

## 4.4 Dam Failure Hazard Profile



Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters, such as earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

### 4.4.1 Regulatory Oversight

#### 4.4.1.1 Colorado Division of Water Resources Dam Safety Branch

The Dam Safety Program is administered by the Division's Dam Safety section. The section consists of two units; one is the Design Review and Construction Inspection Unit, and the other is the Dam Safety Engineering Unit. The program is managed by a Chief Engineer, who develops program goals and objectives and is responsible for deciding the kind and extent of engineering programs needed to accomplish the objectives, and to assure they are being met. The section carries out two principal duties of the State Engineer: to determine the safe storage level of the reservoir dams in the state; and to approve the plans and specifications for the construction and repair of Jurisdictional dams.

#### 4.4.1.2 U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety.

#### 4.4.1.3 Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. The FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. There are 3,036 dams that are part of regulated hydroelectric projects in the FERC program. Two-thirds



of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC staff inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent consulting engineer, approved by the FERC, must inspect and evaluate projects with dams higher than 10 meters (32.8 feet), or with a total storage capacity of more than 2,000 acre-feet.

FERC staff monitors and evaluates seismic research in geographic areas where there are concerns about seismic activity. This information is applied in investigating and performing structural analyses of hydroelectric projects in these areas. FERC staff also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC staff visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

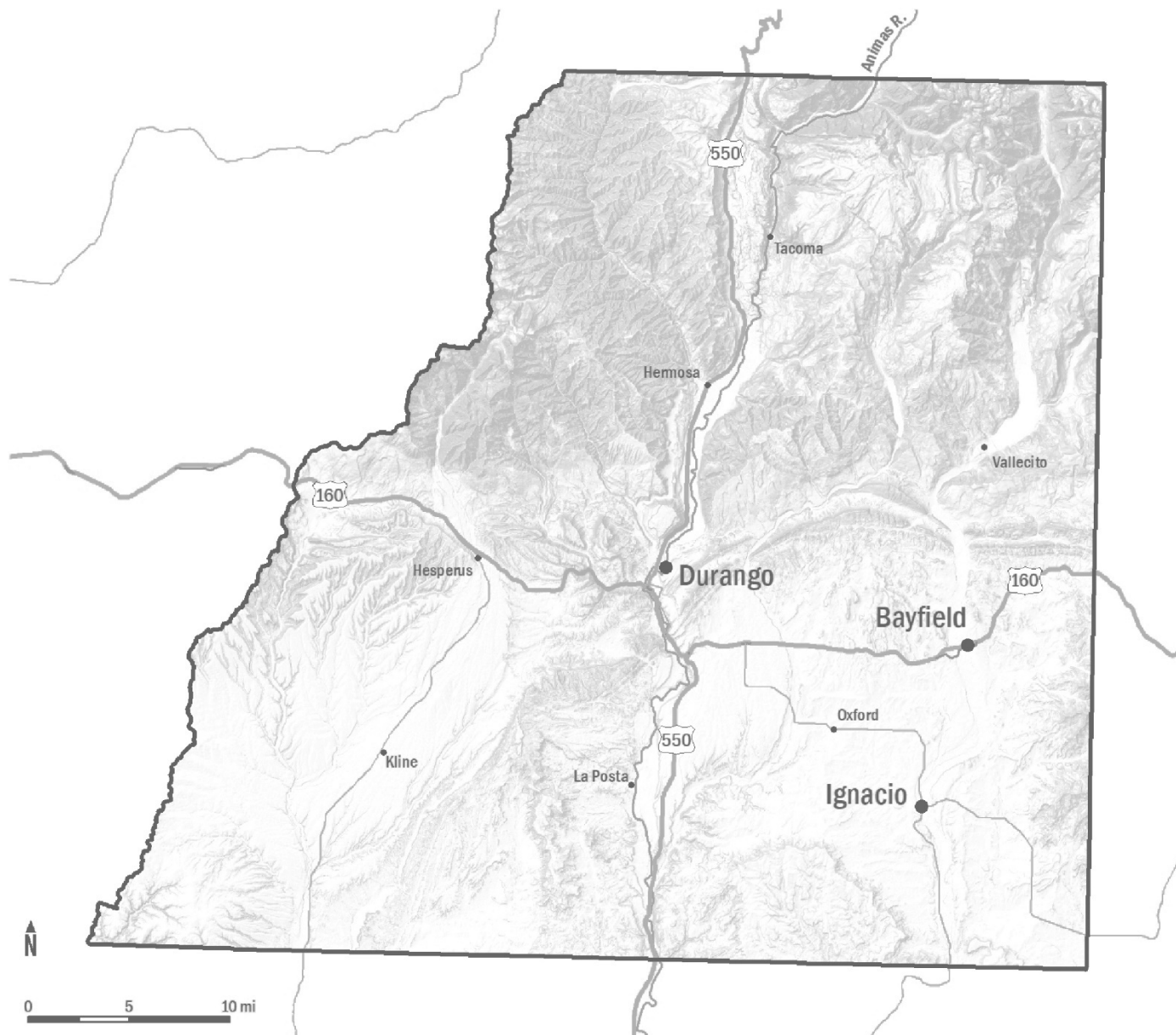
The FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

