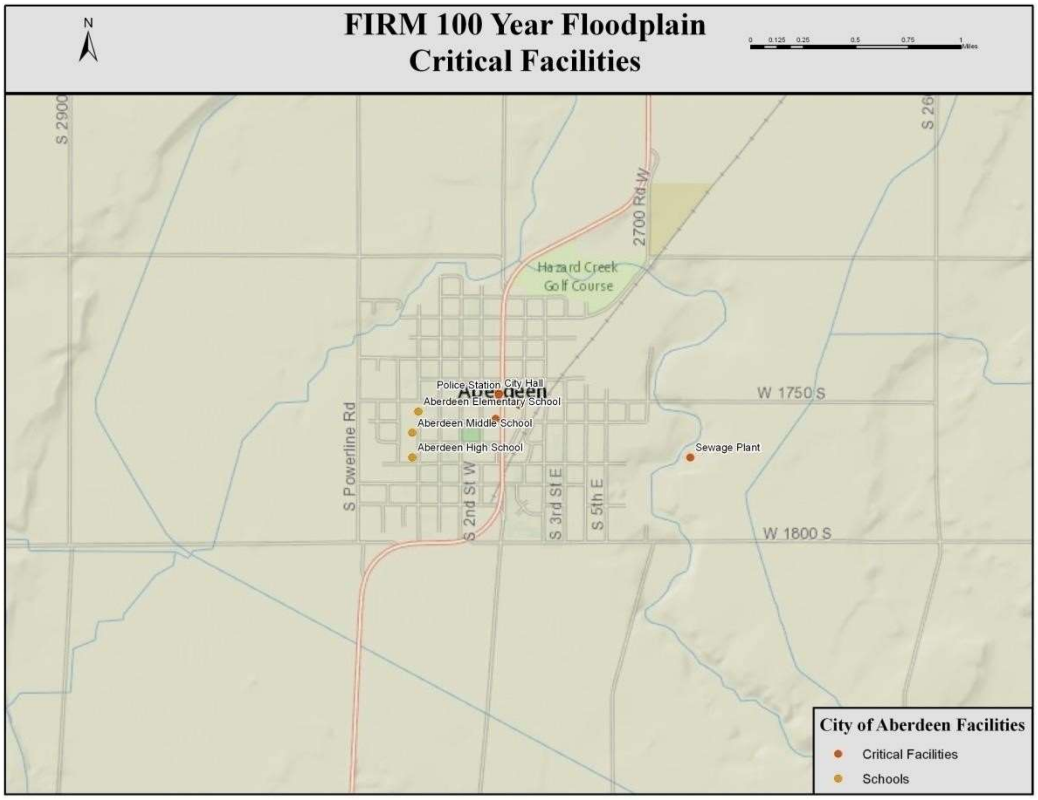
Vulnerability Analysis

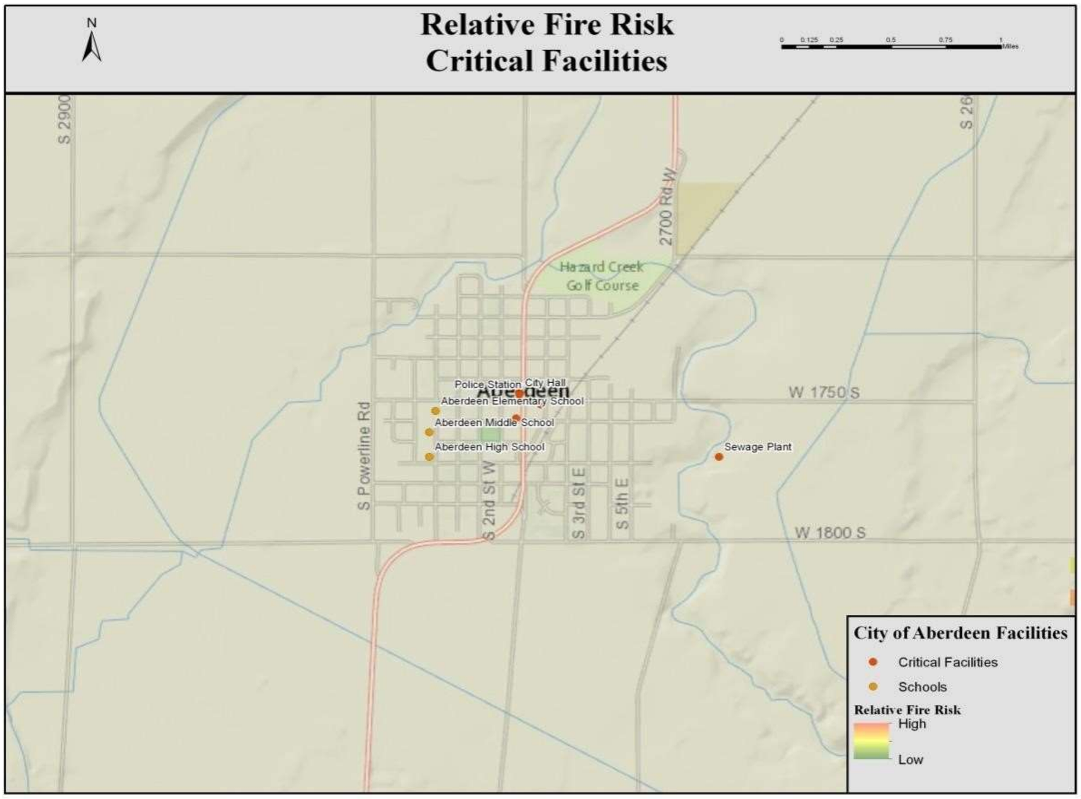
The City of Aberdeen is located on the west side of Bingham County in a beautiful agricultural plain. The City is relatively safe from natural hazards. The City has a very small mapped floodplain along Hazard Creek, which is an agricultural drainage way. The City has elevated its waste treatment facility which is located within the Hazard Creek floodplain. There are no other critical facilities within the City that are vulnerable to flooding.

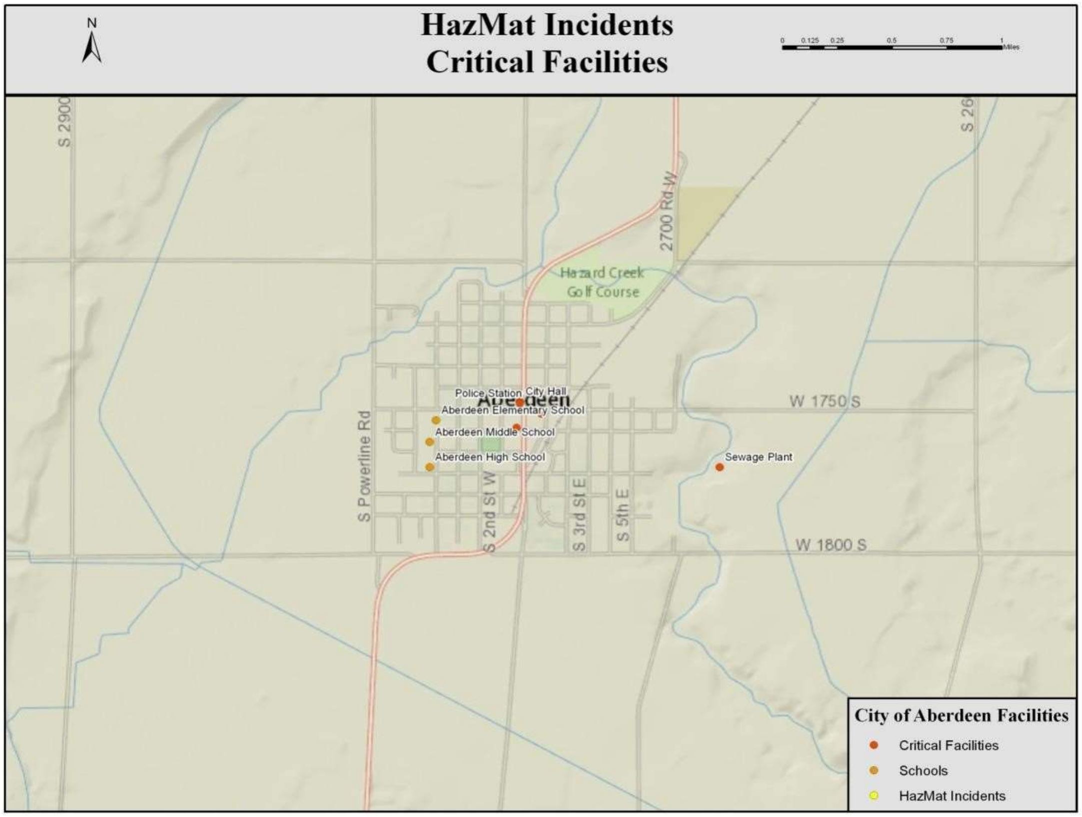
As with other rural areas in Bingham County, the City of Aberdeen experiences frequent straight-line winds which cause damage to private property.

Even though there are significant quantities of hazardous materials stored in the food processing facilities to the west of the City, there have been no historical hazardous material releases, but the potential exists for a significant hazardous material event from the fixed storage sites.

The risk summary for the City of Aberdeen follows the maps.




Relative Fire Risk
Critical Facilities
N
Hazard Creek Golf Course
2700 Rd W
Police Station
City Hall
Aberdeen
Aberdeen Elementary School
Aberdeen Middle School
Aberdeen High School
Sewage Plant
W 1750 S
W 1800 S
S Powerline Rd
S 2nd St W
S 3rd St E
S 5th E
S 2900
City of Aberdeen Facilities
Critical Facilities
Schools
Relative Fire Risk
High
Low



2021 Risk Rankings - Aberdeen							
Hazard	**Historical Occurrence**	**Probability**	**Vulnerability**	**Spatial Extent**	**Magnitude**	**Total**	**Rank**
Communicable Disease	2	2	4	4	4	**16**	**H**
Hazardous Materials	3	4	3	3	2	**15**	**H**
Severe Winter Storms	3	4	3	2	2	**14**	**H**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Structure Fire	3	4	2	2	2	**13**	**M**
West Nile Virus	3	4	1	1	3	**12**	**M**
Earthquake	2	2	2	3	2	**11**	**M**
River Flooding	2	2	2	2	3	**11**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Flash Flooding	1	3	2	2	1	**9**	**M**
Nuclear Event	0	1	2	3	3	**9**	**L**
Drought	2	3	1	1	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Wildfire	0	1	1	1	2	**5**	**L**
Avalanche	0	1	1	1	1	**4**	**L**
Dam Failure	0	1	1	1	1	**4**	**M**
Landsides	0	1	1	1	1	**4**	**L**

Basalt

Basalt is a city in Bingham County, Idaho, United States. The population was 394 at the 2010 census. According to the United States Census Bureau, the City has a total area of 0.30 square miles (0.78 km^2), all of it land.

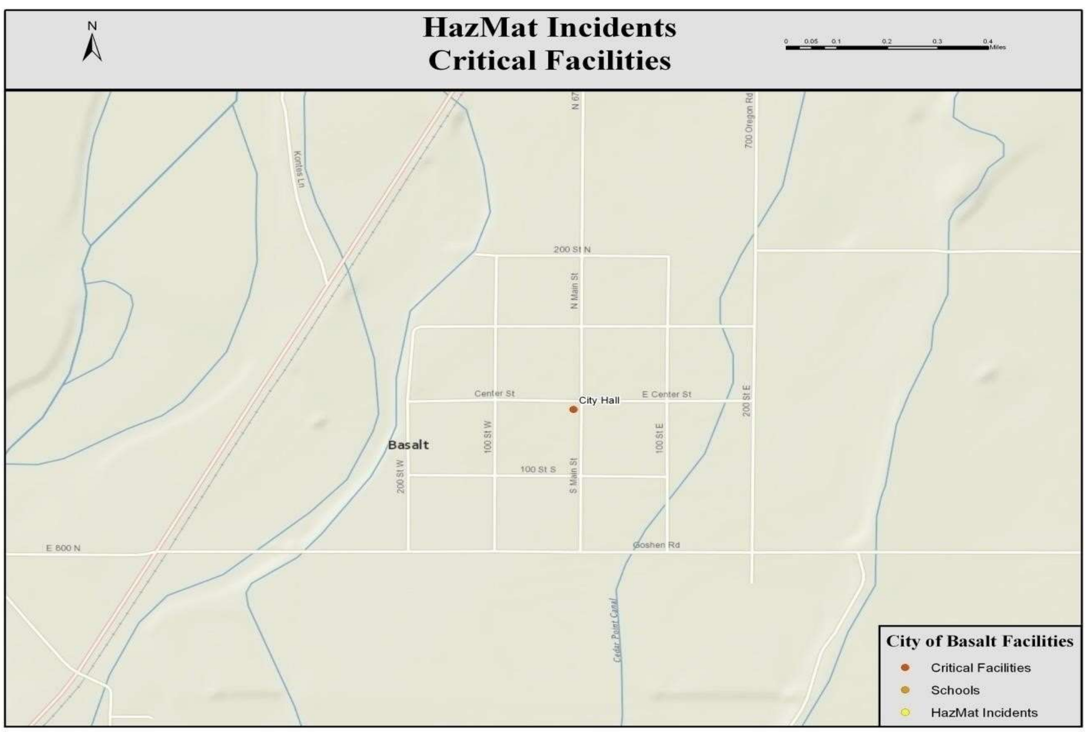
Vulnerability Analysis

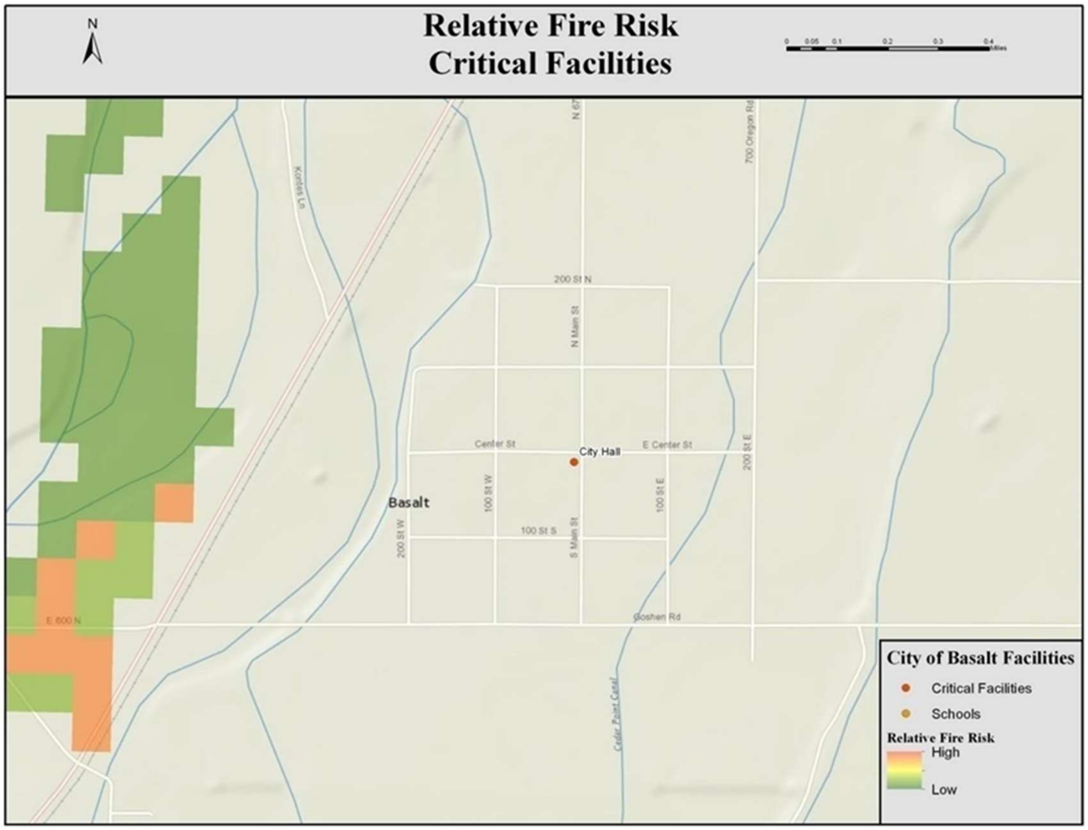
The small City of Basalt borders the City of Firth on the north east side. The City has no natural bodies of water and no floodplains. The City is surrounded by agricultural lands and has no wildfire vulnerability.

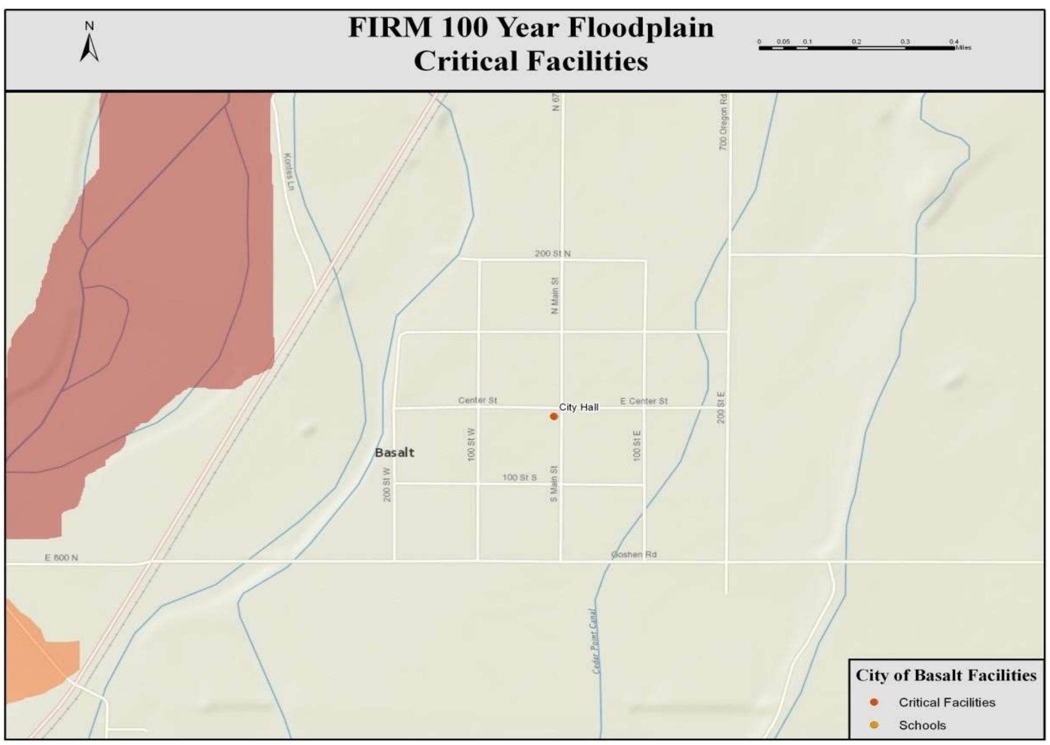
Basalt experiences severe weather events, including blowing and drifting soils and snow.

There is a potato processing facility to the north and west which stores hazardous materials which could impact the City of Basalt if there were to be an accidental release.

The risk analysis summary follows the maps.




