

Natural Hazards Mitigation Plan

January 2020



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Summary

The City of Beaverton (the City) developed and maintains this Natural Hazards Mitigation Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

This is the second revision to the original NHMP which was originally completed in 2003 and revised in 2011.

The information used to inform this plan is constantly changing. The specific information in this revision is a “snapshot” in time and was the most current information available at that point in the plan update process.

Natural Hazard Mitigation

Natural hazard mitigation is defined as a method permanently reducing or alleviating losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Natural hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.¹

Why Have a Mitigation Plan

Federal law requires that the City identify a comprehensive set of mitigation measures related to local natural hazards. An additional stipulation is that to receive pre- and post- disaster mitigation funds from FEMA, local governments must have a current, FEMA approved NHMP. NHMPs must be updated and re-approved every five years.

These requirements were established when Congress passed and the President signed the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under DMA 2000 and the associated rules published in 44 CFR Part 201.6, communities, states, and tribal governments must have FEMA-approved natural hazard mitigation plans to be eligible for certain federal assistance programs such as the Hazard Mitigation Grant Program (HMGP).²

What are the City’s Overall Risk to Natural Hazards?

The City of Beaverton’s Emergency Management Program reviews and updates the risk assessment regularly to evaluate the probability of each natural hazard as well as the vulnerability of the community to those hazards. Scores are based on the City’s Hazard Analysis that is submitted to the Oregon Office of Emergency Management as part of the update cycle of the City’s Emergency Operations Plan. Table 1 below summarizes hazard probability and vulnerability as determined by the methodology developed by FEMA and refined by Oregon Office of Emergency Management (for more information see Section 2, Risk Assessment and Appendix G).

Table 0.1 Risk Assessment Summary

Hazard	Probability	Vulnerability	Total Score	Hazard Rank
Severe Weather - Windstorms	High	High	208	#1
Severe Weather - Winter Storms	High	Moderate	203	#2
Earthquakes	High	High	203	#3
Flood	High	Moderate	188	#4
Volcano (Ash Fall)	Moderate	Moderate	178	#5
Drought	Moderate	Moderate	155	#6
Landslides and Debris Flow	Moderate	Low	86	#7

How Does the Plan Reduce Risk?

This Natural Hazards Mitigation Plan (NHMP) is intended to assist the City of Beaverton in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City. The City received one third of the funds to develop the original plan, with the assistance of a consultant, from the Flood Mitigation Assistance (FMA) Program, a Federal Emergency Management Agency (FEMA) grant program. The City of Beaverton provided the additional funds for the plan’s development from its General Fund. The maintenance and update to the plan was conducted by City staff and volunteers from the community serving on the NHMP Steering Committee. All costs associated with the maintenance, update and distribution of the plan were paid for out of the City’s general fund.

Mitigation Plan Mission

The mission of the Beaverton Natural Hazards Mitigation Plan is to assist in reducing risk, preventing loss, and protecting life, property, and the environment from future natural hazard events. The plan fosters coordinated partnerships and the development of multi-objective strategies for reducing the risks posed by natural hazards.

Mitigation Plan Goals

The mitigation plan goals help to guide the direction of future activities aimed at reducing risk and preventing loss from natural hazards. These goals serve as checkpoints as the City continues implementing mitigation action items.

The following are the goals for the City of Beaverton's Natural Hazards Mitigation Plan.

Goal 1: Develop and Implement Strategies to Protect Human Life, Commerce, Property, and Natural Systems from Natural Hazards

Goal 2: Improve Partnerships for Communication and Coordination

Goal 3: Enhance Emergency Services

Goal 4: Ensure Implementation of Mitigation Strategies

Who Participated in Developing the Plan?

The initial City of Beaverton Natural Hazards Mitigation Plan was the result of a collaborative effort between Beaverton citizens, public agencies, non-profit organizations, the private sector, and state and regional organizations. Public participation played a key role in the development of goals and action items. The research team conducted interviews with stakeholders throughout the City, held multiple focus groups, and researched and reviewed information on each of the hazards most common to Beaverton. A project steering committee consisting of City staff and stakeholders guided the process of developing the plan.

Plan Revision

Federal requirements for the maintenance of natural hazards mitigation plans, and for remaining eligible for mitigation grants, includes the need to review and update the plan at least every five years. This is to help ensure that the plan remains an active and relevant document. The City's Emergency Management Program, assisted by the Natural Hazards Mitigation Plan (NHMP) Steering Committee, is responsible for the review and update of the plan.

This is the second revision to the original NHMP which was originally completed in 2003 and revised in 2011. While this current update was started in 2015 to meet the 5

year requirement of being completed in 2016; various factors contributed to multiple delays in getting the revision completed. During that timeframe a number of people were involved in the review and comments; including some who no longer work for the City or the agency that they were representing.

NHMP Steering Committee

The Natural Hazards Mitigation Plan Steering Committee serves as the coordinating body for the plan and is responsible both for coordinating the implementation of plan action items and for undertaking the formal review process. The Mayor's Office will ensure that appropriate representatives are assigned from the applicable City departments and programs, including, but not limited to, the current Natural Hazards Mitigation Steering Committee members. Members of the steering committee include representatives from:

- City of Beaverton Emergency Management Program
- City of Beaverton Community Development Department
- City of Beaverton Public Works
- City of Beaverton Finance/ISD/GIS Service
- Beaverton Community Emergency Response Team (CERT)
- Beaverton Committee for Citizen Involvement (BCCI)
- City of Beaverton Mayor's Office
- City of Beaverton City Council

The Natural Hazards Mitigation Steering Committee meets no less than bi-annually. These meetings provide an opportunity to discuss the progress of the action items in the plan, and maintain the partnerships that are essential for the sustainability of the Mitigation Plan. Some of these meetings are conducted electronically.

External partners who have participated on the Steering Committee or have provided recommendations on plan sections includes:

- Washington County Emergency Management
- Tualatin Valley Fire & Rescue
- Portland General Electric (PGE)
- Northwest Natural
- Oregon Department of Land Conservation and Development

How is the Plan Organized?

There are two parts of the plan, the Basic Plan and the Appendices. Each section provides specific information and resources to assist readers in understanding the

hazard-specific issues facing City of Beaverton residents, businesses, and the environment. Combined, the sections work together to create a mitigation plan that furthers the community’s mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. The plan’s structure also enables stakeholders to easily locate and use the section(s) of interest to them. Additional details on the plan components are contained in Section 1 of the Basic Plan.

Basic Plan

Plan Summary

Section 1 - Introduction

Section 2 - Risk Assessment

Section 3 - Mitigation Strategy

Section 4 - Implementation and Maintenance

Map Directory

Appendices

Appendix A: Action Items

Appendix B: Planning and Public Process

Appendix C: Community Profile

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

Appendix E: Grant Programs and Resources

Appendix F: 2019 Preparedness and Mitigation Survey

Appendix G: Hazard Analysis

Executive Summary Endnotes

¹ Massachusetts Department of Environmental Management. 1999. “Hazard Mitigation: Managing Risks, Lowering Costs. <http://www.state.ma.us/dem/programs/mitigate/whatis.htm> Accessed 8/2/02

² DMA 2000, State and Local Plan Criteria: Mitigation Planning Workshop for Local Governments, http://www.fema.gov/fima/planning_toc4.shtm

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Section 1

Introduction

The City of Beaverton (the City) developed this Natural Hazards Mitigation Plan in an effort to protect life, property and the environment from the impacts of natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

A natural disaster occurs when a natural hazard impacts people or property and creates adverse conditions within a community. Natural hazards include: floods, earthquakes, coastal erosion, tsunami, volcanic eruption, severe winter storm, windstorm, drought, and wildfire, and each has the potential to harm people or property.¹ This plan focuses on the natural hazards which could affect the City of Beaverton, Oregon.

While the City of Beaverton's climate is generally mild and its terrain relatively gentle in its relief, natural hazards do pose a threat to the city's economy and its citizen's property and health. As noted throughout this plan, natural disasters have caused major problems in Beaverton in recent history. Heavy winter rainstorms and windstorms, along with occasional severe winter snow or ice storms, pose a threat to the City. Beaverton's location near a major geologic subduction zone places it in danger of experiencing significant earthquake damage as well as fallout from volcanic eruption. Planning for the occurrence of these hazards will help strengthen vital components of the city's infrastructure and minimize the risk and incidence of personal injuries, fatalities, and property damage. Wildfires and landslides have not significantly impacted Beaverton in the past, but these hazards may become more prominent as the City annexes lands to the northeast and southwest in the future.

What is Natural Hazard Mitigation?

Natural hazard mitigation is defined as permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.²

Engaging in mitigation activities provides jurisdictions with a number of benefits including reduced loss of life, property, essential services, critical facilities and economic hardship, reduced short-term and long-term recovery and reconstruction costs, increased cooperation and communication within the community through the planning process and increased potential for state and federal funding for recovery and reconstruction projects.

Why Develop a Mitigation Plan?

The dramatic increase of the costs associated with natural disasters over the past decades has fostered interest in identifying and implementing effective means of reducing vulnerability. This natural hazards mitigation plan is intended to assist the City of Beaverton in reducing its risk from natural hazards by identifying resources, information, and strategies for risk reduction. It will also help to guide and coordinate mitigation activities throughout the City.

The plan is non-regulatory in nature, meaning that it does not set forth any new policy. It does however, provide:

- (1) A foundation for coordination and collaboration among agencies and the public in the City of Beaverton;
- (2) Identification and prioritization of future mitigation activities; and
- (3) Assistance in meeting federal planning requirements and qualifying for assistance programs.

The mitigation plan works in conjunction with other City plans and programs including the Comprehensive Land Use Plan, Emergency Operations Plan, Economic Development Strategic Plan, Capital Improvement Plan; as well as the Washington County and Oregon Natural Hazard Mitigation Plans.

The plan provides a recommended set of actions to prepare for and reduce the risks posed by natural hazards through education and outreach programs, the development of partnerships, and implementation of preventative activities such a land use or watershed management programs. The actions described in the plan are intended to be implemented through existing plans and programs within the City.

This plan is not the first effort the City has undertaken in natural hazard mitigation. The City has undergone a seismic survey of city facilities, developed and routinely conducts public and employee preparedness training, upgraded portions of the Griffith Building,³ and upgraded the Public Works Operations Facility.

Why Revise the Plan?

Federal requirements (DMA 2000 and 44 CFR 201) for the maintenance of natural hazards mitigation plans, and for remaining eligible for mitigation grants, includes the need to review and update the plan at least every five years. This is to help ensure that the plan remains an active and relevant document. Local, state and federal approval of this plan ensures that the city remains eligible for pre- and post- disaster mitigation project grants.

Who Will the Plan Affect?

The plan affects the City of Beaverton, which includes the incorporated areas north of Highway 26 south to Scholls Ferry/Taylor's Ferry Roads and from the Multnomah/Washington County line west to 170th & 185th. While this plan does not establish mandates for the City, it does provide a viable framework for planning for natural hazards. The resources and background information in the plan are applicable citywide, and the goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships. Recognizing that natural hazards do not start or stop a jurisdictions boundaries, mitigation action items identified in the Beaverton plan overlap with mutual benefit to many actions identified in the Washington County mitigation plan, which includes the cities of Tigard and Hillsboro, which share some boundaries with the City of Beaverton.

What Federal Requirements Does This Plan Address?

The Disaster Mitigation Act of 2000, commonly known as DMA 2000 is the federal law that addresses mitigation planning. It reinforces the importance of mitigation planning and emphasizes planning for natural hazards before they occur. As such, this Act established the Pre-Disaster Mitigation (PDM) grant program and the post-disaster Hazard Mitigation Grant Program (HMGP). Section 322 of the Act specifically addresses mitigation planning at the state and local levels. State and local jurisdictions must have approved mitigation plans in place in order to qualify to receive PDM, HMGP, and Flood Mitigation Assistance (FMA) grant funds. Some grant funds can be used to fund hazard mitigation planning projects. Mitigation plans must demonstrate that state and local jurisdictions' proposed mitigation measures are based on a sound planning process that accounts for the risk to the individual and the capabilities of state and local jurisdictions.

Pursuant of Chapter 44 CFR, the NHMP planning processes shall include public comments on the plan during review, and the updated NHMP shall include documentation of the public planning process used to develop the plan. The NHMP

update must also contain a risk assessment, mitigation strategy, and a plan maintenance process that has been formally adopted by the governing body of the jurisdiction. Lastly, the NHMP must be submitted to the Oregon Military Department – Office of Emergency Management (OEM) for initial plan review and then to the Federal Emergency Management Agency (FEMA). Additionally, a recent change in the way OEM administers the Emergency Management Performance Grant (EMPG), which helps fund local emergency management programs, also requires a FEMA- approved NHMP.

What is the Policy Framework for Natural Hazards Planning in Oregon?

Planning for natural hazards is an integral element of Oregon’s statewide land use planning program, which began in 1973. All Oregon cities and counties have comprehensive plans and implementing ordinances that are required to comply with the statewide planning goals. The challenge faced by state and local governments is to keep this network of local plans coordinated in response to the changing conditions and needs of Oregon communities.

Statewide land use planning Goal 7, Areas Subject to Natural Hazards, calls for local plans to include inventories, policies, and ordinances to guide development in hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. Through risk identification and the recommendation of risk-reduction actions, this plan aligns with the goals of the comprehensive plans for the three jurisdictions and helps each jurisdiction meet the requirements of statewide land use planning Goal 7.

The primary responsibility for the development and implementation of risk reduction strategies and policies lies with local jurisdictions. However, resources exist at the state and federal levels. Some of the key agencies in this area include Oregon Emergency Management (OEM), Oregon Building Codes Division (BCD), Oregon Department of Forestry (ODF), Oregon Department of Geology and Mineral Industries (DOGAMI), and the Department of Land Conservation and Development (DLCD).

How Was the Plan Developed and Updated?

The initial NHMP was developed in 2003 using a planning process created by the Oregon Natural Hazard Workgroup at the University of Oregon. The planning process was designed to:

- (1) Result in a plan that is DMA 2000 compliant,
- (2) Coordinate this plan with the Washington County Natural Hazard Mitigation Plan⁴, and;

(3) Build a network of jurisdictions and organizations that can play an active role in plan implementation.

The initial NHMP plan was developed with funding assistance from the Flood Mitigation Assistance (FMA) Program, a Federal Emergency Management Agency (FEMA) grant program. The City of Beaverton provided the balance of the funds for the plan's development from its general fund. Costs associated with the maintenance, revision and distribution of the plan are paid for out of the City's general fund.

The City's Emergency Management Program, assisted by the Natural Hazards Mitigation Plan (NHMP) Steering Committee, is responsible for the review and update of the plan. The plan was originally adopted in 2003 and was reviewed and updated in 2011. The revised plan was subsequently adopted by the City Council and approved by FEMA. Due to competing priorities within the Emergency Management Program this update has been delayed but the information contained in the previous version was still relevant and used to guide the City's mitigation activities.

The review and update of this version of the plan was conducted through meetings of the NHMP Steering Committee and electronically through email and shared documents. Additional coordination was done electronically with staff and organizations who are not part of the Steering Committee.

An open public involvement process is essential to the development of an effective NHMP. In order to develop a comprehensive approach to reducing the effects of natural disasters, the planning process included opportunities for the public, neighboring communities, local and regional agencies, and private and non-profit entities to comment on the NHMP during review.⁵

The previous version of the plan was maintained on the City's public website along with a link where comments on the plan could be provided to the Emergency Management Program. When the process to revise and update the plan was started, information on the update and solicitation for comment were posted on the Home Page of the City's website and published in the "Your City" newsletter. Information on how to submit comments and proposed changes were included in the information. Links to the on-line survey were also provided in the "Your City" article and on the City's Home Page. See Appendix B for additional information on public involvement.

Public participation during the plan updates were significantly more through the website and survey than during hosted public open houses combined that were conducted for the plan's initial development.

How is the Plan Organized?

There are two parts of the plan, the Basic Plan and the Appendices, which provide background information. Each section provides specific information and resources to assist readers in understanding the hazard-specific issues facing the City of Beaverton

residents, businesses, and the environment. Combined, the sections work together to create a mitigation plan that furthers the community’s mission to reduce or eliminate long-term risk to people and their property from hazards and their effects. The plan’s structure also enables stakeholders to easily locate and use the section(s) of interest to them.

Basic Plan

Plan Summary

The Plan Summary provides an overview of the FEMA requirements, planning process and highlights the key elements of the risk assessment, mitigation strategy, and implementation and maintenance strategy.

Section 1 - Introduction

The Introduction briefly describes the citywide mitigation planning efforts and the methodology used to develop the Plan.

Section 2 - Risk Assessment

The Risk Assessment provides the factual basis for the mitigation strategies contained in Section 3. The Risk Assessment includes a brief description of community sensitivities and vulnerabilities, and characteristics that may be impacted by natural hazards.

A hazards summary is provided for each of the hazards addressed in the NHMP, which includes a hazard characteristic, history, probability assessment, and vulnerabilities.

The following hazards are profiled in the Risk Assessment:

- Severe Weather – Windstorm
- Severe Weather – Winter Storm
- Earthquakes
- Flood
- Volcano (Ash Fall)
- Landslides and Debris Flows
- Drought

Additionally, this section provides information on the City’s participation in the National Flood Insurance Program (NFIP).

Section 3 - Mitigation Strategy

The Mitigation Strategy documents the Plan vision, mission, goals, and mitigation actions and describes the components that guide implementation of the identified actions.

Mitigation actions are based on community sensitivity and resilience factors and the Risk Assessment.

Section 4: Plan Implementation and Maintenance

This section provides information on the implementation and maintenance of the NHMP. It describes the process for prioritizing projects and includes a suggested list of

tasks for updating the NHMP to be completed at the semi-annual and five-year review meetings.

Appendices

The resource appendices are designed to provide the users of the City's NHMP with additional information to assist them in understanding the contents of the mitigation plan, and provide them with potential resources to assist with plan implementation.

Appendix A: Action Items

This appendix contains the detailed action items for the city.

Appendix B: Planning and Public Process

This appendix includes documentation of the city public processes utilized to develop the Plan.

Appendix C: Community Profile

The Community Profile describes the city from a number of perspectives in order to help define and understand the area's sensitivity and resilience to natural hazards. The information in this section represents a snapshot in time of the current sensitivity and resilience factors in the region during this NHMP update.

Appendix D: Economic Analysis of Natural Hazard Mitigation Projects

This appendix describes FEMA's requirements for benefit cost analysis in natural hazards mitigation, as well as various approaches for conducting an economic analysis of proposed mitigation activities.

Appendix E: Grant Programs and Resources

This appendix lists hazard-specific state and federal resources and programs.

Appendix F: 2019 Preparedness and Mitigation Survey

This appendix includes the survey instrument and results from the hazards public opinions survey administered by the City.

Appendix G: Hazard Analysis

This appendix contains the City's Hazard Analysis which is revised every two years for the City's Emergency Operations Plan

Section Endnotes

¹ Federal Emergency Management Agency. 2002. How-To Guide #2: Understanding Your Community's Risks; Identifying Hazards; and Determining Risks.

² Massachusetts Department of Environmental Management. 1999. "Hazard Mitigation: Managing Risks, Lowering Costs.

<http://www.state.ma.us/dem/programs/mitigate/whatis.htm> Accessed 8/2/02

³ Metro Regional Government. Survey of Natural Hazard Mitigation Practices of Cities and Counties in the Portland, Oregon Metropolitan Region. 1997. http://hazards.metro-region.org/mapoptix_hazards/adobe_docs/guide-app3.pdf Accessed 9/3/02

⁴ To preserve the ties between the Washington County Plan and the City of Beaverton plan, some information and text found in this plan was taken directly from the Washington County Plan.

⁵ Code of Federal Regulations, Chapter 44. Section 201.6, subsection (b). 2015

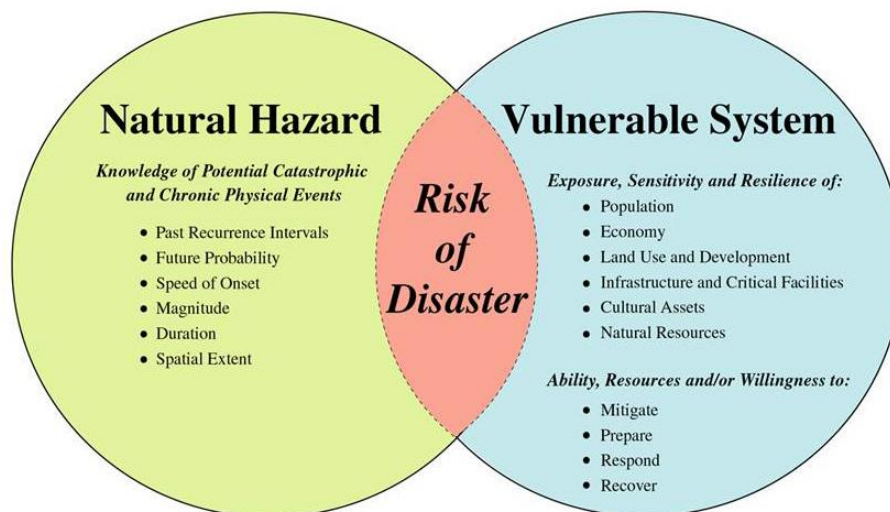
Section 2

Risk Assessment

This section provides information of the natural hazard risk assessment for the City of Beaverton.

The information presented in this section, along with information presented in Appendix G: Hazard Analysis and Appendix C: Community Profile, are used to inform the risk reduction actions identified in Section 3: Mitigation Strategy. Understanding Risk is graphically depicted in Figure 2-1 below. Ultimately, the goal of hazard mitigation is to reduce the area where hazards and vulnerable systems overlap. The Risk Assessment satisfies the NHMP plan requirement identified in 44 CFR 201.6(b)(2).

Figure 2-1 Understanding Risk



Source: <http://pubs.usgs.gov/fs/2011/3008>

What is a Risk Assessment?

A risk assessment is the process for identifying threats and vulnerabilities of natural hazards for specific communities. Conducting a risk assessment can provide information on the areas where the hazards may occur, the value of existing land and property in those areas; and an analysis of the potential risk to life, property, and the environment that may result from natural hazard events. Specifically, the levels of a risk assessment per Federal Section 322 requirements are as follows:

- 1) **Hazard Identification** identifies the geographic extent of the hazard, the intensity of the hazard, and the probability of its occurrence. Maps are frequently used to display hazard identification data. Beaverton identified seven major hazards that consistently affect this geographic area. These hazards – floods, landslides, drought, severe weather – windstorms, severe weather – winter storms, earthquakes, and volcanic eruptions (Ash Fall) – were identified through a process that utilized input from a project steering committee as well as through the Beaverton Hazard Analysis, in the City’s Operations Plan. The City’s Geographic Information Systems (GIS) Service, using the best available data, has identified the geographic extent of each of the identified hazards. The Map Section of this plan contains the maps used for this plan.
- 2) **Profiling Hazard Events** describes the causes and characteristics of each hazard, how they have affected Beaverton in the past, and what part of Beaverton’s population, infrastructure, and environment has historically been vulnerable to each specific hazard. A profile of each hazard addressed in this plan is provided in the hazard specific sections.
- 3) **Vulnerability Assessment/Inventorying Assets** combines the hazard identification with an inventory of existing (or planned) property and population that would be exposed to a hazard. Critical facilities are of particular concern because they provide essential products and services that are necessary to preserve the welfare and quality of life in the city and fulfill important public safety, emergency response, and/or disaster recovery functions. The critical facilities have been identified, mapped, and are illustrated in the Map Section of this plan. A description of the critical facilities in the city is also provided in the Community Profile Appendix C. A vulnerability summary is included in each hazard section that identifies the most vulnerable and problematic areas in the city, including critical facilities and other public and private property.
- 4) **Risk Analysis/Estimating Potential Losses** involves estimating the damage, injuries, and financial losses likely to be sustained in a geographic area over a given period of time. This level of analysis typically involves using mathematical models. The two measurable components of risk analysis are magnitude of the impact that may result from the hazard event and the likelihood of the hazard occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets. Where available, the best available data was used to determine the magnitude and likelihood of future natural hazard events. For each hazard where data was available, quantitative estimates for potential losses are included in the hazard assessment.
- 5) **Assessing Vulnerability/ Analyzing Development Trends** provides a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions. This plan provides comprehensive description of the character of Beaverton in Appendix C: Community Profile. This description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, transportation and commuting patterns, and historic and cultural resources.

Analyzing these components of Beaverton can help in identifying potential problem areas and can serve as a guide for incorporating the goals and ideas contained in this mitigation plan into other community development plans.

Hazard assessments are subject to the availability of hazard-specific data. Gathering data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard-specific section of the plan includes a section on hazard identification using data and information from city, county, and state agency sources.

Table 2-1. Federal Criteria for Risk Assessment

Section 322 Requirement	How this is addressed in the plan.
Identifying Hazards	The Risk Assessment section includes a description of the best available data sources that identify hazard areas. To the extent that GIS data is available, the City developed maps identifying the location of the hazards within city limits.
Profiling Hazard Events	Information on each hazard in the Risk Assessment Section includes documentation of the history, characteristics and probability of the hazard in the city.
Assessing Vulnerability: Identifying Assets	Information on each hazard in the Risk Assessment Section provides information on the vulnerable areas of the city. Vulnerabilities are also touched on in the Community Profile Appendix.
Assessing Vulnerability: Estimating Potential Losses	The Risk Assessment section and associated hazards maps identify critical and essential facilities. Vulnerability assessments were completed for each hazard where data was available.
Assessing Vulnerability: Analyzing Development Trends	The Community Profile Appendix provides a description of the development trends in the city, including geography and environment, population and demographics, land use and development, housing and community development, employment and industry, transportation and community patterns, and historic and cultural resources.

Climate Change

The most reliable information on climate change to date is at the state level¹. The state information indicates that hazards projected to be impacted by climate change in the Northern Willamette Valley/ Portland Metro (Region 2), which includes Washington County, include drought, wildfire, flooding, and landslides. Climate models project warmer drier summers and a decline in mean summer precipitation for Oregon. Coupled with projected decreases in mountain snowpack due to warmer winter temperatures, all eight regions are expected to be affected by an increased incidence of drought and wildfire. In addition, flooding and landslides are projected to occur more frequently throughout western Oregon. An increase in extreme precipitation is projected for some areas of Region 2 and can result in a greater risk of flooding in certain basins, including an increase in size and frequency of occurrence. Landslides in Oregon are strongly correlated with

rainfall, so increased rainfall — particularly extreme events — will likely trigger increased landslides.

While winter storms and windstorms affect Region 2, there is little research on how climate change influences these hazards in the Pacific Northwest. For more information on climate drivers and the projected impacts of climate change in Oregon, see the Introduction to Climate Change section of the Oregon Natural Hazards Mitigation Plan.

Hazard Identification

The City’s Hazard Analysis identified seven natural hazards that could have significant impact. Summary information for each of these hazards is presented below; additional information pertaining to the types and characteristics of each hazard is available in the Oregon Natural Hazard Mitigation Plan Region 2 Risk Assessment (Tornado is covered within the Windstorm section of the Oregon NHMP). Table 2-2 lists the hazards identified in the city in comparison to the hazards identified in the Oregon NHMP for Region 2, and Washington County’s NHMP.

Table 2-2. City of Beaverton Hazard Identification		
City of Beaverton	State of Oregon NHMP Region 2: Northern Willamette Valley/ Portland Metro	Washington County NHMP
Severe Weather – Windstorm	Windstorm	Windstorm • Tornado
Severe Weather – Winter Storm	Winter Storm	Winter Storm
Earthquakes	Earthquakes	Earthquakes
Flood	Flood	Flood
Volcano (Ash Fall)	Volcano	Volcano
Drought	Drought	Drought
Landslides and Debris Flow	Landslide	Landslide
Wildland Fire*	Wildfire	Wildland Fire
Sources: City of Beaverton Hazard Analysis 2019 Oregon NHMP, Region 2: Northern Willamette Valley/Portland Metro (2015) Washington County Hazard Analysis (2015) *Wildland Fire is not covered in the City’s NHMP		

Hazard Analysis Methodology

This Natural Hazards Mitigation Plan includes a summary of the revised City of Beaverton Hazards Analysis (2019). The hazard analysis methodology used is the same that is used by

counties and some cities in Oregon as part of their emergency response planning. The methodology was first developed by FEMA circa 1983 and has been gradually refined by the Oregon Military Department’s Office of Emergency Management over the years.

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

The Oregon method provides the jurisdiction with a sense of hazard priorities, or relative risk. It doesn't predict the occurrence of a particular hazard but it does "quantify" the risk of one hazard compared with another. By doing this analysis, planning can first be focused where the risk is greatest.

In this analysis, severity ratings and weight factors, are applied to the four categories of history, vulnerability, maximum threat (worst-case scenario), and probability. Specific information on the scoring of each of the hazards contained in this plan can be found in Appendix G: Hazard Analysis.

Risk has two measurable components:

- The magnitude of the harm that may result, defined through the vulnerability assessment (assessed in the previous section).
- The likelihood or probability of the harm occurring.

Table 2-3, contains the natural hazards (except pandemic) that are included in the Hazard Vulnerability Analysis (2019) for the City of Beaverton. 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. Considering past historical events, the probability or likelihood of a particular hazard event occurring, the vulnerability to the community, and the maximum threat or worst-case scenario, winter storm, windstorm, and earthquake events rank as the top hazard threats to the city.

Table 2-3. City of Beaverton Hazard Rankings	
City of Beaverton	City Hazard Score
Severe Weather – Windstorm	208
Severe Weather – Winter Storm	203
Earthquakes	203
Flood	188
Volcano (Ash Fall)	178
Drought	155
Landslides and Debris flow	86
Wildland Fire*	58
Sources: City of Beaverton Hazard Analysis 2019 *Wildland Fire is not covered in the City’s NHMP	

Hazard Information

The following subsections briefly describe relevant information for each hazard. For additional background on the hazards, vulnerabilities and general risk assessment information for hazards in the Northern Willamette Valley/Portland Metro (Region 2) refer to the [State of Oregon NHMP Risk Assessment \(2015\)](#).

Wildland Fire

Wildland Fire is not included as one of the City's hazards addressed in the Natural Hazards Mitigation Plan. The Washington County Wildfire Protection Plan (2007) shows the City as High Density Urban area that is not a Federal Register Community at Risk and is not in one of the plan's Strategic Planning areas. The city's "wildland-urban interface" is defined as an *occluded wildland-urban interface*, which exists where islands of wildland vegetation occur inside a largely urbanized area. These islands are primarily parks maintained by Tualatin Hills Park & Recreation District, with others being undeveloped lands on the edge of city limits. Based on this and supported by the significantly lower score that Wildland Fires scored than any of the other natural and man-caused hazards in the City's Hazard Analysis (58 on a scale of 24 to 240), it's not addressed in this plan.

Severe Weather – Windstorm

Severe wind events pose a significant threat to life, property, and the local economy in Beaverton by creating conditions that disrupt essential regional services such as public utilities, telecommunications, and transportation routes. Such storms can produce high winds, which can destroy trees and power lines, potentially interrupting utility services. A windstorm in 1995 damaged numerous homes, businesses and public facilities, and generated tons of disaster related debris. Washington County sought and received a Presidential Disaster Declaration to recover from the event.

Characteristics/Types of Windstorm Hazards

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Most of the winds that come from the west are subdued by the time they reach the Beaverton area because of the influence of the Coast Range. The most destructive winds are those which blow from the south, parallel to the major mountain ranges.² Windstorms affect areas of Beaverton with significant tree stands, as well as areas with exposed property, major infrastructure, and above ground utility lines. The lower wind speeds typical in the lower valleys are still high enough to knock down trees, bring down power lines, and cause other property damage. The Columbus Day Storm of 1962 was a classic example of a south windstorm. The storm developed well off the coast of California and moved from the

southwest, then turned and came directly from the south toward the Oregon Coast. Atmospheric pressure fell rapidly ahead of the storm center and rose rapidly once the storm center passed, creating very tight and sharp pressure gradients. When the strong surface winds are further reinforced by upper airflow in the same direction, as was the case in the Columbus Day Storm, the surface wind speed is enhanced.³

Location and Extent

Although windstorms can affect the entirety of the City and Washington County, they are especially dangerous in developed areas with significant tree stands and major infrastructure, especially above ground utility lines. A windstorm will frequently knock down trees and power lines, damage homes, businesses, and public facilities, and create tons of storm related debris. Increasing population and new infrastructure in Beaverton means that more lives and property are exposed to risk; this situation creates a higher probability that damage will occur from severe windstorm events. In some cases, other areas of Washington County and the Metro area have received significant damages and power outages, while the City had minimal impacts.

Windstorms have the ability to cause damage over 100 miles from the center of storm activity. Wind pressure can create a direct frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift and suction forces that act to pull building components and surfaces outward. The effects of winds are magnified in the upper levels of multi-story structures. The forces applied by the wind to the building's protective envelope (doors, windows, and walls) can cause the failure of some of the building's components resulting in considerable structural damage.

While relatively rare, tornados can and do occur in the Portland metropolitan area. A small, short-lived tornado near Forest Grove in June 1966.⁴ In December 8, 1993 a tornado developed near Newberg and was the most powerful tornado to occur in Oregon in many years. A dairy farm was damaged, roofs were blown off some small buildings, and many trees were broken. People reported that the funnel was sucking water from the Willamette River as it moved northeast and severely damaged a mobile home park.

History

Destructive storms, producing high winds have occurred throughout Northwestern Oregon's history. However, the most destructive windstorm occurred in 1962. The Columbus Day Storm of 1962 brought extensive damage to Beaverton, as it did to the rest of the state. During the storm, School District 48 (which includes Beaverton) suffered damage totaling approximately \$194,600, in 1962 dollars (\$1,613,061.16 in 2018 dollars)⁵. The storm significantly damaged many other structures throughout the city and caused multiple injuries.

On December 12, 1995 a large low pressure system hit Washington County. Gusts of over 100 mph occurred along the coast while gusts in the Willamette Valley exceeded 60 mph. Hundreds of thousands of people in the state lost power and there was widespread damage to homes, buildings, and boats. The damage resulted in a presidential disaster declaration. Four Oregonians lost their lives during the storm.

The dates below represent occurrences of windstorms meeting the following established criteria:

- Damage from high winds generally resulted in downed utility lines and trees.
- The interruption of electrical power ranged anywhere from a few hours to two or three days.

October 1962	November 1962	October 1967	January 1971
November 1981	November 1982	January 1991	December 1995
January 2006	February 2006	December 2007	September 2014

Probability

New areas of development are often more at risk from natural hazards. New homes and development are pushed into hazard prone areas and “new development leaves some stands of trees vulnerable to ‘wind throw’ by removing the edges of the stand.”⁶

There is a high probability that the city will be impacted by severe weather events over the next several years. A **high probability** incident can be expected once within a 10 to 35 year period and, based on the city’s history of notable severe wind weather events in the last 25 years, there is a high probability that such events will continue to occur fairly frequently.⁷

Vulnerability

Vulnerability assessment is the second phase of a hazard assessment. It combines the information generated through severe weather identification with an inventory of the existing development exposed to this hazard, assisting in the prediction of how different types of property and population groups will be affected by a hazard.⁸ Data including the areas exposed to severe weather in Beaverton can be used to assess the population and total value of property at risk from severe storms.

Old or poorly constructed structures are vulnerable to strong winds and can be heavily damaged. Well-built and newly constructed structures are more resilient to strong wind events, although the entire built environment is vulnerable to high winds and may experience varying degrees of damage.

When severe windstorms strike a community, downed trees, power lines, and damaged property can be major hindrances to emergency response and disaster recovery. Debris carried along by extreme winds can directly contribute to injuries or

loss of life and indirectly to the failure of protective building envelopes, siding, or walls of buildings. Storm winds can damage buildings, power lines, and other property and infrastructure by means of falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds.

While a quantitative vulnerability assessment (an assessment that describes the number of lives or amount of property exposed to the hazard) has not yet been conducted for Beaverton severe weather storm events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Severe weather can cause power outages and transportation and economic disruptions, and pose a high risk for injuries and loss of life. The events can also be typified by a need to shelter and care for adversely impacted individuals. Beaverton has suffered severe weather in the past that brought economic hardship and affected the life safety of City residents. Future severe weather events may cause similar impacts citywide.

The City of Beaverton's 2019 Hazard Analysis rated the city as having a **high vulnerability** to windstorm hazards, meaning that between 1-10% of the city's population and or property will be affected

Severe Weather – Winter Storm

Severe winter storms pose a significant risk to life and property in the City of Beaverton by creating conditions that disrupt essential regional systems such as public utilities, telecommunications, and transportation routes. Severe winter storms can produce rain, freezing rain, ice, snow, cold temperatures, and wind. Ice storms accompanied by high winds can have destructive impacts, especially to trees, power lines, and utility services. Severe ice storms occur more frequently in areas exposed to east winds blowing out of the Columbia River Gorge. Severe freezes, where high temperatures remain below freezing for five or more days, occur every three to five years in Washington County which includes the City of Beaverton. Severe or prolonged snow events occur less frequently, but have widespread impacts on people and property in the city.

Severe storms affecting Beaverton with snow and ice typically originate in the Gulf of Alaska or in the central Pacific Ocean. These storms are most common from October through March.⁹

Characteristics/Types of Hazards

The principal types of winter storms that occur include:

- **Snowstorms:** Require three ingredients: cold air, moisture, and air disturbance. The result is snow—small ice particles that fall from the sky. In Oregon, the further inland and north one moves, the more snowfall can be expected. Blizzards are included in this category.

- **Ice storms:** Are a type of winter storm that forms when a layer of warm air is sandwiched by two layers of cold air. Frozen precipitation melts when it hits the warm layer, and refreezes when hitting the cold layer below the inversion. Ice storms can include sleet (when the rain refreezes before hitting the ground) or freezing rain (when the rain freezes once hitting the ground).
- **Extreme Cold:** Dangerously low temperatures accompany many winter storms. This is particularly dangerous because snow and ice storms can cause power outages, leaving many people without adequate heating.

Unlike most other hazards, it is not simple to systematically map winter storm hazard zones. The City in its entirety is susceptible to damaging winter storms. Winter storms that bring snow and ice can impact infrastructure, business, and individuals. Those resources that exist at higher elevations will experience more risk of snow and ice but the entire county, including Beaverton, may be impacted by winter storms and the hail or dangerously cold temperatures that winter storms bring.

