HAZARD MITIGATION PLAN

Arlington Public Schools

2025-2030

Arlington Public Schools
135 North French Avenue
Arlington WA 98223

The 2024 Arlington Public Schools' 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 Arlington Public Schools Hazard Mitigation Plan (HMP) covers each of the major natural hazards that pose significant threats to the District.

The **Mission Statement** of the Arlington Public Schools HMP is to:

Proactively facilitate and support district-wide policies, practices, and programs that make the Arlington Public Schools more disaster resistant and disaster resilient.

Making the Arlington Public Schools more disaster resistant and disaster resilient means taking proactive steps and actions to protect lives, 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 Arlington Public Schools is neither technologically possible nor economically feasible. However, taking steps to reduce exposure to hazards will potentially reduce the negative consequences of future disasters

Mitigation simply means actions taken 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 Arlington Public Schools 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 hazard that poses the greatest threat to the District's facilities and people. For the Arlington Public Schools this is an "Earthquake". Other natural hazards that pose lesser threats are addressed briefly. Climate change is also having a potentially larger impact in Washington State and is reviewed as well.

1.0 INTRODUCTION

1.1 What is a Hazard Mitigation Plan?

The Arlington Public Schools HMP covers each of the natural hazards that pose potential threats to the District.

The effects of potential future disaster events on the Arlington Public Schools 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 Arlington Public Schools HMP is to:

Proactively facilitate and support district-wide policies, practices, and programs that make the Arlington Public Schools more disaster resistant and disaster resilient.

Making the Arlington Public Schools more disaster resistant and disaster resilient means taking proactive steps and actions to protect lives, reduce property damage, minimize economic losses and disruption, and shorten the recovery period from future disasters.

This plan is an educational and planning document 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 HMP 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 Arlington Public Schools is neither technologically possible nor economically feasible. However, substantially reducing the negative consequences of future disasters is achievable with the implementation of a pragmatic HMP.

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

The Arlington Public Schools mitigation plan has several key elements:

- Each natural hazard that may significantly affect Arlington Public Schools' facilities is reviewed to estimate the probability (likelihood) and severity of occurances.

- The vulnerability of Arlington Public Schools to each hazard is evaluated to determine the likely severity of physical damages, casualties, and economic consequences.

- A range of mitigation actions are evaluated to identify those with the greatest potential to reduce future damages and losses to the Arlington Public Schools and that are desirable from the community's political and economic perspectives.

1.2 Why is Mitigation Planning Important for the Arlington Public Schools?

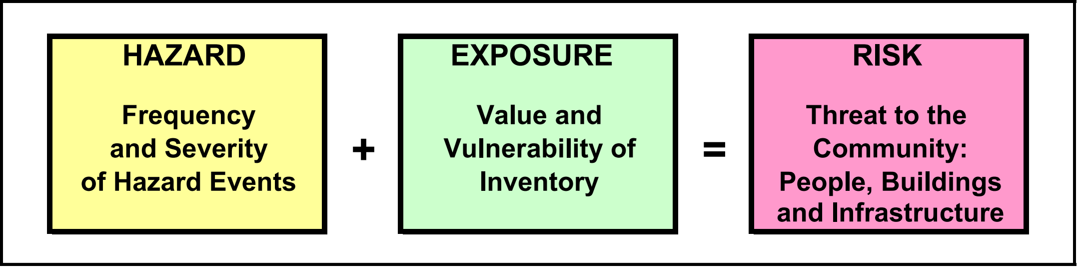
Effective mitigation planning will help the Arlington Public Schools deal with natural hazards realistically and rationally. That is, to identify where the level of risk from one or more hazards may be unacceptably high and then to find cost effective ways to reduce such risk. Mitigation planning strikes 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-HMP 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 Arlington Public Schools' ability to secure future FEMA mitigation funding.

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

1.3 The ARLINGTON PUBLIC SCHOOLS HAZARD MITIGATION PLAN

The Arlington Public Schools HMP is built upon a quantitative assessment of each of the hazards that may significantly affect the Arlington Public Schools, including their frequency, severity, and the campuses most likely to be affected. This assessment draws extensively on statewide data collected for the development of the Washington State K-12 Facilities HMP, the Washington State Enhanced Mitigation Plan, the Washington State K-12 Facilities Hazard Plan verbiage itself, and additional district-specific data.



The reviews of the hazards and the vulnerability of the Arlington Public Schools 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 Arlington Public Schools.

The Arlington Public Schools HMP deals with hazards realistically and rationally and strikes a balance between suggested physical mitigation actions to eliminate or reduce the negative consequences of future disasters and planning measures. These potential actions better prepare the community to respond to and recover from disasters for which physical mitigation actions are not possible or not economically feasible.

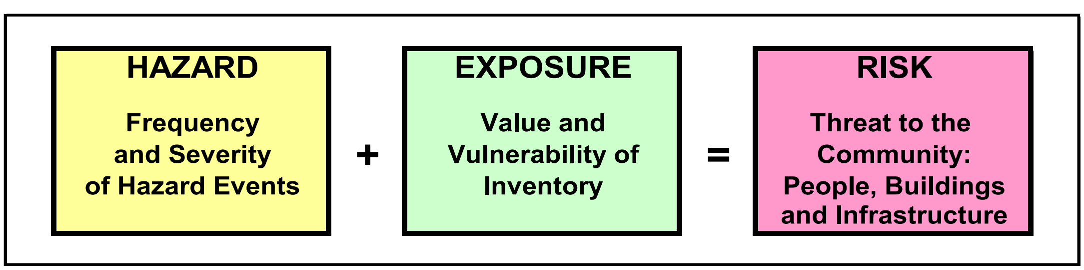
1.4 Key Concepts and Definitions

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 Arlington Public Schools 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 below.

Figure 1.1

Hazard and Exposure Combine to Produce Risk



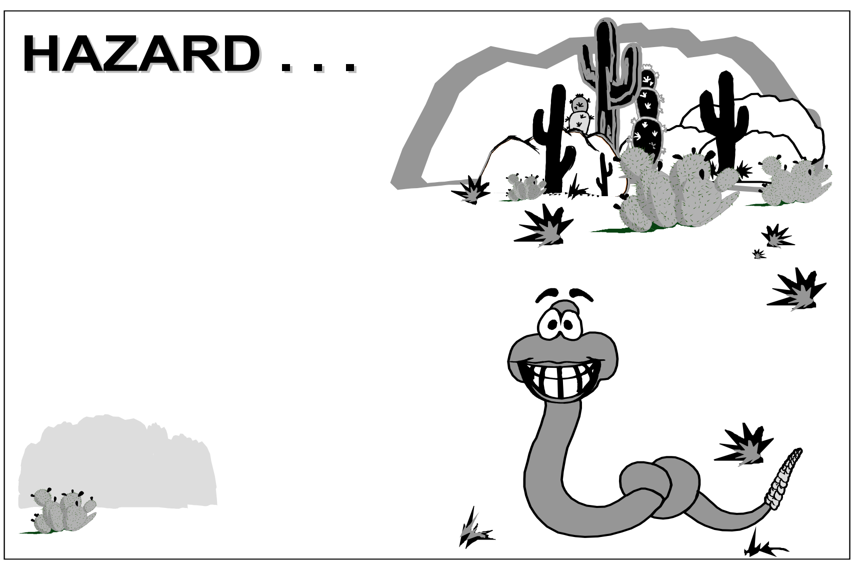
Risk is generally expressed in dollars (estimates of potential damages and other economic losses) and numbers of casualties (deaths and injuries).

There are four key concepts that govern hazard mitigation planning: hazard, exposure, risk, and mitigation.

HAZARD refers to a natural event 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 a wetland 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 hazard) may be environmentally beneficial by providing wildlife habitat, recreational opportunities, and so on.

Figure 1.2
Hazard Alone Does Not Produce Risk



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.

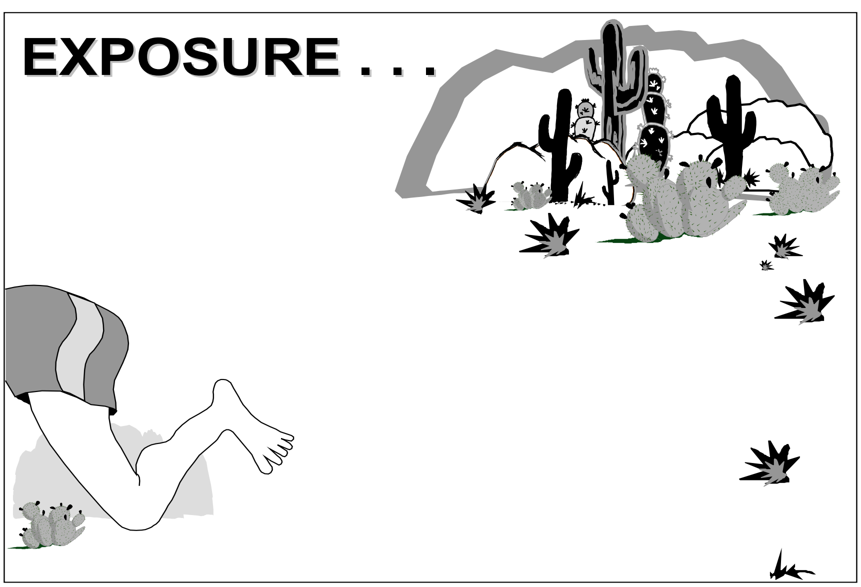
EXPOSURE is the quantity, value, and vulnerability of the built environment (inventory of people, buildings, and infrastructure) in a particular location subject to one or more hazards. Inventory is described by the number, size, type, use, occupancy of buildings, and by the infrastructure present. Infrastructure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

For the Arlington Public Schools, 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.

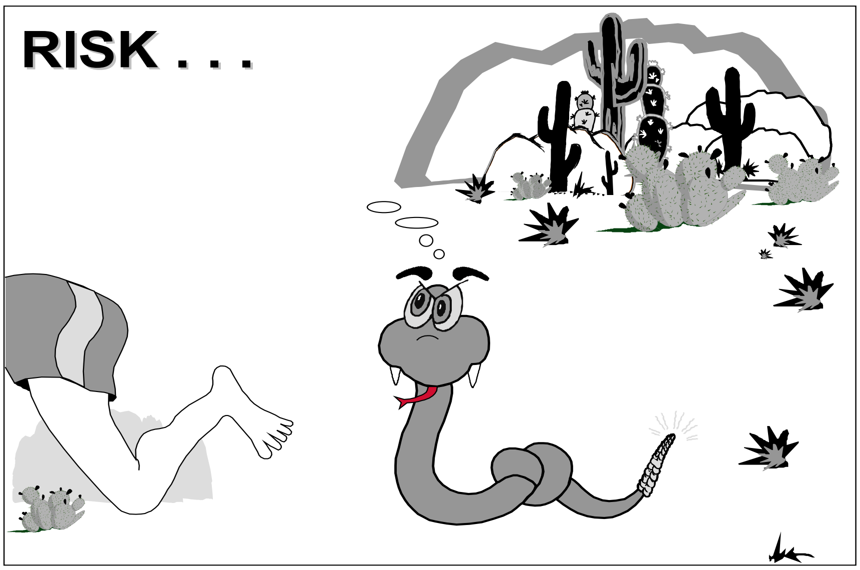
Figure 1.3

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.

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 an 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 taken 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 on the following page.

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 location in a high risk area (possible FEMA buyout) and building a 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

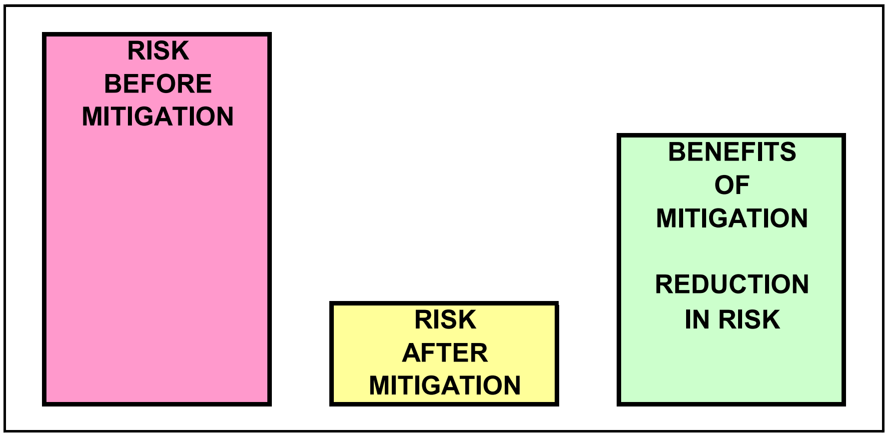
The mitigation project list above is not comprehensive; mitigation projects can encompass many other actions to reduce future damages, losses, and casualties.

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 decreased level of 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



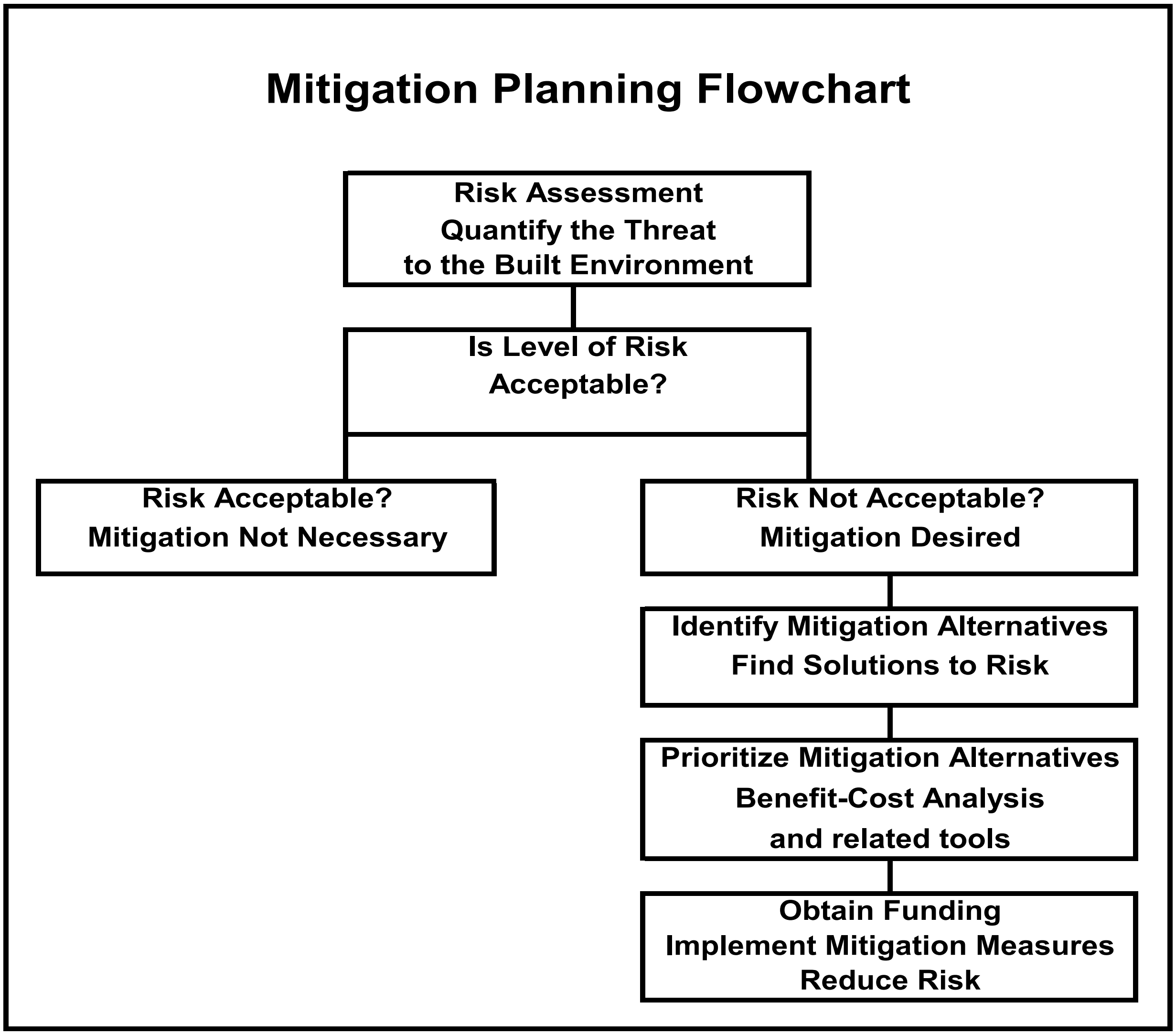
Quantifying the benefits of a proposed mitigation project is an essential step in hazard mitigation planning and implementation. Only by quantifying benefits is it possible to compare the benefits and costs of mitigation to determine whether or not a particular project is worth doing (i.e., whether it 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, which shows the major steps in hazard mitigation planning and implementation for the Arlington Public Schools.

Figure 1.6
The Mitigation Planning Process



The first steps are quantitative evaluation of the hazards (frequency and severity) affecting the Arlington Public Schools 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 Arlington Public Schools.

The next key step is to determine whether or not the level of risk posed by each of the hazards affecting the Arlington Public Schools 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 intolerable, 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 Arlington Public Schools.

1.6 The Role of Benefit-Cost Analysis in Mitigation Planning

Communities, such as the Arlington Public Schools, 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?

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

Further details about BCA are given in the Appendix B: Principles of Benefit-Cost Analysis.

1.7 Hazard Synopsis

The traditional natural hazard events are earthquake, tsunami, volcanic, flood, and wildland/urban interface fires (WUI). Data regarding the potential effects that these events may have on the Arlington Public Schools is found in the Educational Data System (EDS) through the Office of the Superintendent of Public Instruction (OSPI).

The most common natural hazard events in Washington are extreme weather, flooding, landslides, and wildfires. They are also the most widespread, each capable of having direct statewide impacts. In many previous disasters, these natural hazards triggered each other. For example, extreme rainfall triggered flash flooding and landslides in 2021 [Disaster Recovery Number (DR)-4635)], and extreme heat and wind increased the potential for severe wildfires in 2020 (DR-4584). The combination of climate change and continued population growth, and subsequent urban development in hazard-prone places, has contributed to the increased frequency and severity of these natural hazard events, and therefore, the state's vulnerability to these hazards. These natural hazards are often referred to as climate-related natural hazards. These events used to be high frequency but low severity, but they are now becoming high frequency *and* high severity events. **Given the severity of recent climate-related disasters and the increasing likelihood of future disasters related to climate change, it has been determined that the natural hazards placing Washingtonians at the highest risk in the near term are (1) extreme weather, (2) flooding, and (3) wildfire** (Washington State Enhanced HMP p. 1)**.**

As natural disasters relating to climate change are relatively new, the data relating to hazard and risk to district buildings and recorded in OSPI's Information and Condition of Schools (ICOS) data-base only focuses on the six traditional major hazards of Earthquake, Tsunami, Volcanic, Flood, WUI fire and Landslide.

The following figure illustrates the relative level of hazard for the six hazards at each of the District's campuses. These hazard levels are based on statewide geographic information systems (GIS) data and additional district-specific data entered into the OSPI's ICOS Pre-Disaster Mitigation (PDM) database. The Arlington Public Schools HMP addresses each of the major natural disasters that pose significant threats to District facilities.

Figure 1.7
ARLINGTON PUBLIC SCHOOLS: Major Hazards Matrix

STATE OF WASHINGTON

SUPERINTENDENT OF PUBLIC INSTRUCTION

DISTRICT PDM HAZARD SUMMARY

	Earthquake	Tsunami	Volcanic	Flood	WUI	Landslide
Arlington						
"A" Building and District Storage	Moderate	None	Low	Moderate	None	None
Arlington High School	Moderate	None	None	None	None	None
District Administration	Moderate	None	Low	Moderate	None	None
Eagle Creek Elementary School	Moderate	None	Low	Moderate	None	None
Haller Middle School	Moderate	None	Low	Moderate	None	None
Kent Prairie Elementary School	Moderate	None	None	None	None	None
Pioneer Elementary School	Moderate	None	None	None	None	None
Post Middle School	Moderate	None	Low	Moderate	None	Very High
Presidents Elementary School	Moderate	None	Low	Moderate	None	None
Stillaguamish Valley School	Moderate	None	Low	Moderate	None	None
Transportation	Moderate	None	None	None	None	None
Weston High School	Moderate	None	None	None	None	None

All of the Arlington Public Schools' campuses have moderate levels of earthquake hazard because of their proximity to many active earthquake faults. A moderate hazard level doesn't necessarily mean moderate risk. The level of earthquake risk for each building depends upon the design and condition of that building. Further details are provided in Section 6.2: Earthquakes.

No campuses are subject to tsunamis as the district is located many miles from the coast and at elevations above any possible tsunami events.

The ARLINGTON PUBLIC SCHOOLS are 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.

Even though several campuses are located within the designated distance of major waterways to be considered a flood hazard, there are no flood risks for the campuses as all are well above FEMA mapped floodplains, are not near un-mapped streams, and have no history of significant problems with localized storm water drainage flooding.

There are no significant wild land/urban interface fire risks because all campuses have limited vegetative fuel load, good defensible space, and access to city water for fire suppression.

Post Middle School campus has some degree of exposure to landslide hazard which appears very high. A geological survey has been completed indicating landslide hazard potential is not at this level. Further details are provided in Section 6.4: Landslides.

Climate change is introducing other natural hazards in Washington State that need to be considered as well. Most notably Wild Fire Smoke from Wildland Fires, Extreme Heat, and Drought. Further details are provided in Chapter 6.

1.8 Risk Synopsis

The following Table illustrates the relative level of risk for the six traditional major hazards at each of the District's campuses. These risk levels are based on district-specific data entered into OSPI's ICOS PDM database.

Table 1.3
ARLINGTON PUBLIC SCHOOLS: Major Risk Matrix

STATE OF WASHINGTON
SUPERINTENDENT OF PUBLIC INSTRUCTION
DISTRICT PDM TOTAL RISK SUMMARY

	Earthquake	Tsunami	Volcanic	Flood	WUI	Landslide
"A" Building and District Storage	Very High	None	Low	Low	None	None
Arlington High School	Not Complete	None	None	None	None	None
District Administration	Not Complete	None	Low	Low	None	None
Eagle Creek Elementary School	None	None	Low	Low	None	None
Haller Middle School	Very High	None	None	Low	None	None
Kent Prairie Elementary School	Low	None	None	None	None	None
Pioneer Elementary School	Low	None	None	None	None	None
Post Middle School	High	None	Low	Low	None	Very High
Presidents Elementary School	Low	None	Low	Low	None	None
Stillaguamish Valley School	Not Complete	None	Low	Low	None	None
Transportation	High	None	None	None	None	None
Weston High School	Moderate	None	None	None	None	None

* As noted above, even though several campuses are located within the designated distance of major waterways to be considered a flood hazard, there are no flood risks for the campuses as all are well above FEMA mapped floodplains, are not near un-mapped streams, and have no history of significant problems with localized storm water drainage flooding.

Further details regarding these hazards and the level of risk to District facilities and people are presented in the following Sections:

Section 6.2: Earthquakes

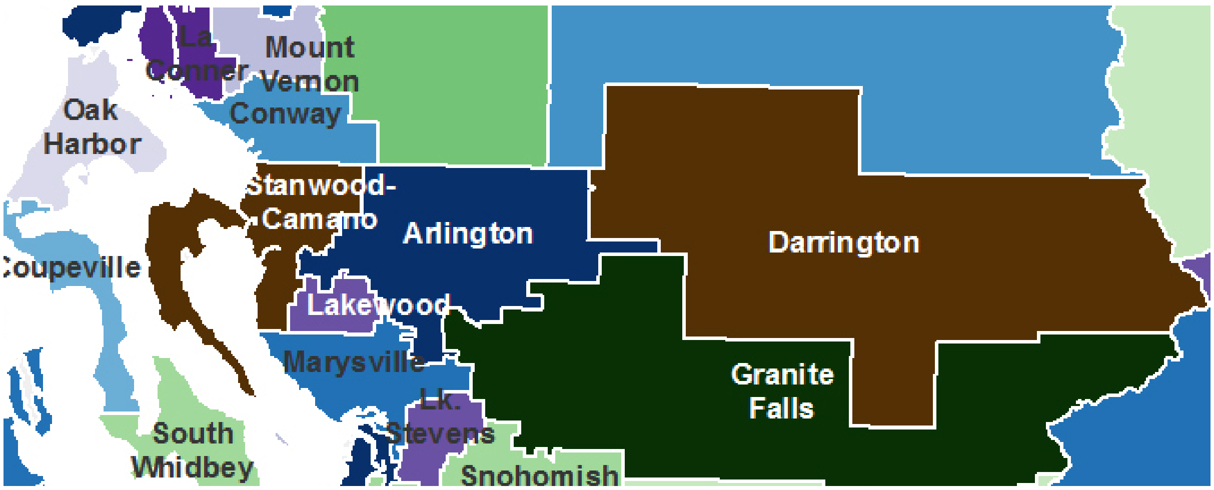
Section 6.4: Landslides

2.0 ARLINGTON PUBLIC SCHOOLS PROFILE

2.1 District Location

The Arlington Public Schools are located in Snohomish County on the I-5 corridor 45 miles North of Seattle next to the Cascade foothills.

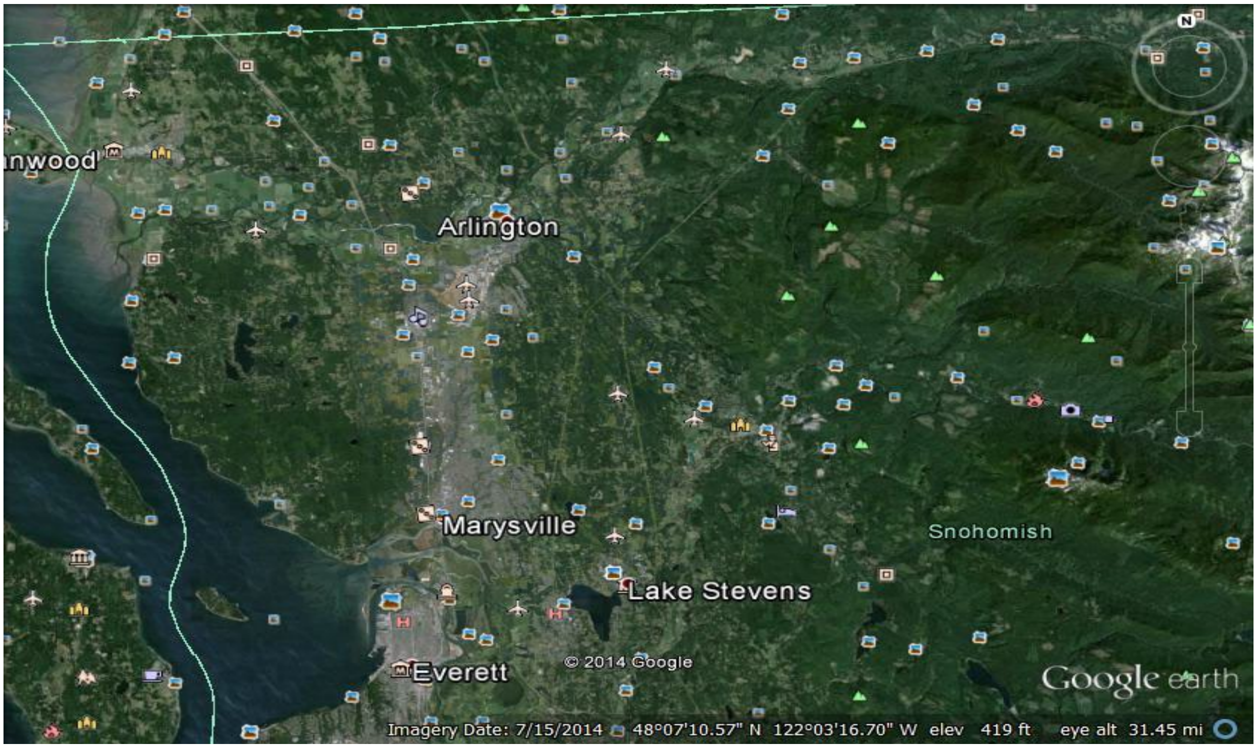
Figure 2.1
Arlington Public Schools Map



The Arlington Public Schools include the city of Arlington, a section of Smokey Point, and several unincorporated communities. The total population within the district's boundaries is approximately 32,502 as of 2023.

As shown in the Google Earth image in Figure 2.2 on the following page, the population within the Arlington Public Schools is located in North Snohomish County in an area between Puget Sound and the Cascade mountains.

Figure 2.2
ARLINGTON PUBLIC SCHOOLS and Vicinity



2.2 District Overview

The City of Arlington is flanked by the Stillaguamish River with a history as a logging and agricultural area. Originally, there were two separate towns: Arlington and Haller City. Eventually, those who settled in Haller City moved to Arlington.

In 1884-1885, plans were made for the first school in the Arlington area. In 1885, the newly formed District 16 was established at Kent's Prairie. The original school building was made of cedar wood and Native Americans brought the flooring from Stanwood to Gifford's landing by canoe and then dragged by mules to the school. There were 12 Native American children and two Caucasian children when the school opened. In 1889, the school increased to 30 students.

Additional schools opened around 1887, including Trafton and Haller City. By 1894 the Lincoln school was added and started with two rooms before expanding to four rooms. In 1893, Garfield School was built and took the place of Kent's Prairie School. The first high school classes were held in the Garfield School in 1904-1905.

In 1904, Haller City District No. 50 and Arlington District No. 16 became School District No. 89 at the time the two cities incorporated. In 1908, $15,000 was voted for a new high school building with classes beginning on September 14, 1908. The

new high school was named the Washington School. At the same time, the small neighboring schools from Edgecomb, Island, Trafton, Lake Riley, Ebey, Sisco Heights, Halterman, Greenwood, Oso, Cicero, Jordan, Jim Creek, Lower Pilchuck and Loyal Heights consolidated into the Arlington Public Schools.

In 1921, The Roosevelt School was built for the 4th through 12th grade students living in Arlington. The Roosevelt building is still in use for the district administration office. The Civilian Conservation Corps (CCC) opened a camp in Darrington in 1933 due to the loss of jobs when the mills closed down. The Works Progress Administration (WPA) built a new high school in 1936 along with sidewalks in the area. The high school is still being used by Arlington Public Schools and houses the Support Services Department including Child Nutrition, Custodial, Grounds, and Maintenance.