Relative Fire Risk
Critical Facilities
N
200 St N
N Main St
Center St
City Hall
E Center St
Basalt
100 St W
100 St E
100 St S
200 St W
S Main St
200 St E
700 Oregon Rd
Kordes Ln
E 600 N
Goshen Rd
Cedar Point Canal
City of Basalt Facilities
Critical Facilities
Schools
Relative Fire Risk
High
Low


FIRM 100 Year Floodplain
Critical Facilities
N
200 St N
N Main St
Center St
City Hall
E Center St
Basalt
100 St W
100 St E
100 St S
200 St W
S Main St
200 St E
700 Oregon Rd
Kordes Ln
E 600 N
Goshen Rd
Cedar Point Canal
City of Basalt Facilities
Critical Facilities
Schools

2021 Risk Rankings - Basalt							
Hazard	**Historical Occurrence**	**Probability**	**Vulnerability**	**Spatial Extent**	**Magnitude**	**Total**	**Rank**
Communicable Disease	2	2	4	4	4	**16**	**H**
Severe Winter Storms	3	4	3	2	2	**14**	**H**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Hazardous Materials	1	3	3	3	2	**12**	**M**
Earthquake	2	2	2	3	2	**11**	**M**
Terrorism	0	1	3	2	4	**10**	**M**
Nuclear Event	0	1	2	3	3	**9**	**M**
Structure Fire	1	4	1	1	2	**9**	**M**
West Nile Virus	1	3	1	1	3	**9**	**M**
Drought	2	3	1	1	1	**8**	**L**
Flash Flooding	1	3	1	2	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Wildfire	0	1	1	1	2	**5**	**L**
Avalanche	0	1	1	1	1	**4**	**L**
Dam Failure	0	1	1	1	1	**4**	**L**
Landsides	0	1	1	1	1	**4**	**L**
River Flooding	0	1	1	1	1	**4**	**L**

Firth

Firth began as a Swedish settlement in 1885. It was named for Lorenzo J. Firth, an English emigrant, who gave land for the railroad section house and water tank; the railroad named the station for him in 1903. The post office was established in 1905.

According to the United States Census Bureau, the City has a total area of 0.54 square miles (1.40 km^2), all of it land. Firth is located on the eastern side of the Snake River, facing the Blackfoot Mountains.

Vulnerability Analysis

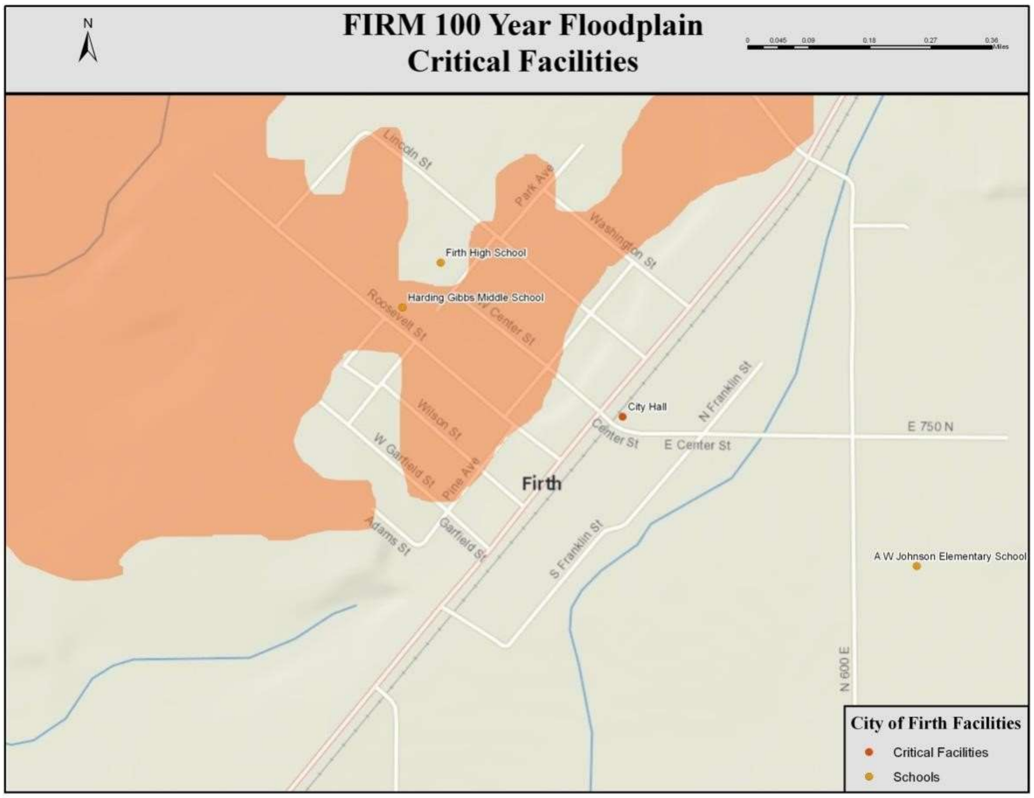
The City of Firth is the most vulnerable community in Bingham County from the natural hazards posed by the Snake River. The Snake River Flood Plain extends into the west side of the City of Firth. The City has experienced historical flooding. The City and the County work together to replace the dyke on the north end of the City to protect low lying areas from spring flooding. The Firth Middle School is located in the flood plain along with several private residences.

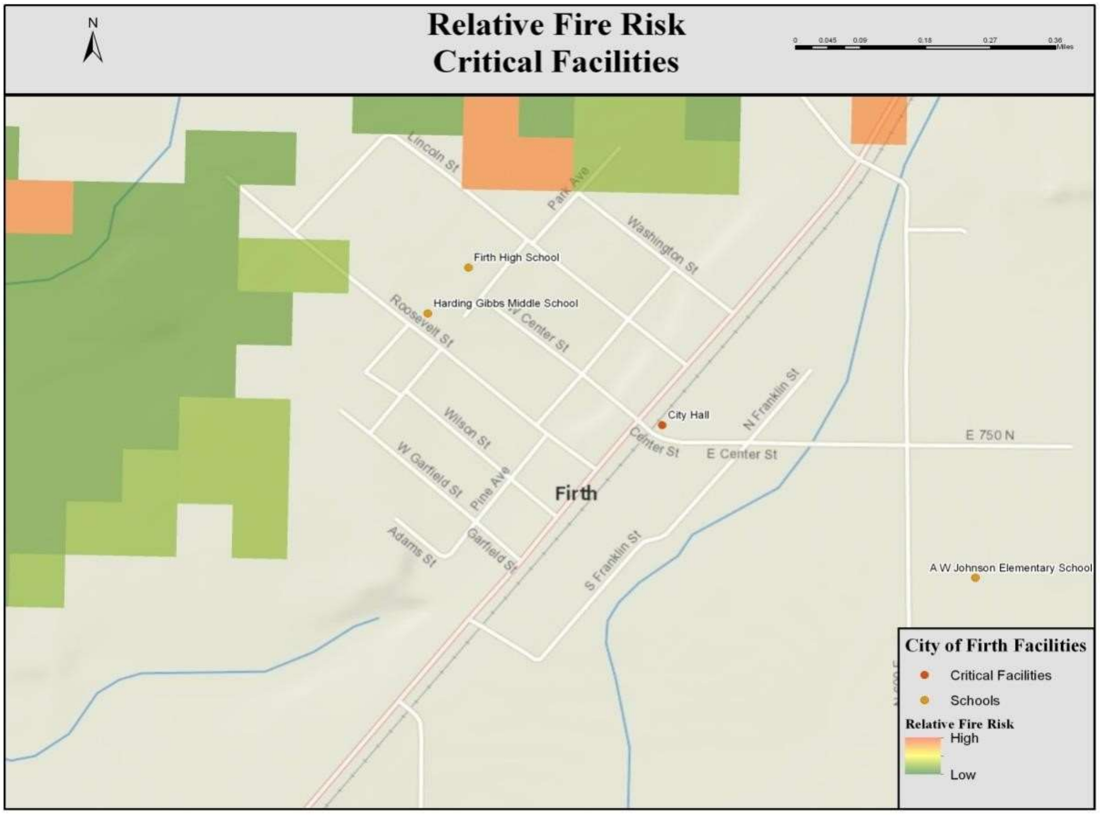
The riparian area on either side of the River contains large amounts of wildland fuels. The City has worked to reduce fuels on the east side of the River in an effort to protect private residences. The wildfire risk on the west side of the River just outside the city boundary is significant. The City's east side is bordered by agricultural lands and the City of Basalt, and is free from wildland fire risk.

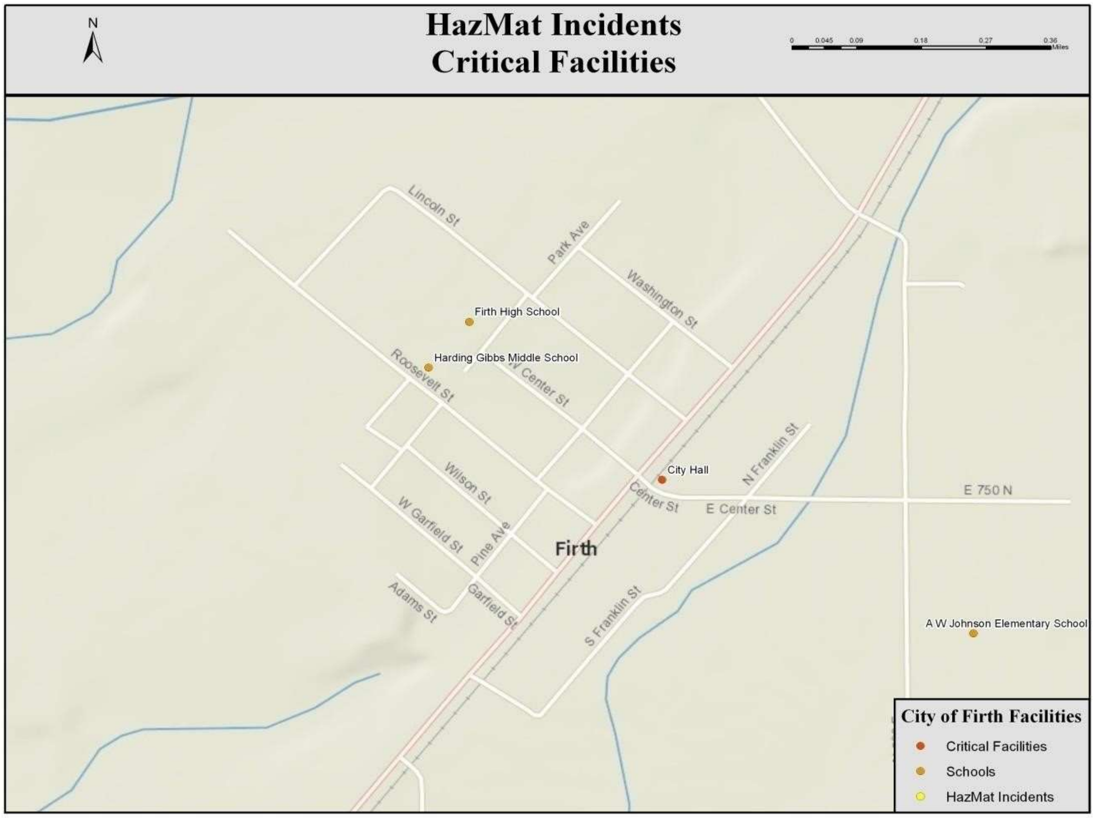
The City does experience severe weather events primarily related to straightline wind.

Highway 91 and the Union Pacific Rail Line bisects the City north and south. Hazardous materials are transported on these transportation systems. The City is therefore vulnerable to hazardous material releases from transportation activities.

The risk summary analysis is found following the maps.




Relative Fire Risk
Critical Facilities
N
Lincoln St
Park Ave
Washington St
Firth High School
Harding Gibbs Middle School
Roosevelt St
W Center St
Wilson St
W Garfield St
Pine Ave
Adams St
Garfield St
City Hall
Center St
E Center St
N Franklin St
S Franklin St
E 750 N
Firth
A W Johnson Elementary School
City of Firth Facilities
Critical Facilities
Schools
Relative Fire Risk
High
Low



2021 Risk Rankings - Firth

Hazard	Historical Occurrence	Probability	Vulnerability	Spatial Extent	Magnitude	Total	Rank
Communicable Disease	2	2	4	4	4	**16**	**H**
River Flooding	3	4	3	3	3	**16**	**H**
Severe Winter Storms	3	4	3	2	2	**14**	**H**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Hazardous Materials	1	3	3	3	2	**12**	**M**
Dam Failure	1	1	3	3	3	**11**	**M**
Earthquake	2	2	2	3	2	**11**	**M**
Structure Fire	3	4	1	1	2	**11**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Nuclear Event	0	1	2	3	3	**9**	**L**
West Nile Virus	1	3	1	1	3	**9**	**L**
Drought	2	3	1	1	1	**8**	**L**
Flash Flooding	1	3	1	2	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Wildfire	0	1	1	1	2	**5**	**L**
Avalanche	0	1	1	1	1	**4**	**L**
Landsides	0	1	1	1	1	**4**	**L**

Shelley

Shelley, Idaho is located in Bingham County just 10 miles south of Idaho Falls. Residents of Shelley enjoy a relaxed lifestyle in a hometown atmosphere. Shelley has been the home of the Idaho Annual Spud Day since 1927. This event commemorates the harvest of Idaho's most famous export, the potato.

Shelley was established in 1904. It was named for John F. Shelley, who moved to the area in 1892. He'd moved to the area intending to open a small store, and needed lumber and other supplies to build it. Since the site was some distance from the nearest existing community, he asked the railroad company to make a special stop to offload the supplies he'd ordered. They consented, provided he could offload the supplies in less than 20 minutes. On September 4, 1902 a large fire destroyed seven buildings on State Street. Only two buildings, a general merchandise store, and Nalder's Furniture store were saved.

According to the United States Census Bureau, the City has a total area of 1.81 square miles (4.69 km^2), all of it land. Shelley is located on the eastern side of the Snake River, facing the Blackfoot Mountains.

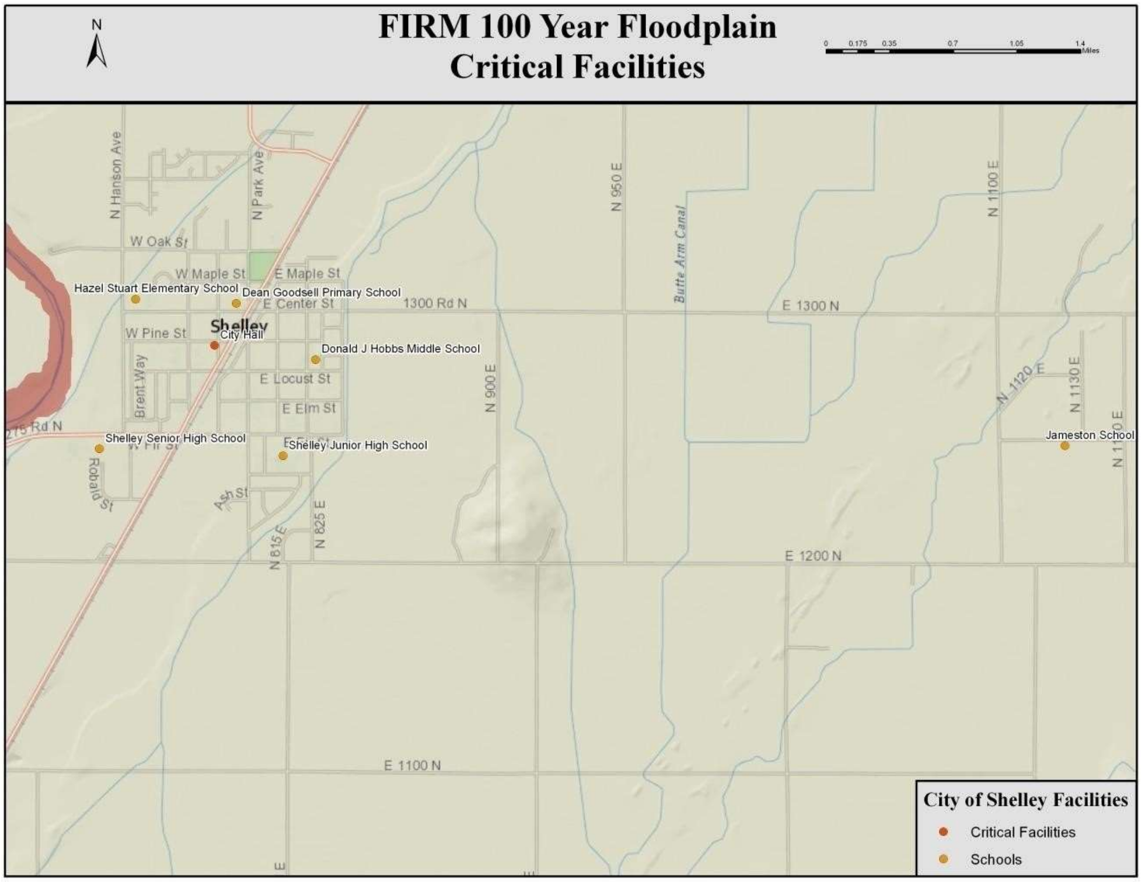
Vulnerability Analysis

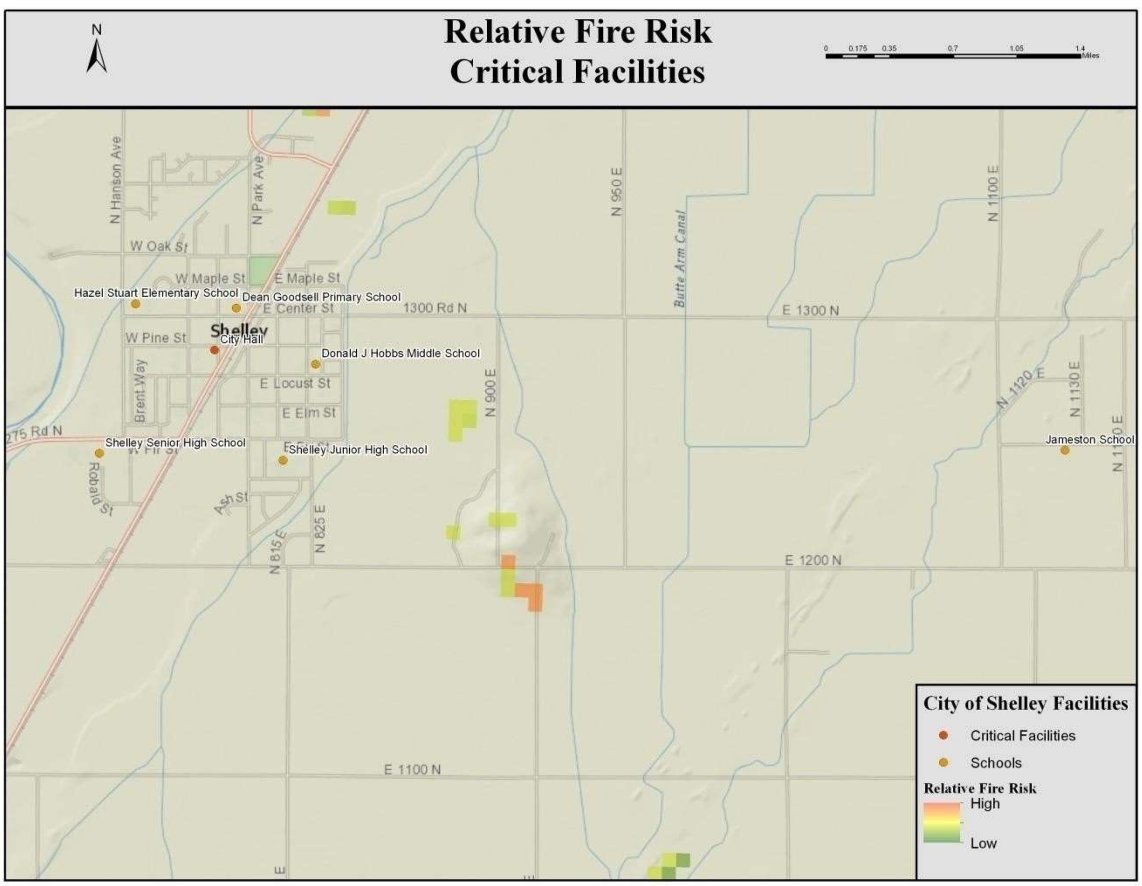
Shelley is situated west of the Snake River on an elevated plateau. There are no natural bodies of water in the City of Shelley, and thus there is no flood plain.

