11.0 NATURAL HAZARD MITIGATION ELEMENT

11.1 Introduction

Throughout history, the residents of the City of Covington have dealt with various natural hazards. Photos, journal entries, and newspapers from the mid to late 1800s show that the residents of the area dealt with high water, severe windstorms, harsh winter storms, wildfires, earthquakes, landslides, and even volcanic activity. Although there were fewer people in the area, the natural hazards adversely affected the lives of those who depended on the land and climate conditions for food and welfare. As the population of the city increases, the exposure to natural hazards creates an even higher risk than experienced historically.

Covington is one of the fastest growing cities in King County, and is characterized by the unique and attractive landscape and transportation system that connects the various communities throughout the area. However, the potential impacts of natural hazards associated with the terrain make the environment and population vulnerable to natural disaster situations. The city is subject to flooding, earthquakes, landslides, wildfires, severe winter storms, windstorm, and volcanic activity. 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.

Covington most recently experienced small-scale destruction during the Nisqually Earthquake of February 2001 and the severe weather events in February 1996. The Little Soos and Soos Creek, plus Jenkins Creek, and their tributaries swelled beyond the 100-year flood level, causing flooding in both rural and urban areas. Prolonged precipitation accompanied by an early snowmelt caused very unstable soil conditions, resulting in many landslides and debris flows in the county. A significant amount of building damage was incurred by structures outside of identified flood hazard areas.

The damage to Covington businesses, residences, and infrastructure was significant. The Covington Emergency Management Office estimated that the flood of February 1996 directly or indirectly affected three-quarters of the City's 12,000 residents. No known claims were filed under the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program (NFIP) from Covington residences and businesses, though these records could be combined within King County's disaster records.

Why Develop a Natural Hazard Mitigation Element?

The rising cost of natural disasters and technological disasters has led to a renewed interest in identifying effective ways to reduce vulnerability to disasters. Natural hazard mitigation planning helps communities reduce risk from natural hazards by identifying resources, information, and strategies for risk reduction, while helping to guide and coordinate mitigation activities throughout the city.

The element provides a set of strategies to reduce risk from natural hazards through education and outreach programs, the development of partnerships, and implementation of preventative activities, such as code enforcement, land use or watershed programs. It is a very condensed summary of the Covington Hazard Mitigation Action Plan prepared by the City to meet the requirements for emergency management planning set forth by FEMA. The Action Plan goes into great detail about the requirements of emergency management planning as it relates to hazard identification, vulnerability assessment and mitigation techniques.

Planning for natural hazards is an integral element of Washington's statewide land use planning program, which falls under the GMA. Other related parts of the planning framework include the Shoreline Master Program rules and guidelines, which now provide for the integration of master programs, and comprehensive plans. Natural Hazard Mitigation Elements are an optional element under the GMA.

The continuing challenge faced by local officials and state government is to keep this network of coordinated local plans effective in responding to the changing conditions and needs of Washington communities. This is particularly true in the case of planning for natural and technological hazards where communities must balance development pressures with detailed information on the nature and extent of hazards. Washington's land use program has given its communities and citizens a unique opportunity to ensure that natural and technological hazards are addressed in the development and implementation of local comprehensive plans.

Why Plan for Natural Hazards in Covington?

Hazards impact citizens, property, the environment, and the economy of Covington. Flooding, landslides, severe local storms, volcanoes, and earthquakes have exposed Covington residents and businesses to the financial and emotional costs of recovering after natural disasters. The risk associated with natural hazards increase as more people move to the areas affected by natural hazards. To this, add the potential for civil disorders, energy shortages and utility outages, food and water contamination, hazardous materials release, transportation accident hazards, and dam failures of the technological hazards type. The inevitability of natural or technological hazards or both, and the growing population and activity within the city create an urgent need to develop strategies, coordinate resources, and increase public awareness to reduce risk and prevent loss from future hazard events. Identifying risks posed by natural and technological hazards, and developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens and businesses.

The increase of people living in Covington and the increase in business activity creates more community exposure, thus changing how agencies prepare for and responds to hazards. For example, more people living on the urban fringe can have an increase risk of fire. Wildfire has an increased chance of starting due to human activities in the urban/rural interface, and has the potential to injure more people and cause more property damage. Furthermore, increased density can affect risk. For example, narrower streets may be more difficult for emergency service vehicles to navigate, the higher ratio of residents to emergency responders affects response times, and homes located closer together increase the chances of fire spreading. Localized flooding can render roads and rail systems unusable. A severe local storm has the potential to disrupt the daily driving routine of thousands of people. Failure of the Lake Youngs South Dam has the potential to isolate Covington from the outside world and sever the state highway route used to commercial freight between Interstate Highway 5 and 90.

Hazards do not discriminate, but the impacts in terms of vulnerability and the ability to recover vary greatly among the population. FEMA reports that 80 percent of the disaster burden falls on the public, and within that number, a disproportionate burden is placed upon special needs groups: women, children, minorities, and the poor. The 2000 census of the King County area indicates a significant increase in Hispanics, Asian and Russian Republic population. The ethnic and cultural diversity suggests a need to address multi-cultural needs and services. A significant percentage of the Covington population is school age, with a small but growing population over 65 years of age. Vulnerable populations, including seniors, disabled citizens, women, and children, as well as those people living in poverty, may be disproportionately impacted by natural hazards.

11.2 Flood Hazard

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

The City was most recently affected by the seasonal flooding of the Soos and Jenkins Creeks in January 1997. However, the devastation brought about by the regional floods of February and November 1996 far surpassed the city's (then County's) normal seasonal flood events, such as that in 1997.

In February 1996, prolonged precipitation accompanied by an early snowmelt caused many rivers and creeks throughout King County watersheds to rise to 100-year flood levels. The Soos and Jenkins Creeks and their tributaries were filled beyond capacity, causing flooding in both rural and urban areas. The confluence of these two streams occurs just South of Covington, where the floodwaters caused significant damage to a large portion of the rural area in unincorporated King County.

Still recovering from the February floods, the City was hit with a major storm on November 10 and 11, 1996. The storm delivered at least 2.8 inches of rain in one night - a weather event that occurs an average of once every 205 years. Many of the rivers and smaller tributaries in the County quickly reached their flood levels, causing both urban and riverine flooding. Although the damage from this event was not as severe as the February floods, it did warrant road closures and the evacuation of homes in the 100-year floodplain. The 1996 floods caused a statewide loss in the millions of dollars.

Covington has many small tributaries in both unincorporated King County and incorporated areas that are susceptible to flooding. Major floods have affected the citizens of the City. Table 11.1 illustrates major flood events on the Soos and Jenkins Creeks. Although the 1996 floods were devastating to the entire region, the floods of 1861, 1890, and 1964 were larger. All four floods have been estimated to exceed the 100-year or base flood.

The properties in and near the floodplains of Covington are subject to flooding events almost annually. Since flooding is such a pervasive problem throughout the City, many residents have purchased flood insurance through the NFIP to help recover from losses incurred from flooding events. Flood insurance covers only the improved land, or the actual building structure. Although flood insurance assists in recovery, it can provide an inappropriate sense of protection from flooding. Many residents who have had flood damage rebuild in the same vulnerable areas, only to be flooded again. These properties are termed repetitive loss, and are very troublesome because they continue to expose lives and valuable property to the flooding hazard. Local governments as well as federal agencies such as FEMA recognize this pitfall in floodplain insurance, and attempt to remove the risk from repetitive loss properties through projects such as acquiring land and relocating the home, or by elevating the structure.

Continued repetitive loss claims from flood events lead to an increased amount of damage caused by floods, higher insurance rates, and contribute to the rising cost of taxpayer funded disaster relief for flood victims.

Flooding is most common from November through April, when storms from the Pacific Ocean, 60 miles away, bring intense rainfall to the area. Covington receives about 36 inches of rain on average each year. Most of the rainfall occurs in winter and spring from November to April. This results in high water, particularly in December and January. The larger floods are the result of heavy rains of two-day to five-day durations augmented by snowmelt at a time when the soil is near saturation from previous rains. Frozen topsoil also contributes to the frequency of floods.

A large portion of Covington is area that lies in the Soos, Little Soos or Jenkins Creek drainage areas. The broad floodplain of the plateau can be easily inundated by floodwaters. The surface material includes poorly drained, unconsolidated, fine-grained deposits, sand, and gravel. Torrential flood events can introduce large deposits of sand and gravel that assist in the drainage of the otherwise poorly drained soils.

The flood events in Covington usually occur when storms move in from the Pacific, dropping heavy precipitation in the region. Flooding in the natural drainage basins becomes a problem when human activities infringe on the natural floodplain.

11.2.1 Flood Terminology

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

100-Year Flood

The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood. Figure 11.1 illustrates the 100-year floodplain in Covington.

Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For NFIP purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. Covington regulations prohibit all development in the floodway. The NFIP floodway definition is "the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. In Title 21A of the Covington Zoning Ordinance, the flood fringe is defined as "the land area, which is outside of the stream's floodway, but is subject to periodic inundation by regular flooding."

This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Development

For floodplain ordinance purposes, development is broadly defined by Covington Municipal Code to mean "any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level) that the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Characteristics of Flooding

Two types of flooding primarily affect Covington: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's (ditch or sewer) capability to remove it.

Riverine Flooding

Riverine flooding is the overbank flooding of rivers and streams. 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.

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 one to three feet. These areas are generally flooded by low velocity sheet flows of water.

Urban Flooding

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. 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.

Almost one-eighth of the area in Covington is unincorporated, and has a high concentration of impermeable 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 often back up with vegetative debris causing additional, localized flooding.

Dam Failure Flooding

Loss of life and damage to structures, roads, utilities and crops may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of the Lake Youngs earthen dam north of Covington. The South Dam on Lake Youngs Reservoir is located less than 2 miles north of the City of Covington (just north of SE 224th Street). The reservoir covers an area of 690 acres and serves as a municipal water supply for the City of Seattle. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there may be coordination with City officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner. For more detailed information regarding dam failure flooding, and potential flood inundation zones for Lake Youngs South Dam, refer to the Covington Emergency Action Plan.

Analysis conducted by the City of Seattle indicate that a dam-break or failure on Lake Youngs would result in severe flooding along Soos Creek. Damage would most likely occur to most structures and road embankments in the inundation area along Soos Creek downstream to the confluence with the Green River. Flood inundation zones from a dam-break on Lake Youngs are shown on the Flood Hazard Map in Figure 11.1.

11.2.2 Effect of Development on Floods

When structures or fill are placed in the floodway or floodplain, water is displaced. Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and/or is removed to compensate, serious problems can arise. Floodwaters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels.

Local governments must require engineer certification to ensure that proposed developments would not adversely affect the flood carrying capacity of the Special Flood Hazard Area (SFHA). Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the flood plain to ensure that structures are prepared to withstand base flood events.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.

11.2.3 Flood-Prone Area Identification

Flood Insurance Rate Maps (FIRM's) are often used to identify flood-prone areas. FIRM's are part of the NFIP established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and "sound floodplain management." In Covington, the NFIP and related building code regulations went into effect in 1997. NFIP regulations (44 Code of Federal Regulations [CFR] Chapter 1, Section 60.3) require that all new construction in floodplains must be elevated at or above base flood level. The Washington State Building Code Act requires new construction to be elevated to 1 foot above the base flood elevation. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. In Covington, all homes legally constructed in the floodplain after March 1, 1978 must be mitigated to NFIP standards with the first floor being elevated at least one foot above base flood level.

