HAZARD MITIGATION PLAN

WENATCHEE SCHOOL DISTRICT

DRAFT

Insert Date the Plan is Effective
(Date of Board Adoption After FEMA Approval)

Wenatchee School District
235 Sunset Avenue
Wenatchee, WA 98801

The 2017 Wenatchee School District's Hazard Mitigation Plan is a living document which will be reviewed and updated periodically.

Comments, suggestions, corrections, and additions are enthusiastically encouraged from all interested parties.

Please send comments and suggestions to:

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EXECUTIVE SUMMARY

The Wenatchee School District Hazard Mitigation Plan covers each of the major natural hazards that pose significant threats to the District.

The mission statement of the Wenatchee School District Hazard Mitigation Plan is to:

> Proactively facilitate and support district-wide policies, practices, and programs that make the Wenatchee School District more disaster resistant and disaster resilient.

Making the Wenatchee School District more disaster resistant and disaster resilient means taking proactive steps and actions to protect life safety, reduce property damage, minimize economic losses and disruption, and shorten the recovery period from future disasters. This plan is an educational and planning document that is intended to raise awareness and understanding of the potential impacts of natural hazard disasters and to help the District deal with natural hazards in a pragmatic and cost-effective manner.

Completely eliminating the risk of future disasters in the Wenatchee School District is neither technologically possible nor economically feasible. However, substantially reducing the negative consequences of future disasters is achievable with the implementation of a pragmatic Hazard Mitigation Plan.

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Mitigation simply means actions that reduce the potential for negative consequences from future disasters. That is, mitigation actions reduce future damages, losses, and casualties. Effective mitigation planning will help the Wenatchee School District deal with natural hazards realistically and rationally. That is, to identify where the level of risk from one or more hazards may be unacceptably high and then to find cost effective ways to reduce such risk. Mitigation planning strikes a pragmatic middle ground between unwisely ignoring the potential for major hazard events on one hand and unnecessarily overreacting to the potential for disasters on the other hand.

This mitigation plan focuses on the hazards that pose the greatest threats to the district's facilities and people: Earthquakes, Floods and Wildland/Urban Interface Fires. Other natural hazards that pose lesser threats are addressed briefly.

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1.0 INTRODUCTION

1.1 What is a Hazard Mitigation Plan?

The Wenatchee School District Hazard Mitigation Plan covers each of the major natural hazards that pose significant threats to the district.

The effects of potential future disaster events on the Wenatchee School District may be minor, a few inches of water in a street, or may be major, with widespread damages, deaths and injuries, and economic losses reaching millions of dollars. The effects of major disasters on a district and on the communities served by a district can be devastating: the total damages, economic losses, casualties, disruption, hardships, and suffering are often far greater than the physical damages alone.

The mission statement of the Wenatchee School District Hazard Mitigation Plan is to:

> Proactively facilitate and support district-wide policies, practices, and programs that make the Wenatchee School District more disaster resistant and disaster resilient.

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Making the Wenatchee School District more disaster resistant and disaster resilient means taking proactive steps and actions to protect life safety, reduce property damage, minimize economic losses and disruption, and shorten the recovery period from future disasters.

This plan is an educational and planning document that is intended to raise awareness and understanding of the potential impacts of natural hazard disasters and to help the district deal with natural hazards in a pragmatic and cost-effective manner. It is important to recognize that the Hazard Mitigation Plan is not a regulatory document and does not change existing district policies or zoning, building codes, or other ordinances that apply to the district.

Completely eliminating the risk of future disasters in the Wenatchee School District is neither technologically possible nor economically feasible. However, substantially reducing the negative consequences of future disasters is achievable with the implementation of a pragmatic Hazard Mitigation Plan.

Mitigation simply means actions that reduce the potential for negative consequences from future disasters. That is, mitigation actions reduce future damages, losses, and casualties.

The Wenatchee School District mitigation plan has several key elements:

1. Each hazard that may significantly affect the Wenatchee School District's facilities is reviewed to estimate the probability (frequency) and severity of likely hazard events.

2. The vulnerability of Wenatchee School District to each hazard is evaluated to determine the likely severity of physical damages, casualties, and economic consequences.

3. A range of mitigation actions are evaluated to identify those with the greatest potential to reduce future damages and losses to the Wenatchee School District and are desirable from the community's political and economic perspectives.

1.2 Why is Mitigation Planning Important for the Wenatchee School District?

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

Furthermore, the Federal Emergency Management Agency (FEMA) now requires each local government entity to adopt a multi-hazard mitigation plan to remain eligible for future pre- or post-disaster FEMA mitigation funding. Thus, an important objective in developing this plan is to maintain eligibility for FEMA funding and to enhance the Wenatchee School District's ability to attract future FEMA mitigation funding.

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Further information about FEMA mitigation grant programs is given in Appendix A: FEMA Mitigation Grant Programs.

1.3 The Wenatchee School District Hazard Mitigation Plan

This Wenatchee School District Hazard Mitigation Plan is built upon a quantitative assessment of each of the major hazards that may significantly affect the Wenatchee School District, including their frequency, severity, and the campuses most likely to be affected. This assessment draws heavily on statewide data collected for the development of the Washington State K–12 Facilities Hazard Mitigation Plan and on additional district-specific data.

These reviews of the hazards and the vulnerability of Wenatchee School District to these hazards are the foundation of the District's mitigation plan. From these assessments, the greatest threats to the District's facilities are identified. These high risk situations then become priorities for future mitigation actions to reduce the negative consequences of future disasters affecting the Wenatchee School District.

The Wenatchee School District Hazard Mitigation Plan deals with hazards realistically and rationally and also strikes a balance between suggested physical mitigation actions to eliminate or reduce the negative consequences of future disasters and planning measures which better prepare the community to respond to, and recover from,

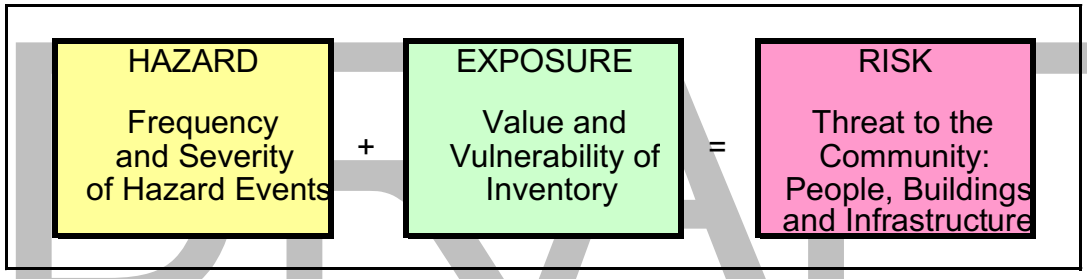
disasters for which physical mitigation actions are not possible or not economically feasible.

1.4 Key Concepts and Definitions

The central concept of mitigation planning is that mitigation reduces risk. **Risk** is defined as the threat to people and the built environment posed by the hazards being considered. That is, risk is the potential for damages, losses, and casualties arising from the impact of hazards on the built environment. The essence of mitigation planning is to identify facilities in the Wenatchee School District that are at high risk from one or more natural hazards and to evaluate ways to mitigate (reduce) the effects of future disasters on these high risk facilities.

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

Figure 1.1
Hazard and Exposure Combine to Produce Risk



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

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

HAZARD refers to natural events that may cause damages, losses, or casualties, such as earthquakes, tsunamis, and floods. Hazards are characterized by their frequency and severity and by the geographic area affected. Each hazard is characterized differently, with appropriate parameters for the specific hazard. For example, earthquakes are characterized by the probable severity and duration of ground motions while tsunamis are characterized by the areas inundated and by the depth and velocity of the tsunami inundations.

A hazard event, by itself, may not result in any negative effects on a community. For example, a flood-prone five-acre parcel may typically experience several shallow floods per year, with several feet of water expected in a 50-year flood event. However, if the parcel is wetlands, with no structures or infrastructure, then there is no risk. That is, there is no threat to people or the built environment and the frequent flooding of this parcel does not have any negative effects on the community. Indeed, in this case, the

very frequent flooding (the high hazard) may be beneficial environmentally by providing wildlife habitat, recreational opportunities, and so on.

Figure 1.2
Hazard Alone Does Not Produce Risk

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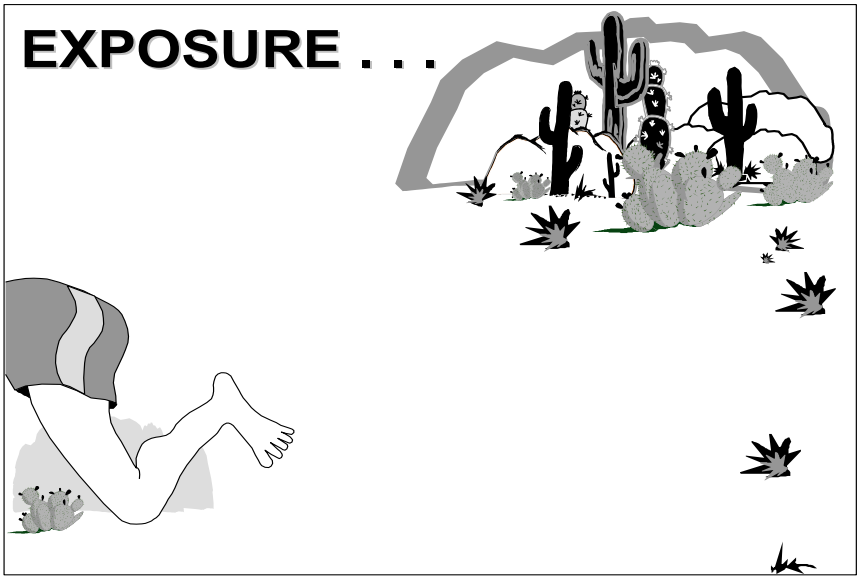
The important point is that hazards do not necessarily produce risk to people and property unless there is vulnerable inventory exposed to the hazard. Risk to people, buildings, or infrastructure results only when hazards are combined with an exposure to the hazard.

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

For the Wenatchee School District, the built-environment inventory of concern is largely limited to the district's facilities. For planning purposes, schools are often considered critical facilities because they may be used as emergency shelters for the community after disasters and because communities often place a very high priority on providing life safety for children in schools.

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

Figure 1.3
Exposure (Quantity, Value and Vulnerability of Inventory)



RISK is the threat to people and the built environment - the potential for damages, losses, and casualties arising from hazards. Risk results only from the combination of Hazard and Exposure as discussed above and as illustrated schematically in Figure 1.4 on the following page.

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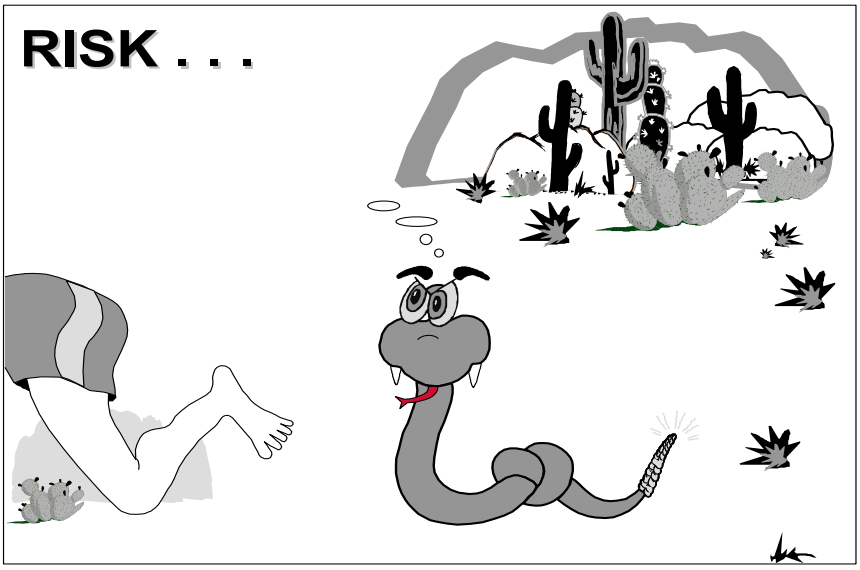
Figure 1.4
Risk Results from the Combination of Hazard and Exposure



Risk is the potential for future damages, losses, or casualties. A disaster event happens when a hazard event is combined with vulnerable inventory (that is, when a hazard event strikes vulnerable inventory exposed to the hazard). The highest risk in a

community occurs in high hazard areas (frequent and/or severe hazard events) with large inventories of vulnerable buildings or infrastructure.

However, high risk can also occur with only moderately high hazard if there is a large inventory of highly vulnerable inventory exposed to the hazard. Conversely, a high hazard area can have relatively low risk if the inventory is resistant to damages (such as strengthened to minimize earthquake damages).

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

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

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Table 1.1
Examples of Mitigation Projects

Hazard	Common Mitigation Projects
Earthquake	Structural retrofits for buildings
	Nonstructural retrofits for building elements and contents
	Replace existing building with new, current-code building
Tsunami	Enhance evacuation planning, including practice drills
	Build structure for vertical evacuation
Volcanic Hazards	Enhance evacuation planning, including practice drills
Floods	Flood barriers and other floodproofing measures
	Elevate at risk buildings
	Abandon campus at high risk (possible FEMA buyout) and build new campus outside of floodplain
Wildland/Urban Interface Fires	Enhance defensible space around buildings
	Fuel reduction measures near campus
	Improve fire resistance of existing buildings with non-flammable roofs and exterior finishes and other fire-safe measures
Landslides	Stabilize slopes with improved drainage and/or retaining walls.
Multi-Hazard	Replace vulnerable facility with new current-code facility, outside of high hazard zones when possible
	Obtain insurance to cover some damage/losses
	Enhance emergency planning, including drills
	Expand education/outreach to improve community understanding of natural hazards

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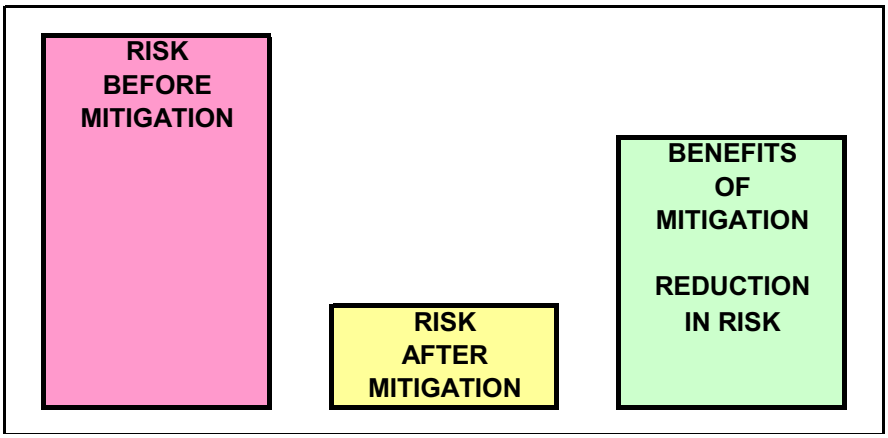
The mitigation project listed above is not comprehensive; mitigation projects can encompass many other actions to reduce future damages, losses, and casualties.

1.5 The Mitigation Process

The key element for all hazard mitigation projects is that they reduce risk. The benefits of a mitigation project are the reductions in risk (i.e., the avoided damages, losses, and casualties attributable to the mitigation project). Benefits are the difference in expected damages, losses, and casualties before mitigation (as-is conditions) and after mitigation. These important concepts are illustrated in Figure 1.5.

Figure 1.5
Mitigation Projects Reduce Risk



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

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

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

The overall mitigation planning process is outlined in Figure 1.6 on the following page, which shows the major steps in hazard mitigation planning and implementation for the Wenatchee School District.

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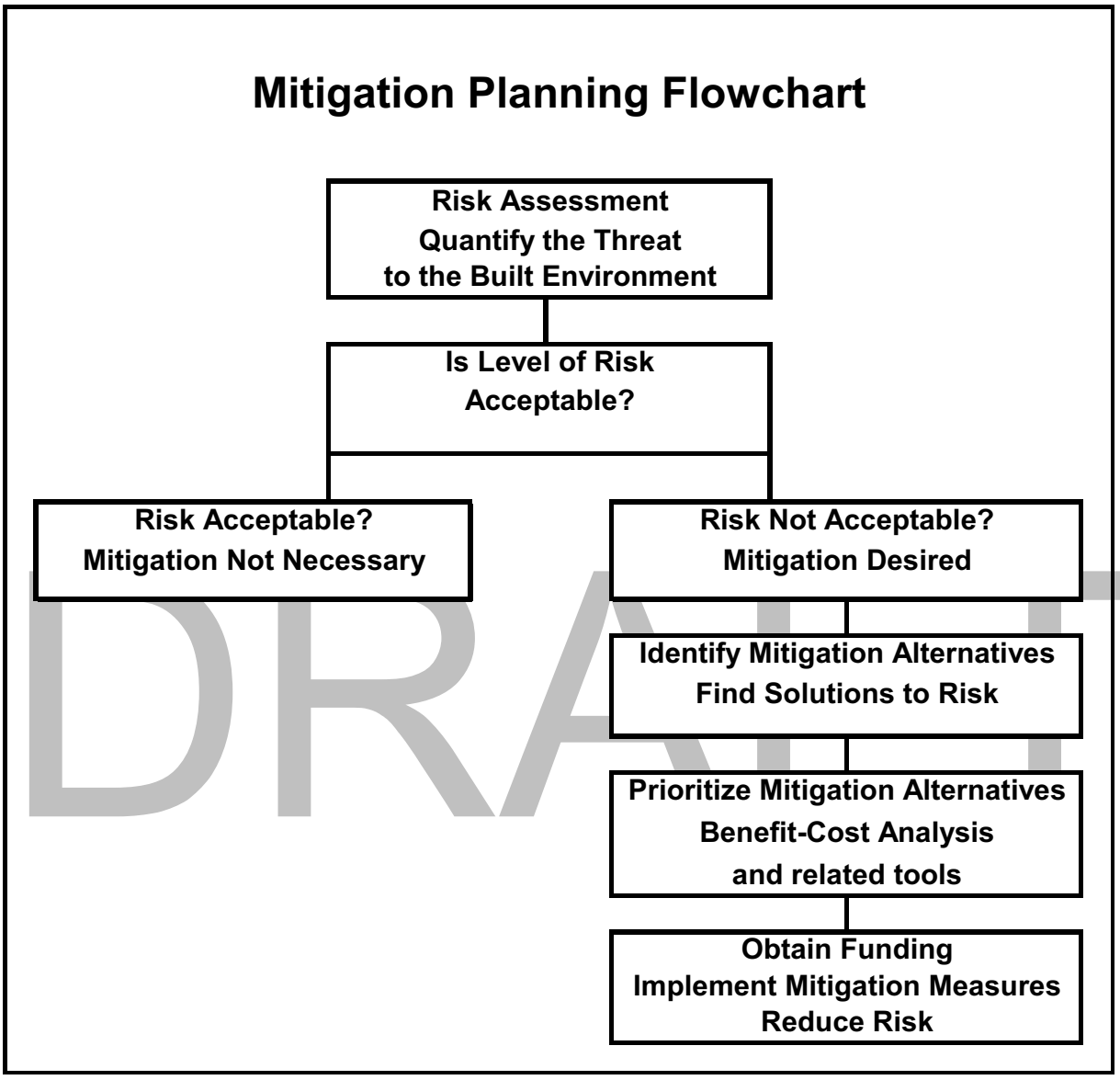
Figure 1.6
The Mitigation Planning Process



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The first steps are quantitative evaluation of the hazards (frequency and severity) affecting the Wenatchee School District and of the inventory (people and facilities) exposed to these hazards. Together, these hazard and exposure data determine the level of risk for specific locations, buildings, or facilities in the Wenatchee School District.

The next key step is to determine whether or not the level of risk posed by each of the hazards affecting the Wenatchee School District is acceptable or tolerable. If the level of risk is deemed acceptable or at least tolerable, then mitigation actions are not necessary or at least not a high priority. There is no absolute universal definition of the

level of risk that is tolerable or not tolerable. Each district has to make its own determination.

If the level of risk is deemed not acceptable or tolerable, then mitigation actions are desired. In this case, the mitigation planning process moves on to more detailed evaluation of specific mitigation alternatives, prioritization, funding, and implementation of mitigation actions. As with the determination of whether or not the level of risk posed by each hazard is acceptable or not, decisions about which mitigation projects should be undertaken can only be made by the Wenatchee School District.

1.6 The Role of Benefit-Cost Analysis in Mitigation Planning

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

What is the nature of the hazard problem?

How frequent and how severe are hazard events?

Do we want to undertake mitigation actions?

What mitigation actions are feasible, appropriate, and affordable?

How do we prioritize between competing mitigation projects?

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

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

Further details about benefit-cost analysis are given in Appendix B: Principles of Benefit-Cost Analysis.

1.7 Hazard Synopsis

The following figure illustrates the relative level of hazard for the six major hazards at each of the district's campuses. These hazard levels are based on statewide GIS data and additional district-specific data entered into OSPI's ICOS PDM database.

Figure 1.7
Wenatchee School District: Major Hazards Matrix

STATE OF WASHINGTON
SUPERINTENDENT OF PUBLIC INSTRUCTION
DISTRICT PDM HAZARD SUMMARY

Wenatchee	Earthquake	Tsunami	Volcanic	Flood	WUI	Landslide
Abraham Lincoln Elementary	Moderate	None**	None**	Low	High	None**
Columbia Elementary	Moderate	None**	None**	Low	High	None**
Foothills Middle	Moderate	None**	None**	Low	High	None**
John Newbery Elementary	Moderate	None**	None**	Moderate	High	None**
Lewis and Clark Elementary	Moderate	None**	None**	Low	High	None**
Mission View Elementary	Moderate	None**	None**	Low	High	None**
Orchard Middle	Moderate	None**	None**	Low	High	None**
Pioneer Middle	Moderate	None**	None**	Moderate	High	None**
Special Education	Moderate	None**	None**	Low	High	None**
Sunnyslope Elementary	Moderate	None**	None**	Low	Very High	None**
Valley Academy Of Learning	Moderate to High	None**	None**	Moderate	High	None**
Washington Elementary (old)	Moderate	None**	None**	Moderate	High	None**
Wenatchee High	Moderate	None**	None**	Low	High	None**
Wenatchee Valley Technical Skills Center	Moderate	None**	None**	Low	High	None**
WestSide Alternative High	Moderate	None**	None**	Moderate	High	None**

**"None" means that the risk to facilities and people is nil or minima.

This table has been updated with non–ICOS data and has been edited from what is in ICOS.

All of the district's campuses have an earthquake hazard. Campuses modernized in the last ten years possess low to moderate risks and schools with higher risk are on schedule to be modernized in the next two to four years.

"Modernization" doesn't necessarily mean seismic retrofits – often modernization often just means updates to mechanical, electrical, plumbing systems, windows, energy efficiency etc. not structural or nonstructural seismic retrofits.

Sunnyslope Elementary, Valley Academy of Learning, and Wenatchee Valley Technical Skills Center have low to moderate flood risk.

Eight of the district's campuses are identified as having high wildland/urban interface fire risk. This preliminary assessment is based on statewide mapping of wildland/urban interface fire hazards and may or may not accurately reflect the level of fire risk. See the Wildland/Urban interface fire chapter for further details.

The Wenatchee District is not subject to volcanic hazards, except possibly for minor volcanic ash falls, because none of the campuses are in, or near, any of the mapped volcanic hazard zones for any of the active volcanoes in Washington state.

The Wenatchee District is not subject to tsunamis because the district is located many miles from the coast and at elevations far above any possible tsunami events.

The Wenatchee District is not subject to landslides. Wenatchee schools are not located within the hazard mapping and there is no risk for potential landslides.

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Chapter 6: Earthquakes

Chapter 7: Floods

Chapter 8: Wildland/Urban Interface Fires

Chapter 9: Other Natural Hazards

2.0 WENATCHEE SCHOOL DISTRICT PROFILE

2.1 District Location

The Wenatchee School District is located in Wenatchee, a city located in north-central Washington and is the largest city and county seat of Chelan County.

The population estimate for 2016 is 33,070 based on Office of Financial Management.

The Wenatchee School District student population is approximately 7,908[1].

