

Section 4

Risk Assessment Requirements

Identifying Hazards--- Requirement §201.6(c)(2)(i):

[The risk assessment **shall** include a] description of the type ... of all natural hazards that can affect the jurisdiction.

- Does the plan include a description of the types of all hazards that affect the jurisdiction?
- Does the plan describe the sources used to identify the hazards?
- Does the plan indicate any data limitations?
- Does the plan provide an explanation for eliminating any hazards from consideration?

Profiling Hazard Events---Requirement §201.6(c)(2)(i):

[The risk assessment **shall** include a] description of the ... location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.

- Does the risk assessment identify the location of each hazard being addressed in the plan?
- Does the risk assessment identify the extent of each hazard being addressed in the plan?
- Does the plan provide information on the previous occurrences of each natural hazard?
- Does the risk assessment identify for each hazard, a scale of likelihood of occurrence and the impact?
- Is the location of the natural hazard specifically defined?
- Is the quality of information on the extent above average
- Does the plan document the sources of the information on local, extent, and previous occurrences?

Assessing Vulnerability: Identifying Assets---Requirement §201.6(c)(2) (ii)(A):

[The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community. The plan **should** describe vulnerability in terms of:§ The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas...

- Does the plan include an overall summary description of the jurisdiction vulnerability to the hazards?
- Does the plan address the impacts of the hazards on the community?
- Does the plan provide information on the types and numbers of vulnerable buildings--infrastructures--critical facilities?
- Does the plan address the vulnerability to future buildings, infrastructure, and critical facilities based on current planned development or anticipated areas of growth within the community?
- Does the plan identify the jurisdictions' repetitive loss areas/structures?

Assessing Vulnerability: Estimating Potential Losses---Requirement §201.6(c)(2) (ii)(B):

[The plan **should** describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) of this section and a description of the methodology used to prepare the estimate...

- Does the plan identify vulnerability assets as required in Part 201.6 (c)(ii)(A)?

Assessing Vulnerability: Analyzing Development Trends---Requirement §201.6(c)(2) (ii)(c):

[The plan **should** describe vulnerability in terms of providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

- Does the plan describe the vulnerability to hazards as required in 201.6(c)(ii)(a)?
- Does the plan indicate the methodology used to prepare the estimate?

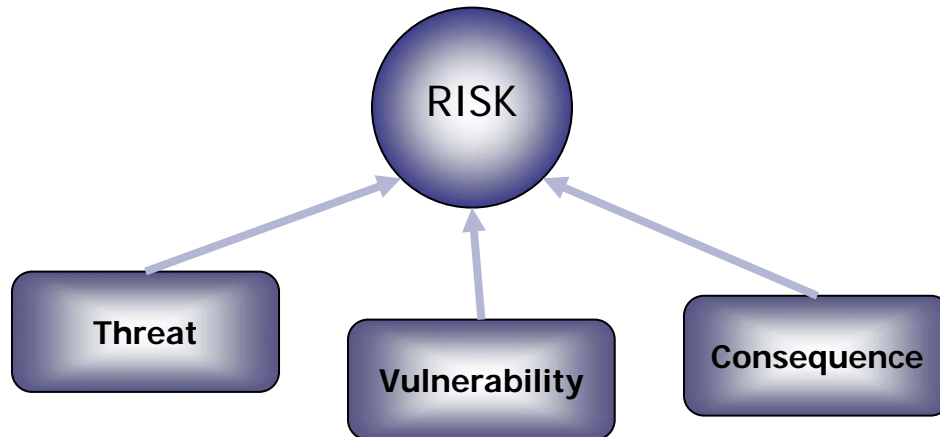
**REGION 5 HAZARD MITIGATION PLAN
GRAHAM FIRE & RESCUE
RISK ASSESSMENT SECTION**

Table of Contents

RISK ASSESSMENT REQUIREMENTS 1
TABLE OF CONTENTS 2
SECTION OVERVIEW 3
 Table 4-1a WA Region 5 Hazard Identification Summary – Geological.....5
 Table 4- 1b WA Region 5 Hazard Identification Summary – Meteorological.....6
 Table 4- 2 Vulnerability Analysis: General Exposure.....11
 Table 4- 3 Vulnerability Analysis: Population Exposure11
 Table 4- 4 Vulnerability Analysis: General Infrastructure Exposure.....12
 Table 4-5a Consequence Analysis Chart – Geological13
 Table 4-5b Consequence Analysis Chart – Meteorological.....14
ENDNOTES 15

Section Overview

The Risk Assessment portrays the threats of natural hazards, the vulnerabilities of a jurisdiction to the hazards, and the consequences of hazards impacting communities. Each hazard is addressed as a threat and is identified and profiled in the Hazard Identification. The vulnerabilities to and consequences of a given hazard are addressed in the Vulnerability Analysis. Vulnerability is analyzed in terms of exposure of both population and infrastructure to each hazard. Consequences are identified as anticipated, predicted, or documented impacts caused by a given hazard when considering the vulnerability analysis and the characteristics of the hazard as outlined in its identification.



