

SUB-SECTION 4.M3

**REGION 5 HAZARD MITIGATION PLAN
FLOOD HAZARD SUB-SECTION¹**

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Identification Description

Definition²

A flood is a general and temporary condition of partial or complete inundation of normally dry land areas from:

- The overflow of inland or tidal waters,
- The unusual and rapid accumulation or runoff of surface waters from any source, or
- Mudflows or the sudden collapse of shoreline land, see Volcanic Hazard Sub-Section 4.G5 and Landslide Hazard Sub-Section 4.G3³.

Pierce County's flood hazards are divided into two types: riverine and urban stream/groundwater.⁴

Types⁵

Riverine Flood Hazard

Riverine flooding results from heavy and prolonged rainfall and may include substantial snowmelt if there is rise in freezing levels after a measurable snowfall. Flooding of this type can last several days after the storm.

The most severe flooding on the County's rivers and major streams results from low- to moderate-elevation (1,000 to 3,800 feet) snowmelt runoff occurring in conjunction with a prolonged moderate- to high-intensity rainfall event. This is commonly referred to as a rain-on-snow event. Accumulating snowfall usually occurs for brief periods (one to three days) and can be followed by accelerated warming from warm Pacific frontal storm systems arriving from the tropics and containing a significant amount of precipitation. Rain-on-snow events typically result in sharp rise in river flow that can yield flood stages and can last for several days. The rise in peak flow can occur quickly, making consistent monitoring of river flow gages essential during the flood season.

Urban Stream/Groundwater Flood Hazard

The second category of flood hazard in Pierce County occurs when runoff exceeds the conveyance capacity of natural and manmade drainage systems. Surface water runoff volumes in urban stream channels, closed depressions (potholes),⁶ roadway ditches, culverts and conveyance pipe systems typically exceed the available conveyance and storage capacity of such systems during the fall, winter, and early spring wet seasons. This typically occurs with moderate- to high-intensity storms that can last for several days or occur in succession over a period of weeks. These events are characterized as rainfall of three inches or more in a 24-hour period. Urban area flooding generally occurs gradually and allows time for property owners to identify an

impending flood situation and prepare for it. In some areas, however, flooding can occur rapidly and may leave little time for preparation.

In some cases, debris can accumulate in stormwater collection systems and reduce the capacity of the system to convey flow. Such a reduction in capacity can lead to more frequent flooding events. Regular maintenance, however, can ensure that the stormwater systems function as designed.

Urban stream flooding is exacerbated by rain-on-snow events. During the winter months, these events usually result in widespread flooding along streets, streams, ditches, culvert pipe systems, and storm drains. Conditions in the basins can change rapidly and the onset of flooding can occur at an accelerated rate.

Groundwater flooding is associated with a large amount of cumulative rain over several storms or consecutive rainy seasons. High groundwater may occur weeks after the last significant rainfall and can also shift locations as groundwater levels change throughout the region. This type of flooding may last for several weeks or even months.

Profile

Location and Extent

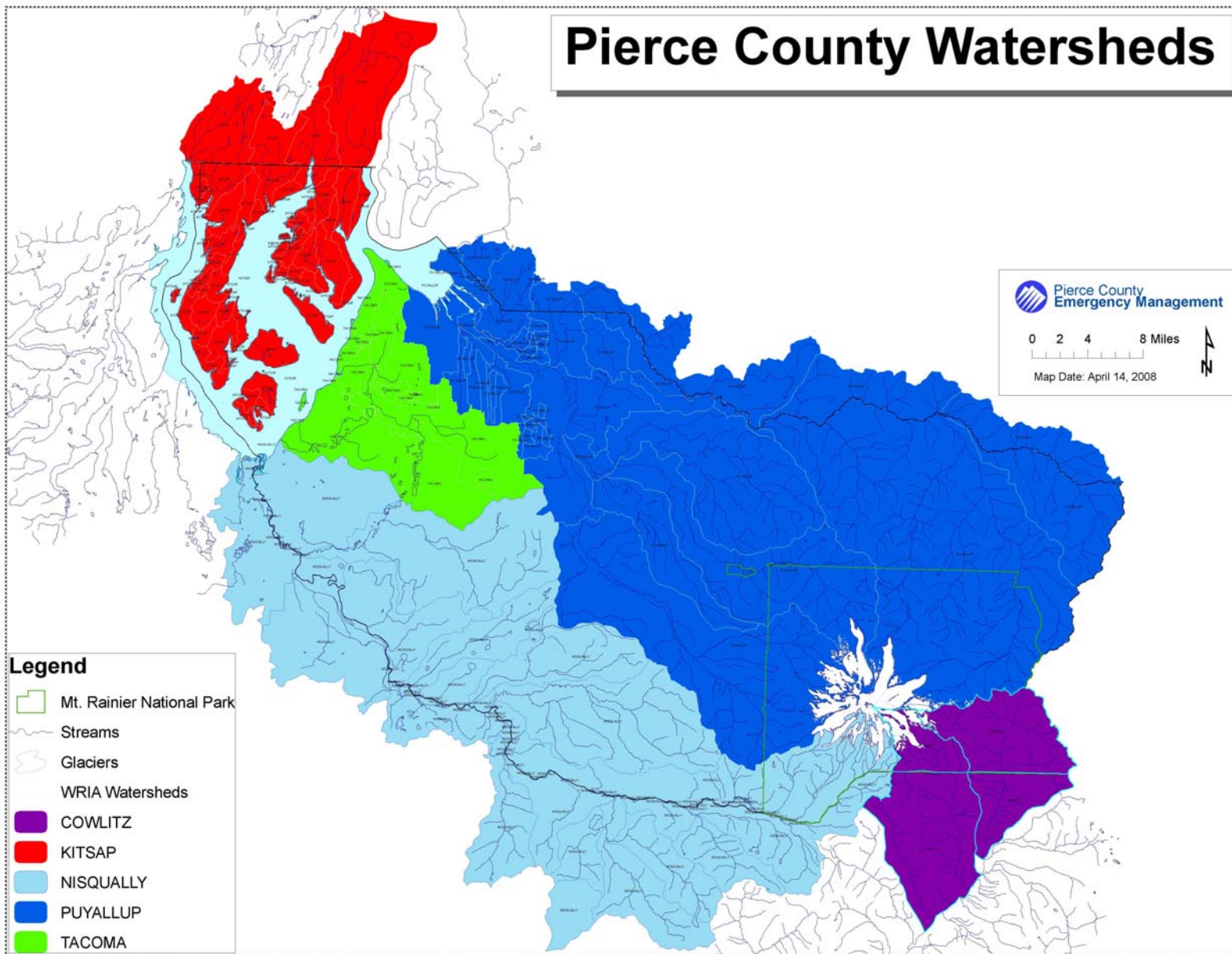
Flooding directly affects less than 50% of Pierce County. The location of the flooding is categorized by the five major watersheds in Pierce County: the Puyallup/White River Watershed, the Nisqually River Watershed, the Chambers/Clover Creek Watershed, Kitsap Watershed, and Cowlitz Watershed, see Map 4.M3-1.

