3.7 RISK ASSESSMENT: DAM/LEVEE/CANAL FAILURE

DESCRIPTION

Dams

A dam is defined as an artificial barrier constructed across a watercourse for the purpose of storage, control, or diversion of water. Most dams typically are constructed of earth, rock, and/or concrete. Instead of storing water, some dams are designed and constructed to impound mine tailings slurry, wastewater, and liquefied industrial or food processing byproducts. A dam failure generally implies an uncontrolled release of impounded water or waste due to a catastrophic collapse, breach, or overtopping of the dam resulting in downstream flooding.

The storage area behind a dam commonly is referred to as the reservoir. The amount of storage in the reservoir is measured in acre-feet or gallons. An acre-foot is the volume of water that covers one surface acre of land (43,560 ft^2) to a depth of 1 foot (1 acre-foot equals 325,850 gallons). In most cases, three (3) factors influence the potential severity of a full or partial dam failure: the height of the dam, the amount of water impounded, and the extent of development and infrastructure located downstream.

American Falls Dam, Power County, Idaho / Source: Reclamation

Dam failures occur most often when the spillway capacity is exceeded and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation goes undetected or is allowed to continue without repair. On those occasions when internal erosion or overtopping results in a complete structural breach of the dam, the sudden release of a high-velocity wall of debris-laden water can rush downstream, damaging or destroying everything of value in its path.

Dam failures can result from any one or a combination of the following causes:

- Prolonged periods of rainfall or snowmelt runoff that exceeds the design capacity of the emergency spillway;
- Poor design, including inadequate spillway capacity, resulting in overtopping of the dam;
- Internal erosion caused by embankment or foundation leakage or piping;
- Lack of necessary maintenance and/or repair of deficient components;

- Improper construction , including the use of inadequate construction materials and practices;
- Negligent operation, including the failure of the dam owner to implement previously recommended safety features, practices, or standards of care;
- Failure of upstream dams on the same waterway;
- Landslides into reservoirs, which cause surges that result in overtopping;
- High winds, which can cause significant wave action and result in substantial erosion; and
- Earthquakes, landslides, and prolonged high winds; the latter which can cause significant wave erosion.

Levees

A levee is defined both as a naturally occurring ridge of sediment deposited by a flowing river, or an artificial structure designed to contain, control, or divert the flow of water to prevent flooding of adjacent lands. Natural levees are usually relatively low in height, broad at the base narrowing at the top, with side slopes generally equal to the material's angle of repose. Artificial levees are constructed using various materials ranging from soil, rock, concrete, sandbags, gabions, sheet-piling, or any combination thereof. Railroad and highway grades can serve to act as a levee(s) even though they may not have been constructed specifically for that purpose.

"Even though levees were originally constructed to reduce damages from flooding, they have often inadvertently increased flood risks by attracting greater development to the floodplain. In fact, many levees built to protect agricultural fields now stand between waterways and large urban communities."[1]

Similar to earthen dams, levees may fail by breaching or overtopping. Breaches potentially cause the most damage and can occur either through gradual erosion or sudden breaks, both of which can result in large amounts of water to flow uncontrollably onto adjacent lands. Contributors to levee failures include inadequate design, poor construction, lack of repair or maintenance to remove invasive vegetation and burrowing animals, earthquakes, and large floods that can cause erosion or overtopping. However, levees are unlike dams which typically are designed and constructed against overtopping for all but the most extreme of hydrologic events. Many levees are designed to accommodate a minimum standard. The minimum standard for the United State Army Corps of Engineers (USACE) rehabilitation and inspection program is 10% or a 10-year flood with 2 feet of freeboard. The implication to communities protected by a levee against a 100-year flood is not one of whether the levee will be overtopped, but instead when and/or how often the levee will be overtopped resulting in its potential failure and catastrophic flooding of adjacent lands. Communities need to consider fully the flood risks and establish protection measures for levee failures before they occur.

"Levees function as part of a system — what is happening upstream and downstream matters. A levee in a rural agricultural area may be designed to overtop in order to release floodwaters before it reaches

[1] http://www.leveesafety.org/levee.cfm

levees protecting a larger population where flood damages may be greater. Even the unexpected breach or levee failure in one part of the system may reduce the flood stage and thus save the system from failing in another section. In overtopping, the level of the flood water is simply higher than the height of the levee, and water flows over the top."[2] Up to date surveys of the height of the levee relative to its surroundings and awareness of any low areas at the top of the levee are important in reducing unexpected overtopping. During a flood event, the top of the levee may be raised temporarily by sandbags to prevent overtopping.

When a levee is overtopped and the land side of the levee is not adequately armored, the flowing waters can erode and undercut the levee and cause it to collapse. Water flowing through or under a levee will weaken and cause flooding on the land side. Water easily can flow through animal tunnels, along channels in the soil left by root systems, or through poorly compacted or sandy soils. "Sand boils" on the land side of the levee are an indication of water seepage. Wave action or scouring on the water side of the levee can reduce the width of the levee causing it to fail.

"For those who live or work behind a levee, the amount of time you have to prepare can make a significant difference. Studies have indicated that as little as 1 hour of notice can result in a ten-percent reduction in flood damages and lives saved. Saving property with less than 18 hours lead time is generally restricted to moving highly valued property, such as automobiles and major appliances, out of harm's way. When lead times are longer than 18 hours, floodplain residents can flood proof and flood fight (construct temporary levees, place sand bags, etc.) and evacuate well ahead of the flood."[3]

Canals

Thousands of canals throughout the state provide essential irrigation to agricultural lands. Unfortunately many of these existing features pose a potential flood risk to neighboring communities. Because most canals are earthen structures, they share many of the same potential failure modes with dams and levees. As with levees, canals may breach or overtop, threatening loss of life and property due to the flooding consequences. The probability for canal failure is increased when maintenance, repair, and regular inspection are neglected, and the risks to life and property are greater due to encroachment of subdivisions onto formerly vacant agricultural lands.

