Woodland School District #404 Annex to the Natural Hazards Mitigation Plan for Cowlitz County

Draft Update May 2, 2011

Table of Contents

This page left intentionally blank.

Placeholder for Adopting Resolution

This page left intentionally blank.

I. Introduction

The Woodland School District (WSD) has been working to make the population, neighborhoods, and facilities of the district more resistant to the impacts of future disasters. The district has been undertaking a comprehensive, detailed evaluation of the vulnerabilities of the district to all types of future natural hazards in order to identify ways to make the district more resistant to their impacts. This document reports the results of that planning process.

The WSD's vision is to create a disaster-resistant future for the entire district, by having:

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

A. Mission

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

B. Purpose

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

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

C. Goals and Objectives

The plan goals describe the overall direction that the WSD can take to work towards mitigating risks from natural, technological and societal hazards. The goals are stepping stones between the broad direction of the mission statement and the specific recommendations outlined in the hazard mitigation initiatives. The goals and objectives help to focus the efforts of the jurisdiction in the mitigation planning effort to achieve an end result that matches the community's unique set of needs, interests and desires.

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

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

3. Promote a Sustainable Economy
   - Form partnerships to leverage and share resources
   - Continue critical business operations

4. Protect the Environment
   - Develop hazard mitigation policies that protect the environment

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

D. Scope

1. Jurisdiction

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

2. Hazards

   For purposes of assisting in hazard identification, the WSD utilized the following:
   - The existing Hazard Mitigation Plan
   - Cowlitz County Hazard Identification and Vulnerability Analysis (HIVA)

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

E. Limitations

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

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

3. Proposed hazard mitigation initiatives were developed utilizing the knowledge and expertise of the WSD staff members, and based on readily available information. At such time as resources/funding become available to implement a particular hazard mitigation initiative, the district may elect to do additional technical or cost-benefit analysis.

II. Jurisdiction Description

A. Summary Description

The WSD serves the City of Woodland and outlying areas. The District has approximately 2,074 students and 330 full and part-time employees as of April, 2010. Properties within the district are valued at $509,744,300.

The WSD #404 serves Woodland, which has a population of 5,195, and outlying areas (parts of Ariel, Cougar and Amboy, also), which have a population of over 10,000 persons. It is located at the junction of Interstate 5 and State Highway 503. It is situated at the confluence of the Lewis and Columbia Rivers in Southwest Washington, and is a rapidly growing, friendly community enjoying the marriage of small town life and a close association with neighboring metro centers Vancouver, Washington and Portland, Oregon. Major rail service, river transportation, shipping facilities and immediate access to Interstate 5, position the District for continued growth. The School District serves both Cowlitz and Clark Counties.

Historically, the only hazard WSD has experienced is flooding. The District is vulnerable to all of the high-risk County hazards (earthquake, flooding, severe winter storm, wildland fires, high winds), as well as hail and lightning.

The District has been through one Presidentially Declared disaster, the flood event of February 1996, with a total eligible loss of $4,865. The eligible losses were to reimburse the district for housing provided for displaced persons, food and staff time, not for damage to the school.

Additionally, a windstorm event during the winter of 2010 caused $33,000 worth of damage to the Woodland Middle School roof. No one was injured in the wind storm.

- **Value of Critical Facilities:**

Yale Elementary School =	$1,518,859
Woodland Primary School =	$8,972,814
Woodland Intermediate School =	$9,479,478
Woodland Middle School =	$7,679,040
Woodland High School =	$12,831,842
District Office/Business Services=	$267,864
Woodland School District Total=	**$40,749,897**
KWRL* =	$1,830,166
TEAM High School Portable Bldg.=	$140,000
Total =	**$42,720,063**

*Kalama-Woodland-Ridgefield-La Center Transportation Cooperative

- **Value of Critical Infrastructure/Equipment:**

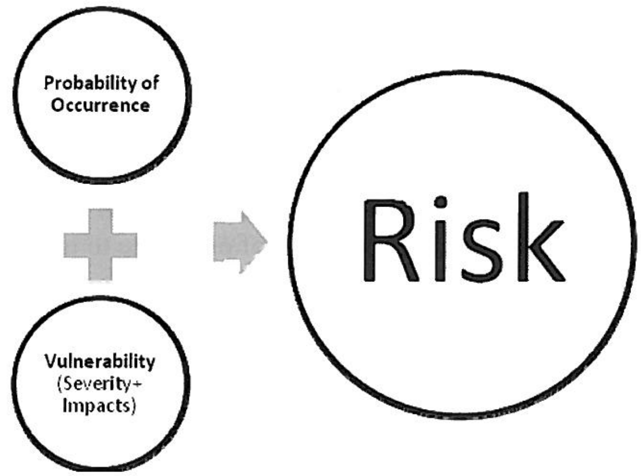
95 Buses at $115,000 =	$10,925,000
13 District Vehicles =	$116,745
	$11,041,745

WSD #404 Risk Assessment

Disaster Mitigation Act Risk Assessment Planning Requirements

DMA Section	Requirement
§201.6(c)(2)(i):	[The risk assessment **shall** include a] description of the type … of all natural hazards that can affect the jurisdiction …
§201.6(c)(2)(i):	[The risk assessment **shall** include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.
§201.6(c)(2)(ii):	[The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.
§201.6(c)(2)(ii):	[The risk assessment in all] plans approved after October 1, 2008 **must** also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.
§201.6(c)(2)(ii)(A):	The plan **should** describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas …

Hazard Analysis Definitions



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

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

Risk Rating:

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

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

Probability of Occurrence:

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

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

Vulnerability:

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

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

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

Summary Risk Assessment

Based on the regional risk assessment and the local risk assessment in the subsequent section, the following hazards pose the greatest threat to WSD #404.

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

Local Risk Assessment

A comprehensive risk assessment of the major natural hazards that threaten WSD #404 was developed for this plan through the regional risk assessment process described in Chapter 4.0. The regional risk assessment and its hazard profiles serve as the foundation for this jurisdiction's risk assessment. A list of all of the potential natural hazards that could impact this jurisdiction is located in Chapter 4. Chapter 4 includes six natural hazard profiles for earthquake, storm, flood, landslide, wildland fire, and volcanic events. Each profile defines the hazard and describes its effects, severity, impacts, probability of occurrence, and historical occurrences. The regional profiles describe this jurisdiction's local vulnerabilities in terms of the portion of the jurisdictions land base or service area, population, employment, dwelling units, jurisdiction-owned assets, and critical facilities that are within each hazard zone.

This section of the plan provides additional details or explains differences where this jurisdiction's risks for each hazard vary from the risks facing the entire planning area. Maps of the hazards that affect WSD #404 are scaled to local boundaries and are included in this section.

