Linn-Benton Community College

NATURAL HAZARDS MITIGATION PLAN

2024 Update is underway, and your input is needed!

RISK ASSESSMENT is now available.

Please provide comments on the feedback form at Natural Hazard Mitigation Plan | LBCC (linnbenton.edu) by January 19, 2024

Questions?

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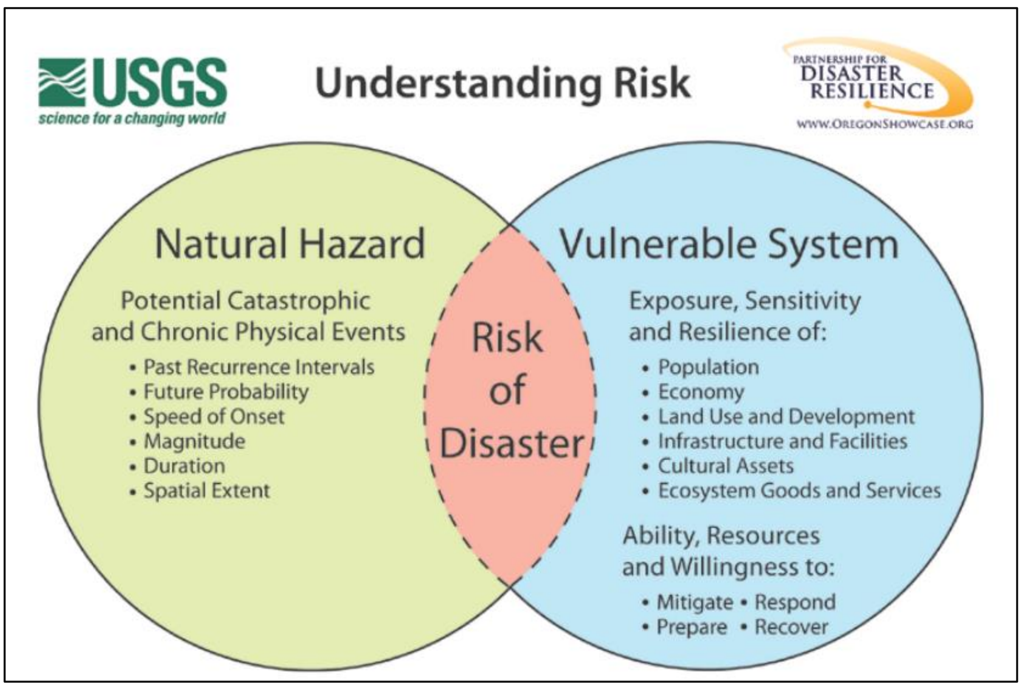
SECTION III: ALL-HAZARD RISK ASSESSMENT

This section of the NHMP addresses 44 CFR 201.6(b)(2) - Risk Assessment. Assessing natural hazard risk begins with the identification of hazards that can impact the college. Included in the hazard assessment is an evaluation of potential hazard impacts—type, location, extent, etc. The second step is the identification of important college assets and system vulnerabilities. Example vulnerabilities include student populations, community-based service programs, campus buildings, roads, cultural assets, and utility infrastructure. The last step is to evaluate the extent to which the identified hazards overlap with, or have an impact on, the important assets identified by the college.

The information presented below in Figure 1, along with hazard-specific information presented in the subsequent Hazard Profiles and college characteristics presented in the College Profile (Section II), will be used as the institution-level rationale for the risk-reduction actions identified in the Mitigation Strategy (Section IV). The goal of hazard mitigation is to reduce the area where hazards and vulnerable systems overlap.

Figure 1. Understanding Risk

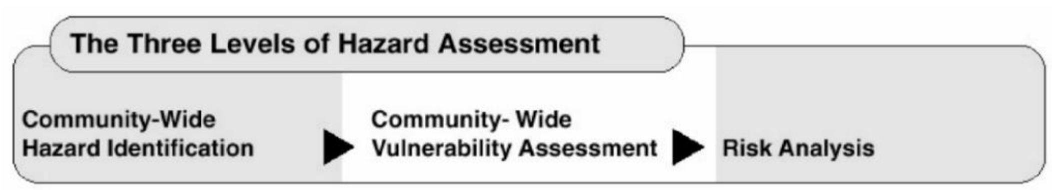


Source: Oregon Partnership for Disaster Resilience, 2012

WHAT IS A RISK ASSESSMENT?

According to the FEMA Local Mitigation Planning Handbook, risk assessment is a product or process that collects information and assigns values to risks for the purpose of informing priorities, developing, or comparing courses of action, and informing decision making. Conducting a risk 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. A risk assessment consists of three primary levels: hazard identification, vulnerability assessment, and risk analysis. For the purposes of this plan, “community-wide” refers to the college, including staff, faculty, students, and structures and campuses.

Figure 2. Three Phases of a Hazard Assessment



Source: Planning for Natural Hazards: Oregon Technical Resource Guide, 1998.

- **First Phase:** This phase aims to identify hazards that can impact the jurisdiction. This includes an evaluation of potential hazard impacts – characteristic, location and extent, history of previous occurrences, and probability of occurrence. The outputs from this phase can also be used for land use planning, management, and regulation; public awareness; defining areas for further study; and identifying properties or structures appropriate for acquisition or relocation. (Burby, 1998)
- **Second Phase:** This phase identifies important community assets and system vulnerabilities. Example vulnerabilities include people, infrastructure, historic places, and essential operations and industries. It will attempt to determine the extent to which a hazard will affect various kinds of property, resources, and population groups. By utilizing this step, there may be justification to revise building codes or development regulations, property acquisition programs, policies concerning critical facilities and infrastructure, taxation strategies for mitigating risk, and educational programs for vulnerable community members. (Burby, 1998)
- **Third Phase:** This phase evaluates the extent to which identified hazards coincide with or threaten essential and critical community assets. The risk analysis involves estimating the damage, injuries, and costs likely to be incurred in a geographical area in the event of a natural hazard. Risk has two measurable components: (1) the magnitude of harm that may result because of a natural hazard, which is defined through the vulnerability assessment, and (2) the likelihood or probability that the hazard will occur.

It is recommended that the three phases of developing a risk assessment should be conducted sequentially as each phase builds upon the information generated during the previous phase. However, data collection for a risk assessment does not necessarily have to occur sequentially.

RISK ASSESSMENT COMPONENTS

HAZARD IDENTIFICATION

LBCC identifies eight natural hazards that could have an impact on the college. These hazards include air quality, earthquake, extreme heat, flood, volcanic event, wildfire, windstorm, and winter storm . Table 1 categorizes the hazards identified by LBCC and compares them to the regional hazards identified in the NHMPs for Linn County, Benton County and the State of Oregon's NHMP for the mid-southern Willamette Valley region, which includes LBCC. Due to the topography surrounding LBCC campus locations, landslide is not a significant threat to campus assets. Similarly, the committee did not feel that drought posed a significant threat to specific campus populations, assets, or services.

Table 1. Regional NHMP Profiled Natural Hazards

LBCC NHMP	Benton County NHMP	Linn County NHMP	Region 3: Mid-Southern Willamette Valley Hazards — Oregon NHMP
Air Quality	-	-	-
-	Dam Failure	-	-
-	Drought	Drought	Drought
Earthquake	Earthquake	Earthquake	Earthquake
	Epidemic/Pandemic	-	-
Extreme Heat	Extreme Heat	-	Extreme Heat
Flood	Flood	Flood	Flood
-	Landslide	Landslide	Landslide
Volcanic Event	Volcanic Event	Volcanic Event	Volcanic Event
Wildfire	Wildfire	Wildfire	Wildfire
Windstorm	Windstorm	Windstorm	Windstorms
Winter Storm	Winter Storm	Winter Storm	Winter Storms

Source: LBCC NHMP Steering Committee, 2023; Benton County Multi-Jurisdictional Natural Hazards Mitigation Plan, 2023; Linn County Natural Hazard Mitigation Plan, 2017; State of Oregon Natural Hazard Mitigation Plan, Region 3: Mid-Southern Willamette Valley, September 2020

PROBABILITY AND VULNERABILITY ANALYSIS

Probability assesses the likelihood that a hazard event will take place in the future. Table 2 presents the probability scores for each of the natural hazards that LBCC is susceptible to and compares them to the regional hazard probability identified in the NHMPs for Linn County, Benton County and the State of Oregon's NHMP for the mid-southern Willamette Valley region, which includes LBCC.

Table 2. LBCC and Regional NHMP Probability

Hazard Probability	LBCC	Linn County	Benton County	Region 3 - Benton	Region 3 - Linn
Flood	High	High	High	Very High	Very High
Earthquake	High	High	Moderate	High	High
Air Quality	High	-	-	-	-
Extreme Heat	High	-	High	Moderate	Moderate
Windstorm	High	High	High	High	High
Winter Storm	High	High	High	Moderate	High
Wildfire	High	High	High	Low	High
Volcano	Low	Low	Moderate	Low	Moderate

Source: LBCC NHMP Steering Committee, 2023; Benton County Multi-Jurisdictional Natural Hazards Mitigation Plan, 2023; Linn County Natural Hazard Mitigation Plan, 2017; State of Oregon Natural Hazard Mitigation Plan, Region 3: Mid-Southern Willamette Valley, September 2020

Vulnerability assesses the extent to which people are susceptible to injury or other impacts resulting from a hazard. It also includes assessing the exposure of the built environment or other community assets (social, environmental, economic, etc.) to hazards. Assessing the exposure of community assets to hazards is critical to estimating the degree of risk a community has to each hazard. Table 3 presents the vulnerability scores for each of the natural hazards that LBCC is susceptible to and compares them to the regional hazard probability identified in the NHMPs for Linn County, Benton County and the State of Oregon's NHMP for the mid-southern Willamette Valley region, which includes LBCC.

Table 3. LBCC and Regional NHMP Vulnerability

Hazard Vulnerability	LBCC	Linn County	Benton County	Region 3 - Benton	Region 3 - Linn
Flood	High	Moderate	Moderate	Low	High
Earthquake	Moderate	High	High	Low	Very High
Air Quality	Moderate	-	-	-	-
Extreme Heat	Moderate	-	Moderate	Moderate	High
Windstorm	Moderate	Moderate	Moderate	Moderate	Moderate
Winter Storm	Moderate	High	Moderate	Moderate	High
Wildfire	Low	Moderate	High	Very Low	Moderate
Volcano	Low	Moderate	Moderate	Low	High

Source: LBCC NHMP Steering Committee, 2023; Benton County Multi-Jurisdictional Natural Hazards Mitigation Plan, 2023; Linn County Natural Hazard Mitigation Plan, 2017; State of Oregon Natural Hazard Mitigation Plan, Region 3: Mid-Southern Willamette Valley, September 2020

The hazard assessment also involves a **vulnerability assessment**, which is derived by integrating information from the hazard profiles with an inventory of existing property and populations exposed to the hazard. As a matter of priority, special consideration is given to populations with characteristics of social vulnerability (described in Section 2, College Profile), given their disproportionate vulnerability to the effects of these natural hazards. Accordingly, it attempts to estimate how different types of property and population groups will be impacted by the hazard.

RISK ASSESSMENT AND ANALYSIS

The third phase, **risk assessment**, involves estimating the damage, injuries, and costs likely to be incurred in a geographical area due to a natural hazard, either during or immediately after the event, or over a prolonged period of time. Risk can be determined by assessing two measurable components: (1) the magnitude of the harm that may result due to a natural hazard (which is defined through the vulnerability assessment), and (2) the likelihood or probability of the hazard occurring.

The following risk analysis draws upon **six** sources: *2024 Benton County Multi-Jurisdictional NHMP, 2017 Linn County Multi-Jurisdictional NHMP*[1]*,* Hazard Vulnerability Assessment (HVA) exercise conducted with LBCC NHMP Steering Committee, the DOGAMI Risk Report of Benton County and Linn County, the OCCRI Future Climate Projection Report of Benton County and Linn County, and the list of critical facilities and infrastructure as compiled from LBCC.

NHMP PLANNING AREA

This NHMP assesses each of the Linn-Benton Community College campuses, which include the Albany Campus (the main campus), the Benton Center and Chinook Hall (both in Corvallis), and the Healthcare Occupations Center and Advanced Transportation Technology & Heavy Equipment Centers (both in Lebanon).

HAZARD VULNERABILITY ASSESSMENT

The probability and vulnerability assessment summaries provided above in Table 2 and Table 3 are derived from a commonly employed methodology developed by FEMA in 1983 and has been adjusted by the Oregon Department of Emergency Department (OEM) for the state of Oregon.

The risk assessment is conducted by first identifying the community's relevant hazards, then scoring each one in four categories: history, probability, vulnerability, and maximum threat. Total scores range from 24 (low) to 240 (high). This method provides local jurisdictions with a sense of hazard priorities, or relative risk. It is also intended to provide comparison of the same hazard between local jurisdictions statewide.

Severity scores assigned to each category are based on the following:

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[1] Linn County and Benton County were updating their NHMP concurrent with LBCC. Therefore, LBCC obtained the best available data at the time from county's previous NHMP or data collected for the updated NHMP.

- LOW = assign a score between 1 to 3 points
- MODERATE = assign a score between 4 to 7 points
- HIGH = assign a score between 8 to 10 points

HISTORY

History is the record of previous occurrences of the identified natural hazards. Events to include in assessing history of a hazard in your jurisdiction are events for which the following types of activities were required: the Emergency Operations Center (EOC) was activated; three or more EOP functions were implemented; extraordinary multi-jurisdictional response was required; and/or local or tribal emergency was declared. Severity scores are assigned based on the follow criteria:

- LOW = 0-1 event past 100 years
- MODERATE = 2-3 events past 100 years
- HIGH = 4 + events past 100 years

PROBABILITY

Probability is the likelihood of future occurrences of the natural hazard within a specified period of time. LBCC evaluated the best available probability data to develop the probability scores presented below. Severity scores are assigned based on the follow criteria:

- LOW = one incident likely within 75 – 100 years,
- MODERATE = one incident likely within 35-75 years,
- HIGH = one incident likely within 10-35 years.

VULNERABILITY

Vulnerability is the percentage of population and property likely to be affected under an average occurrence of the hazard. Severity scores are assigned based on the follow criteria:

- LOW = < 1% affected, scores between 1 and 3 points
- MODERATE = 1 – 10% affected, scores between 4 and 7 points
- HIGH = > 10% affected, scores between 8 and 10 points

MAXIMUM THREAT

Maximum threat is the highest percentage of population and property that could be impacted under a worst-case scenario. Severity scores are assigned based on the follow criteria:

- LOW = < 5% affected
- MODERATE = 5 – 25% affected
- HIGH = > 25% affected

While this methodology is consistent statewide, the reported raw scores for each county are based on partially subjective rankings for each hazard. Because the rankings are used to describe the relative risk of a hazard within a county, and because each county conducted the analysis with a different team of people using slightly different assumptions, comparisons between local risk assessments must be treated with consideration and caution.

Table 4 presents the updated hazard analysis matrix for LBCC. The hazards are listed in rank order from high to low. The table shows that hazard scores are influenced by each of the four categories combined, resulting in flood, earthquake, and poor air quality rank as the top hazard threats to LBCC.

Table 4. Hazard Analysis Matrix

LBCC Hazards	History	Vulnerability	Maximum Threat	Probability	Total Threat Score	Hazard Ranking
Flood	16	40	100	63	219	**1**
Earthquake	18	35	100	63	216	**2**
Air Quality	20	25	100	70	215	**3**
Extreme Heat	20	20	100	70	210	4
Windstorm	20	25	90	70	205	5
Winter Storm	20	20	90	70	200	6
Wildfire	4	10	80	70	164	7
Volcano	2	10	80	7	99	8

HAZARD PROFILES

The following subsections describe relevant information for each hazard. For additional background on the hazards, vulnerabilities and general risk assessment information for hazards in **Mid/Southern Willamette Valley** Oregon (Region 3), refer to the State of Oregon NHMP,Region 3: Mid/Southern Willamette Valley.

AIR QUALITY

CHARACTERISTICS

Communities across Oregon have begun to recognize the impacts of inversion layers trapping particulates in smoke from wood stove, prescribed fire, wildfire, and field burning as a natural hazard. In addition, LBCC has begun to recognize the impacts of reduced outdoor air quality with warmer temperatures and increase in the number and size of wildfires in the region.

The nature of air movement or stagnation in a valley causes inversion layers to form. At the valley floor daytime temperatures heat the air. In the evening, air further up the slope of the mountains cools faster than the air lower down the slope. Because cool air is slightly heavier than warm air, the cool air sinks into the valley which displaces the warm air above it to form a “lid.” If the weather creates stagnant conditions this inversion “lid” may persist trapping air pollutant discharges to create poor air quality.

The Oregon Climate Change Research Institute’s *Future Climate Projections Benton County, Oregon* report (Dalton et al., 2023) and *Future Climate Projections Linn County, Oregon* report (Dalton et al., 2023) discusses how fire seasons have increased in length over the past several decades, as well as increased in intensity and severity. Wildfires that have occurred in the western United States have created extensive plumes of smoke, which travel at high altitudes over long distances. This can affect air quality near and far from a wildfire site. The trend is expected to continue to grow as the effects of climate change grow, as does the population density in fire-risk zones increase.

Air quality can be affected by several types of pollutants including ozone, particulate matter, air toxics (such as benzene), greenhouse gases (such as carbon dioxide), and products of combustion (such as carbon monoxide, sulfur dioxide and NOx). Among these, particulate matter with particles 2.5 microns or smaller (PM2.5) is the pollutant of highest concern for LBCC.

Wildfires[2] tend to provide a wide-ranging source of smoke that can blanket large areas and be detrimental to the health of people, animals, and plants. Diesel emissions, often from vehicles on roads, also contribute to lower air quality. If a volcano[3] were to erupt, ashfall could inundate the surrounding areas sufficiently to impact transportation and cause widespread health concerns.

