

City of Castle Rock Annex to the Natural Hazards Mitigation Plan for Cowlitz County

Draft Update: April 11, 2011

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Placeholder for Adopting Resolution

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I. Introduction

Through this update of the 2005 Hazard Mitigation Plan and associated mitigation efforts, the City of Castle Rock continues to make the population, neighborhoods, and facilities of the city more resistant to the impacts of future disasters. The city now has undertaken a comprehensive, detailed updated evaluation of the vulnerabilities of the city to specific types of future natural hazards in order to identify ways to make the city be more resistant to their impacts. This document reports the results of that planning process.

The City of Castle Rock's vision is to create a disaster-resistant future for the entire city by having:

- Hindsight into the mistakes of the past that made the city more vulnerable to the impacts of disasters.
- Insight into how the city is currently vulnerable to the impacts of disasters.
- Foresight on the means to make the city more resistant to the impacts of future disasters.
- Creation of a disaster-resistant community by the Year 2020.

A. Mission

The mission of the City of Castle Rock Hazard Mitigation Plan update is to continue promoting sound public policy designed to protect citizens, critical facilities, infrastructure, private property and the environment from natural, technological, and societal hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss prevention, and identifying activities to guide the city towards building a safer, more sustainable community.

B. Purpose

The Disaster Mitigation Act of 2000 (DMA2000), Section 322 (a-d) requires that local governments, as a condition of receiving federal disaster mitigation funds, have a mitigation plan that describes the process for identifying hazards, risks and vulnerabilities; identifying and prioritizing mitigation actions; encouraging the development of local mitigation activities; and providing technical support for those efforts.

The purpose of this plan is to fulfill Local Hazard Mitigation Plan update requirements. The plan will identify hazards, establish community goals and objectives and select mitigation activities that are appropriate for the City of Castle Rock.

C. Goals and Objectives

The plan goals describe the overall direction that the City of Castle Rock can take to work towards mitigating risks from natural, technological and societal hazards. The goals

are stepping stones between the broad direction of the mission statement and the specific recommendations outlined in the hazard mitigation initiatives. The goals and objectives help to focus the efforts of the jurisdiction in the mitigation planning effort to achieve an end result that matches the community's unique set of needs, interests and desires.

1. Protect Life

- Improve systems that provide warning and emergency communications.
- Develop or amend local codes/ordinances so they effectively address hazard mitigation.
- Reduce the impacts of hazards on vulnerable populations.
- Strengthen local building code enforcement.
- Train emergency responders.

2. Protect Property

- Protect critical assets.
- Protect and preserve facility contents.
- Reduce repetitive losses, including those caused by flooding.

3. Promote a Sustainable Economy

- Form partnerships to leverage and share resources.
- Continue critical business operations.

4. Protect the Environment

- Develop hazard mitigation policies that protect the environment.

5. Increase Public Preparedness for Disasters

- Understand natural, technological and societal hazards and the risk they pose.
- Improve hazard information, including databases and maps.
- Improve public knowledge of hazards and protective measures so individuals appropriately respond during hazard events.
- Develop new policies to enhance hazard mitigation initiatives.

D. Scope

1. Jurisdiction

The Cowlitz County Hazard Mitigation Update Basic Plan includes jurisdiction-specific plans for each of the political subdivisions in Cowlitz County. The scope of this jurisdiction-specific plan is limited to facilities, systems and infrastructure located within the legal geographic boundaries of the City of Castle Rock.

2. Hazards

For purposes of assisting in hazard identification, the City of Castle Rock utilized the following:

- Hazard identification list from the 2005 Hazard Mitigation Plan.
- City Critical Areas data

This information is available in detail in the Cowlitz County Hazard Mitigation Basic Plan.

E. Limitations

1. The development of a Local Hazard Mitigation Plan does not provide a guarantee that the City of Castle Rock can implement any or all of the hazard mitigation initiatives identified. The ability of the city to implement one or more of the hazard mitigation initiatives included in the plan is contingent upon the ability of the city to obtain the resources and/or funding necessary to support the costs of implementing the mitigation project/program.

2. The City of Castle Rock is not limited to implementing only those initiatives identified in the plan. The city has the flexibility to add, delete or modify the hazard mitigation initiatives identified during this initial planning period in order to best meet their needs.

3. Proposed hazard mitigation initiatives were developed utilizing the knowledge and expertise of city staff, and based on readily available information.

II. Jurisdiction Description

A. Summary Description

The City of Castle Rock was founded along the banks of the Cowlitz River in the 1870's and was incorporated as a town in June 1890. Interstate 5 and the main North/South rail line between Portland, Oregon and Seattle, Washington bisect the city. Castle Rock is located along the Cowlitz River. Castle Rock is 15 miles North of Longview/Kelso, 61 miles North of Portland, Oregon, and 110 miles south of Seattle. The city covers 1.3 square miles and has a population of 2,150 people.

Historically, the City of Castle Rock has experienced significant damage from flooding and severe winter storm. The jurisdiction is vulnerable to all of the high-risk County hazards (flooding, earthquake, severe winter storm, high winds), as well as volcanic activity.

The City of Castle Rock has been through six Presidentially Declared Disasters since 1995. The total eligible loss was \$294,707

The 1995 Flood/Winter Storm and the Floods of 1996 caused damage to the sanitary sewer system, stormwater system and drinking water. The well for drinking water was contaminated and had to be cleaned, the digester for the wastewater treatment plant became clogged with flood debris, and there was some flooding of citizens' basements. The City of Castle Rock received \$31,075 for the 1995 event and \$109,814 for the 1996 event.

The 1996/1997 Winter Storm caused damage to the circuits at the water plant as a result of a power outage and landslide. Eligible losses for this event were \$8,341.

In November, 2006, winter storms caused flooding and landslides causing damage to streets, paved trails, the wastewater treatment plant, sewer collection system and a stormwater pump totaling \$78,401.

A winter storm in December, 2008/January, 2009 caused \$12,361 worth of damage to various city streets and the Public Works Shop Complex.

In January, 2009 winter storms caused flooding and landslides causing damage to streets, paved trails, the water treatment plant, sewer collection system and the stormwater collection system totaling \$54,715.

RISK ASSESSMENT

Introduction

The risk assessment provides information about the hazards that threaten Castle Rock. This information provides the factual basis to identify and support a strategy that can effectively mitigate the effects of the hazards that threaten this jurisdiction's safety and challenge its ability to perform essential functions.

The content and structure of this plan's risk assessment was developed using the Federal Emergency Management Agency's (FEMA) 2008 "Local Multi-Hazard Mitigation Planning Guidance." The table below shows the Disaster Mitigation Act (DMA) Risk Assessment Planning Requirements that must be met in order for this plan to receive a "satisfactory" score. Each of these planning requirements is met through the information contained in both the regional risk assessment and in this local annex.

Disaster Mitigation Act Risk Assessment Planning Requirements

DMA Section	Requirement
§201.6(c)(2)(i):	[The risk assessment shall include a] description of the type ... of all natural hazards that can affect the jurisdiction ...
§201.6(c)(2)(i):	[The risk assessment shall include a] description of the ... location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.
§201.6(c)(2)(ii):	[The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community.
§201.6(c)(2)(ii):	[The risk assessment in all] plans approved after October 1, 2008 must also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.
§201.6(c)(2)(ii)(A):	The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas ...
§201.6(c)(2)(ii)(B):	[The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate ...
§201.6(c)(2)(ii)(C):	[The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.
§201.6(c)(2)(iii):	For multi-jurisdictional plans, the risk assessment must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

In general the Federal DMA planning requirements with the words "**shall**" and "**must**" indicate that the item is mandatory and must be included in the plan, otherwise it will not be approved by FEMA. Regulations with the word "**should**" indicate that the item is strongly recommended to be included in the plan, but its absence will not cause FEMA to disapprove the plan.

Hazard Analysis Definitions

The adjective descriptors (High, Moderate, and Low) for each hazard's probability of occurrence, vulnerability, and risk rating are consistent with the terms used in the regional assessment.

The following terms are used in this plan to analyze and summarize the risk of the hazards that threaten this jurisdiction:

Risk Rating:

An adjective description (High, Moderate, or Low) of the overall threat posed by a hazard is assessed for the next 25 years. Risk is the subjective estimate of the combination of any given hazard's probability of occurrence and vulnerability.

- High: There is strong potential for a disaster of major proportions during the next 25 years; or History suggests the occurrence of multiple disasters of moderate proportions during the next 25 years.
- Moderate: There is medium potential for a disaster of less than major proportions during the next 25 years.
- Low: There is little potential for a disaster during the next 25 years.

Probability of Occurrence:

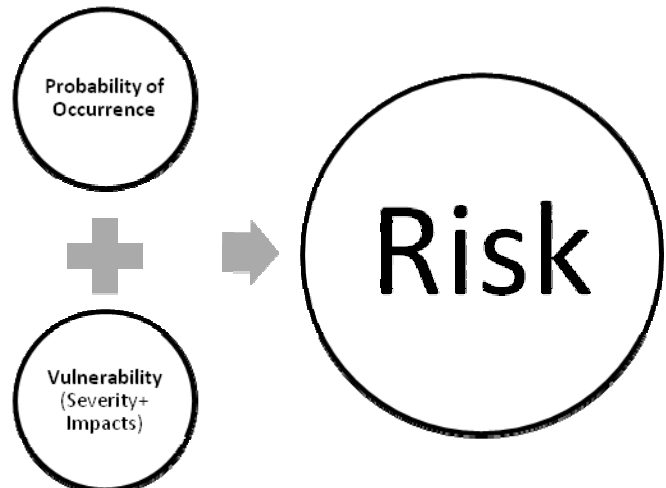
An adjective description (High, Medium, or Low) of the probability of a hazard impacting the jurisdiction within the next 25 years.