Earthquake

Severity

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

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

1. Crustal (shallow) earthquakes occur along faults close to the surface of the North American plate. They have a maximum depth of about 19 miles, though most occur much closer to the surface. The majority of earthquakes in the Pacific Northwest are of the shallow type. They could potentially produce magnitudes as high as 7.5, though most are less than 3.0. Scientists are locating and studying active faults that are located within the Puget Sound lowlands. The Seattle fault is perhaps the most infamous as it lies under the most densely populated area of the state. A magnitude 6.0 or greater earthquake originating from a surface fault could render incredible destruction. More research is necessary to verify the existence of the Olympia fault structure and its probability of rupturing.

2. Subduction zone or interplate earthquakes emanate from the boundary where the Juan de Fuca plate subducts eastward into the North American Plate. The width of the Cascadia Subduction Zone fault varies along its length, depending on the temperature of the subducted oceanic slab, which heats up as it is pushed deeper beneath the continent. As it becomes hotter and more molten it eventually loses the ability to store mechanical stress and generate earthquakes. An earthquake from this zone would be considered "the Big One," as it could travel over hundreds of miles and last for several minutes. Subduction zone earthquakes are considered to be the most destructive with potential magnitudes of 9.0 or greater. The last subduction zone earthquake is believed to have occurred in 1700.

3. Deep earthquakes occur along faults in the Juan de Fuca plate as it sinks beneath the North American plate. These earthquakes are located under the North American Plate; therefore their energy translation to the surface is buffered by their depth. Their depths generally range from 16-62 miles. Magnitudes of 7.5 have been recorded. The 1949, 1965, and 2001 earthquakes all emanated from this zone. The 2001 Nisqually earthquake's focus was located about 32 miles deep below its epicenter on Anderson Island.

Impacts

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

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

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

Probability of Occurrence

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

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

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

Historical Occurrences and Impacts Specific to this Jurisdiction

February 28, 2001, Federal Disaster 1361: Nisqually Earthquake

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

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

One year after the earthquake, news reports put reported property damage at approximately $500 million. However, when factoring in unreported damage, actual losses may run significantly higher. A University of Washington study of damage to households only, estimates that the earthquake caused $1.5 billion in damage to nearly 300,000 residences.[1] This estimate does not include public and business sector losses. Other estimates of the combined losses to public, business, and household property have ranged from $2 billion to $4 billion. Most buildings performed well from a life-safety standpoint, in that the limited structural damage that occurred caused no loss of life or collapse. However, the economic cost of nonstructural damage, i.e., damage to nonessential building elements, such as architectural features, ceiling failures, shifting of equipment, fallen furniture/shelving, desktop computer damage, fallen light fixtures, and losses due to lost productivity, was high. In general, new buildings and buildings that had recently been seismically upgraded typically displayed good structural performance, but many still sustained non-structural damage.

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

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

April 13, 1949, Olympia Earthquake

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

Summary Assessment

History suggests a moderate probability of occurrence of another damaging earthquake sometime in the next 25 years. With the 2001 Nisqually earthquake still fresh in the district's memory, it is important to note that it was not the largest earthquake event possible in the district. It is conceivable that a similar magnitude earthquake could emanate from a shallow crustal fault which would result in much greater damages. Damage from the 1949, 1965, and 2001 earthquakes indicate that an earthquake of a greater magnitude would have a catastrophic impact on WSD #404. Considering that a large population lives and works in higher risk earthquake hazard areas, the entire district has a high vulnerability rating. Accordingly, a moderate risk rating is assigned.

Summary Risk Assessment for Earthquake in WSD #404

Probability of Occurrence	Vulnerability	Risk
Moderate	High	Moderate

Storm

Severity

The coastal mountains afford WSD #404 some protection from severe southerly and westerly winds. The coastal mountain range acts as a buffer and shields the district from extreme winds in excess of 80 mph. WSD #404 does not encounter the 100 mph or greater winds that sometimes wreak havoc on Washington's Pacific coast communities. Nevertheless, the entire district is directly or indirectly susceptible to the effects of high winds. Facilities in the district can suffer power outages and be left in the cold and dark for extended periods.

Impacts

The district, like most of western Washington, is vulnerable to high winds because of the climatic conditions and the prevalence of 100 to 150 foot tall conifer trees. High winds weaken standing trees and structures that are weighted with snow or ice. Douglas fir and western hemlock tree species have shallow lateral root systems with top heavy crowns and entire trees are vulnerable to falling when soils are soaked from previous rainfall. Regular autumn rains saturate soils and decrease tree roots' ability to adhere to soil. Sustained high winds and gusts cause trees to sway significantly. Repetitive swaying motion can eventually weaken a tree's root hold in the saturated ground and force it to topple. These tall columnar trees and their massive branches act like giant hammers and sever electrical transmission lines, crush vehicles, damage homes and buildings, and block transportation routes. Falling tree limbs and other flying debris can injure or cause the death of people and animals.

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

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

Between 1960 and 2007, 79 windstorms have occurred in western Washington that caused at least $50,000 or more in damage area wide. The combined damages from these wind storms are estimated to have cost the region in excess of $27 million dollars (adjusted to 2007 dollar value).[2]

Probability of Occurrence

The Washington State Natural Hazard Mitigation Plan identified Cowlitz County and 22 other counties as susceptible to high winds. Counties that were considered most vulnerable to high winds are those with an annual high wind recurrence rate of 100%. The state plan indicated that Cowlitz County's annual high wind recurrence rate is 113%. At least 18 notable Pacific Northwest cyclones have impacted the region in the last 25 years, thus probability of occurrence is high.

Historical Occurrences and Impacts Specific to this Jurisdiction

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

Winter, 2010

A winter wind storm caused $33,000 to the Woodland Middle School roof.

January 6-16, 2009, Federal Disaster 1817: Severe Winter Storm[3]

On January 21, 2009, Governor Christine O. Gregoire requested a major disaster declaration as a result of a severe winter storm that yielded widespread and damaging effects from flooding, mudslides, landslides, avalanches, high winds, and freezing rain, during the period of January 6-16, 2009. The Governor requested a declaration for Individual Assistance for nine counties and Hazard Mitigation for all counties. During the period of January 13-16, 2009, joint federal, state, and local Individual Assistance Preliminary Damage Assessments (PDAs) were conducted in the requested counties and are summarized below. PDAs estimate damages immediately after an event and are considered, along with several other factors, in determining whether a disaster is of such severity and magnitude that effective response is beyond the capabilities of the state and the affected local governments, and that federal assistance is necessary.[4] Cowlitz County received approximately $600,000 in disaster relief.