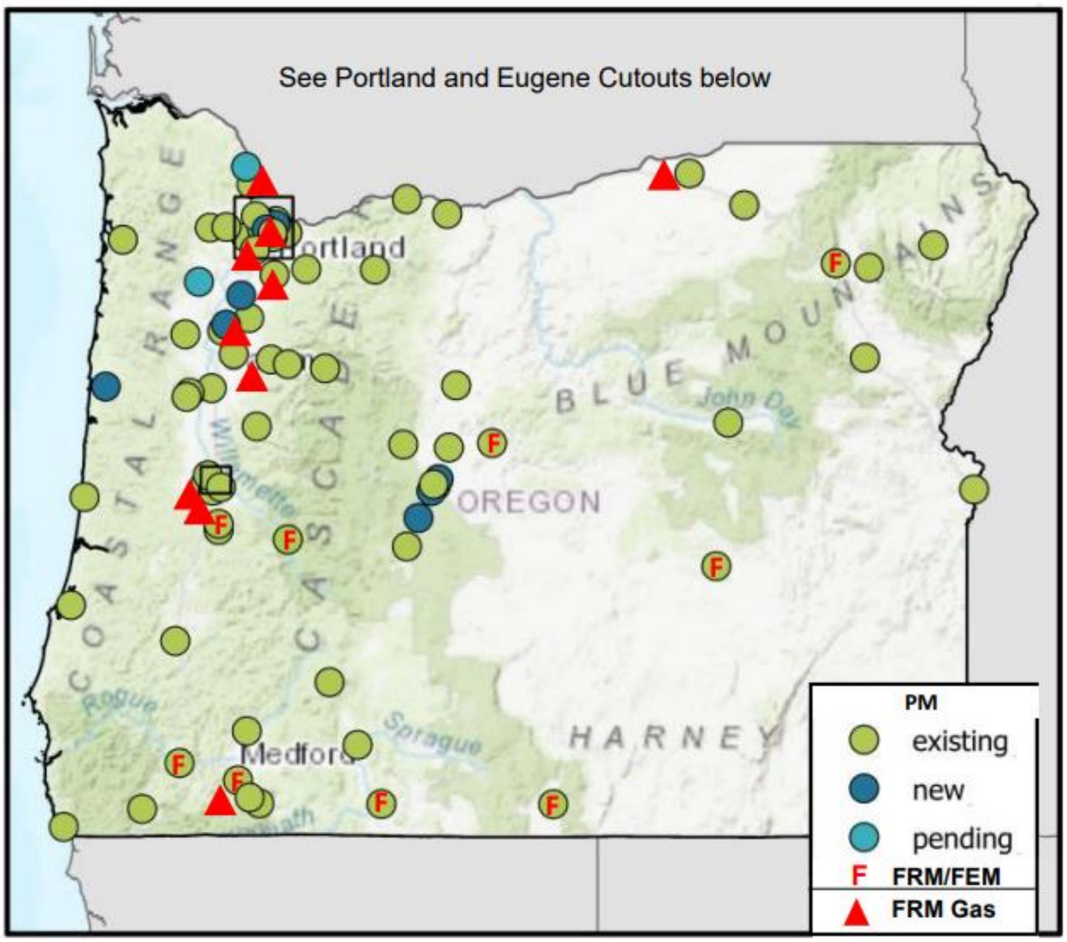
LOCATION AND EXTENT

According to the *2022 Oregon Annual Ambient Criteria Pollutant Air Monitoring Network Plan* issued by DEQ, air quality pollutants are currently monitored in Albany at the Calapooia School and at various locations in the Corvallis area including in North Corvallis and South Corvallis. Poor Air Quality has seasonality in that inversion layers tend to form from November to February. Once air temperatures

[2] See the Wildfire Hazard for more information about wildfire impacts.
[3] See the Volcano hazard for more information about volcano impacts.

warm the inversion layer conditions dissipate. During the summer months from June through August high pressure weather systems can remain in place for an extended period resulting in the accumulation of airborne particles in the lower levels of the atmosphere affecting the air quality. In addition, smoke from surrounding fires could impact Linn and Benton County and affect the air quality prompting Air Stagnation Advisories (Dalton et al., 2023). Figure 3 shows the 2022 Ambient Air Monitoring Network sites in Oregon. In addition, the figure shows the types of air quality monitoring station in and around Benton County and Linn County.

Figure 3. Oregon 2022 Ambient Air Monitoring Network (DEQ and LRAPA sites)



Source: Oregon Department of Environmental Quality, 2022
Note: Portland metro and Eugene metro cutouts are not shown here.

AIR QUALITY POLLUTANTS

Oregon DEQ monitors air quality pollutants. DEQ operates the ambient monitoring network for the entire state, except Lane County, which is operated by the Lane Regional Air Protection Authority (LRAPA). These air quality monitoring networks measure ambient concentrations of the criteria pollutants – ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter, and lead. Air quality pollutants are currently monitored at various locations in Corvallis and Albany area.

OZONE

DEQ's Oregon Air Quality Monitoring Annual Report: 2020 (2021) describes Ozone as secondary pollutant formed when there are elevated levels of nitrogen dioxide and volatile organic compounds that undergo chemical reactions in high temperatures, and sunlight. In Oregon, elevated ozone occurs in the summer, and can also be formed by human-caused pollution, such as fossil fuel combustion and also by naturally caused pollution from wildfire smoke, which contains NO2 and VOCs.

Data with wildfire contributions are included because it is very difficult to determine if the ozone would have exceeded the NAAQS without the smoke from wildfires. Additionally, it is noted that the wildfire smoke in 2018 and 2020 contributed to the elevated ozone levels, which likely caused Portland and Medford to violate the NAAQS. However, it is very difficult to determine what the ozone level would have been since high levels typically occur in the summer months, which is also during wildfire season.

The 2022 Oregon Annual Ambient Criteria Pollutant Air Monitoring Network Plan describes the 10 DEQ and LRAPA monitoring sites for ozone. The nearest monitoring stations are located in Eugene and Turner/Salem.

$PM_{2.5}$

Fine particulate matter ($PM_{2.5}$) is a concern due to smoke impacts from woodstoves, fireplaces and other wood burning appliances besides wildfire smoke in the summer. Other sources of $PM_{2.5}$ include open burning, prescribed burning, wildfires, smoke from industrial stacks, and some road dust from vehicle travel.

The Future Climate Projections report issued by OCCRI stated that with the increasing wildfires and $PM_{2.5}$ levels, there is a greater risk of wildfire smoke exposure through increasing frequency, length, and intensity of "smoke wave" days. "Smoke wave" days are two or more consecutive days with high levels of $PM_{2.5}$ from wildfires.

There are harmful effects from breathing particles measuring less than 10 microns in diameter (PM_{10}). Fine particle matter $PM_{2.5}$ may be responsible for the most significant health effects, like hospital admission, and respiratory illness. These particles can be inhaled deeply into the lungs where they enter the bloodstream or can remain for years. The health effects of particulate matter vary with the size, concentration, and chemical composition of the particle, according to the EPA.

CARBON MONOXIDE, SULFUR DIOXIDE, NITROGEN DIOXIDE

Carbon monoxide was above the standard in the Portland Metro area for three days during the wildfire impacts. Otherwise, for the rest of the year carbon monoxide, sulfur dioxide, and nitrogen dioxide [met] federal health standards. These pollutants, according to the *Oregon Air Quality Monitoring Annual Report: 2020* (2021), have been trending mostly downward for most locations over the last ten years.

AIR TOXICS

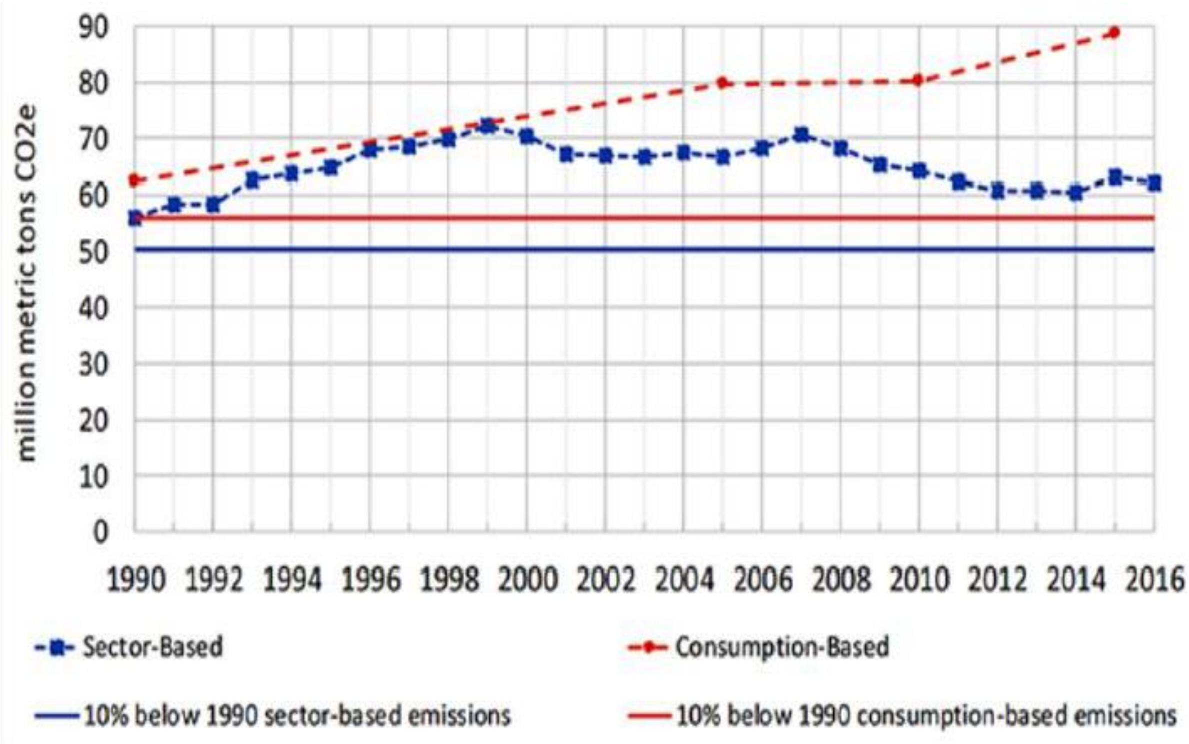
The *Oregon Air Quality Monitoring Annual Report: 2020* (2021) describes data for the toxics, or hazardous air pollutants, of concern: benzene, tetrachloroethylene, acetaldehyde, formaldehyde, naphthalene, arsenic, cadmium, chromium, lead, manganese, and nickel. According to the annual report, the values are compared to the Oregon ambient concentration health benchmarks. These benchmarks are the levels where people exposed for a lifetime have an additional one in a million risk of cancer or of experiencing non-cancer health effects. The information provided in the report is for neighborhood monitoring only and does not include monitoring next to industrial facilities. Information regarding monitoring next to industrial facilities is presented in separate reports issued by the Oregon Health Authority, specific to the monitoring project and facility.

GREENHOUSE GASES

Greenhouse gas emissions are produced directly from activities such as driving cars and heating homes. Also, greenhouse gas emissions are indirectly contributed by the purchasing of goods and foods that are manufactured in other states or counties, due to the excess energy and electricity required to transport the goods. Additional information about greenhouse gas emissions in Oregon are presented on DEQ's website at https://www.oregon.gov/deq/ghgp/Pages/GHG.aspx.

Figure 4 is excerpted from the *Oregon Air Quality Monitoring Annual Report: 2020* (2021) report and shows Oregon's greenhouse gas emissions from 1990 through 2016 by sector. Emissions from transportation and electricity use are Oregon's largest sources of greenhouse gas emissions, as shown in Figure **4** by the *Oregon Greenhouse Gas Sector-Based Inventory Data* (n.d.).

Figure 4. Oregon total greenhouse gas emissions by sector 1990-2016



Source: Oregon Department of Environmental Quality, 2021.

IDENTIFYING POOR AIR QUALITY

Air quality is determined by both measurements of specific poor air quality components (discussed above) and a general Air Quality Index (AQI).

The Air Quality Index (AQI) is a daily index of air quality that reports how clean the air is and provides information on potential health risks. Oregon's index is based on three pollutants regulated by the federal Clean Air Act: ground-level ozone, particle pollution, and nitrogen dioxide. The highest of the AQI values for the individual pollutants becomes the AQI value for that day. For example, if values are 90 for ozone and 88 for nitrogen dioxide, the AQI reported would be 90 for the pollutant ozone on that day. A rating of good, moderate, unhealthy for sensitive groups, unhealthy, very unhealthy, and hazardous are designated for the AQI providing a daily air quality rating (Table 5). The EPA provides all states with the AQI equation for national uniformity.

Table 5. Air Quality Index Ranges and Episode States for PM2.5 and ozone.

Air Quality Rating	Air Quality Index (AQI)	$PM_{2.5}$ 24-hour Average ($\mu g/m^3$)	Ozone 8-hour Average (ppm)
GOOD	0 - 50	0.0 - 12.0	0.000 - 0.054
MODERATE	51 - 100	12.1 - 35.4	0.055 - 0.070
UNHEALTHY FOR SENSITIVE GROUPS	101 - 150	35.5 - 55.4	0.071 - 0.085
UNHEALTHY	151 - 200	55.5 - 150.4	0.086 - 0.105
VERY UNHEALTHY	201 - 300	150.5 - 250.4	0.106 - 0.200
HAZARDOUS	>300	>250.5	>0.200

Source: Oregon Department of Environmental Quality, 2021

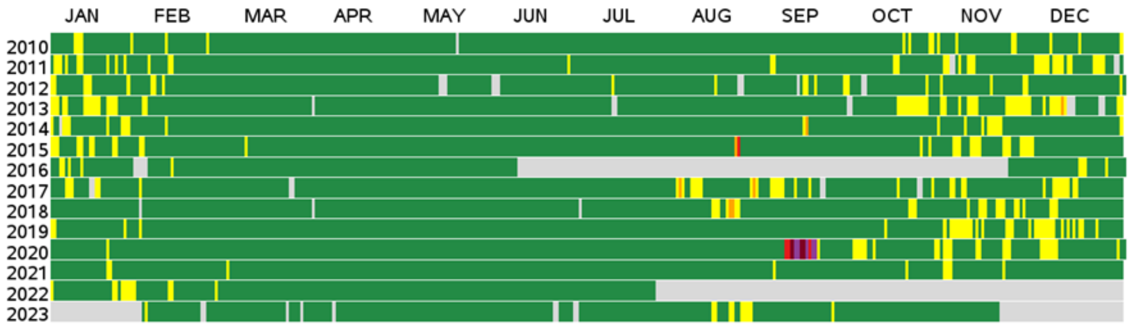
According to *Oregon Air Quality Monitoring Annual Report: 2020* (2021), the air pollutants of greatest concern in Oregon were the following:

- Fine particulate matter (mostly from combustion sources) known as PM2.5
- Air Toxics - pollutants that cause or may cause cancer or other serious health effects.
- Ground-level ozone, a component of smog.
- Greenhouse gas (GHG) emissions and global climate change. These are an overall issue across all of Oregon but of more concern in higher population density areas.

HISTORY

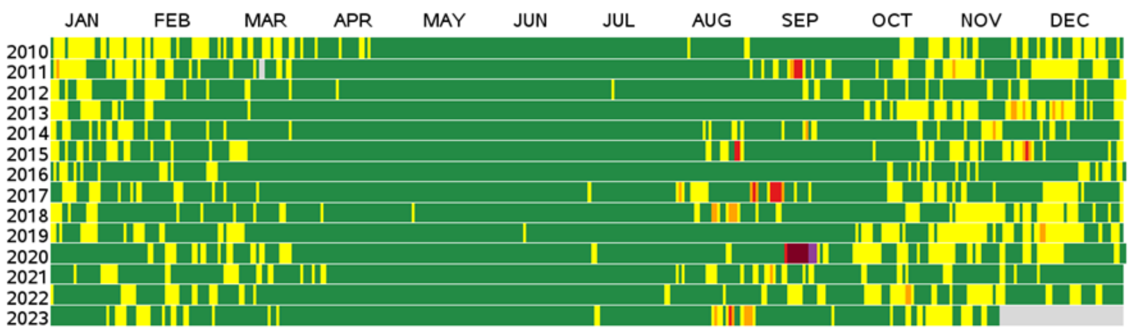
The data available to track poor air quality conditions in Benton County and Linn County are limited to three permanent monitoring stations measuring $PM_{2.5}$. Figure 5 and Figure 6 below both show a pattern of periods of the year where the likelihood of high levels of particulate matter of this diameter (2.5 microns) have been present at these stations. One example that can be seen to affect both regions is during the September 2020 wildfires, which is depicted in dark red, and during which both counties experienced extremely poor air quality.

Figure 5. Daily AQI Values, 2010 to 2023 for Benton County, OR



Source: U.S. Environmental Protection Agency, 2023.

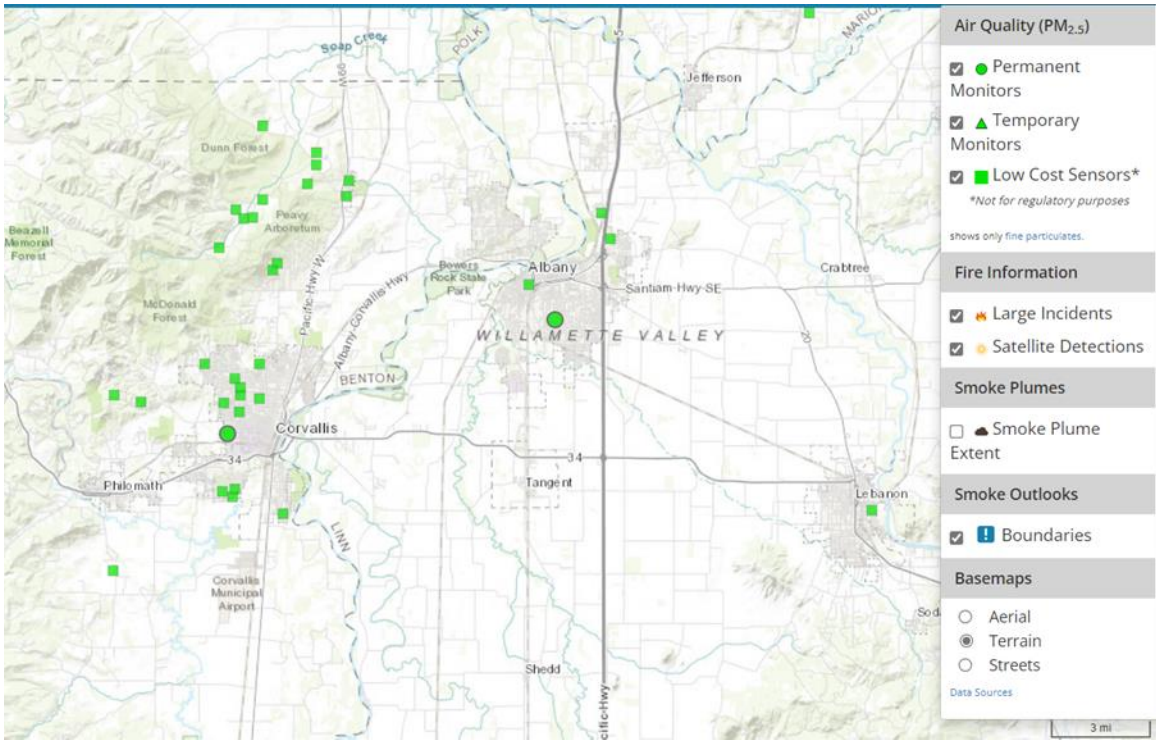
Figure 6. Daily AQI Values, 2010 to 2023 for Linn County, OR



Source: U.S. Environmental Protection Agency, 2023

The EPA AirNow website maintains a real time Fire and Smoke Map for monitoring air quality and provides a tool for NHMP plan holders to use when using the plan. Figure 7 shows locations of both regulatory and low-cost sensors not valid for regulatory purposes but represented on the map in the interest of public health.