LOCATION, EXTENT, AND MAGNITUDE

Dams and levees are considered to be localized in the state and are most likely to affect pre-determined inundation areas downstream and areas immediately around the dam or levee. Assessing the risk that a dam or levee poses to downstream areas can be divided into three analyses: (1) analysis of the probability of failure for a given structure, (2) analysis of the flood wave characteristics and extent of inundation resulting from the uncontrolled release, and (3) analysis of the potential consequence to life

[2] http://www.leveesafety.org/lv_levee101.cfm
[3] http://www.leveesafety.org/lv_levee101.cfm

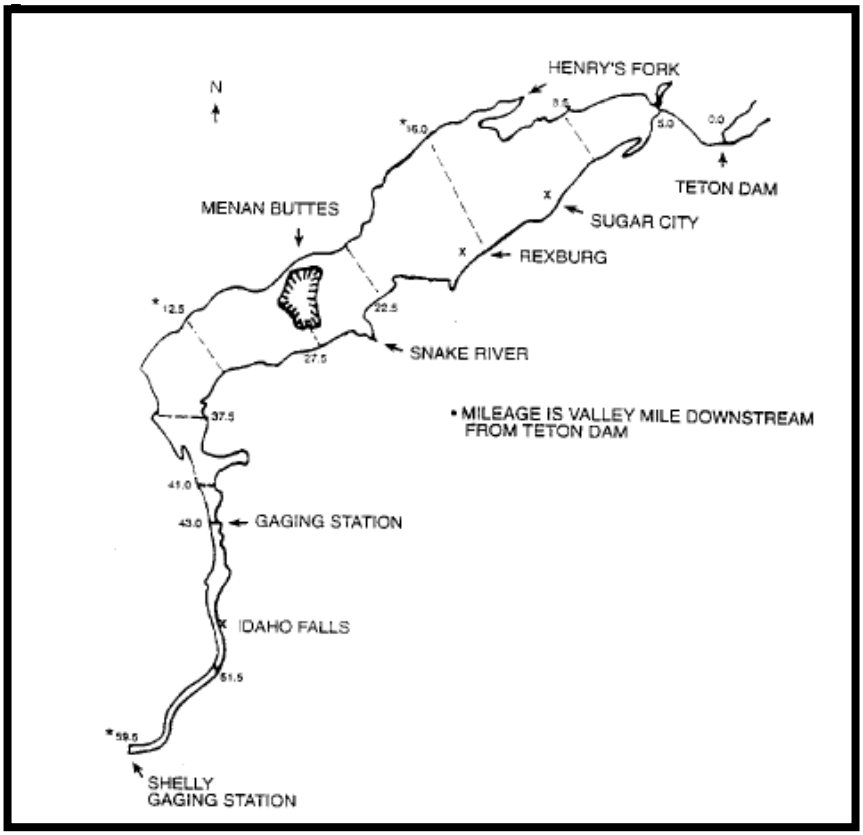
and property within the inundation zone. In other words, a dam fails, the failure causes flooding downstream, and the flooding has negative impacts on people or property. Prior to the occurrence, each of these analyses includes substantial uncertainty. Legitimate estimates of discharge from a breach can differ by over 200 percent. The sudden, uncontrolled release of water from a breach of a large dam is usually several times the 1-percent-annual-chance flood; therefore, typical flood studies are of limited use in estimating the extent of flooding.

Inundation studies require individuals with specialized training and hydraulic modeling software. Determining the impact of flooding is also difficult to accomplish, especially for estimating loss of life. Loss of life is a function of the time of day, warning time, population density, prior knowledge and awareness of those affected and particular failure scenarios. Many safety agencies have used "population at risk" to describe the potential for loss of human life. The population at risk is the total number of people living or working within the inundation area, who would be subject to significant personal danger if they took no action to evacuate. The impacts of a dam, levee, or canal failure are contingent on many factors and, therefore, cannot be concisely predicted. However, case studies based on the characteristics of dams that have failed in the past can provide valuable information for future planning.

Dams

In Idaho, the Teton Dam, a 300-foot-high earthen dam with a 3,000-foot-long crest and 250,000 acre-feet of stored water, failed catastrophically on June 5, 1976. This failure caused significant damages to the downstream Teton-Snake River Valley, with the inundation of an area as much as 9 miles wide and as far as 16 miles downstream of the dam (see Map 3.7.A).

A study conducted by the National Weather Service (NWS) explained that the Teton Dam failure had an approximate peak value of 2,183,000 cfs, a peak period of 1.43 hours, and a total duration of significant outflow of about 6 hours. This peak discharge was about 30 times greater than the flood of record at Idaho Falls.



Map 3.7.A: Teton Dam Inundation Area (Shelly Gaging Station is approximately 60 miles downstream of Teton Dam) / Source: BHS

Dams greater than or equal to 10 feet high or reservoirs with a storage capacity greater than or equal to 50 acre-feet are regulated by the Idaho Department of Water Resources (IDWR) Dam Safety Program. Each dam inspected by IDWR has a classification for both size and hazard. The size classification is a combination of dam height and reservoir storage capacity, as described below:

- Large – 40 feet high or more, or with a storage capacity of more than 4,000 acre-feet of water. *104 dams are currently listed as large*.

- Intermediate – between 20 and 40 feet high or with a storage capacity of 100 to 4,000 acre-feet of water. *198 dams are currently listed as intermediate*.

- Small – 20 feet high or less, with a storage capacity of less than 100 acre-feet of water. *244 dams are currently listed as small*.

The hazard rating that is used by the Dam Safety Program to classify dams and reservoirs is based on a three-tier system consisting of Low, Significant, and High hazard categories. It is important to note that the hazard classification assigned to any particular structure is based solely on the potential consequences to downstream life and property based on a potential failure of the dam and uncontrolled release of water. In addition, "Hazard" is not to be used synonymously with the term "Risk". Risk incorporates the probability of failure; thus risk is equal to some probability that a failure will occur multiplied by the resulting consequences to downstream life and property.

Cascade Dam / Source: ThinkStock.com

- High Hazard – A high-hazard rating does not imply or otherwise suggest that a dam suffers from an increased risk of failure. It simply means that if failure were to occur, the resulting consequences likely would be the direct loss of human life and extensive property damage. For this reason, all high-hazard dams must be properly designed, and at all times responsibly maintained and safely operated, because the consequences of failure are much too great. The Department of Water Resources considers the inundation of residential structures with floodwater from a dam break to a depth greater than or equal to 2 feet to be a sufficient reason for assigning a high hazard rating. *There are over 90 dams currently listed as having a high hazard potential*.

- Significant Hazard – Dams with a significant hazard are structures whose failure would result in significant damage to developed downstream property and infrastructure or indirectly cause the loss of human life. An example of the latter would be people killed or injured in an automobile crash after a roadway is washed out by flooding from a dam failure. *There are more than 130 dams currently listed as having a significant hazard potential*.

