The City of Lake Oswego, Oregon

Natural Hazards Mitigation Plan Addendum

Prepared by
City of Lake Oswego

In cooperation with
Clackamas County

July 26, 2004

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Natural Hazards Mitigation Plan Addendum

Prepared for
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Section 1:
Planning Process

The City of Lake Oswego Natural Hazards Mitigation Plan includes resources and information to assist city residents, public and private sector organizations, and others interested in participating in planning for natural hazards. The mitigation plan provides a list of activities that may assist the City of Lake Oswego in reducing risk and preventing loss from future natural hazard events. Lake Oswego has developed this Plan as an addendum to the Multi-Jurisdictional Clackamas County Natural Hazards Mitigation Plan in an effort to take a more regional approach to planning for natural hazard scenarios.

Who Participated in Developing the Plan?

The City of Lake Oswego Natural Hazards Mitigation Plan is the result of a collaborative effort between City of Lake Oswego divisions, non-profit organizations, the private sector, and regional and state organizations. A project Hazard Mitigation Advisory Committee (HMAC) guided the process of developing the plan. The HMAC was comprised of the following representatives:

- Jenelle Byram, Lake Oswego Community Development – Engineering/GIS
- Carole Dickerson, Lake Oswego Public Affairs
- Dan Duncan, Lake Oswego Police
- Dennis Egner, Lake Oswego Community Development – Planning
- Larry Goff, Lake Oswego Fire
- Bob Kincaid, Lake Oswego City Manager's Office
- Jerry King, Lake Oswego Community Development – Engineering
- Jerry Knippel, Lake Oswego Maintenance/Special Projects
- Cindy Kolomechuk, Clackamas County Emergency Management
- Joel Komarek, Lake Oswego Community Development – Engineering
- Stephan Lashbrook, Lake Oswego Community Development
- Susan Millhauser, Lake Oswego Community Development – Planning
- Jim Sanders, Lake Oswego Parks

Planning Process

The Lake Oswego HMAC held regularly scheduled meetings to complete the planning process. Residents of the City of Lake Oswego had an opportunity to participate in county-wide public workshops designed to gain citizen input, as well as one local workshop conducted on April 6, 2003. The planning process is described in Appendix B of the Clackamas County Natural Hazards Mitigation Plan.

The Lake Oswego Natural Hazard Mitigation Public Workshop was held on April 6, 2003, from 7:00 to 9:00 p.m. at City Hall. The purpose of this workshop was to engage Lake Oswego residents in the mitigation planning process. The HMAC targeted active community members such as the Community Emergency Response Teams (CERT) to ensure attendance.

Workshop attendees had an opportunity to visit a variety of hazard stations to learn more about potential local hazards, and voice any concerns they had related to the specific hazards. At each hazard station a member of the HMAC was available to answer questions and document any community issues regarding the potential local hazard. This community input has been incorporated into the Lake Oswego Natural Hazards Mitigation Plan. Additionally, at a subsequent CERT general training session, information about the mitigation planning process was presented to those in attendance.

Multi-Jurisdictional Planning Effort

The City of Lake Oswego is dedicated to taking a regional approach to planning for natural hazards. The City of Lake Oswego has representation on the Clackamas County Hazard Mitigation Advisory Committee to ensure that the City's interests are represented in the larger scale planning effort. The City will partner with the County in implementation of appropriate action items, and will work with other jurisdictions and public and private entities to reduce losses from future natural hazards.

What is the Plan Mission?

The mission of the Lake Oswego Natural Hazards Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the city towards building a safer, more sustainable community.

The City of Lake Oswego will work to achieve the above mission through plan implementation. This mission statement is the same as the mission statement developed during the Clackamas County planning process.

What are the Plan Goals?

The City of Lake Oswego agrees with the goals developed during the Clackamas County planning process, and has slightly revised the emergency services section to suit local needs.

Protect Life and Property

- Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to losses from natural hazards.
- Reduce losses and repetitive damages from chronic hazard events while promoting insurance coverage for catastrophic hazards.
- Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

Public Awareness

- Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.

- Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.

Natural Systems

- Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.
- Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

Partnerships and Implementation

- Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.
- Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.

Emergency Services

- Establish policies to identify and prioritize mitigation projects for critical facilities, services, and infrastructure.
- Strengthen emergency operations by increasing collaboration and coordination among public agencies, citizen emergency response teams, non-profit organizations, business, and industry.
- Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

How Will the Plan be Implemented, Monitored, and Evaluated?

The plan maintenance process includes a schedule for implementing, monitoring, evaluating, and reviewing this plan addendum. It is essential to have this process to ensure plan sustainability.

Plan Adoption

The Lake Oswego City Council will be responsible for adopting the City of Lake Oswego Addendum to the Multi-Jurisdictional Clackamas County Natural Hazards Mitigation Plan, as well as the portions of the County Plan which are referenced in the City's Addendum. This governing body has the authority to establish public policy regarding natural hazards. The Lake Oswego Fire Department will be responsible for submitting the Plan to the State Hazard Mitigation Officer at Oregon Emergency Management.

Coordinating Body

The Lake Oswego HMAC will serve as the coordinating body, with the Lake Oswego Fire Department taking the lead. The City Manager will assign representatives from City divisions, including, but not limited to, the current members of the HMAC. At this time, additional representatives from the Lake Oswego School District and Lake Oswego Corporation will be invited to attend Advisory Committee meetings. The HMAC will meet as a large group no less than

quarterly, with regular meeting dates to be determined upon plan acceptance by FEMA. The purpose of the meetings will be to make recommendations to the City Manager regarding the completion of hazard mitigation grant applications, and plan monitoring, evaluation, and updating.

Due to the nature of this project-based committee, technical advisory committees as well as other ad hoc committees may be established to implement appropriate mitigation projects and tasks, and meetings will be held as needed. The attendees of these technical advisory committees will report on their actions to the HMAC at the regularly scheduled meetings.

Convener

The Lake Oswego Fire Department will be responsible for plan administration, including facilitating and convening future HMAC meetings. The convener will also assign tasks for plan maintenance and implementation to the members of the committee. Plan evaluation and preparing recommendations for the implementation of Plan elements for City Manager review will be a shared responsibility among all of the HMAC members.

Implementation through Existing Programs

The City of Lake Oswego addresses statewide planning goals and legislative requirements through its Comprehensive Plan, Community Development Code, Capital Improvement Plans, and Building Code. The Natural Hazard Mitigation Plan provides a series of recommendations that are closely related to the goals and objectives of these existing planning programs. If the implementation of a recommendation requires updates to the City's Comprehensive Plan or its implementing ordinances, Planning Commission review and recommendation for approval to the City Council will be required. The City of Lake Oswego will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's accepted methods for determining the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Given federal funding, the HMAC will use a FEMA-approved benefit/cost analysis approach to analyze and prioritize mitigation action items. For other projects and funding sources, the Advisory Committee may use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix C of the Clackamas County Natural Hazards Mitigation Plan.

Formal Review Process

The City of Lake Oswego Addendum to the Clackamas County Natural Hazards Mitigation Plan will be evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. Annual evaluation of the Plan Addendum may include removal of completed action items, addition of new action items, and revision of action item timelines. This review and evaluation will be tracked by the HMAC, with updates to the Plan Addendum every four years, resulting in recommendations to the City Manager and subject to City Council approval, prior to submittal to FEMA in the fifth year. The Lake Oswego Fire Department will be responsible for initiating the evaluation process, with the HMAC as a whole taking responsibility for developing Plan Addendum update recommendations. The Addendum will be submitted by the Fire Department to Oregon Emergency Management/FEMA every five years for review and approval.

Continued Public Involvement

The City of Lake Oswego will continue to involve the public in the review and update of the Hazard Mitigation Plan through public workshops during plan updates and through the formal City Council adoption process. The City's newsletter, Hello LO, and website will be used to share information about the Plan and subsequent updates, with contact information provided for feedback. Copies of the Plan will be distributed to appropriate City agencies, boards, and commissions, Advisory Committee members, and City Council members. The Plan will be made available on the City website and at the Lake Oswego Library on CD-ROM for citizen check-out. A copy of the Clackamas County Plan will also be provided with the addendum.

Special Service Districts

The following special service districts, associations, and agencies provide services within the Lake Oswego Urban Services Boundary or to Lake Oswego residents. These organizations will have an opportunity to provide feedback on the Plan during the public participation process. Contact information for the following can be found in the Resource Directory portion of this document.

- Alto Park Water District
- City of Lake Oswego
- City of Portland
- Clackamas Community College
- Clackamas County
- Clackamas County Vector Control
- Clackamas Education Service District
- Clean Water Services
- Dunthorpe-Riverdale Service District #1
- Glenmorrie Cooperative Association
- Lake Grove Fire District 57
- Lake Grove Park District
- Lake Grove Water District
- Lake Oswego Corporation
- Lake Oswego School District 7J
- Lake Oswego Urban Renewal District

- Metro Service District 2
- Multnomah County
- Palatine Hill Water District #26
- Port of Portland
- Portland Community College
- Portland School District 1J
- Rivergrove Water District #14
- Riverdale-Dunthorpe Fire District JT-11
- Riverdale School District 51J
- Skylands Water Company
- Southwood Park Water District #21
- Tigard-Tualatin School District 23J
- TriMet
- Tualatin Valley Fire and Rescue
- Washington County
- Water Environment Service District
- West Linn-Wilsonville School District 3J

What are the Mitigation Strategies Identified by Lake Oswego?

Mitigation strategies include the identification of action items, which are a listing of activities in which agencies and citizens can be engaged to reduce risk. Each action item includes an estimate of the timeline for implementation. Short-term action items (ST) are activities that agencies may implement with existing resources and authorities within one to two years. Long-term action items (LT) may require new or additional resources or authorities, and may take between one and five years to implement. The action items are organized within the following matrix, Table 1-1 below, which lists all of the multi-hazard and hazard-specific action items included in the mitigation plan. Each action item is discussed in more detail, including ideas for implementation, under the corresponding hazard in Section 4 of this plan. The implementation and completion of action items will be dependent upon the availability of funding and staff resources.

Table 1-1. City of Lake Oswego Action Items

Natural Hazard	Action Item	Coordinating Department	Ideas for Implementation	Timeline	Plan Goals Addressed				
					Protect Life & Property	Emergency Services	Public Awareness	Partnerships & Implementation	Natural Systems
Short-Term Multi-Hazard #1	Ensure that there are adequate shelter facilities in hazard-free zones to serve Lake Oswego residents and employees.	Fire	p. 47	1-2 years	✓	✓		✓	
Short-Term Multi-Hazard #2	Improve and obtain resources and equipment essential for responding to and recovering from disasters.	Engineering & Maintenance Services	p. 47	1-2 years	✓	✓		✓	✓
Short-Term Multi-Hazard #3	Develop, enhance, and implement education programs designed to reduce the losses from natural hazards.	Fire & Public Affairs	p. 48	Ongoing	✓	✓	✓	✓	
Short-Term Multi-Hazard #4	Evaluate and update Surface Water Management Plan.	Engineering	p. 48	1-2 years	✓			✓	✓
Short-Term Multi-Hazard #5	Integrate the goals and action items from the Lake Oswego Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.	Community Development	p. 48	Ongoing	✓	✓	✓	✓	✓
Short-Term Multi-Hazard #6	Address 800 MHz communication deficiencies locally and regionally.	Lake Oswego Communications	p. 49	1-2 years	✓	✓		✓	
Short-Term Multi-Hazard #7	Continue to update and improve the hazard assessment in the Lake Oswego Natural Hazards Mitigation Plan.	Engineering/GIS	p. 49	Ongoing	✓	✓	✓	✓	✓
Long-Term Multi-Hazard #1	Obtain funding for implementing recommendations for improving infrastructure outlined in the updated Surface Water Management Plan.	Engineering	p. 50	5 years	✓			✓	✓
Long-Term Multi-Hazard #2	Replace Oswego Lake sewer interceptor line.	Engineering	p. 50	5 years	✓			✓	✓
Short-Term Flood #1	Reduce the vulnerability in the Foothills area to the flooding hazard.	Parks & Engineering	p. 27	1-2 years	✓	✓		✓	✓
Long-Term Flood #1	Implement alternatives for reducing the flooding hazard for properties along Oswego Lake and canals.	Engineering	p. 27	3-5 years	✓			✓	✓
Long-Term Flood #2	Conduct a study to identify appropriate mitigation strategies for repetitively flooded properties along Oswego Lake and canals, and prioritize for implementation.	Engineering & Planning	p. 27	3-5 years	✓	✓	✓	✓	✓
Long-Term Flood #3	Pursue participation in the Community Rating System program by identifying the requirements that are currently being met and those that need to be addressed.	Engineering & Planning	p. 28	3-5 years	✓		✓	✓	✓
Short-Term Landslide #1	Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas.	Planning & Engineering	p. 32	1-2 years	✓		✓	✓	✓
Long-Term Wildfire #1	Promote the use of non-combustible roofing materials by evaluating and making recommendations to current code to encourage noncombustible roofing standards in high fire-hazard areas.	Fire, Planning & Building	p. 36	3-5 years	✓	✓	✓	✓	✓
Long-Term Wildfire #2	Develop and implement an Urban Forest Fire Management Plan.	Fire	p. 37	3-5 years	✓	✓	✓	✓	✓
Long-Term Wildfire #3	Research new wildfire early warning detection systems, and obtain funding to apply the most appropriate warning system in fire-prone areas.	Fire	p. 37	3-5 years	✓	✓	✓	✓	✓
Long-Term Severe Storm #1	Reduce frequency and duration of power outages from the severe wind and winter storm hazards, where possible.	Engineering & Planning	p. 40	5 years	✓	✓	✓	✓	
Long-Term Earthquake #1	Conduct seismic evaluations on identified critical/essential facilities and infrastructure for implementing appropriate structural and non-structural mitigation strategies.	City Manager & City Departments	p. 45	3-5 years	✓	✓	✓	✓	✓

Section 2:
Community Profile

Geography and the Environment

The City of Lake Oswego covers an area of about 11 square miles, is located in the northwestern corner of Clackamas County, and lies in the eastern portion of the Tualatin Valley. There are three major drainage basins within Lake Oswego's Urban Services Boundary: Oswego Lake, the Tualatin River, and the Willamette River. Lake Oswego has a complex geography with many steep, wooded hillsides and streams that flow from the higher areas into the Tualatin River, Oswego Lake and the Willamette River. Oswego Lake is the City's largest physical feature and its geographic center. The Willamette River forms the eastern boundary of the City, and the Tualatin River is located to the south.

Major Rivers and Water Bodies

Oswego Lake

Oswego Lake is 3.5 miles long, with the main portion covering 385 acres, and an additional 7 acres in West Bay and 28 acres in Lakewood Bay. The Lake is a reservoir, and is privately owned and managed by the Lake Oswego Corporation, commonly known as "The Lake Corporation". The Lake Corporation has owned and maintained the Lake since 1942. Rolling hills, steep hillsides, and rocky bluffs surround Oswego Lake, with elevations ranging from 98 feet on the Lake to 970 feet on Mt. Sylvania to the north. The surrounding hills are bisected by many streams that direct surface water into Oswego Lake, the most notable of which is Springbrook Creek. The Tualatin River is a major source of water for the Lake, and enters through Oswego Canal.[1]

Before the pioneer settlement period in the 1860s, Oswego Lake was a natural, smaller body of water, fed by streams and springs. It was called Waluga Lake by the Clackamas Indians, meaning "wild swan." Early settlers called it "Sucker Lake" for a type of whitefish that may have dwelled in its warm waters. The Lake was renamed "Oswego Lake", after the turn of the century, by the owner of the Oregon Iron & Steel Company, to promote surrounding residential real estate development as a supplement to the Lake's primary use as a reservoir.[2]

The Lake has commercial and industrial functions important to the culture of the community. The Oswego Canal was dug between the Lake and the Tualatin River to increase water flow and raise the reservoir's level. The Lake was used for a short time on a trial basis to transport people and goods between the Willamette and Tualatin Rivers, via ferry boat across the Lake and horse drawn railroad cars along the canal's bank. Lake waters that flow into Oswego Creek were used to operate the Durham sawmill when Oswego was first settled. Much more significantly, the increased flow was used to operate first iron and then steel foundries operated by Oregon Iron & Steel Company. A hydroelectric power generating plant was built on Oswego Creek in 1909, and the Lake Corporation continues to operate this plant today, selling surplus power to PGE. A spillover dam was completed in 1921 that raised the Lake and greatly increased its size,

creating Blue Heron Bay and West Bay on the west end and Lakewood Bay on the east end.[3]

There are a few remaining undeveloped natural areas surrounding the Lake at the mouths of streams, and forested areas on steep slopes. A few natural riparian areas and small pockets of wetlands remain along the streams which enter the Lake. These natural edges are important for wildlife nesting, food, and shelter. The remaining forest is typically Douglas fir on the north-facing slopes, and oak/madrone and fir on the south-facing rocky bluffs. These remaining forested areas provide perch sites for birds of prey such as osprey and heron.

The Lake is also an important habitat for resident and migratory waterfowl including dabblers, diving ducks, Canada geese, and great blue heron. Fish species in the Lake include bass, catfish, bluegill, carp, crappie, and yellow ring tail perch.[4]

In addition to its natural resource values, Oswego Lake is a multiple-use facility that serves the community in a variety of roles. It is a hydroelectric reservoir at the center of a 7,400 acre drainage basin. The Lake receives the majority of its water from the Tualatin River via a canal and also surface water from tributary streams, storm drain outfalls, and surface runoff. Also, there is a city sanitary sewer interceptor below the Lake's normal surface water elevation that has been constructed at an engineered grade to convey sewage to the Tryon Creek Sewage Treatment Plant.[5]

The Lake offers shoreline recreation opportunities to specific residents at the Lake Grove Swim Park and the Lake Oswego Swim Park. A City park at Lakewood Bay offers visual access, but not physical access, to the Lake. Oswego Lake is heavily used for water-related recreation by lakeside residents and others with Lake easements recognized by the Lake Corporation. The Lake is also valued by residents for its open space and aesthetic aspects, and for its historical and cultural importance. Residents consider the Lake to be a vital part of Lake Oswego's identity, and a natural resource valuable to the community.[6]

Tualatin River

The Tualatin River is a tributary to the Willamette River Watershed, entering the Willamette River at river mile 28.5. The Tualatin River drainage basin is approximately 43 miles long and 29 miles wide and covers an area of 712 square miles.[7] Annually, more than 1.1 million acre-feet of water flow out of the Tualatin River Watershed into the Willamette River. Nearly 85 percent of this flow is discharged during November through March, and less than 3 percent typically is discharged during June through October.[8]

The Tualatin River Watershed is a low elevation, low gradient drainage area. Mountains form the perimeter, separating it from the Pacific Ocean to the west. The Tualatin River headwaters originate in the Coast Range and tributaries flow from the Tualatin Mountains, a spur of the Coast Range rising up to 1,000 feet. These hills form a barrier to the valley on the north and east. The southern rim is formed by the Chehalem and Parrett Mountains (1,630 and 1,240 feet maximum elevations, respectively). After dropping about 2,700 feet over its first 14 miles, the river meanders the rest of its 83 mile length.[9]

Nearly half the watershed is a broad alluvial valley where elevations are between 100 and 200 feet. There are only four low notches in the wall of mountains around the Tualatin River basin. The Tualatin River drains into the Willamette River through a steep, walled canyon, falling about 50 feet over its last three miles beyond the dam at Lake Oswego. The other notches are found at Wapato Lake, Fields Bridge which is the mouth of the Tualatin, Oswego Notch, and at Tonquin. Through these low spots, prehistoric floods filled the Tualatin River basin with approximately 500 feet of water. Scabland channels from these floods can still be seen at Tonquin.[10]

Willamette River

A description of the Willamette River basin is provided in the Community Profile in the Clackamas County Natural Hazards Mitigation Plan. As such, the information will not be repeated here.

Climate

Lake Oswego is located in the northwestern portion of Clackamas County. Temperatures, measured at an elevation of 100', range from a monthly average low of 35°F in the winter months to a high of 82°F in the summer months. The coldest month is January and the hottest month is August. Historically, the wettest month is December and the driest month is July. The average annual precipitation is 47 inches.[11]

Population and Demographics

Lake Oswego is the largest city in Clackamas County, with a 2001 population of 35,580 and a 2003 certified population estimate of 35,860)[12]. Between 1990 and 2001, the population of Lake Oswego increased 16%. In 2000, the median age in Lake Oswego was 41.2 years, with 26% of the population 19 years old and younger, and 11% of the population 65 years and older (Tables 2-1 and 2-2).[13]

Table 2-1. City of Lake Oswego Population[14]

1980	1990	1998	1999	2000	2001
22,868	30,576	34,280	34,110	35,278	35,580

Table 2-2. Community Age Groups[15]

	1970	1980	1990	2000
Under 5 years	922	1,114	1,736	1,711
5-19 years	4,788	5,635	2,401	7,587
20-44 years	1,571	9,064	1,216	10,746
45-64 years	3,366	5,010	7,089	11,121
65+ years	926	2,045	3,420	4,057
Median Age	29	33	37	41.2

The 2000 U.S. Census reported the median household income in Lake Oswego as $71,597 (in 1999 dollars), the median family income as $94,587 (in 1999 dollars), and 2.3% of families were below the poverty level.[16]

Land and Development

Land use planning involves the consideration and balancing of many different factors and issues to make the best decisions for the community both for the short and long term. The goals and policies of the Lake Oswego Comprehensive Plan (1994) are intended to guide the community in making these decisions. The Plan is intended for use by all those who have concerns with the City's land use planning process including: local officials; persons with development interests; state, regional, and federal agencies; neighborhood and community groups; and citizens of all interests. Lake Oswego's quality of life and unique character depends, to a great extent, upon the character of development and the City's ability to provide needed and desired services. The Comprehensive Plan and implementing regulations are important tools to accomplish these objectives.