Map 4.M3-2 illustrates the location and extent of the flood hazard for Pierce County. The map shows the extent of the 100-yr and 500-yr flooding areas based on the flood hazard areas from the Flood Insurance Rate Maps (FIRMs).

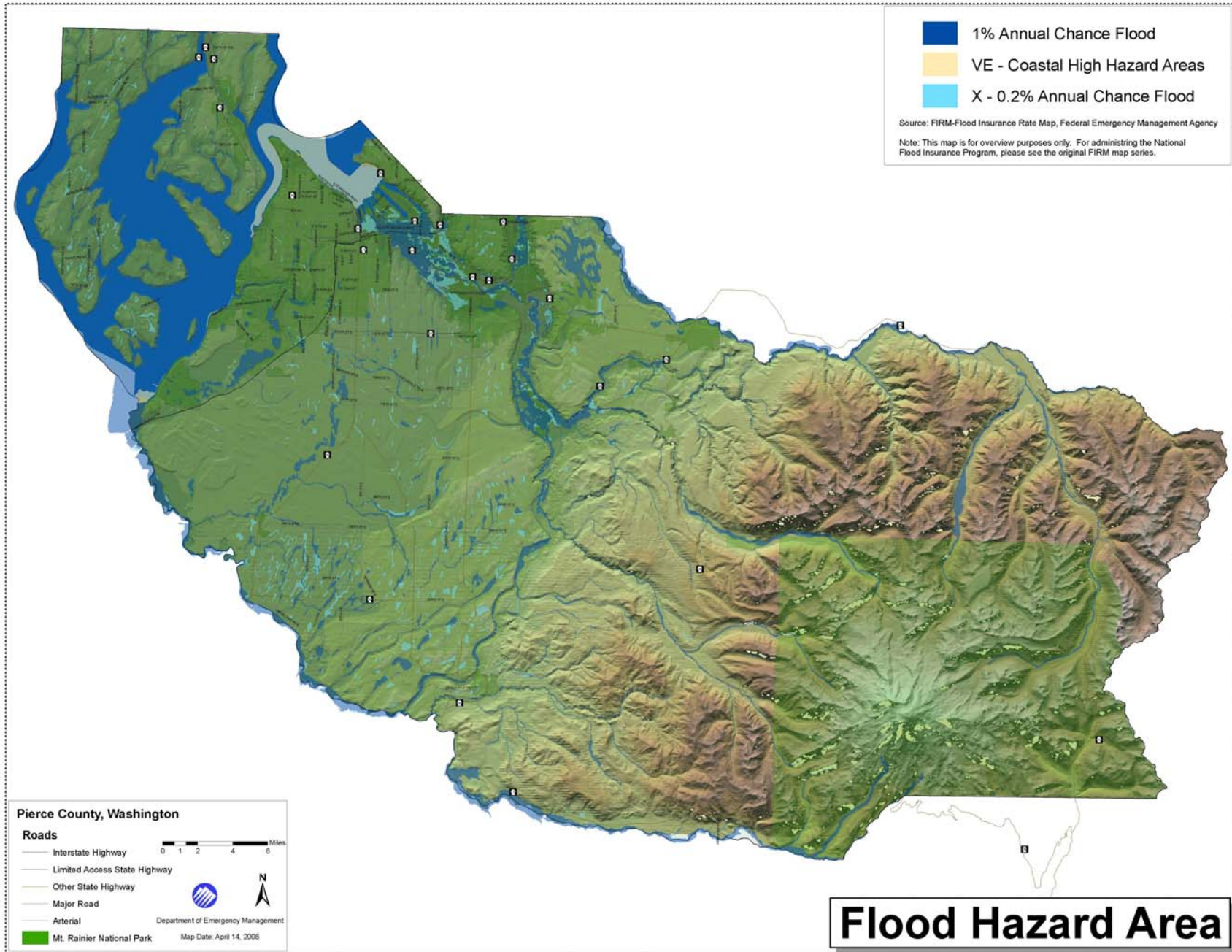
Areas of repetitive flood loss further illustrate the extent of the flood hazard, see Map 4.M3-3. Some individual jurisdictions may also have repetitive loss properties that are not marked on this map. This analysis focuses primarily on those watersheds that contain these repetitive flood loss areas—the Puyallup/White River Watershed, the Nisqually Watershed, and the Chambers/Clover Creek Watershed—and more specifically, the basins in which the repetitive flood loss areas are located. Also included is a description of each type of flooding that occurs.

Pierce County's main flood hazards are divided into two categories: riverine and urban stream/groundwater. Below is a description of the location and extent of the two types of flooding within Pierce County.

