City of Renton

Hazard Mitigation Plan

April 2010

RENTON. AHEAD OF THE CURVE.

City of Renton

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1.0 INTRODUCTION

1.1 What is a Mitigation Plan?

The City of Renton and the surrounding areas are subject to a wide range of natural and anthropogenic hazards, including: floods, winter storms, earthquakes, landslides, hazardous material spills and more. The impacts of potential future hazard events on Renton may be minor, like a few inches of water in a street, or they may be major, with damages and economic losses reaching millions of dollars.

The impacts of major disasters on communities can be devastating. The total damages, economic losses, casualties, disruption, hardships and suffering are often far greater than the physical damages alone. Furthermore, recovery from major disasters often takes many years and some heavily impacted communities may never fully recover. Completely eliminating the risk of future disasters in Renton is neither technologically possible nor economically feasible. However, substantially reducing the negative impacts of future disasters is achievable with the implementation of a pragmatic hazard mitigation plan.

Renton's Hazard Mitigation Plan addresses each of the natural hazards that pose a significant risk to Renton, along with the major anthropogenic hazards. The mitigation plan addresses hazards such as severe weather events or localized storm water drainage flooding that may happen in some locations almost every year. The plan also addresses larger hazard events that will affect much or all of the Renton community, albeit with lower probabilities of occurrence in a given year. Infrequent hazard events, such as a major earthquake, which may occur only every few decades or every few hundred years, still pose a substantial threat to Renton because the consequences, when they do occur, may be extremely high.

Renton's Hazard Mitigation Plan has several key elements.

1. Each hazard that may impact Renton significantly is reviewed to determine the probability (frequency) and severity of likely hazard events.
2. The vulnerability of Renton to each hazard is evaluated to estimate the likely extent of physical damages, casualties and economic impacts.
3. A range of mitigation alternatives are evaluated to identify those with the greatest potential to reduce future damages and losses in Renton, and to protect facilities deemed critical to the community's well-being that are desirable from the community's political and economic perspectives.

The purpose of Renton's Hazard Mitigation Plan is to address only the mitigation of hazards that originate within the City of Renton and those that have an effect in Renton. Response to disasters and emergencies are covered in detail in Renton's Comprehensive Emergency Management Plan.

Furthermore, this plan addresses only the mitigation efforts the City can and will take in accordance with the legal limits of its authority. Although some of the recommendations within the plan are made for infrastructure providers that are not part of City of Renton government, individuals, businesses and other government agencies are responsible for protecting their own property from hazards and disasters. Private and public entities alike are encouraged to review this plan and consider making mitigation efforts as appropriate. Additional mitigation information resources for Renton residents and businesses are available by contacting the Emergency Management Office located at Renton City Hall.

1.2 Why is Mitigation Planning Important for Renton?

Mitigation simply means actions that reduce the potential for negative impacts from future disasters including: future damages, losses and casualties.

Effective mitigation planning will help the residents of Renton deal with natural and manmade hazards realistically and rationally. It will help identify specific locations in Renton where the level of risk from one or more hazards may be unacceptably high and then find cost effective ways to reduce such risk. Mitigation planning strikes a pragmatic middle ground between unwisely ignoring the potential for major hazard events on one hand and unnecessarily overreacting to the potential for disasters on the other hand.

Furthermore, the Federal Emergency Management Agency (FEMA) now requires each local government entity to adopt a multi-hazard mitigation plan and to update that plan every five years to remain eligible for future pre- or post-disaster FEMA mitigation funding. An important objective in updating Renton's Hazard Mitigation Plan is to maintain eligibility for FEMA funding and enhance Renton's ability to attract future FEMA mitigation funding.

This Plan is specifically designed to help Renton gather the data necessary to compete successfully for future FEMA funding of mitigation projects. FEMA requires that all FEMA-funded hazard mitigation projects must be "cost-effective" (i.e., the benefits of a project must exceed the costs). Benefit-cost analysis is an important component of mitigation planning, not only to meet FEMA requirements, but also to help evaluate and prioritize potential hazard mitigation projects in Renton, regardless of whether funding is from FEMA, state or local government, or from private sources.

1.3 Renton's Hazard Mitigation Plan

This Plan is built upon quantitative assessments, to the extent that data allows, of each of the major hazards that may impact Renton including their frequency, severity and areas of the City likely to be affected. The hazards addressed are: floods, severe winter storms, earthquakes, landslides, volcanic events, coal mine hazards, hazardous materials incidents and terrorism/civil disturbance. Other hazards, including extreme temperatures, drought and wildland/urban interface fires are briefly addressed, but are not considered in detail, because they pose less significant risks to Renton.

Renton's Hazard Mitigation Plan also includes a qualitative or quantitative assessment on the vulnerability of buildings, infrastructure and people possibly impacted by each of these hazards, to evaluate the likely magnitude of future disasters on Renton.

The review of hazards and the vulnerability of Renton to hazards is the foundation of the mitigation plan. From these assessments, specific locations where buildings, infrastructure and/or people may be at high risk are identified. These high risk situations then become priorities for future mitigation actions to reduce the negative impacts of future disasters on Renton.

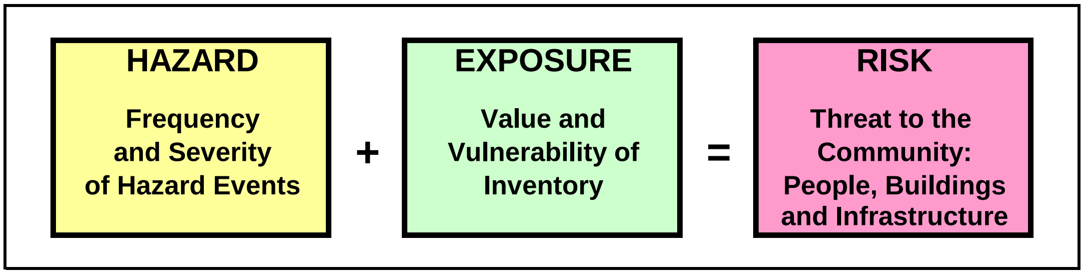
Renton's Hazard Mitigation Plan deals with hazards realistically and rationally and strikes a balance between suggested physical mitigation measures and planning measures. The overall goal is to reduce the negative impacts of future disasters and better prepare the community to respond and recover from disasters.

1.4 Key Concepts and Definitions

The central concept of mitigation planning is that mitigation reduces risk. **Risk** is defined as the threat to people and the built environment posed by the hazards being considered. That is, risk is the potential for damages, losses and casualties arising from the impact of hazards on the built environment. The essence of mitigation planning is to identify high risk locations/situations in Renton and to evaluate ways to mitigate (reduce) the impacts of future disasters on these high risk locations/situations.

The level of risk at a given location, building or facility depends on the combination of **hazard** and **exposure** as shown in Figure 1.1 below.

Figure 1.1
Hazard and Exposure Combine to Produce Risk



Risk is generally expressed in dollars (estimates of potential damages and other economic losses) and in terms of casualties (numbers of deaths and injuries).

There are four key concepts that govern hazard mitigation planning: hazard, exposure, risk and mitigation. Each of these key concepts is addressed in turn.

HAZARD refers to natural or manmade events that may cause damages, losses or casualties (e.g., floods, winter storms, landslides, earthquakes, hazardous material spills, etc.). Hazards are characterized by their frequency, severity and the geographic area affected. Each hazard is characterized differently, with appropriate parameters for the specific hazard. For example, floods may be characterized by the frequency of flooding, along with flood depth and flood velocity. Winter storms may be characterized by the amount of rainfall in a 24-hour period, by the wind speed or by the amount of snow or ice associated with a storm. Earthquakes may be characterized by the severity and duration of ground motions and so on.

A hazard event, by itself, may <u>not</u> result in any negative impacts on a community. For example, a flood-prone five-acre parcel may typically experience several shallow floods per year, with several feet of water expected in a 50-year flood event. However, if the parcel is wetlands, with no structures or infrastructure, then there is no risk. That is, there is no threat to people or the built environment and the frequent flooding of this parcel does not have any negative impacts on the community. Indeed, in this case, the very frequent flooding (i.e., the high hazard) may be beneficial environmentally by providing wildlife habitat and recreational opportunities.

The important point here is that hazards do not produce risk to people and property unless there is vulnerable inventory exposed to the hazard. Risk to people, buildings and/or infrastructure results only when hazards are combined with **exposure**.

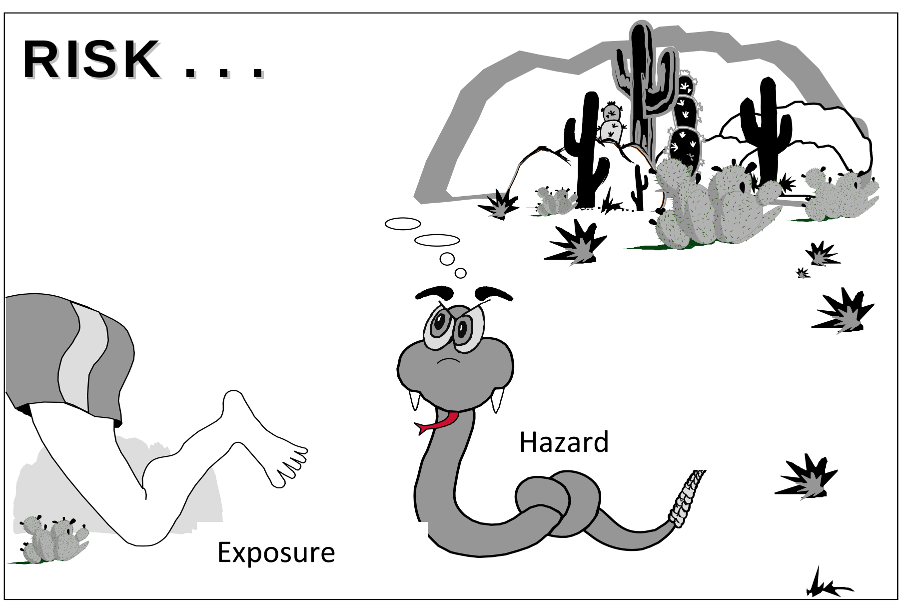
EXPOSURE is the quantity, value and vulnerability of the built environment (inventory of people, buildings and infrastructure) in a particular location subject to one or more hazards. Inventory is described by the number, size, type, use and occupancy of buildings and by the infrastructure present. Infrastructure includes roads and other transportation systems, utilities (potable water, wastewater, natural gas, and electric power), telecommunications systems and so on.

Inventory varies markedly in its importance to a community and thus varies markedly in its importance for hazard mitigation planning. Some types of facilities are identified as "critical facilities" due to their import to the community, particularly during disaster situations. Examples of critical facilities include police and fire stations, hospitals, schools, emergency shelters, 911 centers and other important buildings. Critical facilities may also include infrastructure elements that are important links or nodes in providing service to large numbers of people such as a potable water source, an electric power substation and so on. "Links" are elements such as water pipes, electric power lines and telephone cables that connect portions of a utility or transportation system. "Nodes" are locations with important functions, such as pumping plants, substations or switching offices.

For hazard mitigation planning, inventory must be characterized not only by the quantity and value of buildings or infrastructure present but also by its vulnerability to each hazard under evaluation. For example, a given facility may or may not be particularly vulnerable to flood damages or earthquake damages, depending on the details of its design and construction. Depending on the hazard, different measures of the vulnerability of buildings and infrastructure are often used.

RISK is the threat to people and the built environment - the potential for damages, losses and casualties arising from hazards. Risk, which results <u>only</u> from the combination of Hazard and Exposure as discussed above, is illustrated schematically in Figure 1.2 below.

Figure 1.2
Risk Results from the Combination of Hazard and Exposure



A disaster event happens when a hazard event is combined with vulnerable inventory. The highest risk in a community occurs in high hazard areas (frequent and/or severe hazard events) with large inventories of vulnerable buildings or infrastructure.

However, high risk can also occur with only moderately high hazard, if there is a large inventory of highly vulnerable inventory exposed to the hazard. For example, seismic hazard is lower in Washington than in the seismically active areas of California. For some buildings the seismic risk in Washington may be comparable to or even higher than the seismic risk in California, because some of the building inventory in Washington is much more vulnerable to earthquake damages. Conversely, a high hazard area can have relatively low risk if the inventory is resistant to damages (e.g., elevated to protect against flooding or strengthened to minimize earthquake damages).

MITIGATION means actions to reduce the risk due to hazards and reduce the potential for damages, losses and casualties in future disaster events. Repair of buildings or infrastructure damaged in a disaster is not mitigation because repair simply restores a facility to its pre-disaster condition and does not reduce the potential for future damages, losses or casualties. Hazard mitigation projects may be initiated - before a disaster, or after a disaster has already occurred. In either case, the objective of mitigation is always to reduce future damages, losses or casualties.

A few of the most common types of mitigation projects are shown below in Table 1.1.

Table 1.1
Common Mitigation Projects

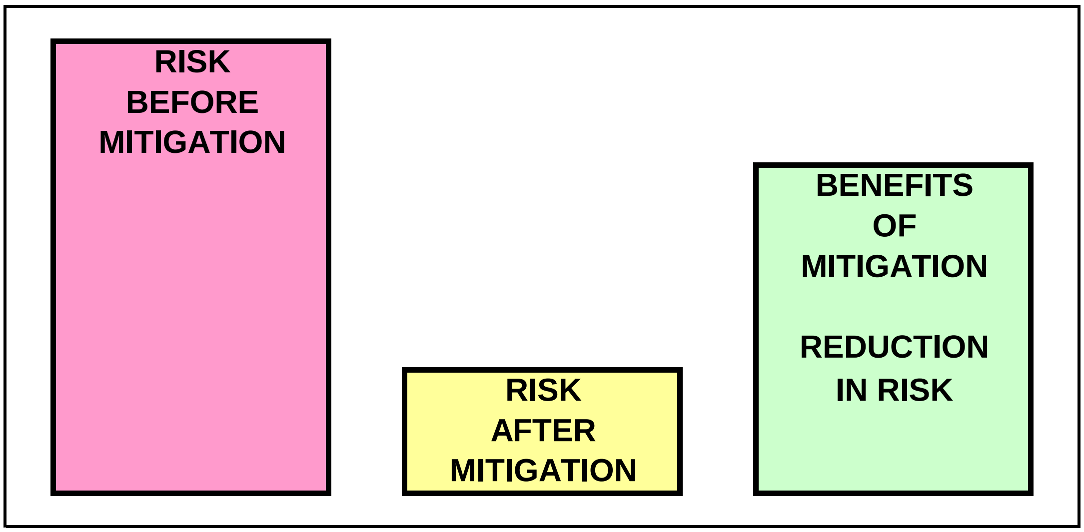
Hazard	Mitigation Project
Flood	Build or improve levees or flood walls
	Improve channels for flood control
	Improve drainage systems and culvert capacities
	Create detention ponds for storage
	Relocate, elevate or floodproof flood-prone structures
	Acquire and demolish highly flood-prone structures
Winter Storms	Add emergency generators for critical facilities
	Improve redundancy of utility systems
	Trim trees to reduce failures of utility lines
Earthquakes	Upgrade seismic performance of buildings
	Upgrade seismic performance of infrastructure
Landslides	Remediate slide conditions
	Relocate utility lines or structures
Wildland/Urban Interface Fires	Increase fire safe construction practices
	Vegetation (fuel load) control
General	Enhance emergency planning and mutual aid
	Expand public education programs

The mitigation project list above is not comprehensive and mitigation projects can encompass a broad range of other actions to reduce future damages, losses and casualties.

1.5 The Mitigation Process

The key element for all hazard mitigation projects is that they reduce risk. The benefits of a mitigation project are the reductions in risk, or the difference in expected damages, losses and casualties before mitigation versus after mitigation. These important concepts are illustrated below in Figure 1-3.

Figure 1.3
Mitigation Projects Reduce Risk



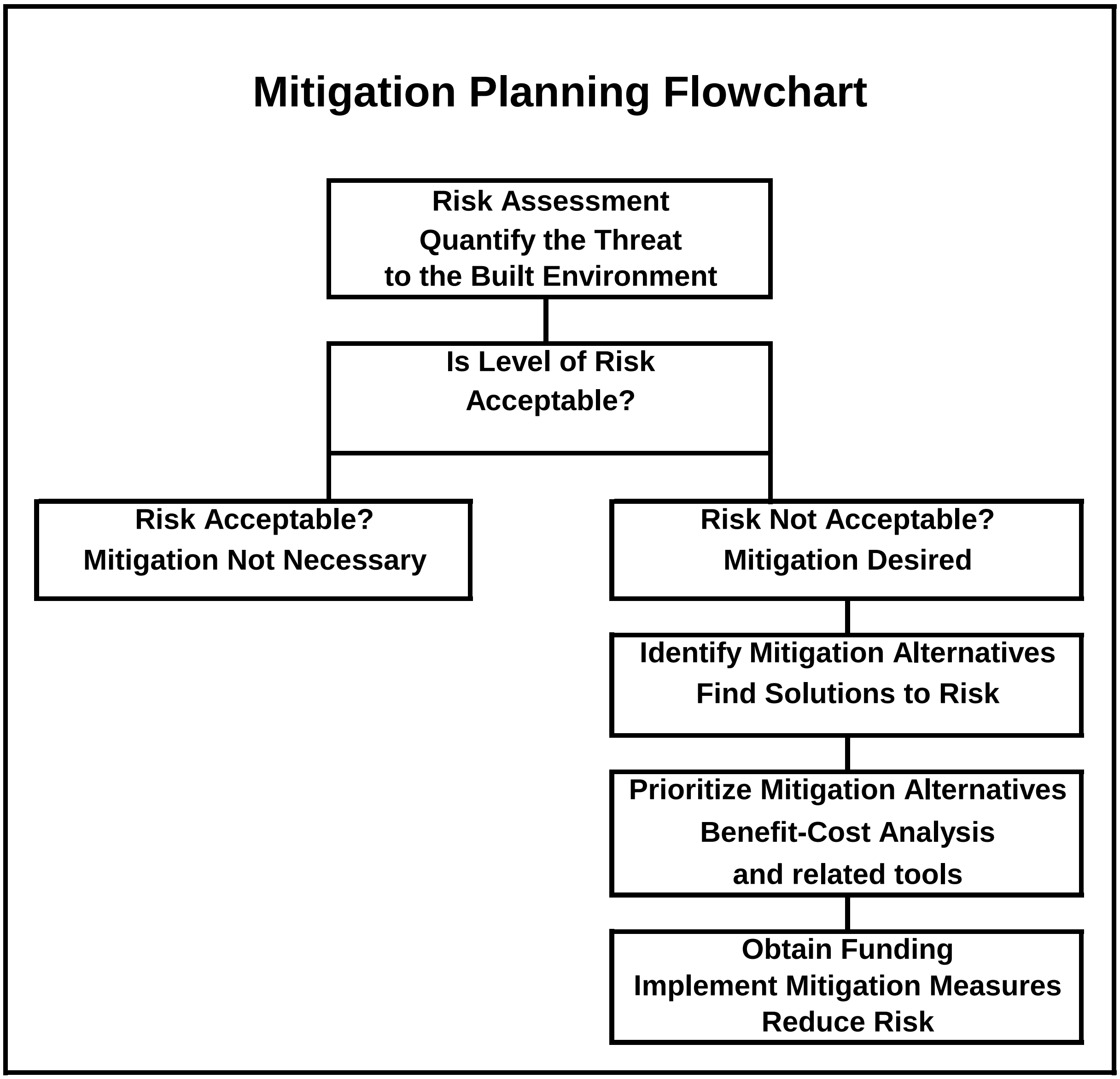
Quantifying the benefits of a proposed mitigation project is an essential step in hazard mitigation planning and implementation. Only by quantifying benefits is it possible to compare the benefits and costs of mitigation to determine whether or not a particular project is worth doing or economically feasible. Real world mitigation planning almost always involves choosing between a range of possible alternatives, often with varying costs and varying effectiveness in reducing risk.

Quantitative risk assessment is centrally important to hazard mitigation planning. When the level of risk is high, the expected levels of damages and losses are likely to be unacceptable and mitigation actions have a high priority. Thus, the greater the risk the greater the urgency of undertaking mitigation.

Conversely, when risk is moderate both the urgency and the benefits of undertaking mitigation are reduced. It is neither technologically possible nor economically feasible to eliminate risk completely. Therefore, when levels of risk are low and/or the cost of mitigation is high relative to the level of risk, the risk may be deemed acceptable (or at least tolerable). Proposed mitigation projects that address low levels of risk, or the cost of the mitigation project is large relative to the level of risk, are generally poor candidates for implementation.

The overall mitigation planning process is outlined in Figure 1.4 below.

Figure 1.4
The Mitigation Planning Process



The first step is a quantitative evaluation of the hazards (frequency and severity) impacting Renton and of the inventory (people, buildings and infrastructure) exposed to these hazards. Together the hazard and exposure data determine the level of risk for specific locations, buildings or facilities in Renton.

The next step is to determine whether or not the level of risk posed by each of the hazards impacting Renton is acceptable or tolerable. Only the residents of Renton can make this determination. If the level of risk is deemed acceptable or at least tolerable, then mitigation actions are not necessary or at least not a high priority.

On the other hand, if the level of risk is deemed not acceptable or intolerable, then mitigation actions are desired. In this case, the mitigation planning process moves on to a more detailed evaluation of specific mitigation alternatives, prioritization, funding and implementation of mitigation measures. As with the determination of whether or not the level of risk posed by each hazard is acceptable or not, decisions about which mitigation projects to undertake can only be made by the residents of Renton.

1.6 The Role of Benefit-Cost Analysis in Mitigation Planning

Communities, like Renton, that are considering whether or not to undertake mitigation projects must answer questions that don't always have obvious answers, such as:

What is the nature of the hazard problem?

How frequent and how severe are hazard events?

Do we want to undertake mitigation measures?

What mitigation measures are feasible, appropriate and affordable?

How do we prioritize between competing mitigation projects?

Are our mitigation projects likely to be eligible for FEMA funding?

Benefit-cost analysis is a powerful tool that can help communities provide solid, defensible answers to these difficult questions. Benefit-cost analysis is <u>required</u> for all FEMA-funded mitigation projects, under both pre-disaster and post-disaster mitigation programs. However, regardless of whether or not FEMA funding is involved, benefit-cost analysis provides a sound basis for evaluating and prioritizing possible mitigation projects for any natural hazard.

Benefit-cost analysis software, technical manuals and a wide range of guidance documents are available from FEMA at no cost to communities.   A Benefit-Cost Analysis Toolkit CD which contains all of the FEMA benefit-cost materials is available from FEMA. The publication *What is a Benefit? Guidance for Benefit-Cost Analysis* is particularly recommended as a general reference. This publication includes categories of benefits to count for mitigation projects for various types of buildings, critical facilities and infrastructure and has simple, standard methods to quantify the full range of benefits for most types of mitigation projects.

1.7 Hazard Synopsis

To set the overall context of hazard mitigation planning, we briefly review the major hazards that impact Renton. Some hazards affect the entire city, while some hazards have more localized impacts.

Renton has several areas of flood plains mapped by FEMA. These include areas along the Cedar River, Green River, Springbrook Creek, May Creek and their tributaries. Other portions of Renton, outside of the mapped floodplains, are subject to flooding from local storm water drainage.

The entire City of Renton is subject to the effects of winter storms, including wind, rain, snow and ice, as well as secondary effects such as power outages.

The entire City of Renton is subject to the impacts of earthquakes on the Cascadia Subduction Zone off the Washington coast, on the Seattle Fault and other faults within Washington.

Portions of the hilly areas of Renton are subject to landslides or mudslides, which may affect buildings, roads and utilities.

Historically, several areas of Renton had active coal mines. Although none of these mines are currently active, the old mine sites pose risks from possible collapses and the release of underground water.

The entire City of Renton is subject to volcanic hazards from eruptions in the Cascades, although the impacts are likely to be very minor ash falls.

Hazardous material releases are possible nearby or downwind from fixed site concentrations (e.g., industrial sites) as well as along transportation corridors from truck or rail accidents.

Terrorist incidents or other deliberate malevolent actions by vandals, disturbed individuals, or employees or members of organized groups could affect Renton.

There are several other hazards, including extreme temperatures, drought and wildland/urban interface fires, which pose only minor threats to Renton. Renton's moderate climate indicates that extremes of temperature (either hot or cold) sufficient to have major impacts are very unlikely. Similarly, the high average rainfall indicates that potential droughts are not a major concern. Renton and the surrounding communities are largely built out, with very limited areas of high fuel load vegetation, making the potential for major wildland/urban interface fires is low. These hazards pose only minor threats to Renton and are not considered further in this mitigation plan.

The approximate level of risk posed to Renton by each of the hazards covered in this mitigation plan is summarized below in Table 1.2. This ranking is based on quantitative/qualitative judgment about the likely long-term average annual damages and losses from each hazard, taking into account the probability of hazard events and the severity of damages and losses when such events occur.

Table 1.2
Relative Risk to Renton from Hazards

Hazard	Relative Risk to Renton
Earthquakes	High
Floods	High
Winter Storms	Moderate
Landslides	Moderate
Coal Mine Hazards	Moderate
Hazmat Incidents	Moderate
Terrorism	Low
Volcanic Events	Low
Extreme Temperatures	Very Low
Wildland/Urban Interface Fires	Very Low
Drought	Very Low

The remaining chapters of the Renton Mitigation Plan include the following:

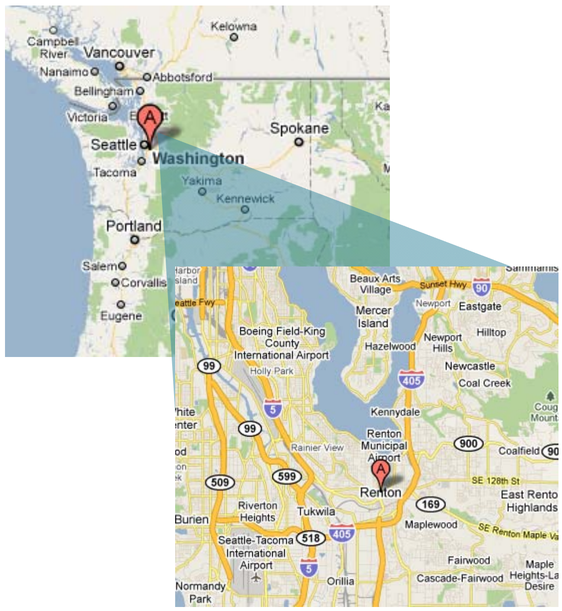
- Chapter 2 provides a brief community profile for the City of Renton.
- Chapter 3 documents the community involvement and public process involved in developing this mitigation plan.
- Chapter 4 outlines the mitigation plan goals, mitigation strategies and action items.
- Chapter 5 documents the formal process of plan adoption, implementation and maintenance.
- Chapters 6 through 13 cover each of the major hazards addressed in this mitigation plan, including: floods, winter storms, earthquakes, landslides, volcanic hazards, coal mine hazards, hazmat incidents and terrorism.

The Appendices include synopses of FEMA mitigation grant programs and benefit-cost analysis.

2.0 COMMUNITY PROFILE: RENTON

2.1 Population, Geography, Hazards and Climate

The City of Renton is located at the southern end of Lake Washington in King County, about 10 miles southeast of downtown Seattle. Renton, which was founded in the 1850s and incorporated in 1901, occupies an area of 22.9 square miles.



The estimated 2008 population of Renton was 80,708. Renton is the 5th largest city in King County and the 11th largest city in Washington. Renton has experienced rapid population growth in recent years with the 1990 population of 39,340 more than doubling by 2008.

Renton's dominant natural landscape features are Lake Washington and the Cedar and Green Rivers. The Howard Hanson Dam provides flood protection for the Green River, but there are concerns about the dam's safety. The topography of Renton varies, with generally flat areas near Lake Washington and hilly areas in eastern and southeastern Renton. Elevations in Renton range from about 45 feet at Lake Washington to about 400 feet in the hills.

Earthquakes and floods pose the greatest risk for Renton. The entire city is subject to the effects of winter storms and to volcanic hazards. Portions of Renton are subject to landslide hazards, coal mine hazards, and wildland-urban interface fire hazards as well. The city is also exposed to risks from human-caused hazards, including hazardous materials or terrorism incidents.

The climate for Renton is moderate. Mean daily temperatures range from highs of about 77 degrees and lows of about 55 degrees in July and August to highs of about 47 degrees and lows of about 35 degrees in December and January. The average annual rainfall is about 38 inches. Average monthly precipitation varies from nearly 6 inches in November through January to about 0.75 inches in July. Average annual snowfall is about 12 inches.

2.2 Demographics

Demographic data for Renton from the US Census Bureau is shown below in Table 2.1. The age and ethnicity categories in Table 2.1 intentionally include overlapping subsets for planning purposes.

Table 2.1
Population Demographics
2005-2007 American Community Survey Estimates, US Census Bureau)

Demographic Data		Renton
Age		
	Under 5 years	8.7%
	Under 18 years	23.7%
	18 years and over	76.3%
	18 years to 65 years	66.9%
	65 years and over	9.4%
Ethnicity of Households		
	White	58.9%
	Black or African Amerian	11.4%
	American Indian and Alaska Native	0.2%
	Asian	18.3%
	Native Hawaiian and Pacific Islander	0.1%
	Other or two or more races	3.7%
	Hispanic or Latino (of any race)	10.7%

For emergency planning purposes, children, elderly adults, the disabled, people whose primary language is not English and low income residents are considered special needs populations. Based on census data, Renton has a substantial population of children and elderly adults. As shown in Table 2.1 above, about 24% of the population are children less than 18 years old, while about 9% are adults over 65 years old. About 14% of the population 5 years or older is classified as disabled, per the Census data.

Renton has large populations of Asian (18%) and Hispanic (11%) households. Overall, about 25% of Renton's residents were born outside the United States; for most of these residents, English is a second language. Nearly 33% of the residents 5 years or older speak a language other than English at home.

According to census data (2005 American Community Survey), about 12% of the residents of Renton are below the poverty line.

The US Census website (www.census.gov) has a vast amount of demographic data for Renton and for King County. See the website for additional demographic data, including school enrollment, educational levels, disability status and other categories of demographic data useful for planning purposes.

2.3 Transportation, Employment, Economics and Housing

Renton is situated at the center of a regional and international transportation network, surrounded by freeways and in close proximity to air, sea and rail transportation hubs. Renton is at the center of the regional highway transportation network with three interstate highways and four major state highways in or near Renton.

Seattle-Tacoma International Airport is located only six miles from Renton. In addition, Renton maintains its own airport, Renton Municipal Airport-Clayton Scott Field which has a runway just over one mile in length capable of serving most types of aircraft from general aviation to corporate jets and turboprops. The airport is also home to the Will Rogers and Wiley Post Memorial Seaplane Base on Lake Washington. The seaplane base provides land access for amphibian aircraft of all types, and a few businesses at the airport provide floatplane launch/retrieval services. Renton Municipal Airport is also home to The Boeing Company's 737 with more than 5,000 deliveries and 7,000 orders. All new 737 aircraft produced in the factory depart on their maiden voyage from the Renton airport.

Renton has a broad, diversified employment base with over 2,700 employers and nearly 45,000 employees in the city. The Boeing Company is the largest employer in Renton, providing approximately 30% of the jobs in the City. Renton has been the home of Boeing for over 65 years. In addition to The Boeing Company, Renton's leading aerospace companies include AIM Aviation, Aero-Plastics, Harper Engineering, Renton Coil Spring, Honeywell, Worldwind Helicopters and the regional headquarters of the Federal Aviation Administration.

Other major private sector employers in Renton include: PACCAR Inc., Wizards of the Coast, Seattle Seahawks, TOPICS Entertainment, Providence Health & Services, ER Solutions, IKEA, Wal-Mart, Young's-Columbia of Washington, Kaye-Smith Business Graphics, Fry's Electronics and Sam's Club. Major public sector employers include: Valley Medical Center, Federal Reserve Bank of San Francisco (Seattle Branch), Federal Aviation Administration, Renton School District, City of Renton and Renton Technical College.

Overall, Renton's economic condition is robust, with median household income, average household income and per capita income all above the national averages.

Summary US Census Data for Renton's housing stock is given below in Table 2.2.

Table 2.2
Renton Housing Data
2005-2007 American Community Survey Estimates, US Census Bureau)

Housing Data	
Occupied Housing Units (25,524)	
Single Family, Detached	48.0%
Single Family, Attached	6.0%
Apartments (2 to 9 units)	17.7%
Apartments (10 or more units)	25.8%
Mobile Home or Other	2.6%
Year Structure Built	
2000 or later	16.4%
1990s	17.5%
1980s	15.9%
1960s or 1970s	30.1%
1940s or 1950s	17.1%
Before 1940	3.1%

The Census website (www.census.gov) has a vast amount of other economic data for Renton. See the Census website for additional economic data.

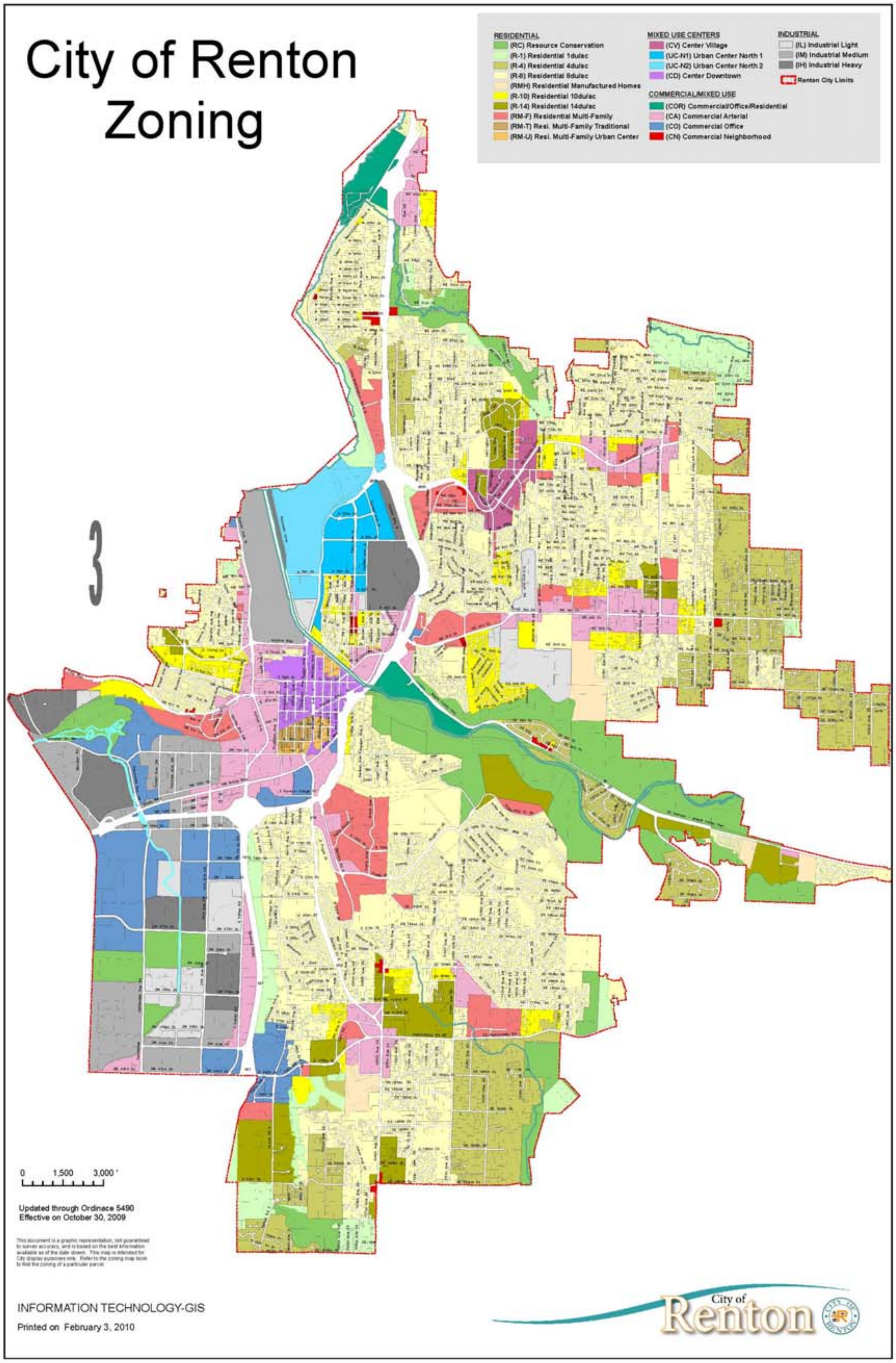
2.4 Land and Development

The City of Renton is located at the south end of Lake Washington, between Seattle, Tacoma and Bellevue. Renton covers 16 square miles and is bordered by King County, Kent, Tukwila, Newcastle, and Bellevue, with downtown Seattle 20 miles to the north. Two major freeways bisect the City, Interstate 405 and Highway 167.

The overall pattern of land use and development in Renton is shown in Figure 2.1 on following page, the Renton zoning map.

Renton has a mix of land uses throughout the City. The land uses within the City include industrial and commercial uses located primarily in the downtown areas of Renton. Boeing and the Renton Airport are located on the southern end of Lake Washington in northwestern Renton, at the mouth of the Cedar River and the site of past severe flooding. Also downtown are mixed use residential and commercial land uses, with a mix of single and multi-family homes. Single family residential dominates the eastern and southeastern portions of the City. In addition, in those areas there are pockets of mixed-use commercial centers aimed at providing services for residents living along the eastern edges of the City.

Figure 2.1
Renton Zoning Map (10/30/2009)



Southwest Renton, west of Highway 167, is a mix of commercial office space, light and heavy industrial and resource conservation lands. To the east of Highway 167, in southern Renton, is a mix of low-density single family, multi-family infill lands, single family homes and commercial office space.

The Comprehensive Plan provides a vision of Renton development 20 years into the future. The vision includes infill into existing neighborhoods on vacant lots with an increase in multi-family housing in the downtown areas, again with the emphasis on infill rather than on urban sprawl. Resource conservation lands are located along major rivers and creeks in areas associated with critical areas (wetlands, aquifer protection areas, fish and wildlife habitat, frequently flooded and geologically hazardous areas as defined by the Growth Management Act and RMC 4-3-050, Critical Area Regulations) and in the Valley (south of SW 16th Street and west of Highway 167) where significant wetlands exist.

