Whatcom County

Natural Hazards Mitigation Plan

A MULTI-HAZARD, MULTI-JURISDICTIONAL PLAN DEVELOPED FOR THE BENEFIT OF ALL CITIZENS AND GOVERNMENTAL JURISDICTIONS WITHIN WHATCOM COUNTY, INCLUDING THE COUNTY'S PORT OF BELLINGHAM

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Geographic Information Systems (GIS) Maps:

Summit GIS developed all of the maps included in this plan, unless indicated otherwise. Summit GIS used the best information publicly available in the creation of these maps, and they are provided "as is." Summit GIS cannot accept any responsibility for any inaccuracies, errors, or omissions and, therefore, there are no warranties that accompany these products (maps).

The datasets used in the maps in this plan were from the following sources:

Department of Natural Resources (DNR) – Hydro information, Fire Hazard and History data

Federal Emergency Management Agency (FEMA) – Floodplain Boundaries

National Oceanic & Atmospheric Administration (NOAA) – Tsunami Grids

US Geological Society (USGS) – Volcano Lahar and Blast Zone Boundaries

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THIS PLAN IS ADOPTED BY:

Entity	Signer	Date Adopted	Ordinance

INTRODUCTION

In 2004 Whatcom County's Emergency Management Division undertook the process of writing a multi-jurisdictional hazard mitigation plan to identify natural hazards present in the county and protect the citizens and resources living there. This process was instigated by the Code of Federal Regulation (CFR) 201.6 (see Appendix A), enacted in October, 2002. The purpose of the plan is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during immediate recovery from a disaster. According to the Federal Emergency Management Agency (FEMA) hazard mitigation planning is an important aspect of a successful mitigation program. States and communities use the hazard mitigation planning process to set short- and long-range mitigation goals and objectives. Hazard mitigation planning is a collaborative process in which hazards affecting the community are identified, vulnerability to the hazards is assessed, and a consensus is reached on how to minimize or eliminate the effects of these hazards. In recognition of the importance of planning, States with an approved enhanced State Mitigation Plan in effect at the time of disaster declaration will be eligible to receive funds allocated by the Hazard Mitigation Grant Program (HMGP).

Mitigation is the cornerstone of emergency management. It's the ongoing effort to lessen the impacts disasters can have on people's lives and property through damage prevention and flood insurance. Through measures such as building safely within the floodplain or removing homes altogether; engineering buildings and infrastructures to withstand earthquakes: and creating and enforcing effective building codes to protect property from floods, hurricanes and other natural hazards, the impact on lives and communities is lessened.

The initial step of creating this plan was to identify and analyze the natural hazards present and hazardous to Whatcom County. Six hazards were identified in this process: earthquakes, floods, geologic hazards, tsunamis, volcanoes, and wildland fires.

The second step was to invite and involve the major jurisdictions to participate in compiling information for the plan. The nine recognized jurisdictions of Whatcom County assisted in the creation of this plan:

1. Bellingham
2. Blaine
3. Everson
4. Ferndale
5. Lynden
6. Nooksack
7. Port of Bellingham
8. Sumas
9. Whatcom County

In addition to assisting in the creation of the plan, each jurisdiction committed to consider it for adoption upon completion. Their assistance involved compiling a list of critical facilities and resources they consider priority facilities in the event of a natural hazard, as well as providing information when requested. Smaller organizations – water districts, cemetery districts, diking districts, fire departments, water districts – were also eligible to participate in the planning process. Refer to Appendix B for a complete list of the participating agencies.

Purpose:

Each chapter of the mitigation plan provides information and resources to assist people in understanding the county and the hazard-related issues facing citizens, businesses, and the environment. Combined, the chapters of the plan work together to identify existing and potential

hazards and create a document that guides the mission to reduce risk and prevent loss from future natural hazard events. The structure of the plan allows people to use a section, whether hazard- or jurisdiction-specific, of interest to them. It also allows county government to review and update sections when new data becomes available. Decision-makers can allocate funding and staff resources to selected pieces in need of review, thereby avoiding a full update, which can be costly and time-consuming. New data can be easily incorporated, resulting in a plan that will remain current and relevant to Whatcom County.

The mitigation goals and strategies for this Whatcom County plan are:

1. Protect life during and after the occurrence of disasters from identified hazards
2. Reduce property damage
3. Increase public awareness
4. Protect natural resources and the environment
5. Preserve or restore natural mitigation values, such as flood plains
6. Support regional efforts relating to emergency preparedness, disaster response, and hazard mitigation

Organization

The mitigation plan is organized into three sections. Section I details the six hazards present in Whatcom County. Section II contains infrastructure and hazard information for each of the nine jurisdictions that participated in the plan. Section III is comprised of appendices.

Section 1: Hazard-Specific Information

The first section contains chapters specific to the natural hazards present in Whatcom County. These chapters are broken down into:

1. Hazard-Related Definitions
2. Background Information
3. History
4. Vulnerability Assessment
5. Mitigation Strategies
6. Maps

Section 2: Jurisdiction-Specific Information

The second section contains jurisdiction-specific chapters, with the following information:

1. Contact Information
2. Hazards Present to the Jurisdiction
3. Critical Facility List
4. Infrastructure
5. Urban Growth Areas (growth trends)
6. Ranked Critical Facilities
7. Mitigation Strategy & Action Plans

This section ends with a description of how the Plan will be maintained in the future.

Section 3: Appendices

A. Language of the Code of Federal Regulations 201.6
B. Plan Development Process
C. Participating Agencies
D. List of Acronyms
E. Whatcom County RAMS Assessment (wildland-fire related)

The Whatcom County Hazard Mitigation plan is an evolving document that will eventually include additional information and discussions of additional natural hazard studies, man-made hazards such as terrorism, and general updates as they become available.

WHATCOM COUNTY BACKGROUND

Whatcom County, the northwestern most county of Washington State, has an area of 2,120 square miles. It is bordered to the north by Canada, to the west by the Strait of Georgia, a deep-water ship transit, and another waterway called the Rosario Strait. The eastern half of the county is composed of the North Cascades Mountain range, which occupies roughly two-thirds of the county. No Whatcom County roads, originating in the western half of the county, connect to the eastern half. Towns in eastern Whatcom County can only be accessed by driving over 60 miles through the southern adjacent Skagit County. According to a 2003 Census Bureau estimate, the population of Whatcom County was 176,571. Only 4.5% of the land area is incorporated, while the majority is unincorporated. A unique characteristic of Whatcom County is that not all of its populated areas are contiguous with the mainland County, including Point Roberts and Lummi Island.

An understanding of the geography, weather, industries and income, and unique characteristics of the county is critical to mitigate the natural hazard identified in this plan.

CLIMATE

Annual precipitation varies greatly, depending on elevation:

- Lowlands: rainfall varies from 30-40 inches
- East toward the Cascade Mountains: precipitation increases
- Mount Baker Summit: 140 inches, adding to the snow pack and glaciers, year round.

GEOGRAPHY

- **Lowlands**

  West of Cascade Foothills: Part of the huge Fraser / Nooksack river-delta system. This system runs north from the Chuckanut Hills to the mouth of the Fraser, where Vancouver, British Columbia is sited. [To the south (beyond the Chuckanut Hills, in Skagit County) is the delta of another great river, the Skagit. This river delta is important to Whatcom County because of its related flood, earthquake, and volcano hazards.]

- **Mount Baker Foothill Communities**

  Scattered in the rural area along the Valley Highway (Highway 9) and up through the foothills along the Mount Baker Highway, crossing all three forks of the Nooksack River, are the communities of Van Zandt, Acme, Wickersham, Welcome, Maple Falls, Glacier, and Kendall.

- **Nooksack River**

  This river is 96 miles in length and is made up of three forks (North, Middle, and South). Its watershed basin includes most of the county's western lands. The river corridor links the various landscapes of Whatcom County.

- **Coast and Islands**

  There are 134 miles of seacoast in Whatcom County: 51 % is steep, eroding sea bluff (such as the mountain view coast at Birch Point.), 16% is rocky shoreline, which includes parts of Lummi Island, 17% is accreting (building up or extending shoreline), and 5% estuarine shore.

- **Lakes**

  There are 245 lakes In Whatcom County: 4 large reservoirs inside the Federal Lands (Ross, Diablo, Gorge, Baker) and 2 large natural lakes in the Chuckanut region (Lake Whatcom, Samish).

  Seven lakes are over 100 acres in size:

  1. Whatcom (5,000 acres)
  2. Samish (825 acres)
  3. Terrell (440 acres)
  4. Silver (185 acres)
  5. Padden (150 acres)
  6. Wiser (125 acres)
  7. Judson (112 acres)

- **The North Cascades Mountains**

  Roughly two-thirds of Whatcom County is federally protected land contained in the North Cascades, which is controlled by the U. S. Forest Service and the National Park Service. The Cascades extend from Canada's Fraser River south beyond Oregon. They shape the climate and vegetation over much of the Pacific Northwest.

  1. The Mount Baker / Snoqualmie National Forest lies east of the Foothills and west of the "North Unit" of North Cascades National Park.
  2. The North Cascades Park is located adjacent to the east portion of the Mount Baker / Snoqualmie National Forest.
  3. East of the National Park is the Pasayten Wilderness, administered through the Okanogan National Forest. This is a roadless area.

  There are about 350,000 acres of National Forest Lands in Whatcom County. Three roads connect western Whatcom County with the Federal lands:

  1. Mount Baker Highway (Highway 542) provides access to the Mount Baker Recreation Area.
  2. Middle Fork Road (secondary, more primitive entrance) leading to hiking and camping region on south and west sides of Mount Baker, including the Twin Sisters area.
  3. Highway 20 (through Skagit County) is the principal access to Baker Lake, as well as to North Cascades National Park.

  Two parts of the North Cascades National Park Complex are located in Whatcom County:

  1. The North Unit (Picket Range) – roadless, primitive, high country.
  2. Ross Lake National Recreation area – Seattle City Light with three dams on the Skagit River.

<u>TRANSPORTATION</u>

Major Roads

- Interstate 5, which connects Mexico to Canada, runs north and south through Whatcom County.
- Highway 9 traverses north and south crossing the south and north forks of the Nooksack River.
- Mount Baker Highway (542), from Bellingham, meets Highway 9 and winds east to Mount Baker.

Marinas

- Bellingham – Squalicum Harbor is the second largest marina in Puget Sound. Over 1,800 pleasure, commercial boats, and fishing fleets are moored here.
- Blaine – Drayton Harbor: pleasure and fishing fleet.
- Point Roberts – Accessed by water from Strait of Georgia or by land through Canada.
- Private Marinas along Bellingham Bay, Lummi Island, Gooseberry Point, Birch Bay, Eliza Island, Fairhaven.

Rail

- Amtrak: Bellingham is on routes from Seattle and Vancouver, Canada.
- Rail Corridors from Sumas to Everson to Lynden.
- From Whatcom County along Chuckanut Bay to Bellingham
- Along the I-5 rail corridor to Blaine and northwest to Cherry Point vicinity.
- Cherry Point to Custer and link with I-5 rail corridor.

Vessel Traffic Lanes

- Oil Tankers
- Ships
- Barges
- Tug Boats
- Commercial Fishing Vessels
- Recreation Boats
- Coast Guard Vessels

Ferry Crossings

- Alaska Marine Highway System Ferry departs from Bellingham to Alaska.
- The Whatcom County Ferry crosses Hales Pass from Gooseberry Point to Lummi Island. (8-minute transit time).
- Plover Ferry crosses from Blaine to Semiahmoo Spit. This ferry is open seasonally on the weekends from Memorial Day to Labor Day.
- Commercial sight-seeing ferries to San Juan Islands and Victoria, Canada depart from the Bellingham Ferry Terminal.
- Canadian Ferries cross northwestern Whatcom County waterways: Tsawwassen through Strait of Georgia, to Channel Islands, to Sidney on Vancouver Island, British Columbia.

Rivers

- Nooksack River, used by canoes, kayaks, small fishing boats, and for float trips.

AIR TRANSPORTATION

- Bellingham International Airport: Commercial jets use a 6,700-foot runway.
- Blaine Municipal Airport: 2,100-foot runway.
- Lynden Municipal Airport: 2,450-foot runway.
- Vancouver International Airport, an "air hub" with worldwide nonstop flights, is 45 miles north in Vancouver, Canada.
- Sea-Tac International Airport is 90 miles south in Seattle, Washington.

LAND TRANSPORTATION

- Whatcom Transportation Authority (WTA)

- Greyhound Bus
- Private Charters / Shuttles
- Taxis
- Car Rentals

SERVICES

Hospital

- Two locations: St. Joseph's Hospital and the Outpatient Center are the two hospitals in Whatcom County, both located in Bellingham.

Local Media

- One local television station: Channel 12, Bellingham. Several companies provide television cable services.
- Telephone Companies:
    1. Qwest Communications in Bellingham
    2. Whidbey Telephone Company in Point Roberts
    3. Verizon Northwest in the remainder of Whatcom County
- Ten radio stations: AM / FM
- Emergency Alert System Station: KGMI (790 AM)
- One daily newspaper
- Seven weekly newspapers
- Two monthly publications

School Districts: Public Education, Kindergarten through 12th grade

- 34 Elementary Schools
- 11 Middle Schools
- 9 High Schools
- Numerous Private Schools

Colleges / Universities

- Bellingham Technical College
- City University
- Northwest Indian College
- Western Washington University
- Whatcom Community College

Utilities

- Electricity: Puget sound Energy, Public Utility District (PUD) #1, Blaine PUD, Sumas PUD, Bonneville Power (to direct-service customers)
- Gas: Cascade Natural Gas, Williams Natural Gas Pipeline, Arco Natural Gas Pipeline, Olympic Pipeline
- Water: Approximately 350 public water systems in Whatcom County. Bellingham, Lynden, Blaine, Glacier, Nooksack, and Sumas have their own water districts. Some smaller communities rely on private wells and lakes.
- Cogeneration Plants: Three cogeneration plants are located in Whatcom County: Sumas Cogeneration Company LP in Sumas; Tenaska Cogeneration Plant in Ferndale; Encogen Cogeneration Plant in Bellingham.

HAZARD SUMMARIES

Six hazards were identified to be risks to the county, specifically hazardous to the populated western areas of Whatcom County:

1. Earthquakes
2. Floods
3. Geologic Hazards
4. Tsunamis
5. Volcanoes
6. Wildland Fires

The following section describe these six hazards and their potential threats to Whatcom County. Much of the information collected in these hazard summaries came from local experts working in hazard assessment or hazard mitigation for a specific hazard. The purpose of these summaries is to describe the hazards, convey the areas at potential risk of each hazard, and describe mitigation measures, implemented in the past or to be implemented in the future, to control the hazards effects of natural disasters in Whatcom County.

Each hazard chapter is organized into sections:

1. **Hazard-Related Definitions**

2. **Background Information** – General description of the hazard relevant to Whatcom County and Washington State.

3. **History** – Historical background on the presence of the hazard in Whatcom County. Much of this information was obtained from agencies such as FEMA, DNR, and USGS.

4. **Vulnerability Assessment** – Descriptions of specific areas within the county at risk for each hazard, when this information was available.

5. **Mitigation Strategies** – Recommended mitigation strategies to lessen the dangers posed by each hazard.

6. **Maps** – Areas at risk for each hazard. Whatcom County's Planning and Development Services provided all the hazard GIS datasets, except for the Wildland Fire data, which came from DNR's North Region. (An earthquake map is not provided because an earthquake event puts all areas of Whatcom County at risk.)

EARTHQUAKES

DEFINITIONS:

Earthquake – a term used to describe both a sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the Earth.

Crust – the outermost major layer of the Earth, ranging from about 10-65 km in thickness worldwide. The uppermost 15-35 km of crust is brittle enough to produce earthquakes.

Fault – a fracture along which the blocks of crust on either side have moved relative to one another, parallel to the fracture.

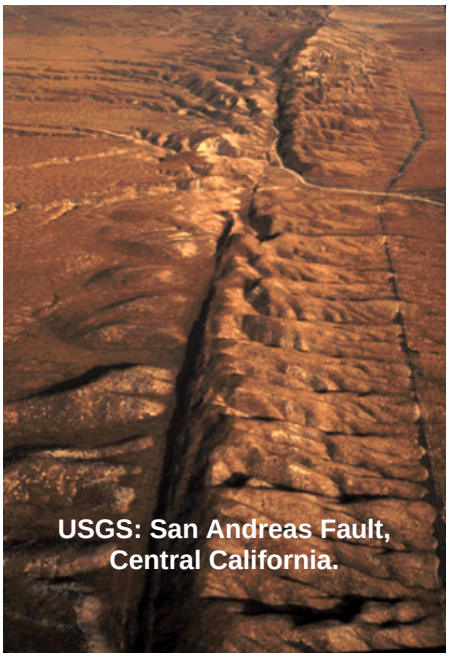
Liquefaction – the phenomenon in which loosely packed, water-logged sediments lose their strength in response to strong shaking, causing major damage during earthquakes.

Lithosphere – the outer solid part of the earth, including the crust and uppermost mantle. The lithosphere is about 100 km thick, although its thickness is dependent on age. The lithosphere below the crust is brittle enough at some locations to produce earthquakes by faulting, such as within a subducted oceanic plate.

Subduction Zone – the place where two lithospheric plates come together, one riding over the other. The process of subduction is where the oceanic lithosphere collides with and descends beneath the continental lithosphere.

BACKGROUND INFORMATION:

For hundreds of millions of years, the forces of plate tectonics have shaped the Earth as the huge plates that form the Earth's surface slowly move over, under, and past each other.



USGS: San Andreas Fault, Central California.

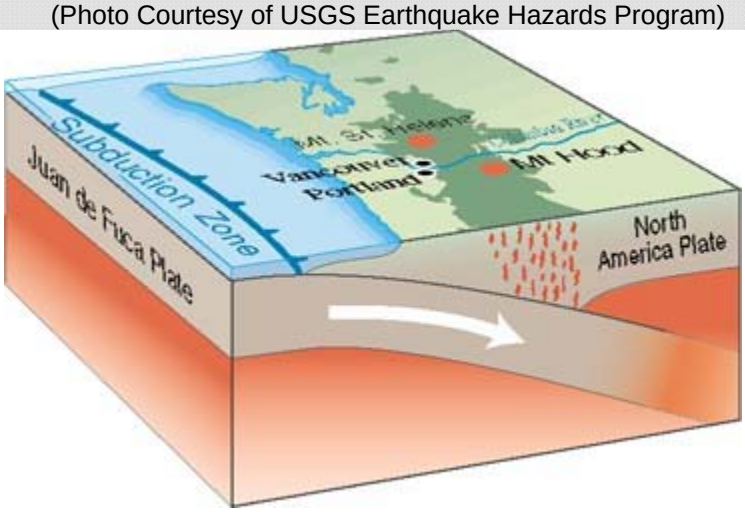
Sometimes the movement is gradual. At other times, the plates are locked together, unable to release the accumulating energy. This energy can also be generated by a sudden dislocation of segments of the crust, by a volcanic eruption, or even by man-made explosions. When the accumulated energy grows strong enough, the plates break free, resulting in an earthquake. If the earthquake occurs in a populated area, it may cause deaths, injuries and extensive property damage. Most destructive quakes, however, are caused by natural dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and "snap" to a new position.

Geologists have found earthquakes tend to occur along faults, which reflect zones of weakness in the Earth's crust. Even if a fault zone has recently experienced an earthquake, however, there is no guarantee all stress has been relieved. Another earthquake could still occur. Furthermore, relieving stress along one part of the fault may increase stress in another part.

The Juan de Fuca Plate is an ocean tectonic plate that is colliding with the North American Continental Plate near the western coast of Washington State in a subduction zone called the Cascadia Subduction Zone (CSZ). The CSZ extends from southern British Columbia to northern California. One of the results of the colliding forces at the CSZ is the Cascade Mountain Range; another, of more concern, is earthquakes.

Subduction zone earthquakes can be very powerful and of long duration. Recent geologic work along the Oregon and Washington coasts, and tidal wave data from Japan, indicate very large magnitude quakes occur, on average, every 550 years along the CSZ. The last major subduction quake to occur on the Washington Coast took place in 1700. Several fault zones have been identified in Western Washington, including the MacCaulay Creek Thrust Fault near Deming.

(Photo Courtesy of USGS Earthquake Hazards Program)



According to the USGS, Washington ranks 5th in the nation of states at risk of earthquakes with a magnitude 3.5 or greater. Since 1974, earthquakes occurring in Washington have accounted for 2.0% (424 earthquakes) of all the nation's earthquakes. According to a FEMA study, however, Washington ranks second in the nation (after California) susceptible to earthquake losses.

HISTORY:

Each year more than 1,000 earthquakes are recorded in Washington. Fifteen to 20 of these cause ground shaking strong enough to be felt. According to the USGS, recent geologic findings indicate that earthquakes generated within the CSZ pose a significant hazard to urban areas of the Pacific Northwest. Evidence gleaned from syntheses of global subduction-zone attributes, as well as from local tsunami deposits, suggest that major earthquakes rocked the Pacific Northwest perhaps as recently as 300 years ago.

The last intense earthquake to cause widespread damage in Washington occurred in 1965. Since that time the state's population has increased by nearly 50 percent. Washington residents have largely forgotten the 1965 earthquake, and this has contributed to a general lack of public awareness of the state's earthquake hazards. Some scientists suggest that even larger earthquakes have occurred every several hundred or thousand years in the Pacific Northwest. A more recent earthquake, although less severe than the one in 1965, occurred in 2001. This quake was centered farther south than Whatcom County, yet was still felt in and caused damage in the area. Table 1 lists the Pacific Northwest's largest earthquakes over the last 150 years.

Date	Depth	Magnitude	Approximate Location
December 1872	Shallow	7.3 Richter	North Cascades
October 1877	Shallow	5.3 Richter	Portland, OR
December 1880		?	Puget Sound
November 1891		?	Puget Sound
March 1893	Shallow	4.7 Richter	SE Washington
January 1896		5.7 Richter	Puget Sound
March 1904		5.3 Richter	Olympic Peninsula, Eastside
January 1909	Deep	6.0 Richter	Puget Sound
August 1915		5.6 Richter	North Cascades
December 1918		7.0 Richter	Vancouver Island
January 1920		5.5 Richter	Puget Sound
July 1932	Shallow	5.2 Richter	Central Cascades
July 1936	Shallow	6.4 Richter	SE Washington
November 1939	Deep	6.2 Richter	Puget Sound
April 1945		5.9 Richter	Central Cascades
February 1946		6.4 Richter	Puget Sound
June 1946	Deep	7.4 Richter	Vancouver Island
April 1949	54 km	7.1 Richter	Puget Sound
August 1949		8.1 Richter	Queen Charlotte, BC
August 1959	35 km	5.5 Richter	North Cascades, Eastside
November 1962	18 km	5.3 Richter	Portland, Oregon
April 1965	63 km	6.5 Richter	Puget Sound
February 1981	7 km	5.8 Richter	South Cascades

Table 1 – Largest Known Earthquakes Felt in Washington
(Information obtained from the Pacific Northwest Seismograph Network)

Most of Washington's earthquakes occur within the Puget Sound region, between Olympia and the Canadian border, along the western side of the Cascade Mountains, and along the Washington-Oregon border. This is not to say distant earthquakes do not affect Washington, such as the two Vancouver Island quakes listed in Table 1 that were felt in Washington.

The damage caused by earthquakes is not limited to the obvious, such as architectural failure in buildings due to the heavy swaying created from an earthquake. Liquefaction is another significant hazard that sometimes results from an earthquake, resulting in ground failure. Liquefaction and related phenomena have been responsible for tremendous amounts of damage in earthquakes around the world.

Liquefaction occurs in saturated soils, when the spaces between individual soil particles are completely filled with water. The shaking from an earthquake causes the water pressure within the soil to increase to the point where the soil particles readily move with respect to each other. Once liquefaction has begun in an area, such as under a building, it would act similar to a tub of rocking gelatin.

Population-dense areas in Whatcom County could be significantly impacted by future earthquakes and their related hazards, such as liquefaction. The nature and extent of earthquake risk in Washington is determined by a variety of factors, such as estimating the level of expected ground shaking and identifying sites susceptible to ground failures and tsunamis. Combining such hazard information with information concerning the distribution of population, types of building construction, and technological hazards in the state allows for assessing earthquake. For this plan, all the identified critical facilities were classified as affected by earthquakes since all of Whatcom County is at risk. Future revisions to the plan will include each critical facility's building structure and more accurate assessments of vulnerability to earthquake danger.

VULNERABILITY ASSESSMENT:

For all intents and purposes, the entire population of Whatcom County is vulnerable to the effects and impacts of an earthquake. An earthquake event in urban areas would involve especially high risk levels. Tall structures built on seismically-sensitive soils and fill are particularly at risk, due to the potential of liquefaction. The earthquake risk in Bellingham is exaggerated in areas of artificial fill where mud pumped out of Bellingham Bay has never compacted.

Possible types of damage from an earthquake may include, but will likely not be limited to:

- Cracking and/or structural failure of foundations, chimneys, decorative cornices, parapet walls, and cantilevered porches or roofs.
- Wall failure in older buildings of non-reinforced masonry construction.
- Damage to waterfront buildings and piers built on pilings and artificial fill.
- Structural damage or failure of bridges.
- Damage to streets and roads.
- Damage to railways and airport facilities.
- Broken water lines and natural gas lines.
- Power and communication failures due to damage of electrical and telephone distribution systems.

Specific examples of possible earthquake effects in Whatcom County include:

Landslides could impact various locations throughout the county: Chuckanut Mountain, Bellingham residential areas on steep slopes, Sudden Valley, upper Baker Highway, part of Highway 9, unstable bluffs on Lummi Island, Point Roberts, Western Washington University, and Sumas Mountain.

Highways

- Bridges are the most vulnerable component of highway systems, such as the I-5 overpasses.
- Bridge foundations in liquefiable soils can move, allowing spans they support to slide off. Areas at significant risk are Roeder Avenue bridges near Georgia Pacific and over Whatcom Creek Waterway; I-5 over Whatcom Creek and Nooksack River; Mount Baker Highway and Highway 9 over the Nooksack River; Guide Meridian and Hannegan Roads over the Nooksack River.
- Supporting columns can buckle.

Railways

- Railway bridges have performed well, but may be subject to liquefaction, such as those along the Bellingham waterfront.
- Landslides may cover the tracks.

Airports

- The Bellingham Airport runway, built on the site of an old lake, may be vulnerable to liquefaction.

Pipelines – Water, Wastewater, Liquid Fuel, Natural Gas:

- Water pipelines – Commonly fail, quickly draining the water system, making water unavailable for fire suppression, drinking, toilet flushing, etc.
- Sewer pipelines – These are often gravity systems and change in grade can impact system operation.
  - These sewer lines relying on pumps will not work if there is no electric power.
  - These pipelines are vulnerable to flotation if the ground around them liquefies.
- Liquid Fuel and natural gas pipelines – Those constructed of steel with welded joints have performed well except in extreme conditions. The high-pressure lines are made of welded steel or polyurethane plastic, which are flexible. Pipelines constructed of brittle materials are most vulnerable.
  - Water and older gas distribution systems contain brittle materials such as cast iron and asbestos cement. Pipelines buried in liquefiable soils or landslide areas may fail.

MITIGATION STRATEGIES:

Earthquakes have long been feared as one of nature's most damaging hazards. Earthquakes continue to remind us that nature still can strike without warning and, after only a few seconds, leave casualties and damage in their wake. Therefore, it is important that each person and community take appropriate actions to protect lives and property.

Although earthquakes cannot be prevented, current science and engineering provide tools that can be used to mitigate the damage. Science can now identify, with considerable accuracy, where earthquakes are likely to occur and what forces they will generate. Modern engineering has resulted in design and construction techniques that allow buildings and other structures to survive the tremendous forces of earthquakes.

FEMA's National Earthquake Hazards Reduction Program (NEHRP) has four basic strategies related to the mitigation of hazards caused by earthquake:

1. Promote understanding of earthquakes and their effects
2. Work to better identify earthquake risk
3. Improve earthquake-resistant design and construction techniques
4. Encourage the use of earthquake-safe policies and planning practices

Future study of earthquake behavior to understand the relationship between the different kinds of earthquakes will lead to a better understanding of preparing for and dealing with earthquake hazards.

FLOODING

DEFINITIONS:

Avulsion – the sudden cutting off of land by floods due to a change in the course of a river body.

Flood – an inundation of dry land with water caused by weather phenomena and events that deliver more precipitation to a drainage basin than can be readily absorbed or stored with the basin. The National Flood Insurance Program defines a flood as a, "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties."

Floodplain – the land area of a river valley that becomes inundated with water during a flood.

National Flood Insurance Program (NFIP) – a Federal program enabling property owners in participating communities to purchase insurance protection against losses from flooding. This insurance is designed to provide an insurance alternative to disaster assistance to meet the escalating costs of repairing damage to buildings and their content caused by floods. Participation in the NFIP is based on an agreement between local communities and the Federal Government which states if a community will adopt and enforce a floodplain management ordinance to reduce future flood risks to new construction in Special Flood Hazard Areas, the Federal Government will make flood insurance available with the community as a financial protection against flood losses.

BACKGROUND INFORMATION:

The natural hazard of most concern to Whatcom County, primarily due to its frequency, is flooding. Whatcom County flood events generally occur on floodplains in the Lower Nooksack River watershed. A floodplain is the land adjoining rivers, streams, coastal waters, ditches, wetlands, low-lying areas or lakes that are likely to flood. According to an October, 1999, report, prepared by the Whatcom County Public Works Department, the most significant floodplains in Whatcom County are those present in the lower Nooksack River watershed, This report, "Lower Nooksack River Comprehensive Flood Hazard Management Plan" (CFHMP), details flooding characteristics on the Lower Nooksack River, and served as the primary source of information for this flooding summary.

Most of the Nooksack River watershed is in the steep, mountainous Cascade foothills at the base of the Cascade Mountain Range. The Lower Nooksack River begins at the confluence of the north, south, and middle forks and extends down to Bellingham Bay. The watershed encompasses approximately 825 square miles over an elevation range of 10,000 feet to sea level. The Cascade foothills receive more rainfall than the flatter, western lowlands of the County. This precipitation, combined with the steep slopes of the watershed in the foothills and size of the upper watershed, contributes to the conditions that allow floodwater to quickly reach the flat lower river reaches. The devastating and frequent flooding in 1989 and 1990 prompted county residents and government to find solutions to perennial flood problems. Because of severe damages occurring along the Lower Nooksack River floodplain, this area was the focus of initial planning efforts and development of the CFHMP.

In the CFHMP, the Lower Nooksack River was reviewed by river reach as described below and as shown in Table 2. The five reaches begin with Reach 1 at the mouth of the Nooksack and move upstream.