#### **4.4.2 Past Events**

There has been one instance of dam failure within La Plata County. In October 2006, flooding along Vallecito Creek over a two-day period breached flood control structures at several points. The flood control structures were subsequently destroyed and flood waters came up to the foundation of houses, leaving at least 18 surrounded by water. Residents of Vallecito and North Vallecito were evacuated by law enforcement and other emergency service providers mostly prior to the dike and levee failures. (La Plata County Hazard Mitigation Plan, 2013)

#### **4.4.3 Location**

According to the Colorado Division of Water Resources Dam Safety Branch, there are 47 dams in La Plata County. Table 4-9 lists these dams. Hazard class definitions can be found in Table 4-10 in Section 4.4.2.4. Inundation zones for the Electra Terminal, Electra Stage, Forest Lakes, Lemon, Long Hollow, Pastorious East, Pastorious West, Red Mesa, Ridges Basin, Turner, and Vallecito have been omitted from this plan due to their sensitive nature (see Figure 4-10). These are dams affecting the planning area for which inundation mapping has been prepared. Areas of the County most threatened by dam inundation are those primarily along the Animas River, Pine River and Florida River corridors.



**MAP REDACTED**  
contact county for more information

Figure 4-10: Redacted Dam Inundation Map



Table 4-9: Dams in La Plata County

Dam Number	Dam Name	Year Completed	Hazard Class	Overall Conditions
300102	Durango Terminal	1954	High	Conditionally Satisfactory
300104	Columbine	1905	N	
300105	Terminal	1981	High	Satisfactory
300106	Haviland Lake	1927	High	Conditionally Satisfactory
300107	Henderson Lake	1966	Low	Conditionally Satisfactory
300109	Hutchinson	1947	Low	Conditionally Satisfactory
300110	Keeler	1945	Significant	Satisfactory
300111	Lemon	1963	High	Satisfactory
300113	Turner	1969	High	Satisfactory
300115	Durango #1	1899	Low	Conditionally Satisfactory
300123	Clifty Lodge	1952	N	
300124	Charles Lemon R R	1971	Low	Conditionally Satisfactory
300125	Cascade #3	1902	Low	Conditionally Satisfactory
300126	Pastorius - Main Dam	1903	Significant	Conditionally Satisfactory
300127	Warner #5	1970	Low	Conditionally Satisfactory
300128	Johnson	1982	High	Conditionally Satisfactory
300129	Aspaas	1981	Low	Satisfactory
300130	Duncan	1978	Significant	Satisfactory
300131	Granite Dam	1983	Low	Satisfactory
300132	Lake Susan	1965	NPH	
300133	Muleshoe	1996	Low	Conditionally Satisfactory
300134	Warner #4	1995	Low	
300135	Sierra Verde #1	1950	Low	Conditionally Satisfactory