Some existing development occurred in hazard areas prior to the adoption of current zoning and development standards regulating development in sensitive areas. According to the City of Renton Zoning Map (October 30, 2009), much of the hazardous and sensitive areas are zoned to allow only very low-density residential uses. The exception is building within the areas where soil conditions and the potential for liquefaction or lateral spreading increase seismic hazards, since seismic hazard areas encompass much of downtown and southwest Renton. Multi-family infill development has increased over the past ten years to accommodate the growth expected within the City. Much of the downtown increased seismic hazard area is designated as a mixed-use downtown center. While this accommodates the growth expected for the region it may also increase both the day and nighttime populations of downtown Renton. Single-family residential growth is occurring in eastern Renton, largely outside of hazard zones.

The City currently controls development of lands that are identified hazard areas in several ways. The Critical Areas Regulations, adopted into zoning in 1999, protect lands with identified aquifers, flood hazards, steep slopes, geologic hazards, and wetlands. Lands that are mapped in these designations, and lands that are identified as "critical areas" based upon adopted criteria upon site-specific review, are subject to restrictive standards and additional environmental analysis. Development regulations require that critical areas be deducted from the buildable area of the land in question for regulated hazards. For lands with characteristics below regulated thresholds, additional technical analysis – such as geotechnical reports or wetlands analysis – is required to ensure that development adequately addresses hazardous conditions.

Analyzing Development Trends

The Puget Sound Regional Council population and employment forecast growth for the City over the twenty-one-year interval from 2001 to 2022 is an increase of 9,723 households and 33,600 jobs. Growth targets adopted by the Growth Management Planning Council anticipate 6,198 households and 27,597 jobs. Both forecast growth and targets are well within the City's estimated land capacity of 11,261 units and 32,240 jobs established through the Buildable Lands requirements of the Growth Management Act (GMA). Renton is planning for its regional share of forecast growth over the next 20 years at the high end of the range, and the adopted target at the low end of the range. In the first nine years of growth management actual growth in Renton exceeded targets, but was within the range predicted by the forecast growth assumptions. With external factors, including the regional economy, state/federal transportation funding and the GMA regulatory environment remaining constant or improving, Renton's growth is anticipated to continue.

Table 2.3 summarizes Renton's forecast growth, targets and land-use capacity.

Table 2.3
Renton's Forecast Growth

	Incorporated Renton 2001-2011	Adjusted Target/Capacity Reflecting Growth/Annexation/Land Use Changes in 2001 and 2002
Forecast Growth	9,723 Units 33,600 Jobs 22,266 Population	None
Growth Targets	6,198 Units 27,597 Jobs 14,194 Population	4,253 Units 26,736 Jobs

2.5 Parks and Recreation

Renton has an extensive park, open space and urban trails system. The City's park system includes:

- 28 developed public parks
- 12.5 miles of trails (including a 4.5-mile paved trail along the Cedar River)
- 732 acres of open space for hiking, wildlife viewing and enjoying nature
- Maplewood Golf Course, an 18-hole, 190-acre, public golf course

- 45-acre Ron Regis Park includes a lighted regulation sized baseball/softball field and all-weather soccer field, lighted basketball court and opportunities for future baseball/softball and soccer field expansion.
- Gene Coulon Memorial Beach Park, a beautiful 55-acre park with nearly 1.5 miles of Lake Washington waterfront and a public boat launch, is the most popular city park with 1.5 million visitors each year. Additional amenities include two restaurants, 1.5 miles of shoreline and over-water walking paths, picnic facilities and a large children's play area.
- The public has additional water access at the mouth of the Cedar River on Lake Washington where the Cascade Canoe and Kayak Center offers canoe and kayak rentals.

In addition, the City has a unique combination of recreational and cultural opportunities and facilities that make Renton a quality community where people choose to live, work and play, including:

- The Henry Moses Aquatic Center which features two separate pools, a 9,000-square-foot leisure pool and a 3,300-square-foot, six-lane lap pool. The leisure pool includes popular features such as a zero-depth entry, wave machine, water spray play area, lazy river, island lagoon, water slide, toddler water area, large sun and shade spaces, a bathhouse and a concession area.
- A skate park, community center, two neighborhood centers, senior center, two City library branches and a history museum.
- The City's historic walk -- "History Lives Here" a self-guided tour of 22 markers highlighting historically significant places, people and events in Renton. Brochures along with a brief summary, historical photographs and pictures of related memorabilia are available at the Renton Library and other City buildings.

3.0 PLANNING PROCESS

3.1 Historical Overview

Renton has always considered hazards as part of the community planning process. Hazard maps are maintained at Renton City Hall in a common area for public review. Formal consideration of flood hazards is an integral part of Renton's participation in the National Flood Insurance Program; with about 951 flood insurance policies currently in place in Renton.

Hazard mitigation planning has been conceptually incorporated into Renton's Comprehensive Emergency Management Plan (CEMP), the latest revision of which was authorized by City Council Ordinance No. 3988 adopted on December 8, 2008. The Basic Plan portion of the CEMP provides a listing of the major hazards posing threats to the City of Renton. Each Emergency Support Function includes a supportive statement and encouragement to apply mitigation measures appropriately.

3.2 Planning Process

Renton's first hazard mitigation plan was developed as a result of the Disaster Mitigation Act of 2000 and was authorized by City Council Ordinance No. 3680 adopted on December 22, 2003.

The current revision of the Renton Hazard Mitigation Plan was coordinated by the Emergency Management Section of the Renton Fire & Emergency Services Department with the assistance of consultant Ken Goettel. The work began in late 2008, with ten steering committee meetings from November 2008 to April, 2010.

The City of Renton's Emergency Management Group functions as the Hazard Mitigation Steering Committee in Renton. The Emergency Management Group meets monthly and carries out the full spectrum of emergency management coordination topics including mitigation, preparedness, response and recovery. Although the composition of the group is primarily City staff, the local hospital and college are included in the membership. As a result of the Hazard Mitigation Plan development process, the Emergency Management Group has recommended the formation of a separate group, the "Community Risk Reduction Committee". This committee will meet at least twice yearly to gain more external and public participation, on an ongoing basis, for prevention and mitigation activities citywide to better inform the Emergency Management Group on mitigation issues and progress.

During the current revision of the Renton Hazard Mitigation Plan, three public workshops were held at Renton City Hall. The first, held April 9, 2009, presented the expired Hazard Mitigation Plan to the public and initiated dialogue for suggestions on improvements to the plan. After extensive coordination within the Emergency Management Group and with other City staff to develop revision recommendations, a second public workshop, held on March 16, 2010, provided an opportunity to review and comment on the final draft of the plan. Additionally, the plans were posted on the City of Renton website for public review and electronic comment.

These public workshops in Renton gave both public-sector and private-sector stakeholders in Renton ample opportunity to contribute the City of Renton Hazard Mitigation Plan. These public workshops were advertised on the rentonwa.gov website and in the local Renton newspaper. City staff with subject-matter expertise were in attendance at the first two workshops with maps and other visual displays to explain the hazards, answer questions and engage in dialogue with members of the public.

Hazard mitigation planning and public meetings conducted during the development of the Renton Hazard Mitigation Plan are summarized below. Meeting attendees are listed in the appendix at the end of this chapter.

Planning Meeting #1 (November 6, 2008).

The Emergency Management Group was introduced to the Hazard Mitigation Plan revision needs on November 6, 2008 at Renton City Hall. A brief discussion emphasized the importance of hazard mitigation planning and garnered participation from the key contributors to the plan revision.

Planning Meeting #2 (March 3, 2009).

The Community Services Department set up a meeting with consultant Ken Goettel for advice on Hazard Mitigation Grant Program applications. Additionally, the smaller meeting group entertained a verbal proposal to have him compile and put narrative to the hazard mitigation planning efforts of the City's Emergency Management Group.

Planning Meeting #3 (March 5, 2009)

The third planning meeting was held on March 5, 2009 to identify the hazards most significant for Renton and to begin the process of identifying mitigation goals, objectives and action items. Consensus opinions and suggestions from this meeting included:

- The greatest losses to the City would be caused by earthquakes and floods.

- Power outage is a potential in all disasters and can also be the primary disaster in and of itself. The December 2006 windstorm highlighted the need for backup power for City facilities to protect critical services.
- Public input in this plan is important and a meeting for input should be held soon.

Planning Meeting #4 (April 2, 2009)

Considerable internal coordination and information sharing with the consultant occurred between the third and fourth planning meeting. The fourth planning meeting was held on April 2, 2009 at Renton City Hall. This meeting followed up on action items proposed in Meeting #2. Participants also reviewed and discussed the relative merits of two grant project proposals being considered for submission under the Hazard Mitigation Grant Program. City staff were confirmed for their roles in the scheduled April 9, 2009 public meeting to present the expired mitigation plan to the public and solicit input and concerns to guide plan development.

Public Meeting #1 (April 9, 2009).

The first public meeting with representatives of the planning team was held on April 9, 2009 at Renton City Hall. Major topics addressed included:

- Purpose of a Hazard Mitigation Plan.
- Identification of the major hazards within the City of Renton: floods, winter storms, earthquakes, landslides and debris flows, abandoned coal mines, hazmat incidents, volcanic eruptions and terrorism.
- Explanation of mitigation measures and solicitation of input into plan revision.

Planning Meeting #5 (May 7, 2009).

The fifth planning meeting was held on May 7, 2009 at Renton City Hall. Only a portion of the Emergency Management Group meeting was devoted to the Hazard Mitigation Plan and focused on general updates on the status of the consultant’s work and outstanding information needs to be satisfied by planning team members.

Planning Meeting #6 (June 4, 2009).

The sixth planning meeting was held on June 4, 2009 at Renton City Hall. The first draft of the Hazard Mitigation Plan from the consultant was available for review. Emergency Management Group members went through a page by page review of the plan and identified missing information and discussed action items.

Planning Meeting #7 (July 2, 2009).

The seventh planning meeting was held on July 2, 2009 at Renton City Hall. Between the sixth and seventh planning meetings, Emergency Management Group members worked on their narrative assignments and provided them to the Emergency Management Director for compilation in advance. The second draft of the Hazard Mitigation Plan was presented to the group members for another detailed review. Additional clarification was made through discussion on various topics as they were systematically reviewed. Follow up assignments were given to specific team members.

Planning Meeting #8 (August 6, 2009).

The eighth planning meeting was held on August 6, 2009 at Renton City Hall. Only a portion of the Emergency Management Group meeting was devoted to the Hazard Mitigation Plan and focused on final edits needed to the plan.

Planning Meeting #9 (February 4, 2010).

The ninth planning meeting was held on February 4, 2010 at Renton City Hall. Only a portion of the Emergency Management Group meeting was devoted to the Hazard Mitigation Plan and consisted of a last call for final edits needed to the plan before presentation at the March 16, 2010, public meeting.

Public Meeting #2: Presentation and discussion of Public Review Draft Hazard Mitigation Plan. (March 16, 2010).

The Public Review Draft of the Renton Hazard Mitigation Plan was presented and discussed March 16, 2010, at a specially scheduled public meeting at Renton City Hall. The context and purposes of the plan were discussed, along with goals, objectives and action items. Additional public comment was encouraged.

Planning Meeting #10 (April 1, 2010).

The tenth and final planning meeting was held on April 1, 2010 at Renton City Hall. The group reviewed and considered public comments received during the open comment period and incorporated them appropriately into the plan before submission.

3.3 Planning Participants

City of Renton Hazard Mitigation Planning Team

Kelley Balcomb-Bartock, Executive, City of Renton
Kelly Carey, Fire & Emergency Services, City of Renton
Kent Curry, Police, City of Renton
Dennis Conte, Community Services, City of Renton

Suzanne Dale-Estey, Community & Economic Development, City of Renton
Jeff Dosch, Security & Emergency Management, Valley Medical Center
William Flora, Fire & Emergency Services, City of Renton
Abdoul Gafour, Public Works, City of Renton
Lisa Garvich, Executive, City of Renton
Gregory Hartman, Fire & Emergency Services, City of Renton
Gina Jarvis, Finance & Information Services, City of Renton
Adriana Johnson, Community & Economic Development, City of Renton
Kayren Kittrick, Community & Economic Development, City of Renton
Bob Mac Onie, Public Works, City of Renton
Mindi Mattson, Fire & Emergency Services, City of Renton
George McBride, Finance & Information Services, City of Renton
Elman McClain, Emergency Management, Renton Technical College
Norma McQuiller, Community & Economic Development, City of Renton
Sonja Mejlaender, Community Services, City of Renton
Rachel Myers, Fire & Emergency Services, City of Renton
Deborah Needham, Fire & Emergency Services, City of Renton
David Pargas, Fire & Emergency Services, City of Renton
Robert Robertson, Human Resources & Risk Management, City of Renton
Tracy Schuld, Finance & Information Services, City of Renton
Colleen Shannon, Human Resources & Risk Management, City of Renton
Preeti Shridhar, Executive, City of Renton
Raymond Sled, Public Works, City of Renton
Michael Stenhouse, Public Works, City of Renton
Ron Straka, Public Works, City of Renton
Rocale Timmons, Community & Economic Development, City of Renton
Timothy Troxel, Police, City of Renton
Chip Vincent, Community & Economic Development, City of Renton
Donnaann Visneski, Finance & Information Services, City of Renton
Neil Watts, Community & Economic Development, City of Renton
Marty Wine, Executive, City of Renton
Cindy Zinck, Finance & Information Services, City of Renton

Distribution List for Notices and Planning Materials

Renton Hazard Mitigation Planning Team members listed above
Renton Reporter
300 Emergency Worker Volunteers
350 Neighborhood Leaders
http://www.rentonwa.gov

Planning Meeting #1 (November 6, 2008)

Kelley Balcomb-Bartok, Communications Specialist, Executive
Dennis Conte, Facilities Supervisor, Community Services

Jeff Dosch, Security & Emergency Management, Valley Medical Center
Abdoul Gafour, Water Utility Supervisor, Public Works
Jim Henriksen, Emergency Prep, Public Health
Kayren Kittrick, Engineering Supervisor, CED
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
Norma McQuiller, Neighborhood Program Coordinator, Community & Economic Development
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Linda Parks, Director, Finance & Information Services
Robin Robertson, Risk Manager, Human Resources & Risk Management
Karl Rufener, Fire Battalion Chief/Safety Officer, Fire & Emergency Services
Mike Stenhouse, Director, Public Works
Clark Wilcox, Sergeant, Police

Planning Meeting #2 (March 3, 2009)

Leslie Betlach, Parks Director, Community Services
Todd Black, Capital Project Coordinator, Community Services
Kelly Beymer, Golf Course Manager, Community Services
Ken Goettel, Consultant
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Peter Renner, Facilities Director, Community Services

Planning Meeting #3 (March 5, 2009)

Daniel Carey, Surface Water Engineer, Public Works
Kent Curry, Commander, Police/Patrol Services
Dennis Conte, Facilities Maintenance Supervisor, Community Services
I. David Daniels, Fire Chief/Emergency Services Administrator, Fire & Emergency Services
Jeff Dosch, Security & Emergency Management, Valley Medical Center
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Robin Robertson, Risk Manager, Human Resources &Risk Management
Mary Roy, Admin Sec I, Finance & Information Services
Ray Sled, Water Maintenance Manager, Public Works

Preeti Shridhar, Communications Director Administrative, Judicial and Legal Services
Ron Straka, Surface Water Engineer, Public Works

Planning Meeting #4 (April 2, 2009)

Kelley Balcomb-Bartok, Communications Specialist, Executive
Todd Black, Capital Projects Coordinator, Community Services
Kent Curry, Commander, Police
Suzanne Dale-Estey, Economic Development Director, Community & Economic Development
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Steve Lee, Surface Water Supervisor, Public Works
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
George McBride, Information Services Director, Finance & Information Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Linda Parks, Fiscal Services Director, Finance & Information Services

Public Meeting #1 (April 9, 2009)

I. David Daniels, Fire Chief/Emergency Services Administrator, Fire & Emergency Services
Victor Eskenazi
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Jennifer Henning
Katie McClincy, Commander, Police
Rachel Myers, Emergency Management Inter, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Gary Palmer
King Parker, Renton City Council Member
Don Perkins
Peter Renner, Facilities Director, Community Services
Dallin Slaugh
Ron Straka, Utility Engineering Supervisor, Community Services

Planning Meeting #5 (May 7, 2009)

Kelley Balcomb-Bartok, Communications Specialist, Executive
Mark Baldridge, Facilities Technician, Community Services/Facilities
Jeff Dosch, Security & Emergency Management, Valley Medical Center
Floyd Eldridge, Commander, Police
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services

Lisa Garvich, Communications Specialist, Fire & Emergency Services
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
George McBride, Information Services Director, Finance & Information Services
Joan Montegary, Assistant to the Chief, Fire & Emergency Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Preeti Shridhar, Communications Director, Executive
Marty Wine, Assistant Chief Administrative Officer, Executive

Planning Meeting #6 (June 4, 2009)

Mark Baldridge, Facilities Technician, Community Services
Jan Conklin, Development Services Representative, Community & Economic Development
Kent Curry, Commander, Police
I. David Daniels, Fire Chief/Emergency Services Administrator, Fire & Emergency Services
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Lisa Garvich, Communications Specialist, Fire & Emergency Services
George McBride, Information Services Director, Finance & Information Services
Norma McQuiller, Neighborhood Coordinator, Community & Economic Development
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
David Pargas, Assistant Fire Marshal, Fire & Emergency Services
Mark Peterson, Deputy Fire Chief, Fire & Emergency Services
Mary Roy, Administrative Secretary, Finance & Information Services
Ray Sled, Water Manager, Public Works
Preeti Shridhar, Communications Director, Executive

Planning Meeting #7 (July 2, 2009)

Dennis Conte, Facilities Supervisor, Community Services
Kent Curry, Commander, Police
I. David Daniels, Fire Chief/Emergency Services Administrator, Fire & Emergency Services
Jeff Dosch, Security & Emergency Management, Valley Medical Center
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Abdoul Gafour, Utility Engineering Supervisor, Public Works
Lisa Garvich, Communications Specialist, Fire & Emergency Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services

Deborah Needham, Emergency Management Director, Fire & Emergency Services
Ray Sled, Water Manager, Public Works
Pauletta Sulky, Risk Analyst, Human Resources & Risk Management

Planning Meeting #8 (August 4, 2009)

Dennis Conte, Facilities Supervisor, Community Services
Kent Curry, Commander, Police
Suzanne Dale-Estey, Economic Development Director, Community & Economic Development
I. David Daniels, Fire Chief/Emergency Services Administrator, Fire & Emergency Services
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Abdoul Gafour, Utility Engineering Supervisor, Public Works
Lisa Garvich, Communications Specialist, Executive Department
Peter Hahn, Deputy Administrator, Public Works
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
George McBride, Information Services Director, Finance & Information Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Linda Parks, Fiscal Services Director, Finance & Information Services
David Pargas, Assistant Fire Marshal, Fire & Emergency Services
Tim Troxel, Deputy Chief, Police
Ray Sled, Water Manager, Public Works
Pauletta Sulky, Risk Analyst, Human Resources & Risk Management
Clark Wilcox, Commander, Police
Greg Zimmerman, Administrator, Public Works

Planning Meeting #9 (February 4, 2010)

Kelly Carey, Administrative Secretary, Fire & Emergency Services
Dennis Conte, Facilities Supervisor, Community Services
Kent Curry, Commander, Police
Suzanne Dale-Estey, Economic Development Director, Community & Economic Development
Sonja Mejlaender, Community Relations Specialist, Community Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
David Pargas, Assistant Fire Marshal, Fire & Emergency Services
Colleen Shannon, System Technician, Human Resources & Risk Management
Ray Sled, Water Manager, Public Works

Public Meeting #2: Presentation and discussion of Public Review Draft Hazard Mitigation Plan. (March 16, 2010)

Dennis Conte, Facilities Supervisor, Community Services
Kent Curry, Commander, Police
Roy Gunsolus, Fire Battalion Chief/Safety Officer, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Ray Sled, Water Maintenance Manager, Public Works
Ron Straka, Engineering Supervisor, Public Works
Chip Vincent, Director, Community & Economic Development
Dennis Wood

Planning Meeting #11 (April 1, 2010)

Craig Burnell, Plan Reviewer, Community & Economic Development
Kelly Carey, Administrative Secretary, Fire & Emergency Services
Suzanne Dale-Estey, Economic Development Director, Community & Economic Development
Bill Flora, Deputy Fire Chief/Fire Marshal, Fire & Emergency Services
Abdoul Gafour, Utility Engineering Supervisor, Public Works
Lisa Garvich, Communications Specialist, Executive Department
Gina Jarvis, Fiscal Services Director, Finance & Information Services
Mindi Mattson, Emergency Management Coordinator, Fire & Emergency Services
Sonja Mejlaender, Community Relations Specialist, Community Services
Rachel Myers, Emergency Management Intern, Fire & Emergency Services
Deborah Needham, Emergency Management Director, Fire & Emergency Services
Ann Nielsen, Assistant City Attorney, City Attorney
Preeti Shridhar, Communications Director, Executive
Ray Sled, Water Manager, Public Works
Tim Troxel, Deputy Chief, Police

4.0 MISSION STATEMENT, GOALS, OBJECTIVES and ACTION ITEMS

4.1 Overview

The overall purpose of Renton's Hazard Mitigation Plan is to reduce the impacts of future natural or human-caused disasters on Renton. To make Renton more disaster resistant and disaster resilient, by reducing the vulnerability to disasters and enhancing the capability of the City and its citizens to respond effectively to, and recover quickly from, future disasters.

Completely eliminating the risk of future disasters in Renton is neither technologically possible nor economically feasible. However, substantially reducing the negative impacts of future disasters is achievable with the adoption of this Plan and ongoing implementation of risk reducing Action Items.

Incorporating risk reduction strategies and Action Items into Renton's existing programs and decision making processes will facilitate moving Renton toward a safer and more disaster resistant future. This Plan provides the framework and guidance for both short and long-term proactive steps that can be taken to:

- protect life safety,
- reduce property damage,
- minimize economic losses and disruption and
- shorten the recovery period from future disasters.

In addition, Renton's Hazard Mitigation Plan is intended to meet FEMA's (Federal Emergency Management Agency) mitigation planning requirements so that Renton remains eligible for pre and post-disaster mitigation funding from FEMA.

This Plan is based on a four-step framework that is designed to help focus attention and action on successful mitigation strategies: Mission Statement, Goals, Objectives and Action Items.

- **Mission Statement.** The Mission Statement defines the purpose and primary function of the Plan. The Mission Statement is an action-oriented summary that answers the question "Why develop a hazard mitigation plan?"
- **Goals.** Goals identify priorities and specify how Renton intends to work toward reducing the risks from natural and human-caused hazards. The Goals represent the guiding principles toward which the community's efforts are directed. Goals provide focus for the more specific issues, recommendations and actions addressed in Objectives and Action Items.

- **Objectives.** Each Goal has Objectives which specify the directions, methods, processes or steps necessary to accomplish the Plan's Goals. Objectives lead directly to specific Action Items.
- **Action Items.** Action Items are specific well-defined activities or projects that work to reduce risk. The Action Items represent the steps necessary to achieve the Mission Statement, Goals and Objectives.

4.2 Mission Statement

The mission of Renton's Hazard Mitigation Plan is to:

Proactively facilitate and support community-wide policies, practices and programs that make Renton more disaster resistant and disaster resilient.

This Plan documents Renton's commitment to promote sound public policies designed to protect citizens, critical facilities, infrastructure, private property and the environment from natural hazards by increasing public awareness, identifying resources for risk assessment, risk reduction, loss reduction and identifying specific activities to help make Renton more disaster resistant and disaster resilient.

4.3 Mitigation Plan Goals and Objectives

Mitigation plan goals and objectives guide the direction of future policies and activities aimed at reducing risk and preventing loss from disaster events. The goals and objectives listed here serve as guideposts and checklists as the City, other agencies, businesses and individuals begin implementing mitigation Action Items within Renton.

Renton's Hazard Mitigation Plan goals and objectives are based broadly on and are consistent with the goals established by the State of Washington's Hazard Mitigation Plan. However, the specific priorities, emphasis and language are Renton's. These goals were developed with extensive input and priority setting by Renton's Mitigation Plan Steering Committee (the Emergency Management Group) and the other stakeholders and citizens of Renton.

Goal 1: Reduce the Threat to Life Safety

Objectives:

A. Enhance life safety by minimizing the potential for deaths and injuries in future disaster events.

B. Enhance life safety by improving public awareness of earthquakes and other natural hazards posing life safety risk to the Renton community.

Goal 2: Reduce the Threats to Renton Buildings, Facilities and Infrastructure

Objectives:

A. Identify buildings and infrastructure at high risk from one or more hazards.

B. Conduct risk assessments for critical buildings, facilities and infrastructure at high risk to determine cost effective mitigation actions to eliminate or reduce risk.

C. Implement mitigation measures for buildings, facilities and infrastructure which pose an unacceptable level of risk.

D. Ensure that new buildings and infrastructure in Renton are adequately designed and located to minimize damages in future disaster events.

Goal 3: Enhance Emergency Response Capability, Emergency Planning and Post-Disaster Recovery

Objectives:

A. Ensure that critical facilities and critical infrastructure are capable of withstanding disaster events with minimal damages and loss of function.

B. Enhance emergency planning to facilitate effective response and recovery from future disaster events.

C. Increase collaboration and coordination between Renton, nearby communities, utilities, businesses and citizens to ensure the availability of adequate emergency and essential services for the Renton community during and after disaster events.

Goal 4: Vigorously Seek Funding Sources for Mitigation Actions

Objectives:

A. Prioritize and fund Action Items with the specific objective of maximizing mitigation, response and recovery resources.

B. Explore both public (local, state and federal) funding and private sources for mitigation actions.

Goal 5: Increase Public Awareness of Natural Hazards and Enhance Education and Outreach Efforts

Objectives:

A. Develop and implement education and outreach programs to increase public awareness of the risks from natural hazards

B. Provide information on resources, tools, partnership opportunities and funding resource sources to assist the community in implementing mitigation activities.

C. Strengthen communication and coordinate participation among and within public agencies, non-profit organizations, business, industry and the public to encourage and facilitate mitigation actions.

Goal 6: Incorporate Mitigation Planning into Natural Resource Management and Land Use Planning

Objectives:

A. Protect the aquifer supplying Renton's potable water and environmentally sensitive areas within Renton.

B. Balance natural resource management, land use planning and natural hazard mitigation to protect life, property and the environment.

C. Preserve, rehabilitate and enhance natural systems to both improve habitats and serve natural hazard mitigation functions.

4.4 Renton Hazard Mitigation Plan Action Items

The Mission Statement, Goals and Objectives for Renton are achieved via implementation of specific mitigation Action Items. Action Items may include refinement of policies, data collection to better characterize hazards or risks, education, outreach or partnership-building activities, as well as specific engineering or construction measures to reduce risk from one or more hazards to specific buildings, facilities or infrastructure within the Renton community.

Many of the high priority Action Items focus on facilities which are critical or essential for Renton. Critical facilities are facilities necessary for emergency response and recovery activities, especially public safety facilities and hospitals. Essential utility services such as electric power, water and wastewater are also extremely important to communities, especially after a disaster. Such utilities are often characterized as "lifeline" utilities because they are so important to a community for life safety (e.g., services to hospitals) and for the economic recovery after a disaster. Although not included, additional infrastructure important to the City, region and nation are also present in Renton, including the Federal Reserve Bank of San Francisco.

Critical facilities identified by Renton are shown below in Table 4.1

Action items identified and prioritized during the development of the Renton Hazard Mitigation Plan are summarized in Table 4.2. Individual action items may address a single hazard (such as floods, or earthquakes) or they may address two or more hazards concurrently. The first group of action items is for multi-hazard items that address more than one hazard, followed by groups of action items for each of the hazards considered in this plan, as addressed in more detail in Chapters 6 to 13

Table 4.1
Critical Buildings and Infrastructure for Renton

Infrastructure and Capital Facilities	Source/Type of Facility
City of Renton Water System	• 10 Wells • 1 Spring • 12 Booster Pump Stations • 9 Reservoirs • 9 Metered Connections to Outside Sources • 2 Water Treatment Facilities • 290 Miles of Water Main
City of Renton Wastewater System	• 23 Lift Stations • 4,219 Manholes • 180 Miles of Sewer Main
City of Renton Surface Water Utility	• 2 Pump Stations • 225 Miles of Storm Sewer Main • 83 Water Quality and Detention Facilities • 1.25 Miles of Levees and Floodwalls
Seattle Public Utilities	• 5 Water Transmission Mains
King County Wastewater Treatment	• 7 Sewer Interceptors (trunk lines) • 1 Treatment Plant
Public Safety	• 1 Police Facility, including jail services and facilities
Fire Facilities	• Station 11 - 211 Mill Ave. S. 98057 • Station 12 - 1209 Kirkland Ave. NE 98056 • Station 13 - 18002 108th Ave. SE 98055 • Station 14 - 1900 Lind Ave. SW 98057 • Station 16 - 12923 156th Ave. SE 98059 • Station 17 - 14810 SE Petrovitsky Rd. 98058 • Fire District 25 – King County Station, serving the east portion of the City
City of Renton Facilities	FACILITIES • Renton City Hall: 1055 S. Grady Way - 262,884sq.ft. • Old City Hall: 200 Mill Ave. S - 51,000sq.ft. • Renton Community Center: 1715 Maple Valley Hwy. (Potential Shelter) 36,000sq.ft. • Renton Senior Activity Center: 211 Burnett Ave. N., (Potential Shelter) 22,150sq.ft. • Carco Theatre: 1717 Maple Valley Hwy., (Potential Shelter) 11,090sq.ft. • Highlands Neighborhood Center: 800 Edmonds Ave. NE, (Potential Shelter) 11,960sq.ft. • North Highlands Neighborhood Center: 3000 NE 16th St. (Potential Shelter) 4,430sq.ft. • Tiffany Park Neighborhood Center: 1902 Lake Youngs Way SE, (Potential Shelter) 1600sq.ft. • Spirit of Washington Events Center: 233 Burnett Ave. S. (Potential Shelter) 11,780sq.ft. • Main Library: 100 Mill Ave. S. - 22,400sq.ft. • Highlands Library: 2902 NE 12th St. - 6,580sq.ft. • Facilities Shop: 107 Williams Ave. N. - 3,850sq.ft.

	• Park Maintenance Shops: 100 Bronson Way N. - 3,850sq.ft., and 105 Williams Ave. N. - 7,500sq.ft. • Public Works City Shops Bldg. A,B,C,D,& F: 3555 NE 2nd St. - 52,400sq.ft. • Boathouse: 1060 N. Riverside Dr. - 8,900sq.ft. • City Center Parking Garage: 655 S. 2nd St. - 179,243sq.ft. • Renton Historical Museum: 235 Mill Ave. S - 5,300sq.ft. • Maplewood Golf Course/ Clubhouse/Driving Range: 4040 Maple Valley Hwy., (Potential for Shelter with open Spaces) 27,000sq.ft. PARKS/OPEN SPACES WITH RESTROOM FACILITY • Cedar River Park: 1703 Maple Valley Hwy. – 450sq.ft. • Cedar River Trail/Park: Riverside Drive & 6th St. • Gene Coulon Memorial Beach Park: 1201 Lake Washington Blvd. N., (Open Spaces and Picnic Structures) • Henry Moses Aquatic Center: 1719 Maple Valley Hwy. - 6,320sq.ft. • Cedar River Park: 1703 Maple Valley Hwy. • Jones Park: Wells Avenue S. & the Cedar River • Kennydale Beach Park: Lake Washington Blvd. and N. 36th St. • Kennydale Lions Park: 2428 Aberdeen Ave. NE • Kiwanis Park: 815 Union Ave. NE • Liberty Park: 1101 Bronson Way N. • Maplewood Park: 3400 SE 6th St. • Heritage Park: 233 Union Ave. NE • Philip Arnold Park: 720 Jones Ave. S • Riverview Park: 2901 Maple Valley Hwy. • Talbot Hill Reservoir Park: 701 S. 19th St. • Thomas Teasdale Park: 601 S. 23rd St. • Windsor Hills Park: 432 Windsor Way NE • NARCO Property: 1500 S. Houser Way (18 acres, undeveloped) • Edlund Property: 17611 103rd Ave. SE (15 acres, undeveloped)
Utilities: Electricity	• Bonneville Power Administration o 5 Transmission Circuits • Puget Power o Talbot Hill Station, High Capacity Lines
Utilities: Natural Gas	• Puget Sound Energy o SWARR Station & Gate Station o Network of high pressure mains and distribution lines
Utilities Fuel Product Pipelines	• Olympic Pipeline o Central monitoring station at 2319 Lind Ave. SW o Petroleum enters and leaves Renton via 2 pipelines
Hospitals	• Valley Medical Center (169 beds), includes an emergency room
Schools	• 36 schools and related facilities
Airport	• Renton Municipal Airport

Table 4.2
Master Action Items Table

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Multi-Hazard Mitigation Action Items									
Short-Term #1	Establish a formal role for the Renton All Hazard Mitigation Planning Committee (Emergency Management Group) to develop a sustainable process to encourage, implement, monitor, and evaluate citywide mitigation actions.	Hazard Mitigation Planning Committee - Emergency Management (EM) Group	Ongoing	X			X		
Short-Term #2	Identify and pursue funding opportunities to implement mitigation actions.	City staff	Ongoing	X	X	X	X	X	X
Short-Term #3	Develop public and private sector partnerships to foster hazard mitigation activities.	Hazard Mitigation Planning Committee - EM Group	Ongoing	X			X		
Short-Term #4	Develop detailed inventories of at-risk buildings and infrastructure and prioritize mitigation actions.	Hazard Mitigation Planning Committee - EM Group	1-2 Years	X			X		
Long-Term #1	Develop education programs aimed at mitigating the risk posed by hazards.	Hazard Mitigation Planning Committee - EM Group	Ongoing	X	X	X			
Long-Term #2	Integrate the Mitigation Plan findings into planning and regulatory documents and programs.	Hazard Mitigation Planning Committee - EM Group	Ongoing	X			X		X
Long-Term #3	Integrate hazard, vulnerability and risk Mitigation Plan findings into enhanced Emergency Operations planning.	EM Group	Ongoing	X				X	

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Flood Mitigation Action Items: Within FEMA-Mapped Floodplains									
Short-Term #1	Complete an inventory of structures, critical facilities and important transportation or utility system components within mapped floodplains, including elevation data and structure/facility information.	Community Services (for City facilities), Public Works	1-2 Years	X	X	X			
Long-Term #1	Identify and implement cost-effective mitigation measures for high risk structures, with the highest priority for critical facilities, transportation and utility components.	Community Services (for City facilities), Public Works	Ongoing	X	X	X			
Long-Term #2	Identify and implement measures and policies to increase Renton's Community Rating System score to reduce flood insurance rates.	Community and Economic Development, Public Works	Ongoing	X	X	X	X		
Long-Term #3	Continue to be a member of the National Flood Insurance Program to enable property owners in Renton to purchase flood insurance from FEMA and allow the City to receive flood disaster funding to repair damages due to flooding following a federally declared disaster.	Public Works	Ongoing	X		X	X		
Long-Term #4	Continue to require new construction of structures in the floodplain to be constructed in accordance with FEMA standards and the National Flood Insurance Program requirements, including requiring compensatory floodplain storage for filling of the floodplain.	Community and Economic Development, Public Works	Ongoing	X		X	X		X

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #5	Implement the Reasonable and Prudent Measures identified in the NOAA Fisheries Biological Opinion regarding FEMA's National Flood Insurance Program as required by FEMA.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #6	Continue to enforce, maintain and update the Renton Critical Areas Regulations and Shoreline Master Program requirements.	Community and Economic Development, Public Works	Ongoing	X		X			X
Long-Term #7	Continue to perform maintenance dredging, maintenance of floodwalls and levees associated with the Army Corps of Engineers Cedar River Section 205 Flood Hazard Reduction Project.	Community and Economic Development, Public Works	Ongoing	X		X	X		
Long-Term #8	Continue to implement the Surface Water Utility programs related to flood hazard management, which include the Capital Improvement Program, engineering program, maintenance and operations program, public education and customer service programs.	Community and Economic Development, Public Works	Ongoing	X		X	X		
Long-Term #9	Adopt storm water design standards equivalent to the Ecology 2005 Stormwater Management Manual for Western Washington to better control the quantity and quality of storm water runoff from new construction and redevelopment projects and meet the requirement of the Phase II National Pollutant Discharge Elimination System (NPDES) permit requirements.	Community and Economic Development, Public Works	Ongoing	X		X	X		X

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #10	Integrate flood hazard reduction with other objectives related to water quality protection, habitat protection and habitat restoration efforts including complying with the Clean Water Act NPDES Phase II permit, the Endangered Species Act and the regional salmon recovery efforts.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #11	Continue to be consistent with the King County Flood Hazard Reduction Plan.	Community and Economic Development, Public Works	Ongoing	X	X	X	X	X	X
Long-Term #12	Continue to participate in the King County Flood Warning System and the King County Flood Control Zone District.	Community and Economic Development, Public Works	Ongoing	X	X	X	X	X	X
Long-Term #13	Continue to be a member of the FEMA Community Rating System that enables property owners to obtain flood insurance at a reduced rate.	Community and Economic Development, Public Works	Ongoing	X		X	X		
Long-Term #14	Re-evaluate future land use and zoning designations in FEMA mapped 100-year floodplain areas.	Community and Economic Development, Public Works	Ongoing	X		X			X
Flood Mitigation Action Items: Outside of FEMA-Mapped Floodplains									
Short-Term #1	Complete an inventory of structures, critical facilities and important transportation or utility system components in locations with a history of severe or repetitive flooding.	Community Services (for City facilities), Public Works	1-2 Years	X		X			

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Short-Term #2	Evaluate and improve notification, evacuation and response planning for areas within the potential inundation area for failure of the Hanson Dam.	Fire & Emergency Services, Police, Public Works	1-Year	X	X	X	X	X	
Long-Term #1	For locations with repetitive flooding and significant damages or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage capacity.	Public Works, Community Services	Ongoing	X	X	X	X		X
Dam Safety Mitigation Action Items									
Short-Term #1	Maintain copies of high resolution maps of dam failure inundation areas and update emergency response plan, including public notification and evacuation routes.	Fire & Emergency Services, Police, Public Works	Ongoing	X	X			X	
Short-Term #2	Research seismic vulnerability assessments for Howard Hanson Dam and Chester Morse Dam lobby dam owners to make seismic improvements as necessary.	Fire & Emergency Services	Ongoing	X	X	X	X		
Winter Storms Mitigation Action Items									
Short-Term #1	Enhance tree trimming efforts especially for transmission lines and trunk distribution lines.	PSE, Community Services (secondary support)	Ongoing	X	X	X		X	
Short-Term #2	Encourage property owners to trim trees near service drops to individual customers.	PSE, Community Services (secondary support)	Ongoing	X	X	X		X	
Long-Term #1	Ensure that all critical City facilities in Renton have backup power and emergency operations plans to deal with power outages.	Community Services	5 Years	X	X	X		X	

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #2	Consider upgrading lines and poles to improve wind/ice loading, undergrounding critical lines, and adding interconnect switches to allow alternative feed paths and disconnect switches to minimize outage areas.	PSE, Community Services (secondary support)	5 Years		X	X		X	
Long-Term #3	Encourage new developments to include underground power lines.	Community and Economic Development	ongoing		X	X		X	
Earthquake Mitigation Action Items									
Short-Term #1	Evaluate the seismic vulnerability of critical city-owned buildings, utilities and infrastructure and establish priorities to retrofit or replace vulnerable facilities to ensure adequate seismic performance of critical facilities.	Community Services	1-2 Years	X	X	X		X	
Short-Term #2	Conduct a sidewalk survey of residential, commercial and industrial buildings in Renton using FEMA's Rapid Visual Screening to identify especially vulnerable buildings, raise awareness and encourage mitigation actions.	Community and Economic Development	1-2 Years	X	X	X			
Short-Term #3	Disseminate FEMA pamphlets to educate homeowners about structural and non-structural retrofitting of vulnerable homes and encourage retrofit.	Community and Economic Development	1-2 Years	X	X	X	X		
Long-Term #1	Ensure that all critical City facilities in Renton have backup power and emergency operations plans to deal with power outages.	Community Services	5 years		X			X	
Long-Term #2	Obtain funding and retrofit important public facilities with significant seismic vulnerabilities.	Community Services	10 years		X	X	X	X	

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Landslide Mitigation Action Items									
Short-Term #1	Complete the inventory of locations where buildings or infrastructure are subject to landslides.	Community and Economic Development, Public Works	1-2 Years	X					
Long-Term #1	Consider landslide mitigation actions for slides seriously threatening buildings or infrastructure.	Public Works	5 Years		X	X		X	
Long-Term #2	Limit future development in high landslide potential areas.	Community and Economic Development	Ongoing	X	X	X		X	
Volcanic Hazards Mitigation Action Items									
Short-Term #1	Update public emergency notification procedures for ash fall events.	Fire & Emergency Services	1-2 Years	X	X			X	
Short-Term #2	Update emergency response planning for ash fall events.	Community Services, Fire & Emergency Services, Police, Public Works	1-2 Years	X	X			X	
Short-Term #3	Evaluate capability of water treatment plant to deal with high turbidity from ash falls and upgrade treatment facilities and emergency response plans to deal with ash falls.	Public Works, METRO	1-2 Years					X	
Coal Mine Hazard Mitigation Action Items									
Long-Term #1	Continue mapping of abandoned coal mine areas as additional data become available.	Community and Economic Development	Ongoing	X	X	X			
Long-Term #2	Require geological or geotechnical engineering studies before permitting new construction in identified coal mine hazard areas.	Community and Economic Development	Ongoing	X	X	X			

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Hazmat Incident Mitigation Action Items									
Short-Term #1	Ensure that first responders have readily available site-specific knowledge of hazardous chemical inventories in Renton.	Fire & Emergency Services	1 year		X			X	
Short-Term #2	Enhance emergency planning, emergency response training and equipment to address hazardous materials incidents.	Fire & Emergency Services, Police, Public Works	Ongoing		X			X	
Terrorism Mitigation Action Items									
Short-Term #1	Enhance emergency planning, emergency response training and equipment to address potential terrorism incidents.	Fire & Emergency Services, Police	Ongoing	X	X			X	
Long-Term #1	Upgrade physical security detection and response capability for critical facilities, including water system.	Community Services, Police	Ongoing		X	X	X	X	
Long-Term #2	Evaluate and implement hardening measures for highly vulnerable critical facilities.	Police, Community Services	5 - 10 Years		X	X	X	X	
Long-Term #3	Identify and establish secure surveillance cameras and monitoring at all critical infrastructure.	Police, Community Services, Public Works	5 Years		X	X			
Long-Term #4	Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Detection and security devices/elements integrated at critical city infrastructure.	Police, Community Services	5 Years		X	X			

5.0 PLAN ADOPTION, MAINTENANCE and IMPLEMENTATION

5.1 Overview

For a hazard mitigation plan to be effective, it has to be implemented gradually over time as resources become available, continually evaluated and periodically updated. Only through developing a system which routinely incorporates logical thinking about hazards and cost-effective mitigation into ongoing public and private-sector decision making will the mitigation action items in this document be accomplished effectively. The following sections depict how Renton has adopted and will implement and maintain the vitality of Renton's Hazard Mitigation Plan.