Location and Extent

While snow is relatively rare in Western Oregon, 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. If a wet Pacific storm happens to reach the area at the same time, larger than average snow events may result.¹⁰

Ice storms occasionally occur in northern areas of Oregon, resulting from cold air flowing westward through the Columbia Gorge.¹¹ Like snow storms, 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.¹²

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. The Columbia Gorge is the most significant east-west air passage through the Cascades. Rain arriving from the west can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.¹³

History

In January 1969 one of the fiercest winter storms in recent history occurred causing heavy icing on Beaverton streets and sidewalks. Canyon Road closed briefly as the storm continued through the end of January. As the movement of traffic in and out of the Portland Metro area was severely limited, livestock shipments were delayed,

causing beef to become unavailable in stores for a short period. The storm was also responsible for one death.¹⁴

In early January 1979 a severe winter storm struck, causing the closure of several schools and business due to broken pipes. Pipes also ruptured in several homes throughout Beaverton. A 1,500 gallon oil truck lost control on icy roads, spilling its entire contents. The storm's freezing rain lead to several minor accidents throughout Beaverton.¹⁵ Later in mid-January 1979, 10,000 Washington County residents lost power due to broken limbs and downed trees brought down by freezing rain. An ice-generated electrical short led to a fire causing \$35,000 in damages to one Beaverton home.¹⁶

In early January of 1980 a snowstorm hit Beaverton, and several businesses reported a sharp drop in business due to traffic difficulties.¹⁷

In February 1989 and December 1990, severe storms caused school closings, accidents, and widespread incidence of broken pipes and downed power lines. Approximately 14,000 residents of Beaverton lost power in February 1989.¹⁸ A section of Highway 217 closed briefly due to the hazardous conditions caused by the storm of December 1990.¹⁹

The last severe freeze that affected the city occurred in December 1998. This freeze significantly affected the Tualatin Valley Water District water system by causing multiple breaks in the mainline water system.

In 2008, three different weather systems brought snow to the area at different periods of time from December 14 to 26. The majority of the snow fell from Saturday December 20 through Monday December 22. During that 3-day period, Beaverton received over 16 inches of snow greatly surpassing the previous record of 5 inches that occurred 24 years before.

The City of Beaverton endured a significant snow event from December 2015 into January 2016 which had considerable impacts on the transportation infrastructure. This included abandoned vehicles, stranded motorists and an abundance of automobile collisions and delays in traffic.

Probability

Beaverton is at risk from two types of winter storms: snow and ice. The impacts of both storms are similar.

- Heavy snowfall rarely occurs in Beaverton. When it does occur, many of the subsequent problems are directly related to the public's unfamiliarity in dealing with such conditions.
- Ice storms may occur as a result of a combination of weather factors, either with or without a related snowfall.
- The heavy ice on utility lines typically results in outages throughout the city.

- Heavy snow or ice that occurs before the trees lose all of their leaves can knock down limbs and possibly entire trees and consequently power and telephone lines.

There is a high probability that the city will be impacted by windstorm events over the next several years. In the hazard analysis methodology used, probability is based on the likelihood of another occurrence within a specified period of time. A high probability incident can be expected once within a 10 to 35 year period. Based on the city's history of severe winter storm events during the last 25 years, probability that such events will continue to occur fairly frequently, is high.²⁰

Vulnerability

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for Beaverton severe weather storm events, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Severe weather can cause power outages, transportation and economic disruptions, and pose a high risk for injuries and loss of life. The events can also be typified by a need to shelter and care for adversely impacted individuals. Beaverton has endured severe winter storms in the past that brought economic hardship and affected the life safety of city residents. Future winter storm events may cause similar impacts citywide.

Beaverton is susceptible to direct impacts on infrastructure and property, and indirect costs stemming from business closures and lost work time resulting from winter storms. Industry and commerce can suffer losses from power interruptions and extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from winter storms related to both physical damages and interrupted services.

Rising population growth and new infrastructure in the county creates a higher probability for damage to occur from winter storms as more life and property are exposed to risk. As both an industry best practice and hazard mitigation action, Washington County's electric infrastructure is increasingly being built, or retrofitted, underground which lessens the risk from winter storms.

The City of Beaverton's 2019 Hazard Analysis rated the city as having a **moderate vulnerability** to winter storm hazards, meaning that between 1-10% of the city's population and or property will be affected.

Earthquakes

Earthquakes pose a serious threat to many Oregon communities. The state ranks third in the nation for future earthquake damage estimates. Scientific evidence shows us that a Cascadia Subduction Zone earthquake could happen at any time. The Oregon

Department of Geology and Mineral Industries (DOGAMI) has released a new study that examines potential impacts of a Cascadia earthquake for Clackamas, Multnomah, and Washington Counties.²¹

By using updated data and the latest mapping and modelling techniques, this study greatly improves our understanding of potential earthquake impacts for our region – and for each neighborhood within the counties that were studied. These new estimates of building damages, injuries and fatalities, and people needing shelter helps us plan and prepare for potential impacts, and take action to reduce them. The full report is available on-line at: <http://www.oregongeology.org/pubs/ofr/p-O-18-02.htm>²²

Local governments, planners, emergency managers, and engineers must consider this threat as they seek to balance development and risk. Identifying locations susceptible to seismic activity generated by local faults or the Cascadia Subduction Zone, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in Beaverton.²³

Social and geological records show that Oregon has a history of seismic events. Recent research suggests that the Cascadia Subduction Zone is capable of producing magnitude 9 earthquakes.

Characteristics/Types of hazards

Earthquakes from three different sources threaten communities in Oregon and the Pacific Northwest. These sources are crustal, subduction zone and intraplate earthquakes.

Crustal are the most common earthquakes. Crustal earthquakes typically occur along faults, or breaks in the earth's crust, at shallow depths of 6-12 miles (10-20 km) below the surface. The two largest earthquakes in recent years in Oregon, Scotts Mills (magnitude 5.6) and the Klamath Falls main shocks (magnitude 5.9 and magnitude 6.0) of 1993, were crustal earthquakes.

Subduction zone earthquakes occur in places where the tectonic plates that make up the surface of the earth collide. When these plates collide, one plate slides (subducts) beneath the other, where it is reabsorbed into the mantle of the earth. This dipping interface between the two plates is the site of some of the most powerful earthquakes ever recorded, often having magnitudes of 8 to 9 or larger. The 1960 Chilean (magnitude 9.5) and the 1964 Great Alaska (magnitude 9.2) earthquakes were subduction zone earthquakes.

Deeper intraplate earthquakes occur within the remains of the ocean floor that is being subducted beneath North America. This type of earthquake could occur beneath much of the Northwest at depths of 25–37 miles (40–60 km). The magnitude 6.8 intraplate Nisqually earthquake that struck the Puget Sound area on February 28, 2001 caused \$2 billion in damage but was much less destructive than a crustal earthquake of the same magnitude. This would have been because of its great depth (33 miles deep). Intraplate earthquakes have also caused damage in the Puget Sound region in 1949 and again in 1965.

Location and Extent

Based on recorded and geologic history, geologists say the northwest will experience major to large earthquakes. However, there is no method to estimate when they will take place. Recent evaluation of the earthquake threat in Oregon indicates the area may experience a “great” subduction zone earthquake. Earthquake hazard mapping identifies the potential of major damage for Beaverton.

Beaverton has mostly silt-type soil, which is subject to liquefaction. Liquefaction happens when earthquake waves cause water pressures to increase in the sediment and sand grains to lose contact with each other, leading the sediment to lose strength and behave like a liquid. The soil can lose its ability to support structures, flow down even very gentle slopes, and erupt to the ground surface to form sand boils. Many of these phenomena are accompanied by settlement of the ground surface — usually in uneven patterns that damage buildings, roads and pipelines.²⁴

History

Earthquakes felt in Beaverton, have originated in other areas. The Scotts Mills earthquake on March 25, 1993, was the first significant earthquake (in recorded history) to originate close enough to Beaverton to be felt. Beaverton experienced only minor damage, but surrounding counties, including Clackamas, incurred significant damage and received a federal disaster declaration.

The Nisqually earthquake on February 28, 2001, was felt in the city but did very little damage. Numerous small quakes occurred in the Portland Metro area in 2013, 2014, and 2015. Most of these earthquakes were not strong enough to be felt. Though too small to be felt, in 2003 a small quake was detected under Cooper Mountain, in the southern part of the city, on a fault that had been previously designated by geologists as “inactive.”

Probability

The City of Beaverton is susceptible to deep intraplate events within the CSZ where the Juan de Fuca Plate is diving beneath the North American plate, ruptures of the CSZ, and shallow crustal events within the North American plate.

Establishing a probability for earthquakes is difficult and could vary between the types of earthquakes that could impact the city. Based on history, there is a high probability of an earthquake occurring in the region that could be felt in Beaverton. The probability of a damaging earthquake, however, is harder to determine. The 2008 United States National Seismic Hazard Map shows that the city lies in an area where there is a 2% chance in a 50 year period that it will experience significant horizontal shaking. The level of shaking is expressed as a percentage “g” which is the rate of acceleration of a falling object due to gravity. The region that includes Beaverton will experience horizontal shaking of at a level of 32 to 48% of “g.”²⁵

Based on the available data and research for City of Beaverton, the 2019 Hazard Analysis determined the **probability of experiencing an earthquake is “high”** meaning one incident is likely within the next 10-35 year period.

Vulnerability

The effects of earthquakes span a large area, and an earthquake occurring in the city would likely be felt throughout the county. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges, many high tech and hazardous material facilities, extensive sewer, water, and natural gas pipelines, a petroleum pipeline, and other critical facilities and private property located in the city. The areas that are particularly vulnerable to potential earthquakes in the city have been identified as those areas near the crustal fault lines.

The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

Table 2-4 looks at the estimated damages for 4 different scenarios; Cascadia subduction zone magnitude 9.0 during dry versus saturated soil conditions and the Portland Hills fault magnitude 6.8 during dry versus saturated soil conditions.

Table 2-4. City of Beaverton Earthquake Loss Estimates				
Population*	89,803			
Number of Buildings	24,005			
Square Footage (Thousand)	96,327			
Building Value (Million)	\$13,813			
Earthquake Loss Scenarios	Cascadia Subduction Zone magnitude 9.0 earthquake		Portland Hills fault magnitude 6.8 earthquake	
	Dry Soil Conditions	Wet (saturated) Soil Conditions	Dry Soil Conditions	Wet (saturated) Soil Conditions
Building Repair Costs (Million)	\$1,230	\$1,943	\$3,510	\$5,201
Building Loss Ratio**	9%	14%	25%	38%
Debris (Thousands of Tons)	548	751	1,310	1,775
Long-Term Displaced Population	1,227	6,267	5,597	19,130
Daytime Total Casualties (Includes fatalities)	845	1,313	2,721	3,850
Nighttime Total Casualties (Includes fatalities)	223	633	787	1,861
*2010 U.S. Census				
**Building damage expressed as a loss ratio — the total repair cost estimate for all buildings in a given spatial unit divided by the total replacement cost for all buildings				

Source: DOGAMI Open-File Report O-18-02; EARTHQUAKE REGIONAL IMPACT ANALYSIS FOR CLACKAMAS, MULTNOMAH, AND WASHINGTON COUNTIES, OREGON

A Cascadia Subduction Zone (CSZ) magnitude 9.0 earthquake will have a severe impact on the three-county area. Although damage estimates vary widely throughout the study area, no community will be unharmed. Depending on the time of day an earthquake occurs, casualties may be in the thousands or low tens of thousands. The earthquake will generate several millions of tons of debris from damaged buildings. Damage and casualty estimates resulting from a magnitude 6.8 Portland Hills fault earthquake are more than twice as high as a CSZ earthquake, primarily because the Portland Hills fault is located below densely populated and heavily developed areas. However, the likelihood of a Portland Hills fault earthquake is considerably less than a Cascadia Subduction Zone earthquake.²⁶

The City of Beaverton’s 2019 Hazard Analysis rated the city as having a **“high” vulnerability to earthquake hazards**, meaning more than 10% of the region’s population or assets would be affected by a major disaster.

Flood

The City of Beaverton has a long-standing, historic relationship with flooding, including repetitive flood losses. Due to the city’s on-going growth and development, Beaverton faces potential increased frequency of flooding. Development generally removes vegetation and increases impervious surfaces, a combination that increases storm water runoff and velocity.

Characteristics/Types of Hazards

Flooding results when rain and snowmelt creates 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 bring intense rainfall. Most of Oregon’s destructive natural disasters have been floods.²⁷

During this seven-month period, Beaverton receives approximately 81% of its annual precipitation. Snowfall occurs a few days each year, with depths seldom exceeding six inches. Figure 2-2 illustrates the average monthly precipitation that Beaverton receives in inches.

Two types of flooding primarily affect

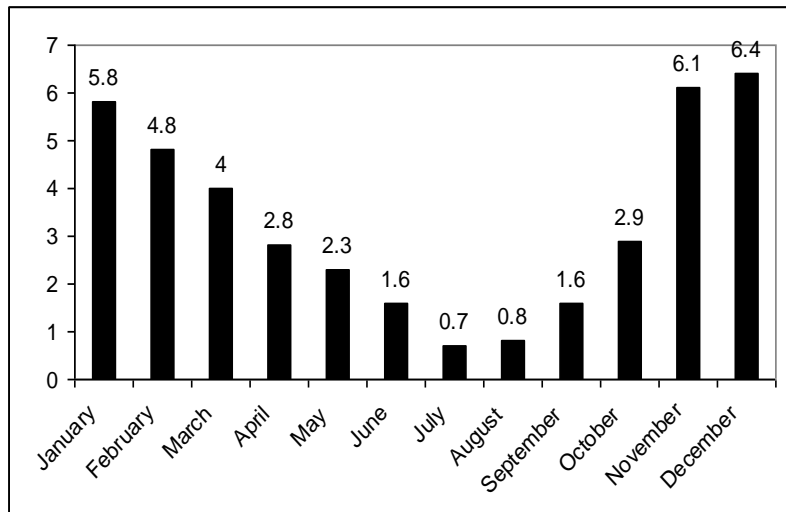


Figure 2-2. Average Monthly Rainfall for Beaverton, OR

Source: Washington County Natural Hazard Mitigation Plan

Beaverton: *urban* flooding and *riverine* flooding. In addition, any low-lying area has the potential to flood. Flooding of developed areas may occur when the amount of rainfall and runoff exceeds a storm water system's (creek, ditch, or storm drain) capability to remove it. Unlike some urban areas, all storm water runoff in Beaverton is directed to the nearest creek or stream. At no point is storm water intentionally directed into the sanitary sewer system.

Urban Flooding

Urbanization of the watershed changes the hydrologic systems of the basin. As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb and slowly release rainfall. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. The resulting high water volume and turbidity contribute to erosion of streambanks.

A majority of land within Beaverton is urbanized, and has a high concentration of impervious surfaces that either collect water or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains and catch basins often back up with vegetative debris causing additional, localized flooding.

There are currently numerous areas subject to urban flooding and the potential exists for more as development continues throughout Beaverton. Continued development and re-development in the city contributes to the city's future flood risk. This development generates more surface area that does not absorb rain (e.g., roofs, parking lots, and roads), increasing the amount of water that runs off into creeks and streams, causing them to flood quicker and more often than in the past.

Riverine Flooding

Riverine flooding, when rivers and streams flow over their banks, is the largest single form of flooding in Beaverton. Streams in the city regularly overflow their banks and inundate low-lying areas. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers.²⁸

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as "*areas that are inundated by the 100-year flood with flood depths of only 1 to 3 feet.*" These areas are generally flooded by low-velocity sheet flows of water.

Location and Extent

Beaverton Creek, the most significant stream in the community, drains approximately 36 square miles as it flows northwesterly through the major commercial area of Beaverton. Streams in the city include five tributaries to Beaverton Creek: South Fork Beaverton Creek, Johnson Creek, Hall Creek, Willow Creek, and Cedar Mill Creek.

Erickson Creek flows northwesterly through central Beaverton and drains 1.7 square miles. South Johnson Creek flows northerly along the Beaverton western corporate limits and has a 3.7-square mile drainage area. Hall Creek, which drains 3.6 square miles, flows westerly, entering Beaverton Creek just upstream of the Hall Boulevard Bridge. Willow Creek, which drains 6.2 square miles, flows westerly through the North Section of Beaverton entering the community just south of Highway 26. Fanno Creek, another significant stream, flows westerly to State Highway 217, then southerly through the city to its confluence with the Tualatin River, after draining 32 square miles. Cedar Mill Creek flows northwesterly and has a drainage area of 8.6 square miles.

There are a total of 18 flood loss properties in Beaverton that are dispersed throughout the city but concentrations occur near the following locations: (as of 2011)

Highway 217 and Denny Road (Fanno Creek);

Near 217 between the Beaverton-Hillsdale Highway and Canyon Road (Beaverton Creek); and

Near the intersection of Murray and Allen Boulevards, along the Johnson Creek corridor.

The potential for property damage from Beaverton Creek flooding is especially severe for several reasons. Inadequate size and moderate grade of the channel causes over-bank flooding during even mild storms. Many culverts and bridges constrict Beaverton Creek flow; additionally, banks that were artificially constricted by farmers in the first half of the last century and the last half of the previous century result in increased upstream flood heights. The potential for property damage is significant due to the extensive commercial and residential development within the Beaverton Creek floodplain. The city experiences flooding frequently from rising creeks and streams as well as localized flooding from overtaxed storm water systems.

The single largest impact on communities from flood events is the loss of life and property. Washington County has experienced millions of dollars in flood damage in the past three decades, with Beaverton's losses reflecting a subtotal of this amount. Loss from floods strikes both private property and public property. Public sector impacts (e.g., impacts to water and sewer systems, roads, etc.) state-wide resulted in approximately two-thirds of the damage from the 1996 flood events.²⁹

In a survey of stakeholders, Clean Water Services (CWS, formerly Unified Sewerage Agency) found that stakeholders desired a greater connection between flood control,

water quality, the mitigation of growth impacts, and the effectiveness of land use systems. Many citizens are concerned about the relationship between rapid urban growth and flood damage. While there are no strong sentiments to stop growth, some Beaverton residents are concerned that growth is pushing development into floodplains. CWS manages wastewater treatment and sets minimum standards for surface water management within the urbanized area of Washington County. The City of Beaverton sets higher standards for control of damaging run-off rates from new developments than are used by Clean Water Services for areas outside the current city limits.

History

Beaverton residents share a statewide concern regarding flood events. According to the National Flood Insurance Program (NFIP), Oregon has 256 flood-prone communities throughout the state’s 36 counties.³⁰ That number includes a majority of Oregon’s 240 incorporated communities and counties, of which Beaverton is one. Flooding can cause severe damage to public and private property and pose a threat to life and safety. Oregon’s largest economic loss from natural disasters have resulted from flooding.³¹ Damage during the Christmas Flood of 1964 totaled over \$157 million dollars, and 20 Oregonians lost their lives.³² The city has a designated Floodplain Manager and complies with the standards set forth in the NFIP program.

In 1996, many rivers and creeks throughout the Willamette River watershed rose to flood levels. Washington County sought and received a Presidential Disaster Declaration to obtain federal assistance for its flood recovery effort in February 1996. Fortunately, in Beaverton, the intensity of the storms experienced locally didn’t approach the predicted 100-year flood event potential (1% annual chance of occurring). For example, the February event levels were only slightly higher than a 10-year flood event; however, several creeks rose to these levels a number of times over three consecutive days. A November 1996 flood event on Beaverton Creek neared a 10-year flood event (10% annual chance of flooding), and, within the city limits, Fanno Creek flooded to slightly greater than a 50-year event (2% annual chance of flooding). Within Beaverton, this inundation of low-lying areas caused natural gas line

Table 2-5. NFIP Community Status

Community Name	City of Beaverton
County	Washington County
Effective FIRM (Flood Insurance Rate Map) and FIS (Flood Insurance Survey)	11/04/16
Initial FIRM	09/28/84
Initial FHBM (Flood Hazard Boundary Map)	02/01/74
Total Policies	275
Post-FIRM Policies	0
Post-FRIM Policies in the SFHA (Special Flood Hazard Area)	
Pre-FIRM Policies	199
Pre-FRIM Policies in the SFHA	80
Source: The National Flood Insurance Program Community Status Book https://www.fema.gov/cis/OR.html Loss Statistics from Jan 1, 1978 through 1/31/2018 And State NFIP Coordinator	

regulators to flood, threatening the operations facility of Northwest Natural Gas. Since those events, the company has developed a back-up emergency plan and put backup emergency positions and systems in place.

Repetitive Loss Properties

A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than \$1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978.³³ A RL property may or may not be currently insured by the NFIP. Currently there are over 122,000 RL properties nationwide. (FEMA.gov site)

The National Flood Insurance Program (NFIP) indicates that Beaverton has 6 recorded repetitive loss properties, according to NFIP data dated 4/26/2018. All but one of the repetitive loss properties has had two losses apiece. The other had three. None of the properties meet the definition of a Severe Repetitive Loss Property. There are no “clusters” of repetitive loss properties within the city; but one location with two neighboring homes (#4 & #5) had one event in common but suffered the other losses at different times.

Table 2-6. NFIP Loss Statistics

Community Name	City of Beaverton
Insurance in Force	\$80,376,300
Total Paid Claims	31
Pre-FIRM Claims Paid	26
Substantial Damage Claims	0
Total Payments	\$448,027
Repetitive Loss Structures	6*
Severe Repetitive Loss Properties	0
CRS Class Rating	10
Last Community Assistance Visit	5/25/2016
Source: State NFIP Coordinator	
*FEMA Sources show 7 properties but one is outside city limits	

Table 2-7 - Repetitive Loss Properties

Property Ref	Zone	Nearby Stream/Creek	Insured?	Date of Loss	Date of Loss	Date of Loss
1	Unk	Fanno Creek	No	11/08/80	12/02/80	
2	A02	Johnson Creek	No	02/06/96	11/19/96	
3	C	Hall Creek	No	02/08/96	11/19/96	
4	X	None	Yes	12/9/2010	6/25/2014	
5	X	None	Yes	6/25/2014	10/31/2015	12/7/2015
6	AE	Fanno	Yes	1/2/2009	12/7/2015	
Source: State NFIP Coordinator						

Probability

Flood hazard areas identified on the Flood Insurance Rate Map are identified as a Special Flood Hazard Area (SFHA). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or

100-year flood. Moderate flood hazard areas are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood. The areas of minimal flood hazard are the areas outside the SFHA and higher than the elevation of the 0.2-percent-annual-chance flood.³⁴

Based on the available data and research for the City of Beaverton, the 2019 Hazard Analysis determined the **probability of experiencing a flood is “high”**, meaning one incident is likely within the next ten year period.

Vulnerability

Vulnerability assessment is the second phase of flood hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. It identifies the number of properties at risk from flooding, and the dollar value of the property at risk. Floodplain data for Beaverton can be used to conduct a preliminary vulnerability assessment for flood and drainage hazard areas.

The floodplains in Beaverton are generally located along Beaverton Creek, Fanno Creek, and its tributaries. There are approximately 750 acres within the 100-year floodplain boundaries in the City’s jurisdiction. A total of 845.69 acres of tax lots that lie within the 100-year floodplain in Beaverton. Within the tax lots, there are 320 total structures valued at \$339,537,830. See Table 2-10 for a breakdown of these properties by types of tax lots.

Table 2-8. Vulnerability Assessment for the 100-year Floodplain³⁵

Building Code Category	Number of Properties	Assessed Improved Value	Acreage within 100-year Floodplain
COMMERCIAL	34	\$78,014,890	103.26
INDUSTRIAL	39	\$126,973,670	226.27
SINGLE FAMILY RESIDENTIAL	199	\$29,201,790	171.75
MULTI-FAMILY RESIDENTIAL	48	\$105,347,480	344.41
TOTAL	320	\$339,537,830	845.69

Source: City of Beaverton GIS, 2003

Soils in and around Beaverton are silt loams that range in grade from nearly level to steep slopes. Drainage characteristics for those soils are poor along the level areas of the floodplains, but drainage (run off) improves on sloping terrain. Trees, grass and shrubs are the dominant vegetation type. The rapid urbanization of the city is leading

to decreased vegetation, and thus an increase in impervious surface and infringement of natural drainage areas.

Changes to development patterns since 2010 have the potential to incur increased risk of flooding. However, Metro and county development regulations restrict new development in areas identified as floodplain. This reduces the impact of flooding on future buildings. As new land has been brought into the regional Urban Growth Boundary, the applicable development codes have been written to prevent the siting of new structures in flood prone areas.

At the time of publication of this plan, data was insufficient to conduct a full risk analysis for flood events in Beaverton. However, in accordance with the 2019 City Hazard Analysis, Beaverton is **rated with a “moderate” vulnerability** to flood hazards, meaning that between 1-10% of the region’s population or assets would be affected by a major disaster.

Table 2-9 –Flood Insurance Policies by Building Type

Single Family	2 to 4 Family	Other Residential	Non-Residential	Minus Rated A Zone	Minus Rated V Zone
109	44	52	12	6	0

Volcano-Related Hazard

Beaverton and the Pacific Northwest lie on 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.

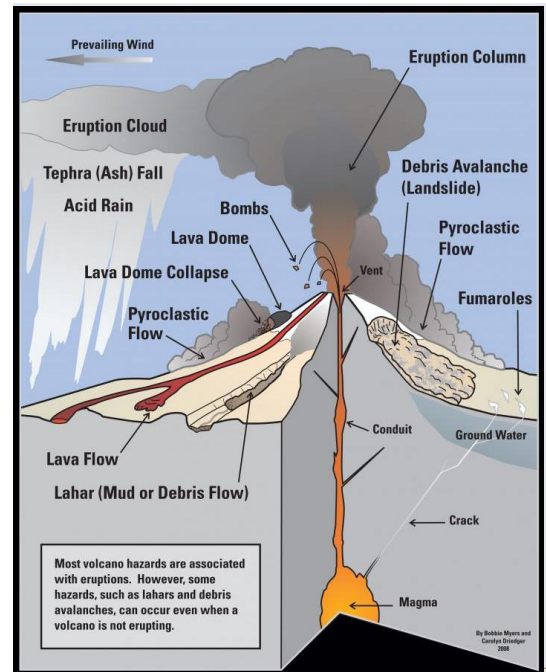
The primary threat to lives and property from active volcanoes is from violent eruptions that unleash tremendous blast forces, generate mud and debris flows, and produce flying debris and ash clouds. The immediate danger area in a Volcano-Related event generally lies within a 20-mile radius of the blast site. Although there are no active volcanoes in Beaverton or Washington County, there are a number of active volcanoes within the 100-mile danger areas that do pose a threat to city residents and property. The threat they pose is associated primarily with ash fall.

Characteristics/Types of Hazards

This section describes hazards related to Volcano-Related Events. Figure 2-3 shows a cross-section of a volcano and some of the hazards associated with volcanoes. Tephra, or ash, is the primary volcano related hazard that may impact the city.

Tephra consists of sand-sized or finer particles of volcanic rock and larger fragments. During explosive eruptions, tephra, together with a mixture of hot volcanic gases, is ejected rapidly into the air from volcanic vents. The suspended materials are carried high into the atmosphere and begin to move downwind. As the ash particles cool or become moisture laden they start to fall under the influence of gravity. The larger fragments fall near the volcanic vent, while finer particles drift downwind as a large cloud and then fall to the ground to form a blanket-like deposit of ash.³⁶

Figure 2-3. Cross section of a volcano



Source: United States Geological Survey.
<https://volcanoes.usgs.gov/observatories/cvo/hazards.html>

Location and extent

Due to Beaverton's proximity to nearby volcanos, volcanic hazards such as lava flows, lahars and debris flows do not pose a threat. However volcanic ash from an eruption can contaminate water supplies, cause electrical storms, create health problems, and clog conveyance systems. Additionally, lahars (mudflows) from Mt. Hood can cause the loss of potable water supply for the county from the Bull Run Watershed.

There are five major volcanoes in the Cascade region that are in relative proximity and pose a potential threat to Beaverton. They include Mount St. Helens, Mount Hood, Mount Rainier, Mount Adams, and Mount Jefferson. Of the five, all are known or suspected to be active, and most have geological records that indicate past histories of explosive eruptions with large ash releases. Mount Hood is the only volcano that has no geological evidence of large explosive events, though it still poses a threat of ash releases.

Geologic hazard maps have been created for most of the volcanoes in the Cascade Range by the USGS Volcano Program at the Cascade Volcano Observatory in Vancouver, WA and are available at http://vulcan.wr.usgs.gov/Publications/hazards_reports.html.

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.

History

The only historical incidence of a volcano directly affecting Beaverton was the eruption of Mount St. Helens on May 18, 1980. The Beaverton *Valley Times* followed the story of “mountain watchers” who watched the volcano from a campground near Cougar, Washington, throughout the spring of 1980. The eruption resulted in massive mudflows, floods and other land-changing forces.”³⁷ Ash from the eruption clouded the air in the Portland Metropolitan area, but did not ultimately cause damage in Beaverton. Emergency management in Washington County was prepared for the ash by providing facemasks and preparing for road closures. Because wind direction continued to head to the east after the eruption, Beaverton escaped significant accumulations of ash fall.³⁸

A few millimeters of ash fell onto Beaverton during small events on May 25, June 12, and October 16-18, 1980. The May 25 event left ash covering buildings, vehicles, lawns, and streets. For days, even weeks afterward, residents and government officials worked to clear away the fine powder and local hospitals treated a large number of patients suffering from respiratory problems attributed to the ash. They handed out surgical masks to help filter the ash, but the masks were largely ineffective. Residents and government officials worked aggressively to remove the ash deposits by flushing them into storm drains or sweeping them up and hauling them to landfill sites. Parks and outdoor swimming pools were particularly hard hit, requiring pool drainage and frequent filter cleaning. Ash also worked its way into equipment causing premature failures or requiring unscheduled maintenance.³⁹

Probability

The USGS/Cascades Volcano Observatory (CVO) produced volcanic hazard zonation reports for Mount St. Helens and Mount Hood in 1995 and 1997 as well as an update to the Mount Hood report in 2000. The reports include a description of potential hazards that may occur to immediate communities. In 2001, the CVO created an updated map on the annual probability of tephra fall for the Cascade region, which can be used by the City as a guide for forecasting potential tephra hazard problems.

The map is based on the combined likelihood of tephra-producing eruptions occurring at Cascade volcanoes. Probability zones extend farther east of the range because winds blow from westerly directions most of the time. The map (figure 2-4) shows annual probabilities for a fall of one centimeter (about 0.4 inch). The patterns on the map show the dominating influence of Mount St. Helens as a tephra producer. Because small eruptions are more numerous than large eruptions, the probability of a thick tephra fall at a given location is lower than that of a thin tephra

fall. The annual probability of a fall of one centimeter or more of tephra is about 1 in 10,000 on the county level, even less for the City.

Based on the available data and research and as determined in the 2019 City of Beaverton Hazard Analysis, the **probability of experiencing a volcano related hazard is “medium”**, meaning one incident is likely within the next 35-50 year period.

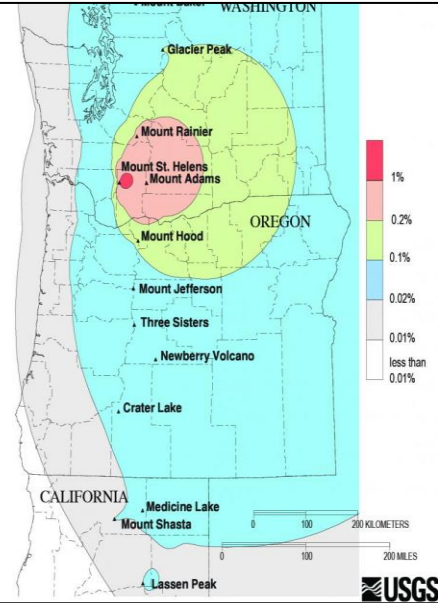
Vulnerability

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not been conducted for volcano-related events in Beaverton, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerability. Beaverton faces no direct threat from a volcano-related event. However, its proximity to a number of Cascade Range volcanoes places the city at risk from ash fallout originating from such an event. The amount of ash fall experienced and its impact will depend, to a large degree, on the weather conditions. A substantial portion of the city could be impacted by the ash fall generated by a volcanic eruption of Mount St. Helens while volcanologists also consider Mount Hood to be potentially active as well.

While Mount Hood has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of lava dome growth accompanied by small explosions, and lava-dome collapse generating pyroclastic flows, ash clouds, and lahars. Future eruptions from Mount Hood could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in northwestern Oregon and southwestern Washington.

The impacts of a significant ash fall are substantial. Persons with respiratory problems are at risk, transportation, communications, and other lifeline services are interrupted, drainage systems become overloaded/clogged, buildings can become structurally threatened, ventilation systems can become clogged and the economy takes a major hit. Any future eruption of a nearby volcano (e.g., Hood, St. Helens, or Adams) occurring during a period of easterly winds would likely have adverse consequences for the city.

Figure 2-4. Map showing one-year probability of accumulation of 1 centimeter (0.4 inch) eruptions of or more of tephra from volcanoes in the Cascade Range.



Source: United States Geological Survey-Cascades Volcano Observatory (CVO), (Figure assembled by OPDR)

The City of Beaverton's 2019 Hazard Analysis rated the city as having a **moderate vulnerability** to volcanic hazards, meaning that between 1-10% of the city's population and or property will be affected

More information on this hazard can be found in the Risk Assessment for [Region 2, Northern Willamette Valley/ Portland Metro](#), of the Oregon NHMP (2015).

Drought

A drought is a period of drier than normal conditions. Drought occurs in virtually every climatic zone but its characteristics vary significantly from one region to another. Drought is a temporary condition; it differs from aridity, which is restricted to low rainfall regions and is a permanent feature of climate. The extent of drought events depends upon the degree of moisture deficiency and the duration and size of the affected area. Typically, droughts occur as regional events and often affect more than one city and county.

Characteristic/Types of Hazards

There are four different ways that drought can be defined or grouped:

- **Meteorological Drought-** defined usually on the basis of the degree of dryness (in comparison to some "normal" or average amount) and the duration of the dry period. Definitions of meteorological drought must be considered as region specific since the atmospheric conditions that result in deficiencies of precipitation are highly variable from region to region.⁴⁰
- **Agricultural Drought-** Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and so forth. Plant water demand depends on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil. A good definition of agricultural drought should be able to account for the variable susceptibility of crops during different stages of crop development, from emergence to maturity.⁴¹
- **Hydrological Drought-** Hydrological drought is associated with the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (i.e., streamflow, reservoir and lake levels, groundwater). The frequency and severity of hydrological drought is often defined on a watershed or river basin scale. Although all droughts originate with a deficiency of precipitation, hydrologists are more concerned with how this deficiency plays out through the hydrologic system. Hydrological droughts are usually out of phase with or lag the occurrence of meteorological and agricultural droughts. It takes longer for precipitation deficiencies to show up in components of the

hydrological system such as soil moisture, streamflow, and groundwater and reservoir levels. As a result, these impacts are out of phase with impacts in other economic sectors.⁴²

- **Socioeconomic Drought-** Socioeconomic definitions of drought associate the supply and demand of some economic good with elements of meteorological, hydrological, and agricultural drought. It differs from the aforementioned types of drought because its occurrence depends on the time and space processes of supply and demand to identify or classify droughts. The supply of many economic goods, such as water, forage, food grains, fish, and hydroelectric power, depends on weather. Because of the natural variability of climate, water supply is ample in some years but unable to meet human and environmental needs in other years. Socioeconomic drought occurs when the demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply.⁴³

Location and Extent

Drought may occur in the City of Beaverton and may have profound effects on the economy, particularly the agricultural and recreational sectors, which are a small part of the city's overall economy. Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method which incorporates precipitation, runoff, evaporation, and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore, it is not believed to provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest.

History

Although Beaverton has suffered periods of drought in the past, the impacts have not been severe enough to reach major emergency or disaster proportions. The drought of 2000-01 is the worst on record for the city. Hagg Lake, the reservoir behind Scoggins Dam, fell to a record low of 9%. A combination of effective water management, significant conservation on the part of local irrigators, and adequate potable water supplies from the City ASR (Aquifer Storage and Reclamation) wells averted a major water crisis that year. A major drought affected several Oregon counties in 2015 but did not directly affect Beaverton.

Probability

Climate change forecasts highlight an increased risk for drought conditions in the Pacific Northwest. According to the U.S. National Climate Assessment report Climate Change Impacts in the United States Highlights "Changes in the timing of streamflow

related to changing snowmelt are already observed and will continue, reducing the supply of water for many competing demands and causing far-reaching ecological and socioeconomic consequences.”⁴⁴

Oregon’s drought history reveals many short-term and a few long-term events. The average recurrence interval for severe droughts in Oregon is somewhere between eight and 12 years. Based on the 2019 Hazard Analysis for the City of Beaverton the **probability of experiencing a severe drought is “moderate,”** meaning that one incident is likely in the next 35-75 year period.

Vulnerability

The environmental and economic consequences can be significant, especially for the agricultural sector. Drought also increases the probability of wildfires. Drought can affect all segments of the City of Beaverton’s population, particularly those employed in water- dependent activities (e.g., agriculture, recreation, etc.). Also, domestic water-users may be subject to stringent conservation measures (e.g., rationing)

Potential impacts to community and farming water supplies are the greatest threats. Additionally, long-term drought periods of more than a year can impact forest conditions and set the stage for potentially destructive wildfires. The 2019 Hazard Analysis for the City of Beaverton rated the city as having a **“moderate” vulnerability to drought hazards**, meaning between 1-10% of the region’s population or assets would be affected by a major drought emergency or disaster.

Landslides

There is an abundance of settlements that are located among the steep and mountainous slopes of the Pacific Northwest. Due to the urbanization process, many of these areas have become increasingly unsteady, as the integrity of the land has become compromised. Landslides, which are often secondary hazards generated by earthquakes, heavy rains, melting snow, or rapidly declining water levels at the base of the slope, are also in and of themselves considered a major geological hazard.

Nationally, landslides cause 25 to 50 deaths each year.⁴⁵ The best estimates of the direct and indirect costs of landslide damage in the United States range between \$1 billion to \$2 billion annually.⁴⁶ In Oregon, a significant number of locations are at risk to dangerous landslides. While landslides have had little to no impact in Beaverton, they have created a number of problems throughout Washington County. Although not all landslides result in private property damage, many landslides impact transportation corridors, fuel and energy conduits, and communication facilities.⁴⁷ They can also pose a serious threat to human life.

Landslides can be broken down into two categories: (1) rapidly moving; and (2) slow moving. Rapidly moving landslides (debris flows and earth flows) present the greatest

risk to human life, and persons living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Rapidly moving landslides have also caused most of the recent landslide-related injuries and deaths in Oregon. A rapidly moving debris flow in Douglas County killed five people during the storms of 1996. Slow moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

Characteristics/Types of Hazards

Landslides are downhill or lateral movements of rock, debris, or soil mass. The size of a landslide usually will depend on the geology and the triggering mechanism. Landslides initiated by rainfall tend to be smaller, while those initiated by earthquakes may be very large.

Slides associated with volcanic eruptions are typically large and can include as much as one cubic mile of material. Slides caused by erosion occur when ditches or culverts beneath hillside roads become blocked with debris. If the ditches are blocked, run-off from slopes is inhibited during periods of precipitation. This causes the run-off water to collect in soil, and in some cases, cause a slide. Usually the slides are small (100 – 1,000 cubic yards), but some have been known to be quite large.