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Figure 2.1
Wenatchee School District Map

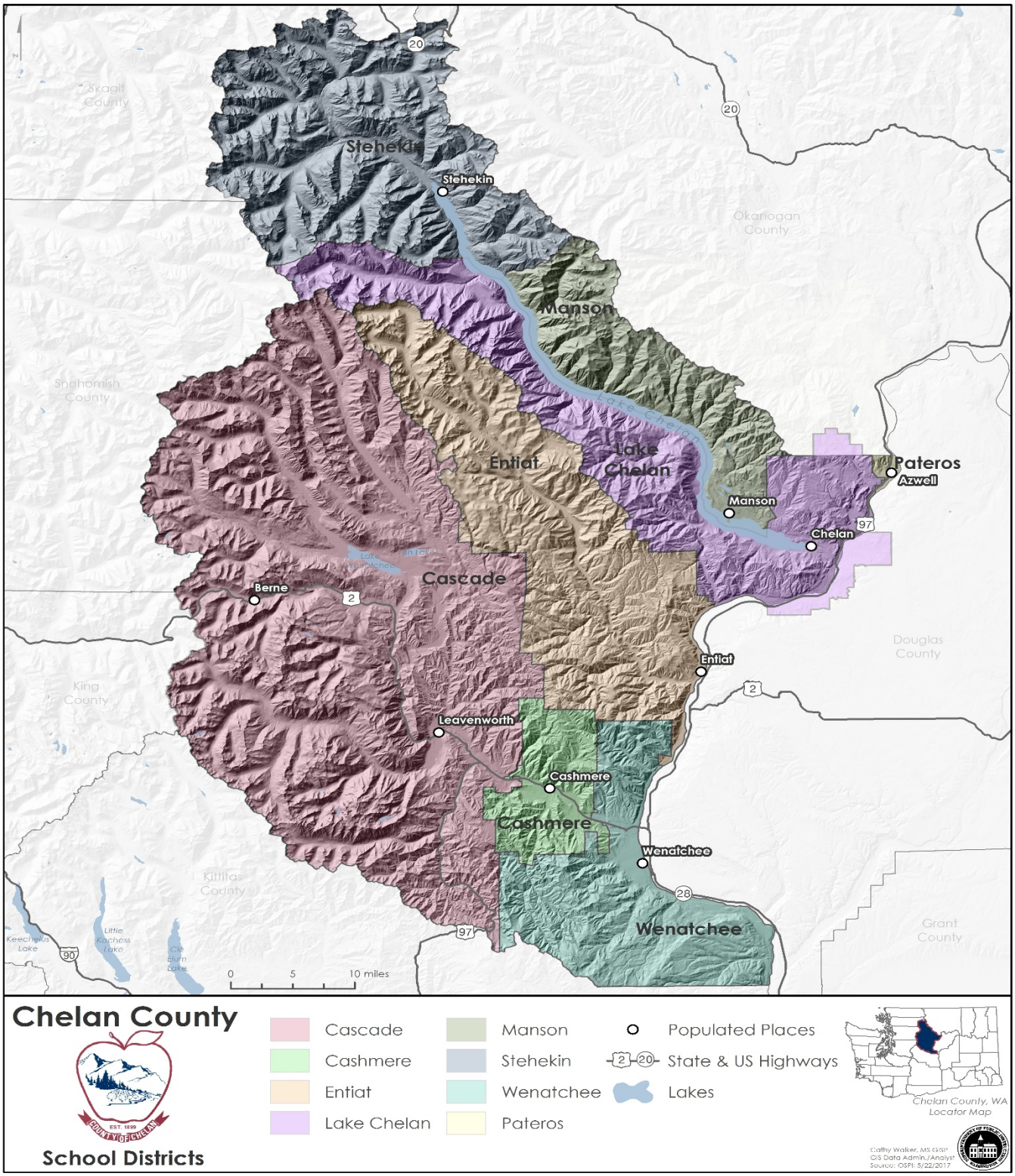
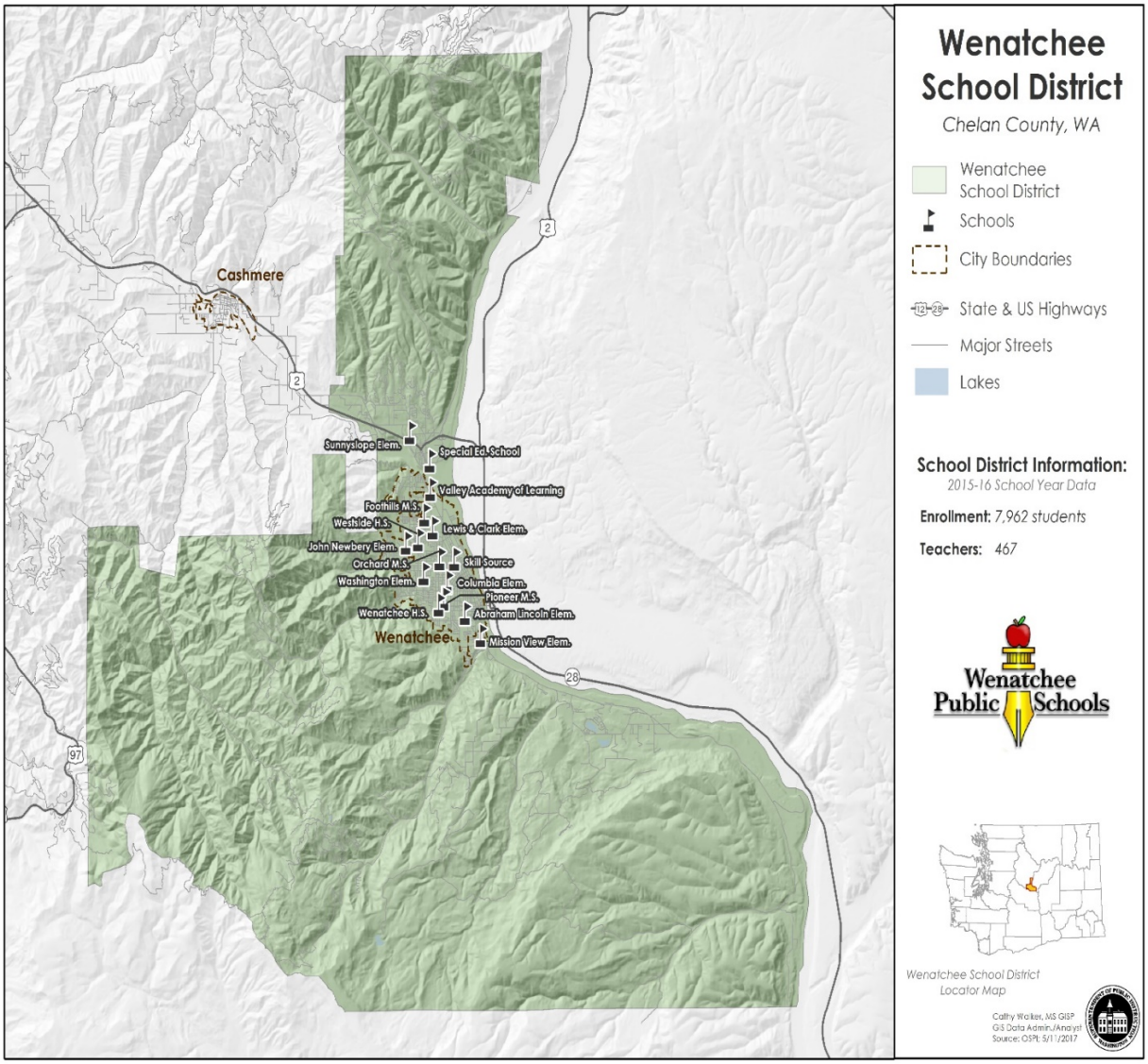


Figure 2.2
Wenatchee School District and Vicinity



2.2 District Overview

The Wenatchee School District is committed and designed to provide a comprehensive instructional program from kindergarten through the completion of high school. Student learning is accomplished through a quality educational system by dedicated, caring staff working in partnership with students, parents, and the community.

Our mission is to:

- *Personally know and encourage students as individual learners and recognize their academic, citizenship and co-curricular accomplishments;*

- *Assist students to learn and apply essential skills and values to be contributing community citizens with a global perspective;*

- *Challenge students to continually stretch and grow while working with family and community as active partners.*

The Wenatchee School District has seven elementary schools, three middle schools, an alternative high school, a 4A high school, and a skills center. The total number of students is approximately 7,900; we have 540 teachers. The Wenatchee School District has a large minority student population: 39 percent are Hispanic, 1.3 percent Asian, and 0.6 percent African American. Our district strives to employ exceptional educators to serve our diverse student population.

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Wenatchee educators are focused on aligning with the state goals. We are committed to having our students meet standards in reading, writing, and communication--a responsibility which belongs to ALL of us, regardless of grade level, subject area, or students' special needs.

Emphasis on high expectations and academic achievement, partnership with parents to achieve educational goals, respect for students' cultural and linguistic backgrounds, and opportunities and resources for staff professional development are characteristics of the Wenatchee School District. All clearly support the educational success of the students served.

Table 2.1
Student Count Data1
Wenatchee School District

October 2016 Headcount for Wenatchee SD																
		Grade														
School #	School Name	KF	KH	1	2	3	4	5	6	7	8	9	10	11	12	Total
3209	Abraham Lincoln Elementary	76	-	85	85	89	88	78	-	-	-	-	-	-	-	501
2301	Columbia Elementary School	60	-	80	84	76	64	82	-	-	-	-	-	-	-	446
4423	John Newbery Elementary	72	-	82	78	92	92	101	-	-	-	-	-	-	-	517
2279	Lewis And Clark Elementary Sch	82	-	91	84	86	71	71	-	-	-	-	-	-	-	485
2347	Mission View Elementary School	100	-	106	87	74	76	98	-	-	-	-	-	-	-	541
3208	Sunnyslope Elementary School	40	-	43	50	54	53	61	-	-	-	-	-	-	-	301
2907	Washington Elementary School	91	-	90	92	98	95	107	-	-	-	-	-	-	-	573
1742	Valley Academy Of Learning	-	26	18	20	27	21	18	21	9	10	7	8	-	-	185
4432	Foothills Middle School	-	-	-	-	-	-	-	183	219	185	-	-	-	-	587
3370	Orchard Middle School	-	-	-	-	-	-	-	154	147	130	-	-	-	-	431
3210	Pioneer Middle School	-	-	-	-	-	-	-	208	209	218	-	-	-	-	635
1612	Skill Source	-	-	-	-	-	-	-	-	-	-	-	2	-	-	2
2134	Wenatchee High School	-	-	-	-	-	-	-	-	-	-	560	572	487	396	2,015
4105	Wenatchee Valley Technical Skills Center	-	-	-	-	-	-	-	-	-	-	-	2	40	54	96
1613	Westside High School	-	-	-	-	-	-	-	-	-	-	21	48	60	159	288
	TOTAL	521	26	595	580	596	560	616	566	584	543	588	632	587	609	7,603

Demographic data is often included in mitigation plans, especially in the context of evacuation planning and for communication, education, and outreach efforts. The data shown below is specific and solely for the City of Wenatchee. The following table shows Wenatchee School District numbers which are slightly higher than the city's language demographics.

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Table 2.2
Selected Demographic Data
City of Wenatchee

Population*	Number	Percent
Total	31,925	100.0%
Under 5 Years	2,502	7.8%
Under 18 Years	10,606	26.1%
18 to 64 Years	24,280	59.3
65 Year and Over	6,091	14.9
Language		
Language Other than English Spoken at Home**		24.6%
Spanish		23.2%
Other Indo-European Languages		.05%
Asian and Pacific Island Languages		.04%
Other Languages		.04%
*Source: U.S. Census Bureau, 2010 Census.		
**Source: U.S. Census Bureau, 2008-2012 American Community Survey		

Based on the district's student information system the district has approximately 4,800 families. The home language spoken at home is listed in Table 2.3

Table 2.3
Language Spoken at Home[2]
Wenatchee School District

Language	Number	Percentage
English	3085	64.2%
Spanish	1683	35%
Other Indo-European Languages	22	.4%
Asian and Pacific Island Languages	9	.2%
Other Languages	9	.2%

2.3 District Facilities

The Wenatchee School District has fifteen (15) campuses and several other facilities including a district office building, maintenance and operations building, a Special Education Transition House, Westside Early Learning Center and 9th Street Preschool.

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[1] Skyward, WSD Student Information System: October 2014 count day

[2] U.S. Census Bureau 2000

Table 2.4
District Facilities

Wenatchee Pre-Disaster Mitigation Summary						
Campus/ Building	Building Condition	Floors	Building Area	Built	SqFt	Structural Sys
Abraham Lincoln Elementary School						
New School – Main Building	100.00% Excellent	1	100-Wing	2016	82,232	RM1L, FLT
Columbia Elementary School						
Main Building	65.45% Fair	1	Area 1	1989	48,509	FLT
Portable B-03-2-08	62.00% Fair	1	Area 1	2003	1,792	MH
Portable B-06-2-03	63.36% Fair	1	Area 1	2006	1,792	MH
Foothills Middle School						
Main Building	82.79% Fair	1	Area 1	1993	84,854	S1L
Portable M-97-2-17	81.89% Fair	1	M-97-2-17	1997	1,792	MH
John Newbery Elementary School						
Main Building	81.28% Fair	1	Area 1	1993	48,620	FLT
Newbery Main Building	62.45% Fair	1	Main Area	1992	1	
Newbery Sprung Structure						84.65% F
Portable B-05-2-12	-	1	Main Area	2005	1	
Portable B-05-21-2						90.00% G
Portable B-06-2-11	90.00% Good	1	Area 1	2006	1,792	MH
			Main Area	2006	1	

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Wenatchee Pre-Disaster Mitigation Summary - District Facilities						
Campus/ Building	Building Condition	Floors	Building Area	Built	SqFt	Structural Sys
Lewis and Clark Elementary School						
Main Building	57.67% Poor	1	Area 1	1989	48,509	FLT
Portable B-08-2-14	70.78% Fair	1	Area 1	2008	1,792	MH
Portable B-08-2-15	71.32% Fair	1	Area 1	2008	1,792	MH
Mission View Elementary School						
300 Wing 1971	60.60% Poor	1	Area 1	1971	13,022	W1
Main Building	55.10% Poor	1	Area 1	1989	38,168	FLT
Portable B-08-2-01	62.00% Fair	1	Area 1	2008	1,792	MH
Portable M-97-2-02	60.68% Poor	1	Area 1	1997	1,792	MH
Orchard Middle School						
2003 Addition	90.00% Good	1	Area 1	2003	6,601	RM1L
Main Building	89.59% Good	1	Area 1	1962	72,396	C3L
Orchard Main Building	67.08% Fair	1	Main Area	1956	1	
Pioneer Middle School						
04 Addition	91.57% Good	1	Area 1	2004	2,524	FLT
62 Addition	91.14% Good	1	Area 1	1962	3,551	
			Area 2	1962	16,352	C1L
Gymnasium	60.34% Poor	2	Area 1	1957	35,488	C1L
Main Building	91.90% Good	1	Area 1	1957	54,715	PC2L
Portable B-12-2-20	96.93% Excellent	1	Area 1	2012	1,792	MH
Washington Annex (ECLC)						
	100.00% Excellent	1	Area 1	2016	18,973	FLT
Sunnyslope Elementary School						
03 Addition	90.29% Good	1	Area 1	2003	20,290	W1
Main Building	85.80% Good	1	Area 1	1958	21,127	RM1L
Valley Academy Of Learning						
Main Building	62.66% Fair	1	Area 1	1985	17,500	S3
Washington Elementary School						
Main Building	100.00% Excellent	1	Area 1	2016	73,265	RM1L, S2L

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Wenatchee Pre-Disaster Mitigation Summary - District Facilities							
Campus/ Building	Building Condition	Floors	Building Area	Built	SqFt	Structural Sys	
New Main Level	100.00% Excellent	2	Area Main New	2016	1		
Wenatchee High School							
04 Addition							60.79% P
East Building	51.26% Poor	1	Area 1	1972	243,133	RM1L	
West Building	75.25% Fair	1	Area 1	1993	26,135	RM1L	
Portable B-12-2-20	78.67% Fair	1	Area 1	2012	1,792	MH	
Portable B-13-2-22	-	1	Area 1	2013	1,800		
Portable M-06-2-21	80.82% Fair	1	Area 1	2006	1,792	MH	
Portable xx (Science)	100% Excellent	1	Science Classroom	2015	1,792		
Portable B-97-1-10	62.00% Fair	1	Area 1	1997	896	MH	
Portable E-01-1-09	62.00% Fair	1	Area 1	2001	892	MH	
Portable M-99-2-18	57.21% Poor	1	Area 1	1999	1,792	MH	
WestSide Alternative High School							
Fitness Building							89.51% G
Main Building	96.66% Excellent	1	Main	1985	18,300	RM1L	
PE Building	83.34% Fair	1	Main Area	1990	1		
Portable B-04-2-04	89.76% Good	1	Area 1	2004	1,792	MH	
Portable B-04-2-16	90.00% Good	1	Area 1	2004	1,792	MH	
Portable B-04-2-15	-	1	-	2004	1,792	MH	
Portable B-05-2-07	62.00% Fair	1	Area 1	2005	1,792	MH	
Portable B-08-2-05	76.32% Fair	1	Area 1	2008	1,792	MH	
Portable B-05-2-06	62.00% Fair	1	Area 1	2006	1,792	MH	
Wenatchee Valley Technical Skills Center							
Building A							75.34% Fa
Building B	88.47% Good	1	Area 1	1995	34,911	C3L	
Building C	100.00% Excellent	1	Area 1	2015	10,312		

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3.0 MITIGATION PLANNING PROCESS

3.1 Overview

The Wenatchee School District's mitigation planning process began in September 2014. The District's mitigation plan is consistent with, and draws extensively from, the Washington State K–12 Facilities Hazard Mitigation Plan. However, the Wenatchee School District's Hazard Mitigation Plan has an in-depth focus on the District, its facilities, and its people and includes more district-specific content, including district-specific hazard and risk assessments and mitigation priorities.

3.2 Mitigation Planning Team

The mitigation planning team was led by: Bryan Visscher, Director of Facilities and Risk Management. The planning team included the following members:

- Greg Thompson, WSD Director of Maintenance & Operations
- Adam Bergstrom, WSD Director of Security & Risk Management
- Gregg Herkenrath, WSD Director of Facilities and Capital Projects

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The mitigation planning team's roles and responsibilities were defined as follows:

- Participate actively in planning team meetings,
- Provide local perspectives re: natural hazards and the threats that they pose to the District's facilities and people.
- Help to identify existing plans, studies, reports, and technical information for inclusion or reference in the mitigation plan.
- Forge consensus on mitigation action items and their priorities.
- Help to facilitate the public outreach actions during the mitigation planning process, and
- Provide review comments on draft materials during development of the Wenatchee School District Hazard Mitigation Plan.

3.3 Mitigation Planning Team Meetings

Mitigation planning team meetings are documented below with dates and brief summaries. Meeting agendas, attendees, and minutes for the planning team meetings are provided as an Appendix at the end of this chapter.

1st Meeting: November 18, 2014 Mitigation Planning Kick-Off Meeting

Present:

- Wenatchee District Staff: Bryan Visscher, Greg Thompson, Adam Bergstrom, Maria Iniguez

- Other: Robert Dengel, Program Development Manager (OSPI), Kenneth Goettel, Consultant (Goettel & Associates Inc.)

November 18, 2014
Meeting Minutes

Present: Bryan Visscher, Adam Bergstrom, Greg Thompson, Maria Iniguez, Robert Dengel & Kenneth Goettel

- What are the priorities? Bond projects could be used as action items. Include timetable.
- Next round of CIP will lower the risks.
- For the fire chapter make sure to work with the fire marshal.
- Hazards not applicable to district need to be addressed in Chapter 1 with the comment "considered but not applicable".
- Public Process: Getting the word out through newsletter, emails, PTSA, WenEA, website, etc.
- Need to do a press release to include the planning team, meeting dates and time and agenda.
- Put the plan online with a comment link. Surveys are not mandatory.
- Approval Process:
    - The final plan will need to go to the Washington Emergency Mitigation Plan – they will comment.
    - FEMA Region 10 – the staff will review
        - Check FEMA Checklist for final documents
    - Board Adoption – after approval from FEMA

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August 9th, 2017
Meeting Minutes

Present: Gregg Herkenrath, Adam Bergstrom

- How to incorporate plan into existing and future District generated plans and studies?
    - Include as Appendix in District's Emergency Response Plan.
- Compare plan to District Earthquake Procedures document.
- Reach out to local First Responders about the plan status and location.

3.4 Public Involvement in the Mitigation Planning Process

The District took robust efforts to involve the public and stakeholders throughout the mitigation planning process, including the following actions:

Notices

The District announced the initiation of the mitigation planning via:

- Posting a notice on the district's website,
- Incorporating the plan into the Wenatchee School District "Safe Schools Preparedness and Response Plan",
- Presenting plan to School Board and general public.

Public Meetings

Public meetings were announced via the modes listed above and held on the following dates:

- Meeting 1 date June 27, 2017 – Public School Board Meeting
    - Provided a brief description of plan and discussed the status of the draft completion.
- Meeting 2 date September 26, 2017 – Public School Board Meeting
    - Presented the draft Hazard Mitigation Plan to the School Board.
- Meeting 3 date October 10, 2017 – Public School Board Meeting
    - School Board approved the draft Hazard Mitigation Plan.

Meeting agendas, minutes, and summary of attendees for the public meetings are included in Appendix C.

Review and Comment on Mitigation Plan Drafts

Mitigation plan drafts were posted on the district's website for review. Notices of the district's requests for comments being solicited from all interested parties were made via the Wenatchee School District website.

Key inputs received during the review and comment periods included the following:

- No comments received as of October, 2017.

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3.5 Review and Incorporation of Existing Plans, Studies, Reports, and Technical Information.

The Wenatchee School District's Hazard Mitigation Plan drew heavily on the content of the Washington State K–12 Facilities Hazard Mitigation Plan and the Pre-Disaster Mitigation parts of the Office of Superintendent of Public Instruction's ICOS (Inventory and Condition of Schools) database. ICOS includes a comprehensive database of school facility information, including condition assessments, remodeling and modernization, and other data bearing on school facilities.

The Pre-Disaster Mitigation part of ICOS was invaluable in providing GIS data for campus locations and for automating the processing and interpretation of technical data relating to natural hazards and the risks that arise from these hazards to the district's facilities and people.

ICOS is an actively maintained database that will be periodically updated, including hazard and risk data. Thus, the strong linkage between ICOS and the district's mitigation planning will keep the mitigation plan "alive" and current and will be especially helpful during the 5-year updates.

The Wenatchee School Districts Pre-Disaster Mitigation Plan will be included as an appendix and incorporated into the Districts Safe Schools Preparedness and Response Plan.

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4.0 GOALS, OBJECTIVES, AND ACTION ITEMS

4.1 Overview

The purpose of the Wenatchee School District Hazard Mitigation Plan is to reduce the impacts of future natural disasters on the district's facilities, students, staff, and volunteers. That is, the purpose is to make the Wenatchee School District more disaster resistant and disaster resilient, by reducing the vulnerability to disasters and enhancing the capability to respond effectively to, and recover quickly from, future disasters.

Completely eliminating the risk of future disasters in the Wenatchee School District is neither technologically possible nor economically feasible. However, substantially reducing the negative impacts of future disasters is achievable with the adoption of this pragmatic Hazard Mitigation Plan and ongoing implementation of risk reducing action items. Incorporating risk reduction strategies and action items into the District's existing programs and decision making processes will facilitate moving the Wenatchee School District toward a safer and more disaster resistant future.

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

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Mission Statement. The Mission Statement states the purpose and defines the primary function of the Wenatchee School District Hazard Mitigation Plan. The Mission Statement is an action-oriented summary that answers the question, "Why develop a hazard mitigation plan?"

Goals. Goals identify priorities and specify how the Wenatchee School District intends to work toward reducing the risks from natural and human-caused hazards. The Goals represent the guiding principles toward which the district's efforts are directed. Goals provide focus for the more specific issues, recommendations, and actions addressed in Objectives and Action Items.

Objectives. Each goal has Objectives which specify the directions, methods, processes, or steps necessary to accomplish the Wenatchee School District Hazard Mitigation Plan's Goals. Objectives lead directly to specific Action Items.

Action Items. Action Items are specific, well-defined activities or projects that work to reduce risk. That is, the Action Items represent the specific, implementable steps necessary to achieve the District's Mission Statement, Goals, and Objectives.

4.2 Mission Statement

The mission statement for the Wenatchee School District Hazard Mitigation Plan is to: Proactively facilitate and support district-wide policies, practices, and programs that make the Wenatchee School District more disaster resistant and disaster resilient.

Making the Wenatchee School District more disaster resistant and disaster resilient means taking proactive steps and actions to:

- Protect life safety.
- Reduce damage to district facilities.
- Minimize economic losses and disruption.
- Shorten the recovery period from future disasters.

4.3 Mitigation Plan Goals and Objectives

The following Goals and Objectives serve as guideposts and checklists to begin the process of implementing mitigation Action Items to reduce identified risks to the District's facilities, students, staff, and volunteers from natural disasters.

The Goals and Objectives are consistent with those in the Washington State K–12 Facilities Hazard Mitigation Plan. However, the specific priorities, emphasis, and language in this mitigation plan are the Wenatchee School District's. These goals were developed with extensive input and priority setting by the Wenatchee District's hazard mitigation planning team, with inputs from district staff, volunteers, parents, students, and other stakeholders in the communities served by the district.

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Goal 1: Reduce Threats to Life Safety

Reducing threats to life safety is the highest priority for the Wenatchee School District.

Objectives:

A. Enhance life safety by retrofitting existing buildings or replacing them with new current-code buildings and by locating and designing new schools to minimize life safety risk from future disaster events.

B. Develop robust disaster evacuation plans and conduct frequent practice drills. When evacuation is impossible in the anticipated warning time, consider vertical evacuation for tsunamis, other physical measures to shorten evacuation time, such as pedestrian bridges over rivers, or relocate campuses with extreme life safety risk to locations outside of hazard zones when possible.

C. Enhance life safety by improving public awareness of earthquakes, tsunamis, volcanic events, and other natural hazards that pose substantial life safety risk to the district's facilities, students, staff, and volunteers.

Goal 2: Reduce Damage to District Facilities, Economic Losses, and Disruption of the District's Services

Objectives:

A. Retrofit or replace existing buildings with a high vulnerability to one or more natural hazards to reduce damage, economic loss, and disruption in future disaster events.

B. Ensure that new facilities are adequately designed for hazard events and located outside of mapped high hazard zones to minimize damage and loss of function in future disaster events, to the extent practicable.

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

Objectives:

A. Enhance collaboration and coordination between the district, local governments, utilities, businesses, and citizens to prepare for, and recover from, future natural disaster events.

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

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Goal 4: Increase Awareness and Understanding of Natural Hazards and Mitigation

Objectives:

A. Implement education and outreach efforts to increase awareness of natural hazards throughout the Wenatchee School District, including staff, parents, teachers, and the entire communities served by the district.

B. Maintain and publicize a natural hazards section in the high school library with FEMA and other publications and distribute FEMA and other brochures and other educational materials regarding natural hazards.

4.4 Wenatchee School District Hazard Mitigation Plan Action Items

Mitigation Action Items may include a wide range of measures such as: refinement of policies, studies, and data collection to better characterize hazards or risk, education, or outreach activities, enhanced emergency planning, partnership building activities, as well as retrofits to existing facilities or replacement of vulnerable facilities with new current-code buildings.

The 2017 Wenatchee School District's Hazard Mitigation Plan Action Items are summarized on the following pages.

Table 4.2
Wenatchee School District Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Multi-Hazard Mitigation Action Items								
Long-Term #1	Integrate the findings and action items in the mitigation plan into ongoing programs and practices for the district.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X
Long-Term #2	Review emergency and evacuation planning to incorporate hazard and risk information from the mitigation plan.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X
Long-Term #3	Consider natural hazards whenever siting new facilities and locate new facilities outside of high hazard areas.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X
Long-Term #4	Ensure that new facilities are adequately designed to minimize risk from natural hazards.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X
Long-Term #5	Maintain, update and enhance facility data and natural hazards data in the ICOS database.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X
Long-Term #6	Develop and distribute educational materials regarding natural hazards, vulnerability and risk for K–12 facilities.	Ongoing	Local Bond or Grant	Supt.	X		X	X
Long-Term #7	Seek FEMA funding for repairs if district facilities suffer damage in a FEMA declared disaster.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #8	Pursue pre- and post-disaster mitigation grants from FEMA and other sources.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #9	Post the district's mitigation plan on the website and encourage comments stakeholders for the ongoing review and periodic update of the mitigation plan.	Ongoing	Local Bond or Grant	Supt.	X			X

Table 4.3
Wenatchee School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Earthquake Mitigation Action Items								
Short-Term #1	Evaluate the seismic vulnerability of the 1950s portions of the Elementary and Middle Schools by having a structural engineer complete an ASCE 41-13 Tier 1 evaluation.	1-2 Years	Local Bond or Grant	Supt.	X	X		X
Short-Term #2	Have a structural engineer review the drawings of the remodel of the High School to verify that necessary structural seismic mitigation measures were included. If not, complete an ASCE 41-13 Tier 1 evaluation.	1-2 Years	Local Bond or Grant	Supt.	X	X		X
Short-Term #3	Assess the ASCE 41-13 results and select buildings or building parts that have the greatest vulnerability for more detailed evaluations.	1-3 Years	Local Bond or Grant	Supt.	X	X		X
Short-Term #4	Evaluate the foundations of the portable buildings to determine whether they are adequate for earthquakes.	1-3 Years	Local Bond or Grant	Supt.	X	X		X
Long-Term #1	Prioritize and implement seismic retrofits or replacements based on the results of the detailed evaluations, as funding becomes available.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #2	Maintain and update building data for seismic risk assessments in the OSPI ICOS PDM database.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #3	Enhance emergency planning for earthquakes including duck and cover and evacuation drills.	Ongoing	Local Bond or Grant	Supt.	X		X	X

Table 4.4
Wenatchee School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Flood Mitigation Action Items								
Short-Term #1	Complete building-level flood risk assessments for the five campuses where the priority for assessments in Table 7.2 is “moderate”.	1-2 Years	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Complete building-level flood risk assessments for the other campuses, with priority for buildings with basements, buildings with first floors elevations near grade, and buildings where loss of function in future floods would have the greatest impact on the District.	2-5 Years	Local Bond or Grant	Supt.	**X**		**X**	**X**
Short-Term #3	Enhance emergency planning, including flood response measures such as sandbagging, for all campuses that have or may have significant flood risk.	1-2 Years	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Long – Term #1	Locate new campuses outside of FEMA-mapped floodplains or other flood-prone areas whenever possible or construct new buildings in flood-prone areas at elevations as high as possible to minimize flood risk.	On going	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**

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Table 4.5
Wenatchee School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Wildland/Urban Interface Fire Mitigation Action Items								
Short-Term #1	Consult with local fire agency or other fire expert regarding level of fire risk for campuses for which this is recommended by the OSPI ICOS PDM database campus-level wildland/urban interface fire report.	1-2 Years	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Enhance emergency evacuation planning for all campuses for which wildland/urban fires are possible.	1 year	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Long-Term #1	Evaluate and consider implementing fire risk reduction measures including improving defensible space and upgrading building elements such as roofs with materials designed to be fire-resistant and covering vent openings with wire mesh to prevent embers from entering.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X

Table 4.6
Wenatchee School District Mitigation Action Items – Continued

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Other Hazards Action Items								
Short-Term #1	Evaluate portable buildings to make sure that they are adequately tied down to resist high winds and implement mitigation measures, if necessary.	1-2 Years	Local, Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Review and update transportation planning for winter storm events or other events that may disruption transportation to/from schools.	Ongoing	Local, Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #3	Assess the need for emergency generators for some district facilities, and implement as funding becomes available.	1-5 Years	Local, Bond or Grant	Supt.	X	X	X	X
Short-Term #3	Review and update emergency planning for severe weather events including high winds and tornadoes.	Ongoing	Local, Bond or Grant	Supt.	X	X	X	X

5.0 MITIGATION PLAN ADOPTION, IMPLEMENTATION AND MAINTENANCE

5.1 Overview

For a hazard mitigation plan to be effective, it has to be implemented gradually over time, as resources become available. An effective plan must also be continually evaluated and periodically updated. The mitigation Action Items included in the Wenatchee School District's Hazard Mitigation Plan will be accomplished effectively only through a process which routinely incorporates logical thinking about hazards and cost-effective mitigation into ongoing decision making and capital improvement spending.