Low Hazard – Low hazard dams typically are located in sparsely populated areas that would be largely unaffected by a breach of the dam. Although the dam and appurtenant works may be totally destroyed, damages to downstream property would be restricted to undeveloped land, with minimal impacts to existing infrastructure. *There are 340 dams currently listed as having a low hazard*.

The USACE also manages the National Inventory of Dams (NID), which is a GIS database that tracks those dams that meet at least one of the following criteria:

- High hazard classification - loss of one human life is likely if the dam fails,
- Significant hazard classification - possible loss of human life and likely significant property or environmental destruction,
- Equal or exceed 25 feet in height and exceed 15 acre-feet in storage,
- Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

There are currently 447 dams tracked in the NID database. Map 3.7.D at the end of this chapter presents this same information, although it is difficult to visually present structure-related information on a State-wide map.

Levees

Most of the levees in Idaho are locally owned and maintained. There presently exists many miles of levees that have not been mapped, measured, or adequately inspected. Per Idaho Statute, levees are exempted from the IDWR dam safety regulations, and there is no other state agency tasked with specific duties to provide for public safety as it relates to design, construction, or inspection of levees. In most instances, the design, construction, and maintenance of levees is left to the discretion of local entities. Strategies being discussed at the State are to develop a state safety program to regulate new levees in general accordance with the Draft Recommendations for a National Levee Safety Program as presented in the 2009 Report to Congress.

The USACE owns and maintains only 2000 miles of levees out of over 10,000 miles of levees nationwide; however, it is federally authorized to construct and inspect levees with local non-federal sponsors who then are responsible for routine maintenance and repair. The USACE offers levee disaster flood reduction and flood fight training to qualified jurisdictions. Recently, the USACE developed a National Levee Database (NLD) with information and mapping of those Idaho levees that are included in the Corps Levee Safety Program. Unfortunately, the levees listed in the database represent a small percentage of the total number of levees in the state.

The Federal Emergency management Agency (FEMA) is responsible for accrediting levees for Flood Insurance Rate Maps in accordance with 44CFR 65.10, based on local certified documentation. Analysis of non-accredited levees by reaches or segments, public outreach, training, and materials are available through FEMA. FEMA also is in the process of completing work on the Mid-term Levee Inventory (MLI), a tracking geodatabase that will eventually unite under USACE's NLD.

The MLI and NLD datasets do contain the centerlines for all currently mapped levee segments in Idaho. Currently, the combined databases encompass 372 segments. Table 3.7.B below shows a breakdown of these levee segments by BHS Region. Map 3.7.E at the end of this chapter presents this same information, although it is difficult to visually present structure-related information on a State-wide map.

TABLE 3.7.B	Number of Levee Segments
Central	23
North Central	102
Northeast	41
Northern	131
Southeast	23
Southwest	52
TOTALS	**372**
	Source: FEMA (2012) & USACE (2012)

Canals

A majority of Idaho, with its average of 12 inches of rainfall per year, was developed through the Reclamation projects of the early 1900s. These projects included dams to collect water and provide flood control, and canals to deliver water to the agricultural areas. The presence of the canals is generally disregarded by the general public, despite the fact that a large number of canals crisscross the State. New and existing community development has encroached on the areas adjacent to the canals. In Ada County, a considerable number of housing developments are situated downstream of large-capacity canals. The proximity of development to this type of high flow, manmade channel creates a significant risk to life, safety, and property. Canal operators in Idaho have statutory easements so that they can maintain their canals and ditches, and many new and existing developments encroach directly into these easements. This encroachment, which in some cases is actually onto the banks of the canal, makes proper maintenance of the canals very difficult and can also compromise the safety of the canal. Canal operators should be consulted before new developments in the vicinity of their irrigation structures are approved in order to protect canal easements. This will ensure the canal operators have sufficient access to their canals so that they can maintain these irrigation structures and thus prevent future safety issues. Because most canals are privately owned and operated, and their construction

precedes Idaho's surface water laws, widespread data for canal failure events is not readily obtainable. The Silver Jackets technical advisory group has expressed strong interest in monitoring this issue, and BHS anticipates further discussions regarding this hazard.

PAST OCCURRENCE

Past failures of dams, levees, and canals are detailed below in the respective sections. Map 3.7.F at the end of this chapter provides a summary of these past events.

Dam Failure

Dam failure is infrequent but can have significant consequences. Idaho has experienced two major dam failures in recent history: Teton Dam (1976) and Kirby Dam (1991). There have also been a number of "near-miss" incidents, where disaster was averted.

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

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

Teton Dam Failure, June 1976. During the first filling of the reservoir, the dam burst when the water was 270ft deep. It drained in less than 6 hours, setting off more than 200 landslides in the canyon below, taking 11 lives, and causing millions of dollars in property damage. Source: http://www.damsafety.org/

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

Oakley Dam – 1984: Oakley Dam nearly overtopped - constructed canal to mitigate flooding

Twin Falls County Dam – 1984: Salmon Falls Creek release caused flooding

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

Brown's Pond Dam – 2010: Browns Pond Dam overtop and breach during rain on snow event - federal declaration (DR1927)

Levee Failure

Kootenai County Levee Failure – 2011: Hayden Lake imminent threat from wave erosion on dike

Canal Failure

New York Canal Failure – 1917, 1955, 1959: Built from 1906-1908 and enlarged in 1912, the canal runs through Boise, ID west for 40 miles to Lake Lowell. The structure's capacity is 2,800 cfs.

Ridenbaugh Canal Failure – 1973

Gem County Canal Failure – 2005: Occurred in Emmett, breach necessitated assistance from Gem County Road and Bridge Dept.

Mora Canal Failure – 2006: Constructed from 1909-1911 in Kuna, ID with a 1,300 cfs capacity, the canal breached due to unknown causes.

Logan Northern Canal Failure (Utah) – 2009: Southeast neighboring community Logan, Utah suffered a 2009 failure of the Logan Northern Canal resulting in 3 deaths and extensive residential damages. Just three years prior a Utah State University thesis warned the community of this danger as did multiple landslide studies.