Arlington Public Schools has nine operating schools: one traditional high school, one alternative high school, two middle schools, four elementary schools and a parent-partner program. The district also includes Developmental and Early Childhood Education Assistance Program (ECEAP) preschool programs.

The Arlington Public Schools mission statement is:

Arlington Public Schools educates all students, preparing and inspiring them to graduate and seek their full potential as life-long learners.

Table 2.1

District Information 2024

Position	Count
Teachers	317
Classified	333
Administration	36
Exempt	16
Total staff	702

Grade Band	Count
Preschool (Spec Ed & ECEAP)	189
Elementary school students	2564
Middle school students	1232
High school students	1,886
Total number of Students	5,871
Ethnicity*	Percentage
American Indian /Alaskan Native	1.0%
Asian	1.9%
Black / African American	1.3%

Hispanic / Latino of any race(s)	18.7%
Native Hawaiian/Other Pacific Islander	0.3%
Two or more races	7.7%
White	69%
** OSPI October 2024: http://www.k12.wa.us*	

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 are for Arlington Public Schools.

Table 2.2
Demographic Data
ARLINGTON PUBLIC SCHOOLS

Population	Arlington School District, WA				
	Number	Percent		Number	Percent
Male:	16040	49.35%	**Female**	16462	50.65%
Under 5 years	917	2.82%		771	2.37%
5 to 9 years	920	2.83%		927	2.85%
10 to 14 years	1466	4.51%		1098	3.38%
15 to 17 years	623	1.92%		1055	3.25%
18 and 19 years	250	0.77%		262	0.81%
20 years	162	0.50%		112	0.34%
21 years	97	0.30%		117	0.36%
22 to 24 years	389	1.20%		463	1.42%
25 to 29 years	767	2.36%		808	2.49%
30 to 34 years	778	2.39%		932	2.87%
35 to 39 years	1151	3.54%		1360	4.18%
40 to 44 years	956	2.94%		1189	3.66%
45 to 49 years	1101	3.39%		888	2.73%
50 to 54 years	1502	4.62%		1279	3.94%
55 to 59 years	1387	4.27%		1185	3.65%
60 and 61 years	418	1.29%		650	2.00%
62 to 64 years	750	2.31%		693	2.13%

65 and 66 years	283	0.87%	350	.08%
67 to 69 years	772	2.38%	610	1.88%
70 to 74 years	565	1.74%	496	1.53%
75 to 79 years	324	1.00%	398	1.22%
80 to 84 years	266	0.82%	302	0.93%
85 years and over	196	0.60%	517	1.59%
Total: Male and Female	32502			

2.3 District Facilities

Arlington Public Schools has nine campuses and several other facilities including a district office building, Support Services, and Transportation.

Table 2.3
District Facilities

Arlington Pre-Disaster Mitigation Summary		
Campus/ Building	**Building Condition**	**Building Earthquake Performance Assessment Tool (EPAT) Area**
Arlington High School		
Greenhouse	90.00	Main Area
Industrial Arts Building	87.53	Main Area
Main Building	90.93	Auditorium
-	-	First Floor
-	-	Second Floor
-	-	
Stadium	-	Main Area
Stadium Storage	-	Main Area
Stadium Ticket Booth	-	Main Area
AF JROTC Portable		Main Area
Eagle Creek Elementary School		
Main Building	87.17	Covered Play
Metal Storage Building	80.29	Main Area
Portable 3	-	Main Area
Portable 4	-	Main Area

Haller Middle School		
Gymnasium Building	80.50	Main Area
Hartz Field Bathroom and Storage Building	89.13	Main Area
Main Building	-	First Floor
-	-	Second Floor
Music Building	89.97	Main Area
Kent Prairie Elementary School		
Covered Play	69.53	Main Area
Main Building	86.21	Main Area
"A" Building and District Storage		
Building "A"	-	Area 1
-	-	Area 2
-	-	Greenhouse
Food Service Dry Storage Building	-	Main Area
Grounds Department Storage Building	-	Main Area
District Administration		
District Administration Office (Roosevelt)	-	Main Area
		Main Area
Stillaguamish Valley School		
Portable 1 Office		Main Area
Portable 2		Main Area
Portable 3		Main Area
Portable 4		Main Area
Portable 5		Main Area
Portable 6		Main Area
Portable 7		Main Area
Portable 8		Main Area
Portable 9		Main Area
Portable 10		Main Area
Portable 11		Main Area
Transportation		
Pupil Transportation		Main Area
Weston High School		
Main Building	80.22	

During the 2022-23 school year, the Master Facilities Committee reconvened to review the status of the current facilities and district-owned properties. The membership of this committee consisted of an architect, a facilities consultant, district employees, and community members. The Committee made several determinations regarding these properties and presented them to the board. One of the recommendations that applies to this document is the replacement of Post Middle School which could, in effect, be rebuilt away from the adjacent slope and improve its earthquake and landslide resiliency.

Following are pictures of the facilities referred to in table 2.3.


Arlington High


Byrnes Performing


Weston High


Haller Middle


Post Middle


Eagle Creek


Kent Prairie
Elementary


Pioneer Elementary


Presidents Elementary


Stillaguamish Valley
Learning Center


Roosevelt Building
Administrative Offices

3.0 PLANNING PROCESS

3.1 Overview

The Arlington Public Schools mitigation planning process began in the fall of 2013 and put into effect May 8, 2017. Due to COVID, COVID aftermath and recovery, this review of the Pre-Disaster Mitigation Plan is taking place after the five-year mark. The District's mitigation plan is consistent with, and draws extensively from, the Washington State K–12 Facilities HMP and the Washington State Enhanced HMP. However, the Arlington Public Schools HMP has an in-depth focus on the District, its facilities, its people, and includes more district-specific content, including district-specific hazard and risk assessments and mitigation priorities.

3.2 Mitigation Planning Team

The Emergency Management and Response Team (EMART) from the Arlington Public Schools is the primary Mitigation Planning Team for this process. This team consists of representatives from district and building leadership as well as local law enforcement. EMART meets monthly to review, discuss, plan, and implement best practices when responding to disaster/emergency situations that occur in the educational setting. EMART is led by the Executive Director of Operations.

2024-25 EMART Roster

Kyle Axelson	Assistant Principal, Arlington High School
Ed Aylesworth	Director of Child Nutrition and Support Services, District Office
Nate Bauer	School Resource Officer, Arlington Police Department
Krissa Cramer	Registered Nurse, District Office
Julie Davidson	Assistant Supervisor, Transportation
Paul Dobberfuhl	Assistant Principal, Post Middle School
Joseph Green	Assistant Principal, Haller Middle School
Angie Hansen	Assistant Principal, Eagle Creek Elementary
Terri House	Executive Assistant of Operations, District Office
Sue Kraus	Assistant Principal, Pioneer Elementary
Brian Lewis	Executive Director of Operations, District Office
Karrie Marsh	Principal, Stillaguamish Valley Learning Center
Shareene Mossburg	Assistant Principal, Presidents Elementary
Leigh Anne Orcutt	Fiscal Secretary, Weston High School
Gary Sabol	Public Information Officer, District Office
Bob Stoddard	Assistant Principal, Kent Prairie Elementary

EMART’s roles and responsibilities for this process are defined as follows:

- Participate actively in planning team meetings
- Provide local perspectives re: natural hazards and the threats they pose to the District’s facilities and people
- Help 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
- Provide review comments on draft materials during development of the Arlington Public Schools HMP.

3.3 Mitigation Planning Team Meetings

Mitigation planning team meetings are documented below with dates and brief summaries.

ARLINGTON PUBLIC SCHOOLS
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STRATEGIC GOALS

Goal 1:
Student Learning & Achievement

Goal 2:
Safe and Caring Environment

Goal 3:
Resource Stewardship

Goal 4:
Parent & Community Partnerships

OUR NORMS

- *Assume positive intent*
- *Be professional in all interactions*
- *Be kinder than necessary*
- *Be fully present and engaged*
- *Be prepared*

Agenda

Meeting Title:	EMART
Date & Time:	November 21, 2024 9:30am-11:00am
Location:	Lincoln Room

Reflective questions for our time together:

Learning outcomes for our work today:

Time	BELONG and LEARN in Arlington	Facilitator
9:30	• Welcome • Shelter in Place Follow-up	All
9:40	• Hazard Mitigation Plan	Ed Aylesworth
10:00	• Webinar-What's Next for Panic Button-Wearable Devices •	All
11:00	• Next Meeting Nov. 21, 2024 9:30 AM – 10:30 AM Lincoln Room	

2024-11-21 EMART Meeting Minutes

- Welcome/ Meeting called to order
- Quick note- DSHS does not have the legal authority to enter our buildings without producing ID. The one exception to this rule: Law Enforcement in Uniform.

Hazard Mitigation Plan:

- Ed walked the group through- what goes into the Plan. (OSPI and FEMA)
- Why do we do this? Reduces Hazard risks and FEMA money is available for certain things.
- Originally the following hazards were highlighted: floodplain, wildfire, landslide
- What we focus on now: earthquake, landslide, extreme weather, wildfire smoke
- EMARTs role in the plan/process: participate in meetings, provide local perspectives, help identify existing plans, forge a consensus, help facilitate/public outreach.
- Updating the Plan: meet with stakeholders, finalize, Collaborate with SCDEM, send it to the State for review, School Board proposes a Resolution and approves, and finally to FEMA for review and approval.
- EMART will now look at it at the January Meeting and provide feedback.

ACE Committee Presentation:

- Gary gave a brief presentation on the importance of Reporting incidents not reposting
- STA process-upcoming discussion coming to EMART

RAVE Presentation: (online)

- Recent update/changes to in app mapview
- Staff Assist has changed as well. Discussed how/when to use it
- Using practice mode a good option to familiarize yourself or staff with the buttons
- Upcoming-multi floor buildings Staff Assist will be able to pinpoint locations
- Responders will be able to identify location of where button is pushed
- Motorola is testing wearables (buttons) -gives precise indoor location, it's discrete to activate
- Some states /area have laws or policies in place (Alyssa's Law-silent panic alarms for K-12)
- Some Unions have rules against work related apps on personal devices.
- Location Beacons ($22/ea) can be placed in every occupied room . Indoor placement was recommended
- Battery life of 4 years (2 AA batteries per device)
- Motorola has set up a Beta test for 2nd quarter 2025, it will cover a 12 week test program.
- What we took away from the Q and A portion: COST: $150/per person to wear a wearable -FOB

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STRATEGIC GOALS

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Goal 4:
Parent & Community Partnerships

Agenda

Meeting Title:	EMART
Date & Time:	February 20, 2025 9:30am-10:30am
Location:	Lincoln Room

Reflective questions for our time together:

- ***What is Stop the Bleed?***
- ***What further steps are needed to finalize the All HMP?***

Learning outcomes for our work today:

- ***The district's suggested response to ICE agents on campus.***

OUR NORMS

- *Assume positive intent*
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- *Be kinder than necessary*
- *Be fully present and engaged*
- *Be prepared*

Time	BELONG and LEARN in Arlington	Facilitator
9:30	• Welcome • Review last meeting's notes	All
9:40	• Stop the Bleed kits • Hazard Mitigation Plan Update	Krissa Cramer Ed Aylesworth
10:00	• Response to the presence of ICE agents on campus	All
10:30	• Next Meeting Mar. 20, 2025 9:30 AM – 10:30 AM Lincoln Room	

2025-2-20
EMART Meeting

STOP THE BLEED:

- Krissa walked the group through SB 5790- Bleeding Control Kits in each building. Most kits are placed by AEDs. At AHS and the middle schools the kits are located near the gyms. Nurses also have them on their carts.
- Each building should have 2 staff members trained. The more trained the better. Last spring Skagit Regional Health came to the District and trained several people.
- Another training could be possible at the beginning of the school year. Training time is about 1 hour, and it is free.

ED Mitigation Update:

- Ed provided the group with a handout to review before our next meeting- MULTI HAZARD MITIGATION ACTION ITEMS. The changes are listed in RED. Please review and be prepared for a short discussion, and any suggestions you might have.

ICE AGENTS IN BUILDINGS:

- Our District Policy does not allow for ICE Agents to enter our INSTRUCTIONAL area to remove students.
- Request from agents first thing that they provide a warrant signed by a judge. Call Brian or the Superintendent's office.
- Have agents remain in vestibules and not enter instructional areas or playgrounds.
- If they still attempt to enter without waiting for Brian or Dr. Sweeting -place the building in LOCKOUT. If they try to enter after the LOCKOUT then you would proceed to LOCKDOWN.

RESPONSE TO EMERGENCIES:

- HOLD: When we use HOLD it may not necessarily be a dangerous situation.
- LOCKOUT: generally signals to staff that something is happening outside. Business as usual inside.
- LOCKDOWN: Students should not be on their phones. You do not open any doors until an administrator or law enforcement officer does. Ignore all bells and alarms, you do not evacuate during this time.

LOCKDOWN/ LOCKOUT are the most likely scenarios to occur in buildings.

- Lockdown vs Lockout buttons in each building. They are tested yearly by Sonitrol.
- Brian can do individual building Staff Training. The beginning of the school year would be best, and no students present during this training.

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Agenda

Meeting Title:	**EMART**
Date & Time:	**March 20, 2025 9:30am-10:30am**
Location:	**Lincoln Room**

Reflective questions for our time together:
- ***What further steps are needed to finalize the All Hazard Mitigation Plan?***

Learning outcomes for our work today:
- ***The district's suggested response to 1st Amendment Auditors on campus.***

Time	BELONG and LEARN in Arlington	Facilitator
9:30	• Welcome • Review last meeting's notes	All
9:40	• Hazard Mitigation Plan Update	Ed Aylesworth
10:00	• 1st Amendment Auditors-update	Gary Sabol
10:30	• Next Meeting Apr. 17, 2025 9:30 AM – 10:30 AM Lincoln Room	

2025-3-20
EMART Meeting

HAZARD MITIGATION

- Hazzard Migration Review- Ed waked the group through the APS Multi Hazard Mitigation Action Items.
- Actions discussed with the group- TABLE 4.3 Long Term #1. The group wondered if Long Term #1 could be edited to go with Short Term #1 (LANDSLIDE MITIGATION)
- Next Steps for Ed: make edits, put out to the public for comment, then to county for review, then to State for review, then send it to FEMA. The final product will be published after FEMA approval.

1st AMENDMENT AUDITORS

- First amendment auditor discussion: if your building is visited- (discussion points with the group today) say as few words as possible, a non-public area is- anything behind a locked door –usually the second set of doors. Lawsuits can be filed, avoid physical/verbal confrontations, and don't play copyrighted music.
- Brian and Gary are looking at wording for signs to be posted in visible main entrances at all District buildings.
- Follow up on this at next EMART Meeting

KILLEEN SCHOOL DISTRICT

- Killeen School District discussion: Middle school stabbing. A student was stabbed at school and subsequently died.
- There were metal detectors at the school- they do not detect knives
- The incident involved bullying and schools response to bullying reports
- There were 2 known instances prior to the stabbing involving the suspect and victim
- The school had purchased cell phone pouches previously but were not enforcing the use of them

Planning meetings were also held with staff members within the APS Support Services Department as stakeholders as they help maintain the facilities within the District. Agendas and meeting minutes follow:

APS Support Services

Agenda

Meeting Title:	Support Services
Date & Time:	December 2, 2024
Location:	Conference Room

Learning outcomes for our work today:

STRATEGIC GOALS

Goal 1:
Student Learning & Achievement
Goal 2:
Safe and Caring Environment
Goal 3:
Resource Stewardship
Goal 4:
Voices & Partnerships

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	BELONG and LEARN in Arlington	Facilitator
	Schedules HMP What else?	Ed All
Upcoming Meetings	December 16, 2024	

12/2/24

Support Services Hazard Mitigation Meeting

Present: Ed Aylesworth, Ben Bass, Kenny Gilbert, Eric Mitzelfeldt, Sam Turner, Leonard Turner, Terry Gegner

Ed explained what the HMP (HMP) was and that it was created in 2017.

FEMA came up with natural disasters and we created the District HMP on how we would deal with the disasters. This was approved for 5 years. It is now time to update.

Last year Ed updated parts of the HMP. He explained what we are susceptible to and our plans:

- Earthquake – across the District
- Landslide – Post and KP. Core samples were taken at Post and our soil is ok, we just have to observe safety distances.

Ed handed out Chapter 4 and said that most of the decisions are made through EMART but he would like our input to take to EMART. He explained the tables and he would like some input from the department for things not discussed (i.e. drought/excessive heat in buildings with no air conditioning).

Agenda

Meeting Title:	Maintenance/Grounds
Date & Time:	February 10, 2025
Location:	Conference Room

STRATEGIC GOALS

Goal 1:
Student Learning & Achievement
Goal 2:
Safe and Caring Environment
Goal 3:
Resource Stewardship
Goal 4:
Voices & Partnerships

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	BELONG and LEARN in Arlington	Facilitator
	Hazard Mitigation suggestions follow-up Update-Presidents What else?	Ed All
Upcoming Meetings	February 24, 2025	

Support Services Meeting 1/10/25

Attendance – all members throughout 3 meetings in the day.

Extreme Weather Mitigation:

- High winds – trees at Weston, EC & Post – any potential danger?
- Post – trees on east side; stability of land – we were told the land is stable and the trees are fine
- Pioneer – take down trees from wetlands that are leaning
- AC – cooling is not satisfactory at EC, KP and Post
- Air quality – RGF technology?
- Wildfire danger – perhaps concrete siding on the portables (SVLC specifically)
- Mitigation idea – irrigation around the buildings; keep the laws green to reduce potential fire problems

Update on Presidents:

- Replacing freezer this summer – fill in loading dock and expanding onto that. Take away the storage room that PTSA has been using. Possibly build shed for PTSA (their funds)
- Keep entrance to cooler/freezer outside and doorway same size it is now. This will switch current freezer/cooler positions. Enter freezer through the cooler.

3.4 Public Involvement in the Mitigation Planning Process

The Arlington Public Schools took steps to involve the public and stakeholders throughout the mitigation planning process, including the following actions:

Public Meeting Notices

The District announced the initiation of the mitigation planning via:

- Posting a notice on the District's website,
- Distributing the notice via e-mail to a wide audience of stakeholders,
- Publishing the notice in the following local newspaper(s): Insert name or list.

Public Meetings

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

Copies of the above notices are included in Appendix C.

- Meeting 1 (when there is a complete draft?)
- Meeting 2 date (presentation to the Board?)
- Meeting 3 date (if held).

Insert brief synopsis of each meeting

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

Note: FEMA requires that the stakeholders invited to participate in the planning process (public meetings, review, and comment on drafts) must include: 1) local and regional agencies involved in hazard mitigation activities (such as the county and city emergency managers); 2) agencies that have authority to regulate development (city and/or county); and 3) neighboring communities. Suggestions: e-mail notices of meetings and website postings to a list of such people and include neighboring districts in this list. FEMA requires that such stakeholders be given the opportunity to participate but this does not mean that they must participate. See page 16 of the FEMA Local Mitigation Plan Review Guide for what information must be provided for the stakeholders.

Can be an email list.

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 (Insert the ways in which the request for comments on the draft mitigation plan was provided.) Copies of the notices are included in Appendix C.

Key inputs received during the review and comment periods included the following: Insert a list of any significant comments that were received during the review period. If no substantive comments were received, delete this item from your mitigation plan.

- Comment 1
- Comment 2
- Comment 3
-
-
-

Review and Comment on Mitigation Plan Drafts

Mitigation Plan drafts were distributed to various stakeholders in the area surrounding the Arlington Public Schools including the City of Arlington's Emergency Management Team, the Snohomish County Emergency Management Team and the North County Fire District.

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

- "This is a well-written report. I learned a few items. I really don't have anything for comments, you have covered all the hazards and have included site specific info."
- One recipient provided a copy of the document with extensive grammatical corrections which were extremely helpful and appreciated.
- Comment 3

Changes to the document were made according to the suggestions noted through comments as appropriate.

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

The Arlington Public Schools HMP drew heavily on the content of the Washington State K–12 Facilities HMP and the Pre-Disaster Mitigation parts of the OSPI ICOS database. ICOS includes a comprehensive database of school facility information including condition assessments, remodeling, and modernization as well as 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 is periodically updated with 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 five year updates.

Weston High School structural plans were reviewed and a walk-through conducted by a structural engineering firm in December of 2014. The engineers determined that "the building structure is a pre-engineered steel building with tilt-up panels around the perimeter" and that, "In general, the building's lateral force resisting system meets the intent of the current building code requirements." As a result, the Weston High School building is determined to be less of a risk and will not be as high a priority as compared to Post Middle School. A copy of the Engineer’s letter follows:

www.pcs-structural.com

December 23, 2014

Arlington School District
315 North French Avenue
Arlington, WA 98223

ATTN: Sid Logan

RE: *Weston High School Walkthrough*

Dear Sid:

Per your request, I joined Fred Owyen and yourself on a walkthrough of Weston High School in the Arlington School District. The purpose of this walkthrough was to review the existing structural system to determine the structures ability to resist earthquake loads.

During the walkthrough it was determined that the building structure is a pre-engineered steel building with concrete tilt-up panels around the perimeter. The building was determined to be constructed in 1978.

The lateral force resisting system for the building consists of steel moment resisting frames in the transverse direction and concrete tilt-up shear walls in the longitudinal direction. In general the building's lateral force resisting system meets the intent of the current building code requirements.

Thank you for the opportunity to be of continued service to the Arlington School District. Please contact us if you have any questions.

Very truly yours,

PCS STRUCTURAL SOLUTIONS

Donald R. Scott, S.E., F.SEI
Vice President / Director of Engineering

DRSmao
15-109

cc: Fred Owyen – Owyen Consulting

It was noted that Post Middle School is located near a steep slope. A geotechnical company was contracted to complete a surficial observation of the site to determine current status of the site for landslide potential. Their findings are outlined in the following letter beginning on the next page.

NGA

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

Main Office
17311 – 135th Ave NE, A-500
Woodinville, WA 98072
(425) 486-1669 · FAX (425) 481-2510

Engineering-Geology Branch
5526 Industry Lane, #2
East Wenatchee, WA 98802
(509) 665-7696 · FAX (509) 665-7692

MEMORANDUM

KHALED M. SHAWISH · STATE OF WASHINGTON · 35215 · REGISTERED PROFESSIONAL ENGINEER · EXPIRES 7/28/15 · 2/6/14

DATE: February 6, 2014

TO: Fred Owyen – Owyen Consulting, LLC

FROM: Khaled M. Shawish, P.E.
Lee S. Bellah, LG

RE: Geotechnical Engineering Consultation
Post Middle School
1220 East 5th Street
Arlington, Washington
NGA File No. 889014

Introduction

This memorandum documents our surficial observations and preliminary opinions regarding the steep slope conditions at the Post Middle School property located at 1220 East 5th Street in Arlington, Washington. We understand that some concerns regarding the stability of a steep slope to the northeast of the school have been raised and you have requested that we visit the site and provide general opinions regarding the conditions of the steep slope based on surficial observations. This is not an in-depth evaluation of the property, as no subsurface explorations or engineering analysis were performed.

Site Geology

Geology: The Geologic Map of the Arlington East Quadrangle, Snohomish County, Washington, by James P. Minard (U.S.G.S., 1985) was referenced for the geologic conditions at the site. The site is mapped as the Arlington Gravel Member of the Recessional Outwash deposits (Qvra) and Glacial Till (Qvt). The Arlington Gravel deposit consists of sand and gravel. Glacial till in this area consists of a dense, nonsorted mixture of clay, silt, sand, and gravel. We observed exposures within the steep slope generally consisted of sand and gravel soils underlain by silty fine to medium sand with gravel soils consistent with the

description of the Recessional Outwash deposit and Glacial Till, respectively.

Observations

We visited that site on January 14, 2014 to perform a walk through evaluation of the steep slope area and observe surficial conditions. The site is currently occupied by an existing school building within the relatively level, central portion of the property. A steep slope is located to the northeast of the school building with an existing access driveway between the steep slope and the school building. The top of the steep northeast-facing slope is located approximately 14 to 30 feet from the eastern edge of the access driveway. The school building is setback approximately 51 to 87 feet from the top of the steep slope. The slope descends down from the relatively level upper area to a pond area below at approximate gradients in the range of 30 to 75 degrees (58 to 373 percent). The overall slope height is roughly 60 to 70 feet.

We observed soil exposures immediately below the top of the bluff consisting of granular soils interpreted to be recessional outwash deposits underlain by siltier glacial till. The slope is generally well vegetated with young to mature trees, grass and underbrush. We observed some minor shallow surficial sliding and erosion immediately below the top of the slope. Some of these shallow failures appear to have undermined some of the larger trees on the slope. We also did not observe any recent signs of large deep-seated instability of the site slopes within the property.

We did not observe groundwater emitting from the slope face immediately below the top of the slope, however we did observe evidence of outcropping groundwater on the slope. We anticipate that some of the groundwater within this site could daylight on the slope in the form of perched groundwater. Perched water occurs when surface water infiltrates through less dense, more permeable soils and accumulates on top of the underlying, less permeable soils. The more permeable soils consist of the outwash sands. The less permeable soils consist of the underlying glacial till. Perched water does not represent a regional ground water "table" within the upper soil horizons. Perched water tends to vary spatially and is dependent upon the amount of rainfall. We would expect the amount of ground water to decrease during drier times of the year and increase during wetter periods.

Preliminary Opinions and Recommendations

Based on our surficial evaluation of steep slope area to the northeast of the school building, it is our opinion that the steep slope area appears to be generally stable with respect to deep-seated movement.

However, there is a potential for shallow sloughing and erosion events to continue to occur on the steeper portions of the slope as we observed during our site visit. Surface erosional activity is considered common to these types of slopes, which is generally caused by seasonal saturation of the near-surface soils, oversteepening of the native slopes by natural weathering processes (wind, rain, freeze-thaw), and by local groundwater seepage. Due to the steep conditions, underlying soils, erosion and weathering conditions, and the potential of groundwater seepage, the surface soils are considered to be at risk for downslope movement associated with steep slopes within the area which was indeed observed on the site slopes during our site visit. Based on our observations, it is our opinion that the site is not backwasting significantly at this time, but we would anticipate that during periods of extended rainfall and/or as a result of seismic activity, shallow slides and surface erosion could occasionally occur on the steep slopes within this area. This condition can be exacerbated by allowing surface water to flow over the top of slope, and over-steepening caused by erosion and surface sliding.

It is our opinion that some of the trees within the steep slope have been undermined and could pose a hazard to slope stability. We recommend that a certified arborist be retained to evaluate the condition of the existing trees on the steep slope and provide their opinions and recommendations regarding tree management on the slope. At a minimum, we recommend that the undermined trees be cut down near the ground surface and their stumps left in place. No debris from tree removal should be allowed to remain in the steep slope area. Care should also be taken to no impact slope stability conditions on the slope during tree removal. If any areas are disturbed, they should be compacted and covered with erosion control material. Disturbed areas should be planted as soon as practical and the vegetation should be maintained until it is established.

Based on our recent surficial observations it appears that the school building setback is adequate at this time. We understand that the existing school building may be remodeled or replaced entirely in the future. If the school building is to remain and be remodeled, we recommend that stormwater runoff from the school and the existing access driveway along the top of the steep slope be controlled to flow away from the steep slope area. If the existing school is to demolished and a new building constructed, we recommend that we be retained to explore the subsurface conditions throughout the site with deep explorations, and provide a geotechnical evaluation to confirm the proposed setback and provide our opinions and recommendations regarding overall stability of the slope, foundations, drainage and erosion control for the project. No material or structures of any kind should be placed on the steep slope or along the top of the slope without a specific in-depth geotechnical evaluation. We recommend that the existing

access roadway and the top of slope be monitored by school staff, especially during periods of heavy precipitation, for any signs of failures and we be notified to provide an assessment should such signs be observed.

Closure

The opinions and recommendations expressed above are based on limited surficial observations of the steep slope area and are only intended to point out potential concerns with the property. These are not design-level recommendations and should not be used by you or a potential contractor or designer unless a further and specific evaluation is conducted. A more thorough understanding of the subsurface soil and groundwater conditions as well as the stability of the site slopes will require subsurface explorations, mapping, and engineering analysis. The City of Arlington will likely require a geotechnical evaluation of the property prior to issuing construction permits for any future development plans.

Future development plans for the site and long-term maintenance will also have an impact on the site stability and such plans should not be carried out without an engineering evaluation and City of Arlington approval. No other warranty, expressed or implied, is made. Our observations, findings, and opinions are a means to identify the inherent risks to the owner.

We trust this memorandum should satisfy your needs at this time. Please contact us if you have any questions or require additional services.

o-O-o

Based upon this information, a certified arborist was retained to evaluate the trees above the slope. The arborist's findings follow:

From: Thomas Boyce / ISA Certified Arborist PN 6183
12227 Huckleberry Lane
Arlington WA 98223
360 4355935
To: Arlington School District

Date: August 5, 2014

Re: Trees at Post Middle School

I was contacted by Ed Aylesworth in my capacity as a Certified Arborist to assess a stand of trees in the north perimeter of Post Middle School grounds. I looked at the same trees in this area with Sid Logan four years ago . The number a failing trees has increased since then.

These trees are growing on the top of a narrow and extremely steep slope that is slowly eroding. Healthy trees are essential in retaining the soil structure in this currently compromised area. However there are many dead and dying trees in this stand. Removing the dead trees would take a lot of weight off of this bluff to prevent any loss of stability. Most of the dead or dying trees are Western Red Cedars (Thuja plicata) . There a many healthy Cedars that should remain intact. There are also Douglas Firs (Pseudotsuga menzesii) that are in obvious decline as well. Some younger trees have grown in this area that should not be removed.

On the steep slope below there is evidence of recent soil movement . There is no new plant growth in this area. The loss of soil is undermining and exposing the roots of a number of trees noticeably affecting their stability and health. The trees with exposed roots hanging over the slope should be removed. There is evidence (trunk curvature) of soil creep meaning that the a tree leaned with the moving soil and corrected to its trunk growth to straight over time.The majority of the tree species to be removed on the slope are Big Leaf Maples that when cut down will resprout new branches from the stump allowing the tree roots to help in soil stabilization. Eliminating the large tree on this slope will substantially reduce the force of the weight on this slope.