Landslides can vary greatly in the volumes of rock and soil involved, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some of the characteristics that determine the type of landslide are the slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names depending on the type of failure and their composition and characteristics. Types of landslides include slides, rock falls, and flows.

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface, and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow (See Figure 2-5). Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.⁴⁸

Rock falls (see Figure 2-6) occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, where the road has been cut through

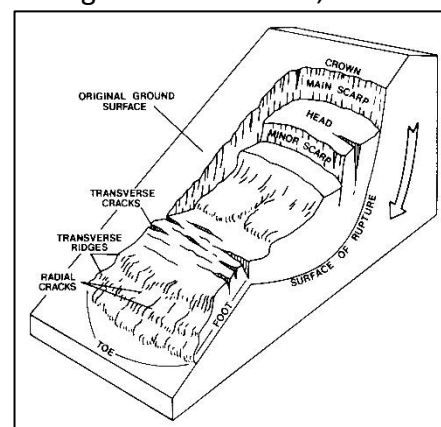


Figure 2-5. Rotational Slide

Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCD

bedrock can cause falls. These slides are fast moving with the materials free falling or bouncing down the slope. The total volume of material involved is generally small, but individually the boulders or blocks of rock can be large and can cause significant damage.

Flows (see Figure 2-7) are slides in which soil and rock breaks up and flows like a plastic or liquid. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically fast moving and also tend to increase in volume as they scour out the channel.⁴⁹ Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances. One example of a flow in Oregon is the Dodson debris flow that occurred in 1996.

This debris flow started high on the Columbia Gorge cliffs, and traveled far down steep canyons to form debris fans at Dodson.⁵⁰ Earthquakes often trigger flows as well.⁵¹

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt but earthquakes, volcanic activity, and excavations might also trigger them. Certain geologic formations are more susceptible to landslides than others are. Human activities, including development on or near steep slopes, can increase susceptibility to landslide events. Because of their general nature, landslides on steep slopes are typically more dangerous because they can occur with little warning and their movements can be very rapid.

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills;
- Steep road-cuts or excavations into steep slopes;
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
- Steep areas where surface runoff is channeled, such as below ground in culverts, V-shaped valleys, canyon bottoms, and steep stream channels;

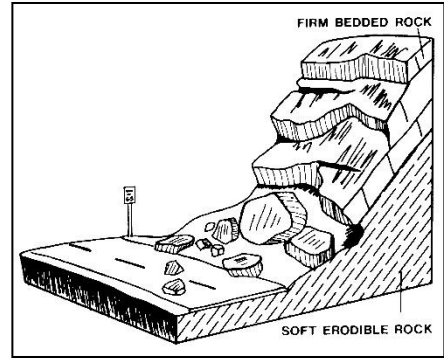
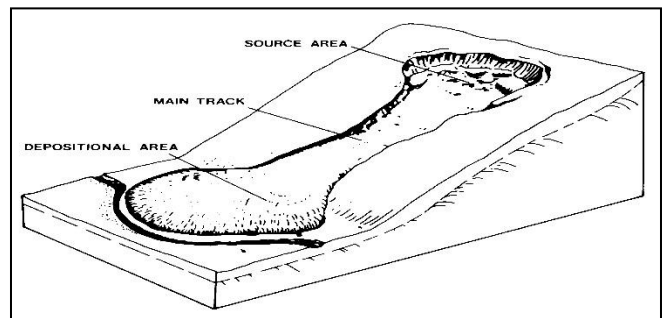


Figure 2-6. Rock Fall

Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCDC

Figure 2-7. Earthflow



Source: *Planning for Natural Hazards: The Oregon Technical Resource Guide*, DLCDC

- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons, large boulders (2 to 20 feet diameter) perched on soil near fans or adjacent to creeks; and
- Occurrences of logjams in streams.¹

Location and extent

While recent landslide events near Beaverton have not been the rapidly moving debris flows, the potential for their occurrence exists. Debris flows generally occur during intense periods of rainfall on previously saturated soil. They typically start on steep slopes and can accelerate to speeds as great as 35 mph. Debris flows have caused most of the recent landslide related injuries and deaths in Oregon,⁵² and they have been the catalyst for the creation of two state agencies: (1) the Oregon Department of Forestry (ODF); and (2) the Department of Geology and Mineral Industries (DOGAMI) to map these types of landslides.

Please refer to Hazard Map in the Map section of the NHMP for more information regarding landslide locations in the Beaverton area.

History

Landslides in surrounding areas of Beaverton have primarily been slow moving and caused greatest impact to roads and culverts.⁵³ There has only been one known landslide that has occurred within current city boundaries. The slide occurred on a man-made slope which is part of the Highway 217 overpass over the Beaverton-Hillsdale Highway. There was no direct impact on the roadways, utilities, or structures. Other than that single event, the City of Beaverton has no known locations susceptible to landslides, avalanches, or debris flows. This may change with future annexations of areas to the north and north east of current city boundaries.

Probability

Landslides tend to move repeatedly over time. As such, the location of existing landslides is critical for predicting the locations of future landslides. However, the location of existing landslides alone is not enough to predict the future. The geology, slope and triggering factors such as water, earthquakes, volcanic eruptions and man also must be considered. All of these factors combined result in landslide susceptibility, or the more- or less-likely locations of future landslides. Inventory and susceptibility maps can be used to guide assessments for future developments and can be used to assist in planning and mitigation of existing landslides.⁵⁴

Based on the single occurrence and existing steep slopes in the city, the **probability of future landslide events in the City is “moderate”**. Probability is based on the likelihood of another occurrence within a specified period of time and a medium probability event is likely to occur once within 35 to 50 years.⁵⁵

Please visit <http://www.oregongeology.org/sub/slido/index.htm> for Statewide Landslide information database (SLIDO). The interactive map lets you view information on location, type, and other attributes related to identified landslides in Oregon. The original studies vary widely in scale, scope, and focus, which is reflected

in a wide range in the accuracy, detail, and completeness with which the landslides are mapped.⁵⁶

Vulnerability

Vulnerability assessment is the second phase of the hazard assessment. It combines the information generated through landslide identification with an inventory of the existing development exposed to landslide hazards. Vulnerability assessments assist in predicting how different types of property and population groups will be affected by a hazard.⁵⁷ The optimum method for doing this analysis at the county or jurisdiction level is to use parcel-specific assessment data on land use and structures.⁵⁸ Data that includes known landslide and debris flow locations can be used to assess the population and total value of property at risk from future landslide occurrences.

There are several steep slopes (slopes greater than or equal to 25%) within the city. LIDAR (Light Detection and Ranging) technology shows evidence of landslide deposits at the base of some of these slopes indicating that the slope has slid in the past (See Hazards Map in the Map Section).

- 4 minor slides are within city limits
- 1 large slide area is both inside and outside the city limits
- 1 large slide area is outside, but close to the city limits

Other than these ancient slides, there are no known active locations prone to landslides, avalanches, or debris flows inside city limits. This may change with future annexations of areas to the north, north east and southwest of current city boundaries.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not been conducted for the Beaverton landslide event, there are many qualitative factors (issues relating to what is in danger within a community) that point to potential vulnerabilities existing in other areas identified for future annexations. Landslides can impact major transportation arteries, blocking residents from essential services and businesses. While past landslide events have not caused major property damage or significantly impacted city residents, continuing to map city landslide and debris flow areas will help in preventing future loss.

The City of Beaverton's 2019 Hazard Analysis rated the city as having a **low vulnerability** to landslide hazards, meaning that less than 1% of the city's population and or property will be affected.

Multi-Hazard Risk

While remote, the potential exists that the city could experience the impacts of two different natural hazards at the same time. Additionally, there are potential impacts that are common among more than one of the hazards covered in this plan, as well as other hazards not addressed (i.e., structural damage can be caused by earthquake, high-winds, or landslides). There are also mitigation measures and potential action items that can be applicable to more than one hazard. Addressing these multi-hazards items together rather than by specific hazard offers a more practical, coordinated, and cost effective approach than trying to address them within each hazard.

Since the multi-hazard items relate to multiple hazards, the established methodology for identifying the hazard, vulnerability, and risk of the specific hazards is not applicable. The primary assessment criteria for the multi-hazard risks are that the actions address more than one of the natural hazards covered in this plan.

Vulnerability Assessment

Community vulnerabilities are an important component of the NHMP risk assessment. For additional information regarding specific community vulnerabilities see Appendix C: Community Profile.

Vulnerability assesses the extent to which people are susceptible to injury or other impacts resulting from a hazard as well as the exposure of the built environment or other community assets (social, environmental, economic, etc.) to hazards. The exposure of community assets to hazards is critical in the assessment of the degree of risk a community has to each hazard. Identifying the populations, facilities, and infrastructure at risk from various hazards can assist the county in prioritizing resources for mitigation, and can assist in directing damage assessment efforts after a hazard event has occurred

¹ Oregon Department of Land Conservation and Development. 2015. *Oregon Natural Hazards Mitigation Plan* https://www.oregon.gov/LCD/NH/Documents/Approved_2015ORNHMP.pdf

²Taylor, George H. and Hannan, Chris, *The Oregon Weather Book*, (1999) Oregon State University Press.

³Ibid (entire paragraph)

⁴ National Weather Service, Portland Bureau, (March 2001) www.wrh.noaa.gov/Portland

⁵ US Department of Labor, Bureau of Labor Statistics CPI Inflation Calculator. https://www.bls.gov/data/inflation_calculator.htm

⁶ Fryer, Barbara, Planning Department, Stakeholder Interview

⁷ City of Beaverton, *Emergency Operations Plan (EOP); Tab B – Hazard Analysis*; revised April 2019.

“Probability is based on the likelihood of another occurrence within a specified period of time. A high probability incident can be expected once within a 10 to 35 year period, a medium probability once within 35 to 50 years and low, once in 75 to 100 hundred years.”

⁸ Burby, R. (Ed.) *Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities*. Washington D.C. (1998), Joseph Henry Press.

⁹ Interagency Hazard Mitigation Team, *State Hazard Mitigation Plan* (2000) Oregon State Police – Office of Emergency Management.

¹⁰ Taylor, George H. and Hannan, Chris, *The Oregon Weather Book*, (1999) Oregon State University Press.

¹¹ Ibid.

¹² Ibid.

¹³ Ibid.

¹⁴ Valley Times, “Worst Storm since ’62 Hits Area Monday Night,” 1967 and Beaverton Valley Times, 1/31/69

¹⁵ Ibid. 1/3/79

¹⁶ Ibid. 1/10/79

¹⁷ Ibid. 1/9/80

¹⁸ Ibid. 2/9/89

¹⁹ Ibid. 2/9/89

¹⁹ Ibid. 12/23/90

²⁰ City of Beaverton, *Emergency Operations Plan (EoP); Tab B – Hazard Analysis*; revised April 2016.

“Probability is based on the likelihood of another occurrence within a specified period of time. A high probability incident can be expected once within a 10 to 35 year period, a medium probability once within 35 to 50 years and low, once in 75 to 100 hundred years.”

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²⁷ Taylor, George H. and Chris Hannan. *The Oregon Weather Book*. Corvallis, OR: Oregon State University Press. 1999

²⁸ *Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000), Ch. 4.

²⁹ *Floodplain Management: a Local Administrator’s Guide to the National Flood Insurance Program*. FEMA, Region 10.

³⁰ The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, June 2000).

³¹ *Planning for Natural Hazards: The Oregon Technical Resource Guide*, Department of Land Conservation and Development (July 2000), Ch. 4.

³² Ibid

³³ FEMA.gov, Retrieved at https://www.fema.gov/pdf/rebuild/repetitive_loss_faqs.pdf

³⁴ FEMA Flood Zones, <http://www.fema.gov/floodzones>

³⁵ The data used to create these files were; Beaverton Zoning current as of July 2003, Beaverton City Limits current as of July 2003, Beaverton Building footprints current as of March 2001, Metro Floodplain current as of June 2002

The taxlot base does not have positional accuracy, and the Metro Floodplain may be outdated. The building footprints are positionally accurate but not up to date, as there have been buildings added and removed since the file was created. All these things have to be taken into consideration.

For the analysis - taxlots with a zone description of (CV, OC, NS, CS, TC-SR and GC) to create the Commercial category. All taxlots with a zone description of (CI, IP and LI) to create the Industrial category. All taxlots with a zone description of (R10, R7, R5 and R4) to create the Single Family Residential category. All taxlots with a zone description of (R3.5, R2 and R1) to create the Multi Family Residential category.

Clip Commercial (then Industrial...) with Floodplain. Intersect this with Planimetric Building Footprints. Calculate table statistics. Number of properties = Count field. For more information on this analysis contact Doug Taylor in Beaverton's GIS Department.

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³⁷ The Valley Times, May 21, 1980. Vol.60 No.37.

³⁸ The Valley Times, May. 23, 1980. Vol.60 No.38

³⁹ Community Planning Workshop, 2002

⁴⁰National Drought Mitigation Center, "Types of Drought", <http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx>. Accessed 28 April, 2018.

⁴¹ Ibid

⁴² Ibid

⁴³ Ibid

⁴⁴ Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: Highlights of Climate Change Impacts in the United States: The Third National Climate Assessment. U.S. Global Change Research Program, p80. Retrieved at http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download

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⁴⁵Mileti, Dennis, *Disasters by Design: A Reassessment of Natural Hazards in the United States* (1999) Joseph Henry Press, Washington D.C.

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⁴⁷ *USGS Landslide Program Brochure*, National Landslide Information Center, United States Geologic Survey.

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⁵⁵ City of Beaverton, *Emergency Operations Plan (EOP); Tab B – Hazard Analysis*; revised April 2019.

⁵⁶ Oregon Department of Geology and Mineral Studies. (Dec 2017). Statewide Landslide Information Database for Oregon (SLIDO). Retrieved from <http://www.oregongeology.org/sub/slido/index.htm>

⁵⁷ Burby, R.(Ed.) *Cooperating with Nature*. (1998) Washington D.C.: Joseph Henry Press.

⁵⁸ Ibid

Section 3

Mitigation Strategy

This section discusses the City of Beaverton’s strategy for reducing or avoiding the long-term vulnerabilities and potential impacts of the hazards identified in the risk assessment. It consists of three main components; mitigation goals, mitigation actions, and an implementation plan for the action items- as identified by the *Local Mitigation Planning Handbook* (FEMA, 2013). These provide the framework to identify, prioritize, and implement Beaverton’s Action Items in order to reduce the risk to hazards.

The 2003 City of Beaverton Natural Hazards Mitigation Plan included 46 mitigation actions to reduce the risk to life, property, and community systems. As part of the 2011 and current update processes, the Natural Hazards Mitigation Plan Steering Committee reviewed the plan mission and goals, including a comparison with current state mitigation goals. In addition, the committee reviewed the actions, activities and projects that took place between 2003 and this update.

See Appendix A – Action Items for information on the specific action items.

Mitigation Plan Mission

The mission of the Beaverton Natural Hazards Mitigation Plan is to assist in reducing risk, preventing loss, and protecting life, property, and the environment from future natural hazard events. The plan fosters coordinated partnerships and the development of multi-objective strategies for reducing the risks posed by natural hazards.

Mitigation Plan Goals

Beaverton’s Natural Hazards Mitigation Plan goals are based on the goals established by Washington County in their Natural Hazards Mitigation Plan. The City’s project steering committee reviewed the County’s goals and made recommendations during a meeting on February 11, 2003, for adapting them to the City’s needs. These goals were subsequently reviewed and approved by the Steering Committee for the 2011 NHMP and for this current plan update.

The plan goals help to guide the direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items. Meetings with the project steering committee, stakeholder interviews, a household and business survey, as

well as a focus group served as methods to obtain input and identify priorities in developing goals for reducing risk and preventing loss from natural hazards in Beaverton.

The following are the resulting goals for the City of Beaverton's Natural Hazards Mitigation Plan.

Goal 1: Develop and Implement Strategies to Protect Human Life, Commerce, Property, and Natural Systems from Natural Hazards

1. Implement strategies to help reduce insurance losses and repetitive claims for chronic hazard events while promoting insurance coverage for catastrophic hazards.
2. Evaluate applicable City guidelines, codes, and permitting processes regarding how they address natural hazard mitigation.
3. Link watershed planning, natural resource management, and land use planning with natural hazard mitigation strategies to protect vital habitat and water quality.
4. Preserve and rehabilitate natural systems to serve natural hazard mitigation functions.
5. Continuously develop and update natural hazard related datasets.

Goal 2: Improve Partnerships for Communication and Coordination

1. Develop and implement natural hazard education and outreach programs to increase awareness among citizens; local, city, and regional agencies; non-profit organizations; and businesses.
2. Strengthen communication, coordination and collaboration among public agencies, citizens, non-profit organizations, and businesses working in natural hazard risk reduction.

Goal 3: Enhance Emergency Services

1. Strengthen emergency operations by increasing communication, collaboration and coordination among public agencies, non-profit organizations, and businesses.
2. Coordinate natural hazard mitigation strategies, where appropriate, with emergency operations plans and procedures.

Goal 4: Ensure Implementation of Mitigation Strategies

1. To implement natural hazard mitigation strategies, develop and continue partnerships and promote leadership within local and regional public agencies; citizens; non-profit organizations; and businesses.
2. Ensure consistency between city, county, regional, and state mitigation strategies.

3. Consistently, seek diverse funding and resource partnerships for future mitigation efforts.

Mitigation Plan Action Items

The mitigation plan identifies short and long-term action items developed through data collection and research, along with the public participation process (See Appendix A). Action items address both multi-hazard (MH) and hazard specific issues for the hazards addressed in this plan. To facilitate implementation, each action item includes information on timeline, coordinating and partner organizations, ideas for implementation, and plan goals addressed.

Timeline. In the initial NHMP, Action Items were identified as being short-term or long-term and included an estimate of the timeline for implementation. *Short-term action items* (ST) were activities that City departments may implement with existing resources and authorities within one to two years. *Long-term action items* (LT) may require new or additional resources and/or authorities, and may take between one and five years to implement.

During the initial plan review cycle in 2011, the Natural Hazards Mitigation Plan Steering Committee reclassified the action items into four categories:

- On-going – Action Items that are by nature continuous or actions that are being worked on; but are not to the point where they are fully incorporated into City operations, plans, or regulations.
- Current Plan Cycle – Action Items that could be accomplished during the 5 years before the next scheduled plan revision.
- Future Plan Cycle – Action Items that are not likely to be started or accomplished in the 5 years before the next scheduled plan revision.
- Completed – Action Items that have been completed or items that are not realistically achievable or practical for the City to do (Example: Long-Term Volcano #1- Map and model ash fall.)

These four categories were validated in the 2018 process.

Coordinating Organization: The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. The coordinating organization for all action items within the Beaverton Natural Hazards Mitigation Plan will be the City of Beaverton.

Internal Partners: Internal partner organizations are departments within the City that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization.

External Partners: External partner organizations can assist the City in implementing the action items in various functions and may include local, regional, state, or federal agencies, as well as local and regional public and private sector organizations.

Ideas for Implementation: Each action item includes ideas for implementation and potential resources. This information offers a transition from theory to practice. These possible actions serve as a starting point for this plan. This component of the action items is dynamic as some ideas may not be feasible and new ideas can be added during the plan maintenance process. (For more information on how this plan will be implemented and evaluated, see Section 4). These possible actions are only suggestions for ways to implement the plan goal. Some of these items may prove to be unrealistic and other more refined ideas may be identified and added to the plan. Possible actions include things such as collaboration with relevant organizations, grant programs, tax incentives, human resources, education and outreach, research, and physical manipulation of buildings and infrastructure. A list of potential resources outlines what organization or agency will be most qualified and capable to perform the implementation strategy. Potential resources often include utility companies, non-profits, schools, and other community organizations.

Plan Goals Addressed. The plan goals addressed by each action item are identified as a means for monitoring and evaluating how well the mitigation plan is achieving its goals following implementation.

The Natural Hazards Mitigation Plan Steering Committee has identified potential funding sources for each priority action item (listed on Action Item Form within Appendix A). Example funding sources can include: the federal Pre-Disaster Mitigation and Flood Mitigation Assistance Programs; state funding sources such as the Oregon Seismic Rehabilitation Grant Program; or local funding sources such as capital improvement or general funds. An action item may also have multiple funding sources.

Action Item Development Process

The majority of the Action Items were first created during the initial planning processes. During this process, maps were developed of local vulnerable populations, facilities, and infrastructure in respect to each identified hazard. Review of these maps generated discussion around potential actions to mitigate impacts to the vulnerable areas. The Oregon Partnership for Disaster Resilience (OPDR), who we contracted with for the development of the initial plan, provided guidance in the development of action items by presenting and discussing actions that were used in other communities. OPDR also took note of ideas that came up in steering committee meetings and drafted specific actions that met the intent of the steering committee.

All actions were then reviewed by the steering committee, discussed at length, and revised as necessary before becoming a part of this document. The action items are reviewed regularly by the Natural Hazards Mitigation Plan Steering Committee and are revised as needed during the plan updates. When identified, additional action items are added.

Methodology for Prioritizing Plan Action Items

Methodology for Prioritizing Plan Action Items

To prioritize the plan's action items the City of Beaverton utilized a multi-tiered approach. First, the plan goals were prioritized. Second, the natural hazards identified in the community were prioritized based on the hazard risk assessments used in the City of Beaverton's Emergency Operations Plan (EOP). Using the outcome of these two activities, each action item was tallied according to a point system in a third step in order to determine its relative priority within the plan. The prioritized list of action items serves simply as a starting point for the implementation of mitigation activities.

The Natural Hazards Mitigation Plan Steering Committee and the leadership of the City of Beaverton have the option to implement any of the action items at any time. This allows the committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of highest priority. The following is the method by which the Natural Hazards Mitigation Plan Steering Committee will prioritize the plan action items.

Step 1: Prioritizing Plan Goals

To accomplish this task the Natural Hazards Mitigation Plan Steering Committee examined and voted on the importance of each of the plan's four goals. The steering committee was led through a "dot prioritization" activity to determine the relative priority of each goal. Steering committee members were given 4 different colored adhesive "dots". Each "dot" had a number assigned to it ranging from 1 to 4 points (four being the highest value). They were asked to place a single "dot" on each of the plan goals, whereby ranking the importance of each goal in making Beaverton more disaster resilient. The steering committee was asked to rank the goals regardless of how easy each goal would be to accomplish. After the vote, their priorities, the "dots" and their associated points were tallied and the results are as follows:

Highest Priority (31 Points) – Goal 1: Develop and Implement Activities to Protect Human Life, Commerce, Property and Natural Systems

2nd Highest Priority (23 Points) – Goal 4: Ensure Implementation of Mitigation Activities

3rd Highest Priority (16 Points) – Goal 3: Enhance Emergency Services

4th Highest Priority (10 Points) – Goal 2: Improve Partnerships for Communication and Coordination

The Natural Hazards Mitigation Plan Steering Committee validated the prioritized list of goals through a similar process conducted by email.

Step 2: Prioritizing Community Hazards

The second step in prioritizing the plan’s action items was to examine which hazards they are associated with and where these hazards rank in terms of community risk.

To re-evaluate the rankings of the hazards, *Tab B – Beaverton Hazard Analysis*, to the City’s Emergency Operations Plan, Basic Plan was utilized. That hazard analysis provides a systematic investigation of potential emergencies/disasters by analyzing history, vulnerability, and probability. The Hazard Analysis was updated in 2019 using a methodology originally developed by FEMA, and currently required by Oregon Emergency Management (OEM). The methodology determines the relative risk by applying severity ratings to four criteria; History, Vulnerability, Maximum Threat, and Probability. According to this analysis, the natural hazards identified in this plan were ranked in the following order or priority: Severe Weather – Windstorm, Severe Weather – Winter Storm, Earthquake, Flood, Volcanic Eruption (Ash Fall), Drought, Landslides and Debris Flow, and then Wildfire.ⁱⁱ

Table 3-1. City of Beaverton Hazard Rankingsⁱ

City of Beaverton	Hazard Score
Severe Weather – Windstorm	208
Severe Weather – Winter Storm	203
Earthquakes	203
Flood	188
Volcano (Ash Fall)	178
Drought	155
Landslides and Debris Flow	86
Wildland Fire*	58
Maximum score possible for each hazard = 240	
Sources: City of Beaverton Hazard Analysis 2019	
*Wildland Fire is not covered in the City’s NHMP	

Step 3: Tallying the Priorities of Plan Goals and Hazards

A prioritized list of action items were developed based on how the goals and hazards were ranked in Steps 1 and 2. In developing the prioritized list – each action item was examined according to the plan goals addressedⁱⁱⁱ and what priority those goals were assigned. In this first step, action items were assigned the following number of points for addressing each goal.

- 4 Points – Goal 1: Develop and Implement Activities to Protect Human Life, Commerce, Property and Natural Systems
- 3 Points – Goal 4: Ensure Implementation of Mitigation Activities
- 2 Points – Goal 3: Enhance Emergency Services
- 1 Point – Goal 2: Improve Partnerships for Communication and Coordination

Action items that address multiple goals were assigned points for all of the goals that they address. Depending on which hazards each action item addresses the following point system will be assigned to each:

- 10 Points – Multi-Hazard*
- 6 Points – Earthquake
- 5 Points – Severe Weather
- 4 Points – Flood
- 3 Points – Volcanic Eruption
- 2 Points – Landslides

*Multi-Hazard action items are assigned the most points due to the fact they address multiple hazards.

The points assigned to each action item depend on which hazard they address. These points are then combined with the points assigned to each item based on the goals addressed as detailed in Step 1 to arrive at an Action Item Priority Score noted in Appendix A. Higher scores indicate higher priorities. The point totals for Step 1 were combined with the point totals in Step 2 to create a number by which each action item is prioritized.

Step 4: Action Item Implementation

While numeric values can be assigned to the individual action items other factors have a direct impact on whether these items will be implemented including:

- Regional Impacts – Any actions taken would have to be done on a county-wide or regional basis.
- Costs – The cost of action items may exclude it from being implemented or it will only be feasible under a grant award.
- Political/Policy – Some recommendations may run contrary to the direction set by the City’s elected officials or strategic plans.

The Emergency Management Program, supported by the City’s Natural Hazards Mitigation Plan Steering Committee, has been monitoring the implementation of action items. During the latest round of plan review and update the Natural Hazards Mitigation Plan Steering Committee divided the Action Items into four categories:

- On-going – Action Items are being worked on; but are not to the point where they are fully incorporated into City operations, plans, or regulations.
- Current Plan Cycle – Action Items that could be accomplished during the 5 years before the next scheduled plan revision.
- Future Plan Cycle – Action Items that are not likely to be started or accomplished in the 5 years before the next scheduled plan revision.
- Completed – Action Items that have been completed.

Mitigation plan activities may be considered for funding through state and federal grant programs, including the Federal Emergency Management Agency’s Hazard Mitigation Grant Program and Pre-Disaster Mitigation Competitive Grant Program, as funds are made available. Action items address both multi-hazard (MH) and hazard specific issues for the hazards addressed in this plan.

In examining the feasibility of funding for action items, a benefit-cost analysis will be conducted for all structural mitigation projects. See Appendix E for more information on this process.

ⁱ City of Beaverton Emergency Operations Plan, Basic Plan, Tab B-Hazard Analysis.

ⁱⁱ The methodology determines the relative risk by applying severity ratings to four criteria;

- History (H) – how often the event has occurred at a level requiring EOC activation or disaster declaration. (WF=2)
- Vulnerability (V) – the percentage of the population and property likely to be affected by the incident under an “average” occurrence. (WF=5)
- Maximum Threat (M) – the highest percentage of population and property that could be impacted under a worst-case scenario. (WF=10)
- Probability (P) – the likelihood of another occurrence within a specified period of time. (WF=7)

The Severity Rating (SR) was determined by applying a numeric value based on low (1 to 3), medium (4 to 7), and high (8 to 10) for each of the four criteria. The Severity Ratings for each area was then multiplied by a pre-designated Weight Factor (WF):

- History = 2
- Vulnerability = 5
- Maximum Threat = 10
- Probability = 7

The final score, or rating, is the sum of the numeric values of the four criteria.

Final Score = H(WF x SR) + V(WF x SR) + M(WF x SR) + P(WF x SR)

ⁱⁱⁱ The Natural Hazards Mitigation Plan Steering Committee had previously identified which goals were covered by which action items.

Section 4

Plan Implementation and Maintenance

The plan maintenance section of this document details the formal process that will ensure that the City of Beaverton Natural Hazards Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing an updated plan every five years. This chapter also describes how the City will integrate public participation throughout the plan maintenance process. Finally, this chapter includes an explanation of how the City intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City comprehensive land use plan, capital improvement plans, and building codes.

Implementing the Plan

The effectiveness of the non-regulatory City of Beaverton Natural Hazards Mitigation Plan will be contingent on the implementation of the plan and incorporation of the outlined action items into existing plans. After the revised plan is formally adopted, the identified activities and their prioritization will be validated by the Natural Hazards Mitigation Plan Steering Committee, and finally, the activities will be implemented, as resources permit, through existing plans, programs, and policies.

Once the plan has been adopted, the City Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer at Oregon Emergency Management. Oregon Emergency Management will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Beaverton will maintain eligibility for Hazard Mitigation Grant Program funds.

Coordinating Body

The Natural Hazards Mitigation Plan Steering Committee will serve as the coordinating body for the plan and will be responsible both for coordinating the implementation of plan action items and for undertaking the formal review process. The Mayor's Office will ensure that appropriate representatives are assigned from the applicable City departments and programs, including, but not limited to, the current Hazard Mitigation Steering Committee members. The current members of the steering committee include representatives from:

- City of Beaverton Emergency Management Program
- City of Beaverton Community Development Department

- City of Beaverton Public Works
- City of Beaverton Finance/ISD/GIS Service
- Portland General Electric (PGE)
- Beaverton Community Emergency Response Team (CERT)
- Beaverton Committee for Citizen Involvement (BCCI)

The Natural Hazards Mitigation Plan Steering Committee will have no less than bi-annual meetings. These meetings will provide an opportunity to discuss the progress of the action items in the plan, and maintain the partnerships that are essential for the sustainability of the Mitigation Plan. Some plan coordination may occur through email in lieu of convening a meeting especially when there are limited items to discuss.

Convener

Although the City Council will provide ownership of the City of Beaverton Natural Hazards Mitigation Plan, the City's Emergency Manager will take responsibility for plan implementation. The Emergency Manager will facilitate the Natural Hazards Mitigation Plan Steering Committee meetings and will assign tasks such as updating and presenting the plan to the rest of the members of the committee. Plan implementation and evaluation will be a shared responsibility among all of the assigned Steering Committee Members.

Implementation through Existing Programs

The City of Beaverton currently addresses statewide planning goals and legislative requirements through its comprehensive land use plan, capital improvement plans, and City building codes. The Natural Hazards Mitigation Plan is non-regulatory in nature and provides a series of recommendations – many of which are closely related to the goals and objectives of these existing planning programs. To the extent possible, the City of Beaverton should incorporate the recommended mitigation action items into existing programs and procedures. These goals and action items will help the City of Beaverton address statewide land-use planning Goal 7 which was developed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards. Goal 7 requires that local governments base development plans on inventories of known areas of natural disasters and hazards and that the intensity of development should be limited by the degree to which the natural hazard occurs within the areas of proposed development. The City can use review of this plan as an avenue to update the Goal 7: Natural Hazards element of their comprehensive plan and to integrate mitigation into zoning and planning documents.

The City Building Division is responsible for administering the building codes in Beaverton. They work with the State Building Code Office to make sure that the City adopts, and is enforcing, the minimum standards established in the new State Building Code. In addition, the Natural Hazards Mitigation Plan Steering Committee will

promote safe building practices in an effort to have structures more resistant from the impacts of all hazards.

Capital improvement planning that occurs in the future will also contribute to the goals in the Natural Hazards Mitigation Plan. Various City departments develop Capital Improvement Programs (CIPs), and review them on an annual basis. The Natural Hazards Mitigation Plan Steering Committee will work with these departments to identify action items from Natural Hazard Mitigation into appropriate sections of the CIPs.

The meetings of the Natural Hazards Mitigation Plan Steering Committee will provide an opportunity for committee members to report back on the progress made on the integration of mitigation planning elements into City planning documents and procedures.

The City's continued participation in the Emergency Management Cooperative for Washington County and monthly Local Emergency Management meetings also provides additional venues for the discussion and coordination of mitigation activities with partner organizations and stakeholders.

Economic Analysis of Mitigation Projects

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

The Natural Hazards Mitigation Plan Steering Committee will use FEMA-approved cost benefit methodology as a tool for identifying and prioritizing mitigation action items when applying for federal mitigation funding. For other projects and funding sources, the Natural Hazards Mitigation Plan Steering Committee will use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix D of the Plan.

Methodology for Prioritizing Plan Action Items

To initially prioritize the plan's action items the City of Beaverton utilized a multi-tiered approach. First the plan goals were prioritized. Second, the natural hazards identified in the community were prioritized based on the hazard analysis used in the City of Beaverton's Emergency Operations Plan (EOP). Using the outcome of these two activities each action item was tallied according to a point system in a third step in order to determine its relative priority within the plan. The prioritized list of action

items serves simply as a starting point for the implementation of mitigation activities. (See Section 3 for additional details on prioritization of action items).

The Natural Hazards Mitigation Plan Steering Committee and the leadership of the City of Beaverton have the option to implement any of the action items at any time. This allows the committee to consider mitigation strategies as new opportunities arise, such as funding for action items that may not be of highest priority.

Evaluating and Updating the Plan

Formal Review Process

The City of Beaverton has implemented a process to ensure that a regular review and update of the Natural Hazards Mitigation Plan occurs. This process is based on a cycle that culminates with a revised plan being approved by Council and distributed at least every 5 years. All Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan and the Emergency Manager is responsible for contacting the Committee members and organizing a plan review meeting at least annually. Participation in the Steering Committee meeting may be expanded.

The committee will review each goal and objective to determine their relevance to changing situations in the City, as well as changes in state or federal policy, and to ensure they are addressing current and expected conditions. The committee will also review the risk assessment portion of the plan to determine if this information should be updated or modified. The designated parties responsible for the various implementation actions will report on the status of their projects and will include which implementation process worked well, any difficulties encountered, how coordination efforts were proceeding, and which strategies should be revised.

Each section is also reviewed for changes in data, policy requirements, activities underway, and possible resources. These reviews occur during the Steering Committee meetings and by email, with internal and external partners/stakeholders.

Review process also includes the review of other documents and reports that may have an impact on the plan and activities. The documents reviewed included, but was not limited to:

- City of Beaverton Water Master Plan – Includes seismic resilience evaluations and capital improvement program
https://beaverton.granicus.com/MetaViewer.php?view_id=2&clip_id=2006&meta_id=107832
- City of Beaverton Comprehensive Plan
<https://www.beavertonoregon.gov/461/Comprehensive-Plan>
- Statewide Planning Goal 7 <https://www.oregon.gov/lcd/OP/Pages/Goal-7.aspx>
- Oregon Department of Land Conservation and Development. 2015. *Oregon Natural Hazards Mitigation Plan*
https://www.oregon.gov/LCD/NH/Documents/Approved_2015ORNHMP.pdf

- Washington County Community Wildfire Protection Plan
https://www.co.washington.or.us/EmergencyManagement/upload/WashCo_CWP_P_Final.pdf
- Washington County Natural Hazards Mitigation Plan
<https://www.co.washington.or.us/EmergencyManagement/upload/WashCo-NHMP-2017-Plan-Summary.pdf>
- Oregon Department of Geology and Mineral Studies. Earthquake Regional Impact Analysis for Clackamas, Multnomah, and Washington Counties, Oregon Report to the Regional Disaster Preparedness Organization Oregon. (Nov 30, 2017)
<https://rdpo.net/dogami-earthquake-impact-analysis>

Copies of the plan have been provided to partner organizations and are available electronically on-line for other partners, stakeholders, businesses, and academia to review and provide comment on.

The Emergency Management Program is responsible for incorporating the changes and updates to the plan before submitting the final document to the Natural Hazards Mitigation Plan Steering Committee members, and presenting it to the City Council for approval. The updated Plan will then be submitted to the State Hazard Mitigation Officer for review. If no changes are necessary, the State Hazard Mitigation Officer will be given a justification for this determination.

Continued Public Involvement

Public participation was also maintained in the review and revision process for this update of the plan. When the process to revise and update the plan was started, information on the update and solicitation for comment were posted on the Home Page of the City's website and published in the "Your City" newsletter. Information on how to submit comments and proposed changes were included in the information. Links to the on-line survey were also provided in the "Your City" article and on the City's Home Page. See Appendix B for additional information on public involvement.

The final NHMP will be maintained on the City's website and will include a link for providing comment during the period of time between updates. Public involvement will also be maintained on the Steering Committee with volunteers from CERT and a representative from BCCI (Beaverton Committee for Community Involvement).

State of Oregon as a Partner

All mitigation is local and the primary responsibility for development and implementation of risk reduction strategies and policies lies with local jurisdictions. Local jurisdictions, however, are not alone. Partners and resources exist at the state and federal levels.

Numerous Oregon state agencies have a role in natural hazards and natural hazard mitigation. Some of the key agencies include:

- Oregon Military Department, Office of Emergency Management (OEM) is responsible for disaster mitigation, preparedness, response, recovery, and the administration of federal funds after a major disaster declaration;
- Oregon Building Codes Division (BCD), is responsible for construction and for some hazards that are building-specific in their occurrence (such as earthquakes); also included are provisions for expansive soils and damage assessment of buildings after an earthquake;
- Oregon Department of Forestry (ODF) is responsible for all aspects of wildland fire protection on private and state lands. Additionally, in Western Oregon, ODF is responsible for Bureau of Land Management forestlands and administers forest practices regulations, including landslide mitigation, on non-federal lands;
- Oregon Department of Geology and Mineral Industries (DOGAMI) is responsible for geologic hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state mandated tsunami zone restrictions; and
- Department of Land Conservation and Development (DLCD) is responsible for planning-based hazard management including implementation of land use planning and Goal 7 (natural hazards), with attention given to hazard assessments and hazard mitigation. In addition, DLCD manages the state Floodplain Management and FEMA Risk MAP programs. Statewide land use planning Goal 7: Planning for Natural Hazards, calls for local plans to include inventories, policies, and ordinances to guide development in hazard areas. Goal 7, along with other land use planning goals, has helped to reduce losses from natural hazards. The City can use review of this NHMP as an avenue to update the Goal 7: Natural Hazards element of its comprehensive plan and to integrate mitigation into zoning and planning documents.