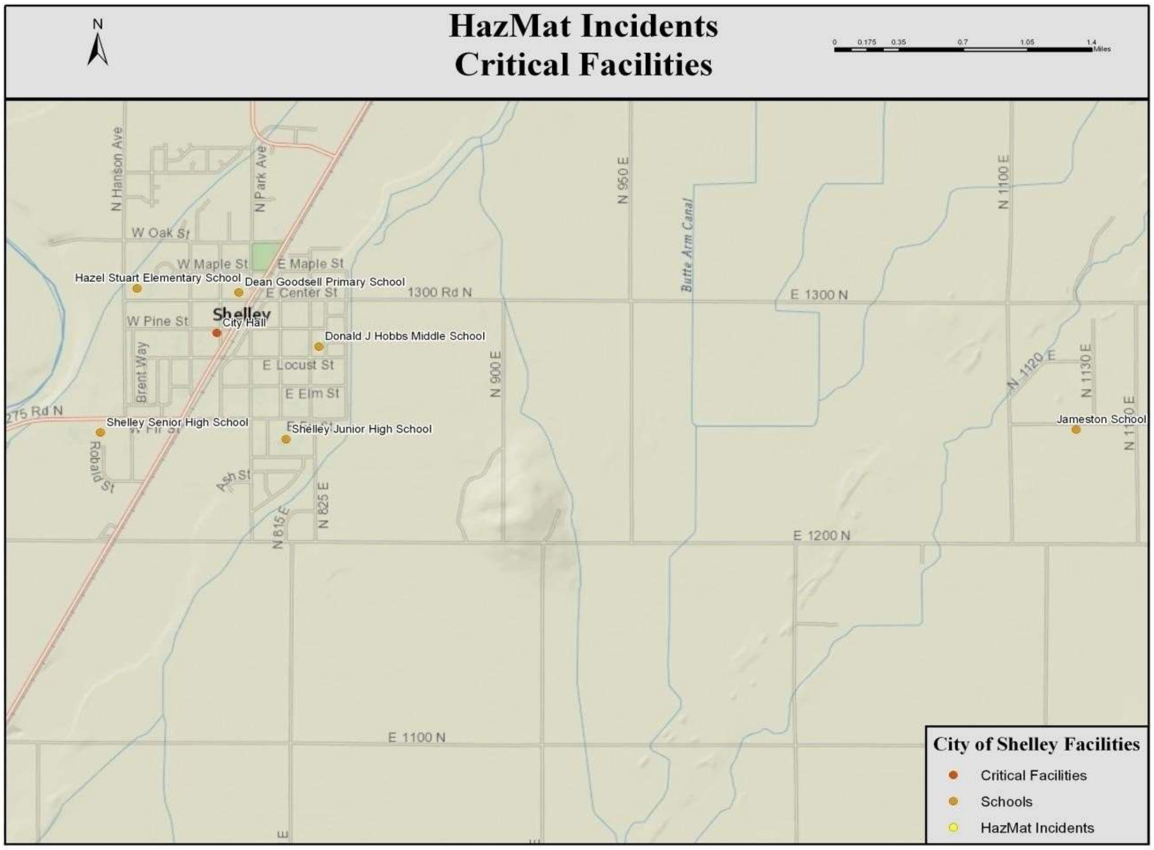
The City of Shelley is surrounded by developed agricultural lands and is generally considered one of the safest communities in Bingham County. This City experiences no wild land fire risk. Severe weather does impact the City in the form of blowing snow, blizzard conditions, and freezing temperatures.

The City is bisected by the Union Pacific Rail Line and Highway 91. There are large potato processing facilities that store hazardous materials used in their processes, making the City vulnerable to accidental releases, both from the fixed facilities, as well as the transportation systems.

A chart showing the risk analysis summary follows the maps.


FIRM 100 Year Floodplain
Critical Facilities
N
0 0.175 0.35 0.7 1.05 1.4 Miles
N Hanson Ave
N Park Ave
W Oak St
W Maple St
E Maple St
Hazel Stuart Elementary School
Dean Goodsell Primary School
E Center St
1300 Rd N
Shelley
City Hall
W Pine St
Donald J Hobbs Middle School
E Locust St
E Elm St
Brent Way
Shelley Senior High School
Shelley Junior High School
Robaid St
Ash St
N 815 E
N 825 E
N 900 E
N 950 E
Butte Arm Canal
E 1300 N
N 1100 E
N 1120 E
N 1130 E
Jameston School
E 1200 N
E 1100 N
City of Shelley Facilities
Critical Facilities
Schools


Relative Fire Risk
Critical Facilities
N
0 0.175 0.35 0.7 1.05 1.4 Miles
N Hanson Ave
N Park Ave
W Oak St
W Maple St
E Maple St
Hazel Stuart Elementary School
Dean Goodsell Primary School
E Center St
1300 Rd N
Shelley
City Hall
W Pine St
Donald J Hobbs Middle School
E Locust St
E Elm St
Brent Way
Shelley Senior High School
Shelley Junior High School
Robaid St
Ash St
N 815 E
N 825 E
N 900 E
N 950 E
Butte Arm Canal
E 1300 N
N 1100 E
N 1120 E
N 1130 E
Jameston School
E 1200 N
E 1100 N
City of Shelley Facilities
Critical Facilities
Schools
Relative Fire Risk
High
Low



2021 Risk Rankings - Shelley							
Hazard	**Historical Occurrence**	**Probability**	**Vulnerability**	**Spatial Extent**	**Magnitude**	**Total**	**Rank**
Communicable Disease	2	2	4	4	4	**16**	**H**
Hazardous Materials	2	4	3	3	2	**14**	**H**
Severe Winter Storms	3	4	3	2	2	**14**	**H**
H5N1 Bird Flu	0	1	4	4	4	**13**	**M**
Severe Weather	3	4	2	2	2	**13**	**M**
Earthquake	2	2	2	3	2	**11**	**M**
Structure Fire	3	4	1	1	2	**11**	**M**
Terrorism	0	1	3	2	4	**10**	**L**
Nuclear Event	0	1	2	3	3	**9**	**L**
West Nile Virus	1	3	1	1	3	**9**	**L**
Drought	2	3	1	1	1	**8**	**L**
Flash Flooding	1	3	1	2	1	**8**	**L**
Riot/Demonstration/Civil Disobedience	0	1	2	1	2	**6**	**L**
Wildfire	0	1	1	1	2	**5**	**L**
Avalanche	0	1	1	1	1	**4**	**L**
Dam Failure	0	1	1	1	1	**4**	**L**
Landsides	0	1	1	1	1	**4**	**L**
River Flooding	0	1	1	1	1	**4**	**L**

Appendices

Appendix A: T-O Engineering Report

Appendix B: Depth to Groundwater Environmental Planning Group

Appendix C: Elected Officials/Public Participation

Appendix D: Bingham County Wildfire Protection Plan (CWPP)

Appendix E: HAZUS Report

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Appendix A: T-O Engineering Report

Preliminary Engineering Report

Flood Mitigation
Snake River Near City of Blackfoot

Bingham County, Idaho
October 18, 2013

PROFESSIONAL ENGINEER
REGISTERED
7909
10/18/13
STATE OF IDAHO
STEVEN E. HOLT

Prepared for: Bingham County, Idaho

**Prepared by: T-O Engineers, Inc.
9777 Chinden Blvd.
Boise, ID 83714**

T-O ENGINEERS

Purpose

This preliminary engineering report addresses reduction of flood hazards associated with the Snake River near the City of Blackfoot in Bingham County, Idaho. The overall approach of flood reduction is to improve carrying capacity of the river by extraction of gravel that has deposited in a previously constructed channel.

The major topics considered in this report are: approach for gravel extraction, data collection and analysis, agency permitting requirements, mitigation measures, construction methods, and opinions of estimated cost.

Some of the information presented in this report was contributed by Bingham County, Whisper Mountain Professional Services, and Environmental Planning Group for which their efforts are acknowledged.

History

The attached Figure 1 shows existing conditions on the Snake River in the south portion of the study area that spans from the State Highway 26 (SH26) bridge crossing to the parallel bridges on I-15 that are locally known as the "Twin Bridges". Essentially all of the south study area, approximately 2 river miles, was channelized in 1962 as part of the construction of I-15. A levee was installed on the east side of the channelized river between SH26 and the Twin Bridges. The levee on the east side of the river extends north of the Twin Bridges and is locally known as the "golf course levee" because of its proximity to the golf course.

The attached Figure 2 shows existing conditions on the Snake River in the north portion of the study area, approximately 2 river miles, which spans from the Twin Bridges to the Rose Road Overpass on I-15. Channelization of the river in the 1960s included a levee on the west bank to accommodate construction of I-15 and the Rose Road Overpass.

This report is preceded by a February 6, 2013 letter report prepared by T-O Engineers that is an overview of flooding concerns, potential causes and conceptual mitigation measures. A copy of the letter report, updated with minor corrections as noted in the text, is provided in Appendix A.

The review of available data and preliminary analysis in the February 6, 2013 letter report showed that gravel accumulation in previously channelized sections of the river can be correlated with increased water levels in the Snake River near Blackfoot and could be contributing to reported increased shallow groundwater levels in developed areas of the city. The February 2, 2103 report concluded that a flood mitigation approach is to restore channel capacity.

Overall Approach

This report begins with the premise that flood hazards have increased on the Snake River near Blackfoot primarily because gravel deposition in the channel that was constructed in the 1960s has resulted in increased flood heights in the river. The February 6, 2013 letter report provides evidence to support that premise.

Analysis of aerial photographs of various dates, including those in Figures 1 and 2, illustrates deposition in the study area occurs as gravel bars with a relatively regular pattern of alternating bars on opposite sides of the river. The main channel area is consequently reduced compared to the 1960s channel with a corresponding reduction in channel capacity. The main channel alignment is also confined between the gravel bars and the banks with a corresponding increase in local flow velocities and potential for bank erosion.

Increased flood heights and erosion potential places additional stress on critically located levees. Of note is the golf course levee that, if breached, could provide a path similar to the pre-1962 river channel for floodwaters to reach portions of the City of Blackfoot. Local knowledge also recalls the Rose Road Overpass was washed out when the river breached and/or overtopped the west bank levee. Increased flood heights can also reduce bridge clearance and can exacerbate flood levels during ice jams that are not infrequent on the Snake River.

Additional data collection and analysis, described herein, is needed to better define the extent of increased flood hazards arising from deposition in the river and to better define the reduction in flood hazards resulting from the proposed gravel extraction. Demonstration of reduction in flood hazards is needed to support the undertaking of gravel extraction along with related considerations including agency permitting.

Literature Review and Adverse Impacts

Literature and case studies exist for gravel extraction from rivers. A common theme in the literature is that extraction must be accomplished so as not to de-stabilize sediment transport in the river. Overly aggressive extraction can lead to deleterious effects on the river and infrastructure.

Adverse impacts reported in the literature are generally a consequence of lowering the channel bottom at the location of gravel extraction, which has three effects. First, the change in slope of the channel bottom at the upstream end of the excavation, known as a “nick point”, creates hydraulic conditions favorable to erosion and the nick point may migrate upstream, also known as “headcutting”. Second, sediment transported from upstream tends to preferentially re-deposit in the excavated area. Third, water leaving the excavated area has a reduced sediment load, also known as “hungry water” where some of the energy in the moving water can be allocated to increased downstream erosion, and tends to propagate a lower channel bottom downstream, also known as “tailcutting”.

Consequences of extracting gravel from the channel bottom as described above are also documented in cases of extraction from gravel bars. Aggressive mining of gravel bars can create a localized change in the profile of the bar that behaves similarly to a change in the channel bottom profile.

Headcutting and tailcutting lead to an overall lowering of the channel bottom, also known as “incision” or “bed degradation” and presents the potential for adverse impacts including: undermining of bridge piers, undermining of diversion dams, reduction in water levels available for diversion, and undercutting of channel banks including levees. Additional adverse impacts include alteration or removal of fish and wildlife habitat, release of finer sediments downstream after gravel removal due to disruption of the channel, alteration of the overall sediment transport process outside the excavated area, and reduction in shallow groundwater levels that may affect wetlands, shallow wells and aquifer storage. Aggressive mining of larger gravel bars can also result in a sudden change in alignment of the main channel into the excavated area, also known as “pit capture” that can lead to a relatively rapid and unstable change in channel alignment, also known as “avulsion”.

Step-Wise Gravel Extraction

This report recommends that gravel extraction be accomplished in a step-wise approach. The first step would be cautious but focused areas of removal in high priority areas followed by monitoring of the system response. Extraction of the tops of the existing gravel bars in selected locations may be the prudent first approach to mitigate potential adverse impacts. Initial removal could lead to 100,000 cubic yards of material. Assuming the system tolerates the initial removal, approximately 500,000 cubic yards of total gravel extraction, in two or more steps, may be required for a meaningful reduction in flood heights in the river. Transport and deposition of sediment is expected to occur in the future and sustaining flood hazard reduction would require periodic gravel extraction over the long-term as a maintenance effort.

Estimated Gravel Extraction - Initial gravel removal of 100,000 cubic yards was estimated as follows. Using aerial photographs, the visible gravel bar area was estimated at 25 acres between the SH 26 Bridge and the Twin Bridges. Comparison of limited river cross-section data from the 1974 FEMA flood study to the 1962 design channel configuration indicates total gravel bar heights in the range of 3 feet to 8 feet. Field inspection during seasonal low water conditions in December 2012 revealed estimated visible gravel bar heights in the range of 2 feet to 6 feet. Removal of the upper 2 feet to 3 feet of gravel bar was estimated as a prudent first step and yielded 100,000 cubic yards over the 25 acres of gravel bars in the south study area.

Existing channel data is insufficient to estimate the total gravel deposition that has occurred in the 1962 constructed channel. Existing channel data is also insufficient to determine whether the ultimate channel configuration following gravel extraction would actually be the 1962 channel shape and bottom profile. However, preliminary assessment of data presented in the February 6, 2013 report indicates that water levels in the river have increased up to 2 feet depending on location and flow rate.

A crude estimate of the total gravel to be removed to mitigate estimated increases in flood heights follows. Removal of gravel at an average depth of up to 2 feet across the roughly 400 foot wide channel on the approximately 10,000 feet between the SH26 bridge and the Twin Bridges yields up to 300,000 cubic yards. This crude estimate is analogous to removing 7 to 8 feet of gravel bar depth over the 25 acres of visible bars in the south study area and is consistent with the maximum estimated gravel bar depth of up to 8 feet.

The north study area from the Twin Bridges to the archery range is of approximately the same length as the south study area although aerial photographs indicate comparatively less visible deposition. Therefore, a budgetary amount of up to 200,000 cubic yards is assigned to the north reach. The total gravel removal in the north and south areas is therefore up to 500,000 cubic yards. This report recommends data collection and analysis that will refine the total yardage of gravel extraction.

Extraction Priority – Gravel extraction should be prioritized for maximum benefit in flood hazard reduction. High priority extraction areas may include: the SH26 bridge to restore hydraulic capacity, the Twin Bridges to restore hydraulic capacity and reduce flood height at the adjacent upstream golf course levee, and the archery range area to reduce overtopping potential and associated pit capture of the existing gravel pits with resulting impacts to the Rose Road overpass.

Risk Mitigation - The purpose of the recommended step-wise gravel removal is to avoid or mitigate potential adverse impacts as documented in the literature. The first conservative extraction effort is intended to eliminate or limit channel incision to focus on protection of existing bridge piers, diversion dams and levees from the adverse structural consequences of undermining and avoid the use of grade control structures to protect existing infrastructure. A typical grade control structure described in the literature is, basically, a protective retaining wall built under the channel to the estimated depth of channel incision. Existing bridges, levees and diversion dams in the gravel extraction area are of sufficiently long dimension to require extensive grade control structures, the construction of which would likely be cost-prohibitive in addition to the logistics of dewatering and water quality control. Analytical methods for estimating the required depth of a grade control structure are not well-defined and would necessarily require a conservative approach.

A disadvantage of step-wise gravel removal is that certain construction efforts and associated costs will be repeated including: mobilization to and from the site, establishment and reclamation of works areas, and water quality mitigation. Also, the initial step of gravel extraction is likely not sufficient to achieve meaningful reduction in flood hazards.

Timing - Monitoring of the river response between each step of gravel removal will probably be a multi-year process because equilibrium in sediment transport and deposition can be gradual and not well correlated with flood events. Aerial photographs dated 1966 indicate point bars were developing in the 1962 channelized river but the extent of the gravel bars is not known because of unknown river stage on the date of the photograph.

Monitoring of the river response following each step-wise gravel extraction is likely to take place over the course of, say, one to three years. A typical spring run-off event should provide sufficient energy for sediment processes and channel incision, if any. Visual observation of gravel deposition or channel incision is best accomplished during low water conditions in the fall or early winter. Monitoring in the first year following initial extraction may reveal notable re-deposition and justify additional extraction the following year.

Data Collection and Analysis

Permitting, design and construction of the gravel extraction project will require additional data and analysis beyond this preliminary engineering report.

Geotechnical Investigation - A documented phenomenon of gravel deposition is armoring that consists of relatively large gravel or stones on the tops of gravel bars and bed of the channel. Armoring results when river flows are sufficient to transport finer sediments from the area where previously deposited. The relatively large surface particles may not accurately represent the composition of sediment through the depth of the gravel bar or beneath the channel that may contain a mixture of particle sizes.

A geo-technical investigation should be performed early in the design process to define the composition of existing deposits. Test pits or bore holes would be excavated on gravel and the channel in selected, non-intrusive locations. A 404 permit would be required to authorize the temporary impacts to the river. The geo-technical information is important for the gravel extraction process to define expected field conditions for stability and sediment production related to operation of equipment and de-watering. The geotechnical information is also important for defining the suitability of the existing gravel for intended purposes once removed from the river. Bedrock may exist and could limit excavation depths.

Mapping - Survey and mapping of the river, including bathymetric (underwater) data is needed for design, permitting, construction and monitoring of the river response to gravel extraction. Survey efforts include establishing control for aerial mapping, spot verification of bathymetry, field location of delineated wetlands, and collecting on-theground topography in vegetated areas of the gravel bars. Aerial mapping by photogrammetry or lidar will define the visible extent of gravel bars. The survey and mapping work is best completed under low water conditions in the fall or early winter.

Field observation indicates the depth and velocity of the river, particularly in the relatively deep channel opposite the gravel bars, is not amenable to traditional field survey techniques. Bathymetry can be completed using underwater sonar techniques or water penetrating lidar, subject to verification of accuracy. At least 20 river cross-sections should be collected, of which at least 10 cross-sections should be located between the bridges at State Highway 26 and I-15. Additional cross sections can be obtained readily from radar data where necessary to increase resolution.

Hydraulic Analysis - A hydraulic analysis will be required to better define existing flood hazards and flood mitigation to support the undertaking of gravel extraction. A hydraulic analysis is also required to address the regulatory “no-rise” condition, including any mitigation required, for local floodplain development permitting. The hydraulic analysis should also be used to predict any changes in scour at bridge abutments and piers that results from changes in hydraulic conditions due to gravel extraction. The hydraulic analysis will assist with targeting the highest priority gravel extraction areas for maximum benefit. The hydraulic analysis can also be used to assess available water levels at diversions including those for Jensen’s pond and the Danskin Canal.

Maintaining diversion levels may involve retaining selected gravel deposits local to the diversions or structural work on the diversions.