The following broad policy issues are addressed by the Land Use Planning element of the Comprehensive Plan:

- All development shall conform to applicable land use regulations and City codes;
- All development shall be adequately served by the full range of public facilities and services;
- Development shall occur at densities appropriate to the scale and character of Lake Oswego's neighborhoods and shall provide for preservation of open spaces and natural resources; and
- City-wide, natural resources shall be protected and open space shall be provided concurrent with development.

Housing and Community Development

Lake Oswego is considered one of the finest residential areas in Oregon. Unlike some communities its size, Lake Oswego offers full-service police and fire protection, a nationally recognized library, and an award-winning senior center. It also provides planning and zoning regulation, building inspection and regulation, street maintenance and improvement, and water, sewer, and surface water services. The schools in the city rate among the best in the county, with more than 80% of high school students going on to attend college.[17]

Between 1970 and 2000, there was more than a threefold increase in the number of housing units built in Lake Oswego. In 2000, the median value of owner-occupied housing was $296,200, which is higher than in Clackamas County at $199,000 (Table 2-3).[18]

Table 2-3. Housing – Lake Oswego Compared to Clackamas County[19]

Total Housing Units	1970	1980	1990	2000	Median Value of Owner-Occupied Housing, 2000
City of Lake Oswego	5,113	8,715	13,123	15,668	$296,200
Clackamas County	49,159	84,424	109,003	136,954	$199,000

In 2000, there were 10,423 owner occupied and 4,346 renter occupied housing units in the City, with a 6.24% vacancy rate. The median mortgaged housing cost to an owner was $1,847, and median gross rent was $839.[20]

Employment and Industry

Lake Oswego is primarily a residential community, but there is some commercial development and light manufacturing. As of June 2002, the city's five largest employers include the Lake Oswego School District, Guidance Medical Personnel, Safeco, Otak, Inc., and Micro Systems Engineering.[21] The City of Lake Oswego is also a large employer. Most of the businesses are located downtown near the Willamette River, which is the City's eastern boundary, or on the west end in Lake Grove near Interstate 5. Tables 2-4 and 2-5 illustrate the 2000 U.S. Census employment and industry figures for Lake Oswego residents.

Table 2-4. Occupations of Employed Civilians Aged 16 Years and Over (2000 Census)[22]

Occupation	Number	Percent
Management, professional, and related occupations	10,491	57.3
Service occupations	1,253	6.8
Sales and office occupations	5,236	28.6
Farming, fishing, and forestry occupations	38	0.2
Construction, extraction, and maintenance occupations	493	2.7
Production, transportation, and material moving occupations	794	4.3

Table 2-5. Industry of Employed Civilians Aged 16 Years and Over (2000 Census)[23]

Industry	Number	Percent
Agriculture, forestry, fishing and hunting, and mining	60	0.3
Construction	773	4.2
Manufacturing	1,909	10.4
Wholesale trade	1,046	5.7
Retail trade	2,256	12.3
Transportation and warehousing, and utilities	654	3.6
Information	731	4.0
Finance, insurance, real estate, and rental and leasing	2,047	11.2
Professional, scientific, management, administrative, and waste management services	2,994	16.4
Educational, health and social services	3,660	20.0
Arts, entertainment, recreation, accommodation and food services	907	5.0
Other services (except public administration)	578	3.2
Public administration	690	3.8

Transportation and Commuting Patterns

Lake Oswego is served by a mixture of municipal road systems, county roads, state and federal highways, and regional public transportation. Interstate 5 to the west of Lake Oswego and State Highway 43 at the east end of the city provide regional access to and from the city. TriMet provides local and regional bus service. The Portland and Western Railroad passes through the city, serving local and regional industry. The Willamette Shore Trolley travels between Lake Oswego and Portland, to the north, providing recreational and sightseeing opportunities.

According to the 2000 U.S. Census, 79% of Lake Oswego residents (16 years old and over) drove to work alone, 8% carpooled, 4% used public transit, 2% walked, and less than 1% commuted by other means. The mean travel time to work for these commuters was 22 minutes.[24]

Section 3:
Hazard Assessment

What is a Hazard Assessment?

Conducting a hazard assessment can provide information on the location of hazards, the value of existing land and property in hazard locations, and an analysis of risk to life, property, and the environment that may result from natural hazard events. Hazard assessments are subject to the availability of hazard-specific data. The City of Lake Oswego conducted a hazard assessment for all of the hazards for which data were available. The three components of a hazard assessment are as follows:

1) ***Hazard Identification*** identifies the geographic extent of the hazard, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data. The City of Lake Oswego identified six major hazards that have the potential to affect this geographic area. These hazards – floods, landslides, severe storms (wind and winter), wildfires, earthquakes, and volcanoes – were identified through an extensive process that utilized input from the Hazard Mitigation Advisory Committee. The geographic extent of each of the identified hazards has been mapped by the City of Lake Oswego GIS department using the best available data, and is illustrated by the maps listed in Table 3.1.

2) ***Vulnerability Assessment/Inventorying Assets*** combines hazard identification with an inventory of the existing (or planned) property and population exposed to a hazard. The exposure of community assets to natural hazards is provided in Table 3-3. Additionally, a more detailed description of the vulnerability of these assets is located in the specific hazard sections.

3) ***Risk Analysis/Estimating Potential Losses*** involves estimating the damage, injuries, and financial losses likely to be sustained in a geographic area over a given period of time. This level of analysis involves using mathematical models. The two measurable components of risk analysis are magnitude of the harm that may result and the likelihood of the harm occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework with which to measure the effects of hazards on assets.

   Unfortunately, there are insufficient data for conducting a risk analysis for the natural hazards affecting the City of Lake Oswego. However, this need is identified in our action plan, and a risk assessment will be completed when the resources are available.

Table 3-1. List of Hazard Mitigation Plan Maps

Map #	Type of Map	Section of the Plan
Figure 3-1	Critical Facilities	Section 3 – Community Assets and Vulnerability Assessment
Figure 3-2	Essential Facilities	Section 3 – Community Assets and Vulnerability Assessment
Figure 3-3	Infrastructure	Section 3 – Community Assets and Vulnerability Assessment
Figure 4-1	Flood Hazard	Section 4 – Flood Hazard
Figure 4-2	Landslide Hazard	Section 4 – Landslide Hazard
Figure 4-3	Wildfire Hazard	Section 4 – Wildfire Hazard
Figure 4-4	Winter Storm Routes	Section 4 – Severe Storm (Wind and Winter) Hazard
Figure 4-5	Earthquake Hazard	Section 4 – Earthquake Hazard

Federal Requirements for a Hazard Assessment

Recent federal regulations for hazard mitigation plans outlined in 44 CFR Part 201.6 (c) (2) include a requirement for a hazard assessment. This hazard assessment requirement is intended to provide information that will help communities to identify and prioritize mitigation activities that will reduce losses from the identified hazards. There are six hazards profiled in the mitigation plan, including: floods, landslides, wildfires, earthquakes, severe storms (wind and winter), and volcanic eruptions. The federal criterion for hazard assessments and information on how the City of Lake Oswego Natural Hazard Mitigation Plan meets those criteria is outlined in Table 3-2, below.

Table 3-2. Federal Criteria for a Hazard Assessment

Section 322 Requirement	How is this addressed?
Identifying Hazards	The Natural Hazard Section (Section 4) of this Plan includes maps illustrating the geographic extent of the each of the hazards affecting Lake Oswego, using the best available data.
Profiling Hazard Events	Volume II of the Clackamas County Natural Hazard Mitigation Plan provides documentation for all of the large-scale hazard events affecting the region. Where data are available, Lake Oswego has provided a description of local impacts from historical hazard events.
Assessing Vulnerability: Identifying Assets	Table 3-3 in this Plan documents the community assets that are vulnerable to natural hazards. A more detailed description of the vulnerability of these assets is located in the specific hazard sections.
Assessing Vulnerability: Estimating Potential Losses	Using the best available data, an estimate of potential losses from natural hazards is located in the hazard specific sections.
Assessing Vulnerability: Analyzing Development Trends	The Community Profile Section of this plan provides a description of the development trends in Lake Oswego.

Community Assets and Vulnerability Assessment

This section outlines the resources, facilities, and infrastructure that, if damaged, could significantly impact public safety, economic conditions, and natural resources in Lake Oswego.

The community assets are defined as follows, and are shown in Figures 3-1, 3-2, and 3-3:

Critical Facilities – Those facilities and infrastructure necessary for emergency response efforts:

- City Hall: Dispatch, Law Enforcement;
- Fire Stations (Main Fire Station: Emergency Operations Center (EOC));
- Adult Community Center (ACC): Primary Shelter; and
- City Maintenance Facility.

Essential Facilities – Those facilities and infrastructure that supplement response efforts:

- Lake Oswego Tennis Center: Shelter;
- Lake Oswego Library: Shelter;
- Schools: Shelter (potential Red Cross sites);
- Churches: Shelter (potential Red Cross sites); and
- All City Facilities.

Infrastructure – Infrastructure that provides essential services for the City of Lake Oswego:

- Tryon Creek Wastewater Treatment Plant and main lines;
- Oswego Lake sanitary sewer interceptor;
- Oswego Lake dam and headgate;
- Water treatment plant; water pumping stations, major water lines, reservoirs, water intake on Clackamas River;
- Highway 43 (State Street), McVey Avenue, Stafford Road: Regional Emergency Transportation Route;
- Transportation networks, including major roads and all bridges;
- Portland General Electric substations;
- NW Natural gas pipelines;
- Fiber optic lines; and
- Communications towers.

The exposure of community assets to natural hazards is provided in Table 3-3, below. Exposure of community assets to natural hazards was determined by manually comparing critical and essential facilities and infrastructure maps with each hazard map, and identifying where assets and hazards, or parcels affected by hazard, intersected.

Table 3-3. City of Lake Oswego Vulnerability Assessment

Hazard	% Land Area Exposed	Critical Facilities Exposed	Essential Facilities Exposed	Infrastructure Exposed
Flood[1]	- 19% - 2% possibly affected[2]	None	Tax lot intersects: - Schools: Christi School/Marylhurst College - Churches[7]: St. Anne's Chapel	Tax lot intersects: - Tryon Creek Wastewater Treatment Plant - Wastewater main lines: Foothills area, Lakeview Blvd., Old River Rd., Blue Heron & Oswego Canals, Springbrook Creek - Oswego Lake sanitary sewer interceptor - Oswego Lake dam & headgate - Major water lines: State St/Hwy. 43, Lakewood Bay - Regional Emergency Transportation Route: State St./Hwy. 43 & McVey Ave. - Transportation network: some major roads & several bridges - PGE substation: Foothills - NW Natural gas pipeline: Bryant Rd. & McVey Ave. - Fiber optic line: State St./Hwy. 43 & McVey Ave.
Landslide	- 1% in landslide hazard area[3] - 4% in potential rapidly moving landslide hazard area[4]	- Adult Community Center	- Schools: Hallinan Elem., Westridge Elem.	- Wastewater main lines: Old River Rd., Tributary to Tryon Creek east of Boca Raton Dr. [passes thru landslide area] - Major water lines: State St./Hwy. 43, George Rogers Park, Oak St, South Shore Blvd., Iron Mountain Blvd. - Regional Emergency Transportation Route: State St./Hwy. 43 - Transportation network: some major roads & several bridges - Fiber optic line: State St./Hwy. 43

(Continued on next page.)

Notes:

1. Based on Flood Management Area (FMA) which is comprised of FEMA 100-year floodplain around Oswego Lake (including its bays and canals north of Bryant Road), and 1996 flood inundation boundary along the Tualatin and Willamette Rivers and canals south of Bryant Road. Results include all tax lots that intersect with FMA.
2. The digital FEMA 100-year floodplain boundary is not accurate so additional tax lots have been selected as "possibly affected by" the flood hazard (see Figure 4-1).
3. DOGAMI, Bulletin 99 - Landslide, 1979.
4. DOGAMI, IMS-22, Potential Rapidly Moving Landslide Hazards in Western Oregon, 2003.

Table 3-3. City of Lake Oswego Vulnerability Assessment (continued)

Hazard	% Land Area Exposed	Critical Facilities Exposed	Essential Facilities Exposed	Infrastructure Exposed
Wildfire[5]	- 31% in high wildfire hazard area - 23% in moderate wildfire hazard area	In High Wildfire Hazard Area: - Adult Community Center	In High Wildfire Hazard Area: - Tennis Center - Schools: Forest Hills Elem., Oak Creek Elem., Westridge Elem., Christi School/Marylhurst College - Churches[7]: St. Anne's Chapel, Westside Baptist Church, Triumphant King Lutheran Church, Lake Grove Presb., Church of Jesus Christ of LDS (Kruse Oaks), First Church of Christ Scientist, Lake Chapel Foursquare Church - Other City Facilities: South Shore Fire Station	In High Wildfire Hazard Area: - Wastewater main lines: Foothills area, George Rogers Park, Old River Rd., Oswego Canal, Springbrook Creek (Iron Mountain Blvd. to Twin Fir Rd.), Waluga Park, Carman Dr., Melrose St., Boones Ferry Rd., McNary Pkwy,. Country Club Rd. - Oswego Lake headgate - Reservoirs: Forest Highlands I & II; Touchstone II; Waluga; South Side; Cook's Butte; Cityview; Palisades II - Water pumping stations: McVey/Cornell, South Shore, Waluga Park, Park Wy. - Major water lines: Hwy. 43, Oak St., McVey Ave./South Shore Blvd., Fernwood Dr., Bryant Rd., Portland & Western R/R, Quarry Rd., Waluga Park, Carman Dr., Park Wy., Springbrook Creek, Twin Fir Rd., Iron Mountain Blvd. - Regional Emergency Transportation Route: State St./Hwy. 43, McVey Ave. - Transportation network: some major roads & several bridges - PGE substation: Mt. Park - NW Natural gas pipeline: Hillshire Dr., Boones Ferry Rd. - Fiber optic line: State St./Hwy. 43, McVey Ave., Stafford Rd. - Communications Tower: Cooke's Butte

(Continued on next page.)

Notes:
5. Clackamas County, Relative Wildfire Fire Hazard Risk Areas, 2003.

Table 3-3. City of Lake Oswego Vulnerability Assessment (continued)

Hazard	% Land Area Exposed	Critical Facilities Exposed	Essential Facilities Exposed	Infrastructure Exposed
Earthquake	- 17% in Zone A[6]	In Zone A: - City Hall - Main Fire Station - Adult Community Center	In Zone A: - Schools: Christi School/Marylhurst College, Westridge Elem., Lake Grove Elem., Our Lady of the Lake School - Churches[7]: St. Anne's Chapel, Church of Jesus Christ of LDS (Westlake & Kruse Oaks), Our Lady of the Lake Church, Unity World Healing Center, Lake Chapel Foursquare Church Fault[8] Line(s) Intersects: - Schools: Lakeridge H.S., Lake Grove Elem. - Churches[7]: Westside Baptist Church, Lake Grove Presb.	In Zone A: - Tryon Creek Wastewater Treatment Plant - Wastewater main lines: Foothills area, south of George Rogers Park, Old River Rd., Evergreen Ave., Country Club Rd., Springbrook Creek (at Boones Ferry/Douglas Way & Lakeview Blvd.) - Oswego Lake headgate - Water pumping stations: Hwy. 43, Waluga Park - Major water lines: Hwy. 43, Oak St., McVey Ave./South Shore Blvd., Upper Dr., Bryant Rd., Quarry Rd., Iron Mountain Blvd., Douglas Wy., Red Cedar Wy, Twin Fir Rd., Lake Forest Dr./Ellis Ave., 6th Ave., D Ave., State St., Country Club Rd. to Boca Raton Dr. - Regional Emergency Transportation Route: State St./Hwy. 43 - Transportation network: some major roads & several bridges - NW Natural gas pipeline: Boones Ferry Road, Hillshire Dr. - Fiber optic line: State St./Hwy. 43) - Communications Tower: City Hall Fault[8] Line(s) Intersect: - Tryon Creek Wastewater Treatment Plant - Wastewater main lines: Country Club Rd., Springbrook Creek (Boones Ferry/Douglas Way) - Major water lines: Hwy. 43, Oak St., McVey Ave./South Shore Blvd., Upper Dr., Quarry Rd., Iron Mountain Blvd. - Regional Emergency Transportation Route: McVey Ave., Stafford Rd. - PGE substation: Foothills - NW Natural gas pipeline: McVey Ave., Stafford Rd., Boones Ferry Rd. - Fiber optic line: State St./Hwy. 43, McVey Ave., Stafford Rd. Other: - Oswego Lake sanitary sewer interceptor

Notes:
6. DOGAMI, GMS-91, Relative Earthquake Hazard, 1995.
7. Churches are listed by name and address in Resource Directory.
8. DOGAMI, Bulletin 99 - Earthquake Faults, 1979.

Section 4:
Natural Hazards

Flooding

Lake Oswego has two large rivers and several smaller tributaries that are susceptible to annual flooding events. Flooding poses a threat to life and safety, and can cause severe damage to public and private property.

Flooding Profile

The City of Lake Oswego has been impacted by floods several times in its 93-year history. Minor flooding is experienced on a near yearly basis, but is generally only an inconvenience. There have been at least six events in the past fifty years which have caused widespread damage.

The probability of flooding events in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of flooding in Lake Oswego is described in Section Five of this report.

Willamette River

The highest recorded flood levels on the Willamette River were recorded in December 1861, however water levels rose high enough at least six times in the past fifty years to cause damage to structures in the Foothills Road, Fielding Road, Stampher Road and other riverfront areas. These Willamette River floods reached a height ranging from 30.0 feet to 41.4 feet (NGVD -National Geodetic Vertical Datum) on December 25, 1964 at Oswego Pointe. Approximately 40 to 50 structures within the City limits are vulnerable when levels exceed the 100-year flood elevation of 34.0 feet.

Tualatin River, Oswego Canal and Oswego Lake

The highest recorded flood levels on the Tualatin River were recorded on February 10, 1996. The period of record on this river only extends back to 1928. This record flood reached an elevation of 120.12 feet (NGVD). Waters that normally flow from the Tualatin River into the Oswego Canal are regulated by the canal headgate structure which has a top of dam height of 113.6 feet. Once Tualatin River levels exceed the top of dam height, the water flows unimpeded into the canal and northward to Oswego Lake. When the river reaches a level of 117.5 feet, water begins to leave the north banks of the Tualatin near the 5400 block of Dogwood Drive and then migrates across Sycamore Avenue eventually rejoining the main Oswego Canal near Childs Road and Bryant Woods Park. At this time, the Lake Corporation's ability to release water at the east end of Oswego Lake is outstripped by the flows entering the lake from the Oswego Canal and the lake level begins to rise uncontrollably.

At the height of the 1996 flood, the Oswego Canal rose 4.2 feet above normal summer levels at the South Shore Bridge, about 13 feet higher than normal at the Bryant Road Bridge, and exceeded normal by nearly 18 feet at the Childs Road Bridge.

Oswego Lake rose to 102.60 feet (NGVD) during the 1996 flood, at which point water was crossing McVey Avenue and State Street. The water that crossed State Street flowed down Foothills Road, through the Oswego Pointe Apartments, and into the Willamette River.

Dozens of homes, businesses, and boathouses were damaged by these floodwaters. Properties along Dogwood Drive, Melissa Drive, Canal Road, Pioneer Court, Bryant Road, Cardinal Drive, Kelok Road, Sarah Hill Lane, Lake Haven Drive, Canal Circle, many homes surrounding Oswego Lake (including all bays and canals), businesses along State Street from the railroad crossing south to North Shore Road, plus many apartments, businesses, and carports in the Oswego Pointe area all experienced severe water and structural damage.

Record flooding is usually accompanied by low elevation snows in the Coast and Cascade Mountain foothills. Often snow is on the ground at the 1,000' elevation and sometimes it is even present all the way down to sea level. Larger than normal snow depths in the middle, easily melted, elevations, such as 2000' to 3,500', are another major source of water runoff. These depths are frequently observed at the Saddle Mountain Snowtel station located at 3,250' in the Coast range of western Washington County. Both the 1964 and 1996 floods were preceded by a period of sub-freezing temperatures that caused the soils of the drainage basins to solidify and become relatively impervious.

Finally, there is a rainfall pattern known as the "Pineapple Express" which brings very heavy and warm rains from the southwest. These warm rains literally begin their journey from parts of the Pacific near Hawaii, holding their heat and moisture until making landfall along the Oregon coast. As an example, at 1 A.M. on the morning of February 8, 1996, the temperature had risen to 61°F with a driving rain following a period of freezing conditions. This warm rain storm preceded the flood crest on the Willamette River by 2½ days.

Characteristics of Flooding

The two basic categories of floods that Lake Oswego is subject to are:

Flash Floods

Flash floods of short duration often occur after intense local rainstorms and can be associated with late-summer (August through September) thunderstorms. These events generally last less than two hours and can damage properties and structures located very close to small streams such as Springbrook Creek, Lost Dog Creek, or can even be generated by run-off from steep street sections.

Riverine Flooding

Riverine floods have a much greater duration. Often, the conditions which precede this type of flooding can be observed 10 to 20 days in advance of the flood crest. Although very heavy rains over a period of five to ten days can bring the Willamette and Tualatin Rivers to flood stage, the worst flooding requires several other conditions.

In general, the rivers have taken twice as long to recede to bank full levels as they did to rise above them. Major forms of this type of flooding can be anticipated from the beginning of December until the end of February, with mid to late January being the peak season.

An additional type of flooding which occurred before the Columbia River dams were in place is a spring-melt condition which caused the Willamette River to back up, resulting in moderate flooding along the Willamette River in May and June. The last time this type of flooding was experienced in Lake Oswego was during the "Vanport" flood of May 30 through June 10, 1948.

Flooding Response Activities

During past flood events, the City's response has been limited to notification of property owners of impending flooding. Generally, we have been able to provide 24 to 36 hour notice. This notice has been followed by evacuation of people and, to a limited extent, personal property.