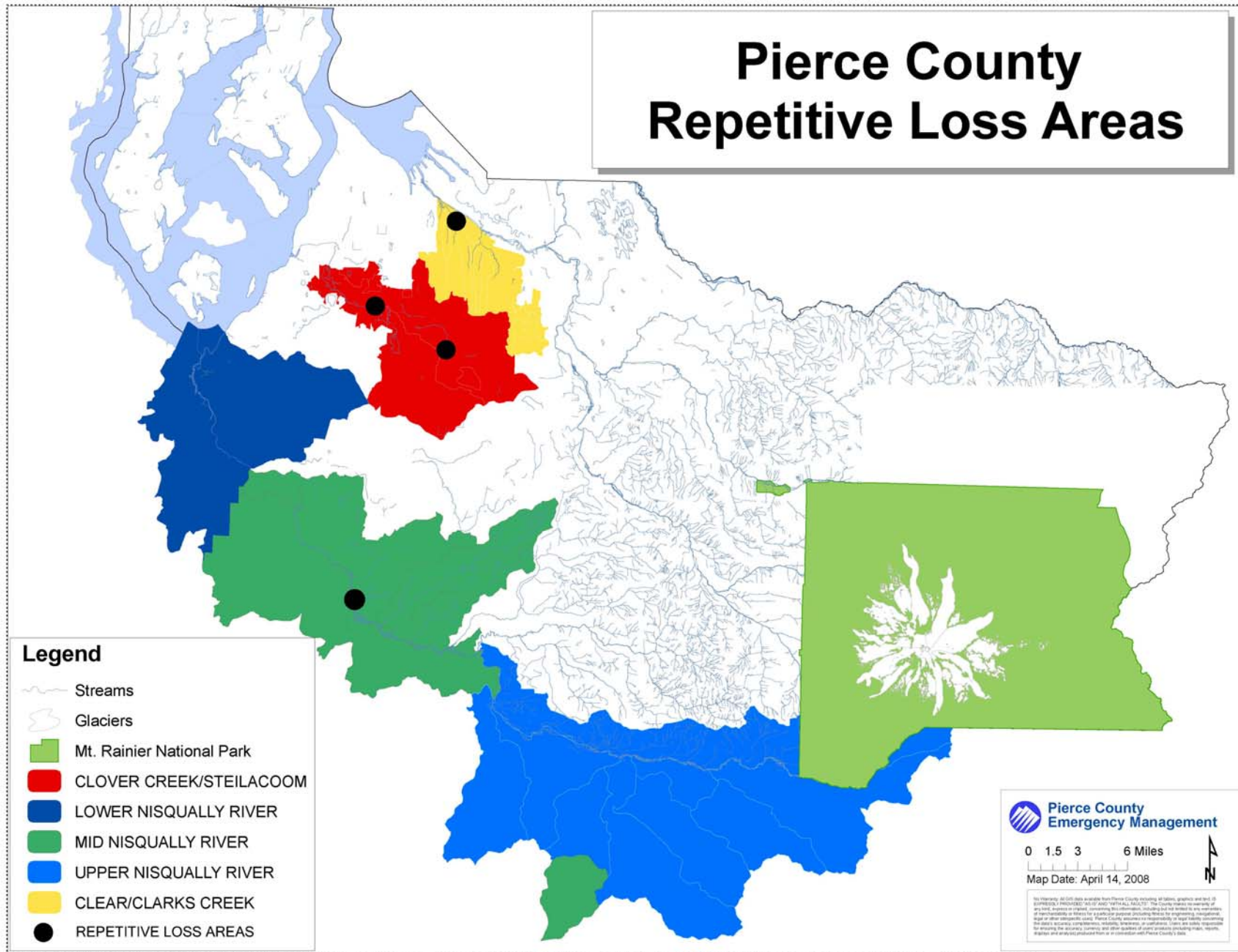
Map 4.M3-1 Pierce County Watersheds



Map 4.M3-2 Pierce County Flood Hazard



Map 4.M3-3 Pierce County Repetitive Loss Areas



Riverine Flood Hazard

The riverine flood hazard typically arises from the Puyallup, White, Carbon, Nisqually, South Prairie Creek, and Mashel Rivers.

The White and Nisqually Rivers are regulated by dams that provide some flood control. However, during major events, neither of these has been able to prevent all flooding downstream from their facilities

White River flows are regulated by the U.S. Army Corps of Engineers at Mud Mountain Dam. Mud Mountain Dam is operated solely as a flood control facility. The dam's primary goal is to provide flood control to the lower reaches of the Puyallup River, from River Mile 10.3 downstream through the Port of Tacoma to Commencement Bay. However, some flood control benefits can be seen within the entire reach of the White River downstream of the dam. As the water level behind the dam increases during major storms, and if there is no break in the amount of water entering the dam, the Army Corps of Engineers has at times had to increase releases to the point that some portions of the White/Stuck River have flooded. However the release levels have been low enough that they have not added enough water to the Puyallup for it to overtop the banks below their confluence.

The lower Nisqually River is regulated by Tacoma City Light's Alder and La Grande Dams.⁷ Neither dam is managed as a flood control facility. Their main purpose is as power generating facilities. As such they are managed to maximize power generation and therefore, flood control benefits from them are reduced. However, during periods when there is a threat of flooding Tacoma City Light does take into account the flood potential and will modify the flow of water released from the dams.

Despite the regulation from the dams, flooding from the White and Nisqually Rivers downstream of the dams occurs when runoff exceeds their storage capacity and the dams must release more water than the downstream channels can convey.

The upper reaches of the Puyallup River and many of its tributaries constitute a largely unregulated and naturally flowing river system. Rapid changes in the quantity of water entering the system, either from heavy rain throughout the basin or rapid snow melt, usually from warm rain on snow, can change the downstream flood potential in a very short time. Because these rapid changes occur in remote areas within the basin, monitoring and forecasting, rain and rain-on-snow events are critical.

Urban Stream/Groundwater Flood Hazard

Urban stream/groundwater flooding occurs when runoff exceeds the conveyance capacity of natural and manmade drainage systems. It typically occurs with moderate- to high-intensity storms that can last for several days or occur in succession over a period of weeks. Urban flooding in the Clear and Clover Creek basins is consistent with flooding areas shown on current FEMA Flood Insurance Rate Maps (FIRMs).

For some streams, flooding inundates broad areas for lengths of 1,000 to 3,500 feet, and longer in some cases. Floodwater can be high and flooding can last for several days until rainfall and saturated soil moisture conditions subside.

Repetitive Loss Areas

FEMA defines a repetitive loss property as being a National Flood Insurance Program (NFIP) insured property that since 1978, regardless of changes in ownership, has experienced any of the three following⁸:

- Four or more paid losses greater than \$1,000;
- Two paid losses in excess of \$1,000 within any 10 year rolling period since 1978;
- Three or more paid losses that equal or exceed the current value of the insured property.

To further illustrate the extent of the flooding hazard in Pierce County, this analysis focuses on those areas within the County that have experienced repetitive flood losses (discussed further in the occurrences section). Based on FEMA records, the County has identified repetitive loss areas in three of the basins: Clear/Clarks Creek, Clover Creek, and the Middle Nisqually River, Map 4.M3-3. These are discussed in further detail below, including a description of each basin and a description of the flooding that occurs.