The following sections depict how the Wenatchee School District has adopted and will implement and maintain the vitality of the District's Hazard Mitigation Plan.

5.2 Plan Adoption

This is the Wenatchee School District's first Hazard Mitigation Plan, which became effective on Month XX, 2017, the date of adoption by the Wenatchee School District's Board. The Board adopted the District's Hazard Mitigation Plan following FEMA's approval of the District's submitted plan. The Board's adoption resolution is shown on the following page.

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INSERT a scan of Board Adoption Resolution when signed, example below may be edited or replaced with district appropriate titles and wording.

Board of Directors Resolution Adopting the Wenatchee School District Hazard Mitigation Plan

Resolution Number 2017-X

A Resolution Adopting the 2017 Wenatchee School District Hazard Mitigation Plan

The Wenatchee School District resolves as follows:

Whereas, the Wenatchee School District has determined that it is in the best interest of the District to have an active hazard mitigation planning effort to reduce the long term risks from natural hazards to school facilities, and

Whereas, the Wenatchee School District recognizes that the Federal Emergency Management Agency (FEMA) requires the district to have an approved hazard mitigation plan as a condition of applying for and receiving FEMA mitigation project grant funding.

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Now, therefore, be it resolved by the Wenatchee School District as follows:

The Wenatchee School District adopts the 2017 Wenatchee School District Hazard Mitigation Plan.

Passed by the School Board on the XXth day of Month, 2017.

Insert signature(s) and title(s) below.

Note: the school board's resolution is best done after FEMA approves the submitted plan because FEMA may require changes to be made to the submitted plan. With adoption after FEMA approval, the district's plan becomes active as of the adoption date and the plan must then be updated by the 5th anniversary of the adoption date. A plan update requires much less effort than creating the initial hazard mitigation plan.

5.3 Implementation

5.3.1 Existing Authorities, Policies, Programs, Resources and Capabilities

The Director of Facilities and Risk Management will have the lead responsibility for implementing the Wenatchee School District Hazard Mitigation Plan, with ongoing support from the facilities committee.

A key aspect of the Plan's implementation will be the integration of the hazard, vulnerability, and risk evaluations, mitigation planning and mitigation Action Items, into ongoing capital improvement planning and other district activities, such as building maintenance, periodic remodeling or modernization of facilities, and future construction of new facilities.

5.3.2 Integration into Ongoing Programs

Prioritization of future mitigation projects within the Wenatchee School District requires flexibility because of varying types of projects, district needs, and available funding sources. Prioritized mitigation Action Items developed during the mitigation planning process are summarized in Chapter 4 and contained in each hazard chapter. Additional mitigation Action Items or revisions to the initial Action Items are likely in the future. The Wenatchee School District Board will make final decisions about implementation and priorities with inputs from district staff, the mitigation planning team, the public, and other stakeholders.

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The Wenatchee School District's prioritization of mitigation projects will include the following factors:

1. The mission statement and goals in the Wenatchee School District Hazard Mitigation Plan including:

   Goal 1: Reduce Threats to Life Safety.

   Goal 2: Reduce Damage to District Facilities, Economic Losses, and Disruption of the District's Services.

   Goal 3: Enhance Emergency Planning, Disaster Response, and Disaster Recovery.

   Goal 4: Increase Awareness and Understanding of Natural Hazards and Mitigation.

2. Benefit-cost analysis to ensure that mitigation projects are cost effective, with benefit exceeding the costs.
3. The STAPLEE process to ensure that mitigation Action Items under consideration for implementation meet the needs and objectives of the District, its communities, and citizens, by considering the social, technical, administrative, political, economic , and environmental aspects of potential projects.

Cost Effectiveness of Mitigation Projects

As the Wenatchee School District considers whether or not to undertake specific mitigation projects or evaluate how to decide between competing mitigation projects, they must address questions that don't always have obvious answers, such as:

What is the nature of the hazard problem?

How frequent and how severe are the hazard events of concern?

Do we want to undertake mitigation measures?

What mitigation measures are feasible, appropriate, and affordable?

How do we prioritize between competing mitigation projects?

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

The Wenatchee School District recognizes that benefit-cost analysis is a powerful tool that can help provide solid, defensible answers to these difficult socio-political-economic-engineering questions. Benefit-cost analysis is required for all FEMA-funded mitigation projects, under both pre-disaster and post-disaster mitigation programs.

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However, regardless of whether or not FEMA funding is involved, benefit-cost analysis provides a sound basis for evaluating and prioritizing possible mitigation projects for any natural hazard. Thus, the district will use benefit-cost analysis and related economic tools, such as cost-effectiveness evaluation, to the extent practicable in prioritizing and implementing mitigation actions.

STAPLEE Process

The Wenatchee School District will also use the STAPLEE methodology to evaluate projects based on the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) considerations and opportunities for implementing particular mitigation action items in the district. The STAPLEE approach is helpful for doing a quick analysis of the feasibility of proposed mitigation projects.

The following paragraphs outline the district's STAPLEE Approach

Social:

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

Technical:

- Will the proposed action work?
- Will it create more problems than it solves?
- Does it solve a problem or only a symptom?

- Is it the most useful action in light of other goals?

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

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

Legal: Include legal counsel, land use planners, and risk managers in this discussion.
- Who is authorized to implement the proposed action?
- Is there a clear legal basis or precedent for this activity?
- Will the district be liable for action or lack of action?
- Will the activity be challenged?

Economic:
- What are the costs and benefits of this action?
- Do the benefits exceed the costs?
- Are initial, maintenance, and administrative costs taken into account?
- Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)?
- How will this action affect the fiscal capability of the district?
- What burden will this action place on the tax base or economy?
- What are the budget and revenue effects of this activity?

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

5.3.3 Wenatchee School District's Capabilities

The Wenatchee School District has the necessary human resources to ensure that the Wenatchee School District Hazard Mitigation Plan continues to be an actively used planning document. District staff has been active in the preparation of the Plan, and have gained an understating of the process and the desire to integrate the Plan into ongoing capital budget planning. Through this linkage, the District's Hazard Mitigation Plan will be kept active and be a working document.

District staff has broad experience with planning and facilitation of community inputs. This broad experience is directly applicable to hazard mitigation planning and to

implementation of mitigation projects. If specialized expertise is necessary for a particular project, the District will contract with a consulting firm on an as-needed basis.

Furthermore, recent earthquake and tsunami disasters worldwide serve as a reminder of need to maintain a high level of interest in evaluating and mitigating risk from natural disasters of all types. These events have kept the interest in hazard mitigation planning and implementation alive among the Wenatchee School District Board, District staff, and in the communities served by the District.

5.4 Plan Maintenance and Periodic Updating

5.4.1 Periodic Monitoring, Evaluating, and Updating

Monitoring the Wenatchee School District Hazard Mitigation Plan is an ongoing, long-term effort. An important aspect of monitoring is a continual process of ensuring that mitigation Action Items are compatible with the goals, objectives, and priorities established during the development of the District's Mitigation Plan. The District has developed a process for regularly reviewing and updating the Hazard Mitigation Plan. As noted previously, the Director of Facilities and Risk Management, will have the lead responsibility for implementing the Wenatchee School District's Hazard Mitigation Plan and for periodic monitoring, evaluating, and updating of the Plan. There will be ample opportunities to incorporate mitigation planning into ongoing activities and to seek grant support for specific mitigation projects.

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The Wenatchee School District Hazard Mitigation Plan will be reviewed annually as well as after any significant disaster event affecting the District. These reviews will determine whether there have been any significant changes in the understanding of hazards, vulnerability, and risk or any significant changes in goals, objectives, and Action Items. These reviews will provide opportunities to incorporate new information into the Mitigation Plan, remove outdated items, and document completed Action Items. This will also be the time to recognize the success of the District in implementing Action Items contained in the Plan. Annual reviews will also focus on identifying potential funding sources for the implementation of mitigation Action Items.

The periodic monitoring, evaluation, and updating will assess whether or not, and to what extent, the following questions are applicable:

1. Do the plans goals, objectives, and action items still address current and future expected conditions?
2. Does the mitigation Action Items accurately reflect the District's current conditions and mitigation priorities?
3. Have the technical hazard, vulnerability, and risk data been updated or changed?
4. Are current resources adequate for implementing the District's Hazard Mitigation Plan? If not, are there other resources that may be available?

5. Are there any problems or impediments to implementation? If so, what are the solutions?
6. Have other agencies, partners, and the public participated as anticipated? If no, what measures can be taken to facilitate participation?
7. Have there been changes in federal and/or state laws pertaining to hazard mitigation in the District?
8. Have the FEMA requirements for the maintenance and updating of hazard mitigation plans changed?
9. What can the District learn from declared federal and/or state hazard events in other Washington school districts that share similar characteristics to the WENATCHEE School District, such as vulnerabilities to earthquakes and tsunamis?
10. How have previously implemented mitigation measures performed in recent hazard events? This may include assessment of mitigation Action Items similar to those contained in the District's Mitigation Plan, but where hazard events occurred outside of the District.

The Facilities Committee will review the results of these mitigation plan assessments, identify corrective actions, and make recommendations, if necessary, to the Wenatchee School Board for actions that may be necessary to bring the Hazard Mitigation Plan back into conformance with the stated goals and objectives. Any major revisions of the Hazard Mitigation Plan will be taken to the Board for formal approval as part of the District's ongoing mitigation plan maintenance and implementation program.

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The Facilities Committee will have lead responsibility for the formal updates of the Hazard Mitigation Plan every five years. The formal update process will be initiated at least one year before the five-year anniversary of FEMA approval of the Wenatchee School District Hazard Mitigation Plan, to allow ample time for robust participation by stakeholders and the public and for updating data, maps, goals, objectives, and Action Items.

5.4.2 Continued Public Involvement and Participation

Implementation of the mitigation actions identified in the Plan must continue to engage the entire community. Continued public involvement will be an integral part of the ongoing process of incorporating mitigation planning into land use planning, zoning, and capital improvement plans and related activities within the communities served by the District. In addition, the District will expand communications and joint efforts between the District and emergency management activities in the cities of Wenatchee and Chelan County.

The 2017 Wenatchee School District Hazard Mitigation Plan will be available on the District's website and hard copies will be placed in the school and public libraries. The existence and locations of these hard copies will be posted on the District's website

along with contact information so that people can direct comments, suggestions, and concerns to the appropriate staff.

The Wenatchee School District is committed to involving the public directly in the ongoing review and updating of the Hazard Mitigation Plan. This public involvement process will include public participation in the monitoring, evaluation, and updating processes outlined in the previous section. Public involvement will intensify as the next 5-year update process is begun and completed.

A press release requesting public comments will be issued after each major update and also whenever additional public inputs are deemed necessary. The press release will direct people to the website and other locations where the public can review proposed updated versions of the Wenatchee School District's Hazard Mitigation Plan. This process will provide the public with accessible and effective means to express their concerns, opinions, and ideas about any updates/changes that are proposed to the Mitigation Plan. The District will ensure that the resources are available to publicize the press releases and maintain public participation through web pages, social media, newsletters, and newspapers.

Regulatory Tools (Ordinances and Codes)

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- RCW 28A – Common School Provisions
- WAC Title 392 – Office of Superintendent of Public Instruction

Administrative Tools (Departments, Organizations, Programs)

Wenatchee School District Resources

- School Board
- Superintendent
- Parent Teacher Association
- Teachers Association/Union
- Safety Committee

Regional and State Resources

- Office of Superintendent of Public Instruction
- Washington State School Directors' Association - WSSDA
- Washington Association of School Administrators - WASA
- Washington Association of School Business Officials – WASBO
- Washington Association of Maintenance and Operation Administrators - WAMOA
- Rapid Responder System
- Chelan County, including Emergency Management, Public Works and GIS, Planning Department and Building Officials.

- City of Wenatchee including Emergency Management, Public Works and GIS, Planning Department and Building Officials
- Wenatchee Fire Department
- Wenatchee Police Department

Other Technical Tools (Plans and Others)

Wenatchee School District Capabilities

- District Website
- School Closure Telephone Plan
- Evacuation Plan
- Lockdown Plan
- Fire Drills
- Earthquake Drills
- Bomb Threat Assessment Guide
- Emergency Response Plan
- Capital Facilities Plan
- Five Year Plan
- Strategic Plan
- Policies and Procedures
- Student Rights and Responsibilities
- District Safety Plan

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Fiscal Tools (Taxes, Bonds, Funds and Fees)

Wenatchee School District Capabilities

- Authority to Levy Taxes
- Authority to Issue Bonds
- Funds
  - General Fund
  - Capital Project Funds
  - Debt Service Fund
  - Transportation Vehicle Fund
- External Funds
  - OSPI School Construction Assistance Program Modernization / New in Lieu
  - FEMA Grants
  - HUD “CDBG” Grants
  - Foundation Grants
  - Legislative Funding/Grants

6.0 EARTHQUAKES

6.1 Introduction

Every location in Washington state has some level of earthquake hazard, but the level of earthquake hazard varies widely by location within the state. Historically, awareness of seismic risk in Washington has generally been high, among both the public and public officials. This awareness in based to a great extent on the significant earthquakes that occurred within the Puget Sound area in 1949 (Olympia earthquake), 1965 (Tacoma earthquake), and 2001 (Nisqually earthquake), as well as other smaller earthquakes in many locations throughout the state.

The awareness of seismic risk in Washington has also increased in recent years due to the devastating earthquakes and tsunamis in Indonesia in 2004 and Japan in 2011. The geologic settings for the Indonesia and Japan earthquakes are very similar to the Cascadia Subduction Zone along the Washington coast.

The technical information in the following sections provides a basic understanding of earthquake hazards, which is an essential foundation for making well-informed decisions about earthquake risks and mitigation Action Items for K–12 facilities.

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6.2 Washington Earthquakes

Earthquakes are described by their magnitude (M), which is a measure of the total energy released by an earthquake. The most common magnitude is called the “moment magnitude,” which is calculated by seismologists from two factors – 1) the amount of slip (movement) on the fault causing the earthquake and 2) the area of the fault surface that ruptures during the earthquake. Moment magnitudes are similar to the Richter magnitude, which was used for many decades but has now been replaced.

The moment magnitudes for the largest earthquakes recorded worldwide and in Washington are shown in Table 6.1.

Table 6.1
Largest Recorded Earthquakes1,

Worldwide	Magnitude	Washington	Magnitude
1960 Chile	9.5	1872 Chelan	6.8[a]
1964 Prince William Sound, Alaska	9.2	1949 Olympia	6.8
2004 Sumatra, Indonesia	9.1	2001 Nisqually	6.8
2011 Japan	9.0	1965 Tacoma	6.7
1952 Kamchatka, Russia	9.0	1939 Bremerton	6.2
2010 Chile	8.8	1936 Walla Walla	6.1
1906 Ecuador	8.8	1909 Friday Harbor	6.0

[a] Estimated magnitude.

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Figure 6.1

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Epicenters of Historic Earthquakes in Washington with Magnitudes of 3.0 or Higher[3]

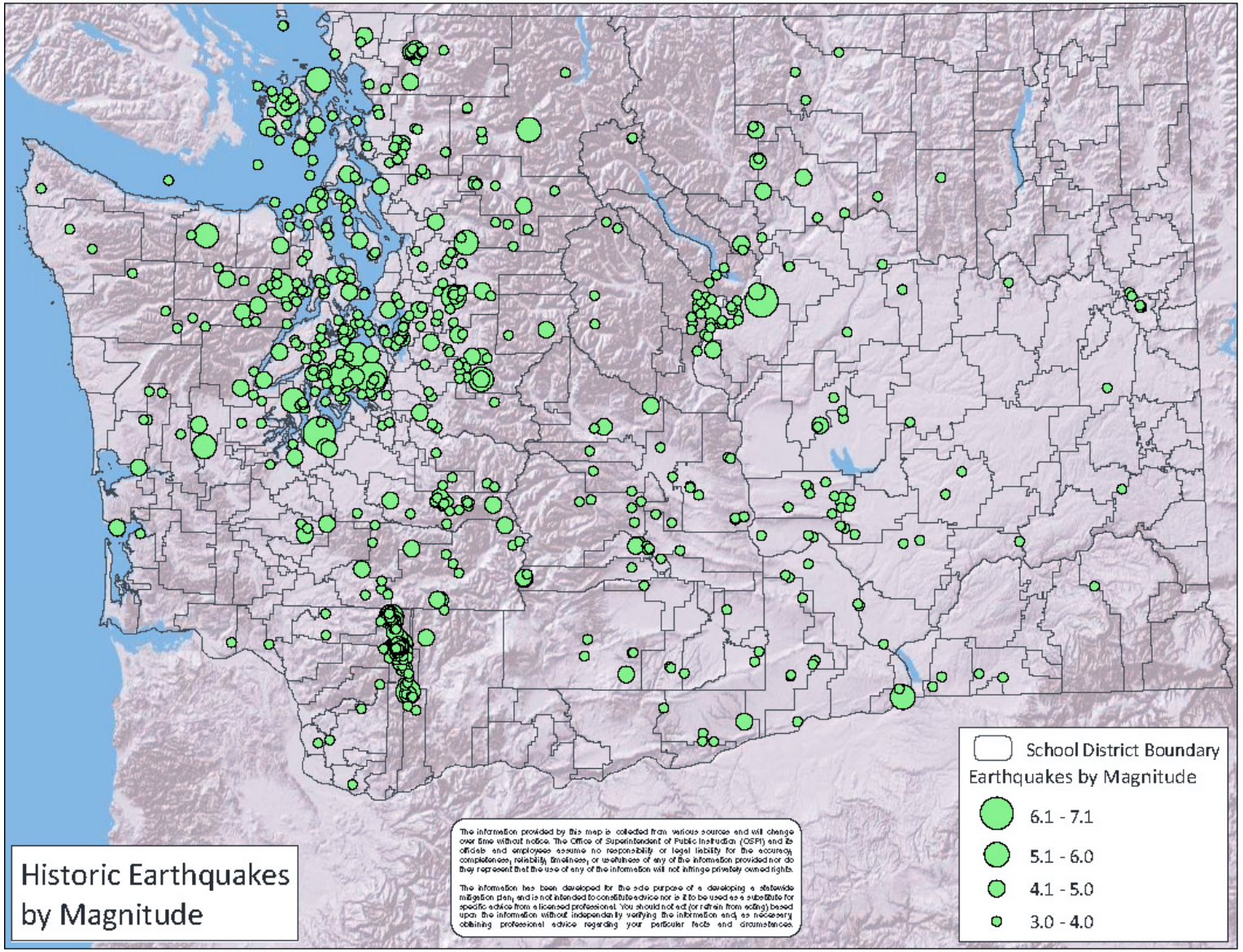

Table 6.1 and Figure 6.1 do not include the January 26, 1700 earthquake on the Cascadia Subduction Zone which has been identified by tsunami records in Japan and paleoseismic investigations along the Washington coast. The estimated magnitude of the 1700 earthquake is approximately 9.0. This earthquake is not shown in Table 6.1 because it predates modern seismological records. However, this earthquake is among the largest known earthquakes worldwide and the largest earthquake affecting Washington over the past several hundred years. The closest analogy to this earthquake and its effects, including tsunamis, is the 2011 Japan earthquake.

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

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

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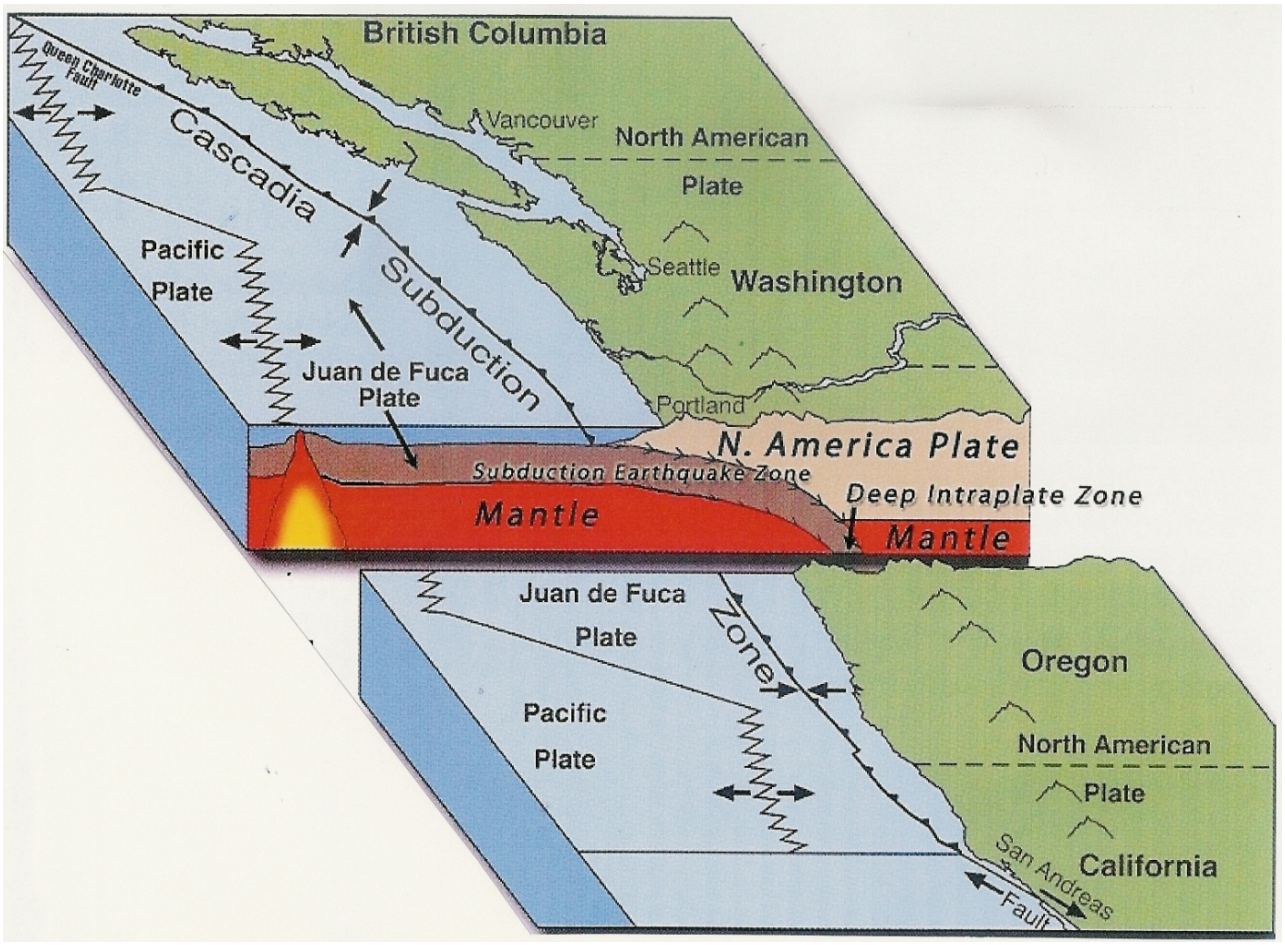
Figure 6.2 on the following page shows the geologic (plate-tectonic) setting of the Cascadia Subduction Zone.

There are three main types of earthquakes that affect Washington state:

1) “Interface” earthquakes on the boundary between the subducting Juan de Fuca Plate and the North American Plate.
2) “Intraplate” earthquakes within the subducting oceanic plates.
3) “Crustal” earthquakes within the North American Plate.

“Interface” earthquakes on the Cascadia Subduction Zone occur on the boundary between the subducting Juan de Fuca plate and the North American Plate. These earthquakes may have magnitudes up to 9.0 or perhaps 9.2, with average return periods (the time period between earthquakes) of about 250 to 500 years. These are the great Cascadia Subduction Zone earthquake events that have received attention in the popular press. The last major interface earthquake on the Cascadia Subduction Zone occurred on January 26, 1700. These earthquakes occur about 40 miles offshore from the Pacific Ocean coastline. Ground shaking from such earthquakes would be the strongest near the coast and strong ground shaking would be felt throughout much of western Washington, with the level of shaking decreasing further inland from the coast.