December 12-27, 2008, Federal Disaster 1825: Severe Winter Storm[5]

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

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

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

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

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

December 12, 1995 Windstorm Federal Disaster 1079

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

February 1 to 8, 1989, Snow Storm

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

November 13-15, 1981

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

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

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

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

1962 Columbus Day storm.

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

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

October 12, 1962 - The Columbus Day Wind Storm

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

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

Summary Assessment

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

Thunderstorms do occur in WSD #404, thus the probability of occurrence of the storm elements is high. Thunderstorms produce a combination of wide-spread elements that cause destruction beyond isolated areas. Therefore, the overall probability of occurrence, the vulnerability rating and the overall risk for thunderstorms are all high.

Summary Risk Assessment for Storm in WSD #404

Probability of Occurrence	Vulnerability	Risk
High	High	High

Flood

Severity

The Lewis River

Lewis River, with a drainage area of l,046 square miles at its mouth, flows into Columbia River at mile 87.0. About one-fourth of the total drainage area lies in Columbia National Forest, and one-tenth of the total drainage area lies in Cowlitz County. The stream flows southwest from its source on the northwest slopes of Mount Adams and is joined by East Fork Lewis River at mile 3.5 about 3 miles south-southwest of Woodland, Washington. The upper limit of this study is at mile 14.5. Drainage area above the upper limit of study is approximately 800 square miles.

The Lewis River watershed is boot-shaped, 40 miles long, 30 miles wide at the downstream end, and 15 miles wide at the upstream end. A small portion of the basin is used for agricultural or related purposes.

Topography of the basin is mountainous and the watershed divides consist of rugged and well-defined ridges. The highest elevation in the basin is 12,307 feet, whereas the average elevation is 2,360 feet. High benches of comparatively level land lie in the middle and lower sections of the basin. The valley width through the study reach averages 1 mile. The widest flood plain in the study reach is in the vicinity of Woodland, Washington.

Total fall of Lewis River from its headwater to its junction with Columbia River is 7,900 feet, an average of 112 feet per mile. In the lower l4.5-mile study reach, Lewis River has an average fall of 2 feet per mile.

The most significant tributary of Lewis River within the reach investigated is East Fork Lewis River which contains little more than one-fifth of the total basin area. Great Northern-Northern Pacific and Union Pacific railroads serve the area. Interstate 5 passes through Woodland, and State Highway 503 provides access along Lewis River to the east.

The Lewis River has a gage located near the Woodland Airport. This gage is monitored by the Northwest River Forecast Center.

Drainage Areas in Watershed of Lewis River			
Stream	**Location**	**River mile**	**Drainage Area sq. mi.**
Lewis River	Mouth	0.0	1,046
	Above Mud Lake outlet	2.0	1,041
	Below East Fork Lewis River	2.4	1,040
	Above East Fork Lewis River	3.5	828
	Upper limit of study	14.5	800
Mud Lake Outlet	Mouth	0.0	5.28
East Fork Lewis River	Mouth	0.0	212
	Below La Center bridge		199
	Bottom Road bridge		154

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

Cowlitz County has three levels of flood severity:

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

Impacts

River floods kill people in the United States every year. People caught unprepared and isolated by swift moving or flash flood waters can die from drowning, hypothermia, or trauma. The February 1996 flood caused nine deaths in the Pacific Northwest. Fortunately advances in weather forecasting technology and hydrologic modeling are producing more accurate flood forecasts that can serve to provide communities with advance warnings. Radio broadcasts, television, and other tools can provide residents of flood prone properties critical information to take necessary precautions to safeguard some belongings and evacuate to safer ground.

Fast rising flood waters can also eliminate opportunity to provide for the safety of domestic animals. Floods kill livestock and pets causing both economic and emotional hardship. Carcasses can become a public health problem if not quickly and adequately disposed of.

Major and moderate flooding frequently inundates low lying roads around WSD #404 resulting in area-wide transportation disruptions. Interstate 5 and State Route 504 have closed multiple times due to floods. As flood waters recede, woody debris and other objects left behind can pose hazards to bridge structures and culverts. Electric, gas, water, and communication utilities are also subject to damage and disruption.

In general, the damaging effects of groundwater flooding are similar to riverine flooding. Some homes may be inundated if they are not elevated above flood levels. Even if a home is elevated above floodwaters, crawl spaces and basements are subject to flooding. Deep water may surround the properties and make it near impossible to enter and exit the property without a boat or makeshift elevated walkway. Septic tanks can become fouled and wells can render useless from contamination. Underground utilities, drainage facilities, and storage tanks are also casualties of groundwater flooding. In many ways groundwater flooding impacts can be worse than surface floods because mitigation is nearly impossible. Sandbagging and pumping have little effect on groundwater flooding and often time the best course of action is temporary relocation or evacuation of affected areas.

Probability of Occurrence

The following table displays the severity of flood in Cowlitz County as compared to the 39 Washington State counties. This table utilizes multiple qualitative data sets to determine that Cowlitz County is the 8th most susceptible county in the state, for flooding.

Jurisdictions Most Vulnerable to Flood

County	Approx. Frequency of Occurrence	% Area in Flood Plain	# Flood Insurance Policies	# Flood Insurance Claims	# Repetitive Flood Loss Properties	# Severe Repetitive Loss	Score
Snohomish	4 Yrs.	5.70%	2061	841	135	10	22
Skagit	5 Yrs.	4.40%	4457	766	112	10	22
King	3 Yrs.	3.00%	3779	1406	139	9	21
Lewis	3 Yrs.	4.50%	1607	1102	75	3	18
Grays Harbor	3 Yrs.	7.50%	2958	335	24	1	17
Pierce	4 Yrs.	4.20%	1696	474	35	0	14
Thurston	3 Yrs.	6.80%	575	195	15	0	13
Cowlitz	4 Yrs.	2.90%	1655	480	24	2	12
Whatcom	5 Yrs.	3.50%	1196	318	36	0	12
Clark	8 Yrs.	7.50%	1131	160	4	0	10
Mason	4 Yrs.	4.80%	280	119	15	0	10
Pacific	5 Yrs.	3.10%	794	130	5	1	9
Legend							
	3 Yrs.	6.5% or More	> 2,000	> 750	> 100	10 or more	4 pts each
	4 Yrs.	4.0 – 6.4%	1,000 – 1,999	300 – 749	50 - 99	7 - 9	3 pts each
	5 Yrs.	3.0 – 3.9%	500 – 999	100 – 299	20 - 49	4 - 6	2 pts each
	6 – 7 Yrs.	2.0 – 2.9%	250 – 499	50 – 99	0 - 19	3	1 pt each

Summary Assessment

The history of major flooding within WSD #404 clearly demonstrates a moderate probability of future occurrence. The December 2006 and January 2009 floods suggest that the district remains vulnerable to floods. Several flood events have occurred on Cowlitz County rivers which have exceeded the 100 year flood event. Because of the relative land area and population affected, the county is exposed to a major flood every 4 years, based on the history of the last 41 years (1968 to 2009). Overall, this data clearly indicates that the probability of occurrence of major flood events in the district is high. Therefore, flooding in WSD #404 is assigned an overall high risk ranking.

