

8.0 DAM SAFETY

8.1 Overview of Dams

Dams are manmade structures built to impound water. Dams are built for many purposes including water storage for potable water supply, livestock water supply, irrigation, or fire suppression. Other dams are built for flood control, recreation, navigation, hydroelectric power or to contain mine tailings. Dams may also be multifunction, serving two or more of these purposes.

The National Inventory of Dams, NID, which is maintained by the United States Army Corps of Engineers, is a database of approximately 76,000 dams in the United States. The NID does not include all dams in the United States. Rather, the NID includes dams that are deemed to have a high or significant hazard potential and dams deemed to pose a low hazard if they meet inclusion criteria based on dam height and storage volume. Low hazard potential dams are included if they meet either of the following selection criteria: 1) exceeds 25 feet in height and 15 acre-feet of storage, or 2) exceeds 6 feet in height and 50-acre feet of storage. There are many thousands of dams too small to meet the NID selection criteria. However, these small dams are generally too small to have significant impacts if they fail and thus are generally not considered for purposes of risk assessment or mitigation planning.

This NID potential hazard classification is solely a measure of the probable impacts if a dam fails. Thus, a dam classified as High Potential Hazard does not mean that the dam is unsafe or likely to fail. The level of risk (probability of failure) of a given dam is not even considered in this classification scheme. Rather, the High Potential Hazard classification simply means that there are people at risk downstream from the dam in the inundation area, if the dam were to fail. The NID potential hazard classification system for dams is as summarized below in Table 8.1.

Table 8.1
NID Hazard Potential Classification for Dams¹

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

Dams assigned the low hazard potential classification are those where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the dam owner's property.

Dams assigned to the significant hazard potential classification are those where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities. Significant hazard potential dams are often located in predominantly rural or agricultural areas. Dams assigned to the high hazard potential classification are those where failure or

mis-operation will probably cause loss of human life. Failure of dams in the high classification will generally also result in economic, environmental or lifeline losses, but the classification is based solely on probable loss of life.

Of the dams in the NID, nearly 60% are privately owned. In addition to the dams in the NID, there are many thousands of dams too small to meet the selection criteria for the NID. Most of these small dams are also privately owned.

The NID is available online through several links at FEMA and the United States Army Corps of Engineers. However, since September 11, 2001, access is somewhat restricted. Basic NID information and links to the database are available at <http://crunch.tec.army.mil/nid/webpages/nid.cfm>

8.2 Dam Primer

In the simplest terms, dams are impervious structures that block the flow of water in a river or stream and thereby impound water behind the dam. Dams have been built for thousands of years from a wide range of materials, including earth, stone, masonry, wood, and concrete. Large modern dams are almost always embankment dams (built primarily from soil, rock, or mixtures) or concrete dams.

Large modern dams almost always have control mechanisms such as gated spillways or outlet pipes for releasing water in a controlled fashion. Typically, dams are operated to smooth natural variations in water flow. During high water flow periods, water is stored behind a dam, while in low water flow periods, water is released to increase flows. Controlled releases typically result in lower peak (flood) flows and higher minimum flows than in uncontrolled streams. The specific patterns of water storage and release vary from dam to dam, depending on the primary purpose(s) of the dam and on a wide variety of economic, regulatory and environmental considerations.

8.2.1 Dam Nomenclature and Types of Dams

Modern dams, whether embankment dams or concrete dams, are typically constructed on a foundation, which may be concrete, natural rock or soils, or compacted soils. Dams are usually constructed along a constricted part of a river valley to minimize cost. Dams are also connected to the surrounding natural valley walls, which become the abutments of the dam structure itself.

Embankment dams are commonly termed earthfill or rockfill dams, depending on the primary material used in their construction. Historically, a wide range of earth and rock materials have been used to construct embankment dams, with various construction techniques including hydraulic fill and compaction. Embankment dams are broad flat structures, typically at least twice as wide at the base as their height. In cross section, embankment dams are typically trapezoidal, with a wide flat base, sloping slides and a narrower flat top.

Depending on the permeability of the materials used in an embankment dam, impervious layers may be added to the upstream side of the structure or in the center

core of the structure. Embankment dams are subject to erosion by running water. Thus, modern embankment dams always have erosion-resistant materials used in the water release and control mechanisms of the dam. Typically, concrete spillways with concrete or steel gates are used to control releases. Many dams also have outlet pipe systems with concrete or steel pipes as part of the water release control system.