The first priority is to remove the already failing trees. Replanting of smaller growing trees and shrubs is recommended in this situation. Because these failing trees are within striking distance of the school building and grounds, removal should be considered for safety concerns to students and school staff.

Respectfully submitted,

Thomas Boyce

Thomas Boyce

Consulting Arborist

In 2017, Nelson Geotechnical Associates, Inc. (NGA) was retained to take core samples of the Post Middle School site in order to assess the risk of landslide on that property and the compatibility of the property to construct a new school complex on the site.

NGA drilled nine borings to depths of 19-39 feet below the surface. It was their opinion "*that the soils that underlie the site and form the core of the site slopes within the eastern portion of the property should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry.*" It was noted that the "*steep northeast-facing slope exhibits signs of surficial erosion and sloughing; however, these issues are considered normal and can be mitigated through proper setback distances and long-term slope maintenance and erosion control.*" This implies the need to be proactive in maintaining vegetation on and around the slope to reduce sloughing.

The summary of the study follows:

NELSON GEOTECHNICAL ASSOCIATES, INC.
GEOTECHNICAL ENGINEERS & GEOLOGISTS

Main Office
17311 – 135th Ave NE, A-500
Woodinville, WA 98072
(425) 486-1669 · FAX (425) 481-2510

Engineering-Geology Branch
5526 Industry Lane, #2
East Wenatchee, WA 98802
(509) 665-7696 · FAX (509) 665-7692

September 6, 2017

Mr. Brian Lewis ARLINGTON PUBLIC SCHOOLS 315 North French Avenue
Arlington, Washington 98223

Geotechnical Engineering Evaluation **Post Middle School Redevelopment 1220 East 5th Street Arlington, Washington**
NGA File No. 8890B17

Dear Mr. Lewis:

We are pleased to submit the attached report titled "Geotechnical Engineering Evaluation – Post Middle School Redevelopment – 1220 East 5th Street – Arlington, Washington." This report summarizes our observations of the existing surface and subsurface conditions within the site and provides general recommendations for the proposed site development. Our services were completed in general accordance with the proposal that was authorized on July 10, 2017.

The property is currently occupied by the Post Middle School campus consisting of classroom buildings, sport fields, and paved driveways and parking lots. The existing school buildings and associated parking areas are generally located within the northeastern and central portions of the site while the existing sports field and track are located within the southwestern portion of the property. A relatively level vacant grass field area is located within the southeastern portion of the site. This vacant grass field area is approximately 10 to 12-feet higher in elevation in relationship to the remainder of the property. A steep northeast-facing slope area is located along the eastern extents of the property. We understand that the preliminary plans for site redevelopment include removal of the existing school buildings and construction of a new school building within the southwestern portion of the property, along with associated parking and driveway areas and other site improvements within the remaining areas of the property.

We monitored the drilling of nine borings extending to depths of 19.0 to 39.0 feet below the existing ground surface throughout the property. Our explorations indicated that competent glacial deposits generally underlie the site with some localized areas of surficial undocumented fill soils. The steep northeast-facing slope exhibits signs of surficial erosion and sloughing; however, these issues are considered normal and can be mitigated through proper setback distances and long-term slope maintenance and erosion control.

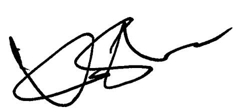
It is our opinion from a geotechnical standpoint that the site is compatible with the planned development provided that our recommendations are incorporated into the design and construction of this project. It is also our opinion that the soils that underlie the site and form the core of the site slopes within the eastern portion of the property should be stable with respect to deep-seated earth movements, due to their inherent strength and slope geometry. We have recommended that the new structures and associated pavements and hard surfaces be founded on the native medium dense or better glacial soil, or structural fill extending to these soils, for bearing capacity and settlement considerations. These soils should generally be encountered approximately two to five feet below the existing ground surface, based on our explorations. However, deeper areas of loose soil and/or undocumented fill could also exist within unexplored areas of the site. In the attached report, we have also included recommendations for site grading, foundation support, retaining walls, and site drainage.

We recommend that NGA be retained to review the geotechnical aspects of the project plans prior to construction. We recommend that NGA be retained to provide monitoring and consultation services during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether or not earthwork and foundation installation activities comply with contract plans and specifications.

We appreciate the opportunity to provide service to you on this project. Please contact us if you have any questions regarding this report or require further information.

Sincerely,

NELSON GEOTECHNICAL ASSOCIATES, INC.



Khaled M. Shawish, PE

Principal

The Arlington Public Schools regularly practice drills per state law. EMART reviewed and up-dated the procedures for earthquake response in 2023 and have been implemented in drills.

The Arlington Public Schools also have designated Haller Middle School and Presidents Elementary for use by the Snohomish County Health Department as needed for services to the community such as mass inoculations and emergency shelters.

The Master Facilities Planning Committee completed a study of assets in the district in 2023. Part of the recommendation to the School Board is to replace Post Middle School which will bring it to earthquake code and potentially mitigate landslide concerns by locating the building further from the adjacent slope. Building a new Post Middle School would also mitigate climate change concerns of increased heat and cold with an updated HVAC system.

4.0 GOALS, OBJECTIVES, AND ACTION ITEMS

4.1 Overview

The purpose of the Arlington Public Schools HMP 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 ARLINGTON PUBLIC SCHOOLS more disaster resistant and disaster resilient by reducing vulnerability to disasters and enhancing capability to respond effectively to, and recover quickly from, future disasters.

Completely eliminating the risk of future disasters in the Arlington Public Schools is neither technologically possible nor economically feasible. However, substantially reducing the negative impacts of future disasters is achievable with the adoption of this pragmatic HMP 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 Arlington Public Schools toward a more safe and disaster resistant future.

The Arlington Public Schools HMP is based on a four-step framework designed to help focus attention and action on successful mitigation strategies: Mission Statement, Goals, Objectives, and Action Items.

Mission Statement-Purpose and Definition: The Mission Statement outlines the purpose and defines the primary function of the Arlington Public Schools HMP. The Mission Statement is an action-oriented summary that answers the question, "Why develop an HMP?"

Goals: Goals identify priorities and specify how the Arlington Public Schools intends to work toward reducing the risks from natural 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 Arlington Public Schools HMP'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 Arlington Public Schools HMP is:

To proactively facilitate and support district-wide policies, practices, and programs that make the Arlington Public Schools more disaster resistant and disaster resilient.

Making the Arlington Public Schools more disaster resistant and disaster resilient means taking proactive steps and actions to:

- Provide life safety,
- Reduce damage to district facilities,
- Minimize economic losses and disruption, and
- 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 HMP. However, the specific priorities, emphasis, and language in this mitigation plan are the Arlington Public Schools'. These goals were developed with extensive input and priority setting by the Arlington Public Schools Hazard Mitigation Planning team, with input requested from district staff, volunteers, parents, students, and other stakeholders in the communities served by the District.

Goal 1: Reduce Threats to Life Safety

Reducing threats to life safety is the highest priority for the Arlington Public Schools.

Objectives:

- Enhance life safety by retrofitting existing buildings as needed or replacing them with new current-code buildings, and by locating and designing new schools to minimize life safety risk from future disaster events.
- Develop disaster evacuation plans and conduct frequent practice drills. When evacuation is impossible in the anticipated warning time, consider 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.

- Enhance life safety by improving student, parent, and staff awareness of the natural hazards posing 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:

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

- Enhance collaboration and coordination between the District, local governments, utilities, businesses, and citizens to prepare for, and recover from, future natural disaster events.
- Enhance emergency planning to facilitate effective response and rapid recovery from future natural disaster events.

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

Objectives:

- Implement education and outreach efforts to increase awareness of natural hazards throughout the Arlington Public Schools, including staff, parents, teachers, and the communities served by the District.
- Maintain and publicize a natural hazards section in the District web page with FEMA and other publications to provide access to hazard information for the community.

4.4 Arlington Public Schools 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 2025 Arlington Public Schools HMP Action Items are summarized on the following tables.

Table 4.1

ARLINGTON PUBLIC SCHOOLS Multi-Hazard 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	District or Grants	Supt	X	X	X	X
Long-Term #2	Review emergency and evacuation planning to incorporate hazard and risk information from the mitigation plan.	Ongoing	District or Grants	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	District or Grants	Supt	X	X	X	X
Long-Term #4	Ensure that new facilities are adequately designed to minimize risk from natural hazards.	Ongoing	District or Grants	Supt	X	X	X	X
Long-Term #5	Maintain, update, and enhance facility data and natural hazards data in the ICOS database.	Ongoing	District or Grants	Supt	X	X	X	X
Long-Term #6	Develop and distribute educational materials regarding natural hazards, vulnerability, and risk for K-12 facilities.	Ongoing	District or Grants	Supt	X		X	X
Long-Term #7	Seek FEMA funding for repairs if district facilities suffer damage in a FEMA-declared disaster.	Ongoing	District or Grants	Supt	X	X		X

Long-Term #8	Pursue pre- and post-disaster mitigation grants from FEMA and other sources.	Ongoing	District or Grants	Supt	**X**	**X**		**X**
Long-Term #9	Post the district's mitigation plan on the website and encourage comments from stakeholders for the ongoing review and periodic update of the mitigation plan.	Ongoing	District or Grants	Supt	**X**			**X**

Table 4.2

ARLINGTON PUBLIC SCHOOLS Earthquake Mitigation Action Items

	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	ce Emergency Pla	ance Awareness Education
Earthquake Mitigation Action Items								
Short Term #1	Evaluate the Seismic vulnerability of the buildings identified by the preliminary screening as likely being at moderate to high risk by having an engineer complete ASCE 41-13 Tier 1 screenings for all or a prioritized subset of these buildings. Order of priority would be Post (completed), Eagle Creek (in progress), Kent Prairie (in progress), Weston (in progress), Transportation and A Building.	1-2 Years	District or Grant	Supt.	X	X		X
Short Term #2	Assess the ASCE 41-13 results and select buildings or building parts that have the greatest vulnerability for more detailed evaluations	1-3 Years	District or Grant	Supt.	X	X		X
Short Term #3	Evaluate the foundations of the portable buildings to determine whether they are adequate for earthquakes.	1-3 Years	District or Grant	Supt.	X	X		X
Long Term #1	Prioritize and implement seismic retrofits or replacements based on the results of the above detailed evaluations, as funding becomes available.	Ongoing	District 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	District or Grant	Supt.	X	X		X
Long Term #3	Enhance emergency planning for earthquakes including duck and cover and evacuation drills	Ongoing	District or Grant	Supt.	X		X	X

Table 4.3
ARLINGTON PUBLIC SCHOOLS Landslide Mitigation Action Items

Hazard	Action Item	Timeline	Source of Funds	Responsible Party	Plan Goals Addressed			
					Life Safety	Protect Facilities	ce Emergency Pla	ance Awareness Education
Landslide Mitigation Action Items								
Long-Term #1	Evaluate possible mitigation measures in response to the geotechnical study as appropriate at Post	1-5 years	District or Grants	Supt.	X	X	X	X

Table 4.4

ARLINGTON PUBLIC SCHOOLS Extreme Weather 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
Extreme Weather Mitigation Action Items								
Short-Term #1	Atmospheric Rivers and High Winds-Assess stands of trees to the North of Weston, South of Eagle Creek, West and North of Stillaguamish Valley Learning Center and East of Post for potential damage to the buildings	1-2 Years	District or Grants	Supt.				
Short-Term #2	High heat-Investigate potential of installing air conditioning in the classroom wings of Eagle Creek and Kent Prairie Elementary schools.	1-2 Years	District or Grants	Supt.				
Short-Term #3	High heat-Investigate efficiency and function of heat pump units at Post Middle school	1-2 Years	District or Grants	Supt.				
Short-Term #4	Wild fire-Investigate the replacement of wood fiber siding of portables at Stillaguamish Valley Learning Center with concrete material	1-2 Years	District or Grants	Supt.				
Short-Term #5	Wild Fire-Assess the potential of fire in the trees surrounding Stillaguamish Valley Learning Center for reaching the portables that have wood fiber siding	1-2 Years	District or Grants	Supt.				
Short-Term #6	Wild Fire-Air quality-Research new technology to mitigate potential poor air quality in the buildings due to wild fire smoke	1-2 Years	District or Grants	Supt.				
Long-Term #1	Review results of short-term items 1-6 and address by priority as funds become available	1-2 Years	District or Grants	Supt.				

5.0 MITIGATION PLAN ADOPTION, IMPLEMENTATION AND MAINTENANCE:

5.1 Overview

For an HMP to be effective, it must 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 Arlington Public Schools HMP 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 Arlington Public Schools has adopted, and will implement and maintain, the vitality of the District's HMP.

5.2 Plan Adoption

This is the Arlington Public Schools second HMP which became effective on Month xx, 2023, the date of adoption by the Arlington Public Schools Board. The Board adopted the District's HMP following FEMA's approval of the District's submitted plan. The Board's adoption resolution is shown on the following page.

Replace following Board Adoption Resolution with an updated scan of Board Adoption Resolution when signed.

ARLINGTON Public Schools

RESOLUTION NO. 17-06
Adoption of the Arlington Public Schools Hazard Mitigation Plan

WHEREAS, Arlington Public Schools 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, Arlington Public Schools 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.

NOW, THEREFORE, BE IT RESOLVED that the Arlington Public Schools Board of Directors adopts the 2017 Arlington Public Schools Hazard Mitigation Plan.

Adopted by the Arlington Public Schools Board of Directors on the 8th day of May, 2017.

ARLINGTON PUBLIC SCHOOLS BOARD OF DIRECTORS:

President

Vice President

Member

Member

Member

ATTEST:

Secretary to the Board

5.3 Implementation

The Executive Director of Operations will have the lead responsibility for implementing the Arlington Public Schools HMP with ongoing support from EMART and the Facilities Committee as needed.

5.3.1 Existing Authorities, Policies, Programs, Resources and Capabilities

The Arlington Public Schools and all school districts in Washington have much narrower domains of authorities than do cities and counties. The district's responsibilities are limited to constructing and maintaining its facilities and providing educational services for the district's students. The district's authorities are limited to these two areas.

The district's policies and programs related to hazard mitigation planning are limited to the criteria for siting new schools, design of new school buildings, maintenance of buildings, and periodic modernization of buildings. The district's resources for these programs include district staff involved with siting, construction, maintenance, and modernization of schools, supplemented by contractor and consultants when needed.

The completion of the Arlington Public Schools HMP has substantially raised the district's awareness and knowledge of natural hazards. Consideration of natural hazards will be included in the siting of new schools, and the design of new school buildings. Furthermore, mitigation measures to reduce risks from natural hazards will be incorporated into maintenance and modernization of buildings whenever possible.

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

District staff have broad experience with planning and facilitation of community inputs. This broad experience is directly applicable to hazard mitigation planning and to the 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, continuing disasters locally and worldwide serve as a reminder of the 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 Arlington Public Schools Board, District staff and in the communities served by the District.

To ensure efficient, effective and timely implementation of the identified mitigation action items, the ARLINGTON PUBLIC SCHOOLS will use the full range of its capabilities and resources and those of the community. The district's goal is to implement as many of the elements of its mitigation strategy (Action Items) over the next five years as possible, commensurate with the extent of funding that becomes available. This effort will be led by the Superintendent with the full support of the School Board and with outreach and cooperation with the community, the region, and the state, especially with OSPI.

Regulatory Tools (Ordinances and Codes)

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

Administrative Tools (Departments, Organizations, Programs)

ARLINGTON PUBLIC SCHOOLS Resources

- School Board
- Superintendent
- Executive Director of Operations
- Arlington Committee for Education (ACE)
- Emergency Management and Response Team (EMART)
- Facilities Advisory Committee (FAC)

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
- Snohomish County, including Emergency Management, Public Works and GIS, Planning Department and Building Officials.
- City of Arlington including Emergency Management, Public Works and GIS, Planning Department and Building Officials

- North County Regional Fire Authority
- Arlington Police Department

Other Technical Tools (Plans and Others)

ARLINGTON PUBLIC SCHOOLS Capabilities

- District Website
- School Closure Communication Plan
- Evacuation Plan
- Lockdown Plan
- Fire Drills
- Earthquake Drills
- Bomb Threat Assessment Guide
- Emergency Response Plan
- Capital Facilities Master Plan
- Strategic Plan
- Policies and Procedures
- Student Rights and Responsibilities
- District Safety Plan
- Regional Capabilities
- Snohomish County HMP and Emergency Response Plan
- City of Arlington HMP and Emergency Response Plan

Fiscal Tools (Taxes, Bonds, Funds and Fees)

ARLINGTON PUBLIC SCHOOLS Capabilities

- Authority to Levy Taxes
- Authority to Issue Bonds
- Funds
- General Fund
- Capital Project Funds
- Debt Service Fund

- Transportation Vehicle Fund
- Trust Fund
- Booster Funds
- External Funds
- OSPI School Construction Assistance Program Modernization / New in Lieu
- FEMA Grants
- HUD “CDBG” Grants
- Foundation Grants
- Legislative Funding/Grants

5.3.2 Integration into Ongoing Programs

As noted above, the ARLINGTON PUBLIC SCHOOLS’ ongoing programs are more narrowly defined than those for cities and counties.

An important aspect of the Plan’s integration into ongoing programs will be the inclusion of the mitigation plan’s hazard, vulnerability, risk evaluations, 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 siting and construction of new facilities.

For example, in evaluating a possible remodeling or modernization of buildings, the district will consider including retrofits to reduce the vulnerability to natural hazards as well as considering other alternatives such as replacement with a new building when the retrofit is very expensive or a site has substantial risks from natural hazards that cannot be mitigated on the existing site.

5.3.3 Prioritization of Mitigation Projects

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

The Arlington Public Schools prioritization of mitigation projects will include the following factors:

- The mission statement and goals in the Arlington Public Schools HMP 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, and
  - Goal 4: Increase Awareness and Understanding of Natural Hazards and Mitigation

- Benefit-cost analysis to ensure that mitigation projects are cost effective, with benefit exceeding the costs.

- The Social, Technical, Administrative, Political, Legal, Economic, and Environmental (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.

5.3.4 Cost Effectiveness of Mitigation Projects

As the Arlington Public Schools 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 these mitigation projects likely to be eligible for FEMA funding?

The Arlington Public Schools 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.

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.

5.3.5 STAPLEE Process

The Arlington Public Schools will also use the STAPLEE methodology to evaluate projects based on the 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 outlines 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?

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?

5.4 Plan Maintenance and Periodic Updating

5.4.1 Periodic Monitoring, Evaluating, and Updating

Monitoring the Arlington Public Schools HMP 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 HMP. As noted previously, The Executive Director of Operations, will have the lead responsibility for implementing the Arlington Public Schools HMP 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.

The Arlington Public Schools HMP 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:

- Do the plans goals, objectives, and action items still address current and future expected conditions?
- Do the mitigation Action Items accurately reflect the District's current conditions and mitigation priorities?
- Have the technical hazard, vulnerability, and risk data been updated or changed?
- Are current resources adequate for implementting the District's HMP? If not, are there other resources that may be available?
- Are there any problems or impediments to implementation? If so, what are the solutions?
- Have other agencies, partners, and the public participated as anticipated? If not, what measures can be taken to facilitate participation?
- Have there been changes in federal and/or state laws pertaining to hazard mitigation in the District?
- Have the FEMA requirements for the maintenance and updating of HMPs changed?
- What can the District learn from declared federal and/or state hazard events in other Washington school districts that share similar characteristics to the Arlington Public Schools, such as vulnerabilities to earthquakes?
- 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.

EMART and/or the Facilities Advisory Committee will review the results of these mitigation plan assessments, identify corrective actions and make recommendations, if necessary, to the Arlington Public Schools Superintendent for actions that may be necessary to bring the HMP back into conformance with the stated goals and objectives. Any major revisions of the HMP will be taken to the Board for formal approval as part of the District's ongoing mitigation plan maintenance and implementation program.

EMART will have lead responsibility for the formal updates of the HMP every five years. The formal update process will be initiated at least one year before the five-year anniversary of FEMA approval of the Arlington Public Schools HMP, to allow ample time for robust participation by stakeholders and the public and for updating data, maps, goals, objectives and Action Items. **Note**: COVID and COVID recovery actions re-

directed the district focus from natural hazard mitigation from 2020-2023 so the Arlington Public Schools did not update the HMP within the five year window.

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 city of Arlington and Snohomish County.

The 2025 Arlington Public Schools HMP will be available on the District's website and hard copies will be placed in the school offices. 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 ARLINGTON PUBLIC SCHOOLS is committed to involving the public directly in the ongoing review and updating of the HMP. 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 five 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 input is deemed necessary. The press release will direct people to the website and other locations where the public can review proposed updated versions of the Arlington Public Schools HMP. This process will provide the public with accessible and effective means to express their concerns, opinions, ideas about any updates/changes that are proposed to the Plan. The District will ensure the resources are available to publicize the press releases and maintain public participation through web pages, social media, newsletters and newspapers.

6.0 Natural Hazards Potentially Effecting the Arlington Public Schools

6.1 DROUGHT

Drought, defined by state statute as below 75% of normal water supply for a given area, is a widespread natural hazard in Washington. Among the most significant impacts of drought in Washington are the effects it can have on agricultural activity, fisheries health, and drinking water supply. The most significant drought exposures and extents are found east of the Cascade Range, which include many counties that are predominantly agricultural.

Between 1980 and 2022 there were 10 official drought declarations in the state. The most recent State-level drought emergency declaration was issued on July 24, 2021, and covered virtually the entire state (aside from parts of King, Pierce, and Snohomish Counties). Streamflows, groundwater levels, and recent precipitation (e.g., previous 90 days) were far enough below normal, with forecasts indicating little likelihood of improved conditions, to warrant a drought declaration.

Table 6.1 summarizes the location, extent, and previous occurrences of droughts in Washington. Table 6.2 provides a summary of the probability of future droughts and projected changes in location, extent, intensity, frequency, and/or duration based on the influence of climate change, population growth, and other external factors.

Table 6.1. Overview of location and extent of previous droughts

Location	Possible Extent (Magnitude/Severity)	Previous Occurrences
Most frequent droughts in Eastern Washington	Hydrologic drought in WA is determined when a declaration was statewide in scale	2022, 2019, 2015, 2006, 2005, 2001, 1994, 1992, 1988

Table 6.2. Overview of probability of future droughts, projected changes in drought impacts, and jurisdictions most at-risk to drought

Probability	Projected changes	Region most at-risk
24% chance of a drought-related disaster declaration each year	Drought (including "abnormally dry" classification) is expected to increase in extent, intensity, frequency, and duration in WA, driven primarily by climate change. The geographic distribution of drought hazards is expected to increase, with western WA becoming more drought prone as climate change continues. However, the primary area at- risk to the most severe droughts continues to be east of the Cascades. Drought intensity was especially high in 2021, with 100% of the state classified as at least abnormally dry that September, including 45% classified as experiencing "extreme" drought.	Central

6.1.1 Drought hazard and vulnerability analysis

According to a 2015 report from the Department of Homeland Security (DHS, 2015), the most vulnerable sectors to drought that may affect the Arlington Public Schools include water/wastewater and energy. As such, this assessment will focus primarily on those sectors and less so on transportation, health, and safety. Additional discussion will focus on potential impacts to agricultural production.

Although much of the state has experienced some form of drought in recent memory, including abnormally dry conditions, the areas most affected by severe drought is east of the Cascade Range. For the purposes of this hazard and vulnerability analysis, the focus was only on the U.S. Drought Monitor drought classifications of severe (D2), extreme (D3), and exceptional (D4) drought in Washington, which may differ from the definition of drought in state statute. For example, it is possible for the U.S. Drought Monitor to identify an area as D2 without a drought declaration from the state because the state considers potential hardship before making a declaration. Data used here is from the U.S. Drought Monitor's most recent complete year (2021) to assess drought risks and vulnerabilities (U.S. Drought Monitor, 2022).

Based on monthly data from the U.S. Drought Monitor, more than half of the state experienced at least severe drought conditions at some point in 2021 (Figure 6.1), including every county east of the Cascades. West of the Cascades, virtually all of San Juan and Clark Counties experienced a minimum of severe drought, as well as portions of Cowlitz, Island, Skagit, Skamania, Wahkiakum, and Whatcom Counties. There are portions of Benton, Grant, Kittitas, Klickitat, and Yakima Counties that were under severe drought (or worse) conditions for all of 2021. There were about four months of exceptional drought in 2021, roughly from August through November.

Drought conditions harmed agricultural production significantly in eastern Washington. In August, 93% of wheat and 66% of barley crops were reported by producers in Washington as being in very poor or poor condition (Tinker & Gutzmer, 2021). Drought also contributed to excessively dry vegetation and soil, which allowed for the potential for wildfires all over the western U.S. (Tinker & Gutzmer, 2021).

Exceptional drought impacted 36% of the state in 2021, including every county in the Eastern region. Extreme drought impacted 45% of the state (again including every Eastern region county), while severe drought impacted 53% of the state and included numerous central and western Washington counties.

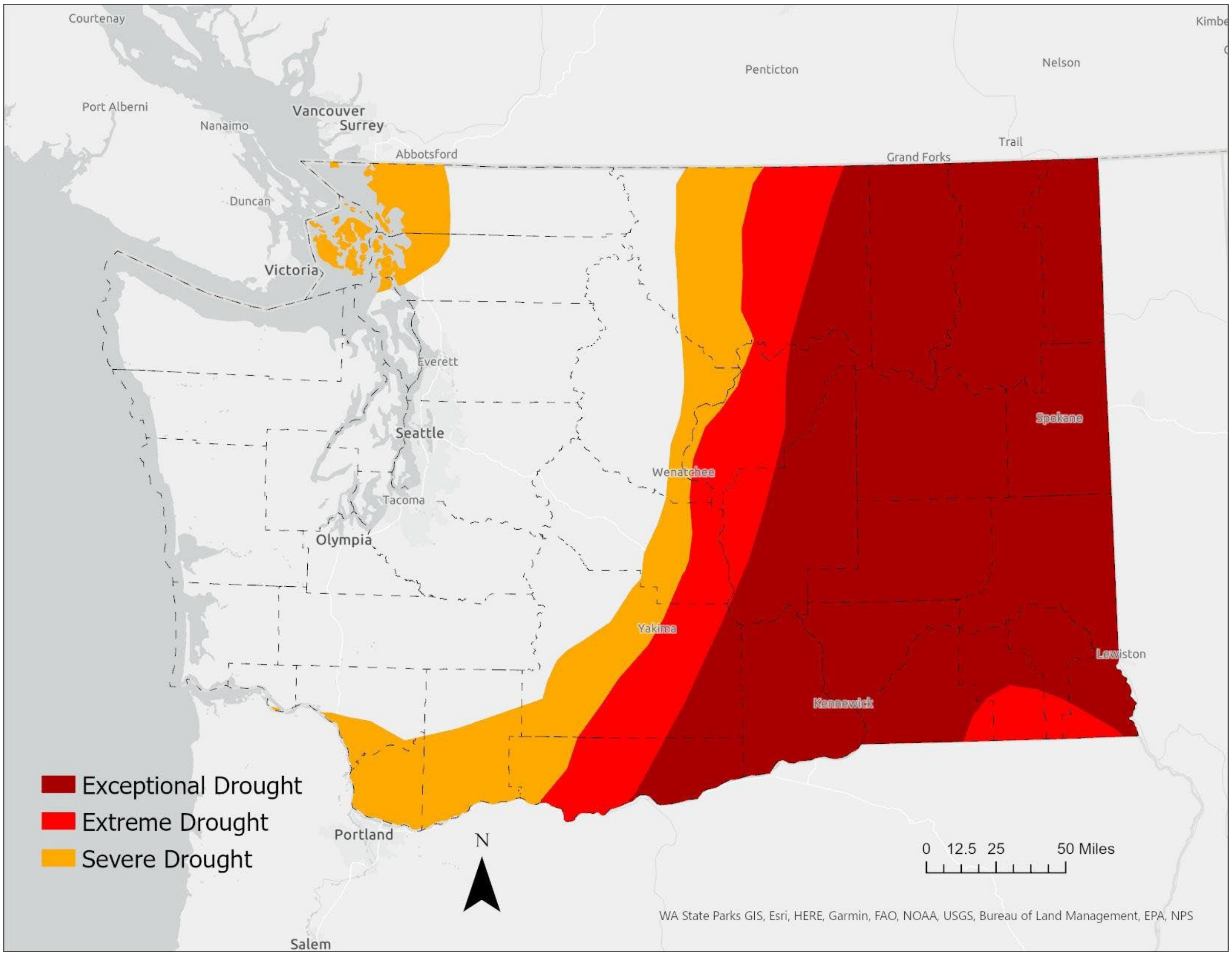


Figure 6.1. Shaded areas represent at least severe drought conditions (U.S. Drought Monitor class DM2 or above) during 2021. Not all areas experienced severe+ drought the entire year. Portions of Benton, Grant, Kittitas, Klickitat, and Yakima Counties did experience severe drought (or worse) throughout all of 2021. Although not mapped above, much of western Washington experienced abnormally dry conditions and were included in the July 2021 drought emergency declaration.

Although virtually all the state is exposed to some level of drought conditions, drought's direct near-term impact on the average Washington resident is relatively minor. However, long-term drought can lead to indirect public health concerns (e.g., drinking water shortage, diminished air quality) that can be difficult to monitor and assess, especially among the state's very small and potentially unmapped water systems. Due to drought's complex nature and multiple dimensions, as well as direct and indirect relationships with other natural hazards, drought risk is often reduced to its environmental impact (e.g., agricultural impacts) (Hagenlocher, et al., 2019). In this update, the attempt is to draw connections between drought exposure and vulnerability while acknowledging that physical vulnerability of a given structure (e.g., a school, power transmission line) to drought is unknown at this time and may in fact be minimal. Because drought has been tied to clear social and environmental impacts, social

vulnerability to drought was prioritized in the analysis, including potential impacts on drinking water supplies.

6.1.2 Critical infrastructure

Transportation: The potential impact of drought on roads is indirect, with primary drought-related road impacts being associated with extreme heat that can accompany drought conditions (DHS, 2015). Although there are many miles of roads located in drought-impacted parts of Washington, the drought-specific impacts are minimal. As such, it can be assumed that roads and transportation facilities are less vulnerable to drought.