	River Mile	River Channel		100-Year Floodplain	
		Length (miles)	Gradient (ft/mile)	Area (mi^2)	Width (avg. miles)
Reach 1	0 to 6.0	6.0	1.8	13.8	2.8
Reach 2	6.0 to 15.3	9.3	2.3	8.3	1.1
Reach 3	15.3 to 23.6	8.3	4.9	12.0	1.9
Reach 4	23.6 to 26.6	13.0	21.3	7.5	1.3
Reach 5	---	13.2	4.5	21.5*	22.5**

* Drainage Area
** Average Creek Width

Table 2 – River Reach Description
(Information obtained from the CFHMP)

Reach 1 includes the area from the mouth of the Nooksack River to Ferndale west to Haxton Way, including a portion of the Lummi Indian Reservation. Reach 1 is physiographically diverse and includes a complex delta estuary, a broad flat plain, and two large, shallow ponds, Tennant Lake and Clay (Brennen) Pond. Both sides of the river are diked, either directly along the existing river channel or set back a short distance from the bank. The banks are heavily rip-rapped, especially adjacent to the levee.

Reach 2 extends from the Interstate 5 bridge at Ferndale to the Guide Meridian bridge, just southwest of Lynden. The river channel is characterized by looped meanders, and relatively small gravel bars. Natural topography along the river includes discontinuous natural levees formed by sediments deposited during flooding. Constructed levees confine the river to a narrow channel along much of Reach 2. A portion of the river upstream of Ferndale is not leveed.

Reach 3 includes the portion of the Nooksack River between the Everson bridge and the Guide Meridian bridge and marks the transition from the braided, unstable channel upstream to the more stable, meandering river channel and broader floodplain that are typical downstream.

Reach 4 is the uppermost reach in the CFHMP study area. It extends from the Everson bridge to the confluence of the middle, north, and south forks. This reach is noticeably different than the lower reaches, primarily because of the steep slope of the active channel. Not only does the channel split into multiple paths at many locations, forming a braided channel, but over time it moves laterally across the floodplain.

Reach 5 is not actually a part of the Nooksack River mainstem, but is a flood overflow corridor between the Nooksack River, near Everson, north to the U.S. / Canada border. At the City of Everson, a low divide separates the Nooksack River basin from the Sumas River basin, where waters flow northward to the Fraser River in British Columbia. During large floods in the Nooksack, floodwaters cross the basin divide and flow to B.C. along the corridor of Johnson Creek and through the city of Sumas.

Flooding Causes

Many factors combine to cause flooding along the Lower Nooksack. River gradient and weather patterns are some of the more significant factors.

River Gradient that Affects Flooding

One of the most important characteristics of the Lower Nooksack River is the change in river gradient from Deming to Bellingham Bay. As mentioned previously, Reach 4 is steep and

constantly migrating with a narrow floodplain. Within Reach 4, many abandoned side channels can accommodate floodwaters. In contrast, the lower reaches are flatter with wider floodplains. Side channels in Reaches 1, 2, and 3 have largely been filled and replaced with agricultural fields. Levees have been constructed along these reaches to protect fields, farmhouses, and roadways.

Weather Patterns that Cause Flooding

Heavy fall and winter rainfall in Whatcom County results from an effect called orographic uplift. This heavy rainfall, along with the large area feeding into the Nooksack River and extreme slopes results in large amounts of runoff that quickly reach the flat floodplains along Reaches 1, 2 and 3. Rainfall varies across the watershed and is significantly greater in the mountains. During the 1990 Veterans Day flood, approximately 14 inches of rain fell in the upper reaches of the watershed over three days, with snow melt adding an extra two inches. During the same storm, Bellingham only recorded five inches of rain.

The worst flooding tends to occur during the "pineapple express" weather patter of the fall and winter. Pineapple express fronts bring warm, wet air into the watershed, resulting in heavy rainfall. If snow has accumulated in the mountains when the warm rains begin, the resulting snowmelt significantly increases runoff to the river. This resulting runoff is most severe when preceding steady rains have saturated soils within the watershed. Together, the conditions of heavy rain, accumulated snow, and saturated soils create the potential for severe flooding.

HISTORY:

Table 3 lists the largest recorded Nooksack River floods as recorded at Deming and Ferndale stream gages.

Date	Deming Flow*, CFS	Ferndale Flow, CFS	Overflow in Everson, causing flood damage.
1/25/1935	39,600	---	Yes
10/25/1945	38,000	41,600	Yes
11/27/1949	36,500	27,500	Yes
2/10/1951	43,200	55,000	Yes
11/03/1955	38,500	35,000	Yes
1/30/1971	---	38,100	Yes
12/3/1975	40,300	46,700	Yes
12/15/1979	---	36,400	No
1/4/1984	---	41,500	Yes
11/23/1986	---	36,000	No
11/9/1989	36,500	47,800	Yes
11/10/1990	37,900	57,000	Yes
11/24/1990	35,100	56,600	Yes

Table 3 – Largest Recorded Nooksack River Floods

** The Deming gage is subject to significant bed instability during flood events. Peak flows reported for Deming are prone to error.*

VULNERABILITY ASSESSMENT:
Understanding existing flood patterns, and the relationship between flooding and existing flood management structures, provides a basis for predicting circumstances of future flood events. The following summary describes historic flooding patterns and problems of the Lower Nooksack River. Please note that right and left bank locations are designated as if you were standing in the channel and looking downstream.

Reach 1 Flooding Patterns
Ferndale Area – The residential area on the right bank upstream of the Burlington Northern Railroad bridge experiences flooding during major events, as do commercial properties along Main Street on the left bank and city golf course. A portion of the levees in Ferndale, on the right bank from the Main Street bridge to immediately north of the city's water treatment plant, offer protection from flooding up to approximately a 60-year event. Significant flood fighting efforts upstream of the water treatment plant were necessary in 1990 to prevent floodwaters from overtopping Ferndale Road.

Right Bank Downstream of Ferndale – Flooding at Marine Drive is frequent, beginning with events of low magnitude. Levee breaks result in inundation of Haxton Way, cutting off access to the Lummi Peninsula and Lummi Island. Other sites of right bank flooding along the reach depend upon levee protection. Levee breaches downstream of Slater Road generally result in flooding between the Nooksack River and Lummi (Red) River south of Slater Road.

Left Bank Downstream of Ferndale – As the river rises to the 5-year flood level, floodwaters overtop the left bank immediately downstream of Ferndale near Hovander Park. Floodwaters travel through Hovander toward Tennant Lake and continue south toward and over Slater Road.

Marietta – Marietta experiences the most frequent flooding of any residential area along the Nooksack River and is susceptible to tidal influences that contribute to flooding. A levee surrounds Marietta, but is low and in poor condition, making it susceptible to overtopping and breaching.

Overflow to Lummi Bay – Floodwaters flowing west toward Lummi Bay are stopped by the seawall and accumulate despite the two sets of culverts that drain the seawall. Floodwaters can overwhelm the capacity of the seawall, leading to seawall breaches, and allowing saltwater to flow inland when floodwaters recede. A set of six 48" diameter culverts near the Lummi (Red) River mouth draining the area south of the river were replaced with five 6'x4' box culverts in 1998. Tide gates in the culverts prevent saltwater from flowing inland as the tide rises. Three 5'x5' box culverts drain the area north of the river.

Reach 2 Flooding Patterns
Overflows from Reach 3 – Floodwaters enter Reach 2 from Reach 3 through the main channel Guide Meridian bridge and two overflow bridges under Guide Meridian in the floodplain. Main channel and left bank overflows are constricted by high ground on the left bank and levees along River Road on the right bank. Left bank overflows encounter a short section of levee and the natural high ground close to the river bank very shortly after passing under the south overflow bridge. The levee and high ground push the left bank overflow waters back into the river and toward right bank levees. Numerous historical breaches in the River Road levee are attributed to this constriction.

Right bank overflows enter Reach 2 behind the River Road levees through the north overflow bridge. Overflows reach levees along Fishtrap Creek, which funnel floodwaters south,

closer to the main river channel, and on toward Bertrand Creek. These flows are augmented by overflows through breaches in levees along River Road.

Fishtrap Creek – Flood overflows pass from Reach 3 to Reach 2 through the north overflow bridge under Guide Meridian. Floodwaters encounter levees along Fishtrap Creek, which extend from just below Guide Meridian approximately 1.8 miles downstream. The levees limit bank overflows, but do not contain floodwaters during large flood events. The levees along both Fishtrap and Bertrand creeks are intended to protect agricultural lands from spring flood events, but are not meant to provide protection during large flood events.

Bertrand Creek – Floodwaters that pass Fishtrap Creek reach Bertrand Creek, which is lined with levees on both sides. The Bertrand Creek levees are approximately perpendicular to flood flows, which causes floodwater to back up onto farmlands upstream of the creek. As a result, high velocity flows cause overtopping and levee breaches during almost every flood event. An overtopping section of the creek's right bank levee near the river channel helps reduce the likelihood of a left bank levee breach during high creek flows, but is insufficient to prevent levee breaches along Bertrand Creek.

Left Bank Overflow Corridor – Levee overtopping has historically occurred on the VanderPol property immediately downstream of the high ground on the left bank; floodwaters follow a natural overflow corridor along the reach. Left bank levees offer varying levels of protection, and floodwaters historically have overtopped the levees at various locations. Approximately two miles upstream of the I-5 bridge, near Lattimore Road, higher topography along the left bank guides floodwaters back into the river channel. A short distance upstream, a levee on the Appel property blocks flow returning to the river and has experienced repeated overtopping and failure.

Right Bank Downstream of Bertrand Creek – Floodwaters that pass Bertrand Creek continue along the right bank corridor to approximately the I-5 corridor. Levees offer sporadic protection of the right bank for three miles downstream of Bertrand Creek, but no levees are in place for the last three miles of the Reach. Random overtopping of levees and river banks is typical.

Ferndale Area – Upstream of the I-5 bridge, Reach 2 includes areas within or immediately outside Ferndale. Residential and commercial urban development is encroaching into the 100-year floodplain, increasing the possibility of flood damage. A residential development, fast-food restaurant, motel, and gas station have been built in the floodplain, and more commercial development is planned.

Reach 3 Flooding Patterns

Levees along both banks have been built and repaired over the years by a variety of public agencies and private property owners, with no coordination of design or maintenance, resulting in a levee system prone to unpredictable breaches and misdirection of flows from natural overflow corridors and floodwater storage areas. Roadway overtopping is common, and floodwaters often remain trapped in depressional areas long after the flood peak passes. Bank erosion has historically been a problem.

Overflows in the Upper Portion of Reach 3 – Natural overflows exist on both banks north of Nolte Road, immediately downstream of Everson. Right bank overflows travel north toward Mormon Ditch and Kamm Creek. During large floods, this flow continues downstream over Hannegan Road, past the Lynden waste water treatment plant, and through the Guide Meridian

north overflow bridge. Left bank overflows travel south to Scott Ditch, then west, and return to the river through Scott Ditch or through the south overflow bridge at Guide Meridian.

Hampton/Timon Road Area – The right bank near Northwood Road is a natural overflow. Floodwaters flow north toward Mormon Ditch and Kamm Creek. Floodwaters from upstream overflow on both banks, inundating and damaging roadways in their path, including Timon Road, Slotemaker Road, and Hampton Road on the right bank; Noon Road, Polinder Road, and Abbott Road on the left bank. Six residences located near the confluence of Kamm Creek along Hampton Road are impacted by right bank overflows as well as by backflows from the Nooksack River up Kamm Creek.

Polinder Road Area – Two farmable levees have been constructed to overtop on the left bank above Polinder Road:

1. North of the intersection of Polinder and Theel Road on the Bedlington property.
2. The river bend just east of Hannegan Road on the Polinder property.

Floodwaters from both overflows travel southwest toward Scott Ditch and the south overflow bridge at Guide Meridian.

Scott Ditch – Scott Ditch serves as a conduit for flows leaving the Nooksack's left bank along most of Reach 3.

Lynden Wastewater Treatment Plant – The floodplain is constricted by natural topography as well as structures built in the area west of Hannegan Road. Floodwaters that overtop Hannegan Road must flow around the north side of the treatment plant and over the plant access road. As floodwaters recede, water backed up between the treatment plant and Hannegan Road drains back to the river by way of a ditch that begins east of the plant, is conveyed through a box culvert under the plant access road, and in a 60" culvert through the right bank river levee. The 60" levee culvert is not equipped with a floodgate and water can back up through the culvert when the river rises.

BC Avenue Area – On the right bank downstream of the treatment plant, there is an overflow on the Stremler property south of BC Avenue in Lynden. The levee at this overflow was restored, strengthened, and raised by the USCOE to prevent future overtopping after the 1990 floods.

Bylsma Road Area – There is an overflow on the left bank between Bylsma Road and the confluence of Scott Ditch and the river. Levees on the right bank opposite this overflow historically overtop.

Guide Meridian Overflow Bridges – The Guide Meridian was supported on piles to let floodwaters pass beneath, through the Nooksack River floodplain, until around 1950. Floodwaters are now conveyed through overflow bridges that convey a significant portion of Reach 3 overflows downstream to Reach 2. As floodwaters pass through these narrow openings, flow velocity increases, threatening the structural integrity of the bridges.

Reach 4 Flooding Patterns

With the relatively narrow floodplain and unstable, rapidly migrating river channel in Reach 4, the primary flood hazards are bank erosion and the threat of avulsion.

The Deming Area – At Deming, the river channel has migrated across the floodplain in the last two decades. Aerial photos show that in 1975, the river flowed on the opposite side of the floodplain from the community. By 1986, the river had moved 600 feet across the floodplain to

its present location. Recent Nooksack River flooding has threatened the Mount Baker School District bus maintenance and sewage treatment facilities, along with the Walton properties along Deming Road on the right bank. At-risk properties are protected by riprap armoring. Immediately downstream of the riprap protection, erosion occurs on the left bank from deflected flows from the right bank riprap.

Mariotta Road Area –
Right Bank – An overflow was created during 1990 floods in the vicinity of Mariotta Road by overtopping and eroding the right bank, resulting in bypassing of the existing river bend. Approximately one-third of the river's flow followed this new channel. Floodwaters returned to the main channel approximately one-half mile from Mariotta Road. After the 1990 flood, 2,000 feet of bank was restored and new riprap was placed along the right bank to prevent a similar future overflow. A bottleneck immediately downstream of the overflow creates stress on the left bank at an area known as the "Clay Banks." By preventing right bank overflows, the new riprap increases the force of floodwaters on the left bank downstream. The bottleneck created by accumulated sediment on the Sande property, on the inside of the river bend in this area (right bank), increases the force of flow on the left bank. Floodwaters that overflow the right bank between Deming and Nugents Corner generally follow low topography and swales toward Smith Creek.
Left Bank – The left bank across from Mariotta Road is a steep hillside of silty clay soil that has been increasingly eroding. Slides from this hill have added silt, clay, and other sediment to the river. As the river undercuts the slope, the land sinks and slides. Groundwater seepage along the face of the hillside may also be destabilizing the slope. Several houses at the top of the bluff have been moved back from the hillside, but remain threatened by the erosion.

Nugents Corner – Flood fighting efforts in 1990 directed floodwaters around the commercial area, following a system of natural channels, but floodwaters damaged some sections of the community's residential area.

Mount Baker Highway Bridge – The Mount Baker Highway bridge at Nugents Corner is the only bridge over the river at Reach 4. A flood in 1989 washed out the left bank approach to this bridge. Riprap was subsequently placed on the upstream side of the left bank bridge abutment to protect it. The Washington State Department of Transportation (WSDOT) has recently completed a bridge replacement project.

Nugents Corner to Everson – The river migrates across the floodplain between Nugents Corner and Everson more than in any other river reach. Channel meandering has resulted in erosion. Bank erosion is limited on the left bank, but the right bank has been heavily impacted by bank erosion. The channel capacity and natural terrain between Nugents Corner and just upstream of Everson is high enough that floodwaters do not overtop the right bank along most of the section. During larger flood events, however, flood waters overtop the high ground divide, separating the Nooksack River and Sumas River basins, to flow toward Sumas, and sometimes into Canada.

Riverberry-Davis-Vandellen Property – The Riverberry property includes a farm located approximately halfway between Everson and Nugents Corner. The river eroded between 30 and 40 acres of this site between 1985 and 1993, and an estimated additional 300 feet since that time. The river has meandered eastward approximately 250 linear feet (LF), eroding raspberry and pasture farmland. The continued erosion was diminishing the natural overbank levee, which was the basin divide between the Nooksack and Sumas basins, increasing the

frequency of overland flow and potential for channel avulsion into the Everson – Sumas Overflow Corridor.

In 1997, Whatcom County completed a pilot project to provide fish habitat and bank stabilization on the property. The Riverberry Davis site, approximately 2,200 LF, incorporates four rock deflectors and four dolo-rock deflectors with woody debris placed between the structures. The Vandellen site, approximately 900 LF, incorporates large organic debris and timber pilings to construct 19 deflector structures.

Left Bank Overflow Corridor Opposite Everson – The Nooksack River has historically overtopped a left bank levee immediately upstream of Everson. Floodwaters follow the low topography through agricultural areas for approximately 1 mile before flowing through a large arch culvert under Everson-Goshen Road (SR 544) and returning to the river.

Reach 5 Flooding Patterns

Floodwaters leave the river channel and overflow through Everson at three locations:

1. South (upstream) of Massey Road
2. Along Emmerson Road between Massey Road and Everson
3. Approximately 1,500 feet upstream of the Everson Bridge

Floodwaters from the three overflow sites combine after crossing Massey and Emerson roads and flow northward over Main Street in Everson and into the Johnson Creek basin. A railroad embankment prevents floodwaters from entering the Sumas River until they reach the vicinity of the City of Sumas. During small overflow events, floodwaters pass over fields and enter a drainage ditch that empties into Johnson Creek just north of Lindsay Road. During major events, floodwaters fill Johnson Creek's valley floor and continue to Sumas, typically flooding the downtown area with several feet of water.

Everson – All major Nooksack River floods cause flooding in Everson. Floodwaters generally flow into the city from the south along Washington Street and from the overflow area to the east. Since 1990, a 1,000' levee, referred to locally as Lagerway Dike, was constructed immediately south of Everson. The levee provides some flood protection but is not high enough to prevent Everson from being flooded during a large overflow.

Sumas – During major floods, flows top the divide between the Nooksack and Sumas watersheds and flow north in the floodplain along Johnson Creek, eventually reaching the city of Sumas. Floodwaters often cross the U.S. / Canada border within hours of an overflow occurring in Sumas.

Sumas Prairie / Abbotsford (B.C.) – After passing through Sumas, floodwaters cross the border into District of Abbotsford and along the Sumas River, overtopping the Sumas River's left bank. Floodwaters have historically backed up from the Whatcom Road interchange of the TransCanada Highway and ponded in the western portion of Wet Sumas Prairie, with some floodwater ponding in the Lower Sumas River, Saar Creek, and Arnold Slough. A dike prevents flooding of the reclaimed Sumas Lake Bottom, a prime agricultural area.

Avulsion Potential at Everson – It is possible that an avulsion would redirect the Nooksack River from its present path to a northward path along the Johnson Creek corridor. The Johnson Creek corridor drops an average of six feet per mile over its 10-mile course, a slope twice as steep as the 3-foot-per-mile drop of the Nooksack River. This steeper slope enhances the tendency toward an avulsion. Geologic evidence indicates the Nooksack River did flow north at Everson into the Sumas River and Frasier River Basins.

A study commissioned by the British Columbia Ministry of Environment, Lands, and Parks predicts the Nooksack River's right bank would have to erode 820 feet at a critical location for an avulsion to occur, and estimates the likelihood of this is 20 percent during a 100-year flood, a statistical occurrence of once every 500 years.

MITIGATION STRATEGIES:

A flood hazard management plan for the lower Nooksack River must incorporate a number of structural and nonstructural elements and activities for both the short and long term to be fully functional. Both operational effectiveness and cost effectiveness must be periodically reviewed and adjusted throughout the life of the plan. Accordingly, the CFHMP has recommended the following actions to be made for flooding mitigation:

1. Hydraulic modeling and alternatives analysis
2. Engineering and design of capital improvement projects
3. Meander limit identification and adoption
4. Sediment management strategy development
5. Floodplain mapping and land use management in the floodplain
6. Land and easement acquisition program development
7. Flood preparedness and emergency response

The CFHMP also outlines recommended projects and programs to implement along the various reaches of the Lower Nooksack River. The CFHMP recognizes that both short- and long-term implementation of structural and nonstructural elements and activities must be put in place for the projects to be fully functional. Below are *recommended* mitigation strategies for the five reaches of the Lower Nooksack. For more details on these projects, refer to the CFHMP, available from Whatcom County's River and Flood Division, Public Works department.

Mitigation for Reach 1

Lummi River – The recommended improvement for the Lummi River (Red River) is not to increase flows to the river but to rehabilitate existing culverts at the diversion from the Nooksack River, including a gate or similar flow control structure and modifying downstream structures, if necessary.

Right Bank Between the Bridges in Ferndale – The recommended improvement is to designate the properties for flood proofing and/or property buyouts, and maintain open space at Vander Yacht Park at the golf course on the left bank. Implementation of this recommendation should include defining and stabilizing the overflow path which could potentially overtop I-5.

Left Bank Downstream of Ferndale – The recommendation for this area is to maintain the overflows in Hovander Park and maintain the existing natural overflow corridor along the left bank. With this approach, agricultural levees downstream from the overflow area that are not continuous now, could be made continuous as maintenance and reconstruction is called for. The rebuilt levees' crest elevations should be the same as those of right bank agricultural levees downstream of Ferndale, and they should be built to withstand overtopping. Computer modeling of this recommendation will be required.

Slater Road Bridge Approach – The initial recommendation for this area is to maintain it at its current elevation to allow overtopping and temporary road closures during floods. Eliminating overtopping of Slater Road on the left bank during large floods would be of little benefit at times when overtopping on the right bank during large floods inundates the road on the other side of

the river. This recommendation should be reconsidered as traffic demands change with time and if special financing were to become available.

Marietta Area – The recommended improvement for the Marietta area is to designate all flood-prone properties in the community for buyout, so that owners would have the option to sell and relocate should federal purchase funds be made available after a future flood. In the interim, property owners are encouraged to flood proof their structures.

Right Bank Downstream of Ferndale – The recommended improvement is a setback levee to provide 100-year flood protection and manage overflows to Lummi Bay. This improvement will require discussions with affected property owners. Existing agricultural levees along the right bank will remain overtoppable, but a right-bank overflow corridor will be in place, necessitating flood easements, flood proofing, and/or property buyouts in the corridor. Haxton Way will not have to be raised and the Lummi Seawall will not have to be rehabilitated.

Treatment Plant and Ferndale, South of the Bridges – This improvement is to provide 100-year flood protection along the right bank downstream of Main Street by raising the existing levee and Ferndale Road, and to connect the Ferndale Road levee to the recommended new levee downstream.

Marine Drive Bridge Approach – Maintain it at its current elevation to allow overtopping and temporary road closure during floods. Lowering the roadway will not be necessary with the recommended setback levee on the right bank to manage overflows to Lummi Bay.

Haxton Way – Implementation of the recommended right bank setback levee would minimize the occurrence of Haxton Way inundation, making the general raising of Haxton Way unnecessary. However, until the right bank cutoff levee recommendation is accepted and fully implemented, levee overtopping and levee breaches will likely continue. Under these circumstances, the raising of the lowest sections of Haxton Way as an interim action is considered appropriate.

Lummi Bay Seawall – The right bank setback levee will minimize inundation of the Lummi Bay seawall, so no significant capital improvements are recommended for the seawall. Continued maintenance of the existing structure and culverts and tidegates is recommended.

Mitigation for Reach 2

Ferndale Urban Area – Analyze flood dynamics in the Ferndale urban area in detail, including an evaluation of the relationship between urbanization, flood storage and conveyance, and the potential for I-5 overtopping. Evaluation of an overflow path in the event of I-5 overtopping should also be included.

River Road Area – Designate a right-bank overflow area and strengthen the remaining levee along River Road.

Fishtrap Creek – Explore with local property owners the possibility of lowering a segment of the levees to provide a wider flow path for overflows from the Nooksack River. This approach will also require regular sediment removal from the creek in order to maintain channel capacity and/or reduction of sediment inflow from the creek's upper watershed.

Bertrand Creek – Establish new levee profiles along the creek and design the levees to be overtoppable.

Guide Meridian & I-5 – Designate left bank overflow corridor between Guide Meridian and I-5.

Mitigation for Reach 3

Detailed Hydraulic Analysis – Recommendation that includes strategically linking the river channel with the agricultural floodplain. The goal is to limit random bank/levee overtopping, random levee failure, and sudden development of off channel flood flow paths. This would be accomplished by distributing those flows which exceed channel capacity over the flood plain and thereby reducing levee and bank stress. Seven overflow locations would be analyzed under this program:

1. Right bank south of Slotemaker Road
2. Left bank near the west end of Nolte Road
3. Bend in the right bank south of Northwood Road
4. Left bank near the intersection of Polinder and Thiel roads.
5. Left bank in the bend upstream of the Polinder/Hannegan intersection
6. Right bank downstream of the Lynden treatment plant
7. Left bank northwest of Bylsma Road, upstream of where Scott Ditch enters the river

Strengthening of Roadway Sections – Along overflow corridors, as appropriate. Designating overflow location will maintain the historical pattern of overtopping some roadways in the floodplain. The designated roadways areas are:

1. Slotemaker Road
2. Timon Road
3. Hampton Road
4. Noon Road
5. Thiel Road
6. Polinder Road
7. Hannegan Road

Guide Meridian Overflow Bridges – This improvement, in the short term, is to provide protection against erosion and scour through armoring. If the roadway is rebuilt in the future, opportunities for lengthening the bridges and/or creating additional openings should be investigated at that time.

Mitigation for Reach 4

Limiting of Channel Migration – These reasonable limits and the prevention of a right bank avulsion are recommended with three levels of priority:

1. Immediate action to move the channel away from limits mapped as part of the CFHMP
2. Future action when the channel is moving toward the meander limits
3. Long-term, ongoing future action to move the channel towards the middle of the corridor along Reach 4.

This action is called for at the following sites:

1. In Deming near the Mount Baker High School
2. Southwest of Williams Road, downstream from Deming
3. West of Mariotta Road
4. The property west of Hopewell Road
5. The property just south of Massey Road and west of Cole Road

Deming Right Bank Areas at High Risk of Avulsion – To perform three projects:

1. Add new protection downstream of Deming and shorten the existing protection at the high school

2. Ensure existing bank protection south of Williams Road provides avulsion protection
3. Add new protection between the protection projects already in place on the Sande property and west of Marietta Road

Mariotta Road – remove 300 feet from the south end of the existing riprap protection, tie the remaining riprap into the right bank, and remove the gravel from the bar on the right bank of Sande property. Retrofit of the remaining riprap to reduce vulnerability to scour and increase fish habitat should be considered. Additional work on the left bank downstream of the clay banks may be warranted.

Nugent's Corner – construct low levees on the upstream and downstream sides of the Mount Baker Highway bridge. This improvement to Nugent's Corner should be given a lower priority than projects to prevent avulsion elsewhere in Reach 4.
Levees near Nugent's Corner – Maintain and strengthen, if necessary, the existing overtopping levee upstream of Everson, on the left bank.

Mitigation for Reach 5
Everson Bridge – Maintain the stand of timber at the upstream end of the overflow on the river's right bank, approximately one mile upstream from the Everson Bridge. Plus, retrofit and maintain an overtopping levee on the left bank in the same area.

Nooksack River & Johnson Creek Watersheds – Maintenance of the divide between the Nooksack and Johnson Creek watershed involves structurally maintaining the divide with an aggressive alternative, a rock trench, as well as holding discussions with property owners to ensure local farming activities do not involve fields along the divide and changing ground elevation. The second measure is to provide continuous hard protection along the entire length of the overflow from the Nooksack River to the John Creek corridor.

Some of the areas other than the flood plains that have been vulnerable to floods, or isolation by flood waters or landslides, in the past, include:

- Sudden Valley
- Smith Creek & North Shore Road
- Hillside Road
- Park Road
- Blue Canyon
- Iowa Heights
- Henderson Road
- Mount Baker Highway Communities

Citizens in Whatcom County should understand the flood potential of areas in which they elect to live. It is important to remember that dangers associated with flooding do not end when the rain stops. Electrocution, structural collapse, hazardous materials leaks, and fire are secondary hazards associated with flooding and flood cleanup.

GEOLOGIC HAZARDS

DEFINITIONS:

Alluvial Fan – an outspread, gently sloping mass of alluvium (stream-deposited sediment) located where a stream or canyon issues onto a valley floor or plain. The term alluvial fan encompasses debris flow fans, composite fans, and fan deltas.

Landslide – a term that includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows.

Seismic Hazard – Areas subject to severe risk of earthquake damage, such as those areas underlain by soils subject to liquefaction. Almost all of the lower Nooksack River floodplain is categorized as seismically hazardous.

BACKGROUND INFORMATION:

Due to their presence in Whatcom County, as well as data availability, four geologic hazards were identified and analyzed as part of this plan:

1. Alluvial Fans – all alluvial fan areas were classified as hazardous.
2. Coal Mines – any areas on top of a historical coal mine were determined to be hazardous.
3. Landslides – risk areas were determined by looking at percent slopes, specifically those hazard areas with a percent slope greater than 15 degrees.
4. Seismic Hazards – areas comprised of seismically-sensitive soils were classified as hazard areas. These hazardous soils are either man-made fill deposits or geologic units subject to shaking or liquefaction during an earthquake.

Alluvial Fans

Alluvial fans form where there is a sharp change in stream gradient and sediment is deposited where the stream velocity decreases, generally where a stream or canyon issues onto a valley floor or plain. Mass wasting, or landsliding, functions as the primary link in the natural transportation of soil material to streams in the Pacific Northwest, and can be expected to occur intermittently as part of on-going erosion processes. The sediment and debris generated by mass wasting events are deposited in stream channels and on fan surfaces, contributing to the build-up of materials.

Alluvial fans are common along the reaches of the Nooksack River where steep side streams encounter the Nooksack Valley floor. Many of the alluvial fans in Whatcom County are subject to periodic debris flows. Debris flows consist of a mixture of water, sediment, and debris that flows down the steep stream channel. They are generally triggered by landslides, mass wasting, or stream blockages in the upper portion of the stream. When the debris flow reaches the alluvial fan, the debris may be quickly deposited within the existing stream channel leading to channel avulsion, the sudden changing of stream course to a new channel.

Coal Mines

According to the *NW Source*, William H. Prattle, one of Bellingham's earliest settlers, responded to Native American tales of local coal outcroppings by opening a marginally successful coal mine in the settlement called Unionville in 1853. The same year, San Francisco investors opened the Sehome Mine, adjacent to the Whatcom settlement, and it became one of the two largest employers in the area until the mine was flooded in 1878. Coal mining ceased until the Bellingham Bay Company opened the largest mine in the state in the city's north end in 1918; it operated until 1951, when decreased demand led to its closure. Refer to Figure 1 for locations of the Bellingham area's primary historical mines.