Groundwater Data and Analysis - The February 6, 2013 letter report included discussion of reported increases in flood hazards due to shallow groundwater levels that may result from several factors including increased flood elevations in the river, water levels in Jensen's pond and increased impervious area associated with development. Preliminary data and analysis by Environmental Planning Group indicates groundwater depths in area wells are relatively shallow near the south end of Jensen's pond and local commercial development (see Appendix B).

Additional collection and analysis of groundwater data is warranted to characterize the relative effects of river levels and Jensen's pond. Piezometers should be installed throughout the study area including south of Jensen's pond. Piezometers should be monitored throughout seasonal fluctuations in river levels and be subject to variations in pond levels. Piezometers may provide a more direct indication of shallow groundwater response compared to groundwater wells.

Water Quality Data - Water quality data and sampling should be collected to establish baseline conditions in the river. Sampling should be conducted throughout the course of seasonal flow variations. Water quality sampling during construction and postconstruction should be anticipated as a permitting requirement. Water quality considerations will be focused downstream of extraction areas as a measure of the efficacy of best management practices to control water quality impacts.

Permitting

404 Permit - A joint 404 permit will be required and will directly involve the U. S. Army Corps of Engineers regarding impacts to waters of the U.S. including wetlands, the Idaho Department of Water Resources regarding proposed work below the ordinary high water mark, the Idaho Department of Lands regarding work on the State-owned beds and banks of the river, and the Idaho Department of Environmental Quality regarding water quality. Referral agencies including but not limited to the Idaho Department of Fish and Game will be part of the permit process owing to the fishery habitat in the river and any related effects of the proposed gravel extraction. Entities with infrastructure on the river including ITD bridges, the USGS gaging station, and diversion dams will be part of the comment process.

Wetland Delineation - A wetland delineation, approved by the U. S. Army Corps of Engineers, is needed to define existing wetlands and assess the extent of wetland impacts arising from gravel extraction. Preliminary analysis of aerial photography and site inspection indicates the gravel bars to be removed contain vegetation that is probably jurisdictional wetlands. Most of the apparent wetland vegetation on the gravel bars is between the bridges at Highway 26 and I-15. Based on an estimated 25 acres of gravel bars in that area, and using a visual estimate of an overall average of 20% vegetation, yields approximately 5 acres of potential wetlands.

The estimated 5 acres of wetlands removed with the gravel bars is a sufficient quantity of impacts to require an individual 404 permit rather than use of an existing nationwide permit that is typically limited to 0.1 acres of impacts. The individual permit requires project-specific justification, exploration of practical alternatives, and strategies for avoidance of impacts. The requirement for avoidance of impacts may preclude complete removal of the most heavily vegetated gravel bars and especially the bar immediately upstream of the SH 26 bridge (see Figure 1). Hydraulic analysis is needed to better define the obstruction effects of that particular gravel bar including any reduction in the hydraulic capacity of the SH 26 bridge.

Wetland Mitigation - Impacts to wetlands generally must be mitigated which can be accomplished by purchase of credits from a wetland bank or creation of wetlands on sites that have the necessary attributes including access to groundwater or surface water and hydric soils. Delineation of the actual quantity and type of wetlands impacted and the required mitigation ratio (generally more than 1 to 1) will dictate the extent of mitigation efforts.

Wetland creation opportunities may exist between I-15 and the levee on the east bank of the river. Approximately 4000 linear feet of relatively bare ground is south of the Twin Bridges, and at a maximum width of 200 feet, yields up to 18 acres for wetland creation. Actual wetland creation area would be less, perhaps 10 acres, because excavation will be necessary to lower existing ground and thereby obtain access to surface water or shallow groundwater. In addition, any excavation would need to be offset a sufficient distance from I-15 and the levee to preserve structural integrity. Future use of the area between the levee and I-15 for construction during ongoing gravel extraction may also limit wetland creation. Off-site mitigation areas will probably need to be secured, the extent of which depends on the required mitigation ratio. A wetlands mitigation plan will also be needed for construction of wetland areas along with monitoring of created wetlands for at least three years to verify the success of wetland establishment.

Best Management Practices - The 404 application will address methods of construction including best management practices to mitigate impacts of gravel extraction on water quality. Extraction methods may include drag-line excavation to reduce equipment tracking in the river and partial excavation of gravel bars to mitigate transport of disturbed sediments. More extensive gravel bar removal may require temporary partial diversions of the river using non-intrusive techniques such as floating dams (bladders) and pumping or well-points for de-watering excavation areas.

Equipment entry into the river will be needed for more extensive gravel removal or if grade control structures are needed to mitigate potential impacts of river changes to existing structures. Direct equipment access would be limited to the minimum number of access points. Timing of gravel extraction is expected to be limited to the late fall or early winter to coincide with low water conditions in the river. Timing may be affected by agency requirements related to the Endangered Species Act. Excavated areas should be armored with selected larger stones screened from extracted material to limit postconstruction uptake and transport of finer sediment downstream.

Mining Permit - A mining permit will be required from the Idaho Department of Lands in accordance with Idaho Code provisions regarding dredge and placer mining. Application requirements include plans for site operations and reclamation, maintenance of water quality including settling ponds, re-vegetation, potential monitoring of water quality, coordination with referral agencies, a performance bond to secure reclamation, potentially a public hearing, and approval by the State Land Board.

A riverbed mineral lease may also be required including payment of royalties to the State as established by the Land Board. The Idaho Department of Lands administrative rules appear to limit riverbed leases to one mile of river length whereas the total study area is 4 miles. The one-mile limitation could influence phasing of gravel extraction where the initial extraction is focused on highest priority areas identified by further analysis.

No-Rise – A FEMA regulatory floodway exists in the gravel extraction area of the Snake River within the City of Blackfoot. Accordingly, a no-rise certification will be required to demonstrate that gravel removal will not increase flood elevations. Increasing channel capacity by removing gravel in an idealized uniform channel of infinite extent would reduce flood elevations and satisfy the no-rise condition. However, residual increases in flood elevations may occur at the limits of the project or at transition areas within the project and any such increases are not acceptable under the no-rise criterion. Analysis and possibly hydraulic mitigation may be required to achieve the no-rise condition.

Interpretation of FEMA regulations may lead to the conclusion that a Letter of Map Revision (LOMR) is required to update the FEMA maps because gravel extraction is expected to reduce flood elevations by more than the FEMA threshold of 1 foot of change. However, effects of gravel re-deposition over time and associated increases in flood heights should also be considered. A more prudent floodplain management approach may be to utilize existing FEMA flood elevations that are influenced by gravel accumulation and assume effects of ice jams.

Local Permits - The gravel extraction project is expected to require a floodplain development permit from both the City and County. The City and/or County may also require a conditional use permit for gravel extraction along with a public hearing. The Idaho Transportation Department will also require a permit for any work within right-ofway, for example, near the State Highway 26 bridge, the Twin Bridges, and along I-15.

Grade Control Structures - Step-wise gravel extraction is intended to avoid grade control structures for protection of existing bridges and diversion dams. However, the river response to either the initial extraction of 100,000 cubic yards or to the estimated total extraction of 500,000 cubic yards may dictate some level of grade control is required. Structure protection should be anticipated in permitting applications.

Design and Construction

Design and construction must balance the goal of flood reduction using gravel extraction with mitigation of impacts to existing structures and the river environment.

Step-Wise Extraction - The initial step-wise gravel removal at 100,000 cubic yards is basically “bar skimming” and is targeted at removing the upper 2 to 3 feet of gravel bars in the south half of the study area. When combined with low water conditions in the river, it is possible the initial extraction could be done mostly “in the dry” to avoid potential impacts associated with in-river excavation and diversion. Some of the gravel bars are adjacent to the river banks and will afford direct equipment access while other gravel bars contain secondary channels near the banks and would require temporary crossings.

The initial gravel extraction should be focused on the high priority areas identified through hydraulic analysis using design approaches consistent with minimizing impacts. Of particular concern is the golf course levee that is likely subject to increased flood heights owing to the gravel bar at the Twin Bridges and subject to erosion on the outside of a channel bend. Gravel adjacent to the SH26 bridge may also markedly reduce the hydraulic capacity of the bridge and result in increased upstream flood heights. Initial extraction should also focus on larger gravel bars that are building at a comparatively fast rate as indicated by a lack of vegetation.

Achieving full benefit from gravel extraction of the estimated 500,000 cubic yards will involve in-river work to remove a portion of gravel bars that are inundated during low water conditions. An overview of best management practices to mitigate impacts to the river system was provided herein in connection with permitting. Development and processing of permits is expected to refine construction requirements for best management practices. Construction activities within any one of the recommended steps of gravel extraction must consider the potentially significant area required for sediment control facilities.

Banks and Levees - Rehabilitation of banks and levees at selected locations should be included in permitting, design and construction. Priority locations for rehabilitation are where the banks and levees are located at the outside of a bend in the main channel and particularly where the channel is bending around a gravel bar. Constriction of the channel around a gravel bar tends to create locally higher velocities and secondary flow patterns conducive to erosion and undercutting of the outside bank.

Preliminary comparison of channel cross sections from the 1974 FEMA flood study data to the 1962 design for the constructed channel illustrates the generally expected erosion at the outside of channel bends. Comparison of the 1974 and 1962 data was possible between the SH 26 bridge and the upstream end of Jensen’s pond. The comparison provides evidence of erosion at toe of the bank (west side) or toe of the levee (east side) with erosion depths in the range of 3 feet to 5 feet. Bathymetry data to be collected will better define the extent of toe erosion.

Rehabilitation of eroded bank and levee slopes is likely to include placement of appropriately sized riprap revetment. Placement of riprap constitutes fill in the floodway and is subject to the no-rise requirement to be considered in the hydraulic analysis. The slope protection should be extended below the channel bottom to accommodate future additional channel scour. Levee rehabilitation will include temporary diversion of the main channel to allow access to the slope.

The existing Flood Insurance Study dated 1998 states that the golf course levee “if maintained, will be sufficient to withstand future floods up to the magnitude of the 500year flood”. Local knowledge indicates the golf course levee, along with the levee between the bridges at SH 26 and I-15, withstood a 100-year event in 2001.

Notwithstanding those facts, this preliminary report recommends flood hazard reduction at the levees by reducing flood heights to the extent related to gravel extraction, implementing levee slope rehabilitation, and other maintenance measures as may be appropriately included in design and construction.

Channel Flowline - Similar to erosion at the toe of banks and levees, the flowline of the main channel is subject to relatively high local velocities with associated erosion during high flow events, particularly so when the main channel is constricted between, and meanders around, the gravel bars. Comparison of the 1974 FEMA data to the 1962 design channel supports the generally accepted occurrence of flowline erosion. Another common trait of the flowline is that some level of natural armoring typically develops due to transport of finer material away from the bottom of the channel.

A valid question is what, if anything, to do with the existing flowline of the channel during design and construction. The preliminary recommendation is to retain the existing flowline without modification, provided erosion at the banks and levees is addressed as described above. Retaining the existing flow line will promote re-deposition of gravel in a pattern similar to present day conditions and allow for future monitoring of deposition that is benchmarked to existing conditions.

Modifications of the flowline could include filling it in with riprap where scoured next to the banks or relocating it to the centerline of a full width channel, in other words, a reconstruction of the 1962 design configuration. However, this approach would likely result in future deposition having a pattern different than present day conditions and the future constricted channel would erode banks and levees in locations not coincident with any riprap placed for bank rehabilitation.

Staging and Hauling - Staging areas and haul roads for gravel extraction deserve consideration during design. The south half of the work area (Figure 1) provides opportunity for a haul road on the 1962 levee on the east bank of the river with staging areas between the levee and I-15, subject to considerations of wetlands and the I-15 rightof-way. A private access road exists on the west bank and staging areas may be available, subject to acquisition of easements.

The north half of the work area has limited opportunities for haul and staging from the Danskin Canal diversion to the Porterville bridge, however, it also appears from inspection of aerial photographs there is comparatively less deposition in this area. Increased opportunities for staging and hauling exist upstream of the Porterville bridge to focus on removal of deposition near the Rose Road overpass. All existing banks and levees should be reviewed for suitability of heavy equipment traffic.

Monitoring and Maintenance

Reduction of flood hazards arising from gravel extraction is expected to be an ongoing process. River systems typically evolve toward a relative state of equilibrium of sediment transport and deposition. Therefore, gravel is expected to re-deposit in the years following final steps of extraction, and in the absence of ongoing maintenance, deposition can be expected to resemble present day conditions. Ideally, ongoing maintenance would occur at intervals and in quantities that match gravel deposition.

Prediction of the frequency and quantity of ongoing gravel extraction can, in principle, be obtained from analysis of the sediment budget of the river. Theoretical and empirical equations are available in the literature for calculation of gravel transport and deposition. An alternative approach is to measure deposition over time using river survey data collected at repeated intervals. However, the data required for either approach is relatively extensive, not now available, and the reliability of analytical results is influenced by several factors including natural variations in annual river flows.

For the above reasons, it is more practical and cost effective to establish methods and benchmarks for visual observation of gravel deposition. For example, ongoing maintenance could be conducted when gravel deposition that appears during low water conditions is some percentage of present day conditions. Maintenance removal at a relatively low percentage of present day deposition will propagate the majority of benefit in flood mitigation but repetitive costs of gravel removal including in-stream work may be cost-prohibitive.

The expected ongoing gravel extraction to maintain flood hazard reduction may require a unique approach to regulatory permits for initial extraction or separate permits for each successive gravel extraction. Permitting and construction of the initial extraction is expected to provide a data set of experience to assist with streamlining future permitting of maintenance removal.

Preliminary Opinion of Potential Costs

Estimated Costs - The attached Table 1 provides preliminary opinions of potential costs. Estimated costs are provided in a range of “low” to “high”. Providing estimated costs in a range is appropriate for several reasons: this preliminary analysis is of limited scope and therefore limited effort to investigate and refine probable costs, probable costs will change as the details of permitting requirements evolve, and the river response to initial gravel extraction may require adjustments to design and construction.

Table 1 also includes assumptions made for purposes of estimating costs. Additional information that develops during the course of the project may invalidate or change the assumptions and therefore the estimated costs.

Table 1 indicates the total expected cost for removal of the estimated 500,000 cubic yards of gravel is in the range of $10.7M to $13.6M and equates to $21/yard to $27/yard. Data collection and analysis recommended in this report will refine the estimated total gravel extraction needed to realize flood hazard reduction. The total 500,000 cubic yards is based on a crude estimate that is more likely on the upper end rather than the low end of actual gravel quantities. Grade control structures are excluded from the costs in Table 1 because the step-wise gravel removal is intended to avoid impacts to existing infrastructure.

The total estimated project cost is dominated by construction cost. Construction costs were based on experience, adjustment to costs of completed projects that are typically not in river environments, and preliminary opinions offered by three contractors in the general project area. The construction costs are heavily influenced by the need to work in a river setting. The project site affords limited access, presents challenging conditions for equipment working on the gravel bars, requires diversion or bridging of waterways along with water quality control, is not yet defined with respect to permitting and design, and is not without risk.

Table 1 indicates estimated costs for administration are in the range of $193K to $275K. Data collection, analysis, permitting and design costs are in the range of $355K to $590K. Taken together, administrative and professional services costs are in the range of $548K to $865K and are approximately 5% to 8% of the lower range of construction cost at $10.7M.

The administrative costs exclude unknown royalties as may be established by the State Land Board. The administration costs include the performance bond for site restoration required by the Idaho Department of Lands as a condition of approval of the mining permit wherein it is assumed Bingham County is the applicant. The performance bond is related to contractor activities and an alternate strategy is for the contractor to be the applicant on the mining permit.

Use of Extracted Gravel – Discussions at a conceptual level with Bingham County, Whisper Mountain, and regulatory agencies considered two initial approaches for use of the extracted gravel. One approach was for the gravel to be used for filling gravel pit(s) operated by the Idaho Transportation Department (ITD). Locally known as the "Moreland pits", they are approximately 5 miles away from the gravel extraction site on the river. The Moreland pits have a purported, but unverified, capacity to hold the estimated 500,000 cubic yards of expected extraction.

Another concept is to sell the gravel to offset project costs. An economic analysis of selling gravel is beyond the limited scope of this preliminary engineering report although initial opinions, not based on research, are offered herein.

Extraction of gravel from a river environment carries inherent logistical challenges as well as risk and drives production costs higher than dry land gravel pit mining. Gravel extracted from the river has limited value because it is not suitable for use on construction projects without processing to produce specified products such as washed rock, road mix, sand, and crushed aggregate. A site for stockpiling, processing and retail sales operations is required and adds to production costs. The time to sell 500,000 cubic yards of raw material, and therefore cost of sales operations, are not now known. Based on these considerations, it may be possible to sell the gravel and offset a portion of the costs; however, substantial cost recovery is unlikely.

Maintenance Cost- The estimated costs in Table 1 can provide a budgetary allowance for ongoing extraction of gravel to maintain reduction in flood heights and to mitigate development of meanders around gravel bars with associated erosion potential at banks and levees. Assuming that periodic gravel extraction events will be on the order of 100,000 cubic yards, most of the gravel removal will be in-stream work with a cost on the order of $20/yard. A budgetary allowance of about 10% should also be made for permitting of maintenance activities. Future observation of the river response and redeposition will provide information as to the frequency of maintenance removal but it is not unreasonable to assume at this preliminary stage that ongoing maintenance may occur every two to four years. Based on the foregoing assumptions, maintenance activities could amount to $2M to $2.2M every two to four years.

Conclusions

This preliminary engineering report addresses reduction of flood hazards associated with the Snake River near the City of Blackfoot in Bingham County, Idaho. The overall approach is to improve carrying capacity of the river by extraction of gravel that has deposited in a previously constructed channel. Recommendations for data collection and analysis are provided to better define flood hazards arising from gravel deposition, to better differentiate effects of gravel deposition from other potential sources of flood hazards near the City of Blackfoot, and to define flood hazard reduction gained from the proposed gravel extraction. An overview of presently known permitting requirements is provided. Preliminary opinions of estimated cost that is based on a limited scope effort yields total project costs in the range of $10.7M to $13.6M.