Modern concrete dams fall into two major classes: gravity dams and arch dams. Concrete gravity dams are designed on principles similar to embankment dams. Concrete gravity dams are broad structures, generally triangular in shape with a flat base, a narrow top, a flat upstream side and a broad sloping downstream side. Much of these dams' capacity to impound water arises from the weight of the dam. Typically, gravity dams are keyed into bedrock foundations and abutments to increase the stability of the dam.

Concrete arch dams rely primarily on the strength of concrete to impound water. Concrete arch dams are much thinner in cross section than concrete gravity dams and are always convex on the upstream side and concave on the downstream side because concrete is much stronger in compression than in tension. With this arch design, the pressure of impounded water compresses the concrete and makes the dam stronger. Like concrete gravity dams, concrete arch dams are also keyed into bedrock foundations and abutments to provide stability. A less common variation of a concrete arch dam is a concrete buttress dam. Buttress dams are arched or straight dams with additional strength provided by buttresses perpendicular to the long axis of the dam.

An excellent introduction to dam nomenclature and descriptions of types of dams is given in the FEMA publication: *Dam Safety: An Owner's Guidance Manual*.³ For further details, the reader is referred to this publication and the references therein.

8.2.2 Dam Failure Modes

Dam failures can occur at any time in a dam's life; however, failures are most common when water storage for the dam is at or near design capacity. At high water levels, the water force on the dam is higher and several of the most common failure modes are more likely to occur. Correspondingly, for any dam, the probability of failure is much lower when water levels are substantially below the design capacity for the reservoir.

For embankment dams, the most common failure mode is erosion of the dam during prolonged periods of rainfall and flooding. When dams are full and water inflow rates exceed the capacity of the controlled release mechanisms (spillways and outlet pipes), overtopping may occur. When overtopping occurs, scour and erosion of either the dam itself and/or of the abutments may lead to partial or complete failure of the dam. Especially for embankment dams, internal erosion, piping or seepage through the dam, foundation, or abutments can also lead to failure. For smaller dams, erosion and weakening of dam structures by growth of vegetation and burrowing animals is a common cause of failure.

For embankment dams, earthquake ground motions may cause dams to settle or spread laterally. Such settlement does not generally lead, by itself, to immediate failure. However, if the dam is full, relatively minor amounts of settling may cause

overtopping to occur, with resulting scour and erosion that may progress to failure. For any dam, improper design or construction or inadequate preparation of foundations and abutments can also cause failures. Improper operation of a dam, such as failure to open gates or valves during high flow periods can also trigger dam failure. For any dam, unusual hydrodynamic (water) forces can also initiate failure. Landslides into the reservoir, which may occur on their own or be triggered by earthquakes, may lead to surge waves which overtop dams or hydrodynamic forces which cause dams to fail under the unexpected load. Earthquakes can also cause seiches (waves) in reservoirs that may overtop or overload dam structures. In rare cases, high winds may also cause waves that overtop or overload dam structures.

Concrete dams are also subject to failure due to seepage of water through foundations or abutments. Dams of any construction type are also subject to deliberate damage via sabotage or terrorism. For waterways with a series of dams, downstream dams are also subject to failure induced by the failure of an upstream dam. If an upstream dam fails, then downstream dams also fail due to overtopping or due to hydrodynamic forces.

An excellent review of the common mechanisms for dam failures is given in the FEMA publication: *Dam Safety: An Owner's Guidance Manual*.³ For further details, the reader is referred to this publication and the references therein.

A National Research Council study⁴ of dam failures in the United States and Western Europe from 1900 to 1969 compiled historical data on the observed probability of failure as a function of type of dam. Dam failures are quite common in the United States. For example, FEMA data from Tropical Storm Alberto (1994) show 230 dam failures in the State of Georgia from this single event.⁵ Fortunately, most dam failures are of small dams where the failure poses little or no risk to life safety and only minor, localized property damage. Most failures are of dams that are too small to be included in the NID database or dams in the NID Low Hazard Potential Category.