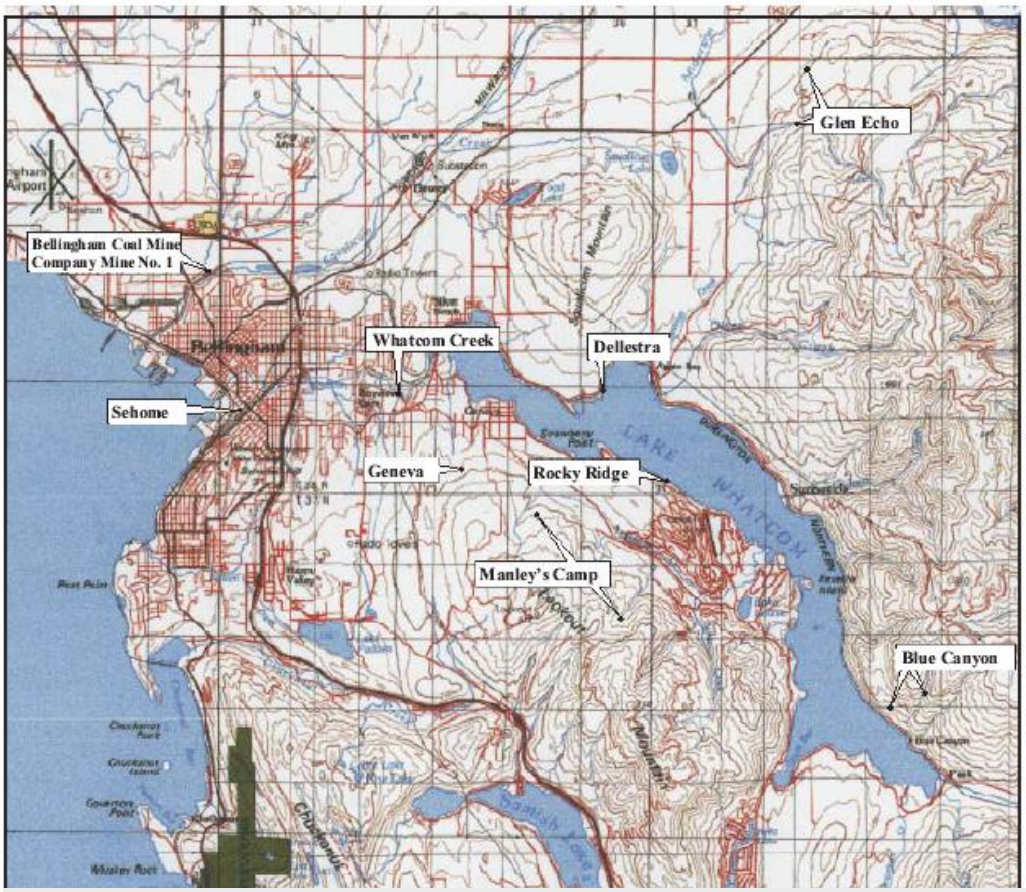


Figure 1 – Locations of Major Historical Mines in and Around Bellingham (Map courtesy of EPA, Region 10)

In a January 2003 report titled "Preliminary Assessment of Bellingham Mines," the U.S. Environmental Protection Agency (EPA) assessed possible environmental problems related to eleven mines in and around Bellingham. Two other mines were inventoried, but not assessed since their exact location was unknown. Preliminary assessment of this report showed that hazardous substances were possibly present and could pose a threat to public health or the environment. The final EPA assessment was not available as of July 2004.

Along with the potential of toxic contamination from these historical mines, these sites pose a risk for ground failure and subsidence in downtown Bellingham.

Landslides

Landslides are a continuing problem along the hillsides and shorelines of Washington due to the area's steep mountainous terrain, its complex geology, high precipitation both as rain and snow, abundance of unconsolidated glacial sediments, and geographic position astride the Cascadia Subduction Earthquake Zone (CSZ). Some landslide areas and the causes of sliding have been recognized for decades, but that information has not always been widely known or used outside the geologic community. As the population of Washington grows, increasing pressures to develop in landslide-prone areas make knowledge about landslide hazards ever more important.

A number of factors contribute to landslides, including geology, gravity, weather, groundwater, wave action, and human actions. Typically, a landslide occurs when several of these factors converge.

Many slides on Puget Sound occur in a geologic setting that places permeable sands and gravels above impermeable layers of silt and clay, or bedrock. Water seeps downward through the upper materials and accumulates on the top of the underlying units, forming a zone of weakness. Gravity works more effectively on steeper slopes, such as the bluffs that surround Puget Sound, but more gradual slopes may also be vulnerable. Most slides on Puget Sound occur during or after heavy rains, from January through March. Groundwater may rise as a result of heavy rains or a prolonged wet spell. As water tables rise, some slopes become unstable. Wave action can erode the beach or the toe of a bluff, cutting into the slope, and setting the stage for future slides. Human actions, most notably those that affect drainage or groundwater, can trigger landslides. Clearing of vegetation, poor drainage practices, and onsite septic systems can all add to the potential for landslides.

HISTORY:

Alluvial Fans

Within the last decade, meteorological conditions and changes in land have combined to increase the frequency and severity of debris and flooding events associated with streams in Whatcom County. This has resulted in an increased awareness of the hazards associated with alluvial fans, and several measures have been taken by the county to address the problem.

These measures include a study conducted in 1983, in response to a storm in January of that year, where a number of debris events generated from the slopes of the Stewart Mountain caused major damage to property, roads, and bridges along the north shore of Lake Whatcom and in the South Fork Nooksack River Valley. The resulting report summarized the causes of these events and recommended mitigation measures, as well as designated hazards zones surrounding Whatcom County streams.

Another report, “Alluvial Fan Hazard Areas,” was created by Whatcom County’s Planning & Development Services Department in August 1992, was an inventory and compilation of all the known alluvial fan problems.

Smith and MacCauley creeks, located within Reach 4 (refer to the Flooding Background Information or Mitigation Strategies), contain alluvial fan areas. The Smith Creek alluvial fan includes both alluvial and debris flow components resulting from past floods and debris flows. Properties on the fan are at risk. The MacCauley Creek alluvial fan is subject to debris flows. Stream avulsions have occurred during past debris flow events. Residences and farm buildings on the alluvial fan are at risk. Two additional reports have been created in the last few years, identifying two more creeks in the County at significant risk of alluvial fan damages: Jones Creek and Canyon Creek.

Coal Mines

The Bellingham abandoned underground mines that stretch from State Street to Sehome Hill and from Connecticut Street northwest to McLeod Road present significant hazards.

Landslides

The susceptibility of Whatcom County to landslides is apparent from the numerous landslides listed in Table 4:

Dates	Description
Great Depression Era	Cutting trees caused a very large Sehome Hill landslide toward Western Washington University.
October, 1975	Following a heavy downpour, the State Street Boulevard hillside turned into wet mud and swept two cars over the 25-foot bank. One hundred yards of mud slid onto the Boulevard.
January, 1983	A debris torrent accompanied by landslides into Lake Whatcom took homes, cars, people, and pets into the lake and caused major flooding.
January, 1983	A huge boulder rolled onto railroad tracks near Larrabee State Park and derailed 12 cars of a 66-car northbound Burlington Northern freight train, and tumbled the lead engine into the Bay.
1996	Landslides at Point Roberts destroyed several beachside vacation homes.
February, 1997	Ground movement on Sumas Mountain resulted in the rupture of a 26-inch natural gas pipeline that subsequently ruptured and exploded.
Ongoing	Rock slides onto I-5, south of Bellingham.
Ongoing	123,000 cubic yards of dirt and rock carried from Sumas Mountain each year and deposited into Swift Creek. This debris and dirt are threatening several hundred acres of farmland near Everson.

Table 4 – Major Whatcom County Landslides, 1900's

VULNERABILITY ASSESSMENT:

Alluvial Fans

Various detailed studies have looked at specific alluvial fans present in Whatcom County. The report, "Alluvial Fan Hazard Areas" inventories the alluvial fans that pose a risk. Table 5 lists these alluvial fans, as well as developments at risk.

Alluvial Fan	Size	Developments/Structures at Risk
Lake Whatcom Watershed		
Austin Creek Fan	150 acres	
Lake Louise 2 Fan	~ 5 acres	Approximately 20 houses, driveways, three development roads, a path around the lake, and Lake Whatcom Boulevard.
Albrecht's Fan	2.5 acres	County Rd., Lake Whatcom Blvd., the private bridge to the Albrecht residence, and the older buildings on the property.
Wildwood Fan	16 acres	Wildwood has a very high population density during the summer months and provides trailer and boat storage during the rest of the year. At least 40 trailers, a general store, cabins, and Lake Whatcom Boulevard are at risk.
South Blue Canyon Creek Fan	?	The Blue Canyon Complex and approximately 11 homes. Future development is planned, which will eliminate existing trees and further increase the risk in this area.
Middle Blue Canyon Creek Fan	?	Limited residences and a picnic area.
North Blue Canyon	?	Limited residences.

Creek Fan		
Smith Creek Fan	107 acres	Residences and a bridge, which is located at the apex of the fan.
Olsen Creek Fan	137 acres	30 homes.
Carpenter Creek Fan	16.5 acres	15 buildings, including the local fire hall, and 2 county roads.
Samish River & Lake Samish Watershed		
Barnes Creek Fan	?	Residences and 4 roads: Interstate 5, East Lake Samish Rd., Old State Route 99, and Manley Rd.
Reed Lake 2 Reed Lake 3 Reed Lake 4	620 acres	Approximately 30 homes, a clubhouse, and numerous roads in the Reed Lake development.
North Fork, Nooksack River		
Glacier Creek Fan	?	Town of Glacier, the Mount Baker Rim Development, a U.S. Forest Service Ranger Station, multiple restaurants, lodgings, approximately 45 houses and outbuildings, Mount Baker Highway.
Gallop Creek Fan	?	Town of Glacier, 25 houses, restaurants, lodgings, the Glacier post office, logging access road and bridge, and Mount Baker Highway.
Cornell Creek Fan	90 acres	Approximately 5 houses, Mount Baker Highway, Cornell Creek Road, a large wetland that may be salmon habitat.
Canyon Creek Fan	210 acres	Glacier Springs Development, The Logs Resort, Mount Baker Highway.
Boulder Creek Fan	126 acres	25 buildings of the Baptist camp, three roads, a county bridge, Mount Baker Highway.
Coal Creek Fan	?	Small community located at the mouth of Coal Creek, Mount Baker Highway.
Racehorse Creek Fan	246 acres	Five residences, several barns, a county road, a private access road, and a county bridge, all near Welcome, WA.
Bell Creek Fan	?	Agricultural lands, Mount Baker Highway, eight residences, and two secondary roads.
Middle Fork, Nooksack River		
Canyon Lake Creek Fan	312 acres	Multiple residences, Mosquito Lake Road, Canyon Lake Road, and three private roads.
Kenney Creek Fan	188 acres	
Filbert Creek Fan	49 acres	
Porter Creek	95 acres	Residences, Mosquito Lake Road, the bridge at Porter Creek, a private road.
Falls/Todd Creek	?	Multiple residences, Hillside Drive, and agricultural lands.
Terhorst Creek	94 acres	Residences, Hillside Drive, a county road, outbuildings.
Sygitowicz Creek Fan	163 acres	Residences, a county bridge, a county road.
Radonski Creek Fan	?	Two farms, residences, Hillside Drive.
Hardscrabble Creek Fan	45 acres	Residences, several barns and outbuildings, a county road, a county low-water bridge.
McCarty Creek Fan	162 acres	Turkington Road county bridge and agricultural land.
Jones Creek Fan	376 acres	Town of Acme, Turkington Road, State Highway 9.
Smith Creek Fan	?	Residences, True Log Homes, Smith Creek Hydro projects, Mount Baker Vineyards, Mount Baker Highway, Burlington Northern Railway.

McCauley Creek Fan	?	Residences, farm buildings, and Mount Baker Highway.
Sumas River		
Swift Creek	?	Residences, Great Western Lumber & Mill, and Mount Baker Mushroom Farm.

Table 5 – Alluvial Fan Inventory in Whatcom County
Information obtained from "Alluvial Fan Hazard Areas", Whatcom County PDS

Detailed reports have been published on the significantly high risks of the fans present in Canyon, Jones, Glacier, and Gallop Creeks.

Landslides
As houses and roads are built onto steeper slopes and mountainsides, landslide hazards become an increasingly serious threat to life and property. Residential development along slopes such as Chuckanut Mountain, and hillsides throughout the county are subject to slides. Forest fires, clear-cutting of trees, and clearing land for housing developments cause unstable soil.

Land stability cannot be absolutely predicted with current technology. Due to population density and peoples' desire to have a home with a view, an increasing number of structures are built on top of or below slopes subject to landslides. These slides take lives, destroy homes and businesses, undermine bridges, derail railroad cars, cover fish habitat and oyster beds, interrupt transportation infrastructure, and damage utilities.
Examples of possible landslide areas and possible damages in Whatcom County include:

- Chuckanut Mountain, residential areas on steep slopes such as Sudden Valley, upper Baker Highway, and parts of Highway 9.
- Unstable bluffs on Lummi Island.
- The Western Washington University bluffs.
- The Sehome Hill Arboretum has had slides in the past – the growth of some tree trunks shows evidence of slow movement downhill above the university.
- Slopes overlooking Hale Passage, Bellingham Bay, Boundary Bay, Strait of Georgia.
- Eldridge Avenue homes overlooking Bellingham Bay.
- Mount Baker – Landslides may be caused by melting snow, or steam resulting in a slurry or rock and water, typical of a lahar. Landslides in this area could possibly cause floods of the Nooksack River and massive mudslides into Baker Lake which could over-top, or break, Baker Lake Dam.

MITIGATION STRATEGIES:
For alluvial fans and landslides, additional measures recommended by studies are listed below. In general, the following steps should be implemented to reduce risk of the four geologic hazards – alluvial fans, coal mines, landslides, seismic hazards – affecting Whatcom County:

1. Limit, and if possible, eliminate new development in high risk hazard areas.
2. If new development is to be permitted, mitigate new construction to address the specific geological hazard.
3. Educate existing property owners at risk to help minimize the risk of the local hazards.
4. If cost effective, buyout high risk properties.
5. As a last-case resort, consider engineering solutions to manage the specific geologic hazard, if proven effective.

Alluvial Fans – To help reduce the impact of debris events, The "Alluvial Fan Hazard Areas" report mentioned above, outlines preliminary mitigation actions when developing on or near an active fan:

1. Leave trees standing – Stands of large trees filter debris from debris flows and dissipate the energy of the flow.
2. Avoid road crossings that obstruct debris passage – Road crossings that have culverts or pilings located in the stream channel invite the formation of debris dams behind them. Water impounded behind these dams can cause a dam-break-flood or lead to channel avulsion around the bridge.
3. Construct dike carefully – Dikes must be made from rock that is larger than the maximum rock size the river is capable of carrying at flood stage, or lateral erosion of the dike will be a chronic problem.
4. Locate and orient roads carefully – Road beds can act as dikes or potential avulsion channels depending on their location and orientation, especially those roads oriented parallel to flow. These roads parallel to the flow should only be placed on inactive fan areas. If roads on the active fan are necessary, orient them perpendicular to the flow and bridge across any potential avulsion routes.
5. Avoid placing structures at channel bends – Channel bends tend to be potential avulsion sites.
6. Avoid breaching debris berms – Debris berms that flank the stream channel act as natural dikes during a flood or debris event. A breech in these berms invites channel avulsion at that site.

The report also details primary and secondary measures to consider in alluvial fan mitigation strategies:

<u>Primary Measures</u>

1. Mapping & Avoidance – The impact zone of debris flows must first be delineated by careful hazard mapping. In general, areas of historic or prehistoric flows, scoured channels and headwaters, and initiation points of debris flows constitute debris flow hazard zones. Appropriate zoning regulations or building restrictions can limit development in these areas. Low intensity settlement land use, such as agriculture or park lands, is appropriate.
2. Precipitation Thresholds – Precipitation thresholds are often suggested as a method to predict debris flow occurrence. Antecedent rainfall and snow melt must be factored in to increase the accuracy of event prediction. Although, Church and Miles (1987) state that simple precipitation thresholds cannot be used to predict debris flow events. However, by analyzing approaching storm events and tying this to areas of known debris flow activity, warnings for potential debris flows may be issued. This would assist those monitoring hazardous areas during storm events.
3. Warning Systems – Warning systems should include advance warning measures, warnings of an event in progress or just past. Existing warning systems that have proved valuable are those used on highways and railways to warn of coming debris flows, as well as a trip wire and transmitter located in a debris flow path. The problem with these is that false alarms could be frequent because these systems are easily damaged. Whatcom County should investigate and put into place durable warning systems for debris flow events.

<u>Secondary Measures</u>

1. Forest Practices – Modifying timber harvest practices in the source area is the first step. Poor forest practices help initiate debris flows by increasing the volume of debris in the channels, destabilizing soils on slopes from the delayed loss of root strength, and increasing the average pore water pressure in soils. Specific recommendations are

leaving adequate tree and vegetation buffers to reduce soil erosion and protect water quality, immediately replanting, removing debris from slopes, locating roads away from stream crossings, installing culverts capable of carrying 25-year runoff, and keeping drainage off unstable fill. Additionally, culverts and water bars must be maintained to keep the roads stable. Systematically retiring logging roads by removing culverts and reestablishing drainage patterns will stabilize slopes.

2. Check Dams & Channel Linings – Check dams to control sediment movement in stream and channel linings to reduce streambank and instream erosion. Channel linings prevent erosion of the stream bank, which reduces the amount of material entrained in a debris flow. Other types of linings are masonry linings of cut stone, rounded boulders embedded in steel-reinforced concrete, and formed concrete with a silica additive. However, channel linings can be damaged by bank failure, increased flow velocities, and subject to extreme erosion, and require extensive maintenance.
3. Slope Modifications – Slopes in the source area can be stabilized to reduce their failure potential. Slope height can be limited, the slope angle decreased, drainage installed, and fill compacted. Drainage systems for the slopes must have culverts sized large enough to carry debris and water.
4. Don't Develop on Debris Flow Areas

Landslides

Washington is one of seven states listed by FEMA as being especially vulnerable to severe land stability problems. An increasing population and demand for "view" property, with the concomitant removal of trees to attain the view, increases the risk of landslides in residential areas. Buildings on steep slopes and bluffs are at risk in seasons of heavy rains or prolonged wet spell.

Landslide, mudflow and debris flow problems are often complicated by land mismanagement. By studying the effects of landslides in slide-prone regions, plans for the future can be made and the public may be educated to prevent development in vulnerable areas. Applying established ordinances where geological hazards have been identified will prevent some landslide losses. However, Whatcom County already has many areas above or below unstable slopes with established houses and businesses. Prevention of erosion through careful maintenance of vegetation on slopes and engineered drainage of slopes is necessary to protect these areas.

The primary mitigation strategy to employ in areas at danger of landslides is to limit or eliminate development in any high risk areas. Employing buyouts of especially high risk areas on reoccurring landslides should be considered. If new development is to occur, the Department of Ecology has outlined the following recommendations and information for the public to equip themselves:

1. Do research – Learn about the geology and the history of your property. Talk to local officials, your neighbors, or visit the local library. Review geologic or slope stability maps of your area.
2. Get advice – Talk with a qualified geologist or geological engineer before buying a potentially unstable site or building your home. Although waterfront lots can be attractive sites, they often have severe natural limitations. They may also be subject to strict environmental and safety regulations.
3. Leave a safe setback – Build a prudent distance from the top or bottom of steep slopes. Avoid sites that are too small to allow a safe setback from the slope. Allow adequate room for drainfields and driveways. Local setback requirements should be viewed as absolute minimums. Resist the urge to trade safety for a view.

4. Keep plants – Maintain existing vegetation, both above and on steep slopes. Trees, shrubs, and groundcovers help anchor soils and absorb excess water. Get expert advice identifying and removing weeds.
5. Maintain drainage – Collect runoff from roofs and improved areas and convey water away from the steep slope or to the beach in a carefully designed pipe system. Regularly inspect and maintain drainage systems.

TSUNAMIS

DEFINITIONS:

Tsunami – a series of traveling waves of extremely long length generated by disturbances associated primarily with earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides can also generate tsunamis.

BACKGROUND INFORMATION:

In the deep ocean, a tsunami's length from wave crest to wave crest may be a hundred miles or more but with a visible wave height of only a few feet or less. They cannot be felt aboard ships nor can they be seen from the air in the open ocean. Large Pacific Ocean tsunamis typically have wave crest-to-crest distances of 60 miles and can travel about 600 miles per hour in the open ocean. A tsunami can traverse the entire 12,000-14,000 miles of the Pacific Ocean in 10-25 hours, striking any land in its way with great force. Tsunamis can cause great destruction and loss of life within minutes on shores near their source, and some tsunamis can cause destruction with hours across an entire ocean basin.

On the Pacific Coast, from southern British Columbia to northern California, people and property are at varied risks both from distantly and locally generated tsunamis. Recent studies indicate about a dozen very large earthquakes (with magnitudes of 8 or more) have occurred in the Cascadia Subduction Zone (CSZ) west of Washington. Computer models indicate that tsunamis waves generated by these local events might range from 5 to 55 feet in height and could affect the entire coastal region.

HISTORY:

Recent research on earthquakes off the Washington, Oregon, and northern California coastlines and resulting tsunamis (Atwater, 1992; Atwater and others, 1995) has led to concern that locally generated tsunamis will leave little time for response. Numerous workers have found geologic evidence of tsunami deposits attributed to the CSZ in at least 59 localities from northern California to southern Vancouver Island (Peters and others, 2003). While most of these are on the outer coast, inferred tsunami deposits have been identified as far east as Discovery Bay, just west of Port Townsend (Williams and others, 2002) and on the west shore of Whidbey Island (Williams and Hutchison, 2000). Heaton and Snavely (1985) report Makah stories may reflect a tsunami washing through Waatch Prairie near Cape Flattery, Washington, and Ludwin (2002) has found additional stories from native peoples up and down the coast that appear to corroborate this and also include apparent references to associated strong ground shaking. Additionally, correlation of the timing of the last CSZ earthquake by high-resolution dendrochronology (Jacoby and others, 1997; Yamaguchi and others, 1997) to Japanese historical records of a distant-sourced tsunami (Satake and others, 1996) demonstrate that it almost certainly came from the CSZ. This tsunami may have lasted as much as 20 hours in Japan and caused a shipwreck about 100 km north Tokyo in A.D. 1700 (Atwater and Satake, 2003). The frequency of occurrence of CSZ earthquakes ranges from a few centuries to a millennium, averaging about 600 years (Atwater and Hemphill-Haley, 1997). It is believed the last earthquake on the CSZ was about magnitude (Mw) 9 (Satake and others, 1996; 2003). It is not known, however, if that is a characteristic magnitude for this fault. Evidence gleaned from syntheses of global subduction-zone attributes, as well as from local tsunami deposits, suggest great earthquakes have rocked the Pacific Northwest perhaps as recently as 300 years ago.

Tsunamis are a threat to life and property to anyone living near the ocean. In 1995, in response to tsunami threat Congress directed the National Oceanic and Atmospheric Administration (NOAA) to develop a plan to protect the West Coast from locally generated tsunamis. A panel

of representatives from NOAA, FEMA, the USGS, and the five Pacific coast states wrote the plan and submitted it to Congress, which created the National Tsunami Hazard Mitigation Program (NTHMP) in October 1996. The NTHMP was designed to reduce the impact of tsunamis through warning guidance, hazard assessment, and mitigation. A key component of the hazard assessment for tsunamis is delineation of areas subject to tsunami inundation. Since local tsunami waves may reach nearby coastal communities within minutes of the earthquake, there will be little or no time to issue formal warnings; evacuation areas and routes will need to be planned well in advance.

Spatial data used to assess tsunami hazards in Whatcom County was developed by the Center for the Tsunami Inundation Mapping Efforts (TIME) at NOAA's Pacific Marine Environmental Laboratory in Seattle. The data and maps were produced using computer models of earthquake-generated tsunamis from nearby seismic sources, and analyzed to determine the risks of a CSZ earthquake.

TIME's tsunami inundation is based on a computer model of waves generated by a scenario earthquake. The earthquake scenario adopted for that study was developed by Priest and others (1997) and designated Scenario 1A (also see Myers and others, 1999). It was one of a number of scenarios they compared to paleoseismic data and found to be the best fit for the A.D. 1700 event. This scenario has been the basis for tsunami inundation modeling for the other maps produced by the NTHMP in both Oregon and Washington based on a CSZ event. The land surface along the coast is modeled to subside during ground shaking by about 1.0 to 2.0 meters (Fig. 1), which is consistent with some paleoseismologic investigations and also matches thermal constraints of Hyndman and Wang (1993). This earthquake is a magnitude 9.1 event, with a rupture length of 1,050 km and a rupture width of 70 km. Satake and others (2003) have recently calculated a very similar magnitude and rupture dimension from an inversion of tsunami wave data from the1700 event. The model used is the finite difference model of Titov and Synolakis (1998), also known as the Method of Splitting Tsunami (MOST) model (Titov and González, 1997). It uses a grid of topographic and bathymetric elevations and calculates a wave elevation and velocity at each grid point at specified time intervals to simulate the generation, propagation and inundation of tsunamis down the Strait of Juan de Fuca and into the Bellingham Bay area.

VULNERABILITY ASSESSMENT:

TIME Results – The computed tsunami inundation model emphasized three depth ranges: 0-0.5m, 0.5-2m, and greater than 2m. These depth ranges were chosen because they are approximately knee-high or less, knee-high to head-high, and more than head-high and so approximately represent the degree of hazard for life safety. The greatest amount of tsunami flooding is expected to occur in the valleys of the Lummi (Red) and Nooksack rivers up to their confluence near Ferndale and then be confined to the relatively narrow valley of the Nooksack. Sandy Point Shores is expected to be flooded to a depth of a few feet. Elsewhere, tsunami flooding is expected only in the immediate vicinity of the shoreline where evacuation to higher ground would be an easy matter.

The inundation data also emphasized current velocities:

1. Less than 1.5 m/s (~3 mph), which is the current speed at which it would be difficult to stand.
2. Between 1.5-5 m/s.
3. Greater than 5 m/s which is a modest running pace. Within zones with this designation, computed velocities locally exceed 20 m/s (~40 mph) in confined channels.

Tide gauge records, at five locations in the bay, show fluctuations of water surface elevation and also the time history of the waves. The initial water disturbance is a trough of about a meter at two hours after the earthquake followed by a crest at between two and one-half and three hours after the earthquake. At around 4 hours after the earthquake, a deeper trough occurs and reaches about 3 meters near the Port of Bellingham. A trough this large, if it occurred at low tide, could cause a significant grounding hazard for ships in the harbor. This is visually displayed in Figure 2, which shows an animation of the tsunami troughs and crests in and around Bellingham Bay.

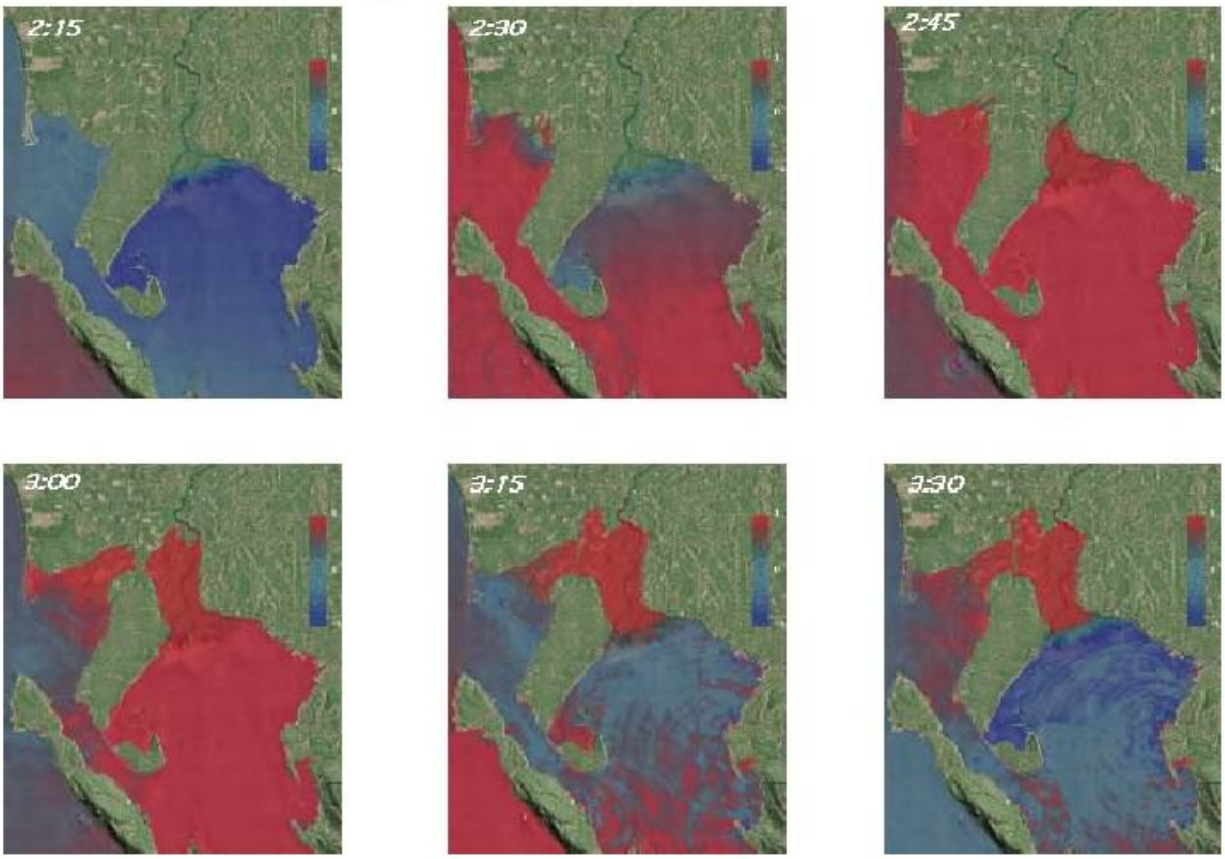


Figure 2 – Screen shots of animation of a tsunami arriving in Bellingham area, lasting about 3½ hours. Red areas are crests, blue are troughs.
(Picture obtained from the NOAA T.I.M.E. Center)

These models do not include potential tsunamis from landslides or nearby crustal faults, which are generally not well enough understood to be modeled. Apparently, locally generated tsunami deposits have been found on Whidbey Island (Williams and Hutchinson, 2000; Atwater and Moore, 1992); in Discovery Bay, southwest of Port Townsend (Williams and others, 2002); in the Snohomish delta near Everett (Bourgeois and Johnson, 2001): and at West Point near Seattle (Atwater and Moore, 1992). Gonzalez (2003) summarizes the evidence for tsunamis generated within the Puget Lowland by local earthquakes and landslides and estimates their probabilities.

When an earthquake that might generate a Pacific Coast tsunami is detected, the Alaska Tsunami Warning Center calculates the danger to the northeast Pacific Coast and notifies the communities at risk. Those warnings may give people a few hours to prepare and evacuate (depending on the distance to the earthquake).

If the earthquake occurs off our coast, however, there may be no time to send out hazard warnings. The first waves could arrive within minutes of the earthquake. The only tsunami warning might be the earthquake itself.