Summary Risk Assessment for Flood in WSD #404

Probability of Occurrence	Vulnerability	Risk
High	High	High

Landslide

Severity

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

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

Impacts

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

Local governments, public works, building inspectors, and other safety officials can become overwhelmed if a landslide hazard impacts a significant portion of the community.

Landslide events necessitate monitoring. Buildings and other infrastructure must be inspected to determine whether they are safe for occupancy or use. If a building is deemed unsafe, law enforcement personnel may need to increase patrols to decrease the risk of theft or criminal trespassing.

Probability of Occurrence

A review of local newspaper media, internet sources, Department of Natural Resources landslide data, and Federal Disaster Declarations for Cowlitz County suggest that the incidences of landslides are concurrent with winter storms, flooding, and earthquakes. The majority of landslides in the district are triggered by heavy precipitation in the winter months. Many smaller landslides regularly block roads with debris or washout transportation facilities and rupture utility pipes. Landslides are a continued concern for Cowlitz County residents, due to the vast majority of mountainous terrain and heavy rainfall. Therefore landslides have a high probability of occurrence and are certain to reoccur within a 25 year period.

Historical Occurrences and Impacts Specific to this Jurisdiction

Few landslides have impacted the district over the last two decades.

Summary Assessment

The history of few landslides within WSD #404 clearly demonstrates a low probability of future occurrence. The probability of landslide occurrence is mitigated through the adoption of Cowlitz County's Critical Area's Ordinances (CAO). Overall, this data clearly indicates that the vulnerability of major landslide events in the district is low. The district's overall risk ranking of landslide remains low.

Summary Risk Assessment for Landslide in WSD #404

Probability of Occurrence	Vulnerability	Risk
Low	Low	Low

Wildland Fire

Severity

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

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

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

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

Soil Conditions - The district has a large area of glacial outwash prairie. Prairies are typically vegetated with grasses and other low growing herbaceous plants and shrubs. Prairie soils drain quickly and the vegetation quickly dries out during the summer months.

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

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

Impacts

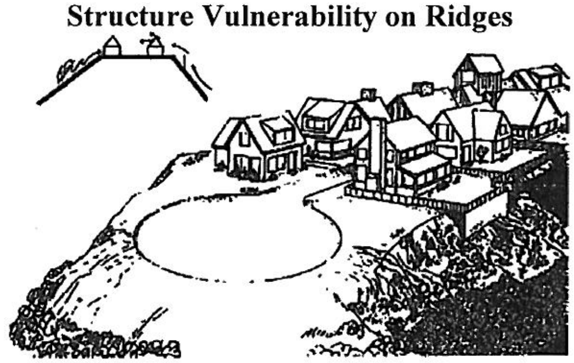
The impact of a wildland fire varies depending upon the size and location of the fire. The heat from intense wind driven flames can destroy virtually any combustible material in its path. People caught off guard by a rapidly spreading fire could suffer burn injuries or other non-burn injuries trying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

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

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

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

Structure Vulnerability on Ridges



Structures on narrow ridges are especially vulnerable to fire.
Source: County of Los Angeles, 1986

Wildfires may spawn secondary hazards, such as flash flooding and landsliding, long after they have been extinguished. Vegetation provides a number of physical functions which contribute to the hydrologic and slope stability regimes of an area. When this vegetation is consumed in high intensity wildfire, resulting changes may include decreased rainfall interception and infiltration; faster concentration times and greater volume of peak flows; increased volume and velocity of overland runoff; and loss of reinforcing deep roots. The intense temperatures of wildfire may also cause chemical changes in the soil, resulting in hydrologic changes similar to those described above.

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

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

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

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

Historically, wildfire management has meant immediate fire suppression. When wildland fire control and prevention are successful, the risk of dangerous, high-intensity fires can actually increase as fuel loads build. These high-intensity fires take on an entirely different character than their low-intensity cousins, consuming all vegetation in their paths and erupting as fire storms. Such conflagrations are driven by winds that they produce and can move quickly and erratically. It may not be possible to stop them once they begin, and it may be impossible or foolhardy to try to save structures that lie in their paths; winter rains and snow might provide the only viable suppression technique. Unfortunately, large fuel loads are often associated with the fringes of the urbanizing areas due to historical suppression efforts setting the stage for high-intensity interface fires. To avoid the possibility of these high-intensity fires, land managers and oversight agencies practice and promote vegetation management techniques that maintain the fuel load at an appropriate, controllable level.

Probability of Occurrence

Firefighting can consume significant local and state resources. Even a small wildland fire in WSD #404 requires rapid containment or suppression in order to protect property. Should multiple wildland fires occur simultaneously in different areas during an extremely warm and dry season, local capabilities could quickly become overwhelmed. This is particularly more problematic when major wildland fires on federal lands require the mobilization of fire fighting assets across the western U.S., further stretching local fire fighting capacity

The documented record of wildland fires in WSD #404 suggests that approximately 97 percent of future fires will be five acres or less. The district can expect at least one fire exceeding 100 acres over the next 25 years. A warmer and drier future climate may create more suitable conditions for more frequent or larger fires.

Historical Occurrences and Impacts Specific to this Jurisdiction

Major forest fires are not common in Western Washington.

In 2001, Congress approved funds for federal and state agencies and local communities to better plan and prepare for future wildfire seasons. The result of that planning and preparation is commonly known as the "National Fire Plan." The goals of the National Fire Plan are to ensure sufficient firefighting resources for the future, to rehabilitate and restore fire-damaged ecosystems, to reduce fuels (combustible forest materials) in forests and rangelands at risk, especially near communities, and to work with local residents to reduce fire risk and to improve fire protection.

In the Pacific Northwest, the National Fire Plan (NFP) is being successfully implemented under the direction of the Pacific Northwest Wildfire Coordinating Group (PNWCG). PNWCG is an interagency group including the five federal wildland fire agencies, two state forestry agencies, and two state fire marshal associations. This interagency and intergovernmental group of local, state, and federal agencies are working cooperatively to reduce wildfire risk and restore fire-adapted ecosystems.