5.2 Plan Adoption

Renton's Hazard Mitigation Plan was adopted by Renton's City Council on **….TBD……**, making this the effective date of the plan. A copy of the resolution is attached in Appendix 4.

After adoption by City Council, FEMA approval will be sought. FEMA approval means that Renton's Hazard Mitigation Plan meets national standards and that the City will continue to be eligible for hazard mitigation funding from FEMA's mitigation grant programs.

Renton has the necessary human resources to ensure this Plan continues to be an active planning document. City staff have been active in the preparation of the plan, and have gained an understanding of the process and the desire to integrate the plan into Renton's Comprehensive Emergency Management Plan. Through this linkage, the plan will be kept active and be an ongoing working document.

Recent major high-profile disasters and the growing understanding of the threats posed to Renton from various national and anthropogenic hazards, have kept the interest in hazard mitigation planning and implementation alive at the City Council and city staff levels, among private sector entities and among the citizens of Renton.

5.3 Implementation

Coordinating Body

The Renton Emergency Management Group, led by the Emergency Management Director, will coordinate the implementation of the plan and be responsible for periodically monitoring, evaluating and updating the plan. The City will continue to provide staffing to accomplish this. Consistent staffing allows for well-organized meetings and will ensure that the right people are involved. The existing active interest in mitigation and emergency planning that exists within Renton will help to ensure the successful implementation of the plan.

Integration of the Hazard Mitigation Plan into Ongoing Programs, Policies and Practices

The mission statement, objectives, goals and action items outlined in this Plan provide a strong framework and guidance for the identified mitigation priorities for Renton. However, the Plan is a guidance document, not a regulatory document. Implementation of the objectives, goals and action items can only be accomplished by fully integrating this guidance into ongoing city-wide programs, policies and practices.

The City of Renton relies on comprehensive land use planning, capital improvements planning, and building codes to guide and control development in the City. After the City officially adopts the Hazard Mitigation Plan, these existing mechanisms will, as appropriate, include and integrate mitigation strategies identified in the Plan.

After adoption of the Plan, the City will address hazards in the comprehensive plans and land use regulations. Specifically, one of the goals in this Plan is to protect life and property from natural disasters and human-caused hazards. The Community and Economic Development Department will review the City's comprehensive plans and land use policies, analyze any plan amendments, and provide technical assistance in implementing these requirements.

The capital improvement planning that occurs in the future will also contribute to the goals in Renton's Hazard Mitigation Plan. The Community and Economic Development Department will work with capital improvement planners to secure high-hazard areas for low risk uses. Within six months of the effective date of the Mitigation Plan, the mitigation activities listed in Chapter 4 will be incorporated into the process of existing planning mechanisms.

Cost Effectiveness of Mitigation Projects

As Renton and other entities, public or private, within the City consider whether or not to undertake specific mitigation projects or evaluate how to decide between competing mitigation projects, they must answer questions that don't always have obvious answers, such as:

What is the nature of the hazard problem?

How frequent and how severe are hazard events?

Do we want to undertake mitigation measures?

What mitigation measures are feasible, appropriate and affordable?

How do we prioritize between competing mitigation projects?

Are our mitigation projects likely to be eligible for FEMA funding?

Renton recognizes that benefit-cost analysis is a powerful tool that can help communities provide solid, defensible answers to these difficult questions. Benefit-cost analysis is required for all FEMA-funded mitigation projects, under both pre-disaster and post-disaster mitigation programs. Benefit-cost analysis provides a sound basis for evaluating and prioritizing possible mitigation projects for any natural hazard. Renton will use benefit-cost analysis and related economic tools, such as cost-effectiveness evaluation, to the extent practicable in prioritizing and implementing mitigation actions. See Appendix 2 at the end of this Plan for details on the benefit-cost analysis process.

STAPLE/E Approach

Renton will also use the STAPLE/E to help evaluate potential mitigation actions. Using STAPLE/E criteria, mitigation activities can be evaluated quickly in a systematic fashion based on Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLE/E) considerations. The STAPLE/E approach is helpful for doing a quick analysis of mitigation projects. Most projects that seek federal funding and others often require more detailed benefit/cost analyses.

The following are suggestions for how to examine each aspect of the STAPLE/E Approach.

Social: Community and Economic Development and Community Services staff, local non-profit organizations or local planning groups can help answer these questions.

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

Technical: Public Works, Community Services, and Community and Economic Development Staff, Police, and Fire & Emergency Services staff can help answer these questions.

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

Administrative: Elected officials can help answer these questions.

- Is the action implementable?
- Is there someone to coordinate and lead the effort?
- Is there sufficient funding, staff and technical support available?
- Are there ongoing administrative requirements that need to be met?

Political: City Council members and planning officials can help answer these questions.

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

Legal: Include legal counsel, land use planners and risk managers in this discussion.

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

Economic: Community and Economic Development and Finance and Information Services Department staff, civil engineers, building officials, and the County Assessment and Taxation office can help answer these questions.

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

Environmental: Public Works and Community and Economic Development staff, environmental groups, land use planners, engineering, and natural resource managers can help answer these questions.

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

5.4 Plan Maintenance

Periodic Monitoring, Evaluation and Updating

The City of Renton has developed a process for regularly reviewing and updating the Hazard Mitigation Plan. The Emergency Management Group will serve as the Hazard Mitigation Plan Steering Committee and members will be responsible for overseeing the progress of the mitigation actions in the Plan. The Emergency Management Group is led by the Emergency Management Director and composed of representatives from all City Departments and two external agencies.

The Emergency Management Group will review and evaluate the plan for progress each year. During the annual review the Emergency Management Group will update information in the Plan, remove outdated items and completed actions, as well as recognize the success of the community in implementation of action items. Annual revisions of the Plan will be summarized for the Public Safety Committee of the City Council for formal acknowledgement as part of the Plan's maintenance and implementation program.

A full review of Renton's Hazard Mitigation Plan will be conducted every five years. The Emergency Management Group will have lead responsibility for the formal updates of the plan. Renton chose this cycle and process in order to provide a sufficient time horizon for mitigation actions to take effect and show results.

During the full review every five years the Emergency Management Group will determine if:

- The goals and objectives address current and expected conditions.
- The nature or magnitude of risks has changed.
- The current resources are appropriate for implementing the plan.
- There are implementation problems, such as technical, political, legal or coordination issues with other agencies.
- The outcomes have occurred as expected.
- The agencies and other partners have participated as proposed.

The Emergency Management Group will then review the results of the Plan assessment, identify corrective actions, and recommend to the Emergency Management Director what actions are necessary to bring the Plan back into conformance with the stated goals and objectives. Emergency Management Group members will then update and make changes to the plan before submitting it to City Council and the State Hazard Mitigation Program Manager. If no changes are necessary, the State Hazard Mitigation Officer will be given a justification for this determination.

Continued Public Involvement and Participation

Implementation of the mitigation actions identified in the Plan must engage the community. The participation that led to the Plan was the result of existing community networks, and these networks will continue to participate as the community-wide mitigation activities identified in the plan are implemented. Some projects can be done at the volunteer level while others will require technical expertise. The stakeholders in the planning process will become project partners, as needed, on specific items.

The City of Renton is committed to involving the public directly in the continual reshaping and updating of the Hazard Mitigation Plan. The Emergency Management Group members are responsible for oversight of the plan. Since members of external agencies and the public are not significantly represented on the Emergency Management Group, an additional committee will be implemented in 2010, the Community Risk Reduction Committee. This committee will focus on prevention and mitigation activities exclusively and will provide ongoing advice and input to the Emergency Management Group regarding the Hazard Mitigation Plan.

Copies of the plan will be catalogued and kept on hand at the Renton Public Library. The existence and location of these copies will be publicized on the City web site. Contained in the plan is the address and phone number of City staff responsible for keeping track of public comments on the plan.

In addition, copies of the plan and any proposed changes will be posted on the City website. This site will also contain an email address and phone number to which people can direct their comments or concerns. The City will further publicize the Plan availability on the City web site through various sources including: the Renton Reporter (newspaper), Channel 21 (Renton cable station), neighborhood association newsletters, Renton School District, Piazza Renton (downtown business association) and Renton Chamber of Commerce. Citizen comment and interest will be solicited and directed to the Emergency Management Group via the Emergency Management Director.

At the discretion of the City, a public meeting may be held after each review of the plan by the Emergency Management Group. This meeting will provide the public a forum for which they can express concerns, opinions or ideas about the plan. The Fire and Emergency Services Department will publicize and host this meeting, and any updates will be posted on the City web-site allowing for additional public input.

5.5 Update from 2003 Plan

Considerable progress has been made in addressing the goals and action items from the 2003 Hazard Mitigation Plan. Detailed below are the goals and action items in that plan and the progress made.

Goal 1 – To protect aquifers used by the City and the City water supply system from contamination by hazardous materials and other hazard effects

Actions:

a. Continue to implement and maintain the Aquifer Protection Plan
b. Continue Risk Assessment Methodology for Water Systems Process; implement measures as appropriate

The Aquifer Protection Plan and the Risk Assessment Methodology for Water Systems Process have been implemented and maintained since 2003. Their implementation and maintenance are ongoing.

Goal 2 – Minimize public and private losses due to flood conditions in specific areas

Actions:

a. Continue to enforce, maintain and update Renton Critical Areas Regulations, development regulations, and Surface Water Management Design Standards;

These regulations have been enforced, maintained and updated since 2003. This work is ongoing.

b. Continue to perform maintenance dredging, when needed, and maintenance of the levees and floodwalls associated with the Army Corps of Engineers Cedar River Section 205 Flood Hazard Reduction project;

This maintenance has been performed since 2003. This work is ongoing.

c. Develop criteria for and conduct hazard-susceptibility assessments of business and public facilities (baseline and changed conditions);

An assessment has been completed for the City and was utilized in the development of this plan. Going forward these assessments will be updated when conditions change.

d. Enhance and continue drainage system maintenance;

Drainage system enhancement and maintenance has been performed since 2003. This work is ongoing.

e. Avoid/reduce instances of non-underground extensions of utility lines which may create debris dams during floods;

As much as possible instances of non-underground extensions of utility lines have been avoided and/or reduced since 2003. This work is ongoing.

f. Evaluate and reconcile competing goals and practices regarding habitat protection and flood mitigation;

This work is ongoing.

g. Maintain and enhance the City of Renton Flood Hazard Reduction Plan;

The City of Renton did not develop an independent Flood Hazard Reduction Plan. We are following the King County Flood Hazard Reduction Plan and are assisting in its maintenance.

h. Continue to participate with King County in the King County Flood Warning System and the Green River Flood Control Zone District Administration.

Participation has occurred since 2003 and will continue. Significant additional coordination has occurred in 2009 as a result of the increased risk of potential flooding on the Green River due to damage at the Howard Hanson Dam.

<u>Goal 3</u> – Minimize damage due to natural hazards

Actions:

a. Conduct hazard-susceptibility assessments of business and public facilities

Assessments have been completed. Assessments will continue as facilities change or are developed.

b. Identify, assess, and maintain critical transportation routes within the City;

This work was completed in 2009 with the development of the Evacuation Annex to the Comprehensive Emergency Management Plan for Renton. Ongoing transportation analysis is occurring through the City's participation in the Regional Catastrophic Planning Team which is exploring

transportation/lifelines in the Greater Puget Sound Area. The routes will be reassessed when the plan is updated.

c. Develop objective criteria and conduct seismic preparedness and retro-fit of critical public and private facilities;

Progress has been made on this since 2003. Most recently Fire Station 11 was retro-fitted to Zone 4 compliance. A detail of current seismic preparedness of critical facilities is provided in Chapter 8 – Earthquakes.

d. Re-enforce utility infrastructure and connections;

Progress has been made since 2003. This work is ongoing.

e. Implement slope stabilization measures in steep/unstable areas;

Progress has been made since 2003. This work is ongoing.

f. Use HAZUS Loss Estimation tool kit to identify and assess vulnerabilities to earthquake damage.

This was completed. The HAZUS report is available in Appendix 3.

Goal 4 – To minimize impacts on critical habitats and wetlands from natural or man-made disasters

Actions:

a. Assess vulnerability of critical habitat and wetland areas to disaster damage;
b. Assess capacity for critical habitat and wetland areas to serve as mitigation buffers for floods;
c. Incorporate habitat and wetland mitigation enhancements into drainage maintenance program;
d. Evaluate and reconcile competing goals and practices regarding habitat protection and flood mitigation.

Progress has been made on these since 2003. This work is ongoing.

Goal 5 – Minimize the impact of technological or man-made disasters on the City (e.g., hazardous materials incidents, terrorist attack, civil disturbance, etc.)

Actions:

a. Robust systems

- Retro-fit critical facilities for blast-resistance and resistance to forced entry;
- Protect utility lifelines (water, power, communications, etc.) by concealing, burying, or encasing;
- Develop backup control center capabilities;

b. Security/Safety

- Incorporate vehicle barriers such as walls, fences, ponds/basins, plantings, sculptures into site planning and design; design grounds and parking facilities for natural surveillance;
- Ensure adequate site lighting;
- Locate critical assets (people, activities, systems) away from entrances, vehicle circulation and parking, and loading and maintenance areas;
- Separate high-risk and low-risk activities; separate high-risk activities from public areas;
- Install public and employee screening systems and closed-circuit television (CCTV) security systems.

c. System Redundancy

- Implement separate emergency and normal power systems; ensure that backup power systems are periodically tested under load;
- Ensure provision of primary and backup fuel supplies; provide secure storage;
- Install exterior connection for emergency power;
- Enhance communications and information management capabilities:
    - Update the telecommunications capabilities of City government offices.
    - Create redundant/backup capability for landline telephone system.
    - Develop off-site backup of information technology systems.

d. Enhanced Emergency Response

- Maintain access (ingress and egress) for emergency responders, including large fire apparatus, and for resident evacuation;
- Develop and maintain comprehensive emergency response and recovery plans;
- Conduct regular evacuation and security drills;
- Regularly evaluate emergency equipment readiness/adequacy;
- Develop backup control center capabilities;

Progress has been made on these since 2003. This work is ongoing.

Goal 6 – Enhance the City's capability for gathering, organizing, and displaying spatial data regarding hazards, vulnerabilities, critical facilities, and vital statistics.

Actions:

a. Maintain comprehensive hazard maps;
b. Create critical facilities database information for use in future mitigation strategies.
c. Obtain and integrate HAZUS Loss Estimation tool and ArcView GIS with existing City GIS geospatial programs.

These have all been completed. We continue to update the information with new studies and technology.

6.0 FLOOD HAZARDS

The City of Renton is subject to flooding from several flood sources, including:

1) over bank flooding from the Cedar River, Green River, Springbrook Creek, May Creek and their tributaries,
2) local storm water drainage flooding, and
3) floods from dam failures.

Major flooding events in Renton generally result from large late fall or winter storms with a combination of intense rainfall, leaves clogging inlets and exacerbated by snow-melt runoff. Larger rivers whose drainage basins include higher elevations experience flooding in late winter to spring, due to large contributions from snowmelt. Flood events often result in simultaneous flooding on all rivers and streams in an affected area. However, because of differences in drainage areas, slopes and other watershed characteristics, the severity of flooding in any given rainfall event often varies significantly from stream to stream and basin to basin.

6.1 Historical Floods in Renton

Flooding has occurred in the Renton area throughout the recorded history of the area. The FEMA Flood Insurance Study for King County, including the City of Renton, dated April 19, 2005 has a brief history of major historical floods in the area.

Cedar River

Flooding along the Cedar River is of special concern to Renton. As noted in the Flood Insurance Study, significant flooding along the Cedar River has occurred every 5 to 10 years when the discharge exceeds about 4,000 cfs (cubic feet per second). The flood of record on the Cedar River, which was somewhat greater than a 100-year event, occurred in November 1990 with a peak discharge of 10,600 cfs.

More recent major flood events on the Cedar River occurred in 1990, 1995, 1996, 2006 and 2009. The last four flood events were Presidentially-declared disaster events. The 1990 flood caused about $8 million in damages to the Renton Airport, Boeing facilities and Cedar River Park. The 1995 and 1996 floods also impacted the Renton Airport, the old Renton City Hall (200 Mill Ave. S), Renton Community Center, Carco Theatre, Renton Senior Activity Center, the Cedar River Trail Park and the Boeing Plant. The 2009 flood caused over four million dollars worth of damage to the Cedar River Trail system, the Elliot Spawning Channel and associated infrastructure. The eastern half of the Maplewood Golf Course and portions of the City's Ron Regis Park is located within the FEMA designated 100-year floodplain. The typical golf course damage from flood events (both '06 and

’09) have been the Cedar overflowing the channel and depositing heavy amounts of sediment across holes number 5 and 7 necessitating golf course closure and loss of revenue. The ’09 flood event engulfed the entire 4 holes located on the east side of the river (#4 - #7), a river formed through the golf course exiting onto the Cedar River Trail. This flood water caused significant washouts and buckling of the trail (approx. 150 yards) and undermined the fill material that supports Highway 169’s westbound approach to the bridge over the Cedar River, causing the support panels and bridge ramp fill to slump and fail. The westbound lane crossing the bridge of Highway 169 and the Cedar River Trail were closed for approximately 9 weeks until repaired by WSDOT.

Green River

Historically, the lower Green River Valley from Auburn to Renton has been inundated by large floods, such as those that occurred in 1933, 1951 and 1959. However, the potential for major floods has been largely mitigated by construction of the Howard Hanson Dam on the Green River. The storage capacity of the dam allows the U.S. Army Corps of Engineers to limit flows to no more than 12,000 cubic foot per second (cfs), as measured at the Auburn gauge, to prevent flooding. Per the Flood Insurance Study, the Howard Hanson Dam provides approximately a 500-year to 600-year level of protection against overbank flooding from the Green River. There are levees located on the lower Green River within the Cities of Auburn, Kent, Tukwila and areas of unincorporated King County. These levees protect the valley floor from flooding up to Green River flows of 12,000 cfs. Other than the Tukwila levee that protects commercial and industrial areas in Tukwila, the Green River levees are not FEMA certified. The King County Flood Control Zone District is responsible for the maintenance, repair and improvement of the Green River levee system. Renton has no Green River levees within in our jurisdiction, but flooding could occur in Renton if a levee failed on the right-bank (east side) of the Green River between river miles 11 and 26.

Although the Howard Hanson Dam ordinarily provides a good level of flood protection, damages sustained in the flooding of January 2009 resulted in a significant reduction in the flood control capabilities of the dam. Due to the damage, the US Army Corps of Engineers has reduced the storage capacity in the reservoir upstream of the dam. During flood events, the Army Corps of Engineers may have to release water from the dam in excess of 12,000 cfs at the Auburn gauge. This could result in levee over topping, breaching and flooding in the Green River Valley including Renton. Time estimates in 2009 for the restoration of the flood control capabilities of the dam range from 2-6 years. During this time, there is a substantially increase in the risk of flooding in the Green River Valley. In the unlikely, but not impossible, failure of the Hanson Dam very severe flooding could occur along the Green River. The worst case scenario for flooding is indicated by the inundation map for failure of the Hanson Dam.

Other Flood Sources

The FEMA-mapped floodplains for Renton include areas along Springbrook Creek and May Creek, as well as their tributaries and the tributaries of the Green and Cedar River. These areas have also experienced frequent flooding in the past.

6.2 Flood Hazards and Flood Risk: Within Mapped Floodplains

6.2.1 Overview

Flood prone areas of Renton include the FEMA-mapped floodplains the Cedar River, Green River, Springbrook Creek, May Creek and their tributaries. The FEMA floodplain maps delineate the 100-year floodplain boundaries. (The 100-year flood is the flood with a 1% chance of being equaled or exceeded in any given year.) Detailed floodplain boundaries are shown on the Flood Insurance Rate Maps.

Figure 6.1 shows the current FEMA approved mapped floodplains developed in 1995. Renton's floodplains are currently being reconfigured by FEMA to match current floodplain information. Figure 6.2 shows the proposed FEMA floodplain map currently under review. When the floodplains are finalized these maps will be updated with the official floodplains. Figure 6.2 should not be used for flood insurance rating until it is approved.

For Renton, the FEMA floodplain maps include the following types of areas:

1. AE: Areas with a 1% annual chance of flooding with detailed flood hazard data including base flood elevations (the elevation of the 100-year flood).

2. A: Unnumbered A-Zones, within 100-year flood plain, but without detailed flood hazard data (no base flood elevations).

3. X: Areas outside the 1% annual chance floodplain, areas of 1% annual chance of flooding where average depths are less than 1 foot, areas of 1% annual chance stream flooding where the contributing drainage area is less than 1 square mile, or areas protected from the 1% annual chance flood by levees.

Figure 6.1 Current FEMA-Mapped Floodplains in Renton

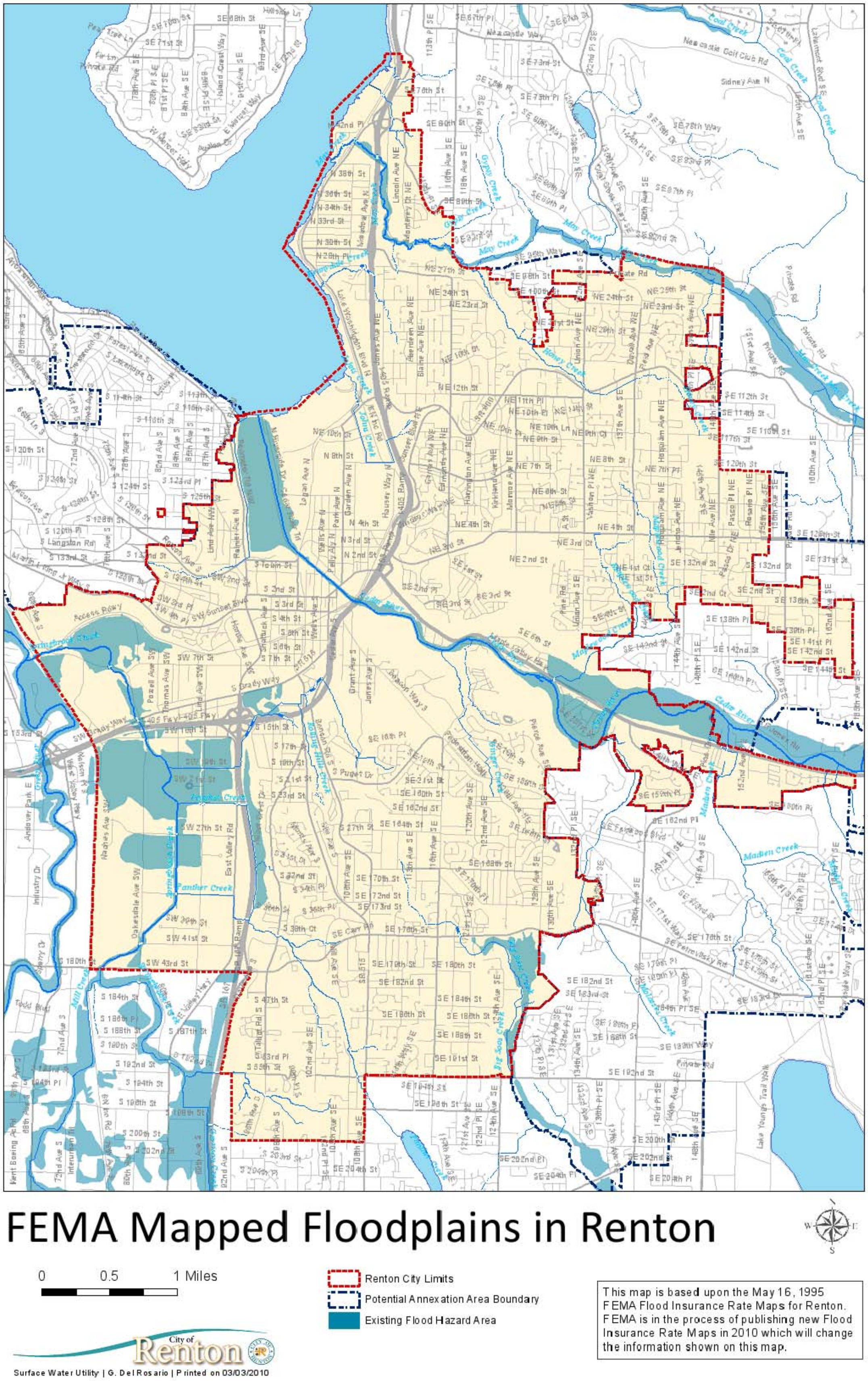
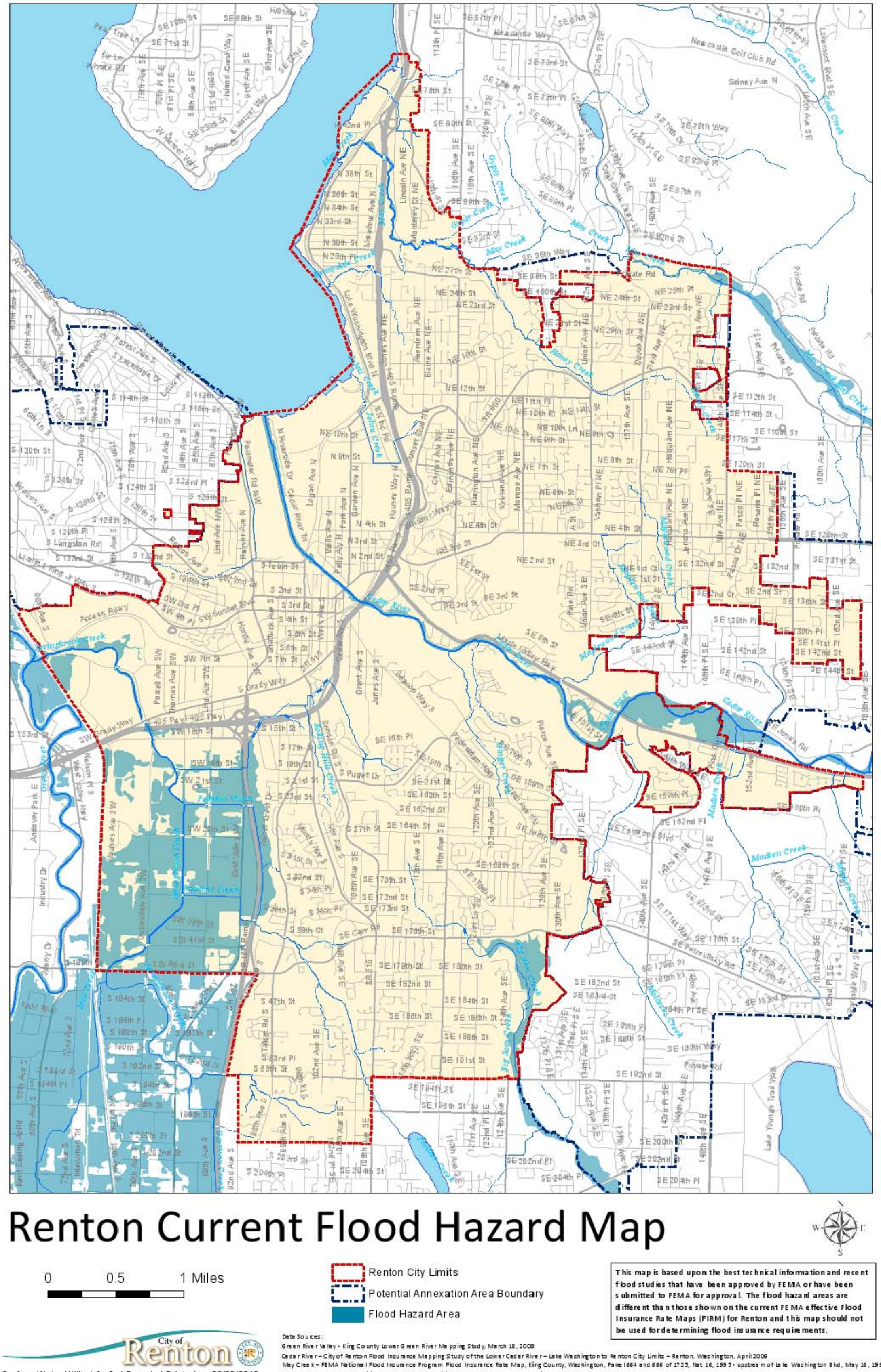


Figure 6.2 Proposed FEMA-Mapped Floodplains in Renton



The FEMA Flood Insurance Study and Flood Insurance Rate Maps for Renton include a large number of acronyms. A good summary of the terms used in flood hazard mapping is available on the FEMA website at:
http://www.fema.gov/pdf/floodplain/nfip_sg_appendix_d.pdf

6.2.2 Flood Hazard Data

For mapped floodplain areas, the flood hazard data included in the Flood Insurance Study (FIS) allowed quantitative calculation of the frequency and severity of flooding for any property within the floodplain.

Table 6.1

Flood Hazard Data
Cedar River: Renton USGS Gauge
Vicinity of the Bronson Way North Bridge (RM 1.6)NAVD 88 Datum

Flood Frequency (years)	Discharge (cfs)	Elevation (feet)
10	5,940	34
50	9,860	36
100	12,000	38
500	18,400	40

The stream discharge data shown above for the Cedar River is from the April 2006 Flood Insurance Mapping Study of the Cedar River (Lake Washington to Renton City Limits) for the City of Renton. Stream discharge refers to the volume of water flowing down the river and is typically measured in cfs.

The flood elevation data is from the Cedar River – Main Channel Flood Profile Figure 2 of the Flood Insurance Study. Flood elevation data varies with location along the reach of the river and thus separate flood elevation data points must be read from the graph at each location along the river. The data shown above is for approximately 1.6 miles above the mouth of the Cedar River immediately downstream of the Bronson Way N Bridge over the Cedar River at USGS gauge site number 12119000.

Quantitative flood hazard data is very important for mitigation planning purposes because it allows for quantitative determination of the frequency and severity (i.e., depth) of flooding for any building or other facility (e.g., road or water treatment plant) for which elevation data exist. Such quantitative flood hazard data also facilitates detailed economic analysis (benefit-cost analysis) of mitigation projects to reduce the level of flood risk for a particular building or facility.

For a given neighborhood, the level of flood risk varies dramatically with the first floor elevation of each house. If the building's first floor elevation is below the 100-year flood elevation, the building could experience flooding above the first floor more frequently. However, a building with a first floor elevation above the 100-year flood elevation has a less than 1% chance of being flooded in any given year.

6.2.3 Caveats for the Renton Flood Insurance Study

The Flood Insurance Study (FIS) for Renton is quite recent (2006). Over time, flood hazards may change because of increasing development upstream, changes in stream channels, improvements (or degradation) of flood protection measures over time and so on. Simply because an FIS is old does not mean that it is outdated or inaccurate. However, the older a study is, the more likely it is that channel or watershed conditions have changed over time.

Another caveat is that flood studies are inevitably less than perfect, due to incomplete data and modeling uncertainties. Thus, in some cases, mapped floodplain boundaries may underestimate or overestimate the actual level of flood risk at a given location.

6.2.4 Interpreting Flood Hazard Data for Mapped Floodplains

The level of flood hazard, or the frequency and severity of flooding, is not determined simply by whether the footprint of a given structure is or is not within the 100-year floodplain. A common error is to assume that structures within the 100-year floodplain are at risk of flooding while structures outside of the 100-year floodplain are not. This simplistic view is simply not true. Some importance guidance for interpreting flood hazards is given below.

A. Being in the 100-year floodplain does not mean that floods happen once every 100 years. A 100-year flood simply means that the probability of a flood at the 100-year level or greater has a 1% chance of happening in any given year.

B. Within or near the 100-year floodplain, the key determinant of flood hazard for a building or other facility is the relationship of the elevation of the structure or facility to the flood elevations for various flood events. Thus, for example, homes with first floor elevations below or near the 10-year flood elevation have drastically higher levels of flood hazard than other homes with first floor elevations near the 50-year, 100-year, or higher elevations.

C. Flooding happens outside of the mapped 100-year floodplain.

    a. The 100-year flood is by no means the worst flood possible. Floods greater than the 100-year flood will affect many areas outside of the mapped 100-year floodplain.

b. Areas protected by levees may flood if the levees fail.

c. Many flood prone areas flood because of local storm water drainage conditions (see Section 6.3 below) and have nothing to do with the 100-year floodplain boundaries.

6.3 Flood Hazards and Flood Risk: Outside of Mapped Floodplains

This section applies to the portions of Renton that are outside of FEMA-mapped floodplains.

Many areas of the United States outside of mapped floodplains are subject to repetitive, damaging floods from local storm water drainage. Nationwide, more than 25% of flood damage occurs outside of FEMA-mapped floodplains.

In most cities, storm water drainage systems are designed to handle small to moderate size rainfall events. Older Storm water systems were designed to handle 10-year flood events, and are rarely designed to handle greater amounts of rainfall. The current design standards require storm water drainage systems to be designed for a 25-year event with consideration for how the system functions during a 100-year event, but flooding could still occur during flood events greater than a 25-year event. New development and other land use changes result in increased runoff that could cause the capacity of existing storm drainage systems to be exceeded and result in flooding.