MITIGATION STRATEGY:

In order to plan for hazards, citizens need to know what to expect. In the last few years, there have been significant advances in understanding the earthquakes that have occurred on the CSZ and the tsunamis that struck the Pacific Coast. This information is the foundation for planning efforts. Because tsunami events provide little warning, one of the keys to mitigating tsunamis to effectively educate the population at risk about the hazards they face:

1. Hold public meetings to educate the public about the hazard they face. Provide handouts, evacuation maps, and a description of the warning system (typically the Emergency Alert System) that will be used to warn residents. Distribute hazard and evacuation maps to all interested parties, such as public safety agencies, citizen groups, etc.

2. Establish evacuation plans for all affected communities to effectively remove all people from the hazard area in the event of a tsunami warning. This includes identifying all facilities that may need extra assistance in evacuating (nursing homes, day cares, etc.). The evacuation plan should also address the timeline for a full evacuation, as well as a division of labor to identify which agencies will do which actions.

3. Establish requirements that existing critical facilities must be reviewed for susceptibility to tsunamis. These facilities should be reviewed to determine what kind of mitigation action should be taken for each facility.
4. Post Tsunami signs that show the existence of the hazard area, and the way to the nearest evacuation route.
5. New critical facilities constructed in the tsunami hazard zone must be elevated above the hazard area, armored in place, or built outside the hazard area if at all possible.
6. Early warning systems should be evaluated to see if an automated system can be put into place to provide automated early warning in the event a tsunami occurs.
7. Develop Tsunami Resistant Communities, according to NOAA's Strategic Implementation Plan for Tsunami Mitigation Projects. These communities would be outfitted with the knowledge and tools outlined above to deal with a tsunami event.

VOLCANOES

DEFINITIONS:

Blast Zone – the area immediately surrounding a volcano, up to several tens of kilometers, that is destroyed by a volcano's blast.

Lava Flow – a stream of molten rock that pours or oozes from an erupting vent.

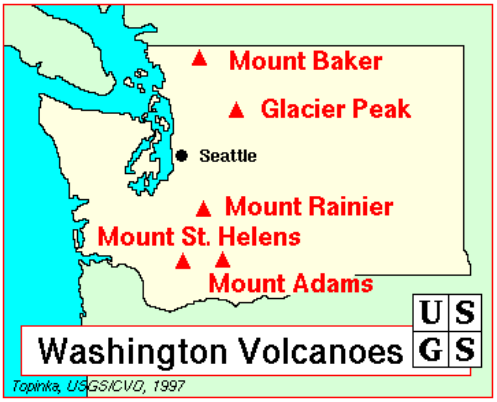
Lahar – a mudflow or debris flow that originate from the slope of a volcano; pyroclastic flows can generate lahars by rapidly melting snow and ice.

Pyroclastic Flows – high-density mixtures of hot, dry rock fragments and hot gases that move away from the vent that erupted them at high speeds.

Tephra – a general term for fragments of volcanic rock and lava, regardless of size, that are blasted into the air by explosions or carried up upward by hot gases in eruption columns or lava fountains.

Volcano – a vent in the earth's crust through which magma (molten rock), rock fragments, associated gases, and ashes erupt, and also the cone built by effusive and explosive eruptions.

BACKGROUND INFORMATION:



The Cascade Range extends more than 1,000 miles. It forms an arc-shaped band extending from Southern British Columbia to Northern California, lying roughly parallel to the Pacific coastline, and includes 14 major volcanic centers. The Cascade Range is made up of a band of thousands of very small, short-lived volcanoes that have built a platform of lava and volcanic debris. Rising above this volcanic platform are a few strikingly large volcanoes that dominate the landscape. The Cascades volcanoes define the Pacific Northwest section of the "Ring of Fire," a fiery array of volcanoes that rim the Pacific Ocean. Many of these volcanoes have erupted in the recent past and will most likely be active again in the future. Given an average rate of two eruptions per century during the past 12,000 years, these disasters are not part of our everyday experience. Whatcom County's eastern boundary follows the crest of the Cascade Range.

The largest of the dormant volcanoes in Washington State include Mount Baker, Glacier Peak, Mount Rainier, Mount Saint Helens, and Mount Adams. Explosions from Mount Baker, located in the eastern portion of Whatcom County, and Glacier Peak would severely impact Whatcom County. Geologic evidence indicates both Mount Baker and Glacier Peak erupted in the past and will no doubt erupt again in the foreseeable future. Due to the topography of the region and the location of drainage basins and river systems, eruptions on Mount Baker could severely impact portions of Whatcom County. A Mount Baker eruption would generate lahar's, pyroclastic flows, tephra or ash fall, and lava flows which would decimate affected areas. Glacier Peak, which is in Snohomish County, is of concern due to its geographic proximity to the County. Ash fall from an eruption at Glacier Peak could significantly impact Whatcom County.

Mount Baker

Mount Baker (3,285 meters; 10,778 feet) is an ice-clad volcano in the North Cascades of Washington State about 50 kilometers (31 miles) due east of the city of Bellingham. After Mount Rainier, it is the most heavily glaciated of the Cascade volcanoes: the volume of snow and ice on Mount Baker (about 1.8 cubic kilometers; 0.43 cubic miles) is greater than that of all the other Cascades volcanoes (except Rainier) combined. Isolated ridges of lava and hydrothermally altered rock, especially in the area of Sherman Crater, are exposed between glaciers on the upper flanks of the volcano; the lower flanks are steep and heavily vegetated. The volcano rests on a foundation of non-volcanic rocks in a region that is largely non-volcanic in origin.

Glacier Peak

Glacier Peak is the most remote of the five active volcanoes in Washington State. It is not prominently visible from any major population center, and so its attractions, as well as its hazards, tend to be overlooked. Yet since the end of the last ice age, Glacier Peak has produced some of the largest and most explosive eruptions in the state. During this time period, Glacier Peak has erupted multiple times during at least six separate episodes, most recently about 300 years ago.

<u>HISTORY</u>:

Eruptions in the Cascades have occurred at an average rate of 1-2 per century during the past 4,000 years, and future eruptions are certain. Seven volcanoes in the Cascades have erupted within the past 225 years (see Table 6).

Volcano	Eruption Type	Eruptions in the past 225 years	Recent Activity
Mount Baker	Ash; Lava	1?	Mid-1800s; 1870?; 1975 steam emission
Glacier Peak	Ash	1+?	Before 1800
Mount Rainier	Ash; Lava	1?	Tephra between 1830-1854
Mount St. Helens	Ash; Lava; Dome	2 eruptive periods	1980 – present
Indian Heaven Volcanic Field	Lava; Scoria	None	8,000 years ago?
Mount Adams	Lava; Ash	None	3,500 years ago
Mount Hood, OR	Ash, Dome	2+?	1865; major eruption in the late 1700s

Table 6 – History of Major Volcanic Eruptions in the Cascade Mountain Range for the last 225 Years
(information obtained from Department of Natural Resources)

Four of those eruptions listed in Table 6 would have caused considerable property damage and loss of life if they had occurred today without warning – the next eruption in the Cascades could affect hundreds of thousands of people. The most recent volcanic eruptions within the Cascade Range occurred at Mount Saint Helens in Washington (1980-1986) and at Lassen Peak in California (1914-1917).

We know from geological evidence that Mount Baker have produced numerous volcanic events in the past. Several of these events, if they took place today, would place Whatcom County communities at considerable risk. Volcanic hazards from Mount Baker result from a variety of different eruptive phenomena such as lahars, ash fall, tephra fall, and pryroclastic flows. Figure 3 displays a model of the inner workings and hazards associated within volcanoes.

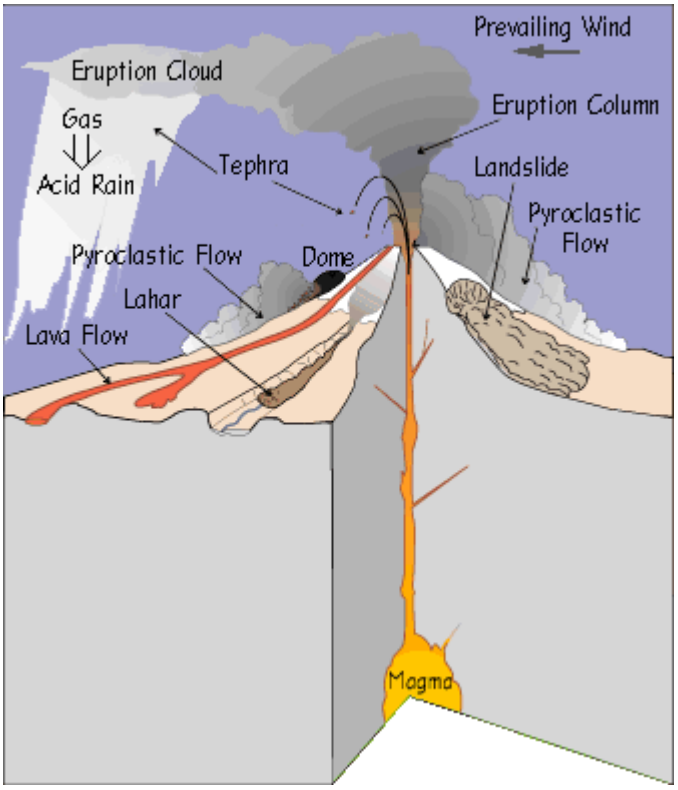


Figure 3 – Effects of a Volcano Eruption
(Diagram courtesy of USGS Cascade Volcano Observatory)

Mount Baker's Eruption History

Geologic evidence in the Mount Baker area reveals a flank collapse near the summit on the west flank of the mountain that transformed into a lahar, estimated to have been approximately 300 feet deep in the upper reaches of the Middle Fork of the Nooksack River and up to 25 feet deep 30 miles downstream. This lahar may have reached Bellingham Bay. A huge hydrovolcanic (water mixed with magma) explosion occurred near the site of present day Sherman Crater, triggering a second collapse of the flank just east of the Roman Wall. This collapse also became a lahar that spilled into tributaries of the Baker River.

Finally, an eruption cloud deposited several inches of ash as far as 20 miles downwind to the northeast. Geologic evidence shows lahars large enough to reach Baker Lake have occurred at various times in the past. Historical activity at Mount Baker includes several explosions during the mid-19th century, which were witnessed from the Bellingham area.

Sherman Crater (located just south of the summit) probably originated with a large hydrovolcanic explosion. In 1843, explorers reported a widespread layer of newly fallen rock fragments and several rivers south of the volcano were clogged with ash. A short time later, two collapses of the east side of Sherman Crater produced two lahars, the first and larger of which flowed into the natural Baker Lake, raising its water level at least 10 feet.

In 1975, increased fumarolic activity in the Sherman Crater area caused concern an eruption might be imminent. Additional monitoring equipment was installed and several geophysical surveys were conducted to try to detect the movement of magma. The level of the present day Baker Lake reservoir (located to the east and south of the mountain) was lowered and people were restricted from the area due to concerns that an eruption-induced debris avalanche or

debris flow might enter Baker Lake and displace enough water to either cause a wave to overtop the Upper Baker Dam or cause complete failure of the dam. However, few anomalies other than the increased heat flow were recorded during the surveys nor were any other precursory activities observed to indicate magma was moving up into the volcano.
This volcanic activity gradually declined over the next two years but stabilized at a higher level than before 1975. Several small lahars formed from material ejected onto the surrounding glaciers and acidic water was discharged into Baker Lake for many months.

VULNERABILITY ASSESSMENT:
Lahars are the primary threat from volcanic activity at Mount Baker. Originating from melted snow and ice, lahars could create torrents of ash, rock, and water. Flank collapses may also create volcanic landslides that may form into lahars. Lahars resulting from flank collapses can also be triggered by earthquakes, gravity, or increases in hydrovolcanic activity. Debris flows can remain hazardous for many years if the deposited material remobilizes from heavy rains.

Most cohesive debris flows will be small to moderate in volume and will originate as debris avalanches of altered volcanic rock, most likely from the Sherman Crater, Avalanche Gorge, or the Dorr Fumarole area. Small volume debris flows will pose little risk to most people, but moderate volume debris flows could travel beyond the flanks of the volcano.

The probability of either Mount Baker or Glacier Peak erupting, collapsing, or causing slides is low. However, volcanic activity from either mountain could result in massive destruction of property and probable loss of lives in or near the floods, lahars, earthquakes, landslides, and ash fall.

Examples of hazards and "worst-case scenarios" in Whatcom County, including adjacent counties and Canadian Provinces**:**

1. Small to moderate collapse in area of Sherman Crater may produce lahars flowing into Baker Lake:
    - Raised level of Baker Lake.
    - Baker Lake Dam failure.
    - Flooding of the entire Skagit flood plain to Puget Sound.
2. Large flank collapses or pyroclastic flows:
    - Inundation of Skagit River Valley by displacement of water in reservoirs by lahars.
    - North Fork, Middle Fork and Nooksack River to Bellingham Bay could be inundated. Enough debris flow could be deposited in the stretch of river between Lynden and Everson to raise the riverbed enough to spill into the Sumas River or to divert the Nooksack River into the Sumas River Basin. Such an event is considered high consequence but low probability.
    - Floodwaters could extend from Sumas into Huntingdon and Abbotsford, British Columbia.
    - Flooding all the way to Bellingham Bay.
3. Hospitals: Bellingham's Saint Joseph Hospital and the Outpatient Center would be isolated from other communities.
4. Transportation Routes: I-5 flooded at Nooksack and/or Skagit Rivers; Highway 9 flooded at Deming Sedro Woolley (Skagit County); Mount Baker Highway (SR 542) flooded.
5. Ash fall: Will depend on direction of the wind (prevailing winds are toward the East). The ash may cause reduced visibility or darkness. Air filters and oil filters in automobiles and emergency vehicles become clogged.
6. Airports: All local airports may be impacted by ash fall.

7. Railroad tracks, power lines, radio towers, highways, campgrounds, natural gas pipelines, and water supplies in these more remote areas may be inundated.
8. Forest fires from ash and volcanic eruption may be expected.
9. Earthquakes may occur.
10. Lightening and thunderstorms often accompany volcanic eruptions.
11. Diversion Dam to Whatcom Lake on Nooksack River at Deming possibly inundated and/or destroyed.
12. Large numbers of farm animals, people, fish, and wildlife may be killed.

Those most vulnerable initially would be those nearest the pyroclastic, mud and lava flows, or heavy ash and rock fall during the eruption. Those people in this recreational area of forests and wildlife may be impossible to locate and rescue. Baker Lake and its dams are vulnerable and, if impacted, could cause extensive loss of property and lives downstream in Skagit County.

Lahars flowing down and flooding the Nooksack, Baker and Skagit Rivers may provide very little warning for evacuation to nearby populations. Earthquakes accompanying an eruption may cause bridge or road damage and trigger landslides. Fine ash fall, even if only an inch thick, may make asphalt road surfaces slippery, causing traffic congestion on steep slopes or accidents at corners and junctions. Even a minor eruption or large flank collapse of Mount Baker could impact some populations physically, psychologically, and economically.

1. Flooding: Baker Lake and Lake Shannon – possibly dams destroyed.
   - Nooksack River from origins to Bellingham Bay.
   - Skagit River from Baker River junction throughout Skagit River Valley to Puget Sound.
2. Transportation – Severe disruption
3. Water Lines, water reservoirs – contaminated or broken and depleted
4. Communication – landlines down, wireless phones overwhelmed.
5. Electric Power – some or all power lost from Mount Vernon to Lynden and possibly further in all directions.
6. Gas and Fuel pipelines – possibly broken.
7. Toxic waste, sewer, and household chemicals in flood areas.

MITIGATION STRATEGIES:

Generally, technology and tell-tale signs of eruptions from volcanoes allow experts to predict volcanic activity, such as the predictions of the 1980 Mount Saint Helen's eruption that saved many lives. However, the magnitude and timing of volcanic activities cannot be precisely predicted, giving the public little to no warning to prepare for a volcano emergency. Because of this, the best way to mitigate against volcanoes is to educate and raise awareness of affected citizens. According to FEMA, one of the best ways to generate awareness and preparedness of volcanoes is to use the media to spread important information to the community. FEMA suggests:

1. In a volcano prone area, publish a special section in your local newspaper with emergency information on volcanoes. Localize the information by including the phone numbers of local emergency services offices, the American Red Cross, and hospitals.
2. Feature an interview with a USGS representative, talking about how he/she determines the likelihood of a volcanic eruption.
3. Conduct a television or radio series on how to recognize the warning signals of a possible volcanic eruption.
4. Work with local emergency services and American Red Cross officials to prepare special reports for people with mobility impairments on what to do if an evacuation is ordered.

WILDLAND FIRE

DEFINITIONS:

Structure Fire – a fire of natural or human-caused origin that results in the uncontrolled destruction of homes, businesses, and other structures in populated, urban or suburban areas.

Wildland Fire – a fire of natural or human-caused origin that results in the uncontrolled destruction of forests, field crops and grasslands.

Wildland Urban Interface – a fire of natural of human-caused origin that occurs in, or near, forest or grassland areas, where isolated homes, subdivisions, and small communities are also located.

BACKGROUND INFORMATION:

Wildland fire is a serious and growing hazard over much of the United States, posing a great threat to life and property, particularly when it moves from forest or rangeland into developed areas. However, wildland fire is also a natural process, and its suppression is now recognized to have created a larger fire hazard, as live and dead vegetation accumulates in areas where fire has been excluded. In addition, the absence of fire has altered or disrupted the cycle of natural plant succession and wildlife habitat in many areas. Consequently, U.S. land management agencies are committed to finding ways, such as prescribed burning to reintroduce fire into natural ecosystems, while recognizing that fire fighting and suppression are still important. USGS conducts fire-related research to meet the varied needs of the fire management community and to understand the role of fire in the landscape; this research includes fire management support, studies of post-fire effects, and a wide range of studies on fire history and ecology.

HISTORY:

Washington State has experienced several disastrous fire seasons in recent years. In 1994, a series of dry lightening strikes started numerous fires in the north-central portion of the state, with major fires occurring in or near Lake Chelan, Entiat, and Leavenworth. During the fire seasons of 2001 and 2002, lightning again caused numerous fires in Washington and Oregon. In some cases, two or more fires merged together, overwhelming resources and creating fires so large and complex that some were not fully extinguished until cooler, damp autumn weather moved into the region.

VULNERABILITY ASSESSMENT:

Should a large wildland or wildland-urban interface fire occur in Whatcom County, the effects of such an event would not be limited to loss of valuable timber, wildlife and habitat, or recreational areas. The loss of large amounts of timber on steep slopes would increase the risk of landslides and mudslides during the winter months and the depositing of large amounts of mud and debris in streams and river channels could threaten valuable fish habitat for many years. In addition, the loss of timber would severely impact the watershed of the Skagit River and could drastically increase the vulnerability to flooding for many years.

The Washington State Department of Natural Resources, Northwest Region, has conducted a region-wide wildland fire hazard assessment utilizing the following method:

1. Risk Assessment and Mitigation Strategies (RAMS) was developed for fire managers to be an all-inclusive approach to analyzing wildland fire and related risks. It considers the

effects of fire on unit ecosystems by taking a coordinated approach to planning at a landscape level. The steps involved in this process include:

A. The identification of spatial compartments for assessment purposes:
    a. Whatcom County (county # 37) was subdivided into 3 risk assessment compartments based on IFPL (Industrial Fire Precaution Level) Shutdown Zones. Zone 653 represents the islands and tidal lowlands; Zone 656 represents the interior lowlands (roughly the Interstate 5 corridor); Zone 658 represents the uplands to the Cascade Crest (roughly 1,500 feet elevation and above). Whatcom County risk assessment compartments are numbered using the county number (37) combined with the shutdown zone number. Using this scheme, the three risk assessment compartments within Whatcom County are numbered 37653, 37656 and 37658.

B. The assessment of significant issues within each compartment, are related to:
    a. Fuels Hazards ~ The assessment of FUEL HAZARDS which deals with identifying areas of like fire behavior based on fuel and topography. Given a normal fire season, how intense (as measured by flame length) would a fire burn? Under average fire season conditions, fire intensity is largely a product of fuel and topography.
    b. Protection Capability ~ Determining fire PROTECTION CAPABILITY for the purpose of this assessment involves estimating the actual response times for initial attack forces and how complex the actual suppression action may be once they arrive because of access, fuel profile, existence of natural or human-made barriers to fire spread, presence of structures, and predicted fire behavior.
        a. Initial Attack Capability – actual time of first suppression resource.
        b. Suppression Complexity – access, fuel conditions, structure density, and so forth.
    c. Ignition Risk ~ Ignition risk evaluation will be completed for each compartment. Ignition risks are defined as those human activities or natural events which have the potential to result in an ignition. Wherever there are concentrations of people or activity, the potential for a human-caused ignition exists. After assessing the risks within an area, it is helpful to look at historical fires to validate the risk assessment. Historical fires alone, however, are not an accurate reflection of the risks within a given area. The objective of this effort is to determine the degree of risk within given areas.
        1. Compartment Ignition Risk is based on:
            a. Population Density
            b. Power Lines – distribution as well as transmission
            c. Industrial Operations – timber sale, construction project, fire use, mining, and so forth
            d. Recreation – dispersed, developed, OHV, hunting, fishing
            e. Flammables
            f. Other – fireworks, children, shooting, incendiary, cultural, power equipment
            g. Railroads
            h. Transportation Systems – state, federal, public access

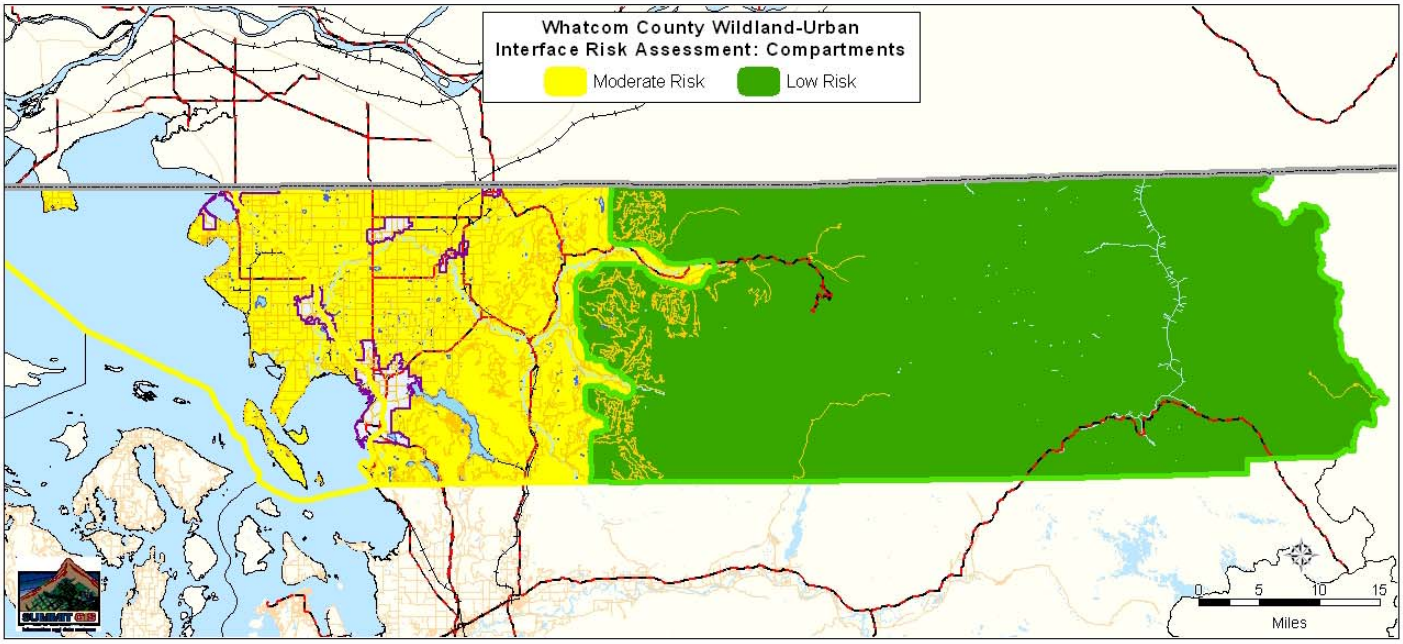
i. Commercial Development – camps, resorts, businesses, schools

d. Fire History ~ Fire history will be completed for each compartment to reflect:
   1. Fire location
   2. Cause
   3. Average annual acres burned
   4. Average annual number of fire by cause

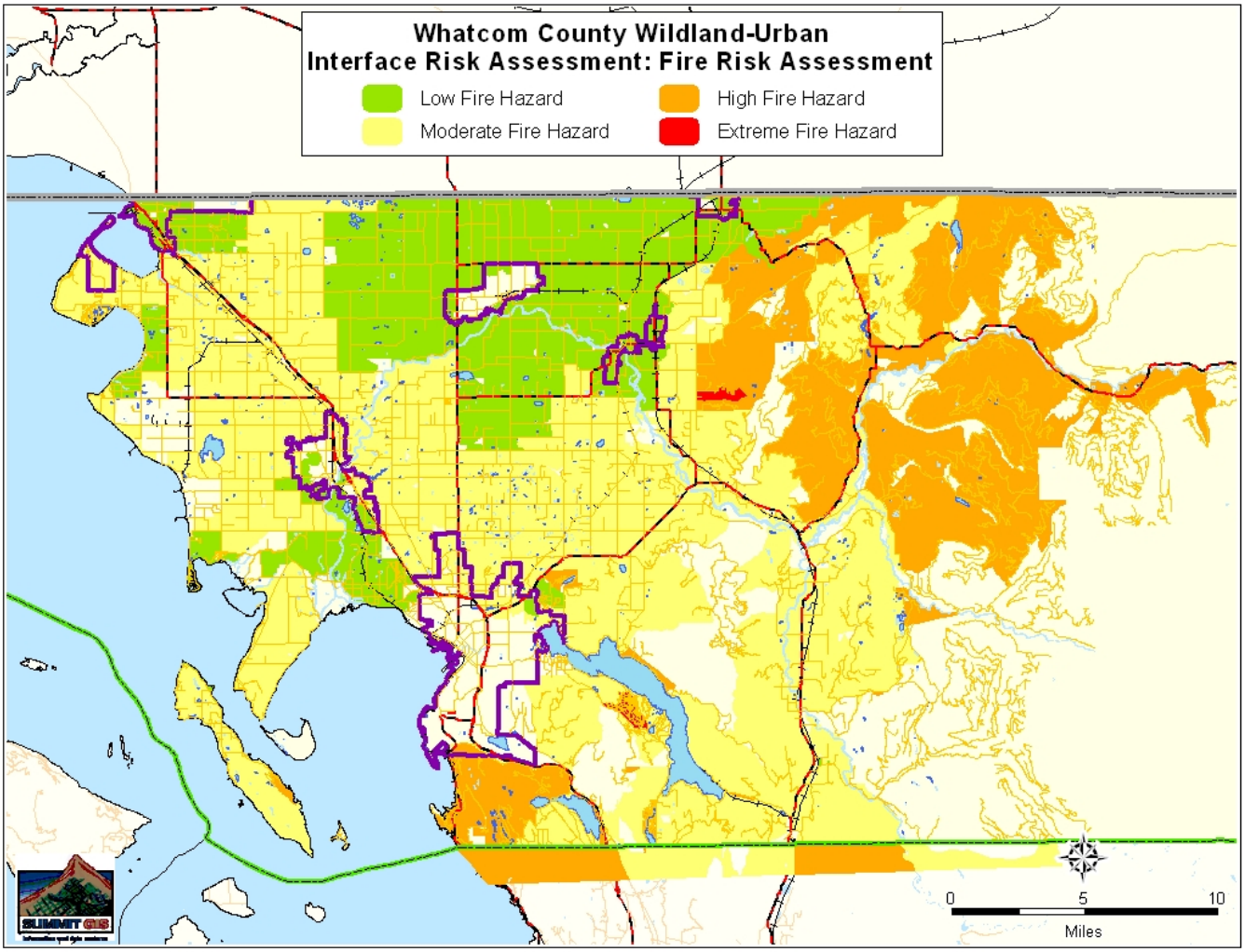
e. Catastrophic Fire Potential ~ An evaluation of fire history reflects the potential for an event to occur. An example is if large damaging fires occur every 20 years and it has been 18 years since the last occurrence, this would reflect a priority for fire prevention management actions.
   1. Evaluate large fire history
   2. What are the odds of a stand replacement type fire occurrence in that compartment?
      a. Unlikely
      b. Possible
      c. Likely

f. Values ~ Values are defined as natural or developed areas where loss or destruction by fire would be unacceptable. The value elements include:
   1. Recreation – undeveloped/developed
   2. Administrative sites
   3. Wildlife/Fisheries – habitat existing
   4. Range Use
   5. Watershed
   6. Timber / Woodland
   7. Plantations
   8. Private Property
   9. Cultural Resources
   10. Special Interest Areas
   11. Visual Resources
   12. T & E Species
   13. Soils
   14. Airshed
   15. Other Necessary Elements

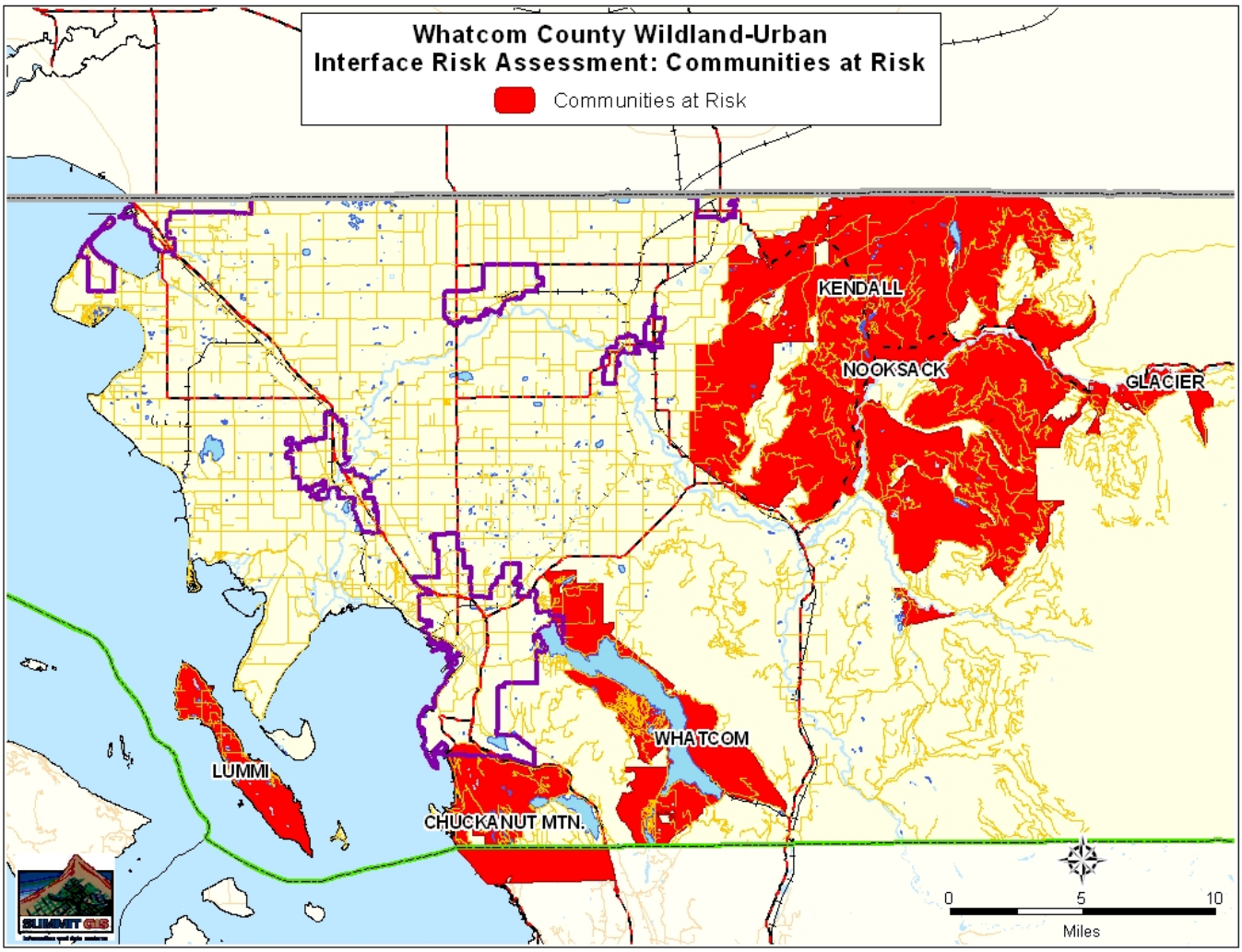
This evaluation process provides the basis for determining the *Whatcom County Wildland-Urban Interface Fire Risk Assessment Compartments* map. Additional information regarding the results of this process can be found in Appendix E, Excerpts from *the Washington State Department of Natural Resources Northwest Region R.A.M.S. Assessment*.