Dam Number	Dam Name	Year Completed	Hazard Class	Overall Conditions
300136	Sierra Verde #2	1960	Low	Conditionally Satisfactory
300139	Amber	1989	Low	Satisfactory
300140	Johnson #2		Low	Satisfactory
300141	Johnson #3		NPH	Conditionally Satisfactory
300142	Pastorius - East Dike	1923	Significant	Conditionally Satisfactory
300144	Upper Railroad	1960	Low	Unsatisfactory
300145	El Rancho Florida	1981	Low	Conditionally Satisfactory
300146	Kem Lake	1984	Low	Conditionally Satisfactory
300147	Smith Lake	1947	NPH	Unsatisfactory
300149	Warner #8	1995	NPH	
300150	Bonner Pond		Low	Unsatisfactory
300151	Ridges Basin	2006	High	
300152	Mill Creek No. 1			
310102	Pine River Watershed P. R. 1	1967	Low	Conditionally Satisfactory
310103	Pine River Watershed P. R. 2	1968	Low	Satisfactory
310104	Wommer #1	1952	High	Conditionally Satisfactory
310105	Vallecito	1941	High	
310108	Charter Corp #1-72	1972	Low	Conditionally Satisfactory
310110	Reservoir #2	1966	N	
310111	Wildorado	1910	NPH	
310113	Thibodeaux		Significant	Conditionally Satisfactory
330105	Red Mesa Ward	1915	High	Conditionally Satisfactory
330106	Labato	1940	Low	Conditionally Satisfactory
330107	Long Hollow	2014	High	Conditionally Satisfactory



### 4.4.4 Frequency / Probability of Future Occurrences

Dams are constructed with safety features known as “spillways” that allow water to overtop the dam if the reservoir fills too quickly. Spillway overflow events, often referred to as “design failures,” result in increased discharges downstream and increased flooding potential. The “residual risk” associated with dams is the risk beyond that for which safeguards have been implemented. However, the probability of any type of dam failure is low in today’s regulatory and dam safety oversight environment. Dam failure events usually coincide with events such as earthquakes, landslides and excessive rainfall and snowmelt.

### 4.4.5 Severity

Dam failure can be catastrophic to all life and property downstream. FEMA developed the classification system shown in Table 4-10 for the hazard potential of dam failures. This hazard potential classification system categorizes dams based on the probable loss of human life and the impacts on economic, environmental, and lifeline interests. Improbable loss of life exists where persons are only temporarily in the potential inundation area. For instance, this hazard potential classification system does not contemplate the improbable loss of life of the occasional recreational user of the river and downstream lands, passer-by, or non-overnight outdoor user of downstream lands. It should be understood that in any classification system, all possibilities cannot be defined. High usage areas of any type should be considered appropriately. Judgment and common sense must ultimately be a part of any decision on classification. Further, no allowances for evacuation or other emergency actions by the population should be considered because emergency procedures should not be a substitute for appropriate design, construction, and maintenance of dam structures.

Table 4-10: FEMA Hazard Potential Classification

Hazard Potential Classification	Loss of Human Life	Economic, Environmental, Lifeline Losses
Low	None expected	Low and generally limited to owner
Significant	None expected	Yes
High	Probable. One or more expected	Yes (but not necessary for this classification)

Source: Federal Guidelines for Dam Safety- Hazard Potential Classification Systems for Dams, April 2004

The dams in La Plata County are irrigation dams, not flood-control structures. Therefore, localized flooding may be exacerbated by mandatory dam releases and overtopping during significant storm events. Discharges during a 100-YR or greater event are a significant problem. For example, in August 2001, Vallecito and Lemon Dams were dangerously close to overtopping. Places at risk include the Town of Bayfield, and residential properties along Vallecito Creek and the Florida and Pine Rivers. (La Plata County Hazard Mitigation Plan, 2013)

### 4.4.6 Warning Time

Warning time for dam failure depends on the cause of failure. In an event of extreme precipitation or massive snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam’s structural type also affects warning time. Earthen dams do not tend to fail instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir water is depleted or the breach resists further erosion. Concrete gravity dams also tend to have a partial breach. The time of breach formation ranges from a few minutes to a few hours.