Attempts at sandbagging have been only partially effective. In areas where a good initial plan is communicated to volunteers, adequate supplies are available, and waters do not exceed 2 feet in depth, sandbagging can help.

Flooding Hazard Assessment

Hazard Identification

The geographic extent of the flooding hazard in Lake Oswego has been mapped by the City of Lake Oswego GIS department, as shown in Figure 4-1, using the best available data. The City's Flood Management Area (FMA) boundary and FEMA 100-year floodplain were used to identify and map the flood hazard and perform the flood hazard analysis. The FMA includes the FEMA 100-year floodplain around Oswego Lake (including its bays and canals north of Bryant Road), and the 1996 flood inundation boundary along the Tualatin and Willamette Rivers, and canals south of Bryant Road. As the digital data of the 100-year floodplain boundary are not accurate, an additional buffering of tax lots was included in the analysis and the results are included as tax lots "possibly affected by" the flood hazard. FEMA and Clean Water Services of Washington County, in partnership with the City and other local jurisdictions, recently completed a Tualatin River Basin floodplain mapping update. At the time this new floodplain data are approved by FEMA, the HMAC will update its flood hazard assessment relative to the new 100-year floodplain.

As shown in Table 4-1, below, parcels totaling 1,331 acres, 19% of Lake Oswego's land area, are located within or intersect the City's Flood Management Area (FMA), with an additional 136 acres, 2% of Lake Oswego's land area, possibly affected by the floodplain. Additionally, 1,656 structures are located within the FMA, with a building value totaling $511,324,260 and a land value of $390,960,195. Land uses within the FMA include commercial, industrial, residential, rural, undeveloped, unknown, and right-of-way (see Table 4-1).

Vulnerability Assessment

The City of Lake Oswego GIS department has completed an analysis, using the best available data, as a component of the vulnerability assessment described in Section 3: Hazard Assessment. This analysis looked at identified hazard areas in conjunction with available data on property exposed to the hazard. Exposure of community assets to natural hazards was determined by manually comparing critical and essential facilities and infrastructure maps with each hazard map, and identifying where assets and hazards, or parcels affected by hazard, intersected. Many community assets are potentially exposed to flood hazards, as discussed below and shown in Table 3-3. For a complete listing of the community assets exposed to flood hazards, please refer to Table 3-3.

Two essential facilities are shown in Table 3-3 as being exposed to the flood hazard. While the parcels that contain these facilities were identified as being affected by the flood hazard, the portion of the parcel exposed to the hazard is at a significantly lower elevation than the facilities themselves.

The Tryon Creek Wastewater Treatment Plant, located in the Foothills area, is located on a parcel that is affected by the Flood Management Area, though the facility itself is located above the 100-year floodplain. In off-peak hours, the facility is remotely operated, reducing potential life safety issues from a flood hazard. However, flood conditions that result in a change in hydraulics could affect the operation of the facility.

The wastewater main line located in the Foothills area is elevated above ground level, potentially increasing its susceptibility to flood damage. Other exposed infrastructure listed in Table 3-3, including wastewater main lines, natural gas pipeline and fiber optic lines are buried, decreasing their vulnerability to damage from flood hazards. However, hazardous flood conditions could potentially limit or delay access for the purposes of operation or repair. The fiber optic line located in Highway 43/State Street, McVey Avenue and Stafford Road is a significant communication link for the entire region.

The regional Emergency Transportation Route follows State Highway 43 from the north City limits, and continues south on State Street to McVey Avenue, and then southwest to and along Stafford Road. This route crosses a bridge on McVey Road (Oswego Lake Outlet/McVey Ave. Bridge) that could be potentially affected during flood conditions. Culverts located along the Emergency Transportation Route could also be affected during hazardous conditions as flood waters could exceed the hydraulic capacity of the facility.

Table 4-1. Flood Hazard Vulnerability Assessment - Additional Data

Flood Hazard[1]	Total Acres	No. of Structures	Land Use / Acres	Value of Land & Structures[2]
Affected by Flood Management Area	1,331	1656[5]	- Commercial / 22.2 - Industrial / 33.2 - MF Residential / 102.9 - Rural / 88.0 - SF Residential / 298.1 - Undeveloped / 747.3 - Unknown / 39.5 - ROW[3] / 34.2	Building value - $511,324,260 Land value - $390,960,195
Possibly Affected by Floodplain[4]	136	410[5]	- Commercial / 3.1 - Industrial / 1.3 - MF Residential / 8.0 - SF Residential / 95.5 - Undeveloped / 26.7 - Unknown / 1.9	Building value - $137,314,280 Land value - $107,688,548

Notes:

1. Based on Flood Management Area (FMA) which is comprised of FEMA 100-year floodplain around Oswego Lake (including its bays and canals north of Bryant Road), and 1996 flood inundation boundary along the Tualatin and Willamette Rivers and canals south of Bryant Road. Results include all tax lots that intersect with FMA.
2. Value is Real Market Value from Clackamas County Assessor's records.
3. Includes right-of-way and other non-tax lot area such as public walkway and utility easements.
4. The digital FEMA 100-year floodplain boundary is not accurate so additional tax lots have been selected as "possibly affected by" the flood hazard (see Figure 4-1).
5. Number of structures on tax lots affected by and possibly affected by floodplain.

Risk Analysis

Due to insufficient data, Lake Oswego is unable to perform a quantitative risk assessment at this time. The City has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Repetitive Flood Loss

The City of Lake Oswego works to mitigate problems regarding flood issues when they arise. Some areas in the city are more susceptible to flooding issues, and have incurred repetitive losses, meaning that they have had greater than two National Flood Insurance Program (NFIP) claims in the past ten years. According to the most current data from Oregon Emergency Management, there is only one repetitive loss property in the Lake Oswego area. The data are not reported here to protect the privacy of the property owner.

Existing Flood Mitigation Activities

Flood mitigation activities listed here include current mitigation programs and activities that are being implemented by Lake Oswego agencies or organizations.

Lake Oswego Codes Pertaining to Flooding

The following Lake Oswego codes, plans, and policies pertain to flooding:

1) Lake Oswego Comprehensive Plan, Goal 7 - Areas Subject to Natural Disasters and Hazards, Section 1, Flood Hazards. The Goal of Section 1, Flood Hazards states: "The City shall protect life and property from flood hazards".

The Federal Emergency Management Agency (FEMA) provides the City with mapped floodplain information which identifies floodplain elevations and areas subject to flooding. Lake Oswego participates in the National Flood Insurance Program, which is administered by FEMA. This program allows residents of Lake Oswego to obtain federally subsidized flood insurance. In order to be eligible to participate in this program, the City adopted floodplain development standards in 1988 that met FEMA standards. Early in 2003, the City adopted revised floodplain management standards (LOC 50.44) in compliance with FEMA, state, and Metro standards.

2) Lake Oswego Community Development Code, Article 50.44 Flood Management Area. This portion of the Community Development Code implements the Goal 7 policies of the Comprehensive Plan and regulates development within the floodplain. The purpose of Article 50.44 is to:

- Promote the public health, safety and general welfare;
- Minimize public and private losses due to flood conditions in specific areas; and
- Maintain eligibility of properties within the City to participate in the National Flood Insurance Program.

3) Lake Oswego Bridge Inspections and Records Manual. This manual outlines the City's bridge inspection program that was implemented to better respond in the event of a natural disaster. The intent of the program is to utilize trained City personnel to closely document bridge conditions through visual inspections, establishing baseline condition information to use for comparison to bridge conditions after a disaster. Overall, bridges throughout the City are old and in need of upgrading. Additionally, the manual outlines a disaster response plan, including identification of disaster response team members and a bridge closure and detour plan.

Flood Mitigation Projects

After the 1996 flood event the City of Lake Oswego commissioned a study, "Lakewood Bay Flood Protection At North Shore Road Bridge" (Pacific Water Resources, June 30, 2000), to evaluate the event of 1996 and what impacts would be experienced by the main part of Oswego Lake if Lakewood Bay were isolated during a similar flood event. During a flood event, blocking the inlet of Lakewood Bay would stop flood waters from filling the bay and overtopping State Street (Highway 43), as occurred in 1996. During the 1996 flood, State Street was flooded and blocked for over a day, affecting emergency access in the eastern part of Lake Oswego.

During the flood event in 1996, the primary cause of the flooding in the Foothills Road area was due to two sources. Both of these sources have since been mitigated, as described below.

1) A low point in the levy behind (north of) the Tryon Creek Treatment Plant allowed flood waters from the Tryon Creek/Willamette River to overtop the levy and enter the Foothills Road area. The City of Portland has since made repairs and improvements to address the problem.

2) A large diameter storm drain pipe that receives runoff from an area of downtown (200+ acres) drains through the Toklat Industries parking lot and discharges into Tryon Creek. Flood waters from the Tryon Creek/Willamette River system backed up through this storm system, surcharging the manholes and catch basins, contributing to the flooding in the Foothills Road area. Subsequently, this problem has been rectified. Redundant check valves have been installed on the storm pipes to prevent back up, and two pump stations have been designed and built that will accept the runoff generated in the upstream drainage basin and "force" it into the drain pipe and through the submerged outlet.

The smaller pump station is an electric submersible pump that is designed to handle runoff that accumulates at the Lakeshore Concrete site. This area is really a bowl within a bowl. Should power fail during a flood event, the pump is set up such that a trailer mounted portable generator could be plugged into the control panel to provide backup power.

The other pump station is located at the north end of Toklat Industries parking lot. These are two, variable speed pumps with a combined capacity of 5,000 GPM. Each pump is powered by a Ford six-cylinder engine, fueled with natural gas. In the event of a loss of supply of natural gas, the backup power source is a power take-off (PTO) drive that is mounted on the vertical drive shaft of the pumps. City Maintenance staff would then mobilize a piece of equipment that employs hydraulics (such as a back-hoe, tractor, or dump truck,) and plug in the quick-connect hoses (stored on site) into the PTO and the piece of mobile equipment.

These pumps were installed in the late 1990's and City Maintenance staff are familiar with their operation. These systems are inspected and exercised on a regular basis.

In addition to the flood mitigation project described above, the development of a new park in the Foothills Area will include improvements that bring the front of the park area out of the floodplain, with a finished elevation of 37.5 feet above mean sea level (MSL).

Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from flood events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. Plan goals and county action items addressed (listed to facilitate city/county coordination) are also noted for each action item.

ST-FL#1: Reduce the vulnerability in the Foothills area to the flooding hazard.

Ideas for Implementation:

- Consider making improvements to the dike system in the Foothills district in conjunction with the Foothills Park Plan to reduce the local flooding hazard.
- Consider large-scale floodplain restoration in the Foothills area through acquisition and/or management strategies.

Coordinating Organization:	Parks & Engineering
Timeline:	1-2 Years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	LT-FL#2

LT-FL#1: Implement alternatives for reducing the flooding hazard for properties along Oswego Lake and canals.

Ideas for Implementation:

- Evaluate and implement recommendations for reducing the flooding hazard identified in the "Evaluation of Flood Management Alternatives for Oswego Lake and Canal" (Pacific Water Resources, 2003), particularly modifications to Lake Corporation dam, headgate, and spillway.

Coordinating Organization:	Engineering
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	LT-FL #3

LT-FL#2: Conduct a study to identify appropriate mitigation strategies for repetitively flooded properties along Oswego Lake and canals, and prioritize for implementation.

Ideas for Implementation:

- Identify repetitively flooded properties and share mitigation strategies with property owners.
- Obtain funding to implement appropriate mitigation strategies.

Coordinating Organization:	Engineering & Planning
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-FL #1

LT-FL#3: Pursue participation in the Community Rating System (CRS) program by identifying the requirements that are currently being met and those that need to be addressed.

Ideas for Implementation:

- Contact FEMA to identify process for entering CRS.
- Coordinate flood prevention strategies with the county and other neighboring jurisdictions that currently participate in the CRS program.
- Conduct public outreach and education to potential affected property owners regarding the reduction of insurance premiums resulting from compliance to the CRS program goals and objectives.

Coordinating Organization:	Engineering & Planning
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-FL#2

Landslide

Landslides and soil erosion hazards exist at different locations within the Lake Oswego Urban Services Boundary because of the presence of hilly terrain, steep ridges, and ravines underlain by unstable geology and overlain by soils which have low carrying capacity for structures. The stability of soils on a hillside are generally dependent upon the slope, the amount of precipitation, vegetative cover, and the underlying geology. However, hillsides are constantly in motion, due to gravity and effects of weathering and erosion. Any time the load on a susceptible hillside is increased or the stabilizing vegetation altered, erosion or landslides can occur. These disturbances can also increase surface water runoff and affect water quality through erosion and siltation.

Landslide Profile

The historical landslide events have been described in the county plan, and are applicable to Lake Oswego. As such, a description of these events will not be repeated here.

The probability of landslide events in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of landslides in Lake Oswego is described in Section Five.

Landslide Hazard Assessment

Hazard Identification

The geographic extent of the landslide hazards in Lake Oswego has been mapped by the City of Lake Oswego GIS department, as shown in Figure 4-2, using the best available data. Landslide data utilized were developed by the State Department of Geology and Mineral Industries (DOGAMI), Bulletin 99 - Landslide, 1979; and IMS-22 Potential Rapidly Moving Landslide Hazards in Western Oregon, 2003. Less than five percent of Lake Oswego is located within Multnomah County, including the northern portion of the Mountain Park neighborhood. However, landslide data for Multnomah County are not currently available.

As shown in Table 4-2, below, parcels totaling 67 acres, 1% of Lake Oswego's total land area, are potentially exposed to landslides, and 268 acres, 4% of Lake Oswego's total land area, are potentially exposed to rapidly moving landslides, or debris flows. Additionally, 137 structures are potentially exposed to landslides, with a building value totaling $36,826,910 and a land value of $27,551,187; and 276 structures are potentially exposed to rapidly moving landslides, or debris flows, with a building value totaling $174,615,680 and a land value of $153,906,087. Land uses within the landslide hazards areas include: commercial, residential, rural, undeveloped, unknown, and right-of-way (see Table 4-2).

Vulnerability Assessment

The City of Lake Oswego GIS department has completed an analysis, using the best available data, as a component of the vulnerability assessment described in Section 3: Hazard Assessment. This analysis looked at identified hazard areas in conjunction with available data on property exposed to the hazard. Exposure of

community assets to natural hazards was determined by manually comparing critical and essential facilities and infrastructure maps with each hazard map, and identifying where assets and hazards, or parcels affected by hazard, intersected. Many community assets are potentially exposed to landslide hazards, as discussed below and shown in Table 3-3. For a complete listing of the community assets exposed to landslide hazards, please refer to Table 3-3.

The Adult Community Center, a Critical Facility, is listed in Table 3-3 as being exposed to landslide hazards as it is in close proximity to a potential landslide area. However, the portion of the parcel that contains the Adult Community Center is relatively flat, while the undeveloped rear portion of the parcel is at the top of a steep slope leading down to Tryon Creek, thereby minimizing risks of the facility to the landslide hazard.

Exposed infrastructure listed in Table 3-3, including wastewater main lines, major water lines and fiber optic lines are buried, decreasing their vulnerability to damage from landslide hazards. However, hazardous landslide conditions could potentially limit or delay access for the purposes of operation or repair. The City's fresh drinking water supply comes from the water treatment plant in West Linn, with the water intake located on the Clackamas River in Gladstone. The water line from the City's water treatment plant located in West Linn enters the City along Highway 43 and runs north through George Rogers Park, an area vulnerable to landslide hazards. The fiber optic line located in Highway 43/State Street, McVey Avenue and Stafford Road is a significant communication link for the entire region.

The regional Emergency Transportation Route follows State Highway 43 from the north City limits, and continues south on State Street to McVey Avenue, and then southwest to and along Stafford Road. At the northern City limits, the Emergency Transportation Route along State Street passes through a potential landslide area, possibly impacting access to and from the City.

Due to unavailability of data, landslide hazards where not mapped for the portion of Lake Oswego in Multnomah County, primarily the northern part of the Mountain Park neighborhood. However, it should be noted that this portion of the City contains steep slopes potentially susceptible to landslide hazards, and a communications tower used for emergency communications is located in this area on Mt. Sylvania.

Table 4-2. Landslide Hazard Vulnerability Assessment - Additional Data

Landslide Hazard	Total Acres	No. of Structures	Land Use / Acres	Value of Land & Structures[1]
Landslide[2]	67	137	- Rural / 14.7 ac. - SF Residential / 38.9 - Undeveloped / 3.6 - ROW[4] / 9.8	Building value - $36,826,910 Land value - $27,551,187
Potential Rapidly Moving Landslide[3]	268.4	276	- Commercial / 0.4 - MF Residential / 3.2 - Rural / 7.7 - SF Residential / 97.6 - Undeveloped / 132.5 - Unknown / 0.9 - ROW[4] / 26.1	Building value - $174,615,680 Land value - $153,906,087

Notes:
1. Value is Real Market Value from Clackamas County Assessor's records.
2. DOGAMI, Bulletin 99 Landslide, 1979.
3. DOGAMI, IMS-22 Potential Rapidly Moving Landslide Hazards in Western Oregon, 2003.
4. Includes right-of-way and other non-tax lot area such as public walkway and utility easements.

Risk Analysis

Due to insufficient data, Lake Oswego is unable to perform a quantitative risk assessment at this time. The City has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Existing Landslide Mitigation Activities

Landslide mitigation activities listed here include current mitigation programs and activities that are being implemented by the City of Lake Oswego agencies or organizations.

City of Lake Oswego Codes Pertaining to Landslides

The following Lake Oswego codes, plans, and policies pertain to landslides:

1) Lake Oswego Comprehensive Plan, Goal 7 – Areas Subject to Natural Disasters and Hazards, Section 3, Landslides, Erosion and Unstable Soils. The Goal of Section 3, Landslides, Erosion and Unstable Soils states: "The City shall protect life and property from hazards associated with landslides, soil erosion, and unstable soils".

2) The following portions of the Community Development Code and City Code implement the Goal 7, Section 3 policies of the Comprehensive Plan, regulating development on steep slopes, erosion control, and earthwork control:

- Community Development Code, Article 50.40 Drainage Standard for Minor Development;
- Community Development Code, Article 50.41 Drainage Standard for Major Development;
- Community Development Code, Article 50.42 Weak Foundation Soils;
- Community Development Code, Article 50.43 Hillside Protection;
- Lake Oswego Code, Chapter 52 Erosion Control; and
- Lake Oswego Building Code (LOC Chapter 45), Article 45.16 Earthwork Control.

Additionally, Article 50.16 of the Community Development Code, Sensitive Lands Overlay Districts, manages the impacts of development on lands with environmental and natural resource significance in order to protect the functions and values of wetlands, stream corridors, and tree groves within the Lake Oswego city limits. Many of these significant resources are associated with hillsides, ravines, and ridge lines.

3) Lake Oswego Bridge Inspections and Records Manual. This manual outlines the City's bridge inspection program that was implemented to better respond in the event of a natural disaster. The intent of the program is to utilize trained City personnel to closely document bridge conditions through visual inspections, establishing baseline condition information to use for comparison to bridge conditions after a disaster. Additionally, the manual outlines a disaster response plan, including identification of disaster response team members and a bridge closure and detour plan.

Landslide Mitigation Projects

City of Lake Oswego staff have been tracking recent research by DOGAMI and related state legislation regarding rapidly moving landslide hazards. The City will be reviewing and evaluating the results of this mapping and modeling, and will update City codes and ordinances, if appropriate.

Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. Plan goals and county action items addressed (listed to facilitate city/county coordination) are also noted for each action item.

ST-LS#1: Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas.

Ideas for Implementation:

- Evaluate the results from the DOGAMI Rapidly Moving Landslide Hazard mapping effort and incorporate appropriate amendments into City planning documents and relevant codes; and
- Develop public information to emphasize economic risk when building on potential or historical landslide areas.

Coordinating Organization:	Planning & Engineering
Timeline:	1-2 years
Plan Goals Addressed:	Protect Life and Property, Public Awareness Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-LS #1

Wildfire

Lake Oswego's character and identity are closely tied to its natural assets and scenic resources. The City of Lake Oswego provides programs that protect open space, scenic resources, and wildlife habitat on public and private property throughout the city, including native woodlands, open fields, and tree groves. As in other parts of Clackamas County, as described in the County Plan, Lake Oswego's urbanized areas coincide with natural areas and open spaces. In some Lake Oswego neighborhoods, private lots abut public land and public and private open space and natural areas where brush and other fuels have been accumulating for years, increasing wildfire exposure and risk. The following areas have been identified as having the highest wildfire potential:

- Iron Mountain Bluff;
- Palisades;
- Cooks Butte;
- Mountain Park;
- Tryon Creek State Park;
- Springbrook Park; and
- Waluga Park.

The City has a long history of protecting tree groves and other natural features within the community. These green features provide an essential part of the overall community character, while also providing abundant habitat for native species. Recognizing the importance of these features, this Plan does not anticipate the removal of valued natural resources as a means of reducing wildfire risks. Rather, this Plan recommends further research and the preparation of an Urban Forest Fire Management Plan that will address both wildfire and habitat protection. It should also be noted that much of the understory brush that exists within the forested parts of the community consists largely of non-native plant species, the removal of which could actually benefit the forests while reducing wildfire risks.

Wildfire Profile

Available records and oral history make no note of any homes in the Lake Oswego area ever being destroyed by a wildfire. There have been some close calls; there has been some damage to homes, but the fire department has extinguished every wildfire to date before it got out of hand or took out any homes. The community has been fortunate with the early detection of wildfires thus far.

The lack of large-scale wildfires in this area translates to an increasing fuel load every year for approximately the last 100 years. With the increasing fuel loads, drier fall weather patterns, and increasing number of people and homes, the possibility and exposure to the wildfire hazard is increasing, as seen in wildfire events like the Portland bluff fires of recent years.