The WA Region 5 **Hazard Identification** was used for this plan. Each jurisdiction’s Vulnerability and Consequence Analysis are based on the Region 5 Hazard Identification. The Region 5 Hazard Identification can be found in Annex (TBD). Each hazard is identified in subsections. The subsections are grouped by hazard-type (i.e., geological and meteorological hazards) and then alphabetically within each type. A summary table of the WA Region 5 Hazard Identification is included in this section as Table 4-1a and Table 4-1b.

The **Vulnerability Analysis** is displayed in five tables:

- **Table 4-2 General Exposure**
- **Table 4-3 Population Exposure**
- **Table 4-4 General Infrastructure Exposure**
- **Table 4-5a Consequence Analysis Chart – Geological**
- **Table 4-5b Consequence Analysis Chart – Meteorological**

Each jurisdiction has its own Vulnerability Analysis, and it is included in this section.

The **Consequence Identification** is organized by Threat. Each threat page summarizes the hazard, graphically illustrates exposures from the Vulnerability Analysis, and lists corresponding Consequences. Each jurisdiction has its own Consequence Identification and it is included in this section: avalanche, earthquake, landslide, tsunami, volcanic, drought, flood, severe weather, and wildland/urban interface fire.

Specific information and analysis of a jurisdiction’s owned (public) infrastructure is addressed in the Infrastructure Section of its Plan.

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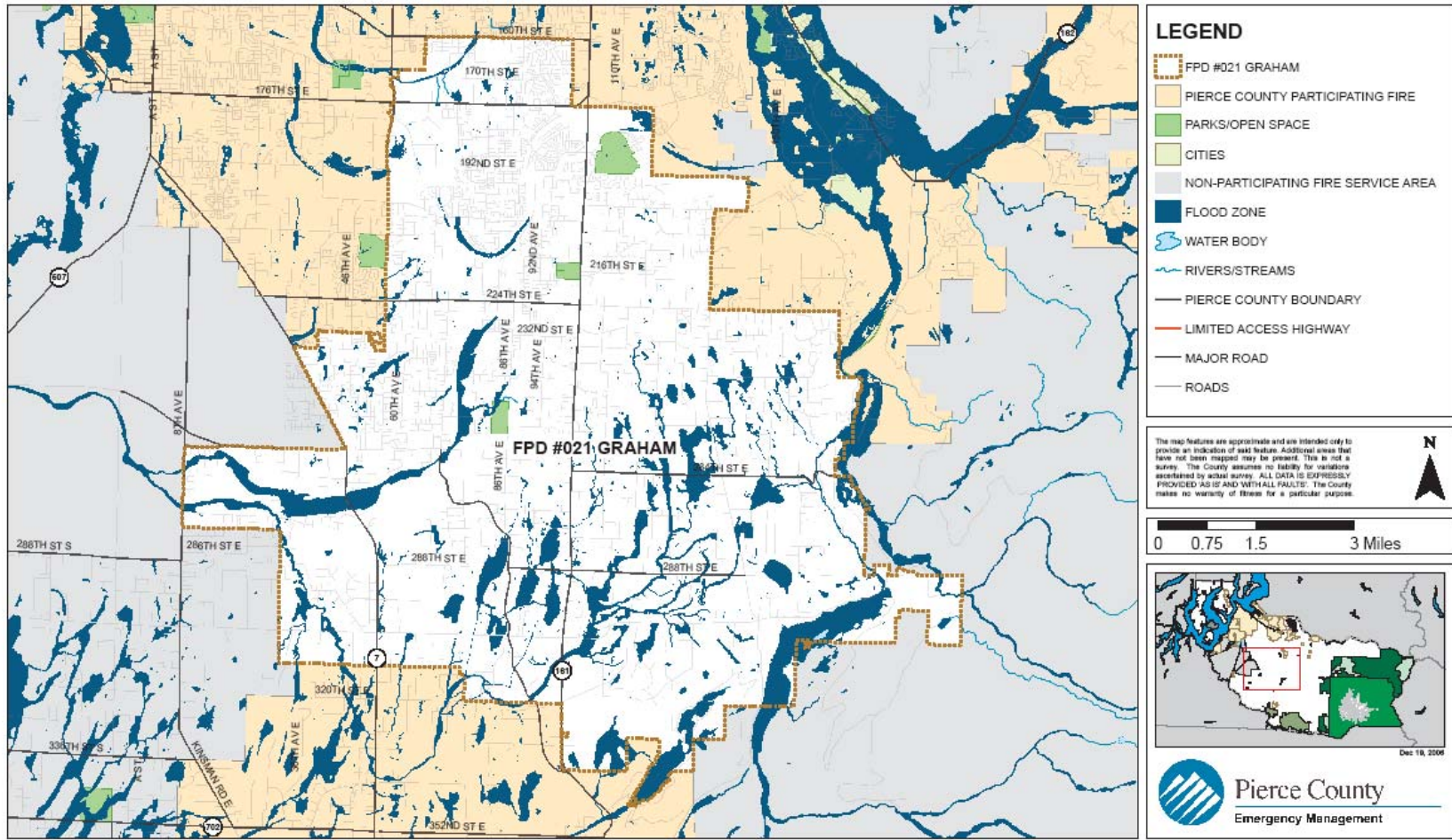
Table 4-1a WA Region 5 Hazard Identification Summary – Geological