Development of Emergency Action Plans (EAPs) for all high and significant hazard potential dams is critical to reducing the risks of loss of life and property damage from dam failures. The EAP contains procedures and information to assist the dam owner in issuing early warning and notification messages to emergency management authorities. The EAP also contains inundation maps to identify the areas subject to flooding in the unlikely event of dam failure.

EAPs are critical in identifying areas downstream from dams requiring warning and evacuation in the event of dam failure. Documented cases have demonstrated that warning and evacuation time for EAPs can dramatically influence the loss of life. Loss of life can vary from 0.02 percent of the persons-at-risk when the warning time is 90 minutes to 50 percent when less than 15 minutes (Graham, 1988). Costa (85-560, 1985) reported that the average number of fatalities per dam failure is 19 times greater when there is little to no warning. Dam breach inundation studies usually assume one of two failure scenarios:

- Flows from a dam failure during “fair weather” or “sunny day” conditions with the reservoir at the normal pool level and receiving normal inflow (usually insignificant). A fair weather failure is generally considered to have the most potential for loss of human life, primarily due to the element of surprise.
- Flows from a dam failure during flood conditions or the inflow design flood. Failure during flood conditions is considered to show the upper limit of inundation and to have less potential for loss of human life because the downstream population is “on alert.” The flood conditions scenario is more expensive to analyze due to the additional cost for the necessary watershed and spillway studies.

Inundation mapping shows a continuous “line of inundation” identifying the area potentially at risk in event of dam failure. It starts at the dam and continues downstream to a point where the breach flood no longer poses a risk to life and property damage, such as a large river or reservoir with the capacity of storing the flood waters. The need to consider the “domino effect” should be made on a case-by-case basis if the assumed failure of a dam would cause the failure of any downstream dams.

Important to Note: EAPs are not publicly available but are on file at the La Plata County Office of Emergency Management. Information provided on flooding conditions at downstream locations will include:

- Distance downstream
- Arrival time of leading edge of flood wave
- Peak flow depth, incremental rise, or water surface elevation (as appropriate)
- Peak velocity

#### **4.4.7 Secondary Hazards**

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat. Dam failure can also impact septic systems.

#### **4.4.8 Climate Change Impacts**

The variability that exists in Colorado’s climate, with both floods and droughts commonly occurring, means Colorado may require additional storage. Increased storage will enable water to be held during times of surplus and released when demand is greatest. This could substantially aid users, such as farmers and municipalities, who have the greatest demand for water in the summer months when peak runoff has already passed. Because of the challenges that exist in building new



reservoirs, additional storage may instead come from enlargement or reallocation of existing reservoirs, thereby making better use of infrastructure already in place. Dam enlargement can be less costly, less environmentally harmful, and somewhat less contentious than construction of entirely new storage facilities—making it a more ideal solution to meet our needs for additional storage. The Colorado Division of Water Resources is analyzing opportunities throughout the state where enlargement potential exists. Further exploration of these opportunities may help increase the state’s climate resilience. Climate change should be considered to the extent practicable to maximize the usefulness of the overall project goals and objectives. (Colorado Climate Plan- State Level Policies and Strategies to Mitigate and Adapt, 2015)

Dams are designed partly based on assumptions about a river’s flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures. If the hydrograph changes, then dam operators may be forced to release increased volumes earlier in a storm cycle to maintain required margins of safety. Such early releases can increase flood potential downstream. Throughout the western United States, communities downstream of dams are already experiencing increases in stream flows from earlier releases from dams.