Figure 7. Air Quality Monitoring Station Types



Source: U.S. Environmental Protection Agency, 2023

The determination of the severity of poor air quality and collecting data demonstrating the problem may provide support for mitigation actions aimed at managing prescribed burning, reduction of the risk of high intensity wildfire, and support for mitigation actions aimed at providing relief for vulnerable people during poor air quality conditions. The EPA Ambient Monitoring Technology Information Center (AMTIC) provides information on monitoring programs and methods, quality assurance and control procedures, and federal regulations.

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research for LBCC, the NHMP Steering Committee assessed the **probability of experiencing locally poor air quality as "High,"** meaning one incident is likely within a 10 to 35-year period.

As previously noted, communities across Oregon have begun to recognize the impacts of inversion layers trapping particulates in smoke from prescribed fire, wildfire, and field burning as a natural hazard. In addition, it is important to recognize the impacts of reduced outdoor air quality with warmer temperatures, in which warmer temperatures may increase ground-level ozone concentrations and increase in the number and size of wildfires in the region.

Depending upon climate conditions, air stagnation can be infrequent or numerous in any given year, which can have a potential impact to air quality levels for both $PM_{2.5}$ and ozone in the area. Prevailing wind direction and strength can influence the location and extent of the air quality impacts. The probability of air quality at one level or another varies, as air quality is a range based on multiple factors such as those measured for carbon monoxide, particulate matter (PM_{10} and $PM_{2.5}$), ozone, and others described above.

The sources of air pollution in the region include prescribed fire, wildfire, and field burning, industrial, and motor vehicle emissions. Concerns for air quality arise when smoke from regional wildfires either blows through the Willamette Valley or becomes trapped during inversions. See the Wildfire Hazard for more information about wildfire impacts. In addition, climate change has a relationship with natural hazards, discussed below.

VULNERABILITY ASSESSMENT

Based on the available data and research for LBCC, the NHMP Steering Committee assessed **the vulnerability of the campus to air quality hazards as "Moderate",** meaning between 1 - 10% of the campus's population or property would be affected by a major air quality emergency or disaster.

A climate-related driver of health is air quality, including pollen, wildfire smoke, smog, and ozone. Poor air quality puts the health of all people at risk. However, people experience the impacts differently. According to OCCRI, *Fifth Oregon Climate Assessment* (2021), inequities and unequal investments in social determinants of health are contributing stress factors and include housing, education, income, race, gender, wealth, transportation access, food security, income security, access to health care. The effects of poor air quality are long-term, chronic, and often difficult to trace. People most at risk tend to be the elderly, very young children, and people with pre-existing respiratory problems. Furthermore, people of color, people with low incomes, unhoused populations, agricultural workers, first responders, and rescue workers are those most susceptible to wildfire smoke exposure (Rudolph et al. 2018). It has been shown that hospitalizations in Oregon due to asthma attacks disproportionately affect Black, Pacific Islander, and Indigenous people as compared to other racial or ethnic groups (OHA 2018a). Exposure to smoke compounds this existing disparity.

Particulate matter is also known as particular pollution; it is a complex mixture of extremely small particles and liquid droplets that get into the air. Once inhaled, these particles can affect the heart and lungs, and cause serious health effects, according to EPA. The size of particles is directly linked to their potential for causing health problems. Small particles less than 10 micrometers in diameter pose the greatest problems, because they can get deep into lungs and the bloodstream. Exposure to such particles can affect both the lungs and heart.

Numerous scientific studies, according to the EPA's *Particulate Matter (PM) Pollution*, have linked particle pollution exposure to problems, including:

- premature death in people with heart or lung disease,
- nonfatal heart attacks,
- irregular heartbeat,
- aggravated asthma,
- decreased lung function, and
- increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

FUTURE CLIMATE VARIABILITY[4]

Both OCCRI *Future Climate Projections Reports* for Benton County (Dalton et al., 2023) and Linn County (Dalton et al., 2023) indicate that future climate projections are for reduced outdoor air quality. Warmer temperatures may increase ground-level ozone concentrations, as well as the rise in the number and size of wildfires may increase concentrations of smoke and particulate matter. In Benton County, the number of “smoke wave” days is projected to increase by 8% and the intensity of those days is projected to increase by 80%, while in Linn County, the number of “smoke wave” days is projected to increase by 13% and the intensity of those days is projected to increase by 88%.

In addition, OCCRI’s report indicates that plants are responding to changes in climate and atmospheric concentrations of carbon dioxide by producing more pollen, and producing pollen earlier in spring, for longer periods of time. In the conterminous United States, pollen seasons increased by about 20 days and pollen concentration increased by 21% from 1990 through 2018. Such poor air quality is expected to exacerbate allergy and asthma conditions and increase the incidence of respiratory and cardiovascular illnesses and death.

[4] OCCRI, “*Future Climate Projections Benton County, Oregon*”, 2023; OCCRI, “*Future Climate Projections Linn County, Oregon*”, 2023

EARTHQUAKE

CHARACTERISTICS

An earthquake is a shaking of the earth's surface by energy waves emitted by movement under the earth's surface, such as the slipping tectonic plates suddenly overcoming friction with one another underneath the earth's surface or from the rupture of fault lines.

Due to the geographic position of Benton and Linn County and Oregon, it is susceptible to earthquakes from four primary sources: (a) the off-shore Cascadia Subduction Zone (CSZ), (b) deep intra-plate events within the subducting Juan de Fuca plate, (c) shallow crustal events within the North America Plate, and (d) earthquakes associated with renewed volcanic activity.

CRUSTAL FAULT EARTHQUAKES

Crustal fault earthquakes are the most common types of earthquakes and occur at relatively shallow depths of six to twelve miles below the surface. While most crustal fault earthquakes are smaller than magnitude 4.0 and generally create little or no damage, they can produce earthquakes of magnitudes 7.0 and higher and cause extensive damage. The Mount Angel Fault, a crustal fault located within the United States, produced a 5.7 magnitude quake in 1993 (Wong et al., 1995).

The western part of Oregon is underlain by a large and complex system of faults (e.g. Portland Hills) that can produce damaging earthquakes. There is a direct relationship between a fault's length and its ability to generate damaging ground motions. Smaller nearby faults produce lower magnitude events, but ground shaking can be strong, and damage can be high because of the fault's proximity. Earthquakes can trigger other geologic and soils failures that contribute to damage.

DEEP INTRAPLATE EARTHQUAKES

Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach magnitude 7.5 (Wong et al., 1995). A Washington State earthquake on February 28, 2001, was a deep intraplate earthquake. It produced a rolling motion that was felt from Vancouver, British Columbia to Coos Bay, Oregon and east to Salt Lake City, Utah (Hill, 2002). In 1965, a magnitude 6.5 intraplate earthquake centered south of Seattle-Tacoma International Airport caused seven deaths.

SUBDUCTION ZONE EARTHQUAKES

Pacific Northwest is located at a convergent plate boundary, where the Juan De Fuca and North American tectonic plates meet, creating what is known as the CSZ, which extends from British Columbia to northern California. As the Juan de Fuca plate moves, it is shoved underneath the

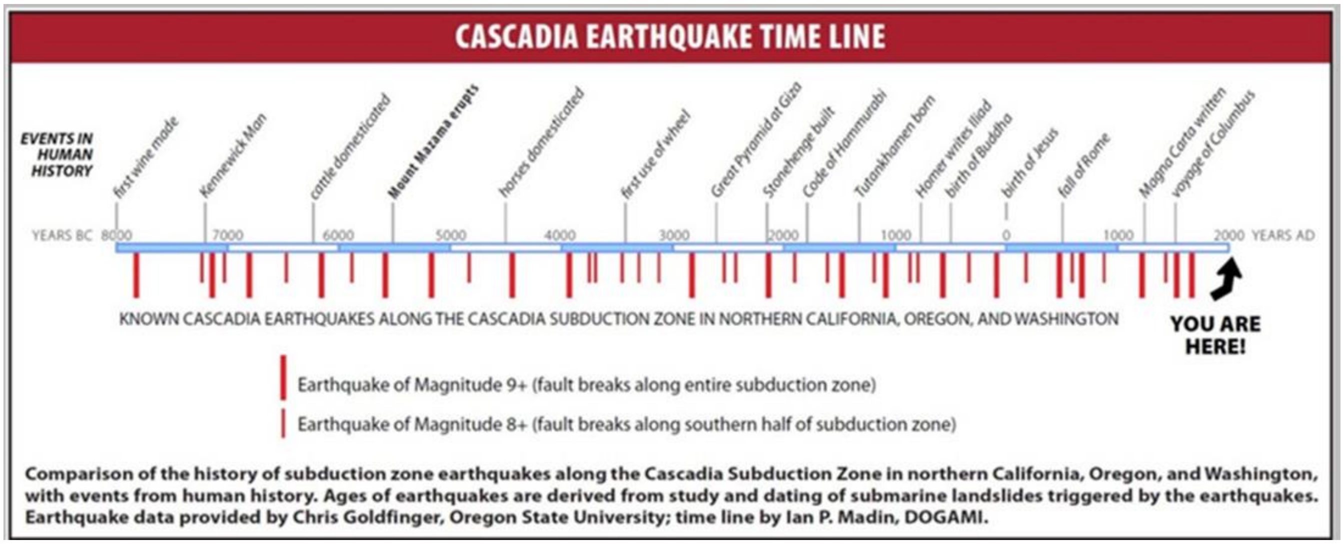
North American plate, as can be seen in Figure 8. As the two plates converge, currently at a rate of about 1 – 2 inches per year, pressure is built up, and once fault's frictional strength is exceeded, the plates slip past each other along the fault in a "megathrust" earthquake, which causes a CSZ earthquake. Subduction zones similar to the CSZ have produced earthquakes with magnitudes of 8 or larger. Historic subduction zone earthquakes include the 1960 Chile (magnitude 9.5), the 1964 southern Alaska (magnitude 9.2), and the 2011 Japan (magnitude 9.0) earthquakes.

Figure 8. Cross Section of Cascadia Subduction Zone

Source: Washington State Department of Ecology

Geologic evidence shows that the CSZ has generated significant earthquakes, most recently about 300 years ago. It is generally accepted to have been a magnitude 9 or greater. The average recurrence interval of a CSZ event is approximately 500 years, with gaps between events as small as 200 years and as large as 1,000 years, which can be seen in **Error! Reference source not found..** Such earthquakes cause significant damage to the coastal area of Oregon as well as inland areas in western Oregon. Shaking from a large CSZ earthquake could last up to five minutes.

Figure 9. Timeline of Identified Ruptures of the Cascadia Subduction Zone in the past 10,000 Years



Source: Yu et al., 2014

A CSZ earthquake is the most likely to occur, and also most likely to be the most damaging across all of Linn and Benton County of the four types of earthquakes possible within our area, even though more shallow and highly localized crustal earthquake could still devastate the targeted community.

SUBDUCTION ZONE EARTHQUAKES

Some earthquakes are related to volcanoes. Most earthquakes occur along the edges of tectonic plates, where volcanoes also occur. Volcanic activity earthquakes are caused by the movement of magma.

Magma exerts pressure on the rocks until it cracks the rock. Then the magma squirts into the crack and starts building pressure again. Every time the rock cracks it makes a small earthquake. These earthquakes are usually too weak to be felt but can be detected and recorded by instrumentation.

LOCATION AND EXTENT

The extent of the earthquake hazard is measured in magnitude. As a result of an earthquake, several specific hazards related to earthquakes occur. These include ground shaking, landslides, liquefaction, and amplification. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Below is a list of earthquake related hazards that occur either during or in the aftermath of an earthquake event:

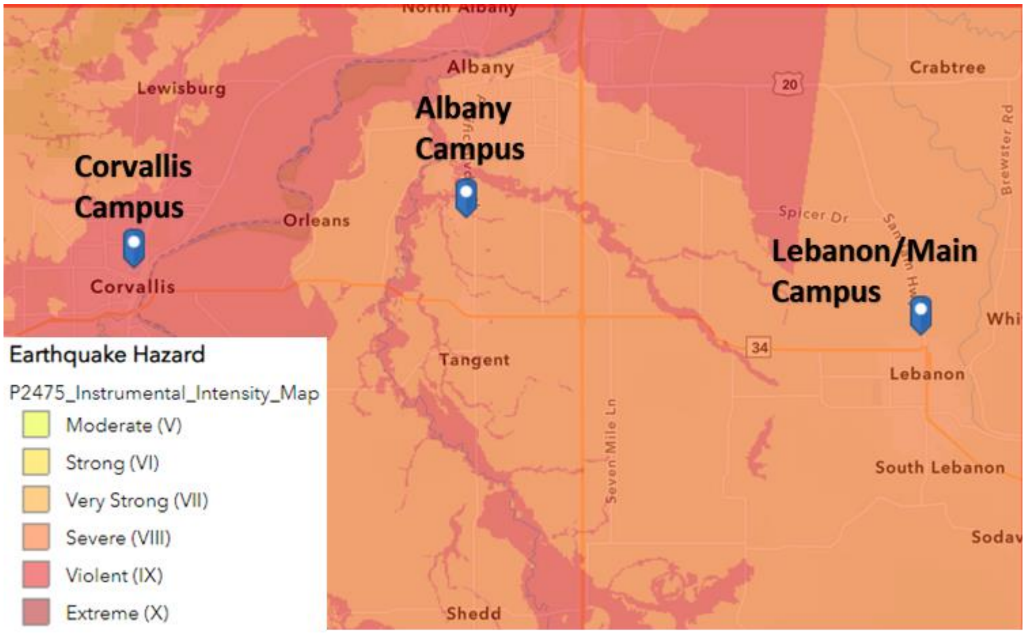
- **Ground Shaking:** When an earthquake occurs, motion is generated on the earth's surface that is caused by seismic waves. It is the primary cause of earthquake damage, and depends on the strength of the earthquake magnitude, type of fault, and distance to epicenter.
- **Amplification:** Soil and soft sedimentary rocks on and near the earth's surface can increase the magnitude of a seismic wave generated by an earthquake due to the ground shaking. As such, structures developed on soft and unconsolidated soil face greater risk. This is particularly dangerous for areas that include deep sediment filled basins and on top of ridges.
- **Surface Faulting:** Surface faulting occur where planes or surfaces in Earth materials along which failure occurs. Such faults can be found deep within the earth or on the surface. Earthquakes occurring from deep lying faults usually create only ground shaking.
- **Earthquake-Induced Landslides**: Landslides that occur due to ground shaking from earthquakes. Many communities, especially those with steep slopes, face this risk.
- **Liquefaction:** When the ground shakes, wet granular soils are changed from a solid state to a liquid state, resulting in the loss of soil strength and its ability to support weight.

Within the LBCC main campus and satellite locations, specific buildings and structures on campus pose the most risk during an earthquake. Many of the structures on campus were built before the 1980s and thus are not seismically sound. A few buildings have been seismically retrofitted, but many need to undergo retrofitting to mitigate potential loss of life and structure damage. The extent of the damage to structures and harm to people will depend upon the type of earthquake, proximity to the epicenter, and the magnitude and duration of the event.

The severity of an earthquake is dependent upon a number of factors including: 1) the distance from the earthquake's epicenter); 2) the ability of the soil and rock to conduct the earthquake's seismic energy; 3) the degree (angle) of slope materials; 4) the composition of slope materials; 5) the magnitude of the earthquake; and 6) the type of earthquake.

Based on the Oregon Department of Geology and Mineral Industries (DOGAMI) projection of earthquake intensity (see Figure 10), LBCC's campuses are susceptible to varying ranges of earthquake shaking intensity, due to their different locations. The structures in Corvallis are susceptible to "violent" shaking, resulting in significant structural and property damage, while both the structures and properties in Albany and Lebanon are susceptible to "severe" shaking.

Figure 10. LBCC Earthquake Intensity Map



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

For more information, see the following reports:

Open-File-Report: O-2013-22 - Cascadia Subduction Zone earthquakes: A magnitude 9.0 earthquake scenario, 2013

Open-File Report O-13-06, Ground motion, ground deformation, tsunami inundation, coseismic subsidence, and damage potential maps for the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes

Interpretive Map Series: IMS-024 - Geologic hazards, earthquake and landslide hazard maps, and future earthquake damage estimates for six counties in the Mid/Southern Willamette Valley including Yamhill, Marion, Polk, Benton, Linn, and Lane Counties, and the City of Albany, Oregon, 2008

HISTORY

The Willamette Valley, including Linn and Benton County, has been affected by earthquakes in the surrounding area of an estimated magnitude of 4.0 and greater. The Pacific Northwest has experienced major earthquakes in 1949 (magnitude 7.1), 1962 (magnitude 5.2), and 2001 (magnitude 6.8). Table 6 describes the location of selected Pacific Northwest earthquakes and Figure 11 presents the locations of regional earthquakes.