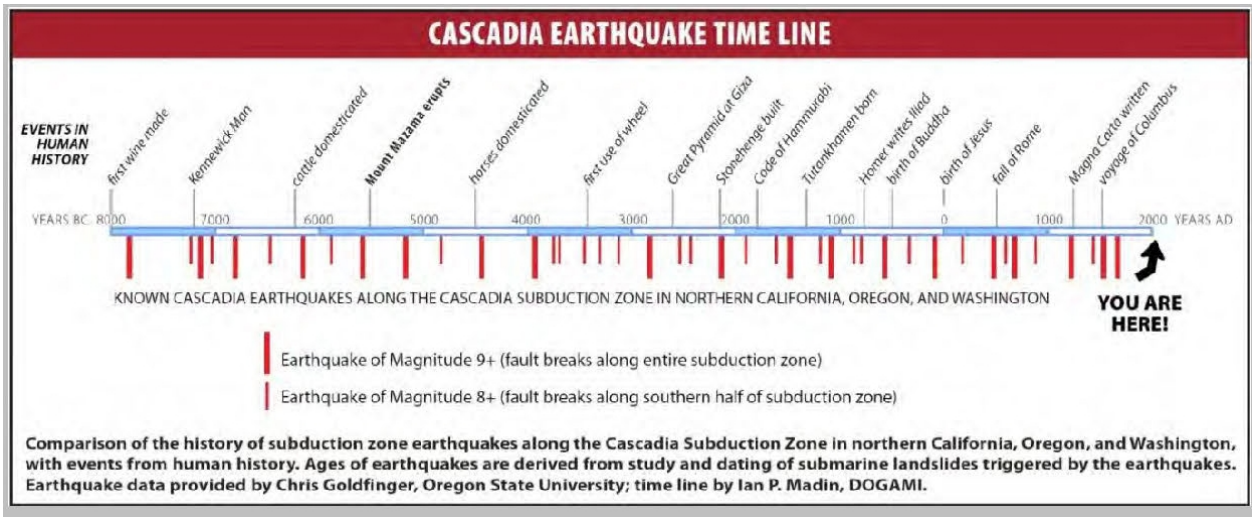
Figure 6.2
Cascadia Subduction Zone4



Paleoseismic investigations, which look at geologic sediments and rocks, for signs of ancient earthquakes, have identified 41 Cascadia Subduction Zone interface earthquakes over the past 10,000 years, which corresponds to one earthquake about every 250 years. Of these 41 earthquakes, about half are M9.0 or greater earthquakes that represent a full rupture of the fault zone from Northern California to British Columbia. The other half of the interface earthquakes represents M8+ earthquakes that rupture only the southern portion of the subduction zone.

The 300+ years since the last major Cascadia Subduction Zone earthquake is longer than the average timeframe of about 250 years for M8 or greater and is shorter than some of the intervals between M9.0 earthquakes. The time history of these major interface earthquakes is shown in Figure 6.3 on the following page.

Figure 6.3
Time History of Cascadia Subduction Zone Interface Earthquakes5



"Intraplate" earthquakes occur within the subducting Juan de Fuca Plate. These earthquakes may have magnitudes up to about 6.5, with probable return periods of about 500 to 1000 years at any given location. These earthquakes can occur anywhere along the Cascadia Subduction Zone. The 1949, 1965, and 2001 earthquakes listed in Table 1 are examples of intraplate earthquakes. These earthquakes occur deep in the earth's crust, about 20 to 30 miles below the surface. They generate strong ground motions near the epicenter, but have damaging effects over significantly smaller areas than the larger magnitude interface earthquakes discussed above.

"Crustal" earthquakes occur within the North American Plate. Crustal earthquakes are shallow earthquakes, typically within the upper 5 or 10 miles of the earth's surface, although some ruptures may reach the surface. In Western Washington crustal earthquakes are mostly related to the Cascadia Subduction Zone. Crustal earthquakes are known to occur not only on faults mapped as active or potentially active, but also on unknown faults. Many significant earthquakes in the United States have occurred on previously unknown faults.

Based on the historical seismicity in Washington state and on comparisons to other geologically similar areas, small to moderate crustal earthquakes up to about M5 or M5.5 are possible almost any place in Washington. There is also a possibility of larger crustal earthquakes in the M6+ range on unknown faults, although, the probability of such events is likely to be low.

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6.3 Earthquake Concepts for Risk Assessments

6.3.1 Earthquake Magnitudes

In evaluating earthquakes, it is important to recognize that the earthquake magnitude scale is not linear, but rather logarithmic (based on intervals corresponding to orders of magnitude). For example, each one step increase in magnitude, such as from M7 to M8, corresponds to an increase in the amount of energy released by the earthquake of a factor of about 30, based on the mathematics of the magnitude scale.

Thus, an M7 earthquake releases about 30 times more energy than an M6, while an M8 releases about 30 times more energy than an M7 and so on. Thus, a great M9 earthquake releases nearly 1,000 times (30 [M7] x 30 [M8]) more energy than a large earthquake of M7 and nearly 30,000 times more energy than an M6 earthquake (30 [M6] x 30 [M7] x 30 [M8]).

The public often assumes that the larger the magnitude of an earthquake, the “worse” it is. That is, the “big one” is an M9 earthquake and smaller earthquakes such as M6 or M7 are not the “big one”. However, this is true only in very general terms. Higher magnitude earthquakes do affect larger geographic areas, with much more widespread damage than smaller magnitude earthquakes. However, for a given site, the magnitude of an earthquake is *not* a good measure of the severity of the earthquake at that site.

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For most locations, the best measure of the severity of an earthquake is the intensity of ground shaking. However for some sites, ground failures and other possible consequences of earthquakes, which are discussed later in this chapter (Section 6.6), may substantially increase the severity.

For any earthquake, the severity and intensity of ground shaking at a given site depends on four main factors:

- Earthquake magnitude.
- Earthquake epicenter, which is the location on the earth’s surface directly above the point of origin of an earthquake.
- Earthquake depth.
- Soil or rock conditions at the site, which may amplify or deamplify earthquake ground motions.

An earthquake will generally produce the strongest ground motions near the epicenter (the point on the ground above where the earthquake initiated) with the intensity of ground motions diminishing with increasing distance from the epicenter. The intensity of ground shaking at a given location depends on the four factors listed above. Thus, for

any given earthquake there will be contours of varying intensity of ground shaking vs. distance from the epicenter. The intensity will generally decrease with distance from the epicenter, and often in an irregular pattern, not simply in perfectly shaped concentric circles. This irregularity is caused by soil conditions, the complexity of earthquake fault rupture patterns, and possible directionality in the dispersion of earthquake energy.

The amount of earthquake damage and the size of the geographic area affected generally increase with earthquake magnitude. Below are some qualitative examples:

- Earthquakes below about M5 are not likely to cause significant damage, even locally very near the epicenter.

- Earthquakes between about M5 and M6 are likely to cause moderate damage near the epicenter.

- Earthquakes of about M6.5 or greater (e.g., the 2001 Nisqually earthquake) can cause major damage, with damage usually concentrated fairly near the epicenter.

- Larger earthquakes of M7+ cause damage over increasingly wider geographic areas with the potential for very high levels of damage near the epicenter.

- Great earthquakes with M8+ can cause major damage over wide geographic areas.

- A mega-quake M9 earthquake on the Cascadia Subduction Zone could affect the entire Pacific Northwest from British Columbia, through Washington and Oregon, and as far south as Northern California, with the highest levels of damage near the coast.

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6.3.2 Intensity of Ground Shaking

There are many measures of the severity or intensity of earthquake ground motions. The Modified Mercalli Intensity scale (MMI) was widely used beginning in the early 1900s. MMI is a descriptive, qualitative scale that relates severity of ground motions to the types of damage experienced. MMIs range from I to XII. More accurate, quantitative measures of the intensity of ground shaking have largely replaced the MMI. These modern intensity scales are used in the Wenatchee School District Hazard Mitigation Plan.

Modern intensity scales use terms that can be physically measured with seismometers (instruments that measure motions of the ground), such as acceleration, velocity, or displacement (movement). The intensity of earthquake ground motions may also be measured in spectral (frequency) terms, as a function of the frequency of earthquake waves propagating through the earth. In the same sense that sound waves contain a

mix of low-, moderate-, and high-frequency sound waves, earthquake waves contain ground motions of various frequencies. The behavior of buildings and other structures depends substantially on the vibration frequencies of the building or structure vs. the spectral content of earthquake waves. Earthquake ground motions also include both horizontal and vertical components.

A common physical measure of the intensity of earthquake ground shaking, and the one used in this mitigation plan, is Peak Ground Acceleration (PGA). PGA is a measure of the intensity of shaking, relative to the acceleration of gravity (g). For example, an acceleration of 1.0 g PGA is an extremely strong ground motion that may occur near the epicenter of large earthquakes. With a vertical acceleration of 1.0 g, objects are thrown into the air. With a horizontal acceleration of 1.0 g, objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10% g PGA means the ground acceleration is 10% that of gravity, and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. The following generalized observations provide qualitative statements about the likely extent of damages from earthquakes with various levels of ground shaking (PGA) at a given site:

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- Ground motions of only 1% g or 2% g are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.

- Ground motions below about 10% g usually cause only slight damage.

- Ground motions between about 10% g and 30% g may cause minor to moderate damage in well-designed buildings, with higher levels of damage in more vulnerable buildings. At this level of ground shaking, some poorly designed buildings may be subject to collapse.

- Ground motions above about 30% g may cause significant damage in well-designed buildings and very high levels of damage (including collapse) in poorly designed buildings.

- Ground motions above about 50% g may cause significant damage in many buildings, including some buildings that have been designed to resist seismic forces.

6.4 Earthquake Hazard Maps

The current scientific understanding of earthquakes is incapable of predicting exactly where and when the next earthquake will occur. However, the long term probability of earthquakes is well enough understood to make useful estimates of the probability of various levels of earthquake ground motions at a given location.

The current consensus estimates for earthquake hazards in the United States are incorporated into the 2014 USGS National Seismic Hazard Maps. These maps are the basis of building code design requirements for new construction, per the International Building Code adopted in Washington state. The earthquake ground motions used for building design are set at 2/3rds of the 2% in 50 year ground motion.

The following maps show contours of Peak Ground Acceleration (PGA) with 10% and 2% chances of exceedance over the next 50 years to illustrate the levels of seismic hazard. The ground shaking values on the maps are expressed as a percentage of g, the acceleration of gravity. For example, the 10% in 50 year PGA value means that over the next 50 years there is a 10% probability of this level of ground shaking or higher.

In very qualitative terms, the 10% in 50 year ground motion represents a likely earthquake while the 2% in 50 year ground motion represents a level of ground shaking close to, but not the absolute, worst case scenario.

Figure 6.4 on the following page, the statewide 2% in 50 year ground motion map, is the best statewide representation of the variation in the level of seismic hazard in Washington state by location:

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- The dark red, pink, and orange areas have the highest levels of seismic hazard.
- The tan, yellow, and blue areas have intermediate levels of seismic hazard.
- The bright green and pale green areas have the lowest levels of seismic hazard.

The detailed geographical patterns in the maps reflect the varying contributions to seismic hazard from earthquakes on the Cascadia Subduction Zone and crustal earthquakes within the North American Plate. The differences in geographic pattern between the 2% in 50 year maps and the 10% in 50 year maps reflect different contributions from Cascadia Subduction Zone earthquakes and crustal earthquakes.

These maps are generated by including earthquakes from all known faults, taking into account the expected magnitudes and frequencies of earthquakes for each fault. The maps also include contributions from unknown faults, which are statistically possible anywhere in Washington. The contributions from unknown faults are included via “area” seismicity which is distributed throughout the state.

An important caveat for interpreting these maps is that the 2014 USGS seismic hazard maps show the level of ground motions for rock sites. Ground motions on soil sites, especially soft soil sites will be significantly higher than for rock sites. Thus, for earthquake hazard analysis at a given site it is essential to include consideration of the site’s soil conditions.

The ground motions shown in the following figures represent ground motions with the specified probabilities of occurrence. At any given site, earthquakes may be experienced with ground motions over the entire range of levels of ground shaking from just detectible with sensitive seismometers to higher than the 2% in 50 year ground motion.

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Figure 6.4
2014 USGS Seismic Hazard Map: Washington State[6]
PGA value (%g) with a 2% Chance of Exceedance in 50 years

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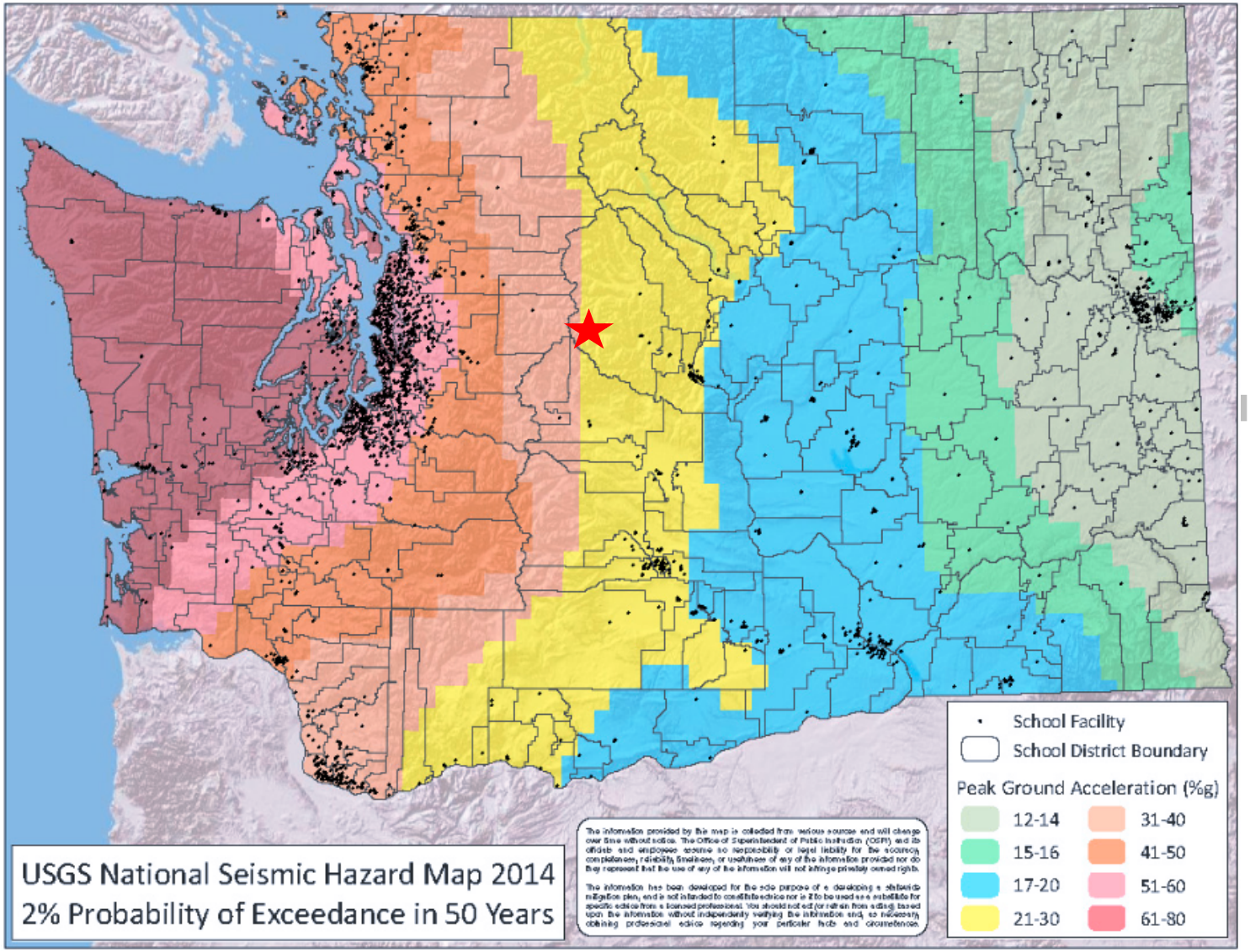
USGS National Seismic Hazard Map 2014
2% Probability of Exceedance in 50 Years
School Facility
School District Boundary
Peak Ground Acceleration (%g)
12-14
15-16
17-20
21-30
31-40
41-50
51-60
61-80

Figure 6.5
2014 USGS Seismic Hazard Map: Washington State[6]
PGA value (%g) with a 10% Chance of Exceedance in 50 years

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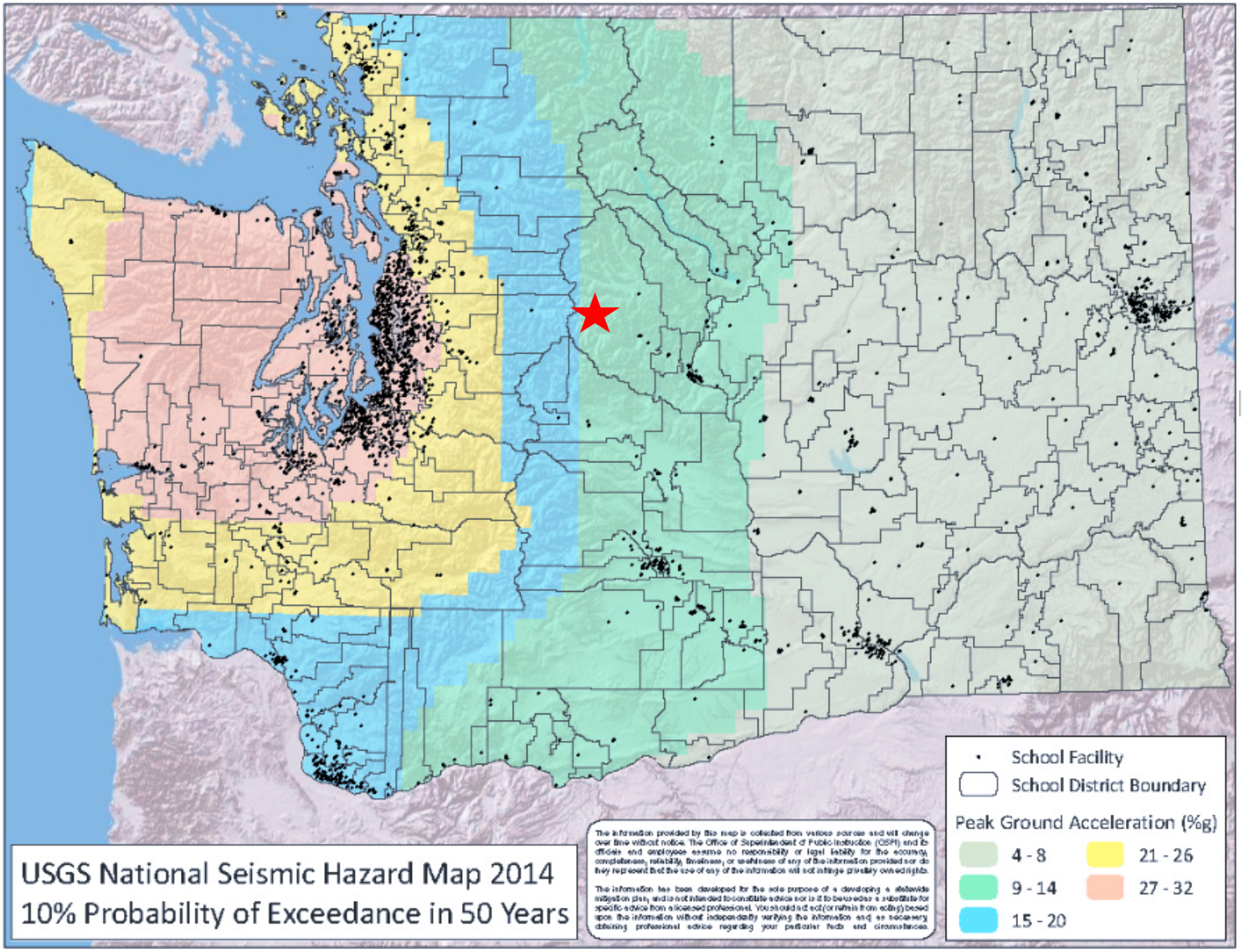
USGS National Seismic Hazard Map 2014
10% Probability of Exceedance in 50 Years
School Facility
School District Boundary
Peak Ground Acceleration (%g)
4 - 8
9 - 14
15 - 20
21 - 26
27 - 32

6.5 Site Class: Soil and Rock Types

As discussed previously, the soil or rock type at a given location substantially affects the level of earthquake hazard because the soil or rock type may amplify or de-amplify ground motions. In general, soil sites, especially soft soil sites amplify ground motions. That is, for a given earthquake, a soil site immediately adjacent to a rock site will experience higher levels of earthquake ground motions than the rock site.

In simple terms, there are six soil or rock site classes:

- A – Hard Rock
- B – Rock
- C – Very Dense Soil and Soft Rock
- D – Firm Soil
- E – Soft Soil
- F – Very Soft Soil

Site classes for each campus in the Wenatchee School District are included in the campus-level report in Section 6.7. These estimates are from DNR or from site-specific determinations if such are entered into the OSPI ICOS PDM database.

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6.6 Ground Failures and Other Aspects of Seismic Hazards

Much of the damage in earthquakes occurs from ground shaking that affects buildings and infrastructure. However, there are several other consequences of earthquakes that can result in substantially increased levels of damage in some locations. These consequences include: surface rupture; subsidence or elevation; liquefaction; settlement; lateral spreading; landslides; dam, reservoir or levee failures; tsunamis, and seiches. Any of these consequences can result in very severe damage to buildings, up to and including complete destruction, and also a high likelihood of casualties.

6.6.1 Surface Rupture

Surface rupture occurs when the fault plane along which rupture occurs in an earthquake reaches the surface. Surface rupture may be horizontal and/or vertical displacement between the sides of the rupture plane. For a building subject to surface rupture, the level of damage is typically very high and often results in the destruction of the building.

Surface rupture does not occur with interface or intraplate earthquakes on the Cascadia Subduction Zone and does not occur with all crustal earthquakes. Faults in Washington state where surface rupture is likely, include the Seattle Fault System and the Tacoma Fault System.

6.6.2 Subsidence

Large interface earthquakes on the Cascadia Subduction Zone are expected to result in subsidence of up to several feet or more along Washington's Pacific Coast. For facilities located very near sea level, co-seismic subsidence may result in the facilities being below sea level or low enough so that flooding becomes very frequent. Subsidence may also impede egress by blocking some routes and thus increase the likelihood of casualties from tsunamis.

6.6.3 Liquefaction, Settlement, and Lateral Spreading

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

Estimates of liquefaction potential for each campus in the Wenatchee School District are included in the campus-level report in Section 6.7. These estimates are from DNR or from site-specific determinations, if such determinations were entered into the OSPI ICOS PDM database by the district.

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6.6.4 Landslides

Earthquakes can also induce landslides, especially if an earthquake occurs during the rainy season and soils are saturated with water. The areas prone to earthquake-induced landslides are largely the same as those areas prone to landslides in general. As with all landslides, areas of steep slopes with loose rock or soils and high water tables are most prone to earthquake-induced landslides.

6.6.5 Dam, Levee, and Reservoir Failures

Earthquakes can also cause failure of dams, levees, and reservoirs. Campuses downslope from dams or water reservoirs or behind levees may be subject to flooding if the dams, reservoirs, or levees fail as a result of an earthquake.

The Wenatchee School District has campuses with some flood risk that include campuses downslope from dams or reservoirs or behind levees. Further information about the District's flood risk is included in the flood chapter in this mitigation plan.

6.7 Seismic Risk Assessment for the Wenatchee School District's Facilities

The potential impacts of future earthquakes on the Wenatchee School District include damage to buildings and contents, disruption of educational services, displacement costs for temporary quarters if some buildings have enough damage to require moving

out while repairs are made, and possible deaths and injuries for people in the buildings. The magnitude of potential impacts in future earthquakes can vary enormously from none in earthquakes that are felt but result in neither damages nor casualties, to very substantial for larger magnitude earthquakes with epicenters near a given campus.

The vulnerability of the Wenatchee School District's facilities varies markedly from building to building, depending on each building's structural system and date of construction (which governs the seismic design provisions). The level of risk on a building by building level is summarized in the building-level earthquake risk tables later in this chapter.

The initial seismic risk assessment for the district's facilities at both the campus level and the building-level is largely automated from the data in the OSPI ICOS PDM database. The data used include GIS data for the location of each campus and district-specific data entered into the OSPI ICOS PDM database.

The three step hazard and risk assessment approach, outlined below, uses data in the OSPI ICOS PDM database for screening and prioritization of more detailed evaluations which usually require inputs from an engineer experienced with seismic assessments of buildings. The auto-generated reports help to minimize the level of effort required by districts and to reduce costs by prioritizing more detailed seismic evaluations, enabling the district to focus on the buildings most likely to have the most substantial seismic deficiencies. The three steps include:

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1. An auto-generated campus-level earthquake report that summarizes earthquake hazard data including ground shaking, site class, and liquefaction potential, and classifies the combined earthquake hazard level from these data. The campus-level report also includes priorities for building-level risk assessments and geotechnical evaluations of site conditions.

2. An auto-generated building-level earthquake report that is based on the ASCE 41-13 seismic evaluation methodology. The building-level report contains the data necessary to determine whether a building is pre- or post-benchmark year for life safety. If a building is post-benchmark, it is generally deemed to provide adequate life safety and no further evaluation is necessary. If not, completing an ASCE 41-13 Tier 1 evaluation is recommended. The auto-generated report includes suggested priorities for Tier 1 evaluations.

3. The third step includes completion and interpretation of the ASCE 41-13 Tier 1 evaluations and:

    a. More detailed evaluation of one or more buildings that are determined to have the highest priority for retrofit or replacement from the previous step.
    b. Design of seismic retrofits for buildings for which a retrofit is the preferred alternative.

c. Implementation of retrofits or replacement of buildings, as funding becomes available.

Most of the campuses in the school district have a moderate earthquake hazard level based on estimated ground shaking, with very low to low probability of liquefaction. The Valley Academy of Learning does have moderate to high hazard level due in part to having softer soils (Site Class D-E).

The level of seismic risk from the District's buildings has been substantially reduced by a combination of modernizations that included structural and nonstructural seismic retrofit measures since 2006 and by the replacement of the old Washington Elementary School with a new, current code building in 2016. These building upgrades are summarized in Table 6-4 below.

Table 6.2
History of Modernizations

School Name	Modernized to Seismic Code	Planned to be Modernized to Seismic Code
Abraham Lincoln Elementary	2015/2016	
Orchard Middle	2007	
Pioneer Middle	2006,2015	
Special Education	2015/2016	
Sunnyslope Elementary	2007	
Washington Elementary	2016	
Wenatchee High		2018
Wenatchee Valley Technical Skills Center	2014	
WestSide High	2013	

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6.8 Previous Earthquake Events

The district has not experienced any damage in previous earthquakes.

Table 6.3
Campus-Level Earthquake Report

Earthquake Campus-Level Hazard and Risk Report: Preliminary[1]									
Campus	**Earthquake Ground Shaking 2% in 50 Years[2] (% g)**	**Site Class°**	**Earthquake Ground Shaking Hazard Level**	**Liquefaction Potential**	**Combined Earthquake Hazard Level**	**Recommendations**			
						Building Level Risk Assessment		**Geotechnical Evaluation**	
						Yes/No[3]	**Priority**	**Yes/No**	**Priority**
WENATCHEE SCHOOL DISTRICT									
Abraham Lincoln Elementary	27.18%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Columbia Elementary	27.30%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Foothills Middle	27.46%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
John Newbery Elementary	27.54%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Lewis and Clark Elementary	27.41%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Mission View Elementary	23.00%	C	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Orchard Middle	27.35%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Pioneer Middle	27.31%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Special Education	27.49%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Sunnyslope Elementary	23.53%	C	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Valley Academy Of Learning	30.61%	D-E	Mod to High	Very Low to Low	Mod to High	Yes	Mod to High	No	N/A

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Earthquake Campus-Level Hazard and Risk Report: Preliminary[1]									
Campus	Earthquake Ground Shaking 2% in 50 Years[2] (% g)	Site Class°	Earthquake Ground Shaking Hazard Level	Liquefaction Potential	Combined Earthquake Hazard Level	Recommendations			
						Building Level Risk Assessment		Geotechnical Evaluation	
						Yes/No[3]	Priority	Yes/No	Priority
Washington Elementary (old)	27.43%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Wenatchee High	27.33%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A
Wenatchee Valley Technical Skills Center	27.44%	D	Moderate	Low to Moderate	Moderate	Yes	Moderate	Yes	Moderate
WestSide Alternative High	27.45%	D	Moderate	Very Low to Low	Moderate	Yes	Moderate	No	N/A

[1] Campus level risk is generally proportional to the combined earthquake hazard, but depends very strongly on the seismic vulnerability of buildings which must be evaluated at the building level. Thus, earthquake risk cannot be defined meaningfully at the campus level, except by doing building-level evaluations and then aggregating building results to provide campus-level risk.