Canyon County Canal Failure – 2010: Occurred in Wilder, Washed out road

Canyon County Canal Failure – 2011: Occurred in Caldwell, Flooded street, no apparent damage to homes, caused by gophers

Canyon County Canal Failure – 2011: Occurred in Caldwell, Washed out roads and flooded several homes

Elmore County Canal Failure – 2011: Occurred in Glenns Ferry, Flooded homes, basements, and streets, damaged a section of main railroad tracks

Jerome County Canal Failure – 2011: Occurred in Jerome, Flooded homes, basements, and streets and damaged a section of main railroad tracks.

Ada County Canal Failure – 2012: Residences in Ada County were threatened by a breach in a ditch that paralleled the Boise River during the summer of 2012. Pioneer Irrigation headgate and breach in poorly maintained section which impacted homes in Eagle and Star.

FUTURE OCCURRENCE

Most of the previously described causes for dam failure can be controlled through good design, proper construction, regular inspection by qualified personnel, and a commitment to strong enforcement to correct identified deficiencies. Likewise, the risk to downstream life and property can be reduced substantially with efforts to limit some types of development adjacent to streams and rivers. Unfortunately, past efforts to proactively mitigate these risks have met with only limited success. This limited success, combined with our aging infrastructure and nature's continued ability to visit extreme events on local populations, may actually have increased a dam's overall risk with each passing year.

Idaho's Dam Safety Program oversees the regulation and safety of dams and reservoirs throughout the State in order to protect the health, safety, and welfare of its citizens and their property. This program is required to assure proper planning, design review, construction oversight, and inspection of regulated dams and reservoirs. The Department currently regulates nearly 600 water storage dams and more than 20 mine tailings impoundment structures located throughout the State. Dam Safety Program personnel regularly inspect existing projects according to the potential consequences that the dam's failure would present to downstream life and property. The frequency of individual dam inspections depends on the project's physical condition, method of construction, maintenance record, age, hazard rating, and size and storage capacity. Nonetheless, all statutory-sized dams must be inspected by the Department at least every 5 years.

Hell's Canyon Dam / Source: ThinkStock.com

RELATIONSHIPS WITH OTHER HAZARDS

Dam, levee, and canal failures can lead to the initiation of a flooding event. The resulting hazard would share some of the characteristics of a flash flood. Dam, levee, and canal failures could also initiate landslide and/or avalanche events, in the areas where the inundation would occur. Depending on the

size of the structure that fails and the infrastructure within the inundation zone, a dam, levee, or canal failure could initiate a cyber-disruption or possible short term energy shortage.

ENVIRONMENTAL IMPACTS

Dam, levee, and/or canal failures can have a greater environmental impact than that associated with a normal flood event. The soil loss from erosion and scouring could be significantly greater, because of a large amount of fast-moving water affecting a small area. Large amounts of sediment from erosion can alter the landscape and change the ecosystem. In addition, hazardous materials are carried away from flooded properties and distributed throughout the floodplain. Industrial and agricultural chemicals and wastes, solid wastes, raw sewage, and common household chemicals comprise the majority of hazardous materials spread by floodwaters along the flood zone, polluting the environment and contaminating everything they come in contact with, including the community's water supply.

DEVELOPMENT TREND IMPACTS

The flood reduction afforded by dams throughout Idaho has allowed the development of lands immediately downstream of these structures. The same can be said of development in areas where levee structures provide protection from certain flooding events. Canals and irrigation structures have been increasingly faced with encroachment by urban and residential structures.

For example, the operator of the New York Canal makes every effort to properly maintain the canal, but decades of encroachment by urban and residential structures have compromised its ability to perform necessary maintenance on the canal. This development pattern likely will continue for the foreseeable future, increasing flood risks unless improved mitigation measures are taken.

CRITICAL INFRASTRUCTURE AND STATE FACILITY IMPACTS

Any State facilities or infrastructure located in the inundation zones of dams, levees, or canals would be those impacted by a failure event.

As part of the 2010 Plan update, one action that the State identified was the need to collect improved and up-to-date State-owned facility and infrastructure data in a geospatial format. As of the writing of the 2013 Plan update, this action is still considered in progress, although great strides have been made. The State Chief Information Officer (CIO) is currently working towards the realization of a State-owned facilities and infrastructure geodatabase. This on-going process has been slowed by recent budget shortfalls in addition to inconsistent data holdings across many of the State's Agencies. Once available, this database will enable for a more in-depth review of State-owned facilities and infrastructure, as it relates to both vulnerabilities to hazards and the associated loss estimations.

VULNERABILITY ASSESSMENT

As these water control structures continue to age, the likelihood or probability of failure increases. Undesirable woody vegetation on the embankment, deteriorated concrete, inoperable gates, and

corroded outlet pipes become problems. In addition to aging components, the probability for failure can be magnified by the inflow design flood and projected flood frequencies.

Property and populations downstream from any dam are vulnerable to harm from dam failure. However, communities downstream of high-hazard dams and large canals should pay particular attention to inspection and maintenance activities that keep their communities safe. Existing and new communities need to respect canal easements so that canal operators have sufficient access to properly maintain their canals to ensure public safety and efficient water delivery. Without these activities and oversight, the vulnerability increases significantly. The statewide occurrence of a high hazard dam failure should remain low if IDWR dam safety program duties are adequately funded and implemented, and enforcement activities are continued that encourage dam owner responsibility for maintenance and repair; including regular update and testing of their emergency action plan.

Levee Failure

Both FEMA and the USACE have produced GIS datasets that attempt to track and locate the numerous levees that are located across the State. The respective MLI and NLD datasets do contain mapped inundation zones for a portion of those areas protected by levees. Of the 372 total levee segments currently in these geodatabases for Idaho, there were 120 areas identified as being protected by those structures. Using this data layer, vulnerability analysis was performed on the ICRMP locally-owned facilities data. Table 3.7.C below presents the results of that analysis, showing those facilities that were located in levee-protected areas. This table, summarized at the BHS Regional level, includes counts of structures considered to be vulnerable to the threat of levee failure, in addition to the associated building values and building content values. Map 3.7.G at the end of this chapter presents this same information, although it is difficult to visually present structure-related information on a State-wide map. Additional details regarding the ICRMP data can be found in the introductory section of this chapter, Section 3.0.

The analysis below shows that all BHS Regions have local jurisdictionally-owned structures located in areas protected by levees, with the exception of the Central Region. The Region most vulnerable from both a percentage and overall total is the Northern, where 131 (9.8%) of those structures were determined to be located in those inundation zones. Statewide, those structures located in levee protected areas equate to 3.2% of these ICRMP local jurisdictional buildings, with a combined building value of $333 million.