Puyallup Watershed: Clear Creek Basin⁹

Description of Basin

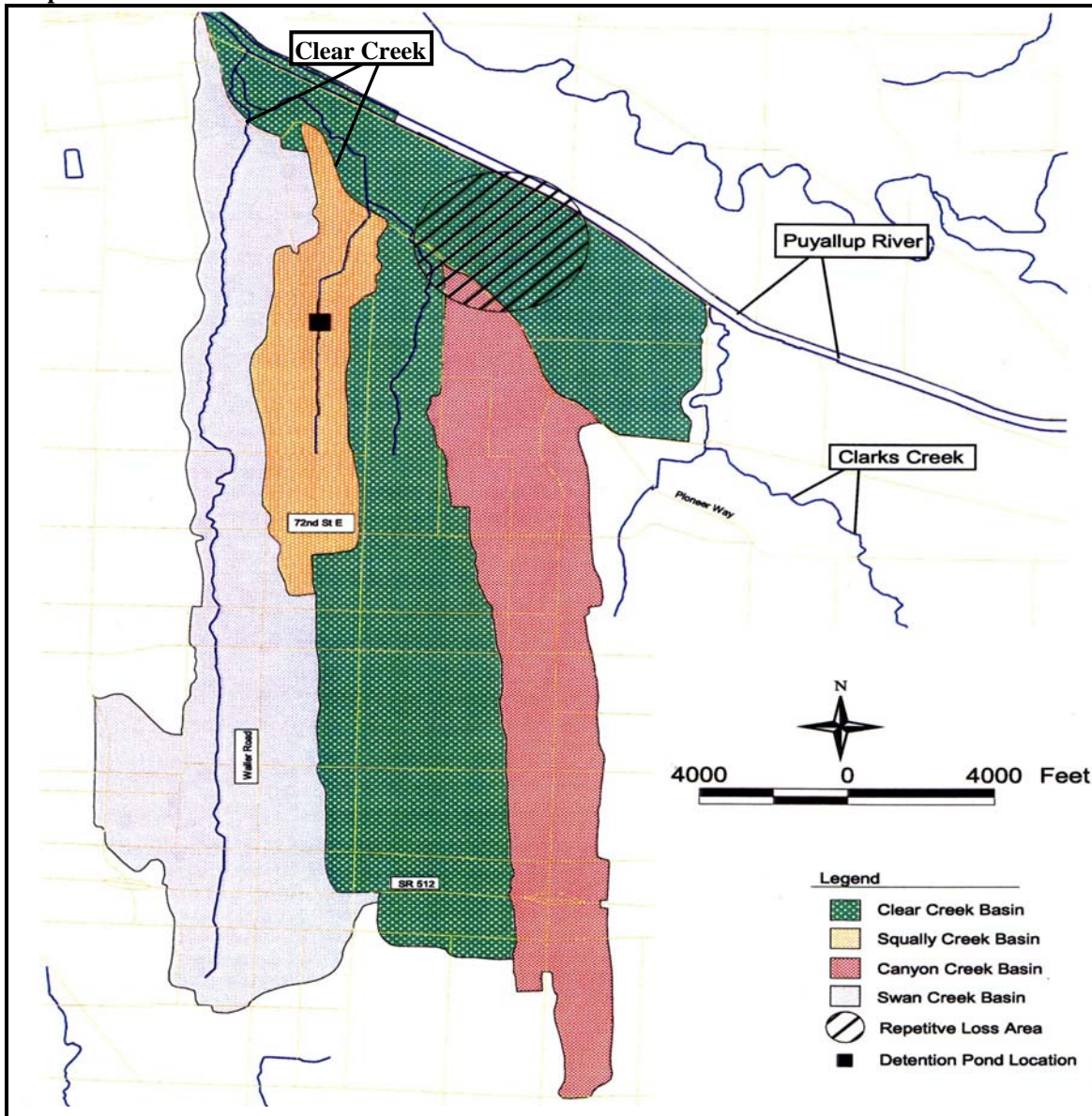
Clear Creek, a tributary to the Puyallup River, is a major source of repetitive and destructive flooding in Pierce County. The majority of repetitive loss properties within Pierce County exist within this basin. Clear Creek and its tributaries drains an area of approximately 12.7 square miles, see Map 4.M3-4. Most of the Clear Creek basin is in unincorporated Pierce County and the Puyallup Tribe Reservation, but it also contains small portions of the Cities of Tacoma and Fife. Topography in the basin is composed of level river bottom in the lower portion of the basin along the Puyallup River and gently rolling hills and flatlands in the upper basin, with steep transition in between.

The Clear Creek Basin includes the East and West forks of Clear Creek (5.8 sq. mi.), Canyon Creek (2.2 sq. mi.), Squally Creek (0.9 sq. mi.), and Swan Creek (3.8 sq. mi.), all of which are narrow, relatively steep creeks, Squally Creek and Swan Creek both enter Clear Creek downstream of the repetitive loss area. Clear Creek also drains a portion of the flat agricultural floodplain south of the Puyallup River that contains the repetitive loss area. In addition to natural drainage courses, many storm drains carry water to the creeks from roads, low-lying farmlands north of Pioneer way and south of the Puyallup River¹⁰, and developments.¹¹

Description of Flooding

The repetitive loss area is in the flatlands of the lower portion of the basin. Map 4.M3-4 shows the Clear Creek basin and repetitive loss study area.¹²