[2] Earthquake ground motion measured as peak ground acceleration (PGA) relative to the "g", the acceleration of gravity.

[3] "Limited" applies only to campuses with low ground shaking hazard level (2% in 50 year PGA less than 20% g) and means building-level risk assessments are recommended only for the most vulnerable building types.

° The six site classes are identified as follows: A-Hard Rock, B-Rock, C-Very Dense Soil and Soft Rock, D-Firm Soil, E-Soft Soil and F-Very Soft Soil. Estimates by DNR also include intermediate classes such as D-E, where the data is not sufficient to distinguish between D and E, as well as G-Unknown, when data is missing.

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The information has been developed and presented for the sole purpose of developing school district mitigation plans and to assist in determining where to focus resources for additional evaluations of natural hazard risks. The reports are not intended to constitute in-depth analysis or advice, nor are they to be used as a substitute for specific advice obtained from a licensed professional regarding

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Earthquake Campus-Level Hazard and Risk Report: Preliminary[1]									
Campus	Earthquake Ground Shaking 2% in 50 Years[2] (% g)	Site Class°	Earthquake Ground Shaking Hazard Level	Liquefaction Potential	Combined Earthquake Hazard Level	Recommendations			
						Building Level Risk Assessment		Geotechnical Evaluation	
						Yes/No[3]	Priority	Yes/No	Priority
the particular facts and circumstances of the natural hazard risks to a particular campus or building.									

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The level of earthquake hazard – the frequency and severity of future earthquake ground motions – is nearly constant for the Wenatchee School District's campuses. The level of earthquake hazard is slightly higher at the Valley Academy of Learning, because the softer soils at this campus will amplify earthquake ground motions.

The level of earthquake risk – the threat of damage and casualties – depends on the *combination* of earthquake hazard and the seismic vulnerability of each building. This the level of earthquake risk may vary substantially from campus to campus and from building to building at a given campus.

The building data in table on the following pages have been edited to reflect the seismic improvements made to many buildings during modernization. These tables differ from those in the ICOS Database. When ICOS is updated to add the capability of adjusting algorithms for buildings with seismic retrofits, the data in these tables should be added to ICOS. The following tables are editable Excel Worksheet Objects.

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Table 6.4
Building-Level Earthquake Report

Wenatchee Building-Level Earthquake Report											
Building-Area	Seismic Design Criteria			Building Type	Seismic Design Basis Code	ASCE 41-13 Tier 1 Evaluation		Further Evaluation Desired	Mitigation Desired (yes/no)	Mitigation Type	Mitigation Complete (yes/no)
	Year Built	Retrofit Year	Post-Benchmark (yes/no)			Yes/ No	Risk Level and Priority				
Abraham Lincoln Elementary School Facility											
87 Addition - Area 1	1987		N	RM1L	Moderate	Y	Moderate	Y	TBD		
Main Building - Area 1	1957	2016	Y	RM1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
New School not just 100-Wing - 100-Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 200 Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 300-Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 400 Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 500-Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 600-Wing	2016		Y	FLt	Moderate	N	Low	N	N		
- 700 Wing	2016		Y	FLt	Moderate	N	Low	N	N		
Columbia Elementary School Facility											
Main Building - Area 1	1989		N	FLT	Low	Y	Moderate	Y	TBD		
Portable B-03-2-08 - Area 1	2003		N	MH	Moderate	Y	Moderate	Y	TBD		
Portable B-06-2-03 - Area 1	2006		Y	MH	Moderate	N	Low	N	N		
Foothills Middle School Facility											
Main Building - Area 1	1993		N	S1L	Low	Y	Moderate	Y	TBD		
Portable M-97-2-17 - M-97-2-17	1997		N	MH	Low	Y	Moderate	Y	TBD		
John Newbery Elementary School Facility											
Main Building - Area 1	1993		N	FLT	Low	Y	Moderate	Y	TBD		
Newbery Sprung Structure - Area 1	1998		N	S3	Low	Y	Moderate	Y	N		
Portable B-05-2-12 - Main Area	2005		Y	MH	Moderate	N	Low	N	N		
Portable B-05-21-2 - Area 1	2005		Y	MH	Moderate	N	Low	N	N		
Portable B-06-2-11 - Area 1	2006		Y	MH	Moderate	N	Low	N	N		

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Wenatchee Building-Level Earthquake Report											
Building-Area	Seismic Design Criteria			Building Type	Seismic Design Basis Code	ASCE 41-13 Tier 1 Evaluation		Further Evaluation Desired	Mitigation Desired (yes/no)	Mitigation Type	Mitigation Complete (yes/no)
	Year Built	Retrofit Year	Post-Benchmark (yes/no)			Yes/ No	Risk Level and Priority				
Lewis and Clark Elementary School Facility											
Main Building - Area 1	1989		N	FLT	Low	Y	Moderate	Y	TBD		
Portable B-08-2-14 - Area 1	2008		Y	MH	Moderate	N	Low	N	N		
Portable B-08-2-15 - Area 1	2008		Y	MH	Moderate	N	Low	N	N		
Mission View Elementary School Facility											
300 Wing 1971 - Area 1	1971		N	W1	Pre	Y	Moderate	Y	TBD		
Main Building - Area 1	1989		N	FLT	Low	Y	Moderate	Y	TBD		
Portable B-08-2-01 - Area 1	2008		Y	MH	Moderate	N	Low	N	N		
Portable M-97-2-02 - Area 1	1997		N	MH	Low	Y	Moderate	Y	TBD		
Orchard Middle School Facility											
2003 Addition - Area 1	2003		Y	RM1L	Moderate	N	Low	N	N		
Main Building - Area 1	1962	2007	Y	C3L	High	Y	Low	N	N	Structural Retrofit	Y
Pioneer Middle School Facility											
04 Addition - Area 1	2004		Y	FLT	Moderate	Y	Low	N	N		
62 Addition - Area 1	1962	2006	Y	C1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
- Area 2	1962	2006	Y	C1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Gymnasium - Area 1	1957	2015	Y	C1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Main Building - Area 1	1957	2006	Y	PC2L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Portable B-12-2-20 - Area 1	2012		Y	MH	Moderate	N	Low	N	N		
Special Education School Facility											
Washington Annex (Castlerock) - Area 1	1959	2016	Y	RM1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Sunnyslope Elementary School Facility											
03 Addition - Area 1	2003		Y	W1	Moderate	N	Low	N	N		
Main Building - Area 1	1958	2007	Y	RM1L	High	Y	Low	N	N	Structural Retrofit	Y

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Wenatchee Building-Level Earthquake Report												
Building-Area	Seismic Design Criteria			Building Type	Seismic Design Basis Code	ASCE 41-13 Tier 1 Evaluation		Further Evaluation Desired	Mitigation Desired (yes/no)	Mitigation Type	Mitigation Complete (yes/no)
	Year Built	Retrofit Year	Post-Benchmark (yes/no)			Yes/ No	Risk Level and Priority				
Valley Academy Of Learning Facility											
Main Building - Area 1	1985		N	S3	Low	Y	Moderate	Y	TBD		
Washington Elementary School Facility											
New Building - Area Lower New	2016		Y	S2L	Moderate	N	Low	N	N		
Gym/Multipurpose Room	2016		Y	RM1L	Moderate	N	Low	N	N		
New Main Level - Area Main New	2016		Y	S2L	Moderate	N	Low	N	N		
Wenatchee High School Facility											
04 Addition - Area 1	2004		Y	RM1L	Moderate	N	Low				
East Building - Area 1	1972	2018 Planned	N	RM1L	Pre	Y	Low After Retrofit	N	N	Structural Retrofit	Planned
West Building - Area 1	1993		N	RM1L	Moderate	Y	Low After Retrofit	N	N		
Portable B-12-2-20 - Area 1	2012		Y	MH	Moderate	N	Low	N	N		
Portable B-13-2-22 - Area 1	2013		Y	MH	Moderate	N	Low	N	N		
Portable M-06-2-21 - Area 1	2006		Y	MH	Moderate	N	Low	N	N		
Portable xx (Science) - Science CLassroom	2015		Y	MH	Moderate	N	Low	N	N		
Portable xx (Science) - Science CLassroom	2016		Y	MH	Moderate	N	Low	N	N		
Portable M-99-2-18 - Area 1	1999		N	MH	Low	Y	Moderate	Y	TBD		
Portable B-97-1-10 - Area 1	1997		N	MH	Low	Y	Moderate	Y	TBD		
Portable E-01-1-09 - Area 1	2001		N	MH	Moderate	Y	Moderate	Y	TBD		
Westside Alternative High School Facility											
Fitness Building - Area 1	1990		N	RM1L	Moderate	Y	Moderate to High	Y	TBD		
Main Building - Main	1985		Y	RM1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Portable B-04-2-15	2004		Y	MH	Moderate	Y	Low	N	N		
Portable B-05-2-07	2005		Y	MH	Moderate	N	Low	N	N		
Portable B-04-2-16	2004		Y	MH	Moderate	Y	Low	N	N		
Portable B-04-2-04	2004		Y	MH	Moderate	Y	Low	N	N		
Portable B-05-2-06	2006		Y	MH	Moderate	N	Low	N	N		
Portable B-08-2-05	2008		Y	MH	Moderate	N	Low	N	N		

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Wenatchee Building-Level Earthquake Report											
Building-Area	Seismic Design Criteria			Building Type	Seismic Design Basis Code	ASCE 41-13 Tier 1 Evaluation		Further Evaluation Desired	Mitigation Desired (yes/no)	Mitigation Type	Mitigation Complete (yes/no)
	Year Built	Retrofit Year	Post-Benchmark (yes/no)			Yes/ No	Risk Level and Priority				
Wenatchee Valley Technical Skills Center Facility											
Building A - Area 1	1996		Y	RM1L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Building B - Area 1	1995	2014	Y	C3L	Moderate	Y	Low	N	N	Structural Retrofit	Y
Building C - Area 1	2015		Y	S1L	Moderate	N	Low	N	N		

[1] ASCE 41-13 seismic evaluations are recommended for buildings that were not designed to a "benchmark" seismic code deemed adequate to provide life safety. However, ASCE 41-13 recommends that post-benchmark code buildings be evaluated by an engineer to verify that the as-built seismic details conform to the design drawings. Most such buildings should be compliant, unless poor construction quality degrades the expected seismic performance of the building.

[2] The priority for 41-13 evaluations is based on the building type, the combined earthquake hazard level (ground shaking and liquefaction potential), the seismic design basis, and whether a building has been identified as having substantial vertical or horizontal irregularities. These priorities recognize that many districts have limited funding for 41-13 evaluations. Districts with adequate funding may wish to complete 41-13 evaluations on all pre-benchmark year buildings.

[3] The earthquake risk level is low for all buildings for which an ASCE 41-13 evaluation is not recommended as necessary. For other buildings, the preliminary risk level and the priority for 41-13 evaluation are based on the earthquake hazard level, the building structural type, the seismic design level and whether a building has vertical and horizontal irregularities.

[a] The final determination of priorities for retrofit are based on whether a building is compliant with the 41-13 life safety criteria. If not, the priorities should be set in close consultation with the engineer who completed the 41-13 evaluation.

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6.9 Earthquake Hazard Mitigation Measures for K–12 Facilities

6.9.1 Typical Seismic Mitigation Measures

There are several possible earthquake mitigation Action Items for the district's facilities, including:

- Replacement of seismically vulnerable buildings with new buildings that meet or exceed the seismic provisions in the current building code.
- Structural retrofits for buildings.
- Nonstructural retrofits for buildings and contents.
- Installation of emergency generators for buildings with critical functions, including designated emergency shelters.
- Enhanced emergency planning, including earthquake exercises and drills.

Of these potential earthquake Action Items, FEMA mitigation grants, which typically provide 75% of total project costs, may be available for structural or nonstructural retrofits and for emergency generators.

Earthquake Action Items for the Wenatchee School District are given in Table 6.5.

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Table 6.5
Wenatchee School District: Earthquake Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Earthquake Mitigation Action Items								
Short-Term #1	Consult with an engineer to determine which of the buildings listed the Building Level Earthquake Table as TBD whether these buildings need further evaluation, retrofit or replacement	1-3 Years	Local Bond or Grant	Supt.	X	X		X
Short-Term #2	Evaluate the foundations of the portable buildings to determine whether they are adequate for earthquakes (and high wind events)	1-3 Years	Local Bond or Grant	Supt.	X	X		X
Long-Term #1	Prioritize and implement seismic retrofits or replacements based on the results of the evaluations, as funding becomes available.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #2	Maintain and update building data for seismic risk assessments in the OSPI ICOS PDM database.	Ongoing	Local Bond or Grant	Supt.	X	X		X
Long-Term #3	Enhance emergency planning for earthquakes including duck and cover and evacuation drills.	Ongoing	Local Bond or Grant	Supt.	X		X	X

6.10 References

1. United States Geological Survey (2013). Largest Earthquakes in the World Since 1900. http://earthquake.usgs.gov/earthquakes/world/10_largest_world.php

2. University of Washington (2002). Map and List of Significant Quakes in WA and OR, the Pacific Northwest Seismograph Network. University of Washington Department of Earth Sciences.

3. Washington State Department of Natural Resources (2013). https://fortress.wa.gov/geology?Theme-wigm

4. Cascadia Region Earthquake Working Group (2005): Cascadia Subduction Zone Earthquakes: A Magnitude 9.0 Earthquake Scenario.

5. Oregon Seismic Safety Policy Advisory Commission (2013). The Oregon Resilience Plan.

6. Washington State Department of Natural Resources (2004). Liquefaction Susceptibility and Site Class Maps of Grays Harbor County, Washington. Open File Report 2004-20.

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7.0 FLOODS

7.1 Introduction

Parts of the area served by the Wenatchee School District may be subject to flooding from several different flood sources:

- Overbank flooding from rivers and streams.
- Local stormwater drainage.
- Channel migration.
- Sheet flow (alluvial fan flooding).
- Flooding from failures of dams, reservoirs or levees.

Overbank flooding from rivers and stream occurs throughout Washington, most commonly from winter storms with heavy rainfall from November to February. Flood events with significant contributions from snowmelt may also occur during the spring snowmelt season for watersheds with high enough elevations to have significant snowfalls. Although it is less common, overbank flooding can also occur at any time of the year. The severity of overbank flooding depends primarily on flood depth. However, other factors such as flood duration, flow velocity, debris loads, and contamination with hazardous materials also significantly impact the severity of any given flood event. Overbank flooding can be very severe and affect broad geographic areas.

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Local storm water drainage flooding, sometimes referred to as urban flooding, occurs when inflows of storm water exceed the conveyance capacity of a local storm water drainage system. With this type of flooding, the drainage system overflows, resulting in water ponding in low lying areas. Storm water drainage flooding is generally localized, with flood depths that may range from a few inches to several feet.

Channel migration flooding occurs when ongoing erosion/deposition on the banks of a river result in the channel of the river or stream migrating (moving) to an extent that structures are affected by floods. Rivers or streams with low gradients (flat topography) and meandering patterns are prone to channel migration**.**

Sheet flow flooding (alluvial fan flooding) occurs when stream flows are not confined to a channel but occur over a broad area. Sheet flows are common in areas within alluvial fans, which are sloping accumulations of sediments eroded from mountains or hills. **For the Wenatchee School District, sheet flow flooding is the predominant risk. All 15 of the district's campuses are subject to this type of flooding, to varying degrees of severity.**

Failures of dams, reservoirs for potable water systems or levees results in flooding areas downstream of dams and reservoirs or behind levees. Failures of major dams

operated and regulated by state or federal agencies are possible, but unlikely because these dams are generally well-designed, well-monitored, and well-maintained. However, failures of smaller dams maintained by local governments, special districts or private owners are more common.

Failures of reservoirs for potable water systems occur, especially from earthquakes. These reservoirs typically have much smaller storage volumes than dams, so flooding from failures is generally localized, but may be severe where flows are confined in narrow channels which contain structures or infrastructure. Similar flooding may occur from failures of large diameter water pipes.

Levee failures before overtopping may occur at any time, not only during high water events but also under normal non-flood conditions. There are numerous causes for such failures, including scour, foundation failures, under-seepage, through-seepage, animal burrows, and others.

7.2 Flood Hazard and Risk Assessments: Wenatchee School District

The potential impacts of future floods on the Wenatchee District are primarily damage to buildings and contents, disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made. The likelihood of deaths or injuries is extremely low, because schools will be evacuated whenever flood warnings are issued and the district's facilities are very unlikely to be affected by flash flooding.

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The vulnerability of the Wenatchee School District's facilities to flooding varies markedly from campus to campus and from building to building on a given campus. The approximate levels of flood hazards and vulnerability are identified in the following sections at the campus-level and the building-level.

7.3 Flood Hazard and Risk Assessments: FEMA-Mapped Floodplains

FEMA Flood Insurance Rate Maps (FIRMs) delineate the regulatory (100-year) floodplain areas in Washington. Per FEMA regulations, there are limitations on new development within the 100-year floodplain.

The 100-year flood is defined probabilistically. A 100-year flood does not occur exactly every 100 years. Rather, the 100-year flood is the flood with a 1% chance of being exceeded in any given year. A 1% annual chance of flooding corresponds to about a 26% chance of flooding in a 30-year time period. A given location may have two or more 100-year (or greater) flood events within a few years or have none in several decades or longer.

FEMA's floodplain mapping provides a good starting point for flood hazard risk assessments. Facilities within FEMA mapped floodplains have at least some level of

flood risk. However, determining the level of risk quantitatively requires additional flood hazard data, including the elevation of facilities relative to the elevation of a range of flood events. It is also important to recognize that some facilities not within FEMA-mapped floodplains also have high levels of flood risk.

FEMA floodplain maps represent the best available data at the time the maps were prepared. FEMA has an ongoing map modernization/update process, but many existing FIRM maps are old—some more than 30 years old. In many cases, flood risk in a given location increases with time because increasing development within the watershed increases runoff, and because development and fill within floodplains or sedimentation in a river channel may increase flood elevations. In some cases, flood elevations for a 100-year flood using current data may be up to several feet higher than outdated floodplain maps indicate.

Flood risk at a given location may also decrease over time if flood control structures such as levees or upstream dams for flood control are constructed or improved. Old floodplain maps are not necessarily incorrect. However, older maps should be interpreted carefully because the older a map is, the more likely it is to be significantly incorrect.

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Recent and future FEMA floodplain maps are available in digital GIS-format and are known as DFIRMs. Older maps, which were originally prepared in paper format only, have been digitized, but contain less detailed information than DFIRMs. These maps are known as Q3 maps. For any given location, the most recent FEMA maps should be used for flood risk assessments.

FEMA floodplain maps identify several types of flood zones, with varying levels of flood hazard. The FEMA flood zone designations have evolved over time, with older maps using different nomenclature than recent maps. FEMA's current and historical flood zone designations are summarized in the following tables.

Table 7.1
FEMA Flood Zones

HIGH RISK AREAS

ZONE	DESCRIPTION
A	Areas with a 1% annual chance of flooding and a 26% chance of flooding over 30 years. Because detailed analyses are not performed for such areas, no depths or base flood elevations are shown within these zones.
AE, A1–A30	The base floodplain where base flood elevations are provided. AE Zones are now used on new format FIRMs instead of A1–A30 Zones.
AH	Areas with a 1% annual chance of shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over 30 years. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
AO	River or stream flood hazard areas and areas with a 1% or greater chance of shallow flooding each year, usually in the form of sheet flow, with an average depth ranging from 1 to 3 feet. These areas have a 26% chance of flooding over 30 years. Average flood depths derived from detailed analyses are shown within these zones.
AR	Areas with a temporarily increased flood risk due to the building or restoration of a flood control system (such as a levee or a dam).
A99	Areas with a 1% annual chance of flooding that will be protected by a Federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.

HIGH RISK COASTAL AREAS

ZONE	DESCRIPTION
V	Coastal areas with a 1% of greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over 30 years. No base flood elevations are shown with these zones.
VE, V1–V30	Coastal areas with a 1% of greater chance of flooding and an additional hazard associated with storm waves. These areas have a 26% chance of flooding over 30 years. Base flood elevations derived from detailed analysis are shown at selected intervals within these zones.

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MODERATE TO LOW RISK AREAS

ZONE	DESCRIPTION
B and X (shaded)	Area of moderate flood hazard, usually the area between the limits of the 100-year and 500-year floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from 100-year flood, or shallow flooding areas with average depths of less than one foot or drainage areas less than 1 square mile.
C and X (unshaded)	Area of minimal flood hazard, usually depicted on FIRMs as above the 500-year flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 500-year flood and protected by levee from 100-year flood.

UNDETERMINED RISK AREAS

ZONE	DESCRIPTION
D	Areas with possible but undetermined flood hazards. No flood hazard analysis has been conducted. Flood insurance rates are commensurate with the uncertainty of the flood risk.

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FEMA Flood Insurance Rate Maps are always accompanied by Flood Insurance Studies. Flood Insurance Studies contain summaries of historical floods, details of the flood mapping and quantitative flood hazard data which is essential for quantitative flood risk assessments.

FEMA Flood Insurance Studies and Flood Insurance Rate Maps include a large number of terms of art and acronyms. A good summary of the terms used in flood hazard mapping is available from FEMA.[1]

The level of flood hazard (frequency and severity of flooding) for a given campus or building is not determined simply by whether the campus or building is or is not within the mapped 100-year floodplain. Rather, the level of flood hazard depends to a great extent on the elevation of buildings relative to the elevation of various flood events, such as the 10-year, 50-year, or 100-year flood event.

For example, consider two schools both within the 100-year floodplain of a given river. The first school has a first floor elevation three feet above the 100-year flood elevation and the level of flood hazard is low (but not zero). The second school has a first floor elevation three feet below the 100-year flood elevation and the level of flood hazard is

very high. In this example, the six foot difference in elevations of the two schools makes an enormous difference in the level of flood hazard.

For buildings within most FEMA mapped flood zones, quantitative flood data in the Flood Insurance Study allow calculation of the probability of flooding for any building, if the building's first floor elevation is known. The flood data used to make this calculation include stream discharges (volume of water flowing in a river) and flood elevations for floods of several different return periods (typically, the 10-, 50-, 100- and 500-year floods). For further details about flooding, see Chapter 10 in the Washington State K–12 Hazard Mitigation Plan. The OSPI Mitigation Planning Toolkit also has more detailed guidance and templates to gather and use the types of flood hazard data discussed above.

The latest FEMA floodplain map for the City of Wenatchee is Community Panel Number 530020 0005 C, dated January 6, 1994. An excerpt from this map is shown on the following page.

Other than the very narrow area adjacent to the Columbia River that has no district campuses, all of the floodplain areas shown on the map are areas subject to sheet flow flooding (alluvial fan flooding): drainage from the hills that are upslope from the mapped areas. Sheet flow flooding is characterized by high-velocity flows, erosion, sediment transport and deposition and unpredictable flow paths that may vary from flood event to flood event.

All of the District's 15 campuses, including the Sunnyslope Elementary School, which is outside the map area, because the floodplain map shown is limited to the City of Wenatchee's boundary, are subject to sheet flow flooding.

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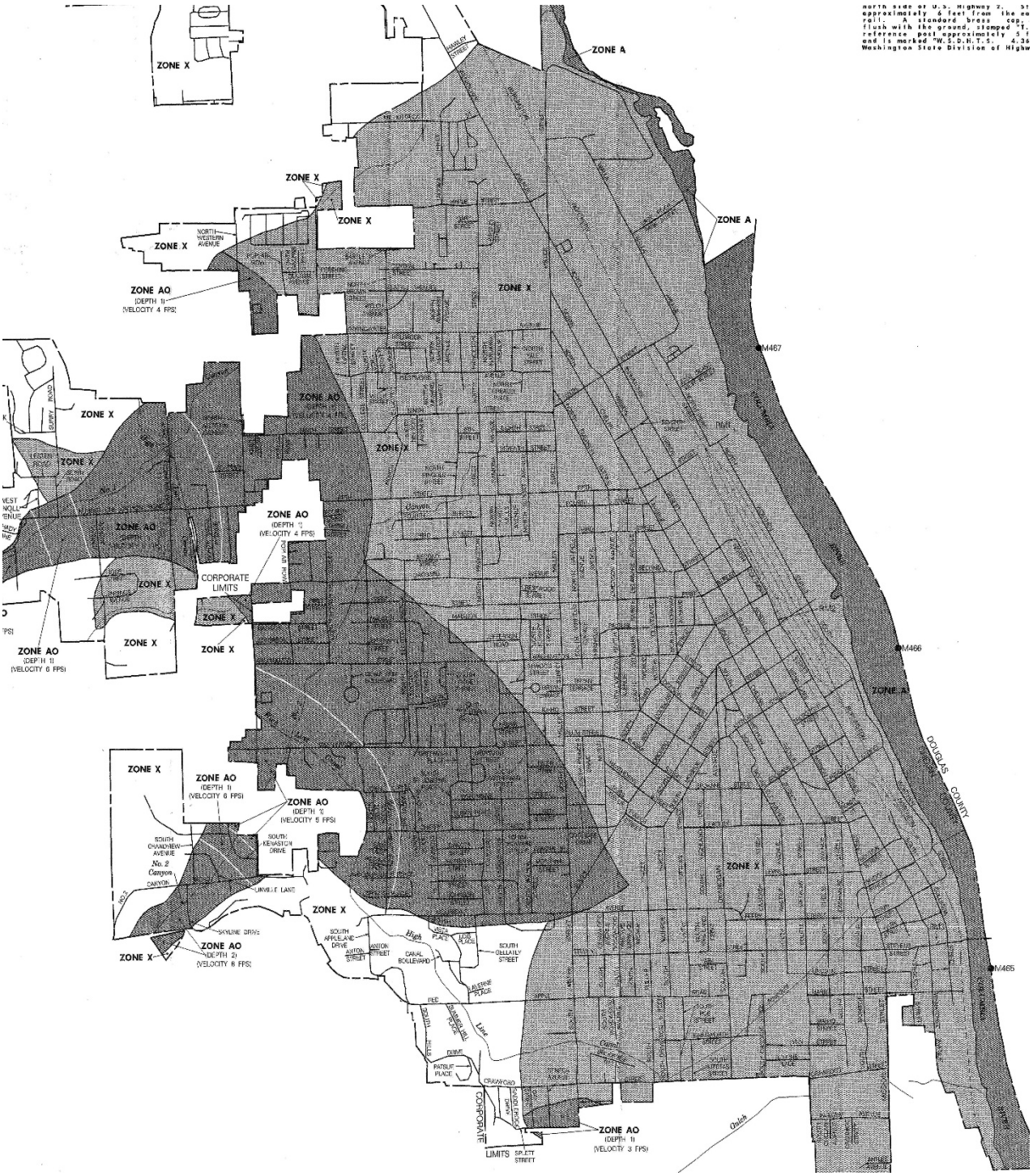
Figure 1
FEMA Floodplain Map for Wenatchee (Excerpt)



The darkest shading areas are Zone AO – areas subject to approximately one foot of sheet flow flooding in events with an average return period of 100 years. The lighter

shaded areas are Zone X (shaded): within the 500-year floodplain and within the 100-year floodplain with depths less than one foot.