Health & safety: Like transportation infrastructure, the vulnerability of police, fire, and healthcare facilities to drought-specific impacts is assumed to be minimal and was not assessed in this update.

Energy: More than half (56%, n=89) of the state's power plants are in the areas impacted by severe (or worse) drought in 2021. Of those, 42 are conventional hydroelectric power plants whose energy production capacity is vulnerable to drought. Most of these conventional hydroelectric power plants are in the Central region (62%) followed by the Eastern region (33%). Grant and Yakima Counties have the most hydroelectric power plants in the drought impact areas of any single county, with five in each. Drought is less likely to impact the functionality of power transmission lines, though drought-associated impacts (e.g., extreme heat) could have some effect (Harto, et al., 2012).

Water & wastewater: There are approximately 7,000 public drinking water supplies (groups A and B combined) in the areas impacted by severe (or worse) drought in 2021, which is about 41% of all drinking water supplies in the state. Of those 7,000, almost half (47%, n=3,300) are in the Central region, particularly in the Yakima Basin, while 18% (n=1,236) are in the Eastern region. The remaining 35% of the drinking water supplies in drought-impacted areas are spilt between the Puget Sound & Northwestern region and the Olympic Peninsula and Southwestern region. The counties with the most public drinking water supplies within the 2021 severe (or worse) drought zones are Yakima, Benton, and Spokane. There are two publicly owned wastewater treatment facilities in the 2021 drought zones, both in Yakima County.

6.1.2 The region most vulnerable to the impacts of drought is the Central Washington region.

This determination is based on the number of critical assets (e.g., drinking water supplies and power plants) exposed to severe, extreme, and exceptional drought in recent years. Additionally, there is a significant population of socially vulnerable residents in the Central Washington region whose vulnerabilities could be easily exacerbated by drought impacts, particularly regarding drought-driven declines in drinking water availability or quality. For example, water shortages are expected to occur more frequently in the Yakima Basin soon, so much so that demand may eventually become greater than available supply (Washington Department of Ecology, 2022). Many of these same residents in Central Washington also live in areas with already diminished air quality, which has been shown to further decline under drought conditions (Wang, et al., 2017). However, many of these same issues can be found in Spokane County, in the Eastern Washington region, elevating that county's risk for drought impacts. It is also known that drought impacts on Washington agriculture are prevalent in both the Central and Eastern regions, though those impacts have not been quantified in this plan update.

Harto et al. (2012) analyzed the impacts of drought on electricity production in the Pacific Northwest and found that **power production could decrease as much as 22% during droughts**. *As climate change continues to increase competition for water supplies, it is possible that our capacity for hydropower will decrease, as much as 11% during the 2020s, while demand continues to increase (Washington Department of Ecology, 2022). The state's hydropower resources provide most of our electricity (approx. 66%), making much of our energy production in Washington directly vulnerable to drought conditions*.

Given this data, the Arlington Public Schools exposure and risk to Drought is mainly tied to potential power grid restrictions and possibly food availability.

6.2 EARTHQUAKES:

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 is 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 on 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.

6.2.1 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 below.

Table 6.3
Largest Recorded Earthquakes[1, 2]

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.

Figure 6.2
Epicenters of Historic Earthquakes in Washington with Magnitudes of 3.0 or Higher[3]

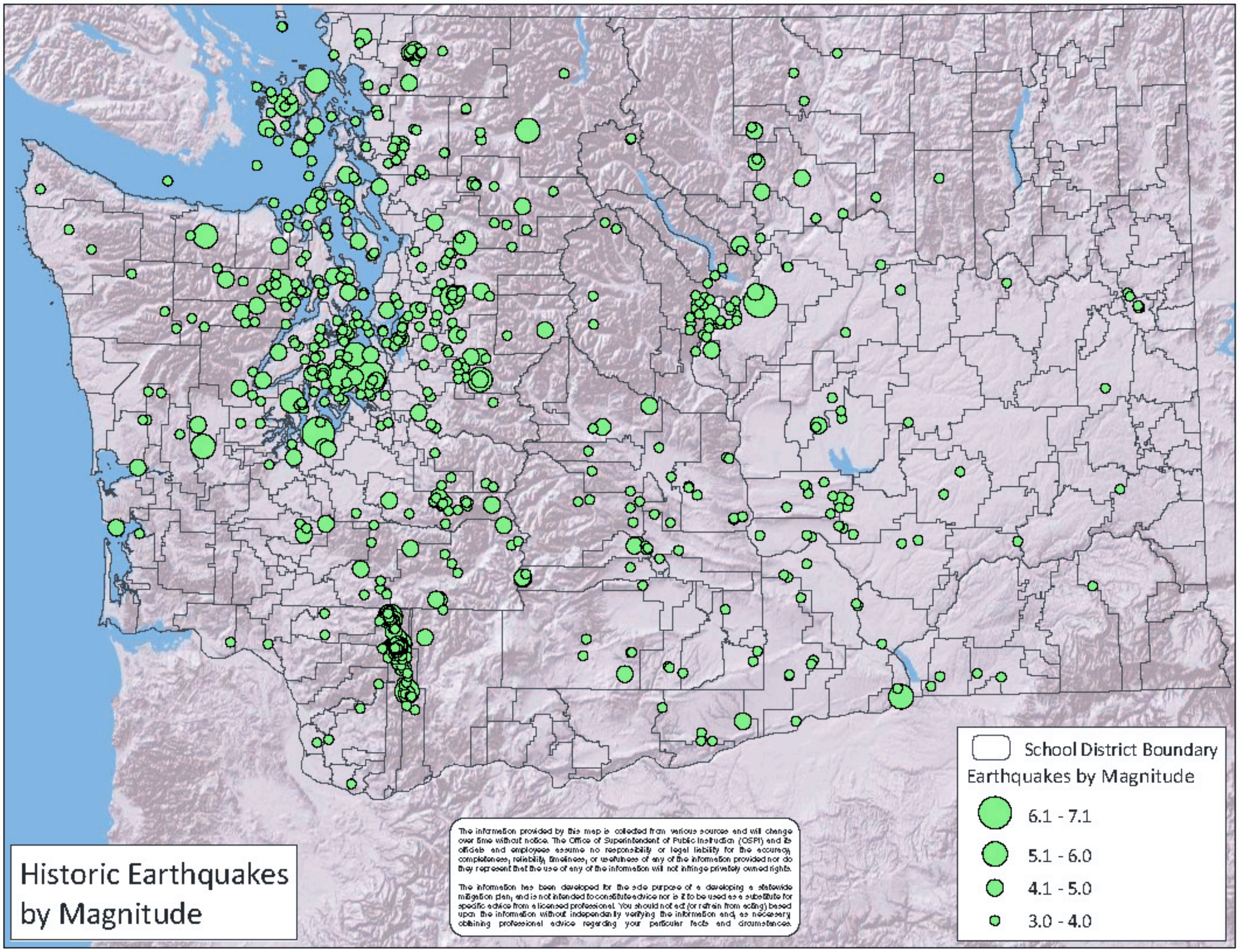


Table 6.3 and Figure 6.2 do not include the January 26, 1700 earthquake on the Cascadia Subduction Zone which has been identified by tsunami records in Japan and paleoseismic investigations along the Washington Coast. The estimated magnitude of the 1700 earthquake was approximately 9.0. This earthquake 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.

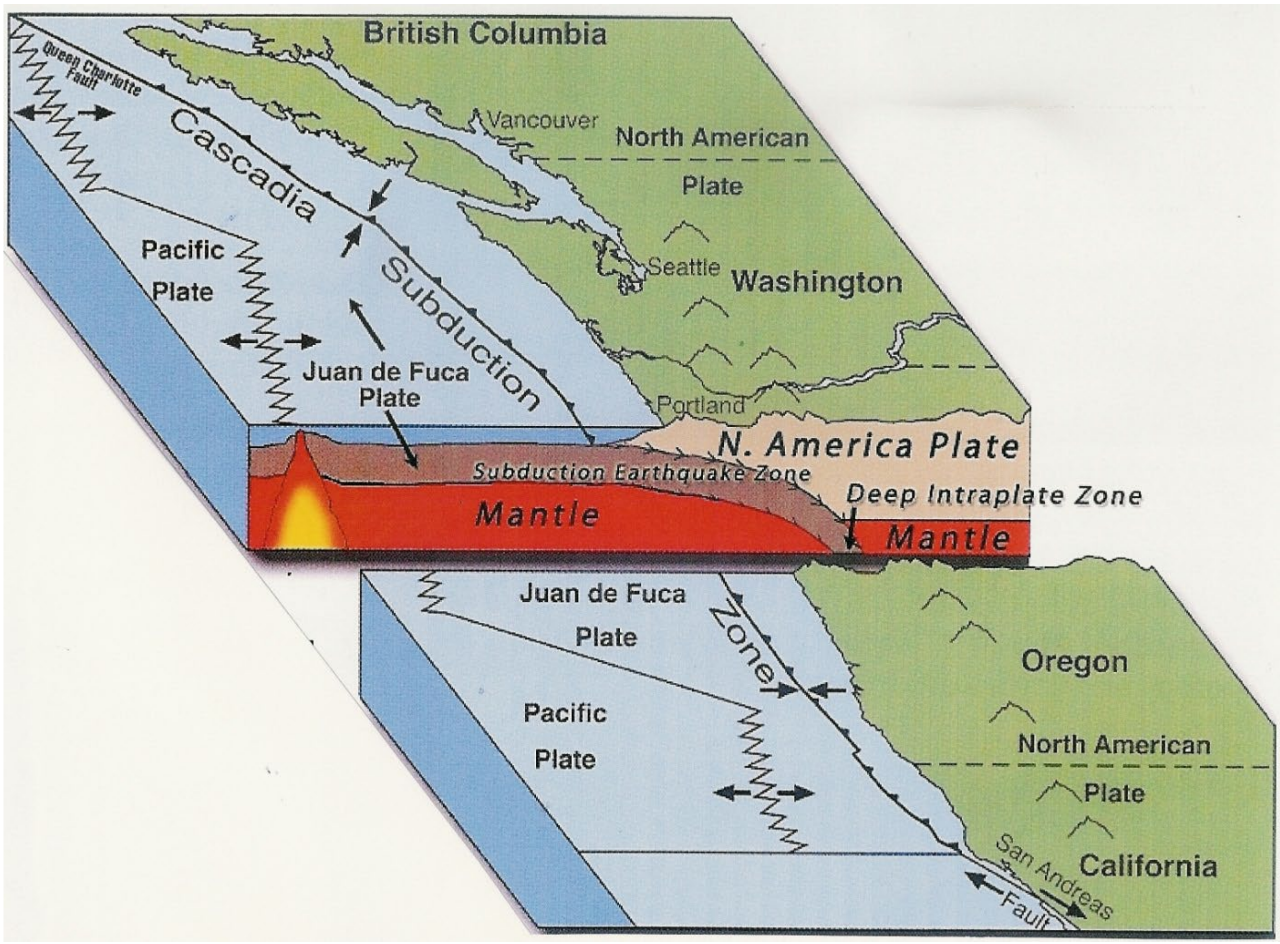
Figure 6.3 on the following page shows the geologic (plate-tectonic) setting of the Cascadia Subduction Zone.

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

- "Interface" earthquakes on the boundary between the subducting Juan de Fuca Plate and the North American Plate,
- "Intraplate" earthquakes within the subducting oceanic plates, and
- "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 6.3
Cascadia Subduction Zone[4]

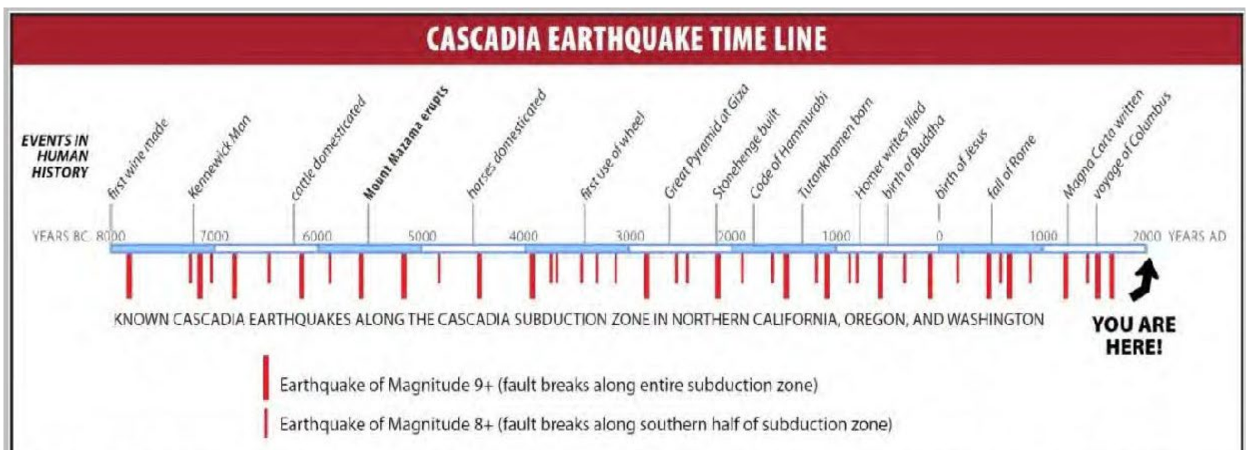


Paleoseismic investigations, which look at geologic sediments and rocks for signs of ancient earthquakes, have identified 41 Cascadia Subduction Zone interface earthquakes over the past 10,000 years, which corresponds to one earthquake about every 250 years. Of these 41 earthquakes, about half are M9.0 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 6.4.

Figure 6.4

Time History of Cascadia Subduction Zone Interface Earthquakes



Comparison of the history of subduction zone earthquakes along the Cascadia Subduction Zone in northern California, Oregon, and Washington, with events from human history. Ages of earthquakes are derived from study and dating of submarine landslides triggered by the earthquakes. Earthquake data provided by Chris Goldfinger, Oregon State University; time line by Ian P. Madin, DOGAMI.

“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.

6.2.2 Earthquake Concepts for Risk Assessments

6.2.2.1 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, a M7 earthquake releases about 30 times more energy than a M6, while a M8 releases about 30 times more energy than a 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 a 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 a 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 <u>not</u> a good measure of the severity of the earthquake at that site.

For most locations, the best measure of the severity of an earthquake is the intensity of ground shaking as well as the duration of the 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 intensity and duration 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 de-amplify 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.

6.2.2.2 Intensity of Ground Shaking

There are many measures of the 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 Arlington Public Schools HMP.

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 that the ground acceleration is 10% that of gravity, and so on.

Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures. 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:

- 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.

6.2.2.3 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 Map. 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 6.5, 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:

- 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 map and the 10% in 50 year map 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.

Figure 6.5
2014 USGS Seismic Hazard Map: Washington State[6]
PGA value (%g) with a 2% Chance of Exceedance in 50 years

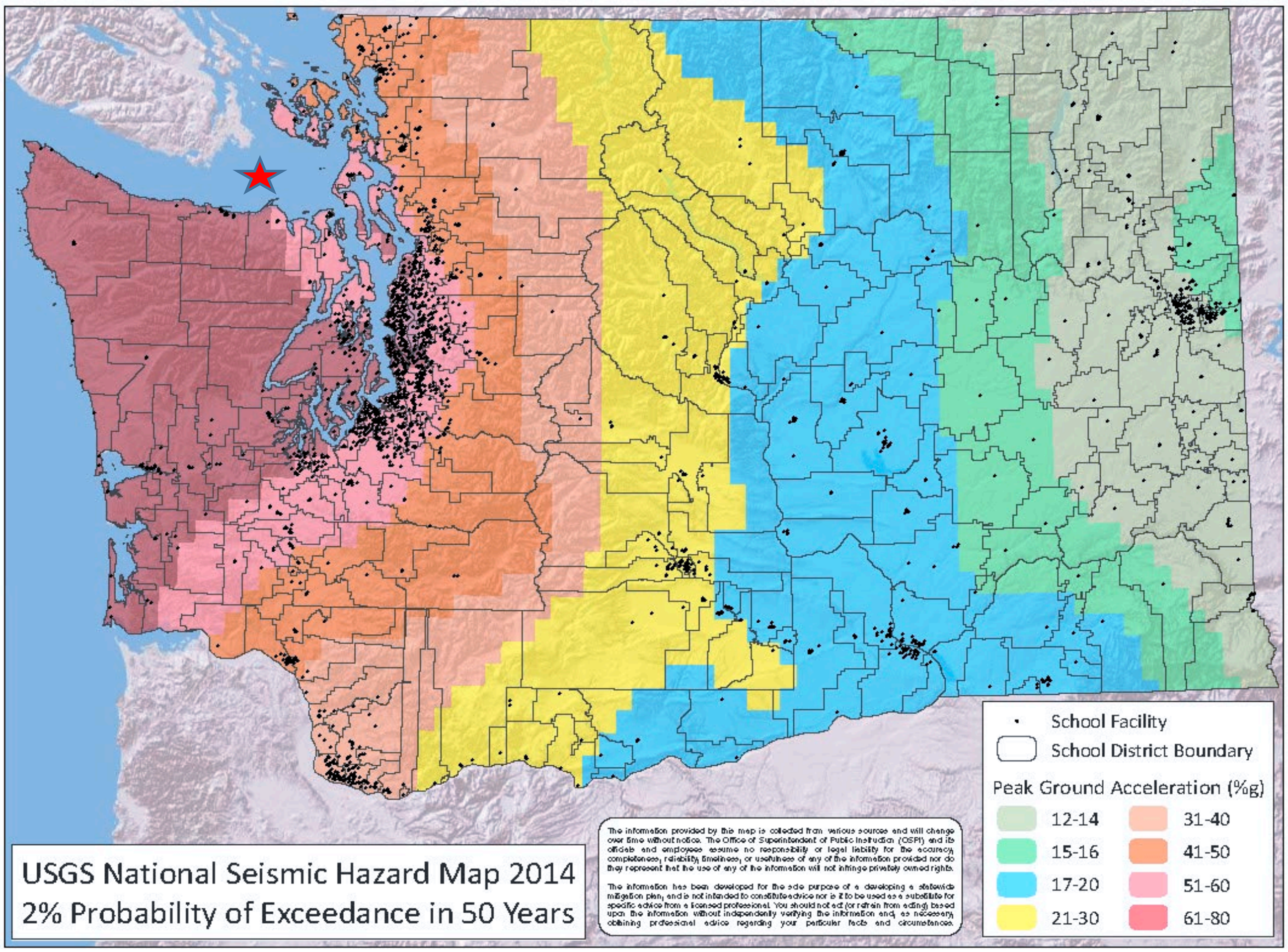


Figure 6.6
2014 USGS Seismic Hazard Map: Washington State[6]
PGA value (%g) with a 10% Chance of Exceedance in 50 years

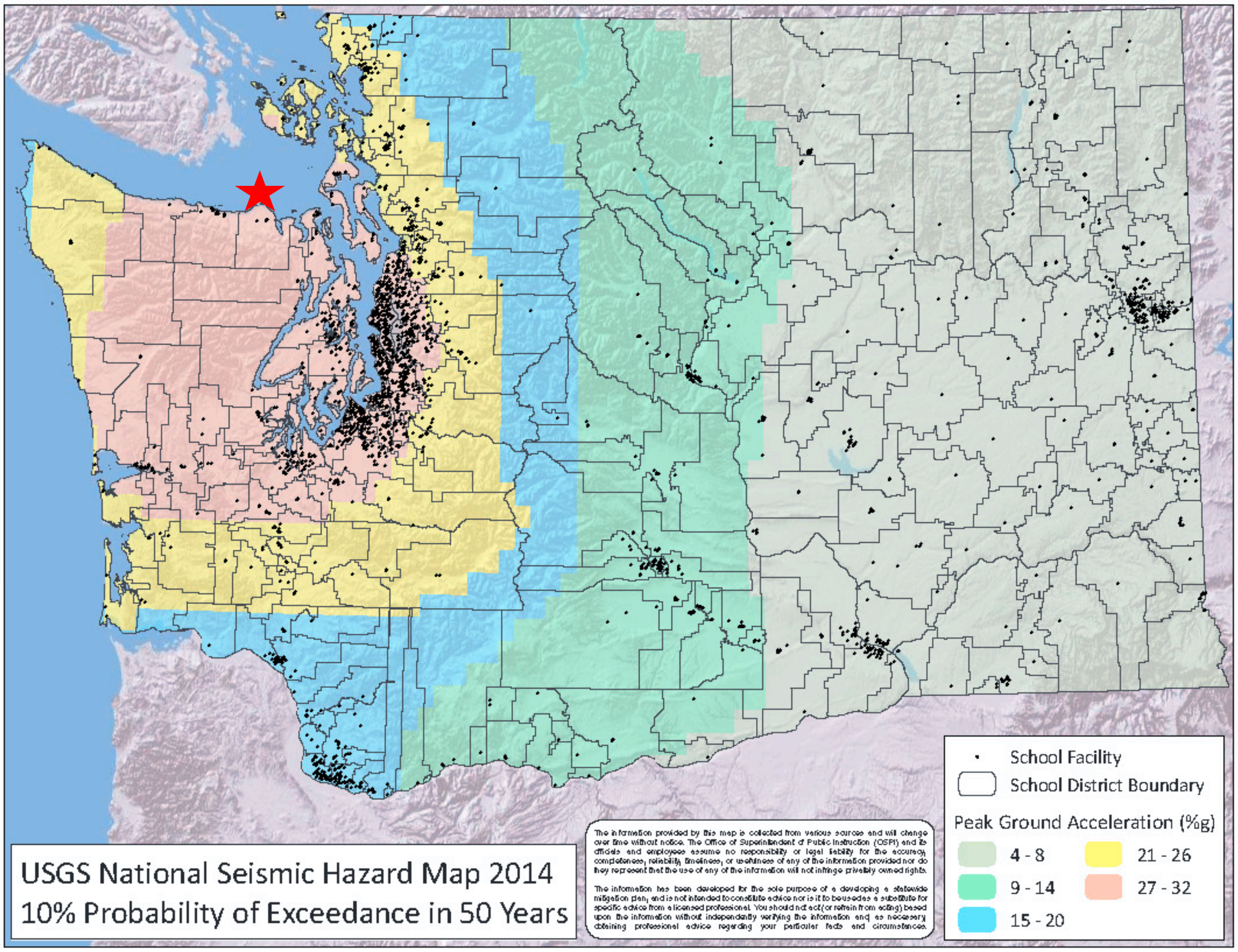


Figure 6.7

2014 USGS Seismic Hazard Map: Puget Sound Area
PGA value (percent g) with a 2% Chance of Exceedance in 50 years

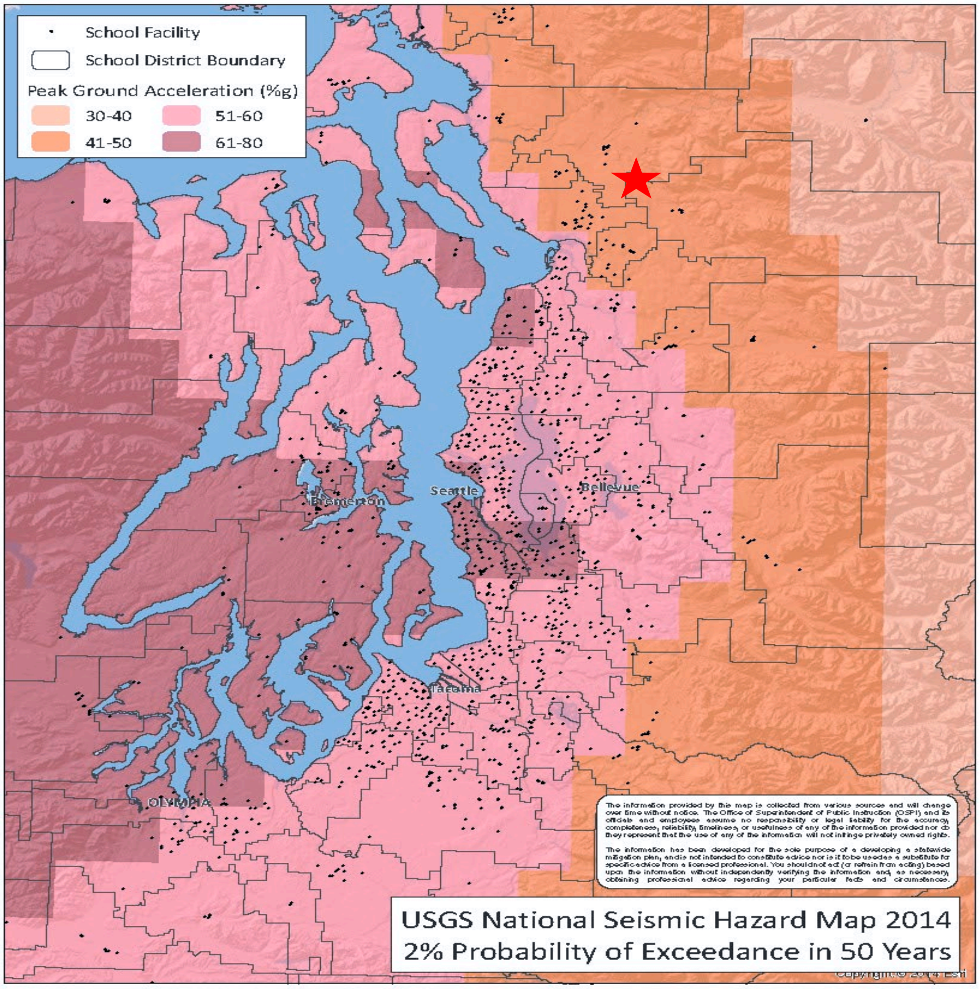
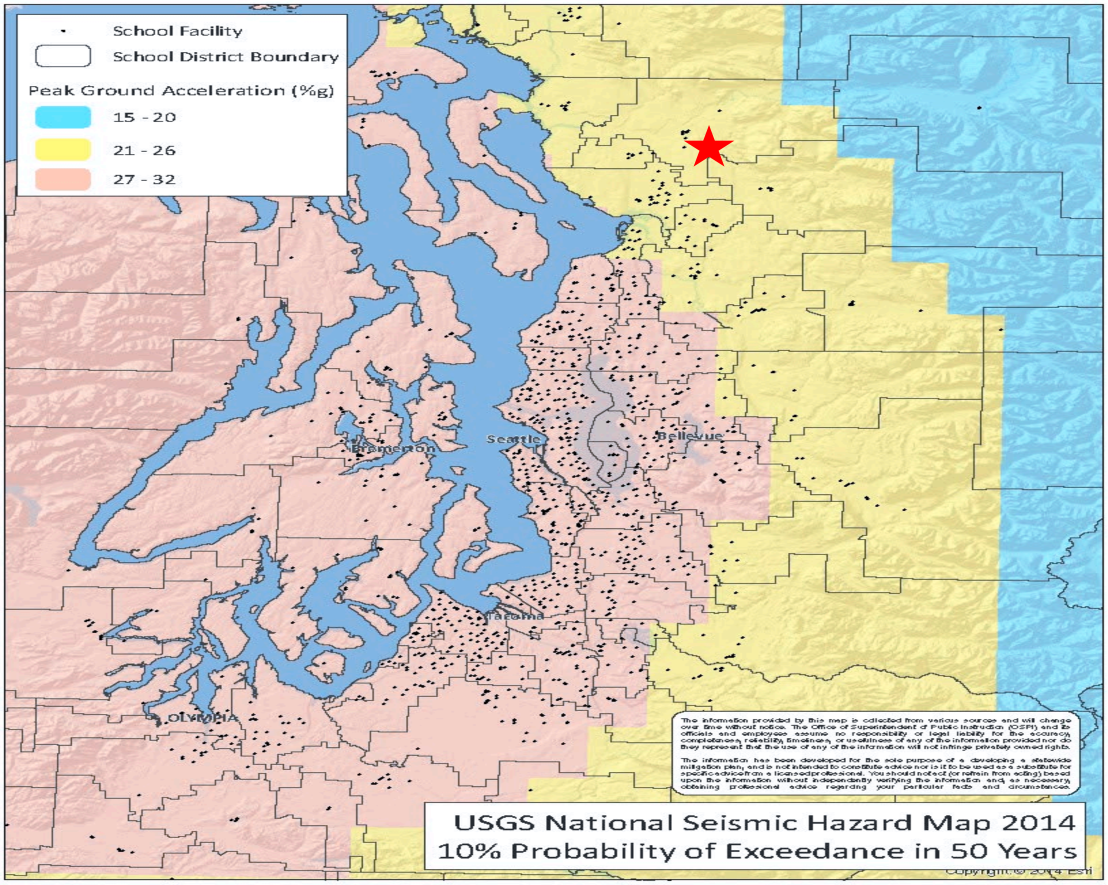


Figure 6.8
2014 USGS Seismic Hazard Map: Puget Sound Area
PGA value (percent g) with a 10% Chance of Exceedance in 50 years



6.2.3 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 ARLINGTON PUBLIC SCHOOLS 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.

6.2.3.1 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.

6.2.3.1 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.

6.2.3.2 Subsidence

Large interface earthquakes on the Cascadia Subduction Zone are expected to result in subsidence, the sinking of ground because of underground material movement, 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.

6.2.3.3 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 ARLINGTON PUBLIC SCHOOLS 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.

6.2.3.4 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.

The ARLINGTON PUBLIC SCHOOLS has campuses with some landslide risk. Further information about this landslide risk is included in the landslide chapter of this mitigation plan.

6.2.4 Seismic Risk Assessment for the Arlington Public Schools Facilities

The potential impacts of future earthquakes on the Arlington 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 Arlington 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:

- Producing 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.

- Producing 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 a 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.

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

- More detailed evaluation of one or more buildings that are determined to have the highest priority for retrofit or replacement from the previous step.
- Design of seismic retrofits for buildings for which a retrofit is the preferred alternative.
- Implementation of retrofits or replacement of buildings, as funding becomes available.

Examples of the OSPI ICOS PDM database campus-level and building-level reports are shown on the following pages.