Although many communities rely exclusively on FIRM's to characterize the risk of flooding in their area, there are some flood-prone areas that are not mapped but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and areas susceptible to manmade flooding. About 10 percent to 20 percent of all flood-related damage from past floods in Covington is located outside the boundaries of the FEMA's

FIRM's. The flood hazards map for the City of Covington is shown in Figure 11.1.

11.2.4 Hazard Identification

Hazard identification is the first phase of flood-hazard assessment. Identification is the process of estimating: (1) the geographic extent of the floodplain (i.e., the area at risk from flooding); (2) the intensity of the flooding that can be expected in specific areas of the floodplain; and (3) the probability of occurrence of flood events. This process usually results in the creation of a floodplain map. Floodplain maps provide detailed information that can assist jurisdictions in making policies and land-use decisions.

11.2.5 Vulnerability Assessment

Vulnerability assessment is the second step of flood-hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events.

Because site-specific inventory data and inundation levels given for a particular flood event (10-year, 25-year, 50-year, 100-year, 500-year) are not readily available, calculating a community's vulnerability to flood events is not straightforward. The amount of property in the floodplain, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential flood losses. Table 11.1 below describes the number of acres and tax lots within Covington's 100-year floodplain.

Table 11.1: Flood Hazard Vulnerability Assessment

Acres in the 100 year Floodplain	537
All Tax lots within the 100 year Floodplain (all or partial)	171

Source: Covington Geographic Information Systems
* Value of property in the 100-year floodplain may include property in tax lots that intersect the floodplain, including property that does not physically reside in the floodplain itself.

11.2.6 Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessment.

A flood risk analysis for Covington should include two components: (1) the life and value of property that may incur losses from a flood event (defined through the vulnerability assessment); and (2) the number and type of flood events expected to occur over time. Within the broad components of a risk

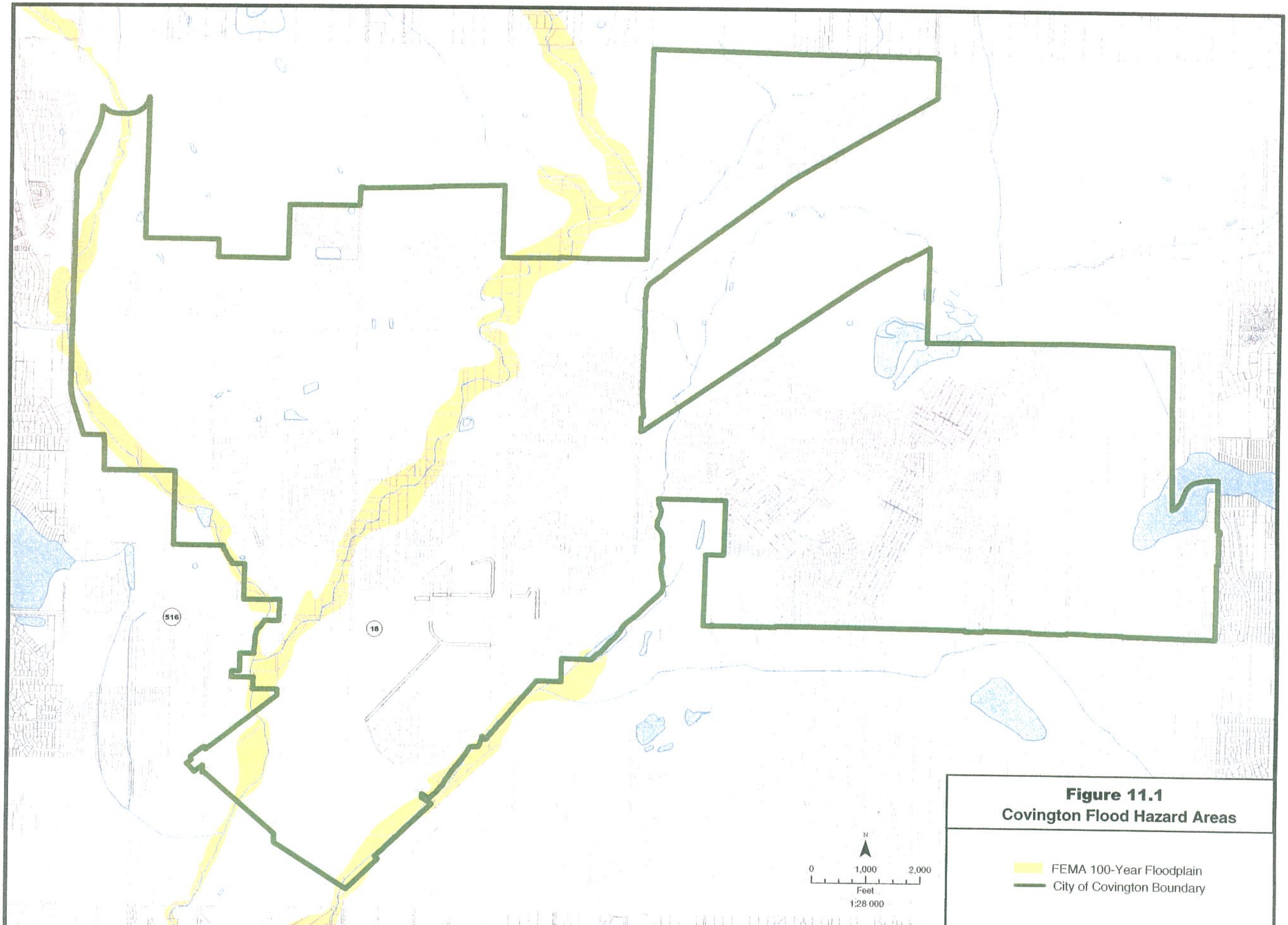

Figure 11.1
Covington Flood Hazard Areas

Source: King County GIS, Gray & Osborne, EDAW, City of Covington, December 16, 2003

P:\3E026.01_Covington_Comp_Plan_Update\GIS\Project\mxd\FINAL_FIGS\Figure11.1.mxd analysis, it is possible to predict the severity of damage from a range of events.

At the time of publication of this plan, data was insufficient to conduct a risk analysis for flood events in Covington. However, this plan includes recommendations for building partnerships that will support the development of a flood risk analysis in Covington.

11.2.7 Flood Hazard Mitigation Activities

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

National Flood Insurance Program (NFIP)

The NFIP was created in 1968 to provide the public with the opportunity to obtain flood insurance coverage to cover flood damages to buildings and their contents and to reduce flood damages by requiring local regulation of new development in flood-prone areas. Insurance is made available to property owners in communities that have agreed to adopt and enforce a floodplain management ordinance that will reduce future flood risks due to new construction. Covington has adopted the NFIP building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps available through the City.

Flood Control Assistance Account Program (FCAAP)

The state's Flood Control Assistance Program (FCAAP), administered by the state Department of Ecology, provides funds for local flood hazard management efforts. The basis for these efforts is a comprehensive, watershed-based flood hazard management plan (RCW 86.12) prepared by the local community. Typically local hazard mitigation plans contain more specific language than the comprehensive plan, but the comprehensive plan can bridge the gap between general policies and specific on-the-ground implementation spelled out in the FCAAP plan. The flood hazard management plan can address flood hazards through a variety of techniques, including:

- Non-structural flood damage reduction techniques, such as wetland restoration;
- Prioritized home acquisition and structural elevations; and
- Land use controls that prohibit or condition new development in flood-prone areas.

Covington Codes

Covington uses building codes, zoning codes, and various planning strategies to address the GMA, which aims at restricting development in areas of known hazards, and applying the appropriate safeguards.

- Mitigation Requirement: All habitable floors must be 1 foot above floodplain (flood level), and developer must complete a Floodplain Development Permit Application as outlined in Covington Municipal Code.
- Affected Properties: All development in the floodplain.
- Mitigation Requirement: Subsections of the critical areas ordinance prohibiting this type of development in identified hazard areas.
- Affected Properties: Essential facilities, major structures, hazardous facilities and special occupancy structures.
- Mitigation Requirements: Urban buffers that by their very nature allow minimal or zero development; Protection of Natural Features, Covington Development Standards; Shoreline Master Plan; and ESA BMPs.
- Affected Properties: Development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards.

Acquisition and Protection of Open Space in the Floodplain

Current efforts to increase public open space in the City have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property.

Preserved open space in the floodplain can help mitigate flood impacts by reducing the amount of allowable development in flood hazard areas. Preserving natural wetlands systems can assist in absorbing water during flood events and providing storage for treated effluent from wastewater treatment plants.

Water Districts

All of the water districts in the City are in the process of replacing old cast iron pipes with more ductile iron pipes, which will be more resilient in disaster situations. During a disaster, water districts in the region work together to provide water for Covington citizens.

Natural Systems

Maintaining and restoring natural systems help to mitigate the impact of flood events on the built environment. Flooding changes the natural environment and hydrology of an affected area. High water can be beneficial to the natural processes within a floodplain, and can benefit riparian areas. The best flood control techniques work to control water using the natural features such as wetlands that assist in water storage and bank stability.

Riparian Areas

Riparian areas are important transitional areas that link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion. During flood events, high water can cause significant erosion.

Population growth and development have strained the land and water, and the community has responded by supporting various improvement projects, such as the Covington Development Regulations, which identify effective actions to prevent problems. The goal of the critical areas ordinance is to develop a basin wide strategy to protect and restore stream, habitat and riparian areas. Well-managed riparian areas can reduce the amount of erosion and help to protect water quality during flood events.

Wastewater Management

There is one wastewater service provider in the City (Soos Creek Water and Sewer District). Working with the district, the City's Operations and Maintenance Division monitors development near the infrastructure that helps to keep the waters of Covington clean and pure.

Wetlands

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater.

Wetlands bordering streams and rivers and those that intercept runoff from fields and roads provide this valuable service free of charge. Many wetland restoration projects have been initiated and completed by various organizations throughout the City.

Many detention ponds are constructed wetlands. Some of these detention ponds are being retrofitted by Covington to use shade to cool stormwater and to provide proper ecosystem function. Covington has taken the lead on many of these projects, removing invasive plant species and debris, and replacing the invasive plant species with more appropriate and substantial vegetation. The City has also conducted stream restoration in selected areas.

Stormwater Systems

Covington is the sole surface water management provider in the City. It is responsible for managing water quality and stormwater runoff from new development. The existing stand-alone storm water ponds are becoming consolidated into regional stormwater treatment features. This effort will provide a higher level of water treatment and lower maintenance costs. The vacated pond areas will become building lots or neighborhood parks adding to the open space inventory.

Flood Management Projects

Flood management structures can assist in regulating flood levels by adjusting water flows upstream of flood-prone areas. There are no dams in Covington at this time.

Developers have developed one regional and one sub-regional storm water detention facility. The facility will help prevent and control flooding up to a point, but is not designed to remove the threat of flooding in all of the downstream floodplains. They will add a heightened level of water quality protection to down stream areas but are not designed as flood control structures.

11.3 Landslide Hazard

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year. The best estimate of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually. In Washington, a significant number of locations are in danger of being impacted by landslides. While all landslides result in private property damage, many landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life.