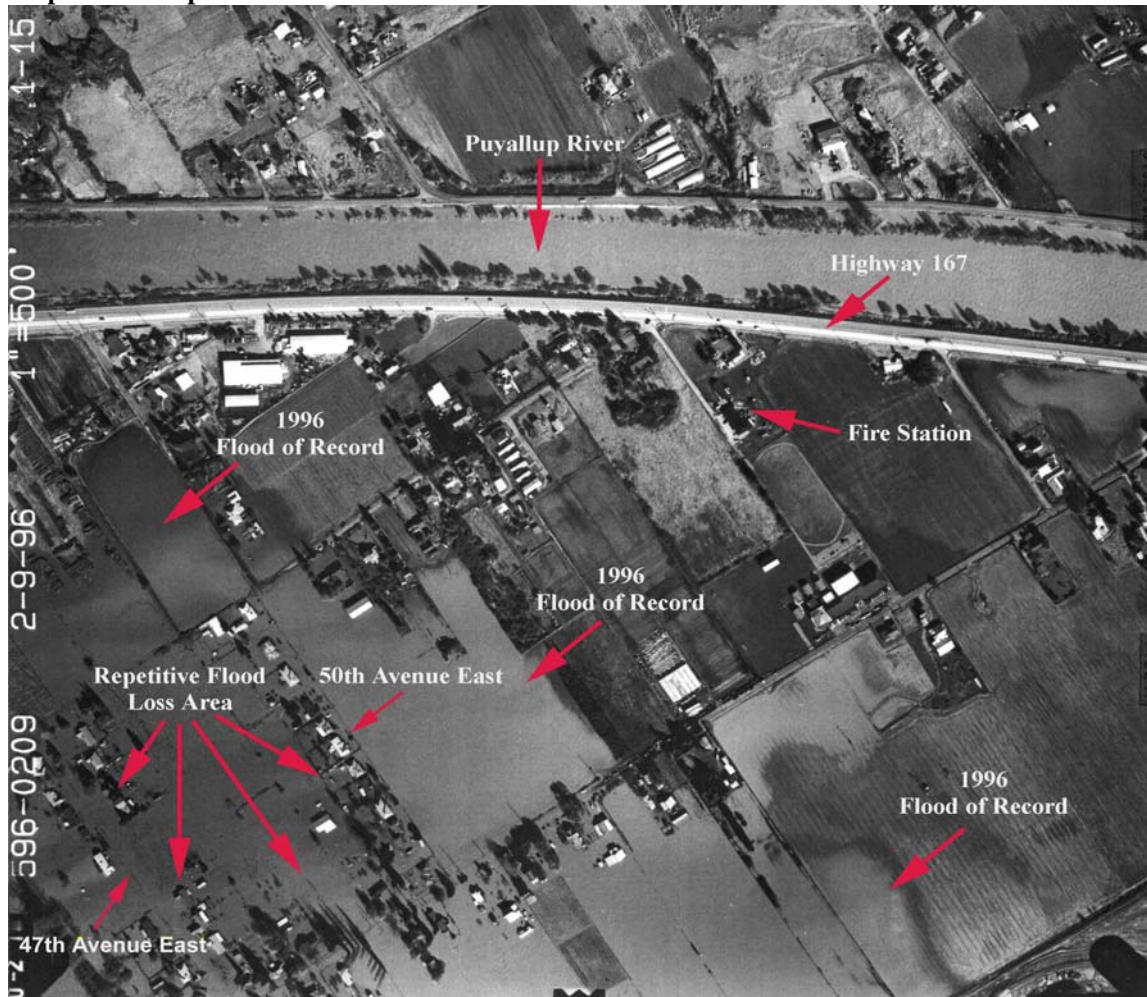
Map 4.M3-4 Clear Creek Basin¹³



Puyallup River flood elevations (stages) at the Clear Creek confluence are influenced by a combination of tidal conditions and flow rates, which in turn influence Clear Creek stages. The outlet structure of Clear Creek into the Puyallup is designed to close at a river stage of 9 feet and reopen at a river stage of 8.5 feet. According to a September 26, 1995, Technical Information Report prepared by the Port of Tacoma, the operating elevations of the gate were chosen so that the gate would close or remain open as follows:

- The gate remains open for the 2-year, 3-day average flow (this is the flow that lasts three days at a magnitude that has a 50 percent chance of occurring in a given year).
- The gate closes for the 2-year instantaneous flow (this is the peak flow that has a 50 percent chance of occurring within a given year).
- The gate closes for the 10-year, 1-day average flow (this is the flow that lasts one day at a magnitude that has a 10 percent chance of occurring in a given year).
- The gate closes for the 10-year, 3-day average flow (this is the flow that lasts three days at a magnitude that has a 10 percent chance of occurring in a given year).

Map 4.M3-5 Repetitive Flood Loss Aerial Photo¹⁴



The flooding in Clear Creek results predominately from backwater in the Creek and ponding within the drainage basin. If Puyallup River water surface elevations are greater than the Creek's, water from the Puyallup River can back into Clear Creek. The operation of the flood gate prevents major flooding. While closure of the floodgate prevents extreme flooding from the Puyallup River, it eliminates the gravity outlet for Clear Creek, causing water to accumulate behind the outlet structure. Since backwater from the creek and ponding within the basin is the primary cause of the Creek's flooding, the velocity of the water within the flooded area is low.

The aerial photo Map 4.M3-5 displays the repetitive flood loss areas during the 1996 flood of record and illustrates the extent of the Creek's flooding.

The repetitive loss areas are concentrated along 47th Avenue East and 50th Avenue East, north of Pioneer Way and South of 40th Street East.¹⁵

Chambers-Clover Creek Watershed: Clover Creek Basin¹⁶

Description of Basin

The Chambers-Clover Creek watershed consists of level flatlands in the lower portion of the basin and gently rolling hills and flatlands in the uplands. Elevations within the watershed range from approximately 210 feet at Steilacoom Lake to 600 feet in the eastern uplands. Terrain was formed by glacial deposition or erosion. High-velocity glacial meltwater streams cut several distinct channels through the area, including the Clover Creek channel. Many of these channels have steep slopes or bluffs defining their boundaries. The Clover Creek channel starts near Puyallup's South Hill on the northeast boundary of the watershed and runs southwest to the Brookdale and Canyon Road area and into the current floodplain of Clover Creek. The repetitive loss areas are within the flatlands that floodplain in the lower portion of the basin.

The Clover Creek basin is part of the Chambers-Clover Creek watershed and contains portions of unincorporated Pierce County, including the Parkland and Spanaway communities, significant portions of the Lakewood incorporated area, a small portion of Tacoma, and portions of McChord Air Force Base and the Fort Lewis military reservation. Urban development is concentrated toward the northern and western areas and near freeway and highway corridors. The basin's land cover is dominated by developed area, forest, and other natural cover, with water and non-vegetative cover over the remainder.

The Clover Creek basin covers approximately 47,400 acres, or 74 square miles. The main channel of Clover Creek is 12.8 miles long. Clover Creek has several tributaries and lakes including Morey and North Fork Clover Creeks, and Spanaway, Tule, and Steilacoom Lakes.

The natural drainage system is modified by collection, detention, discharge, and infiltration facilities. There are many piped systems in the Clover Creek basin. Due to the high propensity of porous surface soils from 50 to 60 percent of the basin's precipitation is absorbed becoming groundwater recharge.¹⁷ Taking advantage of this porosity, the County operates numerous dry wells, excavated pits usually 3 to 12 feet deep filled with aggregate, to help control runoff. These are particularly prevalent in the western half of the basin.¹⁸

Description of Flooding

During high intensity or long duration rainfall, broad flooding occurs in two areas along Clover Creek. Broad flooding occurs in the vicinity of 38th Avenue East and 152nd Street East (Clover Creek South) and in the vicinity of A street/4th Avenue East and 133rd/138th Street East (Clover

Creek North), downstream of the confluences of Clover Creek and the North Fork of Clover Creek. Residents in this loss area have filed flood insurance claims in 1996 and 1997. Five homes have been identified as repetitive loss properties. Surrounding homes are also within the flood hazard area.

Flooding in these areas typically results from overflow of the creek channel during or after large rainfall events, coupled with high flows in the North Fork of Clover Creek. The scale and occurrence of flooding depends on antecedent soil moisture conditions and the duration and depth of the rainfall. The creek overflows when the combination of backwater, flows from upstream, and runoff from surrounding areas exceeds the creek's conveyance capacity. The backwater often begins at constriction in the channel where the creek's capacity is lowest. Water begins to accumulate upstream of these constrictions, and propagates upstream as runoff into the creek increases. Flooding problems occur when the creek water elevation exceeds the channel banks and water overflows onto nearby improved property.¹⁹

Nisqually River Watershed: Mid Nisqually Basin²⁰

Description of Basin

The Nisqually River flows northwest for approximately 80 miles from its origin at the southern base of Mount Rainier to Puget Sound just north-east of Olympia. The repetitive loss area is along a 14.5-mile reach of the river between the City of Centralia diversion dam and the Nisqually Hydroelectric Project, which is owned by Tacoma Public Utilities. Four drainage basins contribute to this reach: the Upper Nisqually River Basin; the Mid Nisqually River Basin; the Mashel River Basin; and the Ohop Creek Basin. The repetitive loss area is in the Mid Nisqually Basin, in the vicinity of Harts Lake.²¹ This basin and the flooding are described in the following paragraphs. For more information on the other basins, they are referenced herein.

The Mid Nisqually Basin consists of level to rolling terrain. Land use in the basin consists of medium development for agriculture purposes.