However, in the United States between 1960 and 1997 there were 23 dam failures that caused at least one death, with total fatalities from these 23 failures estimated at 318 people.⁵ Since 1874, there have been six dam failures in the United States which killed over 100 people.² The worst dam failure, in terms of casualties, was the 1889 Johnstown Pennsylvania dam failure which killed over 2,200 people. Three of the high fatality dam failures occurred in the 1970s: Black Hills, South Dakota, Big Thompson River, Colorado, and Buffalo Creek, West Virginia. These three failures alone resulted in an estimated 514 deaths.² (Note: the published death statistics in this paragraph from these two FEMA sources are inconsistent, but these differences are not significant for the present purposes).

8.3 Oregon Dam Data

The National Inventory of Dams (NID) lists 812 dams in Oregon. Of these NID dams, 34 are in Lane County. The statistical breakdown of these dams by NID Potential Hazard Categories is shown below in Table 8.2.

**Table 8.2
Numbers of Dams by NID Potential Hazard Categories**

NID Hazard	Oregon	Lane County
High	128	9
Significant	151	7
Low	521	16
Undetermined	12	2
Total	812	34

For Oregon, there are 128 dams in the High Potential Hazard Category. In Lane County, there are 9 dams in the High Potential Hazard Category. These 9 dams, all of which are federally owned and operated are listed individually in Table 8.3 below.

**Table 8.3
NID High Potential Hazard Dams
Lane County**

County	Dam Name	River	City	NID Height (feet)	NID Storage (acre feet)
Lane	Cottage Grove	Coast Fork Willamette River	COTTAGE GROVE	103	50,000
Lane	Dexter	Middle Fork Willamette River	EUGENE	117	29,900
Lane	Fall Creek	Fall Creek	SPRINGFIELD	205	125,000
Lane	Dorena	Row River	COTTAGE GROVE	154	131,000
Lane	Lookout Point	Middle Fork Willamette River	EUGENE	276	477,700
Lane	Blue River Dam	Blue River	SPRINGFIELD	312	89,000
Lane	Hills Creek	Middle Fork Willamette River	OAKRIDGE	341	356,000
Lane	Cougar	South Fork McKenzie River	SPRINGFIELD	519	219,000
Lane	Fern Ridge	Long Tom River	EUGENE	49	121,000

Of these NID High Potential Hazard dams all except Fern Ridge are upstream from the Eugene/ Springfield Metro Area and thus have a large potential impact on the largest population center in Lane County.

8.4 Dam Failure Hazard Assessment: Lane County

A 1987 report⁶ on Dam/Levee Failure by the Oregon Emergency Management Division lists 51 historical dam failures in Oregon from 1896 through the 1980s. As of the time of this report, no dam failure fatalities had been recorded in Oregon. However, the potential for dam failure fatalities certainly exists in Oregon and in Lane County, albeit with a low probability of occurrence.

To evaluate the level of risk posed by dams in Lane County, we consider primarily dams in the NID high potential hazard classification. Dams in the significant and low potential hazard categories do not pose a life safety threat and the risk of property

damage is minimal or low. For Lane County, dams in the low or significant category are generally small, typically with storage capacities in the range of 50 to 500 acre feet. Only one of these dams has storage capacity above 1,000 acre feet. The Siltcoos Lake Dam on the Siltcoos River has a storage capacity of 15,070 acre feet, but there is no population in the immediate downstream area.

For completeness, we note that the NID database of dams for Lane County contains two other small dams which are not rated in the potential hazard classification. These dams are listed below in Table 8.4. Because of their small size, the potential impacts of failure are much smaller than for larger dams. However, if there are people living in the inundation areas, there may be some level of life safety risk. Each of these dams may warrant further investigation of possible life safety risk.