Landslides can be broken down into two categories: rapidly moving, and slow moving. Rapidly moving landslides present the greatest risk to human life, and people 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 Washington. A rapidly moving debris flow on Bainbridge Island killed four people during the storms of 1996. Slow moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

11.3.1 History of Landslide Events and Impacts

Landslides are a common hazard in and around Washington. In fact, a prominent theme of the 1996 flood disaster was that a significant amount of building damage affected structures outside of identified flood hazard areas. Many of the Washington applicants eligible for FEMA housing assistance grants were not floodplain cases, but were landslide and erosion losses.

In the northwestern portion of Covington, weathering and the decomposition of geologic materials produces conditions conducive to landslides. Human activity has further exacerbated the landslide problem in many parts of the city. A study conducted by Portland State University found that changes to the slope through cutting or filling increased the risk of landslides to 76 percent of the inventoried landslides in the Portland Metro region. The study documented 48 landslides that occurred in Oregon City in February 1996, and found that only about half the slides were considered natural.

Landslides in Covington are a localized problem. For example, sediment generated by the slides can affect regional water quality. During a recent winter a segment of the hillside on the east side of Soos Creek liquefied and move toward the creek destroying a segment of the park trail. Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As the city continues to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying bedrock as it, along with climate, dictates hazardous terrain. Without proper planning, landslides will continue to threaten the safety of people, property, and infrastructure.

11.3.2 Landslide Characteristics

Landslides are downhill movements of rock, debris, or soil mass. The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are 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 in Covington include slides, rock falls, and earth flows.

Landslides are typically triggered by periods of heavy rainfall or rapid snowmelt. Earthquakes, volcanic activity, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities effecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.

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;
- 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 culverts, V-shaped valleys, canyon bottoms, and steep stream channels; and
- Pan-shaped areas of sediment and boulder accumulation at the outlets of canyons.

11.3.3 Impacts of Development

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures in Covington. Proper planning can be exercised to reduce the threat of safety of people, property, and infrastructure.

11.3.4 Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

11.3.5 Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

11.3.6 Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. The Storm Impacts Study conducted by the Oregon Department of Forestry found that landslide hazards in three out of four steeply sloped areas were highest for a period of roughly 10 years after timber harvesting. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. In addition, woody debris in stream channels (both natural and man-made from logging) may cause the impacts from debris flows to be more severe.

11.3.7 Geologic Characteristics

The City of Covington is located within the Puget Sound Lowlands geologic zone. The Puget Lowland consists of a broad, low-lying region comprised largely of glacial soils situated between the Cascade Range to the east and the Olympic Mountains to the west. The Cascade Range is part of a vast mountain chain that extends from British Columbia to northern California. The Cascades consist of an active volcanic arc that form an effective barrier to moisture carried eastward by the prevailing Pacific winds. This has a great effect on the productivity of the land. The Puget Lowland receives 30 to 50 inches of rain annually, while the western slopes of the Cascade mountains get over 80 inches of precipitation a year.

Washington State, and the Puget Lowland in particular, are subject to earthquakes. Seismographs record more than 1,000 earthquakes each year. Of these, ten or more produce sufficient shaking to be felt by the public. The epicenters for the last three major earthquakes were under Olympia (1949), Seattle (1965) and Nisqually (2001) with Richter magnitudes 7.1, 6.5 and 6.8 respectively. These major earthquakes are attributed to subduction of the oceanic Juan de Fuca plate under western Washington. On a scale of 0 to 4, with 4 being to highest risk, the Puget Lowland is classed as a Seismic Risk Zone 3.

Towering over the Cascade Range is majestic Mount Ranier with its peak at 14,410 feet above sea level. It contains the greatest concentration of glaciers of any single mountain in the lower 48 states. Mount Ranier's eruptive history started nearly 1 million years ago. The volcano has been subjected to repeated cycles of mountain glaciation. Between 6,600 and 5,700 years ago, destructive eruptions modified the summit. Historical eruptions were noted by settlers between 1820 and 1894. The mountain has been the source of huge mud flows that raced down river systems, nearly reaching Tacoma. Mount Rainier is also known for gigantic rock avalanches--the latest occurring on August 16, 1989, when 2.6 million cubic yards of rock tumbled down the north flank of the mountain. That event was recorded on the Washington Division of Geology and Earth Resources seismograph in Olympia, 50 miles to the west. Covington is located outside of the potential mud flow inundation zone from a volcanic eruption on Mount Ranier.

11.3.8 Hazard Identification

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities. The Washington State Department of Natural Resources, Geology and

Earth Resources Division (DGER) is active in developing maps and collecting data on hazard risk. The landslide hazard area map (Figure 11.2) depicts areas subject to landslides and subsequent debris flows. This map shows areas that are in moderate and high debris flow hazard areas using slope, geology, and soil type as determinates.

Vulnerability assessment for landslides will assist in predicting how different types of property and population groups will be affected by a hazard. Data that includes specific landslide-prone and debris flow locations in the city can be used to assess the population and total value of property at risk from future landslide occurrences. The Covington Planning Division uses percent slope as an indicator of hill slope stability. The city uses a 20 percent or greater threshold to identify potentially unstable steep slopes.

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.

11.3.9 Susceptibility to Landslides

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

11.3.10 Roads and Bridges

Large losses incurred from landslide hazards in Covington have been associated with roads. The Covington Planning and Public Works Department is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. The King County Roads Division does its best to communicate with residents impacted by landslides, but can usually only repair the road itself, as well as the areas adjacent to the slide where the city has the right of way.

It is not cost effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The city Maintenance and Operations Division alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term, but is only temporary. Unfortunately, many property owners are unaware of slides and the dangers associated with them.

11.3.11 Lifelines and Critical Facilities

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

11.3.12 Landslide Mitigation Activities

Landslide mitigation activities include current mitigation programs and activities that are being implemented by local or city organizations.

Covington City Zoning Code

Covington addresses development on steep slopes in subsection Title 21A the Zoning Code and Title 15 the Construction Code. These sections outline standards for steep slope hazard areas on slopes of 20 percent or more. Generally, the ordinance requires soils and engineering geologic studies for developments proposed on slopes of 20 percent or greater. More detailed surface and subsurface investigations shall be warranted if indicated by engineering and geologic studies to sufficiently describe existing conditions. This may include soils, vegetation, geologic formations, and drainage patterns. Site evaluations may also occur where proposed grading/filling or land clearing might lessen stability.

Community Hazard Mapping

The City intends to develop a consistent and comprehensive community landslide hazard map of the city. This hazard mapping project will expand on the earthquake-induced hazard mapping to include other likely initiation mechanisms (such as heavy rainfall). Complementary products to accompany the hazard map include a

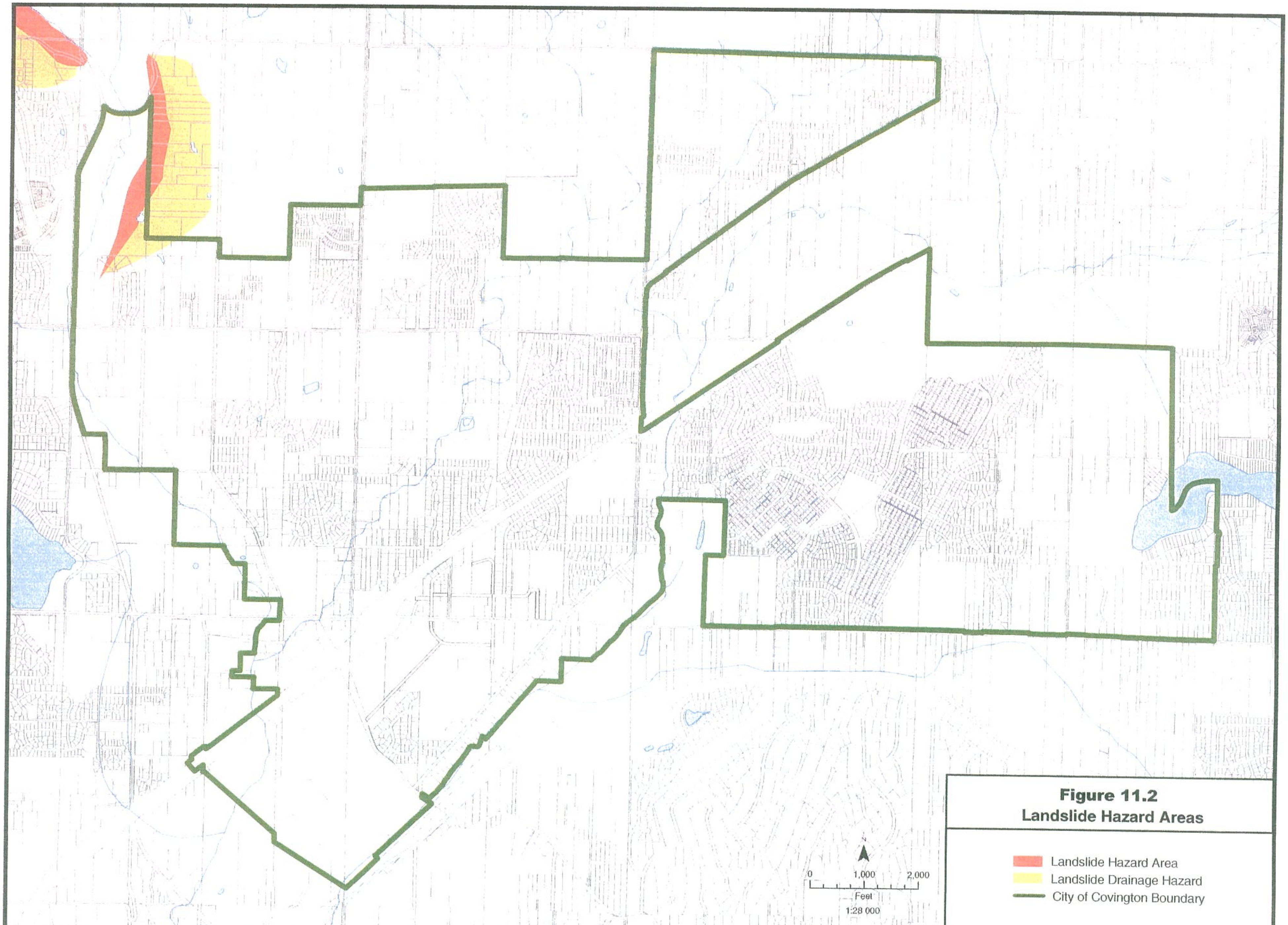

Figure 11.2
Landslide Hazard Areas

Source: King County GIS, Gray & Osborne, EDAW, City of Covington, December 16, 2003

P:\3E026.01_Covington_Comp_Plan_Update\GIS\Project\mxd\FINAL_FIGS\Figure11.2.mxd landslide inventory database (building on previous efforts) and a digital compilation of known landslide topography. The combination of these digital data sets should be extremely valuable for local geologists, engineers, planners, and policy makers interested in addressing landslide hazards and developing targeted end efficient mitigation programs. The project is anticipated to be completed in December 2004-5.

11.4 Earthquake Hazard

More than 1,000 earthquakes occur in the state annually. Washington has a record of at least 20 damaging earthquakes during the past 125 years. Large earthquakes in 1946, 1949, and 1965 killed 15 people and caused more than $200 million (1984 dollars) in property damage. Most of these earthquakes were in western Washington, but several, including the largest historic earthquake in Washington (1872), occurred east of the Cascade crest. Geologists have found evidence of large, prehistoric earthquakes in areas where there have been no large historic events, suggesting that most of the state is at risk.