Summary Assessment

The history of wildland fires within WSD #404 clearly demonstrates a moderate probability of future occurrence, due to the high amount of precipitation west of the Cascade Mountain Range. Because of the relative large undeveloped land area and population affected, the county is exposed to minor wildland fires periodically during dry summer months. Adoption of the International Building Code and International Fire Code by Cowlitz County helps to curtail wildland fires from expansive damage by limiting the flammable materials on remote homes and property. This indicates that the vulnerability of major landslide events in the district is moderate. The district's overall risk ranking of wildland fires is moderate.

Summary Risk Assessment for Wildland Fire in WSD #404

Probability of Occurrence	Vulnerability	Risk
Moderate	Moderate	Moderate

Volcanic Hazards

Severity

WSD #404 is located approximately thirty miles from Mount St. Helens. Mount St Helen's peak is within Skamania County, however a large portion of the mountain resides in Cowlitz County. With the right winds, the entire County could be blanketed with ash. The severity of the hazard would depend on the thickness of the ash deposition. The 1980 eruption of Mount St. Helens blew an ash column 15 miles into the atmosphere above the crater. Over the course of the day of the eruption, nearly 540 million tons of ash was blown by winds to the east.[vi] Fallout from the ash created complete darkness in Spokane, nearly 250 miles away; dropping one half inch of ash only a few hours after the start of the eruption.

Impacts

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

If a large lahar were to occur at Mount St. Helens within the next few decades, the mechanism most likely to affect WSD #404 is rapid melting of snow and ice that would produce a lahar that flows south of the crater into the Lewis River Valley (and downstream). Rainfall is seldom intense enough to directly produce lahars in the Cascades, and the flows produced by this mechanism tend to be fairly small. Likewise, any landslides occurring on the flanks of Mount St. Helens are likely to be relatively small, especially now that the volcano's height has been lowered by the 1980 eruption.

Snow and Ice at Mount St. Helens

A large volume of snow and ice is presently accumulating in the Mount St. Helens crater, protected by the shade of the high, steep crater walls. This accumulation provides a growing potential water source for lahars in the Lewis River valley. It is already mixed with rock debris eroded from the crater walls and this debris would augment the formation of a lahar. It is possible that a large eruption could melt most or all of this snow and ice in a matter of tens of minutes. A very small eruption in 1982 rapidly melted enough snow and ice in the crater to trigger a 4 million m^3 (5.2 million yd^3) flood that transformed into a lahar and flowed all the way to the Cowlitz River. At the present time (1995), about 53 million m^3 (70 million yd^3) of snow and ice has accumulated. If completely melted, this would produce about 38 million m^3 (50 million yd^3) of water. At the present rate of accumulation, the volume of snow and ice will double in about 15 years.

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

Probability of Occurrence

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

Summary Assessment

The eruption of Mount St. Helens negatively impacted the district. While the majority of ash and debris landed east of the mountain, the district suffered numerous damages. Economic tolls devastated the county's resource economy in timber losses. The county's waterways continue to be dredged of debris from the eruption, to this day. Since the eruption, our county has been defined by the event in May of 1980 and continues to rebuild from this disaster.

The *Hazard Mitigation Plan for Cowlitz County* aims to compare and contrast the vulnerability WSD #404 faces from multiple hazards. This means that storms are evaluated with volcanic eruptions. While storms occur much more frequently than eruptions, eruptions cause a plethora of damages compared to storms. Volcanic eruptions are devastating when they occur. However, they occur very rarely. That said, WSD #404 has been assigned a low probability of occurrence, and its vulnerability ranks at a moderate level. The overall risk ranking for volcanic activity in WSD #404 is low.