2. R.A.M.S risk assessment compartments were further broken down to identify Wildland-Urban Interface Hazards. Using 2000 Census data, individual areas were identified in the Wildland-Urban Interface and assessed using the N.F.P.A. (National Fire Protection Association) 299, Wildfire Hazard Assessment. The results of this assessment are depicted in the *Whatcom County Wildland-Urban Interface: Fire Risk Assessment* map.



3. The NFPA 299 was further refined, to reflect Whatcom County Fire Manager's input, producing a map that reflects Landscapes of Like Risk (Communities at Risk). Areas that received a high to extreme risk ranking were grouped into landscapes and named. The result is depicted in the following map. These areas of Whatcom County are at highest risk of catastrophic loss to a Wildland fire.



MITIGATION STRATEGIES:

In cooperation with fire managers from Washington State's Department of Natural Resources, NW Region, three mitigation strategies were developed to address Whatcom County's fire hazards:

1. Inter-Agency Cooperation
2. County-wide Wildland Fire Prevention
3. WUI (Wildland/Urban Interface) Communities at Risk

Inter-Agency Cooperation

Inter-agency cooperation is the key to a successful wildland fire mitigation strategy. In the case of Wildland fire risk mitigation, continued development and enhancement of support between fire protection agencies will be emphasized. Participation in the NW Region Wildland Fire Local Coordinating Group will continue and support of Local Coordination group activities will be a

priority. Support of those activities proclaimed by the governor's office in relation to wildland fire prevention, such as Wildfire Awareness Week, should be made a priority.

County-Wide Wildland Fire Prevention

In the RAMS Compartments, where the wildland fire risk has been assessed at moderate, multi-agency cooperative fire prevention activities will occur during the summer months addressing the following:

1. Public awareness of current fire danger
2. Press releases
3. Media opportunities for fire prevention news articles
4. Radio and TV spots, as needed
5. Use of burn bans during periods of high fire danger
6. Use of Smokey Bear fire prevention programs targeting age-specific audiences during periods of extreme fire danger, or during significant wildland fire events
7. Consideration of mobilizing Washington State Inter-agency fire prevention teams
8. Use of other fire prevention tactics and strategies, as needed, and as conditions warrant

Wildland/Urban Interface (WUI) Communities at Risk

As a result of efforts conducted by the State of Washington Department of Natural Resources, the following list of Landscapes of Like Risk were established.

1. Lake Whatcom – Sudden Valley, in the lake Whatcom watershed, is currently participating in the mitigation strategies set forth in this plan.
2. Nooksack
3. Glacier
4. Lummi Island – Lummi Island Scenic Estates, a community on Lummi Island, has received national recognition for their mitigation activities under the Firewise Communities/USA program.
5. Kendall

The Landscapes of Like Risk will undergo a more detailed Community Wildfire Protection Planning (CWPP) process as outlined in "Preparing a Community Wildfire Protection Plan, A Handbook for Wildland-Urban Interface Communities" (see Appendix F). The CWPP will identify landscape level hazard reduction priorities and provide recommendations to reduce structural ignitability.

In addition to CWPP recommendations, communities located in the Landscapes of Like Risk should consider the following mitigation strategies:

1. Use of the Firewise Communities program (www.firewise.org)
2. Conduct Firewise workshops
3. Increase homeowner awareness
4. Facilitate community involvement and support
5. Facilitate media involvement
6. Use the Firewise Communities/USA program (www.firewise.org/usa) to:
    a. Facilitate Community involvement and support
    b. Provide a course of action for community mitigation
    c. Nationally recognize achievement

JURISDICTIONS

The following information details the seven jurisdictions, the Port, and the County's infrastructure. Each chapter is organized into the following sections:

1. **Contact Information** – the person involved with providing information for the plan from the jurisdiction.

2. **Approving Authority** – the person or persons who will approve the final version of this Hazard Mitigation Plan.

3. **Critical Facilities List** – list of critical facilities for each jurisdiction's area. These facilities were provided by each jurisdiction and include the facility name, type of facility, and location information.

4. **Geography** – describes each jurisdiction's infrastructure information and hazard impacts on the infrastructure, including 2000 Census Bureau population information and the number of structures impacted per hazard (numbers are an estimate, as damage made to structures not directly in the way of a hazard could not be predicted).

5. **Growth Trends** – areas designated as an Urban Growth Area (UGA), under Washington State's Growth Management Act (GMA).

6. **Ranked Critical Facility Assessment** – each jurisdiction assessed their critical facilities, ranked by priority, during a natural hazard event. The purpose of this assessment was to prioritize each facility according to the amount of federal hazard mitigation funds each should receive. Entities took into account the number of hazards affecting each facility and the significance/function of each facility when determining rankings.

7. **Proposed Mitigation Strategies** – jurisdiction-specific mitigation strategies and potential projects put together by each jurisdiction. This information is a detailed jurisdiction-specific extension of the general mitigation strategies provided in each hazard summary, as well as a description of project prioritization. Refer to page 53 for information on the commitments made by any of the adopting jurisdictions.

8. **Hazard Maps** – maps describing the areas and critical facilities affected by each hazard. Please note these maps display only the city limits, so facilities outside city limits may not be displayed. Refer to the map in the Whatcom County section for facilities located outside of a jurisdiction's city limits.

   Due to space limitations on the map pages, the legend to the right describes each critical facility symbol.

Whatcom County Critical Facility Legend

- Assisted Living
- EMS Station
- Economic
- EOC
- Emergency Services
- Fire Station
- Fuel
- Government
- Homeland Security
- Law Enforcement
- Mail
- Public Works
- School Evacuation Center
- Transportation
- Transportation: Airport
- Utility: Communication
- Utility: Power
- Utility: Sewer
- Utility: Water

JURISDICTION ADOPTION AGREEMENT

All the jurisdictions who adopted this Hazard Mitigation Plan agreed to the following:

1. To formally advise the Whatcom County Department of Emergency Management of its decision to officially adopt the Plan, and submit ordinances accordingly.
   Refer to the Appendices for the signed ordinances of participating jurisdictions.

2. To integrate the Plan into other jurisdiction-specific processes, such as Operational Budgets, the Growth Management Act (GMA), Capital Budget, and so on.

3. To formulate a cost-benefit analysis of each individual Proposed Hazard Mitigation upon the implementation of each strategy. Cost-benefits analyses were not calculated and incorporated into the Plan's first edition due to unpredictable factors of future strategy implementation, such as physical conditions, inflation, and implementation methodology.

   However, a benefit cost review of all the mitigation strategies in this version of the Hazard Mitigation Plan was conducted as part of the overall community prioritization process. Table 7 is a consolidated list of all jurisdiction-defined projects. The table prioritizes each mitigation strategy, taking into consideration the perceived costs and overall benefits to the community, the complexity of each project strategy, if the jurisdiction has identified implementation or is recommending initial studies or plan development for the facility/strategy; risk from natural hazards affecting each facility or entire jurisdiction (i.e. facilities and jurisdictions with three impacting hazards will have a higher priority than those with only one hazard); and significance of the facility to the safety of Whatcom County citizens.

Priority	Facility	Jurisdiction	Nature	Brief Description
1	Sumas City Hall & Police Station	Sumas	Implementation	Rebuild outside of flood plain
2	Sumas Fire Station	Sumas	Implementation	Rebuild outside of flood plain
3	Cherry Street Bridge Replacement	Sumas	Implementation	Rebuild to sustain flood events
4	Downtown Ferndale Ring Dike	Ferndale	Implementation	Reinforce current dike and extend levy
5	Lynden Waste Water Treatment Plant	Lynden	Implementation	Mitigate against 100-year flood event or volcanic lahar
6	Blaine Waste Water Collection & Conveyance System	Blaine	Implementation	Construct underground storage
7	Power Generating Capacity	Blaine	Implementation	Install sufficient regenerative power capacity for critical sites
8	Relocate Waste Water Shops & Offices	Lynden	Implementation	Mitigate in place or move out of floodplain
9	Wellfield Backup Power	Sumas	Implementation	Retrofit against earthquakes
10	Fishtrap Creek Flood Storage & Fish Enhancement	Lynden	Implementation	Increase storage capacity
11	Blaine City Hall	Blaine	Implementation	Retrofit against earthquakes
12	Natural Hazard Early Warning Systems	Blaine, Everson, Ferndale, Nooksack, Lynden, Bellingham	Implementation	Establish Community early warning systems for all related hazards, such as flooding, tsunamis, lahar, and earthquake (when technology allows).
13	Telephone-based Early Warning System	Blaine, Everson, Ferndale, Nooksack, Lynden, Port	Implementation	Install computerized early warning system in phone system.
14	Tone Radio Based Early Warning System	Bellingham, Everson, Ferndale, Lynden, Nooksack, Port	Implementation	Install
15	Purchase Repetitive Loss Properties	Everson, Nooksack, Ferndale, Sumas	Implementation	
16	Everson & Nooksack Waste Water Treatment Plant	Everson & Nooksack	Plan Development	Mitigate against 100-year flood event or volcanic lahar
17	Everson & Nooksack City Halls/Everson Police Department	Everson & Nooksack	Plan Development	Mitigate against 100-year flood event or volcanic lahar
18	Sumas Internation Cargo Terminal	Port	Plan Development	Mitigate against flooding
19	Riverside Park	Everson & Nooksack	Plan Development	Mitigate against flood events
20	Dodd Avenue Residential Area	Blaine	Plan Development	Develop contingency plans for flood event
21	Lynden City Hall	Lynden	Plan Development	Retrofit against earthquakes

22	Marine Drive Marina	Blaine	Plan Development	Develop contingency plans for flood event
23	Semiahmoo Marina	Blaine	Plan Development	Develop contingency plans for flood event
24	Bellingham Water & Waste Water Systems	Bellingham	Study	Investigate strengthening structures
25	Bellingham Fire, EMS, & Law Enforcement Stations	Bellingham	Survey	Assess risks and potential strategies
26	Ferndale City Hall	Ferndale	Survey	Retrofit against earthquakes
27	Bellingham Fire Station 5 / St. Joseph Hospital	Bellingham	Survey	Assess risks and potential strategies
28	Bellingham Shipping Terminal	Port	Survey	Survey of alluvial fans and existing mines
29	Squalicum Harbor	Port	Survey	Survey of alluvial fans and existing mines
30	Bellingham International Airport	Port	Survey	Survey of alluvial fans and existing mines
31	Fairhaven Station	Port	Survey	Survey of alluvial fans and existing mines
32	Alluvial Fan Hazards	Ferndale	Survey	Assess risks

Table 7 – Perceived Cost Benefit Analysis of all Jurisdiction-Defined Projects

City of Bellingham

Contact Information: Andy Day
Assistant Fire Chief
1800 Broadway St.
Bellingham, WA 98225
(360) 676-6831

Approving Authority: Mayor Mark Asmundson & City Council Members
210 Lottie Street
Bellingham, WA 98225
(360) 676-6979

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	✓
Volcano	
Wild Land Fire	✓

Hazard Descriptions:

Earthquake – high potential for seismic activity and massive sliding when slopes of 15% or greater are wet.

Flooding – multiple creeks that pass through the city are subject to flooding.

Geologic Hazards – multiple abandoned underground coal mines exist in and around Bellingham. Mines of most significance and potential danger exist near and around the downtown area.

Tsunami – Bellingham borders the Bellingham Bay, and the port area would be at risk of tsunami activity.

Urban Fire – both urban multiple dwellings and commercial structures in Bellingham would be at risk.

Bellingham Critical Facility List

Facility name	Facility type	Location
American Red Cross Chapter	EOC	2111 King Street
Bellingham City Hall	Government	210 Lottie St.
Bellingham Fire 1	Fire Station	1800 Broadway
Bellingham Fire 2	Fire Station	1590 Harris
Bellingham Fire 3	Fire Station	1111 Indian St
Bellingham Fire 4	Fire Station	2306 Yew St
Bellingham Fire 5	Fire Station	3314 Northwest Ave
Bellingham Fire 6	Fire Station	4060 Deemer Rd
Bellingham Police Station	Law Enforcement	505 Grand Ave
Cascade Natural Gas	Fuel	1600 Iowa
City of Bellingham Public Works	Emergency Services	2221 Pacific
Encogen Cogeneration Plant	Utilities: Power	915 Cornwall Ave
Federal Bureau of Investigation	Law Enforcement	104 W. Magnolia
Georgia-Pacific	Economic	300 W. Laurel Street
Grandview Medic	EMS Station	1886 Grandview
Prospect Fire Dispatch	ECO	1800 Broadway
Public Works Central Shop	Public Works	2221 Pacific
Salvation Army	ECO	2912 Northwest Ave
Sehome Tower	Utility: Communications	Top of Sehome hill
Schools - Dist 501	Evacuation Centers	18 Schools Total
Smith Rd Medic	EMS Station	858 E Smith Rd
St. Joseph Hospital-Main	EMS Station	2901 Squalicum Pkwy
St. Joseph Hospital-South	EMS Station	809 E. Chestnut St.
Teresen Pipelines	Utility: Gas	1006 E. Smith Road
US Border Patrol-Bellingham	Law Enforcement	2745 McLeod Rd
US Coast Guard	Law Enforcement	1101 Thomas J Glenn Dr.
Verizon	Utility: Communications	114 W. Magnolia, Suite 411
Washington State National Guard.	Law Enforcement	3928 Williamson Way
Washington State Patrol	Law Enforcement	3860 Airport Way
Waste Water Treatment Plant	Utility: Sewer	200 Mckenzie
Water Treatment Plant	Utility: Water	3201 Arbor St
Whatcom County DEM	EOC	311 Grand Avenue
Whatcom County Sheriff	Law Enforcement	311 Grand Avenue
Whatcom Transit Authority	Transportation	4111 Bakerview Spur
What-Comm Dispatch	Utility: Communications	620 Alabama
WWU Police	Law Enforcement	516 High Street

Geography:

Bellingham Population: **67,171** (2000 Census)

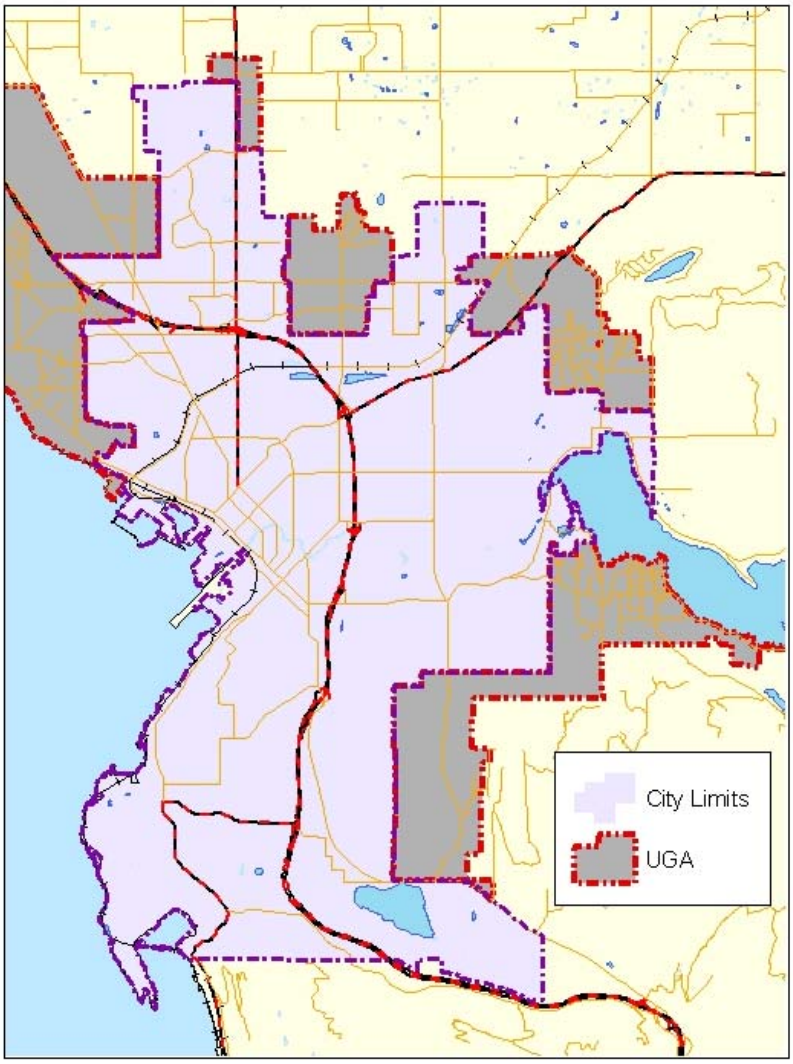
Total area, within city limits: **27.6 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected (mi^2)	Percent of Total Area
Earthquake	40,964	27.6 mi^2	100%
Flooding	773	1.331 mi^2	4.8%
Geologic Hazards	903	1.24 mi^2	4.5%
Tsunami	Less than 100		Less than 5%
Wild Land Fire	1,739	5.558 mi^2	20.1%

Growth Trends:

This map displays the Urban Growth Area for the City of Bellingham, as designated by the Whatcom County Comprehensive Plan.



City of Bellingham & Related UGA Areas

Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Water Treatment Plant	Utility: Water		✓					1	1
Waste Water Treatment Plant	Law Enforcement	✓	✓					2	2
Prospect Fire Dispatch	ECO		✓					1	3
Sehome Tower	Utility: Communications		✓					1	3
What-Comm Dispatch	Transportation		✓	✓				2	3
St. Joseph Hospital-Main	EMS Station		✓	✓				2	4
Bellingham Fire 1	Fire Station		✓					1	5
Bellingham Fire 2	Fire Station		✓					1	5
Bellingham Fire 3	Fire Station		✓					1	5
Bellingham Fire 4	Fire Station		✓	✓				2	5
Bellingham Fire 5	Fire Station		✓	✓				2	5
Bellingham Fire 6	Fire Station		✓	✓			✓	3	5
Grandview Medic	EMS Station		✓				✓	2	5
Smith Rd Medic	Evacuation Center		✓	✓			✓	3	5
Bellingham Police Station	Law Enforcement		✓	✓				2	6
Federal Bureau of Investigation	Law Enforcement		✓	✓				2	6
Washington State Patrol	Law Enforcement		✓	✓				2	6
Whatcom County DEM	Utility: Water		✓	✓				2	6
Whatcom County Sheriff	EOC		✓	✓				2	6
WWU Police	Utility: Communications		✓					1	6
Public Works Central Shop	Public Works		✓	✓				2	7
City of Bellingham Public Works	Emergency Services		✓	✓				2	8
Cascade Natural Gas	Fuel		✓	✓				2	9
Teresen Pipelines	EMS Station		✓	✓			✓	3	10
Verizon	Law Enforcement		✓	✓				2	11
St. Joseph Hospital-South	EMS Station		✓					1	12
Bellingham City Hall	Government		✓	✓				2	13
Schools (18 total)	Evacuation Center	Hazards Vary							14
American Red Cross Chapter	EOC		✓	✓				2	15
Salvation Army	ECO		✓	✓				2	15
US Coast Guard	Law Enforcement		✓		✓			2	16
National Guard	Utility: Communications		✓	✓				2	17
Whatcom Transit Authority	Law Enforcement		✓					1	18
Encogen Cogeneration Plant	Utilities: Power		✓					1	19
Georgia-Pacific	Economic		✓	✓				2	19
US Border Patrol-Bellingham	Utility: Gas		✓	✓				2	20

CRITICAL FACILITY RANKINGS FOR CITY OF BELLINGHAM

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Bellingham's Hazard Mitigation Strategies & Projects

General Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the City of Bellingham.

Provide for an increased level of safety to the citizens of Bellingham.

Responsible Entity:	Bellingham City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Provide for an increased level of protection for public infrastructure.

Responsible Entity:	Bellingham City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Systematically identify and assess the relative risks to critical facilities within the City of Bellingham. Use information as a basis to develop cost effective mitigation alternatives.

Responsible Entity:	Bellingham City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Bellingham can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the City's prioritization for implementation.

EARTHQUAKE

Every one of the critical facilities located within the City of Bellingham is subject to damage or destruction from seismic activity. Specific mitigation projects possible for the highest priority groups of facilities include:

Water & Waste Water Systems

Study the entire Water and Waste Water Systems to assure they substantially exceed the seismic provisions of the current building code. Possible upgrades include strengthening columns, building containment dikes, and adding shear walls and foundation supports.

Responsible Entity:	City of Bellingham Public Works Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Emergency Communication System

The Whatcom County Emergency Communications and Radio Equipment Study, published in 2000, identified the entire emergency communication system does not meet the critical needs of the users (fire, law enforcement, and public works). The study further recommends the current radio system be replaced with an 800MHz system. Included in the overhaul would be hardening of the dispatch centers and communication towers to resist the effects of an earthquake.

Responsible Entity:	Whatcom County Council of Governments
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Fire, EMS, and Law Enforcement Stations
All of these facilities need to be surveyed to assure they substantially exceed the seismic provisions of the current building code. Possible upgrades include strengthening columns, and adding shear walls and foundation supports.

Responsible Entity:	Bellingham Fire and Police Departments, Whatcom County Sheriff's Office, Western Washington University Police, and the Federal Bureau of Investigation.
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

GEOLOGIC HAZARDS
Bellingham Fire Station 5 and St. Joseph Hospital
This fire station, located on Northwest Avenue, and the hospital sit on top of an area containing the abandoned Bellingham Bay Coal Mine. Combined with the fact that the fire station (a 1971 masonry building) has not been retrofitted to current seismic standards, this places these facilities at increased risk for damage or destruction. A study should be completed to assess the risks to these facilities and to recommend alternative mitigation strategies.

FLOODING & TSUNAMI
Waste Water Treatment Plant
This plant is located slightly above sea level on the Bellingham waterfront. Given its location, it is at risk from the effects of a Tsunami. A study should be made to assess the risk from this hazard and identify alternatives for mitigation.

Responsible Entity:	Bellingham Building Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION
Any monies that would come to Bellingham would first be spent on studies to determine the best possible application. The City is unsure of the direction they need to go with regards to Hazard Mitigation funds, but consider earthquakes to be a major threat. They want to use a risk assessment process to base their decisions, form a team of decision-makers and then determine a course of action using a rational-based process.

City of Blaine

Contact Information: Mike Haslip
Police Chief
322 H Street
Blaine, WA 98230
(360) 337-6760

Approving Authority: City Manager Gary Tomsic & City Council Members
344 H Street
Blaine, WA 98230
(360) 332-8311

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	
Wild Land Fire	✓

Hazard Descriptions:

Earthquake – moderate to high risk

Flooding – areas within the city limits are subject to tidal flooding. Dakota, California, and Terrell Creeks all present flooding risks.

Geologic Hazards – seismically-sensitive soils present.

Wildland Fire – numerous mobile homes and seasonal cottages at risk.

Blaine Critical Facility List:

Facility name	Facility type	Location
AT&T (US/Canada fiber optic vault)	Utility: Communications	1715 D Street
Bay Medical Clinic	EMS	377 C Street
Blaine City Hall	Government	344 H Street
Blaine City Municipal Airport	Transportation	1311 Boblett St.
Blaine Community Center	EOC	763 G Street
Blaine Police Department	Law Enforcement	322 H Street
Blaine Public Works	Emergency Services	1200 Yew Street
Blaine Waste Water Treatment Facility	Utility: Water	9235 Semiahmoo Parkway
Cascade Natural Gas Facility	Utilities - Power	1400 blk Peace Portal Way
CPB, Pacific Highway Port of Entry	Homeland Security	9955 SR 543
CPB, Peace Arch Port of Entry	Homeland Security	9955 Interstate Five
Customs/Border Patrol Facility	Homeland Security	S of Sweet Rd, E I-5
Dept. of Homeland Security, Border Patrol	Homeland Security	1590 H Street
Dept. of Homeland Security, Customs	Homeland Security	1777 H Street
Dept. of Homeland Security, Investigations	Homeland Security	808 Harrison Street
Dept. of Justice	Law Enforcement	165 2nd St.
Elementary School - Dist 503	Evacuation Center	Refer to WC GIS Data Layer
Good Samaritin Rest Home	Evacuation Center	456 C Street
Lift Stations	Utility: Sewer	9 Lift Stations Total
Nextel / AT&T Wireless	Utility: Communication	8800 Blk Semiahmoo Parkway
Nextel / FARS Repeater	Utility: Communication	9800 blk Harvey Rd
Port of Bellingham	Law Enforcement	250 Marine Drive
Puget Power	Utility: Power	Sweet Road& W of Odell Rd.
Pump Station	Utility: Sewer	4 Pump Stations Total
Reservoir	Utility: Water	5 Reservoirs Total
Troon	Utility: Sewer	Refer to Map
US Customs/HLS et al	Law Enforcement	9901 Pacific Highway
Verizon Central Office	Utility: Communication	259 Martin Street
Well Head	Utility: Water	7 Well Heads Total
Whatcom County Fire District 13	Fire Station	1510 Odell Road
Whatcom County Fire District 13	Fire Station	9001 Semiahmoo Parkway

Geography:

Blaine Population: **3,770** (2000 Census)

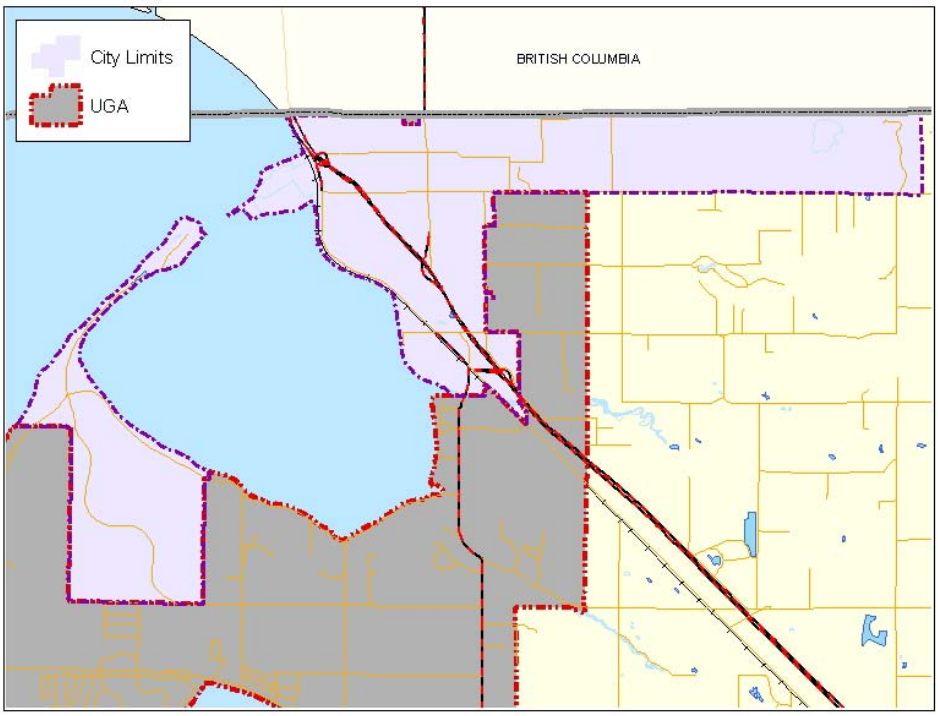
Total area, within city limits: **5.5 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total
Earthquake	2,701	5.5 mi^2	100%
Flooding	178	.247 mi^2	4.5%
Geologic Hazards	443	.785 mi^2	14.3%
Wild Land Fire	599	1.344 mi^2	24.4%

Growth Trends:

This map displays the Urban Growth Areas (UGA) for the City of Blaine, as designated by the Whatcom County Comprehensive Plan.



City of Blaine & Related UGA Areas

Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Blaine City Hall	Government		✓					1	1
Blaine Community Center	EOC		✓					1	1
Blaine Police Department	Law Enforcement		✓					1	1
Blaine Public Works	Emergency Services		✓					1	1
Dept. of Homeland Security, Border Patrol	Homeland Security		✓	✓				2	1
Dept. of Homeland Security, Customs	Homeland Security		✓	✓				2	1
Dept. of Homeland Security, Investigations	Homeland Security		✓					1	1
Nextel / FARS Repeater	Utility: Communication		✓					1	1
Puget Power	Utility: Power		✓					1	1
Whatcom County Fire District 13	Fire Station		✓					1	1
Whatcom County Fire District 13	Fire Station		✓				✓	2	1
AT&T (US/Canada fiber optic vault)	Utility: Communications		✓	✓				2	2
Birch Bay Water and Sewer (Dist 8)	Utility: Water		✓				✓	2	2
Birch Bay Water Connection	Utility: Water		✓	✓				2	2
Blaine City Municipal Airport	Transportation		✓					1	2
Blaine Waste Water Treatment Facility	Utility: Water		✓				✓	2	2
Cascade Natural Gas Facility	Utilities - Power		✓					1	2
CPB, Pacific Highway Port of Entry	Homeland Security		✓					1	2
CPB, Peace Arch Port of Entry	Homeland Security		✓					1	2
Customs/Border Patrol Facility	Homeland Security		✓					1	2
Dept. of Justice	Law Enforcement		✓					1	2
Good Samaritin Rest Home	Evacuation Center		✓					1	2
Lift Station (9 Total)	Utility: Sewer								2
Nextel / AT&T Wireless	Utility: Communication		✓				✓	2	2
Port of Bellingham	Law Enforcement		✓	✓				2	2
Pump Station (4 Total)	Utility: Sewer								2
Reservoir 1 (5 Total)	Utility: Water								2
Troon	Utility: Sewer		✓				✓	2	2
US Customs/HLS et al	Law Enforcement		✓					1	2
Verizon Central Office	Utility: Communication		✓					1	2
Well Head (7 Total)	Utility: Water								2
Bay Medical Clinic	EMS		✓					1	3
BP-Cherry Point Refinery	Fuel		✓	✓				2	3
Elementary School - Dist 503	Evacuation Center		✓					1	3

CRITICAL FACILITY RANKINGS FOR CITY OF BLAINE

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Blaine's Hazard Mitigation Strategies & Projects

General Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the City of Blaine.