Other Partners

Further, mitigation actions can be implemented through the ongoing efforts of city partners. The City will actively seek out opportunities for such partnerships to further NHMP objectives. For example:

- Utilities and Special Districts: As a water resources management utility with nearly 500,000 customers, Clean Water Services is already invested in protecting the health of county residents as well as the quality of natural resources in Washington County. Many of their programs can already be said to be effective mitigation action. For example, they encourage residents to do natural landscaping which incorporates better water management. This can reduce neighborhood flood issues. In response to drought conditions in 2015, Clean Water Services contracted with Tualatin Valley Irrigation District to tap

into its Henry Hagg Lake water right. The purpose of the water purchase was to maintain adequate stream flows in the Tualatin River. Clean Water Services can continue to be a partner in outreach and mitigation actions.

- Portland General Electric is the electrical utility providers that covers the City of Beaverton. They provide an essential resource that city services, private industry, and citizens depend on. Continued collaboration to reduce vulnerabilities and increase the resilience of the power grid is a primary focus of this partnership.
- City Departments: Capital improvement planning that occurs in the future will also contribute to the goals in the NHMP. Many City departments develop Capital Improvement Plans (CIPs) and review them on an annual basis. At the time of annual review, the Natural Hazards Mitigation Steering Committee may work with the departments to integrate the City's NHMP into appropriate sections of the CIPs.
- Washington County Emergency Management Cooperative: The Emergency Management Cooperative for Washington County is committed to the development and maintenance of a countywide, integrated system to prepare for, respond to, recover from, and mitigate against disasters. The EMC is comprised of Beaverton, Cornelius, Forest Grove, Hillsboro, Sherwood, Tigard, Clean Water Services and Tualatin Valley Fire and Rescue. In addition to local governments and special service districts, the EMC provides assistance to local businesses, schools, social service agencies, church groups, neighborhood groups, civic organizations, and youth groups. The EMC takes a proactive approach to enhancing government preparedness and educating the public. Since government's ability to respond may be limited during disasters, citizens need to be prepared to manage on their own for a minimum of three days.
- Citizens: There are numerous ways in which citizens and residents of Beaverton may become involved in mitigation actions. For example, groups such as CERT (Community Emergency Response Team), NACs (Neighborhood Association Committees), Homeowners Owners Associations, and BCCI (Beaverton Committee for Community Involvement).
- Public Health and Social Service Providers: As organizations that interface with the public on a daily basis, public health and social service providers can be a conduit to get information directly to city residents. They can also provide emergency managers with critical information about vulnerabilities that exist in the population. These organizations are natural partners in hazard mitigation.

Connections with the activities of other partners are part of the City's strategy for ongoing public involvement. It allows the City to present mitigation actions and ideas more holistically, within the context of existing groups.

Five-Year Review of Plan

This plan will be updated every five years in accordance with the update schedule outlined in the Disaster Mitigation Act of 2000. **The City of Beaverton NHMP is due to be reapproved FEMA by 2025.** The convener will be responsible for organizing the Steering Committee to address plan update needs. The Steering Committee will be responsible for updating any deficiencies found in the plan and for ultimately meeting the Disaster Mitigation Act of 2000's plan update requirements.

City of Beaverton

Natural Hazards Mitigation Plan

Map Directory

Geographic Information Systems (GIS) Maps:

City of Beaverton GIS Services developed all of the maps included in this plan (See Table M1 on the next page). The contributions from this department were essential in illustrating the extent and potential losses associated with the natural hazards affecting the City.

All maps were revised based on the most current data available. One map (Map #8) has changed from the previous version of the plan. The map previously was a comparison of the FEMA 100 Year Floodplain and a 2006 Revised 100 Year Floodplain that was pending adoption by FEMA. In this revision Map #8 shows the “Perceived Shaking and Damage Potential of a Magnitude 9.0 Earthquake.” The data layers are a product of the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI was contracted by the Regional Domestic Preparedness Organization (RDPO), through a federal grant, to develop greater detail mapping of the potential impacts of a 9.0 Cascadia Subduction Zone Earthquake on the 5 county Portland region.

All map information is derived from the City of Beaverton’s GIS Services using existing city, county, regional and state geographical databases. Care was taken in the creation of these maps, but are provided “as is” using the “best available” data. The City cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties that accompany these products (the maps). Although information from Land Surveys may have been used in the creation of these products, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Table M.1 Map Information

Map #	Map Title	Main Information Featured	Relevant Plan Elements
1	Natural Hazards	100-Year Floodplain, Debris Flows, Steep Slopes, Methane Hazard	Section 2- Risk Assessment Appendix G – Hazard Analysis
2	Critical Facilities	Public and Private Schools, Community Centers, Nursing Homes, Hospitals, Light Rail system	Section 2- Risk Assessment Appendix C – Community Profile
3	Economic Assets – Zoning	City Zoning Map	Appendix C – Community Profile
4	Economic Assets – Employment	Employment Densities	Appendix C – Community Profile
5	Environmental Assets – Significant Trees	Significant Trees, Groves, and Corridors	Section 2- Risk Assessment Appendix G – Hazard Analysis
6	Environmental Assets – Parks and Open Spaces	Parks, Open Spaces, and Significant Wetlands	Section 2- Risk Assessment Appendix C – Community Profile
7	Functional Road Classification	Functional Road Classifications	Appendix C – Community Profile
8	Perceived Shaking and Damage Potential Magnitude 9.0 Earthquake	Perceived Shaking and Damage Potential Magnitude 9.0 Earthquake	Section 2- Risk Assessment Appendix G – Hazard Analysis

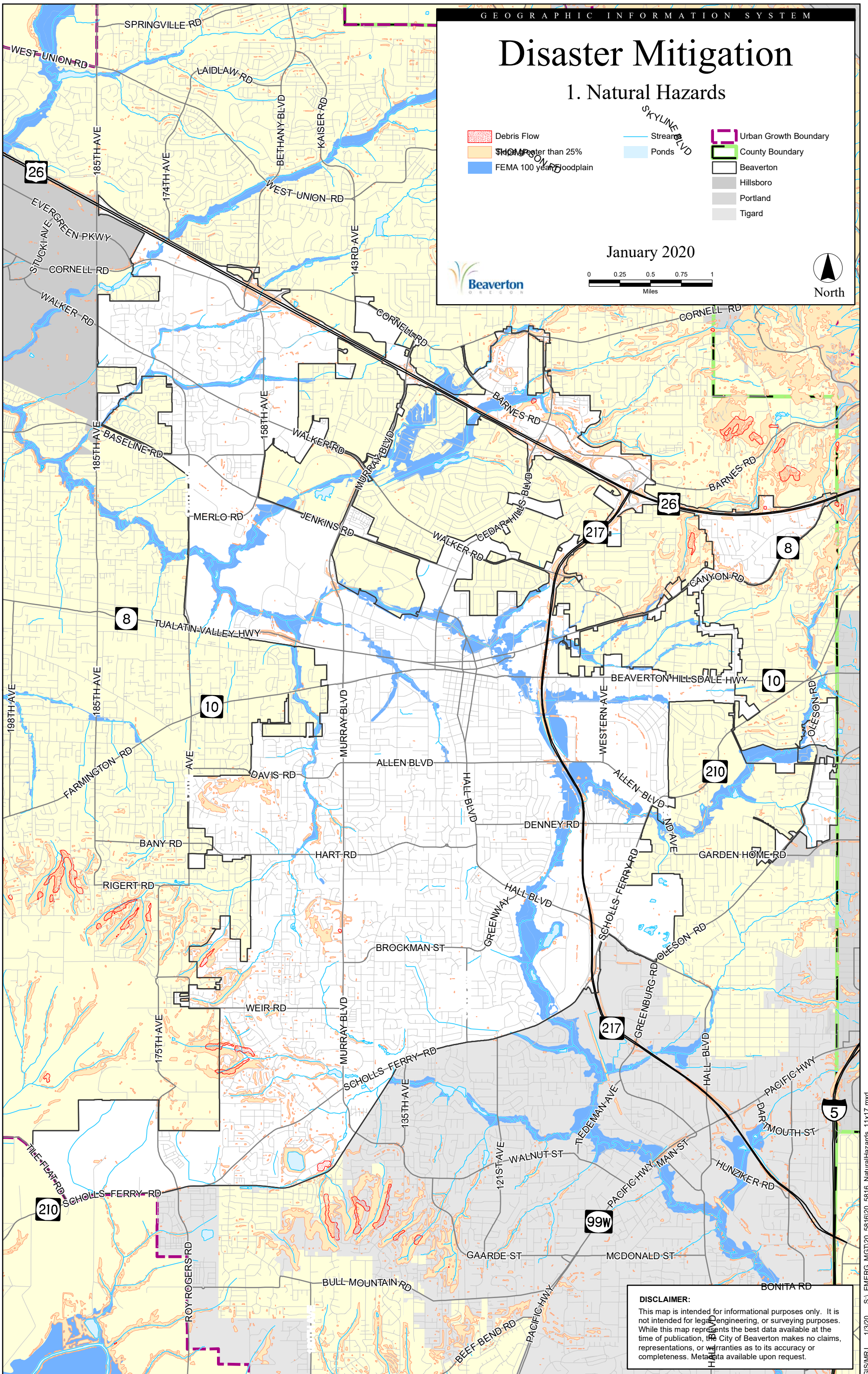
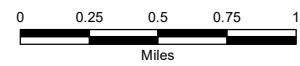
Any questions regarding these maps should be directed to the City of Beaverton’s GIS Services, 503-526-2352.

Disaster Mitigation

1. Natural Hazards

- Debris Flow
- Shallow Water
- FEMA 100 year Floodplain
- Streams
- Ponds
- Urban Growth Boundary
- County Boundary
- Beaverton
- Hillsboro
- Portland
- Tigard

January 2020



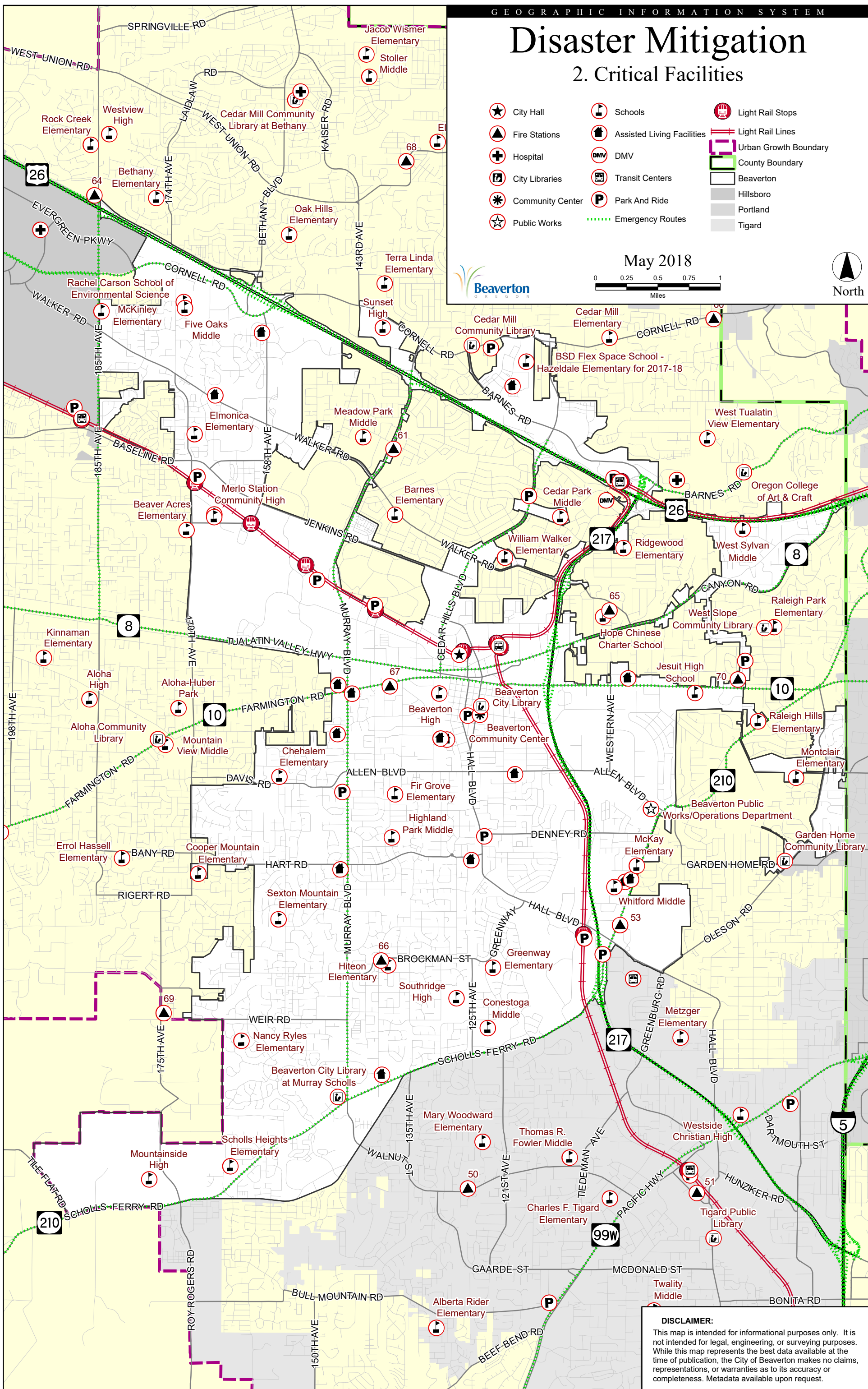
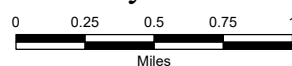
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Disaster Mitigation

2. Critical Facilities

- ★ City Hall
- ▲ Fire Stations
- ⊕ Hospital
- 📖 City Libraries
- ⊛ Community Center
- ⚙️ Public Works
- 🎓 Schools
- 🏠 Assisted Living Facilities
- 🚗 DMV
- 🚏 Transit Centers
- 🅑 Park And Ride
- 🚊 Light Rail Stops
- 🚊 Light Rail Lines
- 📐 Urban Growth Boundary
- 🌿 County Boundary
- 📍 Beaverton
- 📍 Hillsboro
- 📍 Portland
- 📍 Tigard
- 🟢 Emergency Routes

May 2018



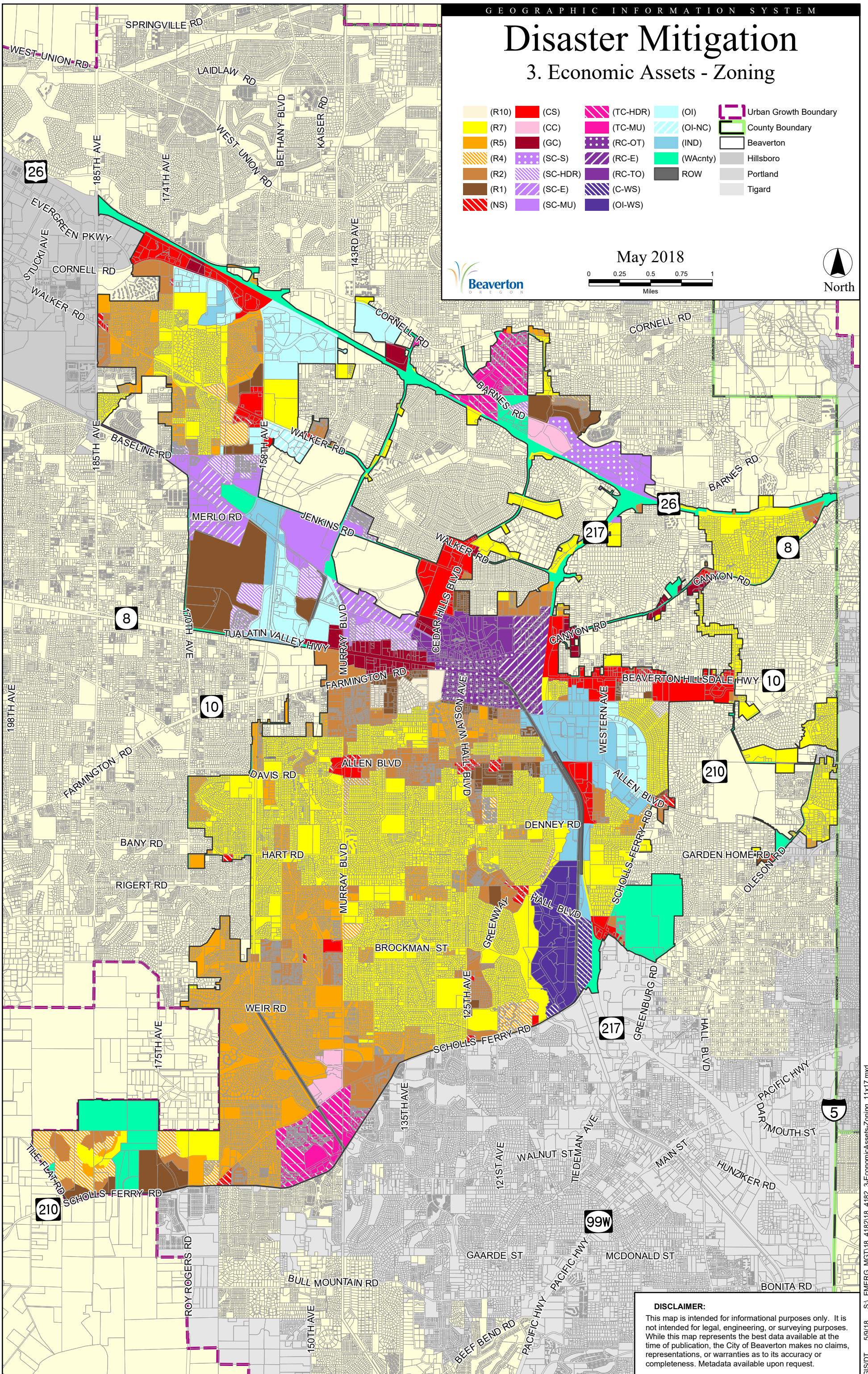
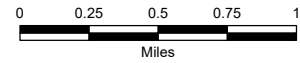
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Disaster Mitigation

3. Economic Assets - Zoning

(R10)	(CS)	(TC-HDR)	(OI)	Urban Growth Boundary
(R7)	(CC)	(TC-MU)	(OI-NC)	County Boundary
(R5)	(GC)	(RC-OT)	(IND)	Beaverton
(R4)	(SC-S)	(RC-E)	(WActy)	Hillsboro
(R2)	(SC-HDR)	(RC-TO)	ROW	Portland
(R1)	(SC-E)	(C-WS)		Tigard
(NS)	(SC-MU)	(OI-WS)		

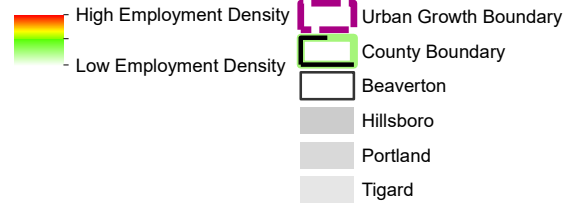
May 2018



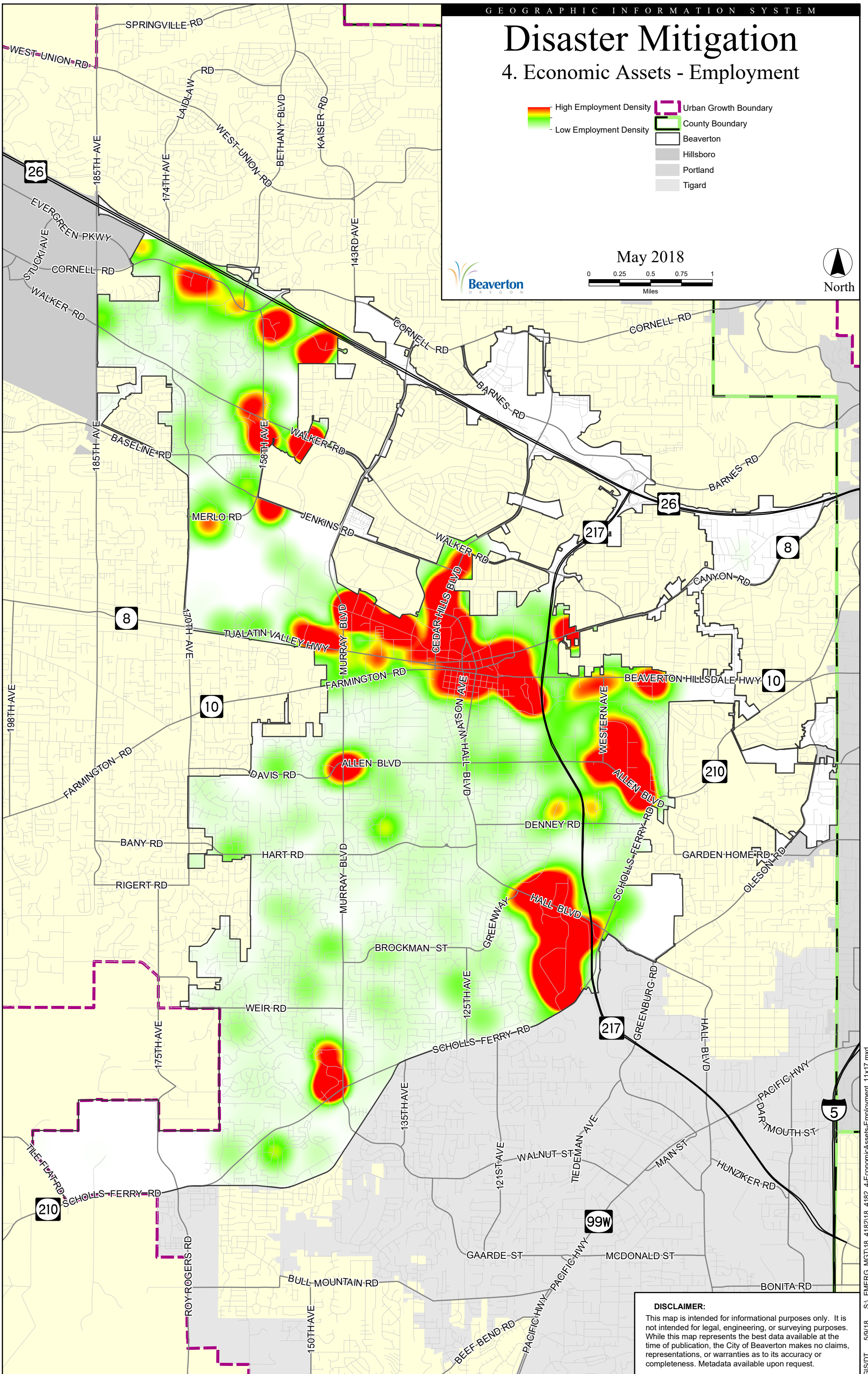
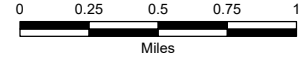
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Disaster Mitigation

4. Economic Assets - Employment



May 2018



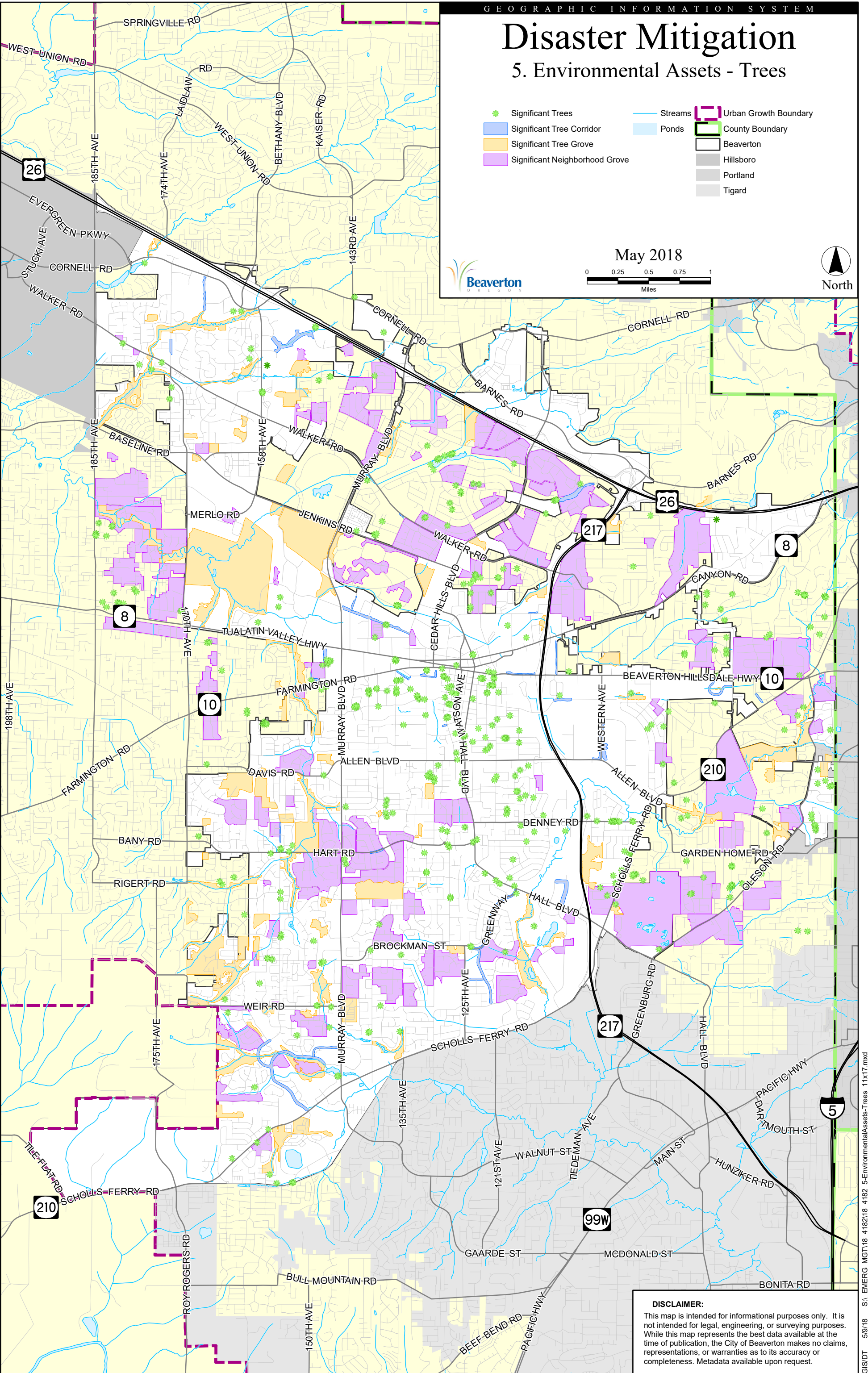
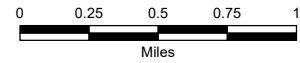
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Disaster Mitigation

5. Environmental Assets - Trees

- * Significant Trees
- Significant Tree Corridor
- Significant Tree Grove
- Significant Neighborhood Grove
- Streams
- Ponds
- Urban Growth Boundary
- County Boundary
- Beaverton
- Hillsboro
- Portland
- Tigard










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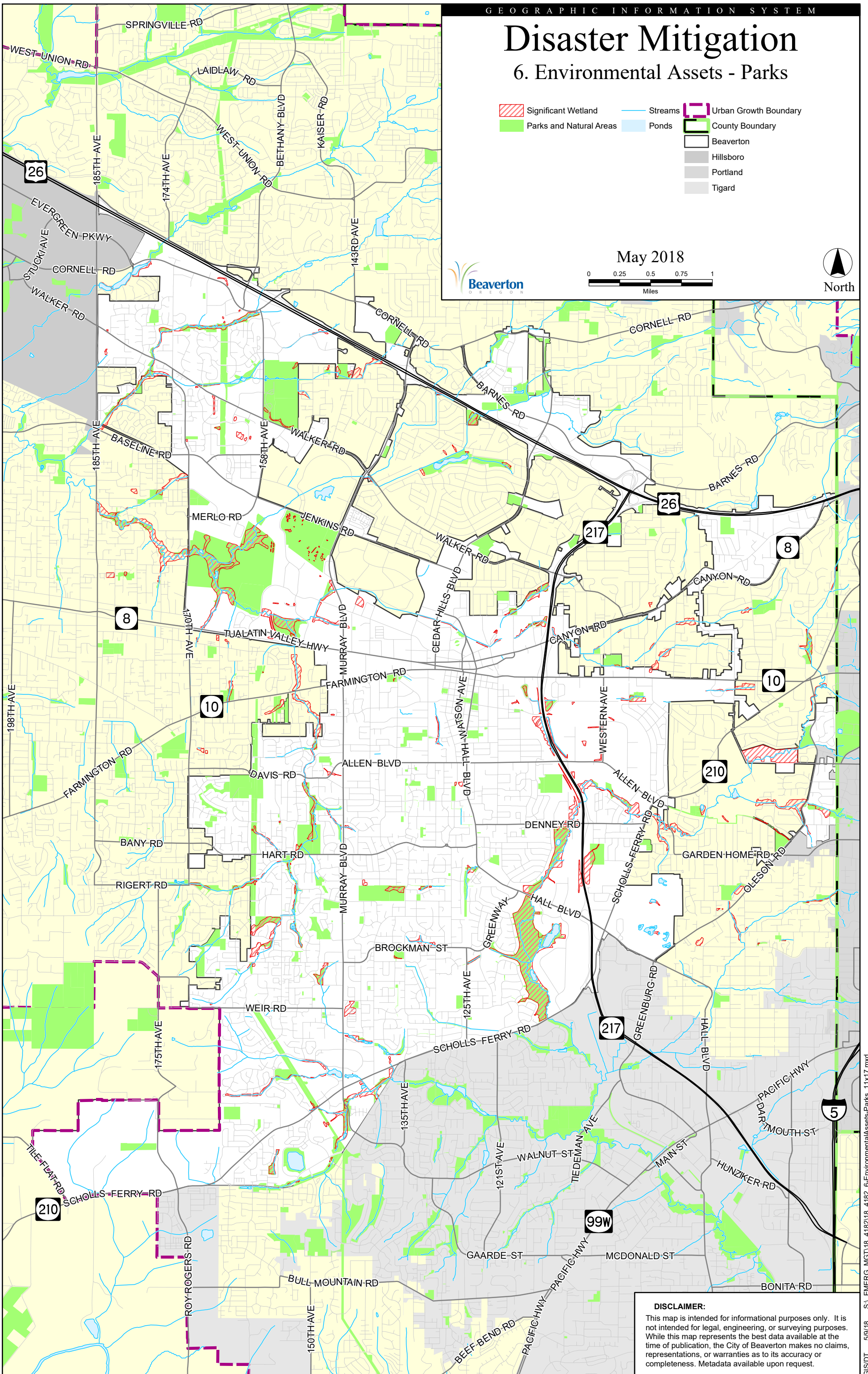
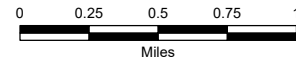
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Disaster Mitigation

6. Environmental Assets - Parks

-  Significant Wetland
-  Streams
-  Urban Growth Boundary
-  Parks and Natural Areas
-  Ponds
-  County Boundary
-  Beaverton
-  Hillsboro
-  Portland
-  Tigard

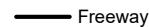





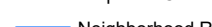
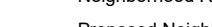

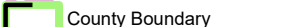



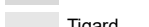
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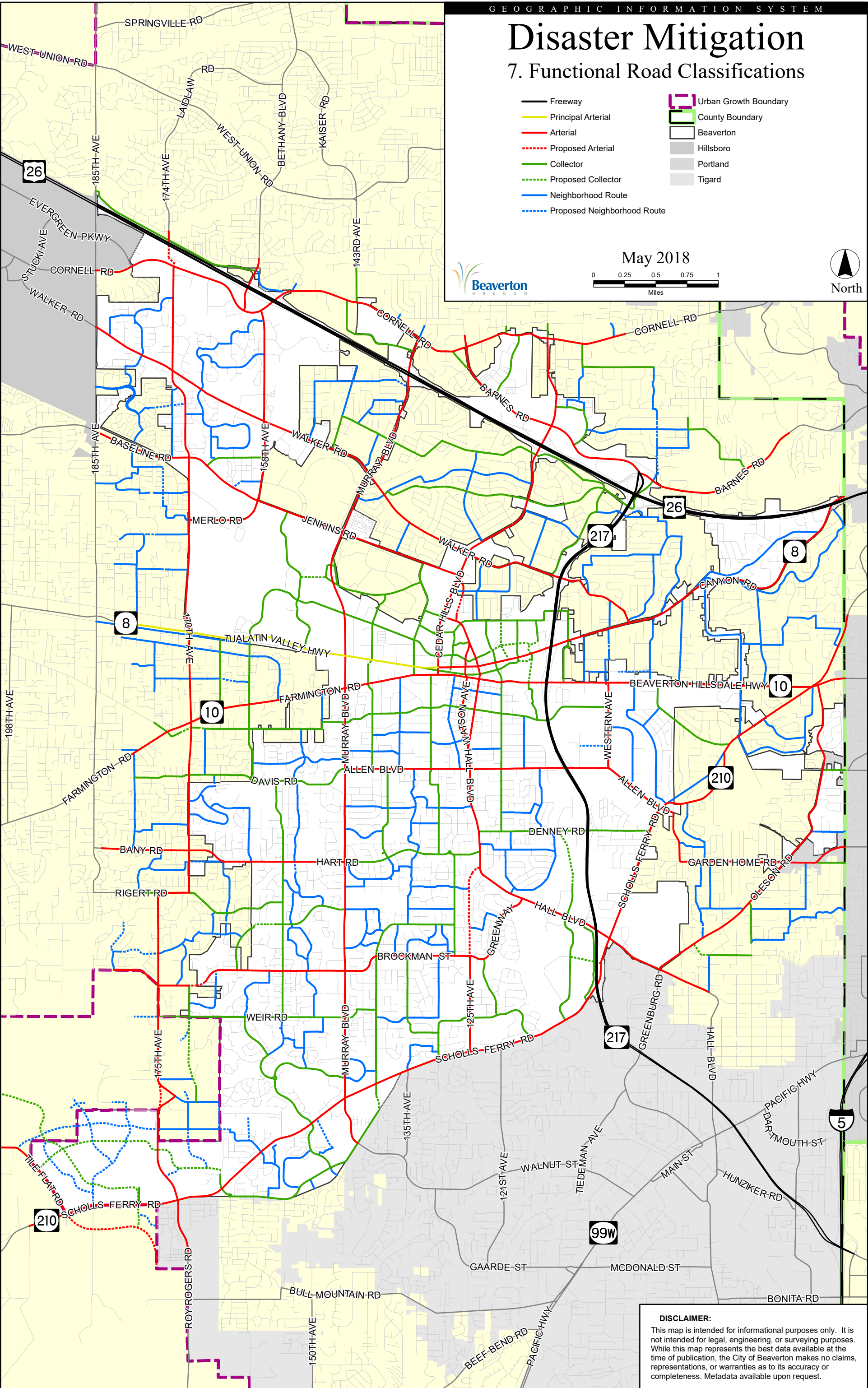
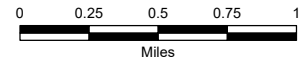
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Disaster Mitigation

7. Functional Road Classifications

-  Freeway
-  Principal Arterial
-  Arterial
-  Proposed Arterial
-  Collector
-  Proposed Collector
-  Neighborhood Route
-  Proposed Neighborhood Route
-  Urban Growth Boundary
-  County Boundary
-  Beaverton
-  Hillsboro
-  Portland
-  Tigard

May 2018



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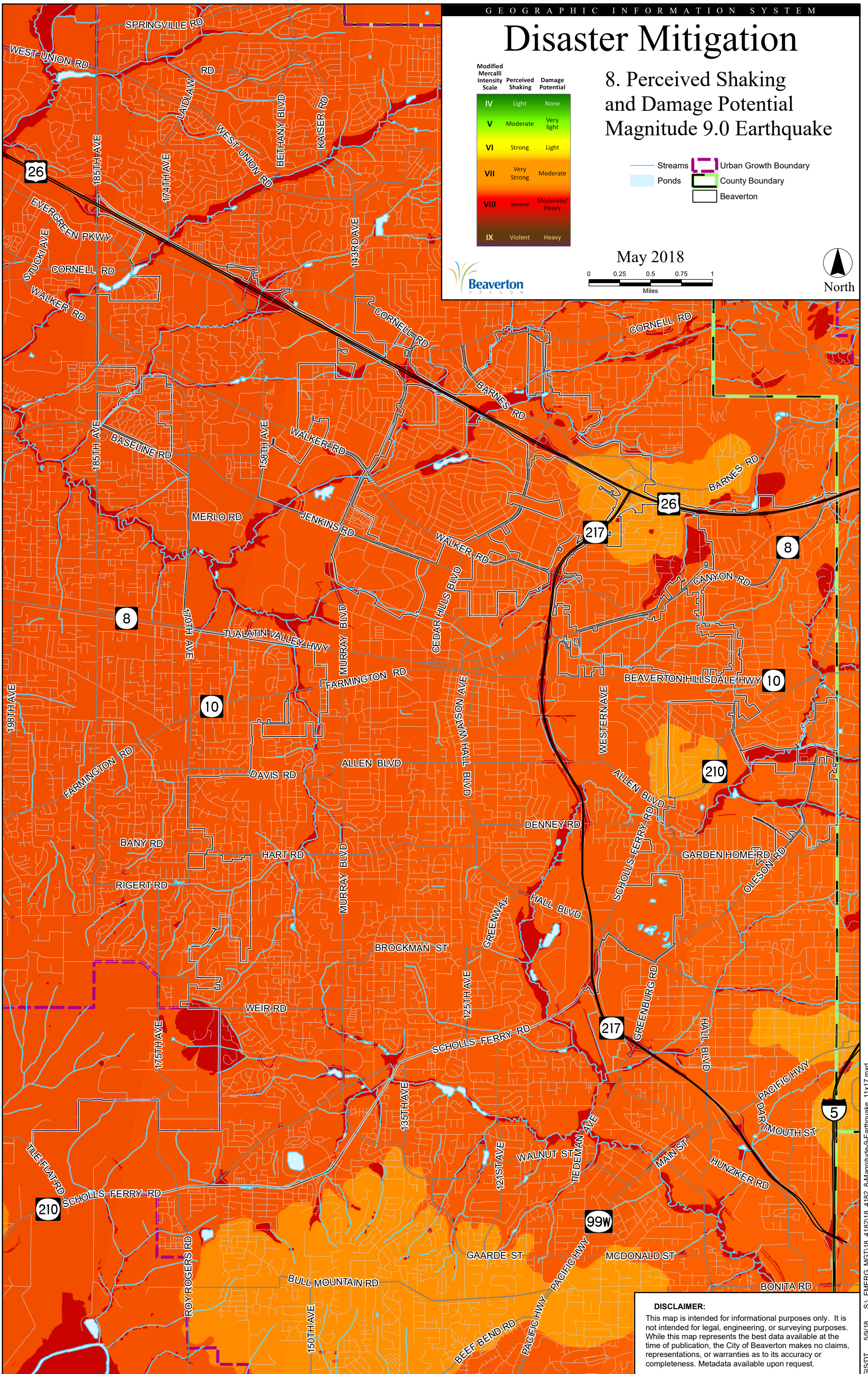
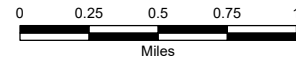
Disaster Mitigation

8. Perceived Shaking and Damage Potential Magnitude 9.0 Earthquake

Modified Mercalli Intensity Scale	Perceived Shaking	Damage Potential
IV	Light	None
V	Moderate	Very light
VI	Strong	Light
VII	Very Strong	Moderate
VIII	Severe	Moderate/Heavy
IX	Violent	Heavy

-  Streams
-  Urban Growth Boundary
-  Ponds
-  County Boundary
-  Beaverton

May 2018



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Appendix A

Action Items

Action Items Overview

This Appendix contains information on mitigation actions taken and being considered. For more specific information regarding Action Items and how they were prioritized see Section 3 of the Mitigation Plan. The list of Action Items is only a small snap-shot of the wide variety of mitigation activities that have been completed or are underway in the City.