The probability of wildfire events in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of wildfire in Lake Oswego is described in Section Five.

Wildfire Hazard Assessment

Hazard Identification

The geographic extent of the wildfire hazards in Lake Oswego has been mapped by the City of Lake Oswego GIS department, as shown in Figure 4-3, using the best available data. Wildfire hazard data utilized (Relative Wildfire Hazards Risk Areas, 2003) were provided by Clackamas County. The relative wildfire hazard risk areas result from a state model that involves fuels, slope, and weather. Small areas of the Lake Oswego are within Multnomah County, including the northern portion of the Mountain Park neighborhood. However, wildfire data from Multnomah County are not currently available.

As shown in Table 4-3, below, parcels totaling 2,208 acres, 31% of Lake Oswego's total land area, are in high wildfire hazard areas, and 1,626 acres, 23% of Lake Oswego's total land area, are in moderate wildfire hazard areas. Additionally, 3,770 structures are potentially exposed to high wildfire hazards, with a building value totaling $889,148,208 and a land value of $540,156,387; and 4,402 structures are potentially exposed to moderate wildfire hazards, with a building value totaling $752,348,977 and a land value of $544,796,426. Land uses within wildfire hazards areas include: agricultural, commercial, forest, industrial, residential, rural, undeveloped, and unknown (see Table 4-3).

Vulnerability Assessment

The City of Lake Oswego GIS department has completed an analysis, using the best available data, as a component of the vulnerability assessment described in Section 3: Hazard Assessment. This analysis looked at identified hazard areas in conjunction with available data on property exposed to the hazard. Exposure of community assets to natural hazards was determined by manually comparing critical and essential facilities and infrastructure maps with each hazard map, and identifying where assets and hazards, or parcels affected by hazard, intersected. Many community assets are potentially exposed to landslide hazards, as discussed below and shown in Table 3-3. For a complete listing of the community assets exposed to landslide hazards, please refer to Table 3-3.

The Adult Community Center, a Critical Facility, is listed in Table 3-3 as being exposed to a high wildfire hazard area. The rear portion of the parcel is treed and slopes steeply down to Tyron Creek to the north, potentially exposing the facility and limiting its availability as a primary shelter site in the event of a wildfire.

Exposed infrastructure listed in Table 3-3, including wastewater main lines, major water lines, natural gas pipeline and fiber optic lines are buried, decreasing their vulnerability to damage from wildfire hazards. However, wildfire conditions could potentially limit or delay access for the purposes of operation or repair. The City's fresh drinking water supply comes from a water treatment plant in West Linn, with the water intake located on the Clackamas River in Gladstone. The water line from the City's water treatment plant in West Linn enters the City along Highway 43 and runs north through George Rogers Park. This alignment includes areas that could be vulnerable to wildfire hazards. The fiber optic line located in Highway 43/State Street, McVey Avenue and Stafford Road is a significant communication link for the entire region. Operation of and access to other exposed infrastructure

listed in Table 3-3, including the Oswego Lake headgate, several water pumping stations and reservoirs, a PGE substation in the Mountain Park area and communications towers used for emergency communications located on Cook's Butte and Mt. Sylvania, could be potentially impacted during a wildfire hazard.

The regional Emergency Transportation Route follows State Highway 43 from the north City limits, and continues south on State Street to McVey Avenue, and then southwest to and along Stafford Road. The Emergency Transportation Route passes through several high wildfire hazard area, at the northern City limits along State Street and McVey Avenue to the south, possibly impacting access to and from the City.

For the portion of Lake Oswego in Multnomah County, primarily the northern part of the Mountain Park neighborhood, Lake Oswego Fire Department staff have determined that due to the steep slopes and wooded character of this neighborhood, the wildfire hazard ranges from moderate to high.

Table 4-3. Wildfire Hazard Vulnerability Assessment - Additional Data

Wildfire[1] Hazard	Total Acres	No. of Structures	Land Use / Acres	Value of Land & Structures[2]
Wildfire – High Hazard	2,208	3,770	- Agricultural / 2.3 - Commercial / 36.0 - Forest / 6.6 - Industrial / 3.9 - MF Residential / 46.2 - Rural / 149.1 - SF Residential / 1,027.2 - Undeveloped / 652.2 - Unknown / 30.8	Building value – $889,148,208 Land value – $540,156,387
Wildfire – Moderate Hazard	1,626	4,402	- Agricultural / 7.0 - Commercial / 45.6 - Industrial / 0.8 - MF Residential / 15.3 - Rural / 91.2 - SF Residential / 967.6 - Undeveloped / 155.4 - Unknown / 122.8	Building value – $752,348,977 Land value – $544,796,426

Notes:
1. Clackamas County, Relative Wildfire Fire Hazard Risk Areas, 2003.
2. Value is Real Market Value from Clackamas County Assessor's records.

Risk Analysis

Due to insufficient data, Lake Oswego is unable to perform a quantitative risk assessment at this time. The City has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Existing Wildfire Mitigation Activities

The City of Lake Oswego Fire Department works to mitigate problems regarding wildfire issues when they arise. Wildfire mitigation activities listed here include current mitigation programs and activities that are being implemented by Lake Oswego agencies or organizations.

City of Lake Oswego Codes Pertaining to Wildfires

The following Lake Oswego codes, plans, and policies pertain to wildfires:

1) The City of Lake Oswego Community Development Code (LOC Chapter 50) specifies site development standards, such as lot setback, coverage, depth, and corner vision; landscape and tree planting and removal standards; and structure height.

2) The City of Lake Oswego Building Code (LOC Chapter 45) regulates building materials and fire flow and sprinkler requirements.

3) The Uniform Fire Code and City Code regulate the removal of fuels that could be a fire hazard, and regulate burning with permits and burning bans when needed due to high fire hazard.

Local Fire Prevention/Education Programs

The Lake Oswego Fire Department fire prevention staff conduct a range of public education activities, including wildland fire education programs. Fire prevention staff also work with the Clackamas County Fire Prevention Co-op that includes the U.S. Forest Service and Oregon Department of Forestry as members. Additionally, the City of Lake Oswego's Community Emergency Response Team (CERT) program includes wildland fire prevention as part of the training.

The City of Lake Oswego has a hydrant system that covers most of the area that Lake Oswego Fire Department protects. The Fire Department continues to look for locations that will enhance wildland urban interface protection. For example, the City just added hydrants to the Iron Mountain Bluff area after firefighters determined the need for protecting homes from wildfire. Additionally, school remodels must now include the installation of sprinkler systems and seismic upgrades.

There are 15 reservoirs serving Lake Oswego. A table detailing the capacity of each reservoir, including fire flow, is included in Appendix A.

Wildfire Mitigation Action Items

The wildfire mitigation action items provide direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from wildfire events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. Plan goals and county action items addressed (listed to facilitate city/county coordination) are also noted for each action item.

LT-WF#1: Promote the use of non-combustible roofing materials by evaluating and making recommendations to current code to encourage noncombustible roofing standards in high fire-hazard areas.

Ideas for Implementation:

- Encourage property owners to use noncombustible roofing materials.

Coordinating Organization:	Fire, Planning & Building
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	LT-WF#2 & LT-WF#4

LT-WF# 2: Develop and implement an Urban Forest Fire Management Plan.

Ideas for Implementation:

- Develop a vegetation inventory for areas believed to be at risk of wildfire.
- Target areas of brush and implement management strategies, consistent with habitat protection requirements.
- Replace flammable non-native vegetation with native plants that are less flammable.
- Enhance water storage facilities and water distribution systems (including hydrants) to serve the wild land/urban interface.

Coordinating Organization:	Fire
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-WF#1 & ST-WF#2

LT-WF# 3: Research new wildfire early warning detection systems, and obtain funding to apply the most appropriate warning system in fire-prone areas.

Coordinating Organization:	Fire
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-WF#1 & ST-WF#2

Severe Storm: Wind and Winter

Severe Storm Profile

The probability of severe storm events in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of severe storms in Lake Oswego is described in Chapter Five.

The historical severe windstorm and winter storm events have been described in the county plan, and are applicable to Lake Oswego. As such, a description of these events will not be repeated here.

Severe Storm Hazard Assessment

Hazard Identification

Severe storms present a significant threat to Lake Oswego residents, property, and infrastructure. Although there is very little data to spatially represent this hazard, the extent of severe storms includes all of Lake Oswego.

Vulnerability Assessment

The severe storm vulnerability assessment that is included in the county plan applies to the City of Lake Oswego. As such, it will not be restated here.

While severe winter storm data are not available to illustrate severe storm hazard areas, City staff have noted several areas in Lake Oswego that are particularly vulnerable. In the past, falling trees, downed power lines, and icy roads have caused problems in the downtown, Palisades, Mountain Park, and Lake Grove areas, and along South Shore Road. Primarily, these areas have tall trees that present problems. Additionally, in Mountain Park the combination of steep roads and icy conditions have hampered emergency response efforts.

In the event of a severe winter storm, the City uses identified sanding routes to coordinate response activity and concentrate resources during an event. These identified routes are shown in Figure 4-4, Winter Sanding Routes.

Risk Analysis

Due to insufficient data, Lake Oswego is unable to perform a quantitative risk assessment at this time. The City has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Existing Severe Storm Mitigation Activities

Severe wind and winter storm mitigation activities listed here include current mitigation programs and activities that are being implemented by Lake Oswego agencies or organizations.

City of Lake Oswego Codes Pertaining to Severe Wind and Winter Storms

The following Lake Oswego codes, plans, and policies pertain to severe wind and winter storms:

1) Lake Oswego Emergency Operations Plan and Related Annexes, Severe Weather Emergency Annex. This plan describes how the City of Lake Oswego's emergency operations system will operate during emergencies involving severe storm conditions within the City and contract districts. The plan is designed to meet Clackamas County, State, and Federal government emergency plans.

The plan describes the roles and responsibilities of all local responders within the City of Lake Oswego. It identifies who will be in charge of responding in the event of an incident and how the response will be handled. It provides guidelines for coordinating emergency services. It also describes how Lake Oswego will coordinate with:

- Adjacent jurisdictions;
- Mutual aid some areas;
- State agencies;
- Federal agencies; and
- Industry (snow removal).

2) Lake Oswego City Building Evacuation Plan. The building evacuation plan is based on the adopted state program. The plan establishes evacuation procedures, including the designation and training of evacuation coordinators.

3) Lake Oswego Bridge Inspections and Records Manual. This manual outlines the City's bridge inspection program that was implemented to better respond in the event of a natural disaster. The intent of the program is to utilize trained City personnel to closely document bridge conditions through visual inspections, establishing baseline condition information to use for comparison to bridge conditions after a disaster. Additionally, the manual outlines a disaster response plan, including identification of disaster response team members and a bridge closure and detour plan.

Severe Wind and Winter Storm Mitigation Projects

The primary mitigation measure taken for severe wind or winter storm events is preparedness. In the fall of each year, the City of Lake Oswego Maintenance Services Department conducts the following activities:

- Inventories existing stockpile of sanding materials and replenishes as necessary;
- Performs routine maintenance and inspection of all sanders, plows, dump trucks, loaders, and chain saws;
- Provides training on sander/snowplow operations; and
- Provides training on:
  - Winter driving safety;
  - Chain saw safety – operation and personal protective equipment; and
  - Working around downed power lines.

Severe Storm Mitigation Action Items

The severe wind and winter storm mitigation action item provides direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from sever winter storm events. The action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Plan goals and county action items (listed to facilitate city/county coordination) addressed are also noted for the action item.

LT-SS # 1: Reduce frequency and duration of power outages from the severe wind and winter storm hazards where possible.

Ideas for Implementation:

- Partner with Portland General Electric, or subsequent electrical utility, to continue hazardous tree inventory and mitigation programs.
- Where possible, during redevelopment construction, promote under grounding of utilities.
- Identify strategies to establish redundant access to the utility grid to increase the reliability of critical infrastructure

Coordinating Organization:	Engineering and Planning
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation
County Action Items Addressed:	LT-SWS#2

Earthquake

Earthquake Profile

The historical earthquake events have been described in the county plan, and are applicable to the City of Lake Oswego. As such, a description of these events will not be repeated here.

The probability of earthquake events in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of earthquakes in Lake Oswego is described in Chapter Five.

Earthquake Hazard Assessment

Hazard Identification

The geographic extent of the earthquake hazards in Lake Oswego has been mapped by the City of Lake Oswego GIS department, as shown in Figure 4-5, using the best available data. Earthquake data utilized were developed by the State Department of Geology and Mineral Industries (DOGAMI), GMS-91 – Relative Earthquake Hazard Map of the Lake Oswego Quadrangle, Clackamas and Multnomah Counties, Oregon, 1995; and DOGAMI Bulletin 99 – Earthquake Faults, 1979. Zone A denotes the highest hazard area. The relative earthquake hazard zones, A – D, are a composite of data that depicts the relative hazard of a site due to a combination of the following effects: amplification of ground shaking by a "soft" soil column; liquefaction of water-saturated sand, creating areas of "quicksand"; and instability of slopes triggered by the shaking of an earthquake. Zones that are expected to have the most pronounced damage in any serious earthquake are shown as having the greatest relative hazard. GMS-91, which further describes the methodology for mapping the relative earthquake hazard, is included in Appendix B.

As shown in Table 4-4, below, parcels totaling 1,219 acres, 17% of Lake Oswego's total land area, are in earthquake Zone A. Included within Zone A are 2,269 structures are, with a building value totaling $1,065,909,740 and a land value of $472,965,684. Land uses within earthquake Zone A include: commercial, industrial, residential, undeveloped, and right-of-way (see Table 4-4).

Vulnerability Assessment

The City of Lake Oswego GIS department has completed an analysis, using the best available data, as a component of the vulnerability assessment described in Section 3: Hazard Assessment. This analysis looked at identified hazard areas in conjunction with available data on property exposed to the hazard. Exposure of community assets to natural hazards was determined by manually comparing critical and essential facilities and infrastructure maps with each hazard map, and identifying where assets and hazards, or parcels affected by hazard, intersected. Many community assets are potentially exposed to landslide hazards, as discussed below and shown in Table 3-3. For a complete listing of the community assets exposed to landslide hazards, please refer to Table 3-3.

City Hall, the Main Fire Station and the Adult Community Center, Critical Facilities, are listed in Table 3-3 as being exposed to relative earthquake hazard

Zone A. City Hall, which contains the City's law enforcement and emergency dispatch facilities, is not up to seismic standards. The Main Fire Station, which houses the backup emergency operations center, was built to seismic Zone 4 standards, a step above the required standard for seismic Zone 3. The Adult Community Center, which would serve as the primary shelter in an emergency, has not had any seismic upgrades and does not meet modern seismic standards.

Several Essential Facilities are listed in Table 3-3 as being exposed to earthquake hazards. These facilities are schools and churches that might serve as Red Cross shelter facilities in the event of an emergency.

Operation of and access to exposed infrastructure listed in Table 3-3, including the Oswego Lake headgate, water pumping stations, a PGE substation and the communications towers located at City Hall, could be potentially impacted during an earthquake. Other exposed infrastructure listed in Table 3-3, including wastewater main lines, major water lines, natural gas pipeline and fiber optic lines are buried, however they are also vulnerable to damage from earthquake hazards, potentially limiting or delay access for the purposes of operation or repair. The fiber optic line located in Highway 43/State Street, McVey Avenue and Stafford Road is a significant communication link for the entire region. Although not located within a mapped earthquake hazard zone, the Oswego Lake sanitary sewer interceptor may be vulnerable during an earthquake event due to the presence of unconsolidated sediment at the bottom of Oswego Lake.

The City's fresh drinking water supply comes from the water treatment plant in West Linn and is located in relative earthquake hazard Zone A, while the water intake located on the Clackamas River in Gladstone is located in Zone C. The water line from the West Linn water treatment plant enters the City along Highway 43, which crosses through earthquake Zone A. The water treatment plant and the intake were recently upgraded to earthquake Zone 4 standards. There are 15 reservoirs serving Lake Oswego. A table detailing the capacity of each reservoir is included in Appendix A. The three newest reservoirs, Touchstone II, McNary II, and Palisades II, were constructed to earthquake Zone 4 standards.

The regional Emergency Transportation Route follows State Highway 43 from the north City limits, and continues south on State Street to McVey Avenue, and then southwest to and along Stafford Road. The Emergency Transportation Route passes through earthquake hazard Zone A at the northern City limits along State Street, possibly impacting access to and from the City.

Table 4-4. Earthquake Hazard Vulnerability Assessment - Additional Data

Earthquake Hazard	Total Acres	No. of Structures	Land Use / Acres	Value of Land & Structures[1]
Earthquake[2] Zone A	1,219.8	2,269	- Commercial / 125.8 - Industrial / 7.8 - MF Residential / 79.6 - SF Residential / 461.4 - Undeveloped / 265 - Unknown / 12.8 - ROW[3] non-tax lot property / 184.6	Building value - $1,065,909,740 Land value - $472,965,684

Notes:
1. Value is Real Market Value from Clackamas County Assessor's records.
2. DOGAMI, Relative Earthquake Hazard.
3. Includes right-of-way and other non-tax lot area such as public walkway and utility easements.

Risk Analysis

Due to insufficient data, Lake Oswego is unable to perform a quantitative risk assessment at this time. The City has addressed this issue in the action items, and will be completing a risk assessment as data and resources become available.

Existing Earthquake Mitigation Activities

Earthquake mitigation activities listed here include current mitigation programs and activities that are being implemented by Lake Oswego agencies or organizations.

A primary mitigation objective is to construct or upgrade critical and essential facilities and infrastructure to withstand future earthquake events. The Main Fire Station, a critical facility which serves as the City's Emergency Operations Center, was constructed to Seismic Zone 4 standards. The South Shore Fire Station recently underwent seismic upgrades, and upgrades are scheduled at the West Lake and Jean Road Fire Stations to harden the bays. Seismic upgrades have also been made to the City' water treatment plant to ensure it remains operational after a magnitude seven earthquake. Additionally, school remodels must now include seismic upgrades and the installation of sprinkler systems.

City of Lake Oswego Codes Pertaining to Earthquakes

The following Lake Oswego plans, policies, and codes pertain to earthquakes:

1) Lake Oswego Comprehensive Plan, Goal 7 - Areas Subject to Natural Disasters and Hazards, Section 2 Earthquake Hazards. The Goal of Section 2, Earthquake Hazards states: "The City shall protect life and property from earthquake hazards".

2) Lake Oswego Building Code (LOC Chapter 45). Section 45.09 of the Building Code lists the various State of Oregon Codes adopted into the City's Building Code, including, but not limited to:

- Oregon Structural Specialty Code;
- UBC Grading Code;
- Oregon One And Two Family Dwelling Code;
- Oregon Manufactured Dwelling Park Rules;

- Oregon Manufactured Home Installations Rules; and
- ICBO Uniform Code for the Abatement of Dangerous Buildings.

3) Lake Oswego Emergency Operations Plan and Related Annexes, Earthquake Annex. This plan describes how the City of Lake Oswego's emergency operations system will operate during emergencies involving earthquake conditions within the City and contract districts. The plan is designed to meet Clackamas County, State, and Federal government emergency plans.

The plan describes the roles and responsibilities of all local responders within the City of Lake Oswego. It identifies who will be in charge of responding in the event of an incident and how the response will be handled.. It provides guidelines for coordinating emergency services. It also describes how Lake Oswego will be in charge of an incident. It provides guidelines for coordinating emergency services

4) Lake Oswego City Building Evacuation Plan. The building evacuation plan is based on the adopted state program. The plan establishes evacuation procedures, including the designation and training of evacuation coordinators.

5) Lake Oswego Bridge Inspections and Records Manual. This manual outlines the City's bridge inspection program that was implemented to better respond in the event of a natural disaster. The intent of the program is to utilize trained City personnel to closely document bridge conditions through visual inspections, establishing baseline condition information to use for comparison to bridge conditions after a disaster. Additionally, the manual outlines a disaster response plan, including identification of disaster response team members and a bridge closure and detour plan.

Preparedness

The City of Lake Oswego has an established Community Emergency Response Team (CERT) program that has trained almost 500 members in mitigation as well as preparedness and response. The City's Emergency Management program works with community groups, business, residential facilities, and public and private schools in promoting earthquake mitigation.

Earthquake Mitigation Action Items

The earthquake mitigation action item provides direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from landslide events. The action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. Plan goals and county action items addressed are also noted for the action item.

LT-EQ#1: Conduct seismic evaluations on identified critical/essential facilities and infrastructure for implementing appropriate structural and non-structural mitigation strategies.

Ideas for Implementation:

- Obtain funding to perform evaluations.
- Gain funding to retrofit/replace City hall as a model project for other critical facilities in Lake Oswego.
- Prioritize seismic upgrades based on criticality of need and population served.

Coordinating Organization:	City Manager, City Departments
Timeline:	3-5 years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-MH#5; ST-MH#6; LTEQ#1

Volcanic Eruption

Volcano Profile

The historical volcanic eruption events have been described in the county plan, and are applicable to Lake Oswego. As such, a description of these events will not be repeated here.

The probability of volcanic eruptions in Lake Oswego was determined using scientific data, historical occurrences, and local knowledge. The probability of volcanic eruptions in Lake Oswego is described in Section Five.

Volcanic Eruption Hazard Assessment

The volcanic hazard assessment that is included in the county plan applies to the City of Lake Oswego. As such, it will not be restated here.

Existing Volcanic Eruption Mitigation Activities

The existing volcanic hazard mitigation activities are conducted at the County, regional, state, and federal levels and are described in the Clackamas County natural Hazards Mitigation Plan. As such, the information will not be repeated here.

Volcanic Eruption Mitigation Action Items

Lake Oswego will not be undertaking any local volcanic eruption mitigation activities, but will partner with the county in the implementation of identified mitigation strategies.