	THREAT	DECLARATION # DATE/PLACE	PROBABILITY/RECURRENCE	MAPS, FIGURES AND TABLES
Geological	<u>AVALANCHE</u>	Not Applicable	Yearly in the mountainous areas of the County including Mt. Rainier National Park and the Cascades.	Slab Avalanche Areas Vulnerable to Avalanche Pierce County Avalanches of Record
	<u>EARTHQUAKE</u>	N/A--7/22/2001 Nisqually Delta N/A--6/10/2001 Satsop DR-1361-WA--2/2001 Nisqually N/A--7/2/1999 Satsop N/A--4/29/1965 Maury Island, South Puget Sound N/A--4/13/1949 South Puget Sound N/A--2/14/1946 Maury Island	Magnitude 4.3 Magnitude 5.0—Intraplate Earthquake Magnitude 6.8—Intraplate Earthquake Magnitude 5.8—Intraplate Earthquake Magnitude 6.5—Intraplate Earthquake Magnitude 7.0—Intraplate Earthquake Magnitude 6.3 40 years or less occurrence Historical Record—About every 23 years for intraplate earthquakes	Types of Earthquakes Major Faults in the Puget Sound Basin Seattle and Tacoma Fault Segments Pierce County Seismic Hazard Major Pacific Northwest Earthquakes Notable Earthquakes Felt in Pierce County Salmon Beach, Tacoma Washington following Feb 2001 Earthquake Liquefaction Niigata Japan-1964 Lateral Spreading – March 2001
	<u>LANDSLIDE</u>	DR-1159-WA--12/96-2/1997 DR-852-WA--1/1990 DR-545-WA--12/1977	Slides with minor impact (damage to 5 or less developed properties or \$1,000,000 or less damage) 10 years or less. Slides with significant impact (damage to 6 or more developed properties or \$1,000,000 or greater damage) 100 years or less.	Northeast Tacoma Landslide 01/2007 Pierce County Landslide and Soil Erosion Hazard Pierce County Shoreline Slope Stability Areas Notable Landslides in Pierce County Ski Park Road – Landslide 01/31/03 SR-165 Bridge Along Carbon River – Landslide 2/1996 Aldercrest Drive - Landslide
	<u>TSUNAMI</u>	N/A--1894 Puyallup River Delta N/A--1943 Puyallup River Delta (did not induce tsunami) N/A--1949 Tacoma Narrows	Due to the limited historic record, until further research can provide a better estimate a recurrence rate of 100 years plus or minus will be used.	Hawaii 1957 – Residents Explore Ocean Floor Before Tsunami Hawaii 1949 – Wave Overtakes a Seawall Puget Sound Fault Zone Locations, Vertical Deformation and Peak Ground Acceleration Seattle and Tacoma Faults Tsunami Inundation and Current Based on Earthquake Scenario Puget Sound Landslide Areas and Corresponding Tsunamis Puget Sound River Deltas, Tsunami Evidence and Peak Ground Acceleration Salmon Beach, Pierce County 1949 – Tsunamigenic Subaerial Landslide Puyallup River Delta – Submarine Landslides Puyallup River Delta – Submarine Landslides and Scarp Damage in Tacoma from 1894 Tsunami
	<u>VOLCANIC</u>	DR-623-WA--5/1980	The recurrence rate for either a major lahar (Case I or Case II) or a major tephra eruption is 500 to 1000 years.	Volcano Hazards Debris Flow at Tahoma Creek – July 26, 1988 Douglas Fir Stump – Electron Lahar Deposit in Orting Landslide from Little Tahoma Peak Covering Emmons Glacier Tephra Types and Sizes Lahars, Lava Flows and Pyroclastic Hazards of Mt. Rainier Estimated Lahar Travel Times for Lahars 10 ₇ to 10 ₈ Cubic Meters in Volume Ashfall Probability from Mt. Rainier Annual Probability of 10 Centimeters or more of Tephra Accumulation in the Pacific NW Cascade Eruptions Mt. Rainier Identified Tephra, last 10,000 years Pierce County River Valley Debris Flow History