Provide for an increased level of safety to the citizens of Blaine.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Current and ongoing

Provide for an increased level of protection for public infrastructure.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Current and ongoing

Work with state and federal agencies to construct temporary wastewater storage capacity for the wastewater collection and conveyance system to minimize bypasses, particularly during severe storms.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Current and ongoing

Partner with neighboring jurisdictions, public and private entities to ensure adequate emergency shelter capacity and utility infrastructure during severe storms and other natural disasters

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Blaine can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the City's prioritization for implementation

HEAVY PRECIPITATION EVENTS

Wastewater Collection and Conveyance System

Construct an underground storage and implement policies to minimize the probability of inflow and infiltration induced wastewater bypasses.

Responsible Entity:	Blaine Public Works Department
Funding Source:	Sewer funds, other local sources, and state and federal grants and loans
Timeline:	In-process: construction completion estimated Spring 2005

EARTHQUAKE EVENTS

Blaine City Hall

Studies have repeatedly indicated that the City Hall and adjacent police service bays would suffer significant damage and casualties in the event of an earthquake. These facilities should be retrofitted, replaced, or relocated so that they can survive a 6.0 magnitude or greater earthquake event.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (minimum of three years after funding is secured)

Acquire sufficient power-generating capacity to serve critical sites during extended power loss

There are several sewer lift stations, water well pumps stations, designated emergency shelters, EOC and Public Works facilities which require backup power generation capacity in the event of a severe storm or other emergency causing widespread extended disruption of power supplies. Sufficient regenerative capacity does not currently exist, and should be purchased, installed and maintained to provide this capacity.

Responsible Entity:	Blaine Public Works and Light Department
Funding Source:	Local sources, enterprise funds, and state and federal grants and loans
Timeline:	Long term (estimate one year after funding is secured)

Dodd Avenue Residential Area

The residential neighborhood bounded by Peace Portal, Bayview Avenue, Drayton Harbor and Dakota Creek west of Peace Portal Drive, can only be accessed by one road, Hughes Avenue, where it cross the Burlington Northern Santa Fe right of way. Closure of this access by a rail incident, earthquake or other incident would strand or trap the resident's occupants. This site should be provided a second roadway for ingress/egress by resident vehicles and emergency equipment. A response plan for this neighborhood should be developed to provide prompt notification to people in the neighborhood, and to provide alternative means for their escape from the area if Hughes Avenue is closed. The plan should include contingency planning should a blocked roadway prevent access by emergency vehicles.

Responsible Entity:	Blaine Public Works and Public Safety Departments
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Moderate term (at least one year after funding is secured)

Marine Drive commercial and marina areas

The Marine Drive commercial and boating neighborhood is home to several commercial businesses, over 400 commercial and pleasure craft, a well visited public pier, marine park and bird sanctuary. It is served to a single point of ingress/egress across the BNSF Railway line. Significant storm driven tidal action has in the past compromised the Marine Drive right of way and exposed adjacent underground utilities. Storm winds and large accumulations of snow place the marina facilities at increased risk. Railroad activity occasionally closes the roadway for extended periods. A natural event such as earthquake, tsunami, or derailment would strand civilians in the harbor and deny access to emergency responders. A plan needs to be developed and provisioned to provide prompt notification to people in the harbor area, and to provide alternative means for their escape from the area if Marine Drive is closed. The plan should include contingency planning should a blocked roadway prevent access by emergency vehicles.

Responsible Entity:	Blaine Public Works and Public Safety Department
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (greater than three years after funding is secured)

Semiahmoo Spit commercial and marina areas
The Semiahmoo Marina, Semiahmoo Inn, Beach Walker condominiums, Whatcom County Park and Blaine WasteWater Treatment Plant constitute several tens of millions of dollars in buildings with a daily occupancy and use rate in the hundreds, year round. It is served by a single point of ingress/egress along the lowland Spit from Drayton Harbor Road. Significant storm driven tidal action can and does compromise the Semiahmoo Parkway roadway on occasion. Storm winds place the marina facilities at increased risk. A natural event such as earthquake, Tsunami, or wind driven tidal surge could damage property and strand civilians in the spit area and deny access to emergency responders. A plan needs to be developed and provisioned to provide prompt notification to people along the Semiahmoo spit, and to provide alternative means for their escape from the area if the roadway is compromised or if quick evacuation is essential. The plan should include contingency planning should a blocked roadway prevent access by emergency vehicles.

Responsible Entity:	Blaine Public Works and Public Safety Department
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (greater than three years after funding is secured)

TSUNAMI
Earthquake/Tsunami Warning System
Blaine has significant lowland exposures to Puget Sound shoreline, valuable properties, infrastructure and populated areas which could be at risk in the event of a tsunami . A more detailed analysis of Blaine's risk from events of this type is needed. If required, the US Geological Survey and National Oceanic and Atmospheric Administration have designed tools, systems and protocols to detect tsunami producing events. These systems then automatically trigger various types of early warning systems, such as sirens or telephone based warning systems for orderly evacuation of low-lying areas.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (one to three years after funding is secured)

COMMUNICATIONS
Community Early Warning System
A community-wide warning system could be built to help provide broad community notice for evacuation in the event of tsunami, large scale hazardous material spills involving rail or truck lines or Weapon of Mass Effect incidents involving the international border. Such an early warning system typically involve a series of sirens that are triggered in the event the City needed to be evacuated.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (greater than three years after funding is secured)

Telephone-Based Early Warning System
A computerized early warning system would automatically dial every telephone number within a specified area, and play a recorded message to whoever picked up the phone. A small version of such a system is currently in use by the Finance Department. A larger capacity system could be very useful for a variety of natural and man made problems.

Responsible Entity:	Blaine City Council
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Short term (within one year after funding is secured)

Earthquake Early Warning System
These systems are envisioned to warn residents of an impending earthquake. Technology doesn't currently exist for early detection with sufficient accuracy, but will likely be available in the future.

Responsible Entity:	Blaine City Council Department
Funding Source:	Local sources, and state and federal grants and loans
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION
The City of Blaine's two foremost concerns are:

1. The ability to continue emergency responsiveness
2. The ability to continue government services when local infrastructure is affected

To mitigate for these concerns, hazard mitigation monies would be prioritized and steered towards these two major projects:
First, the most comprehensive of projects is the retrofit (seismic) of city hall and the adjacent police station, training facility and service bay. This is the nucleus of public service, government and command and control for the city. If these important functions are to be continuously available, the buildings must survive a seismic event.
The second major project is the acquisition/installation of power generation capacity to both provide emergency power to police station and city hall, but also provide portable (trailer) power to maintain both the water and sewage systems. Power is needed to operate water pumps to pump from wells to water storage devices and to operate sewage lift stations.

City of Everson

Contact Information: Erik Ramstead
Police Chief
PO Box 315
Everson, WA 98247
(360) 966-4212

Approving Authority: Mayor Jaleen Pratt & City Council Members
111 W Main St
Everson, WA 98247
(360) 966-3411

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	✓
Wild Land Fire	

Hazard Descriptions:

Earthquake – Part of the city, east of Strandel Road, has known clay soil called phixatropic. Phixatropic liquefies when moved, causing landslides and flow.

Flooding – Hazard presents a frequent and severe risk due to isolated areas. Major flooding occurred in 1989, 1990, 1995. Flooding begins on west side of the City and moves east and north up Highway 9 toward Sumas. A 1991 dike was extended with money from mitigation. A dike runs parallel to the river on the west side, and ends on Emerson Rd, which prevents water from going to Washington Street and on through to Main Street. This dike diverts Nooksack River overflow to the floodway. The Sumas River can flood east of the city, but does not cause severe problems.

Geologic Hazards – seismically-sensitive soils present.

Wildland Fire – Various residential homes at risk. The city has multiple 1970's apartments and duplexes and two senior living facilities. Two mobile home parks are present with a total of 71 units.

Critical Facility List:

Facility name	Facility type	Location
Bank Northwest	Economic	Kirsh & E Main St.
Elementary School - Dist 506	Evacuation Center	SR 544
Everson City Hall	Government	111 West Main
Everson Police Dept.	Law Enforcement	109 West Main
Everson Senior Center	Evacuation Center	111 West Main
Everson Water plant	Utility: Water	610 Freda St
People's Bank	Economic	Kirsh Street
Post Office	Mail	108 Blair Dr.
Public Works Building	Public Works	603 Robinson St
Pump-Station	Utility: Sewer	103 East Main
Pump-Station	Utility: Sewer	401 Lincoln St
Pump-Station	Utility: Sewer	102 Reeds Ln.
Pump-Station	Utility: Sewer	605 Robinson St.
Pump-Station	Utility: Sewer	116 Evergreen Way
Pump-Station	Utility: Sewer	506 East Main
Pump-Station	Utility: Sewer	208 Everson Rd
Verizon Communications	Utility: Communication	Washington St.
Waste Water Treatment Plant	Utility: Sewer	101 Park Dr.
Waste Water Treatment Plant	Utility: Sewer	105 Park Drive
Whatcom County Fire District 1	Fire Station	101 East Main

Geography:

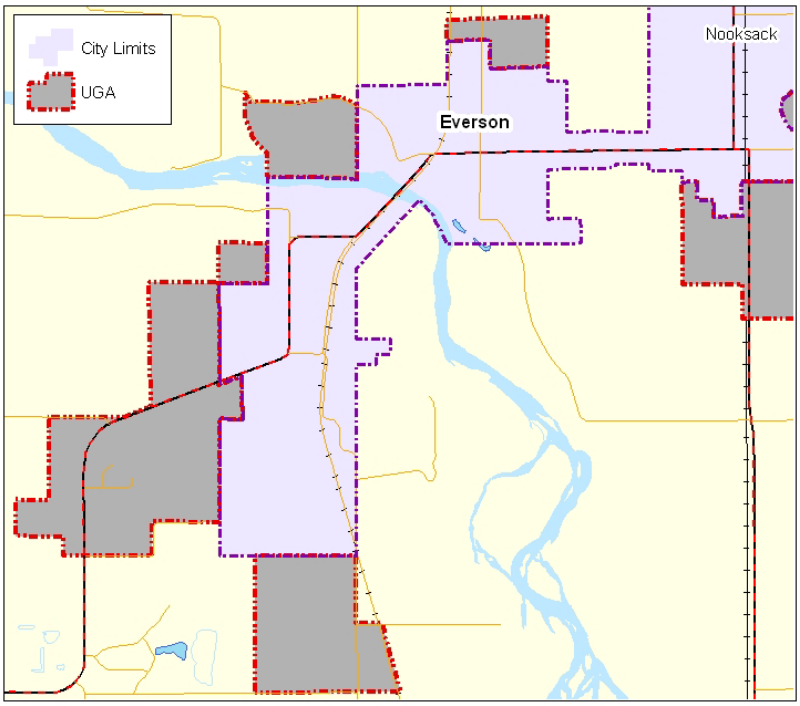
Everson Population: **2,035** (2000 Census)

Everson Total area, within city limits: **1.25 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total
Earthquake	742	1.25 mi^2	100%
Flooding	295	0.586 mi^2	46.9%
Geologic Hazards	61	0.129 mi^2	10.3%
Volcano	474	0.771 mi^2	61.7%

Growth Trends:
The map to the right displays the Urban Growth Areas (UGA) for the City of Everson, as designated by the Whatcom County Comprehensive Plan. The City experienced a noticeable growth spurt in the late 1980's, and again in 1995.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Everson Water plant	Utility: Water		✓			✓		2	1
Verizon Communications	Utility: Communication		✓			✓		1	1
Waste Water Treatment Plant	Utility: Sewer	✓	✓			✓		3	2
Waste Water Treatment Plant	Utility: Sewer	✓	✓			✓		3	2
Everson City Hall	Government		✓			✓		2	3
Everson Police Dept.	Law Enforcement		✓			✓		2	3
Everson Senior Center	Evacuation Center		✓			✓		2	3
Public Works Building	Public Works		✓					1	3
Whatcom County Fire District 1	Fire Station		✓			✓		2	3
Pump-Station	Utility: Sewer		✓			✓		2	4
Pump-Station	Utility: Sewer		✓			✓		2	4
Pump-Station	Utility: Sewer		✓			✓		2	4
Pump-Station	Utility: Sewer		✓					1	4
Pump-Station	Utility: Sewer	✓	✓	✓		✓		4	4
Pump-Station	Utility: Sewer	✓	✓			✓		3	4
Pump-Station	Utility: Sewer	✓	✓			✓		3	4
Elementary School - Dist 506	Evacuation Center		✓					1	5
Bank Northwest	Economic		✓			✓		2	6
People's Bank	Economic		✓			✓		1	6
Post Office	Mail	✓	✓			✓		3	7

CRITICAL FACILITY RANKINGS FOR CITY OF EVERSON

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Everson-Nooksack's Mitigation Strategies & Projects

The cities of Everson and Nooksack chose to collaborate in their mitigation strategies because Everson provides Nooksack with police and sewer services.

General Hazard Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the Cities of Everson and Nooksack.

Provide for an increased level of safety to the citizens of Everson-Nooksack.

Responsible Entity:	Everson and Nooksack City Councils
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Provide for an increased level of protection for public infrastructure.

Responsible Entity:	Everson and Nooksack City Councils
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Work with neighboring jurisdictions to add additional flow capacity to the Nooksack River to minimize catastrophic flooding loss.

Responsible Entity:	Everson and Nooksack City Councils
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the Cities of Everson and Nooksack can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the Cities' prioritization for implementation.

FLOODING

Wastewater Treatment Plant

Construct a ring dike, flood wall or otherwise mitigate the wastewater treatment plant against a 100-year flood event or volcanic lahars.

Responsible Entity:	Everson Public Works Department
Funding Source:	Sewer funds, other local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Everson and Nooksack City Halls, Everson Police Department in Emergencies

The Everson City Hall and Police Department are located in the 100-year floodplain. These should be mitigated in place or moved out of the floodplain.

Responsible Entity:	Everson City Council, Public Works Department, Nooksack City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Riverside Park
Riverside Park is located at the west city limits, and adjacent to the Nooksack River and Everson Wastewater Treatment Plant. When flooded, this site is littered with debris from the floodwaters. This site should be mitigated in place or materials removed and disposed of properly.

Responsible Entity:	Everson Public Works Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Purchase Repetitive Loss Properties in the Floodplain
There are several properties in the floodplain that have been repeatedly damaged by past flood events. Most of these repetitive loss properties were in Whatcom County's jurisdiction and were purchased by the County.

Responsible Entity:	Whatcom County, Everson City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

EARTHQUAKE
Everson-Nooksack City Halls
Both Everson and Nooksack City Halls would suffer significant damage in the event of an earthquake. These facilities should be retrofitted, replaced, or relocated so that they can survive a 6.0 magnitude or greater earthquake event.

Responsible Entity:	Everson and Nooksack City Councils and Building Departments
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

VOLCANO
Lahar Early Warning System
The USGS has designed a number of systems that automatically detect lahars as they descend neighboring valleys. These systems then automatically trigger various types of early warning systems, such as sirens or telephone-based warning systems.

Responsible Entity:	Everson Fire District 1, Everson Police Department, Whatcom Department of Emergency Management, Whatcom County Public Works
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

COMMUNICATIONS
Community Early Warning System
The City of Everson has an outdated civil defense siren that has not been in service or activated in several years. A new audible warning system located in Everson downtown, Strandell neighborhood, and also the City of Nooksack needs to be constructed. Such an early warning system would typically be a series of sirens that could be triggered in the event the Cities needed to be evacuated, or emergency information disseminated.

Responsible Entity:	Everson Fire District 1, Everson Police Department, Everson/Nooksack Public Works
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Telephone-Based Early Warning System
A computerized early warning system would automatically dial every telephone number within a specified area, and play a recorded message to whoever picked up the phone. Such a system is accessed through the Whatcom County Department of Emergency Management.

Responsible Entity:	Everson Police Department, Whatcom County Department of Emergency Management
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Tone Radio Based Early Warning System
Tone Radios turn on when triggered by a central transmitter and then information or instructions are announced over the radio. Such a system is currently used for various types of weather radios, for tornados and severe storms hazard areas. A similar system could be put into place for warning of flooding, lahars, and other related natural hazards.

Responsible Entity:	Whatcom County Department of Emergency Management, NOAA Radio
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Earthquake Early Warning System
Such a system could warn residence of an impending earthquake. Technology doesn't currently exist for such a system, but will likely be possible in the future.

Responsible Entity:	Federal, State, County, and local entities
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION

In the past, both Everson and Nooksack have had community warning equipment (sirens) and plans in place. The citizens relied on this system to protect them from harm. The system no longer exists. The community's first priority is to re-establish a system of warning and start a new public information campaign to reacquaint the citizens with a warning system again. Sirens would be placed in strategic locations in both cities. This is considered the most important hazard mitigation strategy for these two cities and will take priority over any other. The Wastewater Treatment Plant has caused some concern in the past in a flood event. It is seen as important for public health to protect this facility and the effluent from it. A ring dike/floodwall around the Plant is the second priority for Everson/Nooksack.

City of Ferndale

Contact Information: Dale Baker
Police Chief
5640 Third Avenue
Ferndale, WA 98248
(360) 384-3390

Approving Authority: Mayor Jerry Landcastle & City Council Members
2095 Main Street
Ferndale, WA 98248
(360) 384-4302

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	✓
Volcano	✓
Wildland Fire	✓

Hazard Descriptions:

Earthquake – moderate to high risk

Flooding – the city is subject to Nooksack River floods.

Geologic Hazards – seismically-sensitive soils present.

Tsunami – the southern portion of Ferndale, outside the city limits, is subject to tsunami risk.

Volcano – area at risk from a Mount Baker lahar.

Wildland Fire – residential homes at risk of moderate fire risk.

Ferndale Critical Facility List:

Facility name	Facility type	Location
Conoco-Phillips Refinery	Fuel	3901 Unick Road
Ferndale City Hall	Government	2095 Main Street
Ferndale City Shop	Public Works	5735 Legoe Ave.
Ferndale Police	Law Enforcement	5640 Third Ave.
Intalco Aluminum Corp.	Economic	4050 Mount View Road
PUD #1	Utility: Water	1705 Trigg Road
Schools – District 502	Evacuation Centers	9 Locations Total
Sewer Pump Station #1	Utility: Sewer	Ferndale Rd. & Maple Street
Sewer Pump Station #10	Utility: Sewer	NW Corner of Aquarius & Apollo
Sewer Pump Station #11	Utility: Sewer	6156 Unrein Dr
Sewer Pump Station #12	Utility: Sewer	5217 Northwest Dr
Sewer Pump Station #15	Utility: Sewer	Smith Rd & Bellaire
Sewer Pump Station #16	Utility: Sewer	6006 Portal Way
Sewer Pump Station #17	Utility: Sewer	1350 Slater Rd
Sewer Pump Station #18	Utility: Sewer	Nicholas Drive
Sewer Pump Station #2	Utility: Sewer	N or 1951 Main St & Nooksack
Sewer Pump Station #3	Utility: Sewer	N of 5610 Barrett Rd
Sewer Pump Station #4	Utility: Sewer	5345 LaBounty Rd.
Sewer Pump Station #5	Utility: Sewer	5280 Northwest Rd
Sewer Pump Station #6	Utility: Sewer	5336 Poplar Dr.
Sewer Pump Station #7	Utility: Sewer	2090 Main St
Storm Sewer Pump	Utility: Sewer	1920 Main St
Tenaska Cogeneration	Utility: Power	5105 Lake Terrell Road
Texaco Natural Gas	Fuel	4100 Unick Road
Waste Water Treatment	Utility: Sewer	5405 Ferndale Rd.
Water Pump Station #1	Utility: Water	5727 Church Rd
Water Pump Station #2	Utility: Water	2195 Thornton Rd
Water Pump Station #3	Utility: Water	2604 Thornton Rd.
Water Tank #1	Utility: Water	Vista Drive & Thornton Rd.
Water Tank #2	Utility: Water	2601 Thornton Rd
WCFD7 St. 1 Ferndale	Fire Station	2020 Washington St.
WCFD7 St. 2 Whitehorn	Fire Station	4047 Brown Rd.
WCFD7 St. 3 N.	Fire Station	5368 Northwest Rd.
WCFD7 St. 4 Kohen Rd	Fire Station	5491 Grandview Rd.
WCFD7 St. 5 Enterprise	Fire Station	1886 Grandview Rd.
WCFD7 St. 6 Church Rd.	Fire Station	6081 Church Rd.

Geography:

Ferndale Population: **8,758** (2000 Census)

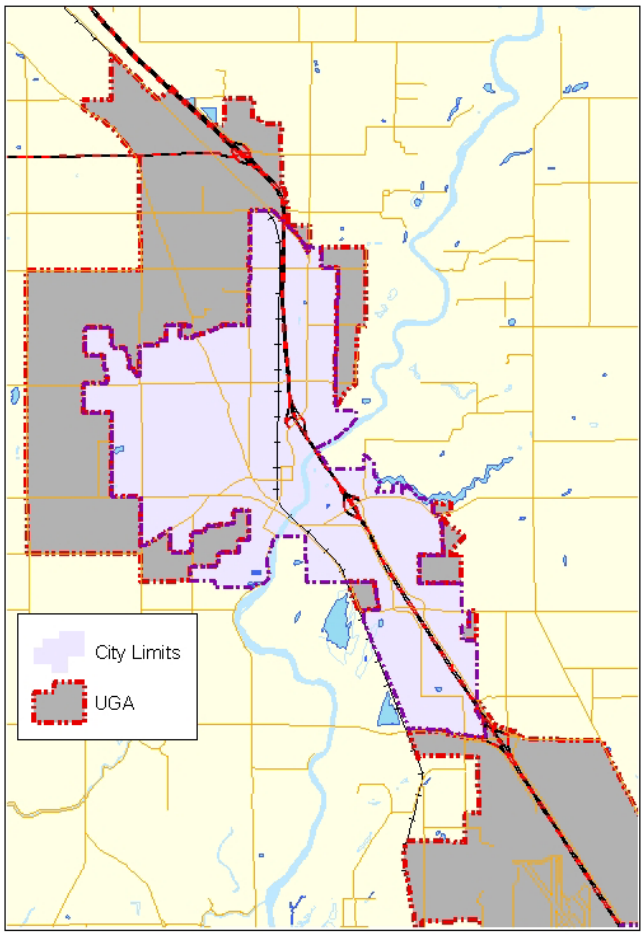
Ferndale Total area, within city limits: **4.7 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total
Earthquake	3,432	4.7 mi^2	100%
Flooding	105	1.095 mi^2	23.3%
Geologic Hazards	2,330	3.538 mi^2	75.3%
Tsunami	Less than 100		Less than 5%
Volcano	642	1.875 mi^2	39.9%
Wildland Fire	359	2.271 mi^2	48.3%

Growth Trends:

This map displays the Urban Growth Areas (UGA) for the City of Ferndale, as designated by the Whatcom County Comprehensive Plan.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Ferndale Police Department	Law Enforcement	✓	✓	✓		✓		4	1
Ferndale City Hall	Government	✓	✓					2	2
PUD #1	Utility: Water		✓				✓	2	3
Waste Water Treatment Plant	Utility: Sewer	✓	✓	✓		✓		4	4
Water Pump Station #1	Utility: Water		✓	✓				2	4
Water Pump Station #2	Utility: Water		✓	✓				2	4
Water Pump Station #3	Utility: Water		✓	✓			✓	3	4
Water Tank #1	Utility: Water		✓	✓				2	4
Water Tank #2	Utility: Water		✓	✓			✓	3	4
Sewer Pump Station #1	Utility: Sewer	✓	✓	✓	✓	✓		5	5
Sewer Pump Station #10	Utility: Sewer		✓	✓				2	5
Sewer Pump Station #11	Utility: Sewer		✓	✓			✓	3	5
Sewer Pump Station #12	Utility: Sewer		✓				✓	2	5
Sewer Pump Station #15	Utility: Sewer		✓				✓	2	5
Sewer Pump Station #16	Utility: Sewer		✓				✓	2	5
Sewer Pump Station #17	Utility: Sewer		✓	✓				2	5
Sewer Pump Station #18	Utility: Sewer		✓	✓				2	5
Sewer Pump Station #2	Utility: Sewer	✓	✓	✓		✓		4	5
Sewer Pump Station #3	Utility: Sewer		✓	✓		✓		3	5
Sewer Pump Station #4	Utility: Sewer	✓	✓	✓		✓		4	5
Sewer Pump Station #5	Utility: Sewer		✓				✓	2	5
Sewer Pump Station #6	Utility: Sewer		✓					1	5
Sewer Pump Station #7	Utility: Sewer	✓	✓					2	5
Storm Sewer Pump Station #8	Utility: Sewer	✓	✓	✓	✓	✓		5	6
Ferndale City Shop	Public Works		✓					1	7
WCFD7 St. 1 Ferndale	Fire Station		✓					1	8
WCFD7 St. 2 Whitehorn	Fire Station		✓				✓	2	8
WCFD7 St. 3 N. Bellingham	Fire Station		✓				✓	2	8
WCFD7 St. 4 Kohen Rd	Fire Station		✓	✓				2	8
WCFD7 St. 5 Enterprise	Fire Station		✓				✓	2	8
WCFD7 St. 6 Church Rd.	Fire Station		✓	✓			✓	3	8
Schools	Evacuation Centers								9
Conoco-Phillips Refinery	Fuel		✓					1	10
Tenaska Cogeneration Plant	Utility: Power		✓				✓	2	10
Texaco Natural Gas	Fuel		✓					1	10
Intalco Aluminum Corp.	Economic		✓					1	11

CRITICAL FACILITY RANKING FOR CITY OF FERNDALE

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Ferndale's Hazard Mitigation Strategies & Projects

General Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the City of Ferndale.

Provide for an increased level of safety to the citizens of Ferndale.

Responsible Entity:	Ferndale City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Provide for an increased level of protection for public infrastructure.

Responsible Entity:	Ferndale City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Potential Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Ferndale can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the City's prioritization for implementation.

FLOODING

Downtown Ferndale Ring Dike

A riverside dike currently exists on the eastern border of Ferndale's old downtown area. This dike is built to the anticipated 100-year flood elevation. To decrease the potential for severe downtown flooding and catastrophic loss, the City would construct an addition to the existing dike that would proceed westward from the southern end of the City's wastewater plant and extending to the west and north, thus providing ring dike protection for the downtown area. This area of the city houses the City's Police Department and City Hall together with a substantial portion of the city's commercial core. The levy should also be extended north of downtown be raising sections of Cedar Street.

Responsible Entity:	Ferndale Public Works
Funding Source:	Local sources, and state and federal funds
Timeline:	Long term (greater than three years after funding is secured)

Purchase repetitive loss properties in the floodplain

There are several properties in the floodplain that have been repeatedly damaged by past flood events. These repetitive loss properties should be purchased and converted to open space or recreational use.

Responsible Entity:	Ferndale Planning Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

GEOLOGIC HAZARDS

Alluvial Fan Hazards
Alluvial Fans are known to exist in parts of Whatcom County, but there hasn't been an alluvial fan hazard previously identified in Ferndale. A survey of possible alluvial fan hazards within the City of Ferndale by a Professional Geologist would help clarify if these hazards exist in Ferndale or not. Any such properties at risk could then be purchased as a mitigation measure to help reduce future loses.

Responsible Entity:	Ferndale Planning Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

EARTHQUAKE

Ferndale City Hall
City Hall should be studied to determine what effects earthquakes would have on it. This facility may be retrofitted so that it can survive a 6.0 magnitude or greater earthquake event.

Responsible Entity:	Ferndale Building Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

VOLCANO

Lahar Early Warning System
The US Geological Survey has designed a number of systems that automatically detect lahars as they descend neighboring valleys. These systems then automatically trigger various types of early warning systems, such as sirens or telephone based warning systems.

Responsible Entity:	Ferndale Police Department / Whatcom Fire District 7
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

COMMUNICATIONS

Community Early Warning System
A community-wide warning system could be built to help provide broad community notice for evacuation in the event of flooding, lahars, dam failures, etc. Such an early warning system would typically be a series of sirens that could be triggered in the event the City needed to be evacuated.

Responsible Entity:	Ferndale Police Department / Whatcom Fire District 7
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Telephone Based Early Warning System
A computerized early warning system would automatically dial every telephone number within a specified area, and play a recorded message to whoever picked up the phone. Such a system could be very useful for a variety of natural and man made problems.

Responsible Entity:	Ferndale Police Department / Whatcom Fire District 7
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Tone Radio Based Early Warning System
Tone Radios turn on when triggered by a central transmitter, and then information or instructions are announced over the radio. Such a system is currently used for various types of weather radios, for tornados and severe storms hazard areas. A similar system could be put into place for warning of flooding, lahars, and other related natural hazards.

Responsible Entity:	Ferndale Police Department / Whatcom Fire District 7
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Earthquake Early Warning System
Such a system could warn residence of an impending earthquake. Technology doesn't currently exist for such a system, but will likely be possible in the future.

Responsible Entity:	Ferndale Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION
This is to describe how the City of Ferndale will prioritize projects if and when funding becomes available. This list assumes that all the projects listed can be funded from the same sources that may become available.

Flooding from the Nooksack River is a frequent problem. Some years there are multiple events. The dike improvement projects would be the top priority.

Earthquakes are a likely event. City Hall and other facilities would be evaluated for their ability to withstand at least a 6.0 magnitude quake. The building(s) would be retrofitted if found to be deficient.

The City needs to study what type of warning system(s) would reach the greatest number of residents. Depending on the ability to predict different events, the system would be designed to assist the City in warning its residents of as many of the types of the disasters as possible.

City of Lynden

Contact Information: Warren Gay
Fire Chief
215 4th Street
Lynden, WA 98264
(360) 354-4400

Approving Authority: Mayor Jack Louws & City Council Members
323 Front Street
Lynden, WA 98264
(360) 354-4270

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	✓
Wild Land Fire	

Hazard Descriptions:

Earthquake – mild risk, but high impact to the North and South.

Flooding – Lynden is located above the flood plain. New construction has currently encroached on the floodplain. Fishtrap Creek, which bisects the City, is subject to seasonal flooding, which could impact sanitary services at the Wastewater Treatment Plant.

Geologic Hazards – seismically-sensitive soils present.

Volcano – the southern portion of the city is at risk of a Mount Baker lahar. This would impact the Wastewater Treatment Plant.