- High: There is great likelihood that a hazardous event will occur within the next 25 years.
- Moderate: There is medium likelihood that a hazardous event will occur within the next 25 years.
- Low: There is little likelihood that a hazardous event will occur within the next 25 years.

Vulnerability:

Vulnerability can be expressed as combination of the severity of a natural hazard's effect and its consequential impacts to the community. An adjective description (High, Medium, or Low) of the potential impact a hazard could have on the community. It considers the population, property, commerce, infrastructure and services at risk relative to the entire jurisdiction.

- High: The total population, property, commerce, infrastructure and services of the community are uniformly exposed to the effects of a hazard of potentially great magnitude. In a worse case scenario, there could be a disaster of major to catastrophic proportions.



Risk is a subjective estimate of the combination of a hazard's probability of occurrence and a community's vulnerability.

- **Moderate:** The total population, property, commerce, infrastructure, and services of the community are exposed to the effects of a hazard of moderate influence; or the total population, property, commerce, infrastructure, and services of the community are exposed to the effects of a hazard of moderate influence, but not all to the same degree; or an important segment of population, property, commerce, infrastructure and services of the community are exposed to the effects of a hazard. In a worst case scenario there could be a disaster of moderate to major, though not catastrophic, proportions.
- **Low:** A limited area or segment of population, property, commerce, infrastructure, or service is exposed to the effects of a hazard. In a worst case scenario, there could be a disaster of minor to moderate proportions.

Summary Risk Assessment

Based on the regional risk assessment and the local risk assessment in the subsequent section, the following hazards pose the greatest threat to Castle Rock.

Hazard	Probability of Occurrence	Vulnerability	Risk
Earthquake	Moderate	Moderate	High
Storm	High	Moderate	Moderate
Flood	Low	Low	Low
Landslide	Low	Low	Low
Wildland Fire	Low	Low	Low
Volcanic Event	Moderate	Moderate	High

Local Risk Assessment

A comprehensive risk assessment of the major natural hazards that threaten Castle Rock was developed for this plan through the regional risk assessment process described in Chapter 4.0. The regional risk assessment and its hazard profiles serve as the foundation for this jurisdiction's risk assessment. A list of all of the potential natural hazards that could impact this jurisdiction is located in Chapter 4. Chapter 4 includes six natural hazard profiles for earthquake, storm, flood, landslide, wildland fire, and volcanic events. Each profile defines the hazard and describes its effects, severity, impacts, probability of occurrence, and historical occurrences. The regional profiles describe this jurisdiction's local vulnerabilities in terms of the portion of the jurisdiction's land base or service area, population, employment, dwelling units, jurisdiction-owned assets, and critical facilities that are within each hazard zone.

This section of the plan provides additional details or explains differences where this jurisdiction's risks for each hazard vary from the risks facing the entire planning area. Maps of the hazards that affect Castle Rock are scaled to local boundaries and are included in this section.

Earthquake

Severity

There are several common measures of earthquakes. The Richter Magnitude Scale (used in this hazard profile) is a mathematical scale which measures the intensity of ground motion. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a ten-fold increase in measured amplitude, and 31 times more energy released. The Modified Mercalli Intensity Scale measures the earthquake intensity by the damage it causes. Peak ground acceleration (PGA) is a measure of the strength of ground movements. It expresses an earthquake's severity by comparing its acceleration to the normal acceleration due to gravity.

The severity of an earthquake is also dependent upon the source of the quake. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter. Three kinds of earthquakes are recognized in the Pacific Northwest: crustal earthquakes, subduction zone earthquakes, and deep earthquakes.

1. Crustal (shallow) earthquakes occur along faults close to the surface of the North American plate. They have a maximum depth of about 19 miles, though most occur much closer to the surface. The majority of earthquakes in the Pacific Northwest are of the shallow type. They could potentially produce magnitudes as high as 7.5, though most are less than 3.0. Scientists are locating and studying active faults that are located within the Puget Sound lowlands. The Seattle fault is perhaps the most infamous as it lies under the most densely populated area of the state. A magnitude 6.0 or greater earthquake originating from a surface fault could render incredible destruction. More research is necessary to verify the existence of the Olympia fault structure and its probability of rupturing.
2. Subduction zone or interplate earthquakes emanate from the boundary where the Juan de Fuca plate subducts eastward into the North American Plate. The width of the Cascadia Subduction Zone fault varies along its length, depending on the temperature of the subducted oceanic slab, which heats up as it is pushed deeper beneath the continent. As it becomes hotter and more molten it eventually loses the ability to store mechanical stress and generate earthquakes. An earthquake from this zone would be considered "the Big One," as it could travel over hundreds of miles and last for several minutes. Subduction zone earthquakes are considered to be the most destructive with potential magnitudes of 9.0 or greater. The last subduction zone earthquake is believed to have occurred in 1700.
3. Deep earthquakes occur along faults in the Juan de Fuca plate as it sinks beneath the North American plate. These earthquakes are located under the North American Plate; therefore their energy translation to the surface is buffered by their depth. Their depths generally range from 16-62 miles. Magnitudes of 7.5 have been recorded. The 1949, 1965, and 2001 earthquakes all emanated from this zone. The 2001 Nisqually earthquake's focus was located about 32 miles deep below its epicenter on Anderson Island.

Impacts

The impact from earthquakes to communities is well evidenced by the catastrophic events in San Francisco and Los Angeles in the United States; Kobe, Japan; Chengdu, China; and Kashmir, Pakistan. Failed buildings, bridges, and other structures can trap or bury people causing injury and death. Damage to infrastructure such as roads, bridges, rail lines, runways, and almost all types of utilities is certain. Infrastructural failures can result in loss of public and private sector services and business. Communities are likely to face communication, electricity, motor fuel, and natural gas disruptions. Structural fires are a secondary hazard from earthquake destruction. Individuals and households may be displaced due to damaged homes. A subsequent economic downturn would likely result from major transportation disruptions and loss of revenue from suspended business and services.

In the Southwest Washington area, older unreinforced masonry structures such as buildings, walls, chimneys, and facades are vulnerable to crumbling from ground shaking. Areas with soft soils, such as downtown Castle Rock have experienced these types of destruction during the 1949, 1965, and 2001 earthquakes.

Fire fighters, police, public works, and other safety and emergency personnel can quickly become over extended with response and recovery operations. Transportation disruptions will hinder emergency response to remote or hard to reach areas. Building and structural inspections will become priorities for public works and development services personnel and disrupt other operations.

The Washington State Hazard Mitigation Plan cites a study of an earthquake scenario of immense destruction and casualties. Should a magnitude 6.7 earthquake emanate from the Seattle Fault, a shallow crustal fault, the central Puget Sound could experience:

- Complete damage to at least 58,000 buildings, costing \$36 billion
- More than 55,000 displaced households
- Possibly 2,400 deaths
- 800 injuries requiring hospitalization

Although tsunamis are known to impact the coast of Washington, the Region is unlikely to be impacted by this hazard. Should the Washington coast be struck, the entire region could be indirectly affected by evacuating populations. Castle Rock could likely be challenged with response and recovery support assistance to affected populations and communities.

Probability of Occurrence

Earthquakes are certain to impact the Region in the future. The following probabilities of occurrence for the three earthquake sources are offered by the Washington State Hazard Mitigation Plan:

- Crustal Earthquake - A magnitude 6.5 or greater earthquake is estimated to occur once about every 333 years in the Puget Sound Lowlands
- Subduction Zone Earthquake - A magnitude 9.0 earthquake is estimated to recur every 350 to 500 years.
- Deep Earthquakes - Five magnitude 6 or greater earthquakes have occurred in the Puget Sound basin since 1900. Since 2001, the Cowlitz region has been rocked by three deep earthquakes; spaced 16 and 36 years apart since 1949 and 1965 respectively (about every 26 years). It is estimated that a magnitude 7.1 earthquake (1949 type event) will occur every 110 years.

Regardless the source of earthquake, past events suggest that a destructive event reoccurs about every 26 years. Therefore, the overall probability of occurrence of a damaging earthquake is high.

Historical Occurrences and Impacts Specific to this Jurisdiction

February 28, 2001, Federal Disaster 1361: Nisqually Earthquake

At 10:54 a.m. a magnitude 6.8 earthquake produced strong ground shaking across Washington State. The epicenter was located near Anderson Island, approximately 11 miles north of Olympia near the Nisqually River Delta. The focus was located nearly 32 miles underground. The depth of the earthquake minimized the intensity of the shaking and limited the impact to the built environment. In addition, drought conditions in Washington reduced the number of landslides and amount of liquefaction that would have otherwise been caused by a quake of that magnitude with saturated soils. Nevertheless, the observations of geotechnical engineers indicate that liquefaction was widespread in parts of the Puget Sound. Several significant lateral spreads, embankment slides, and landslides also occurred. The relatively long duration of the event and the relatively low cyclic resistances of some of the fills in the area are likely causes for the significant liquefaction and ground failure which occurred.

