4.0 Risk Assessment

The risk assessment was established through input and information provided by surveys, steering committee, planning team, participating jurisdictions (stakeholders), and by researching each hazard identified in the Washington State Emergency Management Hazard Mitigation Plan.

4.1 Methodology

For each hazard identified in the State of Washington's Emergency Hazard Mitigation Plan, each jurisdiction within the planning area was required to complete the "Hazard Identification Worksheet." Responses were compiled to create the "Composite Hazard Identification Table." The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. These tables and rankings were compiled after receiving responses from the participants, discussions with the public and their responses, and conducting research on each hazard's presence and risk.

Listed below is the definition of probability of occurrence and the extent of damage as used during the planning process. These terms were applied consistently throughout the plan.

Probability of occurrence is defined as follows:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

4.2 Identifying and Profiling Hazards

The following hazards have been identified as those that have the potential to impact the multi-jurisdictional area:

4.2.1 Avalanche
4.2.2 Dam Failure
4.2.3 Debris Flows
4.2.4 Earthquake
4.2.5 Extreme Heat
4.2.6 Flooding
4.2.7 Landslide
4.2.8 Levee Failure
4.2.9 Severe Wind Storm
4.2.10 Severe Winter Storm
4.2.11 Volcano
4.2.12 Wildfire

Identifying Hazards
Requirement §201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses form identified hazards.
Element

- Does the new or updated plan include a description of the types of all natural hazards that affect the jurisdiction?

These hazards were identified through an extensive process that utilized input from the Planning Team, public input, researching past disaster declarations in the County, and a review of each hazard identified in the Washington State Emergency Management Hazard Mitigation Plan.

Ranking of Identified Hazards											
Natural Hazards	**Lewis County**	**Centralia**	**Chehalis**	**Morton**	**Mossyrock**	**Napavine**	**Toledo**	**Vader**	**Winlock**	**Town of Pe Ell**	**County RANK (Top 15)**
Avalanche	0	0	4	16	0	0	0	4	0	0	
Coastal Erosion	0	0	0	0	0	0	0	0	0	0	
Coastal Storm	0	0	0	0	0	0	0	0	0	0	
Dam Failure	46	26	4	0	10	0	0	20	40	0	8
Debris Flow	46	0	10	40	14	40	0	50	44	0	7
Drought	0	6	10	4	4	0	0	10	0	0	
Earthquake	60	50	60	50	44	40	40	50	60	44	2
Expansive Soils	0	6	10	0	0	0	0	16	0	0	
Extreme Heat	0	0	10	0	50	0	0	36	0	0	
Flooding	70	54	60	50	44	54	40	54	50	40	1
Hailstorm	6	0	10	20	10	0	0	44	0	0	
Hurricane	0	0	16	0	0	0	0	10	0	0	
Land Subsidence	0	0	10	0	0	0	0	4	0	0	
Landslide	60	10	30	44	16	0	40	10	50	44	6
Levee Failure	50	30	30	0	0	0	0	0	0	0	
Thunder Storm	30	0	10	20	4	0	44	10	0	0	
Tornado	0	0	16	30	0	0	44	10	0	44	
Tsunami	0	0	0	60	0	0	40	0	0	44	
Volcano	60	44	36	4	44	40	0	36	46	0	5
Wildfire	30	0	10	0	4	0	0	30	0	0	
Wind Storm	50	44	30	60	14	40	46	54	50	44	3
Winter Storm	50	44	10	30	50	40	40	54	50	40	4

The following hazards have the best chance of occurring again in Lewis County. The order was determined by Lewis County and the participating municipalities and the answers filled out on their Hazard Identification worksheets:

1. Flooding
2. Earthquake
3. Wind Storm
4. Winter Storm
5. Volcanic Eruption
6. Landslide
7. Debris Flow
8. Dam Failure

The following sections provide hazard profiles, vulnerability assessments, and multi-jurisdictional risk assessment. Only the hazard types which have a significant likelihood of occurring or have reason to potentially occur are discussed. Refer to Participant Sections for discussion of unique risk assessments specific to the jurisdictions (i.e. flooding).

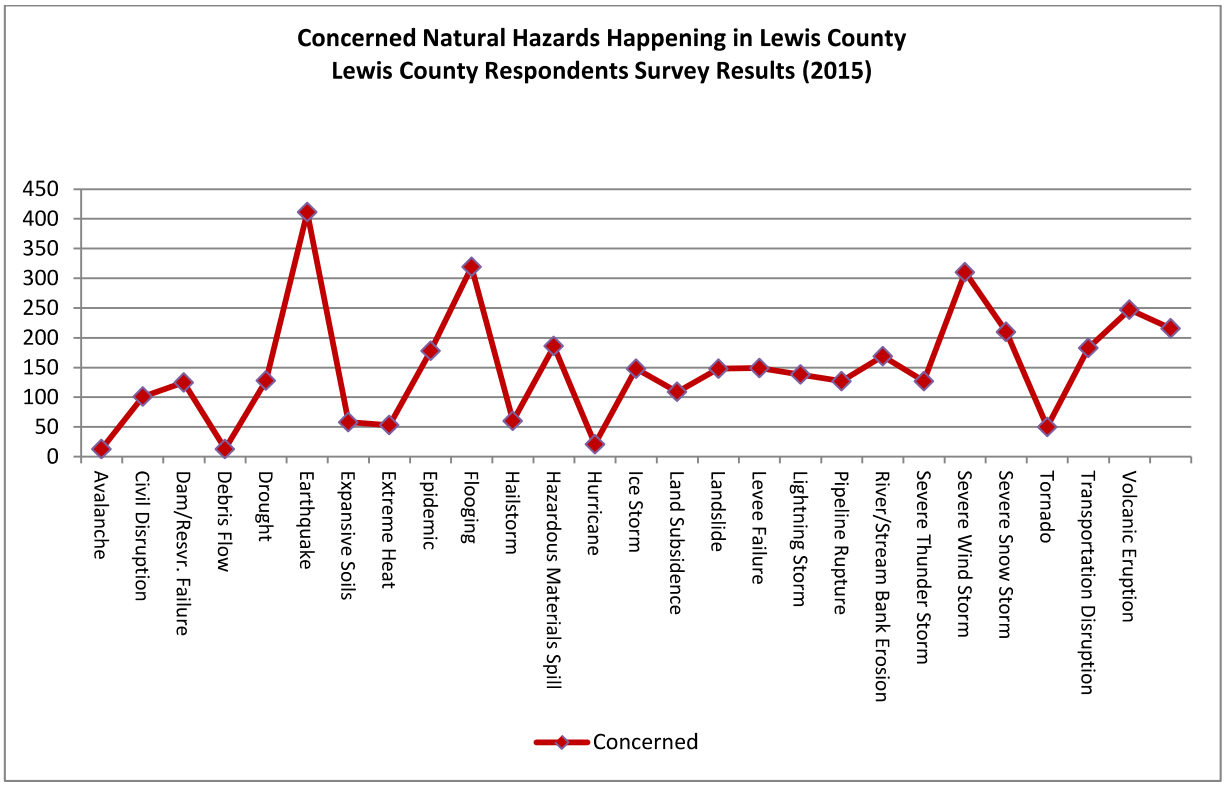
Comparing the Stakeholders results with the survey results from Lewis County respondents showed the similar results as shown on the graph with an earthquake, flooding, severe wind storm, and volcanic followed by a severe winter storm.

Profiling Hazards

Requirement §201.6(c)(2)(i): The risk assessment shall include a description of the …location and extend 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.

Element

- Does the risk assessment identify the location of each natural hazard addressed in the new or update plan?
- Does the risk assessment identify the extent of each hazard addressed in the new or updated plan?
- Does the plan provide information on previous occurrences of each hazard addressed in the new or updated plan?
- Does the plan include the probability of future events for each hazard addressed in the new or updated plan?

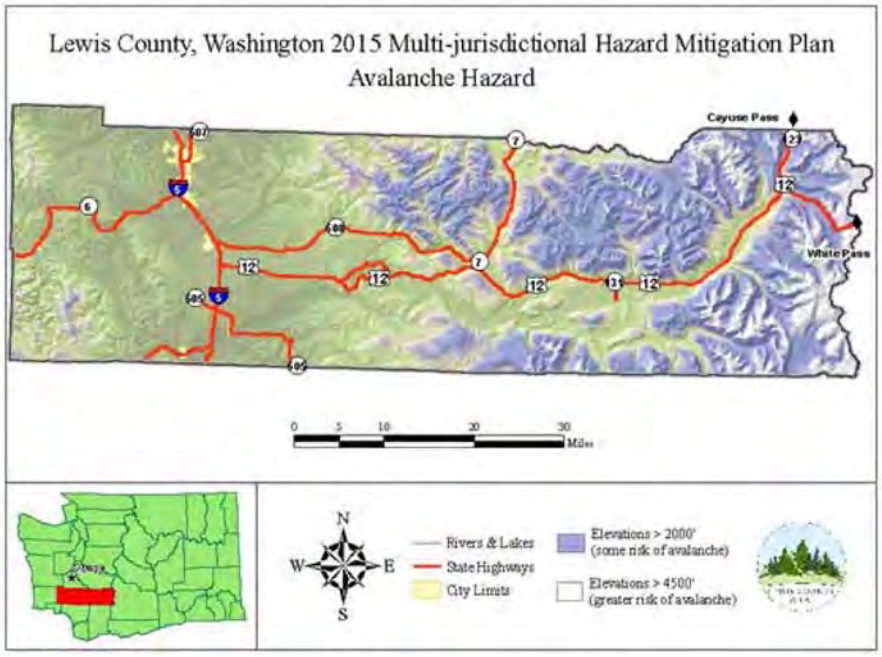


4.2.1 Avalanche

An avalanche occurs when a layer of snow loses its grip on a slope and slides downhill. Avalanches have killed more than 190 people in the past century in Washington State, exceeding deaths from any other natural hazard. (Source: Washington State Emergency Management Division Hazard Mitigation Plan, October 2013). Avalanches kill one to two people, on average, every year in Washington, although many more are involved in avalanche accidents that do not result in fatalities. Most current avalanche victims are participating in recreational activities in the backcountry where there is no avalanche control. Only one-tenth of one percent of avalanche fatalities occurs on open runs at ski areas or on highways.

Avalanches occur in four mountain ranges in the state – the Cascade Range, which divides the state east and west, the Olympic Mountains in northwest Washington, the Blue Mountains in southeast Washington, and the Selkirk Mountains in northeast Washington.

The avalanche season begins in November and continues until early summer for all mountain areas of the state. In the high alpine areas of the Cascades and Olympics, the avalanche season continues year-round.



There are two types of avalanches, loose and slab, and two types of slab avalanches, dry and wet. Although the most dangerous avalanche is the slab avalanche, loose slides can and do produce injury and death.

Loose avalanches occur when grains of snow cannot hold onto a slope and begin sliding downhill, picking up more snow and fanning out in an inverted V. Slab avalanches occur when a cohesive mass of snow breaks away from the slope all at once.

Dry slab avalanches occur when the stresses on a slab overcome the internal strength of the slab and its attachment to surrounding snow. A decrease in strength produced through warming, melting snow, or rain, or an increase in stress produced by the weight of additional snowfall, a skier or a snowmobile cause this type of avalanche. Dry slab avalanches can travel 60 to 80 miles per hour, reaching these speeds within five seconds after the fracture. They account for most avalanche fatalities. Wet slab avalanches occur when water percolating through the top slab weakens it and dissolves its bond with a lower layer, decreasing the ability of the weaker, lower layer to hold on to the top slab, as well as decreasing the slab's strength.

A number of weather and terrain factors determine avalanche danger:

1. Storms – A large percentage of all snow avalanches occur during and shortly after storms.
2. Rate of snowfall – Snow falling at a rate of one inch or more per hour rapidly increases avalanche danger.
3. Temperature – Storms starting with low temperatures and dry snow, followed by rising temperatures and wetter snow, are more likely to cause avalanches than storms that start warm and then cool with snowfall.
4. Wet snow – Rainstorms or spring weather with warm, moist winds and cloudy nights can warm the snow cover resulting in wet snow avalanches. Wet snow avalanches are more likely on sun-exposed terrain (south-facing slopes) and under exposed rocks or cliffs.
5. Ground cover – Large rocks, trees and heavy shrubs help anchor snow.
6. Slope profile – Dangerous slab avalanches are more likely to occur on convex slopes.
7. Slope aspect – Leeward slopes are dangerous because windblown snow adds depth and creates dense slabs. South facing slopes are more dangerous in the springtime.
8. Slope steepness – Snow avalanches are most common on slopes of 30 to 45 degrees.

Profiling Hazard

No instances of avalanche have been recorded within the Planning Area. The Washington State Emergency Management Division did identify avalanches as a hazard for Lewis County along the mountain passes of White Pass US Highway 12 and State Routes 410 and 123 (see Areas Vulnerable to Avalanche Map). The probability of future events for this hazard is discussed below in the assessing vulnerability section.

Assessing Vulnerability: Overview

Below are the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan for avalanches. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections found in their individual sections.

Avalanche Composite Hazard Identification Table

Participant	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	No	No	Unlikely	None
City of Centralia	No	No	Unlikely	None
City of Chehalis	No	No	Unlikely	None
City of Morton	No	No	Unlikely	None
City of Mossyrock	No	No	Unlikely	None
City of Napavine	No	No	Unlikely	None
City of Toledo	No	No	Unlikely	None
City of Vader	No	No	Unlikely	None
City of Winlock	No	No	Unlikely	None
Town of Pe Ell	No	No	Unlikely	None

Probability:

- **Highly Likely**: Near 100% probability in the next year.

- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

There are no specific structures identified as being vulnerable to avalanche because none of the participating jurisdictions identified avalanche as a potential hazard. There is a potential for infrastructure damage to the at-risk highways. However, these highways have been designed and built to withstand extreme weather conditions, so the likelihood of destruction is minimized.

Assessing Vulnerability: Estimating Potential Losses

This profile will not attempt to quantify potential losses to facilities due to an avalanche. No municipalities identified this as a hazard that would affect them. However, this hazard does affect White Pass US 12 and State Route 410 and 123. Both can experience closure due to avalanches during the winter months. Losses to highway infrastructure, personal property (cars, recreation equipment), and human life are possible in the unlikely event of an avalanche.

Assessing Vulnerability: Analyzing Development Trends

Because the at-risk areas within the multi-jurisdictional area are in rural mountainous areas, no significant future development is anticipated.

Multi-Jurisdictional Risk Assessment

While the municipalities and other specific plan participants do not anticipate any foreseeable risk of avalanche, the previously identified highway areas of White Pass US 12, SR 410, and SR 123 have been determined to be at risk. An avalanche in one of the at-risk areas could have an impact on the multi-jurisdictional area if there was a resultant disruption in transportation in the region.

The overall risk of loss of infrastructure, property, or human life is extremely low. However, with the increased interest in the pursuit of backcountry recreational activities such as skiing, snowshoeing, and snowmobiling, the risk of loss may increase.

Resources

- *Washington State Enhanced Hazard Mitigation Plan*, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Avalanche.pdf Accessed May 12, 2015.
- Washington State Department of Transportation: Avalanche Control available at http://www.wsdot.wa.gov
- National Avalanche Center. Available at http://www.fsavalanche.org/encyclopedia/ Accessed May 12, 2015
- Bruce Tremper, *Common Questions about Avalanches*, USDA Forest Service Utah Avalanche Center, http://www.avalanche.org/~uac/Common-questions.html, (November 4, 2002).

4.2.2 Dam Failure

Dam failure is described as the structural failure of a water impounding structure. Structural failure can occur during extreme conditions, which can include:

- Reservoir inflows in excess of design flows;
- Flood pools higher than previously attained;
- Unexpected drop in pool level;
- Pool near maximum level and rising;
- Excessive rainfall or snowmelt;
- Large discharge through spillway;
- Erosion, landslide, seepage, settlement, and cracks in the dam or area; and
- Earthquakes

Reasons for dam failures include:

- Overtopping - 34% of all failures (nationally)
    - Inadequate Spillway Design
    - Debris Blockage of Spillway
    - Settlement of Dam Crest
- Foundation Defects - 30% of all failures (nationally)
    - Differential Settlement
    - Sliding and Slope Instability
    - High Uplift Pressures
    - Uncontrolled Foundation Seepage
- Piping and Seepage - 20% of all failures (nationally)
    - Internal Erosion Through Dam Caused by Seepage-"Piping"
    - Seepage and Erosion Along Hydraulic Structures Such as Outlet
    - Conduits or Spillways, or Leakage Through Animal Burrows
    - Cracks in Dam
- Conduits and Valves - 10% of all failures (nationally)
    - Piping of Embankment Material Into Conduit Through Joints or Cracks
- Other - 6% of all failures (nationally)

According to the Department of Ecology's Dam Safety Office there are 51 dams in Lewis County. These dams are defined as structures that can impound 10 acre-feet or more of watery material at the dam crest elevation as per the Inventory of Dam in the State of Washington, Lewis County, Revised Edition June 2013.

Under state law, the Department of Ecology is responsible for regulating dams that capture and store at least 10 acre-feet (about 3.2 million gallons) of water or watery materials such as mine tailings, sewage and manure waste.

Department of Ecology's Dam Safety Office rates a dam on its potential consequences in the downstream valley. The follow table shows the rating table that is used.

Dam Hazard Classification				
Downstream Hazard Potential	Downstream Hazard Class	Population at Risk	Economic Loss Generic Description	Environmental Damage
Low	3	0	Minimal. No inhabited structures. Limited agricultural development.	No deleterious material in reservoir contents
Significant	2	1-6	Appreciable. 1 or 2 inhabited structures. Notable agriculture or work sites. Secondary highway and/or rail lines.	Limited water quality degradation from reservoir contents and only short term consequences
High	1C	7-30	Major. 3 to 10 inhabited structures. Low density suburban area with some industry and work sites. Primary highway and/or rail lines.	Severe water quality degradation potential from reservoir contents and long term effects on aquatic and human life
High	1B	31-300	Extreme. 11 to 100 inhabited structures. Medium density suburban or urban area with associated industry, property, and transportation features.	Severe water quality degradation potential from reservoir contents and long term effects on aquatic and human life
High	1A	300+	Extreme. More than 100 inhabited structures. Highly developed, densely populated suburban or urban area with associated industry, property, transportation, and community life line features.	Severe water quality degradation potential from reservoir contents and long term effects on aquatic and human life
Source: Inventory of Dams in the State of Washington, Revised Edition June 2013, Publication #94-16				

Lewis County Dam Inventory				
Name of Dam	Owner	River or Stream	Max Storage Acre-ft	Haz. Class
Barrier Dam	Tacoma Power	Cowlitz River	50	3
Borst Lake Dam	City of Centralia	Skookumchuck River	20	3
Carlisle Lake Dam	SW Wash. Dev. Assoc.	South Fork Newaukum River	300	2
Centralia Coal Mine Dam No. 19	TransAlta	Tr-Packwood Creek	130	3
Centralia Coal Mine Dam No. 19A	TransAlta	Tr-Packwood Creek	130	3
Centralia Coal Mine Dam No. 22	TransAlta	Tr-Hanaford Creek	20	3
Centralia Coal Mine Dam No. 22 Sump	TransAlta	Tr-Hanaford Creek	18	3
Centralia Coal Mine Dam No. 36	TransAlta	Hanaford Creek-Offstream	130	3
Centralia Coal Mine Dam No. 36A	TransAlta	Hanaford Creek-Offstream	90	3
Centralia Coal Mine Dam No. 38	TransAlta	Big Hanaford Creek – Offstream	629	3
Centralia Coal Mine Dam No. 38A	TransAlta	Big Hanaford Creek-Offstream	91	3
Centralia Coal Mine Dam No. 38B	TransAlta	Big Hanaford Creek – Offstream	30	3
Centralia Coal Mine Dam No. 38C	TransAlta	Big Hanaford Creek - Offstream	187	3
Centralia Coal Mine Dam No. 3A	TransAlta	Tr-Hanaford Creek	79	3
Centralia Coal Mine Dam No. 3B	TransAlta	Tr-Hanaford Creek	7,750	2
Centralia Coal Mine Dam No. 3C - East	TransAlta	Tr-Packwood Creek-Offstream	5,000	2
Centralia Coal Mine Dam No. 3C - North	TransAlta	South Hanaford Creek-Offstream	2,000	2
Centralia Coal Mine Dam No. 3C - South	TransAlta	Tr-Packwood Creek-Offstream	9,600	2
Centralia Coal Mine Dam No. 3D	TransAlta	Tr-Packwood Creek	15,000	3
Centralia Coal Mine Dam No. 44	TransAlta	Tr-Packwood Creek	325	3
Centralia Coal Mine Dam No. 45	Alco	Tr-Hanaford Creek	25	3

