Oregon Emergency Management (OEM)
HAZARD ANALYSIS METHODOLOGY

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BACKGROUND AND OVERVIEW

This hazard analysis methodology was first developed by FEMA circa 1983, and gradually refined by OEM over the years. During 1984, the predecessor agency to OEM (Emergency Management Division) conducted workshops around the State of Oregon that resulted in all of Oregon's 36 counties producing an analysis using this methodology. Since then, several cities have also conducted an analysis using this method.

The methodology produces scores that range from 24 (lowest possible) to 240 (highest possible), one order of magnitude from lowest to highest. Vulnerability and probability are the two key components of the methodology. Vulnerability examines both typical and maximum credible events, and probability endeavors to reflect how physical changes in the jurisdiction and scientific research modify the historical record for each hazard. Vulnerability accounts for approximately 60% of the total score, and probability approximately 40%.

For local governments, conducting the hazard analysis described in this document is a useful early step in planning for hazard mitigation, response, and recovery. This method provides the jurisdiction with a sense of hazard priorities, or relative risk. It doesn't predict the occurrence of a particular hazard, but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

Among other things, this hazard analysis can:

- help establish priorities for planning, capability development, and hazard mitigation;
- serve as a tool in the identification of hazard mitigation measures;
- be one tool in conducting a hazard-based needs analysis;
- serve to educate the public and public officials about hazards and vulnerabilities; and
- help communities make objective judgments about acceptable risk.

For OEM and other state and regional organizations, this analysis allows comparison of the same hazard across various local jurisdictions; for example, the score for the flood hazard in each county in a four-county region. The best place to view and think about the hazard analysis in this way is at the following website:

http://mtjune.uoregon.edu/website/hazardmaps/webapp/hazardsviewer_content.html

Each local hazard analysis produced using this methodology is ultimately comprised of two main pieces: a hazard analysis matrix (table) and a narrative. A sample matrix is on page 6; sample narrative is provided on pages 7 and 8.

In connection with Emergency Management Performance Grant funding administered by OEM, there is a requirement that hazard analyses must be current and updated within the past ten years, and include a written synopsis (narrative) of the most credible events possible to occur within a jurisdiction. Having a current local hazard analysis is also one element in meeting Oregon Progress Board Benchmark #67, "Emergency Preparedness."

OEM is in the process of integrating this analysis with the three-phase risk assessment used in guidance and taught by the Oregon Natural Hazards Workgroup (ONHW) with respect to the development of local natural hazards mitigation plans.

POSSIBLE HAZARDS TO CONSIDER

NATURAL HAZARDS

Most jurisdictions should examine (score) earthquakes, fires (especially wildland-urban interface or "WUI" fires), floods, landslides and debris flows, snow/ice/extreme cold, and windstorms.

Where it applies, jurisdictions should also develop scores for coastal erosion, drought, tsunamis, and also possibly dust storms, El Niño – La Niña, tornadoes, and volcanic hazards.

With respect to volcanic hazards, score direct hazards such as blast and lahar separately from secondary hazards such as ashfall.[1]

Please do not create a "catchall" category for "severe weather," but rather score floods, windstorms, and snow/ice/extreme cold separately. Even the term "winter storm," though used frequently around the state, means different things in different places. For example, a winter storm on the South Coast is typically very different from a winter storm in the Columbia River Gorge.

TECHNOLOGICAL/PERSON-CAUSED HAZARDS

Jurisdictions should develop scores for the dam failure hazard and hazardous materials. You may score fixed site and transportation hazards separately; some jurisdictions score radiological hazards separately.

Though not required as part of this analysis, at your option, you may want to score riots and acts terrorism.

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[1] Examples from the past that demonstrate the need to do this include:

- Clatsop Co. scored volcanic hazards at 159, but this score reflects the hazard posed by ashfall only.
- Clackamas Co. reported only 131, but is clearly at much greater risk to volcanic hazards than Clatsop Co.
- Lincoln Co. scored 114, but is concerned about underwater volcanoes.

COMPLETING THE HAZARD ANALYSIS MATRIX

The Hazard Analysis Matrix Worksheet on page 5 is provided for you and your team to complete. You would probably benefit by transferring this worksheet onto a large format, such as a flipchart, dry erase board, etc., to assist in facilitating your meeting.