Cowlitz County was among the counties issued for emergency relief in the State. A federal disaster declaration was issued only one day after the event. Statewide, the Nisqually earthquake resulted in 700 injuries (a dozen of them serious) and one confirmed death (a trauma induced heart attack). Federal Emergency Management Agency (FEMA) reported that 41,414 people registered for federal disaster aid, more than three times the number of a previous disaster in Washington.

One year after the earthquake, news reports put reported property damage at approximately \$500 million. However, when factoring in unreported damage, actual losses may run significantly higher. A University of Washington study of damage to households only, estimates that the earthquake caused \$1.5 billion in damage to nearly 300,000 residences.¹ This estimate does not include public and business sector losses. Other estimates of the combined losses to public, business, and household property have ranged from \$2 billion to \$4 billion. Most buildings performed well from a life-safety standpoint, in that the limited structural damage that occurred caused no loss of life or collapse. However, the economic cost of nonstructural damage, i.e., damage to nonessential building elements, such as architectural features, ceiling failures, shifting

of equipment, fallen furniture/shelving, desktop computer damage, fallen light fixtures, and losses due to lost productivity, was high. In general, new buildings and buildings that had recently been seismically upgraded typically displayed good structural performance, but many still sustained non-structural damage.

April 29, 1965, Federal Disaster 196: Seattle Tacoma Earthquake

A magnitude 6.5 earthquake struck the Puget Sound Region at 7:28 a.m. The epicenter was located about 12 miles north of Tacoma at a depth of about 40 miles. Damage from the 1965 quake killed seven people and damage was estimated to be \$12.5 million; with much of the loss in King County. In Olympia, the Union Pacific Railroad reported a hillside fall slid away from beneath a 400 foot section of a branch line just outside Olympia. Damage to the legislative building forced the closure of the legislative session. Governor Dan Evans closed the Capitol Campus and state government operations came to a standstill except for retention of key personnel and critical services.

April 13, 1949, Olympia Earthquake

A magnitude 7.1 earthquake rattled the region at 11:55 a.m. The epicenter was located about eight miles north-northeast of Olympia. Property damage likely exceeded \$25 million (1949 dollars). One student was killed by falling bricks from at Castle Rock High School. An unanchored gable collapsed above the main entrance way, causing this tragedy. Streets were damaged extensively and water and gas mains were broken.



1949 earthquake, Washington State. Gables on a number of unreinforced masonry school buildings collapsed; fatalities recorded

Summary Assessment

History suggests a moderate probability of occurrence of another damaging earthquake sometime in the next 25 years. With the 2001 Nisqually earthquake still fresh in the region's memory, it is important to note that it was not the largest earthquake event possible in the region. It is conceivable that a similar magnitude earthquake could emanate from a shallow crustal fault which would result in much greater damages. Damage from the 1949, 1965, and 2001 earthquakes indicate that an earthquake of a greater magnitude would have a catastrophic impact on Castle Rock. Considering that a large population lives and works in higher risk earthquake hazard areas, the entire region has a high vulnerability rating. Accordingly, a high risk rating is assigned.

Summary Risk Assessment for Earthquake in Castle Rock

Probability of Occurrence	Vulnerability	Risk
Moderate	Moderate	High

Storm

Severity

The coastal mountains afford Castle Rock some protection from severe southerly and westerly winds. The coastal mountain range acts as a buffer and shields the region from extreme winds in excess of 80 mph. Castle Rock does not encounter the 100 mph or greater winds that sometimes wreak havoc on Washington's Pacific coast communities. Nevertheless, the entire region is directly or indirectly susceptible to the effects of high winds. Neighborhoods with stands of tall conifer trees are the most vulnerable to property damage. All communities can suffer power outages and be left in the cold and dark for extended periods.

The average monthly wind speed at the Olympia Airport, as recorded over a 49 year period, is between 6 and 7 mph. Fifty-nine winter windstorm events have buffeted the Pacific Northwest from October 1950 to December 2007.ⁱⁱ Nine of these events produced peak gusts over 58 mph at the Olympia Airport weather station. The most powerful windstorm in the last 100 years occurred on Columbus Day, October 12, 1962. This storm tracked northeast along the Washington coast and produced record peak wind gusts of 78 mph at the Olympia Airport. The Beaufort Scale is provided as reference for damage effects relative to wind speed.

Impacts

The city, like most of western Washington, is vulnerable to high winds because of the climatic conditions and the prevalence of 100 to 150 foot tall conifer trees. High winds weaken standing

trees and structures that are weighted with snow or ice. Douglas fir and western hemlock tree species have shallow lateral root systems with top heavy crowns and entire trees are vulnerable to falling when soils are soaked from previous rainfall. Regular autumn rains saturate soils and decrease tree roots' ability to adhere to soil. Sustained high winds and gusts cause trees to sway significantly. Repetitive swaying motion can eventually weaken a tree's root hold in the saturated ground and force it to topple. These tall columnar trees and their massive branches act like giant hammers and sever electrical transmission lines, crush vehicles, damage homes and buildings, and block transportation routes. Falling tree limbs and other flying debris can injure or cause the death of people and animals. Downed power lines have caused electrocutions elsewhere in the greater Puget Sound Region.

Widespread power outages can take several days to restore. The total mass of downed debris on the transportation network impedes the response capabilities of emergency personnel and utility crews. Electrical blackouts force the closure of government offices, businesses and schools. Power outages can disrupt traffic operations due to debris road blocks, unpowered traffic signals and traffic snarls resulting in thousands of motorists seeking few available alternate routes on local arterials and collectors. When power outages occur simultaneously with heavy stormwater flows, public works crews may struggle to provide auxiliary power to sewer lift stations to prevent backups or flooding in suburban and urbanized areas.

People without power may lack backup home heating systems and may suffer from hypothermia if temperatures persist below freezing levels. Out of desperation, some people may resort to heating their homes with BBQ grills unaware of the risks of carbon monoxide poisoning. The risk of home fires increases county-wide as people use candles to light their homes or start wood fires in stoves or fireplaces that are structurally faulty or have excessively dirty or blocked chimneys. Individuals with home powered life support systems, such as oxygen respirators or suction equipment, may be at risk of health complications if backup power systems are not available. Low income populations are particularly impacted by loss of food due to spoilage from lack of refrigeration.

Between 1960 and 2007, 79 windstorms have occurred in western Washington that caused at least \$50,000 or more in damage area wide. The combined damages from these wind storms are estimated to have cost the region in excess of \$27 million dollars (adjusted to 2007 dollar value).ⁱⁱⁱ

Probability of Occurrence

The Washington State Natural Hazard Mitigation Plan identified Cowlitz County and 22 other counties as susceptible to high winds. Counties that were considered most vulnerable to high winds are those with an annual high wind recurrence rate of 100%. The state plan indicated that Cowlitz County's annual high wind recurrence rate is 175%. At least 18 notable Pacific Northwest cyclones have impacted the region in the last 25 years, thus probability of occurrence is high.

Historical Occurrences and Impacts Specific to this Jurisdiction

Several notable storms have impacted the region over the last few decades. It is important to highlight the effects and damages of these storms to emphasize the severity, cost, and vulnerabilities associated with these events. Estimates of potential dollar losses for future storm events were not calculated as part of the storm hazard risk assessment. Previous storm events perhaps offer the best indication of the types of future losses that local communities are likely to experience with future storms.

January 6-16, 2009, Federal Disaster 1817: Severe Winter Storm^{iv}

On January 21, 2009, Governor Christine O. Gregoire requested a major disaster declaration as a result of a severe winter storm that yielded widespread and damaging effects from flooding, mudslides, landslides, avalanches, high winds, and freezing rain, during the period of January 6-16, 2009. The Governor requested a declaration for Individual Assistance for nine counties and Hazard Mitigation for all counties. During the period of January 13-16, 2009, joint federal, state, and local Individual Assistance Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that federal assistance is necessary.^v Cowlitz County received approximately \$600,000 in disaster relief.

December 12-27, 2008, Federal Disaster 1825: Severe Winter Storm^{vi}

Near record snowfalls, freezing rain, and rain combined with sustained subfreezing temperatures froze the region for a period of nearly two weeks making it one of the worst snow-laden winter storms in decades. Successive snowfall over the first week resulted in 18 to 20 inch depths in the Lacey, Olympia, and Tumwater area. Depths of 36 inches were reported by some county residents at higher elevations outside of city limits. Governor Gregoire declared a state of emergency on December 24. On March 2, a Presidential Disaster Declaration was declared for 27 counties, including Cowlitz County.

November 2-11, 2006 Federal Disaster 1671: Severe Winter Storm, Flooding, Landslides, and Mudslides

On November 6, 3.4 inches of rain fell; a 24 hour rainfall record for that day of the year. The heavy rains caused flooding of urban roads and streets throughout the region. Preliminary damage assessments for personal and business property damage exceeded \$300,000.

December/January 1996/1997 Federal Disaster 1159, Ice, Wind, Snow, Landslides, and Flooding

Snow, ice, and freezing rain crippled Cowlitz County on December 26. This storm produced the worst freezing rain event to hit the region in decades. Sub-freezing temperatures and power outages persisted for over a week into early January.