#### 4.4.9 Dam Failure Vulnerability Analysis

This section describes vulnerabilities to dam inundation in terms of population, property and infrastructure. The primary danger associated with dam failure is the high velocity flooding downstream of the dam and limited warning times for evacuation. Vulnerability varies by community and depends on the particular dam profile and the nature and extent of the failure. Dam inundation zones provided by La Plata County GIS were used to develop exposure for dam failure.

Dam Failure exposure snapshot results for the County were generated using the spatial extent of dam inundation zones and the following data sources: Population: Census TIGER Data (2016); Parcel Value: La Plata County Assessor, La Plata County GIS; Critical Infrastructure: La Plata County GIS, Colorado Health Facilities and Emergency Medical Services Division of the Colorado Department of Public Health and Environment, Colorado Department of Human Services, US Department of Transportation National Bridge Inventory, FEMA, USACE. County assessor data does not include tax exempt structures, such as federal and local government buildings except where market values were provided for such holdings. Table 4-11 provides a snapshot of vulnerability data to dam failure. All data sources have a level of accuracy acceptable for planning purposes. Details for each snapshot can be found in this section.

**Table 4-11: Dam Failure Vulnerability Snapshot (Unincorporated La Plata County)**

Exposed Population	Exposed Market Value (\$)	Exposed Content Value (\$)	Exposed Critical Facilities	Exposed Miles of Lifeline
2,920	\$ 313,385,780	\$ 162,331,260	768	114
11.8% <i>total pop.</i>	7.1% <i>total value</i>	7.0% <i>total value</i>	5.0% <i>total count</i>	4.5% <i>total mileage</i>

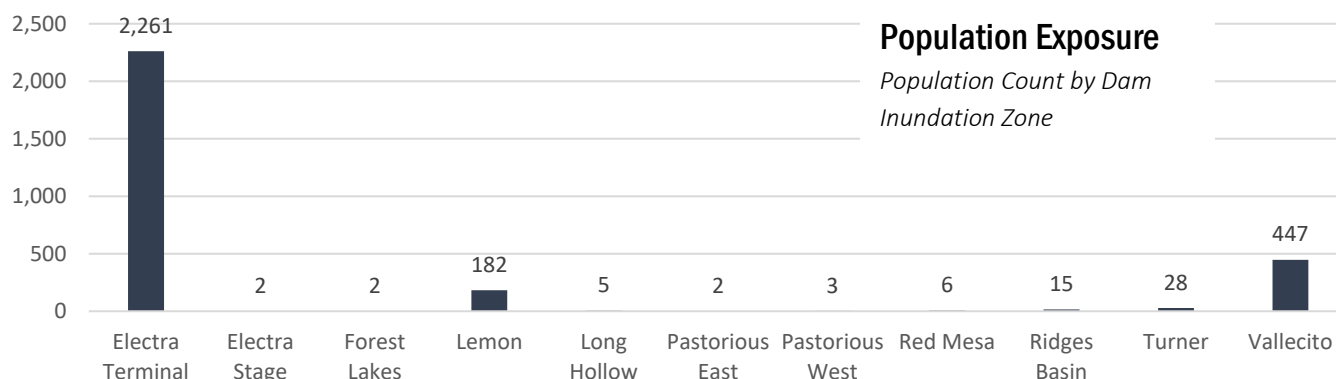
##### 4.4.9.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television,



radio emergency warning system, have not registered with CodeRed, or do not have cell phones that can receive amber alerts. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The entire population in a dam failure inundation zone is exposed to the risk of a dam failure. The estimated population living in the inundation area mapped for this risk assessment is summarized in Figure 4-10 and Table 4-12.