In this analysis, *severity ratings* are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability based as follows:

LOW	=	choose the most appropriate number between 1 to 3 points
MEDIUM	=	choose the most appropriate number between 4 to 7 points
HIGH	=	choose the most appropriate number between 8 to 10 points

Weight factors also apply to each of the four categories as shown below.

HISTORY (weight factor for category = 2)

History is the record of previous occurrences. Events to include in assessing history of a hazard in your jurisdiction are events for which the following types of activities were required:

- The EOC or alternate EOC was activated;
- Three or more EOP functions were implemented, e.g., alert & warning, evacuation, shelter, etc.
- An extraordinary multi-jurisdictional response was required; and/or
- A "Local Emergency" was declared.

LOW – score at 1 to 3 points based on…	0 - 1 event past 100 years
MEDIUM – score at 4 to 7 points based on…	2 - 3 events past100 years
HIGH – score at 8 to 10 points based on…	4 + events past100 years

VULNERABILITY (weight factor for category = 5)

Vulnerability is the percentage of population and property likely to be affected under an “average” occurrence of the hazard.

LOW – score at 1 to 3 points based on…	< 1% affected
MEDIUM – score at 4 to 7 points based on…	1 - 10% affected
HIGH – score at 8 to 10 points based on…	> 10% affected

MAXIMUM THREAT (weight factor for category = 10)

Maximum threat is the highest percentage of population and property that could be impacted under a worst-case scenario.

LOW – score at 1 to 3 points based on…	< 5% affected
MEDIUM – score at 4 to 7 points based on…	5 - 25% affected
HIGH – score at 8 to 10 points based on…	> 25% affected

PROBABILITY (weight factor for category = 7)

Probability is the likelihood of future occurrence within a specified period of time.

LOW – score at 1 to 3 points based on…	one incident likely within 75 to 100 years
MEDIUM – score at 4 to 7 points based on…	one incident likely within 35 to 75 years
HIGH – score at 8 to 10 points based on…	one incident likely within 10 to 35 years

By multiplying the *weight factors* associated with the categories by the *severity ratings*, we can arrive at a subscore for history, vulnerability, maximum threat, and probability for each hazard. Adding the subscores will produce a total score for each hazard.

For example, look at "landslide" on the "Sample Hazard Analysis Matrix" shown on page 6. The history of landslides is high in the sample jurisdiction. History has a weight factor of two (2), and in this case, high is scored with ten (10) points for the severity rating. 2 X 10 = subscore of 20. The vulnerability of the sample jurisdiction is medium. However, a landslide normally would not affect much more than 1% of the people and property in the jurisdiction. Vulnerability has a factor weight of five (5) and this team decided on four (4) points for the severity rating. 5 X 4 = subscore of 20. After figuring maximum threat and probability, the total score for landslides is 133.

The total score isn't as important as how it compares with the total scores for other hazards the jurisdiction faces. By comparing scores, the jurisdiction can determine priorities: Which hazards should the jurisdiction be most concerned about? Which ones less so?

COMPLETING THE NARRATIVE

Your hazard analysis should begin with a description of the local jurisdiction (sometimes called a community profile). These often include an overview of key demographic information, and sometimes include climate data or a climate summary.

In addition to the matrix used to score the hazards, each local hazard analysis should include a narrative that describes how these hazards affect that particular local jurisdiction, especially critical facilities, key infrastructure, and the most important facilities of the jurisdiction's economic base.

One should provide this narrative minimally on those hazards receiving the highest total scores in the jurisdiction; for example, you may include history, areas of vulnerability, areas of planned or current mitigation measures, maps and displays, or any other facts or data that may be relevant.

Some jurisdictions include a brief section on hazards that were considered, but not scored (or scored, but not included in the written hazard analysis), offering the rationale for not scoring or not writing narrative about certain minor hazards.

See pages 7 and 8 for sample narrative.

OTHER METHODOLOGIES

There are many other ways of assessing risk. The OEM Hazard Analysis Methodology should be considered simply one tool in the risk assessment "tool bag." This methodology, in fact, is a "big picture" tool that will often lead to more detailed vulnerability assessments and risk analyses. Among the other prominent tools are various Geographic Information Systems (GIS), FEMA's Hazards U.S. (HAZUS), and Oregon Department of Forestry's (wildfire) "Communities at Risk Assessment." This is only a partial list of the many ways of evaluating risk.