Centralia Coal Mine Dam No. 5	TransAlta	Tr-Packwood Creek	176	3
Centralia Coal Mine Dam No. 5A	TransAlta	Tr-Hanaford Creek	19	3
Centralia Coal Mine Dam No. 5B	TransAlta	Tr-Hanaford Creek	26	3
Centralia Coal Mine Dam No. 5C	TransAlta	Tr-Packwood Creek	90	3
Centralia Coal Mine Dam No. 5D	TransAlta	Tr-Hanaford Creek	21	3
Centralia Coal Mine Dam No. 6	TransAlta	Tr-Hanaford Creek	18	3
Centralia Coal Mine Dam No. 6A	TransAlta	Tr-Hanaford Creek	28	3
Centralia Coal Mine Dam No. 6B	TransAlta	Tr-Hanaford Creek	74	3
Centralia Coal Mine Dam No. 8	Alco	Tr-South Hanaford Creek	89	3
Centralia Coal Mine Dam No. 8A	TransAlta	Tr-South Hanaford Creek	57	3
Centralia Coal Mine Pond 46 Dam	Alco	Tr - Mitchell Creek	16	2
Centralia Coal Mine Pond 46A Dam	Alco	Unnamed Tr - Mitchell Creek	68	2
Cowlitz Falls Dam	Lewis County PUD No 1	Cowlitz River	15,000	1C
Eagle Creek Dam	WA DNR	Eagle Creek	20	3
KOA Dam No. 1	Mhc Ltra, Inc	Tr-Mill Creek	67	3
Kopper Pond	Warren Freece	Lacamas Creek-Offstream	92	2
Long-Bell Mill Pond Dam	Ralph W Eidsmoe	Winston Creek	65	3
Mayfield Dam	Tacoma Power	Cowlitz River	1,780,000	1A
Mossyrock Dam	Tacoma Power	Cowlitz River	1,790,000	1A
Packwood Dam	WA Public Power	Lake Creek	4,200	2
Powell Dam	W Wood	Blue Creek	82	3
Reilly Dam	Robert & Linda Capps	Tr-South Fork Garrard Creek	16	3
Silverado Waterski Pond	Lake Silverado Assoc.	Tr-Chehalis River	115	3
Surge Pond Dam	Pacific Corp	Hanaford Creek	¼	2
Swofford Valley Rearing Pond Dam	Tacoma Power	Sulphur Creek	2,173	2
Toledo Primary Sewage Lagoon No. 1A	Toledo City	Tr-Cowlitz River-Offstream	18	3
Toledo Primary Sewage Lagoon No. 1B	Toledo City	Tr-Cowlitz River-Offstream	18	3
Toledo Secondary Sewage Lagoon No. 2	Toledo City	Tr-Cowlitz River-Offstream	18	3
Winlock Waterski Pond Dam	Miller, Daniel F Inc	Tr-Coon Creek-Offstream	80	3
Woods Creek Weir	Gifford Pinchot NF	Tr-Coon Creek-Offstream	20	3
Source: Inventory of Dams in the State of Washington, Revised Edition June 2013, Publication #94-16				

Profiling Hazard

According to the Department of Ecology's Inventory of Dams from June 2013, 37 out of 51 dams in Lewis County have a rating of a 3 (meaning little to no lives are at risk). There are 11 dams that are rated 2 (1 to 6 lives at risk). The Cowlitz Falls dam is rated a 1C, and the Mayfield and Mossyrock dams are both rated as 1A. Skookumchuck dam is located in Thurston County, but is significant for purposes of hazard mitigation planning because if it failed it would affect thousands of people including the City of Centralia and its Urban Growth Area.

The only historical occurrence of dam failure within the multi-jurisdictional area was Seminary Hill Reservoir (City of Centralia) in October 1991. There was a failure along a weak rock zone in the hillside that caused a massive slide which breached a reservoir. Three million gallons of water drained from reservoir in three minutes destroying two homes and damaging many others. There was approximately $3 million in damage.

Periodic inspections are the primary tool for detecting deficiencies at dams that could lead to failure. Correction of these safety deficiencies in a timely manner can prevent dam failures and other serious incidents from occurring. The use of periodic inspections to detect deficiencies and avert disasters continues to be an important preventative tool in the dam safety program. Periodic inspections also help identify dams where significant development has occurred downstream, resulting in the need for more stringent design loadings due to greater population at risk.

The Department of Ecology's Dam Safety Office conducts periodic inspections of particular projects to reasonably secure safety to life and property, as authorized under RCW 43.21A.064. Inspections are performed on dams where there is the potential for loss of life and significant property damage in the event of a dam failure. Dam with *high* hazard classifications are to be inspected on a 5-year cycle, while dams with *significant* hazard classifications will be inspected on a 10-year cycle. Dams classified as *low* hazard are not included in the periodic inspection program.

The inspections are performed by professional engineers from the Dam Safety Office and involve:

- Review and analysis of available data on the design, construction, operation, and maintenance of the dam and its appurtenances.
- Visual inspection of the dam and its appurtenances.
- Evaluation of the safety of the dam and its appurtenances, which may include assessment of the hydrologic and hydraulic capabilities, structural stabilities, seismic stabilities, and any other condition which could constitute a hazard to the integrity of the structure.
- Evaluation of the downstream hazard classification.
- Evaluation of the operation, maintenance, and inspection procedures employed by the owner and/or operator.
- Review of the emergency action plan for the dam including review and/or update of dam breach inundation maps.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan for dealing with dam failure. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections found in their individual sections.

Dam Failure Composite Hazard Identification Table

Participant	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	No	Possible	Catastrophic
City of Centralia	No	No	Possible	Catastrophic
City of Chehalis	No	No	Unlikely	Limited
City of Morton	No	No	Unlikely	None
City of Mossyrock	No	No	Possible	Limited
City of Napavine	No	No	Unlikely	None
City of Toledo	No	No	Unlikely	None
City of Vader	No	No	Unlikely	Catastrophic
City of Winlock	Yes	No	Unlikely	None
Town of Pe Ell	No	No	Unlikely	None

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.

- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See each Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

Potential losses from dam failure are uniquely related to the specific dam and jurisdiction in which they occur. The potential losses are determined by the Dam Hazard Classification of each specific dam. See Participant Sections for jurisdiction-specific information and individual jurisdiction maps (Dam Inundation).

Assessing Vulnerability: Analyzing Development Trends

In general, the areas that are at-risk for damage in dam failure scenarios are the same areas that are at risk for other flooding events. Development restrictions in flood plain areas can help to prevent some potential losses. The Participating Jurisdictions has specific detailed information about the development trends for each participating municipality.

Multi-Jurisdictional Risk Assessment

New development in areas downstream from dams will increase the risk of property loss. The urban areas that lie below the Cowlitz Falls, Mayfield, Mossyrock, and Skookumchuck dams are at the greatest risk of both loss of property and loss of life.

Resources

- Department of Ecology. Inventory of Dams in the State of Washington, Revised Edition June 2013, Publication #94-16.

4.2.3 Debris Flow

Debris flows are often called mudslides, mudflows, or debris avalanches. They consist of debris mixed with water. Debris consists of soil and other substances, such as tree and rock fragments that are picked up as the flow moves down a slope or channel. A mixture of water and soil-rock-woody debris that have become a liquefied slurry in a channel and commonly move very rapidly down slope (>10m/s~25miles/hour).

Debris flows may be generated when hillside colluvium or landslide material becomes rapidly saturated with water and flows into a channel. Intense rainfall, rapid snowmelt, or high levels of ground water flowing through fractured bedrock triggers the movement. Debris flows and floods also occur when heavy rains on slopes cause extensive hillside erosion and channel scour. Repeated debris flows and/or floods deposit sediment at the mouth of a canyon, forming an alluvial fan. The fan shape is a result of periodic diversion of the main channel back and forth across the fan.

Flows may travel farther down the fan from the mouth of the canyon if the channel becomes entrenched and the flow is confined. Alluvial fans are risky places for homes because it is difficult to predict where flooding or debris flows will occur. Debris flows can be as thick as wet concrete and can transport boulders as large as a car; debris flows may eventually become muddy flood waters as they deposit their debris.

Debris flows tend to move in pulses. Early pulses or previous debris flows form levees that channel the flow until the levees are breached. The presence of older levees indicates the recurrence and characteristics of debris flows in a particular canyon. This is valuable information for developing land on the alluvial fan.

Profiling Hazard

The only instances of debris flow identified by participant responses were the 2006 flooding events on the rivers and creeks on the east end of the County and in 2007 on the upper Chehalis river near Doty and Curtis. These instances, along with the associated flooding, caused major damage resulting in millions of dollars in losses. The nature of debris flows is they are usually associated with other natural hazards such as flooding, wildfires, landslides, volcanic activity, severe rain, wind or a major snow event.

Historical Occurrences

- January 7-8, 2009 storm, over 500 landslides initiated in Lewis County, blocking roads and damaging houses. Rainfall totaled over 10 inches between January 7-8, triggering hundreds of

debris flows between Morton and Randle. Near Glenoma, when the debris flows reached the valley, they transformed into hyper-concentrated flows, moving across fields and pirating on Highway 12 and into roads and driveways.

- December 2007 storm just west of Pe Ell, a massive debris avalanche along with numerous smaller landslides blocked State Route 6, from Pe Ell to Raymond, isolating 21 households without electricity and water. In addition, State Route 8, just west between Porter and Malone, and SR 508 near Onalaska were blocked by landslides. In the Chehalis headwaters area, the hardest hit area from the storm, nearly 20 inches of rain was recorded within a 48-hour period, most of that falling within the first 24 hours. Woody debris and sediment, including material from more than 1,000 landslides in the Chehalis headwaters basin, clogged channels at bridges, creating temporary dams and causing widespread deposition of logs and debris, especially around the Boistfort Valley.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with debris flows. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections found in their section.

Debris Flow Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Possible	Severe
City of Centralia	No	No	Unlikely	None
City of Chehalis	No	No	Possible	Limited
City of Morton	Yes	Yes	Possible	Limited
City of Mossyrock	No	No	Likely	Limited
City of Napavine	Yes	Yes	Possible	Limited
City of Toledo	No	No	Unlikely	None
City of Vader	Yes	Yes	Likely	Severe
City of Winlock	Yes	Yes	Likely	Limited
Town of Pe Ell	No	No	Unlikely	None

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the participant sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information of the structures, infrastructure, and critical facilities and potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

Due to the fact that debris flow events nearly always occur in conjunction with another natural hazard event, it is difficult to identify potential losses for debris flow independent of these other hazards. Specific loss information for local jurisdictions that identified this hazard as significant is found in their sections.

Assessing Vulnerability: Analyzing Development Trends

Any jurisdiction that is adjacent to a river, stream, or creek could be subject to a debris flow. Steep slopes throughout the county are also at risk. Debris-flow risk can be reduced by: (1) preventing debris from entering a stream or river channel, (2) trapping debris on a hillside, in the channel or in a debris basin before it reaches developed property; or (3) distributing or diverting debris on the alluvial fan away from structures.

Most of the debris in a debris flow is picked up as the flow moves down a stream channel; the debris collects in the channel from slope erosion or from other debris flows that did not make it to the mouth of the canyon. Development can increase vulnerability to erosion. Slope erosion can be reduced by terracing, reseeding after wild fires, and intelligent land use such as controlled grazing. Debris can be trapped using sediment fences on slopes, gabion baskets or check dams in channels, and debris basins on alluvial fans.

With proper design and construction, debris and water can be diverted away from buildings by a “plow-shaped” deflection wall, or debris can be trapped with a chain-link fence strengthened to hold the debris. Restrictions on building on slopes, near waterways, and on the alluvial fan will also diminish the risk.

Participating Jurisdictions has specific detailed information about the development trends for each participating municipality.

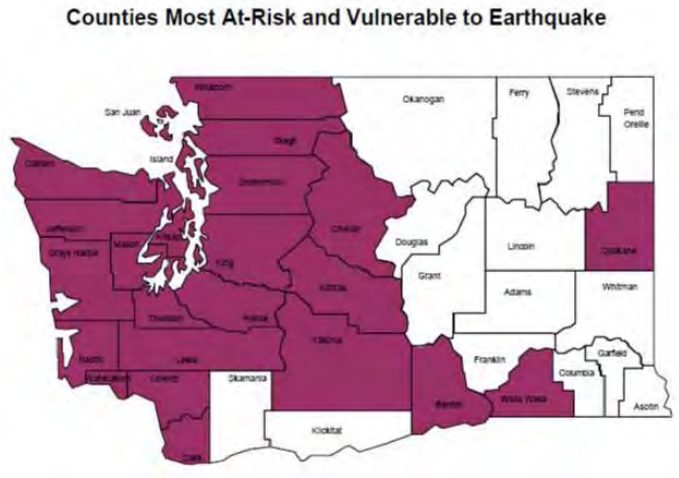
Multi-Jurisdictional Risk Assessment

While all areas within the scope of the plan are at some risk for debris flow, the towns of Pe Ell and Vader are both particularly vulnerable. The cumulative effect of debris flow (waters picking up debris as they flow) create a situation where the actions of one jurisdiction can directly impact the vulnerability of adjacent jurisdiction.

Resources

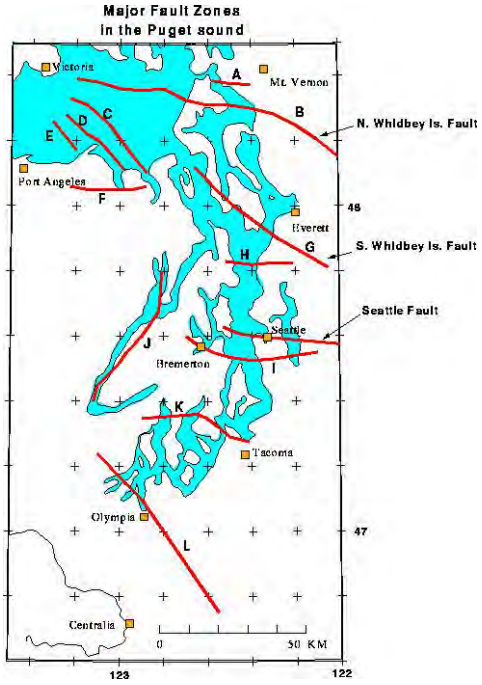
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Landslide_Hazard_Profile.pdf Accessed May 16, 2015.
- Oregon Department of Geology and Mineral Industries
- http://geology.utah.gov/online_html/pi/pi-70/debrisflow.htm

4.2.4 Earthquake



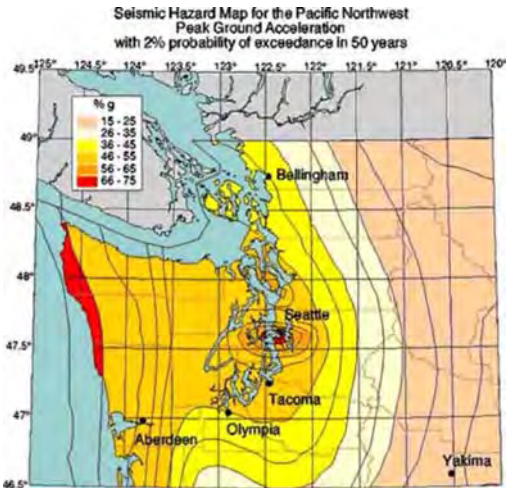
Hazard Profile

There are many faults in the Pacific Northwest that can produce damaging earthquakes, including hard-to-identify faults that exist entirely underground and have not been identified at the earth's surface. At the same time, some mapped faults have been located that have not generated earthquakes in recent geologic time. New faults continue to be discovered as more field observations and earthquake data are collected. (Map: Major Fault Zones in the Puget Sound. Source: Gower and others, 1985, "Seismotectonic Map of the Puget Sound Region, Washington", USGS Map I-1613).



There are three different sources for damaging earthquakes in the Pacific Northwest. The first of these is the "Cascadia Subduction Zone", a 1000 km long thrust fault which is the convergent boundary between the Juan de Fuca and North American plates and is the most extensive fault in the Pacific Northwest area. It surfaces about 50 miles offshore along the coasts of British Columbia, Washington, Oregon and northern California. No historic earthquakes have been directly recorded from this source zone. According to recent research, an earthquake estimated to be as large as 8.0 to 9.0 occurred in this zone in January of 1700.

The second source for damaging earthquakes is the Benioff Zone. This zone is the continuation of the extensive faulting that results as the subduction plate is forced into the upper mantle. The Benioff Zone can probably produce earthquakes with magnitudes as large as 7.5. Benioff Zone earthquakes are deeper than 30km.



(Map: Seismic Hazard Map for the Pacific Northwest. Source: U.S. Department of the Interior/U.S. Geological Survey URL: http://earthquake.usgs.gov/regional/pacnw/hazmap/

The third source consists of shallow crustal earthquake activity (depths of 0 to 20 km) within the North American continental plate where faulting is extensive. Recent examples occurred near Bremerton in 1997, near Duvall in 1996, off Maury Island in 1995, near Deming in 1990, near North Bend in 1945, just north of Portland

in 1962, and on the St. Helens seismic zone (a fault zone running north-northwest through Mount St. Helens) in 1981. Washington State Department of Natural Resources, Geology and Earth Resources Division states that all of these earthquakes were about M5–5.5.

Ground Shaking

The strength of ground shaking generally decreases with distance from the earthquake source, but locally can be much higher than adjacent areas, due to amplification. Strong shaking of long duration is one of the most damaging characteristics of great subduction zone earthquakes. Strong shaking is a hazard both near the epicenter of an earthquake and in areas where amplification occurs. West Seattle and certain areas of downtown Olympia are examples of places where ground motion has been documented as being significantly stronger than in adjacent areas during the same earthquake. Most of the damage and deaths in earthquakes are caused by strong ground motion.

Ground Failures

Ground failures accompanying earthquakes include fault rupture (surface faulting), ground cracking, subsidence, liquefaction, and landslides.

Richter Magnitude Damage Descriptions

Richter Magnitude	Description	Earthquake Effects
10.0+	Great	Never recorded, energy yield extremely high
9.0-9.9	Great	Devastating in areas several thousand miles across
8.0-8.9	Great	Can cause serious damage in areas of several hundred miles
7.0-7.9	Major	Can cause serious damage over larger areas
6.0-6.9	Strong	Can be destructive in areas up to about 100-miles across in population areas
5.0-5.9	Moderate	Can cause major damage to poorly constructed buildings over small regions. At most slight damage to well-designed buildings
4.0-4.9	Light	Noticeable shaking of indoor items, significant damage unlikely
3.0-3.9	Minor	Often felt, but rarely causes damage
2.0-2.9	Minor	Generally not felt, but recorded
0.0-2.0	Micro	Micro earthquakes, not felt
Source: USGS		

Historical Occurrences

The largest historic earthquake in Washington (estimated at M7.4), the North Cascades earthquake of 1872, is also thought to have been shallow. It may rank as Washington's most widely felt earthquake. Because of its remote location and the relatively small population in the region, though, damage was light.

Notable Earthquakes Felt in Lewis County

Date	Location of the Epicenter	Magnitude
February 18, 2015	Ellensburg, WA	4.3

June 26, 2013	Wenatachee Area, WA	4.3
February 14, 2011	Spirit Lake, WA (Mt. St. Helens)	4.3
November 16, 2010	Mossyrock Area, WA	4.2
January 30, 2009	Seattle-Tacoma Urban Area	4.5
June 20, 2003	Carnation, WA	3.6
May 30, 2003	Port Orchard, WA	3.7
September 21, 2002	Friday Harbor, WA	4.1
June 16, 2002	Kitsap Peninsula, WA	3.7
February 28, 2001	Nisqually, WA	6.8
May 18, 1980	Mount St. Helens, WA	5.0
April 29, 1965	Puget Sound, WA – Fatalities 7	6.5
April 13, 1949	Puget Sound, WA – Fatalities 8	7.1
December 15, 1872	Lake Chelan, WA	6.8
Source: U.S. Department of the Interior | U.S. Geological Survey , Accessed 2010 URL: http://earthquake.usgs.gov/regional/states/historical_state.php, Accessed 2010 http://pnsn.org/earthquakes/notable, Accessed: July 7, 2015		

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with earthquakes. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Earthquake Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Likely	Catastrophic
City of Centralia	Yes	Yes	Likely	Limited
City of Chehalis	Yes	Yes	Likely	Catastrophic
City of Morton	Yes	Yes	Likely	Severe
City of Mossyrock	Yes	Yes	Likely	Limited
City of Napavine	Yes	Yes	Possible	Limited
City of Toledo	Yes	Yes	Possible	Limited
City of Vader	Yes	Yes	Likely	Severe
City of Winlock	Yes	Yes	Likely	Catastrophic
Town of Pe Ell	Yes	Yes	Likely	Limited

Probability:

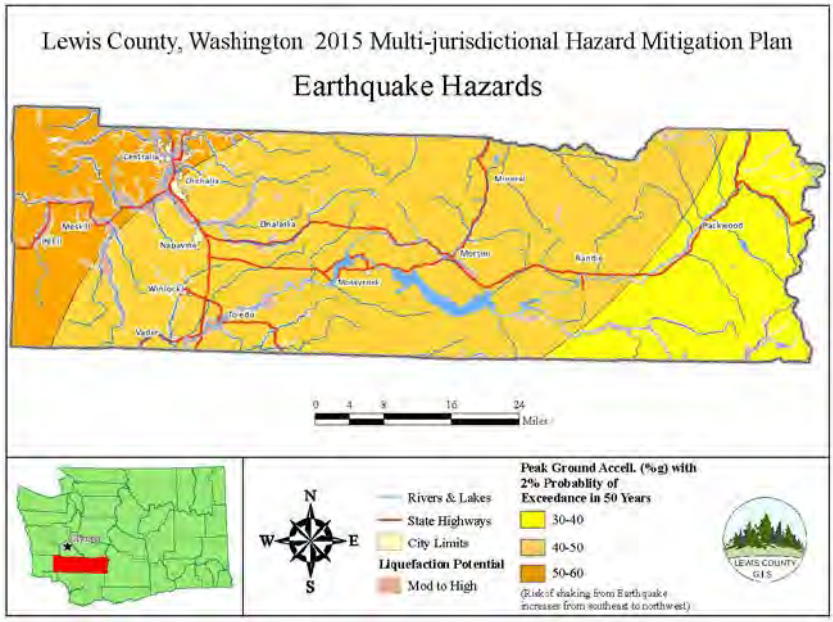
- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

The discover the damage from an earthquake view each Participant Section and review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.