Critical Facility List:

Facility name	Facility type	Street address 1
Christian Health Care Center	Assisted Living	855 Aaron Drive
Lynden City Hall	Government	323 Front Street
Lynden Community Center	Assisted Living	401 Grover St.
Lynden Fire Department	Fire Station	215 Fourth Street
Lynden Manor	Assisted Living	905 Aaron Drive
Lynden Police Department	Law Enforcement	1610 Grover Street
Meadow Greens	Assisted Living	301 W. Homestead Blvd.
North Whatcom Fire & Rescue	Fire Station	307 19th Street
Northwest Washington Fair	Emergency Services	1775 Front Street
Schools – District 504	Evacuation Center	7 Schools Total
Sonlight Church	Evacuation Center	8800 Bender Rd.
US Border Patrol-Lynden	Law Enforcement	Main/Guide Meridian
Waste Water Treatment Plant	Utility: Sewer	800 S. 6th Street
Water Treatment Plant	Utility: Water	525 Judson Street
Word of Life Outreach Center	Evacuation Center	1986 Main Street

Geography

Lynden Population: **9,020** (2000 Census)

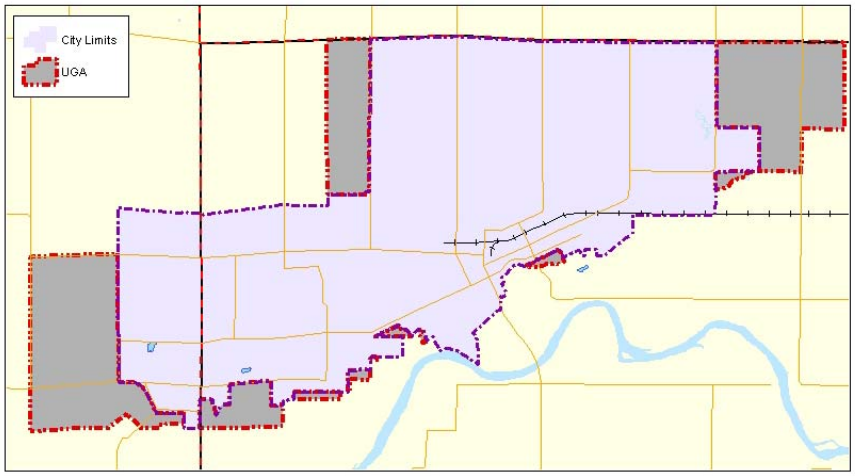
Lynden Total area, within city limits: **6.5 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total
Earthquake	3,446	6.5 mi^2	100%
Flooding	189	0.167 mi^2	2.6%
Geologic Hazards	99	0.0572 mi^2	0.9%
Volcano	5	0.0203 mi^2	0.3%

Growth Trends:

This map displays the Urban Growth Areas (UGA) for the City of Lynden, as designated by the Whatcom County Comprehensive Plan.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Lynden Fire Department	Fire Station		✓					1	1
North Whatcom Fire & Rescue	Fire Station		✓					1	1
Waste Water Treatment Plant	Utility: Sewer	✓	✓	✓				3	1
Water Treatment Plant	Utility: Water		✓					1	1
Lynden Police Department	Law Enforcement		✓					1	2
US Border Patrol-Lynden	Law Enforcement		✓					1	2
Lynden City Hall	Government		✓					1	3
Lynden Community Center	Assisted Living		✓					1	3
Christian Health Care Center	Assisted Living		✓					1	4
Lynden Manor	Assisted Living		✓					1	4
Meadow Greens	Assisted Living		✓					1	4
Northwest Washington Fair	Emergency Services		✓					1	4
Schools	Evacuation Centers								4
Sonlight Church	Evacuation Center		✓					1	4
Word of Life Outreach Center	Evacuation Center		✓					1	4

CRITICAL FACILITY RANKING FOR THE CITY OF LYNDEN

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Lynden's Hazard Mitigation Strategies & Projects

General Hazard Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the City of Lynden.

Provide for an increased level of safety to the citizens of Lynden.

Responsible Entity:	Lynden City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Provide for an increased level of protection for public infrastructure.

Responsible Entity:	Lynden City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Work with neighboring jurisdictions to add additional flow capacity to the Nooksack River in order to minimize catastrophic flooding losses.

Responsible Entity:	Lynden City Council
Funding Source:	Local sources, and state and federal grants
Timeline:	Current and ongoing

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Lynden can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the City's prioritization for implementation.

FLOODING

Wastewater Treatment Plant

Construct a ring dike, flood wall or otherwise mitigate the wastewater treatment plant against a 75-year flood event or volcanic lahars.

Responsible Entity:	Lynden Public Works Department
Funding Source:	Sewer funds, other local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Relocate Waste Water Shops and Offices

The Waste Water Treatment shops and offices are located in the floodplain. These should be mitigated in place or moved out of the floodplain.

Responsible Entity:	City of Lynden Public Works Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Fishtrap Creek Flood Storage & Fish Enhancement
Fishtrap Creek has had a significant amount of its floodwater storage capacity eliminated due to development. With very little storage capacity left, any discharges into the stream system immediately surge downstream. Increasing this storage capacity would mitigate to attenuate stream discharges.

Responsible Entity:	City of Lynden Public Works Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

EARTHQUAKE
Lynden City Hall
City Hall has had numerous studies indicating the Lynden City Hall would suffer significant damage in the event of an earthquake. This facility should be retrofitted, replaced, or relocated so that it can survive a 6.0 magnitude or greater earthquake event.

Responsible Entity:	Lynden Building Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

VOLCANO
Lahar Early Warning System
The US Geological Survey has designed a number of systems that automatically detect lahars as they descend neighboring valleys. These systems automatically trigger various types of early warning systems, such as sirens or telephone-based warning systems.

Responsible Entity:	Lynden Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

COMMUNICATIONS
Community Early Warning System
A community-wide warning system could be built to help provide broad community notice for evacuation in the event of flooding, lahars, dam failures, etc. Such an early warning system would typically be a series of sirens that could be triggered in the event the City needed to be evacuated.

Responsible Entity:	Lynden Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Telephone-Based Early Warning System
A computerized early warning system would automatically dial every telephone number within a specified area, and play a recorded message to whoever picked up the phone. Such a system would be useful for a variety of natural and man-made problems.

Responsible Entity:	Lynden Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Tone Radio Based Early Warning System
Tone Radios turn on when triggered by a central transmitter, and then information or instructions are announced over the radio. Such a system is currently used for various types of weather radios, for tornados and severe storms hazard areas. A similar system could be put into place for warnings of flooding, lahars, and other related natural hazards.

Responsible Entity:	Lynden Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Earthquake Early Warning System
Such a system could warn residence of an impending earthquake. Technology doesn't currently exist for such a system, but will likely be possible in the future.

Responsible Entity:	Lynden Fire Department
Funding Source:	Local sources, and state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION
Priorities will be based on the 'greatest benefit for the largest number of people' with in the jurisdiction and situational. If and when there is money available, the greatest perceived need (by the City) at that time will get the attention.

City of Nooksack

Contact Information: Erik Ramstead
Police Chief
PO Box 4265
Nooksack, WA 98276
(360) 966-4212

Approving Authority: Mayor Jim Ackerman & City Council Members
PO Box 4265
Nooksack, WA 98276
(360) 966-2531

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	✓
Wild Land Fire	

Hazard Descriptions:

Earthquake – the city is subject to seismic activity.

Flooding – this hazard occurs frequently and can be severe, especially due the presence of isolated areas. Major flooding occurred in 1989, 1990, 1995. Flooding begins in the west side of the City and moves east and north up Highway 9, toward Sumas. A dike was extended in 1991 with money from mitigation. The dike runs parallel to the Nooksack River on the West side, ending on Emerson Road. It prevents water from going to Washington St. and on through to Main Street. The dike diverts Nooksack River overflow it to the floodway. The Sumas River can flood east of the City, but doesn't cause severe problems.

Geologic Hazards – seismically-sensitive soils.

Volcano – all of the area within the city limits would be affected by a Mount Baker lahar.

Critical Facility List:

Facility name	Facility type	Location
Elementary School - Dist 506	Evacuation Center	Refer to Maps
Nooksack City Hall	Government	103 West Madison St
Nooksack Water Tanks	Utility: Water	8386 Gillies Rd.
Post Office	Mail	605 Nooksack Ave.

Pump-Station	Utility: Sewer	105 Garfield St.
Pump-Station	Utility: Sewer	610 Nooksack Ave.
Pump-Station	Utility: Sewer	1216 Nooksack Ave.
Starvin' Sams	Fuel	102 Columbia St.

Geography:

Nooksack Population: **851** (2000 Census)

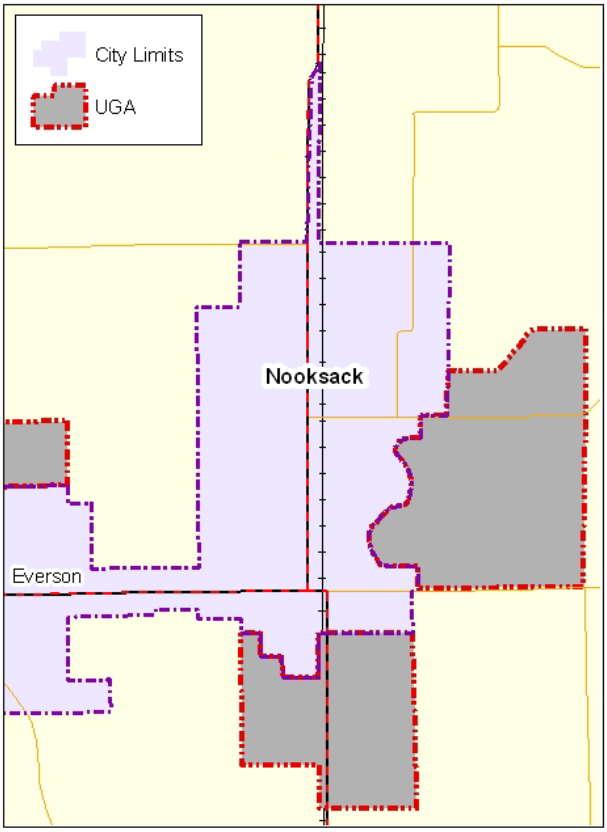
Nooksack Total area, within city limits: **0.66** mi^2

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total Area
Earthquake	366	0.66 mi^2	100%
Flooding	101	0.32 mi^2	45.5%
Geologic Hazards	313	0.597 mi^2	90.5%
Volcano	366	0.66 mi^2	100%

Growth Trends:

This map displays the Urban Growth Areas (UGA) for the City of Nooksack, as designated by the Whatcom County Comprehensive Plan. The City experienced an increase in growth and housing in the 1990's, with many new manufactured homes.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Nooksack City Hall	Government		✓	✓		✓		3	1
Nooksack Water Tanks	Utility: Water		✓	✓		✓	✓	4	1
Pump-Station	Utility: Sewer		✓	✓		✓		3	2
Pump-Station	Utility: Sewer		✓	✓		✓		3	2
Pump-Station	Utility: Sewer		✓	✓		✓		3	2
Starvin Sams	Fuel		✓			✓		2	3
Elementary School - Dist 506	Evacuation Center	✓	✓			✓		3	4
Post Office	Mail		✓	✓		✓		3	5

CRITICAL FACILITY RANKING FOR THE CITY OF NOOKSACK

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Everson-Nooksack's Mitigation Strategies & Projects

Refer to the mitigation strategies and priorities outlined for the City of Everson's section for Nooksack's strategies. The cities of Everson and Nooksack chose to collaborate in their mitigation strategies because Everson provides Nooksack with police and sewer services.

Port of Bellingham

Contact Information: Karen Callery
Engineering Specialist
1801 Roeder Avenue
Bellingham, WA 98225
(360) 676-2500, x312

Approving Authority: Executive Director Jim Darling & Port Commission
1801 Roeder Avenue
Bellingham, WA 98225
(360) 676-2500

Presence of Hazards:
Because the Port does not occupy a specific area, like the cities do, the hazards indicated as present were those affecting facilities critical to the Port. Specifically, these facilities occupied area in the Cities of Bellingham and Blaine. Refer to these Jurisdiction Overviews for the characteristics affecting the Port.

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	✓
Wild Land Fire	

Critical Facility List:

Facility name	Facility type	Location
Bellingham Cruise Terminal	Transportation	355 Harris Ave.
Bellingham International Airport	Transportation: Airport	4255 Mitchel Way
Bellingham Shipping Terminal #1 & #2	Transportation	629 Cornwall
Blaine Harbor	Transportation	235 Marine Drive
Fairhaven Station - Multi-Modal Facility	Transportation	401 Harris Ave.
Squalicum Harbor	Transportation	722 Coho Way
Sumas International Cargo Terminal	Transportation	530 Front Street

Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Bellingham Cruise Terminal	Transportation		✓	✓				2	1
Squalicum Harbor	Transportation		✓					1	2
Bellingham International Airport	Transportation: Airport		✓	✓				2	3
Fairhaven Station - Multi-Modal Facility	Transportation		✓	✓				2	4
Bellingham Shipping Terminal #1 / #2	Transportation		✓	✓				2	5
Blaine Harbor	Transportation		✓	✓				2	6
Sumas International Cargo Terminal	Transportation	✓	✓	✓		✓		4	7

CRITICAL FACILITY RANKING FOR THE PORT OF BELLINGHAM

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

Note: Refer to the Bellingham and Blaine city maps for hazards affecting the Port of Bellingham critical facilities.

Port of Bellingham's Hazard Mitigation Strategies & Projects

General Hazard Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning for the Port of Bellingham.

Provide an increased level of safety for residents of Sumas.

Ensure adequate protection for new structures by compliance with the National Flood Insurance Program (NFIP) and with the earthquake standards established in the International Building Code (IBC).

Provide for an increased level of safety for the citizens of Whatcom County.

Provide for an increased level of protection that reduces hazard vulnerability and the potential of damage to public infrastructure.

Identify potential hazards at Port facilities though a survey by a professional geologist.

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities the Port of Bellingham can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the Port's prioritization for implementation.

For mitigation projects the following applies to all:

Responsible Entity:	Port of Bellingham, Board of Commissioners
Funding Source:	Local sources, state and federal grants
Timeline:	Long term (greater than five years after funding is secured)

FLOODING / VOLCANO EVENTS

Sumas International Cargo Terminal

Work with other jurisdictions to reduce the impacts of flooding from the Nooksack River. Investigate a system to alert citizens that automatically detect lahars as they descend neighboring valleys. The system should automatically trigger various types of early warning systems, such as sirens or telephone based warning systems.

EARTHQUAKE / GEOLOGICAL HAZARDS

Bellingham International Airport

A survey of possible alluvial fan or abandoned coal mine shafts would be conducted by a professional geologist. This work would help clarify if these hazards exist in the area of Bellingham International Airport.

Bellingham Cruise Terminal

The Bellingham Cruise Terminal was constructed in 1989, and was designed to meet all existing building codes in effect at the time. As other buildings and infrastructure are built, the design should meet all of the current building construction codes. Investigate an early warning system for alerting the public and businesses to potential tsunamis events.

Fairhaven Station – Multi-Modal Facility
Fairhaven Station was retrofitted in 1990 to the existing building codes in effect at the time. As other buildings and infrastructure are built, the design should meet all of the current building construction codes. Investigate an early warning system for alerting the public and businesses to potential tsunamis events. A survey of possible alluvial fan or abandoned coal mine shafts should be conducted by a professional geologist. This work would help clarify if these hazards exist in the area of Fairhaven Station.

Bellingham Shipping Terminal
A survey of possible alluvial fan or abandoned coal mine shafts would be conducted by a professional geologist. This work would help clarify if these hazards exist in the area of Bellingham Shipping Terminal. Investigate an early warning system for alerting the public and businesses to potential tsunamis events.

Squalicum Harbor & Blaine Harbor
As other buildings and infrastructure are built, the design should meet all of the current building construction codes. Investigate an early warning system for alerting the public and businesses to potential tsunamis events. A survey of possible alluvial fan or abandoned coal mine shafts would be conducted by a professional geologist. This work would help clarify if these hazards exist in the area of Squalicum Harbor.

COMMUNICATIONS
Telephone-Based Early Warning System
Investigate a computerized early warning system which would automatically dial every telephone number within a specified area, and play a recorded message to whoever picked up the phone. Such a system could be very useful for a variety of natural and man made problems.

Responsible Entity:	Port of Bellingham working with Whatcom County Department of Emergency Services
Funding Source:	Local sources, state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

Tone Radio Based Early Warning System
Tone Radios turn on when triggered by a central transmitter and then information or instructions are announced over the radio. Such a system is currently used for various types of weather radios, for tornados and severe storms hazard areas. A similar system could be put into place for warning of flooding, lahars, tsunamis, and other related natural hazards.

Responsible Entity:	Port of Bellingham working with Whatcom County Department of Emergency Services
Funding Source:	Local sources, state and federal grants
Timeline:	Long term (greater than three years after funding is secured)

PROJECT PRIORITIZATION
With regards to earthquake / geological hazards the Port feels they need to clearly identify, by surveys conducted by a professional geologist, the issues at the various facilities and then prioritize according to their recommendations. With regards to flooding and volcano event notification, and general communications, the Port will commission a consultant that is an expert in this area, and have a scope of work identified to include a survey of existing systems, and then make recommendations to meet the planning goals and objectives.
In either case, the Port feels they need further study to determine where hazard mitigation funds would be best spent.

City of Sumas

Contact Information: David Davidson
City Administrator
733 Cherry St.
Sumas, WA 98295
(360) 988-5711

Approving Authority: Chamber President Tony Kelly & City Chamber Members
433 Cherry Street, Box 9
Sumas, WA 98295
(360) 988-5711

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	
Volcano	✓
Wild Land Fire	

Hazard Descriptions:

Earthquake – subject to seismic activity. Significant risk due to Sumas' highest concentration of older homes in the county.

Flooding – during a flooding event, the entire City floods from the Nooksack River, from west to east, in a northeasterly flow.

Geologic Hazards – seismically-sensitive soils.

Volcano – the City is at risk of a Mount Baker lahar.

Critical Facility List:

Facility name	Facility type	Location
American Legion Hall	Emergency Services	134 Harrison Avenue
Elementary School - Dist 506	Evacuation Center	1024 Lawson Street
High School - District 506	Evacuation Center	Refer to WC GIS Data Layer
May Road Wellfield	Utility: Water	9700 May Road
Middle School - District 506	Evacuation Center	Refer to WC GIS Data Layer
Sumas City Hall	Law Enforcement	433 Cherry Street
Sumas City Reservoir	Utility: Water	205 Washington Street
Sumas City Wellfield	Utility: Water	3670 Kneuman Road
Sumas Cogeneration Company LP	Utility: Power	601-B W. Front Street
Sumas Fire Station	Fire station	143 Columbia Street
Sumas Police Dept.	Law Enforcement	433 Cherry
Sumas Senior Center	Evacuation Center	451 Second Street
Sumas Water & Lights	Utility: Water	433 Cherry
US Border Patrol-Sumas	Law Enforcement	109 Cherry Street
Williams Gas Pipeline	Fuel	4378 Jones Road

Geography:

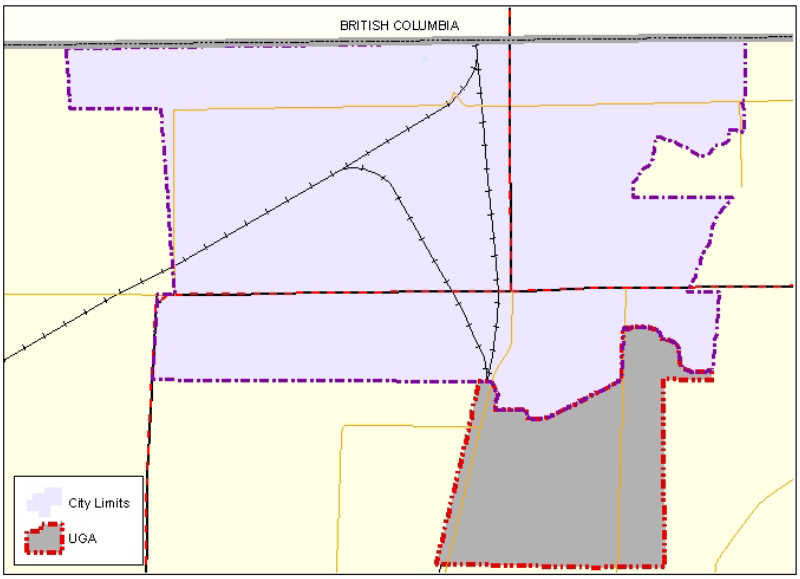
Sumas Population: **960** (2000 Census)

Sumas Total area, within city limits: **1.4 mi^2**

Areas impacted, per hazard:

Hazard	# Structures Impacted	Area Affected	Percent of Total Area
Earthquake	764	1.4 mi^2	100%
Flooding	165	0.976 mi^2	69.7%
Geologic Hazards	698	1.279 mi^2	91.4%
Volcano	554	0.993 mi^2	71.0%

Growth Trends:
This map displays the Urban Growth Areas (UGA) for the City of Sumas, as designated by the Whatcom County Comprehensive Plan.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
May Road Wellfield	Utility: Water		✓					1	1
Sumas City Wellfield	Utility: Water		✓	✓				2	1
Sumas City Reservoir	Utility: Water		✓					1	2
Sumas Water & Lights	Utility: Water	✓	✓	✓		✓		4	2
Sumas City Hall	Law Enforcement	✓	✓	✓		✓		4	3
Sumas Fire Station	Fire Station	✓	✓	✓		✓		4	3
Sumas Police Dept.	Law Enforcement		✓	✓		✓		3	3
US Border Patrol-Sumas	Law Enforcement		✓	✓				2	3
Williams Gas Pipeline	Fuel	✓	✓	✓		✓		4	4
American Legion Hall	Emergency Services	✓	✓	✓				3	5
Elementary School - Dist 506	Evacuation Center	✓	✓	✓		✓		4	5
High School - District 506	Evacuation Center		✓	✓		✓		3	5
Middle School - District 506	Evacuation Center		✓	✓		✓		3	5
Sumas Senior Center	Evacuation Center	✓	✓	✓		✓		4	5
Sumas Cogeneration Company LP	Utility: Power	✓	✓	✓		✓		4	6

CRITICAL FACILITY RANKING FOR CITY OF SUMAS

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

City of Sumas' Hazard Mitigation Strategies & Projects

General Hazard Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within the City of Sumas.

Provide an increased level of safety for residents of Sumas.

- Ensure adequate protection for new structures by compliance with the National Flood Insurance Program (NFIP) and with the earthquake standards established in the International Building Code (IBC).
- Pursue programs and projects that lessen hazards to existing structures.
- Ensure that hazard warning systems are effective.

Ensure provision of essential public services and utilities throughout a natural disaster.

- Replace or rehabilitate facilities that are prone to failure in a disaster.

Lessen the potential frequency and severity of a natural disaster.

- Work with other jurisdictions to control the amount of Nooksack River overflow flooding occurring in Everson, WA.

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Sumas can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the City's prioritization for implementation.

EARTHQUAKE

Wellfield Backup Power

The Sumas City Wellfield is served by a diesel generator that is enclosed within a shipping container that has no permanent foundation. Diesel fuel is stored in a free-standing double-wall tank located next to the container. This arrangement is prone to failure in the event of an earthquake. A permanent enclosure should be built for the generator and the fuel tank, with adequate footings and anchoring to allow the equipment to withstand an earthquake.

Responsible entity:	Sumas Public Works Department
Funding source:	Local funds
Timeline:	Three years

FLOODING

City Hall / Police Station.

This building is subject to flooding and is also prone to major damage in an earthquake, given that the building pre-dates modern building codes. A new facility should be constructed outside the floodplain.

Responsible entity:	City of Sumas
Funding source:	State or federal grants
Timeline:	Within ten years

Fire Station
This building is subject to flooding. A new facility should be constructed outside the floodplain.

Responsible entity:	Whatcom County Fire District # 14
Funding source:	State or federal grants
Timeline:	Within ten years

Flood Corridor Residential Buy-Out
Sumas's 1997 Floodplain Management Plan identified two major corridors of flood flow through the residential area. It proposed that the existing homes within those corridors be purchased and demolished, and that the corridors then be lowered in grade, establishing flood conveyance channels that would reduce the amount of flooding experienced elsewhere in town. The corridor buy-out program should be implemented.

Responsible entity:	City of Sumas
Funding source:	State or federal grants
Timeline:	Within thirty years

Cherry Street Bridge Replacement
In a large flood, the Cherry Street bridge over Johnson Creek is a major impediment to flow. Water is forced out of the Johnson Creek channel, leading to worse inundation in the commercial and residential areas to the north and northeast. The bridge should be replaced at a higher elevation and with less supporting pilings.

Responsible entity:	WA State Department of Transportation
Funding source:	State or federal grants
Timeline:	Within ten years

PROJECT PRIORITIZATION
The City of Sumas will use the following three criteria to prioritize mitigation projects. The criteria are listed in order of importance:

3. Health and safety of persons – Project that provide a direct benefit to the health and safety of the greatest number of persons have priority over projects that provide indirect benefit to persons, or that primarily protect property. As an example, the project involving backup power at the wellfield results in a region-wide benefit of adequate safe water supply in the event of an earthquake. Such a benefit is greater than that associated with replacement of the Cherry Street bridge, which would reduce property damage and would indirectly result in reduced hazard to a subset of city residents within a certain affected area.

4. Cost – A project must be affordable and must return reasonable benefits in comparison to the cost.

5. Severity and longevity of avoided hazard – Consideration is given to the nature of the avoided consequence and to the span of time over which the consequence is avoided. As an example, the replacement of the police station would result in the ability to coordinate disaster response in all future flood events, without having to relocate personnel and equipment to an alternate location prior to or during an event. In contrast, it is simple to relocate the fire truck and aid car to an alternate location. The consequence associated with flooding of the fire station is not as serious as the consequence of flooding the police station.

Whatcom County

Contact Information: Neil Clement
Deputy Director
Whatcom County Sheriff's Office, Division of Emergency Management
311 Grand Avenue
Bellingham, WA 98225
(360) 337-6760676-6681

Approving Authority: County Executive Pete Kremen & County Council Members
311 Grand Avenue, Suite 308
Bellingham, WA 98225
(360) 676-6717

Presence of Hazards:

Hazard	Present? (yes, if checked)
Earthquake	✓
Flooding	✓
Geologic Hazards	✓
Tsunami	✓
Volcano	✓
Wild Land Fire	✓

Hazard Descriptions:

Earthquake – the risk of earthquakes to the county is moderate to high. Lake shores are especially subject to damage, as well as characteristics of geologic materials in the County have caused major slides that impacted ground transportation.

Flooding – the Nooksack River is subject to flooding, and logging around Lake Whatcom has caused severe flooding due to runoff.

Geologic Hazards – various areas around the county are at risk of landslides according to unstable geologic characteristics.

Tsunami – portions of the county exposed to the western straits are at risk of tsunami damage, specifically the area around Sandy Point.

Volcano – many of the populated areas are at risk in the event of a volcanic eruption from Mount Baker.

Wildland Fire – certain Communities at Risk have been identified, as well as levels of fire risk.

Geography:

Whatcom County Population: **166,814** (2000 Census)

Population of Unincorporated Area: 74,249 (2000 Census)

Whatcom County Total area: **2,120 mi^2**

Whatcom County Incorporated area: 95.4 mi^2

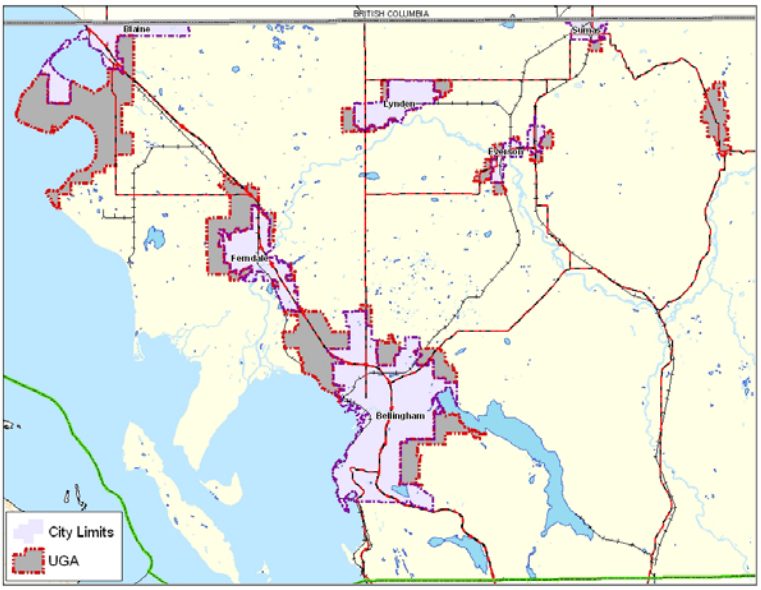
Whatcom County Unincorporated area: 2,024.6 mi^2

Areas impacted, per hazard: Accurate calculations of areas affected by hazards were unavailable because much of the hazard data only involved the populated western half of the county.

Critical Facility List:

Facility name	Facility type	Location
Evergreen Water & Sewer Dist	Utility: Water	Maple Falls
Lummi Law & Order	Law Enforcement	Bellingham
Nooksack Police Department.	Law Enforcement	Deming
Northwest Water Works, Inc.	Utility: Water	Bellingham
Pole Road Water Association	Utility: Water	Lynden
Schools: Districts 501, 503, 505, 507	Evacuation Centers	10 Schools Total
Search & Rescue	EOC	Bellingham
Seattle City Light	Utility: Power	Newhalem
Fire Protection District – 38 Total	Fire Station	Various
Water District #2 / #7	Utility: Water	Bellingham
Water District #4 – Point Roberts	Utility: Water	Point Roberts
Water District #10 – Geneva/Sudden Valley	Utility: Water	Bellingham
Water District #12 – Lake Samish	Utility: Water	Bellingham
Water District #13 – Maple Falls	Utility: Water	Maple Falls
Water District #14 – Glacier	Utility: Water	Bellingham
Water District #18 – Acme	Utility: Water	Acme
BP-Cherry Point Refinery	Fuel	4519 Grandview Road
Birch Bay Water and Sewer (Dist 8)	Utility: Water	7096 Pt. Whitehorn Rd
Birch Bay Water Connection	Utility: Water	2701 Bell Rd.

Growth Trends: This map displays the Urban Growth Areas (UGA) for all the jurisdictions in Whatcom County, as designated by the Whatcom County Comprehensive Plan.