TABLE 3.7.C	In Inundation Area			Statewide		
	Number of Facilities	Building Value ($M)	Building & Contents Value ($M)	Number of Facilities	Building Value ($M)	Building & Contents Value ($M)
Central	0	$0	$0	1,570	$815	$972
North Central	65	$119	$138	756	$248	$289
Northeast	25	$12	$12	994	$474	$580
Northern	131	$188	$257	1,334	$669	$850
Southeast	38	$10	$14	1,270	$381	$488
Southwest	18	$4	$4	2,513	$1,090	$1,310
TOTALS	**277**	**$333**	**$425**	**8,437**	**$3,677**	**$4,489**

Local Hazard Mitigation Plan Vulnerability Assessments

Four local plans (Bonneville County, Canyon County, Custer County, and Fremont County) ranked dam, levee, or canal failure as one of their major hazards (see Map 3.7.H at the end of this section). Bonneville and Canyon Counties assessed that they have 427 and 4,784 structures, respectively, in areas of potential dam or levee failure and corresponding inundation. Custer County assessed that they have 1,568 parcels potentially impacted. Detailed information related to local vulnerability may be found in those local hazard mitigation plans.

Since the 2010 State Plan update, Canyon County was the only jurisdiction to upgrade the risk of the dam/levee/canal failure hazard to high. There were no localities that diminished their consideration of dam/levee/canal failures.

LOSS ESTIMATION

From a statewide perspective, losses from a potential dam or levee or canal failure are difficult to quantify. Based on the historical record, a dam failure with the magnitude of the Teton Dam occurrence would cause estimated losses of approximately $2 billion. However, the Teton Dam failure did not impact major population centers or cause a cascade effect (where downstream dams and levees failed). Smaller dam/levee failures usually result in crop, livestock, and local infrastructure losses (bridge collapses, etc.), possibly affecting buildings and people. Large dam/levee failures have a significantly greater potential impact on the loss of life.

Levee Failure

The vulnerability assessment documented above was able to also provide initial estimates as they relate to possible losses for the hazard of levee failure. See Table 3.7.C above for the loss estimates that were produced as part of that assessment.

Local Hazard Mitigation Plan Loss Estimations

The local mitigation plan roll-up estimates that losses for a levee or dam failure event could reach the millions, depending on where it occurs. Of the four jurisdictions that ranked dam/levee/canal failure as a major hazard, three provided loss estimations that all suggested an event would be capable of causing losses on the order of tens to hundreds of millions of dollars. (Bonneville County - $795,240,000, Custer County - $15,131,352, and Canyon County - $495,212,330).

MITIGATION RATIONALE

The primary rationale for mitigating risks associated with dam, canal, and levee failure is the potential for loss of life and economic loss. Dam safety regulation of dam design and construction, although improving, remains imperfect, and the necessity for risk mitigation remains. Presently, a comprehensive inventory of levees and levee systems in Idaho does not exist. Further, with the exception of some federal-owned levees, most do not benefit from regular safety inspections as typically are provided for Idaho's dams. Risk mitigation is strongly dependent on 1) reducing the probability that failure will occur, and 2) reducing the potential damage to life and property resulting from the failure. Absent a comprehensive levee inventory and inspection program, any substantial mitigation of risk associated with levees/ levee systems is unlikely.

GENERAL MITIGATION APPROACHES

The mitigation of risk associated with dam failure can depend on whether the dam is a new or existing structure. New dams can be designed to meet stringent safety criteria, including the passage of extreme flood discharges and resistivity to earthquakes thereby lowering the probability for failure. Land downstream of new dams, or in the vicinity of existing canals, can be zoned or otherwise regulated to limit new construction and exposure, and thus reduce the hazard potential.

Recent flood events have brought to light concerns regarding levees and dikes in Idaho. For various reasons, confusion and misconceptions exist regarding levees and dikes. Moreover, Idaho residents and elected officials, both new and old, maintain false assumptions regarding the ownership and maintenance of canals, levees, and dikes. The encroachment of existing and new development into canal easements must be addressed so that canal operators can properly maintain their infrastructure. Addressing the risks associated with existing levees often is problematic, especially when the structure is located on multiple properties and/or ownership cannot be determined easily. Regarding dams, an important aspect to help reduce risk is the development of an Emergency Action Plan (EAP) that is focused on the proper operation of the dam, advanced warning, and evacuation instructions. Unfortunately, most levees and levee systems in Idaho do not have an equivalent mechanism comparable to EAPs for high hazard dams. In extreme or unique cases, removing a dam, levee, or canal may be the most efficient and cost-effective approach to mitigating imminent risk to life and property.