Assessing Vulnerability: Estimating Potential Losses

Any structural development will be vulnerable to the losses sustained from earthquakes. However, the rarity of earthquake events keeps the vulnerability and losses negligible. Due to this and limited resources, it was not deemed necessary, nor even feasible, to assess the value of potential current or future losses associated from an earthquake event.

The effects of an earthquake may vary from unperceivable to near total destruction of the physical and economic infrastructure of the area. The effects are highly variable, depending on the magnitude, proximity to the population centers, depth, types of soil on which structures are located, local building codes, type of structures, time of day, and a host of other factors.

The principal ways in which earthquakes cause damage are by strong ground shaking, by the secondary effects of ground failures (surface rupture, ground cracking, landslides, liquefaction, subsidence), or by tsunamis. Most building damage is caused by ground shaking.

The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Most causalities result from falling materials. Other effects include, but are not limited to:

- Broken water and sewer mains
- Downed electric lines
- Cracked and partially displaced roadbeds and rail lines
- Loss of telephone or other telecommunication services
- Houses knocked off their foundations
- Partial or complete collapse of buildings, building facades, cornices, or chimneys
- Fires including urban conflagration
- Chemical spills
- Ruptured gas and oil pipelines

- River beds disrupted
- Broken or cracked dams with possible flooding
- Injury and death
- Psychological trauma
- Economic disruption
- Large numbers of displaced persons.

To assess risks and vulnerability, Lewis County GIS has utilized FEMA's loss-estimation model, HAZUS-MH (Version 1.3 MR3). The results using HAZUS-MH MR3 are summarized for the County and the individual municipal jurisdictions.

Assessing Vulnerability: Analyzing Development Trends

There is no human behavior or activity that can modify the area affected by earthquakes, thus earthquakes will always be capable of affecting the entire Planning Area. Lewis County and the municipalities will continue building in areas that are subject to earthquakes but will require all new structure to build according to the International Building Code earthquake standards. The Participating Jurisdictions has specific detailed information about the development trends for each participating municipality.

Resources

- *Washington State Enhanced Hazard Mitigation Plan*, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Earthquake.pdf Accessed May 12, 2015.
- Washington State Department of Natural Resources, Geology and Earth Resources Division; http://www.wa.gov/dnr/htdocs/ger/index.html
- Washington State Department of Transportation; http://www.wsdot.wa.gov
- University of Washington, Geophysics Program; http://www.geophys.washington.edu/
- United States Geological Survey; http://www.usgs.gov/
- Federal Emergency Management Agency; http:www.fema.gov/
- Pacific Northwest Seismic Network. Available at: http://pnsn.org/ Accessed July 7, 2015.

4.2.5 Extreme Heat

Profiling Hazard

Extreme heat is often associated with periods of drought and can be characterized by long periods of high temperatures in combination with high humidity. During these conditions, the human body has difficulties cooling through the normal method of the evaporation of perspiration. Health risks rise when a person is over exposed to heat. Extreme heat can also cause people to over use air conditioners, which can lead to power failures. Over the last 30 years, more people in the United States have died from extreme heat than from earthquakes, hurricanes, floods, lightning, and tornadoes combined. For the purposes of this plan, extreme heat has been treated as a separate hazard from drought due to the fact that long periods of high temperature and high humidity can occur during a non-drought period.

It was deemed, by a majority of the jurisdictions, that the planning area as a whole has not had previous occurrences of extreme heat. The probability of extreme heat to occur was viewed differently depending on the governmental agency. The extent was determined to be 'limited" or "none" by the participants.

There is no area within the region that is void from the effects from extreme heat periods. Although young children, elderly, and those working and living in non-air-conditioned environments are most vulnerable, no structures are at risk. With high temperatures, people are vulnerable to heatstroke, heat cramps, heat exhaustion, and loss of life. In addition, periods of extreme heat create a significant demand on utilities such as water and electricity which can cause a failure in the electrical system. With the high demand on energy, power loss could occur making an extreme heat event even more dangerous. Structures are not at risk during periods of extreme heat. However periods of extreme heat place a significant demand on utilities, such as water and electricity, which can cause a failure in the system. Power loss could occur with the high demand on energy, making an extreme heat event even more dangerous for the community.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in the plan dealing with an extreme heat event. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Extreme Heat Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	No	No	Unlikely	None
City of Centralia	No	No	Unlikely	None
City of Chehalis	No	No	Possible	Limited
City of Morton	No	Yes	Possible	Limited
City of Mossyrock	Yes	Yes	Likely	Severe

City of Napavine	No	No	Unlikely	None
City of Toledo	No	No	Unlikely	None
City of Vader	Yes	No	Possible	Limited
City of Winlock	No	No	Unlikely	None
Town of Pe Ell	No	No	Unlikely	None

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

Due to the nature of this hazard, no structures are at risk due to extreme heat.

Historical Occurrences

Some municipalities and jurisdictions identified extreme heat as a potential hazard. These communities cited previous occurrences, but no official instances have been recorded within the planning area.

Assessing Vulnerability: Estimating Potential Losses

The direct and indirect effects of extreme heat combined with the difficulty of placing value to losses of life create difficulty in calculating losses from this event. Losses such as power outages could affect businesses and critical facilities. There is not enough information available to quantify damages as a result of extreme heat Planning Area wide.

Assessing Vulnerability: Analyzing Development Trends

There is no human behavior or activity that can modify the area affected by extreme heat, thus extreme heat will always be capable of affecting the entire Planning Area. The primary risk of loss with this hazard is loss to human life.

The vulnerability to the planning area and the jurisdictions within could not be assessed further due to data limitations about the effects of extreme heat on power and water supply. Individual sections can provide detailed information about the development trends for each participating municipality.

Resources

- FEMA: http://www.fema.gov/hazard/heat/background.shtm
- NOAA's Weather Service: http://www.weather.gov/om/heat/index.shtml
- University of Washington Emergency Management: http://www.washington.edu/emergency/hazards/heat
- U.S. Drought Monitor: http://www.drought.unl.edu/dm/index.html

4.2.6 Flooding

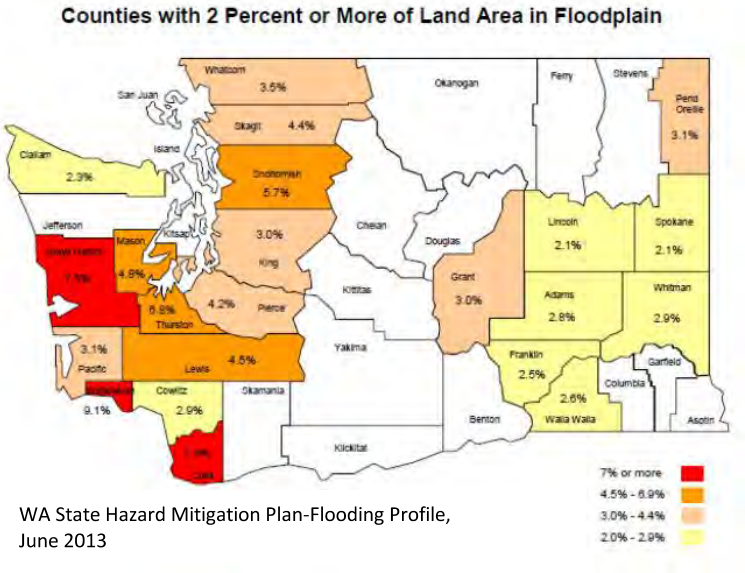
Hazard Profile

Flooding is the accumulation of water where there is usually none or the overflow of excess water from a stream, river, lake, reservoir, or coastal body of water onto adjacent floodplains. Floodplains are lowlands adjacent to water bodies that are subject to recurring floods.

Floods are natural events that are considered hazards only when people and property are affected. Nationwide, on an annual basis, floods have resulted in more property damage than any other natural hazard. Physical damage from floods includes the following:

- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Impact damage to structures, roads, bridges, culverts, and other features from high-velocity flow and from debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.
- Release of sewage and hazardous or toxic materials as wastewater treatment plants are inundated, storage tanks are damaged, and pipelines severed.

Floods also cause economic losses through closure of businesses and government facilities; disrupt communication; disrupt utilities such as water and sewer service; result in excessive expenditures for emergency response; and generally disrupt the normal function of a community.



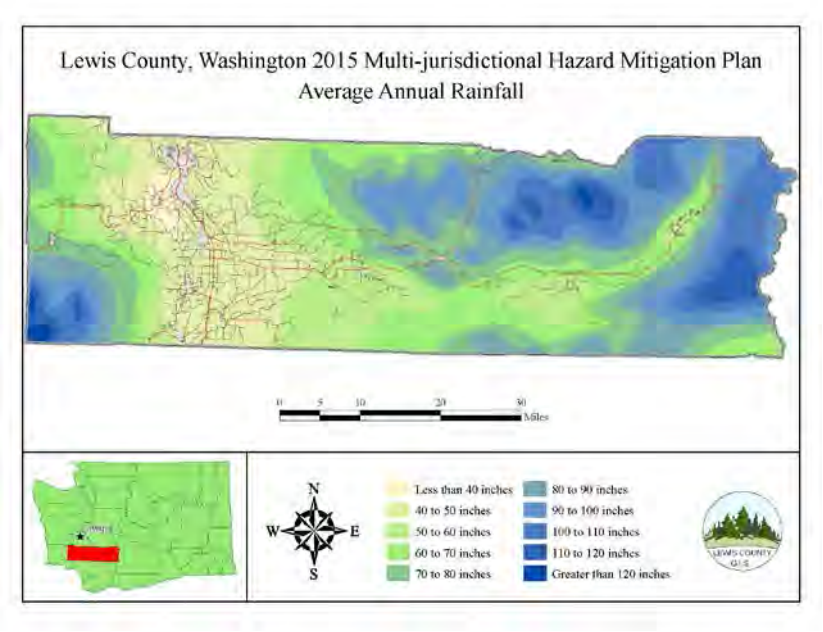
WA State Hazard Mitigation Plan-Flooding Profile, June 2013

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as stream flow gages, to determine the probability of occurrence for floods of different magnitudes. The probability of occurrence is expressed as a percentage for the chance of a flood of a specific extent occurring in any given year.

Factors contributing to the frequency and severity of flooding include the following:

- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount and type of vegetation, and density of development
- Changes in landscape resulting from wild fires (loss of moisture-trapping vegetation and increased sediment available for runoff)

- The existence of attenuating features in the watershed, including natural features such as swamps and lakes, and human-built features such as dams
- The existence of flood control features, such as levees and flood control channels
- Velocity of flow
- Availability of sediment for transport, and the erodibility of the bed and banks of the watercourse



These factors are evaluated using (1) a hydrologic analysis to determine the probability that a discharge of a certain size will occur, and (2) a hydraulic analysis to determine the characteristics and depth of the flood that results from that discharge.

The magnitude of flood used as the standard for floodplain management in the United States is a flood having a 1 percent probability of occurrence in any given year. This flood is also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRMs) prepared by FEMA. These maps are used to support the National Flood Insurance Program (NFIP). The FIRMs show 100-year floodplain boundaries for identified flood hazards. These areas are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for flood insurance and floodplain management requirements.

Source: Washington State Emergency Management Division Hazard Mitigation Plan, Oct 2013

Damage during a flood is typically caused by one of two river processes active during flooding. The first process is inundation, defined as floodwater and debris flowing through an area. Inundation occurs when the water in the river channel rises to the level where it flows over the riverbanks and onto the surrounding floodplain. The level of damage caused by inundation is determined by the velocity and depth of the water, the amount of debris in the water, and the level of development in the inundated area. Areas of flood inundation can be determined through hydrologic analysis and study of historical records. Inundation areas may vary from flood to flood because of the impact of different hydraulic responses from the river system or possible failures of flood control structures.

The second river process that causes damage during a flood is bank erosion. Bank erosion occurs when a river scours its banks, causing the channel to shift position. Sometimes the river will actually move to an entirely new channel during a flood. Bank erosion can also threaten structures high above the floodplain by undermining the bank near where the structure is located. Areas prone to bank erosion can be identified through mapping and hydrologic analysis, but the occurrence of channel migration and channel "jumps" cannot be predicted with confidence.

It was deemed, by both the public input and factual research that the planning area as a whole has had previous occurrences of flooding. The probability of flooding to occur again is 'highly likely' with a near 100% chance they will occur every year within the planning area. The extent varied depending on the jurisdiction some listed that it would be 'limited', as 0 to 25% of the planning area could be affected by a flooding event whereas others listed that it could be much more widespread in the area. Lewis County will continue to have flooding events because of its geography (numerous rivers), mountains, and low-lying areas.

Historical Occurrences

Flooding has been a historic problem in Lewis County, particularly with the Chehalis, Nisqually, and Cowlitz Rivers. Below in the table is the Summary of the Ten Peak Annual Flows for the major rivers in Lewis County.

Summary of Ten Peak Annual Flows

WRIA 11 Nisqually at National		WRIA Chehalis near Grand Mound		WRIA Newaukum at Chehalis		WRIA 26 Cowlitz at Packwood		WRIA 26 Cowlitz below Mayfield Dam*	
Date	Flows (cfs)	Date	Flows (cfs)	Date	Flows (cfs)	Date	Flows (cfs)	Date	Flows (cfs)
Nov-06	21,800	Dec-07	79,100	Feb-96	13,300	Nov -06	40,100	Nov-95	68,400
Feb-96	21,200	Feb-96	74,800	Jan 09	13,100	Dec-33	36,600	Dec-46	67,000
Dec-77	17,100	Jan-90	68,700	Dec07	12,900	Dec 77	36,200	Jan-65	64,700
Jan-74	15,000	Dec-07	62,700	Nov06	11,200	Nov-59	34,300	Dec-75	64,700
Jan-90	14,500	Nov86	51,600	Nov86	10,700	Feb-96	32,900	Nov-59	60,800
Dec-75	13,200	Jan-09	50,700	Jan-90	10,400	Nov-62	32,100	Dec-77	55,200
Dec-80	11,600	Jan-72	49,200	Dec77	10,300	Dec-75	30,600	Feb-51	51,200
Jan-75	11,000	Dec-3	48,400	Nov90	10,300	Dec-80	30,600	Dec-55	49,900
Nov-90	11,000	Nov90	48,000	Nov98	10,000	Dec-17	28,800	Nov-62	49,500
Nov-59	10,900	Dec-33	45,700	Jan-72	9,770	Nov-90	28,700	Dec-53	47,600

Source: USGS National Water Information System, Surface Water for Washington: Peak Streamflow, 2015
National Weather Service, National Oceanic and Atmospheric Administration. http://www.water.weather.gov/ Accessed July 2015.

In more than 30 years, Lewis County has experienced 19 federally declared disasters. Of these, 15 were either caused or exacerbated by flooding. These damage costs are approximate, and of primary and significant structures and businesses. Information about damages is collected by different agencies, and does not include unreported damages. The information is further confused when initial estimates of damage are refined. This can either result in a higher or lower value. At best, the primary damage was erosion of public infrastructures (riverbanks, roads, bridges, and revetments). Costs for public damages are based on actual costs or cost estimates reviewed by FEMA. Private costs are based on information provided by victims, Red Cross, and FEMA, and do not include any reduction in property values.

The scope of the flood damages is related to the magnitude of the flood and location. Low-lying areas, especially river valleys, have flooded regularly for hundreds of years. Final flood damage estimates in Lewis County totaled in the hundreds of millions. FEMA estimated the damages to be around $166

million to private and public property (Lewis County Health Department, February 10, 2008; Long Term Recovery Project). The 1996 flood event was also severe. It too affected interstate travel, thus making the associated damage costs (estimated up to $100 million) the one of the highest to date. The $30 million estimate given in the Table represents damage costs to public structures incurred within the County.

Assessing Vulnerability: Overview

The Composite Hazard Identification Table for Lewis County and the municipalities for flooding is listed below. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Presidential Declared Flood Disasters for Lewis County

Federal Declaration No.	Date	River/Area	Reported Public Damages ($)
DR-4056	March 2012	-	-
DR-1963	March 2011	-	-
DR-1817	Dec 2008	Chehalis	-
DR-1734	Dec 2007	Chehalis	166 M
DR-1172	March 1997	Cowlitz	9.4 M
DR-1159	Dec 96-Jan 1997	Chehalis, Cowlitz	3.2 M
DR-1100	Feb 1996	Chehalis, Cowlitz	30.0 M
DR-1079	Nov-Dec 1995	Cowlitz	12.0 M
DR- 981	Dec 1994	Chehalis	40,000
DR-0883	Dec 1990	Nisqually	700,000
DR-0883	Nov 1990	Chehalis	1.0 M
-	Feb 1990	Chehalis	200,000
DR-0852	Jan 1990	Chehalis	1.4 M
DR-784	Nov 1986	Chehalis	3.9 M
DR-545	Dec 1977	Cowlitz	1.3 M
DR-1079	Dec 1975	Cowlitz	50.2 M
DR-414	Jan 1974	-	-
DR-322	Jan 1972	Chehalis	2.0 M
-	Jan 1971	Chehalis	446,570

Source: FEMA's website: http://www.fema.gov/disasters/grid/state-tribal-government/89 Accessed: 7/12/2015

Flooding Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Highly Likely	Catastrophic
City of Centralia	Yes	Yes	Highly Likely	Limited
City of Chehalis	Yes	Yes	Highly Likely	Severe
City of Morton	Yes	Yes	Likely	Severe
City of Mossyrock	Yes	Yes	Likely	Limited
City of Napavine	Yes	Yes	Highly Likely	Limited
City of Toledo	Yes	Yes	Likely	Limited
City of Vader	Yes	Yes	Highly Likely	Limited
City of Winlock	Yes	Yes	Likely	Severe
Town of Pe Ell	Yes	Yes	Possible	Limited

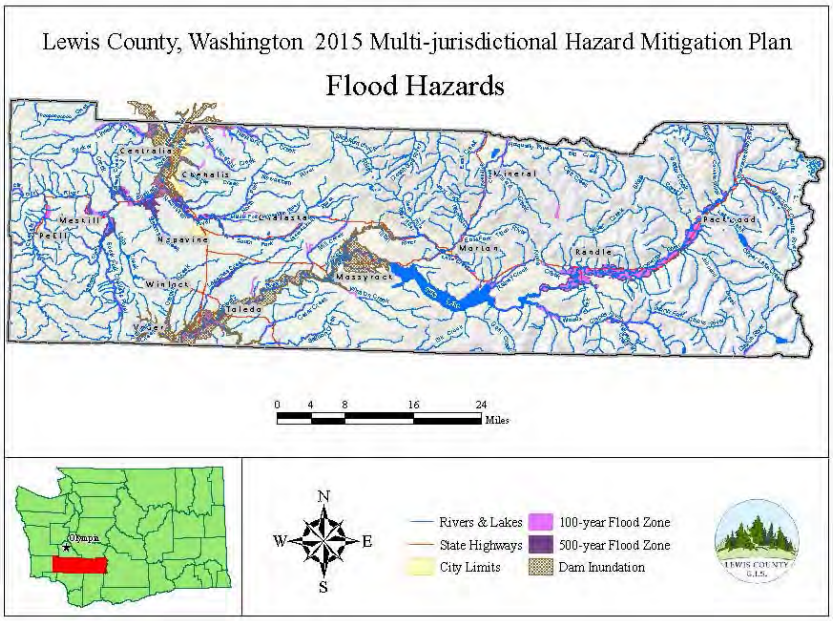
Probability:
- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:
- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected

- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

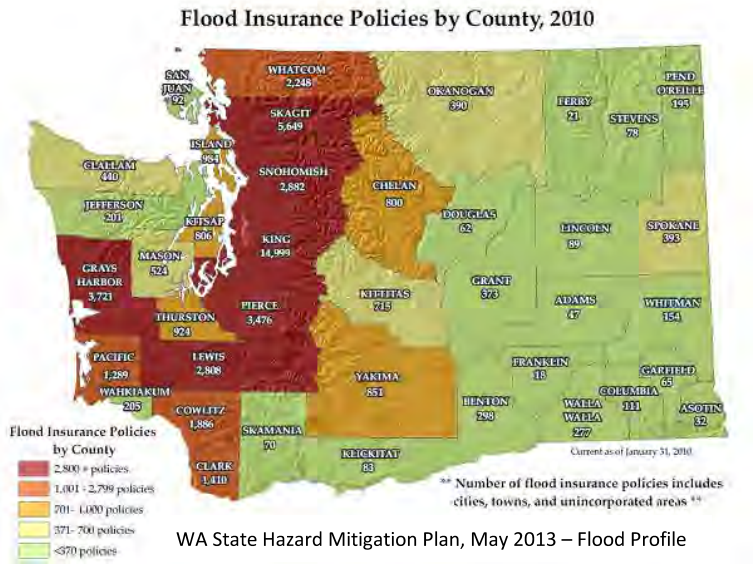
Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.