Facility name	Facility type	FL	EQ	GH	TSUN	VOL	WF	Total Hazards	Rank Assessment
Seattle City Light-Dams	Utility: Power		✓					1	1
Evergreen Water & Sewer Dist	Utility: Water		✓				✓	2	2
Lummi Law & Order	Law Enforcement	✓	✓	✓	✓	✓		5	2
Northwest Water Works, Inc.	Utility: Water		✓					1	2
Pole Road Water Association	Utility: Water		✓					1	2
Search & Rescue	EOC		✓	✓				2	2
Fire Protection Districts (38 Total)	Fire Station								2
Water District #10 – Geneva/Sudden Valley	Utility: Water		✓					1	2
Water District #12 – Lake Samish	Utility: Water		✓				✓	2	2
Water District #13 – Maple Falls	Utility: Water		✓					1	2
Water District #14 – Glacier	Utility: Water		✓			✓	✓	3	2
Water District #18 – Acme	Utility: Water	✓	✓			✓	✓	4	2
Water District #2 / #7	Utility: Water		✓					1	2
Water District #4 – Point Roberts	Utility: Water		✓					1	2
Elementary School - Dist 503	Evacuation Center		✓					1	3
High School - District 505	Evacuation Center		✓				✓	2	3
Nooksack Police Department	Law Enforcement		✓					1	3
Elementary School - Dist 501	Evacuation Center		✓					1	4
Elementary School - Dist 505	Evacuation Center		✓					1	4
Elementary School - Dist 505	Evacuation Center		✓					1	4
Elementary School - Dist 505	Evacuation Center		✓					1	4
Elementary School - Dist 507	Evacuation Center		✓	✓		✓	✓	4	4
Elementary School - Dist 507	Evacuation Center		✓	✓			✓	3	4
Elementary School - Dist 507	Evacuation Center		✓				✓	2	4
Elementary School - Dist 507	Evacuation Center		✓				✓	2	4

CRITICAL FACILITY RANKING FOR WHATCOM COUNTY

FL = Flooding; EQ = Earthquake; GH = Geologic Hazard; TSUN = Tsunami; VOL = Volcano; WF = Wildland Fire

(The methodology used for ranking the critical facilities is described on page 57)

Whatcom County's Hazard Mitigation Strategies & Projects

General Hazard Mitigation Strategies: These provide guidance on the overall hazard mitigation goals for future planning within Whatcom County.

Provide to increase the level of safety of the citizens, lessen the impact to their property, including the public infrastructure and to protect the environment from the effects of natural and man-made disasters within Whatcom County.

Potential Hazard Mitigation Projects: These mitigation projects provide guidance on suggesting specific activities that agencies, organizations, and residents in Whatcom County can undertake to reduce risk and prevent loss from the at-risk hazards. Each action item is followed by the suggested responsible entity and timeline, which can be used by local decision makers in pursuing strategies for implementation.

Following the potential projects is a description of the County's prioritization for implementation.

EARTHQUAKE

The County owns several buildings. Seismic studies need to be done on these buildings to determine their survivability as a result of an earthquake. After reviewing the findings of these studies, further planning can be accomplished and decisions made regarding mitigation plans.

FLOODING

The Mitigation strategies and recommendations for all five reaches of the Nooksack River are explored in the Flooding section of this plan. The River and Flood Division, Whatcom County Public Works has published a Comprehensive Flood Hazard Management Plan (CFHMP) for the Nooksack River which details these projects.

GEOLOGIC HAZARDS

For alluvial fans and landslides, additional measures recommended by studies are listed below. In general, the following steps should be implemented to reduce risk of the four geologic hazards – alluvial fans, coalmines, landslides, and seismic hazards – affecting Whatcom County:

4. Limit, and if possible, eliminate new development in high-risk hazard areas.
5. If new development is to be permitted, mitigate new construction to address the specific geological hazard.
6. Educate existing property owners at risk to help minimize the risk of the local hazards.
7. If cost effective, buyout high-risk properties.
8. As a last-case resort, consider engineering solutions to manage the specific geologic hazard, if proven effective.

See the Geologic Hazard section of this plan for further details.

TSUNAMIS

With new data available, Tsunamis have been identified as a greater threat to Whatcom County and the jurisdictions within that previously thought. Education about Tsunamis and acceptance of the threat must precede any plans. Both civic leaders and the public need to understand that there is a threat, and further, have a clear understanding of what the threat entails. Even with the current new data, there is not a clear understanding of the extent of a Tsunami threat. More data needs to be obtained, specific to each community along the western border of Whatcom County. With the increased data public education about the specific threats needs to be

explored. There is more Tsunami mitigation plan information contained within the Tsunami section of this plan.

VOLCANO

Raising awareness and educating both civic leaders and the public in the areas subject to volcano-related damage is very important. Recent statewide campaigns and the news-related stories of volcanoes in the state have sparked interest for those living in the shadow of Mount Baker, Whatcom County's volcano. More awareness and education needs to take place, especially with regards to warning signals of a volcanic eruption and the types of damage that can occur with an eruption with special attention to Lahars. There is more information about volcano-hazard mitigation planning under the Volcano section of this plan.

WILDLAND FIRE

In cooperation with fire managers from Washington State's Department of Natural Resources, NW Region, three mitigation strategies were developed to address Whatcom County's fire hazards:

4. Inter-Agency Cooperation
5. County-wide Wildland Fire Prevention
6. WUI (Wildland/Urban Interface) Communities at Risk

More information and details can be found in the Wildland Fire section of this plan.

PROJECT PRIORITIZATION

Whatcom County chose to prioritize its hazard mitigation strategies according to hazard, not by specific facilities.

The County is currently very involved with flood hazard mitigation and will continue with flooding as the primary mitigation project priority. Second priority to flooding are all earthquake-related projects.

PLAN MAINTENANCE

Annual Review and Updates to the Plan

The **Whatcom County Multi-jurisdictional Hazard Mitigation Plan** (The Plan) will be reviewed annually by each of the major jurisdictions that have adopted the plan. It will be evaluated to determine the effectiveness of mitigation programs, projects, or other related activities and changed accordingly. As new hazard threats arise, or mitigation data becomes available, it will be incorporated into the plan. Each adopting jurisdiction is responsible for the section of the Plan that refers to its jurisdiction and to provide written changes, if any, annually to Whatcom County Sheriff's Office, Division of Emergency Management (DEM) prior to each annual public meeting.

A public meeting will be announced and held annually (in November) with representatives of the adopting jurisdictions present to answer any questions or concerns regarding their section of the Plan. Public notices will be posted to invite public participation in the process.

A written report containing a summary of any changes based on annual reviews will be produced by the DEM and sent to the Washington State Hazard Mitigation Officer (WSHMO) following each annual review. The annual reviews by each jurisdiction and the public meeting will conclude by November 30 each year. The Division of Emergency Management will facilitate the review process.

Major Plan Update

A major update to the Plan will be performed and published every five years. It will contain all changes in strategy, identified hazards, project updates and will incorporate new data as it relates to the Plan. The public will also be involved in this process through public meetings coordinated by DEM. A copy of the updated plan will be delivered to the WSHMO for approval and forwarding to the Federal Emergency Management, Region X. All the jurisdictions that have adopted the plan within Whatcom County will receive a copy of the updated plan once it is approved.

The next five-year update will be delivered to the WSHMO within 30 days following November 30, 2009

DATE	PRODUCT
November, 2004	Plan submitted for approval
November, 2005	First annual review/update
November, 2006	Second annual review/update
November, 2007	Third annual review/update
November, 2008	Fourth annual review/update
November/December, 2009	Major Plan Update and resubmission

APPENDIX A: Code of Federal Regulations 201.6

[Code of Federal Regulations]
[Title 44, Volume 1]
[Revised as of October 1, 2003]
From the U.S. Government Printing Office via GPO Access
[**CITE**: **44CFR201.6**]

[Page 401-403]

TITLE 44--EMERGENCY MANAGEMENT AND ASSISTANCE

CHAPTER I--FEDERAL EMERGENCY MANAGEMENT AGENCY, DEPARTMENT OF HOMELAND SECURITY

PART 201--MITIGATION PLANNING--Table of Contents

Sec. 201.**6** Local Mitigation Plans.

The local mitigation plan is the representation of the jurisdiction's commitment to reduce risks from natural

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hazards, serving as a guide for decision makers as they commit resources to reducing the effects of natural hazards. Local plans will also serve as the basis for the State to provide technical assistance and to prioritize project funding.

(a) Plan requirements. (1) For disasters declared after November 1, 2004, a local government must have a mitigation plan approved pursuant to this section in order to receive HMGP project grants. Until November 1, 2004, local mitigation plans may be developed concurrent with the implementation of the HMGP project grant.

(2) By November 1, 2003, local governments must have a mitigation plan approved pursuant to this section in order to receive a project grant through the Pre-Disaster Mitigation (PDM) program, authorized under Sec. 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C. 5133. PDM planning grants will continue to be made available to all local governments after this time to enable them to meet the requirements of this section.

(3) Regional Directors may grant an exception to the plan requirement in extraordinary circumstances, such as in a small and impoverished community, when justification is provided. In these cases, a plan will be completed within 12 months of the award of the project grant. If a plan is not provided within this timeframe, the project grant will be terminated, and any costs incurred after notice of grant's termination will not be reimbursed by FEMA.

(4) Multi-jurisdictional plans (e.g. watershed plans) may be accepted, as appropriate, as long as each jurisdiction has participated in the process and has officially adopted the plan. State-wide plans will not be accepted as multi-jurisdictional plans.

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

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

(c) Plan content. The plan shall include the following:

(1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

(2) A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards. The risk assessment shall include:

(i) A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

(ii) A description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate;

(C) Providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

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(iii) For multi-jurisdictional plans, the risk assessment section must assess each jurisdiction's risks where they vary from the risks facing the entire planning area.

(3) A mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools. This section shall include:

(i) A description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

(ii) A section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.

(iii) An action plan describing how the actions identified in paragraph (c)(2)(ii) of this section will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their

associated costs.

(iv) For multi-jurisdictional plans, there must be identifiable action items specific to the jurisdiction requesting FEMA approval or credit of the plan.

(4) A plan maintenance process that includes:

(i) A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

(ii) A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

(iii) Discussion on how the community will continue public participation in the plan maintenance process.

(5) Documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commissioner, Tribal Council). For multi-jurisdictional plans, each jurisdiction requesting approval of the plan must document that it has been formally adopted.

(d) Plan review. (1) Plans must be submitted to the State Hazard Mitigation Officer for initial review and coordination. The State will then send the plan to the appropriate FEMA Regional Office for formal review and approval.

(2) The Regional review will be completed within 45 days after receipt from the State, whenever possible.

(3) Plans must be reviewed, revised if appropriate, and resubmitted for approval within five years in order to continue to be eligible for HMGP project grant funding.

(4) Managing States that have been approved under the criteria established by FEMA pursuant to 42 U.S.C. 5170c(c) will be delegated approval authority for local mitigation plans, and the review will be based on the criteria in this part. Managing States will review the plans within 45 days of receipt of the plans, whenever possible, and provide a copy of the approved plans to the Regional Office.

[67 FR 8848, Feb. 26, 2002, as amended at 67 FR 61515, Oct. 1, 2002]

PARTS 202-203 [RESERVED]

APPENDIX B: Plan Development Process

In October of 2000, the President of the United States signed into law the Disaster Mitigation Act of 2000 to reinforce the importance of mitigation planning and emphasize planning for disasters before they occur. To implement the Disaster Mitigation Act of 2000, FEMA prepared an Interim Final Rule, published in the Federal Registry on February 26, 2002, at 44 CFR Parts 201 and 206, which establishes planning and funding criteria for state and local governments.

In response to CFR 201.6, Whatcom County's DEM contracted with Summit GIS, a consulting firm located in Bellingham, to write the Hazard Mitigation Plan for Whatcom County. Because the plan was intended to be a multi-jurisdictional plan, all of the jurisdictions included in the Hazard Mitigation Plan dedicated time and effort to provide jurisdiction-specific information contained in the plan.

Key contributors in providing jurisdiction-specific information were:

City of Bellingham – Andy Day, Assistant Fire Chief
City of Blaine – Mike Haslip, Police Chief
Cities of Everson & Nooksack – Erik Ramstead, Police Chief
City of Ferndale – Dale Baker, Police Chief
City of Lynden – Warren Gay, Fire Chief
City of Sumas – David Davidson, City Administrator
Port of Bellingham – Karen Callery, Engineering Specialist
Whatcom County – Dale Kloes, Program Specialist

Additional to the participating jurisdiction, smaller agencies throughout the County were invited to participate in the development and adoption of the Hazard Mitigation Plan. Refer to Appendix C for a listing of these participating agencies.

The writing and organization of the Whatcom County Hazard Mitigation Plan was performed by Summit GIS. Summit GIS was also responsible for locating and collecting all natural hazard-related GIS data from local and state sources.

In order to involve the public in the drafting of the Whatcom County Hazard Mitigation Plan, Summit GIS and Whatcom County DEM advertised and conducted a total of three (3) public meetings. These meetings were to provide an opportunity to fully participate in the plan, and just as importantly, to solicit information and comments from the citizens of Whatcom County and better involve them in the plan. Unfortunately, there were no attendees to any of the meetings.

Public Meeting Schedule		
Date	**Time**	**Location**
July 6, 2004	7:00 p.m.	Blaine City Hall
July 7, 2004	7:00 p.m.	Whatcom County Fire District #1
July 12, 2004	7:00 p.m.	Whatcom County Courthouse

Important dates and elements in the Hazard Mitigation Plan development:

January 2, 2004:
Contract between Whatcom County and Summit GIS, for Summit to write Whatcom County's Multi-Jurisdictional Hazard Mitigation Plan, is finalized. Summit GIS representatives, President Adrian Mintz and GIS Analyst Tollie Bohl, and Whatcom County DEM's Program Specialist, Dale Kloes, attended weekly meetings to discuss the plan development process and insure project goals and timelines were met.

February 5, 2004:
Paula Cooper, River & Flood Manager for Whatcom County Public Works, attends weekly meeting between Whatcom County and Summit GIS to discuss flooding hazards in Whatcom County and share available information and data.

March 11, 2004:
Two representatives from the Washington Military Department Emergency Management Division, John Ufford and Marty Best, attend the weekly meeting between Summit GIS and Whatcom County to assist in the development of the plan.

March 16, 2004:
Dale Kloes sends out letters to Whatcom County jurisdictions to invite them to a March 25, 2004 meeting to discuss their optional participation in the Whatcom County Hazard Mitigation Plan. The meeting scheduled for 1:00 p.m., ad the Port of Bellingham Harbor Center.

March 23, 2004:
Whatcom County DEM submits first draft of County critical facilities.

March 25, 2004:
Whatcom County Jurisdiction Representatives attend 1:00 p.m. meeting to learn about the development of the Multi-Jurisdictional Whatcom County Hazard Mitigation Plan and receive invitation to participate in the plan. The attendees of this meeting were:

Name	Affiliation
Lloyd Kirry	Economic Development Administration
Art Cidoat	Port of Bellingham
Karen Callery	Port of Bellingham
Dale Kloes	Whatcom County DEM
Andy Day	City of Bellingham
Dennis Murphy	Whatcom County DEM
Michael Haslip	City of Blaine
Erik Ramstead	City of Everson
Matt Sullivan	City of Everson
David Davidson	City of Sumas
Adrian Mintz	Summit GIS
Tollie Bohl	Summit GIS

Mike Haslip, as the contact for the City of Blaine, agrees to participate in the plan and submits the first draft of Blaine's critical facility list. Although Lynden contact Warren Gay was unable to attend, he had indicated participation prior to the meeting.

April 1, 2004:
Mark Titus, Fire Prevention Coordinator with DNR's NW Region, attends weekly meeting between Whatcom County and Summit GIS to discuss the wildland fire hazard in Whatcom County and share available information and data.

April 5, 2004:
Cities of Everson and Nooksack agree to participate in the plan. Erik Ramstead chosen as the contact and he submits critical facility list.

City of Sumas agrees to participate in the plan. David Davidson chosen as the contact and he submits critical facility list.

The Port of Bellingham agrees to participate in the plan. Karen Callery chosen as the contact and she submits critical facility list.

April 8, 2004:
Dale Kloes sends an invitation to Whatcom County's smaller agencies and districts to an April 20, 2004 meeting, at Fire District #4. The purpose of the informational meeting is to discuss their optional participation in the Whatcom County Hazard Mitigation Plan.

April 9, 2004:
City of Bellingham agrees to participate in the plan. Andy Day chosen as the contact and he submits critical facility list.

April 20, 2004:
Informational meeting held with smaller county agencies and district. The attendees of this meeting were:

Name	Affiliation
Mike Anderson	Bellingham School District
Steve Hovde	Birch Bay Water & Sewer
Jim Kenoyer	Blaine School District
Dave Johnson	Cemetery District 7
Mary Miller	Cemetery District 8
Tom Jones	Cemetery District 9
Patrick Bouma	DID #1
Floyd Bouma	DID #1
Roger Anderson	DID #15
Doug Channel	Diking District 1
Gordon Neevel	Diking District 3
Gordon Travis	Evergreen Water & Sewer District 19
Don Drommond	Evergreen Water & Sewer District 19
Ron Cowan	Ferndale School District
Jan Eskola	Glacier Fire & Rescue
James Evangelista	Glacier Water District
Chip Anderson	Lake Whatcom Water & Sewer District
Dennis Carlson	Lynden School District (504)
Dave Crossen	North Whatcom Fire & Rescue
Terry Klimpel	Samish Water District
Richard Gay	Water District 18, Acme
Michelle Starrs	Water District 4
Jim Trowbridge	Water District 7
Barb Burke	Whatcom FD 1
Neil Good	Whatcom FD 10
Candy Roberts	Whatcom FD 16
Tom Gooch	Whatcom FD 4

Candy Roberts	Cemetery District 1
Michael Foster	Water District 12, Samish
Barbara Curry	Whatcom WCFPD 9

All sub-districts interested in inclusion of the Whatcom County Hazard Mitigation Plan were instructed to email Tollie Bohl, of Summit GIS, with their interest.

April 22, 2004:
Follow-up meeting held at 1:00 p.m. at the Nelson Harbor Building, with the jurisdiction representatives. The purpose of the meeting is to review the Summit GIS' mapped locations of their critical facility and discuss next steps of the plan. Attendees of this meeting were: Dale Kloes, Tollie Bohl, Warren Gay, Any Day, David Davidson, and Karen Callery.

Critical facility locations reviewed with non-attending jurisdiction representatives via email communication.

June 1, 2004:
Summit GIS staff begins writing the Whatcom County Hazard Mitigation Plan.

June 16, 2004:
City of Ferndale formally agrees to participate in the plan. Dale Baker chosen as the contact and Ferndale's critical facility list is submitted.

June 21, 2004:
Summit GIS contacts each jurisdiction to rank each of the critical facilities according to importance to the community. All nine jurisdiction representatives submit their rank assessment within one week.

July 1, 2004:
Summit GIS staff completes the first draft of the Whatcom County Hazard Mitigation Plan.

July 6, 2004:
First meeting open to the public for the Whatcom County Hazard Mitigation Plan held at Blaine's City Hall at 7:00 p.m. The purpose of this meeting was to make the draft available to the public for their review and comment. No attendees.

July 7, 2004:
Second meeting open to the public for the Whatcom County Hazard Mitigation Plan held at Whatcom County's Fire District #1 in Nugents Corner at 7:00 p.m. The purpose of this meeting was to make the draft available to the public for their review and comment. No attendees.

July 12, 2004:
Third meeting open to the public for the Whatcom County Hazard Mitigation Plan held at the Whatcom County Courthouse's Council Chambers in Bellingham at 7:00 p.m. The purpose of this meeting was to make the draft available to the public for their review and comment. No attendees.

August 6, 2004:
Two (2) copies of the Whatcom County Hazard Mitigation Plan submitted to Marty Best and John Ufford of the Washington Military Department's Emergency Management Division for the state's review.

September 9, 2004:
State's review of the Whatcom County Hazard Mitigation Plan is received from Marty Best. This review detailed satisfactory and unsatisfactory areas of the plan that met or didn't meet the state's criteria.

September 22, 2004:
Summit GIS meets with Dale Kloes to discuss the comments submitted by the state about the Whatcom County Hazard Mitigation Plan. The state identified the jurisdiction's hazard mitigation strategies and actions as the most significant area of the plan requiring changes to meet criteria.

October 6, 2004:
Tollie Bohl of Summit GIS sends an email to the nine jurisdiction representatives asking for each jurisdiction's hazard mitigation strategies and actions.

October 11, 2004 – November 22, 2004
Dale Kloes meets with various jurisdictions and resolves their hazard mitigation strategies.

November 23, 2004
Summit GIS receives the revised mitigation strategies and incorporates them into the Hazard Mitigation Plan. Plan is sent back to the state for review.

APPENDIX C: Participating Agencies

Bellingham School District
Birch Bay Water & Sewer
Blaine School District
Cemetery District 1
Cemetery District 6
Cemetery District 7
Cemetery District 8
Cemetery District 9
City of Bellingham
City of Blaine
City of Everson
City of Ferndale
City of Lynden
City of Nooksack
City of Sumas
DID #1
DID #15
Diking District 1
Diking District 3
Diking District 4
Drainage District 2
Evergreen Water & Sewer District 19
Ferndale School District
Glacier Fire & Rescue
Glacier Water District
Lake Whatcom Water & Sewer District
Lummi Island Cemetery
Lynden School District (504)
Meridian School District
Nooksack Indian Tribe
North Whatcom Fire & Rescue
Port of Bellingham
Pt. Roberts Park District #1
Samish Water District
Water District 12, Samish
Water District 18, Acme
Water District 2
Water District 4
Water District 7
Whatcom County
WCFPD 1
WCFPD 4
WCFPD 5
WCFPD 9
WCFPD 10
WCFPD 16

Note: Lummi Island's Fire & Protection District (District 11) and the Lummi Nation completed a Natural Hazard Mitigation Plan independent of Whatcom County's Plan.

APPENDIX D: List of Acronyms

CFHMP – Comprehensive Flood Hazard Management Plan
CFR – Code of Federal Regulations
CSZ – Cascadia Subduction Zone
CWPP – Community Wildfire Protection Plan
DNR – Department of Natural Resources
EPA – Environmental Protection Agency
FEMA – Federal Emergency Management Agency
GIS – Geographic Information Systems
GMA – Growth Management Act
HMGP – Hazard Mitigation Grant Program
IBC – International Building Code
LF – Linear Feet
NEHRP – National Earthquake Hazard Reduction Program
NFIP – National Flood Insurance Program
NFPA – National Fire Protection Association
NOAA – National Oceanic and Atmospheric Association
NTHMP – National Tsunami Hazard Mitigation Program
RAMS – Risk Assessment & Mitigation Strategy
TIME – Tsunami Inundation Mapping Effort
UGA – Urban Growth Area
USGS – US Geological Society
WSDOT – Washington State Department of Transportation
WUI – Wildland/Urban Interface

APPENDIX E: Whatcom County Risk Assessment & Mitigation Strategies for Wildland Fire

This Assessment has been prepared for the Whatcom County using the Risk Assessment and Mitigation Strategies (RAMS) planning process. RAMS was developed for fire managers to be a holistic approach to analyzing wildland FUELS, HAZARD, RISK, VALUE, and SUPPRESSION CAPABILITY. It considers the effects of fire on unit ecosystems by taking a coordinated approach to planning at a landscape level, and allows users to develop fire prevention and/or fuels treatments programs.

The steps involved in this process included:

1. Identification of spatial Compartments for study
2. Fire Management Zone 37 = Whatcom County
3. Assessment of significant issues within each Compartment

Compartment 13: 37653
Part I

Compartment 13 contains 295,228 acres in Fire Management Zone 37. The Compartment experiences 4.00 fires per year, totaling 5 acres. The characteristics of the compartment indicate that: Catastrophic Fire Likely.

Fuels Hazard characteristics are rated:

Fuels (flame length produced): 8 + Feet (**High)**
Crowning Potential: 0 - 2 (**Low)**
Slope Percent: 0 - 20 (**Low)**
Aspect: North (**Low)**
Elevation: 0 - 3500 (**High)**

Protection Capability ratings are:

InitialAttack: 21 - 30 minutes (**Moderate)**
Suppression Complexity: Average (**Moderate)**

Ignition Risk factors include:

- Population Density - Wildland Urban Interface
  - 1001+ Dwellings/structures
- Power Lines In Unit
  - Sub-station
  - Distribution Lines
  - Transmission Lines
- Industrial Operations
  - Active timber sale
  - Maintenance/service contracts
  - Mining
  - Debris/slash burning
  - Construction project
- Recreation

Dispersed camping areas, party areas, hunters, waterbased, hiking
Off highway vehicle use
Developed camping areas

Flammables Present
Powder magazine
Gas pumps or storage
Gas or oil wells/transmission

Other
Woodcutting area, power equipment
Dump
Fireworks, children with matches
Electronic installations
Shooting/target
Government operations
Cultural Activities
Incendiary

Railroads
Railroads are present

Transportation System
Public Access Road(s)
County road(s)
State/Federal highway(s)

Commercial Development
Camps, resorts, stables
Schools
Business, agricultural/ranching

Compartment 13: 37653
Part II

Compartment Values are characterized:
Recreation: Developed recreation site within or adjacent to area (**High)**
Administrative: High value or numerous administrative sites (**High)**
Wildlife/Fisheries: Highly significant habitat. (**High)**
Range Use: Range allotment within area, normal/average use (**Moderate)**
Watershed: Stream Class PI, I. Important water use/riparian area. Domestic water use. (**High)**
Forest/Woodland: Standing timber/woodland on 26 - 50% of area (**Moderate)**
Plantations: 15% or less of area in or programmed for plantations (**Low)**
Private Property: High loss and threat potential due to numbers and placement (**High)**
Cultural Resources: Archaeological/historical findings of high significance (**High)**
Special Interest Areas: Area is adjacent to a Special Interest area (**Moderate)**
Visual Resources: Maximum modification dominates. (**Low)**
T&E Species: Species present. (**High)**
Soils (Erosion): Low significance (EHR < 4). (**Low)**
Airshed: High receptor sensitivity (**High)**
Vegetation: Potential for sensitive plants. (**Moderate)**

Compartment 14: 37656
Part I

Compartment 14 contains 360,471 acres in Fire Management Zone 37. The Compartment experiences 8.00 fires per year, totaling 98 acres. The characteristics of the compartment indicate that: Catastrophic Fire Likely.

Fuels Hazard characteristics are rated:

- Fuels (flame length produced): 8 + Feet (**High)**
- Crowning Potential: 6 + (**High)**
- Slope Percent: 21 - 35 (**Moderate)**
- Aspect: North (**Low)**
- Elevation: 0 - 3500 (**High)**

Protection Capability ratings are:

- InitialAttack: 31+ minutes (**High)**
- Suppression Complexity: Complex (**High)**

Ignition Risk factors include:

- Population Density - Wildland Urban Interface
  - 1001+ Dwellings/structures
- Power Lines In Unit
  - Transmission Lines
  - Distribution Lines
  - Sub-station
- Industrial Operations
  - Active timber sale
  - Construction project
  - Debris/slash burning
  - Mining
  - Maintenance/service contracts
- Recreation
  - Dispersed camping areas, party areas, hunters, waterbased, hiking
  - Developed camping areas
  - Off highway vehicle use
- Flammables Present
  - Powder magazine
  - Gas or oil wells/transmission
  - Gas pumps or storage
- Other
  - Fireworks, children with matches
  - Electronic installations
  - Woodcutting area, power equipment
  - Shooting/target
  - Government operations
  - Incendiary

Cultural Activities
Dump
Railroads
Railroads are present
Transportation System
State/Federal highway(s)
County road(s)
Public Access Road(s)
Commercial Development
Schools
Camps, resorts, stables
Business, agricultural/ranching

Compartment 14: 37656
Part II

Compartment Values are characterized:
Recreation: Developed recreation site within or adjacent to area (**High)**
Administrative: High value or numerous administrative sites (**High)**
Wildlife/Fisheries: Highly significant habitat. (**High)**
Range Use: Range allotment within area, normal/average use (**Moderate)**
Watershed: Stream Class PI, I. Important water use/riparian area. Domestic water use. (**High)**
Forest/Woodland: Standing timber/woodland on 51+% of area (**High)**
Plantations: 31+% or less of area in or programmed for plantations (**High)**
Private Property: High loss and threat potential due to numbers and placement (**High)**
Cultural Resources: Archaeological/historical findings of high significance (**High)**
Special Interest Areas: Area is adjacent to a Special Interest area (**Moderate)**
Visual Resources: Partially retain existing character. (**Moderate)**
T&E Species: Species present. (**High)**
Soils (Erosion): Moderately erodable (EHR 4-12). (**Moderate)**
Airshed: High receptor sensitivity (**High)**
Vegetation: Potential for sensitive plants. (**Moderate)**

Compartment 15: 37658
Part I

Compartment 15 contains 948,133 acres in Fire Management Zone 37. The Compartment experiences 1.00 fires per year, totaling 6 acres. The characteristics of the compartment indicate that: Catastrophic Fire Possible.

Fuels Hazard characteristics are rated:

- Fuels (flame length produced): 8 + Feet (**High)**
- Crowning Potential: 3 - 5 (**Moderate)**
- Slope Percent: 36 + (**High)**
- Aspect: South (**High)**
- Elevation: 5001 + (**Low)**

Protection Capability ratings are:

- InitialAttack: 31+ minutes (**High)**
- Suppression Complexity: Simple (**Low)**

Ignition Risk factors include:

- Population Density - Wildland Urban Interface
  - 501-1000 Dwellings/structures
- Power Lines In Unit
  - Transmission Lines
  - Sub-station
  - Distribution Lines
- Industrial Operations
  - Debris/slash burning
  - Mining
  - Construction project
  - Active timber sale
  - Maintenance/service contracts
- Recreation
  - Dispersed camping areas, party areas, hunters, waterbased, hiking
  - Developed camping areas
  - Off highway vehicle use
- Flammables Present
  - Powder magazine
  - Gas or oil wells/transmission
  - Gas pumps or storage
- Other
  - Electronic installations
  - Fireworks, children with matches
  - Woodcutting area, power equipment
  - Shooting/target
  - Government operations
  - Incendiary

Cultural Activities
Dump
Railroads
Railroads are present
Transportation System
State/Federal highway(s)
Public Access Road(s)
County road(s)
Commercial Development
Schools
Camps, resorts, stables
Business, agricultural/ranching

Compartment 15: 37658
Part II

Compartment Values are characterized:
Recreation: Developed recreation site within or adjacent to area (**High)**
Administrative: Few or no administrative sites (**Low)**
Wildlife/Fisheries: Highly significant habitat. (**High)**
Range Use: Little or no range use (**Low)**
Watershed: Stream Class PI, I. Important water use/riparian area. Domestic water use. (**High)**
Forest/Woodland: Standing timber/woodland on 51+% of area (**High)**
Plantations: 16 - 30% or less of area in or programmed for plantations (**Moderate)**
Private Property: Little or no threat or loss potential (**Low)**
Cultural Resources: Minimal archaeological/historical findings, potential for Native American use. (**Moderate)**
Special Interest Areas: Area is adjacent to a Special Interest area (**Moderate)**
Visual Resources: Preserve and retain existing character. (**High)**
T&E Species: Species present. (**High)**
Soils (Erosion): Moderately erodable (EHR 4-12). (**Moderate)**
Airshed: Low receptor sensitivity (**Low)**
Vegetation: Potential for sensitive plants. (**Moderate)**