Summary Risk Assessment for Volcanic Events in WSD #404

Probability of Occurrence	Vulnerability	Risk
Low	Moderate	Low

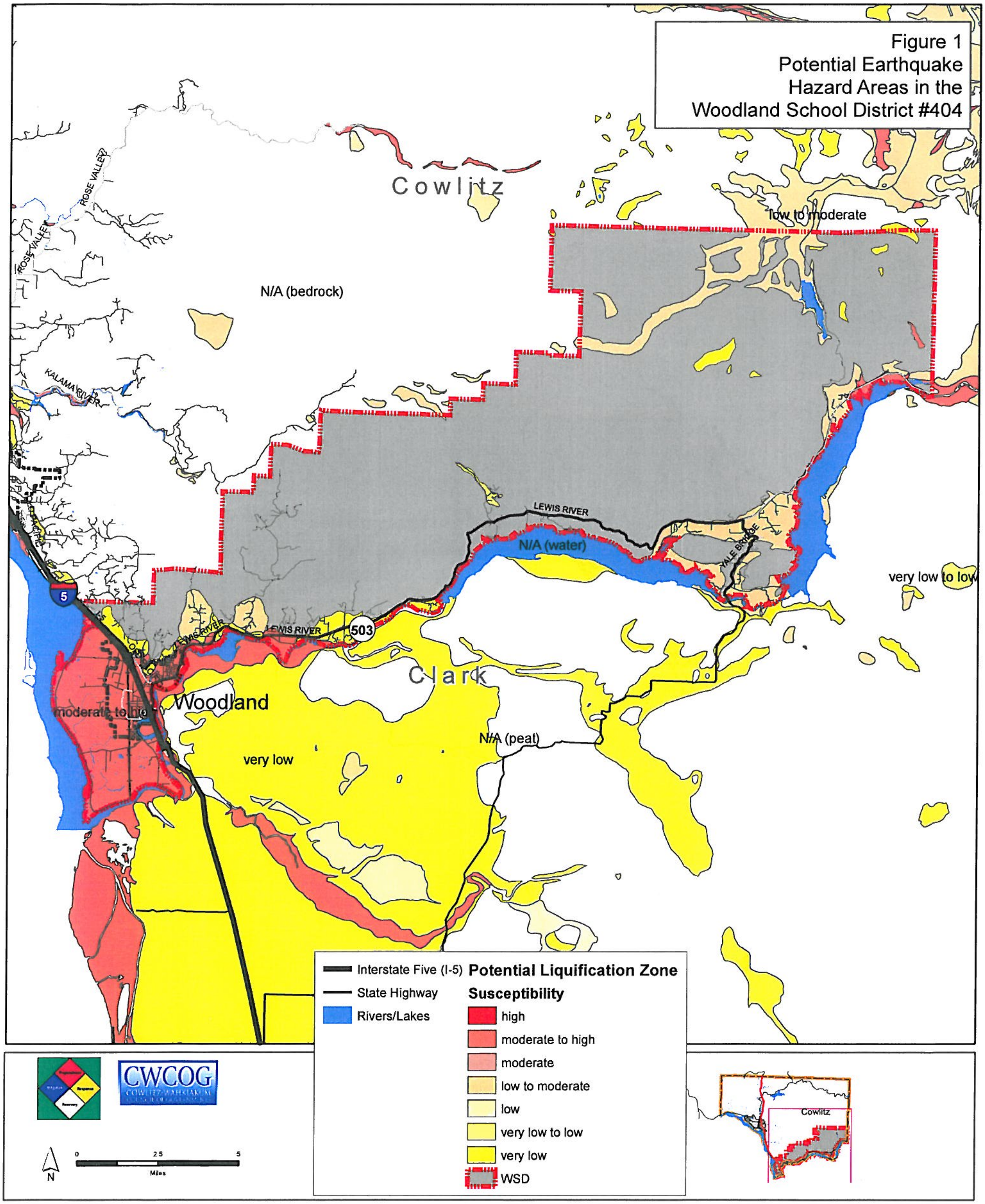


Figure 1
Potential Earthquake
Hazard Areas in the
Woodland School District #404
Cowlitz
Clark
N/A (bedrock)
low to moderate
very low to low
N/A (water)
LEWIS RIVER
YALE BRIDGE
ROSE VALLEY
KALAMA RIVER
5
503
Woodland
moderate to high
very low
N/A (peat)
Interstate Five (I-5)
State Highway
Rivers/Lakes
Potential Liquification Zone
Susceptibility
high
moderate to high
moderate
low to moderate
low
very low to low
very low
WSD
CWCOG
0
2.5
5
Miles
N

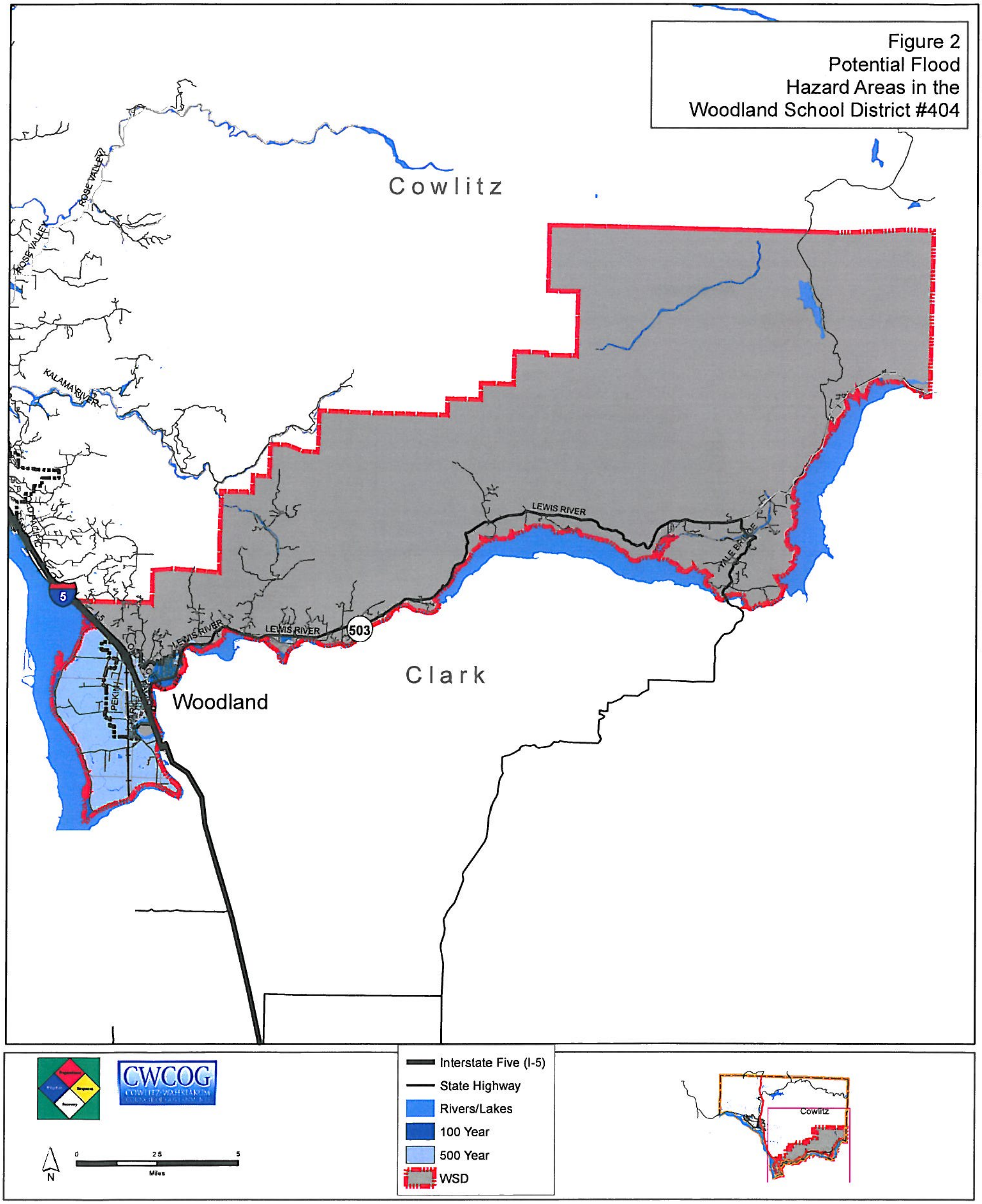


Figure 2
Potential Flood
Hazard Areas in the
Woodland School District #404
Cowlitz
Clark
Woodland
LEWIS RIVER
KALAMA RIVER
ROSE VALLEY
503
5
CWCOG
Interstate Five (I-5)
State Highway
Rivers/Lakes
100 Year
500 Year
WSD
N
Miles