December 12, 1995 Windstorm Federal Disaster 1079

A windstorm caused widespread destruction from northern California to British Columbia. Wind gusts of 57 mph rattled the region causing widespread power outages to nearly 45,000 households and businesses. Road closures from fallen trees and limbs forced the closure of many local and state government offices and area businesses. One Mason County woman was killed when a power transformer exploded near her home setting her residence on fire. First responders could not reach her home due to road blocks.

February 1 to 8, 1989, Snow Storm

Arctic air pushed southward across Oregon between the 1st and the 3rd of the month. Heavy snow fell over all of Oregon. Some coastal areas had 6 to 12 inches of snow, an event of which is almost unheard. Salem reported 9 inches of snow and over a foot settled over the state. Numerous record temperatures were set. Strong winds produced wind chill temperatures of between 30 and 60 degrees below zero. There were extensive power failures as well as considerable home and business damage throughout the state resulting from frozen plumbing. Damage estimates exceeded well over a million dollars. Several moored boats sank on the Columbia River because of ice accumulation. There were five weather-related deaths, three in auto accidents caused by ice and snow and two in which women had frozen to death.

November 13-15, 1981

The strongest wind storm since the infamous Columbus Day storm of 1962 struck the Pacific Northwest with a one-two punch combination. The first punch was delivered Friday, November 13, and early Saturday, November 14, when an intense low-pressure area tracked northward 150 to 200 miles west of the Oregon coast. The central pressure of the low was 958 millibars (mb), 2 mb lower than the 1962 storm, but the storm track was about 90 miles farther west of the 1962 storm track. The second punch was delivered on Sunday, November 15, when a second somewhat weaker low pressure area following a track similar to the first storm causing strong winds over the area again. These winds occurred as people were still recovering from the effects of the first storm.

Strong winds spread into the Pacific Northwest from the south the evening of Friday, November 13. Winds spread into Washington during the morning of November 14. Hoquiam reported wind gusts to 70 mph, Seattle to 67 mph and Olympia to 64 mph. Strong winds also spread as far east as Boise and Reno, where gusts to near 100 mph were reported.

The second storm spread winds near 60 mph along the Oregon coast beginning Saturday morning, November 15. Portland recorded wind gusts to 57 mph, Boeing Field near Seattle had wind gusts to 48 mph, SEA-TAC airport had gusts to 51 mph and Olympia airport had wind gusts to 58 mph.

The November 13-14 storm did the most damage. However, the one-two punch of the two storms resulted in more damage from the weaker, second storm than normally would have been expected. Eleven people were killed and \$50 million in damage were reported as a result of the two wind storms. This compares to 38 fatalities and damage in excess of \$200 million for the

1962 Columbus Day storm.

Numerous injuries resulted from wind-blown debris in western Washington and Oregon. Damage was widespread, including hundreds of downed trees and power lines across the Pacific Northwest. Roof damage was common. For example, on November 14, winds ripped off the 2,500 square foot roof of the Homestead Restaurant in North Bend, Oregon. Downed power lines caused massive power outages. Estimates indicated that nearly 500,000 homes were without power for at least a short time during the weekend. Damage to standing timber was extensive from Washington to northern California.

Many airports across Oregon and Washington suffered damage. At the Hillsboro airport, one airplane was flipped upside down and several hangars were damaged. Three light planes at Salem's McNary Field were damaged by winds that flipped them on their backs Friday night. While damage was extensive throughout western Oregon and Washington as a result of the strong winds, it was still considerably less than that resulting from the 1962 Columbus Day storm.

October 12, 1962 - The Columbus Day Wind Storm

A generation of Washingtonians received searing memories that day. This quintessential windstorm became the standard against which all other statewide disasters are now measured. The storm killed 38 people and injured many more and did more than 200 million dollars in damage (over 800 million in today's dollars). Wind gusts reached 116 mph in downtown Portland. Cities lost power for two to three weeks and over 50,000 dwellings were damaged. Agriculture took a devastating blow as entire fruit and nut orchards were destroyed. Scores of livestock were killed as barns collapsed or trees were blown over on the animals.

- The mother of all wind storms this century, the wind storm all others are compared to
- Strongest widespread non-hurricane wind storm to strike the continental U.S. this century
- Struck from northern California to British Columbia
- Claimed 46 lives, blew down 15 billion, yes, 15 billion board feet of timber (\$750 million worth - 1962)
- Total property damage in the region \$235 million
- Recorded wind speeds (before power went out) Naselle - Gust to 150 MPH Bellingham and Vancouver - Gust 92 MPH

Summary Assessment

The probability of each storm element's occurrence varies, but winter storms frequently pack several hazardous elements across a period of consecutive days or weeks, therefore the overall probability of winter storm occurrence is high. The overall impacts described in both the hazard profile and the brief record of historical occurrences demonstrate that the region's vulnerability is also high. Therefore, the overall risk rating for severe winter storms is high.

Thunderstorms reek havoc in Castle Rock every winter, so the probability of occurrence is high. Even thunderstorms that produce a combination of the numerous elements rarely cause

destruction beyond isolated areas. Therefore, the overall probability of occurrence, the vulnerability rating and the overall risk for thunderstorms is moderate.

Summary Risk Assessment for Storm in Castle Rock

Probability of Occurrence	Vulnerability	Risk
High	Moderate	Moderate

Flood

Severity

Many factors influence the severity of riverine flooding such as the pre-existing condition of the ground (saturated from previous rain, covered with snow, or frozen), the topography and size of the watershed, freezing level, and the influence of human activity on the landscape (development and logging practices).

Cowlitz County has three levels of flood severity:

1. **Minor flooding:** A river exceeds bank-full conditions at one or more locations, generally flooding fields and forests. Some roads may be covered but passable. There may be enhanced erosion of some river banks.
2. **Moderate flooding:** Individual residential structures are threatened and evacuation is recommended for selected properties. Some roads may be closed. Moderate damage may be experienced.
3. **Major flooding:** Neighborhoods and communities are threatened and evacuation is recommended for residents living on specified streets, in specified communities or neighborhoods, or along specified stretches of river. Major thoroughfares may be closed and major damage is expected.

Impacts

Cowlitz River, with a drainage area of 2,180 square miles at its mouth, flows into Columbia River at river mile 68.0. Principal tributaries that flow into Cowlitz River within the study reach are Toutle River at mile 20.0, and Coweeman River at 1.3. At Cowlitz-Lewis county line, upper limit of the study reach, the drainage area is 1,700 square miles. About 70% of Cowlitz River basin area is in Cowlitz County. Cowlitz, Toutle, and Coweeman rivers all have their headwaters in the Cascade Range. Toutle and Coweeman rivers have drainage areas of 512 and 127 square miles, respectively. Plate 1 shows the reach of Cowlitz River investigated.

The main axis of the 1,700-square-mile area above the study reach lies east and west; the area is trapezoidal in shape, 65 miles long, 10 miles wide at the lower end, and 27 miles wide at the upper end. Of the total drainage area, approximately 75% is mountainous terrain. The remainder of the area is bottom land and rolling foothills. Large areas of the bottom land are being used for agricultural purposes.

The topography of the watershed is rugged and timber covered. The highest point in the basin is Mount Rainier, elevation 14,408 feet. The average elevation of the basin is approximately 3,400 feet, and the lowest elevation is less than 50 feet.

The fall in Cowlitz River from mile 134.0 to the mouth is 1,340 feet. This is an average gradient of 10 feet per mile, which varies from several hundred feet per mile in the upper reach to less than 2 feet per mile in the lower reach. In the 26.1-mile reach investigated in Cowlitz County, the fall is 60 feet for an average gradient of 2-3 feet per mile.

The two significant tributaries to Cowlitz River within Cowlitz County are the Coweeman and Toutle rivers. Those streams are discussed separately in following sections of this report.

The valley in Cowlitz County has an average width of about 3 miles and is widest between Castle Rock and the Kelso-Longview area. After 1968, flooding has been infrequent along lower Cowlitz River below Mayfield Dam because floods the magnitude of flood stage or lesser magnitude, will be regulated to bankfull stage at Castle Rock.

Besides the four industrial, commercial and business enterprises in the three largest urban centers, the remaining valley area is primarily agricultural. Most of the bottom land area is cropland, consisting largely of grain and forage for livestock, with small acreages of sweet corn and other more intensively cultivated crops. About 10% of the cropland is irrigated.

The main line of Great Northern-Northern Pacific and Union Pacific Railroad from Seattle to Portland traverses the entire length of the valley. Columbia and Cowlitz Railroad, a logging railroad, connects the Kelso-Longview area to the foothills at the confluence of North and South Fork Toutle Rivers. It crosses Cowlitz River at mile 7.1.

Interstate 5 parallels the valley to the east. State Highway 411 provides access along the valley to the west. Secondary roads make up the balance of the transportation network. Five highway and three railroad bridges cross Cowlitz River in the lower 27 miles. The bridges do not seriously obstruct streamflow. Head losses at each bridge during major floods are less than 1 foot.