The most recent earthquake event affecting Covington was the February 28, 2001 Nisqually earthquake. The epicenter of the 6.8-magnitude earthquake was near Anderson Island in Pierce County. Residents as far away as British Columbia and Oregon felt the tremor. The impacts of this quake were most severe in the Puget Sound area, where economic losses (from damage to buildings, roads and bridges, and other infrastructure and loss of business) were estimated at $1 to $2 billion. The earthquake also caused more than 300 injuries.

Historical and geological records show that Washington has a long history of seismic events. Recent research suggests that regional geologic conditions are capable of producing magnitude 9 earthquakes. Furthermore, there is evidence of the existence of several major faults in the Seattle-Tacoma metropolitan area, as well as other areas of the state. Earthquakes pose a serious threat to many local communities. Local governments, planners, and engineers must consider the threat as they seek to balance development and risk. Identifying locations susceptible to seismic activity, adopting strong policies and implementing measures, and using other mitigation techniques are essential to reducing risk from seismic hazards in Covington.

11.4.1 Earthquake Characteristics

Most large earthquakes in the Pacific Northwest are shallow crustal, deep intraplate, or subduction zone earthquakes. These earthquakes can have great impact on Washington communities.

Crustal fault earthquakes are the most common earthquakes and occur at relatively shallow depths of 6 to 12 miles below the surface. While most crustal fault earthquakes are smaller than magnitude 4 and generally create little or no damage, they can produce earthquakes of magnitudes up to 7, which cause extensive damage. King County has several documented crustal faults that could cause serious damage to buildings and infrastructure in the Covington area. These faults could generate earthquakes 6.5 or larger. Recent examples occurred near Bremerton in 1997, near Duvall in 1996, off Maury Island in 1995, near Deming in 1990, near North Bend in 1945 and on the St. Helens seismic zone (a fault zone running north-northwest through Mount St. Helens) in 1981. All these earthquakes were about Magnitude (M) 5–5.5. The largest historic earthquake in Washington (estimated at M7.4), the North Cascades earthquake of 1872, is also thought to have been shallow. It may rank as Washington's most widely felt earthquake. Because of its remote location and the relatively small population in the region, though, damage was light.

Recent paleoseismology studies are demonstrating previously unrecognized fault hazards. New evidence for a fault system that runs east–west through south Seattle (the Seattle fault) suggests that a major earthquake, M7 or greater, affected the area about 1,000 years ago. Similar large faults occur elsewhere in the Puget Sound but have not been studied in detail.

Occurring at depths from 25 to 40 miles below the earth's surface in the subducting oceanic crust, deep intraplate earthquakes can reach up to magnitude 7.5. The largest of these recorded were the magnitude (M) 7.1 Olympia earthquake in 1949, the M6.5 Seattle-Tacoma earthquake in 1965 (seven deaths), the M5.1 Satsop earthquake in 1999, and now the M6.8 Nisqually earthquake of 2001. Strong shaking during the 1949 Olympia earthquake lasted about 20 seconds; during the 2001 Nisqually earthquake, about 40 seconds. Since 1870, there have been six earthquakes in the Puget Sound basin with measured or estimated magnitudes of 6.0 or larger, making the quiescence from 1965 to 2001 one of the longest in the region's recent history.

The Pacific Northwest is located at a convergent plate boundary, where the Juan de Fuca and North American tectonic plates meet. The two plates are converging at a rate of about 1-2 inches per year. This boundary is called the Cascadia Subduction Zone; it extends from British Columbia to northern California. Subduction zone earthquakes are caused by the abrupt release of slowly accumulated stress along the interface between tectonic plates. Compelling evidence for great-magnitude earthquakes along the Cascadia subduction zone has recently been discovered. These earthquakes were evidently enormous (M8–9+) and recurred on average every 550 years. The recurrence interval, however, has apparently been irregular, as short as about 100 years and as long as about 1,100 years. The last of these great earthquakes struck Washington about 300 years ago. Such earthquakes may cause great damage to the coastal area of Washington as well as inland areas in western Washington. Shaking from a large subduction zone earthquake could last up to five minutes.

11.4.2 Earthquake Hazard Identification

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Washington have a high likelihood of encountering such risks, especially in areas with steep slopes.

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Noteworthy liquefaction took place in Puyallup during the 1949 earthquake. The soils that failed in many cases were sand deposits from historic Mount Rainier debris flows; similar hazards could be expected in other valley floors downstream from other Cascade volcanoes, such as Mount Baker, Mount St. Helens, and Mount Adams.

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk. Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

11.4.3 Susceptibility to Earthquakes

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and utility lines) suffer damage in earthquakes and can cause death or injury to humans. The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of buildings, critical facilities, and infrastructure and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges faced by the city.

Dams

There is an earthen dam 2 miles north of Covington holding billions of gallons of water supply for the City of Seattle. Releases of water from this reservoir would cause high floodwaters in Covington. Seismic activity can compromise the dam structures, and the resultant downstream flooding would cause catastrophic flooding. The largest reservoir is Lake Youngs Dam—690 acres of surface area which drains into Little Soos Creek.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damages is great. In most Washington communities, including Covington, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high. The Washington State Building Code Council (SBCC) revised its construction standards for new buildings to make them more resistant to seismic events. Covington, which follows the State Building Codes, is within a seismic Zone 3 (0 = low and 4 = very high).

Infrastructure and Communication

Residents in Covington commute frequently by automobiles and public transportation such as buses. An earthquake can greatly damage bridges and roads, hampering the movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link - with even minor damages making some areas inaccessible. Because bridges vary in size, materials, siting, and design, any given earthquake will affect them differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

Much of the interstate highway system was built in the mid to late 1960's. The bridges in Covington are state owned. A state-designated inspector must inspect all state bridges every two years, and the inspections are rigorous, looking at everything from seismic capability to erosion and scour. However, private bridges are not inspected, and can be very dangerous.

Upon inspection, the bridges are subject to a sufficiency score. This score uses a scale of 1 to 100 with 1 being the worst rating. The bridges are ranked throughout the state according to their score. The state then prioritizes the bridge repair according to each score. If the bridge receives a sufficiency score of less that 50, it is on the list for upgrading and rehabilitation. If it scores over 50, it is not included on the list. Small repairs to county bridges may be done in house, while the larger projects require funding through the Highway Bridge Replacement and Rehabilitation program (HBRR). HBRR provides 80 percent of funding, and the state is responsible for 20 percent.

Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause water, sewer, storm and gas pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. Many critical facilities are housed in older buildings that are not up to current seismic codes.

Businesses

Seismic activity can cause great loss to businesses; both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Individual Preparedness

A survey shows that about 39 percent of respondents think an earthquake will occur in Washington within the next 10 years. Only 28 percent of Washington residents say they are prepared for an earthquake, and 22 percent have earthquake insurance. In addition, only 24 percent correctly identified what to do during an earthquake.

Because the potential for earthquake occurrences and earthquake-related property damage is relatively high, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

Death and Injury

Death and injury can occur both inside and outside of buildings due to collapsed buildings falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely.

Debris

After damage to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing strong debris management strategies can assist in post-disaster recovery.

11.4.4 Earthquake Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

Covington Code

Implementation of earthquake mitigation policy often takes place at the local government level. The Covington Planning, Public Works and Emergency Management Department is the local agency that enforces zoning codes pertaining to earthquake hazards through the Development Review Division. The standards for development are outlined in the Covington Zoning Ordinance in the Covington Municipal Code (CMC). Generally, these codes seeks to discourage development in areas that could be prone to flooding, landslide, wildfire and / or seismic hazards, therefore "letting such events naturally recur" and allowing "the beneficial effects that natural hazards can have on natural resources and the environment" to occur (CMC). Developers in potential hazard-prone areas are required to retain a professional engineer to evaluate level of risk onsite and recommend mitigation measures.

Coordination Among State Building Officials

The Washington State Building Code Council (SBCC) sets the minimum design and construction standards for new buildings. In 1993, SBCC upgraded the seismic zone rating, which requires that new buildings be built at a higher seismic standard. Since 1993, SBCC also requires that site-specific seismic hazard investigations be performed for new essential facilities, major structures, hazardous facilities, and special occupancy structures such as schools, hospitals, and emergency response facilities.

The city enforces the Uniform Building Code (UBC), as adopted by the SBCC to insure building code standards in new construction. Codes related to Natural Hazard Mitigation are Chapter 16 of the UBC. It introduces seismic zones, which are rated from 0-4 depending on risk. Each zone has different standards that are specific to the level of risk. The codes are scheduled to be changed to the International Codes (I codes) in July of 2004.

Businesses/Private Sector

Natural hazards have a devastating impact on businesses. In fact, of all businesses which close following a disaster, more than 43 percent never reopen, and an additional 29 percent close for good within the next two years. The Institute of Business and Home Safety has developed "Open for Business," which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse affects of natural hazards. The kit integrates protection from natural disasters into the company's risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

Earthquake Education

All three of the state's major public universities (University of Washington, Washington State University, and Western Washington State University) are involved with earthquake education in some capacity. At these institutions, the federally funded work conducted tends to be oriented towards basic research, whereas state funded work typically has more practical application.

The Department of Education is generally concerned with seismic safety in schools. It supports the required monthly earthquake drills. The Department is not authorized to mandate seismic safety efforts in schools but can make recommendations to local school districts on such issues. It encourages the use of a curriculum produced by FEMA that focuses on mitigating non-structural hazards in schools and assists schools in obtaining funds for these purposes. Each year, Washington Emergency Management Division provides information to facilitate school earthquake drills statewide. Currently, Kent School district has committed to retrofit is existing facilities and build new faculties to the current code standards. King County Project Impact has been conducting education outreach in the local schools. Letters were sent to each School District in the county offering them the opportunity to identify a classroom for seismic non-structural mitigation. They were encouraged to identify environments that differed from the norm like a daycare, sports storage area, science lab and kitchen.

11.5 Volcanic Eruption Hazard

The Pacific Northwest lies on the "Ring of Fire," an area of active volcanic activity surrounding the Pacific Basin. Volcanic eruptions occur 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 meet 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.

11.5.1 Volcanic Eruption Hazard Identification

The primary volcanic threat to lives and property in Covington is from eruptions of Glacier Peak, Mount Rainier, and Mount St. Helens or Mount Adams that generate mud and debris flows that can sweep down river valleys for tens of miles, and from ash clouds that drift downwind to the county from near or distant eruptions.

Any eruption in the Cascades could have an effect on Covington if the wind blows in the right direction. Only Mount Rainier and Mount St. Helens are known to have had direct effects in the area of Covington in the past. However, any eruption in the Cascades that affects regional infrastructure, air traffic, bridges, or Interstates 5 and 90 or State Routes 18, 516 or 169 will have a direct or indirect impact on the city.

Glacier Peak

Glacier Peak is located east of Everett and has been recurrently active over the past 500,000 years. It has had six significant eruptive periods in recent times - one in the last 200 years. In addition to these eruptive episodes, there is evidence of an eruption occurring just before Lewis and Clark traversed the region (1804-1806). There is also evidence of several minor eruptions between about 1846 and 1865.