Table 4-1b WA Region 5 Hazard Identification Summary – Meteorological

HAZARD		DECLARATION # DATE/PLACE		PROBABILITY/RECURRENCE	MAPS, FIGURES AND TABLES
Meteorological	<u>CLIMATE CHANGE</u>	Not Applicable		Not Applicable	Global Temperature Change: 1850 to 2006 Recent and Projected Temperatures for the Pacific Northwest Comparison of the South Cascade Glacier: 1928 to 2003 Lower Nisqually Glacier Retreat: 1912 to 2001
	<u>DROUGHT</u>	DR-981-WA--1/1993 DR-137-WA--10/1962		50 years or less occurrence	Sequence of Drought Impacts Palmer Drought Severity Index Pierce County Watersheds % Area of Basin in Drought Conditions Since 1895 % Time in Severe to Extreme Drought: 1895-1995 % Time in Severe to Extreme Drought: 1985-1995 Notable Droughts Affecting Pierce County Columbia River Basin USDA Climate Zones – Washington State
	<u>FLOOD</u> Since 1978 3 Repetitive Loss Areas have produced 83 Claims totaling Nearly \$1.78 Millions Dollars.	DR-1671-WA--11/2006 DR-1499-WA--10/2003 DR-1159-WA--12/96-2/1997 DR-1100-WA--1-2/1996 DR-1079-WA--11-12/1995 DR-896-WA--12/1990 DR-883-WA--11/1990	DR-852-WA--1/1990 DR-784-WA--11/1986 DR-545-WA--12/1977 DR-492-WA--12/1975 DR-328-WA--2/1972 DR-185-WA--12/1964	5 years or less occurrence Best Available Science--The frequency of the repetitive loss claims indicates there is approximately a 33 percent chance of flooding occurring each year.	Pierce County Watersheds Pierce County Flood Hazard Pierce County Repetitive Loss Areas Clear Creek Basin Repetitive Flood Loss Aerial Photo Flood Hazard Declared Disasters Feb 8, 1996 Flooding – Del Rio Mobile Homes Along Puyallup River Nov 2006 Flooding River Park Estates – Along Puyallup River Nov 2006 Flooding State Route 410 – Along Puyallup River Nov 2006 Flooding Rainier Manor – Along Puyallup River
	<u>SEVERE WEATHER</u>	DR-1682-WA--12/2006 DR-1671-WA--11/2006 DR-1159-WA--12/96-2/1997 DR-1152-WA--11/19/1996	DR-981-WA--1/1993 DR-137-WA--10/1962	The recurrence rate for all types of severe storms is 5 years or less.	Fujita Tornado Damage Scale Windstorm Tracks Pierce County Severe Weather Wind Hazard – South Wind Event Pierce County Severe Weather Wind Hazard – East Wind Event Notable Severe Weather in Pierce County Snowstorm 01/2004 Downtown Tacoma Satellite Image – Hanukkah Eve Windstorm Before/After Tornado Damage Greensburg KS 05/04/07 Public Works Responds 2005 Snowstorm Downed Power Pole 02/2006 Windstorm County Road December 2006 Windstorm Tacoma Narrows Bridge – November 7, 1940 Windstorm
	<u>WUI FIRE</u>	Not Applicable		Based on information from WA DNR the probability of recurrence for WUI fire hazard to Pierce County is 5 years or less.	Washington State Fire Hazard Map Pierce County Forest Canopy Industrial Fire Precaution Level Shutdown Zones Carbon Copy Fire August 2006 Washington State DNR Wildland Fire Statistics: 1973-2007 DNR Wildland Response South Puget Sound Region: 2002-2007 Pierce County DNR Fires