Drainage Areas in Watershed of Cowlitz River			
Stream	Location	Mile Above River	Drainage Area sq. mi.
Cowlitz River	Mouth	0.0	2,480
	At Kelso	5.0	2,350
	At Castle Rock	17.3	2,238
	Above Toutle River County line	20.0	1,720
	(Lewis-Cowlitz)	26.1	1,700
Coweeman River	Mouth		127
Toutle River	Mouth		512

Probability of Occurrence

The May 18, 1980 eruption of Mount St. Helens in Washington in 1980 resulted in approximately 3.8 billion cubic yards of earth materials being released in a massive landslide. The resulting debris avalanche deposit has continued to erode and introduce sediment materials into the Toutle-Cowlitz-Columbia river system. These sediment materials continue to filter down the river basin and ultimately settle on the river bed along the way. Increasing sediment on the river bed results in a rise of the water levels, over time.

The city is protected from the Cowlitz River by a levee system. The U.S. Army Corps of Engineers (USACE) was directed by Congress to maintain an authorized level of flood protection (LOP) in Castle Rock along the Cowlitz River that is not less than described in the *Mount St. Helens, Washington, Decision Document (USACE 1985)*.

Levee Locations		
Designation	Index Point Description	River Mile
Castle Rock Levee		
CRIP 1	Approximately 1,500 ft. upstream of Castle Rock bridge	17.42
CRIP 2	Just downstream of Castle Rock bridge	17.00
CRIP 3	Road crossing by sewage treatment plant	15.91

In 2003, Congress passed a bill requiring levees to be certified to maintain the 100 year flood protection designation for the areas protected by the levee. In 2011, Castle Rock received federal certification that their levee system complies with accreditation requirements and continues to provide flood protection from the base flood as shown on the effective Flood Insurance Rate Map (FIRM). Castle Rock is one of two jurisdictions in Region 10 to receive levee certification under the newest FEMA requirements.

Small isolated areas behind the levees have been identified as Special Flood Hazard Areas based on interior drainage analysis. Fortunately, these areas are uninhabited and are not likely to be developed as they are protected by the city's Critical Areas Ordinance.

Summary Assessment

The history of major flooding within Castle Rock has been mitigated with a levee system. FEMA certification of this system ensures adequate protection from rising waters thus giving the city a low probability of occurrence, vulnerability and risk.

Summary Risk Assessment for Flood in Castle Rock

Probability of Occurrence	Vulnerability	Risk
----------------------------------	----------------------	-------------

Low

Low

Low

Landslide

Severity

There is no standard approach to measure the severity of a landslide. Severity can be measured in total cost of damages, impacts to transportation or utility systems, or in terms of injuries and fatalities. The severity of a landslide can also be measured in terms of its size and composition: from a thin mass of soil a few yards wide to deep-seated bedrock slides miles across. Despite the difficulty in predicting landslides, the environment provides visual indicators of where the earth is moving. Discovering sites of prehistoric landslides is difficult as telltale signs are often obscured by vegetation or human development.

The travel rate of a landslide can range from a few inches per month to many feet per second depending on the slope, type of material, and moisture content.

Impacts

The impacts of landslide hazards in Castle Rock are numerous. Landslides can injure or kill people caught in the path of rapid moving earth. No deaths have occurred from a landslide in Cowlitz County. In January 1997 a family of four on Bainbridge Island was buried and killed by 2,000 cubic feet of earth. The fast moving landslide slammed into the back of their home in the early morning hours while the family was still in bed. Past landslides highlight the fact that many homeowners lack insurance covering landslide hazards. Many regional residents have lost their homes due to the damaging effects of landslides. Landslide damage can render the property unstable and permanently uninhabitable. Rebuilding onsite is often not an option, so the financial loss for some homeowners is immense. People can suffer great emotional stress and anguish from losing both their home and their property. Small business owners also face similar financial losses and stress.

Landslides can physically damage or destroy almost any infrastructure including buildings, utilities, streets, rail lines, bridges, and tunnels. Communities at large can face transportation disruptions from the loss of critical travel corridors, like State Route 4 near the Wahkiakum County line, resulting in lengthy detours. Public health and safety can be compromised from loss of energy, communications, water, and uncontrolled wastewater discharge.

The City of Castle Rock, public works, building inspectors, and other safety officials can become overwhelmed if a landslide hazard impacts a significant portion of the community. Landslide events necessitate monitoring. Buildings and other infrastructure must be inspected to determine whether they are safe for occupancy or use. If a building is deemed unsafe, law enforcement personnel may need to increase patrols to decrease the risk of theft or criminal trespassing

Probability of Occurrence

A review of local newspaper media, internet sources, Department of Natural Resources landslide data, and Federal Disaster Declarations for Castle Rock suggest that the incidences of landslides are concurrent with winter storms, flooding, and earthquakes. The majority of landslides in the region are triggered by heavy precipitation in the winter months. The 1998 Aldercrest-Banyon Landslide represents a large scale, but infrequent event for the region. Many smaller landslides regularly block roads with debris or washout transportation facilities and rupture utility pipes. Landslides are a continued concern for city residents, due to the vast majority of mountainous terrain and heavy rainfall. Landslides have a low probability of occurrence due to local ordinances put in place to protect investments

Historical Occurrences and Impacts Specific to this Jurisdiction

No known major landslide occurrences have affected the City of Castle Rock

Summary Assessment

The history of landslides within Castle Rock clearly demonstrates a low probability of future occurrence. Although the region is mountainous, our probability of occurrence is mitigated through the adoption of Critical Area's Ordinances (CAO). CAO adopted by the cities and county provide a mechanism for limiting development near steep slopes. Because of the relative land area and population affected, the county is exposed to a major landslide periodically, based on the history of the last 41 years (1968 to 2009). Overall, this data clearly indicates that the vulnerability of major landslide events in the region is low. The city's overall risk ranking of landslide remains low.

Summary Risk Assessment for Landslide in Castle Rock

Probability of Occurrence	Vulnerability	Risk
Low	Low	Low

Wildland Fire

Severity

The severity of a wildland fire depends upon the extremity of the factors listed above, the extent of the fire, the size of the population, the value of structures that are at risk, and the ability of fire fighters to effectively mobilize and suppress the fire. In general, the cooler, wetter climate of western Washington is less prone to wildland fires because fuel sources have higher moisture content and are less susceptible to ignition. Eastern Washington has a longer and drier fire season and is more vulnerable to lightning strikes than the west of the Cascades.

Physical damages include loss of valuable timber, wildlife habitat, and recreational areas such as trails, parks, and campground facilities. Smaller rural communities can suffer economic losses from destroyed natural resource lands because their economies are dependent on the timber industry or tourism. Buildings and their contents, utility lines, and parked vehicles are also destroyed. Power and communication disruptions can occur, even in areas unaffected by fires, if major transmission lines are damaged or destroyed. The loss of vegetation on steep slopes increases the risk for mudslides or landslides during the fall and winter months. Stream and creek channels could fill with sediment and debris increasing flood risks. It could take years for fish habitat to recover

Although a major wildland fire has not affected Castle Rock in modern times, wildland fires are a common occurrence. They have been documented to occur during every month of the year, particularly during prolonged dry periods due to drought or near-drought conditions. Wildfires are common during the local dry season, mid-May through mid-October, but 75% of all wildfires occur between July and September when temperatures are higher.

In the city, the following conditions influence the extent and severity of wildland fires:

Soil Conditions - The region has a large area of glacial outwash prairie. Prairies are typically vegetated with grasses and other low growing herbaceous plants and shrubs. Prairie soils drain quickly and the vegetation quickly dries out during the summer months. Several Cowlitz County prairies also interface with encroaching Douglas-fir stands, making these areas particularly vulnerable to wildland fires.

Vegetation Type - The severity of a fire is influenced by the composition and extent of fuels available. Vegetation is the primary source of fuels. Dry grasses are prolific; burns rapidly once ignited, and are capable of generating flames up to 40 feet tall.

Access - Road access and mobility for emergency vehicles is mission critical in wildfire suppression efforts. Limited access delays response time or limits the ability to successfully fight a fire when the necessary equipment and apparatuses cannot make contact with the affected area. There are residential communities in Cowlitz County that have only one road in and out. Limited access poses challenges for both evacuation of residents and the ability of fire fighters to mobilize to the affected area.

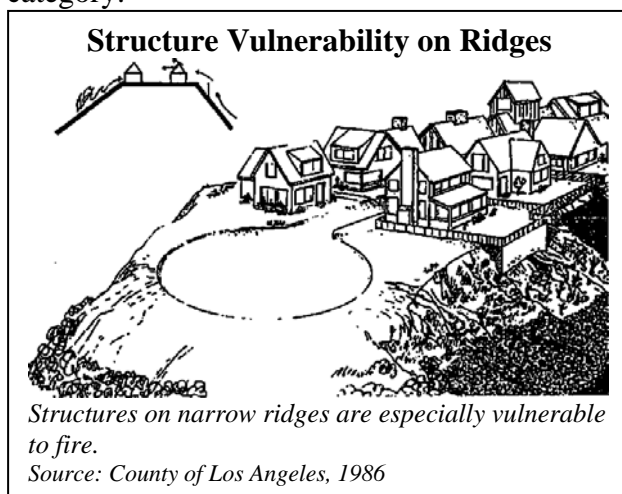
Impacts

The impact of a wildland fire varies depending upon the size and location of the fire. The heat from intense wind driven flames can destroy virtually any combustible material in its path. People caught off guard by a rapidly spreading fire could suffer burn injuries or other non-burn injuries trying to escape a fire, or possibly be killed. People recreating in remote roadless forest or range lands are especially at risk. The loss of a loved one or the loss of a home or a business is a traumatic experience and fire victims are likely to suffer post traumatic stress disorder following a fire-related loss.