Although Glacier Peak does not have a history of violent explosive eruptions, there are significant hazards associated with this volcano. The flanks of the volcano were formed in part by lava flows, which flowed up to 8 miles from the summit. These slow-moving lava flows are destructive, but do not pose a serious threat to life and safety because people have ample time to evacuate. Lava domes, however, can collapse, forming fast moving pyroclastic flows, hot avalanches of lava blocks, ash, and hot gases. These pyroclastic flows can swiftly melt snow and ice to form lahars or volcanic mudflows that can continue far down river valleys. Glacier Peak has also generated lahars from landslides, or debris avalanches, of weakened, saturated masses of rock high on the volcano. Ash deposits are the most dangerous potential threat posed by the seemingly dormant volcano in the Cascades. While Glacier Peak has shown no recent signs of volcanic activity, scientists predict the next eruption will consist of lava dome growth and collapse, which will generate pyroclastic flows, ash clouds, and lahars (mud and debris flows). Future eruptions from the peak could seriously disrupt transportation, water supplies, and hydroelectric power generation and transmission in northwest Washington and southwest Washington.

Mount St. Helens

Mount St. Helens is a 50,000 year old volcano, located in southwestern Washington about forty miles southeast of Covington. In the last 515 years, it is known to have produced 4 major explosive eruptions (each with at least 1 cubic kilometer of eruption deposits) and dozens of lesser eruptions. Two of the major eruptions were separated by only 2 years. One of those, in 1480 AD., was about 5 times larger than the May 18, 1980 eruption, and even larger eruptions are known to have occurred during Mount St. Helens' brief but very active 50,000-year lifetime. Mount St. Helens remains an active and potentially dangerous volcano.

The 1980 eruptions of Mount St. Helens in southwestern Washington marked the re-awakening of the volcano that had been dormant since 1857. The May 18, 1980 eruption of Mount St. Helens was preceded by about two months of precursory activity, including numerous earthquakes, marked deformation of the volcano's north flank, and small steam explosions. The lateral blast, debris avalanche, and lahars associated with the eruption are thought to have occurred just before a Richter Magnitude 5.1 earthquake shook the mountain.

The eruption of Mount St. Helens took the lives of 57 people and nearly 7,000 big game animals. All birds and most small mammals in the area were killed, as were twelve million Chinook and Coho salmon fingerlings that perished when their hatcheries were destroyed.

Damage to the built environment within the immediate hazard vicinity included twenty-seven bridges, about two hundred homes, more than 185 miles of highways and roads, and fifteen miles of railways. Ash from the eruption column and cloud spread across the United States in three days and circled around the earth in fifteen days. Detectable amounts of ash were noted in an area covering 22,000 square miles. Lahars filled the Toutle and Cowlitz Rivers and ultimately flowed into the Columbia River at Longview, Washington. Sediment from the lahars blocked the main shipping channel in the Columbia, stranded ships in port, and closed the ports of Portland, Vancouver, and Kalama for over a month. Several water and sewage treatment facilities were also damaged or destroyed. The estimated damage attributed to the eruption was $1.1 billion.

Following the eruption on May 18, 1980, there were 5 smaller explosive eruptions over a period of 5 months. Thereafter, a series of 16 dome-building eruptions through October 1986 constructed the new, 270-meter- (880 feet) high, lava dome in the crater formed by the May 18, 1980 eruption.

A few inches of ash fell onto Covington during small events on May 25, June 12, and October 16-18, 1980. The May 25 event left ash covering buildings, vehicles, lawns, streets, and agricultural fields. For days and even weeks afterward, residents and government officials worked to clear away the fine powder. 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. 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. Pools had to be drained and the filters cleaned. Ash also worked its way into equipment causing premature failures or requiring unscheduled maintenance.

Mount Rainier

Mount Rainier has produced at least four eruption periods and numerous lahars in the past 4,000 years. Mount Rainier is known to have erupted as recently as in the 1840s, and large eruptions took place as recently as about 1,000 and 2,300 years ago. Mount Rainier is capped by more glacier ice than the rest of the Cascades volcanoes combined, and parts of its steep slopes have been weakened by attack from hot, acidic volcanic gases and water. These factors make this volcano prone to landslide and lahars.

Mount Adams

Mount Adams stands astride the Cascade Crest some 50 kilometers due east of Mount St. Helens. This volcano has produced few eruptions during the past several thousand years. The most recent activity was a series of eruptions about 1,000 years ago. Mount Adams is also prone to landslides of weakened rock.

11.5.2 Characteristics of Volcanic Eruptions

Volcanoes are mountains that are built by the accumulation of their own eruptive products - lava flows, lava domes, pyroclastic flows, and tephra (airborne ash and dust). A volcano is usually built around a vent that connects with reservoirs of molten rock (magma) below the surface of the earth. The term volcano also refers to the opening or vent through which the molten rock and associated gases are expelled.

Active volcanoes can cause explosive or effusive eruptions. Thick and sticky magma usually causes explosive eruptions, which can produce fine volcanic ashes that rise many miles into the atmosphere in enormous eruption columns. Explosive activity also causes widespread tephra fall, pyroclastic flows and surges, debris avalanches, landslides, lahars, earthquakes, and flash floods. Effusive eruptions are characterized more by flowing or gushing magma than by violent blasts.

Tephra

Tephra consists of sand-sized or finer particles of volcanic rock, sometimes called volcanic ash, 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. 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 ash deposit.

Tephra introduces a number of hazards including the impact of large falling fragments, which is only a problem within a few miles of vents, the suspension of abrasive particles in the air and water, and the burial of structures, transportation routes, and vegetation. Tephra can also threaten public health, clog drainage systems, and create major debris management problems. The 1980 eruption of Mount St. Helens, for example, injected tephra to altitudes of 12 to 20 miles and deposited it over an area of 40,000 square miles or more. The direction and velocity of the wind, along with the magnitude and duration of the eruption, determine the location, size, and shape of the tephra fall. Wind forecasts from National Weather Service and models of ash dispersal developed by volcanologists can provide short-term forecasts for areas that might be subject to ash fall.

Lahars

Melting snow and ice caused by pyroclastic flows and surges can generate lahars, also called volcanic mudflows or debris flows. Lahars are rapidly flowing, water-saturated mixtures of mud and rock fragments. Lahars range in consistency from mixtures resembling freshly mixed concrete to very muddy water, and can carry materials as large as truck-sized boulders. Lahars can also form from landslides or debris avalanches of water-saturated material and from breaching of crater or debris-dammed lakes.

Lava Flows

Magma under the earth that reaches the surface is called lava. Lava flows downhill and is channeled into river valleys. A lava flow only affects terrain that is down-slope from its vent. While lava flows are destructive, they are not normally life threatening.

Lava Domes

Volcanic lava domes are mounds that form when viscous lava is erupted slowly and piles up over the vent, rather than moving away as a lava flow. The sides of most domes are very steep and composed of silica-rich lava, which may contain enough pressurized gas to cause explosions. Dome eruption can bury or disrupt the preexisting ground surface. Because of their high temperatures, domes may start fires if they are erupted in forested areas. Domes are extruded so slowly that people can avoid them, but they may endanger man-made structures that cannot be moved.

Earthquakes

Volcanic eruptions can be triggered by earthquakes or cause them. An earthquake produced by stress changes in solid rock from injection or withdrawal of magma (molten rock) is called a volcano-tectonic earthquake. The other categories of volcanic earthquakes, called long period earthquakes, are produced by the injection of magma into surrounding rock. Volcanic earthquakes tend to be mostly small and not a problem for areas tens of miles from the volcano.

Directed Blasts

Directed blasts, also known as lateral blasts, are sideways-directed volcanic explosions that can shoot large pieces of rock at high speeds for several miles. Directed blasts may affect only narrow sectors or spread out from a volcano to cover a sector as broad as 180 degrees. Because they carry rock debris at high speeds, lateral blasts can devastate areas of tens to hundreds of square miles within a few minutes, and can destroy man-made structures and kill all living things by abrasion, impact, burial, and heat.

Pyroclastic Flows

Pyroclastic flows are fluid mixtures of hot rock fragments, ash, and gases that sweep down the flanks of volcanoes. High-speed avalanches of hot ash, rock fragments, and gas move down the sides of a volcano during explosive eruptions or when the steep edge of a dome breaks apart and collapses. These pyroclastic flows, which can reach 1500" F and move at 100 to 150 miles per hour, are capable of knocking down and burning everything in their paths.

Volcanic Landslides

Landslides, or debris avalanches, are a rapid downhill movement of rocky material, snow, or ice. Volcanic landslides are not always associated with eruptions; heavy rainfall or a large regional earthquake can trigger a landslide on steep elopes. Volcanoes are susceptible to landslides because they are composed of layers of weak, fragmented, volcanic rocks that tower above the surrounding terrain. Furthermore, some of these rocks have been altered to soft, slippery, clay minerals by hot, acidic ground water inside the volcano.

11.5.3 Volcanic Eruption Hazard Identification

The United States Geological Survey (USGS)—Cascades Volcano Observatory (CVO) produced a volcanic hazard report for Mount Rainier in 1997 and 2000. The latest report includes a description of potential hazards that may occur to immediate communities. Covington is located outside the probable zones of lava and pyroclastic flows, as well as lahars, from a potential eruption on Mount Rainier. However, depending on wind direction and velocity as well as type and magnitude of the eruption, the city could be affected by significant ash outfall.

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

Ash fall generated by Mount Rainier and other nearby volcanoes is a significant hazard that affects Covington. The impacts of a significant ash fall are substantial. Persons with respiratory problems are endangered, transportation, communications, and other lifeline services are interrupted, drainage systems become clogged, and the economy can be adversely impacted.

11.5.4 Susceptibility to Volcanic Eruptions

Building and Infrastructure Damage

Ash fall accumulation of less than one-half inch is capable of creating temporary disruptions of transportation operations and sewage disposal and water treatment systems. Highways and roads could be closed for hours, days, or weeks afterwards. The series of eruptions at Mount St. Helens in 1980 caused Interstate 90 from Seattle to Spokane to close for a week. The impact of the ash fall caused the Seattle and Portland International Airports to close for a few days.

The fine-grained, gritty ash can also cause substantial problems for internal-combustion engines and other mechanical and electrical equipment. The ash can contaminate oil systems, clog air filters, and scratch moving surfaces. Fine ash can also cause short circuits in electrical transformers, which in turn cause power blackouts.

During an eruption at Mount Rainier, Bonneville Power Administration transmission lines may be severed. A number of high voltage lines are located in the nearby vicinity of Mount Rainier. These lines provide a portion of the electrical power to the Seattle-Tacoma Metropolitan Area.

Pollution and Visibility

Ash fallout from an eruption column can blanket areas within a few miles of the vent with a thick layer of pumice. High-altitude winds may carry finer ash from tens to hundreds of miles from the volcano, posing a hazard to flying aircraft, particularly those with jet engines. Fine ash in water supplies will cause brief muddiness and chemical contamination. Ash suspended in the atmosphere is especially a concern for airports, where aircraft machinery could be damaged or clogged.

Ash fall also decreases visibility and disrupts daily activities. For example, some individuals may encounter eye irritation. When the ash fall produced by the Mount St. Helens' eruption started to blow towards Southwest Washington and Oregon in June 1980, some of the airlines at the Portland International Airport responded immediately by stopping their service.