Table 1
Preliminary Opinion of Cost
Flood Mitigation
Snake River near Blackfoot
Bingham County, Idaho

T-O Engineers, Inc.
October 16, 2013

PROJECT ELEMENT	QUANTITY	UNIT	UNIT COST	PROBABLE LOW COST	PROBABLE HIGH COST	ASSUMPTIONS
1) ADMINSTRATION						
Funding and Administration	1	LS	Est. Range	$75,000	$100,000	
Wetland Mitigation Site(s) Acquisition	20	Acres	$5000 to $7000/ac	$100,000	$140,000	Approximately 20 acres at overall 4:1 mitigation ratio
Application Fees	1	LS	Est. Range	$3,000	$5,000	
IDL Performance Bond	1	LS	Est. Range	$15,000	$30,000	Maximum 180 acres at maximum $1800/acre and 5% - 10% bond cost
Sub-total Administration				***$193,000***	***$275,000***	
2) DATA and ANALYSIS						
Geotechnical Investigation	1	LS	Est. Range	$20,000	$30,000	Requires 404 permit for temporary impacts, test pits and limited bore holes
Survey Control, Mapping and Bathymetry	1	LS	Est. Range	$50,000	$100,000	
Hydraulic Analysis	1	LS	Est. Range	$25,000	$40,000	"No-Rise" condition achievable or can be mitigated, Letter of Map Revision not required
Groundwater Data and Analysis	1	LS	Est. Range	$20,000	$35,000	
Wetland Delineation and Approval	1	LS	Est. Range	$15,000	$25,000	
Baseline Water Quality Data	1	LS	Est. Range	$10,000	$15,000	
Sub-total Data and Analysis				*$140,000*	*$245,000*	
3) PERMITTING						
404 Permit Application	1	LS	Est. Range	$30,000	$40,000	No additional NEPA requirements, e.g., no EIS
404 Permit Mitigation Plan	1	LS	Est. Range	$15,000	$25,000	
404 Permit Processing and Approval	1	LS	Est. Range	$20,000	$40,000	No public hearing
IDL Mining Permit and Lease Applications	1	LS	Est. Range	$20,000	$30,000	Excludes unknown gravel royalty cost
IDL Permit Processing and Approval	1	LS	Est. Range	$15,000	$30,000	No public hearing
City and County Permitting	1	LS	Est. Range	$20,000	$30,000	Conditional Use Permit(s), Floodplain Development Permit(s)
Sub-total Permitting				*$120,000*	*$195,000*	
4) CONSTRUCTION DOCUMENTS						
Preliminary Construction Plans and Specs.	1	LS	Est. Range	$40,000	$50,000	Submitted at permit application stage
Final Construction Plans and Specs.	1	LS	Est. Range	$25,000	$40,000	Site-specific plans and specifications for step-wise removal (1,2 and 3)
Construction Support	1	LS	Est. Range	$30,000	$60,000	
Sub-total Construction Documents				*$95,000*	*$150,000*	
Total Items 2 through 4				***$355,000***	***$590,000***	
5) CONSTRUCTION						
Gravel Extraction - Step 1	100,000	Cubic Yard	$14 to $18/yd	$1,400,000	$1,800,000	Mostly in the dry with side-channel crossings, staging areas, BMPs, restoration
Gravel Extraction - Step 2	200,000	Cubic Yard	$18 to $22/yd	$3,600,000	$4,400,000	De-watering and sediment control, staging areas, BMPs, restoration
Gravel Extraction - Step 3	200,000	Cubic Yard	$18 to $22/yd	$3,600,000	$4,400,000	De-watering and sediment control, staging areas, BMPs, restoration
Wetland Mitigation Site(s)	20	Acres	$3000 to $5000/ac	$60,000	$100,000	One planting/seeding effort
Levee Armoring	5,000	Linear Foot	$300 to $400/ft	$1,500,000	$2,000,000	Limited to existing channel contact locations on bank/levee
Sub-total Construction				***$10,160,000***	***$12,700,000***	
Total Project Cost				***$10,708,000***	***$13,565,000***	
Total Per Yard Cost				***$21***	***$27***	500,000 cubic yards total

Notes:
1) All opinions of cost herein are based on limited scope and effort.
2) IDL permitting costs exclude unknown royalty fees that may be established by the State Land Board.
3) Construction costs exclude grade control structures.

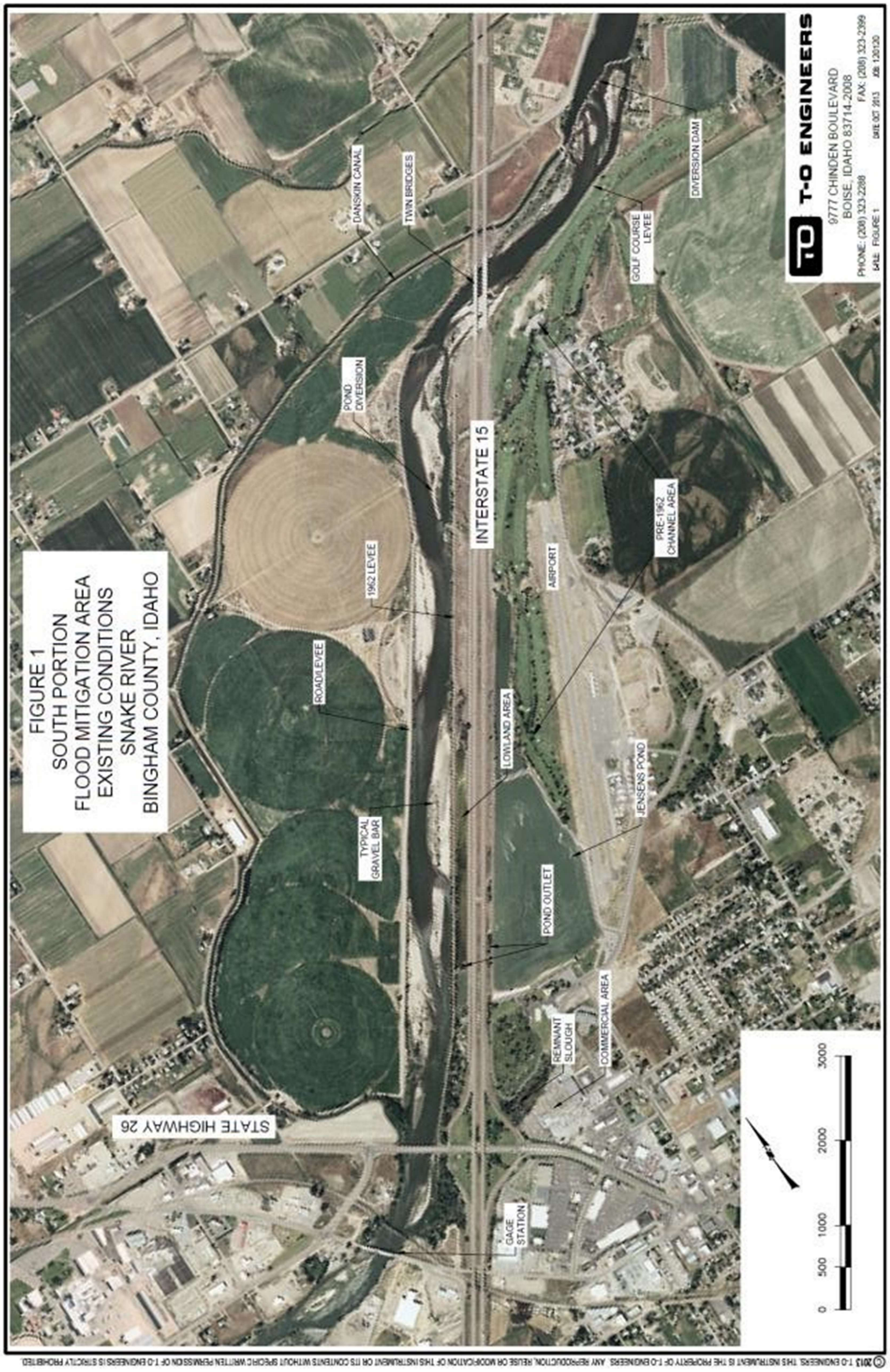
FIGURE 1
SOUTH PORTION
FLOOD MITIGATION AREA
EXISTING CONDITIONS
SNAKE RIVER
BINGHAM COUNTY, IDAHO
INTERSTATE 15
STATE HIGHWAY 26
DANSKIN CANAL
TWIN BRIDGES
POND DIVERSION
1962 LEVEE
ROAD/LEVEE
TYPICAL GRAVEL BAR
LOWLAND AREA
AIRPORT
POND OUTLET
JENSENS POND
PRE-1962 CHANNEL AREA
GOLF COURSE LEVEE
DIVERSION DAM
REMNANT SLOUGH
COMMERCIAL AREA
GAGE STATION
T-O ENGINEERS
9777 CHINDEN BOULEVARD
BOISE, IDAHO 83714-2008
PHONE: (208) 323-2288
FAX: (208) 323-2399
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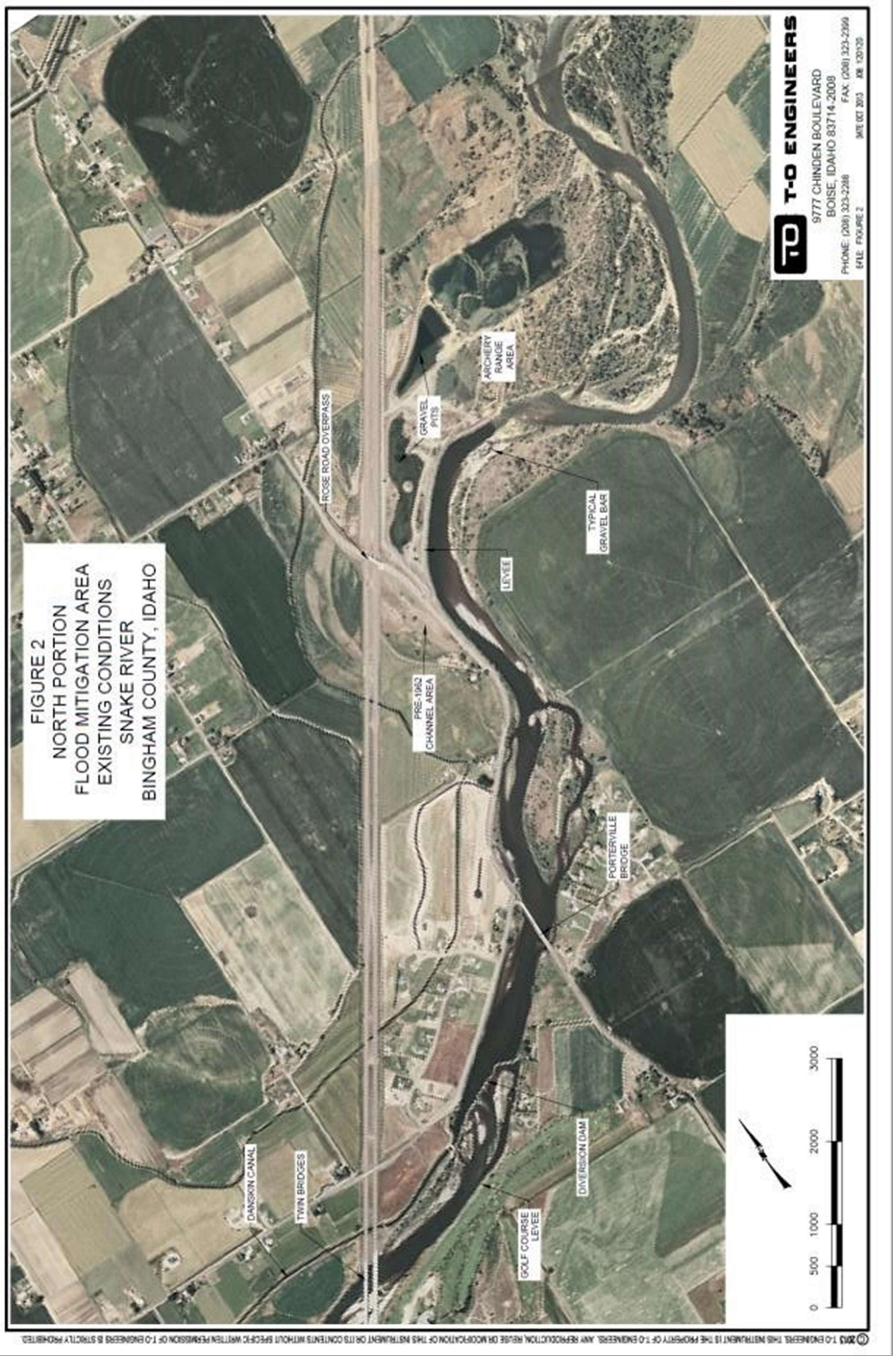
FIGURE 2
NORTH PORTION
FLOOD MITIGATION AREA
EXISTING CONDITIONS
SNAKE RIVER
BINGHAM COUNTY, IDAHO
ROSE ROAD OVERPASS
GRAVEL PITS
ARCHERY RANGE AREA
TYPICAL GRAVEL BAR
LEVEE
PRE-1962 CHANNEL AREA
PORTERVILLE BRIDGE
DIVERSION DAM
GOLF COURSE LEVEE
DANSKIN CANAL
TWIN BRIDGES
T-O ENGINEERS
9777 CHINDEN BOULEVARD
BOISE, IDAHO 83714-2008
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Appendix A

February 6, 2013 Letter Report

Revised to Include Errata Revised to include errata October 14, 2013

February 6, 2013

Mr. Craig Rowland, Bingham County
501 N. Maple Street
Blackfoot, Idaho 83221

Re: Conceptual Overview Reported Flooding Concerns, Possible Causes, Potential Mitigation Snake River and Blackfoot Area

Mr. Rowland:

Purpose

The purpose of this letter is to provide a brief overview of reported flooding conditions near the City of Blackfoot in Bingham County, identify potential causes of flooding and suggest initial concepts for mitigation. The information provided herein is presented at the conceptual level and is intended as a basis for further discussion.

A figure titled "Existing Conditions, Snake River, Flood Mitigation Area, Bingham County, Idaho" accompanies this letter and illustrates existing conditions discussed herein. The study area spans from the State Highway 26 bridge crossing of the Snake River to the Rose Road overpass on Interstate-15, approximately 3.5 miles as measured along I-15.

Reported Flooding Concerns

The flooding concerns summarized herein were reported by Bingham County and Whisper Mountain Professional Services based on their knowledge and observations. No direct evidence or documentation of flooding concerns is offered in this letter. The reported flooding concerns are assumed for the purpose of this letter.

A general consensus opinion exists that water levels in the Snake River have increased over time.

The commercial subdivision near the northeast corner of the State Highway 26 interchange at Interstate-15 reportedly experiences shallow groundwater conditions that may be related to conditions in the Snake River.

Bingham County personnel have observed water leaking laterally through the east side of I-15 road embankment and flowing toward the City of Blackfoot.

The easterly approach road of the Rose Road overpass at I-15 was washed out (date unknown) by overbank flooding on the Snake River.

The SH-26 bridge was subject to significant flooding in 2011 and various agencies considered breaching the bridge to relieve overall structural stress and high water levels that posed a threat to the City of Blackfoot.

History

The Snake River was channelized in 1962 as part of the Interstate-15 roadway construction. Prior to that time, the river flowed, or had flood channels, on both sides of I-15. The 1962 construction, between the Twin Bridges and SH-26, channelized the river to the west side of I-15 and included a levee on the east bank of the river. Upstream of the Twin Bridges on I-15, a levee was constructed along what is now the golf course to close off the historic channels on the east side of I-15. Near the Rose Road overpass, the river was channelized east of I-15 and the east side of the overpass, along with a levee on the west bank of the constructed channel.

Jensen's pond was constructed (after 1962) to the east of I-15 in the historic river channel area. A diversion from the river provides inflow to the north end of the pond. A diversion from the south end of the pond connects to the lowland area between the river and I-15, and a pipe through the 1962 levee connects to the river.

FEMA conducted a flood insurance study on the Snake River using survey data circa 1974. Initial FEMA maps were published in 1979.In the area between SH-26 and the Twin Bridges, the FEMA maps delineated a floodway along the river with an easterly boundary contained by the 1962 levee and a westerly boundary that extended beyond the west bank of the river. The current 1998 FEMA maps appear to be based on the 1974 study but do not show a floodway west of the river. Also of note is that 100-year flood elevations in the published FEMA maps account for the effects of ice jams that were estimated by FEMA to increase 100-year water elevations near Blackfoot by an average of approximately 1.6 feet.

According to the FEMA flood insurance study, the Teton dam failure in 1976 washed out a portion of the 1962 levee that was later re-constructed. FEMA estimates the Teton flood discharge at Blackfoot to have been approximately 60,000 cfs and would be comparable to a natural flood event with a 1000-year return interval.

A shoulder levee along the west side of I-15 was constructed/improved on or about 2001. The improvements included a drain trench inside the shoulder levee.

Preliminary Data Review

Site inspection conducted December 13, 2012 and review of aerial photographs from 1993 to 2011 reveal the presence of gravel bars in the Snake River in the study area. The aerial photographs appear to indicate consistent locations and extent of the gravel bars over the time span of the aerials. Note the time span of the aerials reviewed and consistency of gravel bars therein includes a 100-year flood event (2011) and a 500-year flood event (1997). The gravel bars were not part of the 1962 channelization project.

Analysis of data from the USGS gaging station at Collins Siding Road (old SH-26 alignment) indicates water levels in the Snake River at the gage site have increased over time at comparable flow rates. The gage data spans from 1978 to present and indicates water levels in the river have increased roughly 1.5 ft from 1982 to 2006 at approximately equal flows of 21,600 cfs, which is comparable to the 22,500 cfs developed by the Federal Emergency Management Agency (FEMA) for a 10-year flood event. Gage data also shows water levels have increased roughly 0.7 ft from 1994 to 2005 at approximately equal flows of 9,500 cfs, which appears to be common for a spring runoff event. Specific causes of the increased gage height readings are not conclusively defined and no coordination with the UGSG was conducted to investigate conditions of the gage. The higher gage readings may be related to reduction of channel capacity.

A limited hydraulic analysis of the Snake River was conducted using a reproduction of the existing FEMA flood study including the circa 1974 survey data. The FEMA survey data includes gravel bars that were not part of the 1962 channel design. A brief visual comparison of the 1974 cross-sections to current aerial photographs reveals similarities in gravel bar locations in the channel at some cross-sections and differences at other cross-sections.

The limited study did not include current survey data. A review of available LIDAR was conducted but no LIDAR data exists for the study area. A river survey is beyond the scope of this concept study.

The limited hydraulic analysis investigated water levels in the river from the SH-26 bridge and upstream approximately 1 mile. The analysis predicted increased water levels in the river in the range of 0.5 feet to 2 feet when comparing the 1962 channel design to the 1974 survey data with gravel bars. The low-end of the range at 0.5 feet occurs near the SH-26 bridge where the 1962 channelization begins. The upper end of the range occurs in the middle of the study range. Comparison of water elevations at the upstream end of the hydraulic study is not meaningful because the 1962 design channel invert is almost 4 feet higher than the 1974 invert, and the 1962 invert is higher than the 1974 invert at the Twin Bridges. It is not known if the high invert on the 1962 channel design was constructed.

Potential Causes and Initial Mitigation Concepts

Potential causes of reported flooding concerns are reviewed in this section. The causes are inferred from a site inspection, analysis of aerial photographs and other available data as described herein. No conclusive analysis or evidence of causation is offered at this preliminary scoping level.

Initial mitigation suggested herein is at the concept level only. The mitigation concepts do not include: analysis of efficacy of the mitigation measures, secondary effects of implementing mitigation concepts, permitting requirements, operations and maintenance, or estimated cost.

Gravel Accumulation

A reduction in river channel capacity due to gravel accumulation in the constructed 1962 channel would tend to raise water surface elevations in the river. Higher river elevations could induce the reported higher ground water at the commercial development area by way of what is presumed to be subsurface river gravels in the historic river channel and meanders.

Higher water elevations in the river may also cause increased water levels in the lowland area between the 1962 levee and I-15, thereby contributing to the reported lateral flow through the east shoulder of I-15. The functionality of the seepage trench in the I-15 shoulder levee is not known and may also be a contributing factor to lateral seepage.

With respect to the Rose Road washout, gravel accumulation in the river channel may have also increased water elevations that contributed to overtopping of the 1962 levee on the west bank of the relocated river. With overtopping of the levee and overbank flow west of the river, the excavated gravel pits west of the river and upstream of the Rose Road approach probably increased overbank velocity and erosion potential.

Review of 2009 aerial photography indicates the tops of gravel bars were roughly as high as the 10-year water surface elevation. The gravel bars may exacerbate the effects of ice jams that typically occur near the water surface.

A mitigation concept to remedy the apparent effects of gravel accumulation is to remove gravel from the river channel to restore the river channel capacity toward the 1962 design section and presumably lower water elevations in the river. **Piped Connections to the River**

An existing 4 foot diameter pipe connects the north end of Jensen's pond to the river and appears to be used for inflow into the pond in combination with a diversion dam in the river. An existing 4 foot diameter pipe connects the south end of Jensen's pond to the lowland area between I-15 and the 1962 levee, along with a piped connection to the river that presumably allows for outflow from the pond. Canal gates are also present on the piped connections and appear to be used for regulating flow.