All of the shaded areas in Figure 1 on the previous page are subject to smaller flood events with shallow flooding and possible localized damage with frequencies significantly less than 100-years.

The campus-level flood hazard and risk report exported from the OSPI ICOS Pre-Disaster Mitigation database is shown on the following pages.

The summary interpretation of the flood data shown in Table 7.2 includes:

- Four of the campuses are within FEMA Flood Zone AO.
- All of the other campuses are in FEMA Flood Zone X (Shaded).
- The preliminary level of flood risk is “moderate” for the four campuses in Zone AO and for the Valley Academy of Learning, the only campus with a history of previous flooding.

NOTE: Some of the FEMA Flood Zone designations, the Preliminary Flood Risk Levels and the Priorities for Building Level Flood Assessments have been modified from the data in ICOS. When the mitigation plan is updated, the ICOS database should be updated.

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Table 7.2
Wenatchee School District Campus-Level Flood Hazard and Risk Report

Flood Campus-Level Hazard and Risk Report									Recommendation	
Campus	**Within FEMA Floodplain**	**FEMA Flood Zone**	**Local Flood Study°**	**Within 0.5 Mile of FEMA Flood Zone[1]**	**Number of Flood Events in 20 Years[2]**	**Other Flood Concerns[3]**	**Campus at Grade Elevation (NAVD 1988)‡**	**Preliminary Flood Risk Level†**	**Complete Building Level Flood Assessment (Yes/No)**	**Priority**
WENATCHEE SCHOOL DISTRICT										
Abraham Lincoln Elementary	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Columbia Elementary	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Foothills Middle	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
John Newbery Elementary	Yes	AO	No	In Zone	None	No	N/A	Moderate	Yes	Moderate
Lewis and Clark Elementary	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Mission View Elementary	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Orchard Middle	Yes	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Pioneer Middle	Yes	AO	No	In Zone	None	No	N/A	Moderate	Yes	Moderate
Special Education	No	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Sunnyslope Elementary	No	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
Valley Academy Of Learning	No	X Shaded	No	In Zone	1	No	N/A	Moderate	Yes	Moderate
Washington Elementary (old)	Yes	AO	No	In Zone	None	No	N/A	Moderate	Yes	Moderate
Wenatchee High	Yes	X	No	In	None	No	N/A	Low	Yes	Low

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Flood Campus-Level Hazard and Risk Report									Recommendation	
Campus	**Within FEMA Floodplain**	**FEMA Flood Zone**	**Local Flood Study°**	**Within 0.5 Mile of FEMA Flood Zone[1]**	**Number of Flood Events in 20 Years[2]**	**Other Flood Concerns[3]**	**Campus at Grade Elevation (NAVD 1988)‡**	**Preliminary Flood Risk Level†**	**Complete Building Level Flood Assessment (Yes/No)**	**Priority**
		Shaded		Zone						
Wenatchee Valley Technical Skills Center	No	X Shaded	No	In Zone	None	No	N/A	Low	Yes	Low
WestSide Alternative High	Yes	AO	No	In Zone	None	No	N/A	Moderate	Yes	Moderate

° With quantitative flood hazard data, similar to FEMA Flood Insurance Study.

[1] Applicable only if campus is not within a mapped flood zone.

[2] Severe enough to result in school closure and/or damage to at least on building.

[3] Local storm water drainage flooding, campus near stream/river without FEMA flood mapping, campus behind levee or down stream from a dam, campus on alluvial fan subject to sheet flows, campus near a migrating stream/river, or local flood study completed.

‡ Base on campus at grade elevation relative to flood elevations for 10, 50, 100 and 500 year flood elevations (if data entered on flood PDM screen) and/or on other district-entered data on the flood PDM screen.

† Preliminary estimate of flood risk, based on quantitative flood data (if entered on the Flood PDM Screen) and/or on the number of flood events in 20 years and expressed concerns about floods. More accurate risk assessments require building-level assessments: flood risk may vary markedly from building to building on a given campus, depending on a building's elevation and other factors.

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While a number of school campuses are within a half mile of a FEMA flood zone the risk throughout the district is relatively low to null. Most of the facilities that are within a half mile of a FEMA flood zone are at a significantly at greater elevation than the nearest river or creek. The school district has not experienced any damage at any of the campuses.

7.4 Flood Hazard and Risk Assessments: Outside FEMA-Mapped Floodplains

Nationwide, more than 25% of flood damage occurs outside of FEMA-mapped floodplains. Campuses outside of FEMA-mapped floodplains may have significant flood risk if any of the following conditions apply:

- There is a history of floods from any source affecting or near a campus.
- Local storm water drainage flooding is common on or near a campus.
- Campus is near a river or stream not mapped by FEMA.
- Campus is on an alluvial fan subject to sheet flows.
- Campus is near a migrating river or stream.
- Campus is behind a levee or downstream of a dam or reservoir.
- A local flood hazard study is available for the campus and vicinity.

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Guidance on evaluating flood hazards and risk for the above conditions is given in Chapter 10 of the Washington State K–12 Hazard Mitigation Plan and the OSPI Mitigation Planning Toolkit, and in the Hazard and Risk Assessments for School District Hazard Mitigation Plans: Technical Guidance Manual.

For flood-prone locations without quantitative flood hazard data, a different approach is required to evaluate flood hazards and flood risk than for locations where either a FEMA Flood Insurance Study or an equivalent local flood study provide the stream discharge and flood elevation data necessary for quantitative calculations. There are several possible options:

- For locations with a history of repetitive flooding, empirical estimates of the frequency (return period) of flooding can be made in two ways:
    - Using the FEMA Version 5.2.1 Benefit-Cost Analysis Damage-Frequency software, which is available for download on the FEMA
- For high value facilities where flood risk appears high, it may be worthwhile to have a local hydrologic and hydraulic study completed to obtain the types of quantitative flood hazard data contained in a FEMA Flood Insurance Study. Such local studies may also be worthwhile when the FEMA Flood Insurance Study is old and there are reasons, such as increased development in the watershed, to suspect that flood hazards may have significantly increased.

- For locations subject to stormwater drainage flooding, engineers knowledgeable about the stormwater system may be able to provide quantitative data on the conveyance capacity of the system to supplement historical flood data. Stormwater systems are often designed to handle only 2-year or 5-year flood events, and are infrequently designed to handle rainfall events greater than 10-year or 15-year events.
- Estimating flood hazards and risks for locations behind levees or downstream from dams or reservoirs requires consultation with subject matter experts.

Evaluation of flood hazards and flood risk outside of mapped-floodplains necessarily requires more engineering experience and judgment than required to interpret the flood data in mapped riverine floodplains.

One important caveat is that the absence of a history of past flood events may indicate that flood risk is low, but this is not necessarily the case. Flood risk is inherently probabilistic. A campus that hasn't had a flood in 10, 20, or 30 years may have just been "lucky" and flood damage might occur with floods of similar return periods. Or, the flood risk might have increased over time because of increasing development upstream in the watershed (which increases runoff) or because of channel changes. Or, a campus might not have frequent flooding, but the level of damages for a 50-year or 100-year event might be very severe.

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7.5 National Flood Insurance Program Insured Structures

The Wenatchee District has no NFIP insured structures.

7.6 Flood Mitigation Projects

For K–12 facilities with substantial levels of flood risk there are several types of potential flood mitigation measures available:

- Replacement of a facility at high risk from floods with a new facility located outside of flood hazard zones.
- Elevation of an existing building.
- Construction of levees, berms, or flood walls to protect a facility.
- Installation of flood gates along with building water proofing measures.
- Minor floodproofing actions that address the most vulnerable elements in a facility; such projects include elevating at-grade utility infrastructure or relocating critical equipment or contents from basement levels of a building to higher levels.
- Local drainage improvements where stormwater drainage is a problem.

Replacing an at-risk facility with a new facility outside of flood hazard zones is essentially 100% effective in reducing future flood damages. A new replacement building also has other advantages such as energy efficiency and fully meeting current functionality requirements. Of course, the major impediment to widespread replacement is the cost.

The extent to which any of the above mitigation measures are warranted depends on the level of flood risk and on district priorities. For K–12 facilities at high flood risk, FEMA grant funding may be available for most of the flood mitigation measures noted above.

FEMA doesn't replace existing facilities, but does do acquisition/demolition projects in which the fair market value of a property is the total eligible project cost. FEMA-funded acquisition projects require demolition of the existing facility and deed restrictions to prevent future development of the area. Acceptable uses after demolition are limited to green space such as parks or sports fields with development limited to incidental structures such as a restroom. With such projects, the FEMA funding, which is typically 75% of the total project costs, can be used towards building a replacement facility.

On a community or regional level, larger-scale flood control measures such as construction of upstream dams or detention basins and channel improvements may be effective in reducing flood risks. However, such larger-scale projects are outside the domain of responsibility for school districts.

The Wenatchee School District's flood mitigation Action Items are shown in Table 7.3 on the following page.

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Table 7.3
Wenatchee School District: Flood Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Flood Mitigation Action Items								
Short-Term #1	Complete building-level flood risk assessments for the five campuses where the priority for assessments in Table 7.2 is “moderate”.	1-2 Years	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Complete building-level flood risk assessments for the other campuses, with priority for buildings with basements, buildings with first floors elevations near grade, and buildings where loss of function in future floods would have the greatest impact on the District.	2-5 Years	Local Bond or Grant	Supt.	**X**	X	**X**	**X**
Short-Term #3	Enhance emergency planning, including flood response measures such as sandbagging, for all campuses that have or may have significant flood risk.	Ongoing	Local	Supt.	**X**	**X**	**X**	**X**
Long – Term #1	Locate new campuses outside of FEMA-mapped floodplains or other flood-prone areas whenever possible or construct new buildings in flood-prone areas at elevations as high as possible to minimize flood risk.	On-going	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**

7.7 References

1. FEMA 480: National Flood Insurance Program, Floodplain Management Requirements, A Study Guide and Desk Reference for Local Officials. Available in hard copy and on CD from FEMA at (800) 480-2520.

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8.0 WILDLAND/URBAN INTERFACE FIRES

8.1 Overview

Fire has posed a threat to mankind since the dawn of civilization. Fires often cause substantial damage to property and may also result in deaths and injuries.

For the purposes of mitigation planning, we define three types of fires:

- Structure fires and other localized fires.
- Wildland fires.
- Wildland/urban interface fires.

Structure fires are fires where structures and contents are the primary fuel. In dealing with structure fires, fire departments typically have three primary objectives: 1) minimize casualties, 2) prevent a structure fire from spreading to other structures, and 3) minimize damage to the structure and contents. Structure fires and the other common types of fires, such as vehicle or trash fires are most often limited to a single structure or location, although in some cases they may spread to adjacent structures.

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Wildland fires are fires where vegetation (grass, brush, trees) is the primary fire fuel and with few or no structures involved. For wildland fires, the most common suppression strategy is to contain the fire at its boundaries and then to let the fire burn itself out. Fire containment typically relies heavily on natural or manmade fire breaks. Water and chemical fire suppressants are used primarily to help make or defend a fire break, rather than to put out an entire fire, as would be the case with a structure fire. For wildland fires, fire suppression responsibility is generally with state and federal fire agencies, although local agencies may also participate.

Wildland/urban interface fires are fires where the fire fuel includes both structures and vegetation. The defining characteristic of the wildland/urban interface area is that structures are built in, or immediately adjacent to, areas with essentially continuous vegetative fuel loads. When wildland fires occur in such areas, they often spread quickly and structures in these areas may, unfortunately, simply become additional fuel sources. Fire suppression efforts for wildland/urban interface fires focus first on savings lives and then on protecting structures to the extent possible. Local fire agencies have primary fire suppression responsibility for most wildland/urban interface fires, although state and federal agencies may also contribute.

This chapter focuses on wildland/urban interface fires that pose a substantial threat to districts with K–12 facilities in locations subject to wildland/urban interface fires.

8.2 Wildland/Urban Interface Fires

Many urban or suburban areas have a significant amount of landscaping and other vegetation. However, in most areas the fuel load of flammable vegetation is not continuous, but rather is broken by paved areas, open space and areas of mowed grassy areas with low fuel loads. In these areas, most fires are single structure fires. The combination of separations between buildings, fire breaks, and generally low total vegetative fuel loads make the risk of fire spreading much lower than in wildland areas.

Furthermore, most developed areas in urban and suburban areas have water systems with good capacities to provide water for fire suppression and fire departments that respond quickly to fires, with sufficient personnel and apparatus to control fires effectively. Thus, the likelihood of a single structure fire spreading to involve multiple structures is generally quite low.

Areas subject to wildland/urban interface fires have very different fire hazard characteristics which are more similar to those for wildland fires. The level of fire hazard for wildland/urban interface fires depends on:

- Vegetative fuel load,
- Topography,
- Climate and weather conditions,
- Ignition sources and frequency of fire ignitions, and
- Fire suppression resources (fire agency response time and resources of crews and apparatus, access, and water supplies).

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High vegetative fuel loads, especially brush and trees, increase the level of wildland/urban fire hazard. Steep topography increases the level of fire risk by exacerbating fire spread and impeding fire suppression efforts by making access more difficult.

The level of fire hazard in areas prone to wildland/urban interface fires is also substantially increased when weather conditions, including high temperatures, low humidity, and high winds, greatly accelerate the spread of wildland fires and make containment difficult or impossible.

Fire suppression resources are typically much lower in wildland/urban interface fire areas than in more highly developed areas. Fire stations are more widely spaced, with fewer resources of crews and apparatus and longer response times because of distance and/or limited access routes. Water resources for fire suppression are typically lower in these areas, which are often predominantly residential and may be served by pumped pressure zones with limited water storage or by individual wells which provide no significant water supply for fire suppression.

These reduced fire suppression resources make it more likely that a small wildland fire or a single structure fire in an urban/wildland interface area will spread before it can be extinguished.

The level of risk from wildland/urban interface fires for K–12 facilities depends on:

- Level of fire hazard as outlined above,
- Value and importance of buildings and infrastructure,
- Vulnerability of inventory at risk, including whether fire-safe construction practices and defensible space measures have been implemented, and
- Population at risk and the efficacy of evacuations.

Life safety risk in wildland/urban interface fires arises in large part from delays in evacuations, once a fire has started. For K–12 facilities with significant risk from wildland/urban interface fires, a well-defined, practical, and practiced evacuation plan is essential to minimize potential life safety risk.

8.3 Wildland and Wildland/Urban Fire Hazard Mapping and Hazard Assessment

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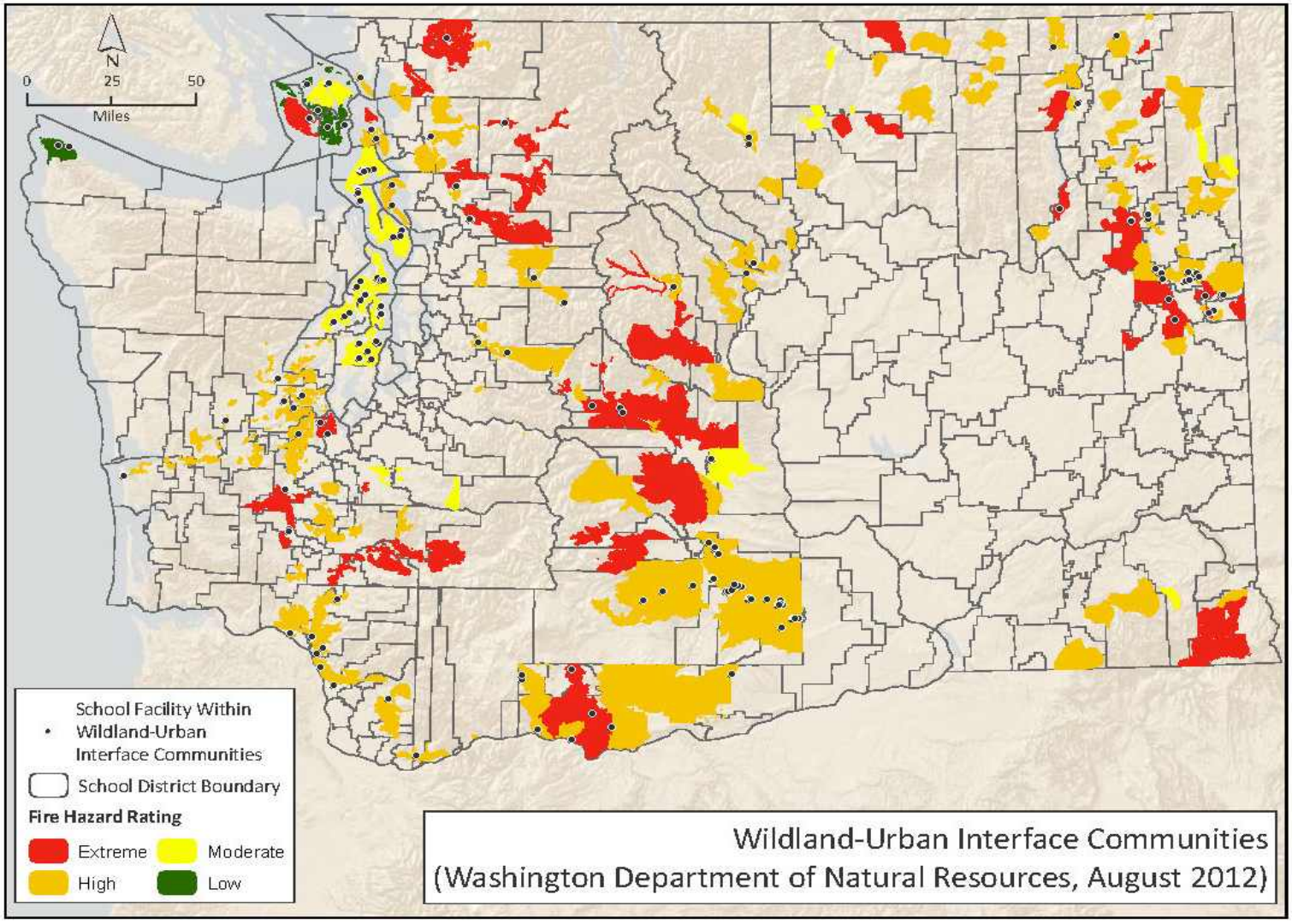
The three maps on the following pages present different measures of wildland and wildland/urban interface fire hazards in Washington. There are important caveats regarding these maps when making wildland/urban interface fire mitigation decisions for K–12 facilities within mapped fire hazard areas:

- The DNR rankings of Wildland/Urban Interface Communities of extreme, high, moderate, or low risk should be interpreted as qualitative or semi-quantitative indicators of the relative level of risk. Facilities identified as being located in communities with “extreme” or “high” levels of risk may not have extreme or high risk as generally understood for mitigation planning purposes. Some of the extreme or high risk interface communities have long burn return periods (the average time interval between fire events) per the USGS Landfire map.
- The USGS Landfire Return Period values should also be interpreted as semi-quantitative indicators of the relative level of risk. The numerical estimates of the burn return period and the corresponding probabilities over a 50-year time period should not be interpreted literally.

The DNR rankings and the USGS Landfire Return Periods are based on analysis of fire regime characteristics, such as vegetative fuel loads, topography, climate, and fire suppression resources. The USGS Landfire Return Periods may indicate higher levels of fire risk than suggested by historical fire data. Furthermore, most of the acreage burned has been wildland with relatively few structures and very few, if any, K–12 facilities.

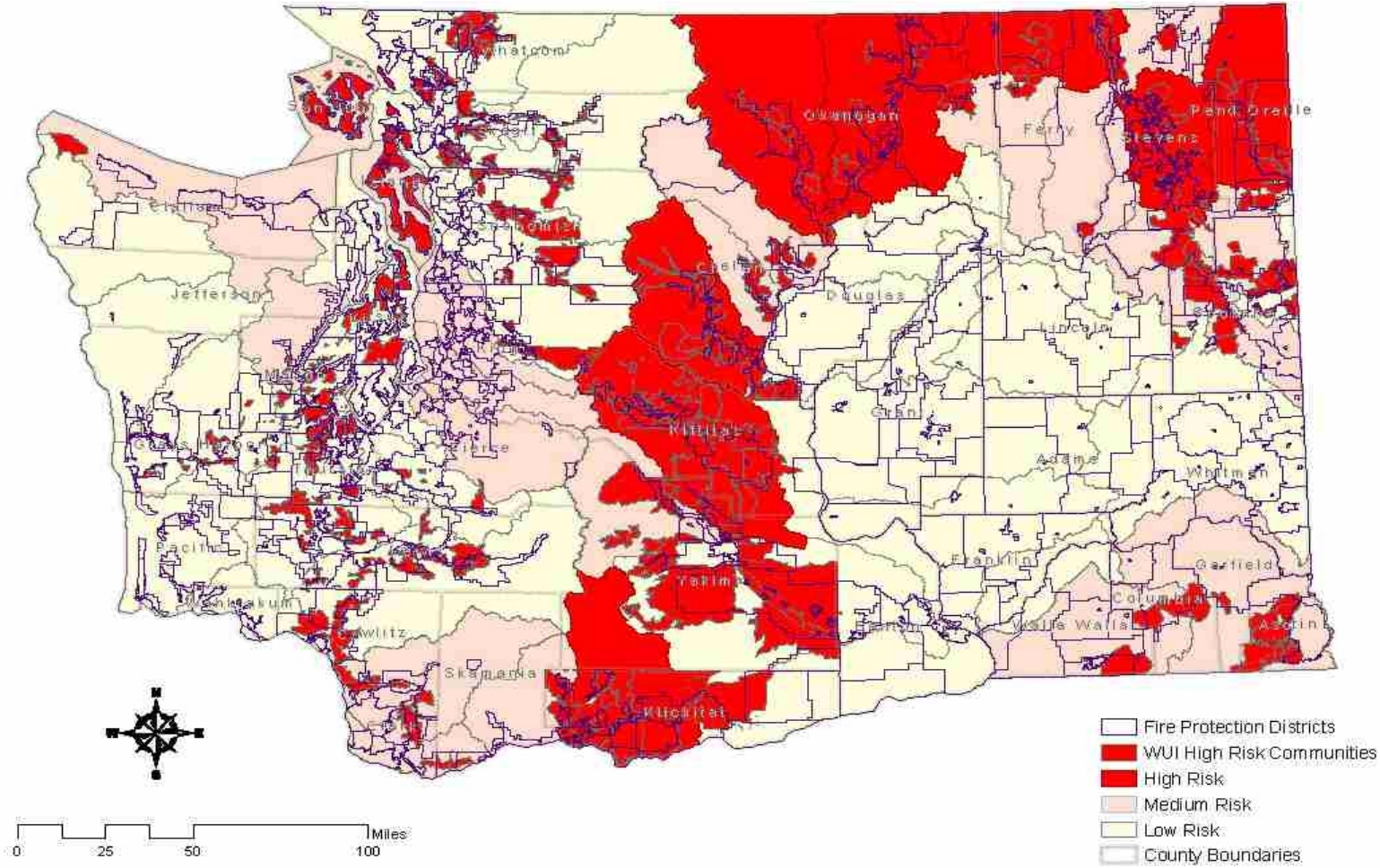
Figure 8.1
Wildland/Urban Interface Communities Identified by Washington Department of Natural Resources



Wenatchee is not identified by DNR as a Wildland/Urban Interface Community. However, adjacent or nearby communities are mapped as such, with High or Extreme wildand/urban interface fire hazard levels.

Figure 8.2

Washington Wildland/Urban Interface High Risk Communities and Statewide Assessment High and Moderate Risk Areas[1]



As Shown above, Wenatchee is mapped as a high or medium fire risk

[1]Washington State Department of Natural Resources, Fire Risk Map, 2010.

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Figure 8.3
United States Geological Survey Landfire Fire Return Period Map

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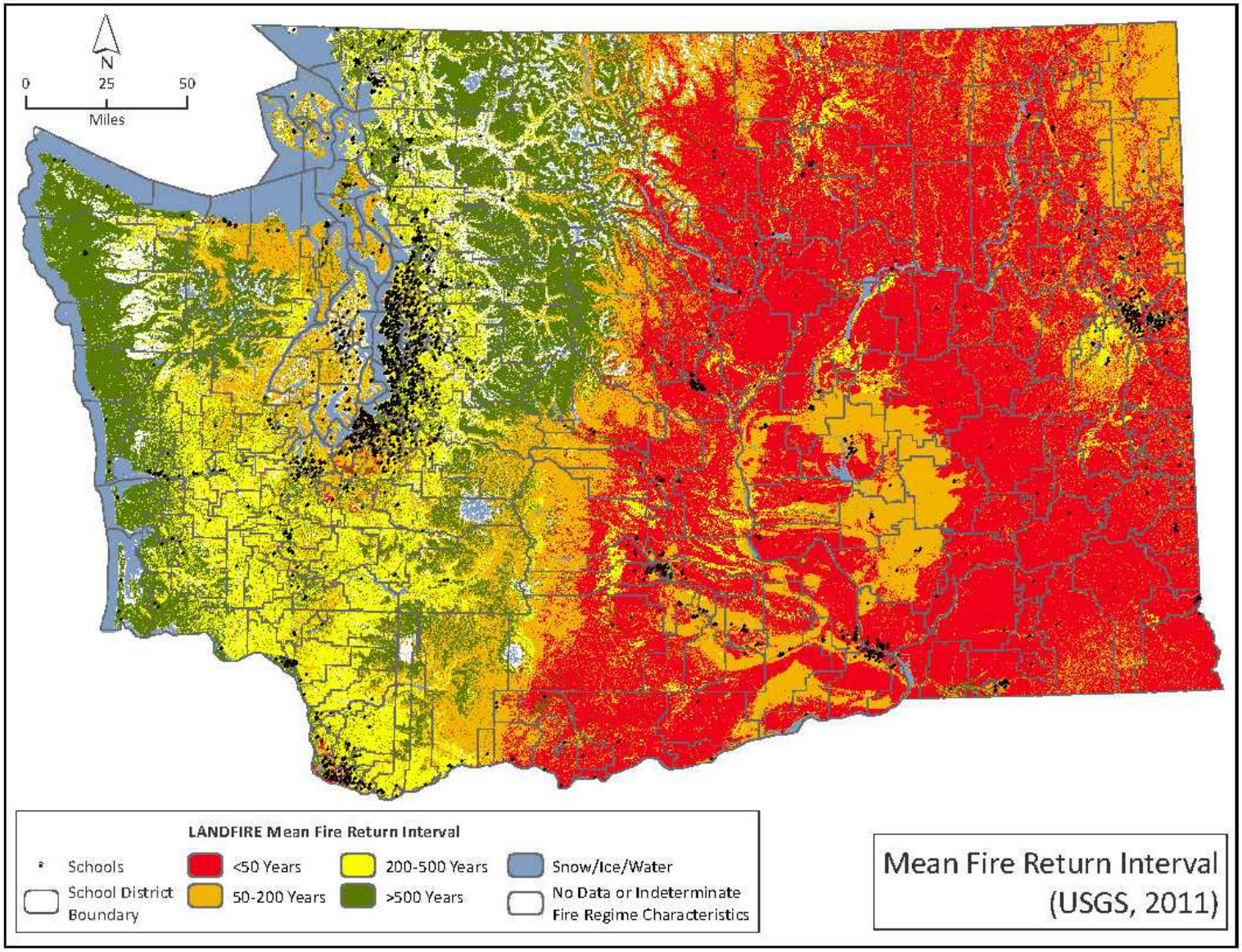
N
0
25
50
Miles
LANDFIRE Mean Fire Return Interval
Schools
School District Boundary
<50 Years
50-200 Years
200-500 Years
>500 Years
Snow/Ice/Water
No Data or Indeterminate Fire Regime Characteristics
Mean Fire Return Interval
(USGS, 2011)

8.4 Wildland/Urban Interface Fire Hazard and Risk Assessments

The potential impacts of future wildland/urban interface fires on the Wenatchee School District are primarily damage to buildings and contents (including, possible complete destruction), disruption of educational services, and displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made. The likelihood of deaths or injuries is generally low, because schools will be evacuated whenever fire warnings are issued. However, in events where evacuation is not timely, there may be a substantial risk of deaths and injuries.