Multi-Hazard

Multi-Hazard Action Items (MH)

Multi-hazard action items are those activities that could pertain to any of the six hazards in the mitigation plan: flood, landslide, wildfire, severe wind and winter storm, earthquake, and volcanic eruption. The multi-hazard mitigation action items provide direction on specific activities that organizations and residents in Lake Oswego can undertake to reduce risk and prevent loss from multi-hazard events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation. Plan goals and county action items addressed are also noted for each action item.

ST-MH#1: Ensure that there are adequate shelter facilities in hazard-free zones to serve Lake Oswego residents and employees.

Ideas for Implementation:

- Identify and contact potential shelter sites to see if there is potential for designating additional Red Cross shelter sites.
- Contact Red Cross Shelter Sites to renew and maintain agreements.

Coordinating Organization:	Fire
Timeline:	1-2 Years
Plan Goals Addressed:	Protect Life and Property, Emergency Services Partnerships and Implementation
County Action Items Addressed:	ST-MH#5; ST-MH#2

ST-MH#2: Improve and obtain resources and equipment essential for responding to and recovering from disasters.

Ideas for Implementation:

- Establish mutual aid agreements or Inter-Governmental Agreements with various state and local agencies for the purpose of instituting actions each party to the agreements would undertake in the event of a disaster, or allocating resources to those parties in need.

Coordinating Organization:	Engineering and Maintenance Services
Timeline:	1-2 Years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	LT MH#1; ST-MH#5; ST-MH#2

ST-MH#3: Develop, enhance, and implement education programs designed to reduce the losses from natural hazards.

Ideas for Implementation:

- Gather hazard related information and public information materials, and disseminate to public through local publications; and
- Identify property owners in the hazard zones, and conduct a target mailing to disseminate hazard information.

Coordinating Organization:	Fire & Public Affairs
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation
County Action Items Addressed:	LT-MH#1; LT-MH#2; ST-LS#1; LT-SWS#1; LT-WS#3; LT-EQ#2; LT-WF#3

ST-MH#4: Evaluate and update Surface Water Management Plan.

Ideas for Implementation:

- Identify development encroachment into storm water detention basins.
- Identify deficiencies in surface water management infrastructure.

Coordinating Organization:	Engineering
Timeline:	1-2 Years
Plan Goals Addressed:	Protect Life and Property, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-MH #2; LT-FL #3

ST-MH#5: Integrate the goals and action items from the Lake Oswego Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.

Ideas for Implementation:

- Use the mitigation plan to help the City's Comprehensive Land Use Plan meet State Land Use Planning Goal 7, designed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards.
- Integrate the county's mitigation plan into current Capital Improvement Plans to ensure that development does not encroach on known hazard areas.
- Partner with other organizations and agencies with similar goals to promote building codes that are more disaster resistant at the state level.

Coordinating Organization:	Community Development Department
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-MH#1; ST-LS#2; LT-LS#2; LT-WS#4

ST-MH #6: Address 800 MHz communication deficiencies locally and regionally.

Ideas for Implementation:

- Assess current deficiencies and identify appropriate technologies to address deficiencies.
- Obtain funding for purchasing and installing necessary equipment and infrastructure.

Coordinating Organization:	Lake Oswego Communications
Timeline:	1-2 Years
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Partnerships and Implementation
County Action Items Addressed:	LT-MH#1; ST-WF#1

ST-MH#7: Continue to update and improve the hazard assessment in the Lake Oswego Natural Hazards Mitigation Plan.

Ideas for Implementation:

- Attain funding to gather more localized hazard data to illustrate the geographic extent of natural hazards in Lake Oswego;
- Update the vulnerability assessment as new development occurs or as new hazard data are developed; and
- Contract with the County or other service provider to conduct a risk analysis for Lake Oswego.

Coordinating Organization:	Engineering/GIS
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Emergency Services, Public Awareness, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-MH #2; LT-WF #1

LT-MH #1: Obtain funding for implementing recommendations for improving infrastructure outlined in the updated Surface Water Management Plan.

Coordinating Organization:	Engineering
Timeline:	5 Years
Plan Goals Addressed:	Protect Life and Property, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	ST-MH #2; LT-FL #3

LT-MH #2: Replace Oswego Lake sanitary sewer interceptor line.

Ideas for Implementation:

- Obtain funding for replacement costs.
- Complete design strategy.
- Acquire easements.

Coordinating Organization:	Engineering
Timeline:	5 years
Plan Goals Addressed:	Protect Life and Property, Partnerships and Implementation, Natural Systems
County Action Items Addressed:	LT-FL#3

Section 5:
Mitigation Planning Priority System

Action Item Prioritization Methodology

As Lake Oswego works toward action item implementation, the Hazard Mitigation Advisory Committee (HMAC) has prioritized the identified mitigation strategies in order to better allocate resources for implementation. The criteria used for prioritizing the action items are the plan goals, hazards addressed, criticality of need, population served, and likelihood of success.

Although this methodology provides a guide for the HMAC in terms of making implementation recommendations to the City Manager, the HMAC has the option of recommending the implementation any of the action items at any time. This option to consider all action items for implementation allows the City to consider mitigation strategies as new situations arise, such as capitalizing on funding sources that could pertain to an action item that is not the highest priority.

Step 1: Prioritize Plan Goals

The Lake Oswego mitigation goals, including: Protect Life and Property, Public Awareness, Emergency Services, Natural Systems, and Partnerships and Implementation, were considered during each phase of the mitigation planning process. As the mitigation action items were developed, the HMAC identified which plan goals were addressed by each action item. The HMAC ranked the plan goals to determine the priorities for Lake Oswego, and each goal was given a score of one point to five points, in ascending order. The points for the plan goals were then totaled for each action item. The prioritized plan goals are as follows:

5 Points: Protect Life and Property
4 Points: Emergency Services
3 Points: Public Awareness
2 Points: Partnerships and Implementation
1 Point: Natural Systems

Step 2: Prioritize Hazards

The natural hazards addressed by the Lake Oswego Natural Hazard Mitigation Plan were prioritized using the FEMA-accepted hazard analysis methodology for Emergency Operations Plans. This methodology considers the history of the hazard, the vulnerability to the hazard, the maximum threat of the hazard (worst case scenario), and the probability of the hazard. Each of these criteria is weighted, and the final score is used for prioritizing the hazard. The following is a full description of the methodology used.

Categories Considered:

HISTORY: The record of occurrences of previous major emergencies or disasters (weight factor = 2).

LOW	0 - 1 event per 100 years
MEDIUM	2 - 3 events per 100 years
HIGH	4+ events per 100 years

VULNERABILITY: The percentage of population and property likely to be affected (weight factor = 5).

LOW	< 1% affected
MEDIUM	1 - 10% affected
HIGH	> 10% affected

MAXIMUM THREAT: The maximum percentage of population and property that could be impacted under a worst case scenario (weight factor = 10).

LOW	< 5% affected
MEDIUM	5 - 25% affected
HIGH	> 25% affected

PROBABILITY: The likelihood of occurrence within a specified period of time (weight factor = 7).

LOW	> 1 chance per 100 years
MEDIUM	> 1 chance per 50 years
HIGH	> 1 chance per 10 years

Severity Ratings:

LOW	= 1 - 3 points
MEDIUM	= 4 - 6 points
HIGH	= 7 - 10 points

Although the methodology used allows the Lake Oswego HMAC to quantify and compare natural hazards, it is flawed in that it compares hazards with high probabilities and relatively low consequences with hazards that have low probabilities and high consequences. The HMAC took this into consideration during the prioritization process, and the results are shown in Table 5-1, below. The hazards were given a hazard score of one point to eight points, in increasing order of importance. The Multi-Hazard action items were given the highest score (eight), as they address more than one hazard. The points for the hazard scores were then totaled for each action item.

Table 5-1. Natural Hazard Prioritization Score

Hazard	History	Vulnerability	Max. Threat	Probability	Total	Hazard Score
Multi-Hazard	-	-	-	-	-	8
Severe Winter Storm	16	45	100	56	217	7
Earthquake	16	50	100	49	215	6
Windstorm	14	35	70	49	168	5
Flood	14	30	70	49	163	4
Wildfire	4	35	60	28	127	3
Landslide	6	5	20	49	80	2
Volcano	4	20	40	14	78	1

Step 3: Incorporate Criticality of Need, Large Number of Population Served, Likelihood of Success

The final score for each action items was computed by summing the plan goal score and the hazard score. The committee then considered the criticality of need, the number of population served, and the likelihood of success. The HMAC was given an opportunity to add four points to action items that fit these criteria. The prioritized action items are as follows:

Table 5-2. Action Item Prioritization Score

Existing Resources		Funding Required	
Short-Term Multi-Hazard #3	26	Long-Term Earthquake #1	37
Short-Term Multi-Hazard #2	24	Long-Term Severe Storm #1	33
Short-Term Multi-Hazard #5	23	Long-Term Multi-Hazard #2	20
Short-Term Multi-Hazard#7	23	Long-Term Flood #2	19
Short-Term Multi-Hazard #1	23	Long-Term Wildfire #2	18
Short-Term Multi-Hazard #6	23	Long-Term Wildfire #3	18
Short-Term Multi-Hazard #4	20	Long-Term Multi-Hazard #1	16
Long-Term Wildfire #1	18	Long-Term Flood #1	16
Short-Term Flood #1	16		
Long-Term Flood #3	15		
Short-Term Landslide #1	13		

Section 6:
Resource Directory

In addition to the County Master Resource Directory, the following list provides contact information for local agencies, organizations, and departments that may address natural hazard mitigation, and could be potential partners in implementation of Lake Oswego's mitigation action items. The HMAC has determined that potential partnerships could apply for all hazards and has assigned general categories of assistance for each partner. The City's Hazard Mitigation Advisory Committee will continue to add contact information for organizations as new partners are identified.

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	Alto Park Water District	Contact: Alto Park Water District 1124 SW Englewood Lake Oswego, OR 97034	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Bethlehem Church	Contact: Bethlehem Church 17979 Stafford Rd. Lake Oswego, OR 97034 Phone: 503-638-8660	Shelter; Public Information
All Hazards	Christ Church Episcopal Parish	Contact: Christ Church Episcopal Parish 1060 Chandler Rd. Lake Oswego, OR 97034 Phone: 503-636-5618	Shelter; Public Information
All Hazards	Church of Jesus Christ of Latter-Day Saints	Contact: Church of Jesus Christ of LDS 1271 Overlook Dr. Lake Oswego, OR 97034 Phone: 503-639-7066	Shelter; Public Information
All Hazards	Church of Jesus Christ of Latter-Day Saints	Contact: Church of Jesus Christ of LDS Portland Oregon Temple 13600 Kruse Oaks Blvd. Lake Oswego, OR 97035 Phone: 503-639-7066	Shelter; Public Information
All Hazards	Church of Jesus Christ of Latter-Day Saints	Contact: Church of Jesus Christ of LDS Lake Oswego Stake Center 14903 Westlake Dr. Lake Oswego, OR 97035 Phone: 503-620-8417	Shelter; Public Information
All Hazards	City of Lake Oswego - City Manager's Office	Contact: City Manager 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0213 Fax: 503-697-6594 Web: www.ci.oswego.or.us	Administration; Emergency Operations; Public Information; Financing
All Hazards	City of Lake Oswego - Engineering; Surveying and Mapping/GIS	Contact: City Engineer 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0270 Fax: 503-635-0269 Web: www.ci.oswego.or.us	Emergency Operations; Public Information; Public Safety; Technical Support

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	City of Lake Oswego - Fire Community Emergency Response Team (CERT)	Contact: Chief or Emergency Manager Main Station - 300 B Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0275 Fax: 503-635-0376 Web: www.ci.oswego.or.us	Emergency Operations; Emergency Response; Public Information; Public Safety; Technical Support
All Hazards	City of Lake Oswego - Maintenance Services	Contact: Director 5705 Jean Road P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0280 Fax: 503-697-7411 Web: www.ci.oswego.or.us	Emergency Operations; Emergency Response; Public Safety
All Hazards	City of Lake Oswego Parks and Recreation	Contact: Director 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-636-6500 Fax: 503-697-6579 Web: www.ci.oswego.or.us	Emergency Operations; Public Information
All Hazards	City of Lake Oswego - Planning and Development	Contact: Director of Community Development 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0290 Fax: 503-635-0269 Web: www.ci.oswego.or.us	Emergency Operations; Public Information; Technical Support
All Hazards	City of Lake Oswego - Police	Contact: Chief 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0250 Fax: 503-697-7406 Web: www.ci.oswego.or.us	Emergency Operations; Emergency Response; Public Information; Public Safety
All Hazards	City of Lake Oswego - Public Affairs	Contact: Director 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0236 Citizen Information Line: 503-697-0257 Fax: 503-697-6594 Web: www.ci.oswego.or.us	Emergency Operations; Public Information; Technical Support

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	City of Lake Oswego - Redevelopment Agency	Contact: Director 380 A Avenue P.O. Box 369 Lake Oswego, OR 97035 Phone: 503-635-0235 Fax: 503- Web: www.ci.oswego.or.us	Public Information; Technical Support
All Hazards	City of Lake Oswego – Water Treatment Plant	Contact: Chief Operator 4260 SW Kenthorpe Way West Linn, OR 97068 Phone: 503-635-0394 Fax: 503-697-7424	Emergency Operations; Public Information; Public Safety; Technical Support
All Hazards	City of Milwaukie	Contact: City of Milwaukie 6101 SE Johnson Creek Blvd. Portland, OR 97206 Phone: 503-786-7616 Fax: 503-774-8326 Web: www.cityofmilwaukie.org	Coordination; Emergency Response; Public Safety; Technical Support (WTP)
All Hazards	City of Portland	Contact: City of Portland 1120 SW Fifth Ave. Portland, OR 97204 Phone: 503-823-4000 Web: www.ci.portland.or.us	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	City of Rivergrove	Contact: City of Rivergrove 5311 SW Childs Rd. P.O. Box 1104 Lake Oswego, OR 97035 Phone: 503-639-6919 Fax: 503-639-0899	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	City of Tigard	Contact: City of Tigard 13125 SW Hall Blvd. Tigard, OR 97223 Phone: 503-639-4171 Fax: 503-684-7297 Web: www.ci.tigard.or.us/default.asp	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	City of Tualatin	Contact: City of Tualatin 18880 SW Martinazzi Ave. Tualatin, OR 97062 Phone: 503-692-2000 Fax: 503-692-5421 Web: www.ci.tualatin.or.us	Coordination; Emergency Response; Public Safety; Technical Support

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	City of West Linn	Contact: City of West Linn 22500 Salamo Rd. West Linn, OR 97068 Phone: 503-657-0331 Fax: 503-650-9041 Web: www.ci.west-linn.or.us	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Clackamas County Emergency Management	Contact: Emergency Manager 2200 Kaen Road Oregon City, OR 97045 Phone: 503-723-4848 Web: www.co.clackamas.or.us/emerg	Coordination; Emergency Response; Public Information; Public Safety; Financing; Technical Support
All Hazards	Dunthorpe-Riverdale Service District #1 (a component of Multnomah County)	Contact: Dunthorpe-Riverdale Service District #1 501 SE Hawthorne, 4th floor PO Box 14700 Portland, OR 97293 Phone: 503-823-4000	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	First Church of Christ Scientists	Contact: First Church of Christ Scientists 751 Country Club Rd. Lake Oswego, OR 97034 Phone: 503-636-1667	Shelter; Public Information
All Hazards	Friends of Tryon Creek State Park	Contact: Executive Director c/o Tryon Creek State Park 11321 SW Terwilliger Blvd. Portland, OR 97219 Phone: 503-636-4398 Web: www.tryonfriends.org	Coordination; Public Information; Technical Support
All Hazards	Glenmorrie Cooperative Association	Contact: Glenmorrie Cooperative Association PO BOX 451 Lake Oswego, OR 97034	Coordination; Technical Support
All Hazards	Home Builders Association of Metropolitan Portland	Contact: Home Builders Association of Metropolitan Portland 15555 SW Bangy Road, Suite 301 Lake Oswego, OR 97035 Phone: 503-684-1880 Web: www.homebuildersportland.com/	Coordination; Public Information; Technical Support
All Hazards	Hope Community Church	Contact: Hope Community Church 14790 Boones Ferry Rd. Lake Oswego, OR 97035 Phone: 503-635-4880	Shelter; Public Information

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	House of Worship	Contact: House of Worship 3890 Upper Dr. Lake Oswego, OR 97035 Phone: 503-635-7659	Shelter; Public Information
All Hazards	Jehovah's Witnesses	Contact: Jehovah's Witnesses 12433 Boones Ferry Rd. Lake Oswego, OR 97035 Phone: 503-246-7289	Shelter; Public Information
All Hazards	Korean United Methodist Church	Contact: Korean United Methodist Church 18788 Pilkington Rd. Lake Oswego, OR 97035	Shelter; Public Information
All Hazards	Lake Bible Church	Contact: Lake Bible Church 4565 Carman Rd. Lake Oswego, OR 97035 Phone: 503-699-9840	Shelter; Public Information
All Hazards	Lake Chapel Foursquare Church	Contact: Lake Chapel Foursquare Church 796 1st St. Lake Oswego, OR 97034 Phone: 503-636-3804	Shelter; Public Information
All Hazards	Lake Family Fellowship	Contact: Lake Family Fellowship 17555 Bryant Rd. Lake Oswego, OR 97035 Phone: 503- 635-3518	Shelter; Public Information
All Hazards	Lake Grove Christian Church	Contact: Lake Grove Christian Church 15751 Quarry Rd. Lake Oswego, OR 97035 Phone: 503-636-3796	Shelter; Public Information
All Hazards	Lake Grove Fire District 57	Contact: Lake Grove Fire District 57 Board Member 16400 Bryant Rd. Lake Oswego, OR 97035 Phone: 503-624-9716	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Lake Grove Park District (managed by Lake Oswego School District)	Contact: Lake Oswego School District P.O. Box 70 Lake Oswego, OR 97034 Phone: 503-534-2300	Coordination; Public Information
All Hazards	Lake Grove Presbyterian Church	Contact: Lake Grove Presbyterian Church 4040 Sunset Dr. Lake Oswego, OR 97035 Phone: 503-636-5656	Shelter; Public Information

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	Lake Grove Water District	Contact: Lake Grove Water District PO Box 1173 Lake Oswego, OR 97035 Phone: 503-636-1617 Fax: 503-635-5066	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Lake Oswego Chamber of Commerce	Contact: Executive Director 242 B Avenue P.O. Box 268 Lake Oswego, OR 97034 Phone: (503) 636-3634 Web: www.lake-oswego.com	Coordination; Public Information
All Hazards	Lake Oswego Corporation / Lake Patrol	Contact: Lake Oswego Corporation 698 McVey Ave. PO Box 203 Lake Oswego Oregon 97034 Phone: 503-636-1422 Fax: 503-636-3226 Web: http://www.cybcon.com/~locorp/	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Lake Oswego Jehovahs Witnesses	Contact: Lake Oswego Jehovahs Witnesses 4801 Jean Rd. Lake Oswego, OR 97035 Phone: 503-246-7289	Shelter; Public Information
All Hazards	Lake Oswego Neighborhood Action Coalition	Contact: Community Planning Department, City of Lake Oswego P.O. Box 369 Lake Oswego, OR 97034 Phone: 503-635-0290 Fax: 503-635-0269 Web: www.ci.oswego.or.us/plan/Neighborhoods/	Coordination; Public Information
All Hazards	Lake Oswego Recognized Neighborhood Associations	Contact: Community Planning Department, City of Lake Oswego P.O. Box 369 Lake Oswego, OR 97034 Phone: 503-635-0290 Fax: 503-635-0269 Web: www.ci.oswego.or.us/plan/Neighborhoods/	Coordination; Public Information
All Hazards	Lake Oswego Review	Contact: Publisher P.O. Box 548 Lake Oswego, OR 97034 Phone, newsroom: 503-635-8811 Fax, newsroom: 503-635-8817 Web: www.lakeoswegoreview.com/	Coordination; Public Information

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	Lake Oswego School District 7J	Contact: Superintendent P.O. Box 70 Lake Oswego, OR 97034 Phone: 503-534-2300 Fax: 503.534.2328 Web: www.losd.loswego.k12.or.us/Default.htm	Coordination; Shelter; Public Information
All Hazards	Lake Oswego United Church	Contact: Lake Oswego United Church of Christ 1111 Country Club Rd.]Lake Oswego, OR 97034 Phone: 503-635-4348	Shelter; Public Information
All Hazards	Lake Oswego United Methodist	Contact: Lake Oswego United Methodist 1855 Southshore Blvd. Lake Oswego, OR 97034 Phone: 503-636-8423	Shelter; Public Information
All Hazards	Metro Service District 2 (METRO) Executive Office Data Resource Center	Contact: 600 NE Grand Ave. Portland, OR 97232 Phone: 503-797-1700	Information Coordination; Financing; Public Information; Technical Support
All Hazards	Mountain Park Church	Contact: Mountain Park Church 40 McNary Pkwy. Lake Oswego, OR 97035 Phone: 503-635-3443	Shelter; Public Information
All Hazards	Multnomah County Department of Business & Community Services (GIS, Land Use Planning, Transportation)	Contact: County Manager 501 SE Hawthorne Blvd., 4th Floor Portland, OR 97214 Phone: 503-988-5000 Fax: 503-988-3093 Web: www.co.multnomah.or.us	Coordination; Technical Support
All Hazards	Multnomah County - Emergency Management	Contact: Emergency Manager 1620 SE 190th Ave. Portland, OR 97233 Phone: 503-793-3305 Web: www.co.multnomah.or.us	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Multnomah County - Sheriff	Contact: Sheriff Administrative Office 501 SE Hawthorne Blvd., Suite 350 Portland, OR 97214 Phone: 503-988-4300 Fax: 503-988-4320 Web: www.co.multnomah.or.us	Coordination; Emergency Response; Public Safety; Technical Support