**Table 8.4
NID Dams in Lane County Not Rated for Potential Hazard**

County	Dam	River	Storage (acre feet)	Year Completed
Lane	Snellstrom-Eugene Log Pond	Amazon Creek	85	1950
Lane	Konyn Waste Lagoon	Muddy Creek	50	1999

Additional data on the nine NID high potential hazard dams in Lane County are given below in Table 8.5

**Table 8.5
Additional Data on NID High Hazard Potential Dams**

County	Dam Name	River	Storage (acre feet)	Date Built	Dam Type	EAP	Owner
Lane	Cottage Grove	Coast Fork Willamette	50,000	1942	RE	Y	Corps
Lane	Dexter	Middle Fork Willamette	29,900	1955	RE	Y	Corps
Lane	Fall Creek	Fall Creek	125,000	1965	ER	Y	Corps
Lane	Dorena	Row River	131,000	1949	RE	Y	Corps
Lane	Lookout Point	Middle Fork Willamette	477,700	1953	RE	Y	Corps
Lane	Blue River Dam	Blue River	89,000	1968	RE	Y	Corps
Lane	Hills Creek	Middle Fork Willamette	356,000	1962	RE	Y	Corps
Lane	Cougar	South Fork McKenzie	219,000	1964	ER	Y	Corps
Lane	Fern Ridge	Long Tom	121,000	1941	RE	Y	Corps

In the table above, the Owner Type Classification is: Federal (F), Local (L), Private (P) and Utility (U). The NID dam type classification includes the following types of dams:

- RE rockfill/earthfill embankment dams, primarily rockfill (fill >3" size)
- ER rockfill/earthfill embankment dams, primarily earthfill (fill <3" size)
- PG concrete gravity dams
- REPG combination dams incorporating rockfill/earthfill and concrete gravity.

These dams were completed between 1941 and 1968. All dams are rockfill/earthfill embankment dams, except Cougar which is an earthfill/rockfill embankment dam. All dams are operated by the US Army Corps of Engineers and all have emergency operations plans in place. All Corps dams are maintained on a regular schedule and undergo regular inspections, with major re-inspections every five years. Furthermore, the Corps is highly experienced in the construction, operation, and maintenance of dams.

As noted previously, the NID classification as High Potential Hazard means only that there is probable loss of life if one of these dams fails. The NID classification contains no information whatsoever about the safety or lack of safety of a given dam and no information about the probability of failure.

For embankment dams, as discussed above, the most common failure modes are overtopping, foundation failures, and seepage through the dam. For concrete dams, the most common failure modes are overtopping and foundation failures. Under normal or flood conditions, failure of the Corps operated dams appears highly unlikely. Failure is perhaps possible, however, in extreme flood events well above the design basis, especially if the reservoirs were close to full at the onset of flooding. The spillway capacities could be exceeded with a potential for overtopping failures.

There are, however, two other circumstances that may pose significant threats to any of these dams: landslides and earthquakes.

A major landslide into a reservoir, whether triggered by seismic activity or not, could result in a large surge wave that could result in dam failure from a combination of overtopping and hydrodynamic forces.

A major earthquake, either a Cascadia Subduction Zone earthquake, or a smaller, interplate or intraplate earthquake in Western Oregon, could cause sufficient damage to these dams to pose a risk of failure.

8.5 Risk Assessment (Preliminary)

Each of these major dams which pose a potential life safety hazard for Lane County are operated by the United States Army Corps of Engineers. The Portland District of the Corps, Geotechnical Engineer Branch, Concrete and Dam Safety Section has safety responsibilities for these dams. As of early 2004, the Dam Safety Coordinator was Jim Hinds, whose phone number is (503) 808-4846. A variety of dam safety related information is also available on the Portland District's web site at www.nwp.usace.army.mil. Under the Corps normal dam operating practices, dams are inspected annually, with a more complete evaluation every five years on a rotating schedule.

8.5.1 Flood Damage to Dams

All of the Corps dams were designed and built with specific flood capacities. Current dam designs are based on Standard Project Floods. Standard Project Floods, as defined in the Corps Engineer Manual 1110-2-1411 (March 1, 1965) are floods

resulting from the Standard Project Storm. In turn, the Standard Project Storm is defined, somewhat imprecisely, as the most severe flood-producing rainfall-snowmelt, depth-area-duration event that is considered “reasonably characteristic” of the drainage basin. Discussions with Corps staff in the Portland District Office indicated that the Standard Project Flood is approximately a 500-year flood event.