Mitigation Plan Goals

The Action Items relate to the four goals established for the mitigation plan:

1. Protect Human Life, Commerce, Property, and Natural Systems.
2. Ensure Implementation of Mitigation Activities.
3. Enhance Emergency Services.
4. Improve Partnerships for Communication and Coordination.

Multi-Hazard Mitigation Action Items

In addition to the hazard specific action items, there are activities that cut across more than one of six hazards in the mitigation plan: flood, severe weather - wind, severe weather – winter storm, landslide, earthquake and volcanic eruption.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, county, regional, state, federal agencies, utilities or other organizations. The list below represent some of the existing mitigation activities in the City and is not intended to be an all-inclusive list:

- Building Code <https://www.codepublishing.com/OR/Beaverton/#!/Beaverton08/Beaverton08.html>
- 2019 Engineering Design Manual and Resources <https://www.beavertonoregon.gov/2246/2019-Engineering-Design-Manual-and-Resou>
- Capital Improvement Program <https://www.beavertonoregon.gov/225/Capital-Projects>
- Development Code <https://www.beavertonoregon.gov/463/Development-Code>
- Comprehensive Plan <https://www.beavertonoregon.gov/461/Comprehensive-Plan>
- Public Works - Urban Forestry Maintenance <https://www.beavertonoregon.gov/1095/Urban-Forestry>
- Public Works - Snow/Ice Emergency Management Plan <https://www.beavertonoregon.gov/451/Winter-Sanding-Routes>

- Water Master Plan – Includes seismic resilience evaluations and capital improvement program
https://beaverton.granicus.com/MapView.php?view_id=2&clip_id=2006&meta_id=107832

Possible Actions

Each action item includes ideas for implementation; “Possible Actions.” These possible actions are only suggestions for ways to implement the plan goal. They serve as a starting point and are dynamic as some ideas may not be feasible and new ideas can be added during the plan maintenance process. Some of these items may prove to be unrealistic and other more refined ideas may be identified and added to the plan.

Completed Activities and Action Items

This section identifies specific projects and activities that were completed since the last plan update.

Completed Projects and Activities not specified in the NHMP

These are some of the mitigation projects and activities that were completed but were not part of the Action Items originally identified in this plan. This is not an all-inclusive list.

- Storm Drain Awareness Murals <https://www.beavertonoregon.gov/2073/Storm-Murals>.
- Storm Ready Community <https://www.weather.gov/stormready/or-sr>.
- Right-of-Way Improvements for Stormwater Management <https://www.beavertonoregon.gov/1466/Projects-Completed>.
- Hocken Ave improvements (included replacing two culverts with a bridge to reduce flooding).
[https://www.beavertonoregon.gov/DocumentCenter/View/9771/Hocken-Avenue-Project-FAQs?bidId=.](https://www.beavertonoregon.gov/DocumentCenter/View/9771/Hocken-Avenue-Project-FAQs?bidId=)
- Seismic Resilience Evaluation of the City’s water system including critical customers and critical facilities (See Chapter 6 of the Water Master Plan).
- GIS Analysis of ages of buildings in Beaverton relative to major changes to the building code related to seismic hazards.
- GIS Analysis of commercial properties in Beaverton in the floodplain.
- Posting of structural and non-structural earthquake mitigation information on City’s website:
 - <https://www.beavertonoregon.gov/1202/Structural-Mitigation>
 - <https://www.beavertonoregon.gov/1168/Nonstructural-Mitigation>

Completed Action Items

The table on the next page is a summary of the items that have been completed or closed by the Natural Hazards Mitigation Plan Steering Committee since the plan was originally written.

Table A-1: Closed and Completed Action Items

Natural Hazard Item	Priority Score	Original Action Item	Comments
Long-Term Multi-Hazard #4	18	Improve public awareness and provide potential steps to reduce natural hazard risk.	Completed – City’s Emergency Management website has been updated, regular preparedness articles are published in “Your City” newsletter, preparedness presentations are given to a wide variety of audiences including staff at assisted living facilities. Example: https://www.beavertonoregon.gov/576/Mitigation
Long-Term Multi-Hazard #2:	18	Implement appropriate mitigation measures at development sites prior to approval.	Completed – Contained in existing City Codes and plans including: <ul style="list-style-type: none"> • Development Code https://www.beavertonoregon.gov/463/Development-Code • Comp Plan https://www.beavertonoregon.gov/461/Comprehensive-Plan
Short-Term Multi-Hazard #5	17	Strengthen emergency services by updating the City Emergency Operations Plan, linking emergency services with natural hazard mitigation programs, and enhancing public education.	Completed – The EOP and Hazard vulnerability assessment are updated on a 2-year cycle to comply with State and Federal standards. The other portions including enhancing public education are standard functions of the Emergency Management Program
Short-Term Multi-Hazard #1	14	Establish a Beaverton Natural Hazards Mitigation Plan Steering Committee to facilitate implementation, monitoring, and evaluation of citywide mitigation activities.	Completed - This is done as part of the NHMP planning process.
Short-Term Severe Weather #1	12	Maintain public awareness of the hazard and the benefits of mitigation through education aimed at households and	Completed – This is part of the City’s overall emergency preparedness education and information activities Example: https://www.beavertonoregon.gov/576/Mitigation

Natural Hazard Item	Priority Score	Original Action Item	Comments
		businesses and increase targeting of special needs populations.	
Long-Term Landslide #5	10	Maintain public and private drainage systems.	Completed – Institutionalized in existing City operations and procedures.
Long-Term Earthquake #2	10	Encourage purchase of earthquake hazard insurance by forming partnerships with the insurance and real estate industries.	Closed – Not viable project for the City
Short-Term Severe Weather #2	09	Maintain tree trimming for above ground power lines.	Completed – The City and PGE have effective tree management programs.
Long -Term Severe Weather #4	09	Support underground utility construction through public incentives and partnerships.	Completed – The issue of undergrounding utilities for new development and redevelopment is addressed in State Statute and City Code.
Long -Term Severe Weather #5	09	Develop strategies for better debris removal after a windstorm.	Completed – Strategies were implemented in the 2007 windstorm including a centralized drop off location for woody debris.
Long-Term Landslide #4	09	Implement construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.	Completed – Contained in existing City Codes and plans including: <ul style="list-style-type: none"> • Development Code https://www.beavertonoregon.gov/463/Development-Code • Comp Plan https://www.beavertonoregon.gov/461/Comprehensive-Plan
Long-Term Severe Weather #1	09	Identify trees that are potentially susceptible to wind-throw.	Closed – Part of operations of Public Work’s Urban Forestry Maintenance Section https://www.beavertonoregon.gov/1095/Urban-Forestry .
Long-Term Severe Weather #2	09	Develop and implement programs to keep trees from threatening lives, property, and	Completed –

Natural Hazard Item	Priority Score	Original Action Item	Comments
		public infrastructure from severe weather events.	<ul style="list-style-type: none"> • Approved Tree list - https://www.beavertonoregon.gov/442/Approved-Tree-List • Planting and Maintenance Police https://www.beavertonoregon.gov/1922/Tree-Planting-Maintenance-Policy
Short-Term Flood #1	08	Evaluate the requirements for Beaverton to become a participant in the NFIP's Community Rating System (CRS).	Closed – It was determined by the Floodplain Manager that the City would not be participating in the CRS.
Long-Term Flood #4	08	Use storm water and urban design best management practices (BMPs).	Closed – Covered in: <ul style="list-style-type: none"> • Comp Plan https://www.beavertonoregon.gov/461/Comprehensive-Plan • Development Code https://www.beavertonoregon.gov/463/Development-Code • Engineering Design Manual https://www.beavertonoregon.gov/232/Engineering-Design-Manual
Long-Term Flood #3	08	Enhance data and mapping for floodplain information within the City.	Closed <ul style="list-style-type: none"> • Public Works maintains a list of problem catch basins and grates that is used when preparing for heavy rains and for monitoring during major rain events. • City GIS does not maintain map layers relative to streams. They use regionally generated layers provided by Clean Water Services and Metro.
Long-Term Volcano #1	07	Map and model ash fall.	Closed - Modeling during an event and for planning is available through the USGS https://vsc-ash.wr.usgs.gov/ashgui/#/ .

On-going Action Items

There are several Action Items that are considered “On-going.” On-going Action Items are by nature continuous or actions that are being worked on; but are not to the point where they are fully incorporated into City operations, plans, or regulations.

On-going Action Items are listed by priority; from the highest to the lowest regardless of the hazard.

Possible Actions

Each action item includes ideas for implementation. Possible actions serve as a starting point and are dynamic as some ideas may be not feasible and new ideas can be added during the plan maintenance process. These possible actions are only suggestions for ways to implement the plan goal. Some of these items may prove to be unrealistic and others more refined ideas may be identified and added to the plan.

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Multi-Hazard #3	18	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Develop public and private partnerships to foster natural hazard program coordination and collaboration within the Beaverton Urban Service Boundary.						
Possible Actions:						
a. Identify and develop partnerships with organizations (public and private) that have programs or interests in natural hazards mitigation to implement specific mitigation projects. b. Establish neighborhood emergency service and mitigation volunteer teams to collaborate with Beaverton Emergency Management. c. Develop formal collaborations with businesses in the City. d. Develop cross-jurisdictional agreements to ensure regional implementation of mitigation activities. e. Create a database of key contacts for each sector, including the public, private, and non-profit sectors. f. Identify and establish incentives for people to participate in mitigation activities.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			

Emergency Management, Community Development Department Neighborhood Program	Utility providers, School District, Chamber of Commerce, Community Organizations, Washington County, Clean Water Services, Cooperating Public Agencies of Washington County
Action Item Status:	<ul style="list-style-type: none"> • The City has CERT and Map Your Neighborhood programs in place. • We are coordinating with Washington County and other cities to do a multi-jurisdiction mitigation plan for 2022.

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long Term Multi- Hazard #3:	18	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Create and maintain a system to support populations with special needs within Beaverton's city limits.						
Possible Actions:						
a. Maintain and update preparedness information aimed at vulnerable populations. b. Create a neighbor-to-neighbor network of voluntary organizations that will assist senior, disabled persons, and non-English speakers during disasters. c. Identify and create an information database on the location of centers with major concentrations of seniors, persons with disabilities (e.g., senior housing facilities and assisted living centers), minorities, and low-income residents, and develop strategies for notification and support of their evacuation.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
ISD/GIS, Community Development Department, Emergency Management, Neighborhood Program			DHS, OEM, FEMA, local non-profit service providers (i.e., SDRI)			

Action Item Status:	<ul style="list-style-type: none"> • We partnered with SDRI to provide preparedness information and presentations to their clients and service providers. • Involved in addressing findings in a federal grant funded report evaluating how participants in the RDPO are meeting the needs of PWD/AFN via their existing emergency management programs. • Added a module in our Basic CERT Course on working with people who have access and functional needs.
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short Term Multi-Hazard #2:	17	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Identify and pursue funding opportunities to develop and implement local mitigation activities.						
Possible Actions:						
a. Allocate City resources and assistance to mitigation projects when possible. b. Explore mitigation-related funding sources (such as FEMA Pre-Disaster Mitigation Competitive Grant Program). c. Explore non-mitigation related funding sources (such as Greenspace bond measure and Community Development Block Grants and others). d. Develop incentives for local organizations (such as Neighborhood Associations and Neighborhood Action Committees), citizens, and businesses to pursue hazard mitigation efforts. e. Partner with other organizations and agencies in Washington County to identify grant programs and foundations that may support mitigation activities and together seek funding for mitigation projects.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Neighborhood Program			Clean Water Services, Westside Economic Alliance, Tualatin River Watershed Council, Washington County, Cooperating Public Agencies of Washington County, US Department of Housing and Urban Development, FEMA			

Action Item Status:	<ul style="list-style-type: none"> Potential funding sources for various mitigation related projects are always considered.
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Multi-Hazard #1	17	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve

Action Item:

Increase technical knowledge of natural hazards and mitigation strategies in Beaverton and implement policies and program based on that knowledge.

Possible Actions:

- Maintain and update hazard vulnerability maps (On-going).
- Create and maintain a GIS inventory map of historic hazard events that documents: location, impacts, loss, etc.
- Maintain a GIS inventory including, but not limited to: critical and essential facilities, large employers, building stock, public assembly areas and essential facilities (Completed).
- Utilize spatial analysis tools to evaluate the city's vulnerability.

Coordinating Organization:	City of Beaverton
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Internal Partners:	External Partners:
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ISD/GIS, Public Works, Emergency Management, Community Development Department	Washington County, DOGAMI, DLCD, OSFM, ODF, OEM, Utilities, ODOT, METRO
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Action Item Status:	<ul style="list-style-type: none"> Hazard layers and maps are regularly updated. DOGAMI's new data relative to the potential impacts of a subduction zone and Portland Hills fault earthquakes have been incorporated. Building inventory is completed including critical and essential facilities. Maps have been created with building ages relative to changes in seismic code and identifying commercial buildings in floodplains that might not be able to rebuild after a disaster because of changes in the floodplain codes.
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Multi-Hazard #4	15	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Encourage households and businesses in Beaverton to consider natural hazard related insurance.						
Possible Actions:						
a. Educate businesses and homeowners on the availability and types of insurance related to natural hazards. b. Partner with insurance companies to promote natural hazard related insurance.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department,			Insurance Providers, Chamber of Commerce			
Action Item Status:						

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Earthquake #1	14	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Establish a program aimed at helping private property owners and businesses perform structural retrofitting.						
Possible Actions:						

<p>a. Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.).</p> <p>b. Lobby state legislature to allow for adopting incentives that authorizes property tax incentives or deferrals to offset the costs of voluntary rehabilitation for existing buildings.</p>	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Emergency Management, Community Development Department, Mayor’s Office, Neighborhood Program	Washington County Assessment and Taxation, State Finance, Federal Emergency Management Agency (FEMA), Beaverton Area Chamber of Commerce, Westside Economic Alliance
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Earthquake #2	13	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Reduce non-structural hazards in homes, schools, businesses, and government offices.						
Possible Actions:						
<p>a. Provide training to government and school facility managers and teachers on securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits.</p> <p>b. Encourage facility managers, business owners, and teachers to refer to FEMA’s practical guidebook: Reducing the Risks of Nonstructural Earthquake Damage.</p> <p>c. Organize retrofitting classes for homeowners, building professionals, and contractors.</p>						
Coordinating Organization:	City of Beaverton					
Internal Partners:	External Partners:					
Emergency Management, Community Development Department	Washington County, Federal Emergency Management Agency, Oregon Emergency Management, School District					

Action Item Status:	<ul style="list-style-type: none"> We do provide schools, daycares and businesses with recommendations on non-structural risks and possible mitigation measures. We have added structural and non-structural information to the emergency management website https://www.beavertonoregon.gov/576/Mitigation
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Earthquake #4	10	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Improve local capabilities to perform earthquake building safety evaluations.						
Possible Actions:						
a. Offer training in procedures for earthquake building safety evaluations to CERT volunteers through Beaverton’s new Community Emergency Response Team Program. b. Offer periodic training in ATC-20 and ATC-21 procedures for earthquake building safety evaluations and encourage local building officials and other public and private officials (facilities, maintenance, engineering, and architects) to attend.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department			Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM), Washington County EMC, RDPO			
Action Item Status:	<ul style="list-style-type: none"> CERT members have been trained in the county-wide post-earthquake rapid damage assessment procedures for critical and essential facilities and have participated in exercises testing those procedures. ATC – 20 and 21 courses are routinely hosted in the Metro Area by Washington County, Portland, OEM and the RDPO. There is legislation at the state level looking at increasing the pool of people who can be certified and trained to conduct post-earthquake damage assessments. 					

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Earthquake #3	10	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Develop public/private partnerships to pursue efficient methods to retrofit structures.						
Possible Actions:						
a. Develop incentives (tax incentives or public recognition) for private contractors and architects to work on retrofitting public buildings and other infrastructure. This may help to minimize the funding shortage issue that has caused a number of high risk sites to remain without retrofitting. b. Educate building contractors and architects on seismic design principles.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Mayor's Office			Home Builders Association, American Planning Association, American Institute of Architects, Westside Economic Alliance, Chamber of Commerce, Downtown Business Association, and renters groups			
Action Item Status:						

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Severe Weather #3	10	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Develop and maintain comprehensive impact database and when possible, map historical severe weather events in Beaverton.						
Possible Actions:						

a. Research and analyze historic windstorm damage in Beaverton. b. Identify reoccurring patterns. c. Map reoccurring hazard sites. d. Document future events including impacts and losses.	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Emergency Management, Community Development Department, Public Works	Washington County, National Weather Service, National Oceanic and Atmospheric Administration, Oregon Climate Service, Overhead Utilities
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Land Slide #3	10	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Protect existing development in landslide-prone areas.						
Possible Actions:						
<ul style="list-style-type: none"> • Provide information to residents on landslide prevention. Publications such as FEMA’s Homeowner’s Landslide Guide for Hillside Flooding, Debris Flows, Erosion, and Landslide Control and Hillside Drainage Flyer have some ideas about reducing landslide susceptibility. • Encourage easements to restrict certain activities on landslide-prone properties. Easements foregoing the right to develop a property can be either sold or granted to the City or other organizations by property owners. • Investigate land purchasing programs. • Use Transfer of Development Rights to transfer development rights of a landslide hazard area by deed, easement, or other legal instrument authorized by local law to another parcel of land that is not prone to landslides. • Construct debris flow diversions to protect existing properties. • Use and publicize the Oregon Department of Forestry’s debris flow warning system. 						

Coordinating Organization:	City of Beaverton		
Internal Partners:	External Partners:		
Emergency Management, Community Development Department, Public Works	Department of Land Conservation and Development (DLCD), Oregon Emergency Management (OEM), Federal Emergency Management Agency (FEMA), Washington County		
Action Item Status:			

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Earthquake #3	8	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input checked="" type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Pursue structural mitigation of critical facilities, infrastructure, public buildings, and schools for the earthquake threat.						
Possible Actions:						
a. Coordinate with Washington County to identify and retrofit critical facilities, to stricter seismic standards. b. Encourage the state legislature to adopt retrofitting incentives.						
Coordinating Organization:	City of Beaverton					
Internal Partners:	External Partners:					
Emergency Management, Community Development Department, Public Works	School Districts, Special Districts, Hospitals, Washington County, Oregon Department of Transportation (ODOT)					

Action Item Status:	<ul style="list-style-type: none"> • TVF&R is in the final phase of upgrading stations and support facilities. • BSD is in the middle of upgrading/replacing several schools in the district bringing them to current building standards and in some cases they are building them to a higher seismic standard so they can be a resource post-earthquake. • The City’s new Public Safety Center, which will include Emergency Management and City’s EOC, will be completed late Spring/Early summer of 2020 and is being built to immediate occupancy seismic standards. • Additional components of resiliency are being incorporated into portions of the City’s new Performing Arts Center so that it can be a resource post-earthquake. • The City’s Water Department had a seismic resilience evaluation conducted on the water system. This information is being used in evaluating design standards and future capital improvement projects.
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Flood #2	8	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Analyze each repetitive loss property to identify viable mitigation options.						
Possible Actions:						
a. Use insurance claim data from FEMA and OEM to identify properties in the city that have filed more than one National Flood Insurance Program (NFIP) insurance claim. b. Consider identified properties for mitigation activities. Funding for mitigation may be available through FEMA’s Hazard Mitigation Grant or Flood Mitigation Assistance program. c. Prioritize properties for mitigation activities using a benefit/cost analysis. d. Map and analyze each repetitive loss property to develop appropriate mitigation actions.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Public Works, ISD/GIS			Oregon Emergency Management, Department of Land Conservation and Development, Federal Emergency Management Agency, Natural Resources Conservation Service			
Action Item Status:	<ul style="list-style-type: none"> • While there are only a few properties with more than one flood insurance claim, mitigating flooding is an on-going activity for the city. 					

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Flood #1	8	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Develop acquisition and management strategies to preserve open space in the floodplain.						
Possible Actions:						
a. Develop a comprehensive strategy for acquiring and managing floodplain open space in Beaverton. b. Explore funding for open space acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations. c. Develop a regional partnership between flood mitigation organizations. d. Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Public Works,			Oregon Emergency Management, Department of Land Conservation and Development, Federal Emergency Management Agency, Natural Resources Conservation Service			
Action Item Status:	While there are only a few properties with more than one flood insurance claim, mitigating flooding is an on-going activity for the City.					

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Volcano #2	8	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Collaborate with USGS-CVO and related agencies to increase awareness of volcanic response efforts through ash fall related messages.						
Possible Actions:						

<ul style="list-style-type: none"> Collaborate with USGS-CVO, OCEM, FAA, National Weather Service, law enforcement offices, and the media to develop a warning message framework that is more appropriate for the area so that communities and individuals have a clear sense of how to respond. Continually update information, monitor and track in the event of a volcanic emergency. Educate residents on what to do and where to go in the event of a volcanic event in the Cascades. 	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Emergency Management,	United States Geological Survey – Cascades Volcano Observatory (USGS-CVO), Federal Aviation Administration (FAA), Department of Geology and Mineral Industries (DOGAMI), Oregon Emergency Management (OEM), National Weather Service, law enforcement offices, local media, RDPO, Federal Emergency Management Agency (FEMA) Region 10 Volcanic Working Group, Tualatin Valley Fire and Rescue District, School Districts
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Landslide #2	7	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Limit activities in identified landslide hazard areas through regulation and public outreach.						
Possible Actions:						
<ul style="list-style-type: none"> Use the hazard identification and mapping processes to determine where to regulate. Coordinate with property owners to reduce risk in landslide hazard areas. Provide information on hazard locations to future residents. Show hazard susceptibility on deeds. 						
Coordinating Organization:	City of Beaverton					
Internal Partners:				External Partners:		

Emergency Management, Community Development Department	Department of Geology and Mineral Industries (DOGAMI), Washington County
Action Item Status:	<ul style="list-style-type: none"> • LIDAR Mapping showed one ancient landslide that is inside city limits and unincorporated county. • A Hazard Map is posted on the City’s website and it includes the slide areas identified by LIDAR. https://www.beavertonoregon.gov/DocumentCenter/View/874/Natural-Hazards-Map?bidId= • An article in a City newsletter in 2014 identified the natural hazards that could impact Beaverton and included links to the hazard map and to preparedness information.

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Flood #3	6	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input checked="" type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Develop mitigation and preparedness measures for critical public infrastructure and facilities located in flood hazard areas.						
Possible Actions:						
a. Document in database format as well as in maps the critical facilities that are at risk from flood events. b. Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should flood events cause damages to the facilities in question.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, GID/ISD			Overhead Utilities Tualatin Valley Water District, Clean Water Services, Washington County			

Action Item Status:	<ul style="list-style-type: none"> • The hazard and critical facilities map layers already exist and are used in maps including the maps for this plan. The information can be exported into an Excel Spreadsheet. • There is only one critical facility structure currently in the 100 floodplain and that's the current Public Safety Center. Police and Emergency Management will move to the new PS Center in 2020, which is outside the floodplain. • Court will remain in the current building but there is a City COOP plan that addresses loss of facilities.
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Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Volcano #1	6	<input checked="" type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input checked="" type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Identify critical facilities and industries that may be affected by ash fall and collaborate with them on ash fall emergency response.						
Possible Actions:						
<ul style="list-style-type: none"> • Collaborate and exchange experiences and knowledge among facility managers of critical industries in the region to reduce the impact of ash fall on their sites. 						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, GID/ISD			Overhead Utilities Tualatin Valley Water District, Clean Water Services, Washington County			
Action Item Status:						

Current Action Items

Current Action Items are items that will be focused on during the current plan cycle as resources and time permits.

Current Action Items are listed by priority; from the highest to the lowest regardless of the hazard.

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Earthquake #5	11	<input type="checkbox"/> On-going <input checked="" type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Provide information to Beaverton residents about earthquakes and opportunities to mitigate earthquake hazards in their homes						
Possible Actions:						
a. Enforce seismic building codes. b. Develop educational materials in Tier 1 and Tier 2 languages						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Mayor's Office,			Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM), Partners for Loss Prevention, Washington County			
Action Item Status:	<ul style="list-style-type: none"> • Our Home Hazard Hunt flyer, which includes information on structural and non-structural mitigation for multiple hazards including seismic, are available in Spanish, Arabic, Vietnamese, Mandarin, and Korean. • Information has been regularly sent out in the City's newsletter addressing the seismic hazards and the need to mitigate. • Seismic Building Codes are enforced. 					

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Earthquake #4	10	<input type="checkbox"/> On-going <input checked="" type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Improve technical data and analysis of earthquake hazards.						
Possible Actions:						
a. Develop and update an inventory of at-risk structures in Beaverton. b. Update Beaverton earthquake HAZUS data to improve accuracy of the vulnerability assessment for Beaverton. c. Encourage local government officials to use Metro’s earthquake hazards reports and earthquake maps to develop additional maps land use documents. d. Conduct risk analysis incorporating HAZUS data and earthquake maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities and regulating land use.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, ISD/GIS			Portland State University, Washington County, Metro, DOGAMI, RDPO			
Action Item Status:	<ul style="list-style-type: none"> • New Data created by DOGAMI in support of the development of Oregon Resilience plan, and through a grant funded project for the RDPO, a greater level of data is available on the potential impacts of seismic events on the city and region. These data layers are already being used by the City’s GIS Division and Emergency Management Program. • A map layer has been created showing the ages and types of structures (Commercial vs Residential) relative to changes in the seismic codes. 					

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Landslide #1	7	<input type="checkbox"/> On-going <input checked="" type="checkbox"/> Current Cycle <input type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in those areas.						
Possible Actions:						
a. Continue mapping county landslide and debris flow areas. b. Identify the location and extent of hazard areas and establish a factual base to support implementation of future measures. c. Analyze the risk of these areas to life, property, and infrastructure.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, ISD/GIS			Department of Geology and Mineral Industries (DOGAMI), Clean Water Services. Washington County			
Action Item Status:	<ul style="list-style-type: none"> • LIDAR Mapping showed one ancient landslide that is inside city limits. • A Hazard Map is posted on the City's website and it includes the slide areas identified by LIDAR. https://www.beavertonoregon.gov/DocumentCenter/View/874/Natural-Hazards-Map?bidId= 					

Future Action Items

Future Action Items are items that will be addressed during a future NHMP cycle.

Future Action Items are listed by priority; from the highest to the lowest regardless of the hazard.

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Short-Term Earthquake #1	14	<input type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input checked="" type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input checked="" type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Identify funding sources for implementing earthquake mitigation in Beaverton.						
Possible Actions:						
a. Coordinate with Washington County to leverage funds for earthquake loss reduction program similar to the City of Seattle’s Project Impact model. b. Evaluate grant and foundations that support earthquake mitigation activities.						
Coordinating Organization:	City of Beaverton					
Internal Partners:			External Partners:			
Emergency Management, Community Development Department, Mayor’s Office,			Federal Emergency Management Agency (FEMA), Oregon Emergency Management (OEM), Partners for Loss Prevention, Washington County			
Action Item Status:						

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Flood #6	9	<input type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input checked="" type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						

Create a regional partnership to reduce flood loss across the region.	
Possible Actions:	
<ul style="list-style-type: none"> a. Work flood issues on a regional basis to avoid moving flood problems to other jurisdictions. b. Create a regional process for naming un-named streams. c. Work with regional partners including the City, Clean Water Services and the State Floodplain Manager to improve floodplain data for the City that will support conducting future full risk analyses in Beaverton. 	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Community Development, Public Works	Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Washington County, Other Cities
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Flood #5	8	<input type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input checked="" type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Update City code to improve risk reduction and prevention of natural hazard impacts.						
Possible Actions:						

<ul style="list-style-type: none"> a. Remove barriers in City codes and planning regulations that prevent best management practices in urban design. b. Protect critical and essential facilities against flood damage at the time of initial construction. c. Consider increasing regulations for all new fill, grading, and dredging in floodplain areas. d. Regulate to prevent construction of flood barriers which will unnaturally divert flood waters or increase flood hazards. e. Review and update City flood ordinance. Provide additional, more stringent standards designed to encourage sound floodplain management, reduce flood risks, and potentially allow property owners to obtain flood insurance at a lower premium rate. f. Write and implement new code requiring developers to install permeable surfaces to reduce storm water runoff volume and encourage aquifer recharging via increased storm water percolation. g. Consider adopting stricter elevation requirements for development within the floodplain. h. Develop codes and ordinances to require owners of private water quality and water detention facilities to maintain them so that they can perform their required function and engineered capacity. 	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Community Development, Public Works	Clean Water Services, Natural Resources Conservation Service, Soil and Water Conservation District, Washington County, Other Cities
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Volcano #2	7	<input type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input checked="" type="checkbox"/> Future Cycle	<input checked="" type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input type="checkbox"/> 4 Improve
Action Item:						
Establish a plan for ash removal following a volcanic event.						
Possible Actions:						

<ul style="list-style-type: none"> a. Educate residents on what they can do to assist in clean-up and debris removal efforts following a volcanic event. b. Assist the public in removing ash by developing a system for ash removal. c. Develop public and private partnerships to ensure proper clean-up. 	
Coordinating Organization:	City of Beaverton
Internal Partners:	External Partners:
Emergency Management, Public Works Department, Recycling/Sustainability	Washington County, Solid Waste Haulers
Action Item Status:	

Natural Hazard Item	Priority Score	Timeline	Alignment with Plan Goals:			
Long-Term Flood #2	7	<input type="checkbox"/> On-going <input type="checkbox"/> Current Cycle <input checked="" type="checkbox"/> Future Cycle	<input type="checkbox"/> 1 Protect	<input type="checkbox"/> 2 Ensure	<input type="checkbox"/> 3 Enhance	<input checked="" type="checkbox"/> 4 Improve
Action Item:						
Provide flood event education and outreach to households and businesses.						
Possible Actions:						
<ul style="list-style-type: none"> a. Identify and map vulnerable populations b. Create flood education and outreach aimed at specific populations (i.e. schools, households, businesses, etc.). c. Identify and provide mitigation guidance to owners of properties at risk from flooding. d. Recruit individuals to speak to households, and businesses/employees about flood issues. e. Develop a “Clean Stream” sponsorship program, using the “Friends of Fanno Creek” model. Erect signage recognizing individuals, households, businesses, and organizations committed to the on-going care of a waterway section. f. Raise awareness level of property owners and developers that impacts upstream result in impacts downstream, and lack of storm water best management practices can result in an increase in flooding events. g. Educate private property owners on restoring natural systems within the floodplain to manage riparian areas and wetlands for flood abatement. h. Erect “monuments” over piped creeks throughout the city and floodplain elevation markers to bring flood awareness to home and business owners who live near them. i. Educate public on the need for them to maintain their private water quality and water detention facilities. 						

Coordinating Organization:	City of Beaverton	
Internal Partners:	External Partners:	
Emergency Management, Public Works Department, Community Development Department	Clean Water Services, Tualatin River Watershed Council, Tualatin Riverkeepers, Insurance Information Service of Oregon and Idaho, Washington County, Department of Land Conservation and Development, Oregon Emergency Management	
Action Item Status:		

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Appendix B

Planning and Public Process

Plan Update

This Appendix describes the changes made to the City’s Natural Hazards Mitigation Plan (NHMP) during this plan update. It also outlines the process used for soliciting public input on the revised NHMP.

Where applicable, the information in the plan was updated to reflect the most current information available at the time that section was written. Such information is a “snapshot in time” and can quickly change.

The more substantive changes are outlined in the 2020 Plan Update Changes section below.

Background

The Disaster Mitigation Act of 2000 requires communities to update their mitigation plans every five years to remain eligible for Pre-Disaster Mitigation (PDM) program funding, Flood Mitigation Assistance (FMA) program funding, and Hazard Mitigation Grant Program (HMGP) funding.

The City’s previous version of the NHMP was developed in 2003 and updated in 2011. While mitigation has been an on-going activity in the City, unforeseen delays stalled the latest plan review and update process. This delay had been coordinated with the state. Several people have participated in this update, including some who are no longer employed by the jurisdiction that they were part of during the process.

Supporting Documents

As part of the plan review.

2020 Plan Update Changes

Plan Format

This revision of the plan includes a complete change in the plan format to closely reflect the format used by Washington County. This new format is more streamlined and easier to follow than the previous format. The format also allowed for the elimination of redundant information that existed in the previous format when each hazard was addressed in separate chapters. Table B.1 shows a comparison of the plan formats. Column 1 is the format of the 2020 Plan. Column 3 is the 2011 Plan format. Column 2 aligns the 2011 plan sections with the 2020 Plan sections in column 1. The unshaded cells under Column 3 are plan sections that were deleted and not used in the

updated plan.

Plan Goals, Strategy and Action Items

There were no major changes to these three key areas of the Plan. The four Goals are the same as they were in the two previous versions of the plan. Other than in the format were no changes to the mitigation strategy. Some of the Action Items were completed during the previous performance period; so they were moved to the completed table.

Wildfire - Removed

As noted in Section 2: Risk Assessment, Wildland Fire is not included in this update as one of the City's hazards being addressed in the plan. The Washington County Wildfire Protection Plan (2007) shows the City as High Density Urban area that is not a Federal Register Community at Risk and is not in one of the plan's Strategic Planning areas. Based on this and supported by the significantly lower score that Wildland Fires scored than any of the other natural and man-caused hazards in the City's Hazard Analysis (58 on a scale of 24 to 240), it's not addressed in this plan. The next lowest score in the Hazard Rankings is Landslides at 86 points.

Volcano - Reduced

The hazard information in the volcano portion of Section 2: Risk Assessment was reduced to the hazards that would have an impact on the City; volcanic ash. Information on Lava flows, Lahars, Pyroclastic Flows and Volcanic Landslides were eliminated.

Severe Weather – Split

Because they offer different sets of impacts and potential different mitigation activities, the previous Severe Weather Section has been split into two sections; Severe Weather – Winter Storm and Severe Weather – Windstorm.

Drought – New

Drought had a hazard score of 155 (out of a max of 240) during the City of Beaverton's 2019 Hazard Analysis. Because of the high score, and with increased potential for droughts through climate change, this section was added to the Plan.

Maps – Changed #8

Map #8 changed from a comparison of floodplain mapping in the previous plan to a map of the Perceived Shaking and Damage Potential of a Magnitude 9.0 Earthquake. During the time of the previous NHMP, the City, County and Clean Water Services were working on getting up-to-date floodplain information adopted by FEMA/NFIP. The map was a comparison of the new 100 year floodplain information and the existing FEMA 100 year floodplain. The data was adopted and a comparison is no longer required as the updated 100 year floodplain is shown in Map #1 – Natural Hazards. The new map is a product of the Oregon Department of Geology and Mineral Industries (DOGAMI). DOGAMI was contracted by the Regional Domestic Preparedness Organization (RDPO), through a federal grant, to develop greater detail

mapping of the potential impacts of a 9.0 Cascadia Subduction Zone Earthquake on the 5 county Portland region. This map is one of the products generated from that partnership.

Table B.1 Comparison of Plan Formats

2019 Beaverton NHMP	Cross Walk 2011 Plan items matched up to relative section in 2019 Plan	2011 Beaverton NHMP In original plan order
Plan Summary	Executive Summary	Executive Summary
Section 1 – Introduction	Chapter 1 - Introduction	Map Directory
Section 2 – Risk Assessment	Incorporates Chapter 3 – Risk Assessment and consolidates all the hazard information from the Hazard Chapters into this one section.	<ul style="list-style-type: none"> Map 1 – Natural Hazards
Section 3 – Mitigation Strategy	Parts of Chapter 4 – Mitigation Plan Goals, Action Items and Public Participation	<ul style="list-style-type: none"> Map 2 – Critical Facilities
Section 4 – Plan Implementation and Maintenance	Chapter 5 – Plan Implementation and Maintenance	<ul style="list-style-type: none"> Map 3 – Economic Assets – Zoning
Map Directory	Map Directory	<ul style="list-style-type: none"> Map 4 – Economic Assets – Employment
<ul style="list-style-type: none"> Map 1 – Natural Hazards 	<ul style="list-style-type: none"> Map 1 – Natural Hazards 	<ul style="list-style-type: none"> Map 5 – Environmental Assets - Trees
<ul style="list-style-type: none"> Map 2 – Critical Facilities 	<ul style="list-style-type: none"> Map 2 – Critical Facilities 	<ul style="list-style-type: none"> Map 6 – Environmental Assets - Parks
<ul style="list-style-type: none"> Map 3 – Economic Assets – Zoning 	<ul style="list-style-type: none"> Map 3 – Economic Assets – Zoning 	<ul style="list-style-type: none"> Map 7 – Functional Road Classifications
<ul style="list-style-type: none"> Map 4 – Economic Assets – Employment 	<ul style="list-style-type: none"> Map 4 – Economic Assets – Employment 	<ul style="list-style-type: none"> Map 8 – Floodplains - Comparison
<ul style="list-style-type: none"> Map 5 – Environmental Assets - Trees 	<ul style="list-style-type: none"> Map 5 – Environmental Assets - Trees 	Chapter 1 - Introduction
<ul style="list-style-type: none"> Map 6 – Environmental Assets - Parks 	<ul style="list-style-type: none"> Map 6 – Environmental Assets - Parks 	Chapter 2 – Community Profile
<ul style="list-style-type: none"> Map 7 – Functional Road Classifications 	<ul style="list-style-type: none"> Map 7 – Functional Road Classifications 	Chapter 3 – Risk Assessment
<ul style="list-style-type: none"> Map 8 – Perceived Shaking and Damage Potential Magnitude 9.0 Earthquake 	<ul style="list-style-type: none"> Map 8 – Content of Map has changed from floodplain comparison to earthquake impact 	Chapter 4 – Mitigation Plan Goals, Action Items and Public Participation
Appendix A – Action Items	Note – Previous plan had the action items at the end of each Hazard Chapter. They are all consolidated in this Appendix including the Multi-Hazard Action Items	Chapter 5 – Plan Implementation and Maintenance
Appendix B – Planning and	Parts of Chapter 4 – Mitigation Plan	Chapter 6 Multi-Hazard Action

Public Process	Goals, Action Items and Public Participation Appendix A – Public Participation	Items
Appendix C – Community Profile	Chapter 2 – Community Profile	Chapter 7 – Flood
Appendix D – Economic Analysis of Natural Hazard Mitigation Projects	Appendix E – Economic Analysis of Natural Hazards Mitigation Projects	Chapter 8 – Severe Weather
Appendix E – Grant Programs and Resources	New Section – Some information from Appendix G – Consolidated Resource Directory	Chapter 9 – Landslide
Appendix F – 2019 Preparedness and Mitigation Survey	Appendix H – 2019 Preparedness and Mitigation Survey	Chapter 10 – Wildfire*
Appendix G – Hazard Analysis	New Section – only portions of the Analysis was in the hazard section of the previous plan	Chapter 11 – Earthquake
		Chapter 12 – Volcanic Eruptions
		Appendix A – Public Participation
	Deleted – Carried over from original 2003 plan. Relative preparedness survey information for comparison is in Appendix F	Appendix B – Household Natural Hazards Preparedness Survey
	Deleted – Carried over from original 2003 plan. Relative preparedness survey information for comparison is in Appendix F	Appendix C – Business Preparedness Survey
	Deleted – Carried over from original 2003 plan. Relative preparedness survey information for comparison is in Appendix F	Appendix D – Focus Group Results
		Appendix E – Economic Analysis of Natural Hazards Mitigation Projects
	Deleted. Acronyms are defined in each plan section where they are used	Appendix F - List of Acronyms
	Deleted – External partners/resources are identified with each of the Action Items	Appendix G – Consolidated Resource Directory
		Appendix H – 2010 Preparedness and Mitigation Survey
	*Wildfire Hazard was deleted in the 2019 update	

PUBLIC PARTICIPATION PROCESS

Public participation is an important component of this Natural Hazards Mitigation Plan. Public participation offers citizens the chance to voice their ideas, interests and opinions. Oregon's land use system addresses the need for public process in Statewide Land Use Planning Goal 1: Citizen Involvement, which ensures the opportunity for citizens to be involved in the planning process. FEMA's Disaster Mitigation Act of 2000 includes new requirements for involving the public in natural hazard mitigation planning. The Act requires:

"An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1. An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.
2. An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and no-profit interests to be involve in the planning process."ⁱ

Plan Review and Update

Public participation was maintained in the review and revision process for this update of the plan.