Connections to the river could create conditions where inflow of water from the river to the north end of pond without a balanced outflow back to the river may cause pond water elevations to trend toward the river elevation at the north (upstream) end and raise the pond relative to the river elevation on south (downstream) end. If these conditions occur, the increased pond elevation could induce higher local shallow ground water as reported at the commercial development area. Outflow from the pond into the wetland area between the 1962 levee and I-15 may also contribute to the reported lateral seepage across I-15.

A potential mitigation concept is to investigate and document operation of the pond, piped connections and gates, and consider modification to operations as may be warranted, particularly during high river levels.

It should also be noted that Jensen's pond by itself, without any influence of connections to the river, will trend toward a level water surface elevation. At the south end of the pond, the pond level could be higher than ambient groundwater levels and contribute to reported shallow groundwater at the commercial development area.

Development

Increased impervious area that accompanies development typically increases runoff volume following storm events or snowmelt and could contribute to the reported higher groundwater in the commercial area depending on the ultimate method of disposal. Accumulation of stormwater into infiltration basins may increase groundwater levels. Disposal of stormwater into the remnant slough near the commercial area may also induce higher groundwater. It is not known from a limited data review whether the remnant slough has a piped connection to the river.

A mitigation concept includes review of stormwater management, investigation as to any influence on reported shallow groundwater, and development of site-specific mitigation.

Site inspection on December 13, 2012 provided indication of fill or improvements to the west bank of the river beginning near the SH-26 Bridge and upstream approximately 1 mile. Based on the limited data review, it is not known how the existing west bank compares to the original 1962 channel construction or pre-1962 existing grade. Therefore, it is not known if the apparent improvements on the west bank may be a contributing factor to reported flooding concerns.

A mitigation concept is to better define existing conditions of the west bank and 1962 levee and investigate relocating either the west bank and/or 1962 levee to increase channel capacity.

SH-26 Bridge Crossing

High water levels and flooding conditions were reported at the SH-26 Bridge during the spring runoff of 2011. Date of the observation is not known. Gage data at the USGS gaging station near Blackfoot showed a peak annual discharge of 32,700 cfs on May 29, 2011. The peak flow is higher than the FEMA defined 100-year event at 29,900 cfs.

Design requirements and design capacity of bridges across the river in the study area were not reviewed. The FEMA flood insurance study profiles indicate the SH-26 bridge should pass the FEMA predicted 100-year water elevations approximately 0.5 feet under the low chord of the bridge, including the FEMA estimated effects of ice jams.

Reported high water observations at the SH-26 bridge in 2011 include verbal accounts of driftwood and fallen trees that constricted the bridge opening. Debris effects are not included in the FEMA study and are expected to increase upstream water heights.

Other factors that may contribute to increased water elevations at the SH-26 bridge could include gravel accumulation in the river channel or near the bridge piers, tailwater effects from potentially higher downstream water elevations, and development on the northwest bank of the river. Determination of the effects, if any, of these factors is beyond the scope of this conceptual analysis.

The mitigation concepts offered in this letter may provide improved hydraulic performance of the bridge as alternatives to bridge replacement. However, further investigation of cause and effect relationships is needed.

Summary

This letter provides an overview of reported flooding concerns near the Snake River in the Blackfoot area of Bingham County, Idaho. Potential causes and mitigation measures were reviewed at the concept level. A common theme is gravel accumulation in channelized sections of the river. Preliminary data review indicates increased that water levels in the river may be correlated to gravel accumulation and suggests mitigation to restore or increase channel capacity. Other potential causes of reported flooding include development and piped connections to the river.

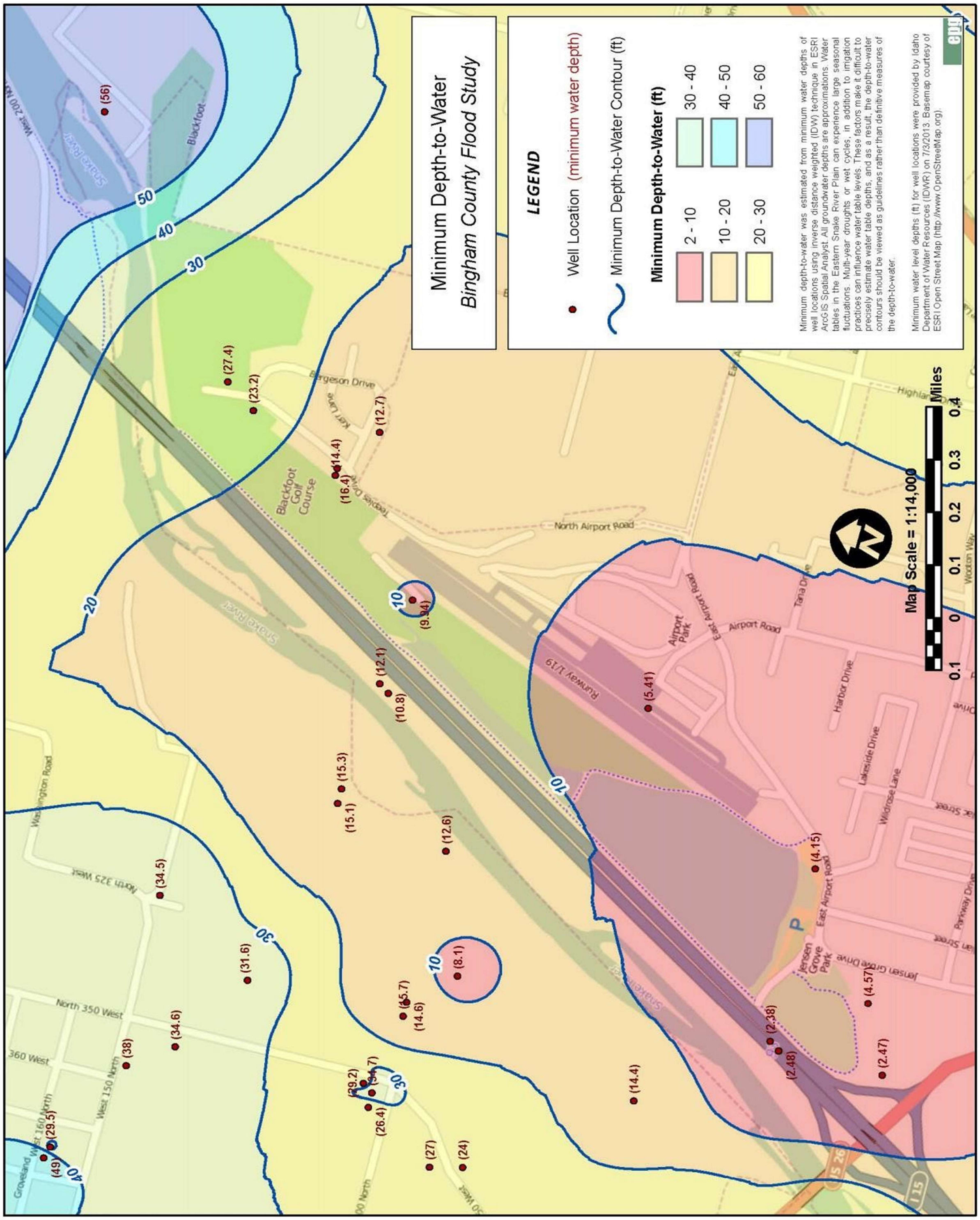
Sincerely,

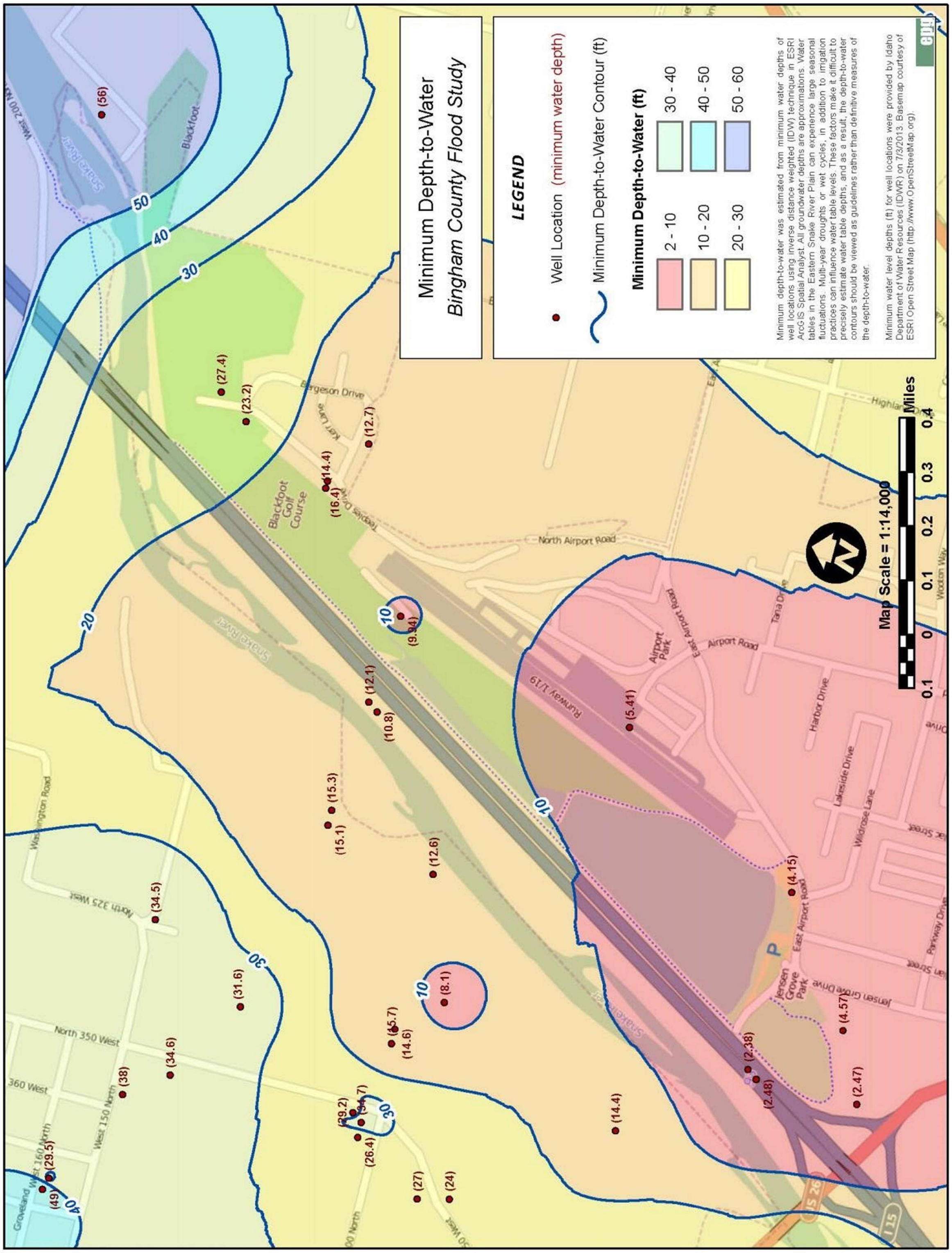
T-O Engineers, Inc.

Steve Holt, P.E.

Project Manager

Appendix B: Depth to Groundwater Environmental Planning Group


Minimum Depth-to-Water
Bingham County Flood Study
LEGEND
Well Location (minimum water depth)
Minimum Depth-to-Water Contour (ft)
Minimum Depth-to-Water (ft)
2 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
Minimum depth-to-water was estimated from minimum water depths of well locations using inverse distance weighted (IDW) technique in ESRI ArcGIS Spatial Analyst. All groundwater depths are approximations. Water tables in the Eastern Snake River Plain can experience large seasonal fluctuations. Multi-year droughts or wet cycles, in addition to irrigation practices can influence water table levels. These factors make it difficult to precisely estimate water table depths, and as a result, the depth-to-water contours should be viewed as guidelines rather than definitive measures of the depth-to-water.
Minimum water level depths (ft) for well locations were provided by Idaho Department of Water Resources (IDWR) on 7/3/2013. Basemap courtesy of ESRI Open Street Map (http://www.OpenStreetMap.org).
Map Scale = 1:14,000
0.1 0 0.1 0.2 0.3 0.4 Miles
Blackfoot Golf Course
Snake River
Airport Park
Jensen Grove Park
North Airport Road
East Airport Road
Runway 1/19


Minimum Depth-to-Water
Bingham County Flood Study
LEGEND
Well Location (minimum water depth)
Minimum Depth-to-Water Contour (ft)
Minimum Depth-to-Water (ft)
2 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
Minimum depth-to-water was estimated from minimum water depths of well locations using inverse distance weighted (IDW) technique in ESRI ArcGIS Spatial Analyst. All groundwater depths are approximations. Water tables in the Eastern Snake River Plain can experience large seasonal fluctuations. Multi-year droughts or wet cycles, in addition to irrigation practices can influence water table levels. These factors make it difficult to precisely estimate water table depths, and as a result, the depth-to-water contours should be viewed as guidelines rather than definitive measures of the depth-to-water.
Minimum water level depths (ft) for well locations were provided by Idaho Department of Water Resources (IDWR) on 7/3/2013. Basemap courtesy of ESRI Open Street Map (http://www.OpenStreetMap.org).
Map Scale = 1:14,000
0.1 0 0.1 0.2 0.3 0.4
Miles

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Appendix D: Bingham County Wildfire Protection Plan (CWPP)

Bingham County Wildfire Protection Plan (CWPP)

Updated 2021

Index

Wildland Urban Interface (WUI)

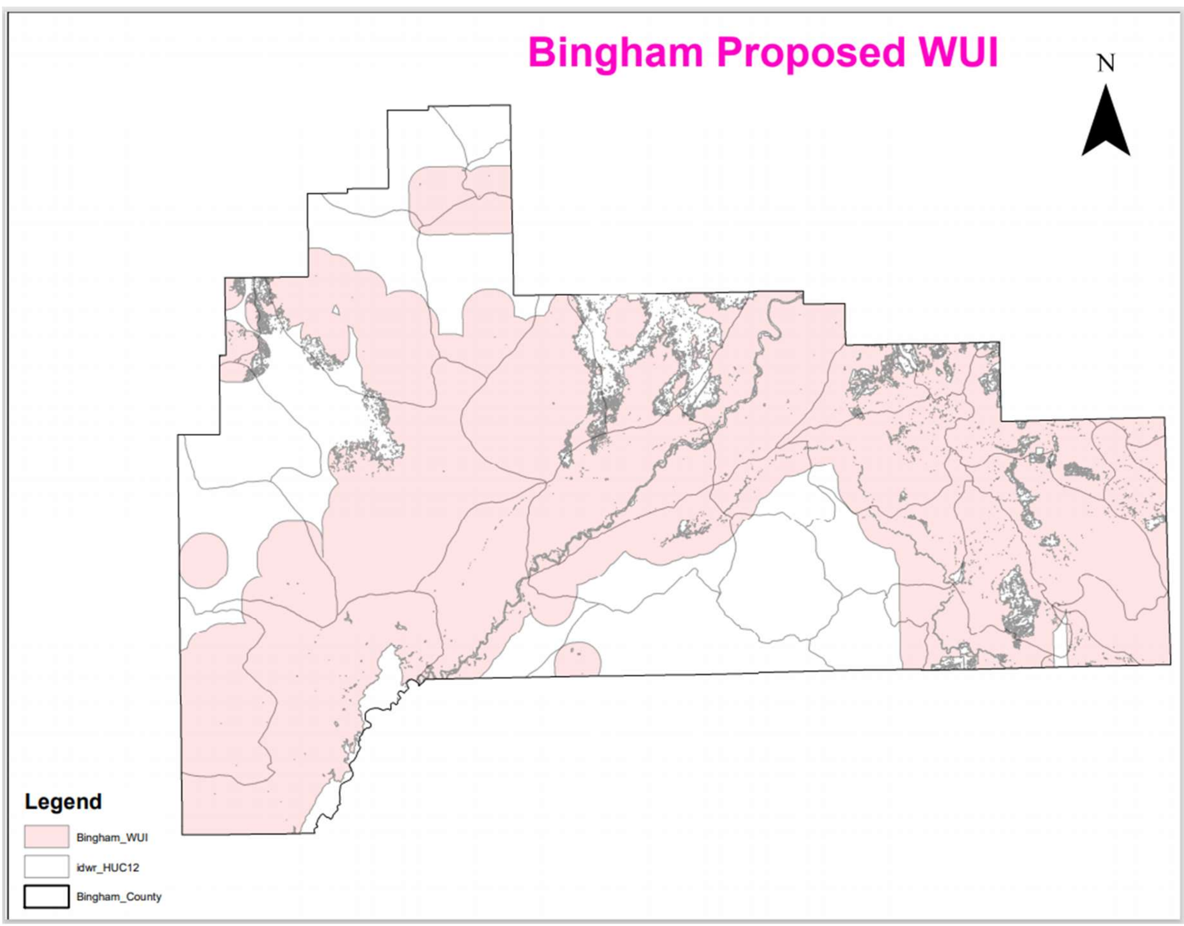
Simple Fire Hazard Model

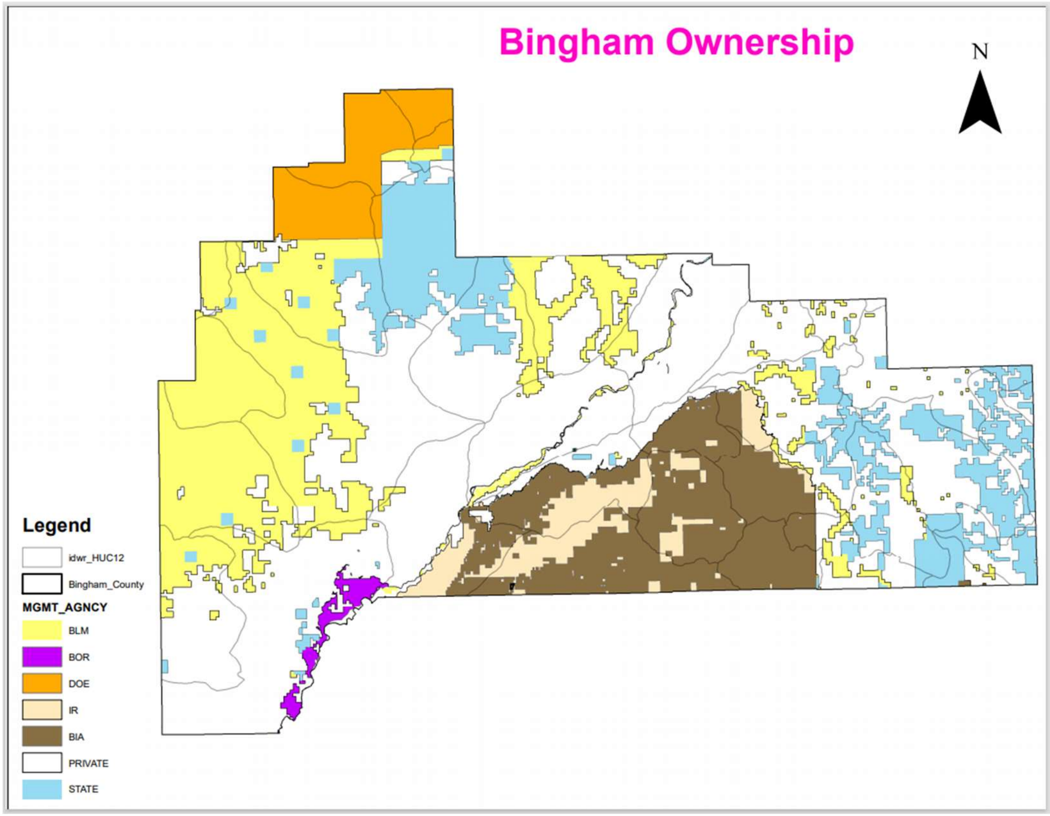
Wildland Urban Interface (WUI)