For local rainfall events that exceed the collection and conveyance capacities of the storm water drainage system, some level of flooding occurs. In many cases, local storm water drainage systems are designed to allow minor street flooding to carry off storm waters that exceed the capacity of the system. In larger rainfall events, flooding may extend beyond streets to include yards. In major rainfall events, local flooding can flood buildings. In extreme cases, local storm water drainage flooding can result in several feet of water in buildings, with correspondingly high damage levels.

Other portions of Renton outside of the mapped floodplains are also at relatively high risk from over bank flooding from streams too small to be mapped by FEMA. The following is a list of some of the flooding locations due to insufficient storm drainage system conveyance capacity:

- NE Fifth Place and Edmonds Avenue NE
- Lake Avenue S. and Rainier Avenue S.
- Oakesdale Avenue SW and SW 41st Street - Springbrook Creek Culvert
- N Eighth Street and Garden Avenue N.
- May Creek Culvert Removal at NE 31st Street
- Hardie Avenue SW Railroad Underpass

- Monroe Avenue NE and NE Fourth Street
- SW 43rd Street and Lind Avenue SW
- Rainier Avenue S. Railroad Underpass
- East Valley Road between SW 27th Street and SW 41st Street
- NE 43rd Street and Lincoln Avenue NE

6.4 Dam Failure Flooding

The Chester Morse Masonry Dam on the Cedar River could inundate residential, commercial and industrial areas of Renton should it fail. Likewise, failure of the Howard Hanson Dam on the Green River would inundate commercial, industrial and residential areas as well as roads and byways. There are less residential areas in the Green River Valley that would be affected by a failure of the Howard Hanson Dam. Although dam failure is unlikely, the inundation maps provided by dam operators to Emergency Management describe those consequences. Those maps are exempt from public disclosure and are not included in this plan.

Recent concerns of Howard Hanson Dam failure, due to damages to the grout curtain during the 2008/2009 winter storms, has made preparing for dam failure flooding a priority for Renton as well as neighboring cities. During 2009 considerable mitigation work was completed including: developing and improving inundations maps and evacuation routes, as well as notifying the public of the increased risk and encouraging them to secure flood insurance coverage. The City partnered with neighboring cities and the county to ensure a coordinated message and response in the event of failure. This work is ongoing. These dam mitigation action items are included in Table 6.3 Flood Mitigation Action Items at the end of this chapter.

6.5 Inventory Exposed to Flood Hazards in Renton

6.5.1 Flood Prone Inventory

The total area of floodplain in Renton is approximately 1,125 acres. There is 7.5% of the City within the floodplain based upon the current effective FEMA floodplain maps. The total number of parcels in the current FEMA effective floodplain is 574 which includes 534 structures with a total assessed value of $1,274,871,700 including $728,598,400 in improvement value. FEMA is in the process of updating the floodplain maps for King County including Renton. This update will significantly increase the amount of area within the FEMA floodplain in Renton in the Green River Valley area. This is due to the fact that FEMA does not recognize the Green River levee system as providing 100-year flood level protection, since the levees are not certified levees.

Figure 6.3 shows Renton's critical facilities overlaid with areas at risk for flooding. The critical facilities in the mapped floodplain are comprised of:

- Fire Station 14,
- the sewer lift station,
- 4 water production wells,
- 10 water monitoring wells and
- 8 water utility structures.

The floodplain is crossed by high pressure gas lines, sewer lines and the Olympic pipeline. Roadways in the Renton portion of the Green River Valley, including: Lind Avenue SW, Oakesdale Avenue SW, SW 41st Street, SW 43rd Street and East Valley Road, would be impacted by flooding.

In the event of Cedar River flooding the critical facilities impacted would be the Maplewood Golf Course and the multiple City owned trails and facilities along the river. The following bridges would be subject to damages and road blockages: Houser, Bronson, Williams, Wells and Logan Avenue.

6.5.2 Flood Insurance Data

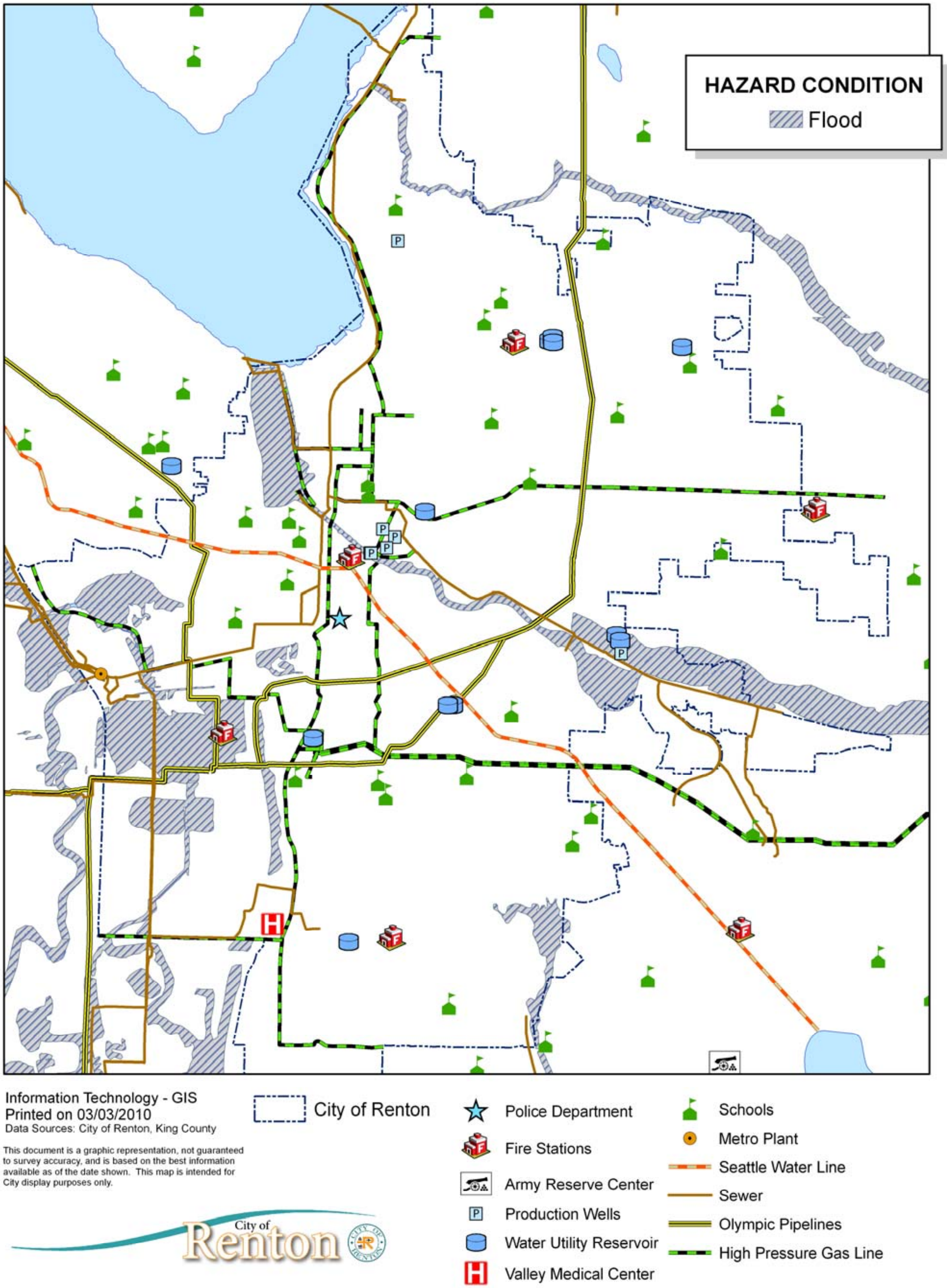
FEMA's National Flood Insurance Program (NFIP) maintains a nationwide database of flood insurance polices and repetitive loss properties. According to their records 951 of the insured properties in Renton have flood insurance. We currently have no properties on FEMA's national repetitive loss or severe repetitive loss lists. NFIP insured properties are often given high priority for flood mitigation actions such as elevation or acquisitions (which are always voluntary and at the owner's discretion).

6.5.3 Flood Damage Estimates

To quantify the level of flood hazard for properties in the FEMA floodplain, it is necessary to determine the elevations of these structures. Only by determining the first floor elevation of each of these flood prone structures can the level of flood hazard be calculated accurately. Acquiring such elevation data is recommended as a high priority. Similarly, acquiring elevation data for additional structures within the 500-year flood plain as well as in other flood-prone areas outside of mapped floodplains would greatly increase the accuracy of hazard, inventory and vulnerability assessments.

The most accurate structure elevations (first floor elevations) are those determined accurately by surveying. Flood insurance certificates generally include survey elevation data. Absent survey data useful estimates of elevations for structures can generally be made by reference to elevations of nearby structures or public infrastructure with surveyed elevation data.

Figure 6.3 Critical Facilities Overlaid with Flood Hazards



In addition to elevation data, quantifying the level of risk faced by these structures requires basic data about each structure, including square footage, number of stories, with or without basement, and information on the type and function of the structure.

As noted above, some areas of Renton outside of the mapped floodplains are also subject to relatively high levels of flood risk. To quantify the level of flood risk posed by these areas, historical data should be compiled to determine frequency and severity of flooding. Severity of flooding can include estimates of past damages, if available, and/or simple narratives reporting whether the flooding in a given area is limited to street flooding, and/or affects yards or buildings as well.

In 1995, prior to the construction of the Lower Cedar River Section 205 Flood Hazard Reduction project that included dredging and construction of levees and floodwalls along the lower 1.25 miles of the Cedar River, the Corps of Engineers conducted a study of the public and private buildings, infrastructure and economic impacts to business that would be affected from a 100 year flood event on the Cedar River. Based upon the 1995 channel conditions and in 1995 dollars, approximately $8 million in annual damages could have resulted under the "without project" condition. Most of the damages would result on the Renton Municipal Airport and the Boeing 737 Renton Plant site.

FEMA's HAZUS regional loss estimation software was used to assess the likely damages in Renton from a Cedar River 100 year flood event. Summary results from the HAZUS report are shown below in Table 6.2.

Table 6.2
Scenario Flood Impacts on Renton

Scenario Flood	
Return Period	100
Damages & Other Losses	$24.39 million
Sheltering	473 people
Debris Generated	2,261 tons

The HAZUS report is available in Appendix 3.

6.6 Common Flood Mitigation Projects

Potential mitigation projects to reduce the potential for future flood losses cover a wide range of possibilities. For any of the mapped flood sources, it would be theoretically possible to reduce future flood losses by improving existing levees or flood walls and/or by adding new levees or floodwalls. Flood losses could also, in principle, be reduced by adding additional upstream storage (dams or detention basins). In practice, however, such projects are often very expensive and have a host of environmental and other regulatory hurdles.

For areas of Renton subject to flooding from storm water drainage, various improvements to water drainage systems may be desirable. Typical improvements include upgrades to the size of drainage ditches or storm water drainage pipes as well as upgrades to pumping capacity (for pumped portions of drainage systems) or construction of local detention ponds. Making storm system improvements to reduce flooding and adopting new surface water design standards to better control the flow of runoff from new development, re-development and construction sites will help prevent existing flooding problems from getting worse, avoid new flooding and protect the water quality and habitat in the City.

For critical facilities at low elevations with high flood risk, construction of berms (raised barriers) or floodwalls to protect the facilities may be desirable. For residential, commercial or public facilities at high flood risk, elevation of structures is a mitigation action. For structures at very high flood risk acquisition and demolition are potential mitigation options. Elevation and acquisition (especially) are expensive mitigation options that are generally not cost-effective unless the levels of flood hazard and flood risk are rather high. These mitigation options are most attractive for structures deep in the flood plain (i.e., with first floors below the 10-, or 20-, or 30-year flood elevations). For structures outside of mapped floodplains, elevation or acquisition would likely be cost-effective only for structures with a strong history of major, repetitive flood losses.

For structures near the fringe of the 100-year flood plain, near the 100-year flood level, or with some history of repetitive flood losses, various small scale flood loss reduction measures such as elevation of furnaces and utilities may be desirable.

The following table, Table 6.3 Flood Mitigation Items, includes flood mitigation action items from the Master Action Items Table in Chapter 4.

Table 6.3
Flood Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Flood Mitigation Action Items: Within FEMA-Mapped Floodplains									
Short-Term #1	Complete an inventory of structures, critical facilities and important transportation or utility system components within mapped floodplains, including elevation data and structure/facility information.	Community Services (for City facilities), Public Works	1-2 Years	X	X	X			
Long-Term #1	Identify and implement cost-effective mitigation measures for high risk structures, with the highest priority for critical facilities, transportation and utility components.	Community Services (for City facilities), Public Works	Ongoing	X	X	X			
Long-Term #2	Identify and implement measures and policies to increase Renton's Community Rating System score to reduce flood insurance rates.	Community and Economic Development, Public Works	Ongoing	X	X	X	X		
Long-Term #3	Continue to be a member of the National Flood Insurance Program to enable property owners in Renton to purchase flood insurance from FEMA and allow the City to receive flood disaster funding to repair damages due to flooding following a federally declared disaster.	Public Works	Ongoing	X		X	X		

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #4	Continue to require new construction of structures in the floodplain to be constructed in accordance with FEMA standards and the National Flood Insurance Program requirements, including requiring compensatory floodplain storage for filling of the floodplain.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #5	Implement the Reasonable and Prudent Measures identified in the NOAA Fisheries Biological Opinion regarding FEMA's National Flood Insurance Program as required by FEMA.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #6	Continue to enforce, maintain and update the Renton Critical Areas Regulations and Shoreline Master Program requirements.	Community and Economic Development, Public Works	Ongoing	X		X			X
Long-Term #7	Continue to perform maintenance dredging, maintenance of floodwalls and levees associated with the Army Corps of Engineers Cedar River Section 205 Flood Hazard Reduction Project.	Community and Economic Development, Public Works	Ongoing	X		X	X		
Long-Term #8	Continue to implement the Surface Water Utility programs related to flood hazard management, which include the Capital Improvement Program, engineering program, maintenance and operations program, public education and customer service programs.	Community and Economic Development, Public Works	Ongoing	X		X	X		

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #9	Adopt storm water design standards equivalent to the Ecology 2005 Stormwater Management Manual for Western Washington to better control the quantity and quality of storm water runoff from new construction and redevelopment projects and meet the requirement of the Phase II National Pollutant Discharge Elimination System (NPDES) permit requirements.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #10	Integrate flood hazard reduction with other objectives related to water quality protection, habitat protection and habitat restoration efforts including complying with the Clean Water Act NPDES Phase II permit, the Endangered Species Act and the regional salmon recovery efforts.	Community and Economic Development, Public Works	Ongoing	X		X	X		X
Long-Term #11	Continue to be consistent with the King County Flood Hazard Reduction Plan.	Community and Economic Development, Public Works	Ongoing	X	X	X	X	X	X
Long-Term #12	Continue to participate in the King County Flood Warning System and the King County Flood Control Zone District.	Community and Economic Development, Public Works	Ongoing	X	X	X	X	X	X
Long-Term #13	Continue to be a member of the FEMA Community Rating System that enables property owners to obtain flood insurance at a reduced rate.	Community and Economic Development, Public Works	Ongoing	X		X	X		

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Long-Term #14	Re-evaluate future land use and zoning designations in FEMA mapped 100-year floodplain areas.	Community and Economic Development, Public Works	Ongoing	X		X			X
Flood Mitigation Action Items: Outside of FEMA-Mapped Floodplains									
Short-Term #1	Complete an inventory of structures, critical facilities and important transportation or utility system components in locations with a history of severe or repetitive flooding.	Community Services (for City facilities), Public Works	1-2 Years	X		X			
Short-Term #2	Evaluate and improve notification, evacuation and response planning for areas within the potential inundation area for failure of the Hanson Dam.	Fire & Emergency Services, Police, Public Works	1-Year	X	X	X	X	X	
Long-Term #1	For locations with repetitive flooding and significant damages or road closures, determine and implement mitigation measures such as upsizing culverts or storm water drainage capacity.	Public Works, Community Services	Ongoing	X	X	X	X		X
Dam Safety Mitigation Action Items									
Short-Term #1	Maintain copies of high resolution maps of dam failure inundation areas and update emergency response plan, including public notification and evacuation routes.	Fire & Emergency Services, Police, Public Works	Ongoing	X	X			X	
Short-Term #2	Research seismic vulnerability assessments for Howard Hanson Dam and Chester Morse Dam lobby dam owners to make seismic improvements as necessary.	Fire & Emergency Services	Ongoing	X	X	X	X		

7.0 WINTER STORMS

7.1 Overview

Winter storms affecting Renton are generally characterized by a combination of heavy rains and high winds throughout the City and surrounding areas, sometimes with snowfall, especially at higher elevations. Heavy rains can result in localized or widespread flooding, debris slides and landslides. High winds commonly result in tree falls which primarily affect the electric power system, but may also affect roads, buildings and vehicles. Winter storms may also result in significant ice accumulation, which primarily affect the electric power system and transportation. This chapter deals primarily with the rain, wind, snow and ice effects of winter storms. (Larger scale flooding is addressed in Chapter 6.)

The frequency, severity and impacts of other severe weather events, including severe thunderstorms, hail, lightning strikes and tornadoes are generally negligible or minor for Renton, compared to winter storm effects. Thusly, these types of events are not considered further.

Winter storms can affect the area directly with damages in Renton, or indirectly through damage outside the City that affects transportation and/or utility services (especially electric power). Historically, Renton has often been subject to both direct and indirect impacts of winter storms.

The winter storms that affect Renton are typically large cyclonic low pressure systems moving from the Pacific Ocean that usually affect large areas of Washington and/or the whole Pacific Northwest. They are not typically local events affecting small geographic areas in the City.

The three most recent major winter storm events affecting Renton occurred in December 2008 – January 2009, December 2006 and December 1996 – January 1997.

The 1996-1997 winter storms started with two days of heavy snow and ice, with over eight inches of snow. Large numbers of tree falls resulted in failures of power lines and widespread outrages which affected over 120,000 Puget Sound Electric customers. The second phase of the storm included heavy rain which, combined with snow melt, resulted in widespread flooding on small streams and major rivers, including the Cedar River. There were numerous landslides throughout the Puget Sound area although none occurred in Renton.

The 2006 Windstorm resulted in numerous and prolonged power outages, felled trees, blocked roads, downed power lines and damaged homes, necessitating the setup of an emergency shelter for a number of Renton residents.

The December 2008 storm was characterized by several serial snowfall events. Very little damaged occurred but high overtime and equipment costs were incurred during snow removal. Some residents were snowbound and experienced difficulty in getting their basic needs met.

7.2 Rain Hazard Data

Severe winter storms in Renton often include heavy rainfall. The potential impact of heavy rainfall depends on both the total inches of rain and the intensity of rainfall (inches per hour or inches per day). In the context of potential flooding, "rainfall" also includes the rainfall equivalent from snow melt. Flash floods, which are produced by episodes of intense heavy rains (usually six hours or less), or dam breaks are rare in Renton (and western Washington) but do represent a potential meteorological hazard.

Larger drainage basins like the Cedar or Green River typically have longer response times. The total rainfall amounts (plus snow melt) over several days or more are what determines the peak level of flooding along large rivers like these. Smaller rivers and larger streams may reach flooding levels in several hours or up to a day or two. Smaller, local drainage basins may reach peak flooding rainfall totals over a period of an hour to a few hours.

Renton annual rainfall data are summarized in Table 7.1 below.

Table 7.1
Renton Rainfall Data

Location	Average Annual Precipitation (inches)	Lowest Annual Precipitation (inches)	Highest Annual Precipitation (inches)	Period of Record
SEA-TAC	38.09	23.78 (1952)	55.14 (1950)	1931-2006

Western Regional Climate Center website: www.wrcc.dri.edu

Average annual rainfall amounts are moderately high in Renton, about 38 inches per year. As shown above, there are also substantial variations in annual rainfall from year to year.

The rainfall data shown in Table 7.1 gives a general overview of the potential for winter storm flooding in Renton, but whether or not flooding occurs at specific sites depends heavily on specific local rainfall totals during individual storms and local drainage conditions. For example, 3" of rain in one area may cause no damage at all, while 3" of rain in a nearby area may cause road washouts and flooding of buildings.

For Renton, identification of specific sites subject to localized flooding during winter storms is based on historical occurrences of repetitive flooding events during past winter storm events. Most of these sites affect roads rather than buildings.

A list of some of the most problematic sites for localized flooding in Renton is given below:

1) 200 Mill Ave. S.: Old City Hall - 51,000sq.ft.
2) Renton Community Center: 1715 Maple Valley Hwy. (Potential Shelter) 36,000sq.ft.
3) Renton Senior Activity Center: 211 Burnett Ave. N., (Potential Shelter) 22,150sq.ft.
4) Carco Theatre: 1717 Maple Valley Hwy., (Potential Shelter) 11,090sq.ft.
5) Monroe Avenue NE and NE Second Street
6) NE Fourth Street Crossings
7) Lincoln Avenue NE Culvert
8) Rainier Avenue Pump Station
9) Puget Drive SE at Rolling Hills Avenue Culverts

7.3 Snow and Ice Hazard Data for Renton

Winter storms can also involve ice and snow in Renton. The most likely impact of snow and ice events in Renton are road closures limiting access/egress to/from some areas, especially higher elevations. Winter storms with heavy wet snow or high winds and ice storms may also result in power outages from downed transmission lines and/or poles.

Average annual snowfalls in Renton are generally low, shown below in Table 7.2.

Table 7.2
Snowfall Data for Renton (SEA-TAC Data)

Location	Average Annual Snowfall (inches)	Lowest Annual Snowfall (inches)	Highest Annual Snowfal (inches)	Period of Record
SEA-TAC	11.80	0.00 (many years)	67.5 (1968-1969)	1931-2006

Western Regional Climate Center website: www.wrcc.dri.edu

Average snowfall in Renton is relatively low, only about 12 inches, with some years experiencing no snowfall. However, the maximum annual snowfall in

Renton was 67.5 inches in 1968-1969. In addition, snowfall was 63.6 inches in 1949-50, with seven other years recording more than 20 inches.

In addition to snow events, Renton is also subject to ice storm and freezing rain events. However, the National Climatic Data Center (NCDC) database shows only one freezing rain event for King County between 1950 and 2006.

Website addresses for NCDC and the state and county storm event databases are:

- www.ncdc.noaa.gov and
- http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms.

Probabilistic ice storm data showing ice thicknesses with return periods from 50 years to 400 years are given in a recent American Lifelines Alliance report: Extreme Ice Thicknesses from Freezing Rain (2004). The 50-year return ice thickness map shows about 0.25 inches for Renton. The 400-year ice thicknesses for Renton are about 0.5 inches. Using ice thickness scaling relationships, ice thicknesses for 25-year and 10-year ice storms in Renton would be about 0.185 inches and about 0.125 inches, respectively.

For Renton, ice thicknesses in a 50-year or more severe event are high enough to cause widespread significant damage, especially to trees and utility lines, with the possibility for widespread power outages. Smaller events would likely result in minor damages to trees and utility lines with localized power outages.

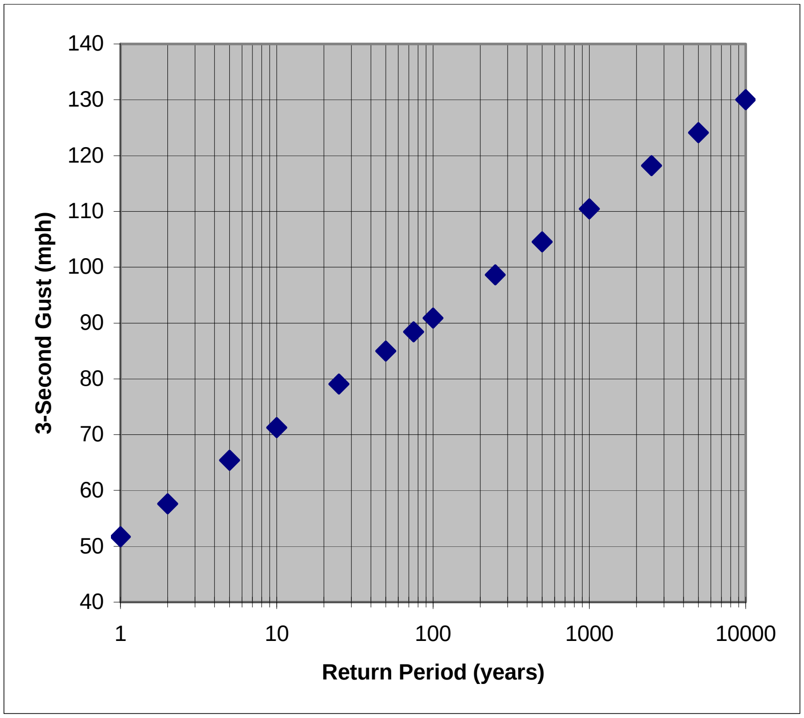
7.4 Wind Hazard Data

Wind speeds associated with winter storms vary depending on meteorological conditions, but also vary spatially depending on local topography. For Renton, given the limited topographic relief, the wind hazard levels are relatively uniform across the City.

The design wind speed for construction of new buildings in the greater Seattle area is based on a three second gust of 85 miles per hour, the 50-year return period wind speed. Typically, three second gusts are roughly 30% higher than the sustained wind speed.

Using the scaling algorithm used for building design, probabilistic wind hazards for Renton are shown below in Figure 7.1.

Figure 7.1
Probabilistic Wind Hazard Data for Renton



7.5 Winter Storm Risk Assessment

Winter rain, snow, ice and wind storms may affect both infrastructure and buildings. Localized flooding from winter storms commonly affect the transportation system, especially roads. Severe winter storms may result in numerous road closures due either to washouts or the depth of water on road surfaces. Such localized flooding may also affect buildings in the flooded areas.

The most common effect of snow and ice storms are disruption of transportation. However, more severe events may results in tree falls and damages to above ground utility lines, with the possibility of widespread power outages.

Wind impacts from winter storms arise primarily from tree falls, which may affect vehicles and buildings, but whose primary impact is often on utility and power lines. Wind damages may result in widespread downing of trees or tree limbs with resulting widespread downing of utility lines. Such tree-fall induced power outages primarily affect the local electric distribution system, because transmission system cables are generally less prone to tree fall damage because of design and tree-trimming maintenance.

Table 7.3
Probable Impacts of Winter Storms on Renton[1]

Inventory	Probable Impacts
Portion of Renton Affected	Entire City may be affected by road closures or loss of electric power; otherwise direct damages to buildings and infrastructure are likely to be localized and relatively minor
Buildings	Isolated minor damage from tree falls, wind or heavy snow loads; a few buildings may be affected by localized flood damage
Streets	Road closures due to tree falls and flooding; limited impact because of short detour routes within communities
Roads to/from Renton	Potential closures of some roads and major highways due to snow, localized flooding and tree falls. Road closures from landslides or debris flow also likely near Renton.
Electric Power	Loss of electric power may be localized or widespread due to tree falls on local distribution lines or very widespread if transmission lines fail.
Other Utilities	Generally minor or no impacts on other utilities from winter storms, except for possible effects of loss of electric power
Casualties	Potential for casualties (deaths and injuries) from tree falls or contact with downed power lines or from traffic accidents.

[1] These winter storm impacts include localized flooding and the effects of wind, snow and ice.

For more quantitative risk assessment of localized flooding and wind damages arising from winter storms, the best approach is to systematically gather data on sites where damages occurred repetitively due to localized flooding or wind damages. By documenting (and mapping using GIS) the sites of repetitive damage events, along with the type and cost of damages and losses, the most seriously impacted sites can be clearly identified. Repetitive loss sites with significant damages would be likely candidates for future mitigation actions.

7.6 Mitigation of Winter Storm Impacts

Potential mitigation projects for winter storms may address any of the aspects of such storms, including rain, flood, winds, snow and/or ice.

For winter storm flooding, the mitigation measures discussed in Chapter 6 (Floods) for flooding due to local storm water drainage systems are exactly the mitigation measures for the flood aspects of winter storms. Common mitigation projects include: upgrading storm water drainage systems, construction of detention basins and structure-specific mitigation measures (acquisition, elevation and flood-proofing) for flood-prone buildings. For roads subject to frequent winter storm flooding, possible mitigation actions include elevation of the road surface and improved local drainage. For utilities subject to frequent winter storm flooding, possible mitigation actions include improved local drainage and elevation or relocation of the vulnerable utility elements to non-flood prone areas nearby.

For wind effects of winter storms, the most common and effective mitigation action is to increase tree trimming, because a high percentage of wind damage to utilities, buildings, vehicles and people arises from tree falls. However, economic, political and aesthetic realities place limits on tree trimming as a mitigation action. Future wind storm damage in Renton could be almost eliminated by cutting down all large trees along roads or in populated areas. Obviously, such an extreme mitigation measure is neither practical nor desirable.

Effective tree trimming mitigation programs focus on limited areas where tree falls have a high potential to result in major damages and economic losses. High priority areas include:

1) Transmission lines providing electric power to the area.
2) Major trunk lines providing the backbone of the electric power distribution system within the area.
3) Distribution lines for electric power to critical facilities in the area.
4) Specific circumstances where falling of large trees poses an obvious threat to damage buildings and/or people or close major transportation arteries.

Mitigation measures for snow and ice are limited, although tree trimming efforts, discussed above under wind, also reduce the impact of snow and ice on trees, roads, and utility lines. For the most part, dealing with snow and ice storms are dependent on proper planning, response and recovery actions.

The following table, Table 7.4 Winter Storm Mitigation Action Items, contains winter storm mitigation action items from the Master Action Item Table in Chapter 4.

Table 7.4
Winter Storm Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Winter Storms Mitigation Action Items									
Short-Term #1	Enhance tree trimming efforts especially for transmission lines and trunk distribution lines.	PSE, Community Services (secondary support)	Ongoing	X	X	X		X	
Short-Term #2	Encourage property owners to trim trees near service drops to individual customers.	PSE, Community Services (secondary support)	Ongoing	X	X	X		X	
Long-Term #1	Ensure that all critical City facilities in Renton have backup power and emergency operations plans to deal with power outages.	Community Services	5 Years	X	X	X		X	
Long-Term #2	Consider upgrading lines and poles to improve wind/ice loading, undergrounding critical lines, and adding interconnect switches to allow alternative feed paths and disconnect switches to minimize outage areas.	PSE, Community Services (secondary support)	5 Years		X	X		X	
Long-Term #3	Encourage new developments to include underground power lines.	Community and Economic Development	ongoing		X	X		X	

8.0 EARTHQUAKES

The greater Seattle area, including Renton, is one of the most seismically active areas in the United States. The area is subject to large earthquakes on the Cascadia Subduction Zone and on several nearby crustal fault systems. The greater Seattle area has experienced three significant earthquakes in the past 60 years:

- 2001 Nisqually Earthquake, Magnitude 6.8, 1 death, 407 injuries, about $2 billion in damages.
- 1965 South Puget Sound Earthquake, Magnitude 6.5, 6 deaths, about $100 million in damages (2006 dollars).
- 1949 South Puget Sound Earthquake, Magnitude 7.1, 8 deaths, about $300 million in damages (2006 dollars).

Although the above earthquakes caused significant damages, more damaging earthquakes are possible on the Cascadia Subduction Zone with magnitudes up to 9.0 as well as on the Seattle Fault which passes directly through highly developed areas.

Before reviewing the levels of seismic hazard and seismic risk in Renton, we first present a brief earthquake "primer" that reviews some basic earthquake concepts and terms.

8.1 Earthquake Primer

In the popular press, earthquakes are most often described by their Richter Magnitude (M). Richter Magnitude is a measure of the total energy released by an earthquake. In addition to Richter Magnitude, there are several other measures of earthquake magnitude used by seismologists, but they are beyond the scope of this discussion.

It is important to recognize that the Richter scale is not linear, but rather logarithmic. A M8 earthquake is not twice as powerful as a M4, but rather thousands of times more powerful. A M7 earthquake releases about 30 times more energy that a M6, while a M8 releases about 30 times more energy than a M7 and so on. Thus, M8 earthquakes may release thousands of times more energy as do moderate earthquakes in the M5 or M6 range.

The public often assumes that the larger the magnitude of an earthquake, the "worse" the earthquake. Thus, the "big one" is the M8 or M9 earthquake and smaller earthquakes (M6 or M7) are not. This is true only in very general terms. Larger magnitude earthquakes do affect larger geographic areas, with much more widespread damage than smaller magnitude earthquakes. However, for a given site, the magnitude of an earthquake is NOT a good measure of the severity of the earthquake at that site. The intensity of ground shaking at the site is a better measure and is dependent upon the magnitude of the earthquake <u>and</u> on the distance from the site to the earthquake <u>and</u> on the depth of the earthquake.

An earthquake is located by its epicenter - the location on the earth's surface directly above the point of origin of the earthquake. Earthquake ground shaking diminishes with distance from the epicenter and with the depth of the earthquake. Thus, any given earthquake will produce the strongest ground motions near the epicenter with the intensity of ground motions diminishing with increasing distance. Thus, a smaller earthquake (M6.5) very close to the site could cause greater damage than a much larger earthquake (M8) quite far away from the particular site.

Earthquakes at or below M5 are not likely to cause significant damage, even very near the epicenter. Earthquakes between about M5 and M6 are likely to cause some damage near the epicenter, with the extent of damage typically being relatively minor. Earthquakes of about M6.5 or greater can cause major damage (e.g., Nisqually), with damage usually concentrated fairly near the epicenter. Larger earthquakes of M7+ can cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter. Great earthquakes with M8+ can cause major damage over wide geographic areas. For example, a M8+ on the Cascadia Subduction Zone could affect the entire Pacific Northwest from British Columbia, through Washington and Oregon, and as far south as Northern California.

The intensity of ground shaking varies not only as a function of magnitude and distance but also is affected by soil types. Soft soils may amplify ground motions and increase the level of damage. Thus, for any given earthquake there will be contours of varying intensity of ground shaking. The intensity will generally decrease with distance from the earthquake, but often in an irregular pattern, reflecting soil conditions (amplification) and possible directionality in the dispersion of earthquake energy.

There are many measures of the severity or intensity of earthquake ground motions. A very old, but still sometimes used, scale is the Modified Mercalli Intensity scale (MMI) a descriptive, qualitative scale that relates severity of ground motions to types of damage experienced. MMIs range from I to XII.
More useful, modern intensity scales use terms that can be physically measured with seismometers, such as the acceleration, velocity or displacement (movement) of the ground. The most common physical measure, and the one used in the Renton Mitigation Plan, is Peak Ground Acceleration or PGA. PGA is a measure of the intensity of shaking, relative to the acceleration of gravity (g). For example, 1.0 g PGA in an earthquake (an extremely strong ground motion) means that objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10% g PGA means that the ground acceleration is 10% that of gravity and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. Ground motions of only 1% or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are minimal. Ground motions below about 10% g usually cause only slight damage. Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in poorly designed buildings. At this level of ground shaking only unusually poorly designed buildings would be subject to potential collapse. Ground motions above 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings. Ground motions above about 50% g may cause high levels of damage in most buildings, even those designed to resist seismic forces.

8.2 Seismic Hazards for Renton

Earthquakes in Washington State, and throughout the world, occur predominantly because of plate tectonics - the relative movement of plates of oceanic and continental rocks that make up the rocky surface of the earth. Earthquakes can also occur because of volcanic activity and other geologic processes.

The Cascadia Subduction Zone is a geologically complex area off the Pacific Northwest coast from Northern California to British Columbia. In simple terms, several pieces of oceanic crust (the Juan de Fuca Plate, Gorda Plate and other smaller pieces) are being subducted (pushed under) the crust of North America. This subduction process is responsible for most of the earthquakes in the Pacific Northwest as well as for creating the volcanoes in the Cascades.

There are three source regions for earthquakes that can affect the Renton area:

1) “interface” earthquakes on the boundary between the subducting oceanic plates and the North American plate,

2) “intraslab” or “intraplate” earthquakes within the subducting oceanic plates, and

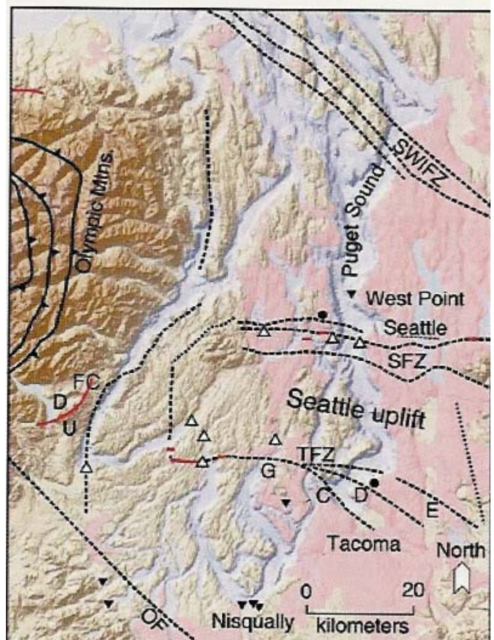
3) “crustal” earthquakes within the North American Plate.

The “interface” earthquakes on the Cascadia Subduction Zone may have magnitudes of 8 or greater, with probable average recurrence intervals of 500 to 800 years. The last major earthquake in this source region occurred in the year 1700, based on current interpretations of Japanese tsunami records. Such earthquakes are the great Cascadia Subduction Zone earthquake events that have received attention in the popular press. These earthquakes occur offshore from the Pacific Ocean coastline. Ground shaking from such earthquakes would be very strong near the coast and strong ground shaking would be felt throughout the greater Seattle area, including Renton.

The “intraslab” earthquakes, which are also called “intraplate” earthquakes, occur within the subducting oceanic plate. These earthquakes may have magnitudes up to about 7.5, with probable recurrence intervals of about 500 to 1000 years (recurrence intervals are poorly determined by current geologic data). These earthquakes occur quite deep in the earth, about 20 to 30 miles below the surface with epicenters that would likely range from near the Pacific Ocean coast to about 50 or 60 miles inland. The Nisqually earthquake was the most recent earthquake of this type.

“Crustal” earthquakes within the North American plate are possible on faults that are mapped as active or potentially active as well as on unmapped (unknown) faults. The major crustal faults, mapped by the United States Geological Society, near Renton are shown below.