- A copy of the NHMP has been available for review on the City's website since it was originally created in 2003.
 - The website includes the opportunity for members of the public to submit questions and comments regarding the plan.
 - Information on the plan changes along with links to the revised plan were also provided to partner and stakeholder agencies.
- We have included members from the community on our Natural Hazards Mitigation Plan Steering Committee including members from the Community Emergency Response Team (CERT).
- Information regarding the NHMP update and solicitation for comment were posted on the Home Page of the City's website and published in the May/June 2018 "Your City" newsletter, which gets distributed to every residence and business in the City. Information on how to submit comments and propose changes were included in the information. Links to the on-line survey were also provided in the "Your City" article (see Figure B-1) and on the City's Home Page.
- During the public review process the revised NHMP were made available on the City's Mitigation website along with the current version. The City's Public Engagement Division started a multi-week engagement period (July 10 – August 6, 2019) inviting people to review the plan, comment and take the survey if they hadn't already.

Information was put out through the City's website, Twitter, Facebook and Next Door. Examples are included at the end of the Annex.

- Facebook: 13 Posts / 12,491 Impressions / 271 Engaged Users
 - Twitter (See Figure B.4) : 13 tweets / 17,487 Impressions / 157 Engagements / 8 re-tweets / 1,539 media views / 61 media engagements
 - Website; plan review landing page (See Figure B.2): 1,031 page views / 356 Unique visitors / 106 returning visitors
 - Next Door (See Figure B.3) – No distribution data
- The update of the NHMP including the changes in the plan was presented to the City Council during a Round Table session on July 23, 2019. All Council meetings are televised on local cable access channel and available for streaming through the City's website.
 - Comments were received from general public as well as some of our partner and stakeholder agencies.
 - As part of the review and update of the Natural Hazards Mitigation Plan, the City conducted a Preparedness and Mitigation survey on line. Understanding how the community views natural hazards is an important part of the natural hazard mitigation process. Examining people's attitudes about hazards may help to identify gaps in preparedness, and ways in which public/private coordination could be improved within the City. 211 relevant surveys were completed.

Figure B.1 - City Newsletter

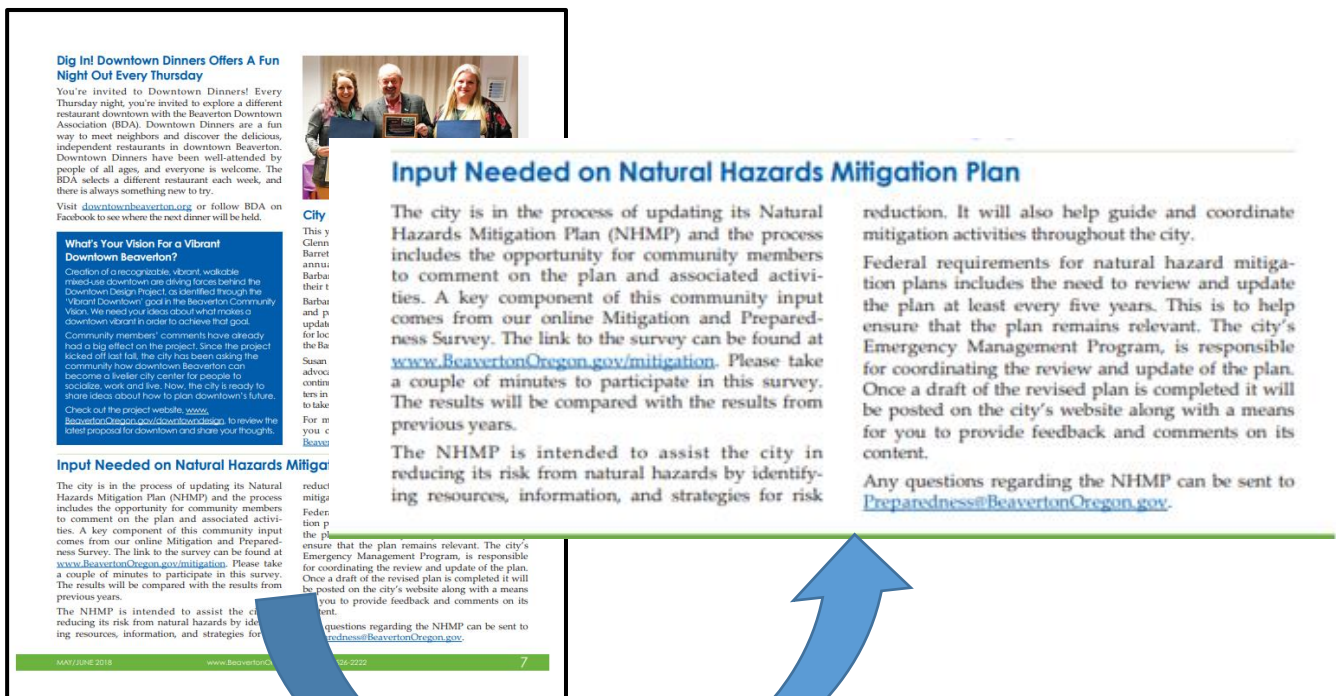


Figure B.2 – City’s Natural Hazards Mitigation Plan webpage

<https://www.beavertonoregon.gov/1166/Natural-Hazards-Mitigation>



GOVERNMENT COMMUNITY SERVICES DEPARTMENTS HOW DO I...

- Current Natural Hazards Mitigation Plan

- Revised Natural Hazards Mitigation Plan

Home > Departments > Emergency / CERT > Mitigation > Natural Hazards Mitigation

NATURAL HAZARDS MITIGATION

Beaverton Natural Hazard Mitigation Plan

The City of Beaverton developed and maintains this Natural Hazard Mitigation Action Plan in an effort to reduce future loss of life and property resulting from natural disasters. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the city. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from natural disasters.

Through the links below you can look at the current plan, review the draft plan and provide us with any comments relative to the plan by [email to the city's emergency manager](#).

[Current Natural Hazard Mitigation Plan](#)

[Draft of Revised Natural Hazard Mitigation Plan](#)

What is "Natural Hazard Mitigation?"

Natural hazard mitigation is defined as a method permanently reducing or alleviating the losses of life, property, and injuries resulting from natural hazards through long and short-term strategies. Example strategies include planning, policy changes, programs, projects, and other activities. Natural hazard mitigation is the responsibility of individuals, private businesses and industries, state and local governments, and the federal government.

Why Have a Mitigation Plan?

Federal law requires that the city identify a comprehensive set of mitigation measures related to local natural hazards. An additional stipulation is that to receive pre- and post- disaster mitigation funds from FEMA, local governments must have a current, FEMA approved NHMP. NHMPs must be updated and re- approved every five years. A 2018 revision of the plan is currently underway.

These requirements were established when Congress passed and the President signed the Disaster Mitigation Act of 2000, commonly known as DMA 2000. Under DMA 2000 and the associated rules published in 44 CFR Part 201.6, communities, states, and tribal governments must have FEMA-approved natural hazard mitigation plans to be eligible for certain federal assistance programs such as the Hazard Mitigation Grant Program (HMGP).

What are the City's Overall Risks to Natural Hazards?

The City of Beaverton's Emergency Management Program reviews and updates the risk assessment regularly to evaluate the probability of each natural hazard as well as the vulnerability of the community to those hazards. Scores are based on the City's Hazard Analysis that is submitted to the Oregon Office of Emergency Management as part of the update cycle of the City's Emergency Operations Plan. The table below summarizes hazard probability and vulnerability of the top 7 natural hazards that may impact Beaverton, as determined by the hazard methodology develop by FEMA and refined by Oregon Office of Emergency Management. These are the 7 natural hazards that are addressed in the 2018 revision of the mitigation plan.

Hazards	Probability	Vulnerability	Total Score	Hazard Rank
Severe Weather - High Winds	High	High	208	#1
Severe Weather - Winter Storms	High	Moderate	203	#2
Earthquakes	High	High	203	#3
Flood	High	Moderate	188	#4
Volcano (Ash Fall)	Moderate	Moderate	178	#5
Drought	Moderate	Moderate	155	#6
Landslides and Debris Flow	Moderate	Low	86	#7

Figure B.3 – Example of Next Door Post

 Neighborhood Program Coordinator Miles Glowacki, City of Beaverton ...

What are the natural hazards in your neighborhood? Are you prepared?

How prepared are you for a natural hazard? The City of Beaverton is updating its Natural Hazard Mitigation plan and we would like your input.

1. Take a look at the plan
2. Take the readiness survey to see how prepared you are
3. Share your thoughts with the City's Emergency Manager

<https://www.beavertonoregon.gov/1166/Natural-Hazards-Mitigation>



Natural Hazards Mitigation | Beaverton, OR - Official Website
BEAVERTONOREGON.GOV

4 days ago · Subscribers of City of Beaverton

 Reply  5  1 · 3097 Impressions


 Kim L., Hart-Davis · 5 hr ago

I tried to take the survey, but it said it is closed already. I noticed that fire was not one of the natural hazards that I saw listed on the page, however. Living close to McWilliams Park, a small forest, I do believe that could be a hazard for many families. Especially as there are other forested areas around Beaverton.


Thank Reply


Add a reply...


Figure B.4 – Examples of Twitter Posts

Type: Post  8/5 05:08 pm


18 interactions in this thread

 **Local Economy** > Business Affairs


 Facebook | Beaverton City Government





How does your business prepare for natural hazards? Take a moment to review the City of Beaverton's proposed Natural Hazards **mitigation** Plan to see what it may mean for your business. #BusinessMonday

Type: Post  7/10 03:03 pm


6 interactions in this thread

 **Public Safety** > Public Safety - General


 Twitter | @CityofBeaverton





Here's a tip from the Emergency Management Program: Standing water can be deeper than it looks! Turn Around Don't Drown. Are you prepared for an emergency? Take a survey! [surveymonkey.com/r/MYV69QL](https://www.surveymonkey.com/r/MYV69QL)

Type: Post  8/4 03:15 pm

2 interactions in this thread


 **Public Safety** > Extreme Weather and Nat...

 Facebook | Beaverton City Government



Did you know the City of Beaverton has a Natural Hazards **mitigation** Plan to help us be prepared for emergencies? Check it out and share your thoughts at <https://www.beavertonoregon.gov/2088/Revised-Natural-Hazards-mitigation-Plan>. Make sure you're prepared for emergencies by taking this survey! <https://www.surveymonkey.com/r/MYV69QL>

Natural Hazards Preparedness and mitigation Survey Update



Did you know the City of Beaverton has a Natural Hazards **mitigation** Plan to help us be ready for emergencies? Check it out and share your thoughts at [beavertonoregon.gov/2088/Revised-N...](https://www.beavertonoregon.gov/2088/Revised-Natural-Hazards-mitigation-Plan) Make sure you're ready for emergencies by taking this survey! [surveymonkey.com/r/MYV69QL](https://www.surveymonkey.com/r/MYV69QL)

Slideshow Right Arrow

The plan goals describe the overall direction City of Beaverton agencies, organizations and residents can take to work toward mitigating risk from natural hazards. The overarching plan vision is to create a disaster resistant and resilient community through four Goals – each with its own list of objectives. The Goals and Objectives were validated during the plan review cycle and are as follows: Goal 1: Develop and implement strategies to protect human life, commerce, property, and natural systems from

Appendix B Endnotes

ⁱ Code of Federal Regulations. 44CFR201 and 44CFR206

Appendix C

Community Profile

Introduction

The Community Profile is an overview of the City of Beaverton providing information on the geology, topography, climate, and historic and cultural resources of the City. It also provides a snapshot of trends in land use and development, population and demography, employment and economy, housing and community development, critical facilities and infrastructure, education, special districts, transportation, freight distribution, and communications. This information provides the basis for understanding the city's vulnerabilities to natural hazards and the natural hazards mitigation planning process.

People and places are not equally affected by natural hazards. Places are unique. People with more economic, social, or political capital are likely to better withstand disaster events and to bounce back more quickly. Structures located outside of hazard areas and those constructed to higher building standards are more resilient to natural hazards. Understanding these distinctions increases our understanding of the disproportionate vulnerability to hazards across the City of Beaverton.

These trends and implications ultimately inform the Mitigation Strategy of the Beaverton NHMP. See Section 3 Mitigation Strategy for more details on the goals and action items for the NHMP, as well as how the implementation of those will be achieved. Section 4 will address the monitoring and evaluating of the plan, and the continued involvement of the public as the Beaverton NHMP is integrated into plans, programs, and policies.

The NHMP focuses on natural hazards, but recognizes that other hazards such as human-caused and technological hazards occur. It is widely recognized that no hazard exists in isolation; therefore, consideration of the relationships of multiple hazards is important. Relationships of natural, human-caused, and technological hazards are linked.

Oregon Natural Hazards Mitigation Plan

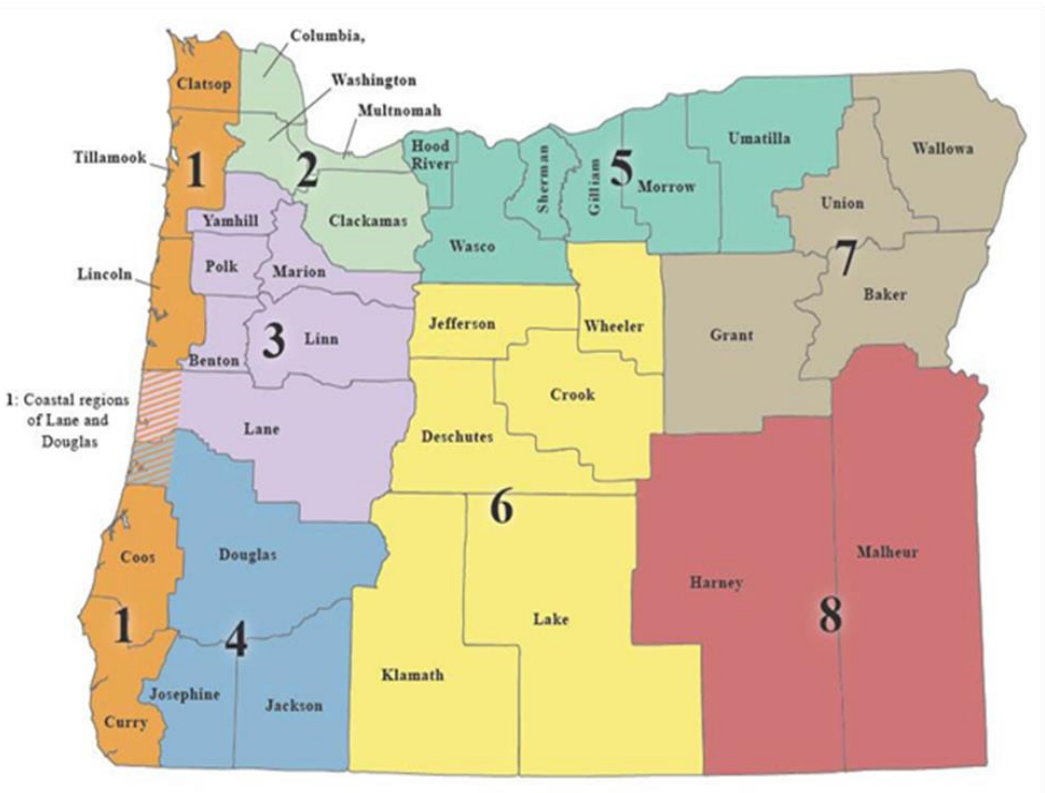
The 2015 Oregon Natural Hazards Mitigation Plan (NHMP) (DLC D, 2015) provides an extensive amount of natural hazard information for the entirety of Oregon, as well as at the regional level.

Beaverton is part of Natural Hazards Region 2 as established by the State. Information from the 2015 Oregon NHMP is used throughout the Beaverton NHMP, particularly

information related to climate change. FEMA has established a new requirement for NHMP to include the recognition of possible future conditions due to climate change. That information is contained in the hazard chapters and risk assessment; to the extent available

According to the State’s Hazards Mitigation Plan (2015 Oregon NHMP), Region 2’s demographic, economic, infrastructure, and development patterns indicate that some populations, structures, and places may be more vulnerable to certain natural hazards than others. Mitigation efforts directed at these vulnerabilities may help boost the area’s ability to bounce back after a natural disaster.

Figure C.1: Oregon NHMP Natural Hazards Regions (DLCD, 2015)



The 2105 Oregon NHMP further identifies for Region 2:

“Regionally, social vulnerability is driven by a high number of tourists who are likely not familiar with the hazard types and level of risk in the region. At the county level, high numbers of disabled persons in Multnomah County; a dramatic increase in the homeless population in Clackamas County; and higher numbers of renters and of persons who do not speak English “very well” in Multnomah and Washington Counties

increase the level of risk to these populations. Columbia County’s low incomes and high poverty rates make it especially vulnerable to heightened economic hardship that often follows a hazard event.

Compared to other areas of the state, communities around the Portland Metro area weathered the financial crisis that began in 2007 due to the diversity of key industries, employment sectors, and higher wages than the state average. The region’s resilience is bolstered by strong Professional and Business Services, Health and Social Assistance, and Government sectors, which have low vulnerability to natural disasters and are key to post-disaster recovery efforts. Columbia County’s economy is struggling the most, with higher unemployment and lower wages.”

Geography and Environment

The City of Beaverton abuts the City of Portland, Oregon, in Washington County and is part of the Portland metropolitan area, which includes Multnomah, Clackamas, and Washington Counties. The dominant natural feature in Washington County is the Tualatin River, which forms the agriculturally rich Tualatin Valley.

Beaverton’s terrain is predominately flat or rolling hills, with an average elevation of 189 feet. There are two prominent features around Beaverton: Portland’s West Hills, which are to the northeast of Beaverton, Cooper Mountain, elevation of 730 feet, to the southwest. Mount Williams, elevation of 471 feet in west Beaverton, and Sexton Mountain, elevation of 413 feet in southwest Beaverton, are two moderate features that create visual relief in the landscape. Maps of Beaverton’s Environmental Assets showing the community’s parks and open space as well as significant trees are located in this plan’s map section.

Rivers and Streams

Beaverton is a fast-growing community with considerable areas of present and potential development adjacent to waterways. Although the City does not contain any rivers, a number of creeks run through it that have a tendency to flood during heavy rains. Beaverton Creek, the most significant stream in the City, drains approximately 36 square miles as it flows through the City’s major commercial center. Numerous wetlands surround Beaverton Creek, which help control runoff and prevent flooding, but flooding continues to present a hazard to



Figure C.2: Flooding on Hwy 217

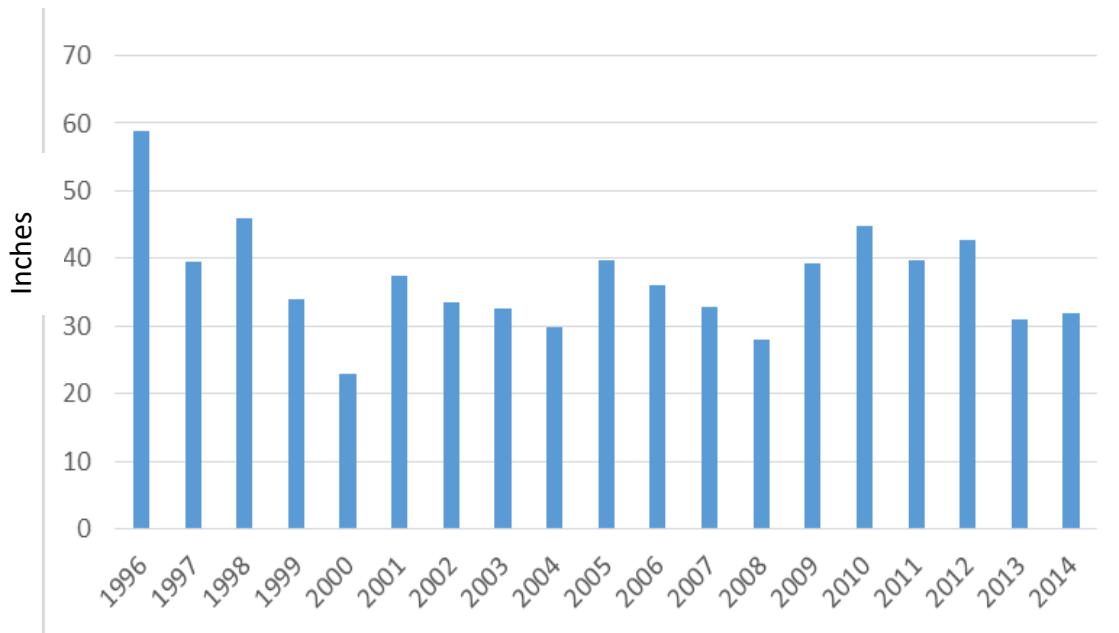
structures located near the stream. Fanno Creek runs through eastern Beaverton from the West Hills, under Highway 217, and then south to Tigard.¹ Fanno Creek presents erosion and flooding hazards to properties on its banks. In December 1996, flooding from Fanno Creek caused the closure of Highway 217, a major north-south transportation route.² Fanno Creek flooding also results in frequent lane restrictions as part of the road surface is below the 2-year floodplain.

As Beaverton has grown, hydrology has been altered by development, which increases runoff from impervious surfaces and can be accompanied by problems like erosion and flooding. Some stream segments in the city have been enclosed in culverts, including a portion of Beaverton Creek that passes beneath the parking lot at City Municipal Court and Police Services Building and the Beaverton Town Square shopping center.

Climate

The climate in Beaverton is mild year-round. Beaverton has a modified marine climate, with most of the weather coming from the Pacific Ocean. The Cascade Mountains to the east help prevent colder continental air from influencing temperatures in the winter. However, arctic air masses occasionally move from the east through the Columbia River Gorge, which result in freezing rain and snow. Large Pacific storms that bring high winds and heavy rain also hit the area, particularly in winter. Beaverton receives approximately 39.4 inches of rain per year³, most of which falls from October through April, with December being the wettest month of the year. The average low temperature for the City of Beaverton is 33 degrees Fahrenheit, and the average high is 81 degrees Fahrenheit. The coldest temperatures typically occur in January and the hottest occur in August. Average humidity ranges from 82% in the winter to 62% in the summer. Figure 2.2 shows the annual rainfall in inches for Beaverton from 1995 to 2014.

Figure C.3: Annual Precipitation (in inches), Beaverton, Oregon, 1996 – 2014



Source: National Weather Service

Minerals and Soils

Several common natural hazards are related to soil stability and water retention. These hazards include landslides, erosion, flooding, and liquefaction resulting from an earthquake. Mineral and soil compositions are important factors for determining whether Beaverton is prone to hazards such as landslides. The soils in Washington County include “semi-consolidated sedimentary rocks, basaltic lavas, marine sedimentary rocks, and Eocene Age volcanic and sedimentary rocks.”⁴ The soils in Beaverton fall into three general soil associations, which are one or more component soils combined with associated landscape characteristics. The main soil association in Beaverton is the Aloha-Amity-Dayton Association. This is a silty or clayey poorly draining soil and is found in floodplains and bottomlands. Natural vegetation linked with this soil type includes Oregon white oak, low shrubs, and grasses. Sedimentation risk is low, but pooling of water during wet months is likely.⁵ In southern Beaverton, the soil changes into the Woodburn-Quatama-Willamette Association. These soils are also found in lowlands, but they are silty, and moderately well drained. Sedimentation risk in this soil association is moderate to high. Associated natural vegetation includes Douglas fir, Oregon white oak, and shrubs. The third major soil type in Beaverton is that of the Cascade-Cornelius Association. These soils are found in the hills of Beaverton, in very steep to gently sloping areas. Formed from loess and alluvium, the Cascade-Cornelius Association ranges from somewhat poorly drained to moderately well drained. The vegetation on this soil type includes Douglas fir, big-leaf maple, western red cedar, shrubs, and grasses. Sedimentation risk from runoff on this soil type is high.

Significant Geological Factors

Most of the Pacific Northwest lies within the Cascadia Subduction Zone, where the Juan de Fuca and North American plates meet. The convergence of these tectonic plates puts most areas of western Oregon and Washington at risk for a catastrophic earthquake with a magnitude of 8.0 or higher. Beaverton lies in this area of risk. Another earthquake risk for Beaverton is the Portland Hills fault, which may be capable of generating moderately large earthquakes. As a result of the subduction zone, there are active volcanoes nearby, including Mount St. Helens in southwest Washington, and Mount Hood. Major eruptions of these volcanoes may cause significant ash fall in the Beaverton area.

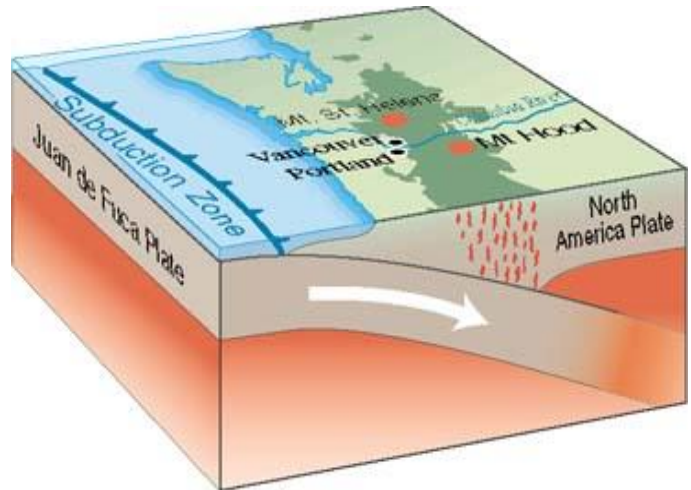


Figure C.4: Cascadia Region Subduction Zone

Population and Demographics

Population size itself is not an indicator of vulnerability. However, the location, composition, and capacity of the population within the community is important. Research by social scientists demonstrates that human capital indices such as language, race, age, income, education and health can affect the integrity of a community. Therefore, these human capitals can impact community resilience to natural hazards.

While natural hazards do not discriminate, the impacts in terms of loss and the ability to recover vary greatly among those affected.⁶ According to Peggy Stahl of the FEMA Preparedness, Training and Exercise Directorate, 80% of the disaster burden falls on the public. Women, children, minorities and the poor bear a disproportionate amount of this burden because of misunderstandings of FEMA's role in disaster relief.⁷ Because women, children, minorities, and the poor are especially at risk during disasters, it is important to identify those populations within Beaverton. Potential language, economic, physical, and social barriers could inhibit disaster preparedness and limit the efficacy of relief efforts during a disaster.

Hazard mitigation that targets the specific needs of these groups has the potential to greatly reduce their vulnerability. Examining the reach of hazard mitigation policies to special needs populations may assist in increasing access to services and programs. FEMA's Office of Equal Rights addresses this need by suggesting that agencies and

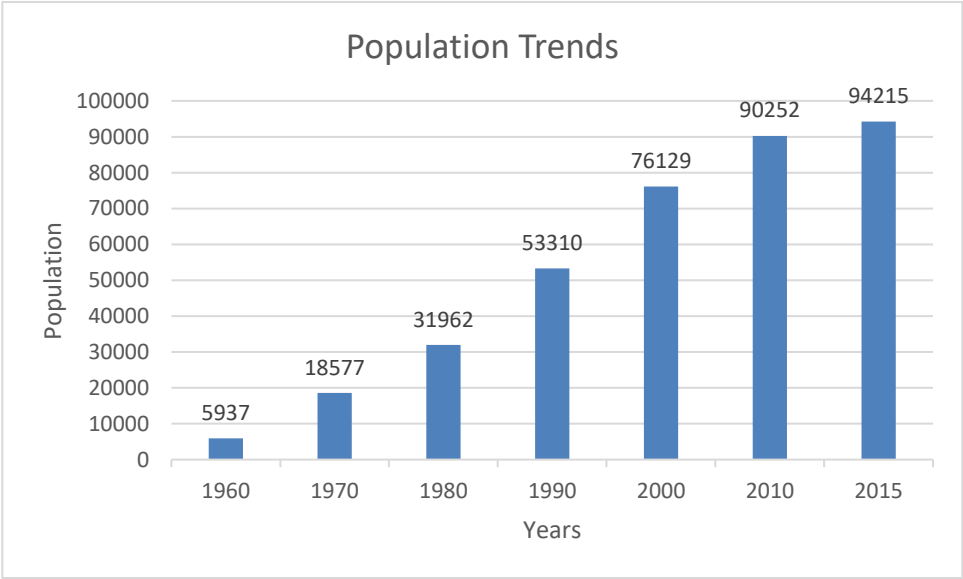
organizations planning for natural hazards identify special needs populations, make recovery centers more accessible, and review practices and procedures to remedy any discrimination in relief application or assistance.

Targets for mitigation actions can be locations where these vulnerable populations exist as population assets. These assets include schools – from pre-kindergarten through to the universities and community colleges. The campuses are where the young people of the communities spend their time and, similarly to workplace safety training, mitigation actions on the physical facilities as well as awareness and training will help keep students safe. Likewise, elderly living at home or in assisted living communities are more vulnerable to the negative impacts of a hazard. These facilities are important community assets that should be given careful consideration for hazard mitigation and preparedness efforts.

Population

According to the 2010 Census, Beaverton’s population in 1990 was 53,310; by the year 2000, the population had grown to 76,129 resulting in a 42% growth rate during that decade. By the year 2010, the population had grown to 90,151 resulting in a 76% growth rate during the two decade period.⁸ As of July 1, 2015 Beaverton’s Population was 94,215. Figure 2.3 illustrates Beaverton’s population from 1960 to 2015.⁹

Figure C.5: Historic Population Trends, Beaverton, 1960 – 2015



Source: City Census information

Language

Special consideration should be given to populations who do not speak English as their primary language. Language barriers can be a challenge when disseminating hazard planning and mitigation resources to the general public, and it is less likely they will be prepared if special attention is not given to language and culturally appropriate outreach techniques.

There are various languages spoken within the City; the primary language is English. Of the city's population who were 5 years and older 72.2% speak only English at home while 27.8% spoke languages other than English. The languages other than English that are spoken at home include:

- Spanish – 13.3%
- Other Indo-European languages – 5.8%
- Asian and Pacific Islander languages – 8.0%
- Other languages – 70.0%

Outreach materials used to communicate with, plan for, and respond to non-English speaking populations should take into consideration the language needs of these populations.

Race/Ethnicity

The impact in terms of loss and the ability to recover may also vary among minority population groups following a disaster. Studies have shown that racial and ethnic minorities can be more vulnerable to natural disaster events. This is not reflective of individual characteristics; instead, historic patterns of inequality along racial or ethnic divides have often resulted in minority communities that are more likely to have inferior building stock, degraded infrastructure, or less access to public services. The tables below reflect the city's population by race and ethnicity.

Table C.1: RACE	
<u>One race</u>	95.9%
<u>Two or more races</u>	4.1%
One race	
White	73.1%
Black or African American	2.3%
American Indian and Alaska Native	0.8%
Asian	12.0%
Asian Indian	3.7%
Chinese	1.4%
Filipino	0.8%

Japanese	1.1%
Korean	1.6%
Vietnamese	1.1%
Other Asian	2.2%
Native Hawaiian and Other Pacific Islander	0.7%
Native Hawaiian	0.4%
Guamanian or Chamorro	0.1%
Samoan	0.1%
Other Pacific Islander	0.2%
Some other race	6.9%
Race alone or in combination with one or more other races	
White	76.9%
Black or African American	3.3%
American Indian or Alaskan Native	2.0%
Asian	14.0%
Native Hawaiian and other Pacific Islander	1.0%
Some other race	7.2%
<i>ACS 2011-15 5-year survey estimate (DP05)</i>	

Table C.2: ETHNICITY	
<u>Hispanic or Latino</u>	16.7%
Mexican	12.5%
Puerto Rican	0.6%
Cuban	0.1%
Other Hispanic or Latino	3.5%
<i>ACS 2011-15 5-year survey estimate (DP05)</i>	
<u>Not Hispanic or Latino</u>	83.3%
White alone	64.6%
Black or African American alone	2.3%
American Indian and Alaska Native alone	0.3%
Asian alone	11.9%
Native Hawaiian and Other Pacific Islander alone	0.6%
Some other race alone	0.1%
<i>ACS 2011-15 5-year survey estimate (DP05)</i>	

It is important to identify specific ways to support all portions of the community through hazard mitigation, preparedness, and response. Culturally appropriate, and effective outreach can include both methods and messaging targeted to diverse audiences. For example, connecting to historically disenfranchised populations through already trusted sources or providing preparedness handouts and presentations in the languages spoken by the population will go a long way to increasing overall community resilience.

Gender

The City has slightly more females than males (Female 51%, Male: 49%). It is important to recognize that women tend to have more institutionalized obstacles than men during recovery due to sector-specific employment, lower wages, and family care responsibilities.

Age

Of the factors influencing socio demographic capacity, the most significant indicator in the City may be age of the population. As depicted in the table below, as of 2015, 10.9% of the city’s population is over the age of 64, a percentage that is projected to rise. The Oregon Office of Economic Analysis projects that, in 2035, there will be a higher percentage of the overall population over the age of 64. As the population ages, the City may need to consider different mitigation and preparedness actions to address the specific needs of this group.

Table C.3: AGE	
Under 5 years	6.4%
5 to 9 years	6.2%
10 to 14 years	6.8%
15 to 19 years	5.7%
20 to 24 years	6.4%
25 to 34 years	18.0%
35 to 44 years	14.8%
45 to 54 years	12.8%
55 to 59 years	6.7%
60 to 64 years	5.2%
65 to 74 years	6.4%
75 to 84 years	2.8%
85 years and over	1.7%
<i>ACS 2011-15 5-year survey estimate (DP05)</i>	
Median age	35.2
<i>ACS 2011-15 5-year survey estimate (DP05)</i>	

The age profile of an area has a direct impact both on what actions are prioritized for mitigation and how response to hazard incidents are carried out. School age children rarely make decisions about emergency management. Therefore, a larger youth population in an area will increase the importance of outreach to schools and parents on effective ways to teach children about fire safety, earthquake response, and evacuation plans. Furthermore, children are more vulnerable to the heat and cold, have few transportation options and require assistance to access medical facilities. Older populations may also have special needs prior to, during and after a natural disaster. Older populations may require assistance

in evacuation due to limited mobility or health issues. Additionally, older populations may require special medical equipment or medications, and can lack the social and economic resources needed for post-disaster recovery.¹⁰

Income

Household income and poverty status are indicators of socio demographic capacity and the stability of the local economy. Household income can be used to compare economic areas as a whole, but does not reflect how the income is divided among the area residents. The median income for the City of Beaverton is \$56,882¹¹ and 15.4% of the city’s population is living in poverty.¹²

Research suggests that lack of wealth contributes to social vulnerability because individual and community resources are not as readily available. Affluent communities are more likely to have both the collective and individual capacity to more quickly rebound from a hazard event, while impoverished communities and individuals may not have this capacity; leading to increased vulnerability. Wealth can help those affected by hazard incidents to absorb the impacts of a disaster more easily. Conversely, poverty, at both an individual and community level, can drastically alter recovery time and quality.¹³

Federal assistance programs such as food stamps are another indicator of poverty or lack of resource access. Statewide social assistance programs like the Supplemental Nutritional Assistance Program (SNAP) and Temporary Assistance for Needy Families (TANF) provide assistance to individuals and families. Those reliant on state and federal assistance are more vulnerable in the wake of disaster because of a lack of personal financial resources and reliance on government support.

Education

Educational attainment of community residents is also identified as an influencing factor in socio demographic capacity. Educational attainment often reflects higher income and therefore higher self-reliance. Widespread educational attainment is also beneficial for the regional economy and employment sectors as there are potential employees for professional, service and manual labor workforces. An oversaturation of either highly educated residents or low educational attainment can have negative effects on the resiliency of the community.

Table C.4: INCOME (households)	
Less than \$10,000	6.0%
\$10,000 to \$14,999	4.6%
\$15,000 to \$24,999	9.4%
\$25,000 to \$34,999	9.6%
\$35,000 to \$49,999	14.1%
\$50,000 to \$74,999	17.2%
\$75,000 to \$99,999	14.1%
\$100,000 to \$149,999	15.2%
\$150,000 to \$199,999	5.6%
\$200,000 or more	4.2%
ACS 2011-15 5-year survey estimate (S1901)	
Median Income	\$56,882
ACS 2011-15 5-year survey estimate (S1901)	
Persons Living in Poverty	15.4%
ACS 2011-15 5-year survey estimate (S1901)	

According to the U.S. Census, 90.3% of the city’s population over 25 years of age has graduated from high school or received a high school equivalency, with 44.6% going on to earn a Bachelor’s Degree.