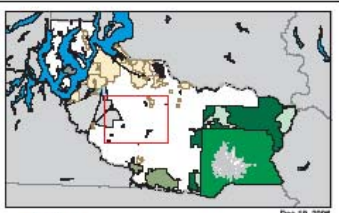
FPD #021 GRAHAM - FLOOD HAZARD AREA



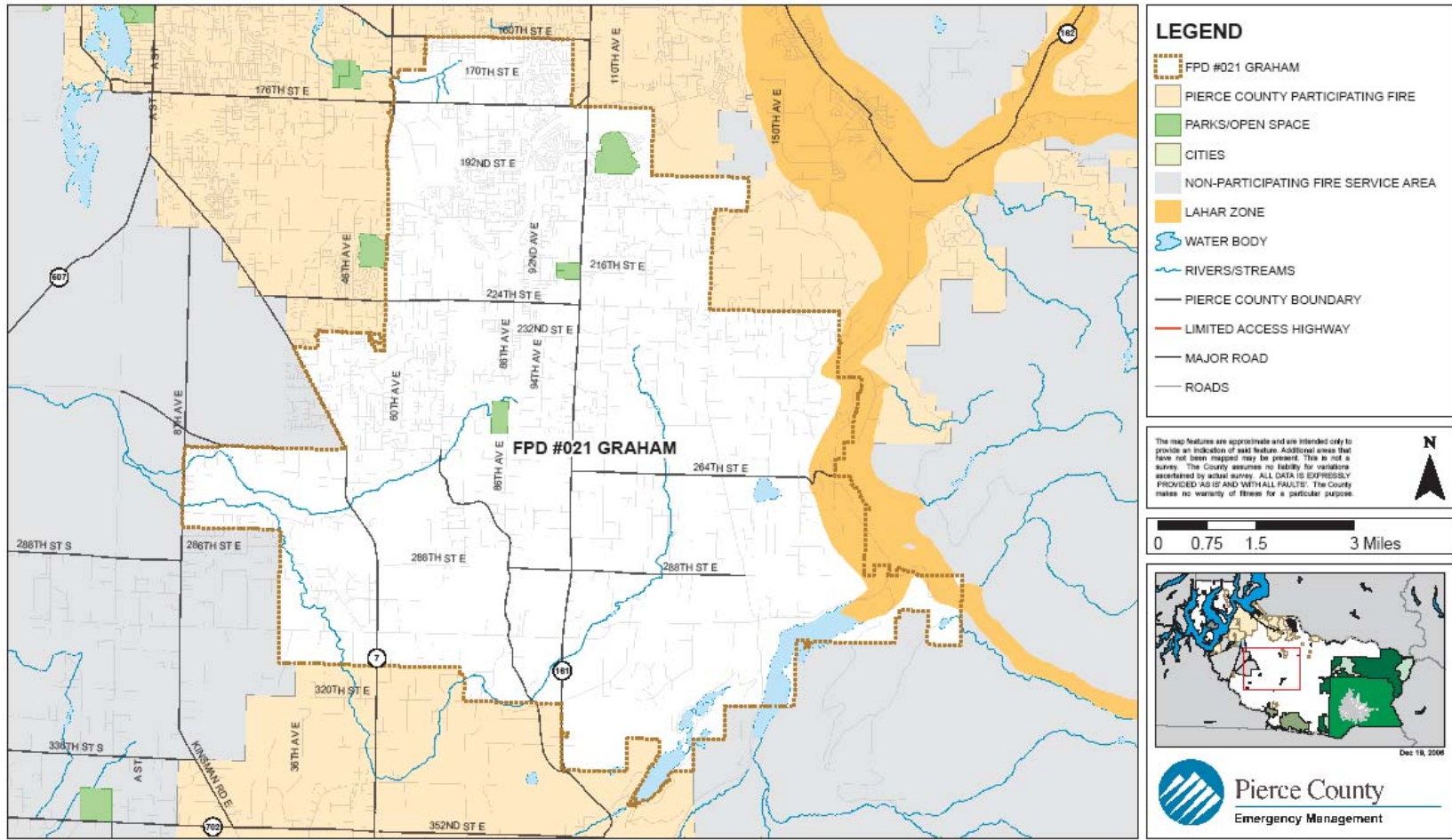
LEGEND

- FPD #021 GRAHAM
- PIERCE COUNTY PARTICIPATING FIRE
- PARKS/OPEN SPACE
- CITIES
- NON-PARTICIPATING FIRE SERVICE AREA
- FLOOD ZONE
- WATER BODY
- RIVERS/STREAMS
- PIERCE COUNTY BOUNDARY
- LIMITED ACCESS HIGHWAY
- MAJOR ROAD
- ROADS

The map features are approximate and are intended only to provide an indication of what features. Additional areas that have not been mapped may be present. This is not a survey. The County assumes no liability for variations ascertained by actual survey. ALL DATA IS EXPRESSLY PROVIDED AS IS AND WITH ALL FAULTS. The County makes no warranty of fitness for a particular purpose.