Table 6.2
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
ARLINGTON PUBLIC SCHOOLS									
"A" Building and District Storage	42.80%	C	High	Low	High	Yes	High	No	N/A
Arlington High School	43.07%	C	High	Very low	Moderate	Yes	High	No	N/A
District Administration	44.36%	C-D	High	Very Low	High	Yes	High	No	N/A
Eagle Creek Elementary School	44.26%	C-D	High	Very Low	Moderate	Yes	High	No	N/A
Haller Middle School	44.38%	C-D	High	Low	Moderate	Yes	High	No	N/A
Kent Prairie Elementary School	42.45%	D-E	High	Low to Moderate	Moderate	Yes	High	Yes	Moderate
Pioneer Elementary School	43.14%	C	High	Very low	Moderate	Yes	High	No	N/A
Post Middle School	44.25%	C-D	High	Very Low	Moderate	Yes	High	No	N/A
Presidents Elementary School	42.76%	C	High	Low	Moderate	Yes	High	No	N/A
Stillaguamish Valley School	42.40%	D-E	High	Low to Moderate	High	Yes	High	Yes	Moderate
Transportation	42.89%	D-E	High	Low to Moderate	High	Yes	High	Yes	Moderate
Weston High School	43.47%	D-E	High	Low to Moderate	High	Yes	High	Yes	Moderate

[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. The numerical value is the level of ground shaking which has a 2% chance of being exceeded in a 50-year time period.

[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 the particular facts and circumstances of the natural hazard risks to a particular campus or building.

The statements in Table 6.2 indicating that building level risk assessments are a high priority for all campuses is based only on the high seismic hazard level of all the District’s facilities. The level of earthquake risk varies markedly from building to building depending on the year built and the structural details. Building-level risk assessments are recommended only for a subset of the District’s buildings as shown in Table 6.3.

Table 6.3
Building-Level Earthquake Report

Building-Level Earthquake Report															
Building - Area	Seismic Design Criteria				Building Type[0]	Seismic Design Basis	ASCE 41-13 Tier 1 Evaluation Recommended[1]		ASCE 41-13 Tier 1 Evaluation[a]			Mitigation Desired (Yes/No)	Mitigation Type	Mitigation Complete (Yes/No)
	Year Built	UBC or IBC	Code Year	Post-Benchmark (Yes/No)			Yes /No	Risk Level and Priority[2,3]	Completed (Yes/No)	ASCE 41-13 Compliant (Yes/No)	Further Eval Desired			
ARLINGTON PUBLIC SCHOOLS														
"A" Building and District Storage Facility														
Building "A" - Area 1	1936	-	-	No	C1	Pre Code	Yes	Moderate to High	No	-	-	-	-	-
Building "A" - Area 2	2005	-	-	Yes	W1	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Building "A" - Greenhouse	1992	-	-	No	S3	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Food Service Dry Storage Building - Area 1	1968	-	-	No	RM1	Low Code	No	Low[4]	N/A[5]	-	-	-	-	-
Grounds Department Storage Building - Area 1	1992	-	-	Yes	W2	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Arlington High School Facility														
AF JROTC Portable - Area 1	1996	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Greenhouse - Area 1	2003	-	-	No	S3	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Industrial Arts Building - Area 1	2003	-	-	No	S3	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Main Building - Area 1	2003	-	-	Yes	RM2	High Code	No	Low[4]	N/A[5]	-	-	-	-	-

Stadium - Area 1	2003	-	-	Yes	RM1	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Stadium Storage - Area 1	2003	-	-	Yes	RM1	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Stadium Ticket Booth - Area 1	2003	-	-	Yes	RM1	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
District Administration Facility														
District Administration Office (Roosevelt) - Area 1	1940	-	-	No	C1	Pre Code	Yes	Moderate to High	No	-	-	-	-	-
Eagle Creek Elementary School Facility														
Portable 3 - Area 1	1998	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 4 - Area 1	1998	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Covered Play - Covered Play	1989	-	-	No	C1	Moderate Code	Yes	Moderate	No	-	-	-	-	-
Main Building - Main Building	1989	-	-	No	RM1	Moderate Code	Yes	Moderate	No	-	-	-	-	-
Metal Storage Building - Area 1	1989	-	-	No	S3	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Haller Middle School Facility														
Gymnasium Building - Gym	1978	-	-	No	RM1	Moderate Code	Yes	Moderate to High	No	-	-	-	-	-
Hartz Field Bathroom and Storage Building - Area 1	1965	-	-	No	RM1	Low Code	No	Low[4]	N/A[5]	-	-	-	-	-
Main Building - Main Building	2006	-	-	Yes	S2	High Code	No	Low[4]	N/A[5]	-	-	-	--	-
Music Building - Music/Art	1968	-	-	No	RM1	Low Code	Yes	Moderate to High	No	-	-	-	-	-
Kent Prairie Elementary School Facility														
Covered Play - Area 1	1993	-	-	No	C1	Moderate Code	Yes	Moderate	No	-	-	-	-	-
Main Building - Area 1	1993	-	-	No	RM1	Moderate Code	Yes	Moderate	No	-	-	-	-	-

Pioneer Elementary School Facility														
Main Building - Main	2002	-	-	Yes	S2	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Post Middle School Facility														
B Building - Gym - Gym	1981	-	-	No	RM1	Moderate Code	Yes	Moderate to High	Yes	Additional analysis may be warranted to verify the stress in the roof diaphragms.	No	Yes	-The walls should be provided with proper anchors and/or blocking between joists to resist both in plane and out of plane seismic forces. -The diaphragms should be provided with additional blocking and strapping as needed to develop proper sub diaphragms.	
Building A Main – Main	1981	-	-	Yes	W2	Moderate Code	Yes	Low[4]	Yes	Additional analysis may be warranted to verify the stress in the roof diaphragms	No	Yes	-The covered walkway structures should be cut back to allow for proper seismic separation -Blocking and strapping are likely to be needed where individual building masses are connected at the roof level	
C Building - Art/Home Living/Woods - Art/Woods/Home	1981	-	-	No	RM1	Moderate Code	Yes	Moderate	Yes	Additional analysis may be	No	Yes	-The covered walkway structures	

										warranted to verify the stress in the roof diaphragms			should be cut back to allow for proper seismic separation -Blocking and strapping are likely to be needed where individual building masses are connected at the roof level	
D Building Classrooms - Classrooms	1993	-	-	No	RM1	Moderate Code	Yes	Moderate	Yes	Additional analysis may be warranted to verify the stress in the roof diaphragms	No	Yes	-The covered walkway structures should be cut back to allow for proper seismic separation -Blocking and strapping are likely to be needed where individual building masses are connected at the roof level	
Metal Storage (Senica) - Area 1	1981	-	-	No	S3	Moderate Code	No	Low[4]	N/A[5]					
Portable 2 - Area 1	1999	-	-	No	Portable	High Code	No	Low[4]	N/A[5]					
Portable 3 - Area 1	1999	-	-	No	Portable	High Code	No	Low[4]	N/A[5]					
Portable 4 - Area 1	1999	-	-	No	Portable	High Code	No	Low[4]	N/A[5]					
Portable 5 - Area 1	1999	-	-	No	Portable	High Code	No	Low[4]	N/A[5]					
Presidents Elementary School Facility														

Main Building - Area 1	2004	-	-	Yes	S2	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Stillaguamish Valley School Facility														
Portable 1 Office - Area 1	1999	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 2 - Area 1	1997	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 3 - Area 1	1997	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 4 - Area 1	2002	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 5 - Area 1	2001	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 6 - Area 1	1995	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 7 - Area 1	1997	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 8 - Area 1	1995	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 9 - Area 1	1995	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 10 - Area 1	1991	-	-	No	Portable	Moderate Code	No	Low[4]	N/A[5]	-	-	-	-	-
Portable 11 - Restrooms	2001	-	-	No	Portable	High Code	No	Low[4]	N/A[5]	-	-	-	-	-
Transportation Facility														
Pupil Transportation - Area 1	1973	-	-	No	W2	Low Code	Yes	Moderate	No	-	-	-	-	-
Weston High School Facility														
Main Building - Area 1	1978	-	-	No	S4	Moderate Code	Yes	Moderate	No	-	-	-	-	-

These codes describe the classifications of the structural type for a building which provide the building's strength to resist both vertical and horizontal forces. See Appendix D for descriptions.

[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.

[4] "Low" indicates that the either the ASCE 41-13 Tier 1 Evaluation wasn't recommended for this building, the building isn't listed as a priority as it was built under the "high" code or has minimal occupancy. These risk levels and priorities for further evaluation have been modified to reflect district-specific information and priorities that differ from the information in ICOS. Therefore, these rankings differ from the auto-generated rankings in ICOS.

[5] "N/A" indicates that the building doesn't require an ASCE 41-13 Tier 1 Evaluation or was not noted to be a high priority.

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Every school in the Arlington Public Schools has a high level of earthquake hazard. A number of schools that have softer soils (Site Class D-E) also have a low to moderate liquefaction risk, which includes Kent Prairie Elementary School, Stillaguamish Valley School, Weston High School, and the Transportation building. A low liquefaction risk exists for the old high school building, Haller Middle School, and Presidents Elementary School.

At the building level, most schools have at least one building with a moderate to high earthquake risk. This includes the old high school building (building area 1 and food service storage), the District Administrative Office, Eagle Creek Elementary School (main building), Haller Middle School (gymnasium and music building) and Post Middle School (gymnasium). Pioneer Elementary School (Main Building), Presidents Elementary School, and Stillaguamish Valley School have a low earthquake risk. According to this data, the highest risk building is the main building at Weston High School. However, as noted in Chapter 3, Weston effectively meets the most recent code and is not as high of a risk.

6.2.5 Previous Earthquake Events

The district has not experienced any damage in previous earthquakes.

6.2.6 Earthquake Hazard Mitigation Measures for K-12 Facilities

6.2.6.1 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, and
- 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 Arlington Public Schools are given in Table 6.4.

Table 6.4

ARLINGTON PUBLIC SCHOOLS: 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	Evaluate the Seismic vulnerability of the buildings identified by the preliminary screening as likely being at moderate to high risk by having an engineer complete ASCE 41-13 Tier 1 screenings for all or a prioritized subset of these buildings. Order of priority would be Post, Eagle Creek, Kent Prairie, Weston, Haller, District Office, Transportation and the old high school building.	1-2 Years	District or Grant	Supt.	X	X		X
Short Term #2	Assess the ASCE 41-13 results and select buildings or building parts that have the greatest vulnerability for more detailed evaluations.	1-3 Years	District or Grant	Supt.	X	X		X
Short Term #3	Evaluate the foundations of the portable buildings to determine whether they are adequate for earthquakes.	1-3 Years	District or Grant	Supt.	X	X		X
Long Term #1	Prioritize and implement seismic retrofits or replacements based on the results of the above detailed evaluations, as funding becomes available.	Ongoing	District 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	District or Grant	Supt.	X	X		X
Long Term #3	Enhance emergency planning for earthquakes including duck and cover, and evacuation drills.	Ongoing	District or Grant	Supt.	X		X	X

6.3 Extreme Weather

Washington is exposed to many weather extremes. These include high winds, heat, cold, thunderstorms, rainfall, and snowfall. Some specific examples of extreme weather types in Washington are atmospheric rivers, tornadoes, heatwaves, and hailstorms, among others. Taken together, these weather extremes account for some of the most common natural hazard events faced in this state. They are often what trigger presidentially declared disasters, with more than 30 weather-related disaster declarations in Washington since 1980.

With continued climate change, expect some extreme weather to become even more extreme. For example, we know that the Pacific Northwest can expect to see heatwaves, like the June 2021 “heat dome” event, to last longer and have higher temperatures (Philip et al., 2021) as well as atmospheric rivers that dump more rain over shorter periods of time (Gao et al., 2015). For these reasons, it has been determined that every county is currently exposed to extreme weather (particularly atmospheric rivers and extreme heat), with likely future increases in frequency, magnitude, and severity driven by continued climate change.

Table 6.5 below provides an overview of the location and extent of previous weather events. Table 6.6 summarizes the probability of future weather disasters, as well as projected changes to weather impacts and the jurisdictions most at-risk.

Table 6.5. Overview of the location and extent of previous extreme weather events.

Location	Possible Extent (Magnitude/Severity)	Previous Occurrences
Statewide	Known weather extremes in WA include: • High winds (> 100 mph) • Heat (> 110°F) • Cold (< -40°F) • Thunderstorms (incl. lightning, hail, tornadoes) • Rainfall (+14” daily/185” annual) • Snowfall (+65” daily/+300” annual)	2022 (DR-4682*, DR-4650); 2021 (DR-4593); 2020 (DR-4539); 2018 (DR-4418); 2017 (DR-4309); 2015 (DR-4253); 2015 (DR-4249); 2015 (DR-4242); 2012 (DR-4083); 2012 (DR-4056); 2011 (DR-1963); 2009 (DR-1825); 2009 (DR-1817); 2007 (DR-1734); 2006 (DR-1682); 2006 (DR-1671); 2006 (DR-1641); 2003 (DR-1499); 1997 (DR-1172); 1997 (DR-1159); 1996 (DR-1152); 1996 (DR-1100); 1995 (DR-1079); 1994 (DR-1037); 1993 (DR-981); 1990 (DR-896); 1990 (DR-833); 1990 (DR-852); 1989 (DR-822); 1986 (DR-784); 1986 (DR-769); 1986 (DR-762); 1983 (DR-676)

*Table 6.6. Overview of future probability of extreme weather disasters, project changes to extreme weather impacts, and the jurisdictions most at-risk to extreme weather. *Indicates the FEMA reference to the occurrence*

Annual Probability	Projected Changes	Region Most At-Risk
72% chance of an extreme weather-related disaster declaration each year.	Extreme weather events currently average at approximately one event/year since 1980. Although no trend has been observed as of 2023, extreme weather is expected to increase in extent, intensity, and frequency, due primarily to climate change. The geographic distribution of extreme weather is also expected to increase (e.g., high-heat events in western WA). Population growth and continued development will put more people and property at risk to extreme weather. Projected population in these areas by 2050 is 4.2-4.3 million. .	Puget Sound & Northwestern regions.

6.3.1 Extreme weather hazard and vulnerability analysis

Because Washington is exposed to multiple types of extreme weather, our hazard and vulnerability analysis focused primarily on counties in the state that have experienced more weather-related disaster declarations than others since 1980. Figure 6.9 shows counties in the 75th percentile for number of weather-related disaster declarations since 1980, which was used as a proxy for understanding where extreme weather exposure is highest. These declarations include atmospheric river events and extreme snowfall. Extreme heat is not currently a natural hazard capable of triggering a presidential disaster declaration, and as such is not captured by this metric.

These counties are referred together throughout this analysis as “extreme weather hazard areas.” It is felt this was an appropriate framework for this analysis given the challenges driven by the variability of extreme weather incidents and the fact that disaster declarations, by definition, include damages to valuable assets. Most of these declarations were associated with severe storms, such as atmospheric rivers, and their secondary effects – such as flooding and landslides. There is no evidence to suggest that areas of Washington that already commonly experience extreme weather will see declines in extreme weather in the future, so locations where weather impacts have been high in the past will likely remain high in the future. Snohomish County has had 19 different weather disasters since 1980,

Given their prevalence and likely increase in the future, it is prudent to highlight two specific types of weather hazards: extreme heat and atmospheric rivers.

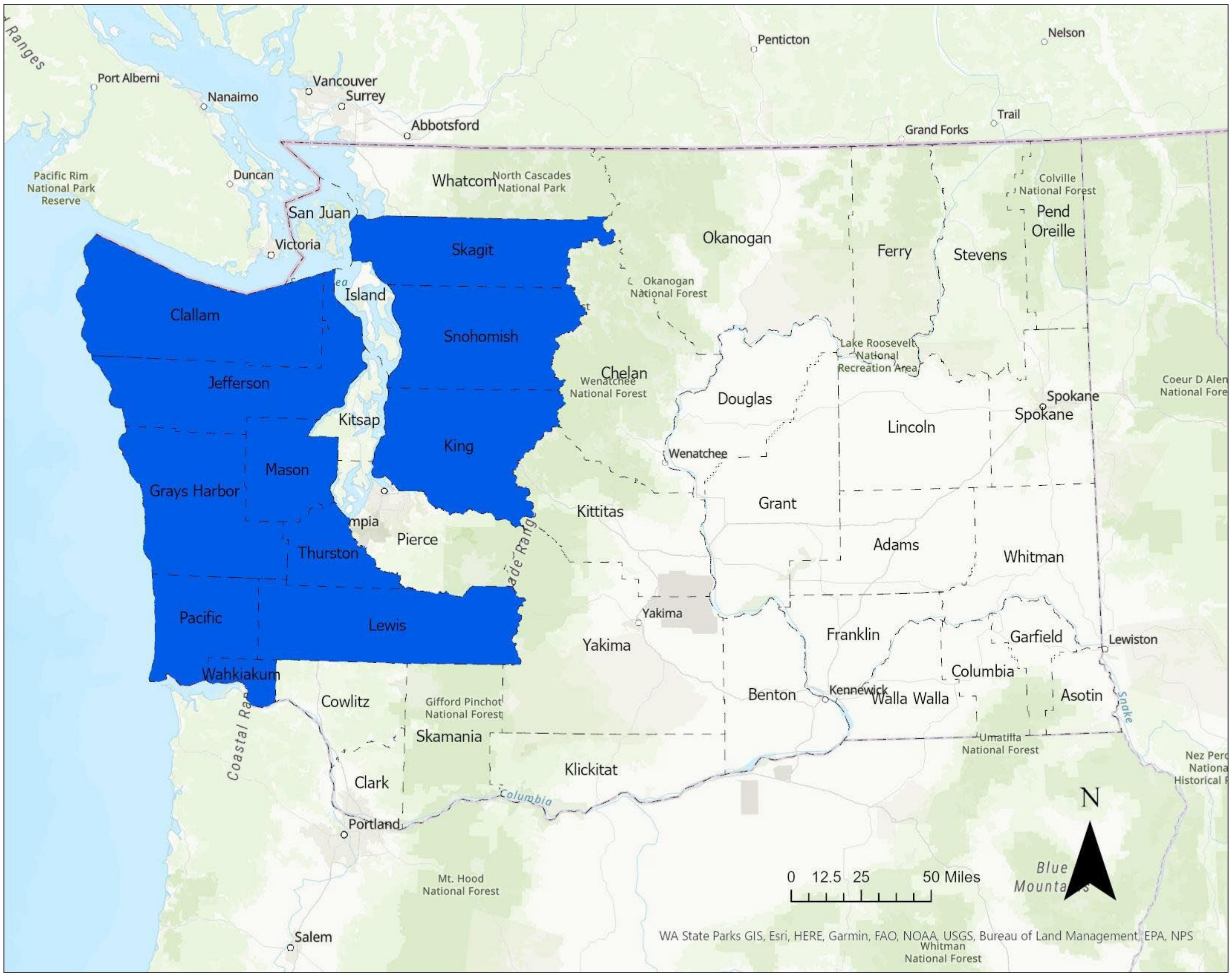

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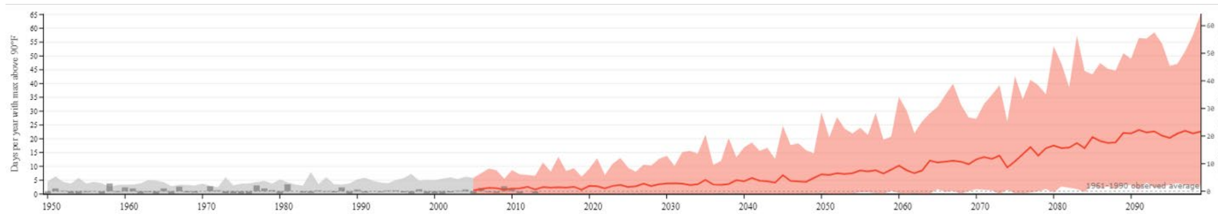
Figure 6.9. Areas in the 75th percentile for weather-related disasters since 1980. These areas are also referred to herein as extreme weather hazard areas

6.3.2 Extreme heat

Periods of high temperatures, including heatwaves, are projected to become more common in the Pacific Northwest. Central and Eastern regions commonly experience temperatures above 90°F each summer, however temperatures that high also occur west of the Cascade Range. Extreme heat is a hazard with a statewide extent, as shown in Figure 6.10 below illustrating the average temperatures statewide for June 2021. Temperatures well above average can be seen statewide, but especially in most of central and eastern Washington, as well as in urbanized areas in western Washington (e.g., Greater Seattle) (Figure 6.11). The urbanized areas in western Washington are showing as much warmer than the rest of that region due primarily to the phenomenon known as urban heat-island effect. Buildings, roads, and other infrastructure absorb more heat than natural features, such as trees and water bodies. When they radiate that heat back, the effect can be an increase in ambient air temperature around that building, road, or other infrastructure. When such features are clustered, such as in cities, that effect can raise temperatures well above the surrounding non-urban areas, creating a “heat island”.

Although the recent heat events in Washington had minor impacts on the built environment, the extreme heat in June 2021 revealed that even in historically cooler climates, such as the Pacific Northwest, temperatures can reach levels previously expected to be seen only in the hottest places on the planet (upwards of 110°F). Such heat can pose severe public health risks. Although heat has not been viewed as a traditional natural hazard or disaster incident, the event in 2021 led to the deaths of more than 150 people in Washington – making it the deadliest natural hazard event in the State’s history. Several of Arlington Public Schools buildings do not have air conditioning capacity throughout the building including the old high school building, Eagle Creek Elementary and Kent Prairie Elementary. These buildings, especially the elementary buildings, would be the highest priority for adding HVAC systems.

a)



b)

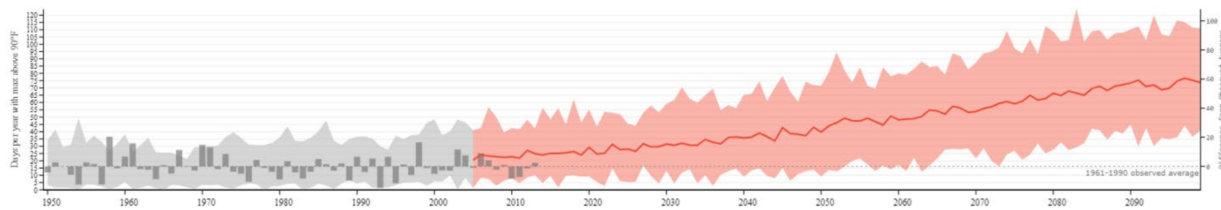


Figure 6.10. Observed and projected 90+ degree days (F) for King County (a) and Spokane County (b). These graphs show clear upward trends in the number of 90+ degree days each year for both western and eastern Washington areas (NOAA, 2022).

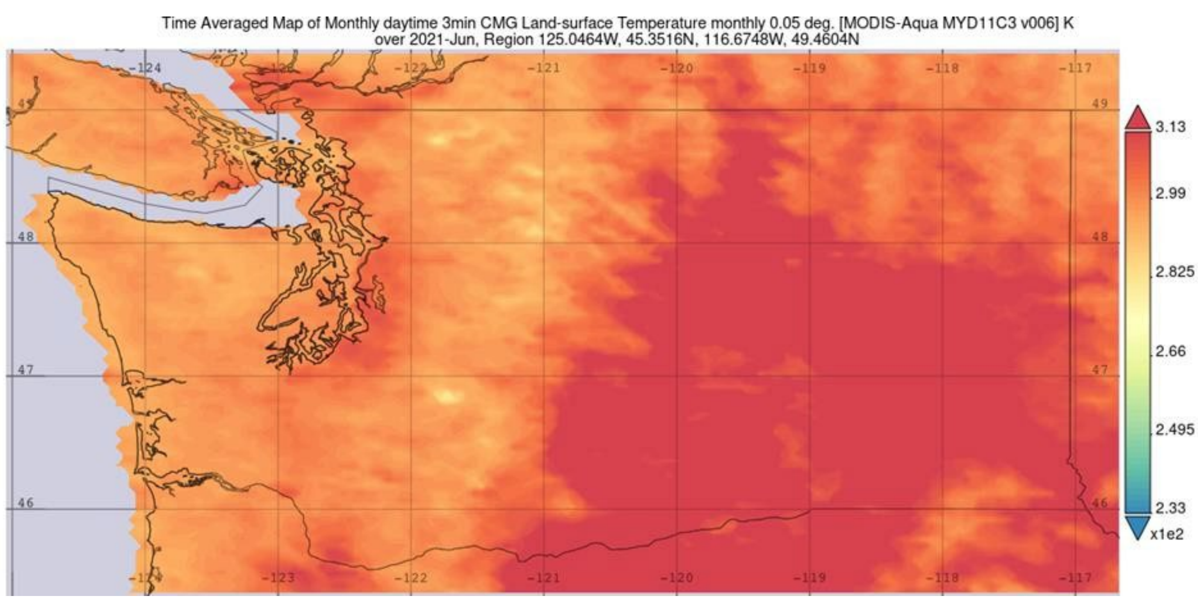


Figure 6.11. Average surface temperatures (in Kelvin) for Washington in June 2021. The highest temperature shown here is 313 K (107°F), located in the central and eastern portions of the state (Source: NASA/MODIS; visualization created with NASA Giovanni v. 4.35).

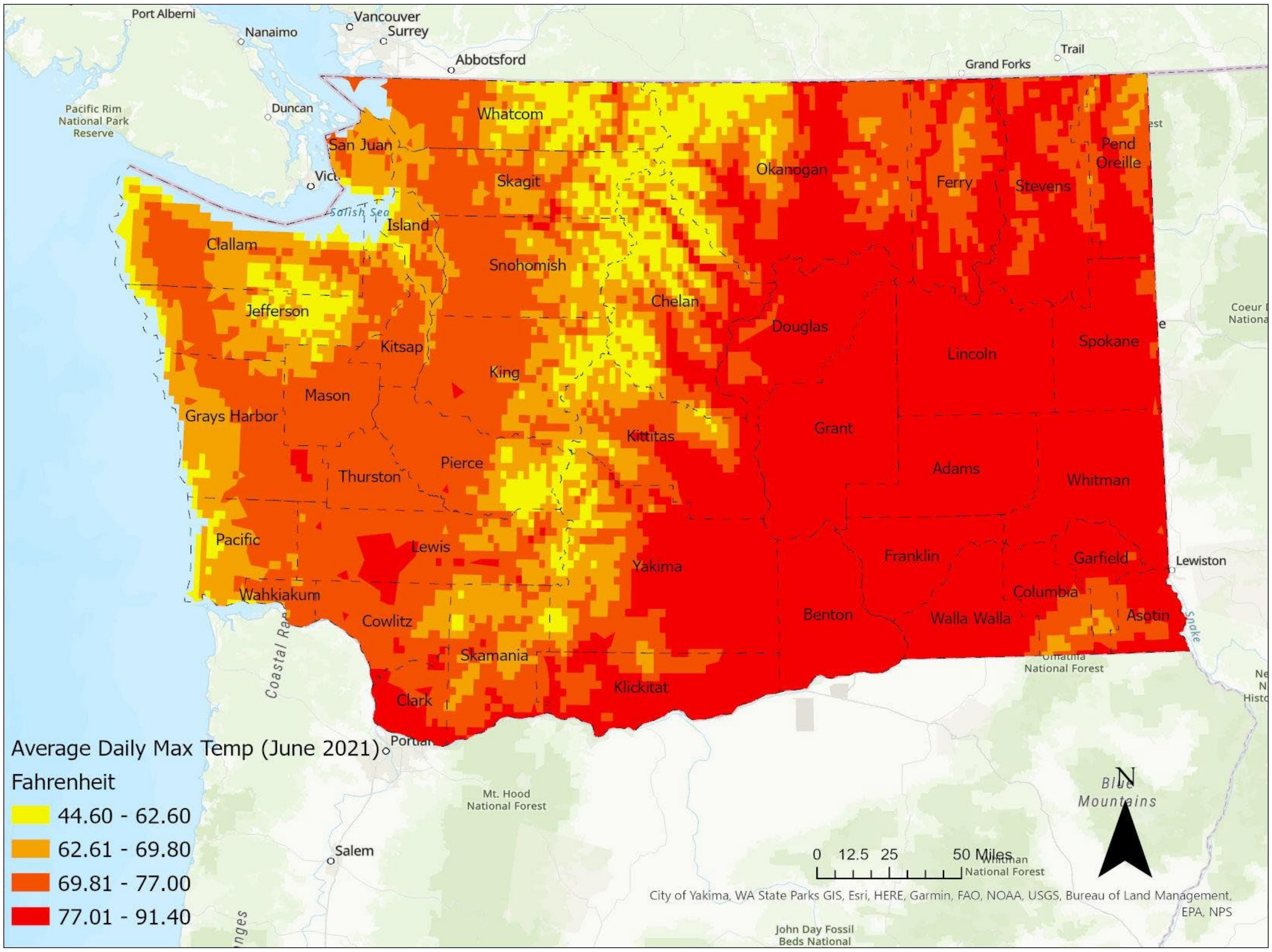


Figure 6.12. Average daily maximum temperature for Washington in June 2021. Some areas of central and eastern Washington reached average daily maximum temperatures above 90 degrees (F) that month. The "heat dome" event in late June 2021 would break multiple heat records across the Pacific Northwest.

6.3.2 Atmospheric Rivers

Extreme wind and rainfall in Washington are often associated with atmospheric river events. Atmospheric rivers are long, narrow jets of air that can transport enormous volumes of water vapor from lower latitudes to the Pacific Northwest. When the moist air is forced up by Washington's mountain ranges, high rates of condensation result in heavy rain. In extreme cases, daily rainfall is well above average and can cause substantial flooding and trigger landslides.

Atmospheric rivers also typically include high wind gusts, sometimes reaching hurricane strength. Of the most destructive windstorms globally over the last 20 years, atmospheric rivers were associated with half – totaling more than $25 billion in wind-related damages (Buis, 2017).

6.3.3 Critical infrastructure

- **Transportation.** More than 18,000 miles of public roads are in the counties with the most weather disasters, including more than 2,000 miles of national and state highways that serve as vital transportation routes.

- **Health & safety.** Of the state's licensed hospitals, 42% are in counties most impacted by weather disasters – totaling close to 8,000 beds in 49 hospitals. Out of those 49 hospitals, 36 are in the Puget Sound and Northwestern region (73%) potentially serving the Arlington area. 54% of the fire stations and 61% of the police stations are in the Puget Sound and Northwestern region (54%),

- **Energy.** More than 5,000 miles of power transmissions lines are in the counties impacted most by weather disasters, with 60% of those lines in King, Snohomish, and Skagit Counties. Of the 158 power plants in the state, 46 (29%) are in the counties most impacted by weather disasters, split evenly between the Olympic Peninsula and Southwestern region and the Puget Sound and Northwestern region.