Table C.5: EDUCATIONAL ATTAINMENT	
<u>Highest level attained</u>	
Less than 9th grade	4.8%
9th to 12th grade, no diploma	4.8%
High school graduate (includes equivalency)	17.2%
Some college, no degree	20.6%
Associate's degree	7.9%
Bachelor's degree	30.1%
Graduate or professional degree	14.5%
<i>ACS 2011-15 5-year survey estimate (DP02)</i>	

Health

Individual and community health play an integral role in community resiliency, as indicators such as health insurance, people with disabilities, dependencies, homelessness and crime rate paint an overall picture of a community’s well-being. These factors translate to a community’s ability to prepare, respond to, and cope with the impacts of a disaster.

Those who lack health insurance or are impaired with sensory, mental or physical disabilities, have higher vulnerability to hazards and will likely require additional community support and resources. The ability to provide services to the uninsured populations may burden local providers following a natural disaster.

Table C.6: Beaverton Residents Without Health Insurance	
• Of Total Population	15.1%
○ Under 18 years of age	5.5%
○ 18 to 64 years of age	20.6%
○ 65 or older	.9%
Social Explorer, Table 145, U.S. Census Bureau, 2010-2014 American Community Survey	

The table below describes disability status of the population. As of 2014, 10.3% of the city’s non-institutionalized population identifies with one or more disabilities.

Table C.7: Beaverton Residents With Disabilities	
• Of Total Population	10.3%
○ Under 18 years of age	0.7%
○ 18 to 64 years of age	5.8%
○ 65 or older	3.6%
Social Explorer, Table 145, U.S. Census Bureau, 2010-2014 American Community Survey	

Homeless

In 2015, Oregon Housing and Community Services (OHCS) conducted a point-in-time homeless count to identify the number of homeless, their age and their family type. This information was not broken out by city but the data can still be used to provide awareness of that vulnerable population as well. The OHCS study found that 591 individuals and persons in families in Washington County identify as homeless; 196 were sheltered (97 individuals and 99 persons in families), 395 were unsheltered (302 individuals and 93 persons in families).

Land and Development

Beaverton is a community of residential, commercial, and industrial uses. Forty-eight percent of the land in the city is designated as “standard density.”¹⁴ Beaverton has many commercial centers serving the community’s needs. Beaverton Town Square and Cedar Hills Crossing form two primary shopping areas in Beaverton’s downtown. Progress Ridge, Murray Scholls Town Center, and Timberland Commercial serve areas of the community outside the downtown.

Beaverton’s position as an inner-ring suburb, largely developed in the second half of the 20th Century, has shaped much of its growth and urban form. The city’s Old Town, first platted in 1868, dates to an era before cars were dominant, and has the small, walkable blocks characteristic of that time. However, the prevalence of cars during the periods in which much of the rest of the City was developed shaped a set of neighborhoods, employment areas, and commercial corridors that are built around automobile access.

The City is also strongly influenced by the presence of Highways 217 and 26, which provide access to major employment areas throughout the west side of the region, as well as connecting to downtown Portland and providing freight routes that connect to other parts of the state and to I-5. The extension of the MAX light rail line in the 1990s began a gradual transition towards more transit-oriented development around light rail stations.

Beaverton’s location within the Portland Metropolitan region is an important context for the City’s growth and livability. Metro, the regional government, sets policies on land use, transportation, and natural resources that local jurisdictions in the region must comply with. It also sets a region-wide land use pattern, in collaboration with local governments. The Metro “2040 Growth Concept” highlights areas where growth should be focused and areas where higher densities and more redevelopment are appropriate (e.g. downtowns and light rail station areas). The 2040 Growth Concept is reflected in the City’s land use designations and policies.

Relationships with other jurisdictions are also essential to Beaverton’s land use and urban form. The City’s boundary is approximately 94 miles in length, sharing borders

with Portland, Tigard, Hillsboro, urban unincorporated Washington County and rural Washington County. It is a jagged and complex boundary that reflects an incremental annexation history and illustrates the importance of coordination with Washington County and adjacent cities. Much of the land now within the city limits was originally developed under Washington County development regulations. In many areas, annexation has occurred after county planning and initial development has occurred, requiring the City to implement the County’s plans through city zoning

Beaverton’s downtown is designated a Regional Center. As such, new development must meet new mixed-used transit-oriented standards. The Round, a mixed-use transit oriented development at the intersection of Watson Avenue and the Westside Light Rail line. The Round includes, 123,500 square feet of retail space, 342,000 square feet of commercial space, 264 residential units, and approximately 810 parking spaces. The development was encouraged by and designed, in part, to meet regional growth policies that encourage compact mixed-use development in close proximity to transit; this type of development is less land consumptive and provides a high level of pedestrian amenities.¹⁵

Designated industrial areas in Beaverton include Allen Business Park, Parkside Business Center, the West Five Industrial Area (formerly, Western Avenue Industrial Area), and developments along Millikan Way.¹⁶ The rest of the employment land in Beaverton is mostly comprised of commercial corridors of primarily retail uses. See this plan’s Map Section for the map titled Economic Assets – Zoning for more information and in addition Table 2-8 illustrates the total number of acres and percentages of each land use designation in Beaverton.¹⁷

Table C.8: Land Use Designation, Beaverton, 2016

Land Use Designation	Acres	Percent of Total Acres
Corridor (COR)	1593.9	13%
Employment (EMP)	530.5	4%
Industrial (IND)	513.6	4%
Main Street (MS)	115.4	1%
NR-High Density (NR-HD)	546.1	4%
NR-Low Density (NR-LD)	87.0	1%
NR-Medium Density (NR-MD)	698.5	6%
NR-Standard Density (NR-SD)	6007.0	48%
Regional Center (RC)	721.9	6%
ROW - unzoned	74.3	1%
Station Community (SC)	711.7	6%
Town Center (TC)	343.6	3%
Interim Washington County (Wacnty)	614.8	5%
Totals	12,558.2	100%

Source: City of Beaverton, Finance/ISD-GIS

Housing and Community Development

Gaining an understanding of the City’s current housing stock as well as trends in community development are important in planning for natural hazards because development in Beaverton has increased steadily with population growth. Each year Beaverton’s Building Division issues a combined total of 5,000 to 5,500 building, mechanical, plumbing, electrical, and sewer permits. In 2016, 1,044 building permits were issued, compared with 1,229 permits issued in 2015 and 1,189 in 2014. The number of overall permits issued has steadily increased since the recession, up 15 percent since 2009.

According to the 2010 US Census, there are 39,654 housing units within the City. Of the total housing units, 46.5% are rental units and 47.7% are owner-occupied. The remaining 5.8% are vacant housing units. The majority of homes in Beaverton were built between 1970 and 2000; new dwelling construction has been on the decline since that period. The year in which a structure is built is an important indicator of how well a structure will perform during an event. For example, in 1990 the State of Oregon Building Code construction standards were revised for new buildings to make them more resistant to seismic events. Those construction standards were increased several times to the current levels established in 2004. Therefore, homes built after 1990, are likely to perform better during an earthquake or related hazard.

The following table provides information on the age structure of Beaverton’s housing units.

Table C.9: Housing Age Structure, Beaverton		
Existing Housing Units		
Year Built	Number	Percent
2014 or later	70	0.18%
2010 to 2013	626	1.59%
2000 to 2009	6276	15.91%
1990 to 1999	7872	19.96%
1980 to 1989	8432	21.38%
1970 to 1979	9038	22.92%
1960 to 1969	4144	10.51%
1950 to 1959	1856	4.71%
1940 to 1949	623	1.58%
1939 or Earlier	502	1.27%
Total	39,439	100.00%
Source: U.S. Census Bureau, 2011-2015 American Community Survey 5-Year Estimates		

Beaverton's housing market has demonstrated a significant drop since 2009. Although some of this slowdown can be attributed to market fluctuations, a significant measure can also be explained by the fact that, while the city's population has increased, the amount of land capable of absorbing the need for new housing has decreased.¹⁸

In recognition of the fact that Beaverton suffers from a shortage of buildable residential land, the City has begun to examine alternatives associated with housing types that emphasize increasing the density potential for new residential development. Recent annexation of the South Cooper Mountain Community Plan Area helps to meet the needed supply of land to meet residential land demand in the next 20 years. The annexation area underwent a community planning process which resulted in the South Cooper Mountain Community Plan which outlines future development in the area which includes approximately 3,000 additional dwelling units around the new High School, and commercial development.

Affordable housing has also become a topic of great concern over the past decade. The problem is largely due the fact that wage rates have not been able to keep pace with escalating housing costs. The result has been an ever-widening affordability gap that has the potential to dislocate area residents. According to Oregon's Multiple Listing Service, the average home price for the Beaverton area in 1990 was \$91,633. By 1999, the average price had almost doubled at \$175,700, and doubled again to \$355,700 by 2016. While a segment of this increase can be attributed to escalating costs in permit fees, transportation impact fees, and system development charges, the bulk of the change comes from increasing land values driven by regional population growth and increasing demand for housing.

Each year, the CDBG program disburses its federal allocation to nonprofit Subrecipient organizations to meet objectives outlined in the CDBG Consolidated Plan (ends June 30, 2020). In turn, the Subrecipient organizations manage programs to support low and moderate income residents in Beaverton.

Grants are awarded in different categories of activities based on a combination of direct award or competitive applications. Con Plan objectives are:

1. Affordable homeownership
2. Housing rehabilitation activities via a non-competitive application process.
3. Efforts supporting homelessness prevention
4. General public services
5. Microenterprise activities.

Employment and History

Beaverton's per capita income, in 2015 inflation adjusted dollars is \$30,820.¹⁹ Median earnings for civilian employed population 16 years and over with earnings was \$35,949. The median earnings for male workers was \$42,207 and \$31,081 for females.²⁰ According to the 2000 Census, Beaverton had 40,922 employees, accounting for one-third of all Washington County employees. Table C.10 provides a breakdown of jobs and the number employed by industry type.²¹

Table C.10: Beaverton Employment by Industry, 2015

Industry	Number Employed
Educational services, and health care and social assistance	8,867
Professional, scientific, and management, and administrative and waste management services	7,442
Manufacturing	6,541
Retail trade	6,048
Arts, entertainment, and recreation, and accommodation and food services	5,512
Finance and insurance, and real estate and rental and leasing	3,416
Construction	2,081
Other services, except public administration	2,072
Transportation and warehousing, and utilities	1,714
Public administration	1,301
Wholesale trade	1,182
Information	1,053
Agriculture, forestry, fishing and hunting, and mining	363
TOTAL JOBS	47,592

Source: U.S. Census Bureau, 2015 5-Year American Community Survey, Table DP03

Some of the Beaverton area's large private employers include Nike, Comcast, Leupold and Stevens, and Pacific Office Automation. Some of the largest public and institutional employers include City of Beaverton, Beaverton School District, and Providence Health Plans.²²

Today, Beaverton's economy is a mix of high tech and software companies, professional and business services, and retail trade. It supports both traditional and knowledge-based industries, as well as provides goods and services to export markets and local consumers.²³

Table C.11: Private Employment by Firm Size in Washington County										
		Number of establishments by establishment size								
Area	Total	0	1-4	5-9	10-19	20-49	50-99	100-249	250-500	500 +
Washington County	20,445	3,262	9,614	3,036	2,127	1,518	504	283	69	32
Beaverton	5,599	931	2,707	801	565	377	119	77	13	9
		Average Number of Employees by Establishment Size								
Area	Total	0	1-4	5-9	10-19	20-49	50-99	100-249	250-500	500 +
Washington County	264,249	-	17,876	20,093	28,850	46,022	34,538	42,175	23,004	51,691
Beaverton	70,282	-	4,922	5,336	7,666	11,409	7,889	11,724	4,258	17,078
			7.0%	7.6%	10.9%	16.2%	11.2%	16.7%	6.1%	24.3%
<i>Source: Oregon Employment Department, Quarterly Census of Employment and Wages (QCEW), 2016 annual Geography for Beaverton city vicinity</i>										

Transportation and Commuting

Transportation in Beaverton includes State and County highways, arterial streets, collector streets, neighborhood routes, local streets, Tri-Met bus service, Westside Light Rail, Westside Commuter Rail and multiple bicycle routes. Beaverton’s transportation network serves both residential and commercial commuters. A map in this plan’s Map Section titled Functional Road Classification further highlights the area’s transportation network.

The Tri-County Metropolitan District of Oregon (Tri-Met) provides public transportation in Beaverton. Tri-Met’s service includes bus, light rail and commuter rail. The MAX Westside Light Rail line is aligned in an east-west direction from downtown Portland following Highways 26 and 217 to the Beaverton Transit Station and continuing west to downtown Hillsboro. The newly opened WES commuter rail line lies in a north-south orientation paralleling portions of Interstate 5 and Highway 217 from Tualatin to the Beaverton Transit Station.

U.S. Highway 26, also known as the Sunset Highway, has the greatest traffic volume, and serves as a central connecting route between the coast and downtown Portland. Oregon Highway 217 serves to connect Highway 26 to and from Interstate 5 and carries the second highest traffic volume in Washington County. Highway 26 runs east to west, while Highway 217 runs north to south. Both of these highways are major traffic routes through and around Beaverton. Highway 210, also known as Scholls Ferry Road, also carries highest traffic volume. Highways 8 and 10 are major commuting routes as well, but carry slightly lower traffic volumes than the aforementioned routes.

Congestion is an increasing problem for Beaverton, even with the recent expansion of the light rail system, with limited redundancy in north-south arterials. Washington County’s thriving economy has led to a significant increase in traffic on all major arterials.

The majority of Washington County residents that work in Washington County drive alone (73%), while transit riders account for 3.5%, carpoolers 10%, bicyclists 1.3% and walkers account for 3.9%. An additional 8.7% find their way to work by other means (e.g. motorcycle, work from home, taxi). At the same time, of the Washington County residents that work outside of the County, 76% drive alone, 3.3% take transit, 10.1% carpool, 0.3% bike, and 0.4% walk. In the “other” category, 0.9% get to work by other means. Of residents living outside of Washington County that work in Washington County, 83.4% drive alone, 4.4% take transit, 10.0% carpool, 1.1% bike, and 0.4% walk. In the “other” category, 7.9% get to work by other means.²⁴

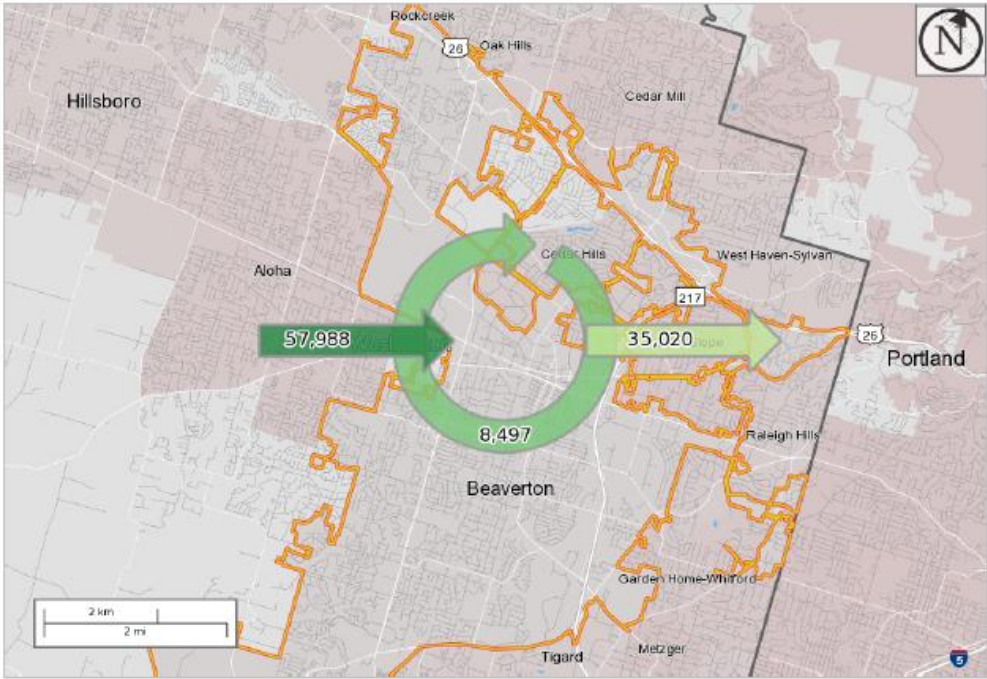


Figure C.6: City of Beaverton Inflow/Outflow Job Counts

Source: U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2015).

Table C.12: Inflow/Outflow Job Counts (Primary Jobs)		
2015		
	Count	Share
Employed inside City limits	66,485	100%
Employed inside City limits but live Outside City limits	57,988	87.2%
Employed and Live Inside City limits	8,497	12.8%
Live in City limits	43,517	100%
Live inside City limits but employed outside	35,020	80.5%
Live and employed inside City limits	8,497	19.5%
Source: U.S. Census Bureau, OnTheMap Application and LEHD Origin-Destination Employment Statistics (Beginning of Quarter Employment, 2nd Quarter of 2002-2015).		

Historic and Cultural Resources

The City of Beaverton has 96 identified historic resources on its Historic Resources Inventory; of those 19 "significant" and 22 "important" historic resources. Regulated resources under Statewide Planning Goal 5 include the "Significant" and "Important" categories on Beaverton's Historic Resource Inventory. "Significant" resources are defined as: individually important buildings, sites, structures or objects in Beaverton distinguished by outstanding qualities or architecture, relationship to environment and/or historic associations.²⁵ "Important" resources are defined as: buildings, sites, structures or objects, which are not of outstanding distinctiveness or variety, in terms of architecture or historic association and/or relationship to environment, but have sufficient significance to make them worthy of preservation. In addition to inventorying the "significant" and "important" resources, the inventory also identifies "contributing" and "un-rankable" resources. "Contributing" is defined as: buildings, sites, structures or objects, which are less significant examples of architecture or of lesser historical association, which may also provide the contexts for more significant resources. "Un-rankable" resources are defined as: lacking sufficient information to be ranked. Additionally, the City has one historic district on the National Register of Historic Places.

Critical Facilities and Infrastructure

Critical and essential facilities are those facilities that are vital to the continued delivery of key governmental services that may significantly impact the public's ability to recover from the emergency. During a natural disaster, it is very important to have operational facilities from which the city and recovery organizations can provide assistance. These critical facilities include 911 centers, emergency operations centers, police and fire stations, public works facilities, hospitals, bridges and roads, and shelters. Facilities that may cause secondary impacts if damaged or destroyed, such as

chemical production plants, are considered critical facilities as well. Essential facilities include schools, jails, law enforcement centers, public service buildings, and the courthouse. A map in this plan’s map section titled Critical Facilities highlights public and private schools, community centers, nursing homes, hospitals, and the light rail system.

Table C.13: Structures in Hazard Area*				
	100 Year Flood	Steep Slope	Debris Flow	Structure Totals
Multi Family	137	139	0	306
Single Family	200	552	84	885
Commercial	118	51	0	170
Multi-Use	1	0	0	1
Industrial	16	0	0	16
Institutional	19	12	0	31
Utilities	3	2	0	5
Other	159	83	1	243
Risk Totals	653	839	85	1657
*Hazard Areas within Beaverton City limits, as of 4/2017; based on GIS data				

Existing Plans and Policies

There are often existing plans and policies that guide and influence land use, land development, and population growth. Such existing plans and policies can include comprehensive plans, zoning ordinances, and technical reports or studies. Plans and policies already in existence have support from local residents, businesses and policy makers. Many land-use, comprehensive, and strategic plans get updated regularly, and can adapt easily to changing conditions and needs.²⁶

The City of Beaverton’s NHMP includes a range of recommended action items that, when implemented, will reduce the city’s vulnerability to natural hazards. Many of these recommendations are consistent with the goals and objectives of the city’s existing plans and policies. Linking existing plans and policies to the NHMP helps identify what resources already exist that can be used to implement the action items identified in the plan.

Implementing the Natural Hazards Mitigation Plan’s Action Items through existing plans and policies increases their likelihood of being supported and getting updated, and maximizes the city’s resources. In addition to the plans listed below the city also has zoning ordinances (including floodplain development regulations) and building regulations.

Existing plans and policies that can incorporate mitigation actions include the:

- Comprehensive Plan
- Emergency Operations Plan
- Beaverton Community Vision Action Plan
- Capital Improvements Plan
- Transportation Plan
- Civic Plan

For more information on these plans see the City website.

(<https://www.beavertonoregon.gov/254/City-Codes-Plans>)

¹ Collins, Cliff and Mike Houck, “Fanno Creek: Urban Streams, Wetlands, Wildlife, Water Quality.” Audubon Society of Portland, Portland, Oregon.

² Bodine, Harry. 1997. “Fanno Creek’s Challenge.” *The Oregonian*, Thursday, March 20.

³ Oregon Climate Services (2003)

⁴ Schlicker, Herbert G. and Deacon, Robert J., *Engineering geology of the Tualatin Valley region, Oregon* (1967), (Bulletin 60). Oregon: Department of Geology and Mineral Industries.

⁵ Green, George L. July, 1982. Soil Survey of Washington County, Oregon. United States

Department of Agriculture Soil Conservation Service in cooperation with the Oregon Agriculture Experiment Station.

⁶ Hazards Workshop *Session Summary #16, Disasters, Diversity, and Equity*. Annual Hazards Workshop, (July 12, 2000) University of Colorado, Boulder.

⁷ Ibid.

⁸ US Census. < <http://www.census.gov>> 2010.

⁹ City of Beaverton <<http://www.ci.beaverton.or.us/beaverton/statistics.html>> 2000

¹⁰ Wood, Nathan. Variations in City Exposure and Sensitivity to Tsunami Hazards in Oregon. U.S. Geological Survey, Reston, VA, 2007.

¹¹ ACS 2011-15 5-year survey estimate (S1091)

¹² ACS 2015 1-year survey estimate (DP03)

¹³ Cutter, S. L. (2003). Social Vulnerability to Environmental Hazards. *Social Science Quarterly*.

¹⁴ City of Beaverton Finance Department, ISD/GIS

¹⁵ City of Beaverton. Health Club Lofts Design Review Staff Report.

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- ¹⁶ City of Beaverton Comprehensive Plan, Chapter Three: Land Use Element
- ¹⁷ Contact the Community Development Department for a detailed description of each land use.
- ¹⁸ City of Beaverton, <http://www.ci.beaverton.or.us/departments/CDD/CDD_bldgpermit_stats.html>
- ¹⁹ Source: U.S. Census Bureau, 2015 5-Year American Community Survey, Table B19301
- ²⁰ Source: U.S. Census Bureau, 2015 5-Year American Community Survey, Table S2411
- ²¹ US Census. <<http://www.census.gov>> (2000).
- ²² Source: Greater Portland Inc. and Portland Business Journal, 2017.
- ²³ City of Beaverton, Beaverton Economic Development Strategic Plan, (July, 2000)
- ²⁴ Washington County Travel Options Assessment: Existing Conditions and Best Practices Report, June 2016, Nelson Nygaard Associates
- ²⁵ City of Beaverton. Historic Resource Inventory. 1987.
- ²⁶ Burby, Raymond J., ed. 1998. Cooperating with Nature: Confronting Natural Hazards with Land-Use Planning for Sustainable Communities.

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Economic Analysis of Natural Hazards Mitigation Projects

This Appendix outlines three approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, *Report on Costs and Benefits of Natural Hazard Mitigation*.

This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred. Evaluating possible natural hazard mitigation activities provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster’s social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

What are Some Economic Analysis Approaches for Evaluating Mitigation Strategies?

The approaches used to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into three general categories:

benefit/cost analysis, cost-effectiveness analysis and the STAPLE/E approach. The distinction between the three methods are outlined below:

Benefit/cost Analysis

Benefit/cost analysis is a key mechanism used by the state Office of Emergency Management (OEM), the Federal Emergency Management Agency (FEMA), and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk. In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented. A project worth pursuing will have a benefit/cost ratio greater than 1 (i.e., the net benefits will exceed the net costs).

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in Public Sector Mitigation Activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions which involve a diverse set of beneficiaries and non-market benefits.

Investing in Private Sector Mitigation Activities

Private sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

STAPLE/E Approach

Conducting detailed benefit/cost or cost-effectiveness analysis for every possible mitigation activity could be very time consuming and may not be practical. There are some alternate approaches for conducting a quick evaluation of the proposed mitigation activities which could be used to identify those mitigation activities that merit more detailed assessment. One of these methods is the STAPLE/E Approach.

Using STAPLE/E criteria, mitigation activities can be evaluated quickly by steering committees in a systematic fashion. This criteria requires the committee to assess the mitigation activities based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLE/E) constraints and opportunities of implementing the particular mitigation item in your community. The second chapter in FEMA's April How-To Guide "Developing the Mitigation Plan – Identifying Mitigation Actions and Implementation Strategies" as well as the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process" outline some specific considerations in analyzing each aspect. The following are suggestions for how to examine each aspect of the STAPLE/E Approach from the "State of Oregon's Local Natural Hazard Mitigation Plan: An Evaluation Process".

Social: Community development staff, local non-profit organizations, or a local planning board can help answer these questions.

- Is the proposed action socially acceptable to the community?
- Are there equity issues involved that would mean that one segment of the community is treated unfairly?
- Will the action cause social disruption?

Technical: The city or county public works staff, and building department staff can help answer these questions.

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?
- Is it the most useful action in light of other community goals?

Administrative: Elected officials or the city or county administrator, can help answer these questions.

- Can the community implement the action?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff, and technical support available?

- Are there on-going administrative requirements that need to be met?

Political: Consult the mayor, city council or county planning commission, city or county administrator, and local planning commissions to help answer these questions.

- Is the action politically acceptable?
- Is there public support both to implement and to maintain the project?

Legal: Include legal counsel, land use planners, risk managers, and city council or county planning commission members, among others, in this discussion.

- Is the community authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity?
- Are there legal side effects? Could the activity be construed as a taking?
- Is the proposed action allowed by the comprehensive plan, or must the comprehensive plan be amended to allow the proposed action?
- Will the community be liable for action or lack of action?
- Will the activity be challenged?

Economic: Community economic development staff, civil engineers, building department staff, and the assessor's office can help answer these questions.

- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)?
- How will this action affect the fiscal capability of the community?
- What burden will this action place on the tax base or local economy?
- What are the budget and revenue effects of this activity?
- Does the action contribute to other community goals, such as capital improvements or economic development?
- What benefits will the action provide? (This can include dollar amount of damages prevented, number of homes protected, credit under the CRS, potential for funding under the HMGP or the FMA program, etc.)

Environmental: Watershed councils, environmental groups, land use planners and natural resource managers can help answer these questions.

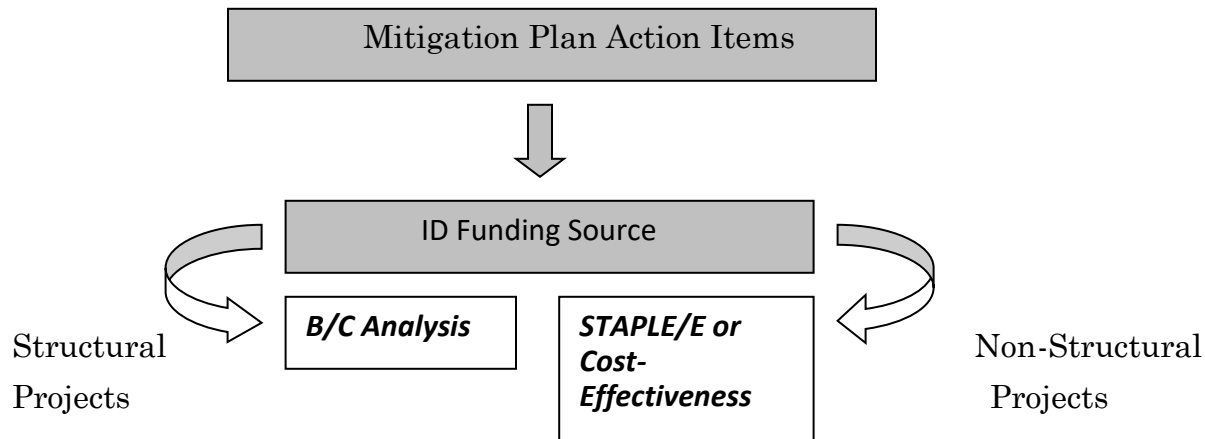
- How will the action impact the environment?
- Will the action need environmental regulatory approvals?
- Will it meet local and state regulatory requirements?
- Are endangered or threatened species likely to be affected?

The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed Benefit/Cost Analyses.

When to use the Various Approaches

It is important to realize that various funding sources require different types of economic analyses. The following figure is to serve as a guideline for when to use the various approaches.

Figure D-1 Guideline for When to Use Various Approaches



Implementing the Approaches

Benefit/cost analysis, cost-effectiveness analysis, and the STAPLE/E are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating mitigation activities is outlined below. This framework should be used in further analyzing the feasibility of prioritized mitigation activities.

1. Identify the Activities

Activities for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation project can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits

Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate activities. Potential economic criteria to evaluate alternatives include:

- **Determine the project cost.** This may include initial project development costs, and repair and operating costs of maintaining projects over time.

- **Estimate the benefits.** Projecting the benefits or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.
- **Consider costs and benefits to society and the environment.** These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.
- **Determine the correct discount rate.** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Activities

Once costs and benefits have been quantified, economic analysis tools can rank the possible mitigation activities. Two methods for determining the best activities given varying costs and benefits include net present value and internal rate of return.

- **Net present value.** Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.
- **Internal rate of return.** Using the *internal rate of return* method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project. Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk, project effectiveness, and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or landowner as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. Many communities are looking towards developing multi-objective projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

Resources

CUREe Kajima Project, *Methodologies For Evaluating The Socio-Economic Consequences Of Large Earthquakes*, Task 7.2 Economic Impact Analysis, Prepared by University of California, Berkeley Team, Robert A. Olson, VSP Associates, Team Leader; John M. Eidinger, G&E Engineering Systems; Kenneth A. Goettel, Goettel and Associates Inc.; and Gerald L. Horner, Hazard Mitigation Economics Inc., 1997.

Federal Emergency Management Agency, *Benefit/Cost Analysis of Hazard Mitigation Projects*, Riverine Flood, Version 1.05, Hazard Mitigation Economics Inc., 1996.

Federal Emergency Management Agency *Report on Costs and Benefits of Natural Hazard Mitigation*. Publication 331, 1996.

Goettel & Horner Inc., *Earthquake Risk Analysis Volume III: The Economic Feasibility of Seismic Rehabilitation of Buildings in The City of Portland*, Submitted to the Bureau of Buildings, City of Portland, August 30, 1995.

Goettel & Horner Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects Volume V, Earthquakes*, Prepared for FEMA's Hazard Mitigation Branch, October 25, 1995.

Horner, Gerald, *Benefit/Cost Methodologies for Use in Evaluating the Cost Effectiveness of Proposed Hazard Mitigation Measures*, Robert Olson Associates, Prepared for Oregon State Police, Office of Emergency Management, July 1999.

Interagency Hazards Mitigation Team, *State Hazard Mitigation Plan*, (Oregon State Police – Office of Emergency Management, 2000).

Risk Management Solutions, Inc., *Development of a Standardized Earthquake Loss Estimation Methodology*, National Institute of Building Sciences, Volume I and II, 1994.

VSP Associates, Inc., *A Benefit/Cost Model for the Seismic Rehabilitation of Buildings*, Volumes 1 & 2, Federal Emergency Management Agency, FEMA Publication Numbers 227 and 228, 1991.

VSP Associates, Inc., *Benefit/Cost Analysis of Hazard Mitigation Projects: Section 404 Hazard Mitigation Program and Section 406 Public Assistance Program, Volume 3: Seismic Hazard Mitigation Projects*, 1993.

VSP Associates, Inc., *Seismic Rehabilitation of Federal Buildings: A Benefit/Cost Model*, Volume 1, Federal Emergency Management Agency, FEMA Publication Number 255, 1994.

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Grant Programs and Resources

Introduction

There are numerous local, state and federal funding sources available to support natural hazard mitigation projects and planning. The Oregon Natural Hazards Mitigation Plan includes a comprehensive list of funding sources. The following section includes an abbreviated list of the most common funding sources utilized by local jurisdictions in Oregon. Because grant programs often change, it is important to periodically review available funding sources for current guidelines and program descriptions.

Post-Disaster Federal Programs

Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) provides grants to states and local governments to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. <http://www.fema.gov/hazard-mitigation-grant-program>

Physical Disaster Loan Program

When physical disaster loans are made to homeowners and businesses following disaster declarations by the U.S. Small Business Administration (SBA), up to 20% of the loan amount can go towards specific measures taken to protect against recurring damage in similar future disasters. <https://www.sba.gov/funding-programs/disaster-assistance>

Pre-Disaster Federal Programs

Pre-Disaster Mitigation Grant Program

The Pre-Disaster Mitigation (PDM) program provides funds to states, territories, Indian tribal governments, communities, and universities for hazard mitigation

planning and the implementation of mitigation projects prior to a disaster event. Funding these plans and projects reduces overall risks to the population and structures, while also reducing reliance on funding from actual disaster declarations. PDM grants are to be awarded on a competitive basis and without reference to state allocations, quotas, or other formula-based allocation of funds.

<http://www.fema.gov/pre-disaster-mitigation-grant-program>

Flood Mitigation Assistance Program

The overall goal of the Flood Mitigation Assistance (FMA) Program is to fund cost-effective measures that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other National Flood Insurance Program (NFIP) insurable structures. This specifically includes:

- Reducing the number of repetitively or substantially damaged structures and the associated flood insurance claims;
- Encouraging long-term, comprehensive hazard mitigation planning;
- Responding to the needs of communities participating in the NFIP to expand their mitigation activities beyond floodplain development activities; and
- Complementing other federal and state mitigation programs with similar, long-term mitigation goals.

<http://www.fema.gov/flood-mitigation-assistance-program>

Detailed program and application information for federal post-disaster and pre-disaster programs can be found in the FY13 Hazard Mitigation Assistance Unified Guidance, available at: <https://www.fema.gov/media-library/assets/documents/33634>. Note that guidance regularly changes. Verify that you have the most recent edition.

For Oregon Military Department, Office of Emergency Management (OEM) grant guidance on Federal Hazard Mitigation Assistance, visit:

<http://www.oregon.gov/OEM/emresources/Grants/Pages/HMA.aspx>

OEM Contact: Angie Lane, State Hazard Mitigation Officer angie.lane@state.or.us

State Programs

Seismic Rehabilitation Grant Program

The Seismic Rehabilitation Grant Program (SRGP) provides state funds to strengthen public schools and emergency services buildings so they will be less damaged during an

earthquake. Reducing property damage, injuries, and casualties caused by earthquakes is the goal of the SRGP. <http://www.orinfrastructure.org/Infrastructure-Programs/Seismic-Rehab/>

Community Development Block Grant Program

The Community Development Block Grant Program promotes viable communities by providing: 1) decent housing; 2) quality living environments; and 3) economic opportunities, especially for low and moderate income persons. Eligible Activities Most Relevant to Hazard Mitigation include: acquisition of property for public purposes; construction/reconstruction of public infrastructure; community planning activities. Under special circumstances, CDBG funds also can be used to meet urgent community development needs arising in the last 18 months which pose immediate threats to health and welfare.

http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs

Oregon Watershed Enhancement Board

While OWEB's primary responsibilities are implementing projects addressing coastal salmon restoration and improving water quality statewide, these projects can sometimes also benefit efforts to reduce flood and landslide hazards. In addition, OWEB conducts watershed workshops for landowners, watershed councils, educators, and others, and conducts a biennial conference highlighting watershed efforts statewide. Funding for OWEB programs comes from the general fund, state lottery, timber tax revenues, license plate revenues, angling license fees, and other sources. OWEB awards approximately \$20 million in funding annually. More information at: <http://www.oregon.gov/OWEB/Pages/index.aspx>

Federal Mitigation Programs, Activities & Initiatives

Basic & Applied Research/Development

National Earthquake Hazard Reduction Program (NEHRP), National Science Foundation.

Through broad based participation, the NEHRP attempts to mitigate the effects of earthquakes. Member agencies in NEHRP are the US Geological Survey (USGS), the National Science Foundation (NSF), the Federal Emergency Management Agency (FEMA), and the National Institute for Standards and Technology (NIST). The agencies focus on research and development in areas such as the science of earthquakes, earthquake performance of buildings and other structures, societal impacts, and emergency response and recovery. <http://www.nehrp.gov/>

Decision, Risk, and Management Science Program, National Science Foundation.

Supports scientific research directed at increasing the understanding and effectiveness of decision making by individuals, groups, organizations, and society. Disciplinary and interdisciplinary research, doctoral dissertation research, and workshops are funded in the areas of judgment and decision making; decision analysis and decision aids; risk analysis,

perception, and communication; societal and public policy decision making; management science and organizational design. The program also supports small grants for exploratory research of a time-critical or high-risk, potentially transformative nature.

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5423

Hazard ID and Mapping

National Flood Insurance Program: Flood Mapping; FEMA

Flood insurance rate maps and floodplain management maps for all NFIP communities.

<http://www.fema.gov/national-flood-insurance-program-flood-hazard-mapping>

National Digital Orthophoto Program, DOI – USGS

Develops topographic quadrangles for use in mapping of flood and other hazards.

<https://pubs.er.usgs.gov/publication/70039554>

Mapping Standards Support, DOI-USGS

Expertise in mapping and digital data standards to support the National Flood Insurance Program. <http://ncgmp.usgs.gov/standards.html>

Soil Survey, USDA-NRCS

Maintains soil surveys of counties or other areas to assist with farming, conservation, mitigation or related purposes. http://soils.usda.gov/survey/printed_surveys/

Project Support

Community Development Block Grant Entitlement Communities Program, US Department of Housing and Urban Development

Provides grants to entitled cities and urban counties to develop viable communities (e.g., decent housing, a suitable living environment, expanded economic opportunities), principally for low- and moderate- income persons. <https://www.hudexchange.info/programs/cdbg-dr/>

National Fire Plan (DOI – USDA)

The NFP provides technical, financial, and resource guidance and support for wildland fire management across the United States. Addresses five key points: firefighting, rehabilitation, hazardous fuels reduction, community assistance, and accountability.

<http://www.forestsandrangelands.gov/>

Assistance to Firefighters Grant Program, FEMA

FEMA AFGM grants are awarded to fire departments to enhance their ability to protect the public and fire service personnel from fire and related hazards. Three types of grants are available: Assistance to Firefighters Grant (AFG), Fire Prevention and Safety (FP&S), and Staffing for Adequate Fire and Emergency Response (SAFER).

<http://www.fema.gov/welcome-assistance-firefighters-grant-program>

Emergency Watershed Protection Program, USDA-NRCS

Provides technical and financial assistance for relief from imminent hazards in small watersheds, and to reduce vulnerability of life and property in small watershed areas damaged by severe natural hazard events.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp>

Public Assistance Grant Program, FEMA.

The objective of the Federal Emergency Management Agency's (FEMA) Public Assistance (PA) Grant Program is to provide assistance to state, tribal and local governments, and certain types of private nonprofit organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President.