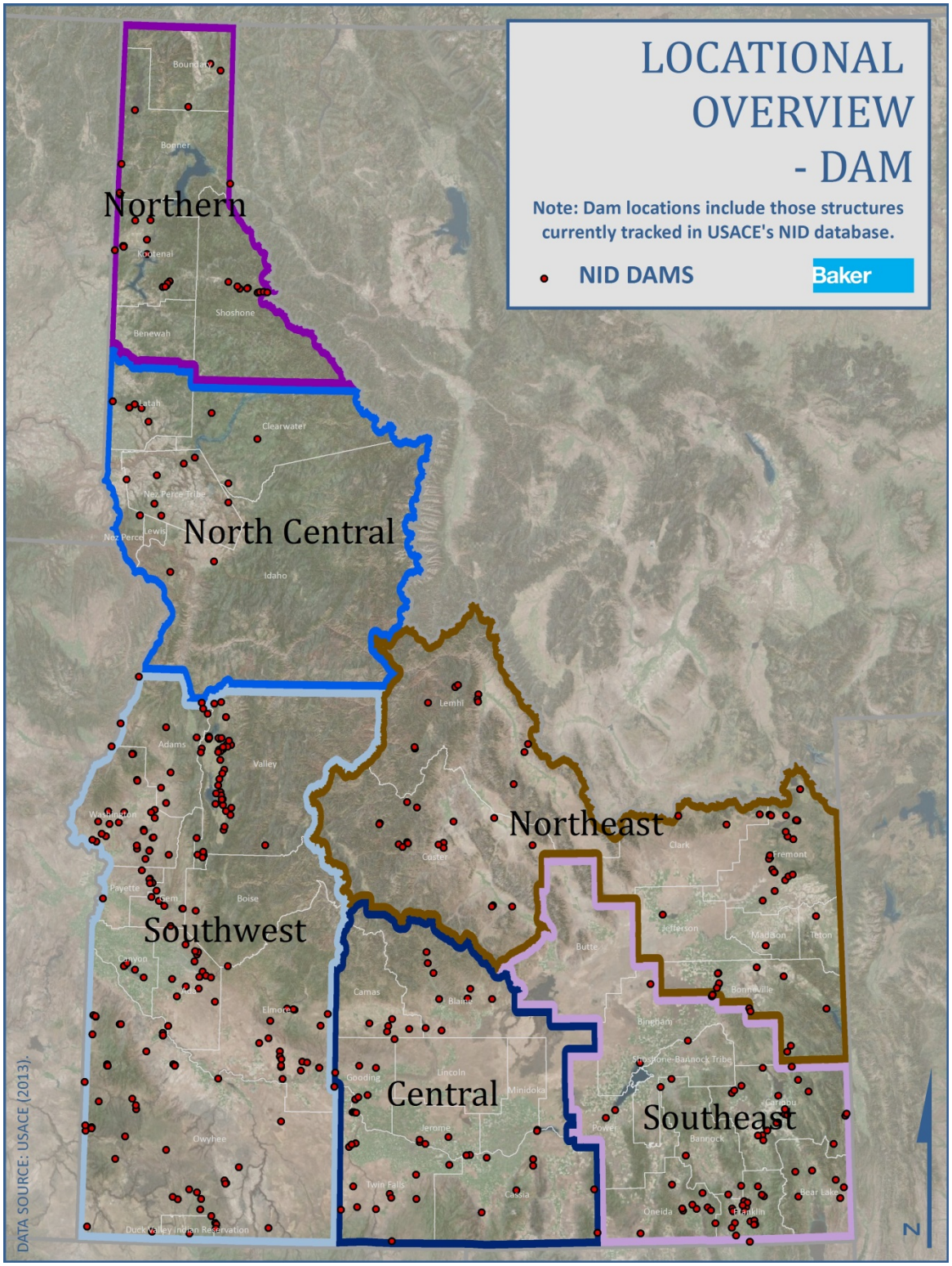
Public awareness measures, such as notices on final plats and public education on dam safety, are proactive mitigation measures that should be implemented by local communities. Reclamation and operators of canals and irrigation structures must be allowed input on future development in the area of

their structures for the safety of both the development and so that operators can safely perform the operation and maintenance of their structures. The Bureau of Reclamation's authority to prevent encroachments and to deal with existing encroachments, including removal, should be strengthened. Also, Emergency Action Plans that establish potential dam failure inundation limits, notification procedures, and thresholds are prepared for response to potential dam related disaster events.

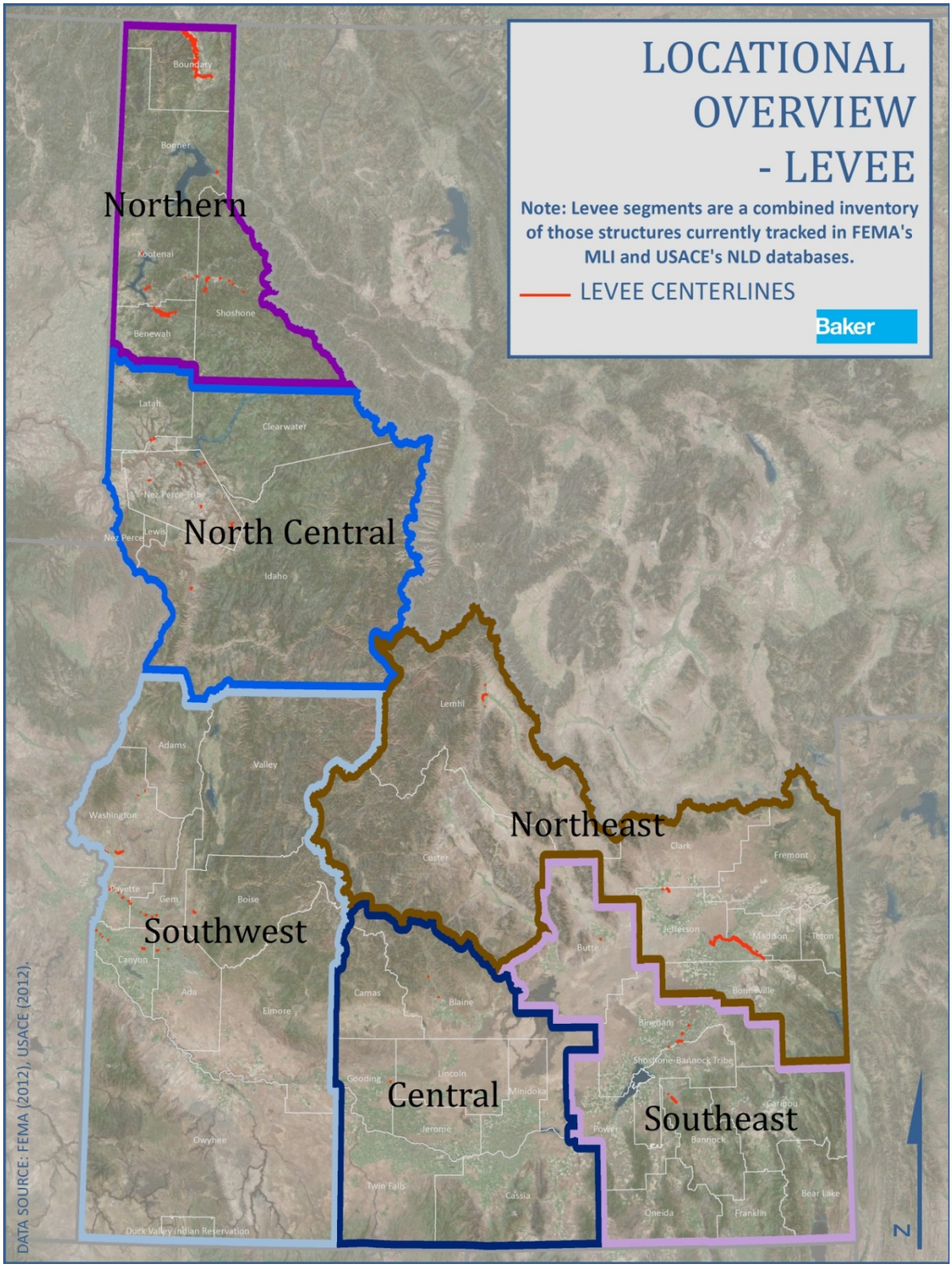
Mapping / Analysis / Planning

An accurate understanding of a hazard is the first step towards successful mitigation. To fully understand a hazard and the risk that it poses, the ability to accurately assess vulnerability is vital. After vulnerability is determined, it is then possible to assess potential losses if a state inventory of facilities and infrastructure is available.