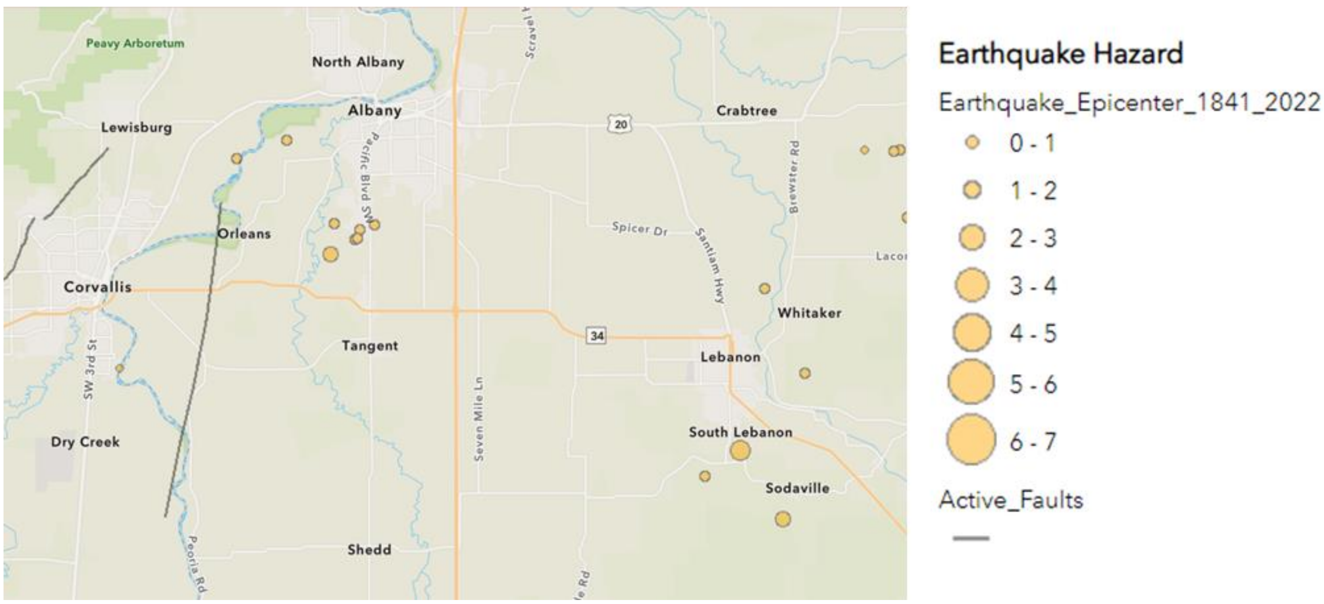
Table 6. Earthquake History in the Willamette Valley

Date	Location	Magnitude	Comments
Oct-22	Lacomb, OR	4.4	-
Jul-15	East of Springfield, OR	4	-
February 2001	Nisqually, WA	6.8	The most recent earthquake to be felt in Marion County was the Nisqually earthquake, on February 28, 2001. The earthquake was centered 35 miles southwest of Seattle and registered 6.8 on the Richter Scale. While the quake caused little damage in Marion County, it did temporarily close businesses and schools to assess potential damage.
Mar-93	Scotts Mills, OR	5.6	The Scotts Mille Earthquake originated about two miles south of Scotts Mills and twelve to thirteen miles underground. In Salem, the rotunda of the state Capitol cracked, and the Golden Pioneer statue nearly rocked off its base.
Mar-63	Salem, OR	4.6	On March 7, 1963, a quake measuring 4.6 on the Richter Scale shook Marion County. Despite the low magnitude of the quake, damage still occurred—especially to older masonry buildings.
Nov-62	Vancouver, WA	5.5	Three and a half weeks after the devastating Columbus Day Storm, an earthquake that measured approximately 5.2 on the Richter Scale shook the Portland area. It was the largest quake to be generated by a fault under Portland and Vancouver. The Oregon Statesman reported little damage, although much of Marion County was shaken up.
Apr-61	Albany, OR	4.5	A quake in April of 1961 caused little damage to the county but startled many residents. The quake was centered just south of Salem and registered 4.6 on the Richter Scale. Described by most as a double shock, it shook houses and rattled dishes, but damage was very limited. Albany reported some cracked plaster.
Nov-57	Salem, OR	4	The 1957 earthquake registered a 5.0 on the Richter Scale. Most reports indicated only one sharp jolt or a few seconds of shaking. The earthquake caused slight damage in Salem, and temporary power outages.
Apr-49	Olympia, WA	7.1	April 13, 1949, Marion County residents felt an earthquake that was centered near Olympia, Washington. While Marion County was shaken by the quake, damage was minimal. In downtown Salem and West Salem areas building trembled, light-fixtures swayed, and dishes rattle in cupboards.

Date	Location	Magnitude	Comments
Jul-30	Perrydale, OR	4	Cracked plaster.
April 1896	McMinnville, OR	4	Felt in Portland.
January 1700	Offshore, Cascadia Subduction Zone	9	Generated a tsunami that struck Oregon, Washington, and Japan; destroyed Native American villages along the coast.
1400 BCE, 1050 BCE, 600 BCE, 400, 750, 900	Offshore, Cascadia Subduction Zone	8.0-9.0	Based on studies of earthquake and tsunami at Willapa Bay, Washington. These are the mid-points of the age ranges for these six events.

Source: *2020 Oregon NHMP*

Figure 11. Earthquake Epicenters from 1841-2020



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research the LBCC NHMP Steering Committee determined **the probability of experiencing an earthquake is "high",** meaning one incident may occur within the next 1- to 35 years. *The previous NHMP rating for earthquake probability increased.*

The LBCC campuses are susceptible to both Cascadia Subduction Zone earthquake and a crustal earthquake.

In regard to a CSZ earthquake, scientists estimate the chance in the next 50 years of a large subduction zone earthquake is between 10% and 20%, assuming that the recurrence is on the order of 400 +/- 200 years. A report released in August 2016 from the OSU Geology Department found, using nearly 200 core samples of underwater landslide deposits left behind by past subduction zone earthquakes, that the northern sections of the CSZ are coming due for an earthquake. The department found evidence that at least 43 major earthquakes have occurred in the last 10,000 years.

In regard to a crustal earthquake, establishing a probability for crustal earthquakes is more difficult. There have been five earthquakes above magnitude 4.0 in the mid-Willamette Valley, of which the 1993 Scotts Mills earthquake was the largest. The total number of earthquakes above a magnitude 4.0 centered in the mid-Willamette Valley is small. Therefore, any prediction would be questionable. Earthquakes generated by volcanic activity in the Cascade Range are possible but likewise unpredictable. Over the last 63 years, seven damaging earthquakes affected the Willamette Valley, ranging from 4.5 to 7.1 in magnitude. This averages out to one damaging earthquake every nine years.

VULNERABILITY ASSESSMENT

Based on the available data and research the Steering Committee determined **the vulnerability of experiencing an earthquake is "moderate",** meaning between 1-10 percent of the population will be affected. *From the previous NHMP rating earthquake vulnerability decreased*.

While earthquakes in the past have caused no injuries on campus, the potential for injuries or deaths from past events or from similar events in other communities could escalate, resulting in multiple deaths and major injuries and/or extensive impact on campus and community social networks.

Furthermore, most facilities throughout the college can anticipate extensive damage due to an earthquake. In terms of campus operations, classes and college business could experience interruptions for a period of a year or longer. Earthquakes have the potential to inflict widespread damage to not only buildings but also the utility infrastructure and transportation network that may inhibit access to campus locations and affect campus operations. According to the DOGAMI Risk Report for Benton County (2023) identified the Benton Center as projected to sustain moderate to complete damage due to a CSZ earthquake, which would equate to roughly $19 million in damages (see Section II: College Profile – Built Environment for more details).

Additionally, utility failure can be the result of seismic activity near LBCC facilities. Failure includes the loss or disruption of any primary energy source and/or utility source needed to maintain campus operations. The primary sources of energy used at LBCC include electricity, natural gas, oil, and gas. Other utilities to consider include heating, cooling, water, and sewage. Utility disruptions can have a major impact on LBCC's ability to operate and provide adequate safety to students and employees.

Finally, as the effects of earthquakes span a large geographic area, an earthquake occurring in or affecting LBCC would probably be felt throughout the County. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. Assets and infrastructure vulnerable to damage from earthquakes include large stocks of old buildings and bridges, hazardous materials facilities, extensive sewer, water, and natural gas pipelines, dams, a petroleum pipeline, and other critical facilities and private property located across the county. The relative or secondary earthquake hazards, such as liquefaction, ground shaking, amplification, and earthquake-induced landslides can be just as devastating as the earthquake.

Mitigation actions to minimize the risks associated with earthquakes and improve campus resilience have been taken by LBCC, primarily in the form of the seismic retrofitting of high-risk buildings. For more information on these seismic updates, refer to Section II: College Profile.

EXTREME HEAT

As the climate continues to warm, extreme heat events will be an emerging hazard with implications for public health as well as infrastructure. Extreme heat events are expected to increase in frequency, duration, and intensity in Oregon due to continued warming temperatures. Due to the growing occurrence and threat of extreme heat waves, LBCC has decided to include Extreme Heat as a new natural hazard in their Natural Hazard Mitigation Plan. The *2020 Oregon NHMP* identifies Linn and Benton County as being likely affected by extreme heat hazards.

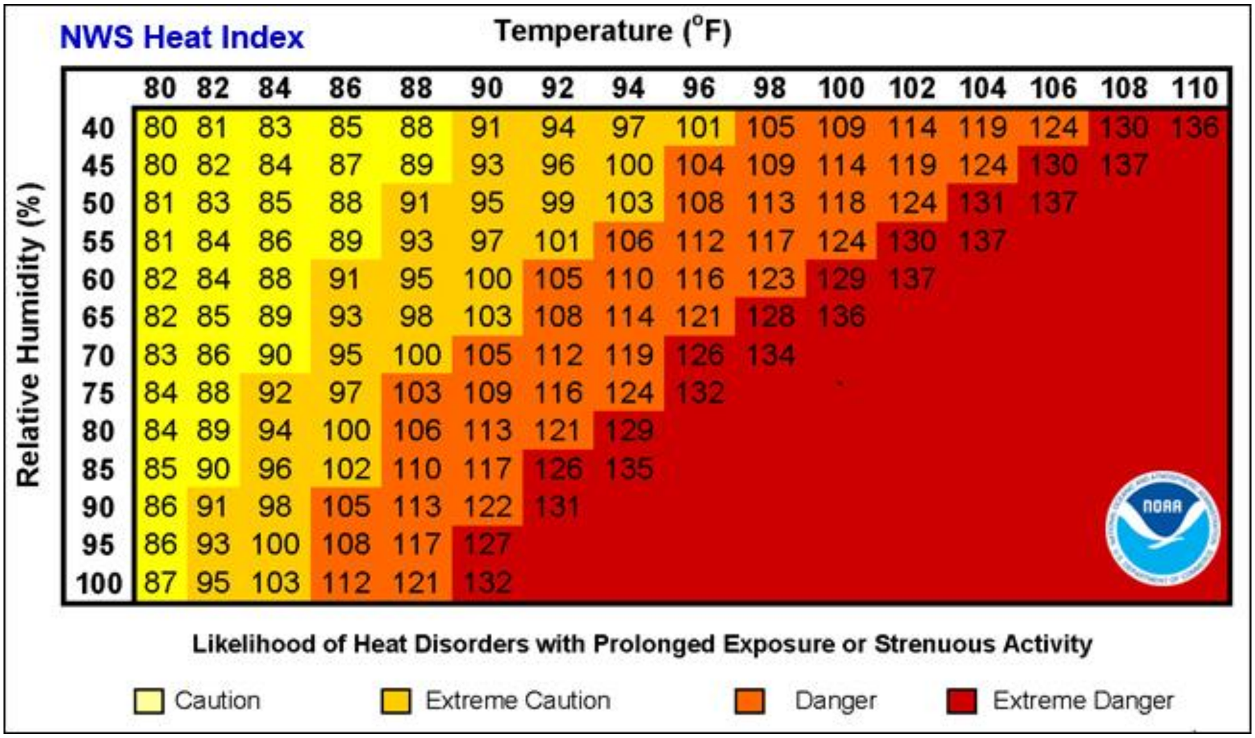
An increasing number of extreme heat events have occurred in Benton and Linn County with 2017, 2019, 2020, 2021, and 2022 all. Though extreme heat events are not as prevalent in Linn and Benton County compared to other Oregon counties, statewide extreme heat occurs more often throughout the summer and varies in how extreme the temperature rises during a given event.

CHARACTERISTICS

Extreme Heat is a period of abnormally, uncomfortably hot and unusually humid weather typically lasting two or more days with temperatures outside the historical averages for a given area, as well as the numbers of days with temperatures above 90°F. Extreme heat can pose risk to communities in several ways, whether in isolation or in combination with each form extreme heat takes. The hazard may represent an increase in daily temperatures exceeding a threshold of safety for human beings, both for dehydration and potential for skin burns. Extreme heat events may exist as heat waves, a streak of consecutive days in which the daily high temperature is above the historical average and/or exceeds a threshold of safety. It is estimated that between 1999 and 2022, heat waves killed at least 19,021 Americans, according to the Centers for Disease Control and Prevention. That's more than any other single hazard-related deaths, including hurricanes, lightning, tornadoes, floods and earthquakes. And it's largely an urban problem—the bulk of those deaths occur in cities.

The National Weather Service issues heat warnings when the heat index exceeds given local thresholds. The heat index is a measure of how hot it feels combining both temperature and relative humidity. As relative humidity increases, a given temperature can feel even hotter. Figure 12 displays NOAA's National Weather Service rubric for temperature and relative humidity according to the danger of heat-related illnesses.

Figure 12. NOAA National Weather Service Heat Index



NWS Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution · Extreme Caution · Danger · Extreme Danger

Source: National Weather Service

LOCATION AND EXTENT

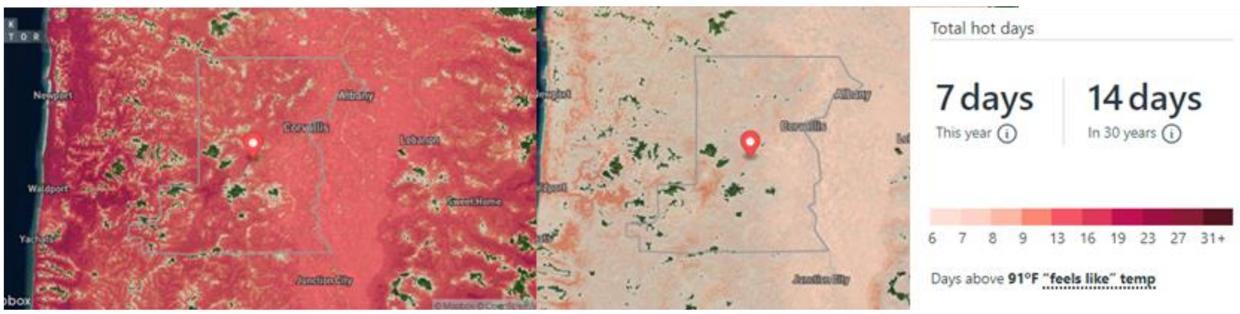
The extent and location of extreme heat can occur region-wide and can affect all segments of a jurisdiction. Urban places, such as cities and heavily developed areas, are more vulnerable to heat waves because that's where more people are concentrated but also because there is less vegetation to permit evaporation, cars and factories give off heat, and the proximity of asphalt roads and buildings store and radiate heat. On a hot summer day, urban areas can be 5°F to 18°F hotter than surrounding rural areas which is enough to turn a heat wave into a serious health crisis.

Figure 13 and Figure 14 shows the average number of days with temperatures over 90°F compared to currently to 30 years in the future. In Figure 14, the number of high heat days in Benton County is projected to increase significantly from 7 days to 14 days. In Figure 13, the number of high heat days in Linn County is projected to increase significantly from 7 days to 15 days. Overall, both of these counties expect to see more days of high heat than previously experienced historically. These high heat days will be even more exacerbated in urban areas due to the urban heat island effect.

Figure 13. Historical and Future Number of Hot Days in Linn County

Source: First Street Foundation

Figure 14. Historical and Future Number of Hot Days in Benton County



Source: First Street Foundation

There are several mitigation actions that aim to reduce the urban heat island effect, including:

- Providing shaded areas throughout campuses, including vegetation options such as planning appropriate trees to provide shade and passive cooling of buildings and to provide local cooling though evaporation. Non vegetation options are also available, such as latticed shade awnings above paved areas and exposed lots where trees are not viable options. These options will assist in reducing the heat island effect and provide shaded relief for people.
- Improving the reflective surfaces of urban roof tops to bounce light (heat) rather than absorbing it. Ideally, solar panel arrays could absorb sunlight and shade the roof tops from storing heat, while also providing a source of energy for the internal powering of fans, or air conditioning and diminish the draw on local and regional power demands at peak use periods.

HISTORY

A severe heat episode or "heat wave" occurs about every two to three years and typically lasting two to three days but can last as many as five days. A severe heat episode can be defined as consecutive days of upper 90s to around 100. On average the region experiences 8.9 days with temperatures above 90-degrees Fahrenheit, and an average historical baseline for the hottest day at 93.7°F.

As global temperatures increase on average and changing climatic patterns, across all of Oregon, including Benton and Linn County have experienced abnormally high temperatures and more frequent periods of heat. Benton and Linn County have both experienced higher then 90s and triple digit temperatures in the past. Over the past 30 years, the likelihood of extended periods of excessive heat (i.e., 3 days or longer) remained around 35-40 percent for both counties (First Street). However, for both counties, this number has increased to just below 70 percent for 2023 and will increase to above 90 percent over the next 30 years. During the recent 2021 "heat dome" that blanketed the Pacific Northwest, and many communities across Oregon, including both Benton and Linn County, reached new record high temperatures. During this extreme heat event, a total of 123 heat related deaths in the Pacific Northwest were reported resulting from limited access to air-conditioning and an increase in the number of drownings when residents sought relief in bodies of water. Widespread business closures and event postponements occurred. Both Benton and Linn County recorded their highest temperatures ever when temperatures reached at and above 110°F (Odegard, 2021).

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research the Steering Committee assessed **the probability of experiencing a locally extreme heat event as "High,"** meaning one incident is likely within the next 10 to 35 years. *This is a new hazard; thus, the rating is new since the last NHMP.*

Probability of future extreme heat events are discussed in further detail below in Future Climate Variability.