Figure 8.1
Crustal Seattle Faults in the Greater Area[1]



[1] Scenario for a Magnitude 6.7 Earthquake on the Seattle Fault (2005)

The nearest crustal faults to Renton are the Seattle Fault Zone (SFZ) and the Tacoma Fault Zone (TFZ) shown on previous page. The SFZ, which runs from Seattle through Mercer Island to Bellevue, poses the greatest threat to Renton. The scenario earthquake study referenced above documents the expected levels of damages and casualties for a M6.7 earthquake on the Seattle Fault. The impacts for this earthquake scenario include more than 1,600 deaths, 24,000 injuries and $40 billion in damages. This earthquake would result in damages that greatly exceed that of the 2001 Nisqually earthquake.

Overall, the level of seismic hazard is very high for Renton. Figures 8.2 and 8.3 show the contours of seismic ground motions (in PGA as a percentage of "g" the acceleration of gravity) with a 10% and 2% chance of being exceeded in a 50-year time period, respectively. The values shown on the map are for rock sites; ground motions for soil sites will typically be higher.

Figure 8.2
USGS 2008 Seismic Hazard Data
(PGA, %g, with a 10% chance of exceedance in 50 years)

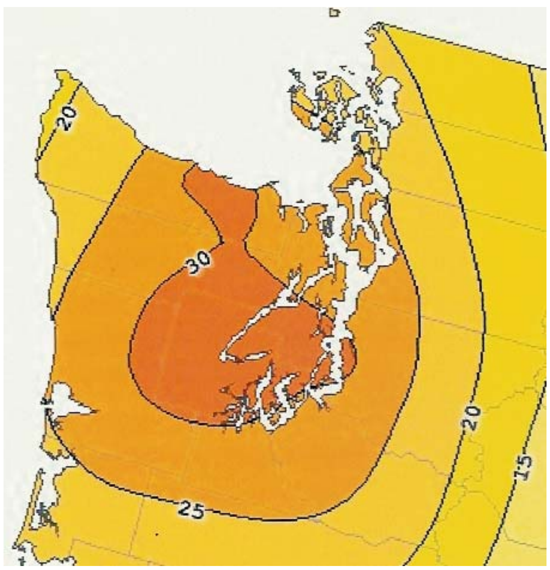
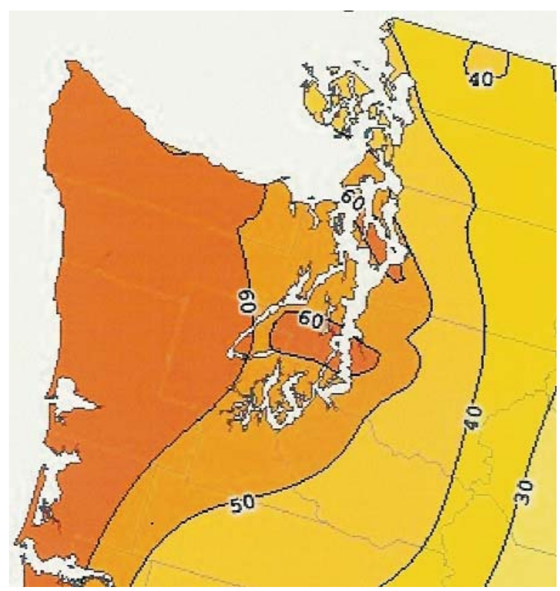


Figure 8.3
USGS 2008 Seismic Hazard Data
(PAG, %g, with a 2% chance of exceedance in 50 years)



For Renton, the 10% and 2% in 50 year PGA values are approximately 30% g and 60% g, respectively. These levels of ground shaking are roughly three to six times higher than those experienced during the Nisqually earthquake. At these high levels of shaking, damages in Renton would be tremendously higher than those experienced in the Nisqually earthquake.

8.3 Other Aspects of Seismic Hazards in Renton

Most of the damage in earthquakes occurs due to ground shaking affects on buildings and infrastructure. However, there are several other aspects of earthquakes that can result in high levels of damage in localized sites: liquefaction, landslides, dam failures and tsunamis.

8.3.1 Liquefaction, Settlement, Lateral Spreading, Amplification

Liquefaction is a process where loose, wet sediments lose strength during an earthquake and behave similarly to a liquid. Once a soil liquefies, it will tend to settle and/or spread laterally. With even very slight slopes, liquefied soils tend to move sideways downhill (lateral spreading). Settling or lateral spreading can cause major damage to buildings and to buried infrastructure such as pipes.

Figure 8.4 on the following page shows areas in Renton where soil conditions suggest high probabilities of liquefaction, settlement, lateral spreading and/or amplification of earthquake ground motions. These areas of greater earthquake risk largely follow the main river and stream drainage channels; as these are areas with loose, wet sediments. Liquefaction does not occur in all areas or in all earthquakes. However, in larger earthquakes with strong ground shaking for a long duration shaking, liquefaction is likely in these areas. Settlements of a few inches or more and lateral spreads of a few inches to several feet are possible. Even a few inches of settlement or lateral spreading is likely to cause significant to major damage to affected buildings or infrastructure.

Figure 8.5 shows areas of high liquefaction risk overlaid with critical facilities. The following critical facilities are in areas considered to have moderate to high risk for liquefaction:

- Fire Stations 11 and 14
- Sartori Education Center
- Renton High School
- St. Anthony’s School
- King County Metro Sewer Treatment Plant
- 7 Water Utility Production Wells
- 99 Water Monitoring Wells

In addition to these, the following critical facilities are in areas of low to moderate risk of liquefaction: Kennydale Elementary School and one Water Utility Production Well.

8.3.2 Landslides

Earthquakes can also induce landslides, especially if an earthquake occurs during the rainy season and soils are saturated with water. The areas prone to earthquake-induced landslides are largely the same as those areas prone to landslides in general. Areas of steep slopes with loose rock or soils are most prone to earthquake-induced landslides. In the Nisqually Quake in 2001, a large landslide on the Jones Road area temporarily blocked the Cedar River. Because of rapid reporting by a resident volunteer and the swift action of Public Works staff, flooding was narrowly averted. This slide also destroyed one single family residence.

Figure 9.5 in Chapter 9 (Landslides) shows areas of Renton subject to earthquake-induced (and other) landslides. See Chapter 9 for further discussion of landslides.

8.3.3 Dam Failures

Earthquakes can also cause dam failures in several ways. The most common mode of earthquake-induced dam failure is slumping or settlement of earth-fill dams where the fill has not been properly compacted. If the slumping occurs when the dam is full, then overtopping of the dam with rapid erosion leading to dam failure is possible. Dam failure is also possible if strong ground motions heavily damage concrete dams. In a few cases, earthquake induced landslides into reservoirs have caused dam failures. The Chester Morse Masonry Dam on the Cedar River and the Howard Hanson Dam on the Green River could potentially be affected by an earthquake.

8.3.4 Tsunamis and Seiches

Tsunamis, which are often incorrectly referred to as “tidal waves,” result from earthquakes which cause a sudden rise or fall of part of the ocean floor. Such movements may produce tsunami waves, which have nothing to do with the ordinary ocean tides. In the open ocean, far from land, in deep water, tsunami waves may be only a few inches high and thus be virtually undetectable, except by special monitoring instruments. These waves travel across the ocean at speeds of several hundred miles per hour. When such waves reach shallow water near the coastline, they slow down and increase in height.

Tsunamis affecting the Washington coast can be produced from very distant earthquakes off the coast of Alaska or elsewhere in the Pacific Ocean. For such tsunamis, the warning time for the Washington coast would be at least several hours. However, interface earthquakes on the Cascadia Subduction Zone can also produce tsunamis and the warning times would be very short (only a few minutes). Because of this extremely short warning time, emergency planning and

Figure 8.4
Areas in Renton with Increased Earthquake Risk due to Soil Conditions

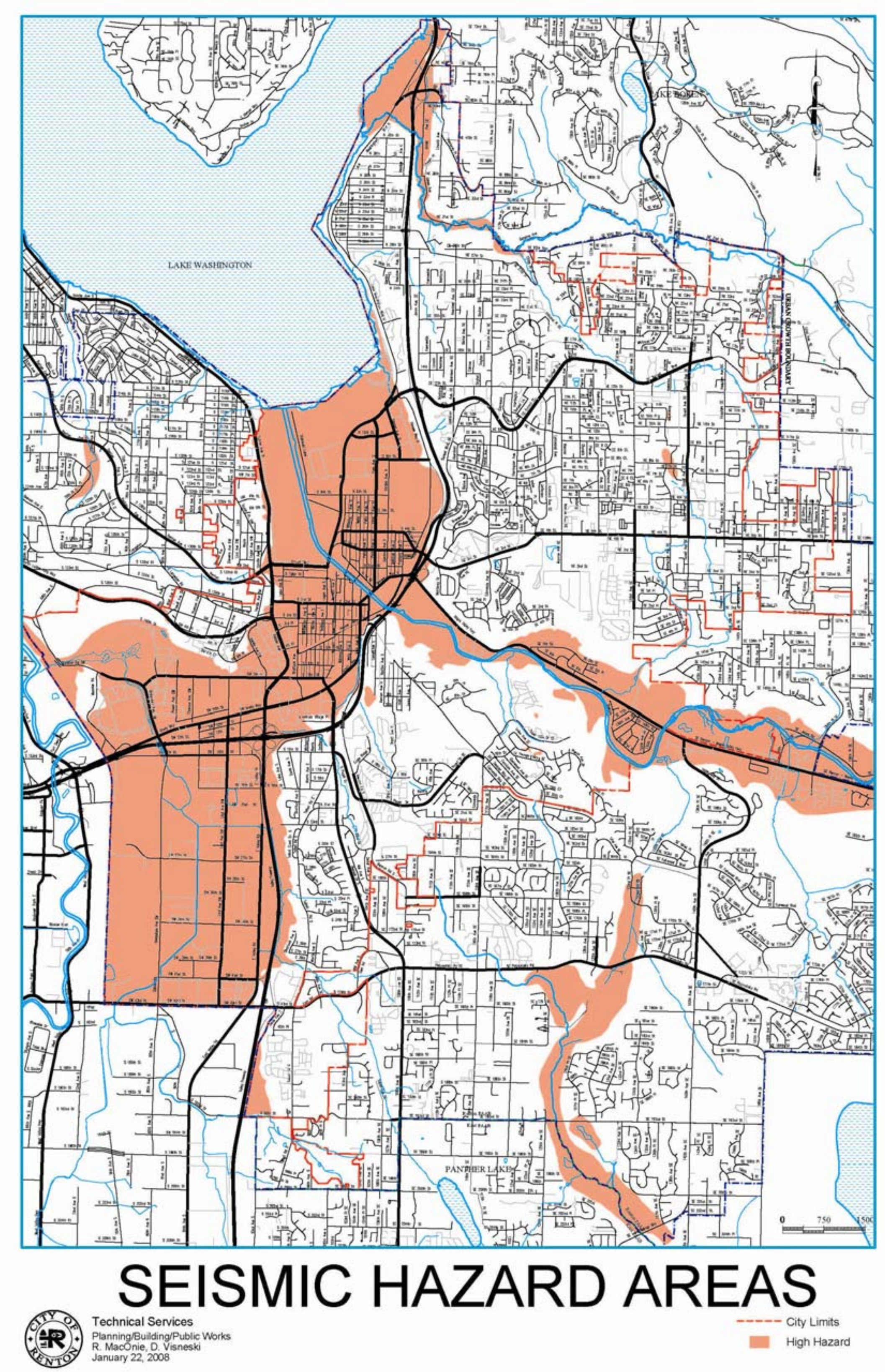
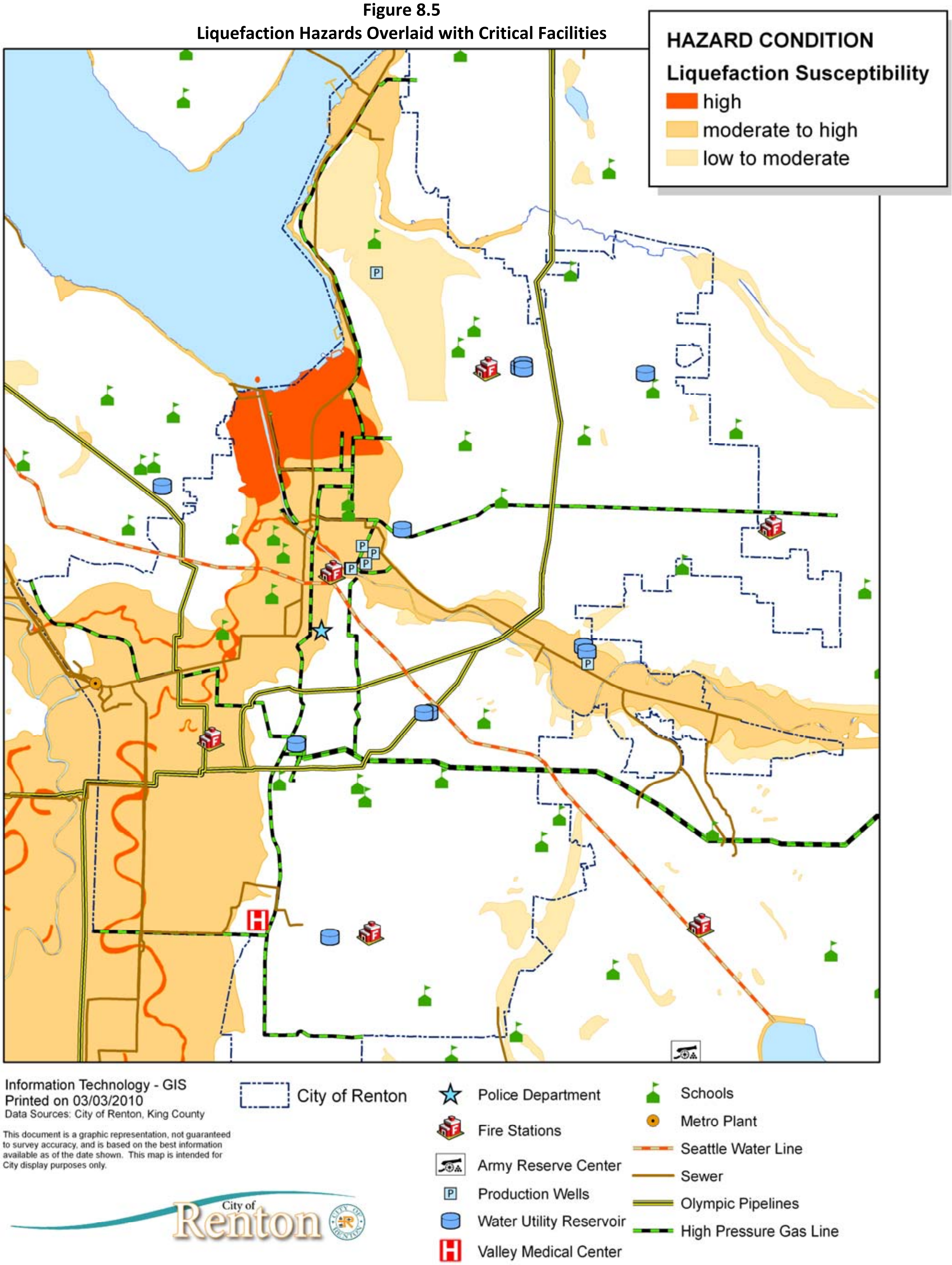


Figure 8.5
Liquefaction Hazards Overlaid with Critical Facilities



public education are essential before such an event occurs. Since the City is not located on the coast it would not be affected directly by tsunamis on the Washington coast. However, a tsunami affecting Puget Sound would have some effect on Lake Washington through the channel connecting the sound and the lake.

A more significant earthquake related phenomenon is “seiches”: waves from sloshing of inland bodies of waters such as lakes, reservoirs or rivers. In some cases, seiches have caused damages to shorefront structures and to dams. Areas of Renton near Lake Washington are subject to damage from seiches in the lake. The Seattle Office of Emergency Management website notes that a seiche in Lake Washington from the 1964 Alaska earthquake damaged boats in Lake Washington and that an 1891 earthquake near Port Angeles caused an eight-foot seiche in the lake. Boats, dock facilities and near-shore structures are at some risk from seiches.

8.4 Risk Assessment for Scenario Earthquakes

Earthquake damage in Renton from the three significant earthquakes in the greater Seattle area in the past 60 years has been minor. The low level of damage in Renton in these earthquakes reflects the locations and magnitudes of the earthquakes. In any future earthquakes that are larger (i.e., Cascadia Subduction Zone earthquakes) or closer to Renton (i.e., earthquakes on the Seattle Fault) will result in damages in Renton far greater than we’ve seen before.

Renton sustained minor damages restricted to masonry structures during the Nisqually Quake including: City Hall, Carco Theatre, Fire Stations 11 and 16, Public Works Shops and the Main Library experiencing damages on the exterior walkways, foundation, interior stacks and suspended ceiling.

FEMA’s HAZUS regional loss estimation software was used to assess the likely damages in Renton from an crustal earthquake along the Seattle Fault.

Summary results from HAZUS are shown below in Table 8.1. The Hazus report is available in Appendix 3.

Table 8.1
Scenario Earthquake Impacts on Renton

Scenario Earthquake	
Parameter	**Seattle Fault**
Magnitude	6.7
Latitude	47.59
Longitude	122.19
Damages	$1,414.90 million
Other Losses	$370.88 million
Injuries	769
Deaths	45

The probable impacts of major earthquakes on Renton vary with the magnitude and location of the earthquake. However, the following paragraphs summarize the likely impacts on Renton. For any major earthquake, the levels of damage will likely be greater in the soft soil, high-hazard areas shown Figure 8.4 compared to the rest of the City.

Buildings

The vulnerability of buildings depends on the structural system and the extent to which seismic design was incorporated into the building. Regardless of structural type, buildings with soft first stories, building on steep slopes and/or in areas subject to soil failures or landslide generally have higher damage levels. Table 8.2 below is the seismic inventory for the City of Renton buildings. It details year of construction and code compliance.

Table 8.2
City of Renton Public and Operational Facilities Seismic Inventory

Facility	*Year of Construction*	*Code Compliance*
City Hall 1055 S. Grady Way	1988 Retrofitted in 1998	Zone 4 Compliant
Fire Station 11 211 Mill Ave. S.	1979 Completed in 2010	Zone 4 Compliant
Fire Station 12 1209 Kirkland Ave. NE	2004	Zone 4 Compliant
Fire Station 13 18002 108th Ave. SE	2007	Zone 4 Compliant
Fire Station 14 1900 Lind Ave. SW	1996	Zone 3 Compliant
Fire Station 16 12923 156th Ave. SE	1974	NA
Fire Station 17 14810 SE Petrovisky Rd.	1970	NA
Historical Museum 235 Mill Ave. S.	1939	NA
Renton Community Center 1715 Maple Valley Hwy.	1989	Zone 3 Compliant
Highlands Neighborhood Center 800 Edmonds Ave. NE	2000	Zone 4 Compliant
North Highlands Neighborhood Center 3000 NE 16th St.	1942	NA
Main Library 100 Mill Ave. S.	1967	NA
Highlands Library 2902 NE 12th St.	1973	NA
Old City Hall 200 Mill Ave. S.	1968	NA

The Facilities Division recognizes the need to upgrade all city facilities to meet the current code requirements. The Community Services Department will attempt to complete this by contracting engineering services to do a seismic survey and recommendation on one site every three years, provided the budget has been appropriated. The department will also seek grants to meet these goals.

> Most wood frame buildings perform relatively well in earthquakes. Damages to wood frame buildings will be concentrated in the most vulnerable types, including older buildings with sill plates not bolted to the foundation or with cripple wall foundations.

Other building types likely to experience higher levels of damage include:

- Unreinforced or lightly reinforced masonry buildings,
- Older pre-cast, tilt-up and concrete frame buildings and
- Concrete and steel frame buildings with unreinforced masonry infill walls.

Infrastructure

Utility and transportation infrastructure is also subject to major damage and loss of service in earthquakes, including:

- Water and wastewater systems – damage to treatment plants and pipe breaks (especially in soft soil areas). Service outages may be widespread and occur for a long duration.
- Natural gas systems – pipe breaks (especially in soft soil areas) but typically fewer than for water or wastewater systems. Service outages may be widespread and for a long duration.
- Electric power – damage to substation equipment is common. Service outages may be widespread but typically for a shorter duration than other utility systems.
- Bridges – damage to older bridges, especially multi-span bridges, may be extensive with disruption of surface transportation routes.
- Dams, especially older dams designed to lower seismic standards, are subject to damage or even complete failure in earthquakes. The worst case scenario includes inundation of downstream areas.

8.5 Earthquake Hazard Mitigation Projects: General Examples

There are a wide variety of possible hazard mitigation projects for earthquakes. The most common projects include: structural retrofit of buildings, non-structural bracing and anchoring of equipment and contents, and strengthening of utility systems, bridges, dams and other infrastructure components.

The seismic hazard (frequency and severity of earthquakes) is high in Renton. However, the risk (potential for damages and casualties) is not uniformly distributed throughout Renton. It is instead concentrated in the most vulnerable buildings and infrastructure.

Structural retrofit of buildings should not focus on typical buildings but rather on buildings that are most vulnerable to seismic damage. Priorities should include buildings on soft soil sites, subject to amplification of ground motion and/or liquefaction, along with critical service facilities such as hospitals, fire and police stations, emergency shelters and schools.

Non-structural bracing of equipment and contents is often the most cost-effective type of seismic mitigation project. Inexpensive bracing and anchoring may protect expensive and/or critical equipment such as medical diagnostic equipment in hospitals, computers, and communication equipment for police and fire services and so on. For utilities, bracing of control equipment, pumps, generators, battery racks and other critical components can be powerfully effective in reducing the impact of earthquakes on system performance. Such measures should almost always be undertaken before considering large-scale structural mitigation projects.

The strategy for strengthening bridges and other infrastructure follows the same principles as discussed above for buildings. The targets for mitigation should not be typical infrastructure but rather specific infrastructure elements that have been identified as being highly vulnerable and/or are critical links in the lifeline system. For example, vulnerable overpasses on major highways would have a much higher priority than overpasses on lightly traveled rural routes.

Earthquake mitigation action items from the Master Mitigation Action Items Table in Chapter 4 are shown below in Table 8.2 Earthquake Mitigation Action Items.

Table 8.2
Earthquake Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Earthquake Mitigation Action Items									
Short-Term #1	Evaluate the seismic vulnerability of critical city-owned buildings, utilities and infrastructure and establish priorities to retrofit or replace vulnerable facilities to ensure adequate seismic performance of critical facilities.	Community Services	1-2 Years	X	X	X		X	
Short-Term #2	Conduct a sidewalk survey of residential, commercial and industrial buildings in Renton using FEMA's Rapid Visual Screening to identify especially vulnerable buildings, raise awareness and encourage mitigation actions.	Community and Economic Development	1-2 Years	X	X	X			
Short-Term #3	Disseminate FEMA pamphlets to educate homeowners about structural and non-structural retrofitting of vulnerable homes and encourage retrofit.	Community and Economic Development	1-2 Years	X	X	X	X		
Long-Term #1	Ensure that all critical City facilities in Renton have backup power and emergency operations plans to deal with power outages.	Community Services	5 years		X			X	
Long-Term #2	Obtain funding and retrofit important public facilities with significant seismic vulnerabilities.	Community Services	10 years		X	X	X	X	

9.0 LANDSLIDES AND DEBRIS FLOWS

9.1 Landslide Overview and Definitions

The term "landslide" refers to a variety of slope instabilities that result in the downward and outward movement of slope-forming materials, including rocks, soils and artificial fill. Four types of landslides are distinguished based on the types of materials involved and the mode of movement. These four types of landslides are detailed below and illustrated in Figures 9.1 to 9.4.

Rockfalls are abrupt movements of masses of geologic materials (rocks and soils) that become detached from steep slopes or cliffs. Movement occurs by free-fall, bouncing and rolling. Falls are strongly influenced by gravity, weathering, undercutting or erosion.

Rotational Slides are those in which the rupture surface is curved concavely upwards and the slide movement is rotational about an axis parallel to the slope. Rotational slides usually have a steep scarp at the upslope end and a bulging "toe" of the slide material at the bottom. Roads constructed by cut and fill along the side of a slope are prone to slumping on the fill side of the road. Rotational slides may creep slowly or move large distances suddenly.

Translational Slides are those in which the moving material slides along a more or less flat surface. Translational slides occur on surfaces of weaknesses, such as faults and bedding planes or at the contact between firm rock and overlying loose soils. Translational slides may creep slowly or move large distances suddenly.

Debris Flows (mudflows) are movements in which loose soils, rocks and organic matter combine with entrained water to form slurries that flow rapidly downslope.

All of these types of landslides may cause road blockages by dumping debris on road surfaces or road damages if the road surface itself slides. Utility lines and pipes are prone to breakage in slide areas. Buildings impacted by slides may suffer minor damage from small settlements or be completely destroyed by large ground displacements or burial in slide debris. Landslides may result in casualties depending on the location, amount and speed of the slide.

There are three main factors that determine susceptibility (potential) for landslides: slope, soil/rock characteristics and water content.

Figures 9.1 to 9.4
Major Types of Landslides

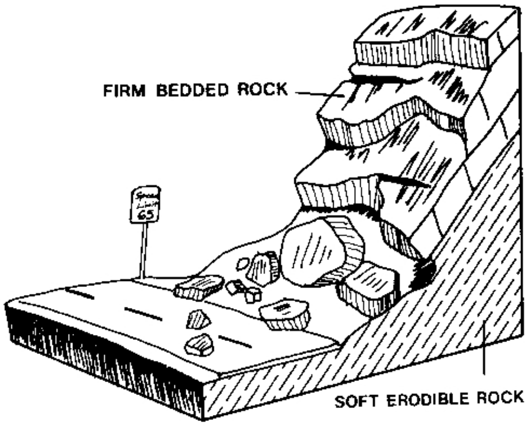


Figure 9.1 Rockfall

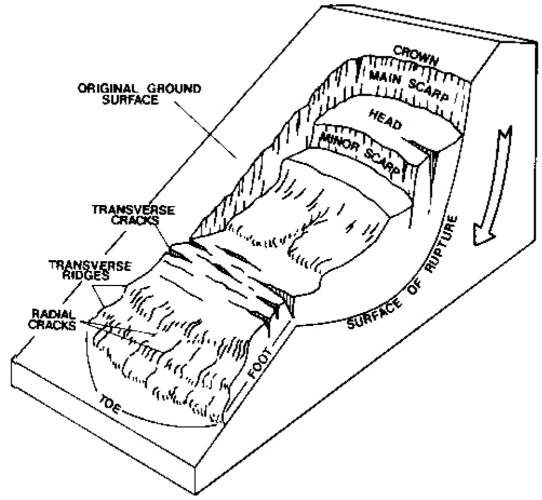


Figure 9.2 Rotational Landslide

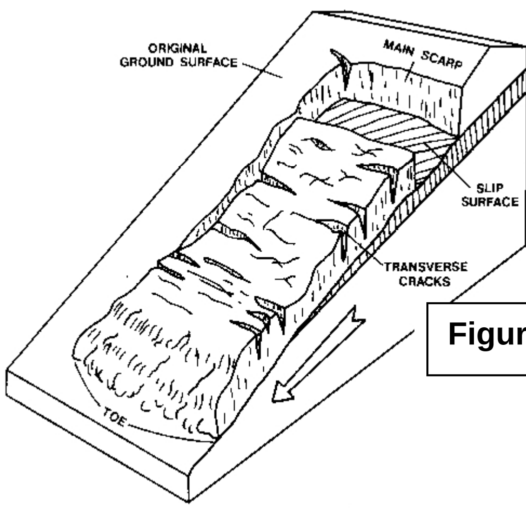


Figure 9.3 Translational Landslide

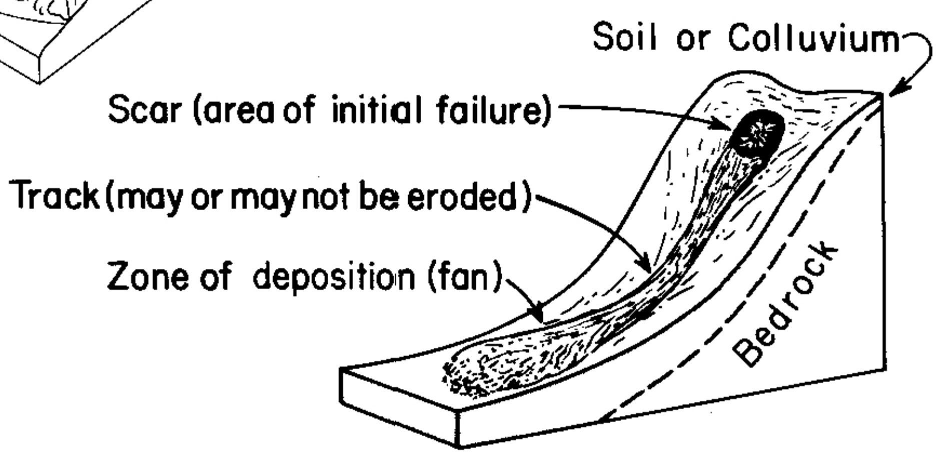


Figure 9.4 Debris Flow

Steeper slopes are more prone to all types of landslides. Loose, weak rock or soil is more prone to landslides than is more competent rock or dense, firm soils. Finally, water saturated soils or rock with a high water table are much more prone to landslides because the water decreases the shear strength of the soil and increases the probability of sliding.

As noted above, the water content of soils/rock is a major factor in determining the likelihood of sliding. Most landslides happen during rainy months, when soils are saturated with water. However, landslides may happen at any time of the year.

In addition to landslides triggered by a combination of slope stability and water content, landslides may also be triggered by earthquakes. Areas prone to seismically triggered landslides are the same as those prone to ordinary (i.e., non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely when soils are saturated with water.

Human activity such as road cuts or removal of vegetation may also increase the potential for landslides at affected locations.

9.2 Landslide Hazard Assessment for Renton

Specific areas with landslide risk include hill slopes along the Cedar River and Maple Valley Highway in eastern Renton; along the Benson Hills and South Puget Drive in south Renton, and along the southeastern banks of Lake Washington in Eastern Renton. There is also a small area of very high landslide risk along Rainier Drive N. in the vicinity of NW 7th Street.

Most of the landslide hazard areas with the highest risk in Renton are located in undeveloped areas along the Cedar River. Slides in these areas may result in temporary dams with subsequent flooding that may affect developed areas nearby. One such slide event with subsequent flooding occurred along the Cedar River in east Renton as a results of the 2001 Nisqually Earthquake.

Areas with high landslide potential within Renton are shown in Figure 9.5. The mapped landslide hazard areas include all slopes of 15^{o} or higher. Figures 9.6 and 9.7 show critical facilities overlaid with areas at risk for landslides or erosion respectively.

Figure 9.5
Landslide Hazard Areas in Renton

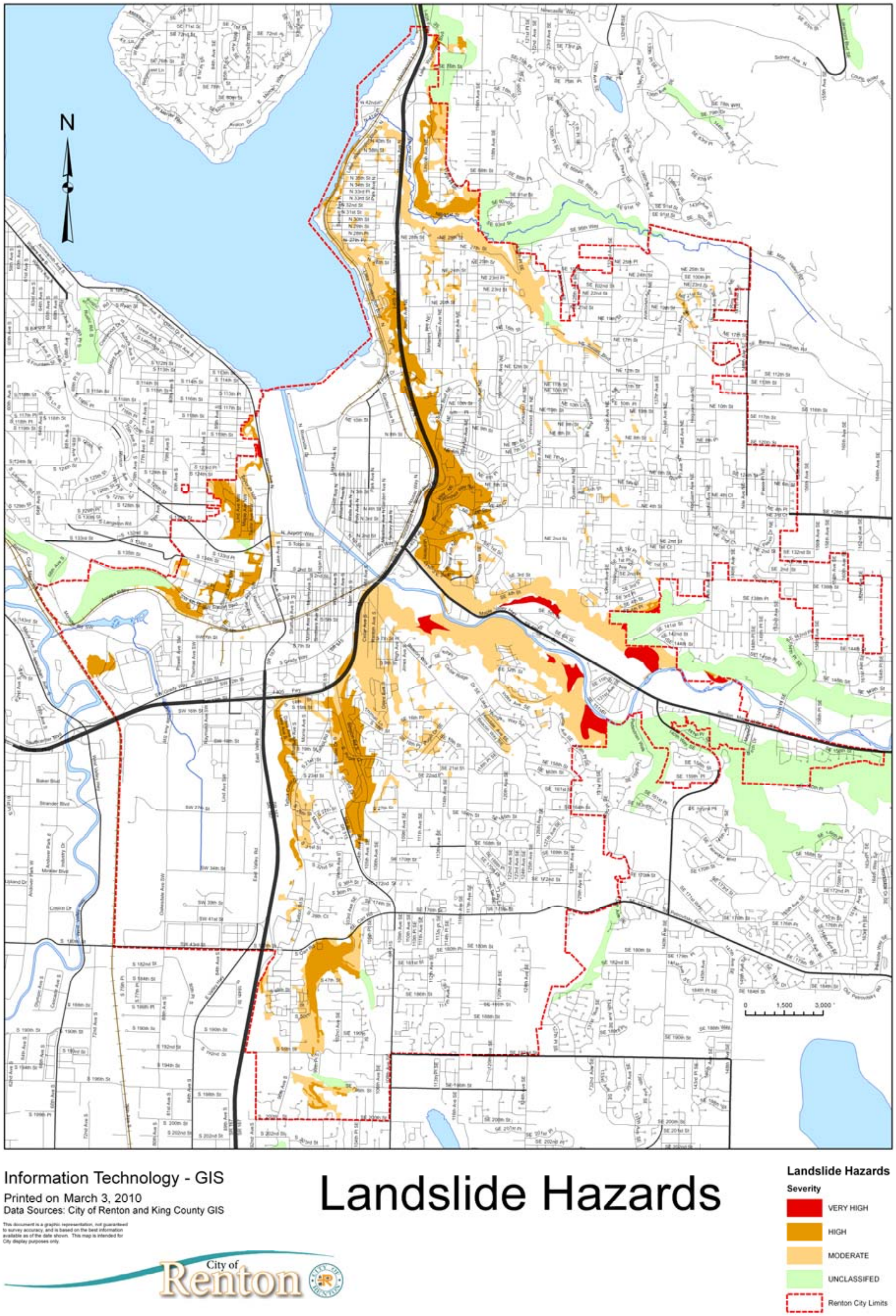


Figure 9.6
Areas at Risk of Landslide Overlaid with Critical Facilities

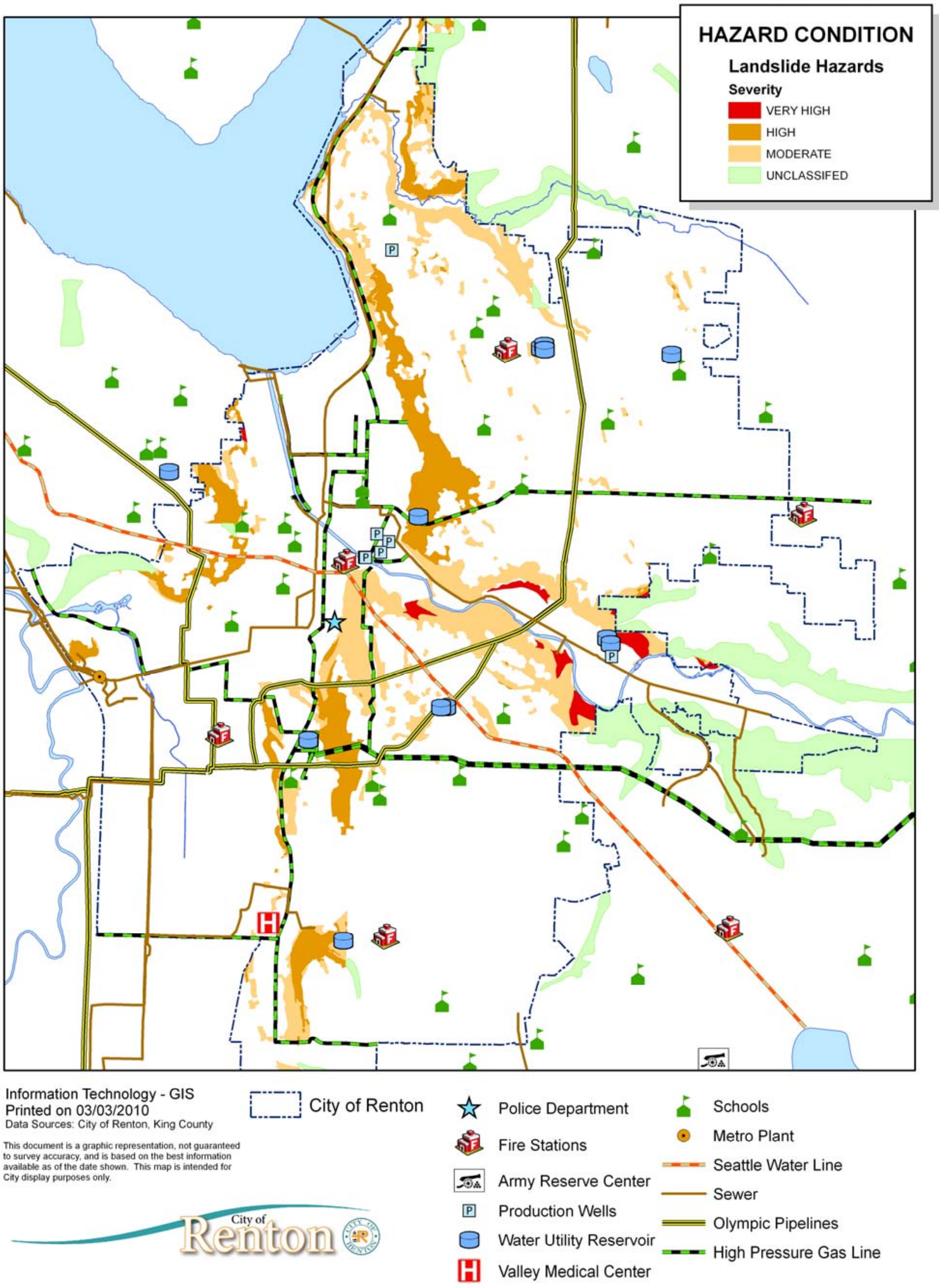
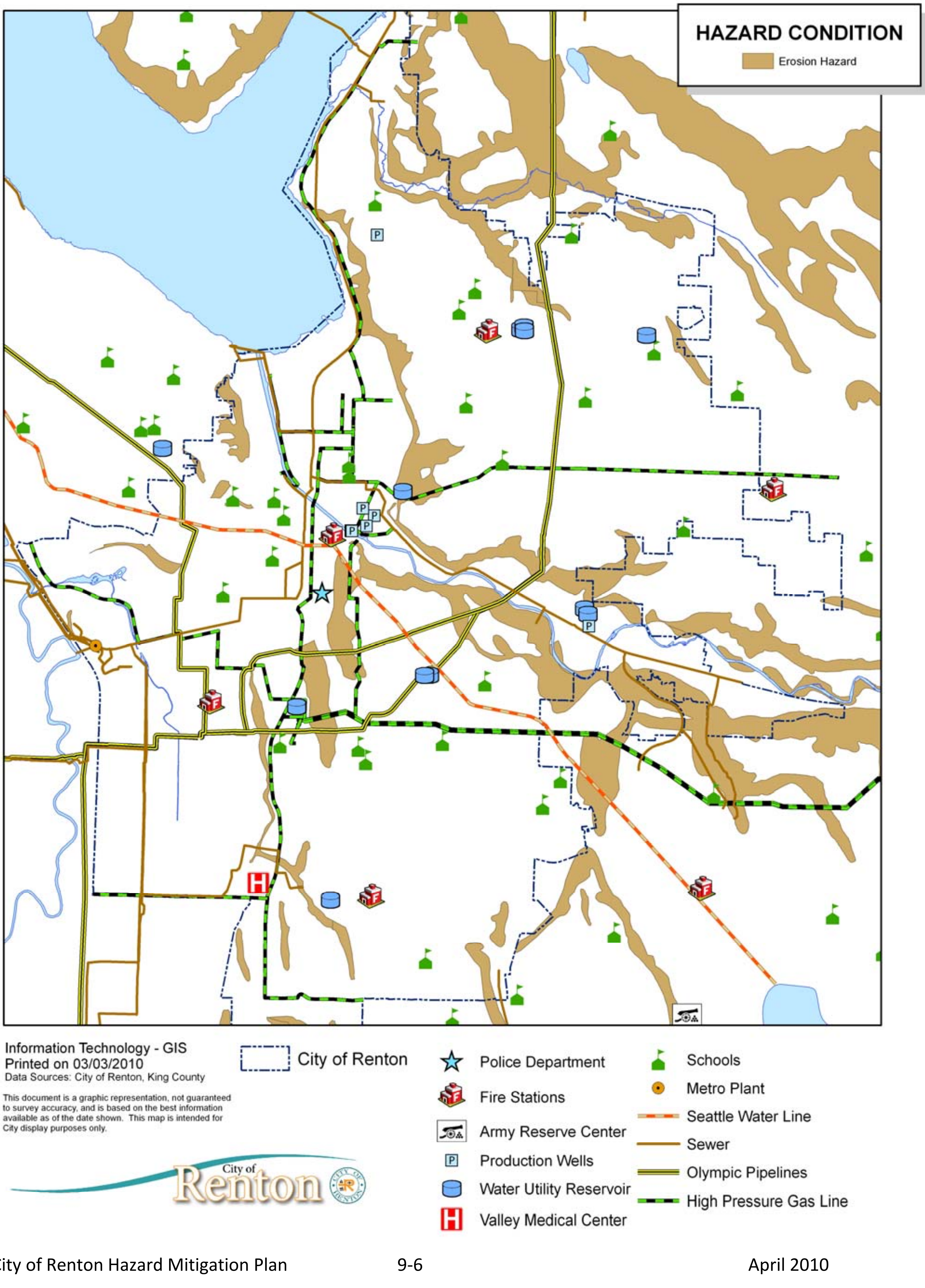


Figure 9.7
Areas at Risk of Erosion Overlaid with Critical Facilities



In mapping landslide hazards the following criteria were used.