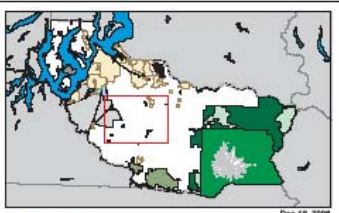
FPD #021 GRAHAM - LAHAR HAZARD AREA



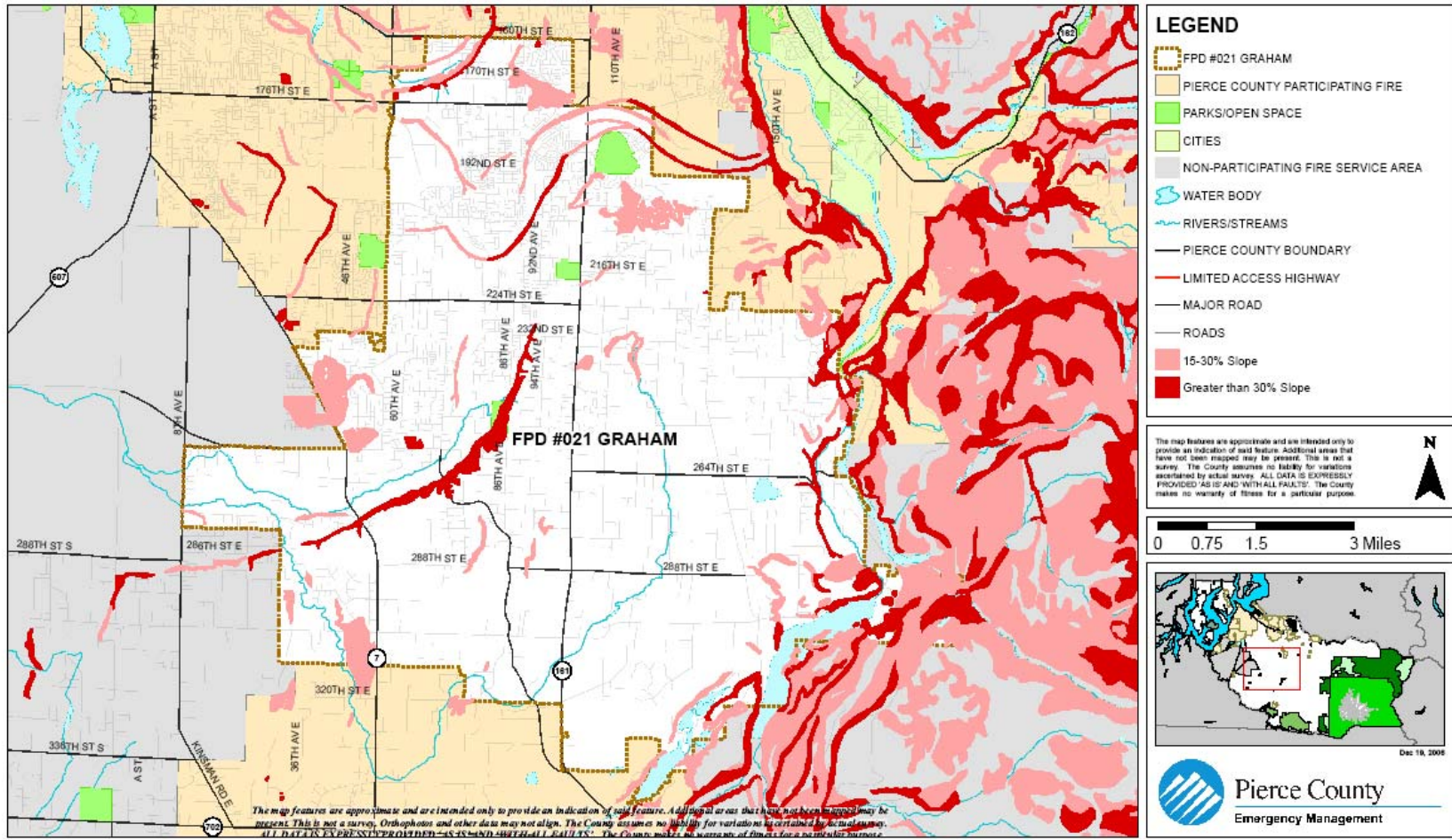
LEGEND

- FPD #021 GRAHAM
- PIERCE COUNTY PARTICIPATING FIRE
- PARKS/OPEN SPACE
- CITIES
- NON-PARTICIPATING FIRE SERVICE AREA
- LAHAR ZONE
- WATER BODY
- RIVERS/STREAMS
- PIERCE COUNTY BOUNDARY
- LIMITED ACCESS HIGHWAY
- MAJOR ROAD
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FPD #021 GRAHAM - LANDSLIDE HAZARD AREA