- **Water & wastewater.** About 33% (n=5,600) of the state's public drinking water supplies are in the counties impacted most by weather disasters. About half of these are in the Puget Sound and Northwestern regions.

6.3.4 The region most at-risk to extreme weather is the Puget Sound and Northwestern region.

Although previous weather disasters have covered a larger area of the Olympic Peninsula and Southwestern region, that area of the state is less populated and less developed – meaning fewer people and critical assets are in harm's way when compared to the Puget Sound and Northwestern part of the state. For example,

although most of Jefferson County is classified as socially vulnerable, the actual estimated population there with a high social vulnerability rank is 2,100, while the estimated socially vulnerable population in King County is 425,000. This reflects the tendency of socially vulnerable residents to cluster in the state's urbanized regions, which have been shown to experience periods of extreme heat above the nearby non-urban areas in recent years as well as other weather impacts. Research in other parts of the Pacific Northwest has shown that socially vulnerable groups, such as those living in poverty, tend to be at higher risk to heat exposure specifically (Voelkel et al., 2018), and that is the case in Washington as well.

However, the risk of extreme weather goes beyond heat and also includes the potential for damaging atmospheric rivers. Although atmospheric rivers impact the Olympic Peninsula and Southwestern region as often as the Puget Sound and Northwestern region, the potential for damage and asset loss is higher where there is more development. The Puget Sound area, in addition to more people, holds a significant amount of critical infrastructure in the state – some of which has been shown to be susceptible to weather extremes. This includes power lines vulnerable to high winds and drinking water supplies vulnerable to heavy rains (e.g., stormwater runoff impacting water quality

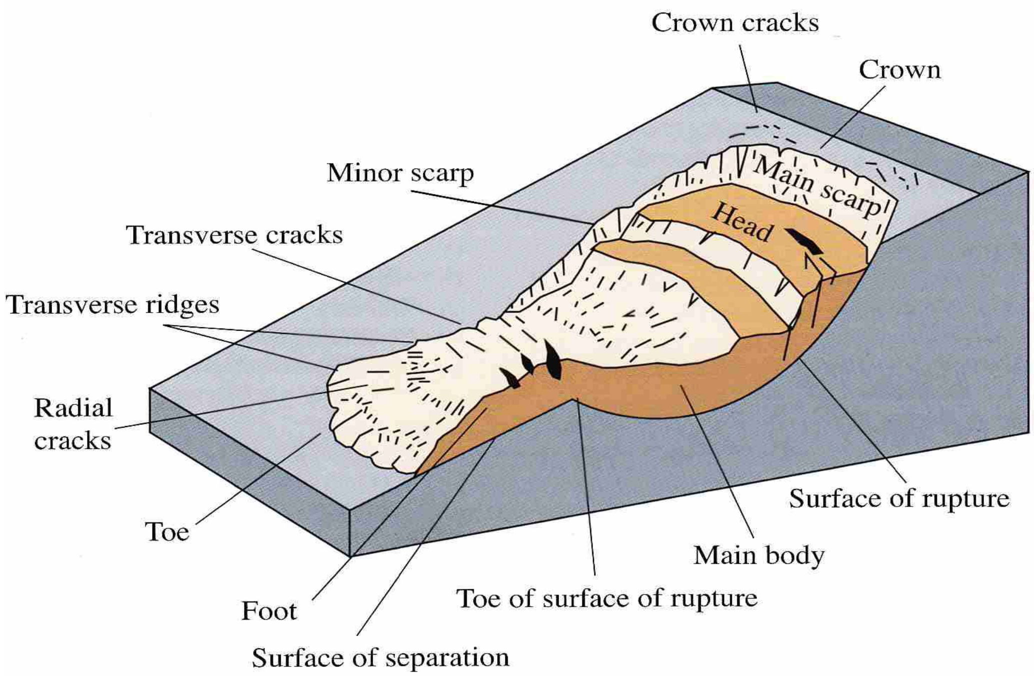
6.4 LANDSLIDES

6.4.1 Landslide Overview and Definitions

The term "landslide" refers to a variety of slope instabilities that result in the downward and outward movement of slope-forming materials, including rocks, soils, and vegetation. Many types of landslides are differentiated based on the types of materials involved and the mode of movement.

The descriptive nomenclature for landslides is summarized in the following figure.

Figure 6.13
Landslide Nomenclature[1]

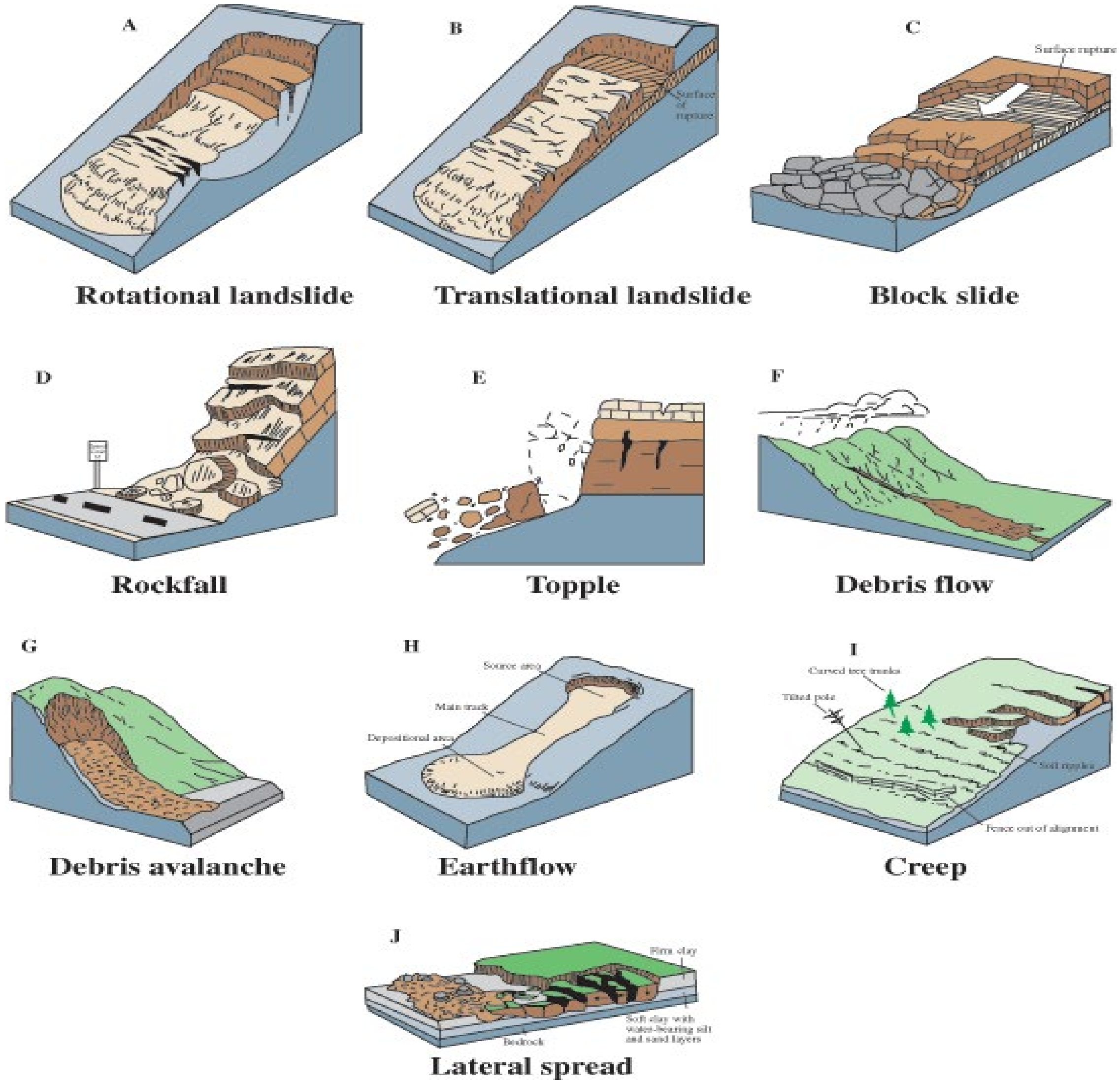


Debris flows and mudslides (mudflows) are often differentiated from the other types of landslides, for which the sliding material is predominantly soil and/or rock. Debris flows and mudslides typically have high water content and may behave similarly to floods. However, debris flows may be much more destructive than floods because of their higher densities, high debris loads, and high velocities.

There are three main factors that determine the susceptibility (potential) for landslides at a given location:

- Slope
- Soil/rock characteristics
- Water content

Figure 6.14
Major Types of Landslides[1]



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

Most landslides occur during rainy months when soils are saturated with water. As noted previously, the water content of soils or rock is a major factor in determining the likelihood of sliding for any given landslide-prone location. However, landslides may occur at any time of year, in dry months as well as in rainy ones.

Landslides are also commonly initiated by earthquakes. Areas prone to seismically triggered landslides are exactly the same as those prone to ordinary (non-seismic) landslides. As with ordinary landslides, seismically triggered landslides are more likely from earthquakes that occur when soils are saturated with water.

Any type of landslide may result in damages or complete destruction of buildings in their path, as well as deaths and injuries for building occupants. Landslides frequently cause road blockages by depositing debris on road surfaces or road damage if the road surface itself slides downhill. Utility lines and pipes are also prone to breakage in slide areas.

The destructive power of major landslides was demonstrated by the devastating March 2014 landslide in Oso, just East of Arlington, which resulted in in several dozen deaths as well as extreme damage to buildings and infrastructure. This landslide is illustrated on the following page.

The following figures show examples of landslides in Washington State.

Figure 6.16
Oso Landslide 2014
Before and After the Landslide
Landslide Type: Debris Flow (Mudslide)

Figure 6.17
Road 170 near Basin City 2006
Landslide Type: Debris Flow

Figure 6.18
Highway 410 near Town of Nile 2009
Landslide Type: Translational

Figure 6.19
Rolling Bay, Bainbridge Island 1997
Landslide Type: Debris Flow

6.4.2 Landslide Hazard Mapping and Hazard Assessment

There are two approaches to landslide hazard mapping and hazard assessment:

- Mapping historical landslides, which also provides an indication of the potential for future landslides, and
- Landslide studies by geotechnical engineers to estimate the potential for future landslides.

Maps of areas within Washington with moderate or high landslide incidence and landslide potential are shown in Figures 6.20 and 6.21.

A more accurate understanding of the landslide hazard for a given campus requires a more detailed landslide hazard evaluation by a geotechnical engineer. Such site-specific studies evaluate the slope, soil/rock, and groundwater characteristics at specific sites. Such assessments of often require drilling to determine subsurface soil/rock characteristics.

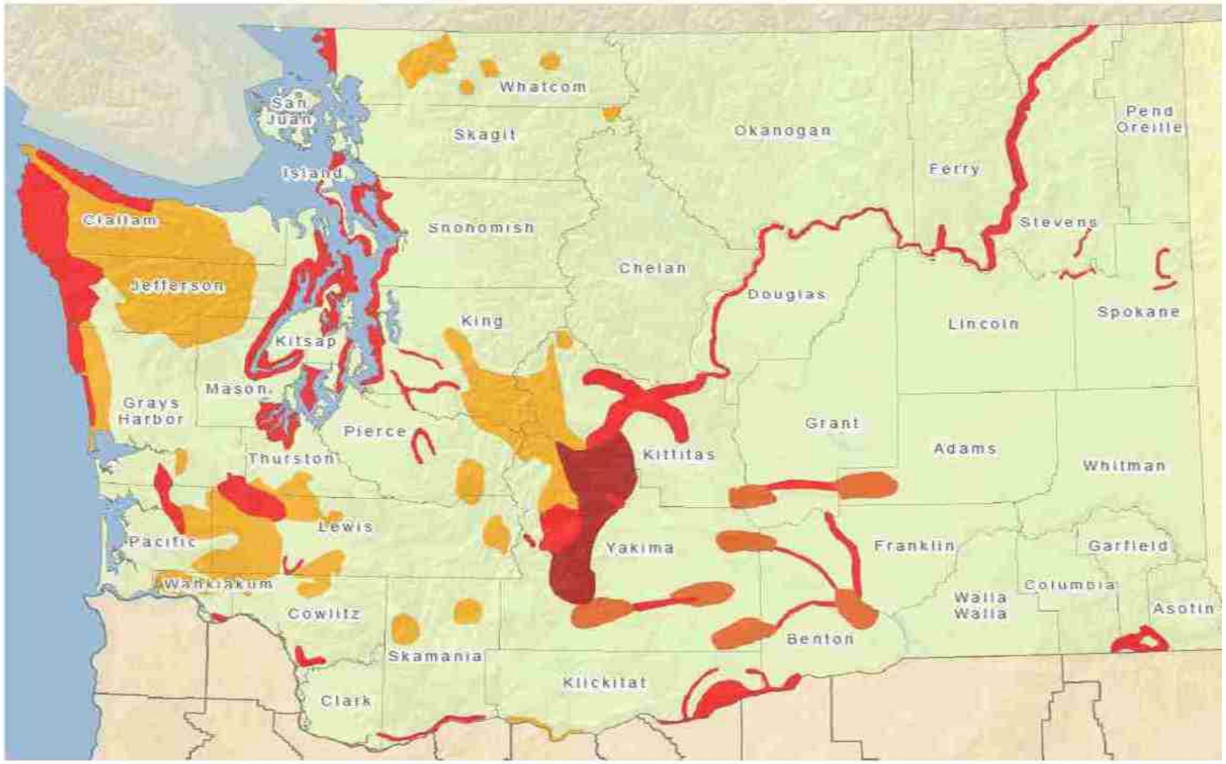
An important caveat for landslide hazard assessments is that, even with detailed site-specific evaluations by a geotechnical engineer, there is inevitably considerable

uncertainty. That is, it is very difficult to make quantitative predictions of the likelihood or the size of future landslide events. In some cases, landslide hazard assessments by more than one geotechnical engineer may reach conflicting opinions.

These limitations and uncertainties notwithstanding, a detailed site-specific landslide hazard assessment does provide the best available information about the likelihood of future landslides. For example, such studies can provide enough information to determine that the landslide risk is higher at one location than another location and thus provide meaningful guidance for siting future development.

Given the above considerations, landslide hazard and risk assessments are generally qualitative or semi-quantitative in nature.

Figure 6.20
Landslide Incidence and Potential



High Incidence: >15% of area involved

Moderate Incidence: 1.5% to 15% of area involved

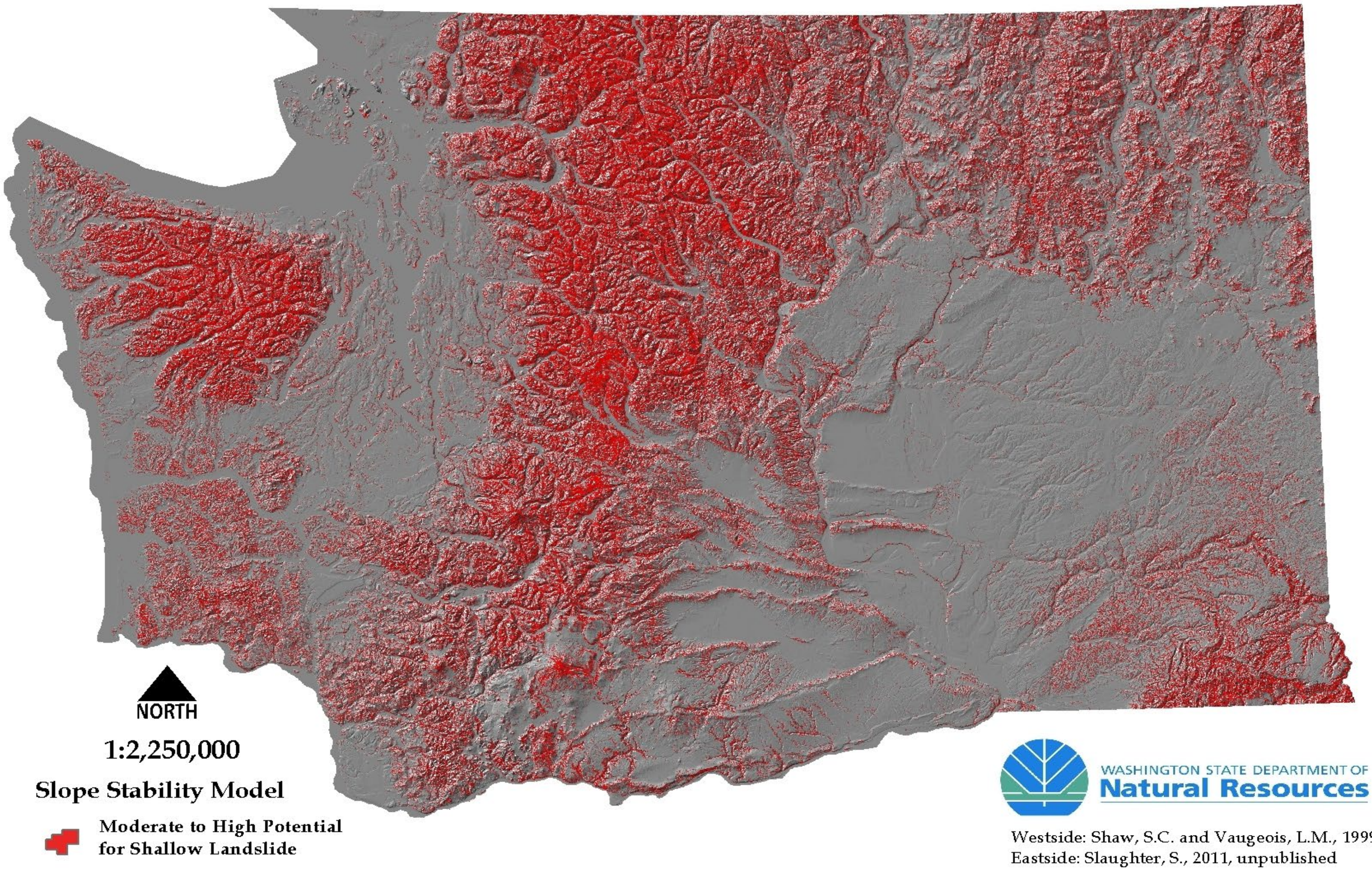
Low Incidence: <1.5% of area involved

High Susceptibility

Moderate Susceptibility

Figure 6.21

Department of Natural Resources – Landslide Potential Map



6.4.3 ARLINGTON PUBLIC SCHOOLS: Landslide Hazard and Risk Assessment

The potential impacts of future landslides on the Arlington District include damage to buildings and contents (including possible complete destruction), disruption of educational services, displacement costs for temporary quarters if some buildings have enough damage to require moving out while repairs are made, as well as deaths and injuries.

The vulnerability of the Arlington District's facilities to landslides varies from campus to campus. The approximate levels of landslide hazards and vulnerability are identified at the campus level in the following sections.

There have been no historical landslides that have directly affected any of the district's campuses. However, the Oso Landslide (described above) occurred within the borders of the district.

Campus-level landslide hazard and risk assessments are made in the OSPI ICOS Pre-Disaster Mitigation database, using the following data:

- Slope data in the vicinity of each campus, from digital elevation data for the campus and a grid of data points in the north, south, east, and west directions from the campus.
- Whether or not the campus is within 500 feet of a DNR mapped landslide.
- Information provided by the ARLINGTON PUBLIC SCHOOLS.
    - Are there channels, gullies or swales upslope from the campus?
    - Are there slumps or historical landslides upslope from the campus?
    - Are there buildings <50 feet from a deeply incised stream or other steep slopes?

The preliminary landslide hazard level is based on slope data only:

Slope	Preliminary Landslide Hazard Level
>40%	High
30% to 40%	Moderate
20% to 30%	Low
<20%	Very Low

The hazard and risk level is increased by one step (but not higher than “high”) if there are yes answers to any of the three data points listed above.

As stated previously, more accurate landslide hazard and risk assessment requires a site-specific investigation by a geologist, engineer, or geotechnical engineer. Consultation with one of these experts is recommended for all campuses where the preliminary determination of the level of landslide hazard and risk is “moderate” or higher.

Table 6.6

ARLINGTON PUBLIC SCHOOLS: Campus-Level Landslide Hazard and Risk Assessment

Landslide Site-Level Hazard and Risk Report								
Site	**Maximum Slope Near Campus**	**Preliminary Landslide Hazard Level°**	**Within 500 feet of DNR Mapped Landslides[1]**	**Channels, Gullies or Swales Upslope**	**Slumps or Historical Landslides Upslope**	**Buildings <50 Feet From Incised Stream or Steep Slopes**	**Preliminary Landslide Risk Level[2]**	**Consult with Geologist or Geotechnical Engineer[3]**
Arlington								
Post Middle School	42.23%	Very High	No	No	Yes	No	Very High	Yes

° The preliminary hazard level reflects only the maximum slope near the campus, as calculated from GIS elevation data.

[1] Indicates that landslides occur near the campus; landslide hazard for the campus may or may not be significant.

[2] Preliminary landslide risk level based on the combination of the GIS data and campus-specific data (if such is entered). More accurate determination of landslide risk for a campus or for specific buildings requires consultation with a geologist or geotechnical engineer.

[3] Consultation means discuss with a geologist of geotechnical engineer knowledgeable about landslides to determine whether a more detailed study is warranted.

DISCLAIMER: The information provided in this report is collected from various sources and may change over time without notice. The Office of Superintendent of Public Instruction (OSPI) and its officials and employees take no responsibility or legal liability for the accuracy, completeness, reliability, timeliness, or usefulness of any of the information provided.

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 the particular facts and circumstances of the natural hazard risks to a particular campus or building.

The preliminary landslide risk levels shown above are based only on statewide GIS data. Review of the site conditions at Post Middle School has refined the landslide risk assessment for that school.

Post Middle School's exposure to a landslide hazard appears to be significant. There is a very steep, nearly vertical drop of about 130 feet, located about 50 feet from the buildings on the east side of the campus. Without more detailed site-specific evaluation of landslide hazards and risk for this campus, it is not possible to make quantitative estimates of the level of risk for each campus.

Qualitatively, for a given campus or a given building, landslide damages can range from very minor damage to complete destruction. Similarly, the numbers of deaths and injuries can range from none, to many dozens (or more) for large slides that occur without warning while a campus or building is highly populated.

6.4.4 Mitigation of Landslide Risk

Mitigation of landslide risks is often difficult from both the engineering and cost perspectives. In many cases, there may be no practical landslide mitigation measures. In some cases, mitigation may be possible. Typical landslide mitigation measures include the following:

- Slope stability can be improved by the addition of drainage to reduce pore water pressure and/or by slope stabilization measures, including retaining walls, rock tie-backs with steel rods, and other geotechnical methods.
- For smaller landslides or debris flows, protection for existing facilities at risk may be increased by building diversion structures to deflect landslides or debris flows around an at-risk facility.
- For very high-risk facilities, with a high degree of life safety risk, abandoning the facility and replacing it with a new facility may be the only possible landslide mitigation measure.
- For new construction, siting facilities outside of landslide hazard areas is the most effective mitigation measure.

The ARLINGTON PUBLIC SCHOOLS Mitigation Action Items for landslides are shown in the table on the following page.

Table 6.7

ARLINGTON PUBLIC SCHOOLS: Landslide 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
Landslide Mitigation Action Items								
Long-Term #1	Evaluate possible mitigation measures in response to the geotechnical study as appropriate at Post	1-5 years	District or Grants	Supt.	X	X	X	X

6.5 Wildfire

The increase in larger, more severe wildfires in the state of Washington over the past few decades (Wing & Long, 2015) follows what is generally happening in wildfire-prone regions around the world. More frequent large fires (Jolly, et al., 2015) are resulting in increases of annual average acres burned (Dennison, et al., 2014) and more extensive property damage (Rasker, 2015) in such regions. Wildfire smoke is diminishing air quality in the western United States (McClure & Jaffe, 2018) with observable increases in mortality among some Washington residents (Doubleday, et al., 2020). It is important to remember, too, that wildfire smoke from fires in other states can impact Washingtonians, making wildfire smoke a regional (or arguably global) hazard. Wildfires can also trigger cascading impacts or multi-hazard events that can include flooding (Brogan, et al., 2017), and erosion and sedimentation (Sankey, et al., 2017).

Table 6.7 below summarizes the location, extent, and previous occurrences of wildfires in Washington. Table 6.8 provides a summary of the probability of future occurrence and projected changes in location, extent, intensity, frequency, and/or duration based on the influence of climate change, population growth, and other external factors. Other key findings from the wildfire hazard analysis include:

- Estimated miles of public roads located in the most wildfire-prone regions in WA: 20,000
- Critical intermodal transportation facilities located in the most wildfire-prone regions in WA: 4
- Number of first responder facilities in the most wildfire-prone regions in WA: 242
- Number of power plants and miles of electric power transmission lines in the most wildfire-prone regions in WA: 29 power plants, 3,000 miles of transmission lines
- Number of public drinking water supplies in the most wildfire-prone regions in WA: 2,378

Table 6.7. Overview of location and extent of previous wildfires.

Location	Possible extent (magnitude/severity)	Previous occurrences
Statewide, but most prevalent east of the Cascade Range	Wildfires in WA often reach class G (>5,000 acres); the Cold Springs Canyon-Pearl Hill fire complex in 2020 was the state's largest recorded and burned >410,000 acres	2021 (8 FMAGs*); 2020 (DR-4584); 2018 (10 FMAGs); 2017 (3 FMAGs); 2016 (4 FMAGs); 2015 (DR-4243); 2014 (DR-4188); 2013 (3 FMAGs); 2012 (8 FMAGs); 2011 (1 FMAG); 2010 (2 FMAGs); 2009 (2 FMAGs); 2008 (2 FMAGs); 2007 (3 FMAGs); 2006 (3 FMAGs); 2005 (2 FMAGs); 2004 (5 FMAGs); 2003 (2 FMAGs); 2002 (2 FMAGs); 2001 (9 FMAGs); 2000 (3 FMAGs); 1998 (3 FMAGs); 1996 (1 FMAG); 1994 (4 FMAGs); 1992 (1 FMAG); 1991 (DR-922); 1988 (1 FMAG); 1985 (1 FMAG)

*FEMA Fire Management Assistance Grants (FMAG)

Table 6.8 Overview of probability of future wildfires, projected changes in wildfire activity, and jurisdictions most at-risk.

Annual probability	Projected changes	Region at most risk
70% chance of a wildfire disaster declaration each year	The frequency of wildfires and number of acres burned has increased significantly in WA since 1970. Wildfires are expected to continue their increase in extent, intensity, and frequency for the entire state, with large fires becoming more likely in central and eastern WA. Western WA is expected to see more fire activity as well. Wildfire season is projected to increase in duration, putting more of the state at-risk for longer periods. These changes are driven by climate change and population growth and development in the wildland-urban interface (~85% of wildfires were human caused in 2020).	Central

6.5.1 Wildfire hazard and vulnerability analysis

When looking at the 50-year timespan between 1970-2020, Washington is shown to have multiple wildfire “hot spots” across large swaths of the state (Zerbe et al., 2022). These hot spots indicate areas where, when compared to the entire state, wildfires happened significantly more in the years between 1970 and 2020 (Figure 6.23). Based on these previous occurrences, these hot spots are areas most likely to see large fires (more than 100 acres) in the future, although additional modeling that incorporates climate change considerations should be done to pinpoint where future occurrences are expected with more accuracy. The number of large wildfires in Washington has significantly increased over time, with no indication of slowing down considering climate change and projected population growth.

Although the areas shaded red in Figure 6.23 are most likely to see large, and potentially destructive, wildfires in the future, large and destructive wildfires can occur elsewhere in the state – including some blue cold spots. The wildland- urban interface (WUI) is rapidly developing in Washington, which is likely putting more property and people in wildfire-prone places around the state than ever before. For now, however, the most at-risk counties for wildfires are still east of the Cascade Range.