- Very High – All locations of mass wasting and landslide deposits as well as two previous landslides on public record.
- High – Areas with a slope greater than 40% and areas with slopes between 15 and 40% where the surface soils are underlain by low permeability geologic units.
- Moderate – Areas with slopes between 15 and 40% where the surface soils are underlain by permeable geologic units.
- Unclassified – Areas that have not been surveyed.

The total square mileage of all levels of landslide hazard is 3.37, which is .14% of Renton's total square mileage. There are 10 structures in very high risk areas, 1,387 structures in the high risk areas, 2,253 structures in moderate risk areas, and 319 structures in areas of unclassified risk. There are no streets in the very high risk areas, 18.05 miles of street in the high risk areas, 19.70 miles of street in the moderate risk areas, and 2.45 miles of street in areas of unclassified risk. There are no critical facilities in the very high risk areas. There are seven Renton water system facilities in the high risk areas and three in the moderate risk areas. The Seattle water line, sewer line, Olympic Pipeline and high pressure gas line all cross through the high and moderate risk areas.

In mapping erosion risk the following criteria were used.

- Hazard – All surface soils on slopes steeper than 15 %.

There is one Renton water system facility in the erosion hazard areas. The Seattle water line, sewer line, Olympic Pipeline and high pressure gas line all cross through the erosion risk areas.

9.3 Landslide Risk Assessment for Renton

Winter storms with intense rainfalls are the most common trigger for landslides in Renton. Major storms with intense rainfall can result in numerous landslides in slide-prone areas.

It is difficult to make quantitative predictions of future landslides damages which depend on the:

1) extent of landslide susceptible areas,
2) inventory of buildings and infrastructure in landslide susceptible areas,
3) severity of winter storm event (inches of rainfall in 24 hours),
4) percentage of landslide susceptible areas that will move and the range of movements (displacements) likely and
5) vulnerability (amount of damage for various ranges of movement).

For Renton, however, the most likely impacts of landslides are damages to buildings, roads and utilities. Severe landslides may also result in injuries or deaths. Small landslides are likely to affect one building or small number of buildings and/or a single road location. Larger landslides may affect numerous buildings and/or roads.

In addition to direct landslide damages within Renton, the City is also subject to the economic impacts of road closures (e.g., Interstate 5) or utility outages from landslides outside of City limits.

9.4 Mitigation of Landslide Risk

Mitigation of landslide risks is often quite expensive. Slope stability can be improved by drainage to reduce pore water pressure, construction of appropriate retaining walls or other types of geotechnical remediation. In some cases, buildings can be hardened to reduce damages. An alternative mitigation strategy for already built buildings or infrastructure with high potential for landslide losses is to relocate the facilities outside of known slide areas.

Mitigation of landslide risk can also be accomplished by effective land use planning to minimize development and the location of critical utility lines in slide-prone areas. Generally, such land use planning requires rather detailed geotechnical mapping of slide potential so that high hazard areas can be demarcated without unnecessarily including other areas of low slide potential.

The impacts of slide damage on road systems can also be partially addressed by identifying areas of high slide potential or of repetitive past slide damages so that alternative routes for emergency response can be pre-determined.

The following table, Table 9.1 Landslide Mitigation Action Items, includes landslide mitigation action items from the Master Action Items Table in Chapter 4.

Table 9.1
Landslide Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Landslide Mitigation Action Items									
Short-Term #1	Complete the inventory of locations where buildings or infrastructure are subject to landslides.	Community and Economic Development, Public Works	1-2 Years	X					
Long-Term #1	Consider landslide mitigation actions for slides seriously threatening buildings or infrastructure.	Public Works	5 Years		X	X		X	
Long-Term #2	Limit future development in high landslide potential areas.	Community and Economic Development	Ongoing	X	X	X		X	

10.0 VOLCANIC HAZARDS

10.1 Overview

The Cascades, which run from British Columbia through Washington and Oregon into northern California, contain more than a dozen major volcanoes and hundreds of smaller volcanic features. In the past 200 years, seven of the Cascade volcanoes in the United States have erupted: Mt. Baker, Glacier Peak, Mt. Rainier, Mt. St. Helens, Mt. Hood, Mt. Shasta, and Mt. Lassen. During this time period, the most active volcano in the Cascades has been Mt. St. Helens with about 14 major eruptions and many smaller eruptions.

Many other volcanoes are deemed active or potentially active. The Smithsonian Institution's Global Volcanism Project lists 20 active volcanoes in Oregon and 7 in Washington. The 7 active volcanoes in Washington are listed below in Table 10.1.

Table 10.1
Active Volcanoes in Washington

Volcano	Type	Last Eruption
Mt. Baker	Stratovolcano	1880
Glacier Peak	Stratovolcano	1700 ± 100
Mt. Rainier	Stratovolcano	1825 (?)
Mt. Adams	Stratovolcano	950 AD (?)
Mount St. Helens	Stratovolcano	1980 - 2008
West Crater	Volcanic Field	5760 BC (?)
Indian Heaven	Shield Volcanoes	6250 ± 100 BC

A great deal of general background information on volcanoes in the Cascades and on volcanoes in general, is available on several websites as detailed below in Table 10.2.

Table 10.2
Volcano Websites

Institution	Website
United States Geological Survey (USGS) - general site	www.usgs.gov
USGS Cascades Volcano Observatory	http://vulcan.wr.usgs.gov
Smithsonian Institution (Global Volcanism Project)	www.volcano.si.edu
Washington State Department of Natural Resources (see: Geology and Earth Resources Division)	www.dnr.wa.gov

The numerous volcanoes of the Cascades differ markedly in their geological characteristics. The largest volcanoes are generally what geologists call composite or stratovolcanoes. These volcanoes may be active for tens of thousands of years to hundreds of thousands of years. In some cases, these large volcanoes may have explosive eruptions such as Mt. St. Helens in 1980, or Crater Lake in Oregon about

6,850 years ago. A more common type of volcano, with more regular activity, is what geologists call mafic volcanoes. This type of volcano is typically active for much shorter time periods, up to a few hundred years, and generally forms small craters or cones. Mafic volcanoes are not subject to large explosive events.

10.2 Volcanic Hazard Types

In this area, awareness of the potential for volcanic eruptions was greatly increased by the May 18, 1980 eruption of Mt. St. Helens. In this eruption, which killed 57 people, lateral blast effects covered 230 square miles and reached 17 miles northwest of the crater. Pyroclastic flows covered six square miles and reached five miles north of the crater while landslides covered 23 square miles. Ash accumulations were about 10 inches at 10 miles downwind, 1 inch at 60 miles downwind and ½ inch at 300 miles downwind. Lahars (mudflows) affected the north and south forks of the Toutle River, the Green River and ultimately the Columbia River as far as 70 miles from the volcano. Damage and reconstruction costs exceeded $1 billion.

Volcanic eruptions often involve several distinct types of hazards to people and property. Major volcanic hazards include: lava flows, blast effects, pyroclastic flows, ash flows, lahars and landslides or debris flows. Some of these hazards (e.g., lava flows) only affect areas very near the volcano. Other hazards may affect areas 10 or 20 miles away from the volcano, while ash falls may affect areas several miles downwind of the eruption site.

Lava flows are eruptions of molten rock. Lava flows for the major Cascades volcanoes tend to be thick and viscous, forming cones and thus typically affecting areas only very near the eruption vent. However, flows from the smaller mafic volcanoes may be less viscous flows that spread out over wider areas. Lava flows destroy everything in their path.

Blast effects may occur with violent eruptions. Most volcanic blasts are largely upwards. However, the Mt. St. Helens blast was lateral, with impacts 17 miles from the volcano. Similar or larger blast zones are possible in future eruptions of any of the major Cascades volcanoes.

Pyroclastic flows are high-speed avalanches of hot ash, rock fragments and gases. Pyroclastic flows can be as hot as 1500 ^{o}F and move downslope at 100 to 150 miles per hour. Pyroclastic flows are extremely deadly for anyone caught in their path.

Ash falls result when explosive eruptions blast rock fragments into the air. Such blasts may include tephra (solid and molten rock fragments). The largest rock fragments (sometimes called “bombs”) generally fall within two miles of the eruption vent. Smaller ash fragments (less than 0.1”) typically rise into the area forming a huge eruption column. In very large eruptions, ash falls may total many feet in depth near the vent and extend for hundreds or even thousands of miles downwind.

Lahars or mudflows are common during eruptions of volcanoes with heavy loading of ice and snow. These flows of mud, rock and water can rush down channels at 20 to 40 miles an hour and can extend for more than 50 miles. For some volcanoes, lahars are a major hazard because highly populated areas are built on lahar flows from previous eruptions.

Landslides or debris flows are the rapid downslope movement of rocky material, snow and/or ice. Volcano landslides can range from small movements of loose debris to massive collapses of the entire summit or sides of a volcano. Landslides on volcanic slopes may be triggered by eruptions or by earthquakes or simply by heavy rainfall.

10.3 Volcanic Hazards for Renton

Several of the active volcanoes in Washington are located relatively near Renton, including Mt. Rainier and Mt. St. Helens. Approximate distances from Renton to four relatively nearby volcanoes are shown below in Table 10.3.

Table 10.3
Distances from Renton

Volcano	Distance (miles)
Mt. Rainier	48
Mt. St. Helens	89
Mt. Baker	93
Mt. Adams	94
Glacier Peak	68

Among these relatively nearby volcanoes, Mt. St. Helens is the most active. Mt. Rainier, Mt. Baker and Glacier Peak are definitely active and Mt. Adams is potentially active.

Renton is approximately 48 miles from Mt. Rainier and about 68 to 94 miles from the other relatively nearby volcanoes.

The USGS analysis of Volcano Hazards from Mt. Rainier, Washington, was published in 1998 (Open-File Report 98-428). As shown in Figure 10.1, the proximal hazard area is the area subject to the most intense volcanic hazards including lava flows, tephra flows, pyroclastic flows, landslides and debris flows and lahars. Fortunately, this high risk area is predominantly within the national park boundary with very low population. Lahars are the primary volcanic hazard which extends into populated areas downslope from Mt. Rainier. The area at risk from lahars extends as least as far as Tacoma and Auburn.

Renton is outside the geographic areas at high risk from lahars from Mt. Rainier. However, as shown in Figure 10.2, Renton may be at some risk from extremely large lahars in the Green River Valley. If so, the return period for such events is likely several thousand years or longer.

Figure 10.1
Mt. Rainier Volcanic Hazards Map

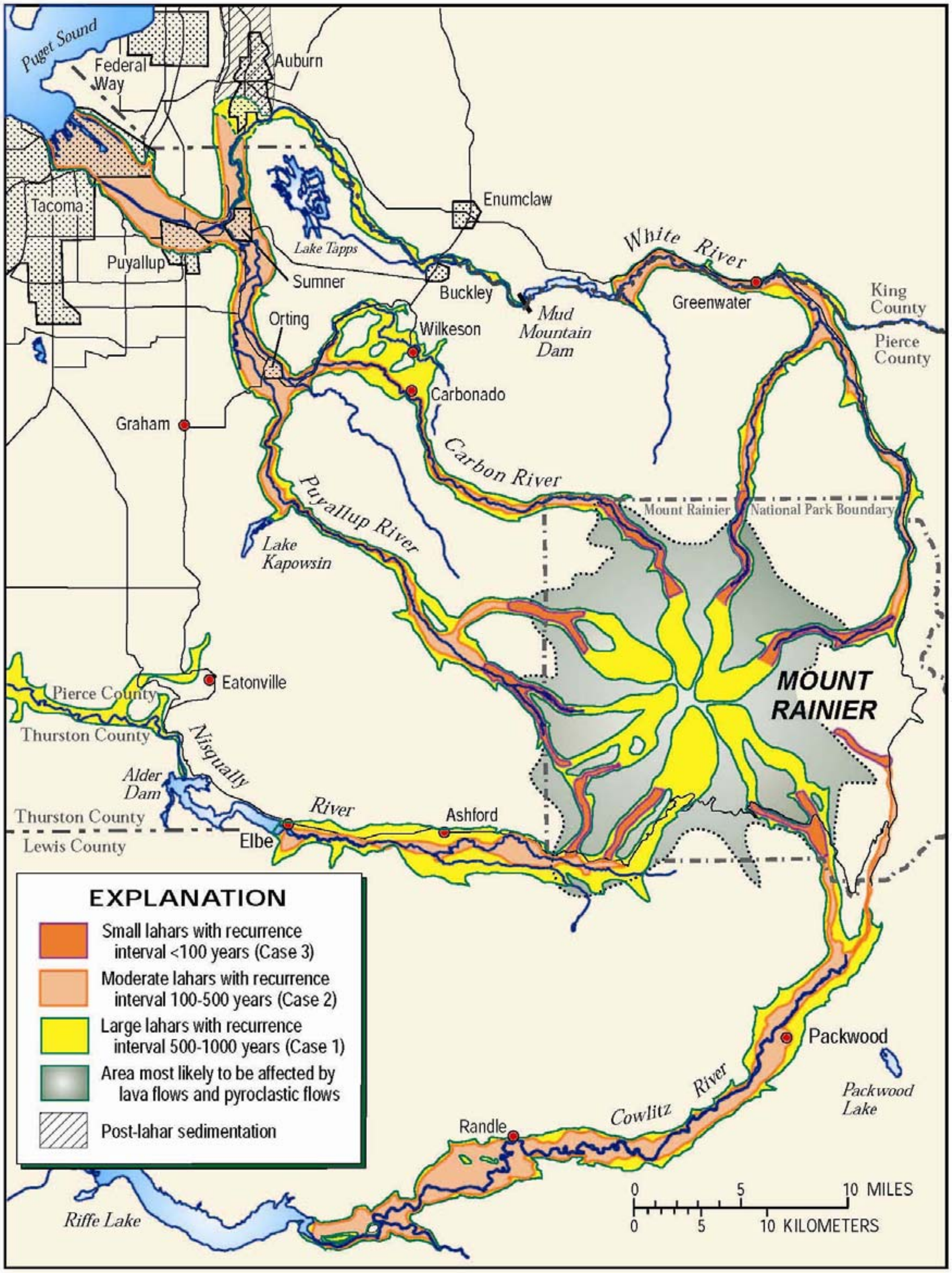
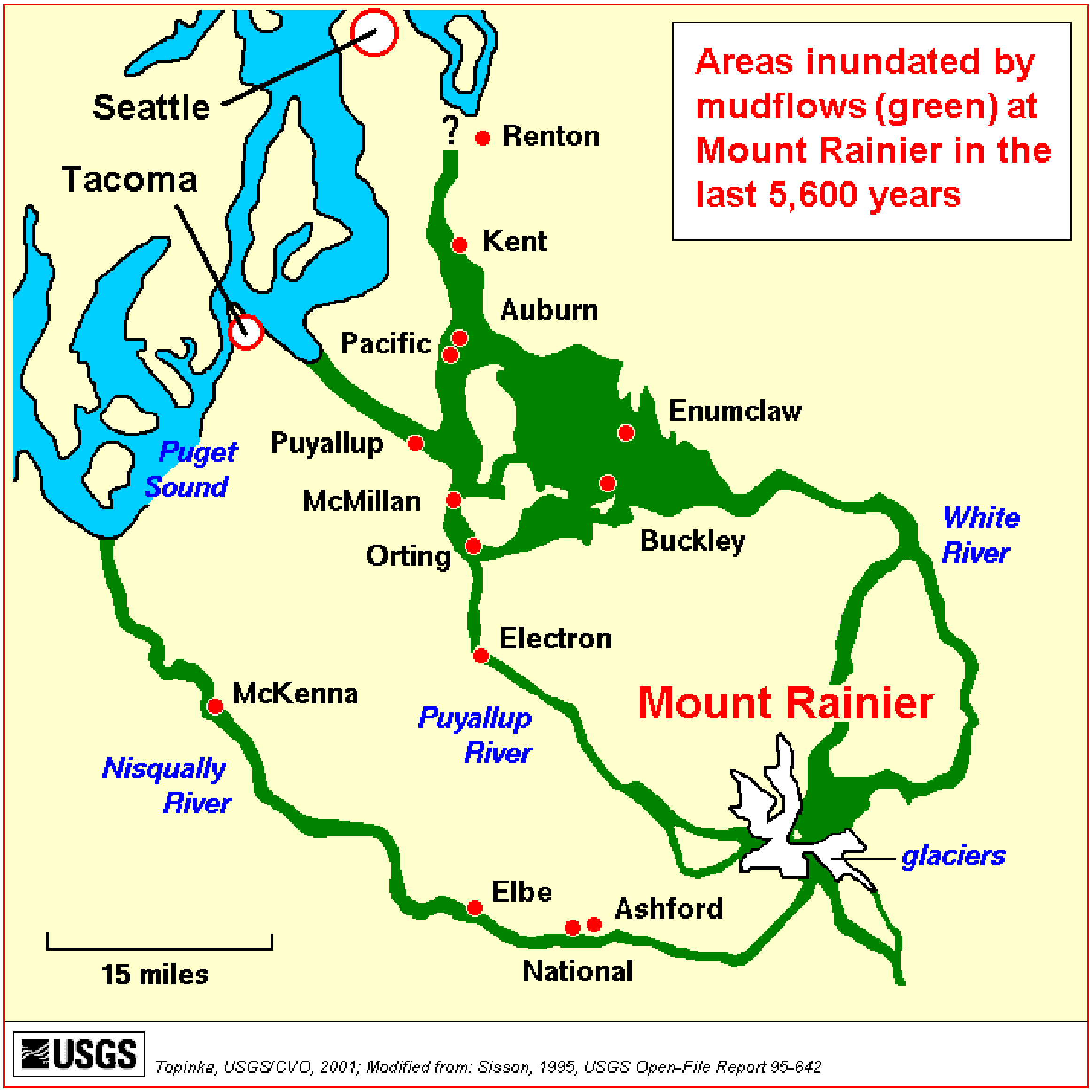


FIGURE 3.—*Hazard zones for lahars, lava flows, and pyroclastic flows from Mount Rainier (Hoblitt and others, 1998; US Geological Survey Open-File Report 98-428).*

Figure 10-2
Mt. Rainier Lahar Map



For Renton, the most significant volcanic risk is ash fall. In addition to effects from Mt. Rainier, ash falls from volcanic activity at Mt. St. Helens or any of the other active volcanoes could also affect Renton. Depending on the volume of volcanic ash ejected by an eruption and on prevailing wind directions at the time of eruption, various thicknesses of ash falls may affect Renton. The impacts of ash falls on Renton include:

a) Clean-up and ash removal from roofs, gutters, sidewalks, roads and vehicles.

b) Clogging of filters on vehicle engines, furnaces, heat pumps, air conditioners and other engines and mechanical equipment, with possible damage to the engines or equipment.

c) Possible respiratory problems for at-risk population such as elderly, young children or others with respiratory problems.

d) Possible impacts on public water supplies drawn from surface waters, including degradation of water quality (high turbidity) and increased maintenance requirements at water treatment plants.

e) Possible electric power outages from ash-induced short circuits in distribution lines, transmission lines and substations.

f) Possible disruptions of air traffic from the Renton Airport, Sea-Tac Airport and/or other airports in the Pacific Northwest region.

The extent of volcanic hazards for most of Renton appears limited to the possibility of ash from a Mt. St. Helens' eruption. Ash falls would likely be very minor with an inch or less of ash likely. In the 1980 Mt. St. Helens' eruption, Renton received less than 1" of ash. Even minor amounts of ash fall can result in the significant impacts noted above.

The following maps show probabilistic data on ash fall in Washington, taking into account all of the active volcanoes (USGS Open File Report 9-437, Plate 1, 1999).

Interpolating between the map contours of Figure 10.3, the annual probability of 1 centimeter (about 0.4 inch) or more of volcanic ash is about 1/2000 Renton. In other words, the return period for such ash falls in Renton is about 2,000 years.

Interpolating between the map contours of Figure 10.4, the annual probability of 10 centimeters (about 4 inches) or more of volcanic ash is about 1/4500 in Renton. So, the return period for such ash falls in Renton is about 4,500 years.

The low probabilities of significant ash falls (i.e., long return periods) arise because ash falls in Renton require volcanic eruptions producing ash and wind directions that deposit ash westward from the volcanoes.

Figure 10.3
Annual Probability of 1 Centimeter (about 0.4 inch) or More of Volcanic Ash

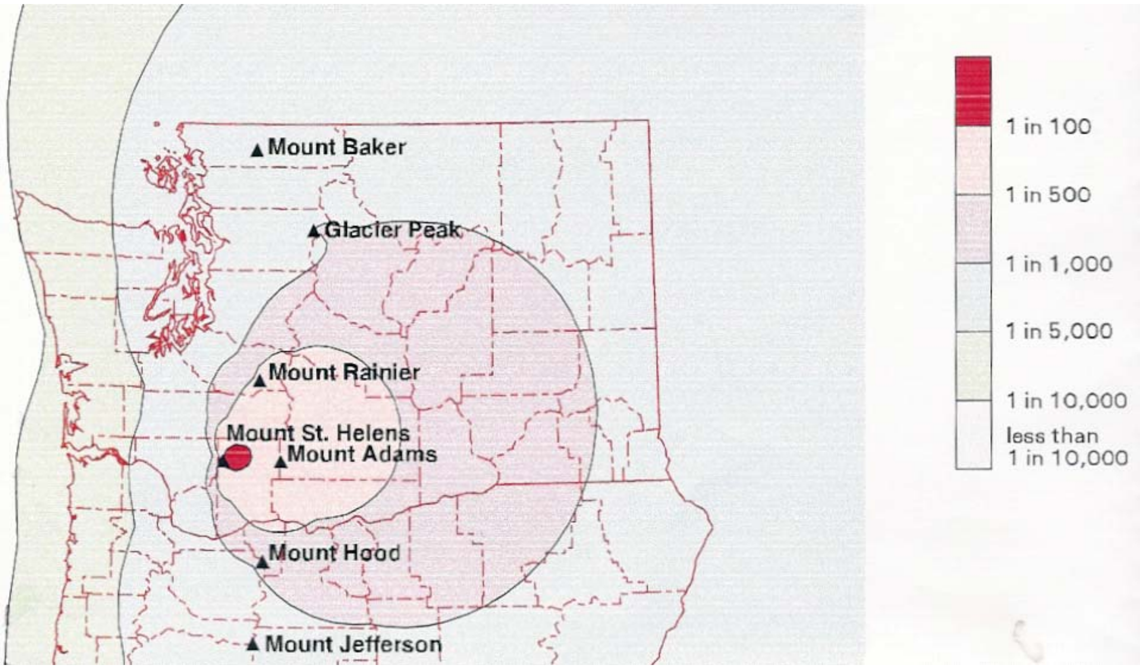
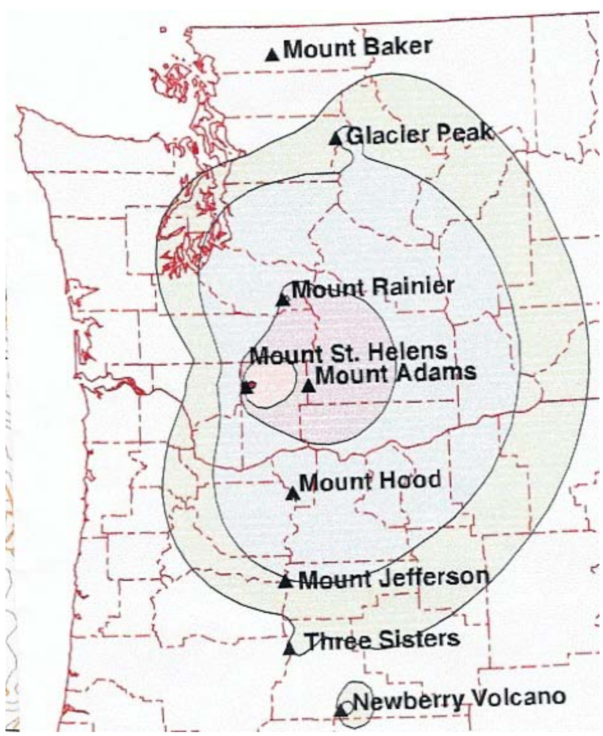


Figure 10.4
Annual Probability of 10 Centimeters (about 4 inches) or More of Volcanic Ash
(same scale as Figure 10.1 above)



10.4 Mitigation of Volcanic Hazards

Mitigation of volcanic hazards is predominantly in the areas of monitoring volcanic activity, warnings, evacuation and emergency response. There are few practical physical measures to mitigate the direct impacts of volcanic activity.

The USGS actively monitors volcanic activity in the Cascades via networks of seismic sensors (which can detect earthquakes related to magma movements) as well as very accurate ground surface measurements. The USGS also has a volcanic warning system with several levels of alert as a potential eruption becomes more likely and more imminent.

For the Cascades, the USGS volcano warning system has three levels. Level One (Volcanic Unrest) means anomalous conditions that could be indicative of an eventual volcanic eruption. Level Two (Volcanic Advisory) means that processes are underway that have a significant likelihood of culminating in hazardous volcanic activity, but the evidence does not indicate that a life- or property-threatening event is imminent. Level Three (Volcano Alert) means that monitoring or evaluation indicate that precursory events have escalated to the point where a volcanic event with attendant volcanologic or hydrologic hazards threatening to life and property appears imminent or is underway.

For most of Renton, which is located well outside of any of the likely direct hazard zones for any Cascades volcanic events, mitigation for volcanic activity is a low priority. In the event of a minor ash flow, public warnings directing people (especially those with respiratory problems) to remain indoors and cleanup are likely the only responses necessary for most volcanic effects impacting Renton. In addition, water treatment plants should be evaluated to ensure that they can handle possible high turbidity events from volcanic ash falls into water supplies.

The following table, Table 10.4, includes the volcanic hazards mitigation action items from the Master Action Items Table in Chapter 4.

Table 10.4
Volcanic Hazards Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Volcanic Hazards Mitigation Action Items									
Short-Term #1	Update public emergency notification procedures for ash fall events.	Fire & Emergency Services	1-2 Years	X	X			X	
Short-Term #2	Update emergency response planning for ash fall events.	Community Services, Fire & Emergency Services, Police, Public Works	1-2 Years	X	X			X	
Short-Term #3	Evaluate capability of water treatment plant to deal with high turbidity from ash falls and upgrade treatment facilities and emergency response plans to deal with ash falls.	Public Works, METRO	1-2 Years					X	

11.0 COAL MINE HAZARDS

11.1 Overview

Coal mining was an important industry in Renton from the 1870s when Renton Coal Company was organized through the 1930s. Most of the large coal mining operations were closed in the late 1930s or soon thereafter. Small scale coal mining operations continued into the 1960s.

There are no active coal mines in Renton. There are four mapped abandoned coal mines and smaller unmapped mines may also exist. Historical coal mining areas in Renton are shown in Figure 11.1. Most of the coal mining areas, and all of the high hazard areas, are located in the vicinity of South Puget Drive, Renton Hill south of Cedar River Park and east of Benson Drive. There has been significant residential development above or nearby these coal mining areas and abandoned mines.

11.2 Coal Mine Hazards

When mines in or near developed areas were closed, mine openings were typically plugged with whatever materials were readily available including: mine waste, land clearing debris and car bodies. Rarely, if ever, were the coal mines properly sealed with engineered plugs prior to the 1950s. Given the timing of the closures, nearly all openings to abandoned coal mines in the Renton area should be considered improperly sealed.

Abandoned underground coal mines pose four main hazards: subsidence, collapse, release of gases and release of water.

- Areas above mine workings are subject to gradual subsidence (movement of surface as it shifts downward), with potential damages to buildings, roads and utility systems. Subsidence can occur for all underground mines, whether the workings are deep (>200 feet) or shallow (<200 feet).
- Sudden localized collapses can occur, especially for shallow mine workings. Collapses may result in major damages as well as injuries or deaths.
- Underground coal mines often release methane and/or carbon dioxide.
    - Methane is a colorless, odorless and lighter than air gas that rises through the ground or through tunnels and shafts. Methane can accumulate in enclosed spaces and result in fires or explosions if ignited.
    - Carbon dioxide is a colorless, odorless heavier than air gas which descends downward through mines and may exit from downward sloping tunnels. Accumulation of carbon dioxide in enclosed spaces may result in asphyxiation.
- For mines that have filled with ground water, failure of plugs may result in unexpected and sudden outbursts of water in unanticipated locations. Collapses or

sudden outbursts of water pose life safety risks as well as threats to buildings and infrastructure.

Failures of abandoned coal mines may occur at any time of year under any conditions. However, failures are more likely during periods of heavy rainfall as slope stability may be diminished. Mine failures may also be triggered by landslides or earthquakes.

11.3 Coal Mine Hazards: Risk Assessment

Overall the risk from abandoned coal mines is fairly low. As discussed in the last section, there is potential for damages and possible life safety impacts from subsidence, collapse, releases of gases or releases of water. Any such events would most likely be localized and affect a small geographic area. Larger events affecting several or more buildings are also possible.

Figure 11.1 shows the mapped coal mine hazards area in Renton. Coal mine hazards may also exist in other areas of Renton because the identification and mapping of abandoned coal mines is incomplete.

The definitions of moderate and high coal mine hazard areas are as follows:

- Moderate hazard. Areas where mine workings are deeper than 200 feet (steeply dipping coal seams) or deeper than 15 times the thickness of the seam or workings (gently dipping seams). These areas may be subject to subsidence.
- High hazard. Areas with abandoned and improperly sealed openings and areas underlain by mine workings shallower than 200 feet (steeply dipping seams) or shallower than 15 times the thickness of the seam or workings (gently dipping seams). These areas may be subject subsidence and collapse.

The total square mileage of coal mine hazards in Renton is 1.61, or .07% of the City's total square mileage. There are 175 structures in high risk areas, 1,809 structures in moderate risk areas and 161 structures in unclassified areas. There are .84 miles of street in high risk areas, 18.99 miles in moderate risk areas and 1.07 miles in areas of unclassified risk.

Figure 11.2 shows an overlay of the mapped coal mine hazard areas with critical buildings and infrastructure. The mapped coal mine hazard areas include two water reservoirs as well as Nelson Middles School and Spring Glen Elementary. The hazard areas are crossed by the Olympic Pipeline, Seattle water line, and high pressure gas lines. There are no recorded coal mine failure events for Renton.

11.4 Mitigation Action Items

Mitigation action items for coal mine hazards are summarized below in Table 11.1 Coal Mine Hazards Mitigation Action Items.