VULNERABILITY ASSESSMENT

The Steering Committee rated LBCC as having **a "Moderate" vulnerability to extreme heat hazards**, meaning it is expected that between 1-10% of the unincorporated County's population or assets would be affected by a major drought emergency or disaster. *This is a new hazard; thus, the rating is new since the last NHMP.*

As many of the buildings located on LBCC campuses are older, they can lack adequate cooling systems (see Section II: College Profile – Built Environment), which can impact the overall well-being of the staff and students utilizing the building during high heat days. This is further compounded by the fact that roughly 10 percent of students are over the age of 65 and over 25 percent of staff are over the age of 55, which are populations more vulnerable to the effects of extreme heat. As hot weather patterns continue to increase in both duration and intensity, the impact to the staff and students will continue to grow, especially for those utilizing the inadequately equipped buildings.

FUTURE CLIMATE VARIABILITY[5]

The OCCRI *Future Climate Projections Report* for both Benton County and Linn County (Dalton et al., 2023) projects that the number, duration, and intensity of extreme heat events will increase as temperatures continue to warm. For both Benton County and Linn County, the number of extremely hot days (where temperature is 90°F or higher) and the temperature on the hottest day of the year are projected to increase by the 2020s and 2050s. Compared to the 1971-2000 historical baselines, the number of days per year with temperatures 90°F or higher in Benton County is projected to increase an average of 18 (range 6-33) by the 2050s, while Linn County is projected to experience an average increase in 17 days (range 5-29).

Additionally, the temperature on the hottest day of the year in Benton County is projected to increase by an average of about 6°F (range 2–9°F) by the 2050s, and Linn County is projected to increase by an average of about 7°F (range 2–10°F)

Heatwaves are extremely dangerous and the leading cause of weather-related deaths in the United States. As extreme heat events have been historically rare in Oregon, many residents do not have air conditioning in their homes, leaving them more vulnerable to heat-related illnesses and possible death. More vulnerable populations include children, the elderly, economically disadvantaged communities, those working outdoors, such as in agriculture or forestry, and people with preexisting conditions. Projected demographic changes, such as an increase in the proportion of older adults, will increase the number of people in some of the populations that are most vulnerable to extreme heat.

[5] OCCRI, *Future Climate Projections Benton County, Oregon*, 2023; OCCRI, *Future Climate Projections Linn County, Oregon*, 2023

FLOOD

CHARACTERISTICS

Flooding occurs when climate, geography, and hydrology combine to create conditions where rain and snowmelt create water flow that exceeds the carrying capacity of rivers, streams, channels, ditches, and other watercourses. In Oregon, flooding is most common from October through April when storms from the Pacific Ocean can bring intense rainfall.

The geography and climate of the region surrounding LBCC combine to create chronic seasonal flooding conditions. Flooding can be aggravated when rain is augmented by snowmelt and frozen ground. If the ground is saturated or frozen, stream flow can be increased even more by the inability of the soil to absorb additional precipitation.

Even though the LBCC campuses may not be located in designated floodplains, and floods have infrequently impacted the campuses directly, floods in the region can impede access to campus facilities, disrupt business functions, and pose risk to the lives and property of students, staff, and faculty. The principal types of floods that occur on the LBCC main campus include riverine and urban flooding, with potential to shallow area flooding as well, and exposure to potential flooding from dam failure.

RIVERINE FLOODING

Riverine flooding directly affects the parts of LBCC that are located along either the Calapooia or North Santiam Rivers and located within the FEMA flood plain. However, flooding of campus assets rarely occurs. That said, regional transportation impacts due to flooding do periodically impact the ability of LBCC's students, faculty, and staff to access campus locations. Riverine floods can be slow or fast rising but usually develop over a period of days. The danger of riverine flooding occurs mainly during the winter months, with the onset of persistent, heavy rainfall, and during the spring, with melting of snow in the Coast Range.

URBAN FLOODING

Urban flooding occurs where land has been converted from open space, such as fields or woodlands to developed areas consisting of homes; parking lots; and commercial, industrial and public buildings and structures. In such areas, the ability of water to filter into the ground is often prevented by the extensive impervious surfaces associated with urban development. This in turn results in more water quickly running off into watercourses, which causes water levels to rise above pre-development levels.

During periods of urban flooding, streets can rapidly become swift moving rivers, and basements and backyards can quickly fill with water. Storm drains and smaller creeks can back up due to yard waste and debris. Clogged storm drainage systems often lead to further localized flooding.

SHALLOW AREA FLOODS

Shallow area floods are a special type of riverine flooding. FEMA defines a shallow area flood hazard as an area that is inundated by a 100-year flood with a flood depth between one to three feet. Such areas are generally flooded by low velocity sheet flows of water.

DAM FAILURE

There are many dams in the region surrounding LBCC. Catastrophic dam failure would cause widespread flooding, damage campus facilities and transportation patterns, and pose a threat to the safety of students, staff, and faculty, particularly in the area of East Linn (Lebanon Center, Health Occupations Center, Advanced Transportation Technology Center, and Sweet Home Center). As identified by the Army Corps of Engineers, Foster and Green Peter have the potential for floodwaters to inundate various campus facilities.

While flooding due to dam failure would cause significant damage to LBCC, LBCC lacks authority to direct the management and operation of nearby dams. Thus, LBCC has no direct control over dam mitigation measures, with the exception of implementing flood mitigation measures that protect their campuses and properties.

LOCATION AND EXTENT

Flooding occurs when weather patterns, geology, and hydrology combine to create conditions where water flows outside of its usual course. Floods are most often described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as streamflow gages, to determine the probability of occurrence for floods of different magnitudes, and the probability of occurrence is then expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

As LBCC has several locations, each campus has a different potential extent of risk it is susceptible to, each of which is discussed in the following.

MAIN CAMPUS

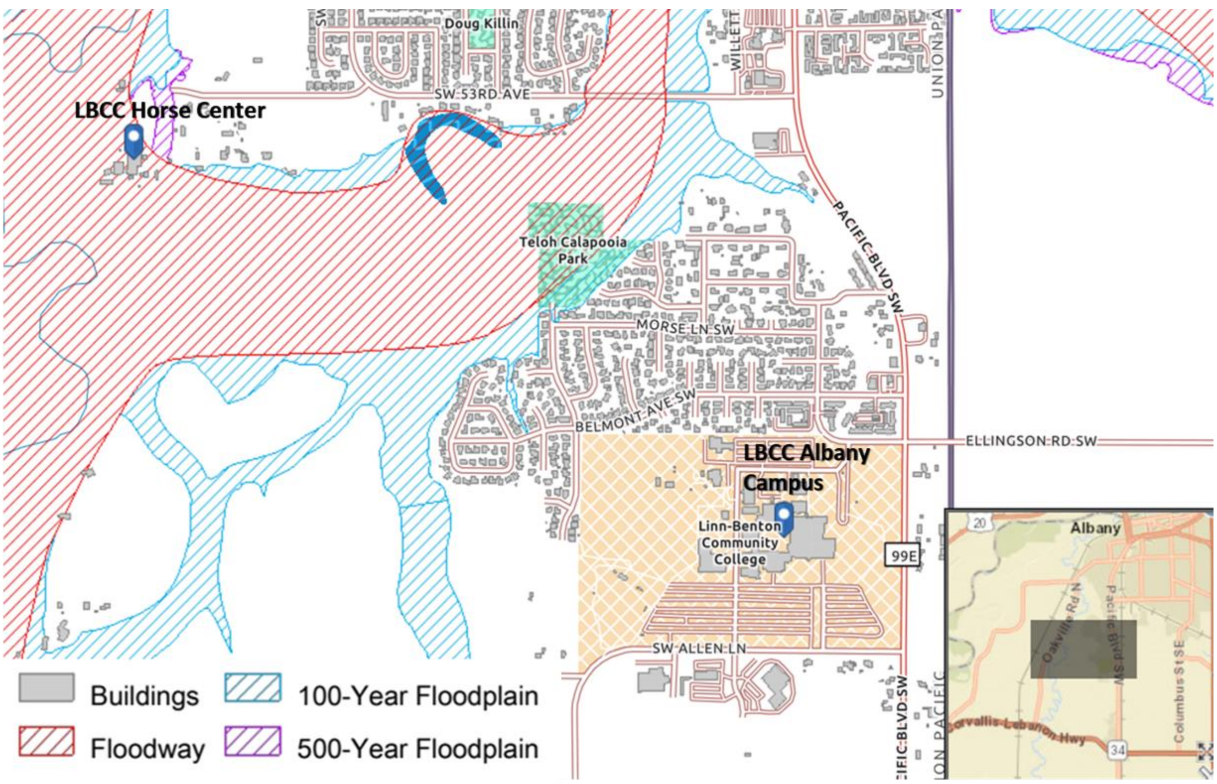
The main flooding risk to the LBCC main campus is urban flooding. Due to storm water management systems that were constructed around campus, the landscape was slightly altered. Excess rainwater and drainage do not always drain off properly, and debris can back up in the swale/culvert system. Historically, urban flooding occurs in certain parking lot areas on campus, with particular emphasis on parking lot #4. The flooding can be severe and limit access and available parking as well as pose a safety and infrastructure issue for the campus.

Riverine flooding along the Willamette River is a significant issue in the City of Albany particularly north of the LBCC main campus, seen in Figure 15. The northern bank of the Willamette River allows frequent over-bank flooding. Over-bank flooding also occurs along the Calapooia River almost every winter, inundating rural farmland to the west of Albany. Periwinkle Creek, Cox Creek, Burkhart Creek, and Truax Creek were deepened and straightened as flood control projects. The capacity of these creek channels was increased to contain the 100-year flood, and consequently riverine flooding along these four creeks is rare (City of Albany, 2017).

LBCC HORSE CENTER

The LBCC Horse Center is located approximately one-and-half miles from the main campus. The Horse Center, seen in Figure 15, sits along the Calapooia River and is located within the floodplain but has not historically experienced flooding. The Horse Center is the only LBCC main campus property that exists within a floodplain. The center has few buildings, horses, and faculty and staff that work at the center.

Figure 15. LBCC Albany Campus and Horse Center Flood Risk Map

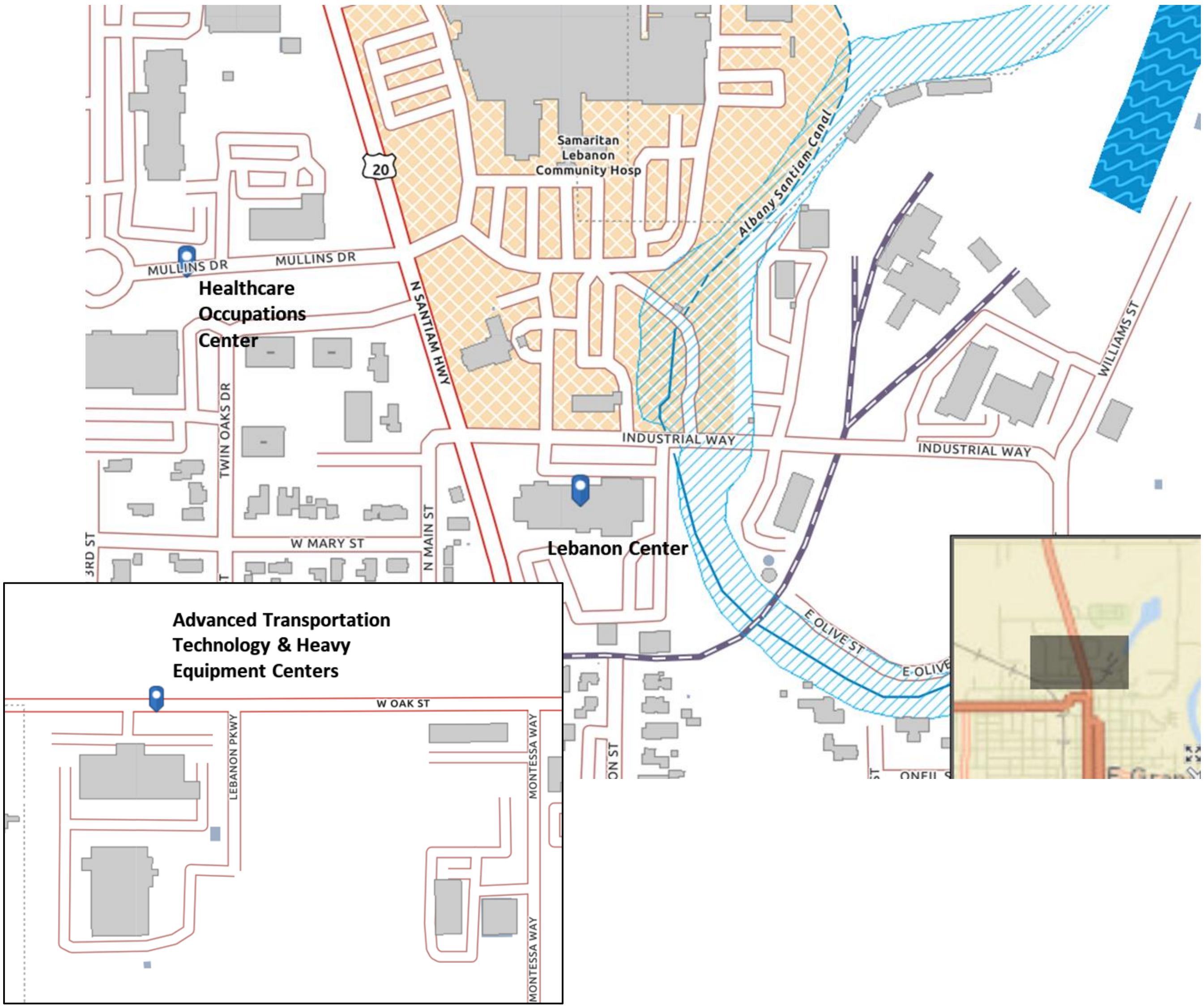


Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

LEBANON CENTER

The Lebanon Centers, including the Healthcare Occupations Center and the Advanced Transportation Technology & Heavy Equipment Centers (seen in Figure 16), are not located within floodplains. However, it is important to note that major access routes, including Highway 20, Highway 99, and Highway 34 may be impassable during a major flood. The closure of roads due to flooding will likely impact campus operations. Even though the main campus and the community center facilities may not be directly at risk to riverine flooding, many of the students, staff, and faculty may be affected.

Figure 16. Lebanon Centers Flood Risk Map



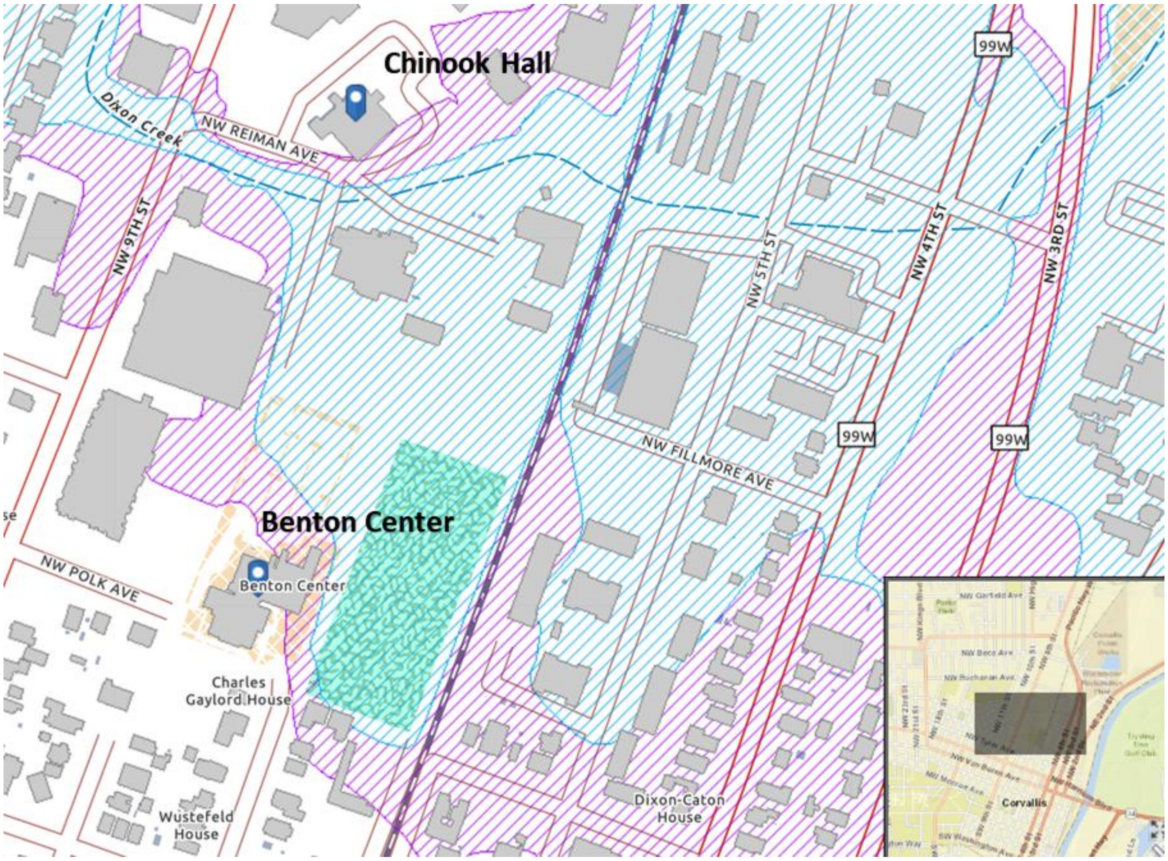
Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

CORVALLIS CENTER

The northeast corner of the parking lot located at 757 Polk Avenue at Corvallis's Benton Center is located in the 500-year flood plain. In addition, the south parking lot for the 931 NW Reiman

(Benton Center) property is also within the 500-year flood plain. The southeast portion of Chinook Hall is also located in the 500-year floodplain. These areas are illustrated in Figure 17.

Figure 17. Corvallis Center (Benton Center and Chinook Hall) Flood Risk Map



Source: Oregon HazVu: Statewide Geohazards Viewer (HazVu)

HISTORY

There are no documented natural floods that have occurred on the LBCC campuses. The main campus has experienced urban flooding impacting Parking Lot #4, often caused by the culvert stream located on campus. The culvert stream was created to divert storm water away from the buildings, but during severe storms the storm water system can become blocked or overwhelmed.

The history of flood events that have occurred in or impacted the local areas within Benton County and Linn County have not impacted any LBCC structures.