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	Oregon Water Resources Department Dam Safety	Contact: Dam Safety Coordinator 158 12th St. NE Salem, OR 97310 Phone: 503-378-8455 Fax: 503-378-2496 Web: www.wrd.state.or.us/index.shtml	Coordination; Public Safety; Technical Support
All Hazards	Our Lady of the Lake Church	Contact: Our Lady of the Lake Church 650 A Ave. Lake Oswego, OR 97034 Phone: 503-636-7687	Shelter; Public Information
All Hazards	Our Savior's Lutheran Church	Contact: Our Savior's Lutheran Church 2000 Country Club Rd. Lake Oswego, OR 97034 Phone: 503-635-4563	Shelter; Public Information
All Hazards	Palatine Hill Water District #26	Contact: Palatine Hill Water District Board Member P.O. Box 1193 Lake Oswego, OR 97034 Phone: 503-223-5181	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Port of Portland	Contact: Executive Director P.O. Box 3529 Portland, OR 97208 Phone: 503-944-7000 Fax: 503-944-7080 Web: www.portofportland.com	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Portland Community College	Contact: President P.O. Box 19000 Portland, OR 97280 Phone: 503-977-4365 Web: www.pcc.edu	Coordination; Shelter; Public Information
All Hazards	Portland & Western Railroad, Inc.	Contact: President 650 Hawthorne Ave. SE, Suite 220 Salem, OR 97301 Phone: 503-365-7717 Fax: 503-365-7787 Web: www.gwrr.com/default.cfm?action=rail&section=3B4a	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Portland School District 1J	Contact: Superintendent 501 North Dixon Street Portland, Oregon, 97227 Phone: 503-916-2000 Web: www.pps.k12.or.us/	Coordination; Public Information

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	River West Church	Contact: River West Church 1595 Greentree Rd. Lake Oswego, OR 97034	Shelter; Public Information
All Hazards	Riverdale School District 51J	Contact: Superintendent 11733 SW Breyman Ave. Portland, OR 97219 Phone: 503-636-8611 Fax: 503-635-6342 Web: www.riverdale.k12.or.us/	Coordination; Public Information
All Hazards	Riverdale-Dunthorpe Fire District JT-11	Contact: Chief 12203 SW Tryon Hill Road Portland, OR 97219 Phone: 503 635-0275	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Rivergrove Water District #14	Contact: Rivergrove Water District 17725 SW Boones Ferry Road Lake Oswego, OR 97035 Phone: 503-635-6041 Fax: 503-699-9423	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	St. Anne's Chapel/Marylhurst University	Contact: St. Anne's Chapel 17600 Pacific Hwy. Marylhurst, OR 97036 Phone: 503-697-8730	Shelter; Public Information
All Hazards	Skylands Water Company	Contact: Skylands Water Company Board President PO Box 451 Lake Oswego, OR 97034 Phone: 503-636-7203	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Southwood Park Water District c/o Tualatin Valley Water District	Contact: Southwood Park Water District 1850 SW 170th Ave. Beaverton, OR 97075 Phone: 503-642-1511 Web: http://www.tvwd.org/	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Three Rivers Land Conservancy	Contact: Director PO Box 1116 Lake Oswego, OR 97035 Phone: 503-699-9825 Fax: 503-699-9827 Web: www.trlc.org	Coordination; Financing; Public Information; Technical Support
All Hazards	Tigard-Tualatin School District 23J	Contact: Superintendent 6960 SW Sandburg St. Tigard, OR 97223 Phone: 503-431-4000 Web: www.ttsd.k12.or.us	Coordination; Public Information

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	TriMet Administrative Offices	Contact: General Manager 4012 SE 17th Ave. Portland, OR 97202 Phone: 503-962-2100 Web: http://www.trimet.org	Coordination; Emergency Response; Public Information; Public Safety; Technical Support
All Hazards	Triumphant King Lutheran Church	Contact: Triumphant King Lutheran Church 4700 Lamont Wy. Lake Oswego, OR 97035 Phone: 503-636-3436	Shelter; Public Information
All Hazards	Tryon Creek State Natural Area	Contact: Tryon Creek State Natural Area 11321 SW Terwilliger Blvd. Portland, OR 97219 Phone: 503-636-9886 Web: www.oregonstateparks.org/park_144.php Contact: Oregon State Parks Area 2 Field Office P.O. Box 500 Portland OR 97207 Phone: 503-731-3293 Fax: 503-731-3296 Web: www.prd.state.or.us/	Coordination; Public Information; Technical Support
All Hazards	Tryon Creek Watershed Council	Contact: Chair 10638 SW Capitol Hwy. #24 Portland, OR 97219 Phone: 503-244-1827 Web: http://members.aol.com/fritzamand/tcwc.htm	Coordination; Public Information; Technical Support
All Hazards	Tualatin Valley Fire and Rescue	Contact: Fire Chief 0665 SW Blanton St. Aloha, OR 97007 Phone: 503-649-8577 Fax: 503-642-4814 Web: http://www.tvfr.com	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Unity World Healing Center	Contact: Unity World Healing Center 366 3rd St. Lake Oswego, OR 97034 Phone: 503-697-9765	Shelter; Public Information
All Hazards	Washington County County Administrator, Government Relations, Land Use & Transportation	Contact: County Administrator 155 N First Ave. Hillsboro, OR 97124 Phone: 503-846-8611 Web: www.co.washington.or.us	Coordination; Technical Support

Hazard Mitigation Resource Directory

Hazard	Agency	Contact Information	Type of Assistance
All Hazards	Washington County Clean Water Services	Contact: Director 155 N First Ave., Suite 270 Hillsboro, OR 97124 Phone: 503-846-8621 24-hour response line: 503-846-8621 Fax: 503-846-3525 Web: www.cleanwaterservices.org/	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	Washington County Emergency Management	Contact: Emergency Management Director 20665 SW Blanton. Aloha, OR 97007 Phone: 503-642-0371 Fax: 503-642-4814 Web: www.co.washington.or.us	Coordination; Emergency Response; Public Safety; Technical Support
All Hazards	West Linn-Wilsonville School District 3J	Contact: Superintendent 22210 SW Stafford Road P.O. Box 35 West Linn, Oregon 97068 Phone: 503 673-7000 Fax: 503 673-7001 Web: www.wlwv.k12.or.us/	Coordination; Public Information
All Hazards	Westside Baptist Church	Contact: Westside Baptist Church 1679 Southshore Blvd. Lake Oswego, OR 97034	Shelter; Public Information
All Hazards	Willamette Shore Trolley	Willamette Shore Trolley 311 State St. Lake Oswego, OR 97034 Phone: 503-697-7436	Coordination; Public Information
All Hazards	Young Nak Presbyterian Church	Contact: Young Nak Presbyterian Church 1040 C Ave. Lake Oswego, OR 97034 Phone: 503-697-4777	Shelter; Public Information

Community Profile Endnotes

[1] Lake Oswego Comprehensive Plan, Adopted December, 1994.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] Ibid.
[6] Ibid.
[7] Tualatin River Watershed Council, http://www.trwc.org/watershed.html, accessed February 12, 2003.
[8] Ibid.
[9] Ibid.
[10] Ibid.
[11] Lake Oswego Community Profile, Oregon Economic & Community Development Department, http://159.121.111.9/FMPro?-db=Community.fp4&-Format=forms.htm&-lay=webpage&-op=eq&sort%20name=Lake%20Oswego&-script=hit%20count&-Find, accessed January 13, 2003.
[12] Population Research Center, Portland State University, December 15, 2003, http://www.upa.pdx.edu/CPRC/publications/annualorpopulation/certifiedest03.xls, accessed March 25, 2004.
[13] Ibid.
[14] Ibid.
[15] Ibid.
[16] U.S. Census Bureau, http://factfinder.census.gov/bf/_lang=en_vt_name=DEC_2000_SF3_U_DP3_geo_id=16000US4140550.html, accessed February 13, 2003.
[17] City of Lake Oswego, http://www.ci.oswego.or.us/, accessed February 13, 2003.
[18] Lake Oswego Community Profile, Oregon Economic & Community Development Department, http://159.121.111.9/FMPro?-db=Community.fp4&-Format=forms.htm&-lay=webpage&-op=eq&sort%20name=Lake%20Oswego&-script=hit%20count&-Find, accessed January 13, 2003.
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] U.S. Census Bureau, http://factfinder.census.gov/bf/_lang=en_vt_name=DEC_2000_SF3_U_DP3_geo_id=16000US4140550.html, accessed February 13, 2003.
[23] Ibid.
[24] Ibid.

Appendices

APPENDIX A - RESERVOIR CAPACITY
APPENDIX B - GMS 91, RELATIVE EARTHQUAKE HAZARD MAP INFORMATION

Appendix A. Reservoir Capacity

Reservoir and Capacity	% of Capacity to Test (decimal)	Test Capacity	Pump Rate to RES (GPM)[1]	Pump Rate to Next RES[2]	Domestic Demand[3]	Fire Flow[4]	Total Demand	To/Fro	Minutes to Empty/Full	Hours to Empty/Full	Days to Empty/Full
1. Summit											
1,500,000	0.75	1,125,000	3,250	0	536	8,000	8,536	5,286.00	212.83	3.55	0.15
2./3. McNary I/II											
5,000,000	0.75	4,500,000	2,100	536	1,419	6,750	8,705	6,605.00	681.30	11.36	0.47
4./5. Forest Highlands I/II											
2,500,000	0.75	1,875,000	3,100	1,955	481	8,000	10,436	7,336.00	255.59	4.26	0.18
6./7. Touchstone I/II											
6,000,000	0.75	4,500,000	4,800	2,436	1,588	4,000[5]	8,024	3,224.00	1,395.78	23.26	0.97
8. Waluga											
4,000,000	0.75	3,000,000	3,000	4,024	800	7,000	11,824	8,824.00	339.98	5.67	0.24
9. 10th Street											
500,000	0.75	375,000	3,000	223	800	7,000	8,023	5,023.00	74.66	1.24	0.05
10. South Side											
1,000,000	0.75	750,000	3,000	1,642	800	7,000	9,442	6,442.00	116.42	1.94	0.08
11. Knaus											
1,100,000	0.75	825,000	3,000[6]	0	223	6,000	6,223	3,223.00	255.97	4.27	0.18
12. Cooks Butte											
200,000	0.75	150,000	100	0	43	1,500	1,543	1,443.00	103.95	1.73	0.07
13./14. Cityview/Bergis											
1,700,000	0.75	1,275,000	3,000[7]	43	854	5,500	6,397	3,397.00	375.33	6.26	0.26
15./16. Palisades I/II [8]											
3,500,000	0.75	2,625,000	2,250	897	745	3,600	5,242	2,992.00	877.34	14.62	0.61
17. Lake Grove Water District reservoir – data not available											

[1] From observed flows
[2] Sum of domestic demand for all service areas above
[3] From master plan
[4] From master plan
[5] Master plan fire flow of 2000 gpm increased because service area is above Iron Mountain Bluff
[6] Assume 2000 gpm additional feed from Forest Highlands service area. Time will be extended by backfeed from Forest highlands if water available
[7] Includes optional McVey Pumps
[8] Time can be extended with backfeed from Cityview/Bergis

State of Oregon
Department of Geology and Mineral Industries
Donald A. Hull, State Geologist

GMS-91
Relative Earthquake Map of the Lake Oswego Quadrangle,
Clackamas and Multnomah Counties, Oregon
By M.A. Mabey and others

Relative Earthquake Hazard Map of the Lake Oswego Quadrangle, Clackamas and Multnomah Counties, Oregon.

1995

By Matthew A. Mabey and Ian P. Madin, Oregon Department of Geology and Mineral Industries;
and Dan B. Meier, Woodward-Clyde Consultants

ABSTRACT

This *Relative Earthquake Hazard Map of the Lake Oswego Quadrangle* was developed to depict areas at relatively greater risk, compared to other areas, due to local geologic conditions. On a neighborhood-to-neighborhood scale, the local geologic conditions contribute as much as, or more than, any other factor to the hazard portion of a risk assessment. Showing in relative terms on a single map the hazard contribution of three different earthquake-related hazards allows a nongeologic and nonengineering audience to work more effectively toward reducing the risk to life and property through planning policy and mitigation measures. This composite hazard map was developed by combining single hazard maps for ground motion amplification, liquefaction, and slope instability. The single component maps were developed to show geographic patterns of stronger earthquake effects for a variety of likely earthquake sources. Zones that are expected to have the most pronounced damage in any damaging earthquake are shown on the map as having the greatest hazard.

INTRODUCTION

During the late 1980s, the scientific understanding of earthquake hazards in the Portland metropolitan area advanced significantly. It is now widely accepted that damaging earthquakes much larger than any in the historical record are possible (Weaver and Shedlock, 1989; Madin, 1990; Yelin and others, 1994). To minimize economic losses and casualties in these future events, a wide variety of mitigation measures may be necessary. These measures should be based on the best possible assessment of the likely extent and distribution of earthquake damage.

It is difficult to predict the amount of damage any individual structure will sustain in an earthquake. The amount of damage depends on the size, type, and location of the earthquake; the response of the soil and geologic materials at the site; and the characteristics of the structure. More needs to be known about sources of earthquakes that might affect the Portland area before scientists can accurately assess the size and location of future earthquakes. They can, however, measure and predict the behavior of geologic and soil columns at any site. This map depicts the relative degree of earthquake hazards for areas within the U.S. Geological Survey (USGS) Lake Oswego 1:24,000 quadrangle for any given earthquake. This map does not depict the absolute degree of earthquake hazard at any site, which means that in any given earthquake it is possible that damage in even the highest relative hazard category will be light. Conversely, in a severe earthquake even the lowest relative hazard category could experience severe damage. The *Relative Earthquake Hazard Map,* which appears on the accompanying map sheet, also contains no information about how frequently earthquake damage of any level is likely to occur.

This assessment of relative hazard is based on detailed mapping of the geology of the area and specialized geophysical/geotechnical measurements, which are combined with state-of-the-practice geotechnical analysis and Geographic Information System (GIS) methodology and tools. The result is a map that categorizes the map area into one of four relative hazard categories. The categories are ranked from greatest hazard (category A) to least hazard (category D).

The map has been developed as data layers in a GIS and can be easily combined with earthquake source information from selected hypothetical events to produce earthquake scenarios. The map also can be combined with future maps of earthquake probability to provide an assessment of the absolute level of hazard and an estimate of how often that level will occur.

EARTHQUAKE HAZARD

The understanding of earthquake hazards within the Portland area has been undergoing rapid change in the last six years. Recently published geologic and seismologic studies have detailed the potential for earthquakes from three different sources (Weaver and Shedlock, 1989; Madin, 1990). In Portland, the most common are crustal earthquakes, which occur at

depths of 6-10 mi below the surface. The few moderate earthquakes that have originated in Portland in its brief recorded history have been this type.

Intraplate or Wadati-Benioff earthquakes are the type that severely rocked the Puget Sound region in 1949 and again in 1965. Those who lived in Portland in 1949 may recall that the Portland area suffered some damaging and frightening effects of that earthquake. Intraplate earthquakes occur within the remains of the ocean floor that has been shoved (subducted) beneath North America. It is now believed that this type of earthquake could occur closer to Portland, perhaps 25-35 mi directly beneath the city.

Great subduction zone earthquakes occur around the world in subduction zones, where continent-sized pieces of the earth's crust are shoved deep into the body of the earth. These earthquakes consistently are among the most powerful recorded, often having magnitudes of 8 to 9 on the moment magnitude scale. The Cascadia Subduction Zone, which has long been recognized off the coast of Oregon and Washington, has had no great subduction earthquakes during our short 200-year historical record. However, in the past five years, a variety of studies have found widespread evidence that these great events have occurred repeatedly in the past, most recently about 300 years ago. The best evidence available suggests that these great earthquakes have occurred, on average, every 350 to 600 years, and there is every reason to believe that they will continue to occur in the future.

Portland is threatened by all three types of earthquakes, but scientists are only now beginning to answer the questions of where, how often, and how big future earthquakes will be. Traditional probability-based (probabilistic) approaches to hazard mapping, which would provide information about absolute levels of ground shaking to be expected and how often such levels might be reached, must await these answers to these questions. When reliable probabilistic ground motion maps become available, they can be integrated with the relative hazard mapping presented here.

EARTHQUAKE EFFECTS

That damaging earthquakes will be a part of the Portland area's future is certain. The exact details of those future earthquakes are still vague, and we will not be able to predict exactly when, where, and how big the next one, or ones, will be. It is possible, however, to evaluate the influence of site geology on potential earthquake damage. This can be done while the exact sources of the earthquake shaking still are being evaluated.

The most severe damage done by an earthquake is commonly concentrated in limited areas. The damage in these areas is generally caused by one or more of the following phenomena:

- Amplification of ground shaking by a "soft" soil column.
- Liquefaction of water-saturated sand, creating areas of "quicksand."
- Instability of slopes triggered by the shaking of the earthquake.

These effects can be evaluated before the earthquake if good data are available on the thickness and nature of the geologic materials and soils at the site (Bolt, 1993). The exact nature and magnitude of these effects are useful to technical professionals such as geologists and engineers, and these data will be made available separately for the Lake Oswego quadrangle. For others, what is more significant is that these effects increase the damage caused by an earthquake and localize the most severe damage.

The *Relative Earthquake Hazard Map of the Lake Oswego Quadrangle* is a composite hazard map depicting the relative hazard at any site due to the combination of all three effects. It delineates areas that will likely experience the greatest effects from any earthquake. Those effects could range from people waking from their sleep to buildings collapsing or gas lines rupturing. These simple composite hazard maps can be used by planners, lenders, insurers, and emergency responders for first-order hazard mitigation and response planning. It is very important to note that the relative hazard map predicts the tendency of a site to have greater or lesser damage than other sites in the area. These zones, however, should not be used as the sole basis for any type of restrictive or exclusionary policy.

HAZARD MAP METHODOLOGY

Geologic Model

The geology of the Lake Oswego quadrangle is described in detail by Beeson and others (1989) and is dominated by the topographic and structural high of the Tualatin Mountains (Portland Hills), a faulted and folded basement uplift. Bedrock consists of basalt of the Columbia River Basalt Group and older basalt of Waverly Heights. These bedrock units are covered along the western margin of the map by Pliocene to Pleistocene(?) siltstone, mudstone, and sandstone (Sandy River Mudstone equivalent of Madin, 1990). Small structural basins (near Mount Sylvania, east end of Lake Oswego) and the valley of the Tualatin River are filled by a few meters to tens of meters of the Pliocene-Pleistocene mudstone. Small volcanoes composed of Quaternary Boring Lava basalt occur at Mount Sylvania and south of Lake Oswego. These older rocks are locally buried by a few meters to tens of meters of catastrophic flood sand and gravel, particularly in the northeast and southwest corners of the map, and along the valley of the Tualatin River. Tens of meters of Holocene sand and silt alluvium line the channel of the Willamette River in the northeast corner of the map, and a few meters of wind-blown silt (loess) mantles the slopes of the Tualatin Mountains in the north half of the map.

Hundreds of boreholes drilled for such purposes as water wells and foundation investigations were used to determine the thickness of each of the six geologic units over the entire map, and these data were entered into a GIS database. This information defines the soil and rock beneath any location on the map so that their effects on earthquake damage can be assessed.

To assess the effects of the local geologic materials, data on more than just their thicknesses are needed. Many of the required measurements such as the Standard Penetration Test (SPT) are acquired in the normal course of a foundation investigation. Thus, the needed information is available from many of the same sources as the thickness information.

In addition to the data acquired from existing borehole records, the assessment technique requires shear-wave velocities. Measurements of shear-wave velocities were made at dozens of carefully selected sites by using both conventional drilling and cone penetrometer techniques. Thirteen sites were on the Lake Oswego quadrangle. The additional velocity measurements have been made at other locations in the Portland area.

All this information combines to give a detailed computer map of what lies beneath the surface throughout the map area. With this information, the response to earthquake shaking at a specific location can be assessed.

HAZARD ANALYSIS

An earthquake causes damage through such effects as ground shaking, liquefaction, landslides, fault rupture, tsunamis, and seiches (Bolt, 1993). The severity of any one of these effects, or hazards, is influenced by a number of factors. Many of these factors can be assessed in relative terms without knowing the exact details of the earthquake itself.

The *Relative Earthquake Hazard Map* integrates three separate earthquake hazard components. They are (1) ground shaking amplification, (2) liquefaction, and (3) earthquake-induced landsliding. Each of these phenomena is a distinct and separate hazard and in concert with others can increase the severity of the total hazard at a given locality. The distinction between each component is important to technical specialists, but the distinctions are not useful to a nontechnical audience. It therefore makes sense to generate a map of each of the individual hazard components that will be available to those able to use them and to then combine the individual maps into a simple, unified hazard map that generalizes the issues in a way useful to nonspecialists. IDRISI, a raster-based GIS (Eastman, 1990), was used with custom software to perform the map analyses.

Ground Shaking Amplification

Bedrock ground shaking caused by an earthquake can be modified by the soils and soft sedimentary rocks near the surface. This modification can increase the strength of shaking (or alternatively decrease it) or change the frequency of the shaking. For example, the shaking could be changed from a rapid vibration (like hearing a jet flying low overhead) to a long rolling motion (like being on a boat in a storm). The nature of these modifications is determined by the thickness of the geologic materials and their physical properties such as shear-wave velocity. With these parameters, sophisticated computer programs can estimate the effects of the local geology on ground shaking. In this way, areas where the ground shaking will tend to be strongest have been identified. A modified version of the computer program SHAKE91 (Schnable and others, 1972; Idriss and Sun, 1992) was used for this map.