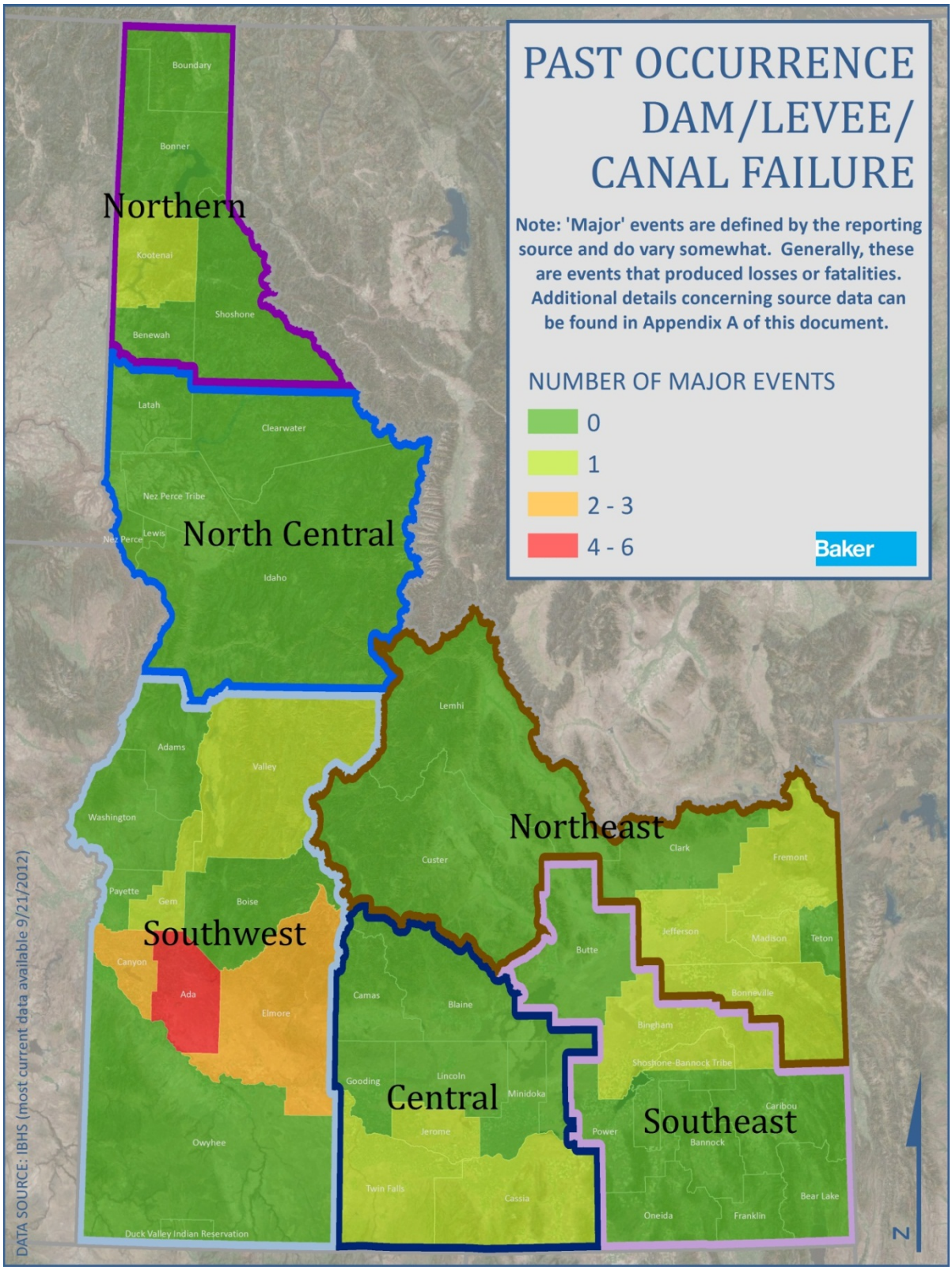
At the time of the 2013 Plan update, major advances in the availability of various data inputs allowed for an improved vulnerability and loss assessment to be performed. Continued refinement of both vulnerability and inventory data will enable for continued refinements in the risk assessment process.