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research, the Steering Committee determined the **probability of experiencing a flood is "high",** meaning one incident is likely within the next 10 to 35-year period. This rating exists for all campuses*. This rating has increased since the previous NHMP.*

Flooding can occur every year depending on rainfall, snowmelt or how runoff from development impacts streams and rivers. FEMA has mapped the 100 and 500-year floodplains in portions of both Benton County and Linn County. This corresponds to a 1% and 0.2% chance of a certain magnitude flood in any given year. The 100-year flood is the benchmark upon which the National Flood Insurance Program (NFIP) is based. Flood risk can be seen above for each the LBCC properties and buildings under section "Location and Extent".

VULNERABILITY ASSESSMENT

Based on the available data and research, the Steering Committee rated the **college's vulnerability to flood as "High"**, meaning that more than 10% of the college's population, property, and equipment would be impacted by a flood.

The vulnerability assessment is conducted by combining the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events. Because site-specific inventory data and inundation levels given for a particular flood event (10-year, 25-year, 50-year, 100-year, 500-year) are not readily available, calculating a community's vulnerability to flood events is not straightforward. The amount of property in the floodplain, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential flood losses.

When structures or fill are placed in the floodway or floodplain, water is displaced and lead to flooding. Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and no fill is removed to compensate, serious problems can arise. Floodwaters may be forced away from historic floodplain areas, and as a result, other existing floodplain areas may experience floodwaters that rise above historic levels.

Utility failure can be the result of flooding and intense storm water runoff. Even though LBCC campuses may not be directly impacted by flooding, community infrastructure such as sewer, storm water, and drinking water systems may be vulnerable to flooding. If city utility systems are overwhelmed and/or contaminated by untreated water, these circumstances can affect operations at LBCC and satellite locations.

LBCC does not participate in the National Flood Insurance Program. Furthermore, LBCC main campus structures and satellite centers are not identified as Repetitive Loss or Severe Repetitive Loss Structures.

FUTURE CLIMATE VARIABILITY[6]

The OCCRI *Future Climate Projections Report* for both Benton County and Linn County (Dalton et al., 2023) both project the intensity and occurrence of extreme precipitation will increase as the atmosphere warms and holds more water vapor. In both Benton County and Linn County, the number of days per year with at least 0.75 inches of precipitation is not projected to change substantially.

Nevertheless, by the 2050s, the amount of precipitation on the wettest day and wettest consecutive five days per year is projected to increase by an average of 13% (range 1–29%) and 10% (range -2–19%), respectively in Benton County, and by an average of 14% (range 1-35%) and 10% (1-22%) in Linn County.

Furthermore, in Benton County (with winter flood risk at mid- to low elevations) and Linn County (with winter flood risk at intermediate to low elevations), where temperatures are near freezing during winter and precipitation is a mix of rain and snow, is projected to increase as winter temperatures increase. The temperature increase will lead to a rise in the percentage of precipitation falling as rain rather than snow.

[6] OCCRI, *Future Climate Projections Benton County, Oregon*, 2023; OCCRI, *Future Climate Projections Linn County, Oregon*, 2023

VOLCANIC EVENT

CHARACTERISTICS

The Pacific Northwest lies within the "ring of fire," an area of very active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur regularly along the ring of fire, in part because of the movement of the Earth's tectonic plates. The Earth's outermost shell, the lithosphere, is broken into a series of slabs known as tectonic plates. These plates are rigid, but they float on a hotter, softer layer in the Earth's mantle. As the plates move about on the layer beneath them, they spread apart, collide, or slide past each other. Volcanoes occur most frequently at the boundaries of these plates, and volcanic eruptions occur when the hotter, molten materials (or magma) rise to the surface. In Oregon, volcanic activity can be found along the Cascade Range, which was formed by the Juan de Fuca plate sinking beneath the North American plate (*2020 Oregon NHMP*).

The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, and produce flying debris and ash clouds. The immediate danger area in a volcanic eruption generally lies within a 20-mile radius of the blast site. The location of LBCC and its satellites means volcanic eruptions only pose one real threat: ash fall. As a result, only ash fall will be discussed in terms of volcanic hazards.

ASH FALL

One of the most serious hazards from an eruption is the rock and dust-sized ash particles—called tephra—blown into the air. The tephra can travel enormous distances and are a serious by-product of eruptions. Within a few miles of the vent, the main tephra hazards include high temperatures as well as the risk of being buried and being hit by falling fragments. Within twelve miles, tephra may set fire to forests and flammable structures.

According to the *2020 Oregon NHMP*, during an eruption, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades is westerly, and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes (*2020 Oregon NHMP*).

Volcanic ash can contaminate water supplies, cause electrical storms, create health problems, and collapse roofs.

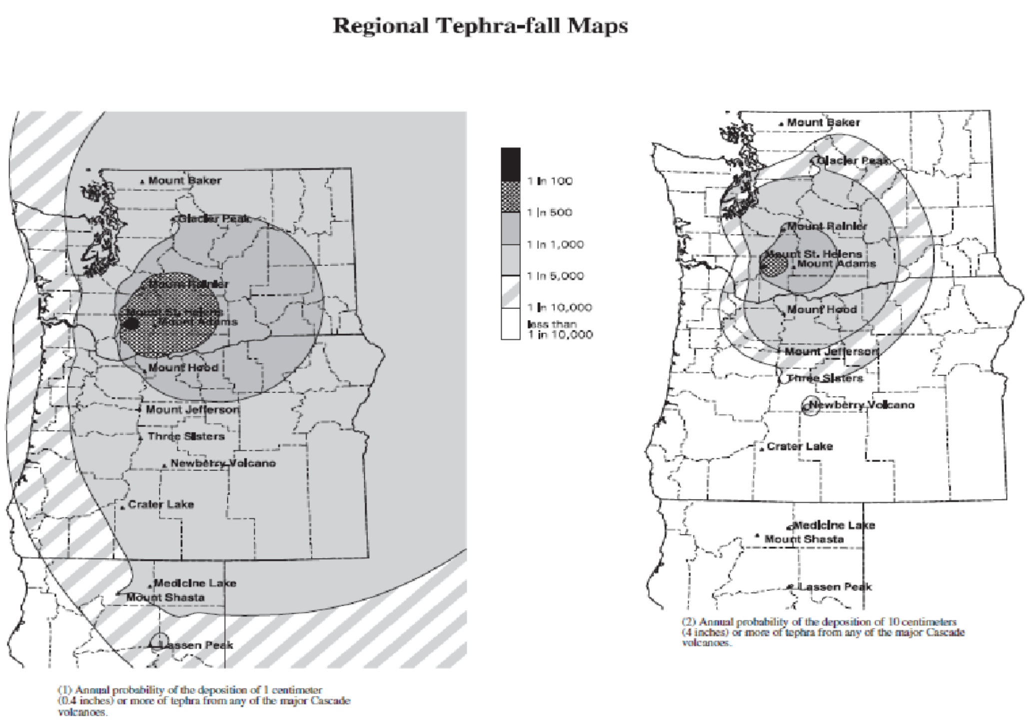
LOCATION AND EXTENT

Both Benton and Linn County are located on the Pacific Rim. Tectonic movement within the earth's crust can renew nearby dormant volcanoes resulting in ash fallout. Volcanic activity is possible from Mount Jefferson, Three Sisters and Broken Top, Mount Hood, Mount St. Helens, and Mount Rainier. If any of these volcanoes erupted, there would be a possibility of ash that could affect air and water quality.

LBCC utility infrastructure (primarily air handling) could be severely impacted by volcanic ash falls derived from regional volcanic activity. The extent of damage from these hazards depends on the distance from the volcano, vent location, and type of hazardous events that occur during an eruption. The main concern for LBCC campuses is ash clogging air ventilation systems and causing wastewater drainage backup.

Scientists use wind direction to predict areas that might be affected by volcanic ash; during an eruption that emits ash, the ash fall deposition is controlled by the prevailing wind direction. The predominant wind pattern over the Cascades originates from the west and previous eruptions seen in the geologic record have resulted in most ash fall drifting to the east of the volcanoes. Regional tephra fall shows the annual probability of ten centimeters or more of ash accumulation from Pacific Northwest volcanoes. Figure 18 depicts the potential and geographical extent of volcanic ash fall more than ten centimeters from a large eruption of Mt. St. Helens. Additionally, Lassen Peak and Mount Shasta are active and potentially active volcanoes, respectively located in northern California. The proximity of these volcanic features suggests that, in the rare event of an eruption, Jackson County could be affected by ash fall and other air quality impacts.

Figure 18. Regional Tephra-fall Maps

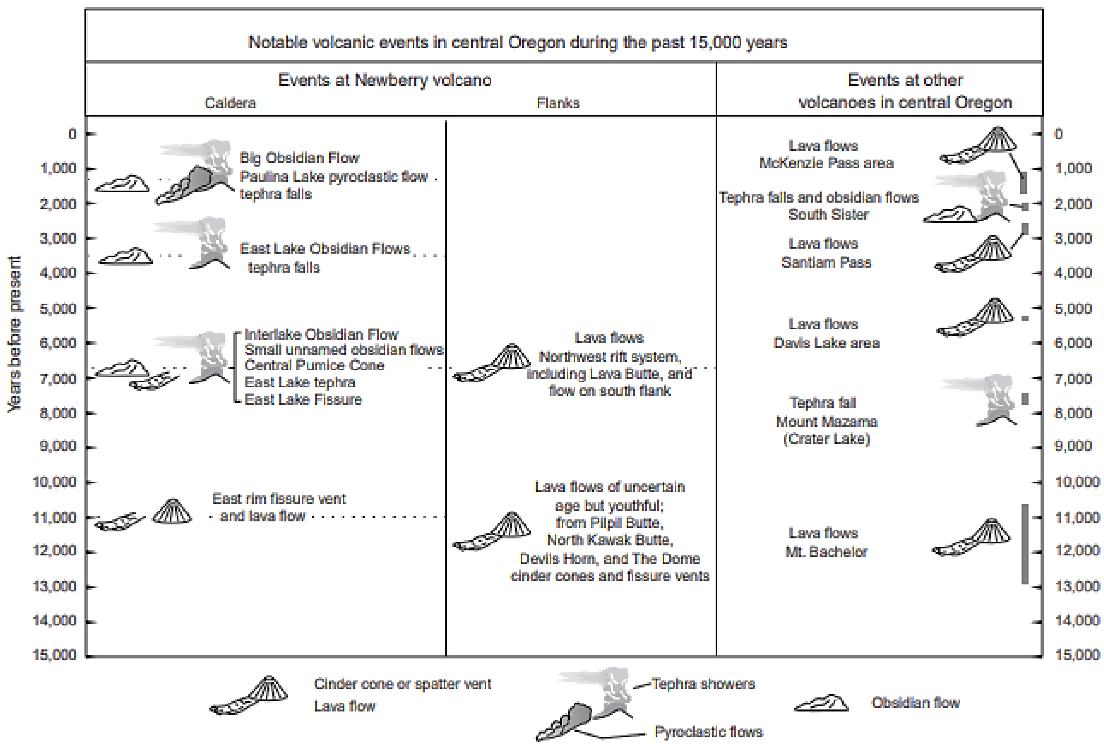


Source: USGS Volcano Hazards in the Mount Jefferson Region, Oregon

HISTORY

Volcanoes in the Cascade Range have been erupting for hundreds of thousands of years. Newberry Volcano, for example, has had many events in the last 15,000 years as shown in Figure 19. The Three Sisters region has also had some activity during this time while the last major eruptive activity at Mount Mazama occurred approximately 7,700 years ago, forming Crater Lake in its wake. Some of the most recent events include Big Obsidian Flow at Newberry Volcano. All the Cascade Range volcanoes are characterized by long periods of quiescence and intermittent activity. These characteristics make predictions, recurrence intervals, or probability very difficult to ascertain.

Figure 19. Notable Volcanic Events in Central Oregon during the Past 15,000 Years



Source: Open-File Report 97-513 Volcano Hazards at Newberry Volcano, Oregon. U.S. Geological Survey

There are five active volcanoes that could potentially impact LBCC and the broader region (see Table 7). These include Mount Jefferson, Three Sisters and Broken Top, Mount Hood, Mount St. Helens, and Mount Rainier. However, only one of these volcanoes, Mount St. Helens, has impacted the area near LBCC within the past 30 years. The closest volcano, Mount Jefferson, has the potential to impact the broader region directly, but it has not been active for at least the past 15,000 years.

Table 7. Description of PNW Volcanic Mountains

Volcano	Comments
Mount St. Helens	Mount St. Helens, located in southwestern Washington, it is 50,000 years old. Over the past 521 years, it has produced four major explosive eruptions and dozens of smaller eruptions. On May 18th, 1980, Mount St. Helens exploded violently after two months of intense earthquake activity and intermittent, relatively weak eruptions, causing the worst volcanic disaster in the recorded history of the United States. Mount St. Helens continued to be active; on March 8th, 2005, a plume of ash and steam spewed nearly seven miles high into the air. Ten small earthquakes were measured in the area leading up to the eruption. The largest appeared to be a magnitude 2.5, according to the USGS.
Mount Jefferson	Mount Jefferson has erupted repeatedly for hundreds of thousands of years, with its last eruptive episode during the last major glaciations, which culminated about 15,000 years ago. Geologic evidence shows that Mount Jefferson is capable of large explosive eruptions.
Three Sisters and Broken Top	The Three Sisters are located in Eastern Oregon. Recently, volcanic activity has been found on the South Sister. The surface moved towards the satellite (mostly upward) by as much as ten centimeters (about four inches) sometime between August 1996 and October 2000. There is no imminent danger of a volcanic eruption or other hazardous activity. The potential exists, however, that further activity could increase danger.
Mount Hood	Mount Hood is located about 140 miles northeast of Albany, Oregon. It has been recurrently active over the past 50,000 years. It has had two significant eruptive periods in geologically recent times, one about 1,500 years ago and another about 200 years ago. Mount Hood has shown no recent signs of volcanic activity.
Mount Rainier	Mount Rainier is located approximately 200 miles north of Albany, Oregon. Mount Rainier is an active volcano that first erupted about half a million years ago. Mount Rainier is known to have erupted as recently as in the 1840s, and large eruptions took place as recently as about 1,000 and 2,300 years ago. The primary hazard posed to LBCC, and satellite locations is ash fallout from Mount Rainier.

Source: *2011 Marion County NHMP*

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research, the Steering Committee determined the **probability of a volcanic eruption as low**, meaning that one incident is likely in 75 to 100 years. *This rating has remained the same since the previous NHMP*.

Because geologic history is fragmentary for these volcanoes, the probability of future explosive eruptions is difficult to estimate. Only two explosive episodes have occurred at the South Sister since the ending of the ice age (about 12,000 years ago). Given the fragmentary record, the annual probability of the South and Middle Sister entering a new period of eruptive activity has been estimated from one in several thousand to 1 in 10,000 (Dzurisin, 2008).

Similar difficulties complicate predictions of future eruptions at Mount Jefferson. There have been four eruptive episodes since the end of the ice age (within the last 20,000 years). Such a frequency suggests an annual probability of about 1 in 4,000 to 1 in 3,000 (Dzurisin, 2008).

VULNERABILITY ASSESSMENT

Based on the available data and research, the Steering Committee rated the **college's vulnerability to volcanic eruption as low,** meaning less than 1% of the population or regional assets would be affected by a volcano. *This rating has remained the same since the previous NHMP*.

LBCC's proximity to a number of Cascade Range volcanoes places the school and region at risk from ash fallout originating from such an event. The greatest vulnerability the campuses face from ash fall is the threat imposed on the ventilation systems and possible health repercussions (with an emphasis on respiratory issues) to people located on campus.

Due to the relative age of the school compared to the thousands of years of volcanic history in the region, LBCC has yet to experience the effects of a volcanic eruption. However, the school is still at risk of ash fall a volcano to erupt. In the event of a volcanic eruption, the potential for future injuries or deaths is anticipated to remain fairly low. It is estimated that less than 1% of LBCC's population and equipment would be affected by a volcanic eruption, considering the primary volcanic hazard that could impact the college is ash fallout, and there would be moderate impact on community social networks (USGS).

WILDFIRE

CHARACTERISTICS

Fires are a natural part of the ecosystem in Oregon. However, wildfires can present a substantial hazard to life and property. Wildfires occur when natural fuel sources ignite and burn out of control. A wildland fire's main fuel source is natural vegetation. Often referred to as forest or rangeland fires, these fires occur in national forests and parks, private timberland, and on public and private range and agricultural lands. A wildland fire can breach into the wildland urban interface (WUI) if it encroaches on developed areas.

While more common to the arid areas of central and eastern Oregon, the potential for losses due to Wildland Urban Interface (WUI) fires in the urbanized region should not be ignored. Wildfire that has the potential to affect the LBCC main campus is WUI interface wildfire. Ignition of wildfire may occur naturally from lightning or from human causes such as debris burns, arson, careless smoking, and recreational activities or from an industrial accident. Once started, fuel, topography, weather, and development conditions affect fire behavior.

Current climate conditions, especially in drought years, influence the frequency, intensity, duration, and extent of fire. Summers are dry and lightning prone because a Pacific coast high-pressure system typically blocks precipitation for much of the season. In the upper elevations, where temperatures are low and rainfall is high, fires are less frequent than in the valleys. Larger climatic factors such as long-term global variations related to El Niño or to sunspot cycles also influence fire regimes, but this influence is confounded by local climatic variations, recent land management activities, and burns.

The following factors and conditions contribute significantly to wildfire behavior and increased wildfire risk.

WILDLAND URBAN INTERFACE (WUI)

WUI fires occur where wildland and developed areas come together with both vegetation and structural development combining to provide fuel. Since the 1970s, Oregon's growing population has expanded further and further into wildland and previously undeveloped resource lands including forestlands, minimizing the space between developed areas and vegetation. The "interface" between urban and suburban areas and the resource lands created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design and capability. Furthermore, human activities increase the incidence of fire ignition and potential damage. The WUI can be divided into three categories:

- The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas.

- The mixed wildland/urban interface is more typical of the problems in areas of exurban or rural development: isolated homes, subdivisions, resorts, and small communities situated in predominantly in wildland settings.
- The occluded wildland/urban interface where islands of wildland vegetation exist within a largely urbanized area.

LBCC is most concerned with the occluded variety. The main campus is surrounded by agricultural lands to the east and southwest, and the campus itself has wooded areas and extensive grass lawns.

FUEL

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading," or the amount of available vegetative fuel. Type of fuel includes the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures, and combustible materials. A structure surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. The accumulation of fuels around urban structures enables high intensity fires to flare and spread rapidly. Because of the many different possible "fuels" found in the interface landscape, firefighters have a difficult time predicting how fires will react or spread.