**Figure 4-11: Population Exposure to Dam Failure (La Plata County Unincorporated)**



**Table 4-12: Population Exposure to Dam Failure (La Plata County Unincorporated)**

		Total Population
La Plata Unincorporated		24,711

Dam Inundation Zone	Population Count	% of Total
Electra Terminal	2,261	9.15%
Electra Stage	2	0.01%
Forest Lakes	2	0.01%
Lemon	182	0.74%
Long Hollow	5	0.02%
Pastorious East	2	0.01%
Pastorious West	3	0.01%
Red Mesa	6	0.02%
Ridges Basin	15	0.06%
Turner	28	0.11%
Vallecito	447	1.81%

**Total\*** 2,920 11.81%

\*total population is not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.



### 4.4.9.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

The county Assessor’s parcel data was used as the basis for the inventory of current market values and content value summaries. GIS was used to create centroids, or points, to represent the center of each parcel polygon – this is assumed to be the location of the structure for analysis purposes. The centroids were then overlaid with the inundation zones to determine the at-risk structures. This methodology assumed that every parcel with a current net value or assessed value was an improved parcel. Building exposure was calculated based on current net values or when absent, assessor’s values as provided by the assessor’s office. Building content exposure was calculated based on occupancy type multipliers and improvement value. Table 4-13 shows the count of at-risk parcels and their associated building and content exposure values to dam failure.

*A total of \$475,717,040 worth of buildings and contents are exposed to dam failure hazards within unincorporated County representing 7% of the total value within unincorporated county.*

**Table 4-13: Parcel Values at Risk from Dam Inundation (Unincorporated La Plata County)**

	Total Parcels	Total Market Value (\$)	Total Content Value (\$)	Total Value (\$)
La Plata Unincorporated	23,417	\$ 4,444,920,130	\$ 2,321,780,140	\$ 6,766,700,270

Dam Inundation Zone	Parcel Count	% of Total	Market Value Exposure (\$)	Content Value Exposure (\$)	Total Exposure (\$)	% of Total
Electra Terminal	631	2.7%	\$ 213,892,230.00	\$ 111,732,985.00	\$ 325,625,215.00	4.81%
Electra Stage	2	0.0%	\$ 469,070.00	\$ 318,270.00	\$ 787,340.00	0.01%
Forest Lakes	8	0.0%	\$ 1,199,740.00	\$ 599,870.00	\$ 1,799,610.00	0.03%
Lemon	243	1.0%	\$ 42,278,350.00	\$ 21,519,980.00	\$ 63,798,330.00	0.94%
Long Hollow	7	0.0%	\$ 748,760.00	\$ 380,060.00	\$ 1,128,820.00	0.02%
Pastorious East	2	0.0%	\$ 823,100.00	\$ 411,550.00	\$ 1,234,650.00	0.02%
Pastorious West	4	0.0%	\$ 852,760.00	\$ 438,600.00	\$ 1,291,360.00	0.02%
Red Mesa	8	0.0%	\$ 801,510.00	\$ 411,145.00	\$ 1,212,655.00	0.02%
Ridges Basin	81	0.3%	\$ 15,807,470.00	\$ 7,919,490.00	\$ 23,726,960.00	0.35%
Turner	39	0.2%	\$ 7,924,200.00	\$ 3,985,400.00	\$ 11,909,600.00	0.18%
Vallecito	244	1.0%	\$ 34,044,820.00	\$ 17,361,180.00	\$ 51,406,000.00	0.76%
<b>Dam Inundation Area*</b>	<b>1,224</b>	<b>5.2%</b>	<b>\$ 313,385,780</b>	<b>\$ 162,331,260</b>	<b>\$ 475,717,040</b>	<b>7.0%</b>

\*totals are not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.