The OEM Hazard Analysis Methodology can and should be one tool used in the development or revision of risk assessments required as part of the local natural hazard mitigation planning process under 44 CFR 201.6(c)(2), which have as their bottom line using best available data.

More information on this topic can be found in the *Oregon Pre-Disaster Mitigation Program Training Manual* developed and maintained by ONHW.[2]

[2] http://csc.uoregon.edu/PDR_website/resources/print/pdm/ppt_pdf/2004/fall_2004/PDM04_Final_Manual_09-16-04.pdf

HAZARD ANALYSIS MATRIX
WORKSHEET

JURISDICTION:

Hazards		**History** **WF = 2**	**Vulnerability** **WF = 5**	**Maximum Threat** **WF = 10**	**Probability** **WF = 7**	**Total Score**
	WF X SR Subscore	2 X ____ =	5 X ___ =	10 X ___ =	7 X ___ =	
	WF X SR Subscore	2 X ____ =	5 X ___ =	10 X ___ =	7 X ___ =	
	WF X SR Subscore	2 X ____ =	5 X ___ =	10 X ___ =	7 X ___ =	
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	WF X SR Subscore	2 X ____ =	5 X ___ =	10 X ___ =	7 X ___ =	
	WF X SR Subscore	2 X ____ =	5 X ___ =	10 X ___ =	7 X ___ =	

DATE: ____

WF = weight factor
SR = severity rating

PREPARED BY:

AGENCY:

SAMPLE HAZARD ANALYSIS MATRIX

Hazards		History WF = 2	Vulnerability WF = 5	Maximum Threat WF = 10	Probability WF = 7	Total Score
FLOOD	WF X SR Subscore	2 X 10 = 20	5 X 9 = 45	10 X 7 = 70	7 X 10 = 70	**205**
WILDFIRE	WF X SR Subscore	2 X 10 = 20	5 X 8 = 40	10 X 5 = 50	7 X 10 = 70	**180**
EARTHQUAKE	WF X SR Subscore	2 X 2 = 4	5 X 10 = 50	10 X 10 = 100	7 X 3 = 21	**175**
WINDSTORM	WF X SR Subscore	2 X 8 = 16	5 X 6 = 30	10 X 6 = 60	7 X 8 = 56	**162**
HAZMAT	WF X SR Subscore	2 X 7 = 14	5 X 5 = 25	10 X 6 = 60	7 X 6 = 42	**141**
LANDSLIDE	WF X SR Subscore	2 X 10 = 20	5 X 4 = 20	10 X 3 = 30	7 X 9 = 63	**133**
DAM FAILURE	WF X SR Subscore	2 X 1 = 2	5 X 5 = 25	10 X 2 = 20	7 X 2 = 14	**61**

SEVERITY RATINGS (to be applied to the four categories)

LOW = 1 - 3 points
MEDIUM = 4 - 7 points
HIGH = 8 - 10 points

WF = weight factor
SR = severity rating

The following categories are used in developing the scores for this analysis:

HISTORY (record of previous occurrences)

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

VULNERABILITY (percentage of population and property likely to be affected)

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

MAX. THREAT (percentage of population and property that could be impacted under a worst-case scenario)

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

PROBABILITY (the likelihood of occurrence within a specified period of time)

LOW one incident likely within a 75 to 100 year period
MODERATE one incident likely within a 35 to 75 year period
HIGH one incident likely within a 10 to 35 year period

SAMPLE NARRATIVE

The following are samples of narrative copied from various hazard analysis documents from around the state. They are in order alphabetically by jurisdiction name (date of analysis).

Benton County (June 2002)

Earthquake (195 points)