Assessing Vulnerability: Estimating Potential Losses

Floods are among the most frequent and costly natural disasters in terms of human hardship and economic loss. Flood damage costs are a way to compare the impacts of different size floods. Flood damage information was obtained by the US Army Corps of Engineers (USACE) from field investigations, damage survey reports, and personal interviews with homeowners, farmers, businessmen, and federal, state, county, city, and public utility officials. Eyewitness accounts of flooding and reports of damage in local newspapers were also used in identifying and quantifying flood damages.



WA State Hazard Mitigation Plan, May 2013 – Flood Profile

Precise information on private property damage is, for the most part, unavailable. FEMA collects several types of data for private property: human resources claims, and requests for short-term assistance and claims through the NFIP and the Small Business Administration (SBA). Human resource claims data and the damage reported in the newspapers are not necessarily alike. Human resource data are aggregated by zip code to protect the privacy of applicants, which makes it difficult to identify localized flood problems, trends, and causes.

Another factor to consider is the unreported private property damages. Flood insurance claims were either not filed due to lapsed flood insurance policies, or to fear of increased rates. Unfortunately, this is a common misconception; rates do not automatically increase based on submission of claims. In any case, the actual damages are likely understated and do not reflect the true magnitude of problems.

To assess risks and vulnerability, Lewis County GIS has utilized FEMA's loss-estimation model, HAZUS-MH (Version 1.3 MR3). The results using HAZUS-MH MR3 are summarized for the County and the individual municipal jurisdictions.

Assessing Vulnerability: Analyzing Development Trends

Flooding will happen again in most of Lewis County. The only question is when it will happen in the future. Floods affect many areas developed for businesses and homes, and they occur with more frequency than most other natural disasters. Based on the frequency of flooding in the past, the probability of future damaging floods is high.

Participating Jurisdictions has specific detailed information about the development trends for each participating municipality. Development trends differ for each jurisdiction some limit growth within the floodplain leaving open space areas, others limit growth based on the finish floor height (1-3 feet above the base flood elevation), others limit the amount of fill.

National Flood Insurance Program (NFIP)

The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements.

As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS:

1. Reduce flood losses;
2. Facilitate accurate insurance rating; and
3. Promote the awareness of flood insurance.

Credit points earned, classification awarded, and premium reductions given for communities in the National Flood Insurance Program Community Rating System

		Premium Reduction	
Credit Points	**Class**	**SFHA* Non**	**SFHA****
4,500+	1	45%	10%
4,000 – 4,499	2	40%	10%
3,500 – 3,999	3	35%	10%
3,000 – 3,499	4	30%	10%
2,500 – 2,999	5	25%	10%
2,000 – 2,499	6	20%	10%
1,500 – 1,999	7	15%	5%
1,000 – 1,499	8	10%	5%
500 – 999	9	5%	5%
0 – 499	10	0%	0%

*Special Flood Hazard Area

**Preferred Risk Policies are available only in B, C, and X Zones for properties that are shown to have a minimal risk of flood damage. The Preferred Risk Policy does not receive premium rate credits under the CRS because it already has a lower premium than other policies. The CRS credit for AR and A99 zones are based on non-SFHAs (B, C, and X). Credits are: classes 1-6, 10% and classes 7-9, 5%. Premium reductions are subject to change.

Source: FEMA - www.fema.gov/business/nfip/crs.shtm

For CRS participating communities, flood insurance premium rates are discounted in increments of 5%; i.e., a Class 1 community would receive a 45% premium discount, while a Class 9 community would receive a 5% discount (a Class 10 is not participating in the CRS and receives no discount). The CRS classes for local communities are based on 18 creditable activities, organized under four categories:

1. Public Information,
2. Mapping and Regulations,
3. Flood Damage Reduction, and
4. Flood Preparedness.

The Community Rating System (CRS) class is important because participating in CRS can reduce the amount of money that residents pay for flood insurance. A lower score provides a higher percentage reduction.

Each year, a jurisdiction must recertify by October 1st that it is continuing to implement the activities for which it has earned credit. Recertification is done on the recertification worksheet, AW-214, which is prepared by ISO and sent to the community each August. The recertification worksheet lists community data and the activities and elements the community is implementing for CRS credit. The table below shows the activities for which a community can receive points for as of October 1, 2007. Lewis County and the City of Chehalis are currently following the 2007 CRS Manual whereas the City of Centralia is following the 2013 edition. Lewis County is currently ranked a Class 6, and residents receive a 20 percent discount on flood insurance rates.

To calculate the number of points a municipality receives, a few term definitions are necessary:

- Series - The CRS activities are divided into four series: Public Information, Mapping and Regulation, Damage Reduction, and Flood Preparedness. Their titles are self-explanatory, and the credits within them follow the main objective of the titles.
- Activity - Each series has from three to six activities. Each activity has a title, such as "Additional Flood Data" or "Flood Warning Program." The titles are mostly self-explanatory, but they may include components that are not specifically named in the title. At the end of the credit calculation process, the credits for all activities are added together to get the community's total score.
- Elements - Within each activity, there are one or more elements. These are discrete pieces of a community's floodplain management program, and each receives a certain number of credit points.

The first step is to review each activity proposed by the community for adequacy and completeness. Under each activity in the CRS Schedule is a section entitled "Credit Points." Each element has a maximum number of credit points that can be earned if the element is being implemented to certain standards throughout the community or throughout the floodplain. A community will receive less than the maximum points if its program does not include all the elements listed in the Credit Points section.

CRS Annual Certification	
Activity #	**Activity Description**
Public Information Activities (Series 300)	
310	(Elevation Certificates) Maintain FEMA elevation certificates for all new construction. Maintaining them after the date of CRS application is a minimum requirement for any CRS credit.
310	(Map Information) Respond to inquiries to identify a property's FIRM zone and publicize this service.

CRS Annual Certification	
Activity #	**Activity Description**
330	(Outreach Projects) Send information about the flood hazard, flood insurance, and flood protection measures to flood prone residents or all residents of the community.
340	(Hazard Disclosure) Real estate agents advise potential purchasers of flood prone property about the flood hazard; or regulations require a notice of the flood hazard.
350	(Flood Protection Information) The public library maintains references on flood insurance and flood protection.
360	(Flood Protection Assistance) Give inquiring property owners technical advice on protecting their buildings from flooding, and publicize this service.
Mapping and Regulatory Activities (Series 400)	
410	(Additional Flood Data) Develop new flood elevations, floodway delineations, wave heights, or other regulatory flood hazard data for an area that was not mapped in detail by the flood insurance study; or have the flood insurance study's hydrology or allowable floodway surcharge based on a higher state or local standard.
420	(Open Space Preservation) Guarantee that a portion of currently vacant floodplain will be kept free from development.
430	(Higher Regulatory Standards) Require freeboard; require soil tests or engineered foundations; require compensatory storage; zone the floodplain for minimum lot sizes of 1 acre or larger; regulate to protect sand dunes; or have regulations tailored to protect critical facilities or areas subject to special flood hazards (e.g., alluvial fans, ice jams, or subsidence).
440	(Flood Data Maintenance) Keep flood and property data on computer records; use better base maps; or maintain elevation reference marks.
450	(Stormwater Management) Regulate new development throughout the watershed to ensure that post-development runoff is no worse than pre-development runoff.
Flood Damage Reduction Activities (Series 500)	
510	(Floodplain Management Planning) Prepare, adopt, implement, and update a comprehensive plan using a standard planning process.
520	(Acquisition and Relocation) Acquire and/or relocate floodprone buildings so that they are out of the floodplain.
530	(Flood Protection) Document flood proofed or elevated pre-FIRM buildings.
540	(Drainage System Maintenance) Conduct periodic inspections of all channels and retention basins and perform maintenance as needed.
Flood Preparedness Activities (Series 600)	
610	(Flood Warning Program) Provide early flood warnings to the public and have a detailed flood response plan keyed to flood crest predictions.
620	(Levee Safety) Maintain levees that are not credited with providing base flood protection.
630	(Dam Safety) All communities in a State with an approved dam safety program receive credit.

Jurisdiction's NFIP Participation

Lewis County Communities – NFIP Program 2015 Status						
CID #	**NFIP Status**	**Jurisdiction**	**Initial FHBM Identified**	**Initial FIRM Identified**	**Current Effective Map Date**	**Reg-Emer Date**
530102	Participating	Lewis County	11/29/1977	12/15/1981	7/17/2006	12/15/1981
530103	Participating	Centralia	3/15/1974	6/1/1982	6/1/1982	6/1/1982
530104	Participating	Chehalis	6/7/1974	5/1/1980	7/17/2006	5/1/1980
530105	Participating	Morton	5/24/1974	12/4/1979	3/2/1982	12/4/1979
	Not in NFIP	Mossyrock				
530254	NOT in NFIP	Napavine	2/14/1975	7/17/2006	7/17/2006	Sanctioned 2/14/1976

530296	Participating	Pe Ell	7/18/1975	3/04/1980	3/04/1980	3/04/1980
530303	Participating	Toledo	7/11/1975	11/5/1980	11/5/1980	11/19/1980
530266	Participating	Vader	9/5/1975	9/14-1979	9/14/1979	1/17/1997
530306	Participating	Winlock	7/18/1975	9/14/1979	9/14/1979	9/14/1979
Source: FEMA http://www.fema.gov/cis/WA.pdf Accessed 7/7/2015.						

Community Name	Date Participating in the NFIP	Number of NFIP Policies	Insurance in Force (Total coverage)	Number of Claims Paid Since 1978	Total Paid Since 1978	Number of Repetitive Losses	CAV Date	FIRM Date	Participating in CRS
Lewis County	12/15/81	1380	$272,959,900	631	$20,635,179.93	137	3/24/2000	7/17/2006	Yes
Centralia	6/1/82	1049	$198,873,600	663	$24,435,760.91	133	6/7/2005	6/1/1982	Yes
Chehalis	5/1/80	332	$67,246,600	440	$26,242,335.82	189	3/26/2004	7/17/2006	Yes
Morton	12/4/79	4	$1,120,000	0	$0	0	1/1/1993	3/2/1982	No
Toledo	11/19/80	32	$6,542,700	3	$75,538.10	0	-	11/5/1980	No
Vader	1/17/97	2	$235,800	0	$0	0	-	9/14/1979	No
Winlock	9/14/79	2	$575,400	1	$859.31	0	-	9/14/1979	No
Town of Pe Ell	3/4/80	7	$1,495,400	1	$37,770.81	0	5/20/1994	3/4/1980	No
County Total	-	2808	$549,049,400	-	$71,427,445	459	-	-	-
Numbers from 2010 Plan									

NFIP Repetitive Loss List (Structures)

Repetitive flooding is a priority for FEMA and the National Flood Insurance Program (NFIP). FEMA defines a Repetitive Loss (RL) property as any insurable building for which two or more claims of more than *$1,000* were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP.

As of December, 2011, Lewis County has fifty-three (53) of which 34 are unmitigated, Centralia has sixty-four (64), and Chehalis has sixty-five (65) repetitive loss properties. The County and cities address repetitive loss properties that are residential by elevating, relocating or buying out the homes. These remedies are usually addressed through the Flood Hazard Mitigation Grant funds or by the property owner.

For, CRS purposes, there are three categories of repetitive loss communities based on the number of properties on the updated repetitive loss list (i.e. after the changes and updates have been reported and accepted by FEMA):
Category A: A community that has no repetitive loss properties, or whose repetitive loss properties all have been mitigated.
Category B: A community with at least one, but fewer than 10, repetitive loss properties that have not been mitigated. At each verification visit a Category B community must
a) Prepare a map of the repetitive loss area(s)
b) Review and describe its repetitive loss problem,
c) Prepare a list of the addresses of all properties with insurable buildings in those areas, and
d) Undertake an annual outreach project to those addresses. A copy of the outreach project is submitted with each year's recertification.
Category C: A community with 10 or more repetitive loss properties that have not been mitigated. A Category C must
a) Do the same things as a Category B community, and
b) Prepare a floodplain management plan or area analyses for its repetitive loss area(s). The plan and area analysis requirements are explained in Activity 510. CRS Coordinator's Manual. Page 500-7 Edition:2013

The County and cities in the past have worked with property owners to elevate, relocate, flood-proof or purchased. The County and cities understand that many repetitive loss properties were constructed prior to the adoption of the floodplain regulations. Governmental agencies are working with the existing commercial buildings that are located in the floodplain to reduce flood losses by developing an emergency flood plan as well as encouraging property owners to flood-proof their structures. Maps are

attached identifying the locations within the community of where the Repetitive Loss Properties are located in each jurisdiction's section.

Lewis County Repetitive Loss Analysis

#	Mitigated	Insured	Address	Area	#	Mitigated	Insured	Address	Area
1	M		XXX BIG HANAFORD RD		27	U		XXX LINCOLN CREEK RD	
2	M		XXX LINCOLN AVE		28	U		XXX JOPPISH RD	
3	M		XXX LINCOLN AVE		29	U		XXXX PACIFIC AVE	
4	M		XXX UNION AVE		30	U		XXX GROVE ST	
5	M		XXX OTTO RD		31	U		XXXX BUNKER CREEK RD	
6	M		XXXX A ST HWY 6		32	U		XXX LITERAL RD	
7	M		XXX SW HILLBURGER RD		33	U		XXXX RIVERSIDE RD	
8	M		XXX SHOREY RD		34	U		XXXX RIVERSIDE RD	
9	M		XXX TUNE RD		35	U		XXX SW HILLBURGER RD	
10	M		XXXX ST HWY 6		36	U		XXX SHOREY RD	
11	M		XXX BUNKER CREEK RD		37	U		XXXX CERES HILL RD	
12	M		XXX BOISTFORT RD		38	U		XXXX RICE RD	
13	M		XXX C STOVER RD		39	U		XXXX A RICE RD	
14	M		XXX ST ROUTE 131		40	U		XXXX RICE RD	
15	M		XXX HAMPTON RD		41	U		XXX TIMBERLINE DR	
16	M		XXX SKINNER RD		42	U		XXX TAUSCHER RD	
17	M		XXX LANCIE RD		43	U		XXXX JACKSON HWY	
18	M		XXX SKINNER RD		44	U		XXX NORTH FORK RD	
19	M		X STATE ROUTE 131		45	U		XXX BOISTFORT RD	
20	U		XXX INDEPENDENCE RD		46	U		XXX GUERRIER RD	
21	U		XXX STATE HWY 507		47	U		XXX ST ROUTE 131	
22	U		XXX BIG HANAFORD RD		48	U		XXX CLINE RD	
23	U		XXX LINCOLN AVE		49	U		XXX CISPUS RD	
24	U		XXX UNION AVE		50	U		XXX KAREN RD	
25	U		XXXX HOWARD RD		51	U		XXX SKINNER RD	
26	U		XXX JOPPISH RD		52	U		XXX LANCIE RD	

Map of Repetitive Loss Properties and Areas are located in the Lewis County Section

Total RLP Properties – 52
Residential Properties: 51
Commercial Properties: 1
Total # of Severe Repetitive Loss Properties – 4

Flood Insurance Coverage in Lewis County, as of May 31, 2014
(Flood Management Analysis-Lewis County, French & Associates, LTD. Dated October 8, 2014)

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
AO1-30 & AE Zones	**496**	**$409,092**	**$83,904,800**	**419**	**$15,702,615.35**	**$499,247.19**
A Zones	**103**	**$90,303**	**$16,297,700**	**48**	**$1,477,3613.31**	**$46,614.71**
AO Zones	**31**	**$29,155**	**$4,759,700**	**0**	**$0**	**$0**
AH Zones	**1**	**$1,291**	**$1,000,000**	**0**	**$0**	**$0**
B, C, & X Zones						
Standard	**43**	**$49,296**	**$8,089,100**	**39**	**$1,108,714.41**	**$39,136.94**
Preferred	**559**	**$241,348**	**$160,103,000**	**78**	**$2,951,505.89**	**$119,949.79**
Total	**1,233**	**$820,485**	**$274,154,300**	**584**	**$21,240,195**	**$704,946**

CRS Data - 2015

CRS Rating 2015 – Class 6 – 20% premium reduction
Number of Building in the SFHA:
Acres of the SFHA in the City Limits:

Lewis County BECEGS Report Summary – March 2013

The Washington Surveying and Rating Bureau prepares reports for participating communities using the Building Code Effectiveness Grading Schedule (BCEGS). BCEGS looks at building code requirements designed to mitigate losses from natural hazards.

BCEGS Class: 4/3 (Residential Other)

Code Activity	Score	Max	Percent
Administration of Codes Section Total	38.6	54.0	71%
Plan Review Section Total	18.3	23.0	80%
Field Inspection Total	22.5	23.0	98%

Adjustment for non-adoption of residential sprinklers	.95		
Total	75.4	100.0	75%

In 2014, French & Associates, LTD of Steilacoom, Washington was contracted by the Flood Authority to perform an analysis of local floodplain management programs to see how communities could strengthen their programs. Lewis County's recommendations from the report included the following:

1. Continue efforts to get updated and accurate mapping
2. Continue supporting programs promoting open space in floodplain areas
3. Review ordinance revisions needed to comply with the NFIP
4. Proceed with developing a coordinated shoreline master program
5. Formally adopt the current Western Washington Stormwater Manual
6. Staff should follow through with intent to attend training
7. Continue to advise residents of the flooding hazard
8. Support efforts to educate insurance agents
9. Support a joint effort to improve hazard mitigation grants
10. Review current outreach projects in light of the new CRS Manual
11. The new CRS Coordinator should become familiar with the program
12. Review current programs in light of the new CRS Manual

City of Centralia Repetitive Loss Analysis

#	Mitigated	Insured	Address	Area	#	Mitigated	Insured	Address	Area
1	YES-Dem	NO	XXXX LENORE ST	DEM	34	NO	YES	XXX COURTLAND	14
2	YES	NO	XXXX LONG RD	1	35	NO-Com	YES	XXX W MAIN ST	12
3	YES-Rai	YES	XXX STATE ST	4	36	YES	YES	XXXX LONG RD	1
4	NO	SDF	XXXX LAKE SHORE DR	14	37	YES	YES	XXX W 7TH ST	11
5	YES-Com	YES	XXX HARRISON AVE	7	38	NO-Com	YES	XXXX ECKERSON RD	7
6	NO	YES	XXXX BROTHERSON RD	1	39	YES	YES	XXX E OAKVIEW AVE	8
7	YES	YES	XXXX HOWARD AVE	8	40	NO	SDF	XXXX GRAND AVE	6
8	NO-Com	NO	XXXX GRAND AVE	DEM	41	YES-Rai	YES	XXX BRYDEN AVE	2
9	YES	NO	XXXX WOODLAND AVE	DEM	42	YES	NO	XXX LAKE SHORE DR	14
10	NO-Com	SDF	XXXX LAKE SHORE DR	14	43	YES-Rai	YES	XXXX W PLUM ST	14
11	NO	NO	XXX HARRISON AVE	DEM	44	NO	YES	XXXX W 1ST ST	7
12	NO	No SDF	XXXX SOUTHGATE DR	2	45	NO-Com	NO	XXX N GOLD ST	10
13	YES	YES	XXXX SHAMROCK DR	3	46	YES	YES	XXX HEMLOCK ST	14
14	NO-Com	YES	XXX HARRISON AVE	7	47	YES-Rai	NO	XXX COURTLAND ST	14
15	NO	NO	XXX W MAGNOLIA ST-MFR	12	48	NO	YES	XXXX N PEARL ST	13
16	YES-Rai	YES	XXXX EUREKA AVE	8	49	YES	YES	XXXX SHAMROCK DR	3
17	YES-Dem	NO	XXXX LONG RD	1	50	YES-Rai	YES	XXX WILLOW LN	13
18	NO-Com	NO	XXXX NATIONAL AVE	6	51	NO	NO	XXX HEMLOCK ST	14
19	YES-Rai	NO	XXXX W MAIN ST	13	52	NO	YES	XXXX LEWIS ST	13
20	YES	YES	XXXX EUREKA AVE	8	53	NO	YES	XXXX W MAIN ST	13
21	YES	YES	XXXX LONG RD	1	54	YES-Rai	YES	XXX YEW ST	14
22	YES-Rai	YES	XXXX HOWARD AVE	8	55	NO	YES	XXX TILLEY AVE	17
23	NO	YES	XXX LAKE SHORE DR	14	56	NO	YES	XXXX SOUTHGATE DR	2
24	YES	YES	XXXX H ST	11	57	NO	YES	XXX CENTRALIA COLLEGE BLVD	12
25	YES	NO	XXXX SEWARD AVE	9	58	NO	YES	XXXX NW AIRPORT WAY	NIC
26	YES-Rai	NO	XXX PURVIS AVE	9	59	NO	YES	XXXX SOUTHGATE DR ST	2
27	NO-Com	SDF	XXX E UNION ST	6	60	NO-Com	YES	XXX STATE ST	4
28	YES	YES	XXXX HOWARD AVE	8	61	NO	YES	XXXX MILITARY RD	3
29	YES	YES	XXXX SHAMROCK DR	3	62	YES	YES	XXX E BRIDGE ST	7
30	NO	NO	XXXX LONG RD	DEM	63	NO	YES	XXXX KRESKY AVE	6
31	NO	NO	XXXX SOUTHGATE DR	2	64	YES-Rai	NO	XXX YEW ST	14