Figure 11.1
Coal Mine Hazard Areas in Renton

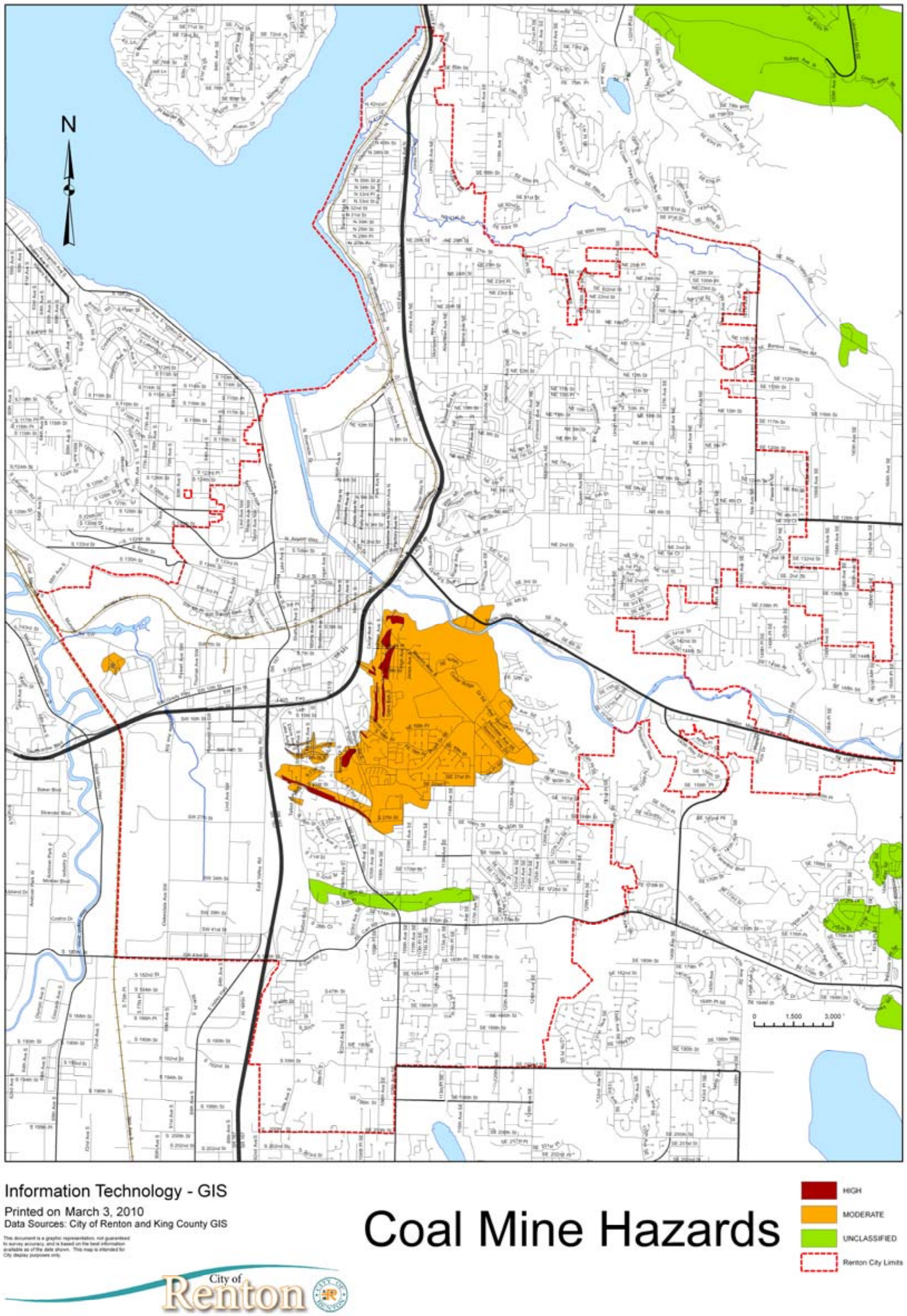


Figure 11.2
Overlay of Critical Facilities with Coal Mine Hazards Areas

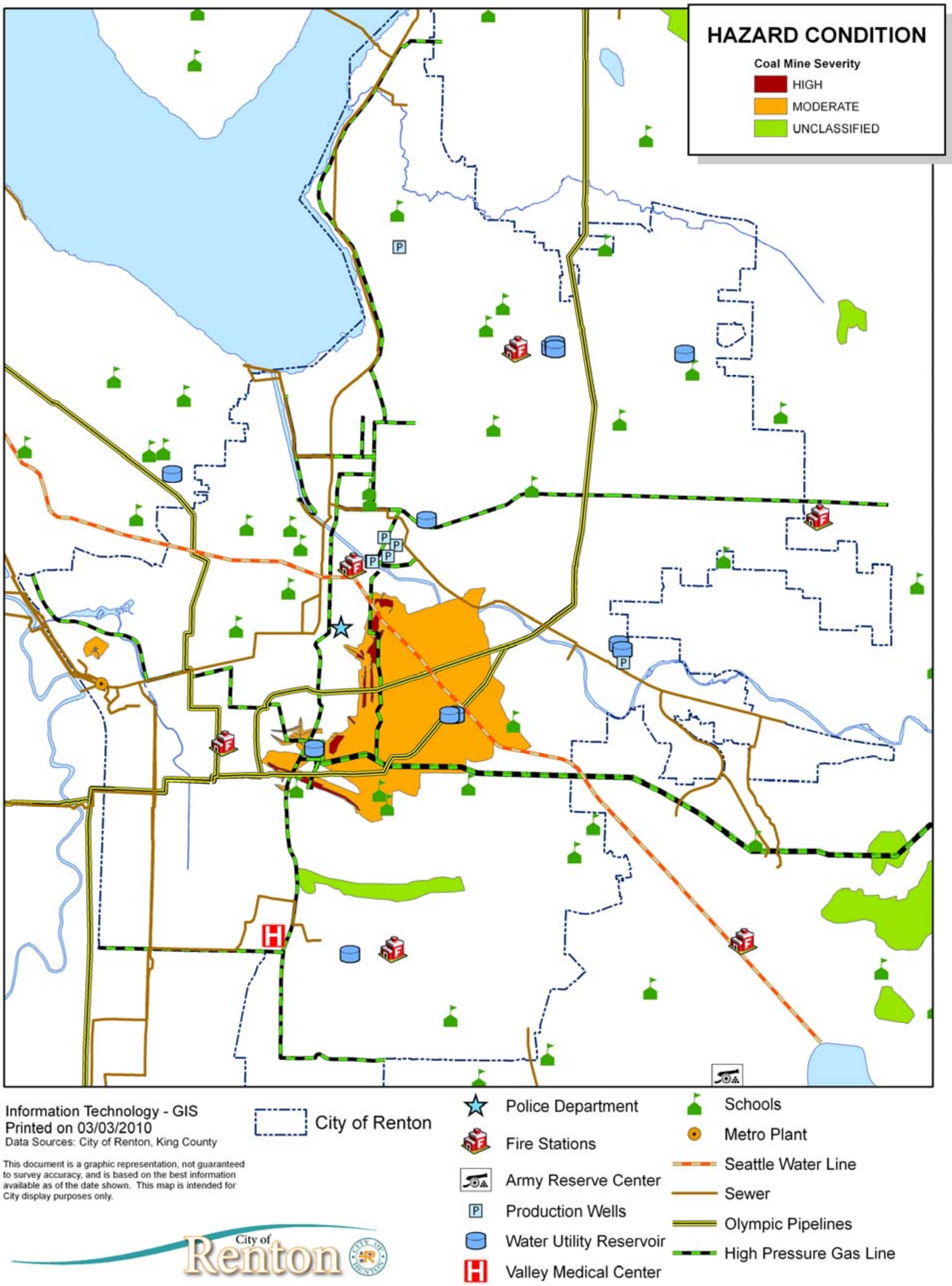


Table 11.1
Coal Mine Hazards Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed					
				Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Coal Mine Hazard Mitigation Action Items									
Long-Term #1	Continue mapping of abandoned coal mine areas as additional data become available.	Community and Economic Development	Ongoing	X	X	X			
Long-Term #2	Require geological or geotechnical engineering studies before permitting new construction in identified coal mine hazard areas.	Community and Economic Development	Ongoing	X	X	X			

12.0 HAZARDOUS MATERIALS

12.1 Introduction

For mitigation planning, hazardous materials may be defined simply as any materials that may have negative impacts on human health. Exposure to these materials may result in injury, sickness or death. The impacts of hazardous materials may be short-term with negative effects immediately, in seconds, minutes or hours or they may be long-term with negative effects starting in days, weeks, or in some cases years after exposure.

Hazardous materials vary widely in their toxicity to humans. Some hazardous materials are highly toxic and even brief exposures to small amounts may be dangerous or fatal. Other hazardous materials are much less toxic and negative effects may occur only after exposure to large amounts over long time periods. The technical term “toxic,” which is widely used to describe hazardous materials is simply a synonym for the more common terms “poison” or “poisonous.”

Hazardous chemicals are widely used in heavy industry, manufacturing, agriculture, mining, the oil and gas industry, forestry, transportation, medical facilities, and commercial, public and residential buildings. There are literally hundreds of thousands of chemicals that may be hazardous to human health to some extent. A typical single family home may contain dozens of potentially hazardous materials including: fuels, paints, solvents, cleaning chemicals, pesticides, herbicides, medicines and others.

For mitigation planning purposes, small quantities of slightly or moderately hazardous materials being used by end users are rarely the focus of interest. Rather, interest is focused primarily on larger quantities of hazardous materials in industrial use and on hazardous materials being transported, where the potential for accidental spills is high. Situations involving extremely hazardous materials or large quantities of hazardous materials in locations where accidents may result in significant public health risk are of special concern.

The toxicity of particular hazardous materials is an important measure of the potential impact of hazardous materials on affected communities for mitigation planning purposes. Other characteristics of hazardous materials, especially the quantity of material and the ease of dispersal, may be as important as, or more important than, toxicity in governing the level of potential threat to a community. For example, a small quantity of a very toxic solid hazardous material in a research laboratory poses a much smaller level of risk than a large quantity of a less toxic gaseous material in an industrial site upwind from a populated area.

The severity of any hazardous material release incident for an affected community depends on several factors:

a) the toxicity of the hazardous material,

b) the quantity of the hazardous material released,

c) the dispersal characteristics of the hazardous material,

d) the local conditions such as wind direction and topography, and

e) the efficacy of response and recovery actions.

12.2 Effects of Hazardous Materials on Humans

There are three principal modes of human exposure to hazardous materials:

1. inhalation of gaseous or particulate materials via the respiratory (breathing) process,

2. ingestion of hazardous materials via contaminated food or water and

3. direct contact with skin or eyes.

Exposure to hazardous materials can result in a wide range of negative health effects on humans. Hazardous materials are generally classified by their health effects. The most common classes of hazardous materials are summarized below.

Flammable materials are substances where fire is the primary threat, although explosions and chemical effects listed below may also occur. Common examples include gasoline, diesel fuel, and propane.

Explosives are materials where explosion is the primary threat, although fires and chemical effects listed below may also occur. Common examples include dynamite and other explosives used in construction or demolition.

Irritants are substances that cause inflammation or chemical burns of the eyes, nose, throat, lungs, skin or other tissues of the body in which they come in contact. Examples of irritants are strong acids such as sulfuric or nitric acid.

Asphyxiants are substances that interfere with breathing. Chemical asphyxiants are substances that prevent the body from using oxygen or otherwise interfere with the breathing process. Common examples are carbon monoxide and cyanides. Simple asphyxiants cause injury or death by displacing the oxygen necessary for life. For example, Nitrogen is a normally harmless gas that constitutes about 78% of the atmosphere. However, nitrogen release in a confined space may result in asphyxiation by displacing oxygen.

Anesthetics and Narcotics are substances which act on the body by depressing the central nervous system. Symptoms include drowsiness, weakness, fatigue and loss of coordination, which may lead to unconsciousness, paralysis of the respiratory system and death. Examples include hydrocarbon and organic compounds.

Hazardous materials may also have a wide variety of more specialized impacts on human health. Other types of toxic effects are briefly summarized in Table 12.1.

Table 12.1
Other Types of Hazardous Materials

Type of Hazardous Material	Effects on Humans
Hepatotoxin	Liver damage
Nephrotoxin	Kidney damage
Neurotoxin	Neurological (nerve) damage
Carcinogen	May result in cancer
Mutagen	May produce changes in the genetic material of cells
Teratogen	May have adverse affects on sperm, ova or fetal tissue
Radioactive materials	May result directly in radiation sickness at high exposure levels or act as carcinogen, mutagen or teratogen
Infectious substances	Biological materials such as bacteria or viruses that may cause illness or death

Much of the information above was summarized from Chapter Six of the Handbook of Chemical Hazard Analysis Procedures[1]. The first few chapters of this handbook contain a concise summary of many of the technical aspects of hazardous materials. These chapters may be useful to readers seeking a more technical introduction to the nomenclature and science of hazardous materials.

12.3 Classification System and Emergency Response Protocols

A standardized system is used to classify and identify hazardous materials. The Emergency Response Guidebook (A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Material Incident[2]) is an extremely useful reference book that outlines the classification system, provides standardized first response protocols and detailed reference sheets for the most common classes of hazardous materials.

Hazardous material releases are predominantly accidental results of traffic accidents, equipment failures or human errors. In rare cases, hazardous material releases may result from deliberate actions of sabotage or terrorism.

First responders for hazardous material incidents are generally public safety personnel (police or fire). The standard protocols for first responders are briefly summarized below, as garnered from the Emergency Response Guidebook.

The primary guidance for first responders is to:

a) resist rushing in,

b) approach the incident site from upwind, uphill or upstream, and

c) stay clear of all spills, vapors, fumes and smoke.

Upon approaching the incident site, a three-step procedure is recommended:

1. Investigate – from a safe distance try to determine if there is a leak, smoke, visible fumes or vapors, which direction the wind is blowing, if there are victims or potential victims, and if those victims can be rescued without entering the atmosphere.
2. Identify the material – from a safe distance, with binoculars or by a representative, obtain the name of the material, or the four-digit ID number from a placard or orange panel.
3. Isolate – using the DOT Emergency Response Guidebook guideline for the product, create a safe zone around the incident area to keep the public, non-responders and non-equipped personnel a safe distance away from the hazard.

Identification of hazardous materials can be accomplished by finding:

a) the four-digit ID number on a placard or orange panel,

b) the four-digit ID number on a shipping document or package, or

c) the name of the material on a placard, shipping document or package.

Once identified by ID number or name material specific information can be located using the ID number or name index. The procedures and precautions outlined in the guide for the identified class of material are then carefully followed. For each class of material, the guides have critical information on potential hazards, suggested evacuation distances for small and large spills and recommended emergency response actions to include first aid. For further technical details see the Emergency Response Guidebook.

The emergency response to hazardous material incidents typically involves first responders (local fire departments) and then specialized emergency response teams if the severity of the incident warrants such a response.

First responders are generally public safety staff trained in basic procedures for the initial response to hazardous materials incidents. The responsibilities of first responders include securing the incident scene and making a preliminary assessment of the potential severity of the incident and the level of threat, if any, to persons in and near the hazardous materials incident area. Emergency response teams are specialized teams, composed primarily of public safety staff, with higher-level training and more specialized equipment for dealing with hazardous materials incidents.

Response planning for hazardous materials incidents is often characterized by a three level response classification. The distinction between Levels I, II, and III depends on:

a) class of hazardous material,
b) size of container,
c) fire/explosion potential,
d) leak severity and container integrity, and
e) threats to life safety.

Level I Responses are those incidents readily controlled or stabilized by first responders. The HazMat Emergency Response Team personnel may provide technical assistance via telephone or on-site assistance, but full response by an Emergency Response Team is not required.

Level II Responses are those incidents that require response from a HazMat Emergency Response Team for control or stabilization of the spill. Depending on the event the response level may be 2-4 personnel, or even a small response team of 6-8 personnel for identification of the material and guidance on appropriate response actions.

Level III Responses are those incidents that require special resources, including one or more full Emergency Response Teams and possibly other outside agencies for support.

12.4 Statutory and Regulatory Context

Hazardous Materials – General Provisions are covered in Chapter 27 of the International Fire Code. Additional restrictions and requirements for particular classes of hazardous materials are referenced in additional chapters.

The manufacture, storage, use, transportation, and disposal of hazardous materials are subject to a myriad of federal, state, and local regulations. In the context of mitigation planning and emergency response, we focus on reporting requirements for chemicals subject to mandatory risk management planning and extremely hazardous substances subject to additional reporting and planning requirements.

Section 112(r) of the Clean Air Act Amendments was designed to prevent accidental releases of hazardous substances. The rule establishes a list of chemicals and threshold quantities that identify facilities subject to subsequent accident prevention regulations. The listed substances have the greatest potential to pose the greatest hazard to public health and the environment in the event of an accidental release.

Hazardous materials may be released to the environment during manufacturing and other ongoing processes or accidentally. Certain types of businesses are required to report such releases annually for a specified list of chemicals. There are additional reporting and planning requirements for materials deemed to be extremely hazardous.

12.5 Fixed Site Hazardous Materials Locations in Renton

There are over 15 facilities within City limits that have significant hazardous chemical quantities. These facilities store, transport or use these chemical in a variety of methods. Any release of these products could trigger a significant response. A major release could activate the EOC, trigger evacuations and sheltering plans, and involve more than one department or jurisdiction.

12.6 Hazardous Materials Transport: Truck Shipments, Rail Shipments and Pipelines

Hazardous materials may be transported once or many times during their "life cycle" of raw materials, manufacturing, incorporation in other products, wholesale and retail trade, use, waste disposal and recycling. The transport of hazardous materials may be local, across a state, across the country or internationally.

Shipment of hazardous materials by truck within or near Renton includes shipments on Interstates 5 and 405, along with shipments on local streets.

The main rail line between Portland and Seattle passes through Tukwila, just west of Renton. Current average daily train counts are 60 trains per day on the segment between Auburn and Seattle. Many of these trains contain shipments of hazardous materials.

There are three types of major fuel pipeline systems in or near Renton.

1) The Williams high pressure natural gas transmission line which runs from British Columbia, through Washington and Oregon to California.
2) The natural gas distribution systems run by utilities in most cities.
3) The BP/Olympic liquid fuels pipeline that carries most of the gasoline and fuels used in the region, including jet fuel for Sea-Tac Airport.

The Williams gas transmission line runs north-south through Issaquah and Renton. The BP/Olympic liquid fuels pipeline runs directly through Renton. Renton also has a natural gas distribution system and pumping station within the City operated by Puget Sound Energy (PSE). PSE also operates a large underground 1.5 million gallon propane-only storage facility.

The natural gas pipeline systems of local gas utilities, including the Renton system, almost always follow road and street patterns because of established utility rights of way and the need to connect with each building served. For areas served by natural gas, the local street network is essentially identical to the natural gas distribution pipe network.

The propane storage facility lies in a valley in close proximity to apartments, homes, office buildings, major power lines and a major transportation corridor. A significant release could easily reach the I-405 area as well as the commercial district near Talbot and Grady. The release of even one 40,000 gallon tank is significant, and there are 36 in-service tanks present. A catastrophic release could liberate many tanks resulting in a huge dispersal area.

Overall, the safety record of natural gas pipelines is good with relatively few significant accidents. Natural gas is not toxic (i.e., not poisonous) but it can be an asphyxiant if it displaces oxygen in an enclosed space. Natural gas burns readily when ignited, but only when gas concentrations are between 4% and 15% in air. In its pure state natural gas is both colorless and odorless. The strong odor normally associated with natural gas is an odorant called mercaptan, deliberately introduced at low concentrations to serve as a warning of the presence of natural gas. Mercaptan is generally added to natural gas at the local distribution level by local gas utilities.

Fires and/or explosions from natural gas leaks in pipelines are rare. In part, the rarity of fires and/or explosions is due to the fact that natural gas is about one-third less dense than ordinary air. Leaking natural gas does not accumulate near the ground or "pond" in low-lying areas (as heavier gases such as liquefied propane gas or gasoline fumes may do). Instead, leaking natural gas rises rapidly and is dissipated by dilution in the atmosphere. The fires and/or explosions that do occur from natural gas leaks are generally in buildings where the confined space allows leaking gas to accumulate until ignited.

Pipeline breaks due to natural causes may occur due to landslides or earthquakes. Earthquake induced pipe breaks for natural gas transmission lines are most likely to occur in areas of soft soils subject to liquefaction and/or lateral spreading which cause significant pipe displacements. The most likely locations for such breaks during an earthquake are on slopes of soft ground near where pipelines cross rivers or streams.

Smaller pipelines are frequently damaged by digging without calling for a locator to where the pipeline location. Most breaks of this type occur in local distribution lines. Pipeline breaks can also be caused by deliberate acts of sabotage or terrorism. Although pipelines are not symbolic targets with political, historical and cultural significance, they are potential targets for terrorist actions. Major pipeline breaks could disrupt gas service over wide areas and result in significant economic impacts.

Natural gas utilities and local emergency responders are generally well prepared to deal with natural gas breaks, because such incidents occur relatively frequently with well-standardized response procedures. Evacuations for natural gas pipeline ruptures are generally limited to the immediate area of the break.

12.7 Summary and Mitigation Strategies

12.7.1 Planning and Response

Effective mitigation planning and emergency response planning can help reduce the number or frequency of hazardous materials incidents as well as reduce the severity of incidents that occur. In combination, these benefits can significantly reduce the negative impacts of hazardous materials incidents on affected communities. The general principles of mitigation planning, emergency response planning (and training) are well standardized and practiced by King County and the City of Renton.

Perhaps the single most critical factor in enhancing both mitigation planning and emergency response planning is specific inventory awareness for major hazardous materials sites within each jurisdiction. Specific inventory awareness means detailed knowledge of the types, quantities and locations of all sites in a jurisdiction with significant quantities of hazardous materials. What constitutes a significant quantity varies depending on the toxicity of the material, the dispersal characteristics and the nature and population of nearby areas likely to be affected.

The complexity and overload of information for hazardous materials is compounded by numerous labeling, placarding and classification systems, with countless cross references to guide numbers, material safety reports and so on. Because of this vast amount of complex information, effective mitigation planning and emergency response planning must occur before an incident occurs, not after. During an incident, the most effective response is impossible to achieve if emergency personnel are thumbing through databases trying to figure out what hazardous materials are at a given location and what the appropriate response precautions and protocols are for the specific materials involved.

Specific inventory awareness means that for every site with hazardous materials of sufficient toxicity, dispersal characteristics and quantities to pose a significant life safety risk to on-site employees and nearby residents must be identified in advance. Ideally, Renton should have specific inventory awareness of every significant fixed site in its jurisdiction. Similarly, each jurisdiction should have specific inventory awareness of the most toxic, most common, large volume shipments of hazardous materials within and throughout the jurisdiction. For each hazardous material deemed to pose a significant life safety threat, the necessary chemical data, response protocols, initial isolation distances, protection distances for small and large spills, and all other data necessary for safe and effective response should be compiled and readily available before incidents occur.

12.7.2 Mitigation Measures

Specific inventory awareness is one cornerstone of reducing the potential for negative impacts from hazardous materials incidents by helping to optimize emergency and response planning. The other cornerstone is pro-active mitigation actions to reduce the number and severity of hazardous materials incidents. A dedicated staff position within the Fire & Emergency Services Department is responsible for the inspection of facilities that store, handle, transport, manufacture or use hazardous materials for compliance with International Fire Code requirements, and to serve as a technical advisor at hazardous material incidents.

The most common mitigation measures for reducing the potential of damaging hazardous materials incidents are briefly summarized below.

12.7.2.1 Physical Safety Measures

The tanks, storage containers and transfer systems (valves, pipes etc.) for hazardous materials are frequently subject to damage in earthquakes, with a correspondingly high potential for accidental releases. Proper seismic design, bracing and anchoring of storage systems for hazardous materials can greatly reduce the potential of accidental releases during earthquakes. Bracing and anchoring measures for storage containers and transfer systems (e.g., piping) are often relatively inexpensive, with a large improvement in seismic performance. For small quantities of materials stored in bottles or jugs on shelving, bracing shelving and restraining containers so that they do not fall in earthquakes are particularly important.

Over time the storage containers and other material handling elements for hazardous materials may change many times. In some cases, later modifications may not be designed to the same seismic standards as the original installation or later modifications may compromise the seismic stability of the original installation. Therefore, periodic review and inspections of seismic design, bracing and anchoring are highly recommended for all hazardous material facilities.

For facilities located in mapped flood plains or other areas subject to floodwaters there are two important physical safety measures. First, any containers subject to floating should be properly restrained. In many floods, improperly restrained tanks break free and float downstream, with high potential for negative impacts including fires and accidental releases of hazardous materials. Second, special precautions should be taken with water-reactive materials. Such materials should never be stored in low-elevation areas subject to flooding or in locations subject to water from storm water drainage or plumbing failures in a facility.

12.7.2.2 Standard Operating Procedures

Standard operating procedures for storing, transporting and handling hazardous materials should be strictly enforced at all facilities. Appropriate training for all staff, with review courses and appropriate protective gear is essential for safety. Rigorous inspection and enforcement of hazardous materials regulations (federal, state and local) are an important part of the overall process of ensuring safety.

12.7.2.3 Mitigation and Emergency Response Planning

Effective pre-event mitigation planning and emergency response planning can help reduce the severity of hazardous material incidents. From the mitigation planning perspective, specific inventory awareness of the types and quantities of hazardous materials present at each facility is particularly important. Local fire departments and other responders should be thoroughly familiar with the specific inventory at each facility containing hazardous materials and with the appropriate response protocols for each hazardous material. First responders and emergency response teams must both have the full range of protective gear and equipment necessary for their respective roles in responding to hazardous materials incidents.

Emergency response planning should include thorough training in all aspects of hazardous materials response, including appropriate response protocols (procedures, protective gear and equipment). Frequent refresher training and frequent exercises (both tabletop and full field exercises) are essential for safe and effective emergency response. Training exercise should include both first responders and emergency response teams, to help ensure appropriate coordination of efforts during actual hazardous materials incidents.

The following table, Table 12.2, contains hazardous materials mitigation action items from the Master Action Items Table in Chapter 4.

Table 12.2
Hazardous Materials Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Hazmat Incident Mitigation Action Items									
Short-Term #1	Ensure that first responders have readily available site-specific knowledge of hazardous chemical inventories in Renton.	Fire & Emergency Services	1 year		X			X	
Short-Term #2	Enhance emergency planning, emergency response training and equipment to address hazardous materials incidents.	Fire & Emergency Services, Police, Public Works	Ongoing		X			X	

References

1. **Handbook of Chemical Analysis Procedures**, Federal Emergency Management Agency, U.S. Department of Transportation, and U.S. Environmental Protection Agency, U.S. Government Printing Office, 1988.

2. **2008 Emergency Response Guidebook** (A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Material Incident), developed jointly by the U.S. Department of Transportation, Transport Canada, and the Secretariat of Transport and Communications of Mexico, 2008.

13.0 TERRORISM

13.1 Overview

For mitigation planning, terrorism is broadly inclusive of a wide range of deliberate malevolent acts intended to damage buildings, infrastructure or to result in deaths and injuries. The probability of international terrorist organizations targeting Renton, is not zero, but is low. Renton is certainly subject to deliberate malevolent acts from many sources including vandals, mentally disturbed individuals, domestic terrorist groups (e.g., eco-terrorists), disgruntled residents and past or present employees.

The range of possible malevolent actions includes vandalism, arson, explosions and armed attacks as well as the use of chemical, biological, radiological or nuclear materials. Chemical attacks include deliberate release of on-site chemicals as well as deliberate dispersal of transported hazardous materials. Biological attacks include deliberate dispersal of biologically active materials (e.g., anthrax) capable of causing sickness or death. Radiological attacks include deliberate dispersal of radioactive materials, via dirty bombs (conventional explosives laced with radioactive materials) or other methods. Nuclear attacks include explosion of nuclear devices and the radioactive fallout from such explosions.

The range of possible malevolent actions also includes cyber-terrorism or deliberate disruption/damage of computer systems and data. Especially for utility systems, cyber-terrorism can also result in loss of service due to disruption/damage to automated Supervisory Control and Data Acquisition (SCADA) systems widely used by utilities.

13.2 Threat Spectrum

For purposes of mitigation planning we will consider three sources of terrorist (malevolent) actions: outsiders, insiders and hackers. In each case we consider three levels of attack. The levels reflect the number of individuals involved, the level of technical knowledge or expertise and the level of equipment or tools available. This threat spectrum is summarized below in Table 13.1.

In Table 13.1, <u>outsiders</u> refers to anyone who is not an employee of the facility under potential terrorist attack. Outsiders could be vandals, disturbed individuals or members of domestic or international organized groups. For Renton, the most likely terrorist or malevolent acts are minor vandalism or actions by disturbed individuals. Deliberate terrorist actions are most likely from domestic groups, including eco-terrorists and are unlikely to be from international organizations.

In Table 13.1, <u>insiders</u> refers to anyone who is an employee of the target under potential attack. Acts of vandalism, theft and other relatively minor actions are common. Larger scale malevolent acts are less common but still occur with some frequency. Such acts include larger scale damage, arson, explosives and contamination of water supplies.

In Table 13.1, computer hackers refers to individuals or groups using remote access to explore, vandalize or destroy websites, computer databases and such. For utility systems, hackers can also impact SCADA systems and may affect system operations directly.

Table 13.1
Threat Spectrum for Terrorist Actions

Adversary	Number of Adversaries	Level of Knowledge	Equipment Tools	Weapons	Objectives
Outsider: high level	1 to small group	Extensive knowledge of security systems, facilities and modes of attack	hand tools, power tools, vehicles	handguns or automatic weapons, incendiary devices, explosives, contaminants	Extensive damage to critical facilities, widespread damage or casualties
Outsider: medium level	1 to 3	Limited knowledge of security systems, facilities and modes of attack	hand tools, power tools, vehicle	handguns, incendiary devices, explosives, contaminants	Damage or casualties
Outsider: low level	1 or 2	Minimal knowledge of security systems, facilities and modes of attack	hand tools	None	Vandalism, damage or casualties
Insider: high level	1	Extensive knowledge of security systems, facilities, operations, policies and procedures	On site tools, chemicals, equipment, vehicles	handguns or automatic weapons, incendiary devices, explosives, contaminants	Damage or casualties
Insider: medium level	1	Moderate knowledge of security systems, facilities, operations, policies and procedures	On site tools, chemicals, equipment, vehicles	handguns, incendiary devices, explosives, contaminants	Damage or casualties
Insider: low level	1	Limited knowledge of security systems, facilities, operations, policies and procedures	On site tools, chemicals, equipment, vehicles	handgun or none	Vandalism, damage or casualties
Hacker: high level	1 to small group	Full knowledge of IT infrastructure, security systems, SCADA systems	Sophisticated hacker tools and methods	N/A	Destruction of data and systems, business operations
Hacker: medium level	1 or 2	Moderate knowledge of IT infrastructure, security systems, SCADA systems	Moderately sophisticated hacker tools and methods	N/A	Denial of servcie or disruption of some business services
Hacker: low level	1	Limited knowledge of IT infrastructure, security systems, SCADA systems	N/A	N/A	Minor cyber-vandalism to non-critical business areas

The probable impacts of terrorist events on the City of Renton are summarized below in Table 13.2. For Renton, the most likely terrorist events are very small scale events (vandalism or minor damage events by insiders, local outsiders or computer hacking events) rather than major terrorist actions by outsiders.

Table 13.2
Probable Impacts of Terrorist Incidents on the City of Renton

Inventory	Probable Impacts
Portion of Renton affected	Localized impacts for minor incidents, large portions or the entire City for extremely unlikely major incidents.
Buildings	Localized impacts to a single building or a few nearby buildings, except for extremely unlikely major incidents.
Streets within Renton	Some incidents may include temporary street closures.
Roads to/from Renton	Some incidents may include temporary road closures.
Electric power	Some incidents may include temporary loss of electric power in localized parts of Renton or for the entire City.
Other Utilities	Some incidents may include temporary loss of utilities in localized parts of Renton or for the entire City. Major damage to water or wastewater treatment plant could result in full or partial loss of service for extended time periods.
Casualties	Major events may result in significant casualties (deaths and injuries).

13.3 Mitigation Actions

Evaluation of the threat of terrorist or other malevolent actions generally includes several steps:

1) determine critical facilities and other risk targets,
2) identify the specific adverse consequences to be avoided,
3) review the likelihood of malevolent actions,
4) evaluate existing countermeasures and
5) implement a prioritized risk reduction plan.

Critical facilities in Renton include key elements of the water system, electric power substations, other facilities with hazardous materials (cf. Chapter 12) and important public facilities such as police and fire stations.

Important non-municipal facilities include the Boeing facilities and the major regional wastewater, natural gas and liquid fuels lines which pass through or near Renton.

The most likely adverse consequences are vandalism and minor destructive actions by outsiders, insiders or hackers. The evaluation of existing countermeasures should include:

1) Physical security measures - fencing, locks and key control, structural integrity of critical assets, detection capabilities such as intrusion detection systems, alarms, operational alarms for utility systems and general security/access.

2) Cyber security measures - protection measures for business/operational computer systems and SCADA systems, fire walls, security policies and protocols, vendor access, system diagnostics, etc.

3) <u>Security procedures and policies</u> - personnel security, physical security, key and badge control, system control and operational data, chemical and other vendor deliveries, and security and emergency response training, exercises and drills.

For Renton, vigilance and modest upgrades to existing physical security, cyber security and security procedures and policies are probably all that are reasonably required.

The potential impacts of terrorism or other malevolent deliberate actions in Renton can also be mitigated by improving emergency planning and emergency response capabilities. For some types of events, such as fires or explosions, the emergency response actions are self-evident and emergency responders are well trained for dealing with such situations. Other types of actions such as release of radiological materials, bioterrorism, or contamination of water or food supplies may not be immediately recognized. For such types of actions, close cooperation with public health officials and awareness of the possibility of deliberate actions are important. Such situations also commonly require specialized expertise and equipment to detect and identify the radiological, biological or chemical materials used in an attack. Emergency response plans should be updated and expanded, as necessary, to include protocols for public notifications and information about appropriate public responses such as shelter in place or evacuation.

The following table, Table 13.3 Terrorism Mitigation Action Items, contains terrorism mitigation action items from the Master Action Items Table in Chapter 4.

Table 13.3
Terrorism Mitigation Action Items

Hazard	Action Item	Coordinating Organizations	Timeline	Plan Goals Addressed: Public Awareness	Life Safety	Protect Property Minimize Losses	Partnerships & Implementation	Emergency Services	Protect Environment
Terrorism Mitigation Action Items									
Short-Term #1	Enhance emergency planning, emergency response training and equipment to address potential terrorism incidents.	Fire & Emergency Services, Police	Ongoing	X	X			X	
Long-Term #1	Upgrade physical security detection and response capability for critical facilities, including water system.	Community Services, Police	Ongoing		X	X	X	X	
Long-Term #2	Evaluate and implement hardening measures for highly vulnerable critical facilities.	Police, Community Services	5 - 10 Years		X	X	X	X	
Long-Term #3	Identify and establish secure surveillance cameras and monitoring at all critical infrastructure.	Police, Community Services, Public Works	5 Years		X	X			
Long-Term #4	Chemical, Biological, Radiological, Nuclear and Explosives (CBRNE) Detection and security devices/elements integrated at critical city infrastructure.	Police, Community Services	5 Years		X	X			

APPENDIX 1

SYNOPSIS OF FEMA GRANT PROGRAMS

April 2, 2009

FEMA FUNDING POSSIBILITIES FOR RENTON

Overview

For public entities, such as the City of Renton, FEMA funding possibilities fall into two main categories:

- The post-disaster Public Assistance Program which covers not less than 75% of eligible emergency response and restoration (repair) costs for public entities who suffer damages in a presidentially-declared disaster. The Public Assistance Program also may fund mitigation projects for facilities damaged in the declared event.
- Mitigation grant programs (either pre-disaster or post-disaster) which typically cover up to 75% of mitigation costs.

FEMA Public Assistance Program

The objective of FEMA's Public Assistance (PA) Grant Program is to provide assistance to State, Tribal and local governments, and certain types of private nonprofit organizations, so that communities can quickly respond to and recover from major disasters or emergencies.

Through the PA Program, FEMA provides supplemental Federal disaster grant assistance for debris removal, emergency protective measures, and the repair, replacement or restoration of disaster-damaged, publicly owned facilities and the facilities of certain private non-profit (PNP) organizations. The PA Program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process.

For Renton, PA assistance would be available only for future presidentially-declared disaster events which resulted in damage to Renton facilities. Further details of FEMA's PA programs are available at:

http://www.fema.gov/government/grant/pa/index.shtm

FEMA Mitigation Funding Sources

FEMA has several mitigation grant programs which provide federal funds to supplement local funds for specified types of mitigation activities. The FEMA grant programs typically provide 75% funding with a 25% local match required. In very limited cases, FEMA grant programs may provide 90% or 100% funding.

The five primary FEMA mitigation grant programs are summarized below:

Grant Program	Frequency	Hazard Mitigation Planning	Risk Assessments	Mitigation Projects	Hazards
Hazard Mitigation Grant Program	Post-Disaster	YES	YES	YES	ALL
Pre-Disaster Mitigation	Annual	YES	NO	YES	ALL
Flood Mitigation Assistance	Annual	YES	NO	YES	Flood
Repetitive Flood Claims Program	Annual	NO	NO	YES	Flood
Severe Repetitive Loss Program	Annual	NO	NO	YES	Flood

These FEMA grant programs have specific eligibility requirements and application deadlines. All of these grant programs have specific requirements including definitions of ineligible projects which are excluded from the grant programs. All mitigation projects (but not planning projects or risk assessments) must be cost-effective, which means that a benefit-cost analysis using FEMA software and following FEMA guidance must demonstrate a benefit-cost ratio >1.0.

These grant programs are not entitlement programs, but rather are competitive grant programs which require strict adherence to the eligibility and application requirements and robust documentation. Robust documentation is especially critical for the Pre-Disaster Mitigation grant program which is nationally competitive.

The Hazard Mitigation Grant Program is initiated within a given state only after a Presidential Declaration of Disaster; thus, there is no fixed schedule. A given state may have several declarations in a given year or go several years without any declarations. Specific application deadlines are established for HMGP funds generated by each disaster declaration.

The other four mitigation grant programs are annual programs with specific deadlines, which vary from year to year. For FY 2009 grants, the application deadline for all four programs was December 19, 2008. For FY 2010 and later years, deadlines are subject to change, but would likely be similar to the FY 2009 deadline. Please note that, these applications are reviewed and ranked by Washington State Emergency Management staff before they go to FEMA for review. Washington State deadlines are typically about six weeks before the FEMA deadlines.

The three flood-only grant programs – Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) – are narrowly defined grant programs which apply only to properties insured under the National Flood Insurance Program (NFIP). Renton would be eligible for these grants only for properties with NFIP coverage. For the RFC and SRL programs Renton would be eligible only if the properties also meet repetitive loss requirements.

The most likely FEMA funding sources for seismic mitigation projects are the Hazard Mitigation Grant Program and the Pre-Disaster Mitigation Program, as well as the Public Assistance Program if Renton suffers damage in a future presidentially-declared disaster event.

Hazard Mitigation Grant Program (HMGP)

The HMGP is a post-disaster grant program. Funds are generated following a Presidential Disaster Declaration for a given state, with the amount of funding being a percentage of total FEMA spending for various other FEMA programs.

FEMA regulations allow HMGP funds to be spent on any mitigation project in the state, for any hazard, regardless of whether or not an applicant was located in a declared county for a specific presidentially-declared disaster. Historically, Washington State Emergency Management has often given priority to the declared counties and to the hazard (e.g., winter storms) that resulted in the presidential declaration. However, mitigation projects outside of the declared counties and for other hazards have also been considered.

HMGP funds are limited to a given state and are competitive only within each state. Each state manages the HMGP process, including setting state priorities and selection of projects for funding. FEMA reviews applications only to ensure that selected projects meet all of FEMA's eligibility requirements. HMGP is the most flexible grant program - grants are possible for any natural hazard and may include hazard mitigation planning and risk assessments as well as physical mitigation projects. States have wide latitude in setting priorities and may restrict grant eligibility to specific counties to which the disaster declaration applies and/or to specific hazards or types of mitigation activities. Washington State Emergency Management has great influence over HMGP grants within Washington, subject to the requirement that all grants meet FEMA's minimum eligibility requirements. The amount of HMGP funding in a given disaster can range from less than $100,000 to more than $1 billion for large disasters (e.g., Hurricane Katrina).

For Washington, declared disasters are relatively common, often with one or more declarations in a given year for winter storms, floods or other disasters. The total amount of HMGP mitigation funds available for mitigation projects (absent a major hurricane or earthquake) will vary from year to year and disaster event to disaster event. HMGP mitigation grants do not have pre-set maximums on grant sizes.

Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation (PDM) grant program is a broad program which includes mitigation projects for any natural hazard as well as mitigation planning grants for the development of a Local Hazard Mitigation Plan. PDM is a nationally-competitive annual program. The annual amount of grant funds available has ranged from approximately $50 million to $250 million. The congressional appropriation for FY 2009 is about $100 million, although congressional earmarks have pre-allocated some of the available funds. Funding levels in future years will depend on congressional appropriations.

PDM grants cover 75% of the costs of mitigation projects up to a maximum federal share of $3,000,000 per project.

Flood Mitigation Grant Programs

The three flood-only mitigation grant programs have annual appropriations specific to each state. As noted above, these programs are applicable only to NFIP insured properties; and for the RFC and SRL programs, only to properties which also meet the repetitive flood loss criteria.

Each of these programs has their specific guidance, outlined in the Hazard Mitigation Assistance unified guidance discussed below. However, the overall grant requirements are similar to those for the HMGP discussed above.