Economy

Volcanic eruptions can disrupt the normal flow of commerce and daily human activity without causing severe physical harm or damage. Ash that is a few inches thick can halt traffic, cause rapid wear of machinery, clog air filters, block drains, creeks, and water intakes, and impact agriculture. Removal and disposal of large volumes of deposited ash can also have significant impacts on government and business. The interconnectedness of the region's economy can be disturbed after a volcanic eruption. Roads, railroads, and bridges can be damaged from lahars and mudflows. The Mount St. Helens' May 1980 eruption demonstrated the negative affect on the tourism industry. Conventions, meetings, and social gatherings were canceled or postponed in cities and resorts throughout Washington and Oregon in areas not initially affected by the eruption. However, the eruption did lead to the creation of a thriving tourist industry for decades following the event.

Transportation of goods may also be halted. Subsequent airport closures can disrupt airline schedules for travelers. In addition, the movement of goods via major highways can also be halted due to debris and tephra in the air. The Mount St. Helens event in May 1980 cost the trade and commerce industry an estimated $50 million in only two days, as ships were unable to navigate the Columbia River. Clouds of ash often cause electrical storms that start fires and damp ash can short-circuit electrical systems and disrupt radio communication. Volcanic activity can also lead to the closure of nearby recreation areas as a safety precaution long before the activity ever culminates into an eruption.

11.5.5 Volcanic Eruption Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

Monitoring Volcanic Activity at Mount Rainier and Mount St. Helens

USGS and Pacific Northwest Seismograph Network at the University of Washington conduct seismic monitoring of all Cascade volcanoes in Washington and Oregon. The USGS collaborated with scientists from the Geophysics Program at the University of Washington to monitor seismic activity at both Mount St. Helens and Mount Rainier after the May 1980 eruption at Mount St. Helens. When unusual activity is observed, scientists immediately notify government officials and the public. The US Forest Service serves as the primary dissemination agency for emergency information. As the activity changes, USGS scientists provide updated advisories and meet with local, state, and federal officials to discuss the hazards and appropriate levels of emergency response. The experience since 1980 at Mount St. Helens and elsewhere indicates that monitoring is sufficient for scientists to detect the ascent of fresh magma that must take place before another large eruption. This information will enhance warnings and facilitate updated assessments of the hazard.

In addition, the USGS and the National Weather Service monitor lahar and flood hazards at Mount St. Helens. The latter agency has responsibility for providing warnings of floods, including lahars. These monitoring activities not only help nearby communities, but can also provide significant benefit to the Pacific Northwest, including Covington.

Volcanic Event Notification

An emergency coordination center (ECC) was established at the US Forest Service office in Vancouver, Washington after the 1980 eruption of Mount St. Helens. A communications network and telephone call-down procedure was developed to facilitate rapid dissemination of information about the activity of the volcano. Information was also disseminated through public meetings, press conferences, and briefings with governmental agencies and private businesses. Emergency coordination and communication is necessary to reduce lessee from potential volcanic eruptions in the Cascade region.

Warning Systems

The best warning of a volcanic eruption is one that specifies when and where an eruption is most likely to occur and what type and size eruption should be expected. Such accurate predictions are sometimes possible but still rare in volcanology. The most accurate warnings are those in which scientists indicate an eruption is probably only hours to days away based on significant changes in a volcano's earthquake activity, ground deformation, and gas emissions. Experience from around the world has shown that most eruptions are preceded by such changes over a period of days to weeks.

A volcano may begin to show signs of unrest several months to a few years before an eruption. In these cases, however, a warning that specifies when it might erupt months to years ahead of time are extremely rare. The strategy that the USGS-CVO uses to provide volcano warnings in the Cascade Range volcanoes in Washington and Oregon involves a series of alert levels that correspond generally to increasing levels of volcanic activity. As a volcano becomes increasingly active or as incoming data suggest that a given level of unrest is likely to lead to a significant eruption, the USGS-CVO declares a corresponding higher alert level. This alert level ranking thus offers the public and civil authorities a framework they can use to gauge and coordinate their response to a developing volcano emergency.

Education and Outreach

The USGS has developed educational volcanic hazards videos ("Understanding Volcanic Hazards" and "Reducing Volcanic Risk") that are designed to increase the public's awareness.

11.6 Wildfire Hazard

Fires are a natural part of the ecosystem in Washington. However, wildfires can present a substantial hazard to life and property in growing communities. There are potential for losses due to wildland/urban interface fires in Covington.

The past several summers' have been documented as some of the most destructive wildfire seasons ever recorded in the state. Historically, wildfires were generally started by lightning strikes. However, the vast majority of fires today (approximately 85 percent on DNR-protected lands) are attributed to human causes.

Many of these fires burned in wildland/urban interface areas and exceeded the fire suppression capabilities of those areas. The magnitude of these fires is the result of two primary factors: (1) severe drought, accompanied by a series of storms that produce thousands of lightning strikes and windy conditions; and (2) the effects of wildfire suppression over the past century that has led to buildup of brush and small diameter trees in the nation's forests and rangelands.

11.6.1 Wildfire Characteristics

There are three categories of interface fire:

- The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expenses of wildland areas;
- The mixed wildland/urban interface is characterized by isolated homes, subdivisions, and small communities situated predominantly in wildland settings; and
- The occluded wildland/urban interface exists where islands of wildland vegetation occur inside a largely urbanized area.

Certain conditions must be present for significant interface fires to occur. The most common conditions include: hot, dry, and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel, topography, weather, drought, and development.

11.6.2 The Interface

One challenge Covington faces regarding the wildfire hazard is from the increasing number of houses being built on the urban/rural fringe compared to twenty years ago. Since the 1970s, Washington's growing population has expanded further and further into traditional resource lands including forestlands. The "interface" between urban and suburban areas and the resource lands created by this expansion has produced a significant increase in threats to life and property from fires, and has pushed existing fire protection systems beyond original or current design and capability. Property owners in the interface are not aware of the problems and threats they face. Therefore, many owners have done very little to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

11.6.3 Fuel

Fuel is the material that feeds a fire, and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading," or the amount of available vegetative fuel. The type of fuel also influences wildfire. Washington, a western state with prevalent conifer, brush, and rangeland fuel types, is subject to more frequent wildfires than other regions of the nation. An important element in understanding the danger of wildfire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures, and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. After decades of fire suppression, "dog-hair" thickets have accumulated. These enable high intensity fires to flare and spread rapidly. Because of the many different possible "fuels" found in the interface landscape, firefighters have a difficult time predicting how fires will react or spread.

11.6.4 Topography

Topography influences the movement of air, thereby directing a fire's course. For example, if the percentage of uphill slope doubles, the rate of spread in wildfire will likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces upslope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildfire hazard mitigation and increased education and outreach to homeowners living in interface areas.

11.6.5 Weather

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

11.6.6 Drought

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. The term droughts applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions, and leave reservoirs and water tables lower. Drought leads to problems with irrigation, and may contribute to additional fires, or additional difficulties in fighting fires. However, most fuel types (not including grasses) require 2 or 3 years of drought before the fuel becomes dangerously dry.

11.6.7 Development

Growth and development in forested areas is increasing the number of human-made structures in the interface in Washington. Wildfire has an effect on development, yet development can also influence wildfire. Owners often prefer homes that are private, have scenic views, are nestled in vegetation, and use natural materials. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and firefighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself.

11.6.8 Wildfire Hazard Identification

Wildfire hazard areas are commonly identified in regions of the wildland/urban interface. Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control, such as the surrounding fuel load, weather, topography, and property characteristics.

11.6.9 Vulnerability and Risk

Covington residents are served by King County Fire District #37 and Maple Valley Fire and Life Safety District. Data that includes the location of interface areas in the City can be used to assess the population and total value of property at risk from wildfire, and direct these fire districts in fire prevention and recovery. Covington is in the process of identify and mapping wildfire hazard areas for the City from aerial photo data and GIS analysis under the direction of the Fire District and the Emergency Management Coordinator. Four-section aerial photography maps will be provided for each fire agency in the City, Fire District, and the Covington Emergency Operations Center. Each agency will receive map books to help define wildland interface areas, identify structures in the threatened areas, support local interpretation of wildland interface zones developed on a regional level, and provide a snapshot of vulnerability to assist mutual aid responders. Additional information layers (hydrants, hazardous materials facilities, schools, etc.) may be displayed, as data is available and requested. Maps will also be provided for each district.

The City has a number of acres that are susceptible to wildland fires. Including federal lands (BPA), the areas of potential wildfires comprise an estimated 20 percent of the City. The mitigation plan will have a direct impact on the health, welfare and safety of residents who live in or near areas of potential wildfires in Covington. The forthcoming wildfire hazard maps will assist City and fire districts and departments in developing fire plan to address the areas most vulnerable to wildfires in Covington.

Key factors included in assessing wildfire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence, and weather, as well as occurrences of drought. At the time of publication of this plan, data was insufficient to conduct a risk analysis. The National Wildland/Urban Fire Protection Program has developed the Wildland/Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildfire. For more information on wildfire hazard assessment refer to http//: www.Firewise.org.

11.6.10 Susceptibility to Wildfire

The forested hills surrounding the outskirts of the City are considered to be interface areas. The development of homes and other structures is encroaching onto the forest wildland and natural areas and is expanding the wildland/urban interface. The interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation, and natural fuels.

In the event of a wildfire, vegetation, structures, and other flammables can merge into unwieldy and unpredictable events. Factors germane to the fighting of such fires include access, firebreaks, proximity of water sources, distance from a fire station, and available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- Combustible roofing material
- Wood construction
- Structures with no defensible space
- Fire department with poor access to structures
- Subdivisions located in heavy natural fuel types
- Structures located on steep slopes covered with flammable vegetation
- Limited water supply
- Winds over 30 miles per hour

Road Access

Road access is a major issue for all emergency service providers. As development encroaches into the rural areas of the City, the number of houses without adequate turn-around space is increasing. Developers are not required to provide adequate space for emergency vehicles in single-family residential homes, causing emergency workers to have difficulty doing their jobs because they cannot access houses. As fire trucks are large, fire fighters are challenged by narrow roads and limited access. When there is doubt concerning the stability of a residential bridge, or adequate turn around space, the fire fighters can only work to remove the occupants, but cannot save the structure.

Fires may become conflagration fires caused by the reduced setbacks between structures. This narrow setback also prevents fire crews from safely laddering the sides of the buildings.

Water Supply

Fire fighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are adapting to these conditions by developing a secondary water source. Areas that once were considered rural during county control became urban with incorporation and annexation coupled with development.

11.6.11 Wildfire Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by City, regional, state, or federal agencies or organizations.

Local Programs

King County Fire District #37 serves Covington residents. The King County Fire District #37 (KFD) is an organization that promotes partnerships among the various fire service providers in the City. The County Zone 3 meets on a regular basis to ensure coordination of resources on a regional scale. The members of this zone are responsible for developing and maintaining the Fire and Emergency Resources Plan, which documents the available resources and defined protocol for providing large-scale emergency response and adequate levels of emergency services during an emergency. In addition to the KFD, many of the fire jurisdictions in the area have partnered to form mutual aid areas, to assist in fire prevention education and outreach, train Citizen Emergency Responders Teams (CERT), and ensure availability of resources.

The fire districts provide essential public services in the communities they serve, and their duties far surpass extinguishing characteristically outfitted with small diameter pipe water systems, inadequate for providing sustained fire fighting flows. Some rural fire districts are fires: In fact, many of the districts and departments provide other services to their jurisdictions, including Emergency Medical Technicians (EMT) and paramedics who can begin treatment and stabilize sick and injured patients before an ambulance arrives.

All of the fire service providers in the City are dedicated to fire prevention, and use their resources to educate the public to reduce the threat of the fire hazard, especially in the wildland/urban interface.