The Nisqually River flows northwest from the Upper Nisqually Basin for about 30 miles across the Mid Nisqually Basin. Tanwax Creek, a tributary to the Nisqually River in this basin, conveys flows that originate in several lakes in the eastern portion of the basin.

The Mid Nisqually basin contains the City of Centralia's Yelm Project, which is west of Harts Lake at the downstream end of the Mid Nisqually Basin. It is a "run-of-the-river" project and diverts water from the river to generate power. Because it is a "run-of-the-river" project, there is no capability to store flood water at the diversion structure. A diversion dam directs water into two intake structures leading to an earthen power canal. The diverted water can generate 12 megawatts of power, and reenters the river 13.6 miles downstream.

Description of Flooding

Flooding in the Nisqually floodplain is extremely variable in terms of frequency, severity, and extent. The river's banks provide inadequate capacity to contain moderate to high flows. The

repetitive loss property is within the 100-year floodplain. Flow in the Nisqually River is regulated by the Nisqually Hydroelectric Project. Using Alder Lake’s storage capacity to regulate discharge, the project allows continuous power production while maintaining downstream flows and provides incidental flood control and recreation benefits. Although one of the dam’s stated objectives is to provide flood control, the dam has also been identified as a possible cause of flooding downstream by holding back floodwaters as long as possible and then passing more water than the river has capacity to contain.²²

Occurrences²³

Throughout the settled history of Pierce County there have been floods that impact the population. Tribes living along the rivers learned to live with them. It was not until settlers with a European agricultural background began to move into the area in the 1850s, cleared the land, built homes and planted crops that the flooding became more than just a nuisance. Fort Maloney, a blockhouse erected to protect a ford on the Puyallup River was washed away in 1867.²⁴

Since the early 1960’s, Pierce County has experienced 20 federally declared disasters. Of these, 13 were either caused or exacerbated by flooding, see Table 4.M3-1.

Table 4.M3-1 Flood Hazard Declared Disasters

Federal Disaster	Notes
DR-1734-WA—12/1-17/2007	Flooding throughout most of W. Washington. Pierce County was not declared.
DR-1671-WA--11/5-6/2006	Major flooding on the Puyallup, Carbon, White, Stuck and Nisqually rivers.
DR-1499-WA--10/2003	Surface flooding
DR-1159-WA--12/96-2/1997	Ice storm, snow and flood. Stafford Act assistance - \$83 million, SBA \$31.7 million.
DR-1100-WA--1-2/1996	Three deaths in Washington. Stafford Act disaster assistance provided – \$113 million. SBA disaster loans approved - \$61.2 million
DR-1079-WA--11-12/1995	100-year flood at Alderton on the Puyallup and 50-year flood at La Grande
DR-896-WA--12/1990	Stafford Act assistance provided \$5.1 million
DR-883-WA--11/1990	Stafford Act assistance provided \$57 million
DR-852-WA--1/1990	Stafford Act assistance provided \$17.8 million
DR-784-WA--11/1986	Two deaths. \$11 million in private property damage and \$6 million in public damage
DR-545-WA--12/1977	16 counties were declared. Very heavy rain in the upper Nisqually caused significant damage.
DR-492-WA--12/1975	13 counties flooded
DR-328-WA--2/1972	King, Pierce and Thurston counties flooding
DR-185-WA--12/1964	Wide ranging flooding affected 19 counties in both eastern and western Washington

The idea of channeling the Puyallup River began to take hold towards the end of the 19th century and in 1906 local citizens began the process of putting in small levees. Various work continued with both Pierce and King counties joining forces, and later, the addition of the Army Corps of Engineers got involved, allowing the levee work to be completed in 1950.

Between 2002 and 1989, more than \$22.8 million in Stafford Act disaster assistance was provided to Region 5 for repairs to public facilities following flood events.²⁵

The floods of 2006, 1997, and 1996 will remain in memory as three of the worst in the County. All of Pierce County's major rivers reached flood stage or above. These included the largest floods on record for the Puyallup and Carbon Rivers. Levees were destroyed or overtopped, revetments eroded, homes damaged or destroyed and some movement of the river channels. During the February 1996 flooding, the Nisqually River had an unprecedented recorded event. The amount of water released from the Alder/LaGrande dams located on the Nisqually River exceeded the capacity of the river channel. Throughout the County, surface water flooding occurred and sandbagging continued for weeks.

Repetitive Flood Loss Areas

Clear Creek Basin

Flooding has affected Pierce County many times in the past. Map 4.M3-4 illustrates the specific occurrences of repetitive flooding within the Clear Creek Basin. Clear Creek is the source of most of this flooding. The flood of record produced by the creek in February 1996 is illustrated from the aerial photo of the basin taken on February 8, 1996 (see Map 4.M3-5). The other major flooding occurred in November, 1995, and largely affected 47th Avenue East. The Creek produced widespread and destructive flooding in February 1996 and the extent of this flood of record is shown.

Figure 4.M3-1 Feb 8, 1996 Flooding - Del Rio Mobile Homes Along Puyallup River



The repetitive loss areas are concentrated along 47th Avenue East and 50th Avenue East, north of Pioneer Way and South of 40th Street East. About 20 homes in this area have been identified as

repetitive loss properties. Residents in the Clear Creek Repetitive loss area filed flood insurance claims in 1997, 1996, 1995, 1991, 1990, 1986, and 1984. The frequency of these claims indicates that each year there is approximately a 33 percent chance of flooding from Clear Creek. The February, 1996 flood was one of the worst in recent history, producing the highest stage of the Puyallup River since 1942. In this flood, the area of inundation greatly exceeded the previously delineated floodplain, emphasizing the need for updated flood mapping.²⁶

Clover Creek Basin

Map 4.M3-3 illustrates the repetitive loss property and flood hazard area. Broad flooding occurs in the vicinity of 38th Avenue East and 152nd Street East (Clover Creek South) and the vicinity of A street/4th Avenue East and 133rd/138th Street East (Clover Creek North). Residents in this loss area have filed flood insurance claims in 1997 and 1996.²⁷

Mid-Nisqually River Basin

Map 4.M3-3 illustrates the repetitive loss property and flood hazard area. The owner of the repetitive loss property has filed flood insurance claims in 1996, 1995, 1994, 1991, 1990, 1982, and 1980 and has indicated that his property also flooded in 1976, 1974, and 1972, although no flood insurance claims were made. The flood history for this property indicates approximately a 33 percent chance of flood damage in any given year. According to the property owner, the February 1996 flood was the most severe, with flood elevations as high as eight feet and rapidly flowing water.

A second area recently identified is in the Ohop Creek Basin. One property has been identified and there is the potential for another five that lie in the same area.

Recurrence Rate

Table 4.M3-1 Flood Hazard Declared Disasters lists 13 disasters that were either flood disasters or were exacerbated by flooding that have impacted Pierce County over the past 44 years, or one every 3.8 years. In between these individual federally declared disasters were other flood issues that did not make it to the federal declaration level. It was then decided, based on the number of incidents, that the probability of recurrence for the flood hazard in Pierce County is five years or less.