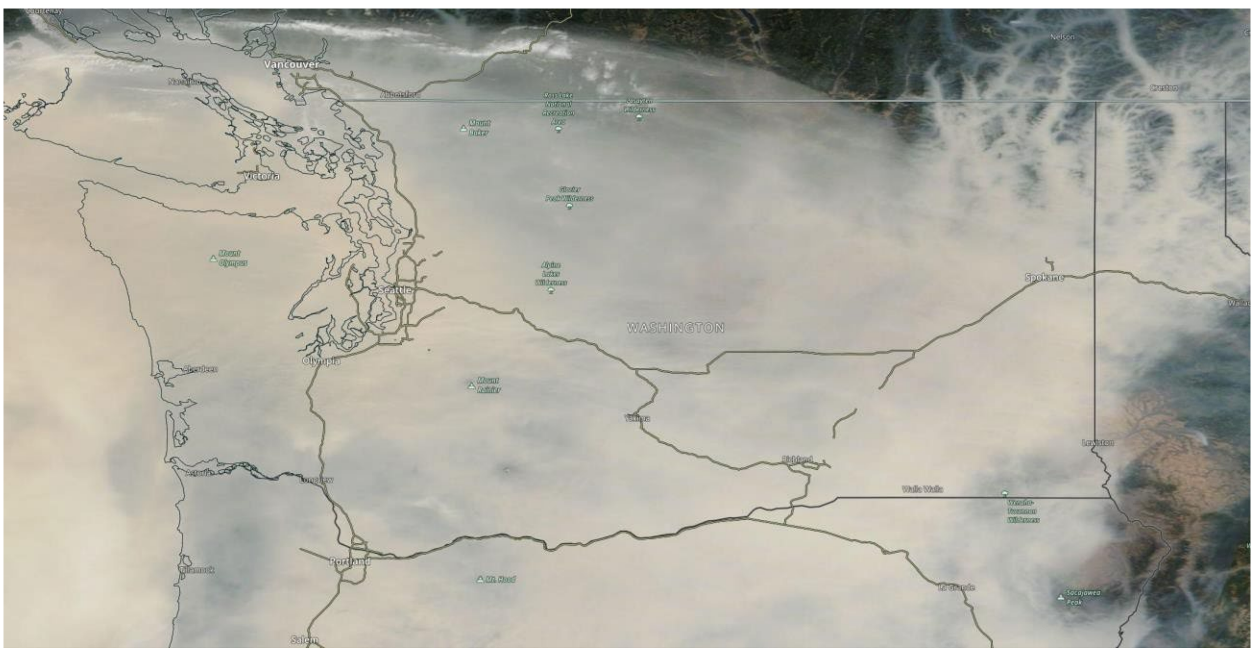
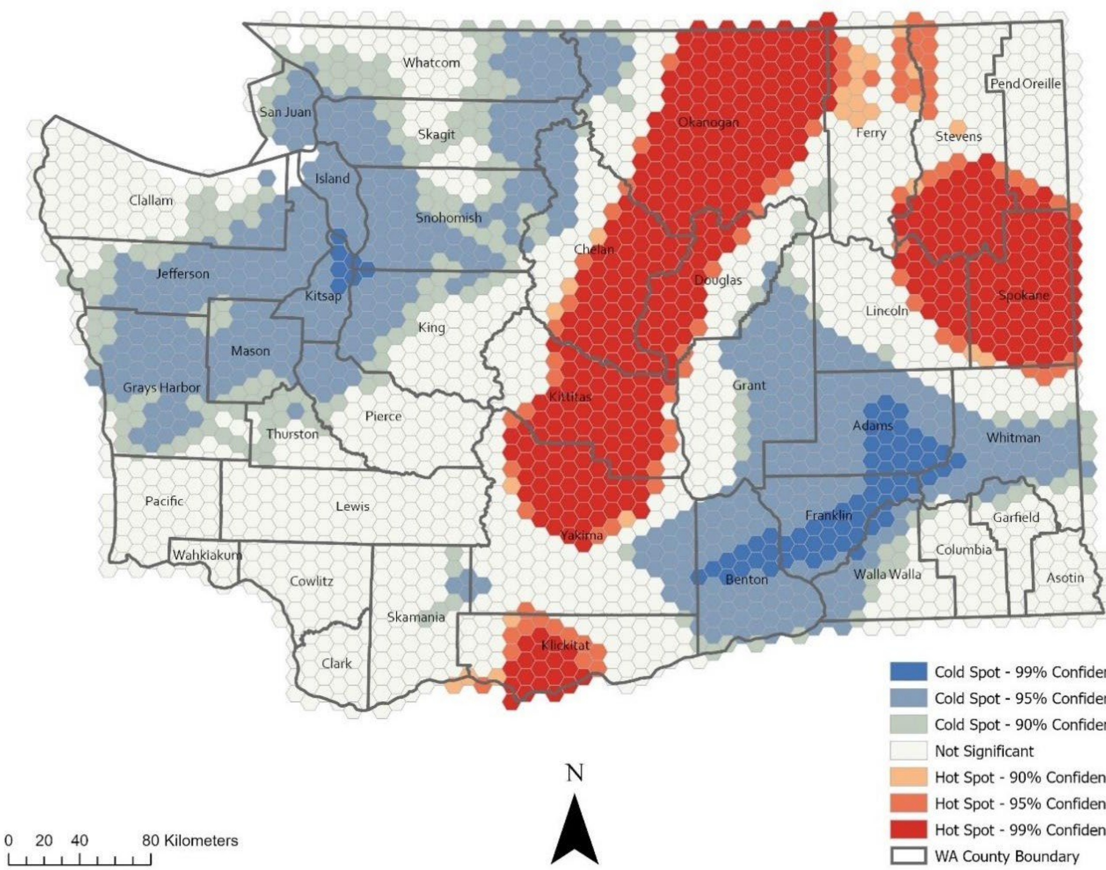


Figure 6.22. NASA MODIS satellite image from 9/12/2020. This image is showing wildfire smoke from fires within and outside WA covering the entire state. The public health implications from such widespread smoke events can be devastating. Source. NASA Worldview

To better understand why wildfire hot spots are located where they are, the relationship between various socioeconomic, land use, and environmental factors and hot spot locations was explored using a statistical model. It was discovered that wildfire hot spot

intensity tends to decrease as socioeconomic status (e.g., income, employment) increases, although this relationship was slight. This could be explained by the tendency for large fires to occur in rural areas where income and employment status may be below state average. Also found was a slight relationship between crowded housing units (i.e., households with more people than rooms) and wildfire hot spot intensity, where a decrease in crowding comes a slight decrease in hot spot intensity. This again may point to the connection between rural areas and large wildfires. Our land use analysis had the same general results, reaffirming that land uses associated with undeveloped or minimally developed areas tend to associate with large wildfires. Of the environmental factors we studied, the average daily maximum temperature between 1980-2019 was shown to have a significant relationship with wildfire hot spot intensity. As the average maximum daily temperature increases, so too does the hot spot's intensity, suggesting that environmental factors contribute significantly to large fires. This is supported by other research on this topic, which has long established the connection between heat and wildfire regime in western states since high heat tends to be followed by increased dryness or drought. As climate change increases the average temperature across Washington, the number of wildfire hot spots, or their intensity, is likely to increase as well.

Figure 6.23. Wildfire hot spots and cold spots based on wildfire activity between 1970 and 2020. Hot spots were



determined by counting the number of wildfire incidents within a 29-mile radius of each hexagon cell and comparing that number with the average for the state. Areas with counts we are 99% sure to be significantly higher than the state average are the deepest red color and are most prone to large fires in the future. Source: Zerbe et al., 2022.

Like temperature, precipitation was seen as having a significant impact on wildfire hot spot intensity, with more precipitation increasing wildfire hot spot intensities (potentially changing a minor hot spot into a significant one). This was a surprising result, but this relationship between precipitation and wildfire is supported by the fact that more spring precipitation in Washington leads to more grass and other vegetation (Weinberger, 2022).

To help fill in the gaps left in the modeling, the local Community Wildfire Protection Plans (CWPPs) and the Washington Department of Natural Resources wildfire statistics data were consulted to better understand ignition sources of specific fires. In addition to lightning strikes, other common ignition sources were debris burning and sparks from various human activity (e.g., electric fencing, structure fires, power lines). Less common, but still significant, sources included recreation activity (e.g., campfires), cigarettes, fireworks, and arson. When looking at the DNR statistical data for the 2020 wildfire season (Washington's worst ever), many large fires around the state were started from the same or similar sources. Although many fires are still being investigated as of this writing, the fires with known ignition sources included electric power lines, lightning, passenger vehicles, debris burning, structure fire, firearm use, and arson.

6.5.2 Wildfire smoke as a natural hazard

Wildfire smoke is a mixture of gases and fine particles that pose a significant health risk to Washingtonians. People with pre-existing health conditions such as asthma or other chronic respiratory conditions and cardiovascular disease, people 18 and younger or older than 65, pregnant women, outdoor workers, people of color, tribal and indigenous people, and people with low income and/or are experiencing homelessness are particularly vulnerable to suffering adverse health effects from smoke exposure. The quantity and duration of smoke exposure, as well as a person's age and health status, play a role in determining whether someone will experience smoke-related health problems. The potential health effects vary depending on the size of the particles. Particles larger than 10 micrometers usually irritate only the eyes, nose, and throat. Fine particulate matter (PM2.5), or particles smaller than 2.5 micrometers, can be inhaled deeply into the lungs, which increases the risk of cardiovascular and respiratory problems.

PM2.5 concentrations are the most useful measurement of smoke levels with respect to health and are commonly used as a proxy for the intensity of wildfire smoke exposure. To improve risk communication, the U.S. Environmental Protection Agency's Air Quality Index AQI) groups PM2.5 concentrations into health hazard levels and six categories. Health precautions in each category are based on current conditions weighted to "24

hour-like" average concentrations. Hourly-updated levels of the AQI are publicly available to help inform decisions.

While the extent of wildfire seasons is generally increasing in Washington and the surrounding region, the impacts of wildfire smoke vary year to year. Between 2012 and 2022 there were four years when most of Washington's population lived in areas where there was "Unhealthy" or worse air quality for at least one day according to the AQI. Often when a larger population is exposed, it is due to smoke from more distant wildfires that blankets Washington and beyond for multiple days. Depending on the meteorological conditions, smoke from more local wildfires can also impact large population centers.

Particulate matter in the atmosphere (dust, smoke, pollution) can block sunlight by absorbing or by scattering light. Aerosol optical depth (AOD) is a measure of the extinction of the solar beam by dust and haze, a common indicator of air quality. An AOD of less than 0.1 indicates a clear sky with maximum visibility, and a value of 1 indicates extreme haze caused by dense particulate matter. The average AOD in the US ranges between 0.1 and 0.15 (NOAA, 2020).

The Moderate Resolution Imaging Spectroradiometer (MODIS) Combined Value-Added Aerosol Optical Depth layer (Levy & Hsu, 2015) can give a quick, synoptic view of the level of aerosols in the atmosphere. Using the EOSDIS Worldview tool, it was found that monthly averages of daily AOD for Washington in August 2018 ranged from 0.31 to 0.9+, with the highest averages closest to the location of active wildfires (within approximately 40 miles of wildfires) (see Gelaro et al., 2017, for more about the monthly reanalysis of MODIS AOD measurements). The EOSDIS Worldview tool shows no part of the state was free from elevated AOD during this time, with the entire state showing above the U.S. average range. Comparable AOD averages were found across the state in August 2015 (range: 0.13 - 0.9+) during similar levels of wildfire activity.

These August 2018 averages across the state are supported by *in situ* measurements of aerosols at two locations in Washington: The Pacific Northwest National Laboratory (PNNL) in Benton County and the Wind River Experimental Forest (WREF) in Skamania County. Figure 32 shows total AOD for a 10-day period in August 2018 as measured by ground-based radiometers.

Given the likelihood of more frequent and severe wildfires, as well as longer wildfire seasons, due to climate change (Snover et al., 2013; May et al., 2018), it is possible that aerosol readings comparable to August 2018 conditions could be repeated and should be considered when determining the overall impact of wildfires to the public.

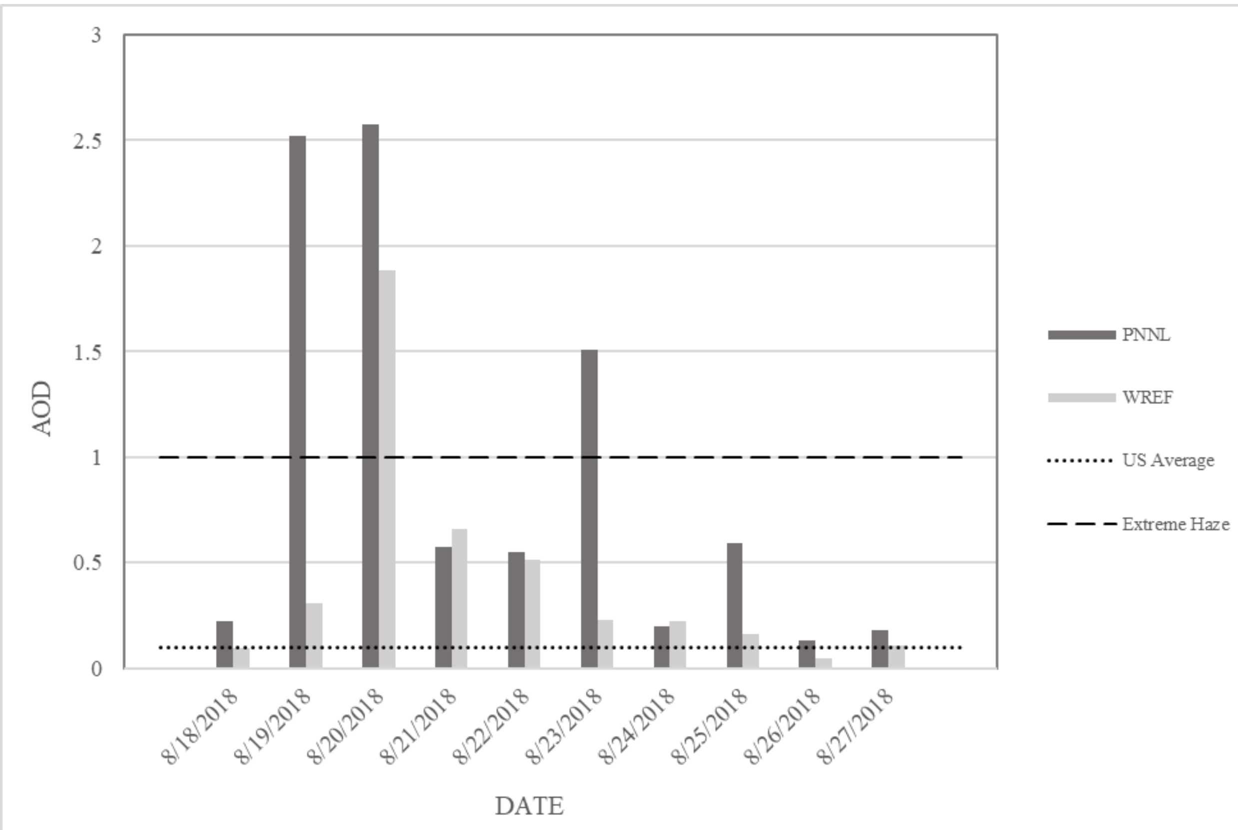


Figure 6.24. Total AOD measurements at the Pacific Northwest National Laboratory (PNNL) (Benton County, WA) and Wind River Experimental Forest (WREF) (Skamania County, WA) over a ten-day period of elevated AOD in August 2018 resulting extreme wildfire smoke. Figure created from Aerosol Robotic Network (AERONET) data (2018).

The potential direct impacts of wildfire on Washington's critical assets would include loss of residences, access to healthcare or other medical facilities, the closing of schools and other educational facilities, loss of recreational facilities such as campgrounds, and much more. Although not currently considered as significantly at-risk relative to the rest of the state, it should be noted that Western Washington is expected to see more frequent and severe wildfires in its future, like those seen in parts of Pierce County in September 2020. Such fires will have the potential to be highly destructive and dangerous for the communities west of the Cascade Range. Population growth is

likely to continue in western Washington, particularly in the greater Seattle area (King, Pierce, and Snohomish Counties), with the potential for more people, property, and critical infrastructure in areas exposed to wildfire hazards.

It is well-established that climate change is contributing to more frequent, larger, and more severe wildfires across the western United States (Wehner, et al., 2017). Wildfire risk is associated with many factors, including temperature, vegetation (i.e., fuels), and soil moisture. The increase in summer temperatures and longer dry spells observed in Washington are the result of climate change (Snover, et al., 2013), and together they create dry fuels that help fires spread and make them more difficult to put out. Climate change is also shown to be the cause of increased wind speeds since at least 2010 (Zeng, et al., 2019; Harvey, 2019), which together with high heat and drought make for extremely dangerous fire conditions. Research shows that this scenario of more frequent dangerous fire weather is likely to get worse over time (Wehner, et al., 2017), with profound changes in western forests and increasing risks for the communities near them. In Washington, that means wildfire risk is expected to increase on both sides of the Cascades (Dunagan, 2020).

APPENDIX A

FEMA MITIGATION GRANT PROGRAMS

FEMA FUNDING POSSIBILITIES FOR SCHOOL DISTRICTS IN WASHINGTON

A-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 (PA) 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 PA 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.

For the Arlington Public Schools, the sources of possible FEMA grant funds include the PA, the Hazard Mitigation Grant Program (HMG), and the Pre-Disaster Mitigation Program (PDM).

A-2.0 FEMA Public Assistance Program

The objective of the FEMA PA 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, PA 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:

- 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

A-3.0 FEMA Mitigation Grant Programs

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 HMP 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:

- The post-disaster HMGP for which funds are available in Washington State after each presidentially-declared disaster in Washington State.

- Annual pre-disaster programs for which funds are available nationwide, including:
  - The PDM Program which includes mitigation for all natural hazards, and
  - 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 (July 2013), and
- Addendum to the Hazard Mitigation Unified Guidance (July 2013).

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 which require strict adherence to the eligibility and application requirements and robust documentation.

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.

A-4.0 Hazard Mitigation Grant Program

The HMG is a post-disaster grant program. HMG 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 PA 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 HMG funding available. However, after a major disaster, such as the Nisqually earthquake in 2001, a large amount of HMG funding may be available.

The Washington Emergency Management Division (WA-EMD) of the Washington Military Department administers the HMG in Washington State and sets the priorities and guidelines after each disaster. For HMG 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. HMG 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.

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

- Public announcement of HMG 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.

A-5.0 Annual Pre-Disaster Grant Programs

FEMA's annual pre-disaster grant programs – 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.

A-5.1 Pre-Disaster Mitigation 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 HMP.

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%.

A-5.2 Flood Mitigation Assistance

The Flood Mitigation Assistance (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 RFL properties provide 90% FEMA funding and grants for SRL properties provide 100% FEMA funding.

A-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.

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.

APPENDIX B

PRINCIPLES

OF

BENEFIT-COST ANALYSIS

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, and
- Public Assistance mitigation projects with costs less than 15% of repair costs, and
- 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).

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), and
- 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 the 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%.

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 5.0) 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, and
- 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.

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 are larger role in the evaluation and prioritization of mitigation projects.

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.

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 B2.1.

Table B2.1
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 B2.1 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.

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 B2.1 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 B2.2 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 B2.2.

Table B2.2

Damages After Mitigation

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

By elevating the 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 B2.3

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.

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.

APPENDIX C

Public Notices
and
Meetings

APPENDIX D

Area

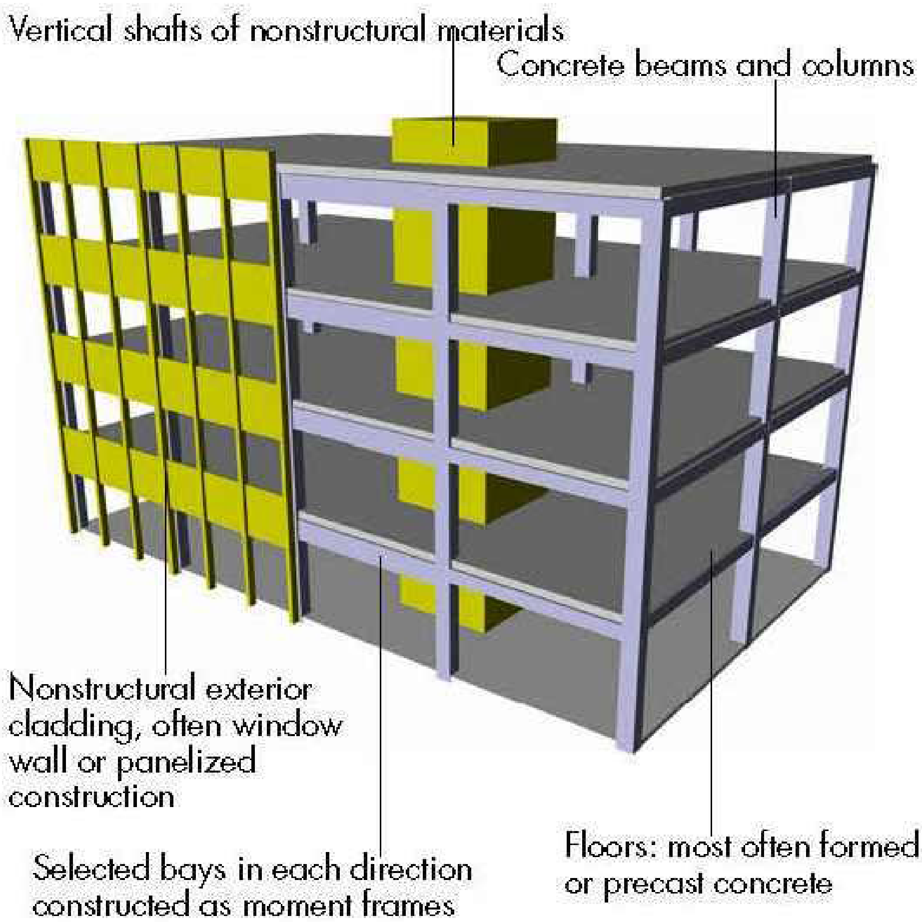
Building Types

A classification of the structural type for a building which provides a building's strength to resist both gravity (vertical) and lateral (horizontal) forces on the building, including steel or concrete frames, weight bearing walls which may be concrete, masonry or wood, and horizontal members including roof and floor structures.

In order to correctly identify the level of seismic hazard, each building type for each area of the building needs to be correctly identified by building type. One building may have several different building types based on the year it was added or even by what it is used for. Different area for the building can be added and/or edited in the Building Inventory screen.

Select the correct building type for each Area for the building. There are 28 possible area building types described below. Building "types" refer to the structural systems of the building not the exterior façade. For example, a wood frame building or concrete shear wall building may have a brick veneer, but the structural system is correctly identified as wood frame or concrete shear wall:

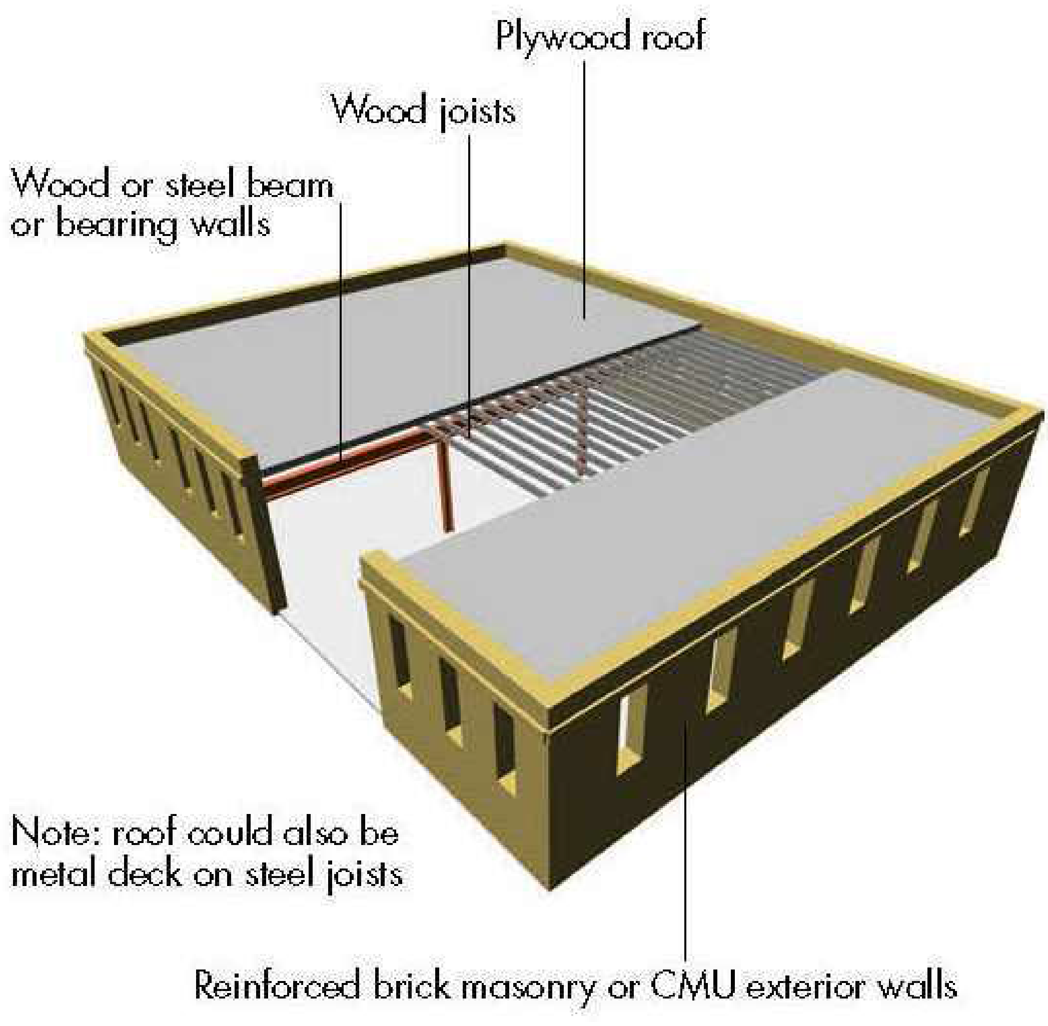
C1 - Concrete Moment Frame Low-Rise – 1 to 3 Stories
This building type has regular rectangular frame geometry like Building Type S1 (see below), but the beams and columns are concrete instead of steel. Floors are typically cast-in-place or precast concrete, but may be wood in older buildings. This is a common building type for older schools.



RM1 - Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms
Low-Rise – 1 to 3 stories

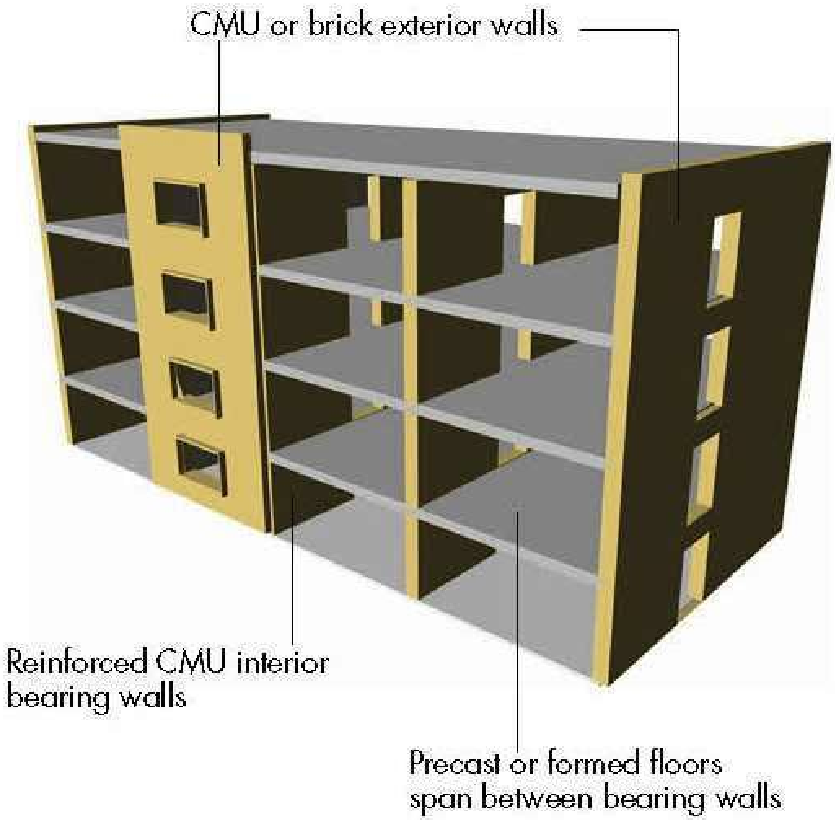
These buildings have bearing walls that consist of reinforced brick or concrete block masonry. The floor and roof framing consists of steel or wood beams and girders or open web joists and are supported by steel, wood or masonry columns. Diaphragms consist of straight or diagonal wood sheathing, plywood or un-topped metal deck and are flexible relative to the walls.

Building types RM1 and RM2 are distinguished by the materials used for floor and roof diaphragms. This is a common building type for schools.

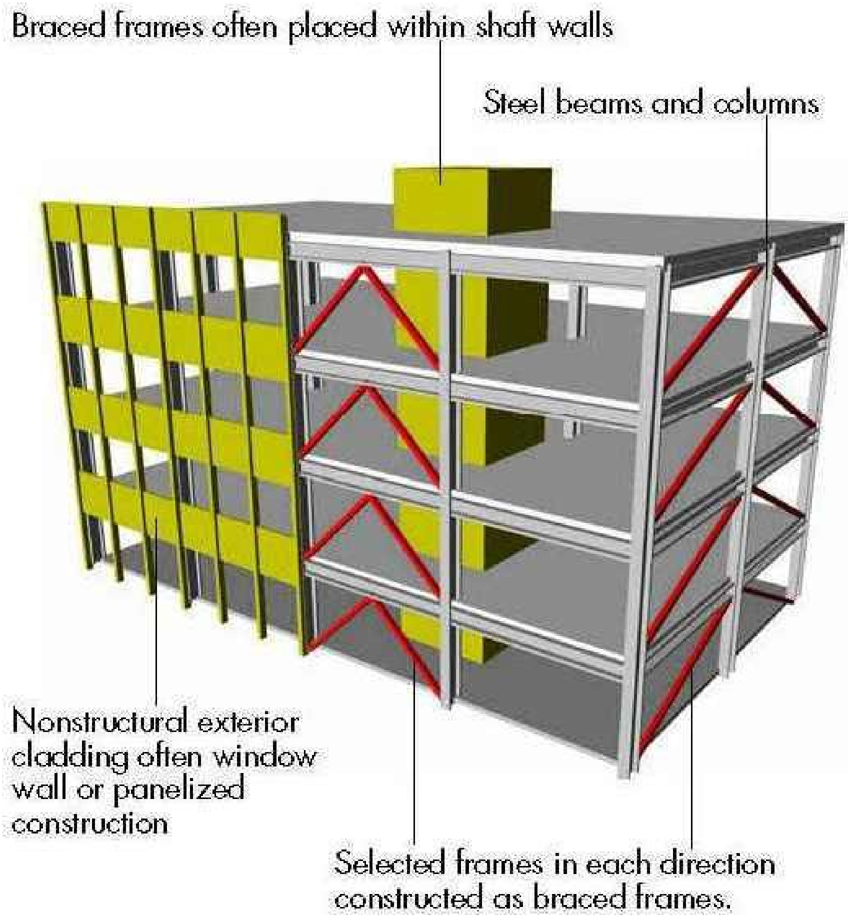


RM2 - Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms
Low-Rise - 1 to 3 stories

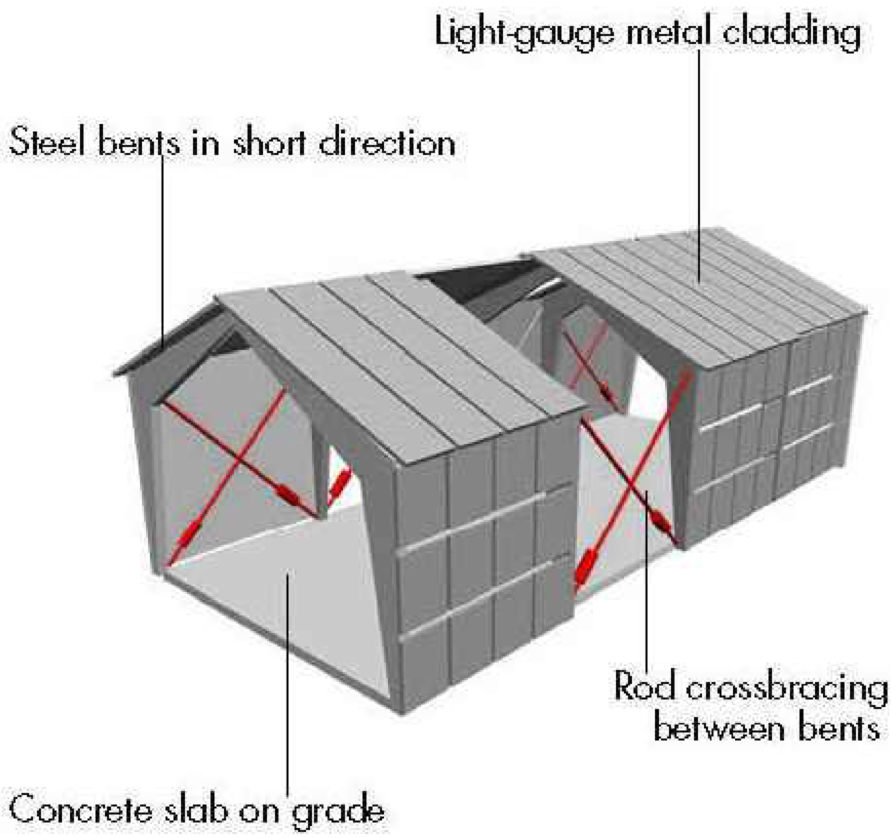
This building type is similar to RM1 buildings, except that the diaphragms consist of metal deck with concrete fill, precast concrete planks, tees or double-tees, without or without a concrete topping slab, and are stiff relative to the walls. Building types RM1 and RM2 are distinguished by the materials used for floor and roof diaphragms. This is a common building type for schools.