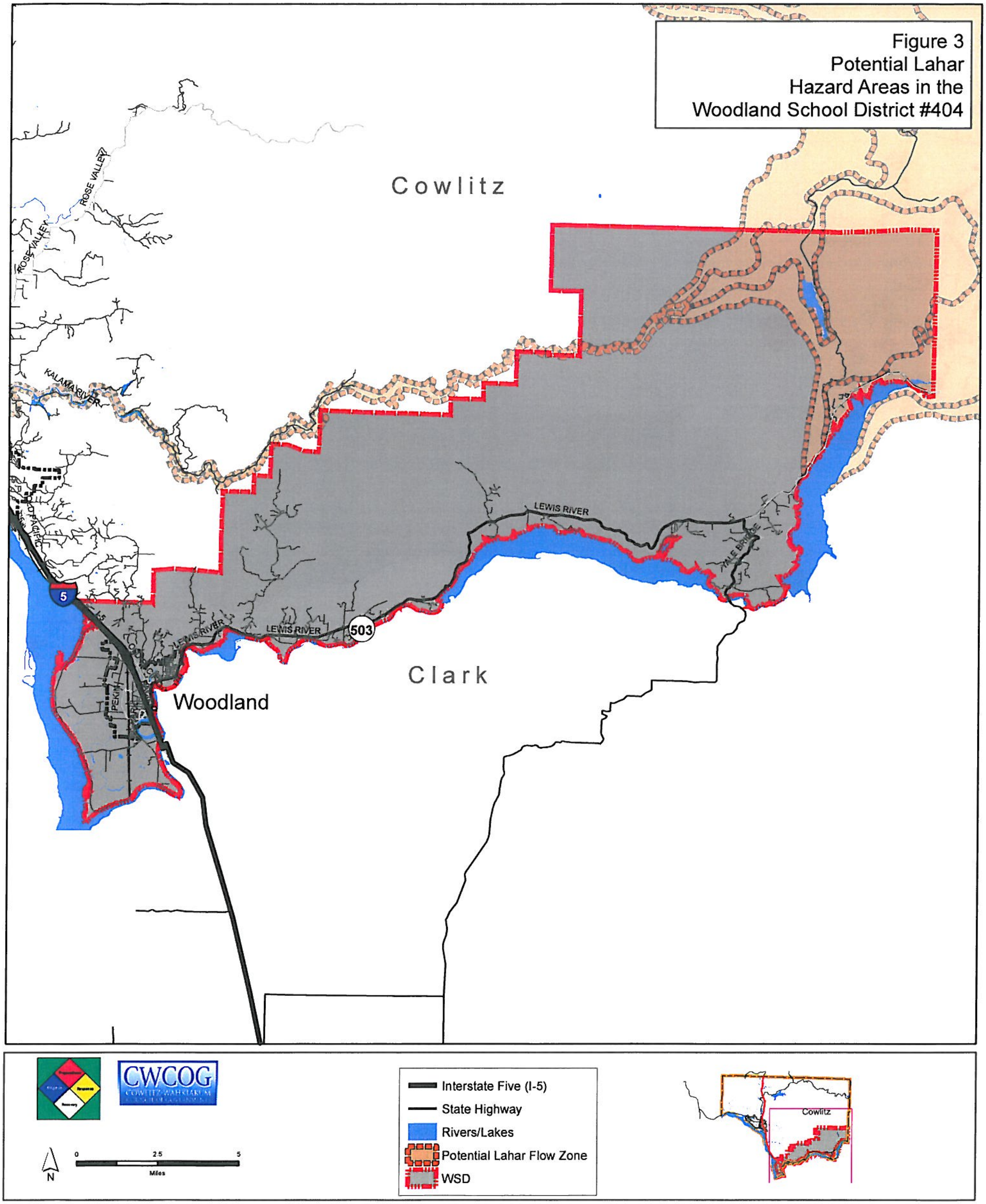


Figure 3
Potential Lahar
Hazard Areas in the
Woodland School District #404
Cowlitz
Clark
Woodland
ROSE VALLEY
KALAMA RIVER
LEWIS RIVER
503
5
YALE BRIDGE
PEKIN
CWCOG
Interstate Five (I-5)
State Highway
Rivers/Lakes
Potential Lahar Flow Zone
WSD
0
2.5
5
Miles
N