Impacts

Health and Safety of Persons in the Affected Area at the Time of the Incident

Flooding kills citizens throughout the United States every year. While that has not been a major problem in Pierce County over the years, it very well could happen with any major flood we have. The fact that Pierce County has had to do swift water rescues in the past with floods in both 1996 and 2006 shows the potential for life threatening situations to evolve during a flood.

Pierce County streams and rivers run very fast, and can quickly overwhelm individuals or vehicles caught in them. Persons caught in flood waters can be pinned under debris and drown. They can receive trauma from other debris being carried along by the river or by impacting rocks or other impediments in the river itself.

During the fall and winter flood season, rivers and streams are comprised largely of cold rain and snow, and for those originating on Mt. Rainier, some glacier melt. They are therefore very cold. In addition, air temperature in the winter during flood season can also be in the thirty degree range, although not usually below that during floods. The result is that persons caught in flood waters can drown not just from direct action of the flood but also as a complication of hypothermia.

Other problems that can compromise a person's health can develop after the flood waters have receded. Mold will grow in wet material, be it clothing, bedding, the walls of a house or the insulation under a floor. Sewage and hazardous chemicals may be present in homes, cars, or just as a layer coating peoples' property. Water and food may be contaminated. Heat and electricity may be off for some time. All of these will contribute to a decrease in not just the quality of life for individuals, but also their current and long term health.

Figure 4.M3-2 Nov. 2006 Flooding River Park Estates – Along Puyallup River



Health and Safety of Personnel Responding to the Incident

Response to flooding is response in hazardous conditions. Whether one is attempting swift water rescue, adding sandbags to dikes, or cleaning up debris after the waters have receded, an individual is working in a hazardous environment.

Impacts to responding personnel are similar to what can affect the citizens residing or working in the flood area. They include death from drowning and/or hypothermia, and either death or injury from trauma. Long term, environmental hazards such as hazardous chemicals, sewage, etc. can cause illness, either acute or chronic.

Continuity of Operations and Delivery of Services

Continuity of operations for most jurisdictions within Pierce County will not be compromised due to flooding. However, those that have their main administration or critical components of

their operations within the flood zone could find their operational continuity at risk. If files, paper or electronic, are damaged or destroyed, an organization may not be able to: contact clients; assign work; complete scheduled jobs; meet deadlines; access, track, and pay accounts; or pay staff. Without a Continuity of Operations Plan (COOP) that takes these issues into account, they may not be able to operate in their normal mode. This would be especially true for those jurisdictions like Orting, Sumner, Puyallup or Fife that lie directly on the river, or have a significant portion of their infrastructure located close to the river.

The delivery of services by the local jurisdictions and agencies within Pierce County is directly related to the degree of damage by the floods, to improved property, the infrastructure, and the areas in which the damage occurs. A flood that closes roads, either with water over the road or a washout, temporarily eliminates the ability of a local jurisdiction to repair other damaged infrastructure, respond to emergencies in the affected area, or deliver the other normal goods and services expected of it. Flooded electric substations, downed lines, contaminated wells, and broken pipelines all have the same impact. In all of these cases the delivery of services will be at least temporarily halted.

Damage to facilities, equipment, or files all could impact the delivery of services to citizens from individual jurisdictions or agencies.

Property, Facilities, and Infrastructure

Flooding is one of the major causes of damage to and destruction of property, facilities and infrastructure throughout the country and it is no different in Pierce County. Individual property has been destroyed in every major flood to hit the County. Over the years this has included homes, barns, equipment, livestock, and transportation vehicles of various types.

Flood waters can damage or destroy a jurisdiction's facilities. Buildings can be flooded. Equipment, electronic or mechanical, ruined or in some cases made inaccessible due to flood waters. Files, electronic or paper, can be destroyed. Both water and the contaminants it carries can either damage or permanently ruin equipment.

Flood waters can erode land containing infrastructure such as roads, power lines, natural gas, fuel, water pipelines, and sewage control facilities. It can breach levees, erode revetments and destroy bridges. Water overtopping dams can cause damage to the dam's structure. Material carried by the flood waters, if not screened out or removed can cause damage to the hydroelectric generating components of a dam.

Figure 4.M3-3 Nov. 2006 Flooding State Route 410 – Along Puyallup River



The Environment

The impacts to the environment from a major flood could include: erosion of stream or river banks; loss of plants and animals; and contamination from chemicals, sewage, etc. picked up, transported and deposited by the flood. The contamination of both the river and the flooded landscape from the various chemicals and debris picked up from farms, homes, and businesses along the river is a serious problem. Industrial chemicals, oil and gas, sewage, old tires, etc. can all pollute the landscape where they come to rest as the water recedes. Some of these materials may take years, decades or even longer to break down and become harmless. Until that happens they can continue to degrade the environment where they have come to rest, in some cases leaching into the water course or into ground water spreading contamination away from the site. Without clean-up this could continue for years.

However, from an environmental standpoint, not all flooding of rivers is bad. Floods are endemic in these valleys and the low areas of the County. They have changed the course of rivers, flooded low areas, uprooted or drowned vegetation, all as part of the natural environment. Areas where the river has changed course, frequently during floods, and moved away from, form oxbow lakes that attract water fowl and other animals. Where the river once ran the river gravels gradually develop a layer of topsoil forming meadows and allowing willows, alders and other open area bushes and trees to thrive. These species attract a growing diversity of animal life which continues to change, as the forest itself changes progressing from open area species to taller trees like Douglas fir and eventually to shade resistant types like Western Hemlock.

Flood waters traditionally have replenished the soil. In bringing down silt from higher elevations and depositing it across the landscape in the flat areas of the County, it adds a new quantity of nutrients to the soil that is already there. This contributes to the fertility of the valley floors aiding the growth of both natural vegetation and agricultural products.

Another development that occurs with flooding is the creation of snags within the river channel itself. As the river erodes the banks, trees become uprooted, fall into the river and either create coverage for fish at that spot or in many cases are transported by the flood down river and later are snagged creating more fish habitat.

Economic and Financial Condition

Economically, the after effects will depend directly on how much damage was done to local businesses, the local tax base, and the local infrastructure. While an individual home damaged by a flood can be devastating to an individual or family, it has very little effect on the overall economic condition of the community. However when a large number of homes, and businesses, are damaged or destroyed it can negatively alter the tax base decreasing the ability of the local jurisdiction to pay, not just for infrastructure repair and community restoration, but also for the normal day to day programs that make the community a viable area in which to live and work. Related to this is the possibility that many people may need temporary relocation assistance. If homes are not repairable families may have to look for alternate housing. Depending on what is available, it could lead some to leave the County, moving to other areas. Depending on the size of the flood and the resulting exodus, there could be a small loss of population and tax revenue.