The Corp dams’ discharge design levels include the combination of spillway discharge capacity and reservoir outlet pipe discharge capacity. As an example, for the Hills Creek Dam, the Standard Project Flood is 64,500 cubic feet per second. The maximum controlled discharge capacity of the dam is 151,760 cubic feet per second, or nearly two and one-half times the Standard Project Flood discharge. These data are included on the Hills Creek Project, Emergency Response Flowchart⁷. At discharges beyond the maximum controlled discharge capacity of the dam, the dam would be overtopped, discharges would be uncontrolled, and there would be a high probability of damage to the dam, with some potential for dam failure. The large margin of safety in the discharge capacity of the dam suggests that the Hills Creek Dam likely has the capacity to withstand floods at least as large as a 1,000 year flood event without expected damage.

The other Corps dams located in Lane County or which may affect Lane County have similar margins of flood design safety.

8.5.2 Earthquake Damage to Dams

All of these dams were designed and built in the 1940s to 1960s. Seismic design considerations were thus significantly lower than current seismic design considerations. A summary tabulation of the seismic design basis and inspection history of these dams is given below in Table 8.6 (Corps of Engineers, Portland District Office, March, 2001).

**Table 8.6
Seismic Design, Evaluation and Inspection Data
Corps of Engineers Dams**

Dam	Date of Last Seismic Evaluation	Seismic Design Basis		Date of Last Periodic Inspection
		Original	Current	
Cottage Grove	1981	None	0.21 g	1997
Dexter	1981	0.10 g	0.21 g	1996
Fall Creek	1981	0.10 g	0.21 g	1999
Dorena	1981	none	0.21 g	1997
Lookout Point	1981	0.10 g	0.21 g	1999
Blue River	1994	0.10 g	0.24 g	1996
Hills Creek	2000	0.10 g	0.22 g	1999
Cougar	1994	0.10 g	0.24 g	1997
Fern Ridge	2001	none	0.35 g	2000

As shown in Table 8.6, the Corps has conducted at least preliminary seismic evaluations of all of these dams. However, some of these evaluations were conducted in the 1980s and thus do not reflect current understanding of the seismic hazard in Oregon or current state-of-the-art seismic evaluation engineering principles. The

Corps has an ongoing regular inspection program and an ongoing seismic evaluation program. Presumably, updated seismic evaluations of these dams will be completed over the next few years.

Seismic considerations were completely absent in the design of two of these dams: Dorena and Fern Ridge. The others were explicitly designed or probably designed to ground shaking levels of 0.10 g, which is the maximum seismic design level for any of the Corps dams in western Oregon. In contrast, the current Corps seismic design levels for dams at these sites (i.e., if new dams were to be built today) would be 0.21 g to 0.24g for the dams in eastern Lane County and 0.35 g for Fern Ridge . Thus, current seismic design requirements are for levels of ground shaking about two times higher than the probable design levels for most of these dams and about three times higher for Fern Ridge.

Seismic evaluations of dam safety are a highly technical, highly specialized art. Separate evaluations must be done for each dam. The evaluation requires a detailed analysis of the design and construction of the dam, an analysis of the current condition of materials and components, geotechnical analysis of the foundation and site, and a site-specific seismic hazard analysis. For emergency planning purposes, a seismic evaluation should include the probabilities of failure for a scenario earthquake such as a large magnitude event on the Cascadia Subduction Zone.

8.5.3 Loss Estimates (Preliminary)

Detailed loss estimates for possible failures of these dams are beyond the scope of this mitigation plan. However, we note that in 1987 the Oregon Emergency Management Division⁶, estimated that a completely catastrophic failure of the Hills Creek Dam, an extremely unlikely event, could require the evacuation of over 250,000 people with damages in excess of \$10 billion. Adjusting these 1987 estimates for inflation and for population growth suggests that damages could easily exceed \$20 billion. Detailed casualty estimates have not been made for catastrophic dam failures affecting Lane County. However, given the large inundation areas, high water depths, and the logistical difficulties in evacuating 250,000 people to safe ground, it is not difficult to imagine that a truly catastrophic dam failure could potentially result in 1,000 or more deaths.

The probability of catastrophic failure of these dams is impossible to estimate with any accuracy, from present data. Most likely, the probability is less than 0.1% per year (less than once in 1,000 years, on average) and perhaps substantially less. However, the consequences of failure are so high that careful evaluation is certainly warranted.

The probable impacts of potential dam failures on communities in Lane County are summarized below in Table 8.7.