Fire prevention professionals throughout the City have taken the lead in providing many useful and educational services to Covington residents, such as:

- Home fire safety inspection;
- Assistance developing home fire escape plans;
- Business Inspections;
- Woodstove installation inspections;
- Free smoke detectors to district residents who qualify;
- Fire extinguisher operation classes;
- Citizen Emergency Response Team training;
- School, church, and civic group fire safety education presentations;

- Fire cause determination;
- Counseling for juvenile fire-setters;
- Teaching fire prevention in schools;
- Conducting CPR classes;
- Teaching proper use of fire extinguishers;
- Coordinating educational programs with other agencies, hospitals, and schools; and
- Answering citizens' questions regarding fire hazards.

City Codes

The Covington Municipal Code detail the setback, coverage, depth, corner vision, and structure height requirements of each development district to provide fire safety and protection of all structures. In addition, Section 510 in the Uniform Building Codes documents further fire resistant standards in regard to roofing. Building inspectors are responsible for enforcing these criteria in single-family residential structures. The Fire District works with the City Building Division to ensure safety in commercial structures.

11.7 Severe Storm Hazard

Severe winter storms pose a significant risk to life and property in Covington by creating conditions that disrupt essential regional systems such as public utilities, telecommunications, and transportation routes. Severe 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, however the Covington area has experienced similar storms from the Frazier River winds. Severe freezes, where high temperatures remain below freezing for five or more days, occur every 5 to 10 years in Covington. Severe or prolonged snow events occur less frequently, but have widespread impacts on people and property in the city.

11.7.1 Historical Severe Storm Events

Destructive storms producing heavy snow and ice have occurred throughout Covington's history, most notably in 1937, 1950 and 1996. A serious winter storm ("Seattle's Greatest Snowstorm") in February 1916 resulted in the death of 25 people in the Seattle area. Record snowfalls in Seattle created snowdrifts up to 25 feet in height, and resulted in a low temperature of 17 degrees

Fahrenheit. Schools and businesses were closed and flood damage was reported in downtown Seattle basements as the snow melted. All major highways were closed, blocking the main transportation arteries for travel and business. Seattle saw January snowfall of 23 inches, February snowfall of an additional 35 inches for a total of 58 inches. On February 1, Seattle recorded its maximum snowfall ever in a 24-hour period of 21.5 inches.

On January 13th, 1950 a severe winter storm produced "devastating wind and snow" over a five day period. During the night of January 13, the temperature fluctuated wildly, and was accompanied by thunder and heavy snow. The second highest snow falls on record in a 24-hour period of 21.4 inches. The accompanying winds ranged from 25 to 40 MPH. During 18 days in January the temperature remained below 32 degrees. Salt-water bodies within Puget Sound froze over to the point people could walk across the inlets. The temperature dropped about 20 degrees, then rose 20 degrees, and then dropped another 20 degrees within a 5-hour time span. Snow melted and then refroze as it hit the ground, creating dangerously icy roads. Power lines were knocked down, communications were severed, and roads and schools were closed. The resulting death toll of 13 in the Puget Sound area was the 2nd highest in record for a snow event.

11.7.2 Characteristics of Severe Storms

Weather Patterns

Severe winter storms affecting Covington typically originate in the Gulf of Alaska and in the central Pacific Ocean. These storms are most common from October through March. Most of King County has average annual precipitation of between 30 and 70 inches, with parts of the Coast Range in the west receiving over 70 inches. The National Climatic Data Center has established climate zones in the US for areas that have similar temperature and precipitation characteristics. Washington's latitude, topography, and nearness to the Pacific Ocean give the state diversified climates. The city's climate generally consists of wet winters and dryer summers.

Normal distribution of precipitation is about 50 percent of the annual total from December through February, lesser amounts in the spring and fall, and very little during summer months. There is an average of only five days per year of measurable snow with snowfall accumulations rarely measuring more than two inches.

Snow

While snow is relatively rare in western Washington, the break in the natural Cascades barrier, the Puget Sound, provides a low-level passage from the Frazier River in British Columbia between the Olympic and Cascade mountain ranges. Cold air, which lies in northern British Columbia, often moves southward through the Sound, and funnels cold air into the Seattle Metropolitan Area. If a wet Pacific storm happens to reach the area at the same time, larger than average snow events may result when the Pacific storm rises over the colder Frazer River air mass.

An example of this type of snowstorm event occurred in January 1996, when strong storms, accompanied by snow, ice, wind, and freezing rain hit western Washington. Impacts in the Seattle area alone included one fatality, 250,000 customers left without power or phone service for several days, and 125 boats, with a combined value of over $3 million dollars, sank in the Puget Sound area as boat houses collapsed under the weight of the snow and ice.

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 Cascade foothills. As noted above, the Puget Sound is the most significant north-south air passage through between the Cascades and Olympics. Rain originating from the west can fall on frozen streets, cars, and other sub-freezing surfaces, creating dangerous conditions.

Windstorms

When a strong windstorm strikes a community, it leaves behind a distinctive trail. Trees toppled over on buildings and cars, downed power lines crisscrossing the roads, and widespread power outages are a few of the signs that a windstorm has struck. After such an event, it can take communities days, weeks, or longer to return to normal activities. In addition to costly structural damages, windstorms can cause injury or even death.

A windstorm on January 20, 1993 damaged numerous homes, businesses, and public facilities, generated tons of disaster-related debris, and caused local governments to spend several million dollars to deal with the storm's impact throughout the state. Washington received $130 million through the FEMA Public Assistance program to repair and restore damaged infrastructure. While Covington did not receive a Presidential Disaster Declaration, as it was not a city yet, for this storm, many other cities and counties in the state did, illustrating the severity of these storms. This storm claimed five lives and left over 750,000 homes and business without power.

The most frequent surface winds in Washington are from the southwest. These widespread winds are associated with storms moving onto the coast from the Pacific Ocean. Winds coming from the south are the most destructive. The Columbus Day Storm of 1962 was an example of this type of windstorm. Chinook winds are strong easterly winds coming down the western face of the Cascade Range. Chinook is a native Indian word meaning "snow eater." The Chinook wind is a warm dry wind that often leads to the rapid disappearance of snow, and can gust up to 100 miles per hour. The gusts are caused by rapid atmospheric pressure changes. Studies have shown that these changes can result in physiological and psychological reactions in humans such as headaches and increased irritability.

West winds generate from the Pacific Ocean and are strong along the coast, but slow down inland due to the obstruction of the Coastal and Cascade mountain ranges. Prevailing winds in Washington vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. However, local topography plays a major role in affecting wind direction. For example, the north-south orientation of the Puget Sound channels the wind most of the time, causing predominately north and south winds.

Tornadoes

Tornadoes are the most concentrated and violent storms produced by the earth's atmosphere. They are created by a vortex of rotating winds and strong vertical motion, which possess remarkable strength and cause widespread damage. Wind speeds in excess of 300 mph have been observed within tornadoes, and it is suspected that some tornado winds exceed 400 mph. The low pressure at the center of a tornado can destroy buildings and other structures it passes over. Tornadoes are most common in the Midwest, and are more infrequent and generally small west of the Rockies. Nonetheless, Washington and other western states have experienced tornadoes on occasion, many of which have produced significant damage and occasionally injury or death.

Washington's tornadoes can be formed in association with large Pacific storms arriving from the west. Most of them however, are caused by intense local thunderstorms. These storms also produce lightning, hail, and heavy rain, and are more common during the warm season from April to October.

11.7.3 Severe Winter Storm Hazard Identification

A severe winter storm is generally a prolonged event involving snow or ice. The characteristics of severe winter storms are determined by the amount and extent of snow or ice, air temperature, wind speed, and event duration. Severe storms can affect the city from the northwest and southeast, and from the western slopes of the Cascade Mountains. If a severe ice storm occurs within Covington, there may be prolonged power outages over widespread areas. The probability of such an ice storm is uncertain due to limited historical records, but is considered less likely than a severe ice storm in the Puget Sound area, given the usual meteorological patterns for the area. The National Weather Service, Seattle Bureau, monitors the stations and provides public warnings on storm, snow, and ice events as appropriate.

Vulnerability and Risk

A vulnerability assessment that describes the number of lives or amount of property exposed to elements of severe winter storms has not yet been conducted for Covington. However, severe winter storms can cause power outages, transportation and economic disruptions, and pose a high risk for injuries and loss of life. The events can also require needed shelter and care for adversely impacted individuals. The city has suffered severe winter storms in the past that brought economic hardship and affected the life safety of city residents.

Factors included in assessing severe winter storm risk include population and property distribution in the hazard area, the frequency of severe winter storm events, and information on trees, utilities, and infrastructure that may be impacted by severe winter storms. When sufficient data is collected for hazard identification and vulnerability assessment, a risk analysis can be completed. Insufficient data currently exists to complete a risk analysis.

11.7.4 Wind Storm Hazard Assessment

A windstorm is generally a short duration event involving straight-line winds and/or gusts in excess of 50 mph. Windstorms affect areas of the city 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 and power lines, and cause other property damage. Mountainous sections of the city experience much higher winds under more varied conditions. Because of the local nature of wind hazards in the mountains, a high-resolution wind speed map would be required to accurately identify the degree of wind hazard throughout the city.

Windstorms can cause power outages, transportation, and economic disruptions, and significant property damage and pose a high risk for injuries and loss of life. They can also be typified by a need to shelter and care for individuals impacted by the events. Several destructive windstorms, (most notably the 1962 Columbus Day storm and the January 20, 1993 windstorm) brought economic hardship and affected the life safety of city residents. Future windstorms may cause similar impacts citywide.

11.7.5 Susceptibility to Winter Storms

Life and Property

Winter storms are deceptive killers. Many of the deaths that occur are indirectly related to the actual storm, including deaths resulting from traffic accidents on icy roads, heart attacks while shoveling snow, and hypothermia from prolonged exposure to the cold. Property is at risk due to flooding and landslides resulting from heavy snow melt. Trees, power lines, telephone lines, and television and radio antennas can be impacted by ice, wind, snow, and falling trees and limbs. Saturated soil can cause trees to lose their ability to stand and fall on houses, cars, utilities, and other property. Similarly, if streets are icy, it is difficult for emergency personnel to travel and may pose a secondary threat to life if police, fire, and medical personnel cannot respond to calls.

Roads and Bridges

Snow and ice events resulting in icy road conditions can lead to major traffic accidents. Roads blocked by fallen trees during a windstorm may have tragic consequences for people who need access to emergency services. The ability to travel after a natural hazard event is a priority issue for city residents, organizations, and providers of essential services such as hospitals and utilities.

Power Lines

Historically, falling trees have been the major cause of power outages resulting in interruption of services and damaged property. In addition, falling trees can bring electric power lines down, creating the possibility of lethal electric shock. Snow and ice can also damage utility lines and cause prolonged power outages. Rising population growth and new infrastructure in the city creates a higher probability for damage to occur from severe winter storms as more life and property are exposed to risk.

Water Lines

The most frequent water system problem related to cold weather is a break in cast iron mainlines. Breaks frequently occur during severe freeze events, as well as during extreme cooling periods during the months of October, November, and December. Another common problem during severe freeze events is the failure of commercial and residential water lines. Inadequately insulated potable water and fire sprinkler pipes can rupture and cause extensive damage to property.

11.7.6 Severe Storm Hazard Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by city, regional, state, or federal agencies or organizations.