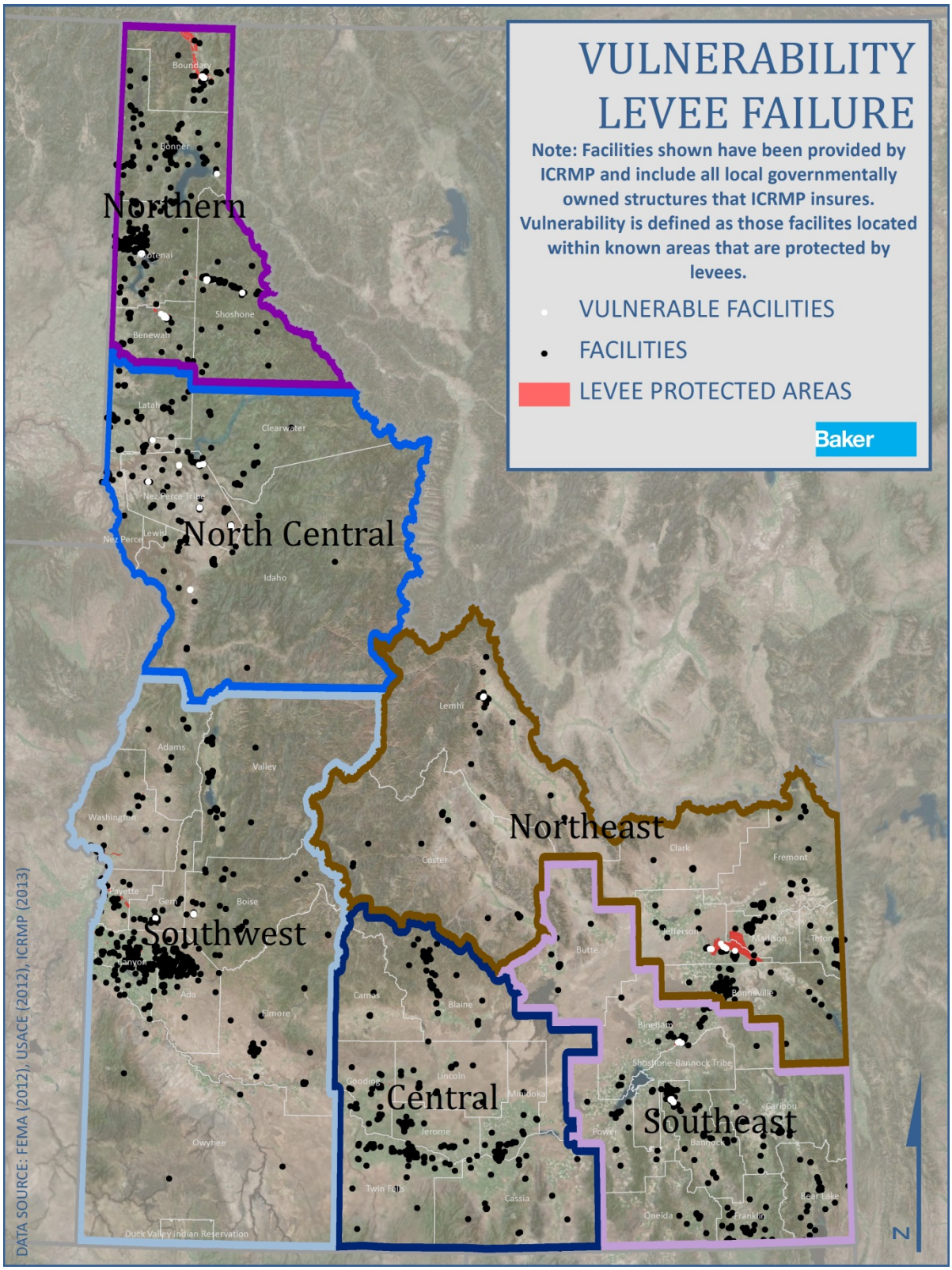
Map 3.7.D: Locations of Dams



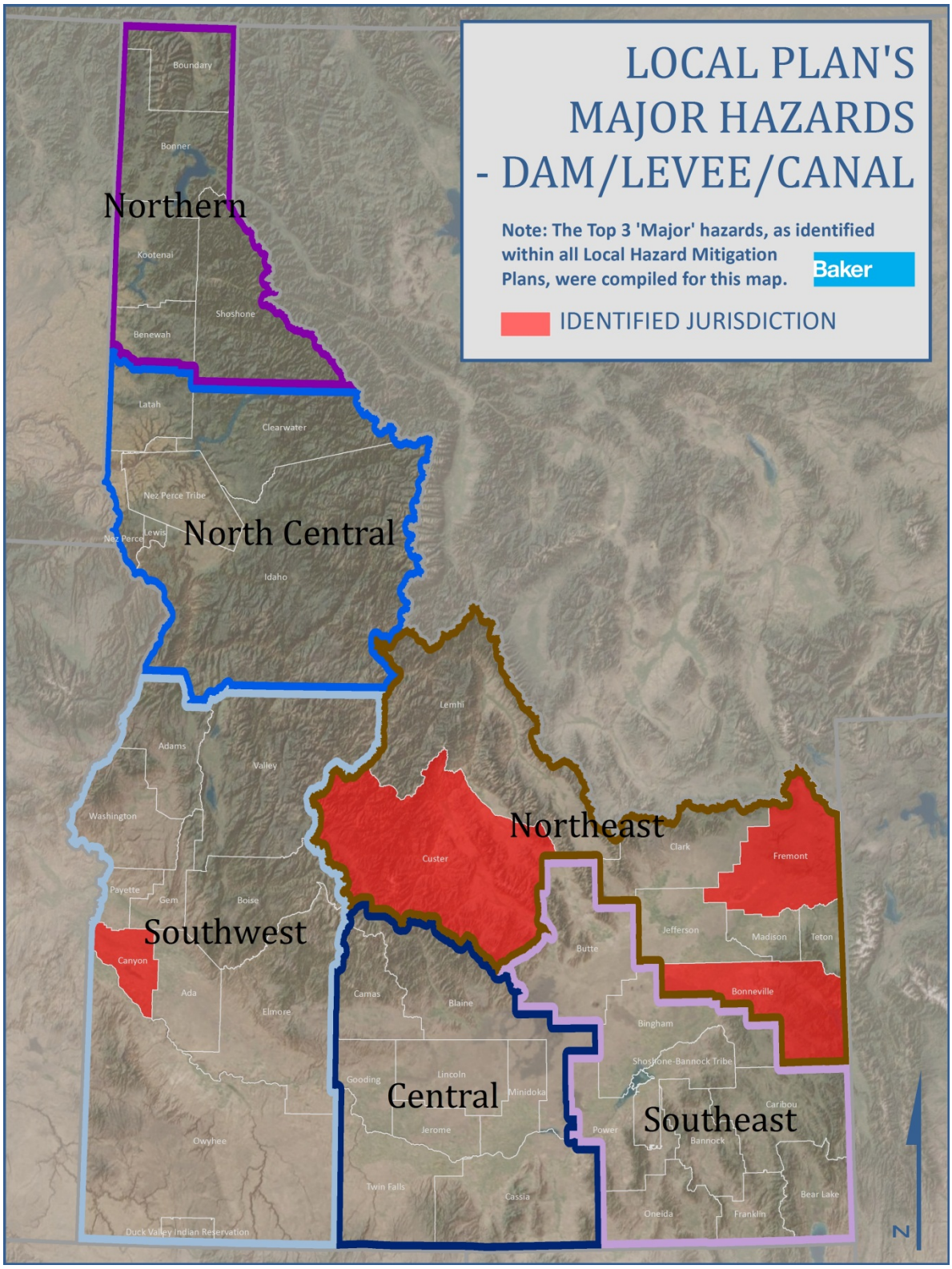
Map 3.7.E: Locations of Levees



Map 3.7.F: Past Dam / Levee / Canal Failure Occurrence



Map 3.7.G: Levee Failure Vulnerability



Map 3.7.H: Dam / Levee / Canal Failure Identified as Local Plan Major Hazard