The likelihood of getting a Flood Mitigation Assistance grant in Renton appears modest. There may be a few homes or other buildings at sufficient flood risk to have elevation or acquisition projects potentially eligible for FEMA grant funding. Absent any properties on FEMA's national repetitive loss list, Renton would not be eligible for either of FEMA's repetitive flood loss grant programs.

Mitigation Grant Guidance and Requirements

Detailed program guidance and the specific requirements for each of the five grant programs discussed above are posted on the FEMA website (www.fema.gov). The guidance and requirements for the four annual grant programs have recently been combined into a uniform hazard mitigation guide (Hazard Mitigation Assistance Program Guidance, June 19, 2008). New uniform hazard mitigation guidance is expected in mid-2009.

Mitigation Project Grant Applications

All of FEMA's mitigation grant programs are competitive, either within a given state or nationally. Successful grant applications must be complete, robust and very well documented. The key elements for successful mitigation project grant applications include:

- The benefits of the project are carefully documented using FEMA benefit-cost software, with all inputs meticulously meeting FEMA's guidance and expectations. A benefit-cost analysis that meets FEMA's requirements is often the most critical step in determining a mitigation project's eligibility and competitiveness for FEMA grants.
- Project locations within high hazard areas.
- For utility mitigation projects, the majority of benefits often accrue from reductions in the calculated economic impacts (using FEMA standard methodologies) of the loss of utility services.
- Project facilities which have major vulnerabilities which pose substantial risk of damages, economic impacts and (especially for seismic projects) deaths or injuries.
- Mitigation project scope and budget are well documented.

A further eligibility requirement for mitigation project grants is that the local applicant must have a FEMA approved local hazard mitigation plan. Renton will continue to be eligible to apply for FEMA mitigation grants, once FEMA approves this updated Plan.

APPENDIX 2

PRINCIPLES OF BENEFIT-COST ANALYSIS

April 8, 2009

Benefit-cost analysis is the tool that provides answers to a central question for hazard mitigation projects: **"Is it worth it?"** If hazard mitigation projects were free, individuals and communities would undertake mitigation with robust enthusiasm and the risks from hazards would soon be greatly reduced. Unfortunately, mitigation is not free, but often rather expensive. For a given situation, it must be determined if the investment in mitigation is justified? Is the owner (public or private) better off economically to accept the risk or invest now in mitigation to reduce future damages? Benefit-cost analysis can help a community answer these difficult questions.

In the complicated real world of mitigation projects, there are many factors which determine whether or not a mitigation project is worth doing or which of two or more mitigation projects should have the highest priority. Consider a town which has two flood prone neighborhoods and each neighborhood desires a mitigation project. The two neighborhoods have different numbers and values of houses as well as different frequencies and severity of flooding. The first neighborhood proposes storm water drainage improvements at a cost of $3.0 million. The second neighborhood wants to elevate houses at a cost of $3.0 million. Which of these projects should be completed? Both? One or the Other? Neither? Which project should be completed first if there is only funding for one? Are there alternative mitigation projects which are more sensible or more cost-effective than the proposed projects?

In determining whether or not a given mitigation project is worth doing, the level of risk exposure without mitigation is critical. Whether or not the project is worth doing depends on the level of risk before mitigation and on the effectiveness of the project in reducing that risk. For example, if the before mitigation risk is low (a subdivision street has a few inches of water on the street every couple of years, or a soccer field in a city park floods every five years or so) the answer is different than if the before mitigation risk is high (100 or more houses are expected to have flooding above the first floor every 10 years, or a critical facility is expected to be shut down because of flood damages every five years).

All well-designed mitigation projects reduce risk, but just because a mitigation project reduces risk does not make it a good project. A $1,000,000 project that avoids an average of $100 per year in flood damages <u>is not</u> worth doing, while the same project that avoids an average of $200,000 per year in flood damages <u>is</u> worth doing.

The principles of benefit-cost analysis are briefly summarized here. The benefits of a hazard mitigation project are the reduction in future damages and losses. To conduct benefit-cost analysis of a specific mitigation project the risk of damages and losses must be evaluated twice: before mitigation and after mitigation. The difference between the two are the benefits.

The benefits of a hazard mitigation project are the future damages and losses avoided because a mitigation action was implemented.

Because the benefits of a hazard mitigation project accrue in the future, it is impossible to know exactly what they will be. We do not know when future floods or other natural hazards will occur or how severe they will be. We do know, however, the probability of future floods or other natural hazards (if we have appropriate hazard data). The benefits of mitigation projects must be evaluated probabilistically and expressed as the difference between annualized damages before and after mitigation.

To illustrate the principles of benefit-cost analysis, we consider a hypothetical single family home in the town of Acorn, located on the banks of Squirrel Creek. The home is a one story building; about 1500 square feet on a post foundation, with a replacement value of $60/square foot (total $90,000). We have flood hazard data for Squirrel Creek (stream discharge and flood elevation data) as well as elevation data for the first floor of the house. We can use these figures to calculate the annual probability of flooding in one-foot increments, as shown below.

Table A2.1
Damages Before Mitigation

Flood Depth (feet)	Annual Probability of Flooding	Scenario Damages and Losses Per Flood Event	Annualized Flood Damages and Losses
0	0.2050	$6,400	$1,312
1	0.1234	$14,300	$1,765
2	0.0867	$24,500	$2,124
3	0.0223	$28,900	$673
4	0.0098	$32,100	$315
5	0.0036	$36,300	$123
Total Expected Annual (Annualized) Damages and Losses			**$6,312**

Flood depths shown above in Table A2.1 are in one foot increments of water depth above the lowest floor elevation. Thus, a “three" foot flood means all floods between two and a half feet and three and a half feet of water depth above the floor. We note that a “zero" foot flood has, on average, damages because this flood depth means water plus or minus six inches of the floor. Even if the flood level is a few inches below the first floor, there may be damage to flooring and other building elements because of wicking of water.

The scenario (per flood event) damages and losses include expected damages to the building, content and displacement costs if occupants have to move to temporary quarters while flood damage is repaired.

The annualized (expected annual) damages and losses are calculated as the product of the flood probability times the scenario damages. For example, a four foot flood has slightly less than a 1% chance per year of occurring. If it does occur, we expect about $32,100 in damages and losses. Four foot floods are therefore expected to cause an average of about $315 per year in flood damages. Note that the smaller floods, which cause less damage per flood event, actually cause higher average annual damages because the probability of smaller floods is so much higher. By combining this data we are able to determine that the house is expected to average approximately $6,312 per year in flood damages. This expected annual or "annualized" damage estimate does not mean that the house has this much damage every year. Rather, in most years there will be no floods, but over time the cumulative damages and losses from a mix of relatively frequent smaller floods and less frequent larger floods is calculated to average $6,312 per year.

Now, let us consider the owner deems this expense as unacceptable and explores mitigation alternatives to reduce the risk by elevating the house four feet. Table A2.2 below shows the estimated damages after raising the house four feet.

Table A2.2
Damages After Mitigation

Flood Depth (feet)	Annual Probability of Flooding	Scenario Damages and Losses Per Flood Event	Annualized Flood Damages and Losses
0	0.2050	$0	$0
1	0.1234	$0	$0
2	0.0867	$0	$0
3	0.0223	$0	$0
4	0.0098	$6,400	$63
5	0.0036	$14,300	$49
Total Expected Annual (Annualized) Damages and Losses			**$112**

By elevating the house four feet, the owner has reduced his expected annual or annualized damages from $6,312 to $112 (98% reduction) and greatly reduced the probability or frequency of flooding affecting his house. The annualized benefits are the difference in the annualized damages and losses before and after mitigation or $6,312 - $112 = $6,200.

Is this mitigation project worth doing? Common sense says yes, because the flood risk appears high and the annualized damages before mitigation are high ($6,312). To answer this question more quantitatively, we complete our benefit-cost analysis of this project. One key factor is the cost of mitigation. A mitigation project that is worth doing at one cost may not be worth doing at a higher cost. Let's assume that the elevation costs $20,000. This $20,000 cost occurs once, up front, in the year that the elevation project is completed.

The benefits, however, accrue statistically over the lifetime of the mitigation project. Following FEMA convention, we assume that a residential mitigation project has a useful lifetime of 30 years. We then compare the present value of the anticipated stream of benefits over 30 years in the future to the up-front out-of-pocket cost of the mitigation project. Money (benefits) received in the future has less value than money received today because of the time value of money. The time value of money is taken into account with a present value calculation. Simply multiplying the annual benefits times the lifetime would ignore the time value of money and give an incorrect, spurious result.

A present value calculation depends on the lifetime of the mitigation project and on what is known as the discount rate. The discount rate may be viewed simply as the interest rate you might earn on the cost of the project if you didn't spend the money on the mitigation project. Let's assume this mitigation project is to be funded by FEMA, which uses a 7% discount rate to evaluate hazard mitigation projects. With a 30-year lifetime and a 7% discount rate, the "present value coefficient" is 12.41. That is, each $1.00 per year in benefits over the lifetime of the project (30 years) is worth $12.41 now. The benefit-cost results are detailed in Table A2.3.

Table A2.3
Benefit-Cost Results

Annualized Benefits	$6,200
Present Value Coefficient	12.41
Net Present Value of Future Benefits	$76,942
Mitigation Project Cost	$20,000
Benefit-Cost Ratio	3.85

These results indicate a benefit-cost ratio of 3.85. In FEMA's terms the mitigation project is cost-effective and eligible for FEMA funding.

The above discussion of benefit-cost analysis of a flood hazard mitigation project is intended to illustrate the basic concepts. Very similar principles apply to mitigation projects for earthquakes or any other natural hazards. For tornado and earthquake mitigation projects, one of the major benefits is life safety. For the purposes of benefit-cost analysis, the statistical values for deaths and injuries must be included in the benefit-cost analysis. The current FEMA statistical value for human life is $5.8 million. Given this high value, many tornado shelter mitigation projects and many seismic mitigation projects are deemed cost-effective and eligible for FEMA hazard mitigation grant funding.

The role of benefit-cost analysis in prioritizing and implementing mitigation projects in Renton is addressed in Chapter 5 (Plan Adoption, Maintenance and Implementation).

Although benefit-cost analysis is a powerful tool for helping to evaluate and prioritize mitigation projects, and a requirement for all FEMA hazard mitigation grants, benefit-cost analysis should not be considered the sole determinant for mitigation actions. In some cases, the potential for negative effects from a particular natural hazard may simply be deemed unacceptable, such as the potential for deaths and injuries, and mitigation may be undertaken without benefit-cost analysis.

APPENDIX 3

HAZUS REPORTS

Earthquake – Seattle Fault

Flood – Cedar River (100 year)

March 10, 2010

HAZUS-MH: Earthquake Event Report

Region Name: RentonEQ

Earthquake Scenario: Run 1 Seattle Fault Mercer Epi

Print Date: April 03, 2009

Totals only reflect data for those census tracts/blocks included in the user's study region.

Disclaimer:
The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific earthquake. These results can be improved by using enhanced inventory, geotechnical, and observed ground motion data.

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General Description of the Region

HAZUS is a regional earthquake loss estimation model that was developed by the Federal Emergency Management Agency and the National Institute of Building Sciences. The primary purpose of HAZUS is to provide a methodology and software application to develop earthquake losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from earthquakes and to prepare for emergency response and recovery.

The earthquake loss estimates provided in this report was based on a region that includes 1 county(ies) from the following state(s):

Washington

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 114.11 square miles and contains 41 census tracts. There are over 78 thousand households in the region and has a total population of 199,627 people (2000 Census Bureau data). The distribution of population by State and County is provided in Appendix B.

There are an estimated 60 thousand buildings in the region with a total building replacement value (excluding contents) of 16,252 (millions of dollars). Approximately 97.00 % of the buildings (and 77.00% of the building value) are associated with residential housing.

The replacement value of the transportation and utility lifeline systems is estimated to be 3,843 and 815 (millions of dollars) , respectively.

Building and Lifeline Inventory

Building Inventory

HAZUS estimates that there are 60 thousand buildings in the region which have an aggregate total replacement value of 16,252 (millions of dollars) . Appendix B provides a general distribution of the building value by State and County.

In terms of building construction types found in the region, wood frame construction makes up 90% of the building inventory. The remaining percentage is distributed between the other general building types.

Critical Facility Inventory

HAZUS breaks critical facilities into two (2) groups: essential facilities and high potential loss (HPL) facilities. Essential facilities include hospitals, medical clinics, schools, fire stations, police stations and emergency operations facilities. High potential loss facilities include dams, levees, military installations, nuclear power plants and hazardous material sites.

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 204 beds. There are 80 schools, 2 fire stations, 5 police stations and 0 emergency operation facilities. With respect to HPL facilities, there are 6 dams identified within the region. Of these, 2 of the dams are classified as 'high hazard'. The inventory also includes 112 hazardous material sites, 0 military installations and 0 nuclear power plants.

Transportation and Utility Lifeline Inventory

Within HAZUS, the lifeline inventory is divided between transportation and utility lifeline systems. There are seven (7) transportation systems that include highways, railways, light rail, bus, ports, ferry and airports. There are six (6) utility systems that include potable water, wastewater, natural gas, crude & refined oil, electric power and communications. The lifeline inventory data are provided in Tables 2 and 3.

The total value of the lifeline inventory is over 4,658.00 (millions of dollars). This inventory includes over 176 kilometers of highways, 121 bridges, 3,254 kilometers of pipes.

Table 2: Transportation System Lifeline Inventory

System	Component	# locations/ # Segments	Replacement value (millions of dollars)
Highway	Bridges	121	2,930.80
	Segments	40	774.90
	Tunnels	1	0.90
		Subtotal	**3,706.60**
Railways	Bridges	1	0.10
	Facilities	3	7.20
	Segments	29	52.80
	Tunnels	0	0.00
		Subtotal	**60.10**
Light Rail	Bridges	0	0.00
	Facilities	0	0.00
	Segments	0	0.00
	Tunnels	0	0.00
		Subtotal	**0.00**
Bus	Facilities	0	0.00
		Subtotal	**0.00**
Ferry	Facilities	0	0.00
		Subtotal	**0.00**
Port	Facilities	1	2.20
		Subtotal	**2.20**
Airport	Facilities	1	6.00
	Runways	2	68.40
		Subtotal	**74.40**
		Total	**3,843.30**

Table 3: Utility System Lifeline Inventory

System	Component	# Locations / Segments	Replacement value (millions of dollars)
Potable Water	Distribution Lines	NA	32.50
	Facilities	3	109.90
	Pipelines	0	0.00
		Subtotal	**142.40**
Waste Water	Distribution Lines	NA	19.50
	Facilities	3	219.80
	Pipelines	0	0.00
		Subtotal	**239.30**
Natural Gas	Distribution Lines	NA	13.00
	Facilities	1	1.20
	Pipelines	0	0.00
		Subtotal	**14.20**
Oil Systems	Facilities	0	0.00
	Pipelines	0	0.00
		Subtotal	**0.00**
Electrical Power	Facilities	4	484.00
		Subtotal	**484.00**
Communication	Facilities	8	0.90
		Subtotal	**0.90**
		Total	**880.80**

Earthquake Scenario

HAZUS uses the following set of information to define the earthquake parameters used for the earthquake loss estimate provided in this report.

Scenario Name	Run 1 Seattle Fault Mercer Epi
Type of Earthquake	Arbitrary
Fault Name	NA
Historical Epicenter ID #	NA
Probabilistic Return Period	NA
Longitude of Epicenter	-122.19
Latitude of Epicenter	47.59
Earthquake Magnitude	6.70
Depth (Km)	10.00
Rupture Length (Km)	25.59
Rupture Orientation (degrees)	90.00
Attenuation Function	WUS Shallow Crustal Event - Extensional

Building Damage

HAZUS estimates that about 10,921 buildings will be at least moderately damaged. This is over 18.00 % of the total number of buildings in the region. There are an estimated 366 buildings that will be damaged beyond repair. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS technical manual. Table 4 below summaries the expected damage by general occupancy for the buildings in the region. Table 5 summaries the expected damage by general building type.

Table 4: Expected Building Damage by Occupancy

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Agriculture	18	0.06	12	0.06	10	0.11	4	0.29	1	0.40
Commercial	524	1.77	334	1.68	394	4.37	185	12.03	58	15.93
Education	15	0.05	10	0.05	11	0.12	5	0.35	2	0.47
Government	20	0.07	13	0.07	14	0.16	7	0.42	2	0.45
Industrial	144	0.49	85	0.43	103	1.14	46	2.98	13	3.54
Other Residential	1,496	5.06	1,339	6.74	1,469	16.28	732	47.72	148	40.40
Religion	28	0.09	19	0.09	18	0.20	9	0.57	3	0.71
Single Family	27,334	92.41	18,043	90.88	7,002	77.62	547	35.64	140	38.10
Total	**29,580**		**19,854**		**9,021**		**1,535**		**366**	

Table 5: Expected Building Damage by Building Type (All Design Levels)

	None		Slight		Moderate		Extensive		Complete	
	Count	(%)	Count	(%)	Count	(%)	Count	(%)	Count	(%)
Wood	27,832	94.09	18508	93.22	7,051	78.16	497	32.35	142	38.69
Steel	189	0.64	129	0.65	185	2.05	81	5.31	20	5.49
Concrete	160	0.54	122	0.61	132	1.46	66	4.30	14	3.83
Precast	154	0.52	87	0.44	119	1.32	62	4.03	18	4.89
RM	792	2.68	317	1.59	364	4.03	149	9.69	19	5.10
URM	29	0.10	34	0.17	53	0.59	42	2.76	33	8.94
MH	424	1.43	658	3.31	1,117	12.39	638	41.56	121	33.06
Total	**29,580**		**19,854**		**9,021**		**1,535**		**366**	

*Note:

RM Reinforced Masonry
URM Unreinforced Masonry
MH Manufactured Housing

Essential Facility Damage

Before the earthquake, the region had 204 hospital beds available for use. On the day of the earthquake, the model estimates that only 109 hospital beds (54.00%) are available for use by patients already in the hospital and those injured by the earthquake. After one week, 85.00% of the beds will be back in service. By 30 days, 99.00% will be operational.

Table 6: Expected Damage to Essential Facilities

Classification	Total	# Facilities		
		At Least Moderate Damage > 50%	Complete Damage > 50%	With Functionality > 50% on day 1
Hospitals	1	0	0	1
Schools	80	0	0	50
EOCs	0	0	0	0
PoliceStations	5	0	0	2
FireStations	2	0	0	2

Transportation and Utility Lifeline Damage

Table 7 provides damage estimates for the transportation system.

Table 7: Expected Damage to the Transportation Systems

System	Component	Number of Locations				
		Locations/ Segments	With at Least Mod. Damage	With Complete Damage	With Functionality > 50 % After Day 1	With Functionality > 50 % After Day 7
Highway	Segments	40	0	0	40	40
	Bridges	121	25	0	96	117
	Tunnels	1	0	0	1	1
Railways	Segments	29	0	0	29	29
	Bridges	1	0	0	1	1
	Tunnels	0	0	0	0	0
	Facilities	3	0	0	3	3
Light Rail	Segments	0	0	0	0	0
	Bridges	0	0	0	0	0
	Tunnels	0	0	0	0	0
	Facilities	0	0	0	0	0
Bus	Facilities	0	0	0	0	0
Ferry	Facilities	0	0	0	0	0
Port	Facilities	1	0	0	1	1
Airport	Facilities	1	0	0	1	1
	Runways	2	0	0	2	2

Note: Roadway segments, railroad tracks and light rail tracks are assumed to be damaged by ground failure only. If ground failure maps are not provided, damage estimates to these components will not be computed.

Tables 8-10 provide information on the damage to the utility lifeline systems. Table 8 provides damage to the utility system facilities. Table 9 provides estimates on the number of leaks and breaks by the pipelines of the utility systems. For electric power and potable water, HAZUS performs a simplified system performance analysis. Table 10 provides a summary of the system performance information.

Table 8 : Expected Utility System Facility Damage

System	# of Locations				
	Total #	With at Least Moderate Damage	With Complete Damage	with Functionality > 50 %	
				After Day 1	After Day 7
Potable Water	3	0	0	3	3
Waste Water	3	1	0	0	3
Natural Gas	1	0	0	0	1
Oil Systems	0	0	0	0	0
Electrical Power	4	1	0	1	4
Communication	8	6	0	8	8

Table 9 : Expected Utility System Pipeline Damage (Site Specific)

System	Total Pipelines Length (kms)	Number of Leaks	Number of Breaks
Potable Water	1,627	474	118
Waste Water	976	375	94
Natural Gas	651	400	100
Oil	0	0	0

Table 10: Expected Potable Water and Electric Power System Performance

	Total # of Households	Number of Households without Service				
		At Day 1	At Day 3	At Day 7	At Day 30	At Day 90
Potable Water	78,482	20,160	4,715	0	0	0
Electric Power		0	0	0	0	0

Induced Earthquake Damage

Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. HAZUS uses a Monte Carlo simulation model to estimate the number of ignitions and the amount of burnt area. For this scenario, the model estimates that there will be 10 ignitions that will burn about 0.11 sq. mi 0.10 % of the region's total area.) The model also estimates that the fires will displace about 249 people and burn about 18 (millions of dollars) of building value.

Debris Generation

HAZUS estimates the amount of debris that will be generated by the earthquake. The model breaks the debris into two general categories: a) Brick/Wood and b) Reinforced Concrete/Steel. This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 0.00 million tons of debris will be generated. Of the total amount, Brick/Wood comprises 0.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 0 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Social Impact

Shelter Requirement

HAZUS estimates the number of households that are expected to be displaced from their homes due to the earthquake and the number of displaced people that will require accommodations in temporary public shelters. The model estimates 1,656 households to be displaced due to the earthquake. Of these, 374 people (out of a total population of 199,627) will seek temporary shelter in public shelters.

Casualties

HAZUS estimates the number of people that will be injured and killed by the earthquake. The casualties are broken down into four (4) severity levels that describe the extent of the injuries. The levels are described as follows;

· Severity Level 1: Injuries will require medical attention but hospitalization is not needed.
· Severity Level 2: Injuries will require hospitalization but are not considered life-threatening
· Severity Level 3: Injuries will require hospitalization and can become life threatening if not promptly treated.
· Severity Level 4: Victims are killed by the earthquake.

The casualty estimates are provided for three (3) times of day: 2:00 AM, 2:00 PM and 5:00 PM. These times represent the periods of the day that different sectors of the community are at their peak occupancy loads. The 2:00 AM estimate considers that the residential occupancy load is maximum, the 2:00 PM estimate considers that the educational, commercial and industrial sector loads are maximum and 5:00 PM represents peak commute time.

Table 11 provides a summary of the casualties estimated for this earthquake

Table 11: Casualty Estimates

		Level 1	Level 2	Level 3	Level 4
2 AM	Commercial	9	2	0	1
	Commuting	0	0	0	0
	Educational	0	0	0	0
	Hotels	5	1	0	0
	Industrial	8	2	0	1
	Other-Residential	123	26	3	6
	Single Family	118	15	1	1
	Total	**263**	**47**	**5**	**9**
2 PM	Commercial	531	137	21	42
	Commuting	0	0	1	0
	Educational	97	25	4	7
	Hotels	1	0	0	0
	Industrial	62	15	2	4
	Other-Residential	23	5	1	1
	Single Family	21	3	0	0
	Total	**735**	**186**	**29**	**55**
5 PM	Commercial	382	99	15	30
	Commuting	22	27	48	9
	Educational	13	3	1	1
	Hotels	1	0	0	0
	Industrial	39	9	1	3
	Other-Residential	46	10	1	2
	Single Family	45	6	0	1
	Total	**548**	**155**	**66**	**45**

Economic Loss

The total economic loss estimated for the earthquake is 1,785.78 (millions of dollars), which includes building and lifeline related losses based on the region's available inventory. The following three sections provide more detailed information about these losses.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the earthquake. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the earthquake.

The total building-related losses were 1,414.90 (millions of dollars); 15 % of the estimated losses were related to the business interruption of the region. By far, the largest loss was sustained by the residential occupancies which made up over 54 % of the total loss. Table 12 below provides a summary of the losses associated with the building damage.

Table 12: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Single Family	Other Residential	Commercial	Industrial	Others	Total
Income Loses							
	Wage	0.00	5.76	66.28	3.07	2.78	77.88
	Capital-Related	0.00	2.44	58.30	1.83	0.67	63.24
	Rental	10.70	20.41	35.56	1.20	1.22	69.09
	Relocation	1.23	0.52	2.11	0.10	0.38	4.35
	Subtotal	**11.94**	**29.13**	**162.24**	**6.20**	**5.05**	**214.56**
Capital Stock Loses							
	Structural	65.83	26.98	79.88	11.13	4.85	188.67
	Non_Structural	330.04	141.78	180.63	34.19	13.56	700.20
	Content	118.14	36.37	99.98	32.51	13.48	300.47
	Inventory	0.00	0.00	3.90	6.91	0.19	11.00
	Subtotal	**514.01**	**205.12**	**364.39**	**84.74**	**32.08**	**1,200.34**
	Total	**525.95**	**234.25**	**526.63**	**90.94**	**37.13**	**1,414.90**

Transportation and Utility Lifeline Losses

For the transportation and utility lifeline systems, HAZUS computes the direct repair cost for each component only. There are no losses computed by HAZUS for business interruption due to lifeline outages. Tables 13 & 14 provide a detailed breakdown in the expected lifeline losses.

HAZUS estimates the long-term economic impacts to the region for 15 years after the earthquake. The model quantifies this information in terms of income and employment changes within the region. Table 15 presents the results of the region for the given earthquake.

Table 13: Transportation System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Highway	Segments	774.90	$0.00	0.00
	Bridges	2,930.79	$254.67	8.69
	Tunnels	0.89	$0.03	2.91
	Subtotal	**3706.60**	**254.70**	
Railways	Segments	52.84	$0.00	0.00
	Bridges	0.09	$0.00	1.28
	Tunnels	0.00	$0.00	0.00
	Facilities	7.19	$1.61	22.35
	Subtotal	**60.10**	**1.60**	
Light Rail	Segments	0.00	$0.00	0.00
	Bridges	0.00	$0.00	0.00
	Tunnels	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Bus	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Ferry	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**0.00**	
Port	Facilities	2.25	$0.62	27.70
	Subtotal	**2.20**	**0.60**	
Airport	Facilities	6.00	$1.59	26.58
	Runways	68.38	$0.00	0.00
	Subtotal	**74.40**	**1.60**	
	Total	**3843.30**	**258.50**	

Table 14: Utility System Economic Losses

(Millions of dollars)

System	Component	Inventory Value	Economic Loss	Loss Ratio (%)
Potable Water	Pipelines	0.00	$0.00	0.00
	Facilities	109.90	$13.15	11.97
	Distribution Lines	32.50	$2.13	6.55
	Subtotal	**142.44**	**$15.28**	
Waste Water	Pipelines	0.00	$0.00	0.00
	Facilities	219.80	$32.79	14.92
	Distribution Lines	19.50	$1.69	8.63
	Subtotal	**239.31**	**$34.48**	
Natural Gas	Pipelines	0.00	$0.00	0.00
	Facilities	1.20	$0.17	14.16
	Distribution Lines	13.00	$1.80	13.84
	Subtotal	**14.22**	**$1.97**	
Oil Systems	Pipelines	0.00	$0.00	0.00
	Facilities	0.00	$0.00	0.00
	Subtotal	**0.00**	**$0.00**	
Electrical Power	Facilities	484.00	$60.45	12.49
	Subtotal	**484.00**	**$60.45**	
Communication	Facilities	0.90	$0.18	20.05
	Subtotal	**0.88**	**$0.18**	
	Total	**880.84**	**$112.36**	

Table 15. Indirect Economic Impact with outside aid
(Employment as # of people and Income in millions of $)

	LOSS	Total	%
First Year			
	Employment Impact	516	0.51
	Income Impact	(9)	-0.17
Second Year			
	Employment Impact	189	0.19
	Income Impact	(32)	-0.60
Third Year			
	Employment Impact	5	0.00
	Income Impact	(42)	-0.79
Fourth Year			
	Employment Impact	0	0.00
	Income Impact	(42)	-0.80
Fifth Year			
	Employment Impact	0	0.00
	Income Impact	(42)	-0.80
Years 6 to 15			
	Employment Impact	0	0.00
	Income Impact	(42)	-0.80

Appendix A: County Listing for the Region

King,WA

Appendix B: Regional Population and Building Value Data

State	County Name	Population	Building Value (millions of dollars)		
			Residential	Non-Residential	Total
Washington					
	King	199,627	12,567	3,685	16,252
Total State		**199,627**	**12,567**	**3,685**	**16,252**
Total Region		**199,627**	**12,567**	**3,685**	**16,252**

HAZUS-MH: Flood Event Report

Region Name: Renton FLD Cedar

Flood Scenario: Cedar River

Print Date: Friday, April 03, 2009

Disclaimer:

Totals only reflect data for those census tracts/blocks included in the user's study region.

The estimates of social and economic impacts contained in this report were produced using HAZUS loss estimation methodology software which is based on current scientific and engineering knowledge. There are uncertainties inherent in any loss estimation technique. Therefore, there may be significant differences between the modeled results contained in this report and the actual social and economic losses following a specific Flood. These results can be improved by using enhanced inventory data and flood hazard information.

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General Description of the Region

HAZUS is a regional multi-hazard loss estimation model that was developed by the Federal Emergency Management Agency (FEMA) and the National Institute of Building Sciences (NIBS). The primary purpose of HAZUS is to provide a methodology and software application to develop multi-hazard losses at a regional scale. These loss estimates would be used primarily by local, state and regional officials to plan and stimulate efforts to reduce risks from multi-hazards and to prepare for emergency response and recovery.

The flood loss estimates provided in this report were based on a region that included 1 county(ies) from the following state(s):

- Washington

Note:
Appendix A contains a complete listing of the counties contained in the region.

The geographical size of the region is 114 square miles and contains 2,698 census blocks. There are over 86 thousand households in the region and has a total population of 222,338 people (2000 Census Bureau data). The distribution of population by State and County for the study region is provided in Appendix B.

There are an estimated 74,785 buildings in the region with a total building replacement value (excluding contents) of 17,915 million dollars (2006 dollars). Approximately 91.79% of the buildings (and 78.76% of the building value) are associated with residential housing.

Building Inventory

General Building Stock

HAZUS estimates that there are 74,785 buildings in the region which have an aggregate total replacement value of 17,915 million (2006 dollars). Table 1 and Table 2 present the relative distribution of the value with respect to the general occupancies by Study Region and Study Case respectively. Appendix B provides a general distribution of the building value by State and County.

Table 1
Building Exposure by Occupancy Type for the Study Region

Occupancy	Exposure ($1000)	Percent of Total
Residential	14,109,886	78.8%
Commercial	2,923,593	16.3%
Industrial	677,070	3.8%
Agricultural	20,003	0.1%
Religion	100,346	0.6%
Government	12,771	0.1%
Education	71,442	0.4%
Total	**17,915,111**	**100.00%**

Table 2
Building Exposure by Occupancy Type for the Study Case

Occupancy	Exposure ($1000)	Percent of Total
Residential	331,870	84.5%
Commercial	52,422	13.3%
Industrial	3,659	0.9%
Agricultural	329	0.1%
Religion	2,844	0.7%
Government	0	0.0%
Education	1,777	0.5%
Total	**392,901**	**100.00%**

Essential Facility Inventory

For essential facilities, there are 1 hospitals in the region with a total bed capacity of 204 beds. There are 83 schools, 2 fire stations, 5 police stations and no emergency operation centers.

Flood Scenario Parameters

HAZUS used the following set of information to define the flood parameters for the flood loss estimate provided in this report.

Study Region Name:	Renton FLD Cedar
Scenario Name:	Cedar River
Return Period Analyzed:	100
Analysis Options Analyzed:	0

Building Damage

General Building Stock Damage

HAZUS estimates that about 121 buildings will be at least moderately damaged. This is over 41% of the total number of buildings in the study case. There are an estimated 8 buildings that will be completely destroyed. The definition of the 'damage states' is provided in Volume 1: Chapter 5 of the HAZUS Flood technical manual. Table 3 below summarizes the expected damage by general occupancy for the buildings in the region. Table 4 summarizes the expected damage by general building type.

Table 3: Expected Building Damage by Occupancy

	1-10		11-20		21-30		31-40		41-50		Substantially	
Occupancy	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Agriculture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Commercial	0	0.00	2	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Education	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Government	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Industrial	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Religion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Residential	0	0.00	14	11.76	69	57.98	12	10.08	16	13.45	8	6.72
Total	**0**		**16**		**69**		**12**		**16**		**8**	

Table 4: Expected Building Damage by Building Type

Building Type	1-10		11-20		21-30		31-40		41-50		Substantially	
	Count	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**	**Count**	**(%)**
Concrete	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
ManufHousing	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	8	100.00
Masonry	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Steel	0	0.00	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00
Wood	0	0.00	14	12.61	69	62.16	12	10.81	16	14.41	0	0.00

Essential Facility Damage

Before the flood analyzed in this study case, the region had 0 hospital beds available for use. On the day of the study case flood event, the model estimates that 0 hospital beds are available in the region.

Table 5: Expected Damage to Essential Facilities

		# Facilities		
Classification	Total	At Least Moderate	At Least Substantial	Loss of Use
Fire Stations	2	0	0	0
Hospitals	1	0	0	0
Police Stations	5	0	0	0
Schools	83	0	0	0

If this report displays all zeros or is blank, two possibilities can explain this.

(1) None of your facilities were flooded. This can be checked by mapping the inventory data on the depth grid.

(2) The analysis was not run. This can be tested by checking the run box on the Analysis Menu and seeing if a message box asks you to replace the existing results.

Induced Flood Damage

Debris Generation

HAZUS estimates the amount of debris that will be generated by the flood. The model breaks debris into three general categories: 1) Finishes (dry wall, insulation, etc.), 2) Structural (wood, brick, etc.) and 3) Foundations (concrete slab, concrete block, rebar, etc.). This distinction is made because of the different types of material handling equipment required to handle the debris.

The model estimates that a total of 2,261 tons of debris will be generated. Of the total amount, Finishes comprises 76% of the total, Structure comprises 10% of the total. If the debris tonnage is converted into an estimated number of truckloads, it will require 90 truckloads (@25 tons/truck) to remove the debris generated by the flood.

Social Impact

Shelter Requirements

HAZUS estimates the number of households that are expected to be displaced from their homes due to the flood and the associated potential evacuation. HAZUS also estimates those displaced people that will require accommodations in temporary public shelters. The model estimates 228 households will be displaced due to the flood. Displacement includes households evacuated from within or very near to the inundated area. Of these, 473 people (out of a total population of 222,338) will seek temporary shelter in public shelters.

Economic Loss

The total economic loss estimated for the flood is 24.39 million dollars, which represents 6.21 % of the total replacement value of the study case buildings.

Building-Related Losses

The building losses are broken into two categories: direct building losses and business interruption losses. The direct building losses are the estimated costs to repair or replace the damage caused to the building and its contents. The business interruption losses are the losses associated with inability to operate a business because of the damage sustained during the flood. Business interruption losses also include the temporary living expenses for those people displaced from their homes because of the flood.

The total building-related losses were 24.24 million dollars. 1% of the estimated losses were related to the business interruption of the region. The residential occupancies made up 69.85% of the total loss. Table 6 below provides a summary of the losses associated with the building damage.

Table 6: Building-Related Economic Loss Estimates

(Millions of dollars)

Category	Area	Residential	Commercial	Industrial	Others	Total
Building Loss						
	Building	10.17	1.33	0.18	0.05	11.72
	Content	6.83	4.55	0.26	0.75	12.38
	Inventory	0.00	0.08	0.05	0.01	0.14
	Subtotal	**16.99**	**5.95**	**0.48**	**0.81**	**24.24**
Business Interruption						
	Income	0.00	0.04	0.00	0.01	0.04
	Relocation	0.03	0.01	0.00	0.00	0.04
	Rental Income	0.01	0.01	0.00	0.00	0.01
	Wage	0.00	0.03	0.00	0.03	0.06
	Subtotal	**0.04**	**0.08**	**0.00**	**0.03**	**0.15**
ALL	**Total**	**17.03**	**6.03**	**0.48**	**0.84**	**24.39**

Appendix A: County Listing for the Region

Washington

- King

Appendix B: Regional Population and Building Value Data

	Population	Building Value (thousands of dollars) Residential	Non-Residential	Total
Washington				
King	222,338	14,109,886	3,805,225	17,915,111
Total	**222,338**	**14,109,886**	**3,805,225**	**17,915,111**
Total Study Region	**222,338**	**14,109,886**	**3,805,225**	**17,915,111**

APPENDIX 4

CITY COUNCIL APPROVAL

March 10, 2010

REPLACE with New Resolution

CITY OF RENTON, WASHINGTON

RESOLUTION NO. 3680

A RESOLUTION OF THE CITY OF RENTON, WASHINGTON, ADOPTING THE HAZARD MITIGATION PLAN.

WHEREAS, Section 322, Mitigation Planning, of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, enacted by Section 104 of the Disaster Mitigation Act of 2000 (DMA) (P.L. 106-390) provides new and revitalized approaches to mitigation planning; and

WHEREAS, the Disaster Mitigation Act establishes the requirement for state and local government mitigation planning as a condition of disaster assistance; and

WHEREAS, the Mayor and City Council recognize that mitigation planning, along with other emergency preparedness actions, provides a significant opportunity to reduce the City's disaster losses; and

WHEREAS, the City has developed the City of Renton Hazard Mitigation Plan and is committed to fulfilling the mitigation goals and objectives outlined in the Plan;

NOW, THEREFORE, THE CITY COUNCIL OF THE CITY OF RENTON, WASHINGTON, DO RESOLVE AS FOLLOWS:

SECTION I. The above findings are true and correct in all respects.

SECTION II. The City of Renton Hazard Mitigation Plan is adopted by the City and all responsible departments are authorized to execute their responsibilities in implementing this Plan.

RESOLUTION NO. 3680

PASSED BY THE CITY COUNCIL this 22nd day of December, 2003.

Bonnie I. Walton

Bonnie I. Walton, City Clerk

APPROVED BY THE MAYOR this 22nd day of December, 2003.

Jesse Tanner

Jesse Tanner, Mayor

Approved as to form:

Lawrence J. Warren

Lawrence J. Warren, City Attorney

RES.1027:12/10/03:ma