City and Water Districts

All of the water districts in the city are in the process of replacing old cast iron pipes with more ductile iron pipes, which will be more resilient in disaster situations. When disasters occur, water districts in the region work together to provide water for Covington citizens. For example, Ham Water District has inter-ties with District 111 for emergency situations.

Puget Sound Energy

Through the Right Tree-Right Place program, PSE educates homeowners, landscapers, and tree propagators on tree species that will not be subject to ongoing stress by constant trimming. PSE distributes brochures that list low-growing trees that fit within the utility right-of-way and are compatible with small urban planting stripe. The brochure includes information on how to select the correct tree, the energy-saving benefits of trees, and proper planting and pruning techniques. PSE offers tree owners a certificate to help defray the cost of a new tree that replaces one that is inappropriate. PSE also runs a tree-trimming program and keeps a database of information in order to build profiles of trees that cause power line outages. PSE foresters work with local government and the public to assess and identify situations in which trees or power lines put life and property at risk. Calls and fares to PSE's tree-trimming program result in immediate response by PSE to clear roads of fallen trees. PSE's database of tree failures intends to identify those trees at, an above-average risk.

National Weather Service

The Seattle Office of the National Weather Service issues severe winter storm watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NMFS weather radio and are forwarded to the local media for re-transmission using the Emergency Alert System.

11.7.7 Susceptibility to Windstorms

Life and Property

Windstorms have the ability to cause damage over 100 miles from the center of storm activity. Isolated wind phenomena in the mountainous regions have more localized effects. Winds impacting walls, doors, windows, and roofs, may cause structural components to fail. Wind pressure can create a direct and 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. As positive and negative forces impact the building's protective envelope (doors, windows, and walls), the result can be roof or building component failures and considerable structural damage.

Debris carried along by extreme winds can directly contribute to loss of life and indirectly to the failure of protective building envelopes, aiding, or walls of buildings. When severe windstorms strike a community, downed trees, power lines, and damaged property can be major hindrances to emergency response and disaster recovery.

Infrastructure

Storm winds can damage buildings, power lines, and other property and infrastructure due to falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds.

Windstorms can result in collapsed or damaged buildings, damaged or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric service and from 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 windstorms related to both physical damages and interrupted services.

Utilities

Historically, falling trees have been the major cause of power outages in Covington. Windstorms can cause flying debris and downed utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Utility lines brought down by summer thunderstorms have also been known to cause fires, which start in dry roadside vegetation. Falling trees can bring electric power lines down to the pavement, creating the possibility of lethal electric shock. Rising population growth and new infrastructure in the city creates a higher probability for damage to occur from windstorms as more life and property are exposed to risk.

11.7.8 Wind Storm Mitigation Activities

One of the most common problems associated with windstorms is power outage. High winds commonly occur during winter storms, and can cause trees to bend, sag, or fail (tree limbs or entire trees), coming into contact with nearby distribution power lines. Fallen trees can cause short-circuiting and conductor overloading. Wind-induced damage to the power system causes power outages to customers, incurs cost to make repairs, and in some cases can lead to ignitions that start wild land fires. The basic strategy adopted by power companies to avoid wind-induced damage is to maintain adequate separation between its transmission circuits and trees. This is done with tree height limitations and ongoing tree trimming. In addition, PSE, the primary power provider for Covington residents, maintains an inventory of tree failures by type of tree, wind speed, type of stand, and type of failure. PSE uses this data to identify the most appropriate vegetation for withstanding windstorms, and further advises customers in vegetative planting and pruning.

11.8 Goals and Policies

This section describes the goals and policies developed as a result of the natural hazard mitigation planning process undertaken by the City. These strategies and policies evolved from analyses done for the Covington Hazard Mitigation Action Plan, prepared by the Covington Department of Public Works, including risk evaluation and identification of suggested mitigation strategies for natural hazards.

NHG 1.0 Reduce city and public exposure to floods, landslides, earthquakes and volcanic eruptions, wildfires and severe storms to minimize reliance on federal and state programs for natural disaster mitigation; protect public and private property; save lives; and use community resources wisely.

NHP 1.1 Integrate the goals and action items from the Covington Hazard Mitigation Plan and Emergency Action Plan into existing *regulatory documents and programs, where appropriate.*

a. *Use mitigation planning to help the city Comprehensive Plan meet State GMA Goals, designed to protect life and property from natural disasters and hazards through planning strategies that restrict development in areas of known hazards;*

b. *Integrate the city's mitigation planning into current capital improvement plans to ensure that development does not encroach on known hazard areas; and*

c. *Partner with other organizations and agencies with similar goals to promote building codes that are more disaster resistant at the state level.*

NHP 1.2 *Identify and pursue funding opportunities to develop and implement local and city natural hazard mitigation activities.*

a. *Explore incentives for local governments, citizens, and businesses to pursue hazard mitigation projects; and*

b. *Allocate city resources and assistance to mitigation projects when possible.*

NHP 1.3 *Conduct a full review of the Hazard Mitigation Action Plan every 5 years by evaluating hazard mitigation successes, failures, and areas that were not addressed and update the plan as necessary to reflect new information.*

NHP 1.4 *Develop inventories of at-risk buildings and infrastructure and prioritize mitigation projects.*

a. *Identify critical facilities at risk from hazard events and develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should a hazard event(s) cause damages to the facilities in question.*

NHP 1.5 *Strengthen emergency services preparedness and response by linking* *emergency services with natural hazard mitigation programs, and enhancing public education on a regional scale.*

a. *Encourage individual and family preparedness through public education projects such as safety fairs.*
b. *Coordinate the maintenance of emergency transportation routes though communication among the City and County Roads Departments, neighboring jurisdictions, and the Washington State Department of Transportation.*
c. *Identify opportunities for partnering with citizens, private contractors, and other jurisdictions to increase availability of equipment and manpower for efficiency of response efforts.*
d. *Work with Kent Fire District #37 and other neighborhood groups to establish Community Emergency Response Teams (C.E.R.T.).*
e. *Familiarize public officials of requirements regarding public assistance for disaster response.*
f. *Make the Covington's Hazard Mitigation Plan available to the public by publishing the plan electronically on the city and emergency management websites.*
g. *Conduct workshops for public and private sector organizations to raise awareness of mitigation activities and programs and develop outreach materials for mitigation, preparedness, response and recovery.*
h. *Distribute information about flood, fire, earthquake, and other forms of natural and technological hazards insurance to property owners in areas identified to be at risk through hazard mapping.*

NHP 1.6 *Use technical knowledge of natural ecosystems and events to link natural resource management and land use* *planning to mitigation activities and technical assistance.*

a. Review ordinances that protect natural systems and resources to mitigate for hazards for possible enhancements.

b. Pursue vegetation and restoration practices that assist in enhancing and restoring the natural and beneficial functions of the watershed.

c. Develop education and outreach programs that focus on protecting natural systems as a mitigation activity.

11.8.1 Flood Hazard Mitigation

NHG 2.0 Analyze each repetitive flood property within Covington and identify feasible mitigation options and recommend revisions to requirements for development within the floodplain, where appropriate.

NHP 2.1 Identify appropriate and feasible mitigation activities for identified repetitive flood properties. Funding may be available through FEMA's Hazard Mitigation Grant and Flood Mitigation Assistance Programs and the Pre-disaster Mitigation Program.

NHP 2.2 Evaluate elevation requirements for new residential and new residential structures in the unincorporated floodplain area identify opportunities to upgrade Federal Insurance Rate Maps.

NHP 2.3 Develop a comprehensive strategy for acquiring and managing floodplain open space in Covington. Such a strategy should include the following activities:

a. Explore funding for property acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations, trails programs, fish programs as well as options for special appropriations;

b. Identify sites where environmental restoration work can benefit flood *mitigation, fish habitat, and water quality;*

c. *Work with landowners to develop flood management practices that provide healthy fish habitat.*

NHP 2.4 *Prepare an inventory of major urban drainage problems, and identify causes and potential mitigation actions for urban drainage problem areas.*

11.8.2 Landslide Hazard Mitigation

NHG 3.0 Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard prone areas.

NHP 3.1 *Increase use of soils mapping and landslide hazard area maps as Building Section review tools.*

NHP 3.2 *Educate high-risk populations about climatic and soil conditions that are conducive to landslides.*

11.8.3 Earthquake & Volcanic Eruption Hazard Mitigation

NHG 4.0 Identify specific activities that agencies, organizations, and residents in Covington can undertake to reduce risk and prevent loss from earthquake and volcanic eruption events.

NHP 4.1 *Conduct risk analysis incorporating best available data and the created hazard maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities and assessing the adequacy of current land use requirements.*

NHP 4.2 *Identify funding sources for structural and nonstructural retrofitting of structures that are identified as seismically vulnerable and provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.).*

NHP 4.3 *Encourage purchase of earthquake hazard insurance and coordinate with insurance companies and organizations such as the Insurance Information Service of*

Washington to produce and distribute earthquake insurance information.

NHP 4.4 Encourage seismic strength evaluations of critical facilities in the city to identify vulnerabilities for mitigation of schools, public infrastructure, and critical facilities to meet current seismic standards.

NHP 4.5 Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices.

NHP 4.6 Strengthen response and recovery programs, and develop and implementation public education programs for volcanic eruption hazards.

11.8.4 Wildfire Hazard Mitigation

NHG 5.0 Increase communication, coordination, and collaboration between wildland/urban interface property owners, local and City officials, and fire prevention crews and officials to address risks, existing mitigation measures, and federal assistance programs.

NHP 5.1 Update wildland/urban interface maps; conduct risk analysis incorporating data and the created hazard maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities.

NHP 5.2 Visit urban interface neighborhoods and rural areas and conduct education and outreach activities; conduct specific community-based demonstration projects of fire prevention and mitigation in the urban interface.

NHP 5.3 Encourage local zoning and planning entities to work closely with landowners and/or developers who choose to build in the wildland/urban interface to identify and mitigate conditions that aggravate wildland/urban interface wildfire hazards, including:

a. Limited access for emergency equipment due to width and grade of roadways;

b. Inadequate water supplies and the spacing, consistency, and species of vegetation around structures;

c. Inadequate fuel breaks, or lack of defensible space;

d. Highly flammable construction materials;

e. Building lots and subdivisions that are not in compliance with state and local land use and fire protection regulations; and

f. Inadequate entry/escape routes.

NHP 5.4 Encourage all new homes and major remodels involving roofs or additions that are located in the interface to have fire resistant roofs and residential sprinkler systems; and encourage the public to evaluate access routes to rural homes for firefighting vehicles and to develop passable routes if they do not exist.

11.8.5 Severe Storm Hazard Mitigation

NHG 6.0 Develop and implement programs to coordinate maintenance and mitigation activities to reduce risk to public infrastructure from severe winter storms.

NHP 6.1 Develop coordinated management strategies for de-icing roads, plowing snow, clearing roads of fallen trees, and clearing debris from public and private property; partner with responsible agencies and organizations to design and implement programs that reduce risk to life, property, and utility systems; and develop partnerships between utility providers and city and local public works agencies to document known hazard areas.

NHP 6.2 Partner with responsible agencies and organizations to design and disseminate education information to property owners to reduce risk from tree failure to life, property, and utility systems; and identify potentially hazardous trees in urban areas.

NHP 6.3 Increase the use of underground utilities where possible.