32	NO	YES	XXX LONG RD	1	65				
33	YES-Rai	YES	XXXX N TOWER AVE	11					

Mitigated: Dem (Demolished), Rai – (Elevated), Com (Commercial), NIC (Not in Centralia)

Map of Repetitive Loss Properties and Areas are located in the City of Centralia Section

Total RLP Properties – 64
Residential Properties: 55
Commercial Properties: 9
Total # of Severe Repetitive Loss Properties: 6

Flood Insurance Coverage in Centralia, as of May 31, 2014
(Flood Management Analysis-Centralia, French & Associates, LTD. Dated September 16, 2014)

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
AO1-30 & AE Zones	559	$493,109	$105,508,800	542	$20,855,637.52	$606,898.70
A Zones	0	$0	$0	17	$205,983.71	$7,450.00
AO Zones	0	$0	$0	0	$0	$0
AH Zones	0	$0	$0	0	$0	$0
B, C, & X Zones						
Standard	23	$34,222	$5,144,400	60	$2,538,519.46	$68,845.81
Preferred	328	$140,445	$82,921,000	51	$1,466,760.91	$54,521.86
Total	910	$667,776	$193,646,200	670	$25,066,899	$737,714

Causes of Repetitive Loss and Repetitive Loss Areas in Centralia

Total Properties in Centralia's Repetitive Loss Area(s) - 272

Area 1: 18 properties – Area 1 is located on Long road. It is subject to flooding from the Chehalis River overflowing its banks and going over the Long Road Levee and around the Interstate at Mellen Street. Once this occurs, water will follows the lowest contours until it returns to the Chehalis River channel or goes into the ground. A number of homes have been elevated in this neighborhood or purchased to resolve the flooding issue.

Area 2: 16 properties – Area 2 is located by Bryden Avenue and Southgate road. This are floods when the Chehalis river overflows its banks. The water follows the lowest contours which go right through this area. Most of the homes that flood have been raised in the past.

Area 3: 30 properties – Area 3 is adjacent to Shamrock and Military drives. Area 3 is subject to flooding from the Chehalis River overflowing its banks. Once this occurs, water will follows the lowest contours until it returns to the Chehalis River channel. This area also floods because of the narrowness of the Mellen Street Bridge and elevation of the ground in your area. A number of homes have been elevated in this area to resolve the flooding issue.

Area 4: 4 properties – Area 4 is located adjacent to Kresky and Grand roads. This Area is subject to flooding from the Chehalis River and Salzer Creek overflowing its banks and not able drain back into the Chehalis River Channel because of the high water levels. Once this occurs, water will follows the lowest contours until it returns to the Chehalis River channel or goes into the ground. A number of homes have been elevated in the area or purchased to resolve their flooding issue. A number of businesses in the area have been flood proofed

Area 5: 5 properties – Area 5 is located on Woodland Avenue. It is subject to flooding from the Chehalis River overflowing its banks and going over the Long Road Levee and around the Interstate at Mellen Street. Once this occurs, water will follows the lowest contours until it returns to the Chehalis River channel or goes into the ground. A number of homes have been elevated in this neighborhood or purchased to resolve the flooding issue.

Area 6: 16 properties – Area 6 is located adjacent to Kresky and Grand roads. This Area is subject to flooding from the Chehalis River and Salzer Creek overflowing its banks and not able drain back into the Chehalis River Channel because of the high water levels. Once this occurs, water will follows the lowest contours until it returns to the Chehalis River channel or goes into the ground. A number of homes have been elevated in the area or purchased to resolve their flooding issue. A number of businesses in the area have been flood proofed.

Area 7: 17 properties – Area 7 is located on Harrison road. This area floods when the Skookumchuck River overflows its banks and the water flows towards the Chehalis River across Hayes Lake. This area backs up because of the Skookumchuck bridge constriction and the high level of the Chehalis river.

Area 8: 28 properties – Area 8 is located in the northeast corner of the City of Centralia this area floods because the Skookumchuck River overflows its banks and it follows the lowest contours until it can reach Coffee Creek or return to the Skookumchuck river or goes into the ground. A number of homes have been elevated in the area to resolve their flooding issue.

Area 9: 18 properties – Area 9 is located in the northeast corner of the City of Centralia this area floods because the Skookumchuck River overflows its banks and it follows the lowest contours until it can reach Coffee Creek or return to the river or goes into the ground. A number of homes have been elevated in the area to resolve their flooding issue.

Area 10: 7 properties - Area 10 is adjacent to China Creek and the Agnew mill ponds. This area floods when water overflows China Creek's banks. China Creek is part of the City's stormwater system and when heavy rains occur and we experience urban flooding.

Area 11: 30 properties - Area 11 is located in south of Skookumchuck river by 6th and 7th streets. This area floods because the Skookumchuck River overflows its banks or goes around the 25-year levee and it follows the lowest contours until it can reach the river or goes into the ground. A number of homes have been elevated in the area to resolve their flooding issue.

Area 12: 30 properties - Area 12 is adjacent to China Creek and this area floods when the creek overflows its banks. China Creek is part of the City's stormwater system and when heavy rains occur and we experience urban flooding.

Area 13: 24 properties - is located by Plummer's and Hayes' lakes. This area floods when the Skookumchuck river overflows its bank which raises Hayes and Plummer's lake and then it combines with China creek which is also flooding. Many homes in this area have been raised in the past.

Area 14: 35 properties - is located by Plummer's and Hayes' lakes. This area floods when the Skookumchuck river overflows its bank which raises Hayes and Plummer's lake and then it combines with China creek which is also flooding. Many homes in this area have been raised in the past.

CRS Data - 2015

- CRS Rating 2015 – Class 6 – 20% premium reduction (November 5, 2015)
- Number of Building in the SFHA: 1490 (1,143 residential + 347 non-residential)
- Acres of the SFHA in City Limits: 1787
- Acres in the City's Zero Rise Area: 426 (294 Residential+132 non-residential)
- Total NFOS in acres: 146.79
- Total Open Space Preserved in SFHA in the City Limits: 369 acres

Centralia BECEGS Report Summary – June 2014

The Washington Surveying and Rating Bureau prepares reports for participating communities using the Building Code Effectiveness Grading Schedule (BCEGS). BCEGS looks at building code requirements designed to mitigate losses from natural hazards.

BCEGS Class: 3 (Residential: Class 3, Commercial/Industrial: Class 3)

Code Activity	Score	Max	Percent
Section 1: Administration of Codes Section Total	39.81	54.0	73.2
Section 2: Plan Review Section Total	21.36	23.0	92.9
Section 3: Field Inspection Total	22	23.0	95.7
Adjustment for non-adoption of residential sprinklers			
Total	83.17	100.0	83.2%

In 2014, French & Associates, LTD of Steilacoom, Washington was contracted by the Flood Authority to perform an analysis of local floodplain management programs to see how communities could strengthen their programs. Centralia's recommendations from the report included the following:

1. Continue efforts to get updated and accurate mapping
2. Revise ordinance to comply with the NFIP
3. Continue to enforce floodplain management criteria in other regulations
4. Proceed with developing a coordinated shoreline master program
5. Formally adopt the current Western Washington Stormwater Manual
6. Continue to advise residents of the flooding hazard
7. Educate insurance agents
8. Continue to implement hazard mitigation plans' recommendations
9. Update the County Hazard Mitigation Plan by 2015 with Lewis County
10. Support a joint effort to improve hazard mitigation grants
11. Review current outreach projects in light of the new CRS Manual

City of Chehalis Repetitive Loss Analysis

#	Mitigated	Insured	Address	Area	#	Mitigated	Insured	Address	Area
1	X		XXX NW FLORIDA AVE		34			XXX SW NEWAUKUM AVE	
2	X		XXX SW RIVERSIDE DRIVE		35			XXX SW CHEHALIS AVE	
3			XXX SW ELZINA ST		36			XXX N NATIONAL AVE	
4	X		XXX SW JAMES ST		37			XXX N NATIONAL AVE	
5			XXX SW PACIFIC AVE		38	X		XXX SW NEWAUKUM AVE	
6			XXX SW NEWAUKUM AVE		39			XXX SW CHEHALIS AVE	
7			XXX SW 3RD ST		40			XXX NW FLORIDA AVE	
8			XXX SW ELZINA ST		41			XXX SW NEWAUKUM AVE	
9	X		XXX SW RIVERSIDE DR		42	X		XXX SW JAMES ST	
10			XXX SW CHEHALIS AVE		43			XXX SW CHEHALIS AVE	
11			XXX NE KRESKY AVE		44			XXX N NATIONAL AVE	
12			XXX SW PACIFIC AVE		45			XXX SW RIVERSIDE DR	
13			XXX SW 3RD ST		46			XXX SW CHEHALIS AVE	
14			XXX N NATIONAL AVE		47			XXX NW SHORELINE DR	
15			XXX SW 3RD ST		48	X		XXX NW PRINDLE ST	

16			XXX SW 3RD ST		49	X		XXX NW PRINDLE ST	
17			XXX SW 3RD ST		50			XXX SW CHEHALIS AVE	
18			XXX SW NEWAUKUM AVE		51			XXX AIRPORT RD	
19			XXX SW 3RD ST		52	X		XXX SW JAMES ST	
20			XXX NW OREGON WAY		53	X		XXX SW JAMES ST	
21			XXX NW LAKE ST		54			XXX SW THOMSEN AVE	
22			XXX SW ELZINA ST		55			XXX NW PRINDLE ST	
23			XXX NW FLORIDA AVE		56			XXX SW CHEHALIS AVE	
24			XXX SW NEWAUKUM AVE		57			XXX N NATIONAL AVE	
25			XXX SW 3RD ST		58			XXX NW RIVER ST	
26			XXX SW JAMES ST		59			XXX SW JAMES ST	
27			XXX SW PACIFIC ST		60			XXX INTERSTATE AVE	
28			XXX SW 3RD ST		61			XXX SW JAMES ST	
29			XXX SW 3RD ST		62			XXX SW JAMES ST	
30			XXX SW 3RD ST		63			XXX SW 3RD ST	
31			XXX NE MEDIAN RD		64			XXX NW PRINDLE ST	
32			XXX NW MARYLAND AVE		65			XXX SW Thomsen Ave	
33			XXX NW RIVER ST						

Mitigated: Dem (Demolished), Rai – (Elevated), Com (Commercial), NIC (Not in Chehalis)

Map of Repetitive Loss Properties and Areas are located in the City of Chehalis Section

Total RLP Properties: 65
Residential Properties: 59
Commercial Properties: 6
Total # of Severe Repetitive Loss Properties: 11

Flood Insurance Coverage in Chehalis, as of May 31, 2014
(Flood Management Analysis-Chehalis, French & Associates, LTD. Dated October 8, 2014)

	Policies in Force	Premium	Insurance in Force	Number of Closed Paid Losses	$ of Closed Paid Losses	Adjustment Expense
AO1-30 & AE Zones	**207**	**$295,168**	**$50,837,100**	**404**	**$22,534,534.89**	**$621,009.75**
A Zones	**0**	**$0**	**$0**	**2**	**$17,210.06**	**$760.00**
AO Zones	**0**	**$0**	**$0**	**0**	**$0**	**$0**
AH Zones	**4**	**$17,880**	**$1,631,100**	**1**	**$685,800.16**	**$14,668.50**
B, C, & X Zones						
Standard	**8**	**$12,242**	**$1,950,400**	**19**	**$3,679,643.06**	**$38,920**
Preferred	**33**	**$15,247**	**$8,524,000**	**8**	**$177,520.70**	**$7,982.53**
Total	**252**	**$340,537**	**$82,942,600**	**434**	**$27,094,707**	**$683,339**

Causes of Repetitive Loss and Repetitive Loss Areas in Chehalis

Total Properties in Chehalis' Repetitive Loss Area(s) – 65

Flooding occurs when climate (or weather patterns), geology, and hydrology combine to create conditions where river and stream waters flow outside of their usual course and "overspill" beyond their banks. In the City of Chehalis, the combination of these factors, including ongoing development, create seasonal flooding conditions.

Flooding is most common from October through April, when storms from the Pacific Ocean, bring intense rainfall to the area. The City of Chehalis receives approximately 40 inches of rain on average each year. Larger floods result from heavy rains that continue over the course of several days, augmented by snowmelt at a time when the soil is near saturation from previous rains. Frozen topsoil also contributes to the frequency of floods. Snowmelt from the Willapa Hills and Cascade Mountain Range may contribute to, but is not considered a significant source of flooding on the Chehalis and Newaukum Rivers.

Riverine and urban are the two types of flooding that primarily affect Chehalis. Riverine flooding is the overbank flooding of rivers and streams, the natural processes of which add sediment and nutrients to fertile floodplain areas. Urban flooding results from the conversion of land from fields or woodlands to parking lots and roads, through which the land loses its ability to absorb rainfall.

Commercial and residential development within the City continues to potentially displace natural areas that have historically functioned as flood storage, but the city has addressed this potential displacement by requiring development to be consistent with the City of Chehalis and Washington State storm water & floodplain management requirements. The city has adopted the FEMA Flood Insurance Study (revised 2006), and associated requirements, so the would-be increase in flood levels caused by the development are within the Federal Insurance Administration and Washington State requirements (no increase in the water-surface elevation of the 100-year flood more than one foot at any point). Source: Chehalis Flood Information Letter – http://ci.chehalis.wa.us/building/floodplain-management Accessed 7/21/2015

CRS Data – 2014

- CRS Rating 2014 – Class 6 – 20% premium reduction

- Number of Building in the SFHA:
- Acres of the SFHA:

Chehalis BECEGS Report Summary – 2009

The Washington Surveying and Rating Bureau prepares reports for participating communities using the Building Code Effectiveness Grading Schedule (BCEGS). BCEGS looks at building code requirements designed to mitigate losses from natural hazards.

BCEGS Class: 3 (Residential: Class 3, Commercial/Industrial: Class 3)

Code Activity	Score	Max	Percent
Section 1: Administration of Codes Section Total	37.4	54.0	69%
Section 2: Plan Review Section Total	18.9	23.0	82%
Section 3: Field Inspection Total	77.6	100	78%
Adjustment for non-adoption of residential sprinklers			
Total	77.6	100.0	78%

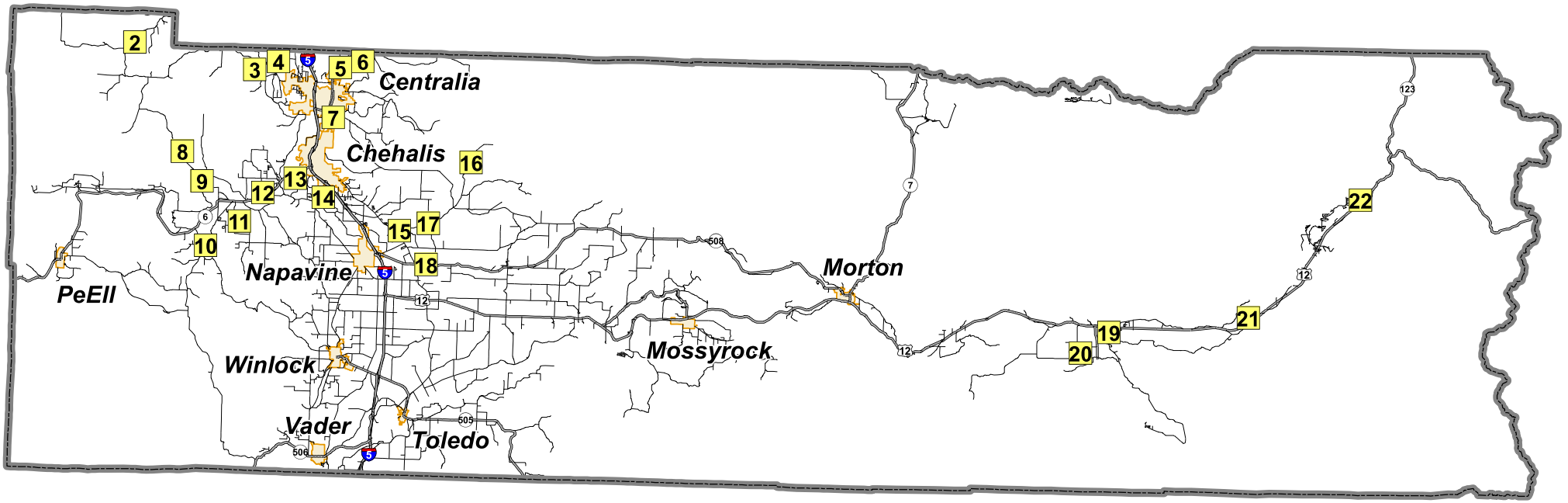
In 2014, French & Associates, LTD of Steilacoom, Washington was contracted by the Flood Authority to perform an analysis of local floodplain management programs to see how communities could strengthen their programs. Chehalis's recommendations from the report included the following:

1. Continue efforts to get updated and accurate mapping
2. Consider alternatives for future development in the floodplain
3. Amend definition of "substantial reconstruction" in 17.21.030
4. Amend ordinance to include Lewis County FIRM data now within City
5. Proceed with developing a coordinated shoreline master program
6. Formally adopt the Western Washington Stormwater Manual
7. Staff should consider training
8. Continue to advise residents of flooding hazard
9. Educate insurance agents
10. Continue to implement the Hazard Mitigation Plan
11. Update Hazard Mitigation Plan by 2015 with Lewis County
12. Support a joint effort to improve hazard mitigation grants
13. Review current outreach projects in light of new CRS Manual
14. The CRS Coordinator should become more familiar with the program
15. Review current programs in light of the new CRS Manual