Mapping of the amplification resulting from near-surface geology has been done previously in other areas such as the San Francisco Bay area and Mexico City. Damage to the Nimitz Freeway during the 1989 Loma Prieta or "World Series" earthquake was localized by near-surface amplification. Fortunately, the areas of the Lake Oswego quadrangle that are affected by large amplifications are small. The magnitude of the most severe amplifications in the Lake Oswego quadrangle does not appear to be as great as has been found in other parts of the world.

The three amplification hazard categories were defined as follows:

(1) Areas with amplification less than 1.25.
(2) Areas with amplification between 1.25 and 1.50.
(3) Areas with amplification greater than 1.50.

The *Relative Amplification Hazard Map* shown on the map sheet accompanying this report is the resulting three-category map of relative amplification hazard.

Liquefaction Analysis

Liquefaction is a phenomenon in which shaking or otherwise disturbing a soil causes it to rapidly change its material properties so that what was solid begins to behave like a liquid. Soils that have this problem tend to be fairly young, loose, granular soils (as opposed to clay) that are saturated with water (NRC, 1985). Unsaturated soils will not liquefy, but they may settle. If liquefaction is induced by the earthquake shaking, several things can happen. The liquefied layer of soil and everything lying on top of it can either move downhill or oscillate back and forth with displacements that are large enough to rupture pipelines, move bridge abutments, and pull buildings apart. Light objects such as underground storage tanks can float up toward the surface, and heavy objects such as buildings can sink. These displacements can range from inches to feet. Obviously, if the soil at a site liquefies, the damage caused by the earthquake is significantly increased over what the shaking would have done alone. Soils that are subject to liquefaction can be identified, as can their thicknesses and influence on the severity of the effects. This was done first for the

Portland quadrangle (Youd and Jones, 1993) and since has been done for Lake Oswego quadrangle.

Maps of liquefaction hazard similar to what has been done for this map have been done in many areas including Seattle, Washington, and Salt Lake City, Utah, where the maps have been incorporated into emergency response planning and development planning (Anderson and others, 1986; Grant and others, 1992).

The three liquefaction hazard categories were defined as follows:

(1) Areas with materials that are liquefiable when they are intermittently saturated.

(2) Areas with a thickness of liquefiable material (for the scenario earthquake) greater than 0 ft (0 m) and less than 20 ft (6 m) where the water table is 15-30 ft (4.5-6 m) deep.

(3) Areas with a thickness of liquefiable material (for the scenario earthquake) greater than 20 ft (6 m) where the water table is 15-30 ft (4.5-9.0 m) deep or areas with liquefiable material where the water table is less than 15 ft (4.5 m) deep.

The rest of the map that is not covered by one of these three categories is described as liquefiable due only to unusual localized conditions.

The *Relative Liquefaction Hazard Map* shown on the map sheet accompanying this report is the resulting three-category map of relative liquefaction hazard.

Landslide Analysis

Landslides are a problem familiar to Oregonians. The shaking resulting from an earthquake tends to cause existing landslides to move as well as generating forces that create new landslides. The steepness of a slope is the primary indicator of the stability of a slope. This one factor has been used to estimate the hazard of landslides in the map area (Varnes, 1978; Brabb, 1987; Mabey and others, 1993). Using the slope information, the authors rated the hazard as one of four categories ranging from 0 to 3.

The three slope instability hazard categories were defined as follows:

(1) A slope between 15 percent (8.5°) and 30 percent (16.7°).

(2) A slope between 30 percent (16.7°) and 45 percent (24.2°).

(3) A slope greater than 45 percent (24.2°).

The rest of the map is characterized as having slope instability only in unusual localized situations.

The *Relative Slope Instability Hazard Map* with the three categories is shown on the map sheet accompanying this report.

Other Hazards

Other hazards have not been factored into the relative hazard map. Certain bodies of water (e.g., Lake Oswego) are subject to waves being generated by the ground motion accompanying an earthquake. Such waves are known as seiches. The effects of a seiche will be limited to the immediate vicinity of the water body, but the size of the waves can be damaging and deadly. The effects of any tsunami generated in the Pacific Ocean by an earthquake are likely to be small along the rivers in the Portland area. Although many faults have been identified and mapped in the Portland area, the hazard that the rupture of specific faults represents is still uncertain. The "activity" of these faults will be defined by studies in coming years. It should be noted that the magnitude 6 to 6.5 range is the threshold at which fault rupture begins to be commonly apparent (Bonilla and others, 1984). Because 6 to 6.5 is the likely maximum magnitude for any crustal earthquakes in the area, fault rupture is likely to be absent altogether or will be of very limited extent. Therefore, the number of structures affected and the severity of the effects also will be limited.

RELATIVE EARTHQUAKE HAZARD MAP

The *Relative Earthquake Hazard Map of the Lake Oswego Quadrangle* was created to show which areas will have the greatest tendency to experience damage due to any one of, or a combination of, these hazards. Hazard maps were generated for each of the individual hazards. On these individual hazard maps, areas of the maps were categorized as zones 0, 1, 2, or 3, with 3 being the greatest hazard. For every point on the map, the zone rating for each individual hazard (amplification, liquefaction, and landslide) was squared, and the resulting numbers were added together. Then the square root of this sum was taken and rounded to the nearest whole number. A result of 4 is assigned to category A, a result of 3 is assigned to category B, a result of 2 is assigned to category C, and a result of 1 is assigned to category D.

Example: Suppose that the block on which your house sits had a ground shaking amplification rating of 2, a liquefaction rating of 2, and a landslide rating of 0. We would take the ground shaking amplification rating of 2 and square it to get 4. We would do the same with the liquefaction rating and also get 4. Squaring the landslide rating of zero gives zero. So we add 4 + 4 + 0 to get a sum of 8. The square root of 8 is 2.8284, which rounds to 3 or a rating of B for this hypothetical block. Since B is the next to the highest rating, this block is of greater concern from an earthquake hazard standpoint than would be a block a few miles away that has a rating of D.

It should be pointed out that, with this system, a numeric result of 0 or 5 is theoretically possible, but in practice neither is likely to be seen. If such a rating were to result, it would have been assigned to the D or A group, respectively.

The actual relative hazard map zones were smoothed using three iterations of IDRISI's low pass filter. Following each application of the filter, values of any cells that were reduced by the filtering process were increased back to their original value.

The result of this system is that areas with a high hazard from a single local effect are assigned the rating of B (next to highest overall hazard rating) as well as areas with a combination of lesser single ratings. The rating of A represents a combination of high ratings. The hazard category B should not be underrated, since it can result from a single hazard being very severe. This approach to arriving at a single relative hazard map is novel but has the benefit of quickly delineating areas of greater earthquake hazard without requiring a detailed understanding of the individual hazards or how they are measured.

USE OF THE RELATIVE EARTHQUAKE HAZARD MAP

The *Relative Earthquake Hazard Map of the Lake Oswego Quadrangle* (on map sheet accompanying this report) delineates the areas where earthquakes present the greatest hazard on average. This information can be used to develop a variety of hazard mitigation policies. It also can be used inappropriately without careful consideration and a thorough understanding of the map and its basis.

Emergency Response and Hazard Mitigation

One of the key uses for this map is to develop emergency response plans. The areas indicated as having higher hazard will be the areas where the greatest and most abundant damage will tend to occur. Efforts and funds for both urban renewal and strengthening or replacing older and weaker buildings can be focused on the areas where the effects of earthquakes will be the greatest. The location of future urban expansion or intensified development certainly should consider earthquake hazards.

Requirements placed on development could be based on the hazard zone in which the development is located. For example, the type of site-specific earthquake hazard investigation that is required could be based on the hazard zone. Since the *Relative Earthquake Hazard Map* is part of the Metro's Regional Land Information System (an ArcInfo-based GIS), it can easily be combined with any of the other land use or hazard information in that system.

Lifelines

The *Relative Earthquake Hazard Map* and its component single-hazard maps are especially useful for mitigation and expected damage estimation for lifelines. The distributed character of lifelines precludes comprehensive site-specific evaluations. These hazard maps allow quantitative estimates of the hazard throughout a lifeline system. This information can be used for assessing vulnerability as well as indicating priorities and approaches for mitigation.

Engineering

The specific quantitative values calculated for this map of any single hazard are no substitute for site-specific evaluations based on subsurface information gathered at a site. The calculated values may, however, be used to good purpose in the absence of such site-specific information, such as at the feasibility study or preliminary design stage. In most cases, the quantitative values calculated for these maps will be superior to a qualitative estimate based solely on lithology or nonsite specific information. Any great deviation of observed site geology from the geologic model used in the analyses indicates the need for additional analyses at the site.

Relative Hazard

It is equally important to recognize the limitations of the *Relative Earthquake Hazard Map,* which in no way includes information with regard to the probability of damage occurring. Rather, it shows that when the map area is shaken by an earthquake, the damage is more likely to occur or be more severe in the higher hazard area. The exact probability of such shaking occurring is yet to be determined.

Neither should the higher hazard areas be viewed as unsafe. Except for landslides, the earthquake effects that are factored into the *Relative Earthquake Hazard Map* are not life threatening in and of themselves. What is life threatening is the way that structures such as buildings and bridges respond to these effects. Locations are not necessarily unsafe or even less safe, but the structures there may be.

The map depicts trends and tendencies. In all cases, the actual threat at a given location can be assessed only by some degree of site-specific assessment. This is similar to being able to say demographically that a zip code zone contains an economic middle class, but within that zone there easily could be individuals or neighborhoods significantly richer or poorer.

In summary, just as some parts of the state are snowier than others, thus influencing the type of planning and development that occurs, some parts of the Portland area are more prone to earthquake effects than others. These maps provide one way this fact can be taken into account in planning, development, and decision making. This methodology is being applied to the remainder of the Portland metropolitan area as quickly as resources permit.

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Figures (on accompanying map sheet)

Figure 1. Relative amplification hazard categories for the Lake Oswego quadrangle.

Figure 2. Relative liquefaction hazard categories for the Lake Oswego quadrangle.

Figure 3. Relative slope instability hazard categories for the Lake Oswego quadrangle.

Figures

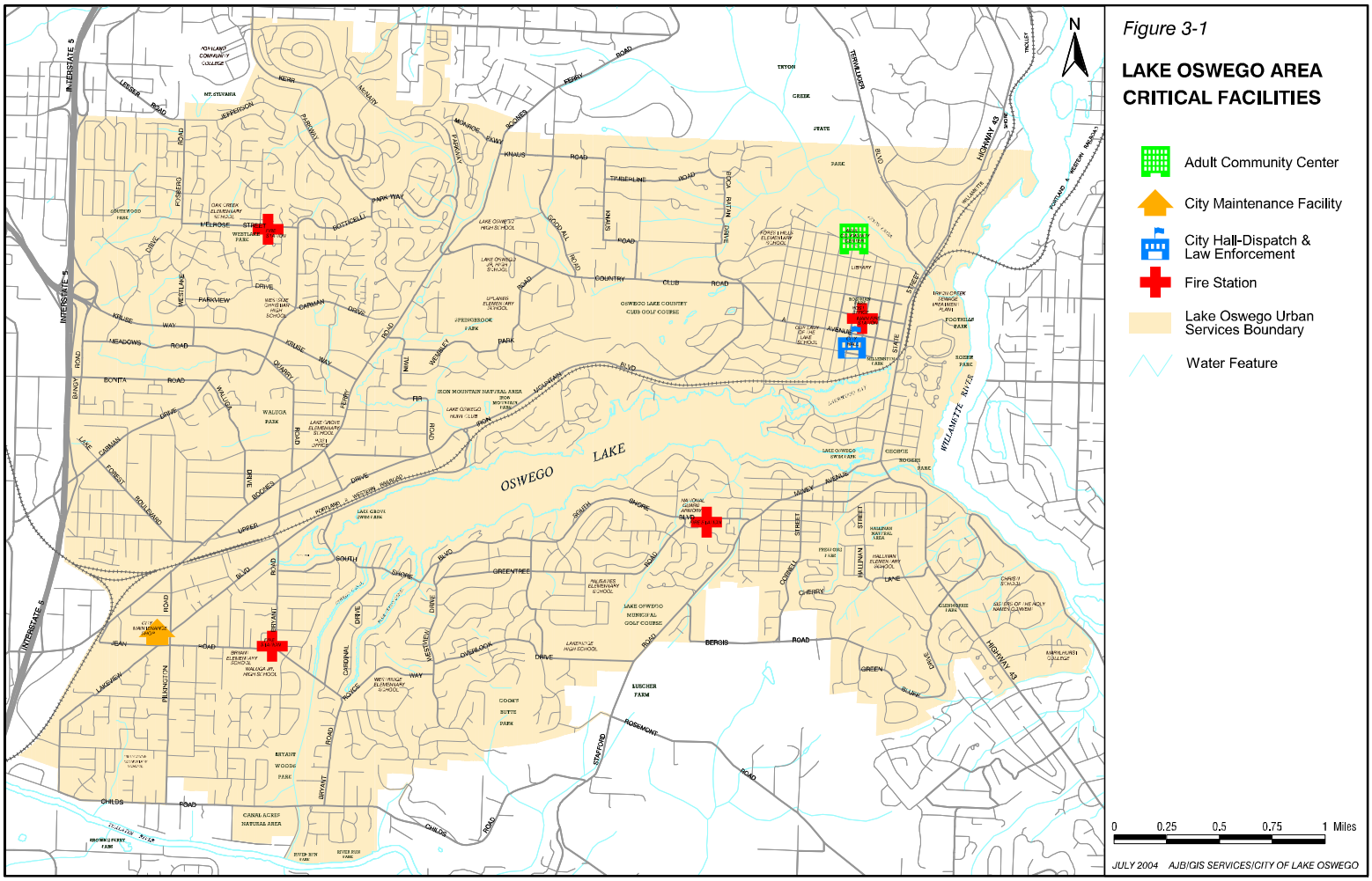
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Figure 3-1
LAKE OSWEGO AREA
CRITICAL FACILITIES
Adult Community Center
City Maintenance Facility
City Hall-Dispatch &
Law Enforcement
Fire Station
Lake Oswego Urban
Services Boundary
Water Feature
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJB/GIS SERVICES/CITY OF LAKE OSWEGO
OSWEGO LAKE
INTERSTATE 5
HIGHWAY 43
WILLAMETTE RIVER

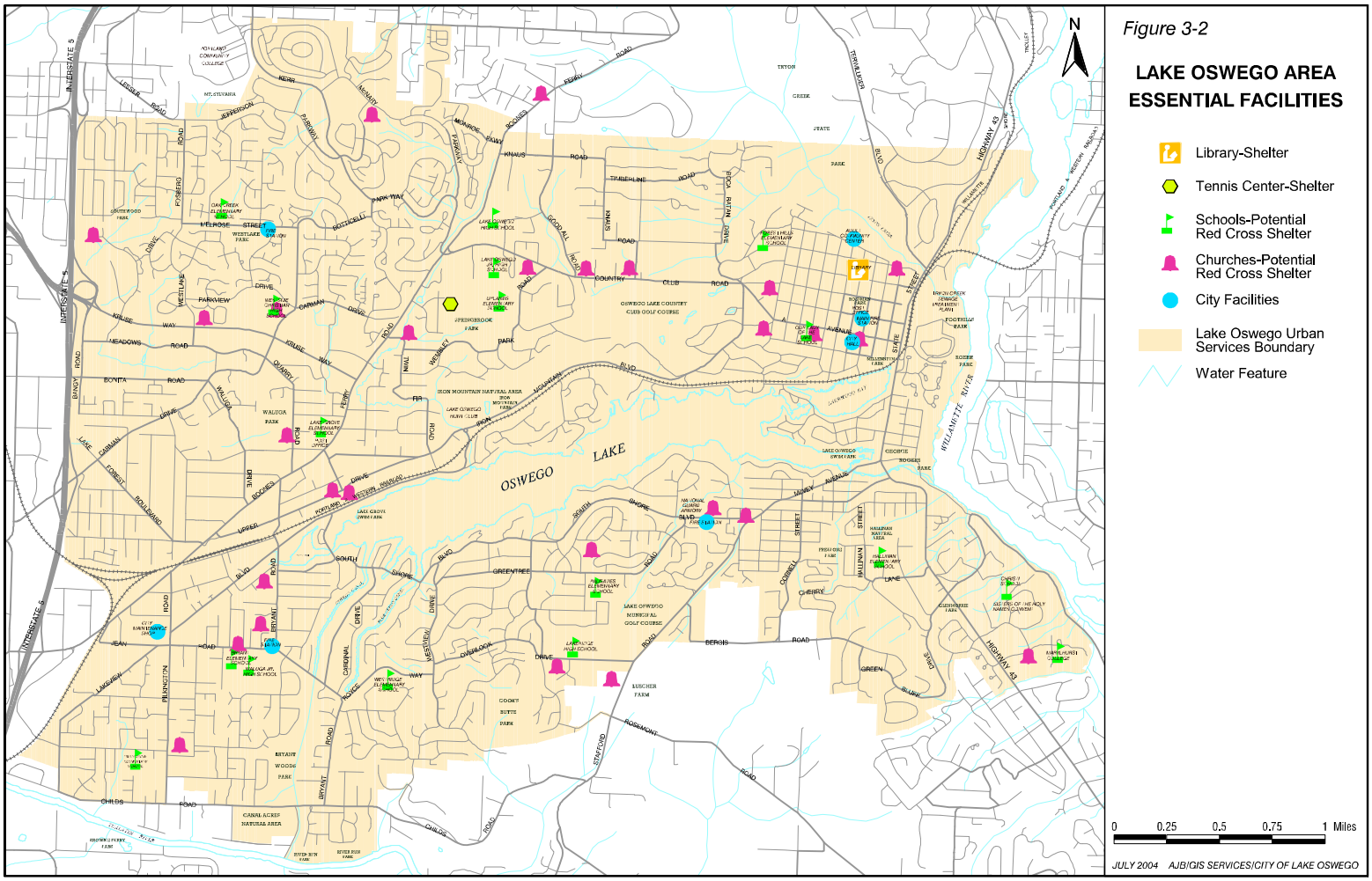
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Figure 3-2
LAKE OSWEGO AREA
ESSENTIAL FACILITIES
Library-Shelter
Tennis Center-Shelter
Schools-Potential
Red Cross Shelter
Churches-Potential
Red Cross Shelter
City Facilities
Lake Oswego Urban
Services Boundary
Water Feature
LAKE
OSWEGO
INTERSTATE 5
HIGHWAY 43
WILLAMETTE RIVER
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJB/GIS SERVICES/CITY OF LAKE OSWEGO

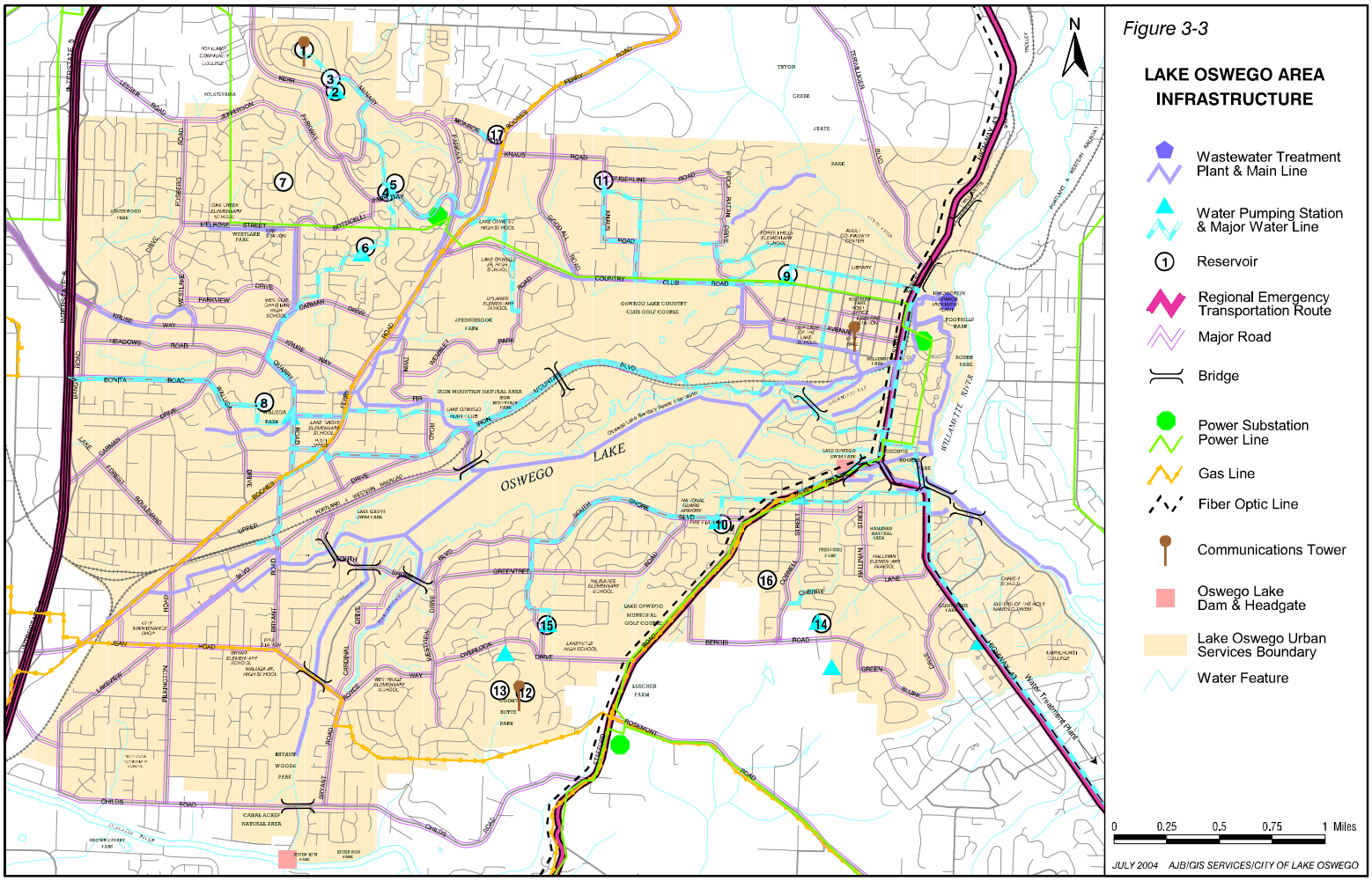

Figure 3-3

LAKE OSWEGO AREA INFRASTRUCTURE

- Wastewater Treatment Plant & Main Line
- Water Pumping Station & Major Water Line
- Reservoir
- Regional Emergency Transportation Route
- Major Road
- Bridge
- Power Substation Power Line
- Gas Line
- Fiber Optic Line
- Communications Tower
- Oswego Lake Dam & Headgate
- Lake Oswego Urban Services Boundary
- Water Feature