Wildfires result from the interaction of the elements of the fire triangle: fuel, flame, and oxygen. A fire requires all three of these elements to begin and sustain itself. Fuel in a wildland setting is typically vegetation; the type and amount of fuel available and consumed controls the intensity of the fire. The various fuels that occur on a site are referred to as the fuel load. The initial flame may be supplied by lightning or human causes. Oxygen is rarely a limiting factor in wildfires, but a fire's dependence on it does control its behavior, leading to a generally wind-driven and upslope burn pattern.

Wildfire spread is controlled by fuel, weather, and topography. A dry and hot weather pattern or climate can contribute to fire outbreak by increasing the combustibility of fuels. Strong winds can propel the fire quickly across the landscape; gusty, shifty winds can lead to erratic fire behavior that make the fire management and control tasks much more dangerous. Fires will in general burn upslope towards ridge tops in hilly or mountainous areas (although strong winds can alter this). Narrow canyons are especially efficient fire conveyors as they create a chimney-effect to carry the fire forward.

Wildland fires occur in three main forms — as understory fires, crown fires, and ground fires. In general, wildland fires under natural conditions burn at relatively low intensities, consuming grasses and other herbaceous plants, woody shrubs, and dead trees. Such understory fires are natural occurrences in many environments and often play an important role in plant reproduction and wildlife habitat renewal. Left to themselves, these fires will burn themselves out when the fuel load is depleted or they are doused by rain or snow. Crown fires, where whole living trees are consumed, are less frequent but considerably more destructive. These are typically what is pictured when people think of large, disastrous fires. In areas with high concentrations of organic material in the soils, ground fires may burn in this material, sometimes persisting for long periods out of sight until a surface fire is ignited. As is often the case with natural phenomenon, most fires will exhibit some combination of these characteristics rather than falling neatly into a category.



Wildfires may spawn secondary hazards, such as flash flooding and landsliding, long after they have been extinguished. Vegetation provides a number of physical functions which contribute to the hydrologic and slope stability regimes of an area. When this vegetation is consumed in high

intensity wildfire, resulting changes may include decreased rainfall interception and infiltration; faster concentration times and greater volume of peak flows; increased volume and velocity of overland runoff; and loss of reinforcing deep roots. The intense temperatures of wildfire may also cause chemical changes in the soil, resulting in hydrologic changes similar to those described above.

Successful prevention of wildfires depends on the control and elimination of one or more of the elements of the fire triangle. Before a fire begins, the fuel load can be managed through either controlled, intentionally set fires (referred to as prescribed burns) or manual or mechanical harvesting. Breaks in the vegetative cover (fire breaks) are often constructed on ridge tops, as fires will tend to burn upslope. Control of ignition sources can also be effective prevention through restriction of hazardous activities during high-risk periods.

Once the fire is underway, there are limited options for the control and suppression of the blaze. Obviously, nothing can be done to change the weather or topography of the fire site. Control and suppression of burning fires must be accomplished through removal of the fuel load (as above, including the intentional use of small, low-intensity fires to consume fuel) and suffocation (elimination of oxygen) by application of water and suppression chemicals.

In urban settings, fire fighters generally deal with structural fires which are fought directly with water readily available from fire mains and hydrants. Rapid response is a key element in extinguishing fire while it is still manageable. In wildland settings, fire fighters use more indirect techniques to contain the fire within a perimeter and deprive it of fuel. Multiple fire fighting organizations or agencies may be involved, requiring a high level of communication and coordination of resources.

Urban-wildland interface fires offer a mix of conditions that are not wholly suited for either technique. Although structures are often involved, an urban-level of water and staff resources is rarely available, especially when multiple structures are threatened. Even if sufficient resources are present, rapid response is often compromised by the distances and qualities of roads available in the area. In addition, wildland techniques, which require the sacrifice of some areas for strategic gain, are not suited to preserving structures scattered throughout the fire zone. Fire managers may find themselves with difficult choices between saving structures or large tracts and their natural resources. The situation may also be complicated by residents who are unfamiliar with the level of fire protection available. They assume that the urban standards with which they are familiar apply, and fail to take adequate precautions (such as storing water on site and clearing a defensible space around their home). When limited resources are challenged by high-intensity fire storms, they are easily overwhelmed, resulting in evacuations and loss of property.

Historically, wildfire management has meant immediate fire suppression. When wildland fire control and prevention are successful, the risk of dangerous, high-intensity fires can actually increase as fuel loads build. These high-intensity fires take on an entirely different character than their low-intensity cousins, consuming all vegetation in their paths and erupting as fire storms. Such conflagrations are driven by winds that they produce and can move quickly and erratically.

It may not be possible to stop them once they begin, and it may be impossible or foolhardy to try to save structures that lie in their paths; winter rains and snow might provide the only viable suppression technique. Unfortunately, large fuel loads are often associated with the fringes of the urbanizing areas due to historical suppression efforts setting the stage for high-intensity interface fires. To avoid the possibility of these high-intensity fires, land managers and oversight agencies practice and promote vegetation management techniques that maintain the fuel load at an appropriate, controllable level.

Probability of Occurrence

Firefighting can consume significant local and state resources. Even a small wildland fire in Castle Rock requires rapid containment or suppression in order to protect property. Local fire districts often rely on DNR assets such as helicopters to reach remote areas or provide rapid response. Should multiple wildland fires occur simultaneously in different areas during an extremely warm and dry season, local capabilities could quickly become overwhelmed. This is particularly more problematic when major wildland fires on federal lands require the mobilization of fire fighting assets across the western U.S., further stretching local fire fighting capacity.

The documented record of wildland fires in Castle Rock suggests that approximately 97 percent of future fires will be five acres or less. The region can expect at least one fire exceeding 100 acres over the next 25 years. A warmer and drier future climate may create more suitable conditions for more frequent or larger fires.

Historical Occurrences and Impacts Specific to this Jurisdiction

No major wildland fire events have impacted the City of Castle Rock.

Summary Assessment

The history of wildland fires within Castle Rock clearly demonstrates a low probability of future occurrence, due to the high amount of precipitation west of the Cascade Mountain Range. Because of the relative large undeveloped land area and population affected, the county is exposed to minor wildland fires periodically during dry summer months. Adoption of the International Building Code and International Fire Code by Castle Rock helps to curtail wildland fires from expansive damage by limiting the flammable materials on remote homes and property. This indicates that the vulnerability of major landslide events in the region is low. The region's overall risk ranking of wildland fires is low.

Summary Risk Assessment for Wildland Fire in Castle Rock

Probability of Occurrence	Vulnerability	Risk
Low	Low	Low

Volcanic Hazards

Severity

Known as the “Gateway to Mount St. Helen’s”, Castle Rock is heavily influenced by the volcano’s activity. Mount St Helen’s peak is within Skamania County, however a large portion of the mountain resides in Cowlitz County. With the right winds, the entire County could be blanketed with ash. The severity of the hazard would depend on the thickness of the ash deposition. The 1980 eruption of Mount St. Helens blew an ash column 15 miles into the atmosphere above the crater. Over the course of the day of the eruption, nearly 540 million tons of ash was blown by winds to the east.^{vii} Fallout from the ash created complete darkness in Spokane, nearly 250 miles away; dropping one half inch of ash only a few hours after the start of the eruption.

Impacts

Ash fall of a quarter inch or more will reduce motorists' visibility and disrupt nearly every mode of transportation. Wet ash could create hazardous driving conditions and result in traffic injuries or fatalities. Aircraft is especially vulnerable as ash may disable engines and completely obscure pilots' visibility. Air transportation would be grounded in the affected area as long as conditions pose a hazard. Inhalation of ash particles could cause respiratory irritation and pose more serious problems for people with asthma or other respiratory diseases, but this could be mitigated by simply avoiding exposure. Ash can destroy agricultural crops, contaminate surface water sources, clog drainage and sewer systems, and inhibit or destroy mechanical systems such as outdoor heating, ventilation, and air conditioning systems. Ash fall of just a few inches in depth could exceed the load capacity of some building rooftops and lead to structural failure. Failure could occur with lower depths if ash absorbed subsequent precipitation. Wet ash has been known to cause power lines to short out. Clean up and recovery would likely be the greatest cost to both the public and private sector. The 1980 eruption of Mount St. Helens posed a major nuisance for communities in Eastern Washington. In Yakima, ash removal took ten weeks and cost \$2.2 million.^{viii}

If a large lahar were to occur at Mount St. Helens within the next few decades, the mechanism most likely to be responsible would be rapid melting of snow and ice in the crater or a sudden outbreak of Castle Lake. Either mechanism would produce a lahar only in the North Fork Toutle River (and downstream). Rainfall is seldom intense enough to directly produce lahars in the Cascades, and the flows produced by this mechanism tend to be fairly small. Likewise, any landslides occurring on the flanks of Mount St. Helens are likely to be relatively small, especially now that the volcano’s height has been lowered by the 1980 eruption.