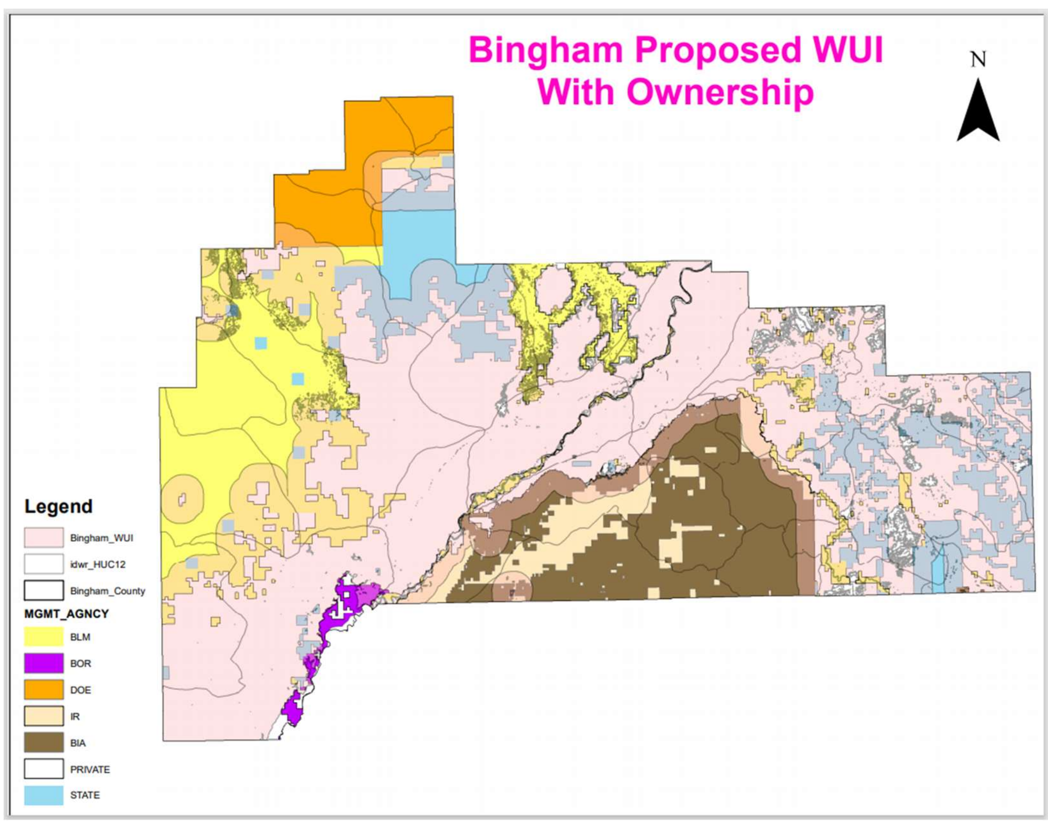
Definition: Is an area were developed lands interact with undeveloped lands and includes the infrastructure and natural resources communities rely on for existence.

Location: It is found in remote scattered development areas to highly developed urban areas and everywhere in between.

Mapping: The use of natural occurring brakes in the landscape are encourage, i.e., HUC12 is a well-established standard for a variety of mapping process.



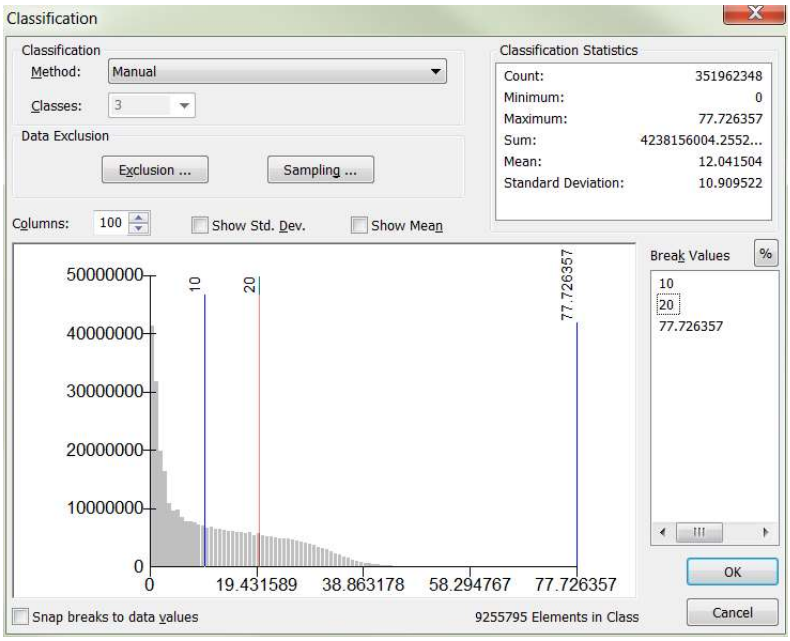

Bingham Ownership
N
Legend
idwr_HUC12
Bingham_County
MGMT_AGNCY
BLM
BOR
DOE
IR
BIA
PRIVATE
STATE


Bingham Proposed WUI
With Ownership
N
Legend
Bingham_WUI
idwr_HUC12
Bingham_County
MGMT_AGNCY
BLM
BOR
DOE
IR
BIA
PRIVATE
STATE

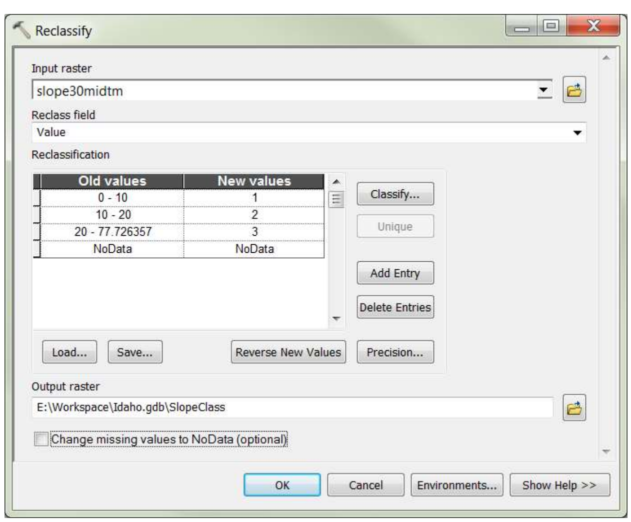
Simple Fire Hazard Model

Data Properties and formats

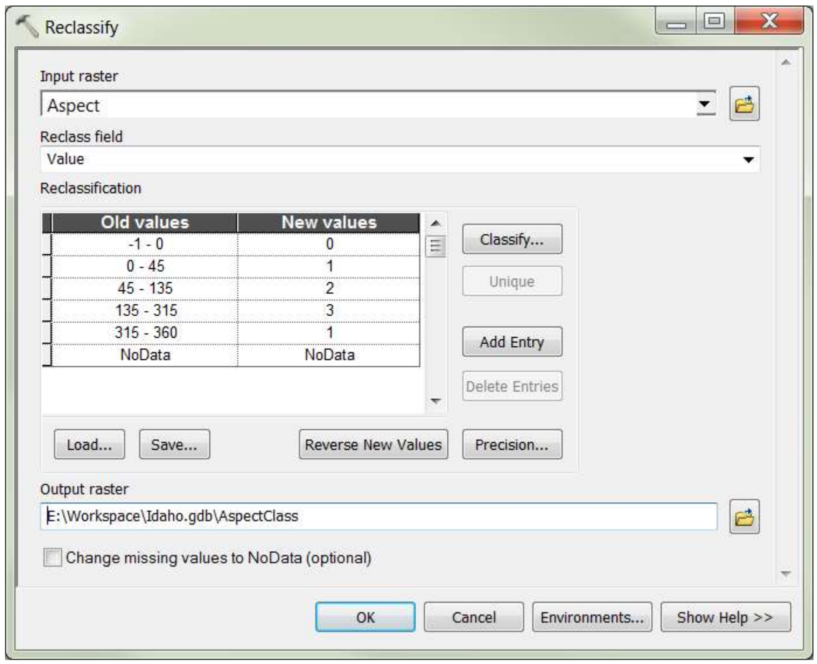
1. Slope
   a. A 30-meter dem used as the source data.
   b. Ran the **Slope** tool in Spatial Analyst on ArcMap. I used PERCENT as the output option.
   c. Ran the **Reclassify** tool to group the slope into 3 categories: 0 – 10%, 10.00001 – 20%, and greater than 20%.



   d. Gave the three class new values of 1, 2 and 3 from low slope to high slope. Named the output Slope Class.



2. Aspect
    a. A 30-meter dem used as the source data.
    b. Ran the **Aspect** tool in Spatial Analyst on ArcMap.
    c. Ran the **Reclassify** tool to group the aspect into 3 categories: 1. North (0 to 45 degrees and 315 to 360 degrees), 2. East (45 to 135 degrees), 3. South & West (135 to 315 degrees), and 0. Flat (0 degrees).
    d. Gave the three class new values of 1, 2, 3, and 0 according to the above aspect range categories. Named the output Aspect Class.



3. Vegetation

The 30-meter vegetation data from Landfire was used. The vegetation was classified into 6 categories: grass, grass-brush, grass-tree, brush, brush-tree, tree. Grass was classified to 1, grass-tree 2, grass-shrub 3, shrub 4, shrub-tree 5 (this included pinion and juniper), and tree was classified to 6. All lakes, rock, agriculture and urban areas are classified to 0. The vegetation was classified as given and written to an attribute. The vegetation file was exported with the new attribute as the new value into a file called Veg_Class.

4. Fire History

A fire history dataset of fire points and polygons (when available) from 1980 to 2016 for Idaho was used. In 30-meter cells there were most cells with no fires many with one fire and a few cells with 2 fires. This did not give a good fire density. The HUC12 watershed polygons were used as the population density area.

Spatial Join was used to count the number of fire points within each HUC12. See http://support.esri.com/cn/knowledgebase/techarticles/detail/30779

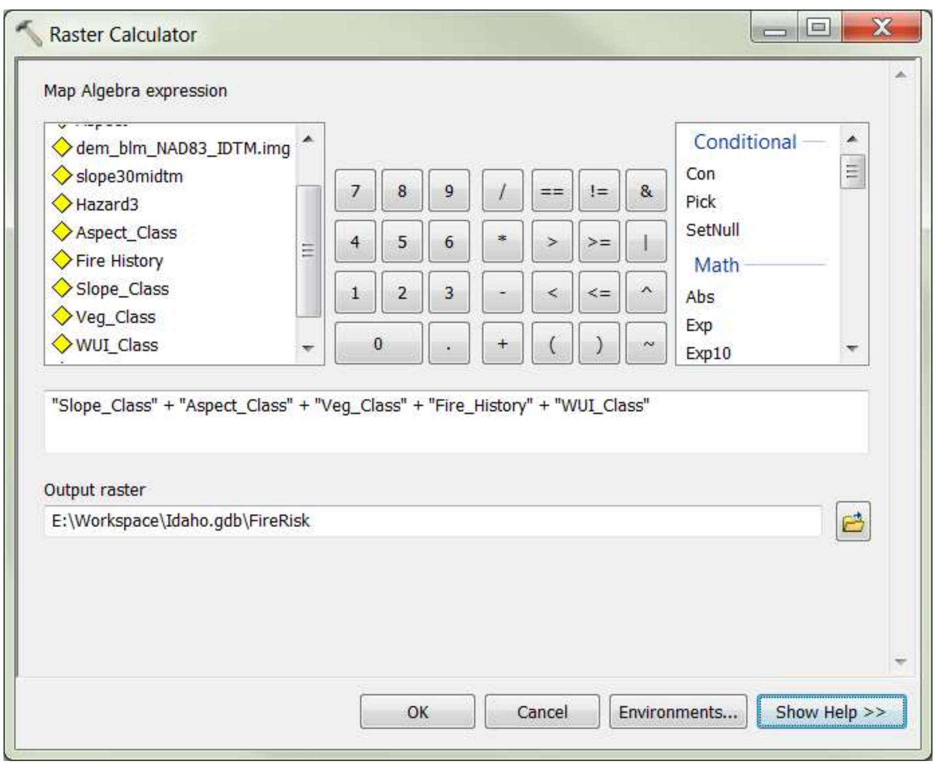
The output polygon layer was classified into three categories by natural breaks and was assigned 1, 2, and 3 from low fire density to high fire density. This polygon layer of fire density was converted to a 30-meter raster file called Fire Class.

5. Wildland – Urban Interface (WUI)

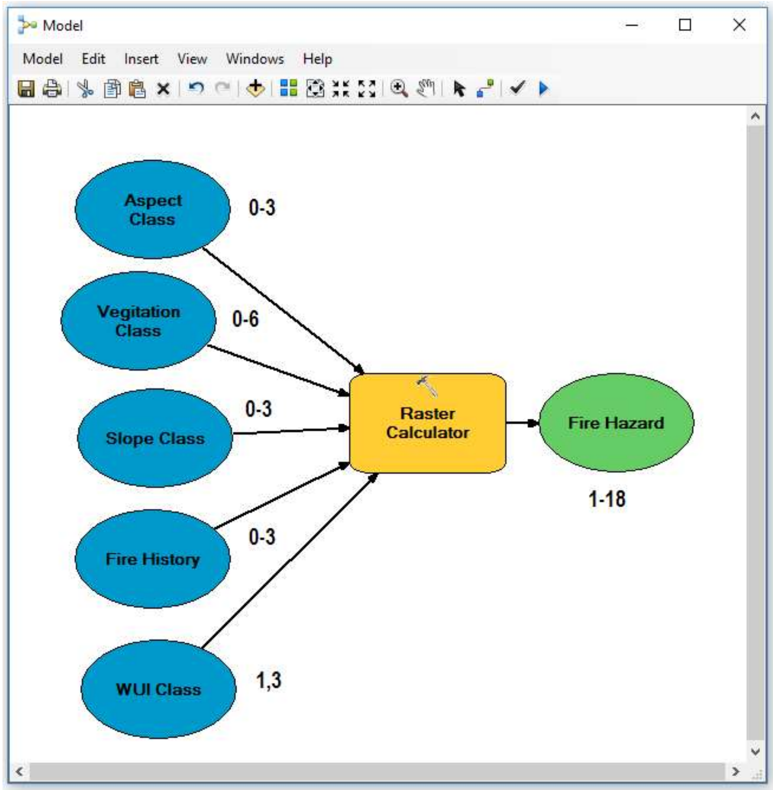
   The WUI layer used was composed of the layers originally developed by the USFS and BLM. Where counties have defined and mapped their WUI as part of their CWPP it was substituted in place of the USFS or BLM layers. The WUI data layer was classified as 3 if in the WUI area and 1 if out of the WUI area. This polygon layer was also converted to a 30-meter raster file called WUI_Class.

Data Analysis

1. Used **Raster Calculator** to sum the values of Slope, Aspect, Vegetation, Fire History, and WUI.

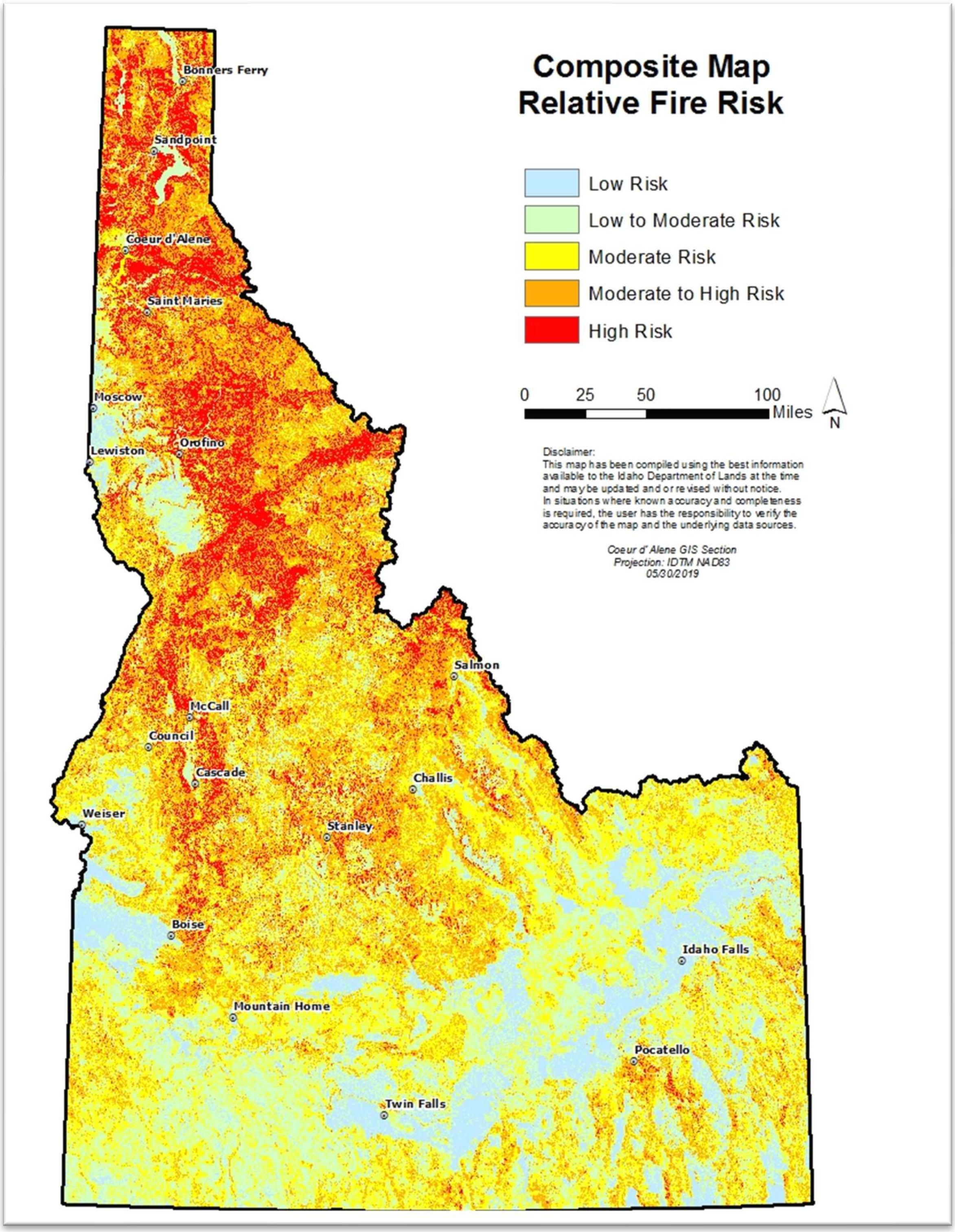


In Model Builder this process is outlined like this:



The output fire hazard will be the sum of the class values for Fire History, Aspect, Slope, Vegetation, and WUI. The lowest value in this analysis was 3 – 1 for aspect, 1 for slope and 1 for WUI. The highest value in this analysis can be 18.

The Hazard layer raster was classified in to 4 classes but can be done in any number of ways. A recommended starting point is to use natural breaks within the display information table of the layer.