S2 - Steel Braced Frame Low-Rise – 1 to 3 Stories
This building type is characterized by a regular, rectangular frame of steel columns and beams with the addition of diagonal braces. The diagonal bracing may be visible on the building exterior or visible in window openings. This is not a common building type for schools, although some do exist.

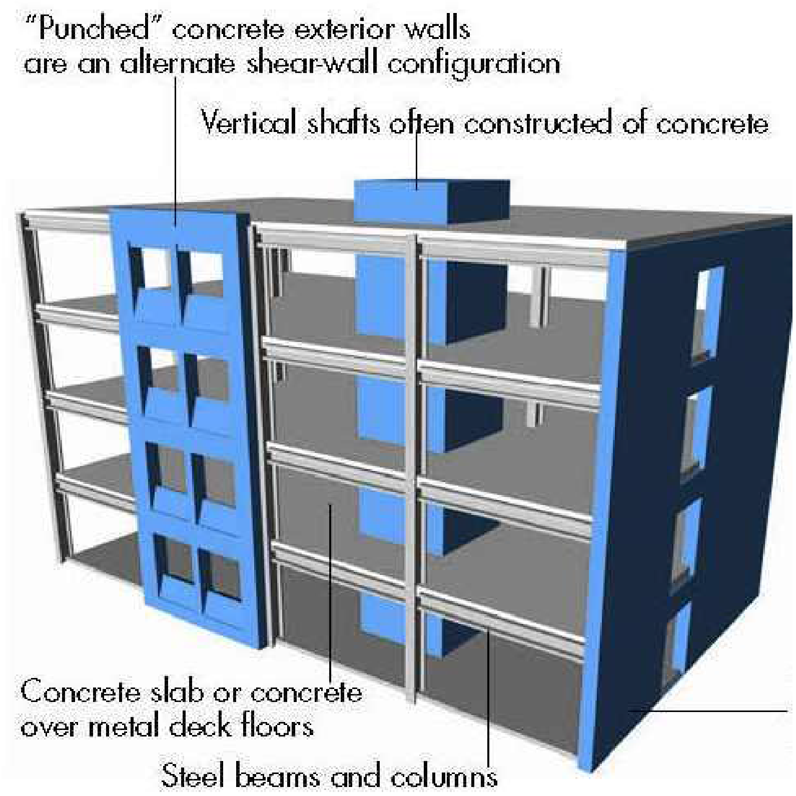


S3 - Steel Light Frame – 1 story
These buildings are one-story pre-engineered and partially prefabricated with light steel framing. The frames are assembled in the field and connected with bolts or welded joints. The roof and walls consist of lightweight metal, fiberglass or cementitious panels. These buildings are not common for schools, although some exist – typically for storage, maintenance or sports facilities.



S4 - Steel Frame with Cast-in-Place Concrete Shear Walls Low-Rise –1 to 3 Stories

The building type includes a steel frame with beams and columns along with concrete shear walls to provide lateral strength. The shear walls include walls in both directions of the building, but may or may not be continuous along the full length of all walls. The floors are typically concrete buy may be wood in older buildings. This is not a common building type for schools, but some do exist.



W1 - Wood Light Frame –
This building type is characterized by wood framing throughout the building including stud walls, joists and rafters. Floor and roof diaphragms may be straight wood, diagonal wood, tongue-and-grove-planks, plywood or oriented strand board. The first floor framing may be supported directly on a slab or perimeter foundation or raised on short cripple-wall studs or post-and-beam supports.
Exterior finish materials may be wood siding, metal siding, stucco or brick veneer. Interior partition walls are sheathed in plaster or gypsum drywall board.

W2-Wood Frame Building: These can be large residential (apartments), commercial, and sometimes light industrial buildings with more than 5000 square feet.

Portable –Portable classrooms are factory built structures, usually in one or two pieces, which are assembled on site. Portables are most similar to W1, small wood frame building, but differ in some characteristics, especially the types of foundations used. Thus, for seismic risk assessments, portables are considered a separate building class.

APPENDIX E

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APPENDIX F

ASCE 41-17 Tier 1 Evaluations

Structural Solutions

Seattle | 1011 Western Avenue, Suite 810 | Seattle, WA 98104 | 206.292.5076
Tacoma | 1250 Pacific Avenue, Suite 701 | Tacoma, WA 98402 | 253.383.2797
Portland | 101 SW Main Street, Suite 280 | Portland, OR 97204 | 503.232.3746

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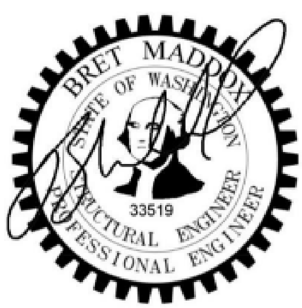
STRUCTURAL EVALUATION

FOR

POST MIDDLE SCHOOL
1220 E 5TH ST
ARLINGTON, WASHINGTON

PREPARED BY

PCS STRUCTURAL *SOLUTIONS*



JANUARY 25, 2023
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JANUARY 2023

STRUCTURAL EVALUATION FOR
POST MIDDLE SCHOOL
ARLINGTON, WASHINGTON

A. SCOPE OF SERVICES

PCS Structural Solutions was retained to perform a structural evaluation of the existing structures that make up the Post Middle School campus located at 1220 5th St in Arlington, Washington. The scope of this evaluation included review of available construction drawings from the original construction in 1980 and from the classroom wing addition in 1992, a walk-through evaluation of the buildings to look for signs of structural distress, deterioration or differential settlement, completion of ASCE 41-17, Tier 1 evaluation checklists (without quick-check calculations), and finally, the development of a summary report of our findings and recommendations.

B. TYPE OF CONSTRUCTION/STRUCTURAL SYSTEM

Post Middle School is a conglomeration of single-story structures connected by free-standing wood frame covered walks. The 1980 structures are primarily wood framed, with use of metal stud bearing walls at the exteriors of the administration building and three classroom buildings. The gymnasium building has a wood framed roof structure with CMU bearing/shear walls throughout. The 1992 addition consisted of one classroom building that is all wood frame. The buildings are all founded on conventional shallow foundations.

1980 Construction

<u>Vertical Load Resisting System</u>:

The vertical load resisting system is composed of plywood roof decking that spans between a combination of plywood web and open web wood joists. The joists are supported by exterior metal stud and interior wood stud bearing walls and glulam beams for most of the buildings. Reinforced CMU walls support the framing at the exterior bearing lines of the gymnasium building. Steel pipe columns support the glulam beams throughout the campus. Bearing walls and columns are supported at the ground level with conventional shallow concrete stem walls and strip/spread type footings. The floors are conventional concrete slab on grade.

<u>Lateral Force Resisting System</u>:

The lateral load resisting system is made of up of plywood roof sheathing acting as a diaphragm to distribute wind and seismic loads to plywood sheathed metal stud shear walls at the administration building and the three classroom buildings and to reinforced CMU walls at the gymnasium building. The shear walls are supported at the ground level by concrete stem walls and strip footings, which transfer lateral forces to the supporting soils via friction and passive bearing pressure.

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STRUCTURAL EVALUATION FOR
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ARLINGTON, WASHINGTON

1992 Construction

Vertical Load Resisting System:

The vertical load resisting system is composed of plywood roof decking that spans between a combination of metal plate wood trusses and solid sawn framing. The joists are supported by wood stud bearing walls and glulam beams. The beams are supported primarily by wood columns, with a few hollow square tube steel columns at exterior locations. Bearing walls and columns are supported at the ground level with conventional shallow concrete stem walls and strip/spread type footings. The floors are conventional concrete slab on grade.

Lateral Force Resisting System:

The lateral load resisting system is made of up of plywood roof sheathing acting as a diaphragm to distribute wind and seismic loads to plywood sheathed wood stud shear walls. The shear walls are supported at the ground level by concrete stem walls and strip footings, which transfer lateral forces to the supporting soils via friction and passive bearing pressure.

C. OBSERVATIONS AND COMMENTS

Overall, the buildings appear to be in a relatively good state of structural repair. There were no significant signs of distress, deterioration, or differential settlement. There were some minor issues noted related to exterior finishes that should be addressed to protect the underlying structural elements. These are as listed below.

- There are some cracks present in the exterior CMU veneer throughout the campus. The appears to be the result of a lack of control joints in the original construction. These cracks are well protected in most cases by the large roof overhangs but should be repaired/resealed to prevent further deterioration due to moisture intrusion and freeze/thaw action.
- There are several areas around the campus where there is moss or other indication of moisture damage in the fascia boards. Left unattended, the deterioration may continue, allowing moisture to affect the underlying structural components.
- On a few of the north facing roof surfaces, there is moss growth noted. Left unaddressed, the roofing may become deteriorated, leaving the underlying plywood decking susceptible to moisture damage.
- There is evidence of moisture damage in the fascia boards in numerous locations across the campus. The fascia boards should be repainted or replaced needed to protect the structure.
- There are several locations where a plaster finish is used on the exterior walls. Based on the vintage of the buildings, it is recommended that further investigation be done to determine if water intrusion has occurred. The products used during this timeframe have proven to be susceptible to moisture intrusion, which can result in deterioration of the exterior plywood sheathing and stud framing.

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STRUCTURAL EVALUATION FOR
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ARLINGTON, WASHINGTON

1992 Construction

Vertical Load Resisting System:

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Lateral Force Resisting System:

The lateral load resisting system is made of up of plywood roof sheathing acting as a diaphragm to distribute wind and seismic loads to plywood sheathed wood stud shear walls. The shear walls are supported at the ground level by concrete stem walls and strip footings, which transfer lateral forces to the supporting soils via friction and passive bearing pressure.

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STRUCTURAL EVALUATION FOR
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D. ASCE 41-17 CHECKLIST NON-COMPLIANT ITEMS

Post Middle School was evaluated using the methodology of the ASCE 41-17 "Seismic Evaluation and Retrofit of Existing Buildings" Tier 1 evaluation, addressing the Life/Safety Performance level for the structural components of the building. The evaluation was abbreviated in the fact that the quick check calculations called for were not included in the scope of services. The checklist items asking for calculations were supplemented using our experience in evaluating and renovating similar structures in the Puget Sound region. The non-structural checklists were not performed, as that work was also beyond the scope of this evaluation. For the evaluation of Post Middle School, the basic structural checklist, the wood light frame walls (W1) checklist, the cold-formed steel light-frame bearing wall (CFS1) checklist, and the reinforced masonry bearing walls (RM1) checklist were used. The following are the items noted as being "non-compliant" with the checklists:

Basic Checklist

- The non-bearing CMU walls at the gymnasium building are not properly anchored into the roof diaphragms to resist seismic forces.
- The various buildings are built directly adjacent to each other or to the covered walk structures without adequate separation or connection to address differential movements under seismic loading conditions.
- While marked as "unknown" in the checklists, the school's location at the top of a large bluff raises concerns over the potential for landslides. To determine if this issue is a problem, additional investigation by a Geotechnical Engineer would be needed.

Wood Light Frame Checklist (W1)

- The checklists prescribe a limit of 40 feet for the horizontal span of the plywood roof diaphragms. There are numerous locations throughout the campus where diaphragms exceed this limit. Due to the relatively low level of force anticipated in the diaphragms, it is anticipated that this will not be a significant concern, but would need additional analysis to confirm.

Cold-Form Steel Light-Frame Checklist (CFS1)

- The checklists prescribe a limit of 40 feet for the horizontal span of the plywood roof diaphragms. There are numerous locations throughout the campus where diaphragms exceed this limit. Due to the relatively low level of force anticipated in the diaphragms, it is anticipated that this will not be a significant concern but would need additional analysis to confirm.

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Reinforced Masonry Bearing Walls Checklist (RM1)

- The reinforcing steel in the 8" walls is below the limits set by the checklists. These walls are primarily non-structural in nature in the bathroom and locker room areas and are not anticipated to be an issue in the overall performance of the structure.
- The non-bearing CMU walls at the gymnasium building are not properly anchored into the roof diaphragms to resist seismic forces. Additionally, there are not properly detailed crossties that would serve to distribute anchorage forces into the diaphragms.
- At the bearing walls at the open web wood joists, here is not a well detailed load path to deliver in-plane loads from the roof diaphragm into the shear walls.

E. RECOMMENDATIONS

The concerns noted below are generally listed in order from most critical to least and are based on both our findings from the ASCE 41 checklists, but also from our site visit observations and our experience with similar school structures. Recommendations are provided to allow for initial planning and are intended to address the noted concerns to bring the building into general compliance with the strength requirements of the current Building Code.

Structural Concern	Structural Recommendation
There is a lack of anchorage for out of plane and in plane seismic loads at most of the CMU bearing walls at the gymnasium building. In this condition, the walls may become separated from the roof structure under heavy seismic loading and may result in extensive damage throughout the structure.	The walls should be provided with proper anchors and/or blocking between joists to resist both in plane and out of plane seismic forces. This may involve adding steel strapping and adhesive anchors in the CMU walls at the non-bearing walls and additional attachment via nails or metal clips at bearing locations.
The plywood diaphragms at the gymnasium lack sufficient crossties to help distribute seismic loads to the perpendicular shear walls. This leaves the diaphragms susceptible to damage under moderate to heavy seismic loading conditions.	The diaphragms should be provided with additional blocking and strapping as needed to develop proper sub diaphragms. It would be most advantageous to consider this work at the time of the next reroofing project.
There is not adequate separation between the buildings where they are connected by the covered walkway and insufficient ties to address differential movement at re-entrant corners where the buildings are connected along one edge. This will leave the buildings susceptible to damage at the joints between structures under seismic loading due to banging of the structures against each other.	The covered walkway structured should be cut back to allow for proper seismic separation, and blocking and strapping are likely to be needed where individual building masses are connected at the roof level.

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The plywood roof diaphragms exceed the limits prescribed in the ASCE 41 checklists but are not anticipated to be of significant concern due to the length of shear walls present in the structure and due to the general level of detailing of the original structure. There is a chance for damage in the diaphragms under heavy seismic loading, but under code prescribed loads, overstresses are anticipated to be minor.	Additional analysis may be warranted to verify the stress in the roof diaphragms. Should areas of overstress be discovered, the diaphragms could be strengthened by adding blocking at the panel edges that run perpendicular to the walls/framing members. This blocking would likely only be needed for short distances from the walls if at all.
There are several maintenance items noted as needing to be completed. Without the proper attention, the buildings are susceptible to damage and deterioration due to moisture intrusion.	The various items noted should be addressed through the ongoing maintenance of the campus.
While it is unclear if a problem exists, the location of the buildings next to a large bluff leaves them at risk in the event of a landslide on the adjacent bluff.	The condition should be investigated by a Geotechnical Engineer to determine the level of risk and potential mitigation measures if needed.

E. CONCLUSION

The Post Middle School buildings are currently in good state of structural repair, but do have some minor concerns noted related to the exterior finishes needing general maintenance. Seismically, there are concerns noted primarily related to the anchorage of the masonry walls to the roof diaphragms at the gym building and to the interface of the adjacent structures where inadequate separation or connection exists. There are a handful of other, less crucial, concerns noted as well. Overall, the concerns noted are common to buildings of similar age and type of construction. By mitigating the noted concerns, it is reasonable to extend the useable life of the structures well into the future.

F. APPENDIX – ASCE 41-17 CHECKLISTS

Project Name Post Middle School
Project # 23-199

ASCE 41-17 Tier 1 Checklists

FIRM:	PCS Structural Solutions
PROJECT NAME:	Post Middle School
PROJECT NUMBER:	23-199
SEISMICITY LEVEL:	High
COMPLETED BY:	Bret M
DATE COMPLETED	1/17/23
REVIEWED BY:	
REVIEWED DATE:	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

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17.1 BASIC CHECKLISTS

Table 17-1. Very Low Seismicity Checklist

Status	Evaluation Statement	Comments
Structural Components		
C NC N/A U ☒ ☐ ☐ ☐	LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
C NC N/A U ☐ ☒ ☐ ☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	Lack of proper anchorage at non-bearing CMU walls at Gymnasium

Table 17-2. Collapse Prevention Basic Configuration Checklist

Status	Evaluation Statement	Comments
Low Seismicity		
Building System—General		
C NC N/A U ☒ ☐ ☐ ☐	LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)	
C NC N/A U ☐ ☒ ☐ ☐	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)	The building "boxes" are connected with covered walkway that are not detailed to allow differential movement of the structures.
C NC N/A U ☒ ☐ ☐ ☐	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)	

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Status	Evaluation Statement	Comments
Building System—Building Configuration		
C ☐ NC ☐ N/A ☒ U ☐	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A.2.2.2. Tier 2: Sec. 5.4.2.1)	Single story
C ☐ NC ☐ N/A ☒ U ☐	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)	Single story
C ☐ NC ☐ N/A ☒ U ☐	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)	Single story
C ☐ NC ☐ N/A ☒ U ☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)	Single story
C ☐ NC ☐ N/A ☒ U ☐	MASS: There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)	Single story
C ☐ NC ☐ N/A ☒ U ☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)	Flexible diaphragms
Moderate Seismicity (Complete the Following Items in Addition to the Items for Low Seismicity)		
Geologic Site Hazards		
C ☐ NC ☐ N/A ☐ U ☒	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2 m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: Sec. 5.4.3.1)	Unknown, but not anticipated

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Status	Evaluation Statement	Comments
C NC N/A U ☐ ☐ ☐ ☒	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: Sec. 5.4.3.1)	Located on a bluff overlooking the south fork of the Stillaguamish River. Potential exists.
C NC N/A U ☐ ☐ ☐ ☒	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: Sec. 5.4.3.1)	
High Seismicity (Complete the Following Items in Addition to the Items for Moderate Seismicity)		
Foundation Configuration		
C NC N/A U ☒ ☐ ☐ ☐	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)	
C NC N/A U ☐ ☐ ☒ ☐	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)	Shallow footings are restrained by soils.

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ASCE 41-17 Tier 1 Checklists

FIRM:	PCS Structural Solutions
PROJECT NAME:	Post Middle School
PROJECT NUMBER:	23-199
SEISMICITY LEVEL:	High
COMPLETED BY:	Bret M.
DATE COMPLETED	1/17/23
REVIEWED BY:	
REVIEWED DATE:	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

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Project Name Post Middle School

Project # 23-199

17.2 STRUCTURAL CHECKLISTS FOR BUILDING TYPES W1: WOOD LIGHT FRAMES AND W1A: MULTI-STORY, MULTI-UNIT RESIDENTIAL WOOD FRAME

Table 17-4. Collapse Prevention Structural Checklist for Building Types W1 and W1a

Status	Evaluation Statement	Comments
Low and Moderate Seismicity		
Seismic-Force-Resisting System		
C NC N/A U ☒ ☐ ☐ ☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	
C NC N/A U ☐ ☐ ☐ ☒	SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the following values: Structural panel sheathing 1,000 lb/ft (14.6 kN/m) Diagonal sheathing 700 lb/ft (10.2 kN/m) Straight sheathing 100 lb/ft (1.5 kN/m) All other conditions 100 lb/ft (1.5 kN/m) (Commentary: Sec. A.3.2.7.1. Tier 2: Sec. 5.5.3.1.1)	Beyond current scope. Anticipated to be below limits based on current loads relative to original loading.
C NC N/A U ☐ ☐ ☒ ☐	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.7.2. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☐ ☐ ☒ ☐	GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used for shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.7.3. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☒ ☐ ☐ ☐	NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☐ ☐ ☒ ☐	WALLS CONNECTED THROUGH FLOORS: Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.7.5. Tier 2: Sec. 5.5.3.6.2)	Single story.

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Status	Evaluation Statement	Comments
C NC N/A U ☐ ☐ ☒ ☐	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-1. (Commentary: Sec. A.3.2.7.6. Tier 2: Sec. 5.5.3.6.3)	
C NC N/A U ☐ ☐ ☒ ☐	CRIPPLE WALLS: Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.7.7. Tier 2: Sec. 5.5.3.6.4)	
C NC N/A U ☐ ☐ ☒ ☐	OPENINGS: Walls with openings greater than 80% of the length are braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.7.8. Tier 2: Sec. 5.5.3.6.5)	
Connections		
C NC N/A U ☒ ☐ ☐ ☐	WOOD POSTS: There is a positive connection of wood posts to the foundation. (Commentary: Sec. A.5.3.3. Tier 2: Sec. 5.7.3.3)	
C NC N/A U ☒ ☐ ☐ ☐	WOOD SILLS: All wood sills are bolted to the foundation. (Commentary: Sec. A.5.3.4. Tier 2: Sec. 5.7.3.3)	
C NC N/A U ☒ ☐ ☐ ☐	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)	
High Seismicity (Complete the Following Items in Addition to the Items for Low and Moderate Seismicity)		
Connections		
C NC N/A U ☒ ☐ ☐ ☐	WOOD SILL BOLTS: Sill bolts are spaced at 6 ft or less with acceptable edge and end distance provided for wood and concrete. (Commentary: Sec. A.5.3.7. Tier 2: Sec. 5.7.3.3)	

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Project Name Post Middle School
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Status	Evaluation Statement	Comments
Diaphragms		
C ☐ NC ☐ N/A ☒ U ☐	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)	
C ☒ NC ☐ N/A ☐ U ☐	ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1)	
C ☐ NC ☐ N/A ☒ U ☐	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
C ☒ NC ☐ N/A ☐ U ☐	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	
C ☐ NC ☒ N/A ☐ U ☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12 m) and have aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	Spans > 40 feet, but not likely to be a problem.
C ☒ NC ☐ N/A ☐ U ☐	OTHER DIAPHRAGMS: The diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	

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Project Name Post Middle School
Project # 23-199

ASCE 41-17 Tier 1 Checklists

FIRM:	PCS Structural Solutions
PROJECT NAME:	Post Middle School
PROJECT NUMBER:	23-199
SEISMICITY LEVEL:	High
COMPLETED BY:	Bret M.
DATE COMPLETED	1/17/23
REVIEWED BY:	
REVIEWED DATE:	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

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Project # 23-199

17.9 STRUCTURAL CHECKLISTS FOR BUILDING TYPE CFS1: COLD-FORMED STEEL LIGHT-FRAME BEARING WALL CONSTRUCTION, SHEAR WALL LATERAL SYSTEM

Table 17-18. Collapse Prevention Structural Checklist for Building Type CFS1

Status	Evaluation Statement	Comments
Low and Moderate Seismicity		
Seismic-Force-Resisting System		
C NC N/A U ☒ ☐ ☐ ☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	
C NC N/A U ☐ ☐ ☐ ☒	SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the following values: Wood structural panel sheathing 1,000 lb/ft (14.6 kN/m) Steel sheet sheathing 700 lb/ft (10.2 kN/m) All other conditions 100 lb/ft (1.5 kN/m) (Commentary: Sec. A.3.2.8.1. Tier 2: Sec. 5.5.3.1.1)	Beyond current scope. Anticipated to be below limits based on current loads relative to original loading.
C NC N/A U ☐ ☐ ☒ ☐	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.8.2. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☐ ☐ ☒ ☐	GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used for shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.8.3. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☒ ☐ ☐ ☐	NARROW SHEAR WALLS: Narrow shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.8.4. Tier 2: Sec. 5.5.3.6.1)	
C NC N/A U ☐ ☐ ☒ ☐	WALLS CONNECTED THROUGH FLOORS: Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.8.5. Tier 2: Sec. 5.5.3.6.2)	Single story.

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Status	Evaluation Statement	Comments
C NC N/A U ☐ ☐ ☒ ☐	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-1. (Commentary: Sec. A.3.2.8.6. Tier 2: Sec. 5.5.3.6.3)	
C NC N/A U ☐ ☐ ☒ ☐	CRIPPLE WALLS: Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.8.7. Tier 2: Sec. 5.5.3.6.4)	
C NC N/A U ☐ ☐ ☒ ☐	OPENINGS: Walls with openings greater than 80% of the length are braced with wood structural panel or steel sheet shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.8.8. Tier 2: Sec. 5.5.3.6.5)	
Connections		
C NC N/A U ☒ ☐ ☐ ☐	POSTS: There is a positive connection of posts to the foundation. (Commentary: Sec. A.5.3.3. Tier 2: Sec. 5.7.3.3)	
C NC N/A U ☒ ☐ ☐ ☐	SILLS (BASE TRACK): All sills or base tracks are bolted to the foundation. (Commentary: Sec. A.5.3.4. Tier 2: Sec. 5.7.3.3)	
C NC N/A U ☒ ☐ ☐ ☐	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)	
High Seismicity (Complete the Following Items in Addition to the Items for Low and Moderate Seismicity)		
Connections		
C NC N/A U ☒ ☐ ☐ ☐	SILL (BASE TRACK) BOLTS: Bolts are spaced at 6 ft (1.8 m) or less with acceptable edge and end distance provided for steel and concrete. (Commentary: Sec. A.5.3.7. Tier 2: Sec. 5.7.3.3)	

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ASCE 41-17 TIER 1 CHECKLISTS

Project Name Post Middle School
Project # 23-199

Status	Evaluation Statement	Comments
Diaphragms		
C NC N/A U ☒ ☐ ☐ ☐	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)	
C NC N/A U ☒ ☐ ☐ ☐	ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1)	
C NC N/A U ☒ ☐ ☐ ☐	SPANS: All diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	
C NC N/A U ☐ ☒ ☐ ☐	UNBLOCKED DIAPHRAGMS: All unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and have aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	Spans > 40 feet, but not likely to be a problem.
C NC N/A U ☒ ☐ ☐ ☐	OTHER DIAPHRAGMS: The diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

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FIRM:	PCS Structural Solutions
PROJECT NAME:	Post Middle School
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17.17 STRUCTURAL CHECKLISTS FOR BUILDING TYPES RM1: REINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS AND RM2: REINFORCED MASONRY BEARING WALLS WITH STIFF DIAPHRAGMS

Table 17-34. Collapse Prevention Structural Checklist for Building Types RM1 and RM2

Status	Evaluation Statement	Comments
Low and Moderate Seismicity		
Seismic-Force-Resisting System		
C NC N/A U ☒ ☐ ☐ ☐	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1)	
C NC N/A U ☐ ☐ ☐ ☒	SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than 70 lb/in.^{2} (0.48 MPa). (Commentary: Sec. A.3.2.4.1. Tier 2: Sec. 5.5.3.1.1)	Beyond current scope, but anticipated to be below prescribed limits.
C NC N/A U ☐ ☒ ☐ ☐	REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls is greater than 0.002 of the wall with the minimum of 0.0007 in either of the two directions; the spacing of reinforcing steel is less than 48 in. (1220 mm), and all vertical bars extend to the top of the walls. (Commentary: Sec. A.3.2.4.2. Tier 2: Sec. 5.5.3.1.3)	8" CMU walls are under-reinforced. 12" walls are okay.
Stiff Diaphragms		
C NC N/A U ☐ ☐ ☒ ☐	TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab. (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4)	
Connections		
C NC N/A U ☐ ☒ ☐ ☐	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)	Several walls are not provided with adequate anchorage.
C NC N/A U ☒ ☐ ☐ ☐	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3)	

Note: C = Compliant, NC = Noncompliant, N/A = Not Applicable, and U = Unknown.

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Status	Evaluation Statement	Comments
C NC N/A U ☐ ☒ ☐ ☐	TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)	Some areas lacking, with partial height or no blocking present between joist bearings.
C NC N/A U ☐ ☐ ☒ ☐	TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2)	
C NC N/A U ☒ ☐ ☐ ☐	FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4	
C NC N/A U ☒ ☐ ☐ ☐	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1)	
High Seismicity (Complete the Following Items in Addition to the Items for Low and Moderate Seismicity)		
Stiff Diaphragms		
C NC N/A U ☒ ☐ ☐ ☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	
C NC N/A U ☒ ☐ ☐ ☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft (2.4 m) long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	
Flexible Diaphragms		
C NC N/A U ☐ ☒ ☐ ☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)	No cross ties present at walls perpendicular to main framing.

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Status	Evaluation Statement	Comments
C NC N/A U ☒ ☐ ☐ ☐	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)	
C NC N/A U ☒ ☐ ☐ ☐	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft (2.4 m) long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3)	
C NC N/A U ☐ ☐ ☒ ☐	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)	
C NC N/A U ☒ ☐ ☐ ☐	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)	
C NC N/A U ☒ ☐ ☐ ☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)	Blocking provided for defined distances in from perimeter shear walls.
C NC N/A U ☒ ☐ ☐ ☐	OTHER DIAPHRAGMS: Diaphragms do not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)	
Connections		
C NC N/A U ☒ ☐ ☐ ☐	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. (3 mm) before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2)	Where present, anchors appear to be tightly installed.

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