Snow and Ice at Mount St. Helens

A large volume of snow and ice is presently accumulating in the Mount St. Helens crater, protected by the shade of the high, steep crater walls. This accumulation provides a growing

potential water source for lahars in the North Fork Toutle River valley. It is already mixed with rock debris eroded from the crater walls and this debris would augment the formation of a lahar. It is possible that a large eruption could melt most or all of this snow and ice in a matter of tens of minutes. A very small eruption in 1982 rapidly melted enough snow and ice in the crater to trigger a 4 million m³ (5.2 million yd³) flood that transformed into a lahar and flowed all the way to the Cowlitz River. At the present time (1995), about 53 million m³ (70 million yd³) of snow and ice has accumulated. If completely melted, this would produce about 38 million m³ (50 million yd³) of water. At the present rate of accumulation, the volume of snow and ice will double in about 15 years.

Permanent and seasonal snow and ice also blanket the outer flanks of Mount St. Helens. A sufficient volume exists there in winter or spring to produce flank lahars similar in magnitude to those of May 18, 1980, if another large eruption were to occur. Lahars formed on the outer flanks can be expected to be substantially smaller than flows generated in the crater.

Probability of Occurrence

Lahars are the effect of volcanic eruption. Since lahars are the result of volcanic eruptions, the probability of occurrence is the same for these two natural hazards. A large eruption of Mount St. Helens can be expected to inject tephra to altitudes of 20–30 km (12–20 mi) and to deposit tephra over an area of 100,000 km² (40,000 mi²) or more. Wind direction and velocity, along with the vigor and duration of the eruption, control the location, size, and shape of the area affected by tephra fall. Wind direction and velocity vary with both time and altitude, making it impossible to predict the velocity and direction of tephra transport more than a few hours in advance. Westerly winds prevail; thus, significant tephra accumulation from a single eruption is more likely east than west of Mount St. Helens. The calculated probability that ten or more centimeters (four or more inches) of tephra from a large eruption will fall as far as 60 km (40 mi) directly east of Mount St. Helens is 20%; the probability that such an eruption would deposit ten or more centimeters (four or more inches) 60 km (40 mi) directly west of Mount St. Helens is less, between 1% and 2%. Mount St. Helens has repeatedly produced voluminous tephra and has erupted much more frequently in recent geologic time than any other volcano in the Cascade Range. Thus, its influence dominates the annual-probability distribution in Washington and Oregon of ten or more centimeters (four or more inches) of tephra accumulation from eruptions throughout the Cascade Range.

Historical Occurrences and Impacts Specific to this Jurisdiction

[Click here to enter text.](#)

Summary Assessment

The eruption of Mount St. Helens was catastrophic for the region. While the majority of ash and debris landed east of the mountain, Castle Rock suffered numerous damages. Economic tolls devastated the county's resource economy in timber losses. The county's waterways continue to

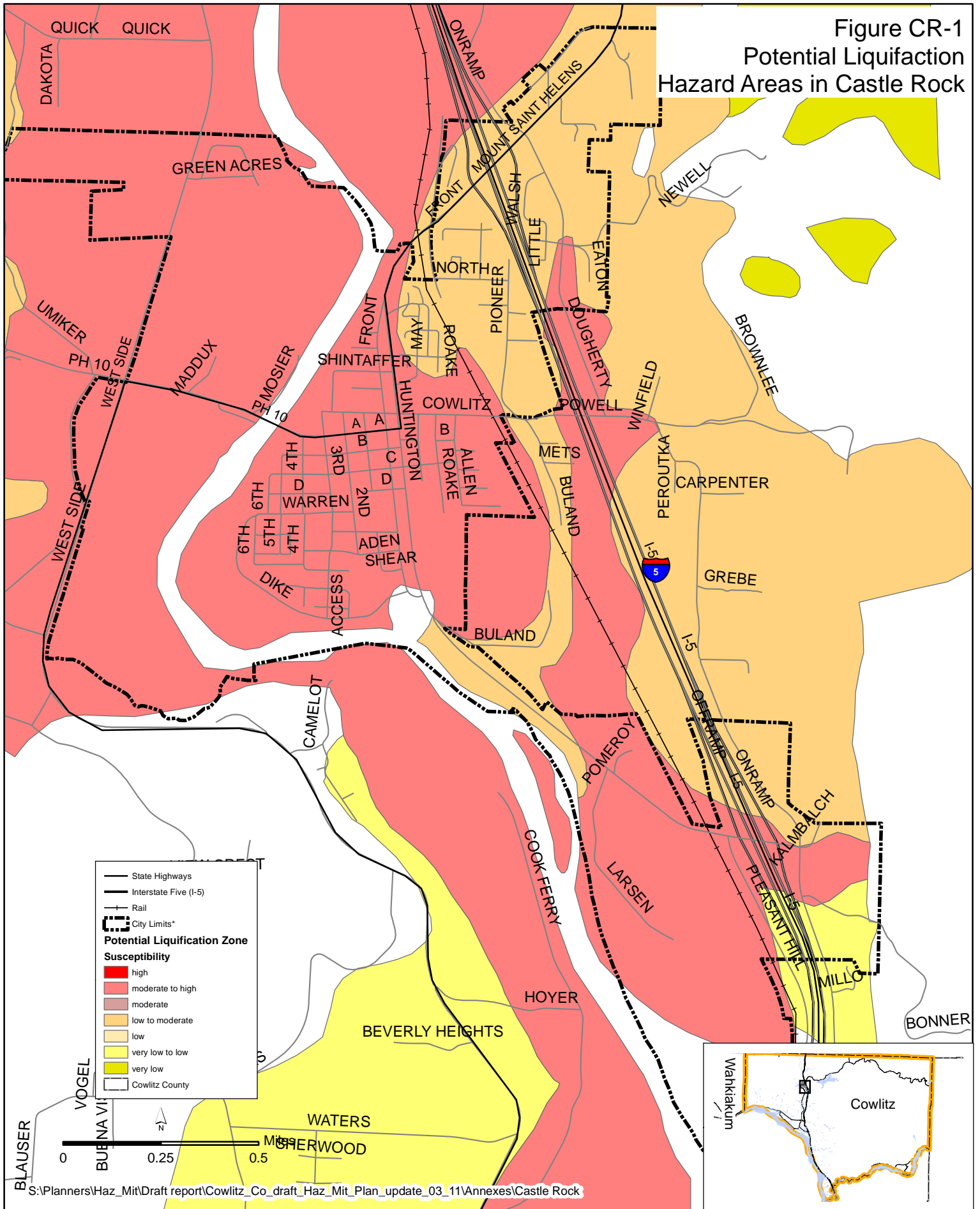
be dredged of debris from the eruption, to this day. Since the eruption, our county has been defined by the event in May of 1980 and continues to rebuild from this disaster.

The *Hazard Mitigation Plan for Cowlitz County* aims to compare and contrast the vulnerability our region faces from multiple hazards. This means that storms are evaluated with volcanic eruptions. While storms occur much more frequently than eruptions, eruptions cause a plethora of damages compared to storms. Volcanic eruptions are devastating when they occur. However, they occur very rarely. Mount St. Helen's continues to record volcanic activity. That said, Cowlitz County has been assigned a moderate probability of occurrence, and its vulnerability is also moderate. The overall risk ranking for volcanic activity in Castle Rock is high, due to the city's proximity to Mount St. Helen's.

Summary Risk Assessment for Volcanic Events in Castle Rock

Probability of Occurrence	Vulnerability	Risk
Moderate	Moderate	High

Figure CR-1
Potential Liquifaction
Hazard Areas in Castle Rock



Priority: 1 of 8

Status: Existing

Hazard Addressed: Flood Hazard

Category: Hazard Damage Reduction

CR-FL 01: Three Portable Generators for Potable Water Wells

Rationale: The use of portable generators reduces vulnerability and increases capability of serving disaster relief victims

Relates to Plan Goal(s) and Objectives:

3B-Ensure that local emergency services facilities can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed

3C-Ensure that utility and communications systems supporting emergency services operations can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed.

4C-Retrofit or relocate buildings and facilities used for routine operations of government so they can withstand the impacts of disasters.

4D-Have available (e.g. purchase and stockpile) redundant equipment, facilities, and supplies to reestablish local government operations after a disaster.

Implementer: City of Castle Rock, Public Works

Estimated Cost: \$40,000

Time Period: 2013

Funding Source: Grants

Source and Date: Cowlitz County Hazard Mitigation Plan 2005

Reference Page: Page 38 Cowlitz County Hazard Mitigation Plan 2005

Priority: 2 of 8

Status: Modified

Hazard Addressed: Flood Hazard
Category: Hazard Damage Reduction

CR-FL 02: Portable Pumps for Stormwater Flooding

Rationale: The use of portable generators reduces vulnerability and increases capability of serving disaster relief victims

Relates to Plan Goal(s) and Objectives:

4D. Have available (e.g. purchase and stockpile) redundant equipment, facilities, and supplies to reestablish local government operations after a disaster.

Implementer: City of Castle Rock, Public Works

Estimated Cost: \$50,000

Time Period: 2015

Funding Source: Grants

Source and Date: Cowlitz County Hazard Mitigation Plan 2005

Reference Page: Cowlitz County Hazard Mitigation Plan 2005, Page 40

Initiative and Implementation Status: Modified to be more specific

Priority: 3 of 8

Status: Existing

Hazard Addressed: Earthquake Hazard

Category: Critical Facilities Replacement/Retrofit

CR-ER 01: City Hall Complex Replacement

Rationale: Seismic Retrofit City Hall Complex to withstand earthquake and operate as a critical facility

Relates to Plan Goal(s) and Objectives:

4C. Retrofit or relocate buildings and facilities used for routine operations of government so they can withstand the impacts of disasters.