Figure 4.M3-4 Nov. 2006 Flooding Rainier Manor – Along Puyallup River



Depending on what is available, it could lead some to leave the County, moving to other areas. Depending on the size of the flood and the resulting exodus, there could be a small loss of population and tax revenue.

Damage to the business and industry sector does not only affect the tax base, but also removes jobs from the local economy. The loss of jobs can escalate into other problems. The unemployed may either move away, go on unemployment, or be forced to take a lower paying job all of which further decreases the financial stability of the community. If the loss of financial stability is not corrected there are other social problems that arise. Those out of work can develop a loss of self esteem that can lead to an increase in crime, alcohol and drug abuse, spouse abuse, and an increase in medical problems.

Flooding may damage the infrastructure by undercutting and washing out transportation corridors such as roads, bridges and train tracks, downing power poles, damaging pipelines, filling sewer lines with silt, and damaging levees and revetments. The time taken to repair these can take from weeks to years depending on the amount of damage and the available resources to repair them. This damage to the infrastructure will slow down the economic recovery for the jurisdiction. It can limit the reopening of businesses. It can force those that may have had no

damage and operate on a just-in-time supply system but cannot get inventory, to close at least temporarily. For some of these, the lack of commerce and therefore loss of income can prove critical. With creditors needing pay and no revenue stream, some may not be able to recover and could close permanently.

Grocery stores, restaurants and food delivery systems may lose product because of the lack of power. Large chains can recover, but small independent businesses may not. Those that have a system of backup power should do much better than those that do not.

In summary, the economic viability of the community will depend on not just how much damage is done, but also on how quickly the infrastructure can be repaired; how prepared businesses are to operate in the post disaster environment; how prepared citizens are for the flood and its after affects; and how well local governments and organizations can respond to the needs of the public for support, cleanup, and if necessary relocation.

Reputation of or Confidence in the Entity

The reputation of any individual jurisdiction within Pierce County or the public's confidence in the jurisdiction is highly dependent on the public's perception on how well the response and recovery were handled during and after the flood. A response that either shows or gives the impression that a jurisdiction is prepared and responsive to the public's needs and that it manages a recovery to gets services back and damage repaired in a timely manner will enhance a jurisdiction's reputation. If however, the perception develops, rightly or wrongly, that the jurisdiction is incompetent, slow to react, or ignores the needs of its citizens, then the reputation of the jurisdiction and the confidence in its abilities will decline.

Resource Directory

Regional

- **Pierce County Department of Emergency Management**
<http://www.co.pierce.wa.us/pc/abtus/ourorg/dem/abtusdem.htm>
- **Pierce County Department of Water Programs**
<http://www.co.pierce.wa.us/pc/services/home/environ/index.htm>
- **Washington State Department of Ecology**
<http://www.ecy.wa.gov/>
- **Western Regional Climate Center**
<http://www.wrcc.dri.edu>
- **Corps of Engineers Northwest Division**
<http://www.nwd-wc.usace.army.mil>

National

- **Association of State Dam Safety Officials**
<http://crunch.tec.army.mil/nid/webpages/nid.cfm>
- **Copies of FIRMs, FISs, DFIRMs, Digital Q3 Flood Data, and FHBMs**
<http://msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1>
- **Flash-Flood Safety Rules**
<http://www.nws.noaa.gov/om/brochures/flashfld.shtml>
- **Flood Risk and Map Information**
<http://www.fema.gov/hazard/flood/index.shtm>
- **Flood Safety Rules**
<http://www.nws.noaa.gov/floodsafety/>

- **Floodplain Management Association**
<http://www.floodplain.org>
- **General Flood Information**
<http://www.fema.gov/hazard/flood/index.shtm>
- **Guide to National Flood Insurance Program on the web**
<http://www.fema.gov/business/nfip/qanda.shtm>
- **Latest hydrological information (flooding, droughts, snow conditions, etc.)**
<http://www.nws.noaa.gov/oh/hic/current/>
- **FEMA Map Service Center 800.358.9616**

Endnotes

¹ Background and specific information for entire Pierce County Flood Section provided through consultation with flood hazard expert, Randy Brake, Pierce County Water Programs. This was conducted throughout the planning process.

² Modified from PC HIVA, Flood Section, September 5, 2002, p.29.

<http://www.co.pierce.wa.us/xml/abtus/ourorg/dem/HIVAWEB.pdf>

³ 386.2 Glossary A-3

⁴ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001. p.6.

⁵ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001. p.1.

⁶ Closed Depression flooding occurs where water collects in low-lying areas with little to no drainage capacity. Once flooding occurs, it can last for the remainder of the wet season until evaporation or slow infiltration lowers the water level. (PC HIVA).

⁷ Tacoma Public Utilities Nisqually River Project.

http://www.tacomapower.com/parksandpower/hydro_power/nisqually_river_project.htm

⁸ Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, TETRA TECH/KCM, p. 1-6.

⁹ Most information on the Clear/Clarks Creek Basin is taken from Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, Tetra Tech/KCM, pp.4-1 to 4-15.

¹⁰ Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, Tetra Tech/KCM, p. 4-2

¹¹ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001, p. 7.

¹² Ibid. p. 7

¹³ Pierce County Repetitive Loss Plan, Pierce County Water Programs, Prepared by Tetra Tech/KMC, Inc., Seattle, WA. July, 2001. Figure 4-1.

¹⁴ Pierce County Water Programs, aerial photos for Clear Creek area, February 9, 1996.

¹⁵ Ibid, p. 1, 9, 10.

¹⁶ Most information on the Clover Creek Basin is taken from Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, Tetra Tech/KCM, pp.5-1 to 5-9.

¹⁷ Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, Tetra Tech/KCM, p. 5-1.

¹⁸ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001. p. 10-11

¹⁹ Ibid. p.11-12

²⁰ Some information on the Mid Nisqually Basin is taken from Pierce County Flood Risk Assessment – Draft, June 2007, Pierce County Public Works & Utilities Water Programs, TETRA TECH/KCM, pp.11-19 to 11-21.

²¹ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001, p.11-12

²² Ibid. p. 14

²³ Modified from PC HIVA, Flood Section, September 5, 2002, p.29.

<http://www.co.pierce.wa.us/xml/abtus/ourorg/dem/HIVAWEB.pdf>

²⁴ City of Puyallup Natural Hazard Mitigation Plan, March 2005, p. 4.5-8.

²⁵ Washington State Hazard Mitigation Plan. Washington State Emergency Management Division, April, 2004. Tab 7.2.5 p. 16.

²⁶ Pierce County Repetitive Loss Plan, Pierce County Water Programs. Prepared by Tetra Tech/KMC, Inc., Seattle, WA: July, 2001. p. 9, 10.

²⁷ Ibid. p.12