Composite Map
Relative Fire Risk
Low Risk
Low to Moderate Risk
Moderate Risk
Moderate to High Risk
High Risk
0
25
50
100
Miles
N
Disclaimer:
This map has been compiled using the best information available to the Idaho Department of Lands at the time and may be updated and or revised without notice.
In situations where known accuracy and completeness is required, the user has the responsibility to verify the accuracy of the map and the underlying data sources.
Coeur d' Alene GIS Section
Projection: IDTM NAD83
05/30/2019
Bonners Ferry
Sandpoint
Coeur d'Alene
Saint Maries
Moscow
Lewiston
Orofino
Salmon
McCall
Council
Cascade
Challis
Weiser
Stanley
Boise
Idaho Falls
Mountain Home
Pocatello
Twin Falls

Appendix E: HAZUS Report - Earthquake

Hazus: Earthquake Global Risk Report

Region Name: BinghamCounty

Earthquake Scenario: Bingham Earthquake

Print Date: May 24, 2021

Disclaimer:
This version of Hazus utilizes 2010 Census Data.
Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using Hazus loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

HAZUS
EARTHQUAKE · WIND · FLOOD · TSUNAMI

FEMA

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General Description of the Region

Hazus-MH is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences. The primary purpose of Hazus is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Idaho

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 2,119.59 square miles and contains 8 census tracts. There are over 14 thousand households in the region which has a total population of 45,607 people (2010 Census Bureau data). The distribution of population by Total Region and County is provided in Appendix B.

There are an estimated 16 thousand buildings in the region with a total building replacement value (excluding contents) of 3,472 (millions of dollars). Approximately 91.00 % of the buildings (and 76.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 2,026 and 1,460 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

Hazus estimates that there are 16 thousand buildings in the region which have an aggregate total replacement value of 3,472 (millions of dollars) . Appendix B provides a general distribution of the building value by Total Region and County.

In terms of building construction types found in the region, wood frame construction makes up 75% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

Hazus breaks critical facilities into two (2) groups: essential facilities and high potential loss facilities (HPL). Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 3 hospitals in the region with a total bed capacity of 153 beds. There are 36 schools, 9 fire stations, 4 police stations and 1 emergency operation facilities. With respect to high potential loss facilities (HPL), there are no dams identified within the inventory. The inventory also includes 3 hazardous material sites, no military installations and no nuclear power plants.

Transportation and Utility Lifeline Inventory

Within Hazus, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 1 and 2.

The total value of the lifeline inventory is over 3,486.00 (millions of dollars). This inventory includes over 154.72 miles of highways, 256 bridges, 12,278.91 miles of pipes.

Table 1: Transportation System Lifeline Inventory

System	Component	# Locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	256	244.8379
	Segments	29	1148.4442
	Tunnels	0	0.0000
		Subtotal	**1393.2821**
Railways	Bridges	48	223.3636
	Facilities	1	2.6630
	Segments	171	269.7321
	Tunnels	0	0.0000
		Subtotal	**495.7587**
Light Rail	Bridges	0	0.0000
	Facilities	0	0.0000
	Segments	0	0.0000
	Tunnels	0	0.0000
		Subtotal	**0.0000**
Bus	Facilities	2	2.9781
		Subtotal	**2.9781**
Ferry	Facilities	0	0.0000
		Subtotal	**0.0000**
Port	Facilities	0	0.0000
		Subtotal	**0.0000**
Airport	Facilities	4	18.6136
	Runways	4	116.0718
		Subtotal	**134.6854**
		Total	**2,026.70**

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Table 2: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	197.6131
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**197.6131**
Waste Water	Distribution Lines	NA	118.5678
	Facilities	8	1064.7000
	Pipelines	0	0.0000
		Subtotal	**1183.2678**
Natural Gas	Distribution Lines	NA	79.0452
	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**79.0452**
Oil Systems	Facilities	0	0.0000
	Pipelines	0	0.0000
		Subtotal	**0.0000**
Electrical Power	Facilities	0	0.0000
		Subtotal	**0.0000**
Communication	Facilities	10	1.0000
		Subtotal	**1.0000**
		Total	**1,460.90**

Earthquake Global Risk Report

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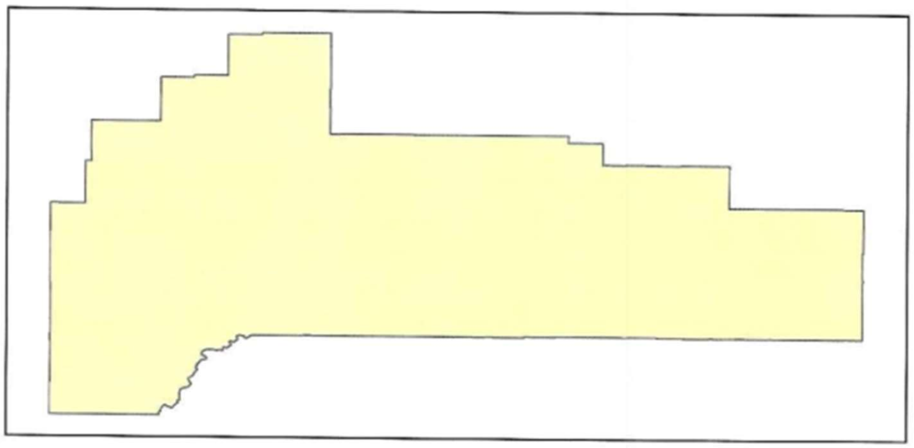
Earthquake Scenario

Hazus uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.



Scenario Name	Bingham Earthquake
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-112.20
Latitude of Epicenter	43.19
Earthquake Magnitude	7.00
Depth (km)	10.00
Rupture Length (Km)	42.66
Rupture Orientation (degrees)	0.00
Attenuation Function	West US, Extensional 2008 - Strike Slip

Direct Earthquake Damage

Building Damage

Hazus estimates that about 2,797 buildings will be at least moderately damaged. This is over 17.00 % of the buildings in the region. There are an estimated 258 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the Hazus technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 below summarizes the expected damage by general building type.

Damage Categories by General Occupancy Type

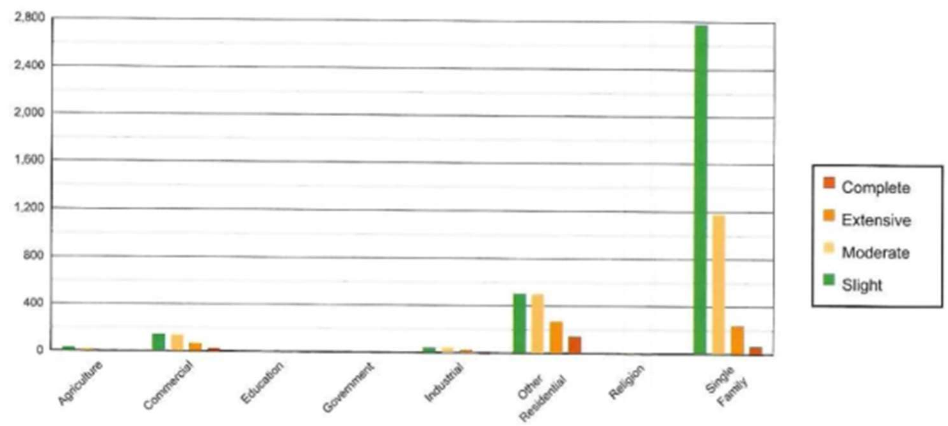


Table 3: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	187.13	1.82	30.40	0.87	20.45	1.07	8.45	1.35	3.57	1.38
Commercial	510.05	4.96	142.04	4.04	140.33	7.33	68.01	10.88	26.57	10.26
Education	29.66	0.29	6.96	0.20	6.40	0.33	3.42	0.55	1.56	0.60
Government	9.29	0.09	3.07	0.09	3.48	0.18	2.09	0.33	1.07	0.41
Industrial	148.41	1.44	44.01	1.25	48.25	2.52	25.54	4.09	11.79	4.55
Other Residential	1269.09	12.34	502.11	14.30	506.46	26.47	272.94	43.67	145.40	56.15
Religion	37.04	0.36	8.34	0.24	7.29	0.38	3.76	0.60	1.57	0.61
Single Family	8092.67	78.70	2775.42	79.02	1180.73	61.71	240.75	38.52	67.43	26.04
Total	10,283		3,512		1,913		625		259	

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Table 4: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	8160.37	79.36	2842.06	80.92	1155.64	60.40	196.73	31.48	45.05	17.40
Steel	201.22	1.96	55.51	1.58	71.17	3.72	40.33	6.45	17.98	6.94
Concrete	149.67	1.46	42.64	1.21	41.27	2.16	22.55	3.61	8.51	3.29
Precast	97.55	0.95	23.22	0.66	30.33	1.59	17.05	2.73	7.20	2.78
RM	494.42	4.81	88.84	2.53	115.36	6.03	76.99	12.32	32.51	12.55
URM	114.83	1.12	46.51	1.32	37.81	1.98	11.76	1.88	5.88	2.27
MH	1065.29	10.36	413.59	11.78	461.81	24.14	259.55	41.53	141.83	54.77
Total	10,283		3,512		1,913		625		259	

*Note:
RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 153 hospital beds available for use. On the day of the earthquake, the model estimates that only 28 hospital beds (18.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 48.00% of the beds will be back in service. By 30 days, 89.00% will be operational.

Table 5: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	3	2	0	0
Schools	36	18	0	11
EOCs	1	0	0	0
PoliceStations	4	0	0	1
FireStations	9	1	0	6

Transportation Lifeline Damage

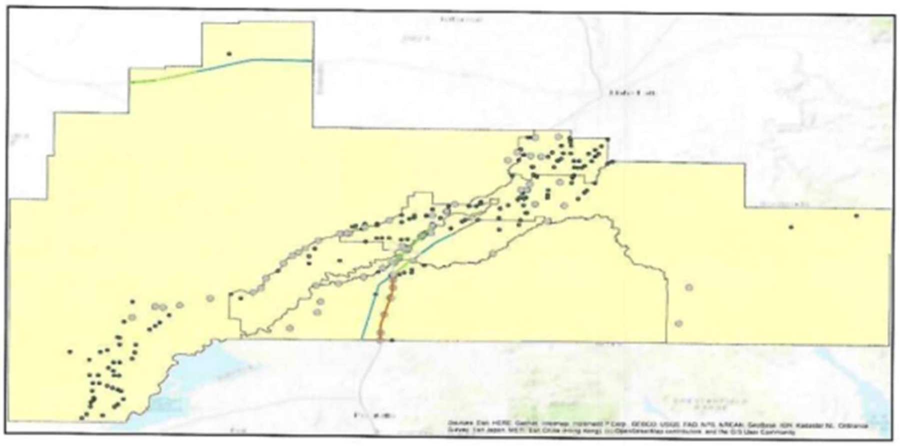

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Table 6: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	29	0	0	29	29
	Bridges	256	16	3	242	247
	Tunnels	0	0	0	0	0
Railways	Segments	171	0	0	171	171
	Bridges	48	0	0	48	48
	Tunnels	0	0	0	0	0
	Facilities	1	1	0	0	1
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	2	0	0	2	2
Ferry	Facilities	0	0	0	0	0
Port	Facilities	0	0	0	0	0
Airport	Facilities	4	0	0	4	4
	Runways	4	0	0	4	4

Table 6 provides damage estimates for the transportation system.

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 7-9 provide information on the damage to the utility lifeline systems. Table 7 provides damage to the utility system facilities. Table 8 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, Hazus performs a simplified system performance analysis. Table 9 provides a summary of the system performance information.

Table 7 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	0	0	0	0	0
Waste Water	8	4	0	2	8
Natural Gas	0	0	0	0	0
Oil Systems	0	0	0	0	0
Electrical Power	0	0	0	0	0
Communication	10	0	0	10	10

Table 8 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (miles)	Number of Leaks	Number of Breaks
Potable Water	6,140	1614	404
Waste Water	3,684	811	203
Natural Gas	2,456	278	69
Oil	0	0	0

Table 9: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	14,999	1,944	1,465	639	0	0
Electric Power		2,217	1,318	512	95	3

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Induced Earthquake Damage

Fire Following Earthquake

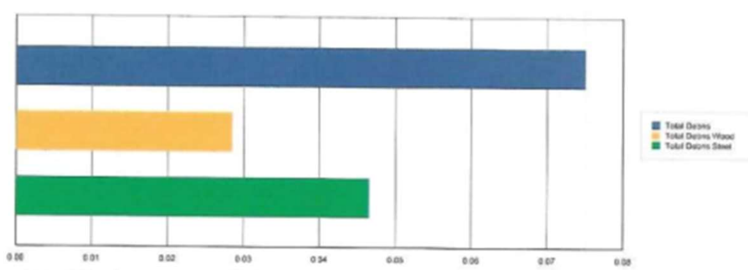
Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. Hazus uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 0 ignitions that will burn about 0.00 sq. mi 0.00 % of the region's total area.) The model also estimates that the fires will displace about 0 people and burn about 0 (millions of dollars) of building value.

Debris Generation

Hazus estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 75,000 tons of debris will be generated. Of the total amount, Brick/Wood comprises 38.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 3,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Earthquake Debris (millions of tons)



Brick/ Wood	Reinforced Concrete/Steel	Total Debris	Truck Load
0.03	0.05	0.08	3,000 (@25 tons/truck)

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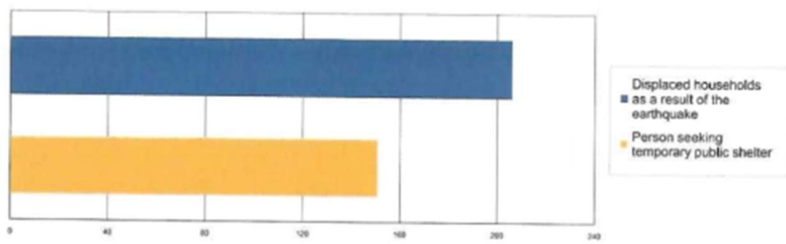
Social Impact

Shelter Requirement

Hazus estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 206 households to be displaced due to the earthquake. Of these, 151 people (out of a total population of 45,607) will seek temporary shelter in public shelters.

Displaced Households/ Persons Seeking Short Term Public Shelter



Displaced households as a result of the earthquake	Persons seeking temporary public shelter
206	151

Casualties

Hazus estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

- Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
- Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
- Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
- Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 10 provides a summary of the casualties estimated for this earthquake

Table 10: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	2.05	0.58	0.09	0.18
	Commuting	0.01	0.03	0.03	0.01
	Educational	0.00	0.00	0.00	0.00
	Hotels	0.00	0.00	0.00	0.00
	Industrial	2.13	0.57	0.08	0.16
	Other-Residential	33.06	7.18	0.54	0.94
	Single Family	34.73	6.44	0.66	1.25
	Total	**72**	**15**	**1**	**3**
2 PM	Commercial	127.69	36.05	5.70	11.14
	Commuting	0.11	0.24	0.29	0.06
	Educational	40.64	11.30	1.81	3.54
	Hotels	0.00	0.00	0.00	0.00
	Industrial	15.66	4.16	0.61	1.18
	Other-Residential	6.51	1.42	0.11	0.19
	Single Family	7.29	1.37	0.15	0.26
	Total	**198**	**55**	**9**	**16**
5 PM	Commercial	96.47	27.18	4.31	8.34
	Commuting	1.82	3.97	4.83	1.03
	Educational	2.48	0.68	0.11	0.21
	Hotels	0.00	0.00	0.00	0.00
	Industrial	9.79	2.60	0.38	0.74
	Other-Residential	11.92	2.59	0.20	0.35
	Single Family	13.50	2.51	0.27	0.47
	Total	**136**	**40**	**10**	**11**

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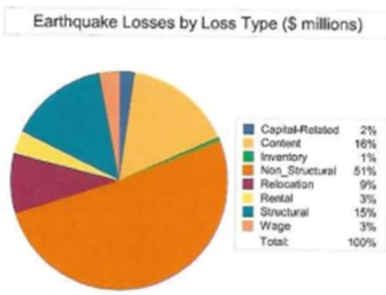
Economic Loss

The total economic loss estimated for the earthquake is 511.06 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 256.85 (millions of dollars); 17 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 61 % of the total loss. Table 11 below provides a summary of the losses associated with the building damage.



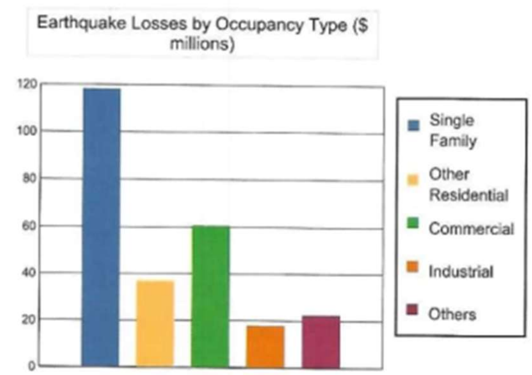


Table 11: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Losses							
	Wage	0.0000	0.2999	6.4565	0.3721	0.5278	7.6563
	Capital-Related	0.0000	0.1274	5.2652	0.2242	0.1949	5.8117
	Rental	3.1994	1.4864	3.3406	0.1427	0.2513	8.4204
	Relocation	11.3054	2.8273	5.2664	0.8613	2.4139	22.6743
	Subtotal	**14.5048**	**4.7410**	**20.3287**	**1.6003**	**3.3879**	**44.5627**
Capital Stock Losses							
	Structural	15.7590	6.0645	8.9155	2.6957	4.5787	38.0134
	Non_Structural	69.0620	22.4373	21.9364	8.2058	10.0804	131.7219
	Content	18.8694	4.0006	9.1061	4.7877	4.3895	41.1533
	Inventory	0.0000	0.0000	0.3564	0.8430	0.1955	1.3949
	Subtotal	**103.6904**	**32.5024**	**40.3144**	**16.5322**	**19.2441**	**212.2835**
	Total	**118.20**	**37.24**	**60.64**	**18.13**	**22.63**	**256.85**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, Hazus computes the direct repair cost for each component only. There are no losses computed by Hazus for business interruption due to lifeline outages. Tables 12 & 13 provide a detailed breakdown in the expected lifeline losses.

Table 12: Transportation System Economic Losses
(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	1148.4442	0.0000	0.00
	Bridges	244.8379	17.6862	7.22
	Tunnels	0.0000	0.0000	0.00
	Subtotal	**1393.2821**	**17.6862**	
Railways	Segments	269.7321	0.0000	0.00
	Bridges	223.3636	3.0791	1.38
	Tunnels	0.0000	0.0000	0.00
	Facilities	2.6630	1.2952	48.64
	Subtotal	**495.7587**	**4.3743**	
Light Rail	Segments	0.0000	0.0000	0.00
	Bridges	0.0000	0.0000	0.00
	Tunnels	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Bus	Facilities	2.9781	0.5154	17.31
	Subtotal	**2.9781**	**0.5154**	
Ferry	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Port	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Airport	Facilities	18.6136	1.8178	9.77
	Runways	116.0718	0.0000	0.00
	Subtotal	**134.6854**	**1.8178**	
	Total	**2,026.70**	**24.39**	

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Table 13: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	197.6131	7.2647	3.68
	Subtotal	**197.6131**	**7.2647**	
Waste Water	Pipelines	0.0000	0.0000	0.00
	Facilities	1064.7000	217.5994	20.44
	Distribution Lines	118.5678	3.6493	3.08
	Subtotal	**1183.2678**	**221.2487**	
Natural Gas	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Distribution Lines	79.0452	1.2502	1.58
	Subtotal	**79.0452**	**1.2502**	
Oil Systems	Pipelines	0.0000	0.0000	0.00
	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Electrical Power	Facilities	0.0000	0.0000	0.00
	Subtotal	**0.0000**	**0.0000**	
Communication	Facilities	1.0000	0.0526	5.26
	Subtotal	**1.0000**	**0.0526**	
	Total	**1,460.93**	**229.82**	

Appendix A: County Listing for the Region

Bingham,ID

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Idaho					
	Bingham	45,607	2,639	833	3,472
Total Region		**45,607**	**2,639**	**833**	**3,472**