### 4.4.9.3 Critical Facilities

Critical Facilities at risk to dam inundation are on file with the County and for national security purposes can only be accessed through La Plata County Office of Emergency Services. As a general note, low-lying areas are vulnerable to dam inundation, especially transportation routes. This includes all roads, railroads, and bridges in the flow path of water. The most vulnerable critical facilities are those in poor condition that would have difficulty withstanding a large surge of water. Utilities such as overhead power lines and communication lines could also be vulnerable. Loss of these utilities could create additional compounding issues for emergency management officials attempting to conduct evacuation and response actions. GIS analysis determined that 768 critical facilities points and 113.9 miles of life line are in a mapped dam inundation area, as summarized in Table 4-14 and Table 4-15.

**Table 4-14: Critical Infrastructure Points in Dam Inundation Zones**

Infrastructure Type	Total Feature Count	Vallecito	Electra Terminal	Forest Lakes	Lemon	Long Hollow	Pastorious East	Pastorious West	Red Mesa	Ridges Basin	Turner	Electra Stage
<b>Essential Facility</b>	<b>3</b>	3	-	-	-	-	-	-	-	-	-	-
Police Station	-	-	-	-	-	-	-	-	-	-	-	-
Fire Station	-	-	-	-	-	-	-	-	-	-	-	-
Hospital	-	-	-	-	-	-	-	-	-	-	-	-
Medical Facility	-	-	-	-	-	-	-	-	-	-	-	-
County-Owned	-	-	-	-	-	-	-	-	-	-	-	-
City-Owned	3	3	-	-	-	-	-	-	-	-	-	-
School	-	-	-	-	-	-	-	-	-	-	-	-
<b>High Potential Loss</b>	<b>78</b>	19	4	-	46	2	2	4	1	10	-	-
Child Care, Licensed	1	-	-	-	1	-	-	-	-	-	-	-
Health Facility, Licensed	-	-	-	-	-	-	-	-	-	-	-	-
Other Government	-	-	-	-	-	-	-	-	-	-	-	-
Shopping Center	-	-	-	-	-	-	-	-	-	-	-	-
Churches	-	-	-	-	-	-	-	-	-	-	-	-
Archeological	-	-	-	-	-	-	-	-	-	-	-	-
Historical Site	7	3	3	-	1	-	-	-	-	2	-	-
Natural Gas Station	-	-	-	-	-	-	-	-	-	-	-	-
Natural Gas Well	70	16	1	-	44	2	2	4	1	8	-	-



Infrastructure Type	Total Feature Count	Vallecito	Electra Terminal	Forest Lakes	Lemon	Long Hollow	Pastoriorous East	Pastoriorous West	Red Mesa	Ridges Basin	Turner	Electra Stage
<b>Transportation and Lifeline</b>	<b>687</b>	164	241	-	179	9	1	5	23	98	1	1
Airport	-	-	-	-	-	-	-	-	-	-	-	-
Bridge	23	6	2	-	11	1	-	-	2	3	-	-
Communication Tower	-	-	-	-	-	-	-	-	-	-	-	-
Power Plant	1	-	-	-	-	-	-	-	-	-	-	1
Primary Substation	-	-	-	-	-	-	-	-	-	-	-	-
Substation	1	1	-	-	-	-	-	-	-	-	-	-
Natural Gas Facility	15	-	5	-	9	-	-	-	-	9	-	-
Waste Water Facility	-	-	-	-	-	-	-	-	-	-	-	-
Water Dock	-	-	-	-	-	-	-	-	-	-	-	-
Water Well	647	157	234	-	159	8	1	5	21	86	1	-
<b>Grand Total*</b>	<b>768</b>	<b>186</b>	<b>245</b>	<b>-</b>	<b>225</b>	<b>11</b>	<b>3</b>	<b>9</b>	<b>24</b>	<b>108</b>	<b>1</b>	<b>1</b>

\*total count is not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.