An earthquake is the result of tectonic movement within the earth's crust. These changes are manifested as localized ground shaking and/or soil liquefaction. After the initial seismic event, tremors and aftershocks can occur for an extended period of time resulting in additional structural damage to buildings and public facilities. The largest earthquake in Oregon occurred in 1872 in the North Cascades. This earthquake had an estimated magnitude of 7.4 and was followed by many aftershocks. More recently, in 1993, a magnitude 5.7 earthquake caused significant damage to a bridge and numerous unreinforced masonry structures in Clackamas, Marion, and Yamhill counties. There is limited recorded data of earthquake activity in Benton County. However, a major fault line (the Corvallis Fault) runs through the northeast corner of the county near the major concentrations of population. While there has been no recorded activity on the fault, recent seismic events in Scott's Mills (March 1993) and Klamath County (September 1993) seem to indicate an increase in seismic activity in the state. Subduction zone earthquakes must also be considered a threat to Benton County residents. In the Pacific Northwest, oceanic crust is being pushed beneath the North American continent along a major boundary parallel to the coast of Washington and Oregon. This boundary, called the "Cascadia Subduction Zone," lies about 50 miles offshore and extends from the middle of Vancouver Island in British Columbia past Washington and Oregon to Northern California. Geologic evidence shows that the Cascadia Subduction Zone has generated great earthquakes (magnitude 8 or greater), and the most recent was about 300 years ago. If a major earthquake were to occur, there would be no warning and the region-wide impact is likely to be quite severe. Extensive damage to private and public facilities could be expected along with mass casualties and disruption of transportation routes, communications, and public utilities. In addition, an earthquake may cause other hazards such as fires, floods associated with dam failures, and hazardous materials spills.

Clatsop County (December 2002)

Hazardous Materials Incident (215 points – fixed site, 165 points – transportation)

This hazard involves an accidental release or spillage of materials that have a detrimental impact on life, the environment, and/or property. This occurrence may be associated with long-term contamination or toxicity to the affected area. A hazardous material incident is most commonly associated with a transportation accident (highway, rail, or waterway), but an incident may also be associated with a fixed facility. Clatsop County has, in addition to some locations where hazardous materials are manufactured or used, areas where those materials are stored, such as distributor petroleum product tank farms. The seafood processing industry uses large quantities of anhydrous ammonia that could become a hazard in the event of a fire or a seismic event. Cargo ship traffic represents a potential incident of horrific proportions.

Deschutes County (February 2001)

Winter Storm (snow/ice/extreme cold - 205 points)

History: With the Cascade Mountain range bordering the western half of Deschutes County, inclement weather is always a possibility, especially during the winter months. While annual snowstorms rarely pose more than an inconvenience, there are occasionally severe storms, which can cause area-wide power disruptions. In addition, heavy snowfall can curtail transportation not only within the county, but also on routes leading into and out of the county.

Deschutes County often goes through a drought cycle, which can last three to four years, resulting in lower than average snowpacks. Following these, several years of above average precipitation during the winter months usually occurs. Such was the case during the winters of 1995-96 and 1996-97. Numerous large storms passed through the area, and snowfall at higher elevations was significant. Fortunately, existing services were able to cope with weather related problems in lower, more densely populated areas.

Vulnerability: Because of the diverse terrain within the county, it is difficult to estimate the impact on the population. However, if a major storm, with snow levels down to 2000 feet materialized, it is possible that up to 60% of the county's population could be affected. That same type storm could affect up to 50% of the county itself.

Maximum threat: Based on a worst-case scenario, up to 90% of the county's population could experience some difficulty in the form of power outages, inability to drive, etc. Up to 70% of the county itself could be affected.

Probability: There have been a number of major winter storms over the past ten years, and there is no reason to believe that the possibility will decrease in the future. Since weather in Central Oregon can be quite diverse, accurate forecasting and early warning of impending storms remain a high priority.

Josephine County (June 2003)

Wildfire (201 points)

A considerable threat in the county is presented by the large amount of public and private forestland managed by state, federal and private entities. More than half of the county contains woodlands, much of which is used for recreation, agriculture, and timber industries. In addition, the county faces the threat of urban interface fires as communities continue their expansion into the wildland.

Umatilla County (December 2003)

Geographic Description[3]

Umatilla County is located along the Columbia River in northeastern Oregon. It has an area of 3,231 square miles with a population of 70,548, according to the U.S. Census 2000 nighttime population data. Twelve incorporated cities lie within the county, in which about two-thirds of the total county population resides. Approximately 12% of the county land area is under state or federal ownership. From an elevation of 296 feet at Umatilla, the county rises to an elevation greater than 5,800 feet in the Blue Mountains on its eastern boundary. Umatilla County is bordered by the Columbia River and Walla Walla County, Washington, to the north, Morrow County to the west, Grant County to the south, and Union and Wallowa counties to the east. Umatilla County is bisected by Interstate 84, west to east, and by U.S. Highway 395, north to south, Interstate 82 passes through the county near Umatilla and Hermiston. The Union Pacific Railroad travels east and west the length of the county.

[3] This is usually the lead piece of local hazard analyses.