FPD #021 GRAHAM - SEISMIC HAZARD AREA

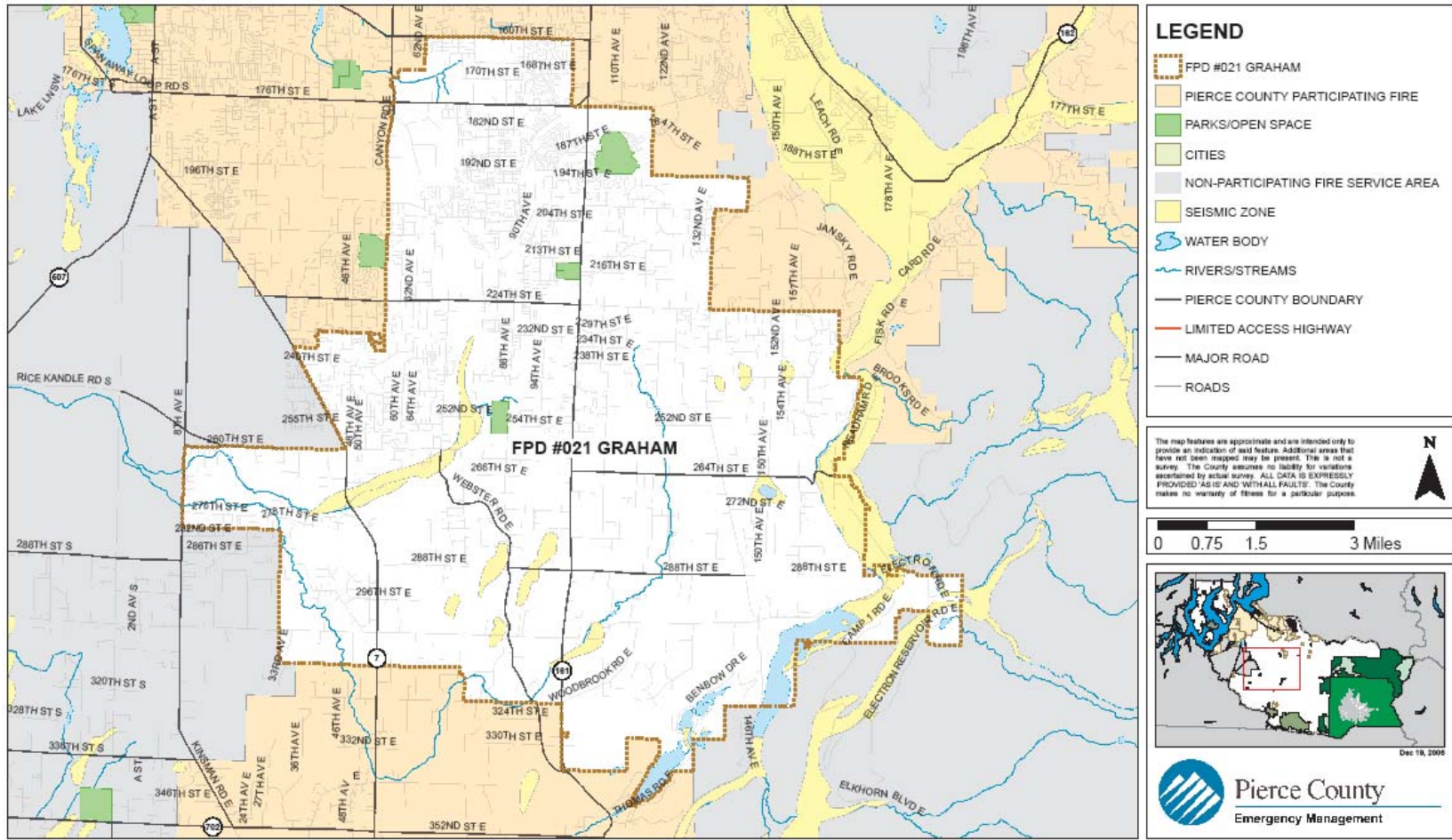


Table 4-2 Vulnerability Analysis: General Exposure

THREAT		AREA (SQ MI)		PARCELS	
		Total	% Base	Total	% Base
BASE		66.44	100%	21,910	100%
<i>Geological</i>	Avalanche ¹	NA	NA	NA	NA
	Earthquake ²	7.80	12%	414	2%
	Landslide	15.46	23%	2,873	13%
	Tsunami ¹	NA	NA	NA	NA
	Volcanic ³	3.11	5%	223	1%
<i>Meteorological</i>	Drought ⁴	66.44	100%	21,910	100%
	Flood	28.05	42%	2,119	10%
	Severe Weather	66.44	100%	21,910	100%
	WUI Fire ⁵	TBD	TBD	TBD	TBD

Table 4-3 Vulnerability Analysis: Population Exposure

THREAT		POPULATION ⁶			SPECIAL POPULATIONS (OF TOTAL EXPOSED POPULATION)			
		Total	% Base	Density (pop/sq mi)	65+ yrs		18- yrs	
					#	%	#	%
BASE		40,236	100%	606	2,483	6%	12,823	32%
<i>Geological</i>	Avalanche	NA	NA	NA	NA	NA	NA	NA
	Earthquake	5,720	14%	733	421	7%	1,631	29%
	Landslide	25,702	64%	1,663	1,555	6%	8,258	32%
	Tsunami	NA	NA	NA	NA	NA	NA	NA
	Volcanic	887	2%	285	66	7%	253	29%
<i>Meteorological</i>	Drought	40,236	100%	606	2,483	6%	12,823	32%
	Flood	25,671	64%	915	1,601	6%	7,973	31%
	Severe Weather	40,236	100%	606	2,483	6%	12,823	32%
	WUI Fire	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Table 4-4 Vulnerability Analysis: General Infrastructure Exposure

THREAT		LAND VALUE			IMPROVED VALUE			TOTAL ASSESSED VALUE		
		Total (\$)	% Base	Avg. Value (\$)	Total (\$)	% Base	Avg. Value (\$)	Total (\$)	% Base	Avg. Value (\$)
BASE		27,069,766,800	100%	123,550	3,148,446,000	100%	143,699	30,218,212,800	100%	1,379,197
<i>Geological</i>	Avalanche	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Earthquake	71,079,100	.26%	171,689	35,861,900	1%	86,623	106,941,000	.35%	258,312
	Landslide	464,284,400	2%	161,603	517,502,700	16%	180,126	981,787,100	3%	341,729
	Tsunami	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Volcanic	29,246,300	.11%	131,149	14,950,600	.47%	67,043	44,196,900	.15%	198,192
<i>Meteorological</i>	Drought	27,069,766,800	100%	123,550	3,148,446,000	100%	143,699	30,218,212,800	100%	1,379,197
	Flood	422,365,700	2%	199,323	617,856,900	20%	291,579	1,040,222,600	3%	490,903
	Severe Weather	27,069,766,800	100%	123,550	3,148,446,000	100%	143,699	30,218,212,800	100%	1,379,197
	WUI Fire	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