<http://www.fema.gov/public-assistance-local-state-tribal-and-non-profit>

National Flood Insurance Program, FEMA

The NFIP makes available flood insurance to residents of communities that adopt and enforce minimum floodplain management requirements. <http://www.fema.gov/national-flood-insurance-program>

HOME Investments Partnerships Program, HUD

The HOME IPP provides grants to states, local government and consortia for permanent and transitional housing (including support for property acquisition and rehabilitation) for low-income persons.

https://www.hud.gov/program_offices/comm_planning/affordablehousing/programs/home/

Disaster Recovery Initiative, HUD

The DRI provides grants to fund gaps in available recovery assistance after disasters (including mitigation). <https://www.hud.gov/info/disasterresources>

Emergency Management Performance Grants, FEMA

EMPG grants help state and local governments to sustain and enhance their all-hazards emergency management programs. <https://www.fema.gov/emergency-management-performance-grant-program>

Partners for Fish and Wildlife, DOI – FWS

The PFW program provides financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats.

<http://www.fws.gov/partners/>

North American Wetland Conservation Fund, DOI-FWS

NAWC fund provides cost-share grants to stimulate public/private partnerships for the protection, restoration, and management of wetland habitats.

<https://www.fws.gov/birds/grants/north-american-wetland-conservation-act.php>

Federal Land Transfer / Federal Land to Parks Program, DOI-NPS

Identifies, assesses, and transfers available federal real property for acquisition for state and local parks and recreation, such as open space.

<http://www.nps.gov/ncrc/programs/flp/index.htm>

Wetlands Reserve program, USDA-NCRS

The WR program provides financial and technical assistance to protect and restore wetlands through easements and restoration agreements.

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/wetlands>

Appendix F

2019 Preparedness and Mitigation Survey

This Appendix shows the findings from the 2018-2019 on-line preparedness and mitigation survey and compares it to the results of the 2003 household survey and 2010 on-line survey. As part of the review and update of the Natural Hazards Mitigation Plan, the City conducted a preparedness and mitigation survey on-line. Understanding how the community views natural hazards is an important part of the natural hazard mitigation process. Examining people's attitudes about hazards may help to identify gaps in preparedness, and ways in which public/private coordination could be improved within the City.

Methods

The City developed the survey using some of the same questions used in the original household surveys conducted in 2003 by the Oregon Natural Hazards Workshop and 2010 on-line survey. The 2003 survey was adapted from one that had been implemented statewide as part of the development of the Partners for Disaster Resistance Strategic Plan.

The survey and its link was sent out through various means including social media and in the City's "Your City" newsletter that is distributed to all residents in the City.

The survey addressed the following topics:

- Preparedness Activities
- Risk Reduction Activities
- Community Planning Priorities

There were 211 relevant participants in the survey, the results are compared with the results of the previous surveys.

Limitations of Sampling Methodology

This survey identifies key issues about how residents perceive their risk from natural hazards in Beaverton; however, there are limitations to the data. There were only 211 respondents to the survey and as an open on-line survey there are no guarantees that they represent a good cross-section of all Beaverton residents. Additionally, it is a snapshot of perceptions at a single point in time and as such, survey responses may reflect external issues, such as terrorism threats or recent occurrences of natural hazards. Since this survey was not targeted to specific demographics within the city's population, there is the potential that those who took the time to participate are likely to be better aware of the hazards and threats than the average resident and as such are likely to be better prepared.

Survey Findings

Level of Household Disaster Preparedness Activities

The on-line survey shows a general decrease in household preparedness activities from the last survey; but is still better than the results of the 2003 survey. Some of the larger changes include:

- 13% fewer households had someone trained in first aid or CPR in the past year.
- 8% fewer households developed an emergency plan.
- 5% more households indicated that they have at least talked to members about what to do in the case of a natural disaster or emergency.
- 6% fewer households indicated that they have not prepared a disaster supply kit.

Table F.1. Level of Household Disaster Preparedness Activities

In the following list, please check those activities that you have done in your household, plan to do in the near future, have not done, are unable to do, or feel are not necessary for you to be prepared.					
	Year	Have Done	Plan to Do	Not Done	Unable to Do
Attended meetings or received written information on natural disasters or emergency preparedness?	'19	74%	4%	21%	0
	'10	81%	3%	14%	1%
	'03	37%	5%	57%	2%
Talked with members in your household about what to do in case of a natural disaster or emergency?	'19	72%	12%	13%	2%
	'10	67%	14%	11%	1%
	'03	46%	20%	29%	5%
Developed a "Household/Family Emergency Plan" in order to decide what everyone would do in the in event of a disaster?	'19	41%	34%	23%	2%
	'10	43%	36%	15%	1%
	'03	26%	26%	44%	4%
Prepared a "Disaster Supply Kit" (Stored extra food, water, batteries, or other emergency supplies)?	'19	65%	20%	13%	1%
	'10	65%	25%	7%	1%
	'03	39%	23%	37%	1%
In the last year, has anyone in your household been trained in First Aid or Cardio-Pulmonary Resuscitation	'19	46%	21%	31%	2%
	'10	59%	10%	28%	0%
	'03	30%	5%	63%	2%

Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

Source: ONHW/CPW, Beaverton Household Risk Perception Survey, 2003

To target effective programs that will better prepare residents for emergency events, the amount of time a person is willing to commit to activities is important to understand. The 2003 and 2010 surveys questions were based on number of hours in a year. For this survey we put it in the context of months and weeks. In 2019 52% of the respondents indicated that they were willing to spend 2 to 3 hours a month getting prepared for natural disasters and emergencies. As a comparable; CERT training takes 3 hours a week for seven weeks.

Table F.2. 2018-19 Survey

How much time are you willing to spend on preparing yourself and/or household for a natural disaster or emergency event?	2019** Survey
0 – 1 hour/month (equates to 0 – 12 hours a year)	32%
2 – 3 hours/month (equates to 24 – 36 hours a year)	52%
1 – 2 hours/week	13%
3 – 4 hours/week	2%
1 hour/day	2%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

How much time (per year) are you willing to spend on preparing yourself and/or household for a natural disaster or emergency event?	2010* Survey	2003^ Survey
0 – 1 hour	3%	18%
2 – 3 hours	19%	35%
4 – 7 hours	14%	18%
8 – 15 hours	26%	13%
16+ hours	29%	11%

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Table F.3 shows a comparison of the three surveys, of the most common steps that households have taken to prepare for natural disasters. Between all three surveys, smoke detectors, flashlights, batteries, fire extinguishers, and medical supplies were the top 4 common items stored among respondents. *Preparing a Disaster Supply Kit* dropped 9% from 2010 and receive first aid/CPR training dropped 19%. One respondent cited cost as a factor for letting their training lapse. *Developed a reconnection plan* was at the bottom for all three surveys. Other steps provided by respondents in the 2019 survey included:

- CERT Training
- HAM radio training/certification
- Talking with neighbors
- Structural and non-structural seismic mitigation
- Disaster preparedness training

Table F.3.

Steps Respondents have taken to prepare for natural disaster	2019**	2010*	2003^
Developed a reconnection plan: Where to go and who to call	40%	42%	21%

Discussed utility shutoffs	50%	58%	28%
Have installed a smoke detector on each level of the house	94%	95%	90%
Have stored a battery-powered radio	60%	73%	57%
Have stored a fire extinguisher	72%	73%	69%
Have stored batteries	76%	80%	74%
Have stored flashlight(s)	87%	92%	83%
Have stored food - enough for at least 3 days	73%	75%	54%
Have stored medical supplies (First aid kit)	84%	85%	63%
Have stored water - enough for at least 3 days	63%	72%	49%
Made a fire escape plan	47%	51%	33%
Other (please explain)	10%	12%	3%
Prepared a Disaster Supply Kit	53%	62%	21%
Received First Aid/CPR Training	49%	68%	38%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003



Property and Financial Recovery

The need to have adequate provisions for financial and property recovery when natural disasters do occur is a necessary component of natural hazard preparedness. The number of people reporting that they have earthquake insurance dropped by 6%. Respondents indicating that they had fire insurance dropped by 14%.

Table F.4.

What household insurance cover for natural hazards do you have?	2019**	2010*	2003^
Flood	16%	17%	28%
Earthquake	51%	57%	56%
Fire	74%	88%	NA

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Additional refinement to these questions could be done to identify what percentage of people who live in a flood risk area carry flood insurance and to identify reasons people do not carry earthquake insurance.

Natural Hazard Risk Reduction

Risk reduction activities are those actions you can take to protect your home from natural hazard events, such as earthquakes, floods or wildfires. These can be nonstructural modifications or retrofits to protect a home's contents against damage, often at minimal cost (See Table F.5). It can also be structural retrofits to strengthen a home's structure or skeleton (See Table F.6). These types of modifications to a structure tend to be quite involved and generally require the expertise of a registered design professional (engineer, architect, or building contractor).

It should be noted that in all three surveys, several of the “Other” comments related to the fact that the respondents were renters which limited them on the nonstructural activities that they could do and prevented them from being able to do any structural modifications.

Securing the water heater to the wall remains the top non-structural mitigation modification.

Table F.5

What nonstructural modifications for earthquakes have you made to your home?	2019**	2010*	2003^
Anchor bookcases, cabinets to wall	34%	30%	17%
Secure water heater to wall	71%	71%	47%
Install latches on drawers/cabinets	8%	8%	8%
Fit gas appliances with flexible connections	32%	40%	28%
None	22%	18%	35%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Table F.6

What structural modifications for earthquakes have you made to your home?	2019**	2010*	2003^
Secure home to foundation	22%	16%	14%
Brace inside of cripple wall with sheathing	5%	4%	4%
Brace unreinforced chimney	4%	0%	3%
Brace unreinforced masonry & concrete walls and foundations	2%	3%	3%
None	76%	73%	44%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

While the percentages were still close between those who did not consider natural hazards when they bought/moved into their current home and those who did, the numbers flipped. Now a slight majority considered natural hazards (See Table F.7). In the 2019 there was a 12% increase of respondents that indicated that they would be willing to spend more money on a home that had features that made it more disaster resistant, compared to the respondents in 2010 (See Table F.8).

Table F.7

Did you consider the possible occurrence of a natural hazard when you bought/moved into your current home?	2019**	2010*	2003^
Yes	51%	49%	37%
No	49%	51%	63%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Table F.8

Would you be willing to spend more money on a home that had features that made it more disaster resistant?	2019**	2010*	2003^
Yes	62%	50%	42%
No	7%	12%	43%
Don't Know	31%	38%	15%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Incentives

Tax breaks became the highest motivator in the 2019 survey for taking additional steps to better protect their homes from natural disasters. Insurance discounts dropped being the second highest motivator (See Table F.9).

Table F.9

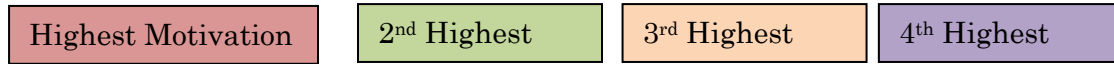
Which of the following incentives, if any, would motivate you to take additional steps to better protect your home from a natural disaster?	2019**	2010*	2003^
Insurance discount	72%	81%	72%
Low interest rate loan	33%	34%	26%
Lower new home construction costs	17%	24%	20%
Mortgage discount	39%	45%	37%
Tax break or incentive	80%	80%	71%

None	8%	5%	9%
Other	10%	8%	2%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003



Barriers identified to better protecting homes from a natural disaster included being a renter, HOAs, living in a duplex or triplex.

Preferred Sources and Formats of Information

The creation of the Disaster Mitigation Act of 2000 expanded the importance of educating and informing the public on natural hazard preparedness. Because of this, it is important to understand the mechanisms for information dissemination to develop and implement effective outreach and education activities. All three survey findings show that the majority of respondents trusted utility companies most to provide information about home and family safety. The American Red Cross and government agencies also ranked high as trusted sources of information. Table F.10 shows the most trusted information sources for survey respondents. Other potential trusted sources provided by respondents included CERT, local businesses, and Home Owner Associations.

Table F.10

Who would you most trust to provide you with information about how to make your household and home safer from natural disasters?	2019**	2010*	2003^
News media	20%	12%	29%
Government agency	66%	66%	42%
Insurance agent or company	34%	36%	33%
Utility company	66%	73%	54%
University or research institution	60%	45%	32%
American Red Cross	65%	65%	45%
Other non-profit organization	38%	49%	15%
Not sure	8%	8%	9%
Other:	6%	8%	7%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

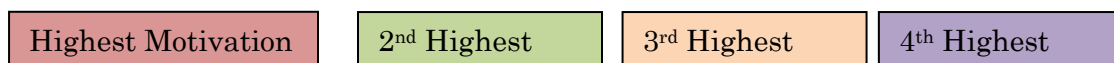


Table F.11 shows the preferences respondents have for 12 different methods of communication. Mail, Internet, and Fact sheet/brochure were ranked in the top 4 of all three surveys, with mail by percentage being the most consistent between the three sets of findings. Future surveys should make a distinction or separation between on-line and social media.

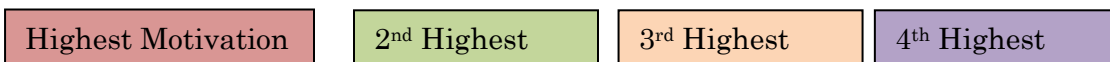
Table F.11

What is the most effective way for you to receive information about how to make your household and home safer from natural disasters?	2019**	2010*	2003^
Newspaper stories	26%	27%	44%
Newspaper ads	3%	7%	9%
Television news	22%	26%	53%
Television ads	5%	16%	13%
Radio news	19%	34%	29%
Radio ads	5%	21%	9%
Schools	15%	15%	13%
Outdoor advertisements (billboards, etc.)	12%	12%	7%
Books	24%	20%	11%
Mail	53%	51%	53%
Fire Department/Rescue	48%	52%	29%
Internet	50%	77%	30%
Fact sheet/brochure	71%	61%	42%
Chamber of Commerce	10%	9%	5%
Public workshops/meetings	56%	45%	13%
Magazine	8%	13%	10%
University or research institution	36%	23%	12%
Other (please explain)	7%	8%	4%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003



Community-Wide Planning Goals and Implementation Strategies

Natural hazards can have a significant impact on a community, but planning for these events can help lessen the impacts. To help Beaverton identify any changes in citizens’ priorities for planning for natural hazards and with the types of strategies that they will support to reduce

the communities' risk. Table F.12 illustrates generally how important respondents feel each goal statement is and provides a comparison between the three sets of survey findings. In all three surveys "Protecting Critical Facilities" received the highest ranking of either "Very Important" with 94% of the respondents in 2019, 93% in 2010 and 86% in 2003.

Table F.12

The following statements will help determine citizen priorities for planning for natural hazards. Please tell us how important each one is to you.						
Statement	Yr	Very Important	Somewhat Important	Neutral	Not Very Important	Not Important
Protecting private property	'19	51%	39%	9%	1%	2%
	'10	39%	39%	18%	4%	1%
	'03	58%	30%	8%	4%	1%
Protecting critical facilities (e.g. transportation networks, hospitals, fire stations)	'19	94%	4%	1%	0	1%
	'10	93%	6%	2%	0%	0%
	'03	86%	12%	2%	1%	0%
Preventing development in hazard areas	'19	62%	30%	6%	1%	1%
	'10	56%	29%	14%	1%	0%
	'03	45%	35%	17%	2%	1%
Enhancing the function of natural features (e.g. streams, wetlands)	'19	52%	34%	9%	2%	2%
	'10	36%	32%	26%	5%	2%
	'03	35%	33%	25%	6%	2%
Protecting historical and cultural landmarks	'19	19%	42%	25%	10%	4%
	'10	17%	38%	30%	10%	4%
	'03	23%	38%	28%	9%	3%
Promoting cooperation among public agencies, citizens, non-profit organizations, and businesses	'19	69%	27%	3%	1%	1%
	'10	75%	21%	4%	0%	0%
	'03	42%	38%	16%	2%	2%
Protecting and reducing damage to utilities	'19	85%	13%	2%	0	1%
	'10	75%	21%	4%	0%	0%
	'03	65%	27%	7%	1%	0%

Strengthening emergency services (e.g. police, fire, ambulance)	'19	75%	21%	3%	1%	1%
	'10	66%	23%	9%	1%	0%
	'03	68%	23%	8%	1%	1%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

There are a number of activities that a community can undertake to reduce the risk from natural hazards. These activities can be both regulatory and non-regulatory. Table F.13 shows respondents' general level of agreement regarding the community-wide strategies included in the survey.

Table F.13

The following statements will help determine citizen priorities for planning for natural hazards. Please tell us how important each one is to you.							
	Yr	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Not Sure
a. I support a regulatory approach to reducing risk	'19	31%	36%	18%	4%	8%	3%
	'10	14%	37%	30%	11%	5%	4%
	'03	15%	38%	24%	13%	5%	6%
b. I support a non-regulatory approach to reducing risk	'19	33%	35%	19%	4%	3%	5%
	'10	23%	38%	25%	8%	2%	5%
	'03	19%	38%	26%	10%	1%	6%
c. I support a mix of both regulatory and non-regulatory approaches to reducing risk	'19	54%	26%	12%	3%	3%	3%
	'10	35%	44%	18%	1%	0%	2%
	'03	22%	42%	21%	7%	3%	5%
d. I support policies to prohibit development in areas subject to natural hazards	'19	61%	30%	6%	2%	1%	1%
	'10	42%	36%	15%	5%	1%	2%
	'03	32%	43%	18%	4%	2%	2%
e. I support the use of tax dollars (federal and/or local) to compensate land owners for not developing in areas subject to natural hazards	'19	8%	23%	27%	23%	14%	4%
	'10	5%	21%	28%	26%	13%	7%
	'03	6%	18%	25%	30%	17%	3%

f. I support the use of local tax dollars to reduce risks and losses from natural disasters	'19	34%	44%	12%	3%	3%	4%
	'10	18%	55%	21%	2%	4%	1%
	'03	7%	51%	27%	9%	4%	2%
g. I support protecting historical and cultural structures	'19	16%	40%	31%	8%	4%	3%
	'10	8%	43%	34%	13%	2%	0%
	'03	10%	39%	39%	8%	4%	0%
h. I would be willing to make my home more disaster-resistant	'19	50%	41%	8%	1%	0	2%
	'10	36%	52%	9%	0%	0%	3%
	'03	13%	59%	23%	1%	1%	3%
i. I support steps to safeguard the local economy following a disaster event	'19	40%	47%	9%	1%	0	4%
	'10	40%	49%	9%	1%	1%	0%
	'03	16%	62%	19%	2%	1%	1%
j. I support improving the disaster preparedness of local schools	'19	70%	25%	4%	0	1%	1%
	'10	59%	36%	5%	1%	0%	0%
	'03	33%	52%	12%	3%	0%	0%
k. I support a local inventory of at-risk buildings and infrastructure.	'19	50%	40%	7%	0	1%	3%
	'10	31%	59%	7%	3%	0%	0%
	'03	17%	53%	23%	4%	2%	2%

** Source: City of Beaverton, Preparedness and Mitigation Survey, 2019

* Source: City of Beaverton, Preparedness and Mitigation Survey, 2010

^Source: ONHW/CPW, Beaverton Household Risk Perception Survey, January 2003

Table F.13 illustrates that in 2003 85% of the respondents strongly agree or agree that they support improving the disaster preparedness of local schools (j.) and in the 2019 and 2010 surveys it was 95%. In the 2019 survey, strong support was also shown for:

- Policies to prohibit development in areas subject to natural hazards (91%)
- Respondents making their homes more disaster-resistant (91%)
- Local inventory of at-risk buildings and infrastructure (90%)

Least popular included:

- The use of tax dollars (federal and/or local) to compensate land owners for not developing in areas subject to natural hazards (31%)
- Protection of historical and cultural structures (56%)

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Appendix G: Hazard Analysis

**This Appendix is the Annex B to the Basic Plan of the City of Beaverton's
Emergency Operations Plan (EOP).**

Page numbers in this section reflect the numbering of the EOP.

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Addendum B. Hazard Analysis

Addendum B. Hazard Analysis

1 Introduction

A hazard analysis is a systematic investigation of potential emergencies/disasters by analyzing history, vulnerability, and probability. It is the foundation for the development of mitigation strategies, planning, and preparedness activities, as well as response and recovery activities. This hazard analysis is based on the Oregon Office of Emergency Management's (OEM's) Hazard Analysis Methodology.

2 Geographic Description

- The City of Beaverton (City) is located 7 miles west of Portland, Oregon in Washington County. It is an incorporated city encompassing 19.61 square miles, with a population over 96,000. The City is a suburban community with a diversified economic base that includes light industrial and high technology businesses, as well as numerous office complexes and retail centers.
- Two major freeways, U.S. Highway 26 (the Sunset Highway) and State Highway 217, connect the City to Interstate 5 (north-south) and to Interstate 84 (east-west). Other major roadways are State Highway 10 (the Beaverton-Hillsdale Highway) and Highway 8 (the Canyon Road -Tualatin Valley Highway), both of which run east and west.
- Multiple rail systems pass through the City, including:
 - The TriMet MAX Light Rail Service (commuter), which extends from Gresham to Hillsboro.
 - Portland and Western Railroad (freight), which passes through the City.
 - Westside Express Service (WES), a commuter rail line that runs from Beaverton to Wilsonville.
- The state's busiest general aviation airport, Hillsboro Airport, is about 10 miles west of the City. Aircraft on approach to, or departure from, this airport and the Portland International Airport may pass over the City of Beaverton, depending on winds and their flight paths.
- The City's climate consists of warm, dry summers and mild, wet winters. Temperatures are usually moderate, ranging from an average January minimum of 34 degrees Fahrenheit (°F) to an average July maximum of 81°F. The annual precipitation is nearly 40

Addendum B. Hazard Analysis

inches, with the majority of the precipitation occurring from November through March. Snowfall occurs on only a few days, if at all, each year. Snow on the ground is generally of short duration, with depths seldom exceeding 5 inches.

3 Hazard Rating System

The potential hazards that may affect the City of Beaverton are discussed in this addendum in the order of relative risk based on the criteria established in OEM's Hazard Analysis Methodology.

3.1 Criteria

The methodology determines the relative risk by applying severity ratings to four criteria:

- Event History
 - Event history is based on events requiring
 - ◆ Activation of the Emergency Operations Center (EOC) or alternate EOC;
 - ◆ Three or more Emergency Operations Plan (EOP) functions to be implemented;
 - ◆ An extraordinary multi-jurisdictional response; and/or
 - ◆ Declaration of a "Local Emergency"
 - A high rating is given for four or more occurrences in the past 100 years, moderate for two to three occurrences, and low for one or none.
- Vulnerability is based on the percentage of the population and property likely to be affected by the incident under an "average" occurrence. High vulnerability affects more than 10% of the population and property, moderate vulnerability affects 1–10%, and low vulnerability affects less than 1%.
- Maximum Threat is the highest percentage of population and property that could be impacted under a worst-case scenario.
- Probability is based on the likelihood of another occurrence within a specified period of time. A high probability incident can be expected once within a 10 to 35 year period, a medium probability once within 35 to 50 years and low, once in 75 to 100 hundred years.

Addendum B. Hazard Analysis

3.2 Severity Rating

The value of the severity ratings are determined based on the following:

- Low = Choose the most appropriate value between 1 to 3 points.
- Medium = Choose the most appropriate value between 4 to 7 points.
- High = Choose the most appropriate value between 8 and 10 points.

3.3 Weight Factor

Weight Factors (multipliers) are applied to each of the four categories:

- History = 2
- Vulnerability = 5
- Maximum Threat = 10
- Probability = 7

4 Beaverton Hazards

There are numerous types of hazards that could impact the city, but this assessment covers those that have a greater likelihood of occurring.

4.1 Hazards Assessed

The hazards that have been assessed are:

- Severe weather
 - High Winds
 - Winter Storms
- Earthquakes
- Flood
- Volcano (Ash Fall)
- Hazardous Materials
- Terrorism
- Landslides and Debris flow

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- Pandemic/Outbreak
- Drought

4.2 Climate Change

While climate change is not a hazard per se, it can be an influencing factor in the impact of hazards that do occur. Two significant factors are extreme temperatures and drought.

Extreme fluctuation of temperature is one of the expressions of climate change. Both higher than normal and lower than normal temperatures not only impact the citizens of Beaverton, but increase the demands on city response resources. Typically, homes in the northwest are not insulated as well as structures in areas that commonly deal with very high or very low temperatures. For that reason some citizens will not be able to adequately escape the elements. If a hazardous event occurs during an extreme temperature event it is possible that a larger section of the city’s population will be adversely effected.

Drought is another expression of climate change, but is not a primary threat to Beaverton at this time. However, considerations for the secondary effects of drought should be on the table to mitigate issues that could impact the city. While Beaverton has a commonly ample water reserve, during a drought a number of hazardous events could cause the loss of water reserves and therefore steps should be considered to mitigate such events.

5 Analysis

5.1 Hazard Analysis Matrix

Hazard	Rating Criteria with Weight Factors				Total Score
	History (WF=2)	Vulnerability (WF=5)	Max Threat (WF=10)	Probability (WF=7)	
Severe Weather - High Winds	H 9	H 8	H 8	H 10	208
Severe Weather - Winter Storms	H 9	M 7	H 8	H 10	203
Earthquakes	L 1	H 9	H 10	H 8	203

Addendum B. Hazard Analysis

Hazard	Rating Criteria with Weight Factors				Total Score
	History (WF=2)	Vulnerability (WF=5)	Max Threat (WF=10)	Probability (WF=7)	
Flood	H 9	M 6	M 7	H 10	188
Pandemic	L 1	H 8	H 9	H 8	188
Volcano (Ash Fall)	L 1	M 4	H 10	M 8	178
Hazardous Materials	H 9	M 4	M 6	H 9	161
Drought	L 1	M 5	H 10	M 4	155
Terrorism	L 1	L 2	M 5	H 8	118
Landslides and Debris Flow	L 1	L 1	L 3	M 7	86

5.2 Severe Weather – High Winds (208)

- Coastal hurricane force winds occasionally penetrate inland to the City of Beaverton, resulting in wind gusts of 75 to 80 miles an hour. Approximately 60% of the recorded high winds are from the south or the west.
 - Damage from high winds has generally resulted in downed utility lines and trees.
 - Electrical power can be interrupted anywhere from a few hours to two or three days. Outdoor signs have also suffered damage.
 - If the high winds are accompanied by rain (which they often are), blowing leaves and debris clog catch basins which contributes to localized inundation flooding.

- History: The following dates represent occurrences of wind storms meeting the established criteria.

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- October 1962
- November 1962
- October 1967
- January 1971
- November 1981
- November 1982
- January 1991
- December 1995
- December 2007

5.3 Severe Weather – Winter Storms (203)

- Beaverton is at risk from two types of winter storms: snow and ice. The impacts of both storms are similar.
 - Heavy snowfall rarely occurs in Beaverton. When it does occur, many of the subsequent problems are directly related to the public's unfamiliarity in dealing with such conditions.
 - Ice storms may occur as a result of a combination of weather factors, either with or without a related snowfall.
 - The heavy ice on utility lines typically results in outages throughout the City.
 - Heavy snow or ice that occurs before the trees lose all of their leaves can knock down limbs and possibly entire trees and consequently power and telephone lines.
- History – The following dates represent occurrences of winter storms meeting the established criteria.
 - January 1962
 - January 1969
 - January 1979
 - January 1980
 - December 1983
 - February 1989
 - December/January 1991
 - January/February 1993
 - November 1996
 - December 1999
 - December 2008
 - December 2009

5.4 Earthquakes (203)

- Earthquakes from three different sources threaten communities in Oregon and the Pacific Northwest. These sources are crustal, subduction zone and intraplate earthquakes.

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- Crustal – the most common earthquakes are crustal earthquakes.
 - ◆ Crustal earthquakes typically occur along faults, or breaks in the earth’s crust, at shallow depths of 6-12 miles (10-20 km) below the surface.
 - ◆ The two largest earthquakes in recent years in Oregon, Scotts Mills (magnitude 5.6) and the Klamath Falls main shocks (magnitude 5.9 and magnitude 6.0) of 1993, were crustal earthquakes.
 - Subduction zone – Subduction zone earthquakes occur in places where the tectonic plates that make up the surface of the earth collide.
 - ◆ When these plates collide, one plate slides (subducts) beneath the other, where it is reabsorbed into the mantle of the earth.
 - ◆ This dipping interface between the two plates is the site of some of the most powerful earthquakes ever recorded, often having magnitudes of 8 to 9 or larger.
 - ◆ The 1960 Chilean (magnitude 9.5) and the 1964 Great Alaska (magnitude 9.2) earthquakes were subduction zone earthquakes.
 - Deeper intraplate earthquakes occur within the remains of the ocean floor that is being subducted beneath North America.
 - ◆ This type of earthquake could occur beneath much of the Northwest at depths of 25–37 miles (40–60 km).
 - ◆ The magnitude 6.8 intraplate earthquake that struck the Puget Sound area on February 28, 2001 caused \$2 billion in damage but was much less destructive than a crustal earthquake of the same magnitude would have been because of its great depth (33 miles deep).
 - ◆ Intraplate earthquakes have also caused damage in the Puget Sound region in 1949 and again in 1965.
- Based on recorded and geologic history, geologists say the Northwest will experience major to large earthquakes. However, there is no method to estimate when they will take place.

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- Recent evaluation of the earthquake threat in Oregon indicates the area may experience a “great” subduction zone earthquake.
 - Earthquake hazard mapping identifies the potential of major damage for Beaverton.
 - Beaverton has mostly silt-type soil, which is subject to liquefaction (a process that takes place during an earthquake which causes sands and silts to lose strength and behave as viscous fluids rather than solids).
- Earthquakes, which have been felt in Beaverton, have originated in other areas.
 - The Mt. Angel earthquake on March 25, 1993, was the first significant earthquake (in recorded history) to originate close enough to Beaverton to be felt. Beaverton experienced only minor damage, but surrounding counties, including Clackamas, incurred significant damage and received a federal disaster declaration.
 - The Nisqually earthquake on February 28, 2001, was felt in the City but did very little damage.
 - Numerous small quakes occurred in the Portland Metro area in 2013, 2014, and 2015. Most of these earthquakes were not strong enough to be felt.
 - Though it was too small to be felt, in 2003 a small quake was detected under Cooper Mountain, in the southern part of the City, on a fault that had been previously designated by geologists as “inactive.”
- History – The following dates include significant earthquakes in the Northwest, though not all of them meet the established criteria:
 - 1946 Vancouver Island (7.3)
 - 1949 Olympia (7.1)
 - 1965 Seattle (6.5)
 - 1992 North Plains (3.0–4.0)
 - 1993 Scott Mills (5.6)
 - 2001 Nisqually (6.8)

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5.5 Flood (188)

- Flooding is a common natural occurrence faced by Beaverton.
 - The flood season for Beaverton extends from late October through April. Historically the majority of flooding has occurred in December, January, and February.
 - Beaverton has recurrent and substantial flood problems from Beaverton Creek, Fanno Creek, Johnson Creek, South Fork Beaverton Creek, and Cedar Mill Creek. However, only a small percentage of the City's population is typically impacted by flood events.
 - ◆ Beaverton Creek, the most significant stream in the community, drains approximately 36 square miles as it flows northwesterly through the major commercial area of Beaverton.
 - ◆ Other streams in the City include five tributaries to Beaverton Creek: South Fork Beaverton Creek, Johnson Creek, Hall Creek, Willow Creek, and Cedar Mill Creek.
 - ◆ Another significant creek is Fanno Creek, which flows westerly to State Highway 217, then southerly through the City to its confluence with the Tualatin River.
 - Soils in and around Beaverton are silt loams that range in grade from nearly level to steep slopes.
 - ◆ Drainage characteristics for those soils are poor along the level areas of the floodplains, but drainage (run-off) improves on sloping terrain.
 - ◆ Trees, grass, and shrubs are the dominant vegetation type. The rapid urbanization of the City is leading to a decrease in vegetation, and thus an increase in impervious surface and infringement of natural drainage areas.
- History – The following dates represent occurrences of storms meeting the established criteria:
 - December 1964
 - January 1972
 - January 1973
 - January 1991
 - February 1996
 - November 1996

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- January 1974
- Nov/Dec 1977
- December 1981
- January 1982
- January 2003
- February 2003
- December 2007
- December 2015

5.6 Pandemic (188)

- A pandemic is a worldwide outbreak of disease in people. Although a pandemic can be caused by a large variety of diseases, influenza is particularly suited to be the cause of a significantly devastating event, and thus is the disease considered here.
 - The influenza virus is easily spread from person to person, and is continuously reassorting and changing.
 - Pandemic flu is caused by a novel (new) flu virus to which humans have little or no immunity.
 - The flu virus that causes a pandemic can spread easily, and may cause large numbers of people to get sick and die.
 - No one can predict when a pandemic will occur or how severe it will be.
- On average, an influenza pandemic has occurred every 30 to 40 years over the last 400 years. There have been four pandemics since 1900, the most deadly of which took place in 1918.
 - Known as the Spanish Flu, the 1918 pandemic killed 20 to 40 million people worldwide and millions more fell ill.
 - Oregon recorded 49,297 influenza cases and 3,688 deaths between 1918 and 1920, with most occurring during the two months of October and November, 1918.
 - The other flu pandemics occurred in 1957, 1968, and 2009-2010. Fortunately, these pandemics were much less severe than the one in 1918.

5.7 Volcano (178)

- The threat of this hazard is primarily ash fall, which could result from an eruption of Mt. St. Helens. Volcanologists also consider Mt. Hood to be potentially active.

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- Beaverton experienced light ash fall from Mt. St. Helens' eruption in May of 1980
- An eruption from Mt. St. Helens or Mt. Hood could potentially cause major damage due to ash fall.
- The amount of ash fall experienced and its impact will depend, to a large degree, on the weather conditions. A substantial part of the City could be impacted from the ash fall.

5.8 Hazardous Materials Incidents (161)

- The City of Beaverton has a history of minor hazardous materials incidents, but none that have risen to the level of major emergency or disaster. However, the increased use of hazardous materials in all aspects of daily life, their increased presence within Washington County, and the proximity of commercial and residential developments to hazardous material facilities raise the probability of a significant future event. This probability is offset somewhat by stricter regulations and tougher regulatory enforcement for facilities and companies that manufacture, transport, or store hazardous materials
- Hazardous materials are commonly used, stored, and/or transported in Beaverton.
 - A hazardous materials incident involves the unintentional release of hazardous substances into the environment and may occur as the result of natural disasters, equipment failure or human error.
 - Hazardous materials incidents may occur at fixed facilities and along transportation routes during transportation-related incidents that involve hazardous and radiological materials.
 - Any hazardous materials incident may represent a potentially dangerous situation. Chemicals that are flammable, explosive, corrosive, toxic, or reactive, along with biological and radioactive materials, pose a special hazard to emergency responders and the general public.
- There are several facilities in or near the Beaverton City limits that keep, use or transport hazardous materials. Under the Emergency Planning and Community Right to Know Act (EPCRA) of 1986 and the Pollution Prevention Act of 1990, these facilities are required to report to the State Fire Marshal.

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- There are commercial rail lines that run through downtown Beaverton that frequently carry hazardous materials beyond the large quantity of diesel fuel in the engines.
- Two major pipelines for the transportation of natural gas and flammable liquids pass through the west side of Beaverton.
- There are several freeways and highways that intersect the City. These roadways carry large numbers of vehicles transporting hazardous materials. Shipments containing hazardous materials are prohibited from going through the Vista Ridge tunnel on State Highway 26 and are diverted through Beaverton on State Highway 217.
- There are sites in Beaverton with contaminated soils that are under the supervision of the Oregon Department of Environmental Quality. The types of contamination include petroleum products and lead.
- History – The following dates represent incidents meeting the established criteria:
 - June 1981
 - September 1983
 - November 1983
 - January 1984
 - February 1989
 - June 1997
 - November 1998
 - September 2001

5.9 Drought/Water Shortage (155)

- A water shortage may arise from a number of causes but would likely derive from drought or a significant diversion/interruption of water supplies into the City. Drought involves a period of prolonged dryness resulting from a lack of precipitation. A severe drought could require that strict conservation measures be implemented to assure an adequate supply of potable water for Beaverton residents. Long term drought conditions typically have devastating consequences for agricultural and other businesses dependent on a good supply of water and place portions of the City at risk for wildland fires.
- Although Beaverton has suffered periods of drought in the past, the impacts have not been severe enough to reach major emergency or disaster proportions. The drought of 2000-01 is the worst on record for the City. Hagg Lake, the reservoir behind Scoggins Dam, fell to a

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record low of 9%. A combination of effective water management, significant conservation on the part of local irrigators, and adequate potable water supplies from the City ASR wells avert a major water crisis that year. A major drought affected several Oregon counties in 2015 but did not directly affect Beaverton.

- Diversions/interruptions of water supplies to the City could stem from failed reservoirs or wells, ruptured pipelines, or contaminated water sources.
- Climate change forecasts highlight an increased risk for drought conditions in the Pacific Northwest. According to the U.S. National Climate Assessment report *Climate Change Impacts in the United States Highlights* “Changes in the timing of streamflow related to changing snowmelt are already observed and will continue, reducing the supply of water for many competing demands and causing far-reaching ecological and socioeconomic consequences.” (See http://s3.amazonaws.com/nca2014/low/NCA3_Highlights_LowRes.pdf?download=1, page 80)

5.10 Terrorism (118)

- Terrorism is the unlawful use, or threatened use of force or violence by a person or an organized group against people or property with the intention of intimidating or coercing societies or governments, often for ideological or political reasons.
- All government facilities, including public schools, libraries, reservoirs, and recreational facilities are potential targets for terrorists. Other potential targets include utilities, transportation systems, and international businesses.
- Possible types of terrorist incidents include:
 - Assault and battery
 - Arson
 - Active Shooters
 - Homicide (assassination)
 - Bombings or bomb threats
 - Interruption of resources, utilities, and/or services
 - Kidnapping and extortion

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- Threat to use or the use of chemical, biological, or radiological agents.
- Potential Terrorist targets include:
 - Governmental/diplomatic facilities and events
 - High profile court cases
 - Public and private schools, including universities and research centers.
 - Political fund-raisers, campaigns, and conventions.
 - Elected officials and City events
 - Religious establishments and events
 - Utilities
 - Transportation
 - International businesses/ corporations
 - International sporting events

5.11 Landslides and Debris Flow (86)

- There are several steep slopes (slopes greater than or equal to 25%) within the City. LIDAR (Light Detection And Ranging) technology shows evidence of landslide deposits at the base of some of these slopes indicating that the slope has slid in the past.
 - 4 minor slides are within city limits
 - 1 large slide area is both inside and outside the city limits
 - 1 large slide area is outside, but close to the city limits
- Other than these ancient slides, there are no known active locations prone to landslides, avalanches, or debris flows inside city limits. This may change with future annexations of areas to the north, north east and southwest of current City boundaries.