The vulnerability of the Wenatchee School District's facilities to wildland/urban interface fires varies from campus to campus. The approximate levels of wildland/urban interface fire hazards and vulnerability are identified at the campus level in the following sections.

There have been no historical wildland/urban interface fires that directly affected or came very close to any of the district's campuses.

There have been no historical wildland/urban interface fires that directly affected any of the district's campuses or caused a school to evacuate for student safety. However Sunnyslope Elementary School has been in roughly a mile from areas that have evacuated due to brushfires. On a few occasions wildfires have impacted air quality resulting in the cancelling of school district sanctioned athletic events.

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In 2015, the Wenatchee Sleepy Hollow Fire burned 2,950 acres destroying 29 homes and several commercial buildings. Officials said the fire's unusual intensity was caused by drought and record high temperatures.

The campus-level wildland/urban interface fire hazard and risk report for the Wenatchee School District is shown on the following page. The fire hazard and risk levels are generated within the OSPI ICOS Pre-Disaster Mitigation database, by combining the DNR Wildland Interface Community rankings, the Landfire fire return periods and the campus-specific information entered into the database.

For campuses where the hazard and risk level is moderate or higher, the recommendation is to consult with the local fire agency regarding the level of risk at each campus and to determine whether fire mitigation measures may be appropriate. However, regardless of risk levels, all campuses in a wildland/urban interface should have evacuation plans for wildland/urban interface fire events.

More accurate evaluation of wildland/urban interface fire risk for a campus or a building starts with the fire hazard factors listed previously, but also requires higher-resolution, campus-level, and building-level information, including:

- Vegetative fuel loads on, adjacent and near the campus, including fuel types, fuel density, and proximity of high fuel load areas to the campus.

- Extent to which campus buildings have fire-safe construction details and defensible space.
- The number of available evacuation routes and the effectiveness of evacuation plans.

Locations with only one or two evacuation routes, which might be blocked by a given fire event, have much higher life safety risk than locations with multiple possible evacuation routes. Evaluation of the above characteristics may require technical advice and support from fire professionals, including local fire agency staff or other fire experts. Such professional advice is beneficial for any campus in a wildland/urban interface.

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Table 8.1
Wenatchee School District Campus Level Wildland/Urban Interface Hazard and Risk Assessment Report

Wildland and Urban Interface (Fire) Campus-Level Hazard and Risk Report							
Campus	**WUI Community DNR Rating**	**USGS Landfire Return Period Range[1] (Years)**	**High Fuel Load Areas Near Campus[2]**	**History of WUI Fires Affecting or Near Campus**	**Fire Agency Concern about WUI Fires**	**WUI Hazard Level and Preliminary Risk Level[3]**	**Recommendation** **Consult with Local Fire Agency About Risk and Mitigation**
WENATCHEE SCHOOL DISTRICT							
Abraham Lincoln Elementary	Not Applicable	36-40	No	No	TBD	High	Yes
Columbia Elementary	Not Applicable	36-40	No	No	TBD	High	Yes
Foothills Middle	Not Applicable	36-40	No	No	TBD	High	Yes
John Newbery Elementary	Not Applicable	36-40	No	No	TBD	High	Yes
Lewis and Clark Elementary	Not Applicable	36-40	No	No	TBD	High	Yes
Mission View Elementary	Not Applicable	36-40	No	No	TBD	High	Yes
Orchard Middle	Not Applicable	36-40	No	No	TBD	High	Yes
Pioneer Middle	Not Applicable	36-40	No	No	TBD	High	Yes
Special Education	Not Applicable	36-40	No	No	TBD	High	Yes
Sunnyslope Elementary	Not Applicable	36-40	No	Yes	TBD	Very High	Yes
Valley Academy Of Learning	Not Applicable	36-40	No	No	TBD	High	Yes
Washington Elementary (old)	Not Applicable	36-40	No	No	TBD	High	Yes
Wenatchee High	Not Applicable	36-40	No	No	TBD	High	Yes
Wenatchee Valley Technical	Not	36-40	No	No	TBD	High	Yes

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Wildland and Urban Interface (Fire) Campus-Level Hazard and Risk Report							
Campus	**WUI Community DNR Rating**	**USGS Landfire Return Period Range[1] (Years)**	**High Fuel Load Areas Near Campus[2]**	**History of WUI Fires Affecting or Near Campus**	**Fire Agency Concern about WUI Fires**	**WUI Hazard Level and Preliminary Risk Level[3]**	**Recommendation** **Consult with Local Fire Agency About Risk and Mitigation**
Skills Center	Applicable						
WestSide Alternative High	Not Applicable	36-40	No	No	TBD	High	Yes

[1] USGS Landfire estimates of fire return periods have very short returns for many locations, with correspondingly high probabilities in 50 years. Historical fire data suggest longer return periods and lower probabilities. These estimates are best interpreted as indicating relative fire risk, not absolute fire risk.

[2] Within 0.5 mile.

[3] The WUI preliminary risk level characterized as the same as WUI hazard level. Building-level assessments required to determine risk more accurately.

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The high WUI risk per the Landfire burn return periods shown in Table 8.1 reflects the hot, dry climate, fuel loads, topography and other factors. The designation of the WUI fire hazard and risk as “High” is based on algorithms in OSPI’s ICOS Database, which draws heavily on the Landfire burn return periods.

The WUI risk for Wenatchee and surrounding areas is clearly significant, as evidenced by the major fires in recent years in Chelan County, including one fire within Wenatchee. Especially on hot, dry windy days, a wildland fire near Wenatchee can spread very quickly. Under these conditions, wind-blown embers can start new fires considerable distances downwind from a wildland fire

However, for the City of Wenatchee, the WUI risk is partially mitigated because of the available fire suppression resources, including water supply and the fire agencies response capabilities. **Considering these factors, the level of WUI risk appears to be better characterized as moderate, rather than high.**

8.5 Mitigation for Wildland/Urban Interface Fires

Common goals for reducing wildland/urban interface fire risk include:

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1) Reduce the probability of fire ignitions.
2) Reduce the probability that small fires will spread.
3) Minimize property damage.
4) Minimize life safety risk.

School districts are not responsible for fire suppression or community-wide mitigation measures for wildland/urban interface fires, which are the responsibility of cities, counties, and fire agencies.

For districts with campuses determined to be at significant risk from wildland/urban interface fires, there are three types of practical mitigation measures:

- For life safety, develop and practice effective evacuation plans for wildland/urban interface fires.
- For existing facilities with significant risk:
    - Maintain the maximum possible defensible space around buildings and reduce vegetative fuel loads adjacent to a campus.
    - Implement fire-safe improvements such as non-flammable roofs, covering vent openings and overhangs with wire mesh to prevent entry and trapping of embers and others.

- Whenever possible, site new facilities outside of areas with high risk of wildland/urban interface fires, include fire-safe features in the design and ensure the maximum possible defensible space around new buildings.

Some types of mitigation projects for wildland/urban interface fire may be eligible for FEMA and other grant funding, including:

- Defensible space activities.
- Hazardous fuel reduction activities.
- Ignition resistant construction activities.

For existing buildings, implementing many ignition resistant building upgrades may be most cost-effective when done incrementally. For example, replacing an old roof covering with a non-flammable roof covering may be done at the time the existing roof has reached the end of its useful life and is scheduled for replacement.

The Wenatchee School Districts' mitigation Action Items for wildland/urban interface fires are shown in the table on the following page.

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Table 8.2
Wenatchee School District: Wildland/Urban Interface Fire Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Wildland/Urban Interface Fire Mitigation Action Items								
Short-Term #1	Consult with local fire agency or other fire expert regarding level of wildland/urban interface fire risk at each of the District's campuses, including assessment of vegetation fuel loads, adequacy of defensible space and building characteristics that may increase fire risk.	1-2 Years	Local Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Review and enhance emergency evacuation planning for all campuses.	1 year	Local	Supt.	**X**	**X**	**X**	**X**
Long-Term #1	Evaluate and consider implementing fire risk reduction measures including improving defensible space and upgrading building elements such as roofs with materials designed to be fire-resistant and covering vent openings with wire mesh to prevent embers from entering.	Ongoing	Local Bond or Grant	Supt.	X	X	X	X

9.0 OTHER NATURAL HAZARDS

Previous chapters have addressed the natural hazards which pose the greatest risks for the Wenatchee School District's facilities and people. In addition to these hazards, there are other natural hazards which pose less risk to the district. This chapter addresses these other natural hazards.

9.1 Avalanches

Avalanches occur in areas with high slopes and large accumulations of snow and ice, and happen when the snow and ice becomes unstable and slides rapidly downslope. Avalanches pose very high levels of life safety to people in their path and may result in severe damage or destruction to buildings impacted, as well as closures of roads and highways. Deaths from avalanches in Washington state have averaged about three per year[1], with nearly all these deaths occurring to back country recreationists. The following figure shows mountainous areas of Washington with elevations above 2,000 feet, where most, but not all, avalanches occur. Elevations above 2000 feet are shown in white on the map.

Figure 9.1
Elevations Above 2,000 Feet in Washington1

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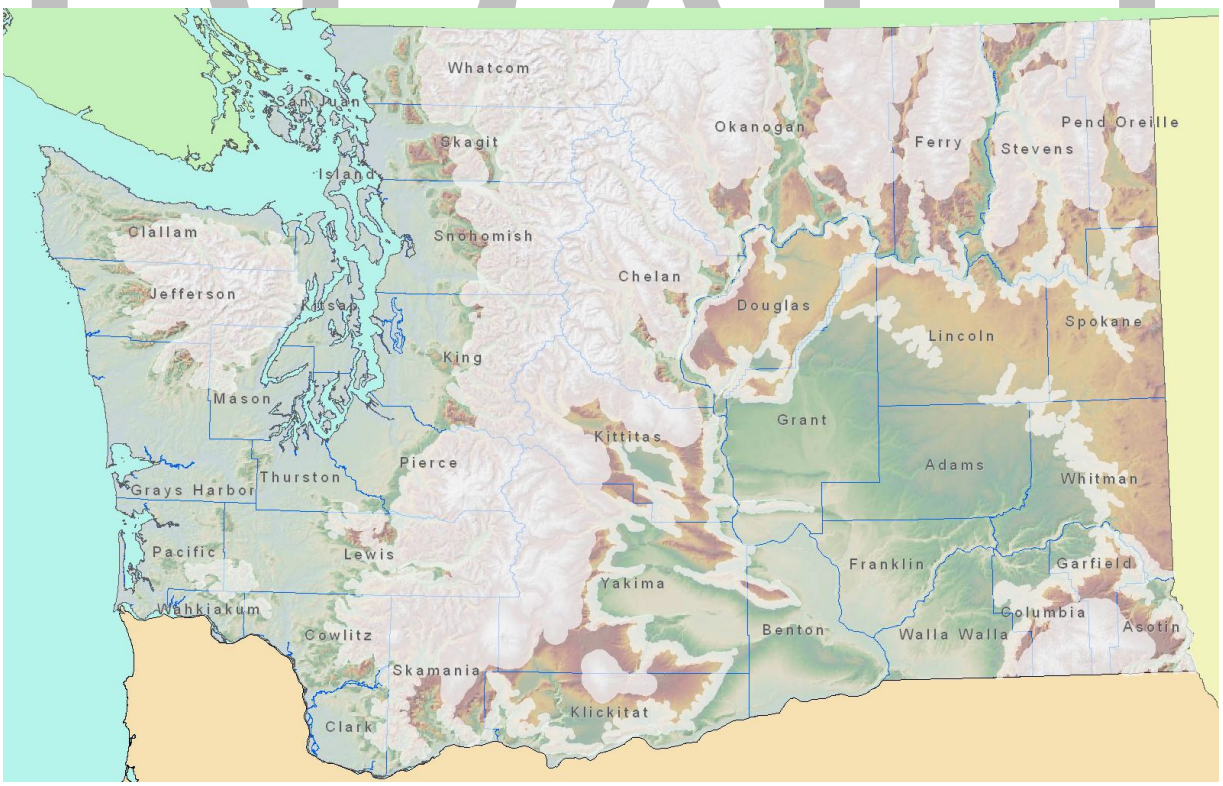

Detailed statewide mapping of avalanche hazard zones has not been completed.

Absent statewide mapping of avalanche hazards, hazard and risk assessments for avalanches must be done on a facility by facility basis. K–12 facilities downslope from steep slopes with substantial accumulations of snow and ice may be at risk. Historical avalanche events on such slopes are a strong indicator of possible risk, but avalanches may also occur on slopes with no history of avalanches during time periods of unusually heavy snow and ice accumulations.

Possible mitigation measures for K–12 facilities at risk from avalanches include:

- Proactive avalanche abatement – triggering small avalanches to prevent large accumulations of snow and ice.
- Building diversion barriers to direct avalanches away from at-risk facilities.
- Relocation of at-risk facilities outside of locations at risk from avalanches.

Wenatchee's mean annual snowfall is about 24 inches and the hills near Wenatchee have moderate slopes. Given these factors, the avalanche risk for Wenatchee is nil or extremely low. No mitigation measures for avalanches are warranted.

9.2 Drought

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Drought is defined as a prolonged period of lower than normal precipitation severe enough to reduce soil moisture, water, and snow levels below the minimums necessary for sustaining plant, animal, and economic systems. Drought is a significant concern in many communities in Washington, especially east of the Cascades.

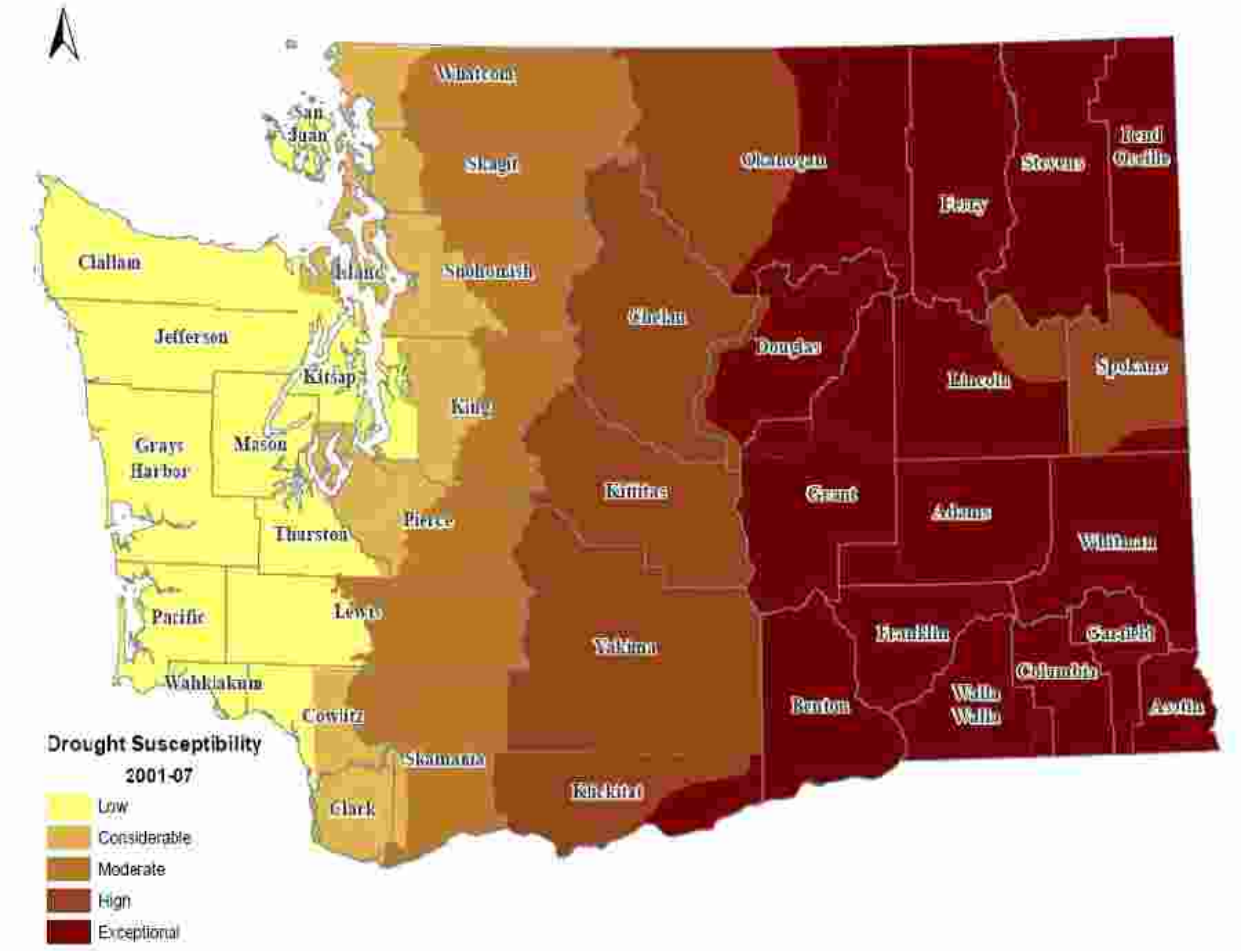
Figure 9.2 shows drought susceptibility in Washington by county. The map of drought susceptibility includes both climate conditions and the severity of drought impacts on counties that may be affected by droughts.

The drought susceptibility for Chelan County is moderate.

For most school districts, the impacts of future droughts are likely to be relatively minor. In most cases, water restrictions during droughts affect irrigation and industrial water uses, but not water use for drinking and sanitation. However, in unusually severe droughts, communities with limited water supplies during normal times may have extremely limited water supplies, or even none. In this case, water for drinking and sanitation may have to be delivered by tanker trucks.

Campuses whose water supply is provided by a single well are especially prone to major impacts during droughts if the well cannot provide adequate water for drinking and sanitation. However, this is not the case for any of Wenatchee's campuses.

Figure 9.2
Drought Susceptibility for Washington State[1]



Possible mitigation measures for K–12 facilities at risk from droughts include:

- Emergency planning to provide emergency water by tanker trucks.
- Relocating students from a school without adequate water supply to other facilities.
- Developing alternative water sources via drilling new wells or adding interties to another water system.

The District will comply with water use restrictions during periods of drought. However, additional mitigation items for drought are not warranted.

9.3 Severe Weather

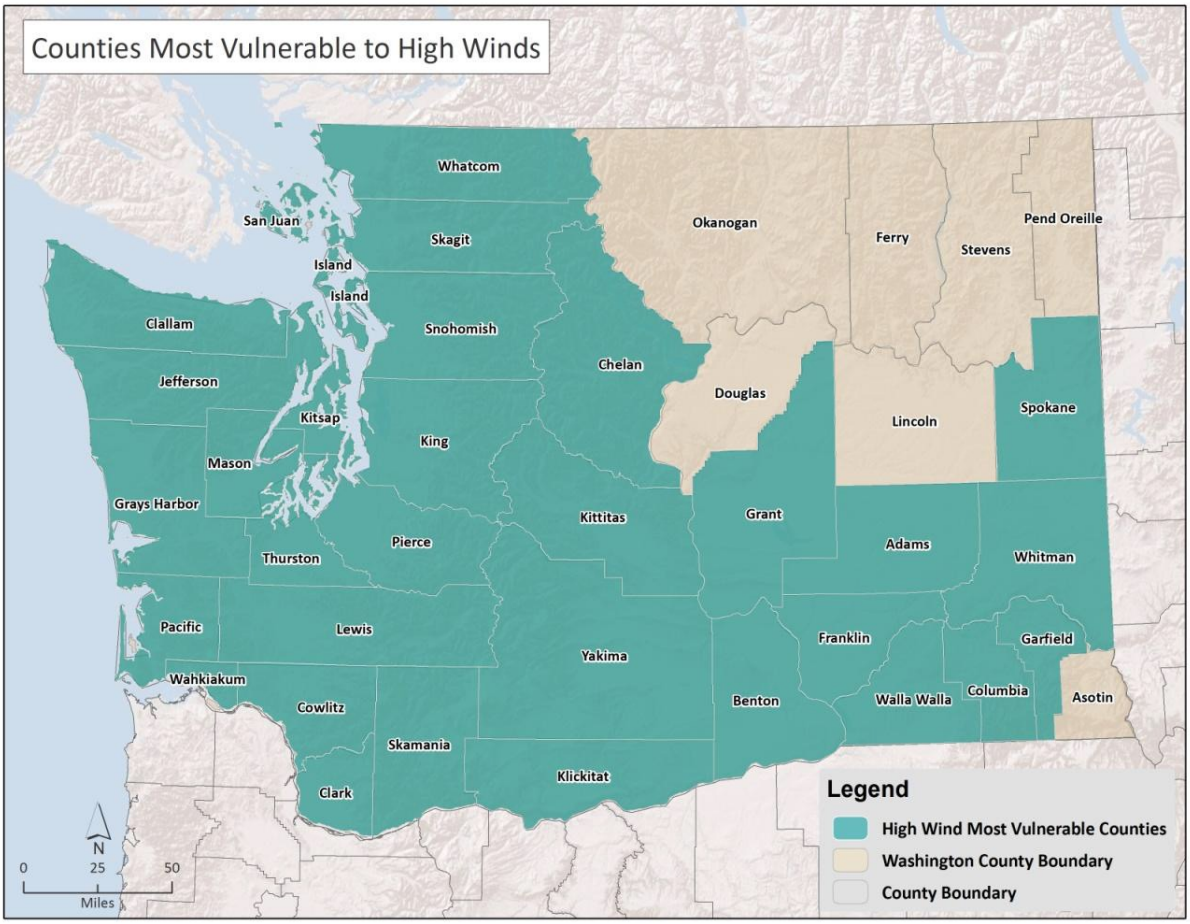
Severe weather events are possible throughout Washington state, including: high winds, snow storms, ice storms, thunderstorms, hail, and tornadoes. Most such events have relatively minor impacts on K–12 facilities, although more severe events may

result in significant damages. Of these types of weather hazards, high winds pose the greatest risk to K–12 facilities, although the level of risk for most facilities is much lower than for facilities at high risk from the major hazards addressed in previous chapters.

High Winds

High wind events can occur anywhere in Washington, but the most severe events have occurred on the Pacific Coast and in the Cascades. The following map from the 2013 Washington State Enhanced Hazard Mitigation plan shows that nearly all counties in the state are deemed at significant risk from high wind events.

Figure 9.3
Counties Most Vulnerable to High Winds[1]



Chelan County is among the many counties designated as being vulnerable to high wind events. The most common impacts from high wind events are loss of electric power from downed overhead power lines due to tree falls or from direct wind forces on power lines. Damage to buildings can range from limited roof damage to major structural damage from wind or from tree falls onto buildings.

Most K–12 facilities will suffer little or no damage in minor to moderate windstorms, with higher levels of damage mostly limited to very severe wind events, especially for the most vulnerable buildings, such as portables, that are not adequately tied down.

Snow and Ice Storms

Numerous snow and ice storms occur in Washington state every year. The principal impacts from severe storms are disruption of electric power from downed overhead lines and disruption of transportation. Severe snow or ice storms result in school closures but rarely result in significant damage to school facilities.

In severe storms, with unusually heavy loading of snow and/or ice, a few very vulnerable buildings may collapse. Most school buildings have been designed for snow loads and thus are unlikely to suffer significant damage except for extreme events with snow and/or ice loads well above the design loads. Districts with older buildings, especially large span buildings, in areas with high annual snowfalls may wish to evaluate some buildings for the capacity to withstand snow and ice loads on the roofs.

Thunderstorms and Hail Storms

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Thunderstorms and hail storms occur fairly frequently in Washington state, although the frequency and severity of such events is much lower than in many parts of the United States. Severe thunderstorms may have high enough winds to result in downed overhead electric lines and tree falls with disruptions to utilities and transportation. However, the likelihood of thunderstorms severe enough to result in significant damage to K–12 facilities appears very low.

Hail storms may occur anywhere in Washington but are more common in eastern Washington. Hail storms with large diameter hail may cause significant damage to exposed vehicles and localized damage to some roofs. However, the likelihood of hail storms severe enough to result in significant damage to K–12 facilities appears extremely low.

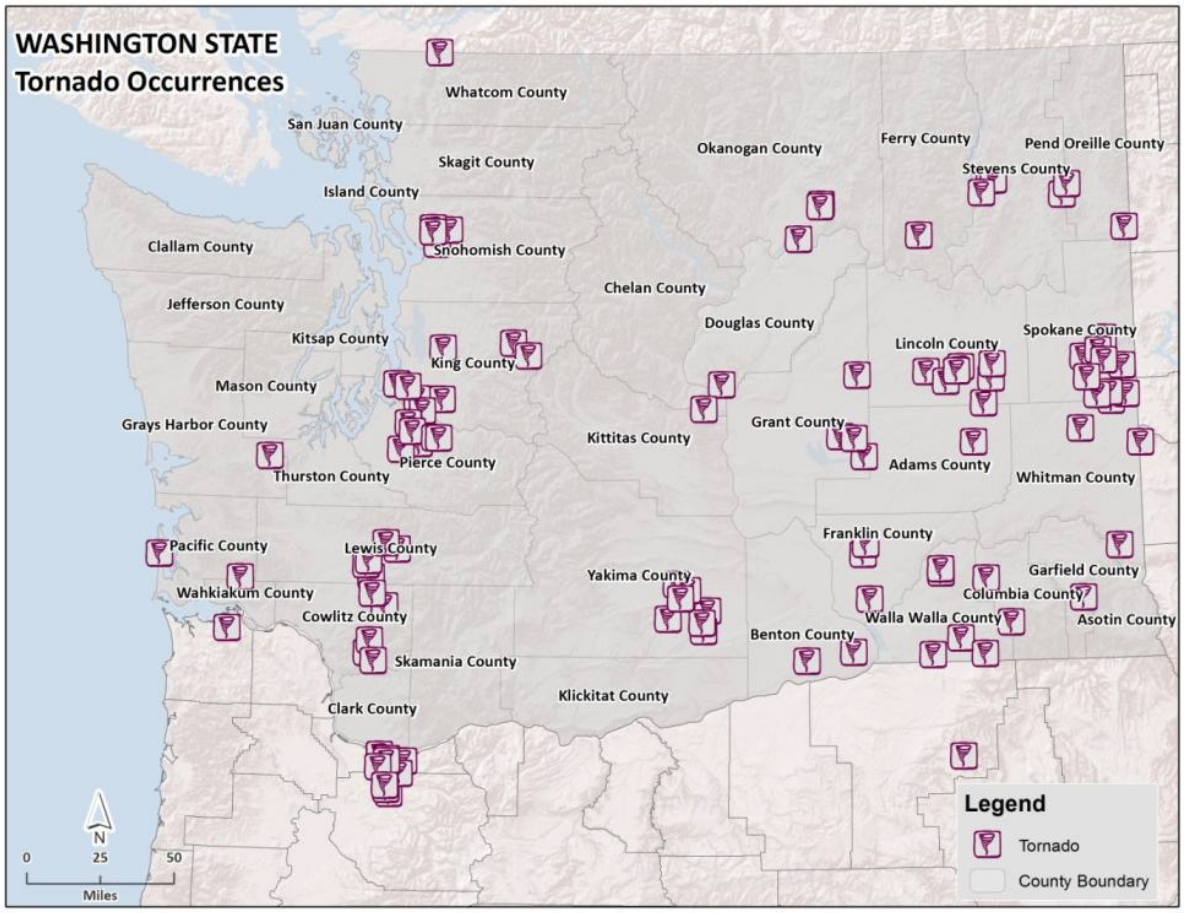
Tornadoes

Between 1954 and 2012, nearly 100 tornadoes have been reported in Washington state, as shown in Figure 12.4. The vast majority of these tornadoes were small, F0 or F1, on the Fujita Scale; or, EF-0 or EF-1, on the Enhanced Fujita Scale. Such small tornadoes often result in minor roof damage but do not generally cause significant damage to buildings, and rarely result in significant injuries or deaths.