Implementer: City of Castle Rock, All Departments

Estimated Cost: \$1,200,000

Time Period: 2025

Funding Source: Unknown

Source, Date and Page Number: Cowlitz County Hazard Mitigation Plan 2005, Page 42.

Priority: 4 of 8

Status: Modified

Hazard Addressed: Storm Hazard
Category: Hazard Damage Reduction

CR-ST 01: Two Portable Generators for Sewer Lift Stations

Rationale: The use of portable generators reduces vulnerability and increases capability of serving disaster relief victims

Relates to Plan Goal(s) and Objectives:

3B-Ensure that local emergency services facilities can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed

3C-Ensure that utility and communications systems supporting emergency services operations can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed.

4C-Retrofit or relocate buildings and facilities used for routine operations of government so they can withstand the impacts of disasters.

4D-Have available (e.g. purchase and stockpile) redundant equipment, facilities, and supplies to reestablish local government operations after a disaster.

Implementer: City of Castle Rock

Estimated Cost: \$50,000

Time Period: 2015

Funding Source: Grants

Source, Date, Page Number: Cowlitz County Hazard Mitigation Plan 2005. Page 44

Initiative and Implementation Status: Modified to amend cost estimate.

Priority: 5 of 8

Status: Existing

Hazard Addressed: Multi Hazard
Category: Hazard Damage Reduction

CR-MH 01: Permanent Generators

Rationale: Install permanent backup power source for the City Hall/Police Department/Senior Center and Fire Hall. Communication is critical in times of disaster for emergency evaluation and response.

Loss of communication and/or emergency response may result in additional fire damage, loss of life and injuries.

Relates to Plan Goal(s) and Objectives:

3B-Ensure that local emergency services facilities can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed

3C-Ensure that utility and communications systems supporting emergency services operations can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed.

4C-Retrofit or relocate buildings and facilities used for routine operations of government so they can withstand the impacts of disasters.

4D-Have available (e.g. purchase and stockpile) redundant equipment, facilities, and supplies to reestablish local government operations after a disaster.

Implementer: City of Castle Rock, Public Works Department

Estimated Cost: \$75,000

Time Period: 2022

Funding Source: Grants

Source, Date, Page Number: Cowlitz County Hazard Mitigation Plan 2005. Page 46

Initiative and Implementation Status: Modified to amend cost estimate.

Priority: 6 of 8

Status: Modified

Hazard Addressed: Multi Hazard
Category: Hazard Damage Reduction

CR-ML 02: Huntington Avenue South - Erosion at Lion's Pride Park

Rationale: The continual erosion during high water events have impacted the parking area at Lion's Pride Park. If this issue is left unresolved, it will lead to the collapse of the city's main arterial Huntington Avenue and several utilities.

Continual erosion at Lion's Pride Park would wash away the RV Disposal Station and Huntington Avenue South, the main arterial in the south end of the city. Given that during a high water event the collapse of Huntington Avenue South could happen suddenly, it is probable that before responders have the opportunity to set up warning devices, a vehicle could drive into the washed out area resulting in four fatalities. A washout of Huntington Avenue South would result in the failure of an 8 inch water main that would leave residents and commercial/industrial property at the south end of the City with no potable water. In addition, the pressurized sanitary sewer main would likely be pulled apart which would result in the failure of the RV Disposal Station creating health and environmental issues. The nearby public restroom would be impacted and most likely need to be shut down. In addition to the potable water and sanitary sewer mains is a 4-inch natural gas main that could also be ruptured during this event. The collapse of Huntington Avenue S. would have a severe economical impact as the majority of goods come into the City via this route. An alternative route would need to be established for residents and commercial suppliers. Citizens, suppliers and school bus routes would need to adjust their schedule to allow time for the detour. The loss of business due to this event could amount to as much as \$3,000,000 while repairs are made over a 90-day period.

Relates to Plan Goal(s) and Objectives:

2F. Ensure that structures for vehicles and equipment needed for emergency services operation can withstand disaster impacts. Retrofit or relocate these facilities, as needed.

3B. Ensure that local emergency services facilities can withstand the impacts of disasters. Retrofit or relocate these facilities, as needed.

Implementer: City of Castle Rock, Public Works Department

Estimated Cost: \$750,000

Time Period: 2020

Funding Source: Federal or State Grants

Source, Date, Page Number: Cowlitz County Hazard Mitigation Plan 2005. Page 48

Priority: 7 of 8

Status: New

Hazard Addressed: Multi Hazard

Category: Critical Facilities Replacement/Retrofit

CR-MH 03: Raise RFT – Westside to prevent Flooding

Rationale: This is a statement of justification for why the mitigation initiative is necessary. A brief narrative should include a problem statement (what is the real or potential impact from the hazard?). Describe how the action will mitigate the problem.

Relates to Plan Goal(s) and Objectives: Identify relevant planning goals and objectives that the mitigation initiative will support. These are the mitigation goals and objectives located in Chapter 5. Example, 1A, 1B.

Implementer: Refers to the agency department or title of the staff member responsible for implementing the initiative.

Estimated Cost: For example, \$450,000. If unknown, state reason the cost is unknown. If the initiative is a carry-over from the original plan, do the cost estimates require updating? If so, enter new cost estimate.

Time Period: For example, 2012 or 2025. If it is complete, state the month and year the initiative was complete. If the initiative is a carry-over, update the new estimated timeline for completion.

Funding Source: Describe the source of revenue that will be used to finance the initiative. If a carry-over initiative, consider a new funding source, if appropriate.

Source and Date: Refers to an agency document from which an initiative may have been originally identified. For example, Natural Hazards Mitigation Plan, Thurston County 1999 Flood Hazard Management Plan. Include Capitol Facility Plans, Storm Water Utility Plans, etc.

Adopted Plan Number: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Reference Page: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Initiative and Implementation Status: Describe the status of this initiative. If new, state as such. See Instructions.

Priority: 8 of 8

Status: New

Hazard Addressed: Multi Hazard

Category: Critical Facilities Replacement/Retrofit

CR-MH 04: Pump Vault

Rationale: This is a statement of justification for why the mitigation initiative is necessary. A brief narrative should include a problem statement (what is the real or potential impact from the hazard?). Describe how the action will mitigate the problem.

Relates to Plan Goal(s) and Objectives: Identify relevant planning goals and objectives that the mitigation initiative will support. These are the mitigation goals and objectives located in Chapter 5. Example, 1A, 1B.

Implementer: Refers to the agency department or title of the staff member responsible for implementing the initiative.

Estimated Cost: For example, \$450,000. If unknown, state reason the cost is unknown. If the initiative is a carry-over from the original plan, do the cost estimates require updating? If so, enter new cost estimate.

Time Period: For example, 2012 or 2025. If it is complete, state the month and year the initiative was complete. If the initiative is a carry-over, update the new estimated timeline for completion.

Funding Source: Describe the source of revenue that will be used to finance the initiative. If a carry-over initiative, consider a new funding source, if appropriate.

Source and Date: Refers to an agency document from which an initiative may have been originally identified. For example, Natural Hazards Mitigation Plan, Thurston County 1999 Flood Hazard Management Plan. Include Capitol Facility Plans, Storm Water Utility Plans, etc.

Adopted Plan Number: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Reference Page: Refers to the identifiers of the initiative within the adopted document. If not applicable, please enter N/A.

Initiative and Implementation Status: Describe the status of this initiative. If new, state as such. See Instructions.

ENDNOTES

ⁱ University of Washington. 2002. Nisqually Quake Damaged Nearly 300,000 Puget Sound Households. Newswise.com, November 20, 2002. Online article.

<http://www.newswise.com/articles/view/?id=QUAKE2.UWA>

ⁱⁱ Wolf Read. 2004. The Strongest Windstorms in the Western Pacific Northwest 1950-2004. From the "Storm King" Series on:

<http://www.climate.washington.edu/stormking/>. Results derived from tabular data for period of 1950 to 2004, appended with current data (2005-2007) from other storm summaries from Wolf Read's recent "Storm King" reports.

ⁱⁱⁱ Hazards & Vulnerability Research Institute. 2008. The Spatial Hazard Events and Losses Database for the United States, Version 6.2 [SHELDUS Online Database]. Columbia, SC: University of South Carolina. Available from <http://www.sheldus.org>.

^{iv} Preliminary Damage Assessment for Declaration 1817. Federal Emergency management Agency (FEMA). January 2009

^v The preliminary damage assessment (PDA) process is a mechanism used to determine the impact and magnitude of damage and resulting needs of individuals, businesses, public sector, and community as a whole. Information collected is used by the State as a basis for the Governor's request for a major disaster or emergency declaration, and by the President in determining a response to the Governor's request (44 CFR § 206.33).

^{vi} Thurston County Emergency Management. 2009. Supplemental Justification Report.

^{vii} Tilling, Robert, I. et.al. 1990. Eruptions of Mount St. Helens: Past, Present, and Future, U.S. Geological Survey Special Interest Publication,

^{viii} Ibid