TOPOGRAPHY

Topography influences the movement of air, thereby directing a fire's course. Slope and hillsides are key factors in fire behavior. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces upslope drafts that can complicate fire behavior.

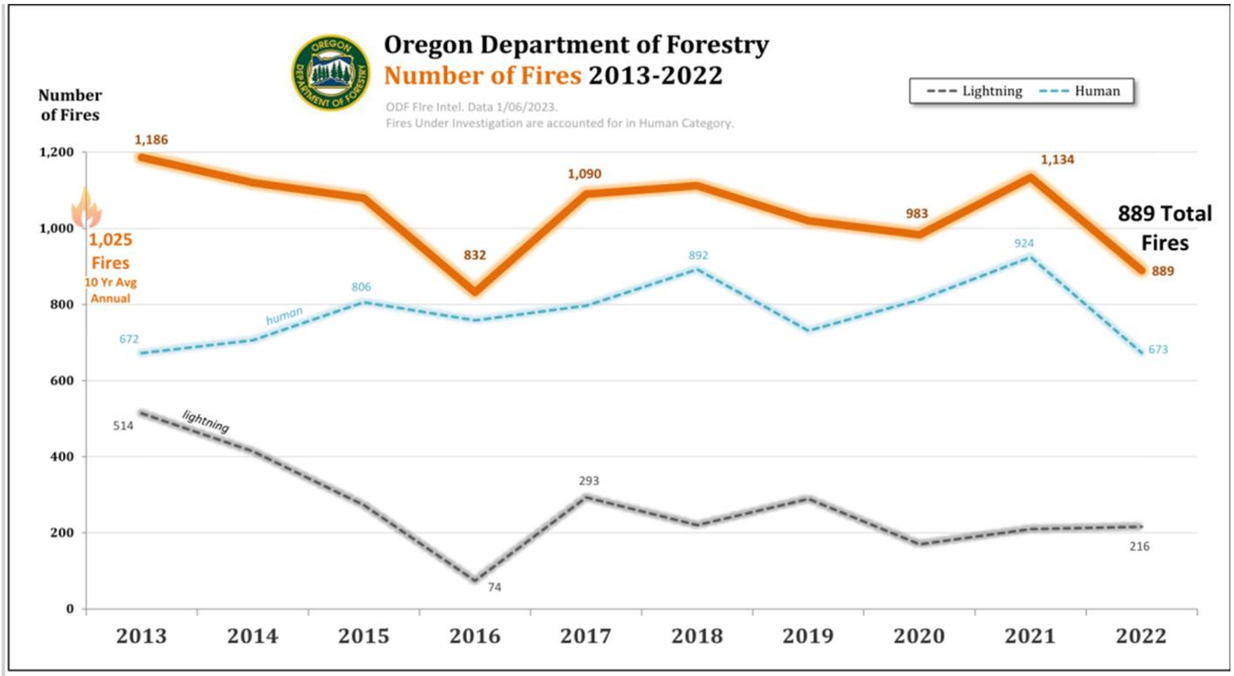
WEATHER

Weather patterns combined with certain geographic locations can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible. High-risk areas in Oregon share a hot, dry season in late summer and early fall when high temperatures and low humidity favor fire activity. Predominant wind directions may guide a fire's path.

HISTORY

Hundreds of wildfires have occurred in Oregon in just the past 10 years, with the ignition source of many of these fires due in part by human activity, while others were caused by natural processes, such as lightning. In general, human caused wildfires typically occur within and around populated areas and within river and stream corridors near transportation routes, while lightning caused wildfires are often in more remote locations. Figure 20 shows the total number of wildfires in Oregon, and a breakdown of how many were started from either natural (lightening) origins and human origins between 2013-2022.

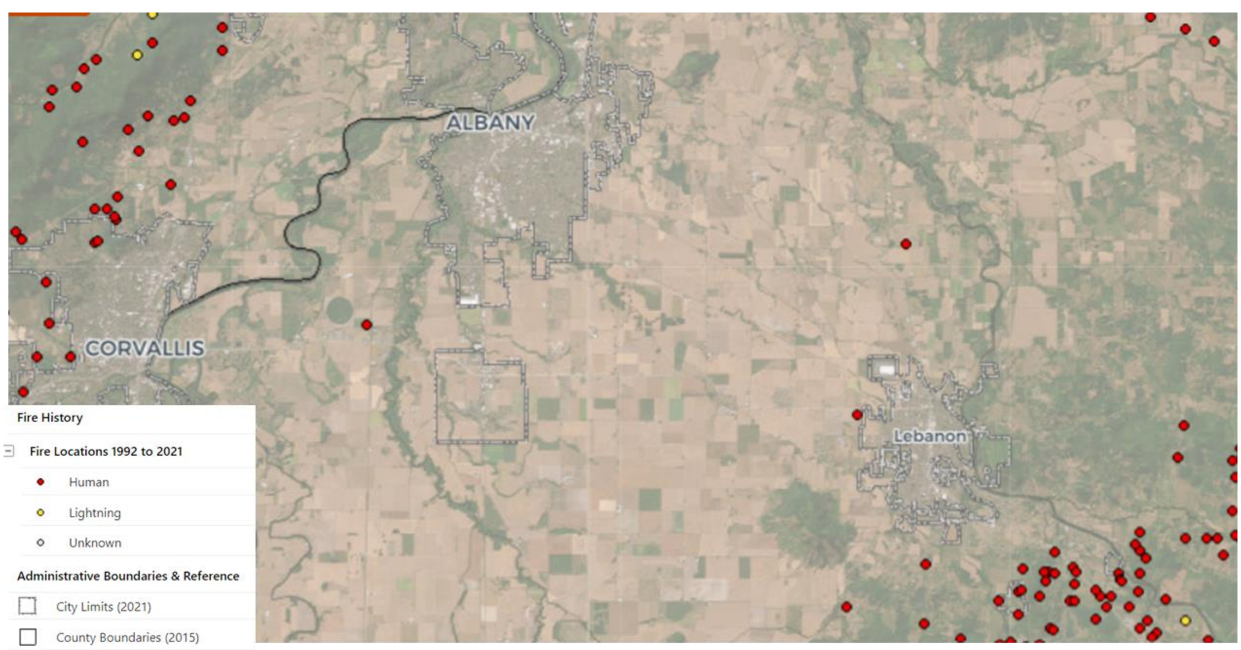
Figure 20. Number of Wildfires Across Oregon from 2013-2022



Source: Oregon Department of Forestry

Many fires, mostly being human caused in origin, have occurred near and around the cities in which LBCC campuses are located. However, there is no history of wildfire has directly affected any of LBCC's campus locations, beyond significant smoke exposure during the 2020 wildfires (Figure 21).

Figure 21. Wildfire Occurrences (1992 to 2021)



Source: Oregon Explorer, 2023

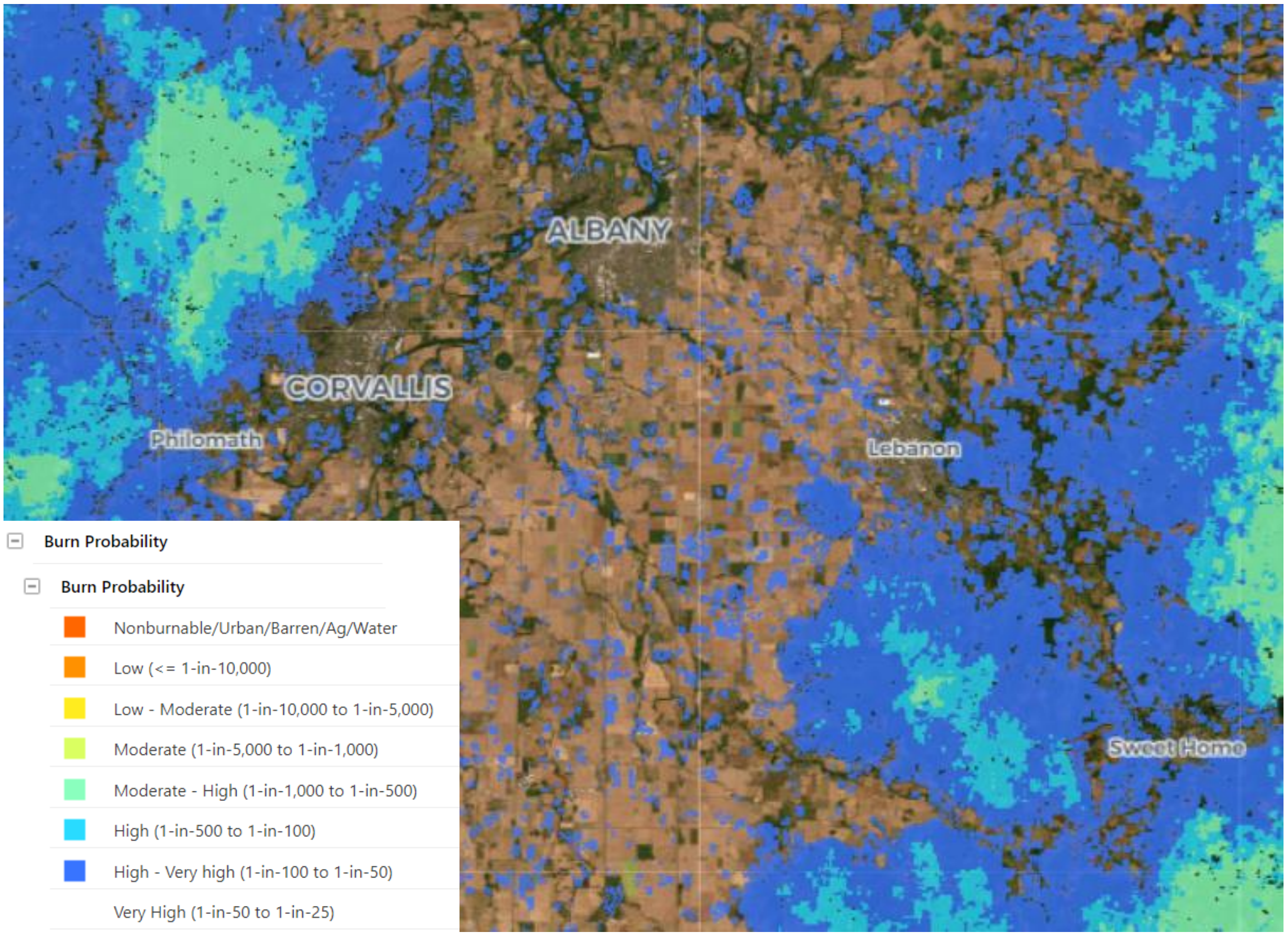
RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on LBCC's historical incidence of wildfire events and most recent science and data, the steering committee **determined that the probability of future wildfires affecting LBCC campuses is "High",** meaning one to no wildfires are likely to occur between 10-35-years. *This rating has increased since the previous NHMP*.

The main threat of wildfire comes from the surrounding agricultural lands and unmanaged, empty grass lots. While wildfire burn probability, seen in Figure 22, is high surrounding the cities houses LBCC's campuses, LBCC maintain well-landscaped properties. Additionally, there are major roads that act as fuel breaks, which provides LBCC with minimal chance of a WUI fire directly affecting LBCC property, structures, or people on main campus. The Advanced Transportation Technology Center is located adjacent to open fields, and these areas could be a potential exposure to wildfire dangers. However, LBCC does maintain gravel and paved driveways and parking lots around the perimeter of the buildings to act as a fire buffer zone.

Figure 22. LBCC Burn Probability*



Source: Oregon Wildfire Risk Explorer, 2018
*Data is out of outdated, but most available data at the time of publishing

VULNERABILITY ASSESSMENT

Considering few areas located on the perimeter of the main campus and centers are considered at risk to wildfires, **the committee determined that the college has a "Low" vulnerability to wildfire,** meaning that less than 10 percent of the college's population, property, and equipment would be impacted. *This rating has remained the same since the previous NHMP*.

A few facilities throughout the main campus (the Horse Center and the Advanced Transportation Technology Center) could sustain damage due to wildfires but are estimated at a low cost for hazard response, structural repairs, and equipment replacement. In terms of campus operations, it is likely that less than 10% of operations could experience interruption for a period of hours. The operations most impacted are those located within the few wood frame structures.

Of particular concern to LBCC are the few wooden buildings located throughout campus and the wooded areas where the Wellness Trail winds through campus. One building of significant wildfire risk is the Horse Center, which is comprised of several large wood-frame buildings.

Campus location and campus buildings, including structure class (specifically reference to the use of fire-resistive construction material) is presented in Section II: College Profile – Built Environment.

FUTURE CLIMATE VARIABILITY[7]

The OCCRI *Future Climate Projections Report* for both Benton County and Linn County (Dalton et al., 2023) both project that wildfire frequency, intensity, and extent will continue to increase across the Northwest and local region. In part, the increased incidence of wildfire is due to growing drought conditions, increased number of extreme heat events, anthropogenic emissions and development occurring in the wildland urban interface (WUI). Wildfire risk is expressed as the average number of days per year where fire danger is very high. Wildfire risk in Benton County is projected to increase by 11 days (range -7–25) by the 2050s, while Linn County is projected to see an increase of very high fire dangers day by 12 days (range -6–31).

Extreme fire weather during late summer and autumn increased by about 40% over the western United States and about 50% over western Oregon. This late season increase in wildfires is largely due to drier vegetation and warmer temperatures during dry wind events. Increased severity of wildfire events and the subsequent increase in wildfire smoke will impact the health of all demographics and vulnerable populations in particular, including people who are unsheltered, people who work outdoors, and people who live with chronic medical conditions such as asthma.

[7] OCCRI, *Future Climate Projections Benton County, Oregon*, 2023; OCCRI, *Future Climate Projections Linn County, Oregon*, 2023

WINDSTORM

CHARACTERISTICS

Extreme winds occur throughout Oregon. Windstorms throughout the Willamette Valley usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain (*2015 Oregon NHMP*). The most persistent high winds take place along the Oregon Coast and in the Columbia River Gorge. West winds generated from the Pacific Ocean are strongest along the coast and slow down inland due to the obstruction of the Coastal Mountain Range U.S. Department of Agriculture). Prevailing winds in Oregon vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction. For example, the north-south orientation of the Willamette Valley channels the wind most of the time, causing predominantly north and south winds (Statesman Journal, 2002). Windstorms at different speeds can have varying effects and extent of damage, which can be seen in the wind speed effect breakdown in the Table 8**.**

Table 8 The Effect of Wind Speed

Wind Speed (mph)	Wind Effects
25-31	Large branches will be in motion.
32-38	Whole trees in motion; inconvenience felt walking against the wind.
39-54	Twigs and small branches may break off of trees; wind generally impedes progress when walking; high profile vehicles such as trucks and motor homes may be difficult to control.
55-74	Potential damage to TV antennas; may push over shallow rooted trees especially if the soil is saturated.
75-95	Potential for minimal structural damage, particularly to unanchored mobile homes; power lines, signs, and tree branches may be blown down.
96-110	Moderate structural damage to walls, roofs and windows; large signs and tree branches blown down; moving vehicles pushed off roads.
111-130	Extensive structural damage to walls, roofs, and windows; trees blown down; mobile homes may be destroyed.
131-155	Extreme damage to structures and roofs; trees uprooted or snapped.
Greater than 155	Catastrophic damage; structures destroyed.

Source: Washington County, Oregon Emergency Management

And although rare, tornadoes can and do occur in Oregon. Nonetheless, Oregon and other western states have experienced tornadoes on occasion, many of which have produced significant damage and occasionally injury or death. Oregon's tornadoes can be formed in association with large storms arriving from the west. Most of them, however, are caused by intense local thunderstorms. These storms also produce lightning, hail, and heavy rain and are more common during the warm season from April to October (Taylor et al., 1996).

LOCATION AND EXTENT

Windstorms that affect LBCC usually occur from October to March, and their extent is determined by their track, intensity (the air pressure gradient they generate), and local terrain, according to the Oregon NHMP (2015).

The most frequent surface winds in Oregon are from the southwest. These widespread winds are associated with storms moving onto the coast from the Pacific Ocean. Winds coming from the south are the most destructive. The Columbus Day Storm of 1962 was an example of this type of windstorm. West winds generate from the Pacific Ocean and are strong along the coast, but slow down inland due to the obstruction of the Coastal and Cascade Mountain range. Prevailing winds in Oregon vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east.

Typically, mountainous terrain slows down wind movement, which is why Oregon's sheltered valley areas have the slowest wind speed in the state. However, in the foothills, the wind speeds may increase due to down-sloping winds from the mountains.

HISTORY

Windstorms have historically been a threat to Willamette Valley. Windstorm events over the last century are listed in the table below in Table 9.

Table 9. Windstorm History

Date	Location	Description
Apr. 1931	**Western Oregon**	Unofficial wind speeds reported at 78 mph; damage to fruit orchards and timber
Nov. 10-11, 1951	**Statewide**	Widespread damage; transmission and utility lines; Wind speed 40-60 mph; gusts 75-80 mph
Dec. 1951	**Statewide**	Wind speed 60 mph in Willamette Valley; 75-mph gusts; damage to buildings and utility lines
Dec. 1955	**Statewide**	Wind speeds 55-65 mph with 69-mph gusts; considerable damage to buildings and utility lines
Nov. 1958	**Statewide**	Wind speeds at 51 mph with 71-mph gusts; every major highway blocked by fallen trees
Oct. 1962	**Statewide**	Columbus Day Storm; Oregon's most destructive storm to date; 116-mph winds in Willamette Valley; estimated 84 houses destroyed, with 5,000 severely damaged; total damage estimated at $170 million

Date	Location	Description
Mar. 1971	**Most of Oregon**	Greatest damage in Willamette Valley; homes and power lines destroyed by falling trees; destruction to timber in Lane County
Nov. 1981	**Most of Oregon**	Highest winds since Oct. 1962; wind speed 71 mph in Salem; marinas, airports, and bridges severely damaged
Jan. 1990	**Statewide**	Heavy rain with winds exceeding 75 mph; significant damage; one fatality
Dec. 1995	**Statewide**	Followed path of Columbus Day Storm; wind speeds 62 mph in Willamette Valley; damage to trees (saturated soil a factor) and homes (FEMA-1107-DR-Oregon)
Nov. 1997	**Western Oregon**	Wind speed 52 mph in Willamette Valley; trees uprooted; considerable damage to small airports
Feb. 2002	**Western Oregon**	Strongest storm to strike western Oregon in several years; many downed power lines (trees); damage to buildings; water supply problems (lack of power); estimated damage costs: $6.14 million (FEMA-1405-DR-Oregon)
Dec. 2005	**Marion and Linn Counties**	$3,000 in property damage
Jan. 2005	**Linn and Marion Counties**	Windstorms cause $6,000 of damage in Linn and Marion Counties; a storm total of $15,000 in damages spread out among, Linn, Marion, Clackamas, Multnomah, and Washington Counties
Feb. 2006	**Linn, Marion, Lane, Benton, Polk, and Yamhill Counties**	Windstorms with gusts up to 77 mph cause $227,000 in damages in Linn, Lane, Marion, Benton, Polk, and Yamhill Counties; storm causes damages in region 2 and region 1 as well for a total storm damage of $575,000
Dec-2012	**Linn County**	A Pacific cold front brought strong southerly winds to the North and Central Oregon Coast. Weather spotter near Lebanon reported peak wind gusts of 62 knots (71mph).
Dec. 2015	**Regions 1-4**	FEMA-4258-DR: Severe winter storms, straight-line winds, flooding, landslides, and mudslides
Apr. 2019	**Curry, Douglas, Linn, Wheeler, Grant, and Umatilla**	FEMA-4452-DR: Severe storms, straight-line winds, flooding, landslides, and mudslides
Sep-2020	**Statewide**	FEMA-4562-DR: Oregon Wildfires and Straight-line Winds
Dec-2022	**Western Oregon, Cascades**	High Winds. A strong frontal system probably. South winds probably. Gusts up to 82 mph.