The most severe tornado outbreak in Washington occurred in April 1972. An F3 tornado hit Vancouver with six deaths, about 300 injuries, and about $50 million in damages. On this same day, there was an F3 near Spokane and an F2 in rural Stevens County.

For K–12 facilities, the risk of significant damage and casualties from tornadoes is very low but not zero. Given the low level of risk, mitigation measures such as building safe rooms are not practical or cost-effective. However, the Wenatchee School District's emergency plan should include identifying the best available safe area in each school if a tornado were to occur. This area should be a small, interior room with the fewest windows; ideally with no windows.

Figure 9-4
Washington State Tornadoes Since 1950[1]



Extreme Temperatures

Extreme cold or extreme heat both pose some risks to students and staff, especially for those that walk or bicycle to/from school. Proactive decisions to close schools are sometimes made for either extreme cold or extreme heat periods. Closures during extreme heat are more likely for schools without air conditioning.

Extreme temperatures also pose some risk to school facilities in several ways:

- Heating and air conditioning systems in schools are more prone to equipment failures at times of extreme demand, such as during periods of extreme temperatures.
- Water pipes in poorly insulated school buildings may freeze during periods of extreme cold, resulting in burst pipes and water damage.
- Utility systems providing electric power and water to schools are more prone to failures during periods of extreme temperatures:
    - Electric power systems have more failures during periods of either extreme cold or extreme heat and such power outages may require school closures, depending on the duration of the outage.
    - Potable water systems may suffer damage during periods of extreme cold, especially small, rural systems with small diameter water pipes with low water flow rates. Loss of water supply typically necessitates school closures.

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Severe Weather Events for the Wenatchee School District

For the most part, addressing severe weather is more in the domain of emergency planning than mitigation planning. Emergency planning measures include developing and practicing responses for events that may require shelter in place (such as tornado warnings) or events that may require evacuations (such as power outages, loss of water service, or loss of air conditioning or heating during periods of extreme heat or cold).

Possible mitigation measures for severe weather events include the following:

- High Wind Events
    - Tie-downs for portable buildings.
    - Increased trimming for trees near above ground electric power lines feeding a school or large trees near school buildings.
    - Installing wind-resistant roofing materials for schools in high wind areas or with a history of wind damage to roofs.
- Snow and Ice Storms
    - Increased trimming for trees as for high winds as noted above.

    - Evaluate and possibly retrofit older buildings, especially large span buildings that may have been designed for inadequate snow loads.
- Extreme temperatures
    - Maintain heating and cooling systems in good working order and replace systems near the end of their useful life.
    - Insulate water pipes with a history of freezing or with poor insulation, in locations with frequent extended periods of below freezing temperatures.
- All Severe Weather Events
    - Install back-up power systems for selected district facilities, such as those designated as emergency shelters.

The Wenatchee School District's mitigation Action Items for subsidence are included in Table 9-1 at the end of this chapter.

References

1. Washington State Enhanced Hazard Mitigation Plan (2013). Washington State Military Department, Emergency Management Division.

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Table 9-1
Wenatchee School District: Other Natural Hazards Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	Enhance Emergency Planning	Enhance Awareness and Education
Other Hazards Action Items								
Short-Term #1	Evaluate portable buildings to make sure that they are adequately tied down to resist high winds and implement mitigation measures, if necessary.	1-2 Years	Local, Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #2	Review and update transportation planning for winter storm events or other events that may disruption transportation to/from schools.	Ongoing	Local, Bond or Grant	Supt.	**X**	**X**	**X**	**X**
Short-Term #3	Assess the need for emergency generators for some district facilities, and implement as funding becomes available.	1-5 Years	Local, Bond or Grant	Supt.	X	X	X	X
Short-Term #4	Review and update emergency planning for severe weather events including high winds and tornadoes.	Ongoing	Local, Bond or Grant	Supt.	X	X	X	X

APPENDIX A

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FEMA MITIGATION GRANT PROGRAMS

2017

FEMA FUNDING POSSIBILITIES
FOR SCHOOL DISTRICTS IN WASHINGTON

1.0 Overview

For public entities in Washington, including school districts, FEMA mitigation funding possibilities fall into two main categories:

- The post-disaster Public Assistance Program which covers at least 75% of eligible emergency response and restoration (repair) costs for public entities whose facilities suffer damages in a presidentially-declared disaster. The Public Assistance Program also may fund mitigation projects for facilities damaged in the declared event.

- Mitigation grant programs (either pre-disaster or post-disaster) which typically cover 75% of mitigation costs, although in some cases, FEMA mitigation grants provide 90% or 100% funding.

These grants programs are summarized below. For more detailed information, see the references to FEMA publications in the narratives below.

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For the Wenatchee School District, the sources of possible FEMA grant funds include the Public Assistance Program, the Hazard Mitigation Grant Program, and the Pre-Disaster Mitigation Program.

2.0 FEMA Public Assistance Program

The objective of the Federal Emergency Management Agency's (FEMA) Public Assistance (PA) Grant Program is to provide funding so that communities can quickly respond to, and recover from, major disasters or emergencies declared by the President. The PA program is sometimes referred to as the 406 program because it is authorized under Section 406 of the Stafford Act which established FEMA's disaster programs.

Through the PA Program, FEMA provides supplemental Federal disaster grant assistance for debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly-owned facilities and the facilities of certain private non-profit (PNP) organizations.

PA funding for school facilities is available only when:

- There is a presidentially-declared disaster in Washington state,
- A facility is located in a county included in the disaster declaration, and
- A facility had damage in the declared disaster event.

The PA Program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process. The PA Program's distinction between repairs and mitigation is important:

- Repairs restore a damaged facility to its pre-disaster condition, with the possible addition of code-mandated upgrades.
- Mitigation measures go beyond repairs to make the facility more resistant to damage in future disaster events.

Under the PA Program, FEMA funding for repairs of damaged facilities and for the other categories of PA assistance are largely automatic, subject only to FEMA's eligibility criteria.

However, mitigation measures under the PA Program and at the discretion of FEMA are not automatically funded. Mitigation measures under PA have to meet eligibility criteria very similar to those for the other FEMA mitigation grant programs, including having a benefit-cost ratio greater than 1.0. However, Public Assistance mitigation projects are automatically determined to be cost effective and a project-specific benefit-cost analysis is not required if the cost of mitigation is no more than the following percentages of the repair costs:

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- 15% of the repair costs for any PA-eligible mitigation project, or
- 100% of the repair costs for categories of mitigation projects defined in the March 30, 2010 version of FEMA Recovery Policy RP9526.1 Hazard Mitigation Funding Under Section 406 (Stafford Act).

Further details of FEMA's PA programs are available on FEMA's website at: http://www.fema.gov/site-page/public-assistance-grant-program.

3.0 FEMA Mitigation Grant Programs

The Federal Emergency Management Agency (FEMA) has three mitigation grant programs which provide federal funds to supplement local funds for specified types of mitigation activities.

For school districts, an important eligibility criterion for all FEMA mitigation grants is that a district must have a FEMA-approved hazard mitigation plan or be covered by a city or county FEMA-approved hazard plan for which the district participated in the planning process.

There are two distinct types of FEMA mitigation grant programs:

1. The post-disaster Hazard Mitigation Grant Program (HMGP) for which funds are available in Washington state after each presidentially-declared disaster in Washington state.

2. Annual pre-disaster programs for which funds are available nationwide, including:

    - The Pre-Disaster Mitigation (PDM) program which includes mitigation for all natural hazards.
    - The Flood Mitigation Assistance (FMA) program which includes mitigation for flood only, with a focus predominantly on facilities with flood insurance.

Further details of these mitigation grant programs are provided in the following two FEMA publications:

Hazard Mitigation Assistance Unified Guidance (February 2015).

Addendum to the Hazard Mitigation Unified Guidance (February 2015).

Additional information is available on the FEMA website:
www.fema.gov/hazard-mitigation-assistance

Each of the FEMA mitigation grant programs has specific eligibility requirements, applications, and application deadlines, which may vary from year to year. These grant programs are not entitlement programs, but rather are competitive grant programs that require strict adherence to the eligibility and application requirements and robust documentation.

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All physical mitigation projects (but not mitigation planning) must be cost-effective, which for FEMA means a benefit-cost ratio >1.0. Therefore, most FEMA mitigation projects require completing a benefit-cost analysis using FEMA software and following FEMA's detailed benefit-cost analysis guidance.

However, there are three categories of mitigation projects which are automatically determined to be cost-effective and thus do not require a project-specific benefit-cost analysis for HMGP and FMA grant applications:

- Acquisition of properties within a Special Flood Hazard Area - 100-year, FEMA-mapped floodplain – when the structure is substantially damaged. Substantial damage is defined as: "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50% of the market value of the structure before the damage occurred."

- Acquisition or elevation projects with a Special Flood Hazard Area that meet the cost limits established in the FEMA Memorandum "Cost Effectiveness Determinations for Acquisitions and Elevations in Special Flood Hazard Areas," August 15, 2013.

- Acquisition or relocation of residential structures subject to landslide hazards that meet the criteria in the FEMA Memorandum "Use of HMGP Funds for Acquisition

or Relocation of Residential Structures Subject to Landslide Hazards," July 22, 1998.

4.0 Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) is a post-disaster grant program. HMGP funds are generated following a Presidential Disaster Declaration for Washington State. Declared disasters for Washington are relatively common, often with one or more declarations in a given year for winter storms, floods, or other disasters.

The amount of HMGP grant funding available after a given declared disaster is a percentage of total FEMA spending for various other FEMA programs such as the Individual and Family Assistance and Public Assistance programs. Thus, the total amount of HMGP mitigation funds available within Washington will vary from year to year and disaster event to disaster event. In some years, there may be no HMGP funding available. However, after a major disaster, such as the Nisqually earthquake in 2001, a large amount of HMGP funding may be available.

The Washington Emergency Management Division (WA-EMD) of the Washington Military Department administers the HMGP in Washington state and sets the priorities and guidelines after each disaster. For HMGP mitigation grants, WA-EMD selects the mitigation projects for funding, with FEMA's only role being to verify that a submitted project meets FEMA's minimum eligibility criteria. HMGP is the most flexible grant program: grants may be possible for any natural hazard and may include hazard mitigation planning and risk assessments as well as physical mitigation projects.

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For HMGP applications, WA-EMD's application process has included the following steps after a declared disaster in Washington:

- Public announcement of HMGP funds availability and guidance re: priorities and grant award limits,
- Review of submitted NOIs and selection of projects for which full applications are requested,
- Review of submitted applications and requests for additional documentation.
- Selection of applications to be submitted to FEMA.
- FEMA approval of grants, for applications that meet FEMA's minimum criteria for eligibility.

In past disasters, Washington state has typically provided one-half of the applicants FEMA-required 25% local matching funds for HMGP grants. In this case, the FEMA grant covers 75% of the total project cost, with Washington state and the applicant each providing 12.5%. That is, the local match required has been only 12.5% of the total eligible project cost. However, continuation of the state's 12.5% match in future declared disasters is contingent upon legislative approval.

5.0 Annual Pre-Disaster Grant Programs

FEMA's annual pre-disaster grant programs – Pre-Disaster Mitigation (PDM) and Flood Mitigation Assistance (FMA) are contingent upon future congressional approval.

WA-EMD processes grant applications for these programs in a step-wise manner generally similar to that described above for HMGP grant applications. However, there are two important differences:

- For these programs WA-EMD forwards ranked applications to FEMA, but FEMA makes the grant determinations, which may or may not match WA-EMD's rankings. Thus, applications for these programs are competitive nationally, not just within Washington state, although there may be partial set-asides guaranteeing Washington some level of funding, if submitted applications meet FEMA's eligibility criteria.

- For these grant programs, Washington state does not provide any matching funds; thus, applicants must provide the full FEMA-required local match percentage.

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5.1 Pre-Disaster Mitigation (PDM) Grant Program

The PDM grant program is a broad program which includes mitigation projects for any natural hazard as well as mitigation planning grants which must result in the development of a Local Hazard Mitigation Plan.

PDM grants typically cover 75% of the costs of mitigation projects up to a maximum federal share of $3,000,000 per project. However, for eligible local government applicants in communities that meet FEMA's definition of small, impoverished community, the Federal share may be 90%.

5.2 Flood Mitigation Assistance (FMA)

The FMA grant program funds only flood projects, with its predominant focus being on flood mitigation projects for properties with flood insurance. FMA special emphasis and priorities on properties which are on FEMA's national listing of Repetitive Flood Loss (RFL) and Severe Repetitive Loss (SRL) properties.

FMA grants generally cover 75% of total eligible project costs, with 25% local match required. However, grants for Repetitive Loss properties provide 90% FEMA funding and grants for Severe Repetitive Loss properties provide 100% FEMA funding.

6.0 General Guidance for FEMA Grant Applications

All of FEMA's mitigation grant programs are competitive, either within a given state or nationally. Thus, successful grant applications must be complete, robust, and very well

documented. The key elements for successful mitigation project grant applications include:

- Project locations within high hazard areas.
- Project buildings or infrastructure that have major vulnerabilities which pose substantial risk of damages, economic impacts, and (especially for seismic projects) deaths or injuries.
- Mitigation project scope is well defined with at least a conceptual design with enough detail to support a realistic engineering cost estimate for the project.
- The benefits of the project are carefully documented using FEMA benefit-cost software, with all inputs meticulously meeting FEMA's guidance and expectations. A benefit-cost analysis meeting FEMA's requirements is very often the most critical step in determining a mitigation project's eligibility and competitiveness for FEMA grants.
- Making sure that the proposed project is eligible for the specific FEMA grant program to which it is being submitted.
- Making sure that the application is 100% complete with credible information and easy for FEMA to understand.

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The effort required for developing a good mitigation project and completing a successful grant application varies with the size and complexity of the mitigation project. In some cases, a successful FEMA grant application requires technical expertise, which may be available on-staff within a given local government entity, or which may require outside consulting support. For example, technical expertise may be desired for:

- Understanding the level of hazard (flood, earthquake, tsunami, etc.) at a given location.
- Quantifying the vulnerability of the building(s) exposed to the hazard at the project site(s).
- Developing a preliminary or conceptual engineering design for the mitigation project.
- Developing a realistic engineering cost estimate for the mitigation project.
- Completing the benefit-cost analysis in full conformance with FEMA's guidance and expectations, along with robust documentation of the credibility of the inputs into the benefit-cost analysis.

Good mitigation projects which address high-risk situations are effective in reducing future damages and losses, with robust, well-documented applications have a

reasonable chance of FEMA funding. Conversely, weakly conceived or poorly documented projects have little or no chance of FEMA funding.

Guidance for FEMA grant applications is available on the FEMA website www.fema.gov/hazard-mitigation-assistance and in the FEMA guidance document referenced previously. Thorough review of this guidance is strongly encouraged before undertaking a FEMA grant application.

Additional guidance is also available on Washington Emergency Management's website www.emd.wa.gov, see Grants category, and from WA-EMD's mitigation staff.

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APPENDIX B

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PRINCIPLES OF BENEFIT-COST ANALYSIS

2017

B-1.0 Introduction

Benefit-cost analysis is required for nearly all FEMA mitigation project grant applications for all FEMA grant programs with only three exceptions:

- Acquisition or relocation of facilities located within FEMA-mapped 100-year floodplains that have been determined to be substantially damaged.
- Public Assistance mitigation projects with costs less than 15% of repair costs.
- Several types of Public Assistance mitigation projects that have costs less than 100% of repair costs.

FEMA's definition of substantial damage is "damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50% of the market value of the structure before the damage occurred." The categories of Public Assistance mitigation projects which do not require benefit-cost analysis are listed in FEMA Disaster Assistance Policy 9526.1 (March 30, 2010).

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For all FEMA-funded mitigation projects, other than the exceptions noted above, the benefit-cost ratio must be greater than 1.0 for a project to be eligible for FEMA funding. The benefit-cost ratio must be calculated using FEMA's benefit-cost analysis software, with all data inputs consistent with FEMA's guidance and expectations.

The primary references for FEMA benefit-cost analysis are:

- BCA Reference Guide (June, 2009).
- Supplement to the Benefit-Cost Analysis Reference Guide (June, 2011).

In addition to the above monographs, there are numerous other FEMA publications related to benefit-cost analysis which are available on the FEMA website: www.fema.gov/benefit-cost-analysis

Help is also available via: bchelpline@fema.dhs.gov and at 1-855-540-6744.

B-2.0 What are Benefits?

The benefits of a hazard mitigation project are the reduction in future damages and losses; that is, the avoided damages and losses that are attributable to a mitigation project. To conduct benefit-cost analysis of a specific mitigation project, the risk of damages and losses must be evaluated twice: before mitigation and after mitigation, with the benefits being the difference.

The categories of benefits included in FEMA benefit-cost analysis varies with the type of facility being mitigated, the hazard being addressed and the type of mitigation project. Common categories of benefits include the reductions in: building damages, contents damages, displacement costs for temporary quarters if a building is damaged, the economic impacts of loss of service from a damaged facility and casualties. The economic value of avoided deaths and injuries are calculated using FEMA's standard statistical values for deaths and injuries.

Some mitigation projects, such as most flood mitigation projects, focus predominantly on reducing future damages and losses. Other mitigation projects, such as most earthquake mitigation projects, focus on reducing casualties as well as reducing damages and losses; in this case, life safety is often the primary motivation for the mitigation project. In some cases, such as tsunami vertical evacuation mitigation projects, life safety is the sole purpose of a mitigation project.

More precisely, a benefit-cost ratio is calculated as the net present value of benefits divided by the mitigation project cost. Net present value means that the time value of money must be considered; benefits that accrue in the future are worth less than those that accrue immediately. The FEMA benefit-cost software discussed in the next section automatically calculates the net present value of benefits from data inputs, including the mitigation project useful lifetime, which varies depending on the type of facility and type of project, and the FEMA-mandated discount rate of 7%.

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Because the benefits of a hazard mitigation project accrue in the future, it is impossible to know exactly what they will be. For example, it cannot be known in advance when a future earthquake or other natural hazard event will occur in a given location or how severe the event will be. However, in most cases, it is possible to estimate the probability of future hazard events. Therefore, the benefits of mitigation projects must be evaluated statistically or probabilistically.

Hazard events don't come in only one size. Rather, the severity of every type of natural hazard event can range from minimal to severe. A benefit-cost analysis always considers a range of severity for hazard events, such as the 10-, 50-, 100- and 500-year floods, and the analysis includes estimates of the expected damages and losses for each level of event.

The FEMA benefit-cost software integrates such data to determine the average annual damages and losses considering the full range of hazard events. The term "average annual" damages and losses doesn't mean that such damage and losses occur every year, but rather represents the long term average from hazard events of many different severities and probabilities occurring.

B-3.0 FEMA Benefit-Cost Analysis Software

The current version of FEMA's benefit-cost analysis software (Version 5.3) may be downloaded and installed from the FEMA website noted previously. There are seven

benefit-cost modules applicable to different types of hazards and different types of mitigation projects:

- Floods.
- Hurricane Winds.
- Earthquake Structural Projects.
- Earthquake Nonstructural Projects.
- Tornado Safe Rooms.
- Wildfire.
- Damage Frequency Assessment.

The applicability of most of the above BCA modules is self-evident, with a couple of exceptions:

- The flood BCA module can be used only when a full set of quantitative flood hazard data is available, including first floor elevations of buildings, stream discharge and flood elevation data for four flood return periods (typically, the 10-, 50-, 100- and 500-year events) and stream bottom elevations. For coastal storm surge flooding, the above data are necessary, less the stream discharge and stream bottom elevation data.

- The Damage Frequency Assessment module is applicable for any natural hazard for which a damage-frequency relationship can be defined from historical data and/or engineering analysis/judgment.

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All of the BCA modules, except for the Damage Frequency Assessment module, have some built-in data which significantly simplifies the BCA process. However, all of the modules also require a considerable number of user-defined data inputs to complete a benefit-cost analysis.

The Damage Frequency Assessment (DFA) module has no built-in data: all of the data inputs are user-defined. The DFA module is the most flexible module, but also the most difficult to use because it requires the most technical expertise to input FEMA-credible data.

The Damage Frequency Assessment BCA module is used for the following types of hazards and facilities:

- Tsunamis.

- Landslides.

- Flood projects where the quantitative flood hazard data necessary to use the flood BCA module are unavailable.

- Seismic projects for utility or transportation infrastructure.

- All other natural hazards for which a damage-frequency relationship can be defined, including snow storms, ice storms, erosion, avalanches, and others.

Benefit-cost analysis of most hazard mitigation projects is unavoidably complex and requires at least a basic technical understanding of facilities, hazards, vulnerability, risk, and the economic parameters of benefit-cost analysis. For many types of mitigation projects, especially seismic projects, technical support from an engineer is almost always necessary. For some mitigation projects, technical support from subject matter experts with experience in making estimates of damages, casualties, and economic losses for benefit-cost analysis may also be helpful.

B-4.0 Benefit-Cost Analysis: Use and Interpretation

For FEMA mitigation grants, the immediate use of benefit-cost analysis is to determine whether a project has a benefit-cost ratio above 1.0 and thus meets FEMA's eligibility criterion. However, benefit-cost analysis can also play a larger role in the evaluation and prioritization of mitigation projects.

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

- What is the nature of the hazard problem?

- How frequent and how severe are hazard events?

- Do we want to undertake mitigation measures?

- What mitigation measures are feasible, appropriate, and affordable?

- How do we prioritize between competing mitigation projects?

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

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

Overall, benefit-cost analysis provides answers to a central question for hazard mitigation projects: “Is it worth it?” That is, are the benefits large enough to justify the costs necessary to implement a mitigation project?

Whether or not a mitigation project is “worth it” depends on many factors, including:

- The level of hazard at a given location.
- The value and importance of the facility being mitigated.
- The vulnerability of the facility to the hazard.
- The cost of the mitigation project.
- The effectiveness of the mitigation project in reducing future damages, economic losses, and casualties.

The best mitigation projects address high risk situations: a high level of hazard for an important facility which has substantial vulnerability to the hazard.

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

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B-5.0 Benefit-Cost Analysis Example

The principles of benefit-cost analysis are illustrated by the following simplified example. Consider a small building in the town of Acorn, located on the banks of Squirrel Creek. The building is a one story building, about 1500 square feet on a post foundation with a replacement value of $60/square foot (total building value of $90,000). We have flood hazard data for Squirrel Creek (stream discharge and flood elevation data) and elevation data for the first floor of the house.

For this BCA, the FEMA flood BCA module is used, because the necessary quantitative flood hazard data are available. The data built into the BCA module, along with user data inputs, allow the module to calculate the annual probability of flooding in one-foot increments, along with the resulting damages and losses shown in Table A2.1.

Table A2.1
Damages Before Mitigation

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

Flood depths shown above in Table A2.1 are in one foot increments of water depth above the lowest floor elevation. Thus, a “3" foot flood means all floods between 2.5 feet and 3.5 feet of water depth above the floor. We note that a “0" foot flood has, on average, damages because this flood depth means water plus or minus 6" of the floor. Even if the flood level is a few inches below the first floor, there may be damage to flooring and other building elements because of wicking of water.

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

The Annualized (expected annual) damages and losses are calculated as the product of the flood probability times the scenario damages. For example, a 4 foot flood has slightly less than a 1% chance per year of occurring. If it does occur, we expect about $32,100 in damages and losses. Averaged over a long time, 4 foot floods are thus expected to cause an average of about $315 per year in flood damages.

Note that the smaller floods, which cause less damage per flood event, actually cause higher average annual damages because the probability of smaller floods is so much higher than that for larger floods. With these data, the building is expected to average $6,312 per year in flood damages. This expected annual or “annualized” damage estimate does not mean that the building has this much damage every year. Rather, in most years there will be no floods, but over time the cumulative damages and losses from a mix of relatively frequent smaller floods and less frequent larger floods is calculated to average $6,312 per year.

The calculated results in Table A2.1 are the flood risk assessment for this building for the as-is, before mitigation situation. The table shows the expected levels of damages and losses for scenario floods of various depths and also the annualized damages and losses.

The risk assessment shown in Table A2.2 shows a high flood risk, with frequent severe flooding which the owner deems unacceptable. The owner explores mitigation alternatives to reduce the risk: the example below is to elevate the house 4 feet. These results are shown in Table A2.2.

Table A2.2
Damages After Mitigation

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

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By elevating the building 4 feet, the owner has reduced the expected annual (annualized) damages from $6,312 to $112 (a 98% reduction) and greatly reduced the probability or frequency of flooding affecting the building. The annualized benefits are the difference in the annualized damages and losses before and after mitigation or $6,312 - $112 = $6,200.

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

The benefits, however, accrue statistically over the lifetime of the mitigation project. Following FEMA guidance for this type of project, we assume that this mitigation project has a useful lifetime of 30 years. Money (benefits) received in the future has less value than money received today because of the time value of money. The time value of money is taken into account with present value calculation. We compare the present value of the anticipated stream of benefits over 30 years in the future to the up-front out-of-pocket cost of the mitigation project.

A present value calculation depends on the useful lifetime of the mitigation project and on what is known as the discount rate. The discount rate may be viewed simply as the interest rate you might earn on the cost of the project if you didn't spend the money on the mitigation project. Let's assume that this mitigation project is to be funded by FEMA, which uses a 7% discount rate to evaluate hazard mitigation projects. With a 30-year

lifetime and a 7% discount rate, the “present value coefficient” which is the value today of $1.00 per year in benefits over the lifetime of the mitigation project is $12.41. That is, each $1.00 per year in benefits over 30 years is worth $12.41 now. The benefit-cost results are now as follows:

Table A2.3
Benefit-Cost Results

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

These results indicate a benefit-cost ratio of 3.85. Thus, in FEMA’s terms, the mitigation project is cost-effective and eligible for FEMA funding.

Taking into account the time value of money (essential for a correct economic calculation), results in lower benefits than if we simply multiplied the annual benefits times the project’s 30-year useful lifetime. Economically, simply multiplying the annual benefits times the project lifetime would ignore the time value of money and thus would yield an incorrect result.

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The above discussion of benefit-cost analysis of a flood hazard mitigation project illustrates the basic concepts.

The actual FEMA BCA modules calculate each category of damage or loss separately and the specific built-in data and the specific user-input data vary from module to module, depending on the hazard, type of facility, and type of mitigation project.