Table 4-15: Miles of Critical Infrastructure (Linear) in Dam Inundation Zones

Infrastructure Type (Linear)	Total Linear Mileage	Vallecito	Electra Terminal	Forest Lakes	Lemon	Long Hollow	Pastoriorous East	Pastoriorous West	Red Mesa	Ridges Basin	Turner	Electra Stage
<b>High Potential Loss</b>	<b>9.4</b>	-	6.1	-	-	-	-	-	-	-	0.5	3.2
Railroad	9.4	-	6.1	-	-	-	-	-	-	-	0.5	3.2
<b>Transportation and Lifeline</b>	<b>104.5</b>	<b>33.3</b>	<b>57.6</b>	<b>1.7</b>	<b>33.4</b>	<b>2.0</b>	<b>1.3</b>	<b>0.8</b>	<b>1.9</b>	<b>17.6</b>	<b>3.3</b>	<b>0.0</b>
Potable Water Pipeline	10.8	2.0	5.5	0.1	2.7	-	-	-	-	-	0.5	-
Sewer Line	14.4	2.9	9.7	1.3	-	-	-	-	-	-	0.5	-
Transmission Lines	21.9	2.3	15.2	-	4.0	-	0.0	0.1	-	0.6	0.8	0.0
Snow Routes	14.1	2.4	3.6	-	4.1	-	0.4	0.2	0.3	3.4	0.2	-
Street	43.2	11.8	11.8	0.2	11.3	1.0	0.4	0.2	0.8	6.8	0.6	-



Infrastructure Type (Linear)	Total Linear Mileage	Vallecito	Electra Terminal	Forest Lakes	Lemon	Long Hollow	Pastorious East	Pastorious West	Red Mesa	Ridges Basin	Turner	Electra Stage
Primary Highway	4.9	0.8	2.1	-	1.3	-	-	-	-	0.8	0.4	-
State/County Hwy	7.9	6.0	-	-	1.0	1.0	-	-	0.3	-	-	-
Ramp	0.0	0.0	-	-	-	-	-	-	-	-	-	-
Major Road	6.0	0.2	2.3	0.0	3.0	-	-	-	-	0.5	-	-
Local road	23.7	4.8	7.3	0.2	5.6	-	0.4	0.2	0.5	5.5	0.2	-
Traffic circle	-	-	-	-	-	-	-	-	-	-	-	-
Cul-de-sac	-	-	-	-	-	-	-	-	-	-	-	-
4wd Trail	-	-	-	-	-	-	-	-	-	-	-	-
Road, parking area	-	-	-	-	-	-	-	-	-	-	-	-
Driveway	0.5	-	0.1	-	0.4	-	-	-	-	-	-	-
Walkway	-	-	-	-	-	-	-	-	-	-	-	-
<b>Grand Total</b>	<b>113.9</b>	<b>33.3</b>	<b>63.7</b>	<b>1.7</b>	<b>33.4</b>	<b>2.0</b>	<b>1.3</b>	<b>0.8</b>	<b>1.9</b>	<b>17.6</b>	<b>3.8</b>	<b>3.2</b>

\*total length is not equal to sum of all dam inundation zones due to dissolved overlapping inundation areas.

#### 4.4.9.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species. The extent of the vulnerability of the environment is the same as the exposure of the environment.

#### 4.4.10 Future Trends in Development

Land use in the County occurs under the advisement of the 2017 La Plata County Comprehensive Plan and as provided in the La Plata County Land Use Code. The Environmental Resources element of the comprehensive plan establishes standards and plans for the protection of the community from hazards. Dam failure is currently not addressed as a standalone hazard, but floodplains are. Most of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the comprehensive plan will help to reduce the risk associated with the dam failure hazard for all future development in the planning area.



#### **4.4.11 Summary of Dam Failure Issues**

Important issues associated with the dam failure hazard include the following:

- There is often limited warning time for dam failure. These events are frequently associated with construction methodology and or severe weather, which limits predictability of dam failure and compounds flood risk. Protocol for notification of downstream citizens of imminent failure needs to be tied to local emergency response planning.
- Mapping that estimates inundation depths for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams is needed to better assess the risk associated with failure of these facilities. Also, access to inundation zones is not readily available to residents area wide.