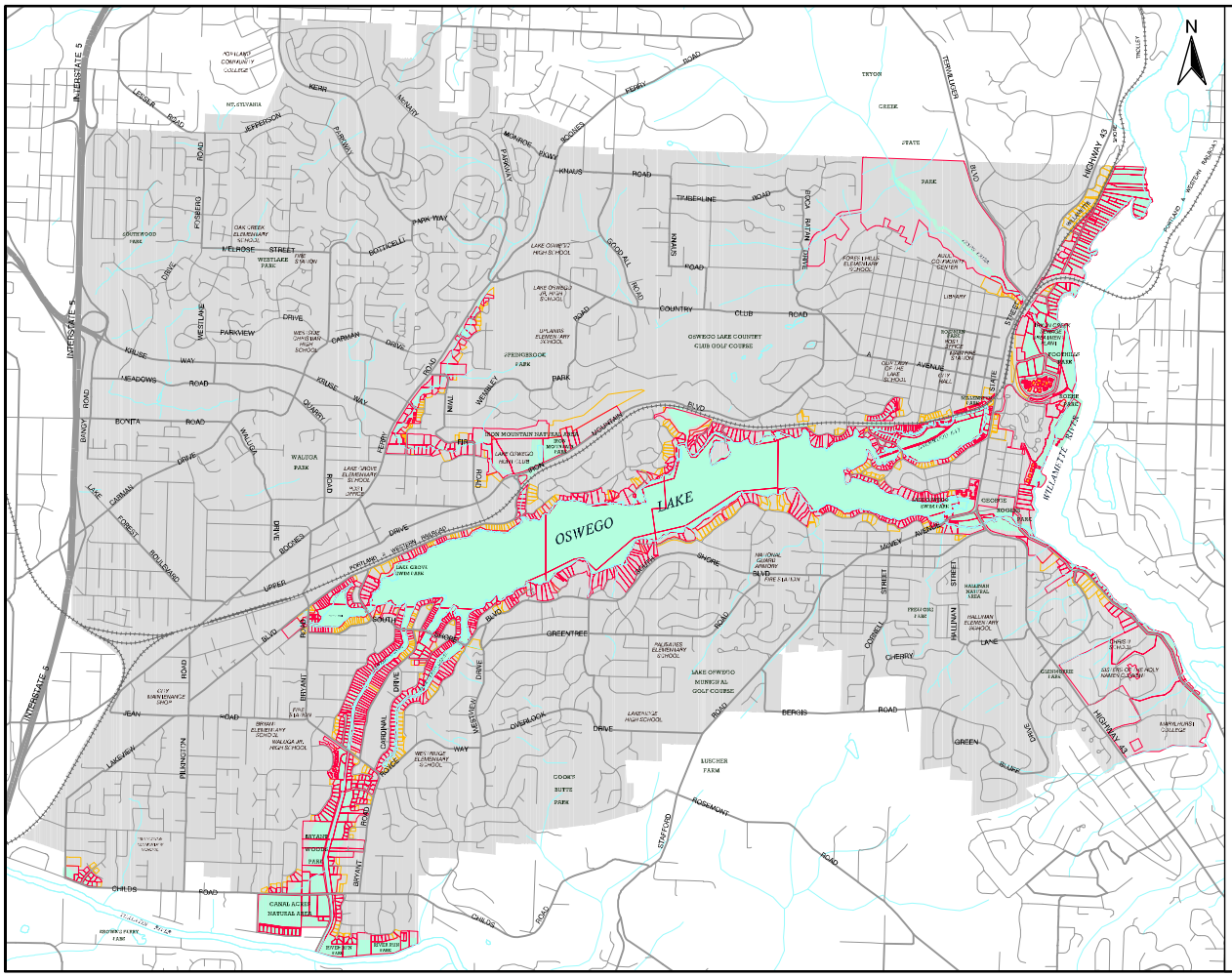

Figure 4-1

LAKE OSWEGO AREA FLOOD HAZARDS

Data Sources Include: FEMA 100-year Floodplain, 1996 Inundation Boundary, City of Lake Oswego 1996 Floodplain Studies

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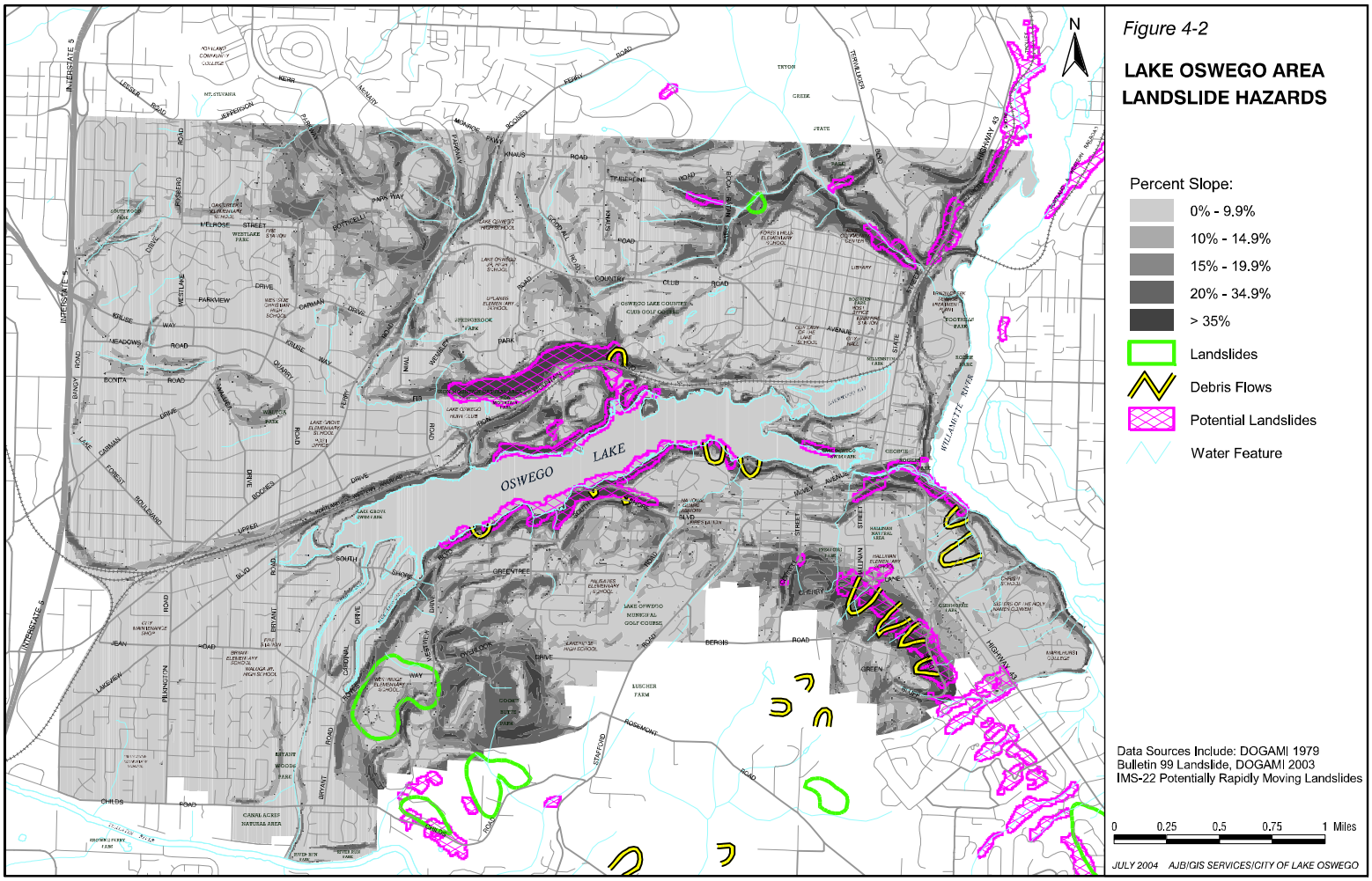
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Figure 4-2
LAKE OSWEGO AREA
LANDSLIDE HAZARDS
Percent Slope:
0% - 9.9%
10% - 14.9%
15% - 19.9%
20% - 34.9%
> 35%
Landslides
Debris Flows
Potential Landslides
Water Feature
OSWEGO LAKE
Data Sources Include: DOGAMI 1979
Bulletin 99 Landslide, DOGAMI 2003
IMS-22 Potentially Rapidly Moving Landslides
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJB/GIS SERVICES/CITY OF LAKE OSWEGO

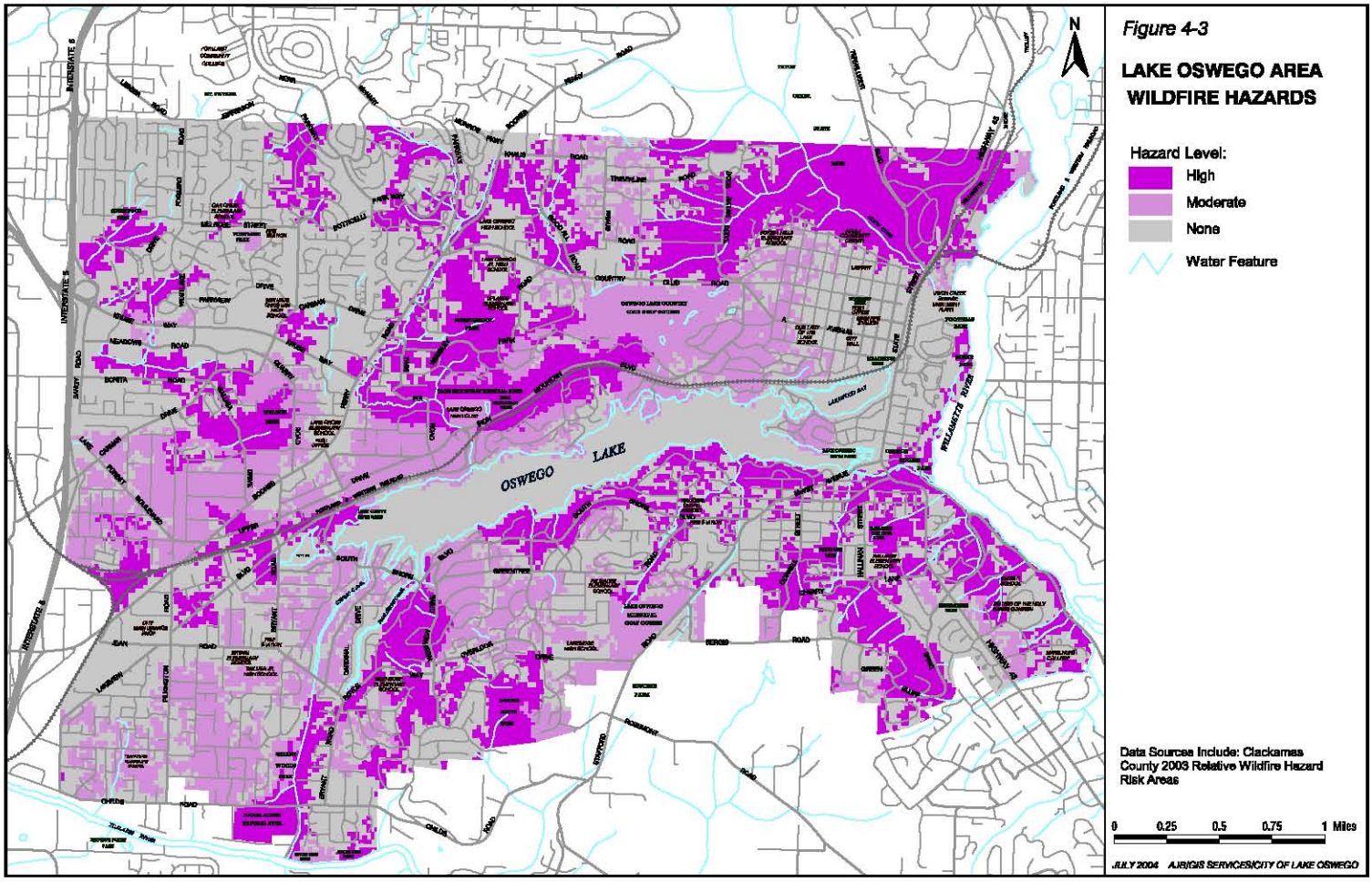
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Figure 4-3
LAKE OSWEGO AREA
WILDFIRE HAZARDS
Hazard Level:
High
Moderate
None
Water Feature
OSWEGO
LAKE
INTERSTATE 5
Data Sources Include: Clackamas County 2003 Relative Wildfire Hazard Risk Areas
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJ/GIS SERVICES/CITY OF LAKE OSWEGO

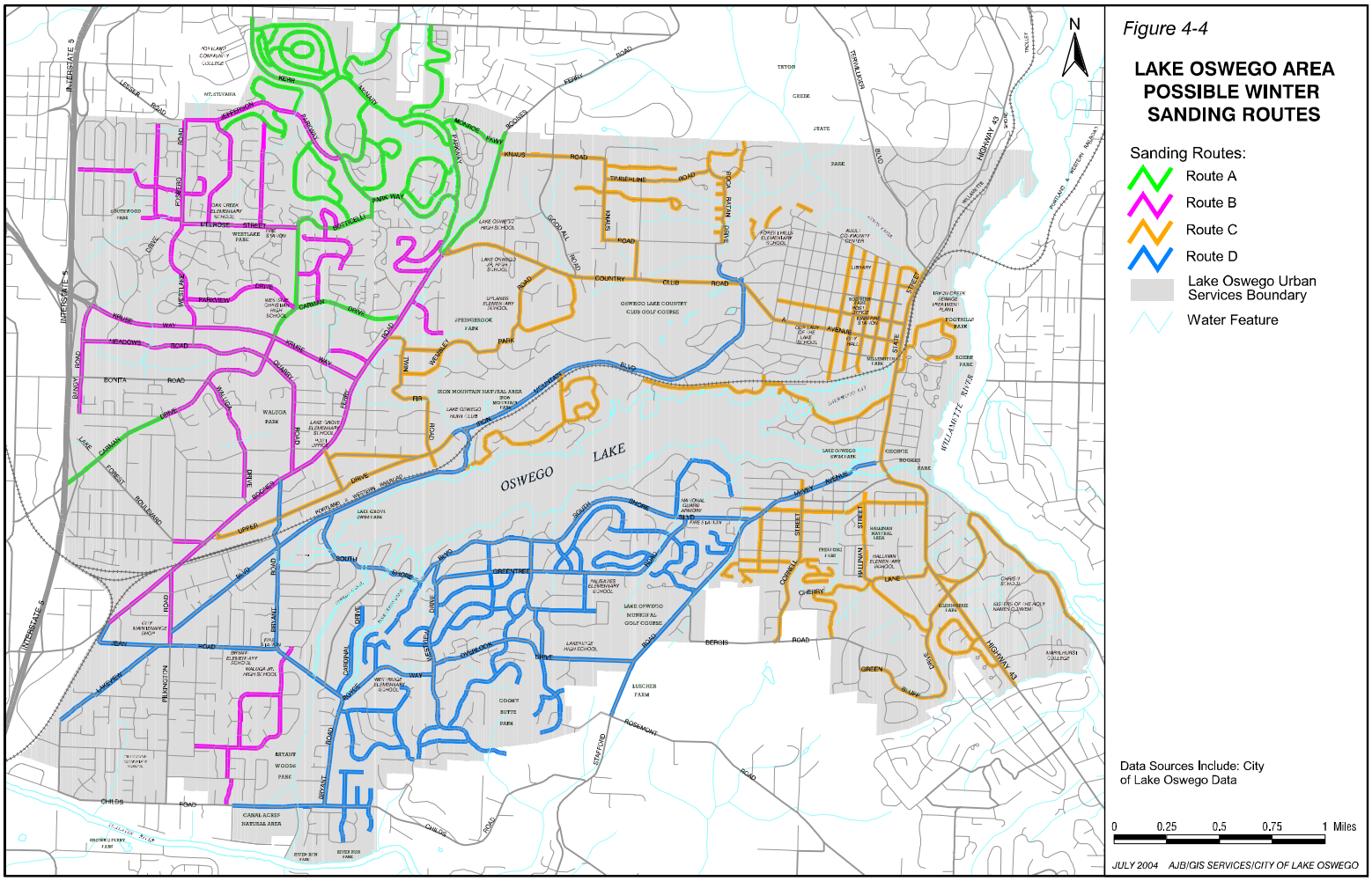
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Figure 4-4
LAKE OSWEGO AREA
POSSIBLE WINTER
SANDING ROUTES
Sanding Routes:
Route A
Route B
Route C
Route D
Lake Oswego Urban
Services Boundary
Water Feature
Data Sources Include: City
of Lake Oswego Data
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJB/GIS SERVICES/CITY OF LAKE OSWEGO
LAKE
OSWEGO
INTERSTATE 5
HIGHWAY 43
WILLAMETTE RIVER

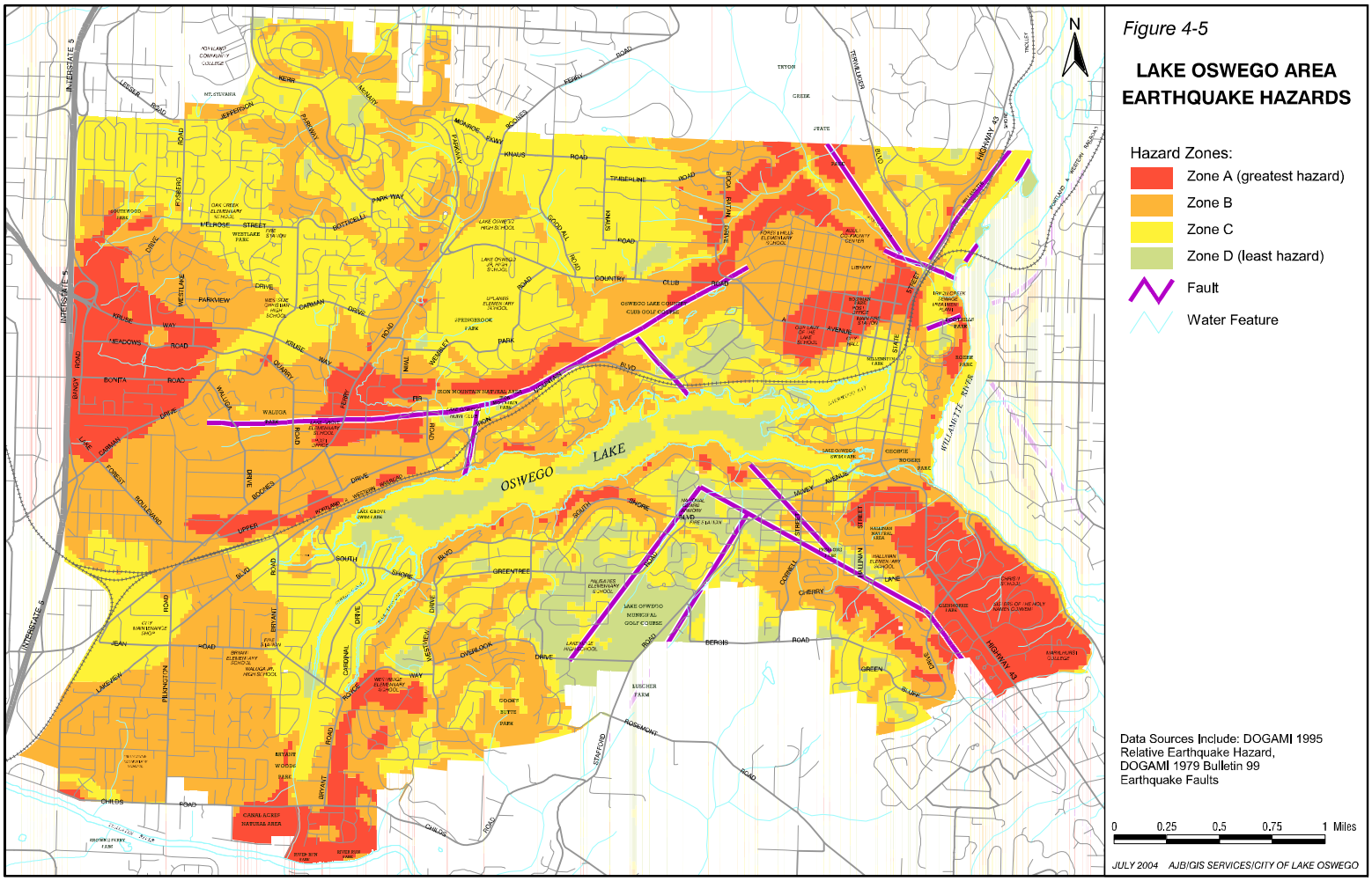
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Figure 4-5
LAKE OSWEGO AREA
EARTHQUAKE HAZARDS
Hazard Zones:
Zone A (greatest hazard)
Zone B
Zone C
Zone D (least hazard)
Fault
Water Feature
OSWEGO
LAKE
Data Sources Include: DOGAMI 1995
Relative Earthquake Hazard,
DOGAMI 1979 Bulletin 99
Earthquake Faults
0 0.25 0.5 0.75 1 Miles
JULY 2004 AJB/GIS SERVICES/CITY OF LAKE OSWEGO