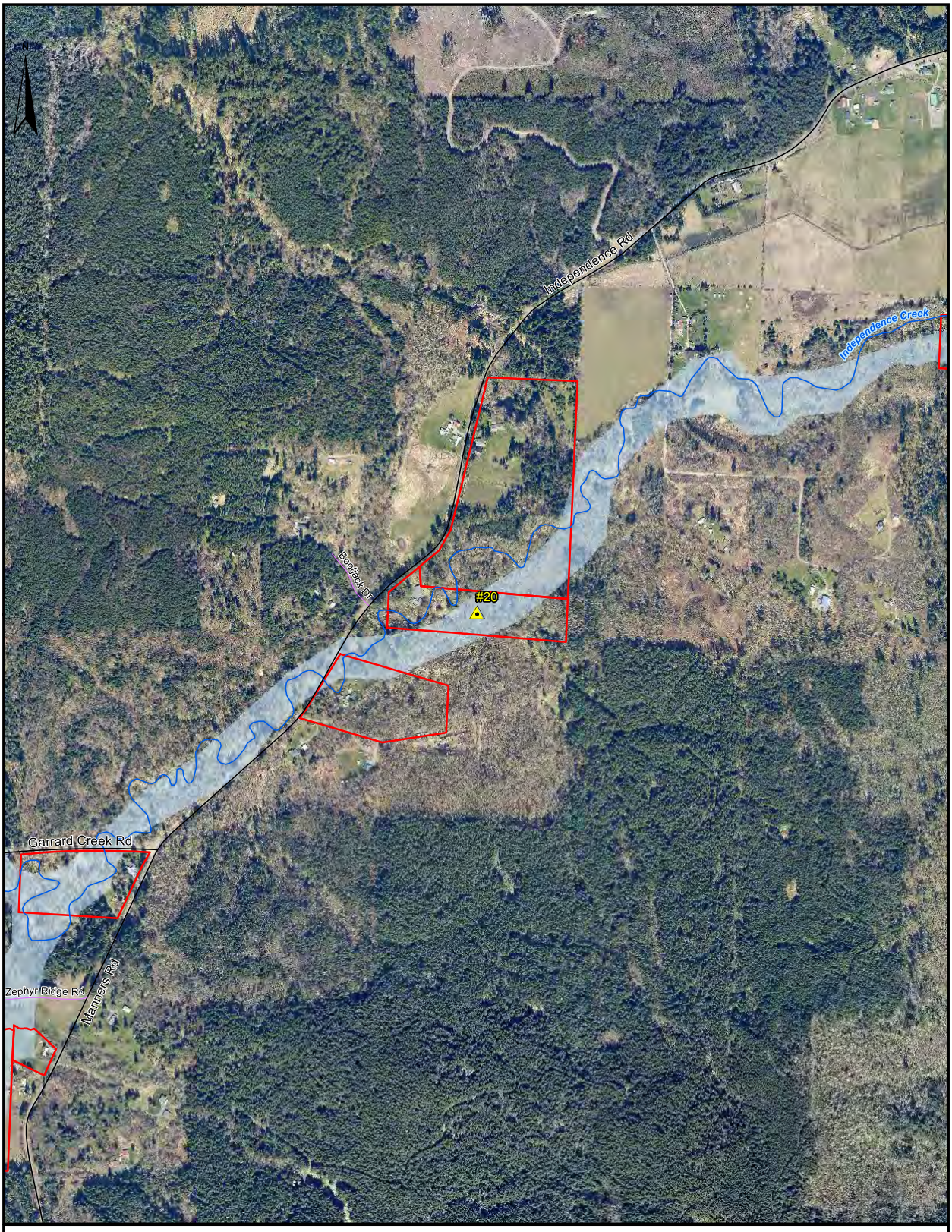
Resources

- Lewis County Flood Hazard Management Plan, 2008
- USGS National Water Information System, www.usgs.gov/ Accessed July 2015.
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Flood_Hazard_Profile.pdf Accessed July 7, 2015.
- FEMA, http://www.fema.gov/index.shtm . Accessed July 2015.
- Chehalis River Basin Flood Authority. https://www.ezview.wa.gov/site/alias__home/34166/default.aspx Accessed on July 7, 2015.
- Flood Protection and Ecosystem Services in the Chehalis River Basin. May 2010. http://www.eartheconomics.org/FileLibrary/file/Reports/Chehalis/Earth_Economics_Report_on_the_Chehalis_River_Basin_compressed.pdf Accessed on July 7, 2015.
- U.S. Department of Homeland Security, FEMA Repetitive Loss Data for Lewis County, Centralia, and Chehalis
- Floodplain Management Analysis – Lewis County. French & Associates, LTD. September 16,2014
    - Lewis County, City of Centralia, City of Chehalis

Map Book Page Index



NFIP CRS 2013 - Repetitive Loss Areas



Repetitive Loss Area - Independence Rd Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

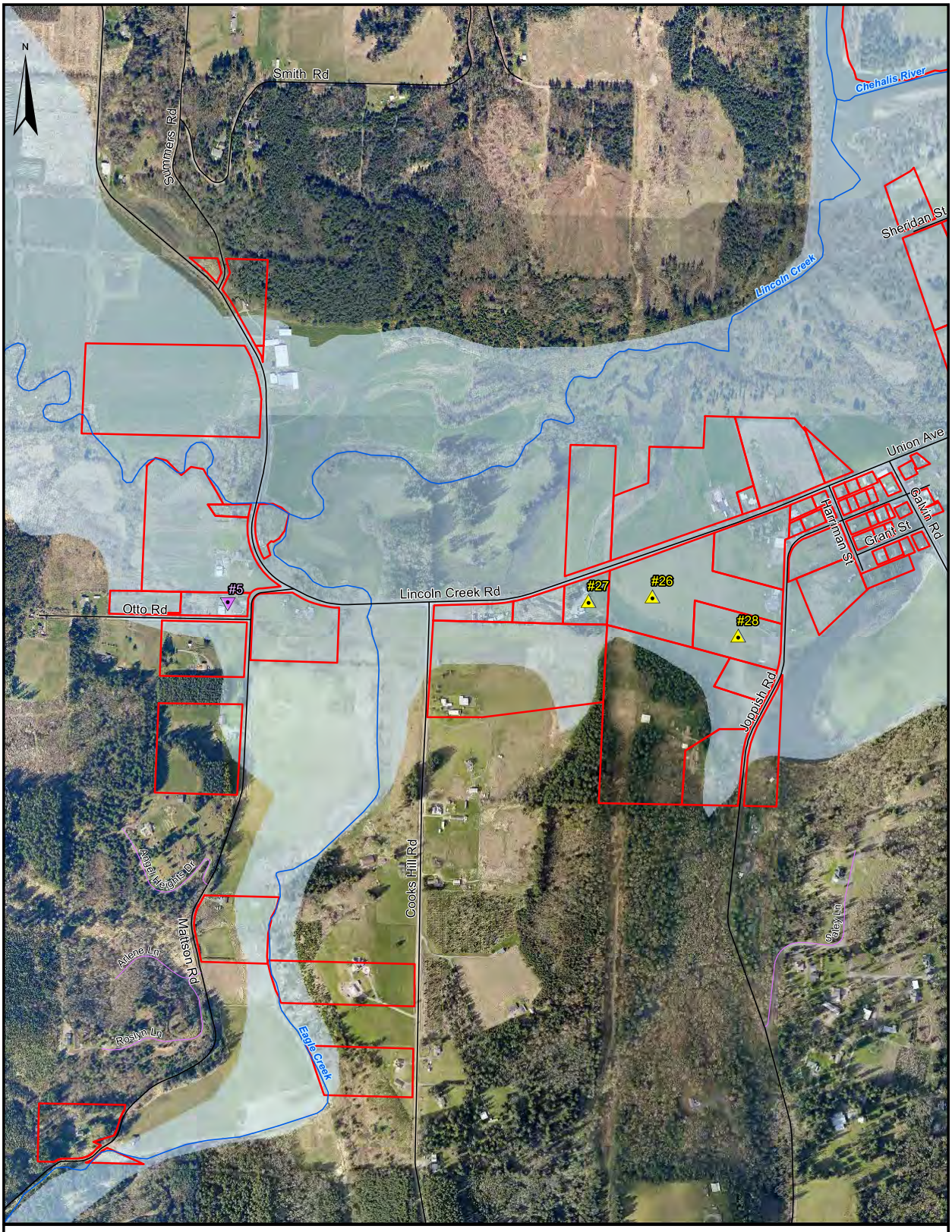
- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

This map was compiled by Lewis County Geographic Information Services. Aerial photography from Pictometry and flown in 2013.
The accuracy of the map has not been verified, and it should be used for informational purposes only. Any possible discrepancies should be brought to the attention of Lewis County Geographic Information Services.

Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Galvin W Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

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- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

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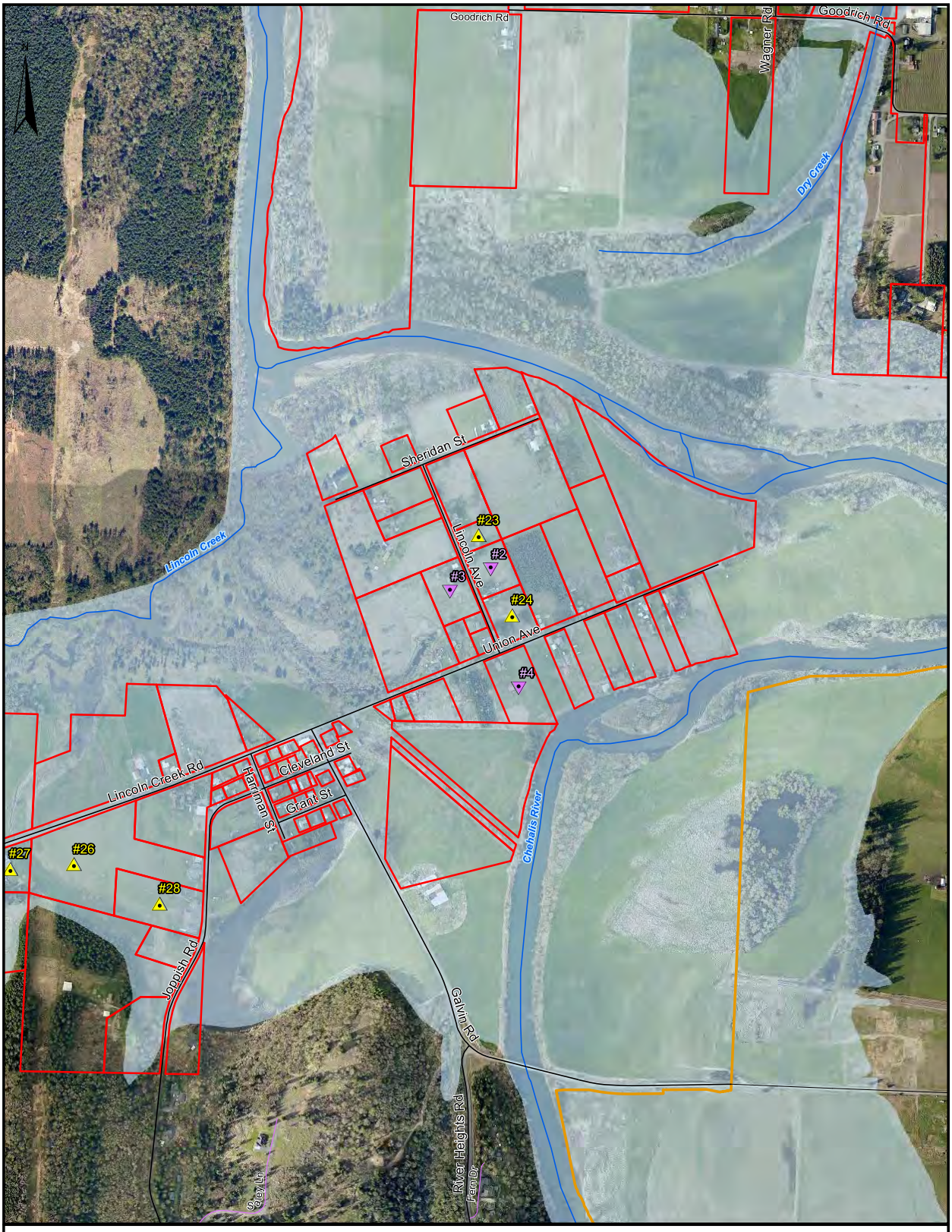
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Galvin E Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

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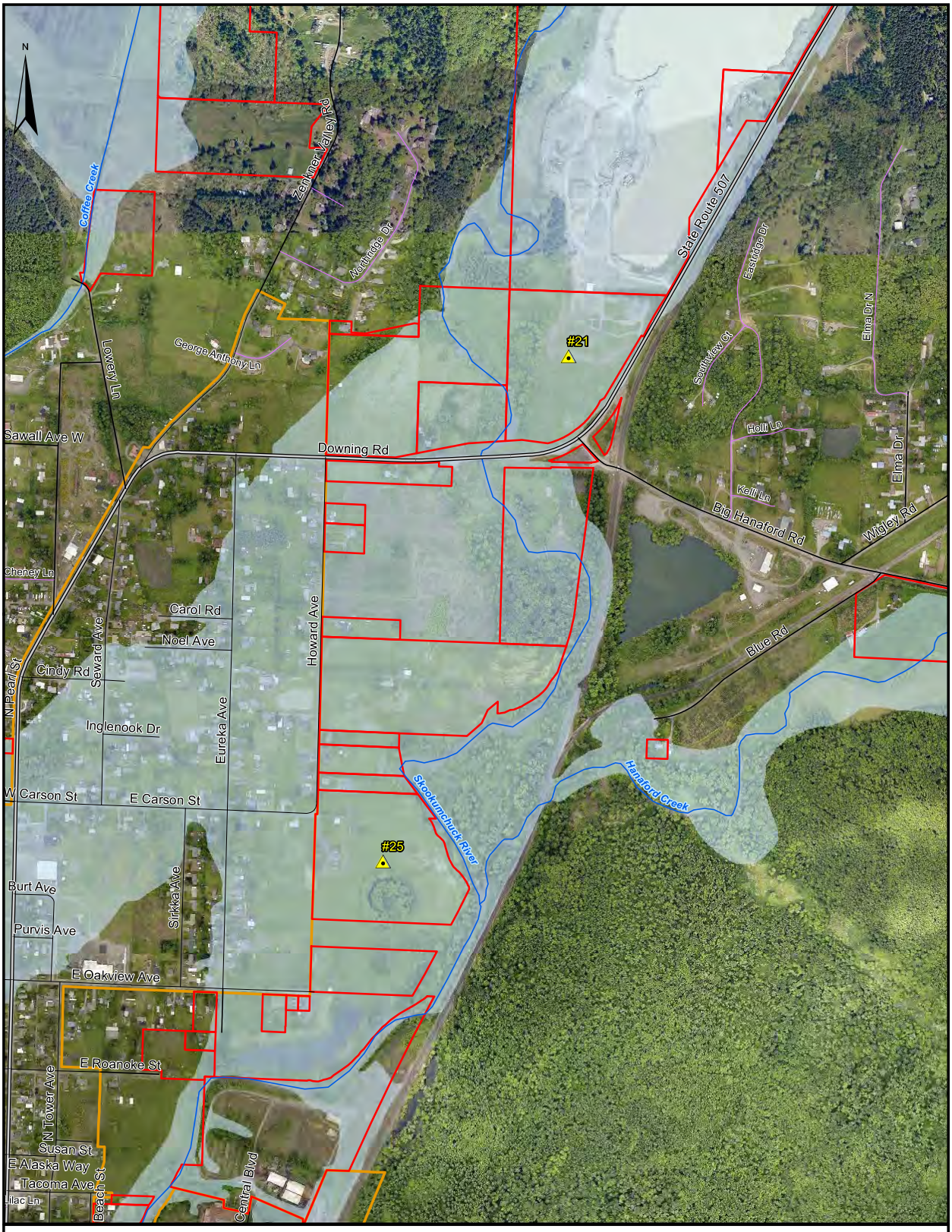
Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Centralia NE Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

This map was compiled by Lewis County Geographic Information Services. Aerial photography from Pictometry and flown in 2013. The accuracy of the map has not been verified, and it should be used for informational purposes only. Any possible discrepancies should be brought to the attention of Lewis County Geographic Information Services.

Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.

Repetitive Loss Area - Big Hanaford Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

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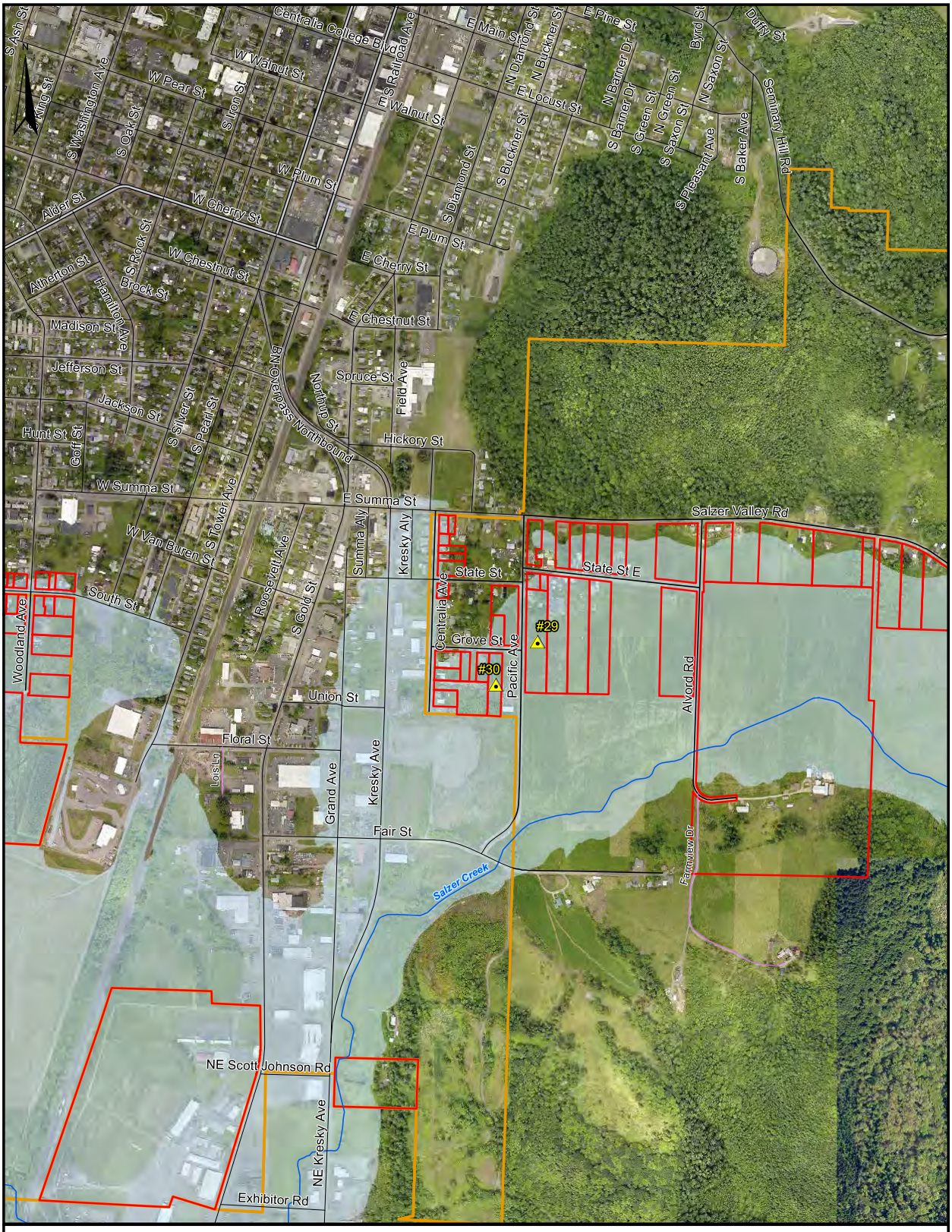
Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Centralia SE Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

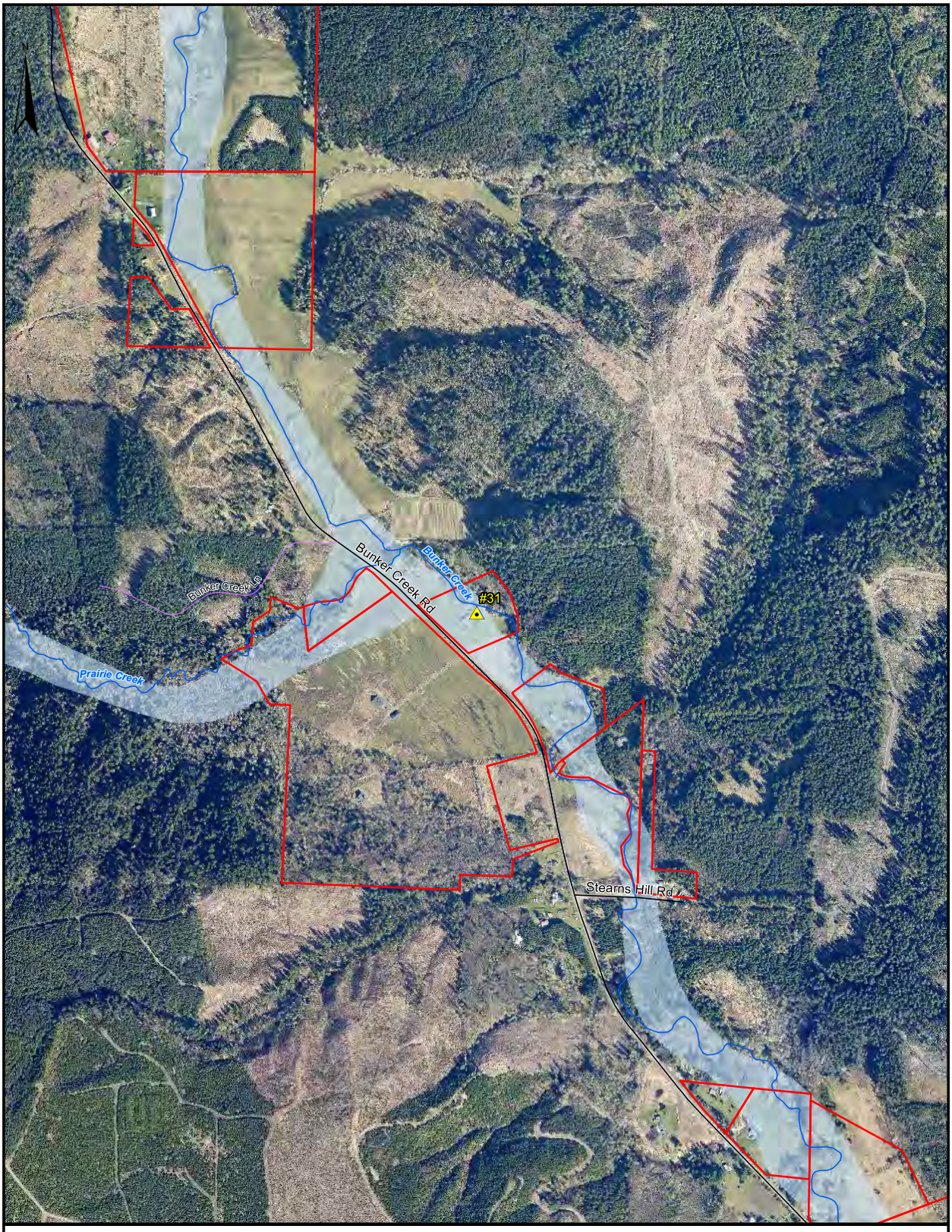
- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

This map was compiled by Lewis County Geographic Information Services. Aerial photography from Pictometry and flown in 2013. The accuracy of the map has not been verified, and it should be used for informational purposes only. Any possible discrepancies should be brought to the attention of Lewis County Geographic Information Services.

Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Bunker Creek Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

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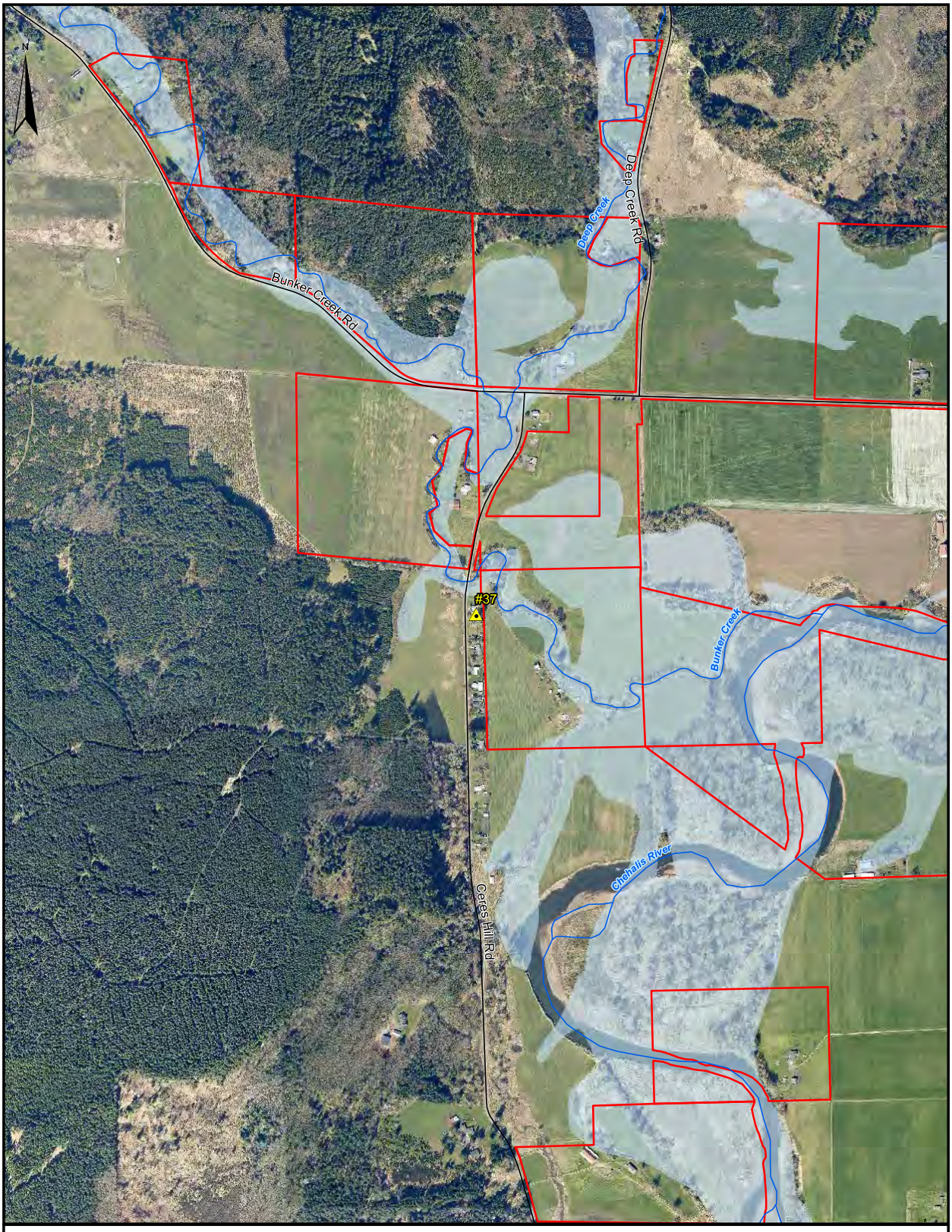
Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.



Repetitive Loss Area - Ceres Hill Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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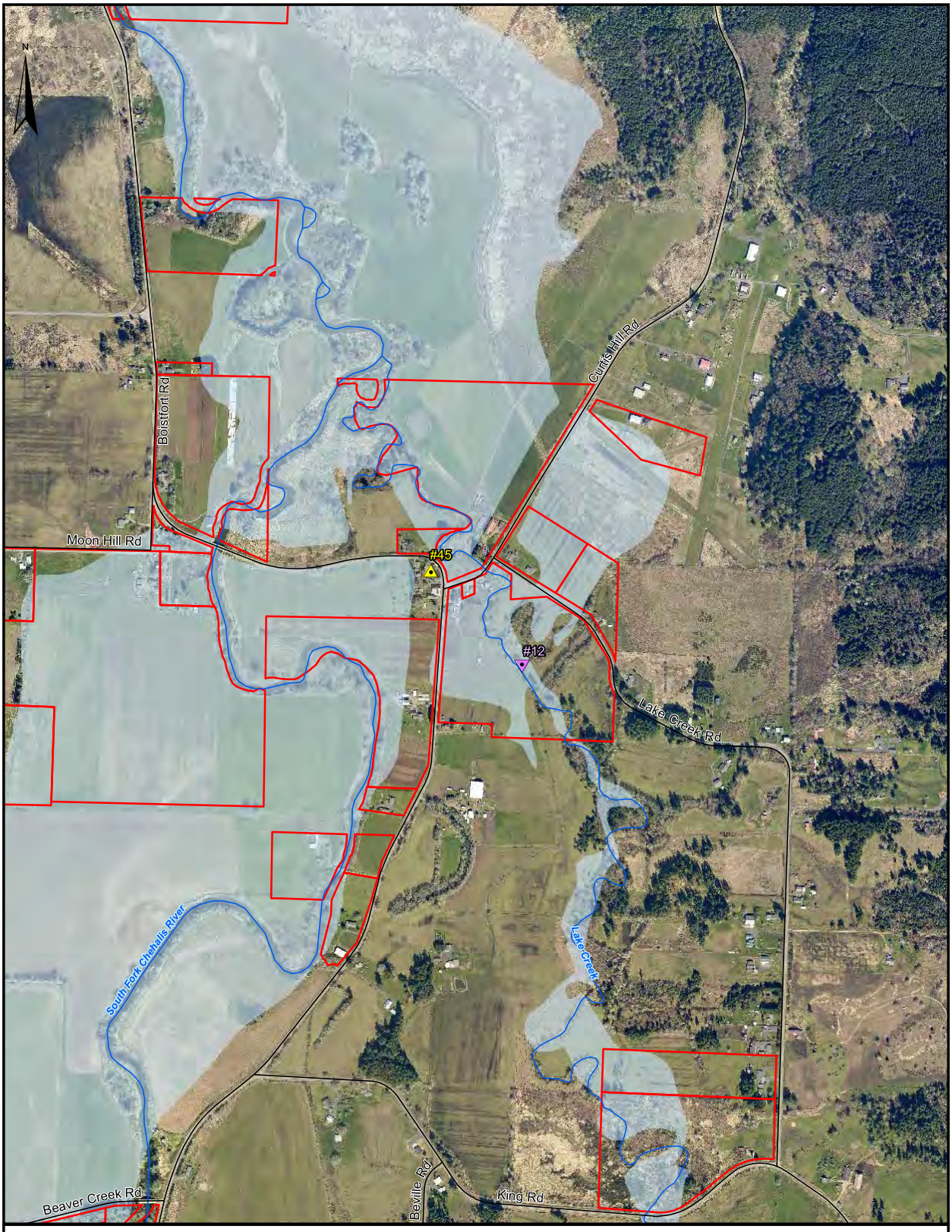
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Boistfort Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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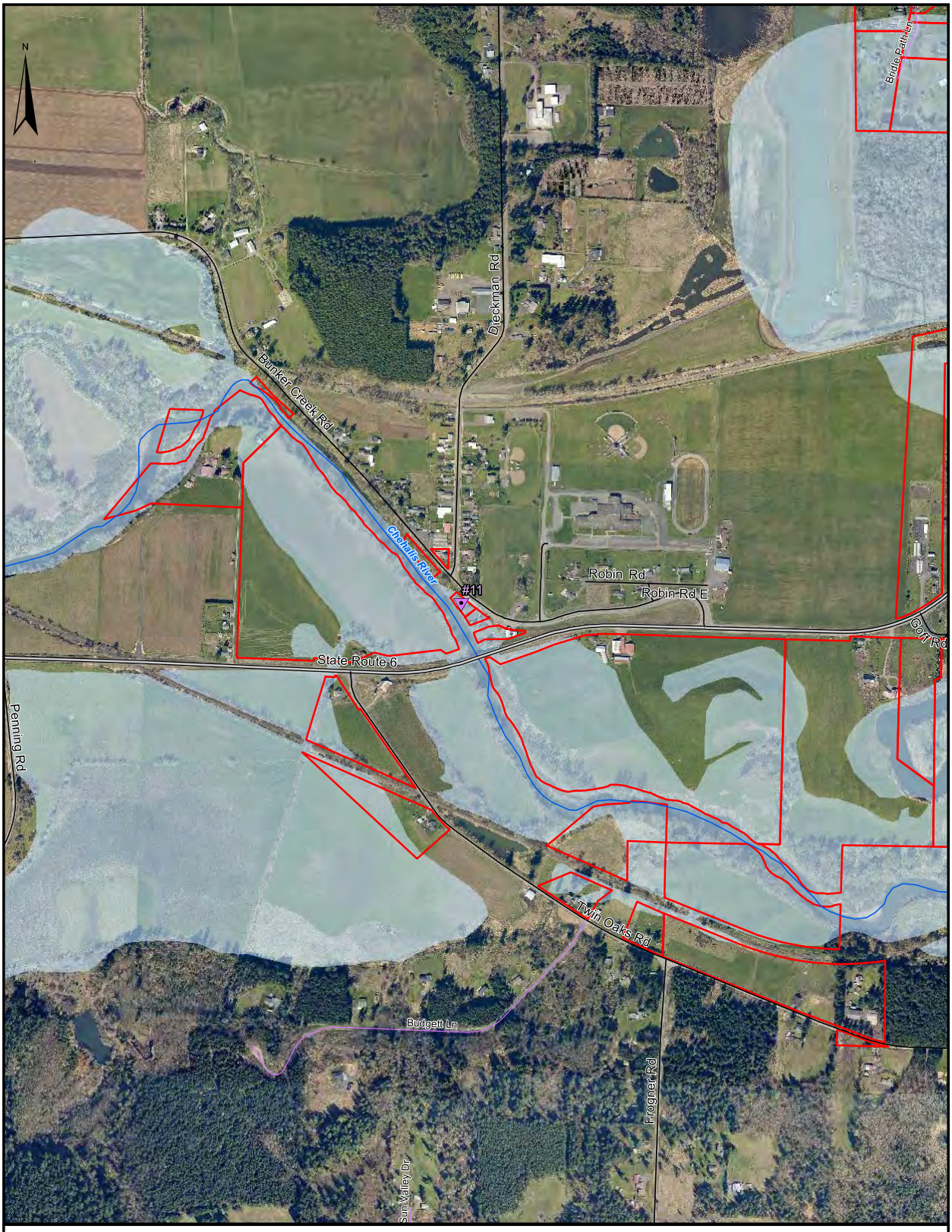
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Adna W Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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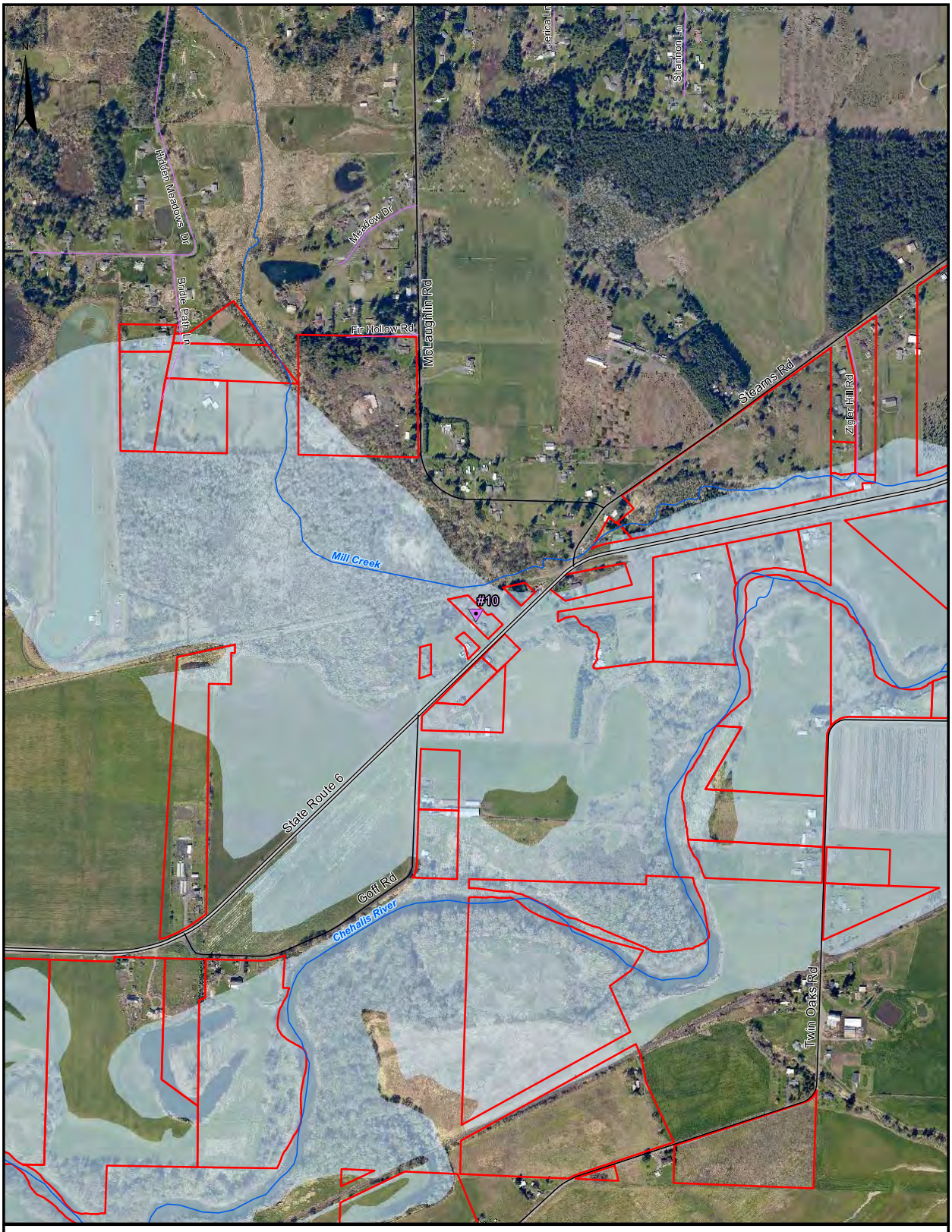
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Adna E Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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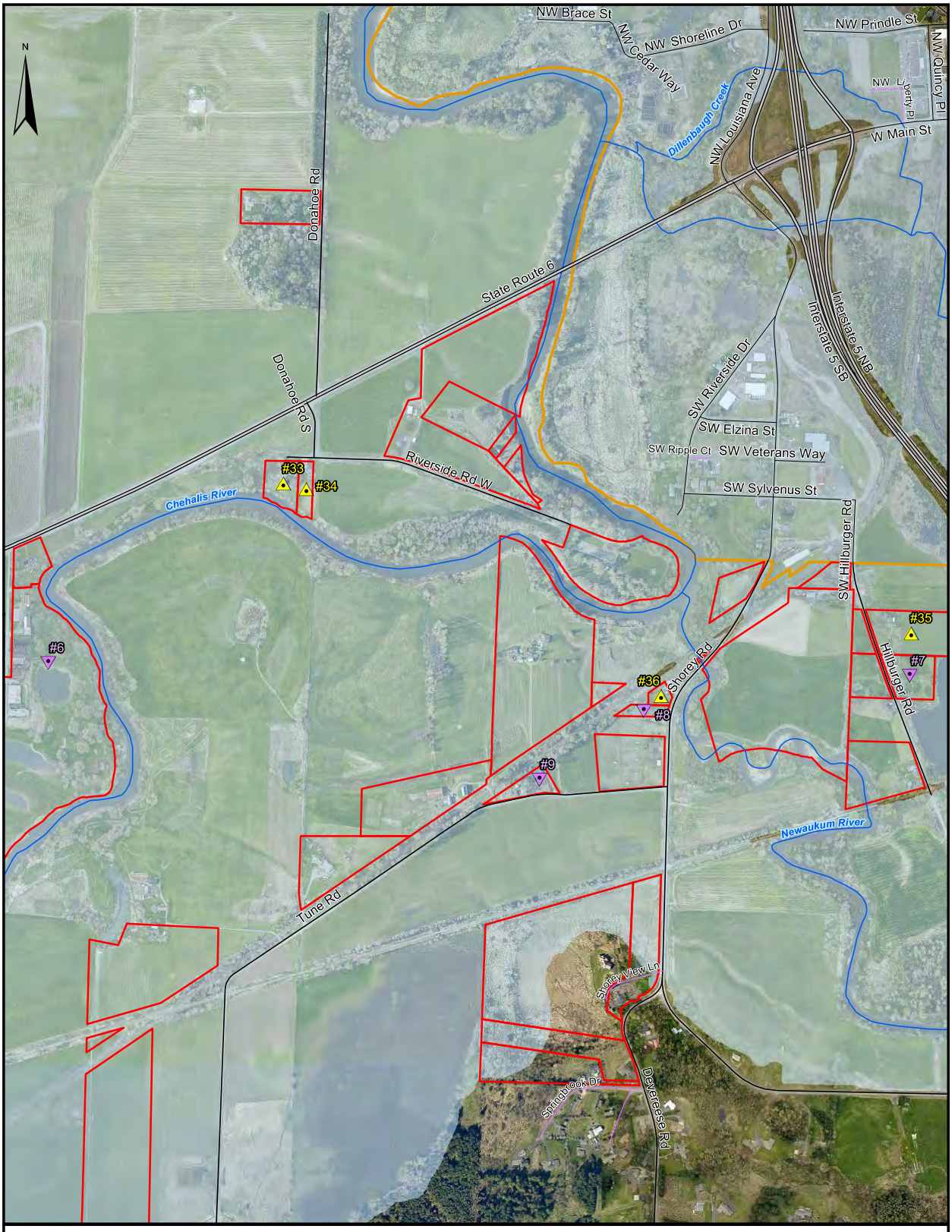
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Chehalis W Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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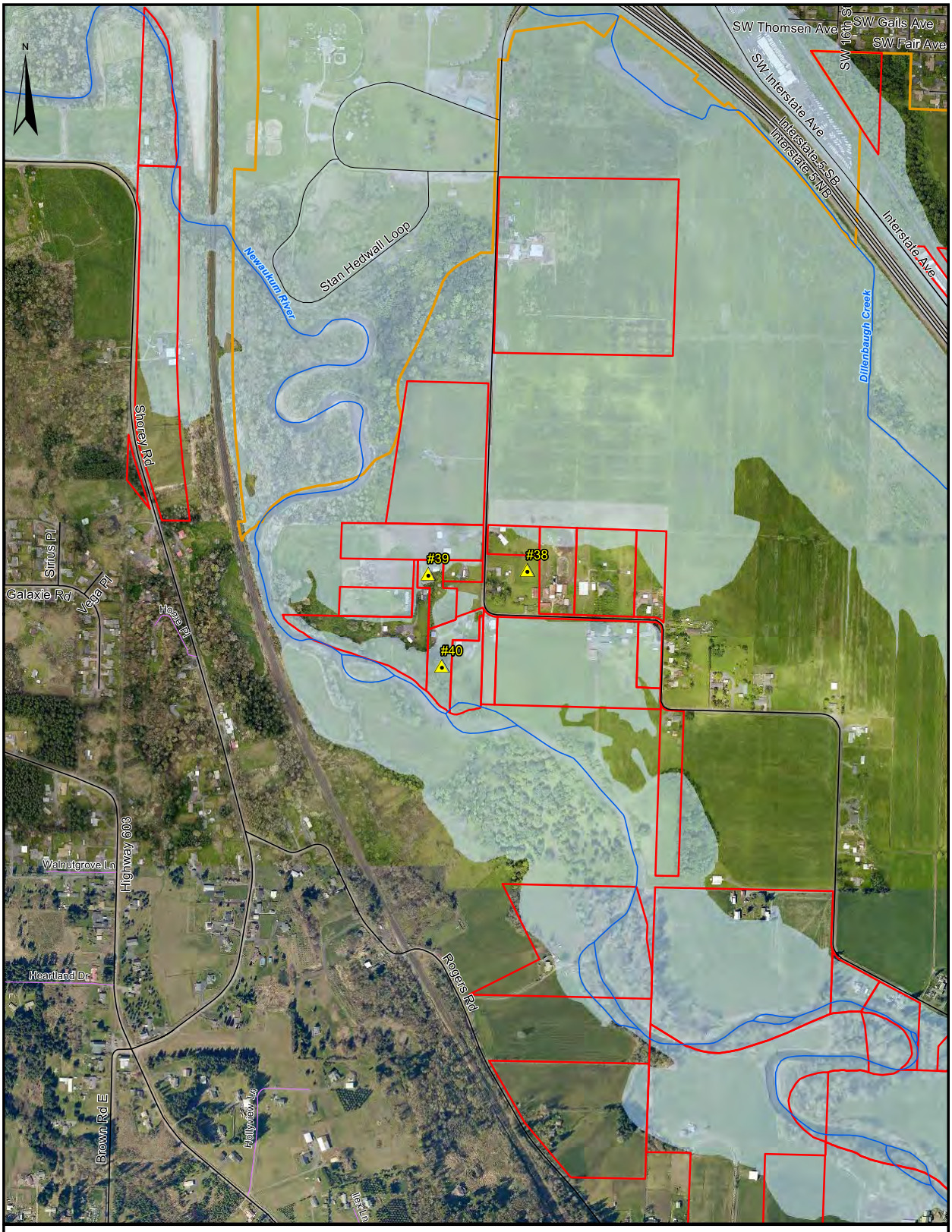
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Chehalis SW Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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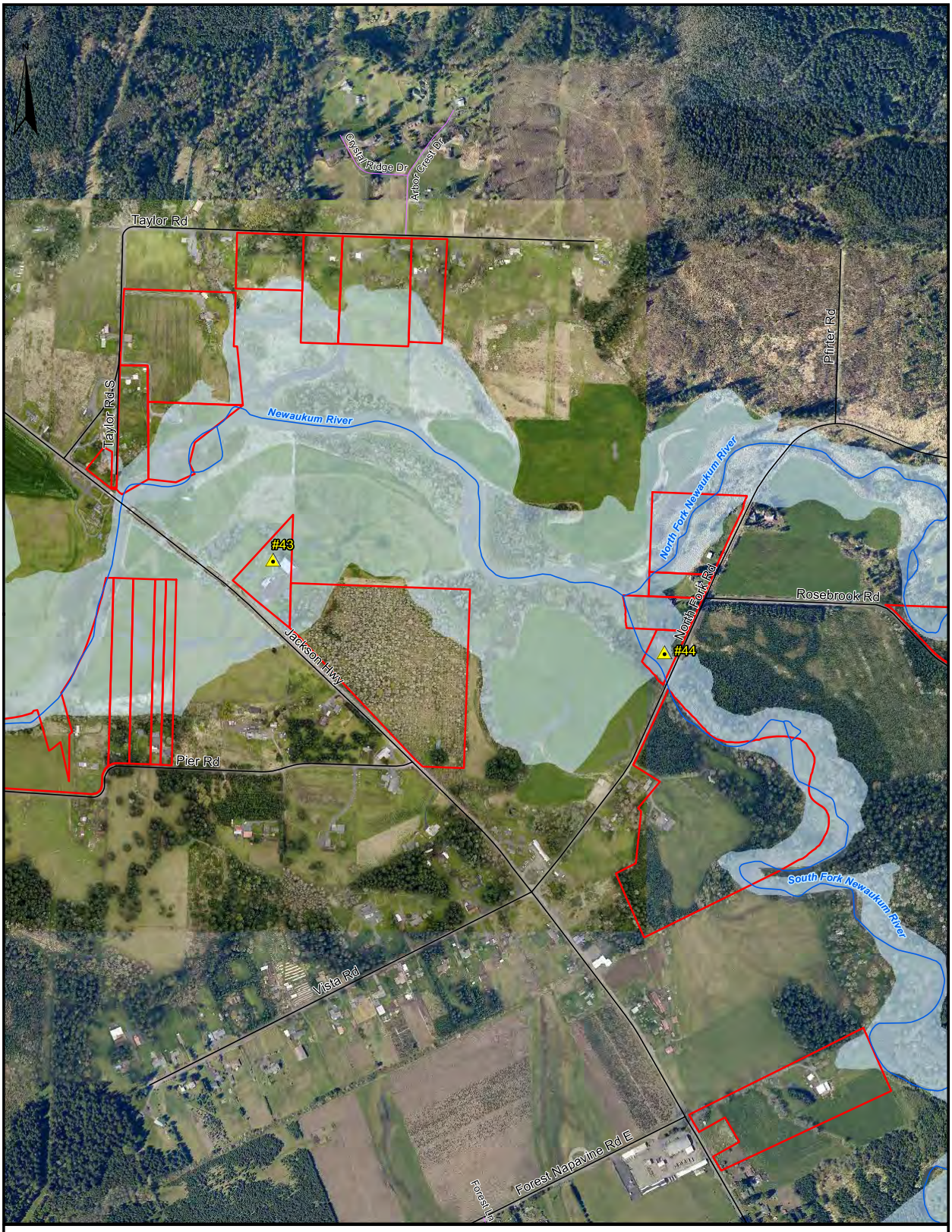