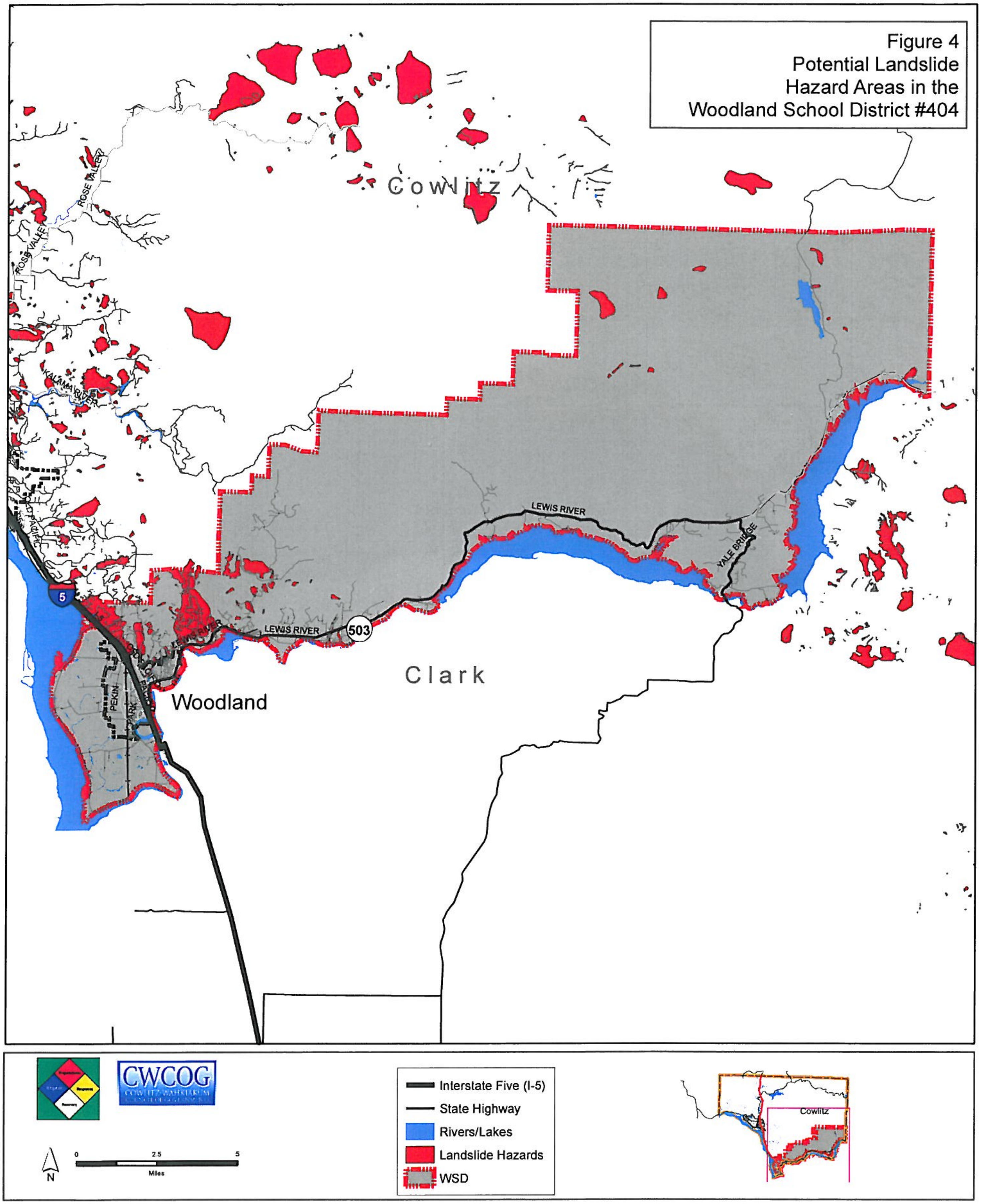


Figure 4
Potential Landslide
Hazard Areas in the
Woodland School District #404

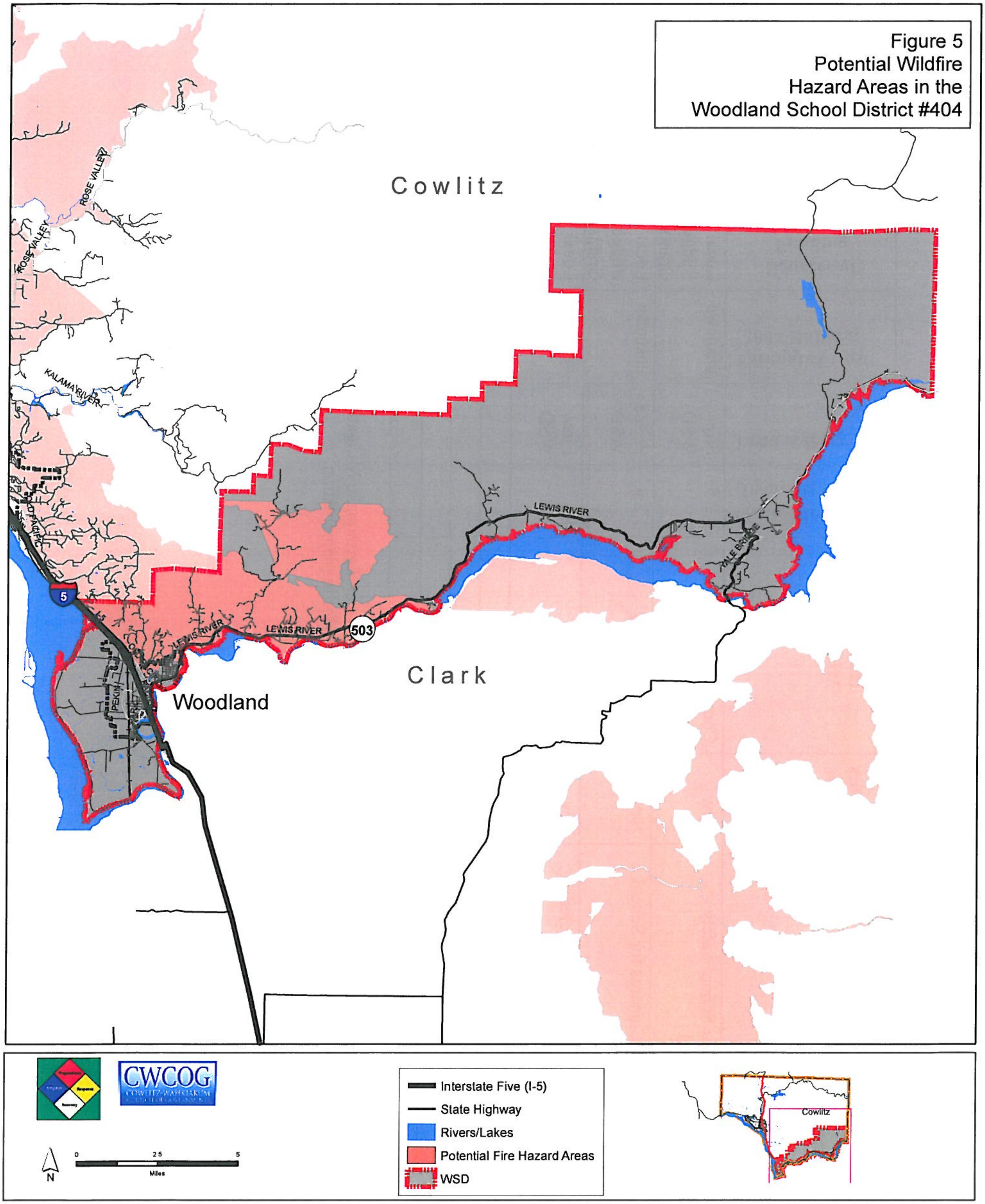


Figure 5
Potential Wildfire
Hazard Areas in the
Woodland School District #404
Cowlitz
Clark
Woodland
ROSE VALLEY
KALAMA RIVER
LEWIS RIVER
503
5
PEKIN
Interstate Five (I-5)
State Highway
Rivers/Lakes
Potential Fire Hazard Areas
WSD
CWCOG
0
2.5
5
Miles
N
Cowlitz

Initiative #	Mitigation Initiative	Applies to New or Existing Assets	Hazard(s) Mitigated	Goals Met (from list below)	Lead Agency	Estimated Cost (2004 Dollars)	Sources of Funding	Time-line
1	Radios for School Safety Personnel	New	Communications Problems	1,2,5	Fire/ WSD	unknown	Local Budgets/ Grants	unknown
2	Security Cameras for School Safety	New	Safety/Security/ Prevention	1,2,4	Police/ WSD	unknown	Local Budgets/ Grants	unknown
3	AED's for Schools (including training for staff)	New	Protect Life	1	Fire/ WSD	unknown	Local Budgets/ Grant	unknown

In the 2005 Woodland School District Hazard Mitigation Plan, an Earthquake Mitigation Program was cited as an initiative. This initiative was not completed due to a lack of available funds for implementation.

List of Goals

1) **Protect life:**
2) **Protect property:**
3) **Promote a Sustainable Economy:**
4) **Protect the Environment:**
5) **Increase Public Preparedness for Disasters:**

[I] University of Washington. 2002. Nisqually Quake Damaged Nearly 300,000 Puget Sound Households. Newswise.com, November 20, 2002. Online article. http://www.newswise.com/articles/view/?id=QUAKE2.UWA

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

3 Preliminary Damage Assessment for Declaration 1817. Federal Emergency management Agency (FEMA). January 2009

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

5 Thurston County Emergency Management. 2009. Supplemental Justification Report.

[vi] Tilling,Robert, I. et.al. 1990. Eruptions of Mount St. Helens: Past, Present, and Future, U.S. Geological Survey Special Interest Publication,

[vii] Ibid