Table 4-5a Consequence Analysis Chart – Geological^{7,8}

THREAT		CONSEQUENCE	YES OR NO
<i>Geological</i>	Avalanche	Impact to the Public	No
		Impact to the Responders	No
		Impact to COG and/or COOP in the Jurisdiction	No
		Impact to Property, Facilities and Infrastructure	No
		Impact to the Environment	No
		Impact to the Jurisdiction Economic Condition	No
	Impact to Reputation or Confidence in Jurisdiction	No	
	Earthquake	Impact to the Public	Yes
		Impact to the Responders	Yes
		Impact to COG and/or COOP in the Jurisdiction	Yes
		Impact to Property, Facilities and Infrastructure	Yes
		Impact to the Environment	Yes
		Impact to the Jurisdiction Economic Condition	Yes
	Impact to Reputation or Confidence in Jurisdiction	Yes	
	Landslide	Impact to the Public	Yes
		Impact to the Responders	No
		Impact to COG and/or COOP in the Jurisdiction	No
		Impact to Property, Facilities and Infrastructure	Yes
		Impact to the Environment	Yes
		Impact to the Jurisdiction Economic Condition	No
	Impact to Reputation or Confidence in Jurisdiction	No	
	Tsunami	Impact to the Public	No
		Impact to the Responders	No
		Impact to COG and/or COOP in the Jurisdiction	No
		Impact to Property, Facilities and Infrastructure	No
		Impact to the Environment	No
		Impact to the Jurisdiction Economic Condition	No
	Impact to Reputation or Confidence in Jurisdiction	No	
	Volcanic⁹	Impact to the Public	Yes
		Impact to the Responders	Yes
Impact to COG and/or COOP in the Jurisdiction		No	
Impact to Property, Facilities and Infrastructure		Yes	
Impact to the Environment		Yes	
Impact to the Jurisdiction Economic Condition		Yes	
Impact to Reputation or Confidence in Jurisdiction	Yes		

Table 4-5b Consequence Analysis Chart – Meteorological

THREAT		CONSEQUENCE	YES OR NO
<i>Meteorological</i>	Drought	Impact to the Public	Yes
		Impact to the Responders	No
		Impact to COG and/or COOP in the Jurisdiction	No
		Impact to Property, Facilities and Infrastructure	No
		Impact to the Environment	Yes
		Impact to the Jurisdiction Economic Condition	No
	Flood	Impact to Reputation or Confidence in Jurisdiction	No
		Impact to the Public	Yes
		Impact to the Responders	No
		Impact to COG and/or COOP in the Jurisdiction	No
		Impact to Property, Facilities and Infrastructure	Yes
		Impact to the Environment	Yes
	Severe Weather	Impact to the Jurisdiction Economic Condition	No
		Impact to Reputation or Confidence in Jurisdiction	No
		Impact to the Public	Yes
		Impact to the Responders	Yes
		Impact to COG and/or COOP in the Jurisdiction	Yes
		Impact to Property, Facilities and Infrastructure	Yes
	WUI Fire	Impact to the Environment	Yes
		Impact to the Jurisdiction Economic Condition	Yes
		Impact to Reputation or Confidence in Jurisdiction	Yes
		Impact to Property, Facilities and Infrastructure	Yes
		Impact to COG and/or COOP in the Jurisdiction	Yes
		Impact to the Responders	Yes

Endnotes

¹ Jurisdiction is not vulnerable to this hazard, therefore it is marked NA or non-applicable.

² It should be noted here that although all residents, all property and all infrastructure of Pierce County Fire District #21 are vulnerable to earthquake shaking, not all are subject to the affects of liquefaction and liquefiable soils which is what is represented here.

³ The threat of volcanic ash fall affects the entire Region 5, however some jurisdictions are specifically threatened by lahar flows directly from Mt. Rainier; an active volcano.

⁴ The entire jurisdiction is vulnerable to drought. There are three things that must be understood about the affect of drought on the jurisdiction: 1) Drought is a Region wide event. When it does affect Pierce County, it will affect every jurisdiction, 2) Drought will gradually develop over time. It is a gradually escalating emergency that may take from months to years to affect the jurisdiction. Initially lack of water may not even be noticed by the citizens. However, as the drought continues, its effects will be noticed by a continually expanding portion of the community until it is felt by all, and 3) Jurisdictions will be affected differently at different times as a drought develops. This will vary depending on the needs of the each local jurisdiction. Some examples are: jurisdictions that have industry that requires a continuous supply of a large quantity of water; others have agriculture that requires water, but may only require it at certain times of the year; and, some jurisdictions have a backup source of water while others do not.

⁵ Graham Fire & Rescue covers a large area of the south/central area of Pierce County. This area consists of a mixture of residential, some businesses, some farms much of which is interspersed with areas of second growth timber. Also included within the District is the Fredrickson industrial area. While much of the area has undergone rapid growth the past few years it still has large areas with second growth timber on it; areas that can be impacted by wildland/urban interface fires. Further study is needed to determine how much of the area that could be affected.

⁶ Population in this section is derived from Census 2000, Office of Financial Management.

⁷ In the Impact to Property, Facilities and Infrastructure, both Tables 4-5a and 4-5b, look at the impact to all property, facilities and infrastructure existing in the jurisdiction, not just to that owned by the jurisdiction.

⁸ The consideration for each of these hazards, in both Tables 4-5a and 4-5b, as to whether an individual hazard's consequences exist, or not, is based on a possible worst case scenario. It must also be understood that a "yes" means that there is a good possibility that the consequence it refers to could happen as a result of the hazard, not that it will. Conversely "No" means that it is highly unlikely that that consequence will have a major impact, not that there will be no impact at all.

⁹ While the major volcanic hazard from Mt. Rainier is from a lahar descending the main river valleys surrounding the mountain, it is not the only problem. Most jurisdictions could receive tephra in greater or lesser amounts, sometimes with damaging results. Consequence analyses in this section take into account the possibility of tephra deposition in addition to a lahar.