Source: *2020 Oregon NHMP*; NOAA Storm Events Database

RISK ASSESSMENT

PROBABILITY ASSESSMENT

The steering committee determined that based on the recent science and data, **the probability of a windstorm occurring is "High",** meaning that LBCC will be affected by multiple and severe windstorms within 10-35 years. *This rating has remained the same since the previous NHMP.*

The hazard history section details 20 severe windstorms affecting the Willamette Valley in the last 92 years. While other storms could have been included with more background information available, those included average out to one windstorm or tornado every 3.4 years.

VULNERABILITY ASSESSMENT

The committee determined that **the campus vulnerability to windstorms is "Moderate",** meaning that between 1-10% of the population, property, and equipment would be affected by a windstorm. *This rating has decreased since the previous NHMP*.

Windstorms can result in damaged or blocked roads and bridges, downed utility lines, and damaged traffic signals and streetlights, among other impacts that may inhibit campus accessibility. Also, the damaging effects of windstorms can extend distances of 100 to 300 miles from the center of storm activity, which further hinders students' ability to commute to school.

Damage to structures and property is also a common result of a windstorm, as buildings adjacent to open fields or trees are more vulnerable to windstorms than more protected structures.

Utility failure can often be the result of severe windstorms. Overhead power lines can be damaged even in relatively minor windstorm events and are vulnerable to flying debris. Utility failure includes the loss or disruption of any primary energy source and/or utility source needed to maintain operations at LBCC and satellite locations. The primary sources of energy used at LBCC include electricity, natural gas, oil, and gas. Other utilities to consider include heating, cooling, water, and sewage. Utility disruptions can have a major impact on LBCC's ability to operate and provide adequate safety to students and employees.

Since LBCC mainly relies on the local civic government and private companies for energy and utilities, failures affecting LBCC may be outside of campus control. The magnitude and severity of a utility failure is dependent on a series of factors, such as time of year, temperature, community priorities, and vulnerable populations.

FUTURE CLIMATE VARIABILITY[8]

The OCCRI *Future Climate Projections Report* for both Benton County and Linn County (Dalton et al., 2023) both project that while mean wind speeds and frequency of strong easterly winds during peak wildfire season will decrease, extreme winter wind speeds may increase. These changes in wind patterns will affect natural disturbances, the provision of electricity, transportation safety, and contribute to the spread of wildfires and pollutants.

[8] OCCRI, *Future Climate Projections Benton County, Oregon*, 2023; OCCRI, *Future Climate Projections Linn County, Oregon*, 2023

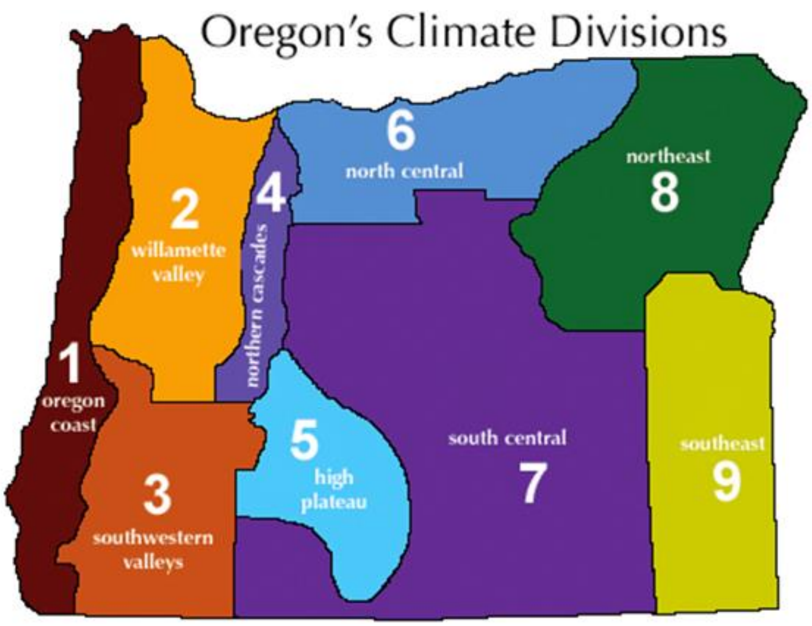
WINTER STORM

CHARACTERISTICS

Severe winter storms can consist of rain, freezing rain, ice, snow, cold temperatures, and wind. They originate from troughs of low pressure offshore that ride along the jet stream during fall, winter, and early spring months. Severe winter storms affecting Linn and Benton Counties typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from October through March, according to the *2020 Oregon NHMP*.

The National Climatic Data Center has established climate zones in the United States for areas that have similar temperature and precipitation characteristics, as seen in Figure 23. Oregon's latitude, topography, and proximity to the Pacific Ocean give the state diversified climates. Linn and Benton Counties, home to LBCC facilities, are in Zones 2 and 4, which generally consist of wet winters and dry summers (Western Regional Climate Center).

Figure 23. Oregon Climate Zones



Source: Oregon Climate Service

While snow is relatively rare in western Oregon, the break in the natural Cascades barrier at the Columbia Gorge provides a low-level passage through the mountains. Cold air, which lies east of the Cascades, often moves westward through the gorge and funnels cold air into the Portland area, which can then sink southward into the Willamette Valley. If a wet Pacific storm happens to reach the area at the same time that cold air is present, larger than average snow events may result.

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia Gorge. Like snow, ice storms are comprised of cold temperatures and moisture, but subtle changes can result in varying types of ice formation, including freezing rain, sleet, and hail. Freezing rain can be the most damaging of ice formations. While sleet and hail can create hazards for motorists when it accumulates, freezing rain can cause the most dangerous conditions within a community. Ice buildup can bring down trees, communication towers, and wires, creating hazards for property owners, motorists, and pedestrians alike. The most common freezing rain problems occur near the Columbia Gorge but also pose a hazard to Linn and Benton Counties.

LOCATION/EXTENT

The magnitude or severity of severe winter storms is determined by a number of meteorological factors, including the amount and extent of snow or ice, air temperature, wind speed, and event duration. Like windstorms, the major hazard risk for the campus is tree hazards and pedestrian walks becoming inaccessible.

All of the LBCC campuses are vulnerable to winter storms. When these winter storms occur, the effects are not localized; they typically extend region wide. The magnitude or severity of winter storms is determined by a number of meteorological factors, such as the amount and extent of snow or ice, air temperature, wind speed, and event duration.

Precipitation, an additional element of winter storms, is measured by gauging stations. The Portland Bureau of the National Weather Service monitors the stations and provides public warnings on storm, snow, and ice events as appropriate.

HISTORY

Destructive storms, producing heavy snow and ice, have occurred throughout the Willamette Valley. The most significant storms that have affected are listed below in Table 10.

Table 10. Winter Storm History

Date	Location	Description
Dec. 1861	**Statewide**	Snowfall varied between 1 and 3 feet; did not leave Willamette Valley floor until late February.
Dec. 1864	**Willamette Valley and Columbia Basin**	Heavy snowfall; Albany (Linn County) received 16 inches in one day.
Jan. 1916	**Statewide**	Two snowstorms, each totaling 5 inches or more.
Dec. 1919	**Corvallis (Benton County**	Corvallis received 22 inches of snow and set an all-time low temperature record of 14 °F.
Jan.- Feb. 1937	**Statewide**	Heavy snow throughout the Willamette Valley; Dallas (Polk County) had 24 inches; Salem (Marion County) had 25 inches.

Date	Location	Description
Jan. 1950	**Statewide**	Heaviest snowfall since 1890; many highway closures; considerable property damage.
Jan. 1956	**Western Oregon**	Packed snow became ice; many automobile accidents throughout the region.
Mar. 1960	**Statewide**	Snowfall: 3–12 inches, depending on location; more than 100 snow-related accidents in Marion County.
Jan. 1969	**Statewide**	Lane County surpassed old snowfall record; Eugene (Lane County) had a total snow depth of 47 inches; three to $4 million in property damage.
Jan. 1980	**Statewide**	A series of storms bringing snow, ice, wind, and freezing rain; six fatalities.
Feb. 1985	**Statewide**	Western valleys received 2–4 inches of snow; massive power failures (tree limbs broke power lines).
Dec. 1985	**Willamette Valley**	Heavy snowfall throughout valley.
Mar. 1988	**Statewide**	Strong winds and heavy snow.
Feb. 1989	**Statewide**	Heavy snowfall and record low temperatures; Salem (Marion County) received 9 inches.
Feb. 1990	**Statewide**	Average snowfall from one storm about 4 inches (Willamette Valley).
Dec. 1992	**Western Oregon**	Heavy snow; interstate highway closed.
Feb. 1993	**Western Oregon**	Record snowfall at Salem airport.
Winter 1998-99	**Statewide**	Series of storms; one of the snowiest winters in Oregon history.
Dec. 2003 -Jan. 2004	**Statewide**	FEMA-1510-DR: Wet snow blanketed highways in the Willamette Valley, causing power lines and trees to topple; Oregon 34 east of Philomath was closed for 30 hours January 5 and 6 while crews removed trees; Presidential disaster declaration for 30 of Oregon's 36 counties.
Mar. 8–10, 2006	**Lane, Linn, Benton, Marion, Polk, Yamhill Counties**	snow fell up to a few inches at the coast and through the Willamette Valley; many school closures.
Dec. 9–11, 2009	**Marion, Linn, Lane Counties**	freezing rain covered the central valley with a coating of ice; south of Salem, numerous road closures due to accidents caused by icy roadway; I-84 from Troutdale to Hood River closed for 22 hours.
Feb. 6–10, 2014	**Lane, Benton, Polk, Yamhill, Linn, and Marion Counties**	FEMA-4169-DR: A strong winter storm system affected the Pacific Northwest bringing a mixture of arctic air, strong east winds, significant snowfall and freezing rain to several counties in northwest Oregon. During the 5-day period, 5 to 16 inches of snow fell in many valley locations and 2 to10 inches in the coastal region of northwest Oregon; freezing rain accumulations generally were 0.25 to 0.75 inches; the snowfall combined with the freezing rain had a tremendous impact on the region.

Date	Location	Description
Feb. 11–14, 2014	**Lane, Benton, Polk, Yamhill, Linn, and Marion Counties**	FEMA-4169-DR: Another weather system moved across northwest Oregon during the February 11–14-time frame. This storm was distinctly different from the storm that produced the snow and ice the week prior and brought abundant moisture and warm air from the sub-tropics into the region. As this storm moved across the area, 2 to 7 inches of rain fell across many counties in western Oregon; the heavy rainfall combined with warm temperatures led to snowmelt and rainfall runoff that produced rapid rises on several rivers, which included flooding on three rivers in northwest Oregon.
Nov. 13, 2014	**Marion, and Linn Counties (North Cascade foothills)**	An early cold snap hit the Pacific Northwest before moist Pacific air moved in and resulted in one of the earliest snow, sleet, and freezing rain events in northwestern Oregon. Farther south, 1/2 of freezing rain accumulated on trees in the coast range foothills outside of Corvallis and Dallas, Oregon. Upwards of a quarter of an inch of ice fell around Dallas, Oregon. Some snow fell, but accumulations were primarily restricted to the Cascade valleys and the central Columbia River Gorge. Spotters reported around 6 to 8 inches of snow for the Cascade Foothills followed by a quarter of an inch of ice.
Dec. 6-23, 2015	**Statewide**	FEMA-4258-DR: Several pacific storm systems moved across the region over the Dec 12-13 weekend. Each storm system brought several inches of snow to the mountain areas. At first the snow was limited to higher elevations...but lowered with time to some of the west side valley floors.
Mar. 13, 2016	**Marion, Linn and Lane Counties (North Oregon Cascades and Cascades in Lane County)**	A strong low-pressure system generated frequent and persistent snow showers over the northern and central Oregon Cascades. Several SNOTEL stations measured 16 to 24 inches of snow over a 24-to-30-hour period above 3500 feet.
Dec. 14-15, 2016	**Lane, Benton, Marion, and Linn Counties (Southern Willamette Valley, Cascade foothills in Lane County, Northern Cascade foothills)**	FEMA-4296-DR: Severe winter storm and flooding. East winds ahead of an approaching low-pressure system brought temperatures down below freezing across the area leading to a mix of freezing rain, sleet, and snow. Snow followed by sleet and freezing rain. The freezing rain turned into a major ice storm occurred in Eugene and the vicinity with 0.5 to 1.0 inch of ice accumulation observed. There was significant damage to trees and power lines, and fairly widespread power outages across the region. 15,000 people were without power.
Dec. 26-27, 2016	**Linn and Marion, Counties (North Oregon Cascades)**	A frontal system brought high winds to the Central Oregon Coast, heavy snow to the Cascades and a mix of ice and snow in the Columbia River Gorge and Hood River Valley. SNOTELs and other stations reported a range of 12 to 25 inches of snow in the Cascades.

Date	Location	Description
Jan. 7-8, 2017	**Lane, Benton, Polk, Yamhill, Linn, and Marion Counties (Central and Southern Willamette Valley, North Cascades foothills)**	FEMA-4328-DR: Severe Winter Storms, Flooding, Landslides, and Mudslides. A broad shortwave trough brought multiple rounds of precipitation, including a wintry mix of snow and ice for many locations across Northwest Oregon. Strong easterly pressure gradients generated high winds through the Columbia River Gorge. General snowfall totals of 2-4 inches were reported, with the greatest total being 4.5 inches. Major ice accumulations occurred after the snow, with several locations reporting 0.50-1.00. The combination of snow and ice resulted in significant power outages and closures across the area.
Feb. 11-15, 2021	**Clackamas, Yamhill, Polk, Marion, Benton, and Linn Counties**	FEMA-4599-DR: Wide variety of impacts due to snow and ice, ranging from a crippling snow/ice event in the northern half, a crippling ice event in the Santiam Canyon, to minimal impacts in mostly plain rain for the extreme southern portion of the zone. There were reports of over 2 feet of snow just east of the zone boundary, even at elevations below 2500'.

Source: *2020 Oregon State NHMP*

RISK ASSESSMENT

PROBABILITY ASSESSMENT

Based on the available data and research, the Steering Committee **determined the probability of experiencing a winter storm is "High",** meaning one incident is likely within the next 10 to 35-year period. *This rating has remained the same since the previous NHMP*.

The Willamette Valley has experienced approximately 25 severe winter storms in the last 100 years, in the form of snow, ice, or severe cold. This averages out to one severe winter storm every seven years.

VULNERABILITY ASSESSMENT

The committee determined that **the vulnerability of a severe winter storm to LBCC campuses is "High",** meaning between 1-10 percent of the population, facilities, equipment, and campus operations would be impacted by a severe winter storm. *This rating has decreased since the previous NHMP*.

Severe winter storms can cause power outages, create transportation and economic disruptions, and pose a high risk for injuries and loss of life. Linn and Benton Counties have suffered severe winter storms in the past that brought economic hardship and affected the life and safety of community residents, including the students, staff, and faculty of LBCC.

The most likely impact of snow and ice events on Benton and Linn County are road closures limiting access/egress to/from some areas, especially roads to higher elevations. Closed roads due to debris and damage to infrastructure can become a major obstacle to students, faculty and staff when commuting to class. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles, which can impact students' and staffs' access to the internet, especially for those who take online courses.

Several facilities throughout the main campus anticipate mild damage due to winter storms. In terms of campus activity, it is likely that LBCC could experience campus operations interruption for a period of days until driving conditions improve, resulting in temporary school closure. Winter storms will likely have the greatest impacts on the transportation system, as snow and ice can cause dangerous driving conditions. Lastly, winter storms could likely have extensive impacts on vehicles, pedestrians, and trees. Hundreds of trees cover the main campus. During winter storms, these trees can pose a threat through falling branches, ice, and snow. In addition, icy sidewalks can create pedestrian hazards as sidewalks are the major method of access to campus buildings beyond the parking lot.

FUTURE CLIMATE VARIABILITY[9]

The OCCRI *Future Climate Projections Report* for both Benton County and Linn County (Dalton et al., 2023) both project cold extreme to become less frequent and intense as the climate warms. However, the frequency of cold extremes decreases at a slower rate than the increase of heat extremes. Cold extremes will diminish as winter temperatures warm and become less variable. It is estimated that the number of cold days (maximum temperature 32°F or lower) per year in Benton County will decrease by an average of 0.5 (range -1.1–0.3) by the 2050s, while the temperature on the coldest night of the year is projected to increase by an average of 5°F (range 1–10°F). In Linn County, the number of cold days is projected to decrease by 4 (range 2–5), and temperatures on the coldest night of the year is projected to increase by an average of 6°F (range 1–11°F).

The number of county residents vulnerable to extreme cold is likely to grow, although the decrease in incidence of cold extremes may offset a percentage of residents affected.

[9] OCCRI, *Future Climate Projections Benton County, Oregon*, 2023; OCCRI, *Future Climate Projections Linn County, Oregon*, 2023