**Table 8.7
Probable Impacts of Potential Dam Failures on Lane County**

Inventory	Probable Impacts
Portion of Lane County affected	Direct impacts limited to mapped inundation areas for very unlikely complete dam failures, or to smaller areas for more likely partial failures. Many communities in Lane County are downstream from one or more large dams and thus the potential impacts are very large.
Buildings	Heavy damage in inundation areas
Streets within Lane County	Damage and closures in inundation areas
Roads to/from Lane County	Damage and closures in inundation areas
Electric power	Damage and loss of service in inundation areas
Other Utilities	Damage and loss of service in inundation areas. Potential for major damage to water and wastewater treatment plants in extreme events
Casualties	Potential for high casualties (deaths and injuries) in extremely unlikely major dam failures, depending on warning time available and effectiveness of evacuations

8.6 Mitigation Strategies

Possible dam failures affecting Lane County are low probability events, but the potential casualties and economic impacts are high. The combination of low probability but large impacts makes analysis of such situations difficult from both a technical and a public policy perspective. The evaluation is difficult technically because it requires detailed engineering analysis of each dam and careful probabilistic risk analysis. As always, communication with the public must be non-alarmist, but factual, realistic and informative.

Recommendations

1. The first step in mitigation planning for dam safety is emergency planning. Emergency planners in Lane County should obtain copies of the inundation maps for each of the major dams to familiarize themselves with the areas of potential flooding. Inundation maps which are available from the USACE only as paper copies should be scanned or otherwise entered into LCOG and local GIS mapping systems. For emergency planning, the estimated flood depths and the time periods from dam failure are particularly important. Flood depths and flood times both vary markedly with distance downstream from the dam locations. For emergency planning, key elements include community emergency notification procedures and evacuation planning (routes and traffic control). Because of the very large numbers of potential evacuees, training seminars and scenario exercises are strongly recommended.
2. All dams have Emergency Action Plans. These plans should be reviewed to ensure that they are complete and up to date. Emergency planning officials in each county should be fully informed of the detailed consequences of the potential failure of each dam. Public notification and evacuation plans should be updated and tested. For some types of dam failures, for example, those due to extreme floods, there may be some warning time. Decision making procedures, protocols, and procedures for issuing watches, warnings, and evacuation notices should be reviewed and updated

and coordinated among all responsible federal, state, and local agencies.

3. Because of the age of these dams, the seismic design basis is significantly below current seismic design requirements. Preliminary seismic evaluations have been done but without sufficient detail to evaluate the probabilities of dam failures. Because of the extreme consequences of potential failure of one or more of these dams, we recommend that detailed seismic evaluations be conducted for all of these dams.

The table on the following page contains dam safety mitigation action items from the master Action Items table in Chapter 4.

References

1. FEMA, Federal Guidelines for Dam Safety: Hazard Potential Classification Systems for Dams, FEMA 333, October 1998.
2. FEMA, Multihazard Identification and Risk Assessment, A Cornerstone of the National Mitigation Strategy, Chapter 20, Dam Failures, 1997.
3. FEMA, Dam Safety: An Owner's Guidance Manual, FEMA 145, August 1987.
4. National Research Council, Safety of Existing Dams, Evaluation and Improvement, National Academy Press, 1983.
5. FEMA website (www.fema.gov), National Dam Safety Program webpage.
6. Oregon Emergency Management Division, Dam/Levee Failure, Statewide Hazard Analysis, March, 1987.
7. Hills Creek Lake Project, Emergency Response Flowchart, Distributed January 2000, United States Army Corps of Engineers, Portland District, 5 pages.

**Table 8.18
Dam Safety Mitigation Action Items**

Hazard	Action Item	Coordinating Organizations	Timeline	Ideas	Plan Goals Addressed					
					Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Dam Safety Mitigation Action Items										
Short-Term #1	Prepare high resolution maps of dam failure inundation areas and update emergency response plan, including public notification and evacuation routes	Lane Council of Governments	1-2 Years	pg. 4-4 pg. 12-9	X	X			X	
Short-Term #2	Encourage the Corps of Engineers to complete seismic vulnerability assessments for dams upstream of the Eugene/Springfield Metro Area and to make seismic improvements as necessary	Lane Council of Governments and U.S. Army Corps of Engineers	Ongoing	pg. 4-4 pg. 12-9	X	X	X	X		