Repetitive Loss Area - Newaukum River Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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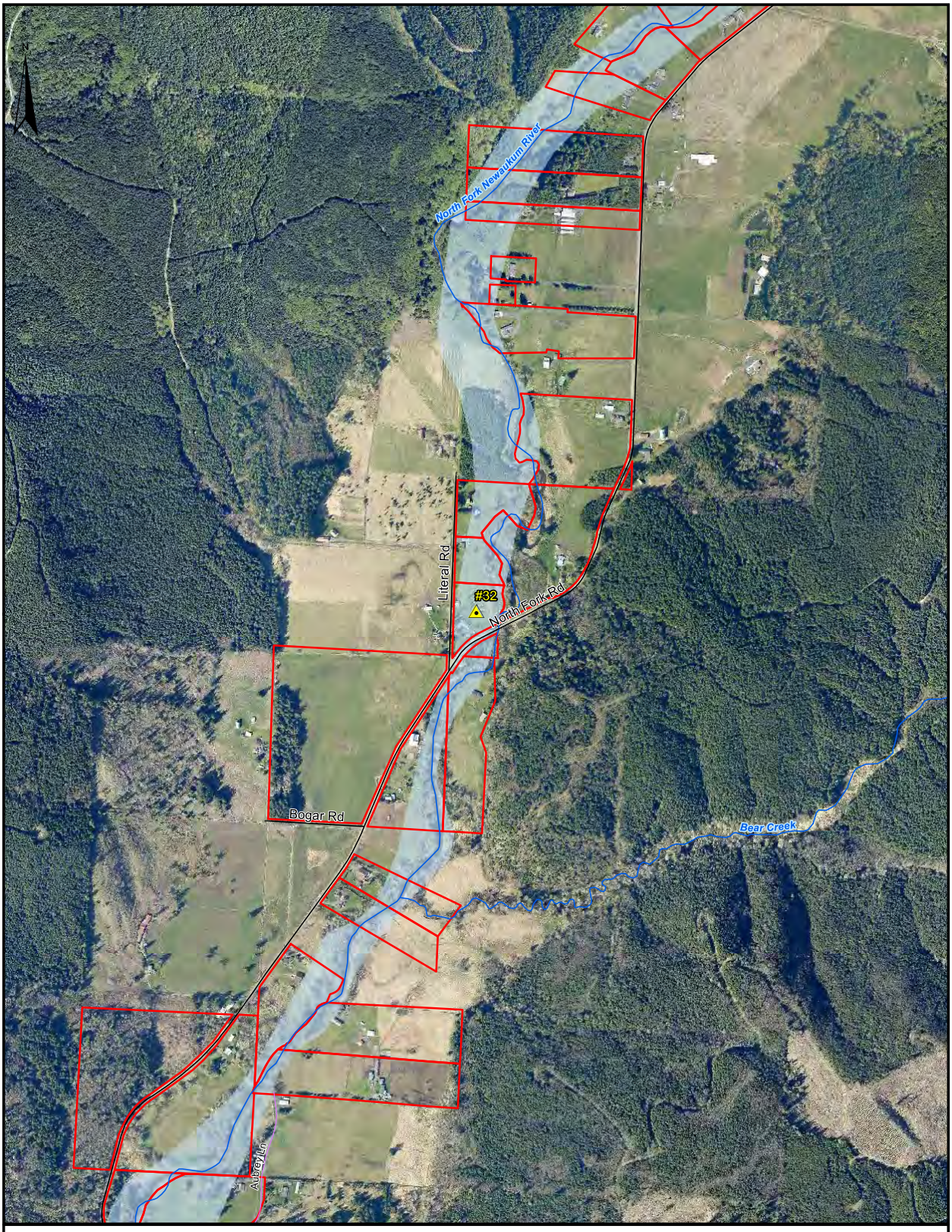
LEWIS COUNTY G.I.S.



Repetitive Loss Area - North Fork Rd Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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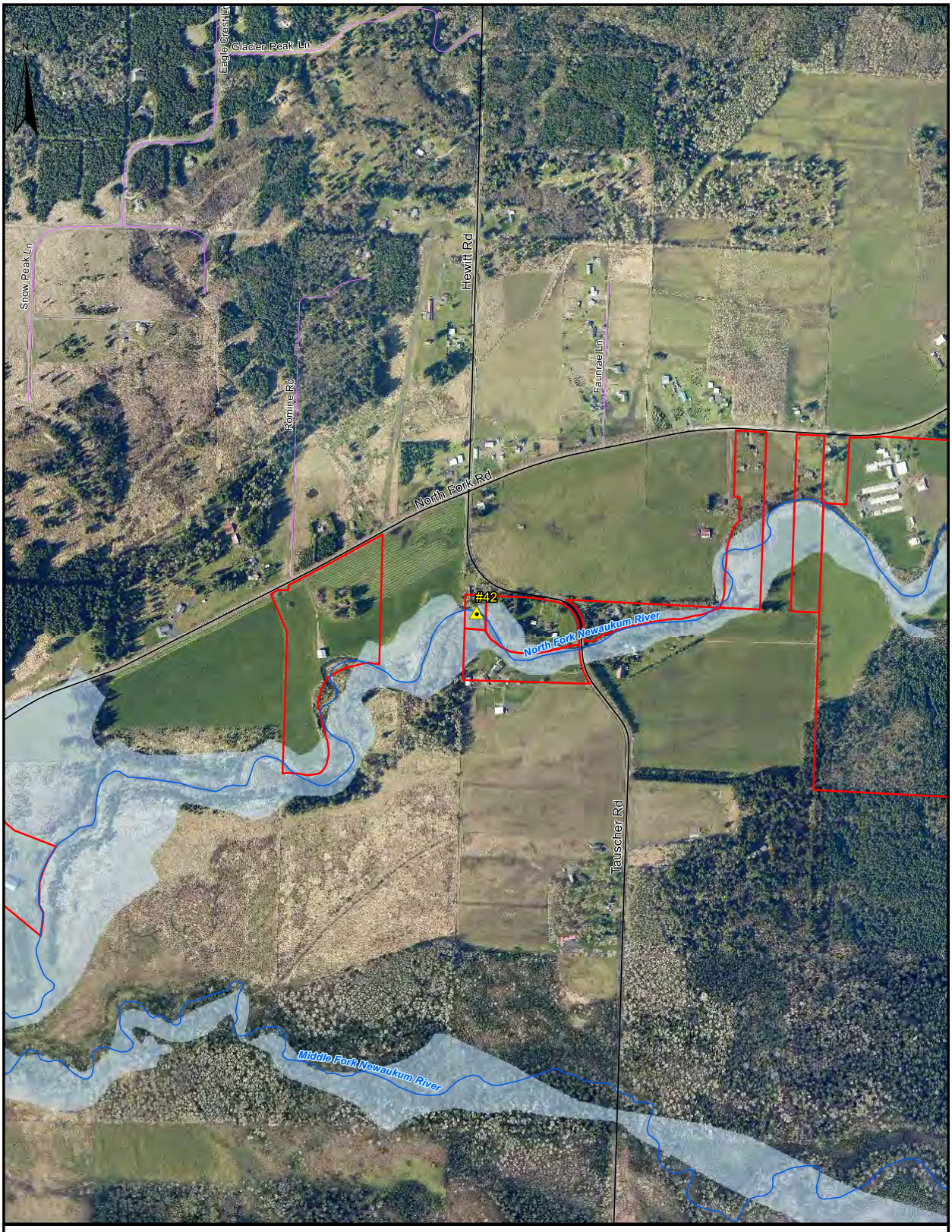
LEWIS COUNTY G.I.S.



Repetitive Loss Area - Tauscher Rd Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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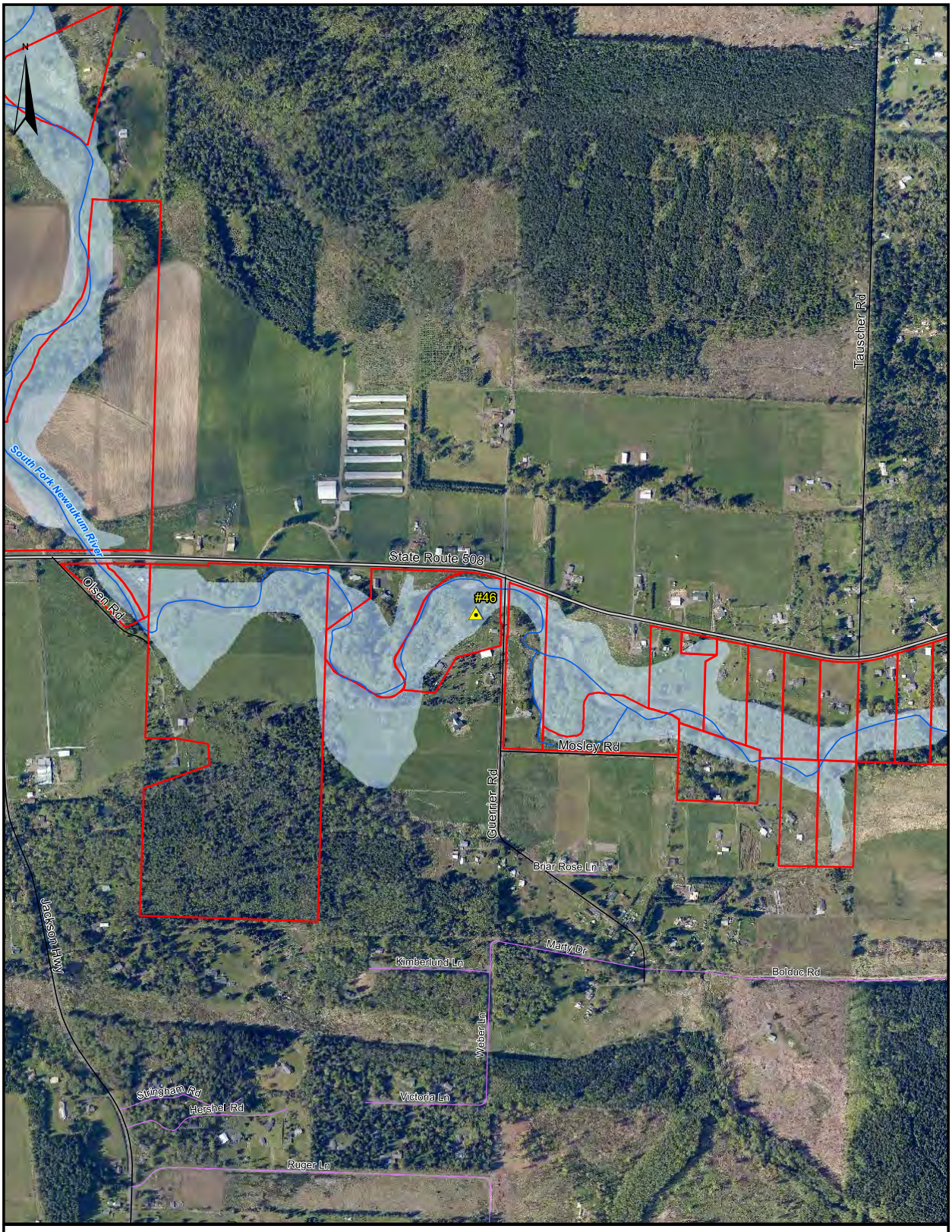

Repetitive Loss Area - Guerrier Rd Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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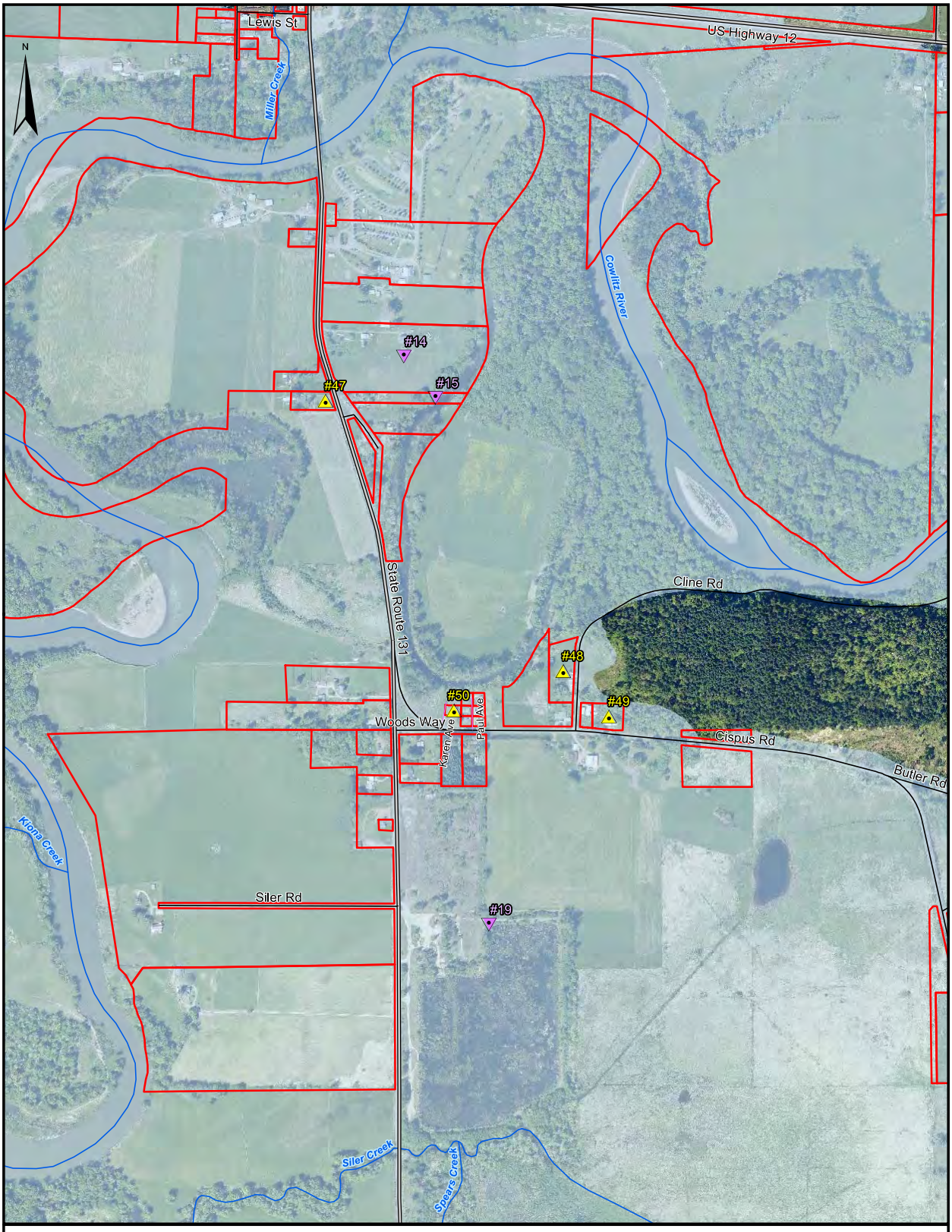

Repetitive Loss Area - Randle Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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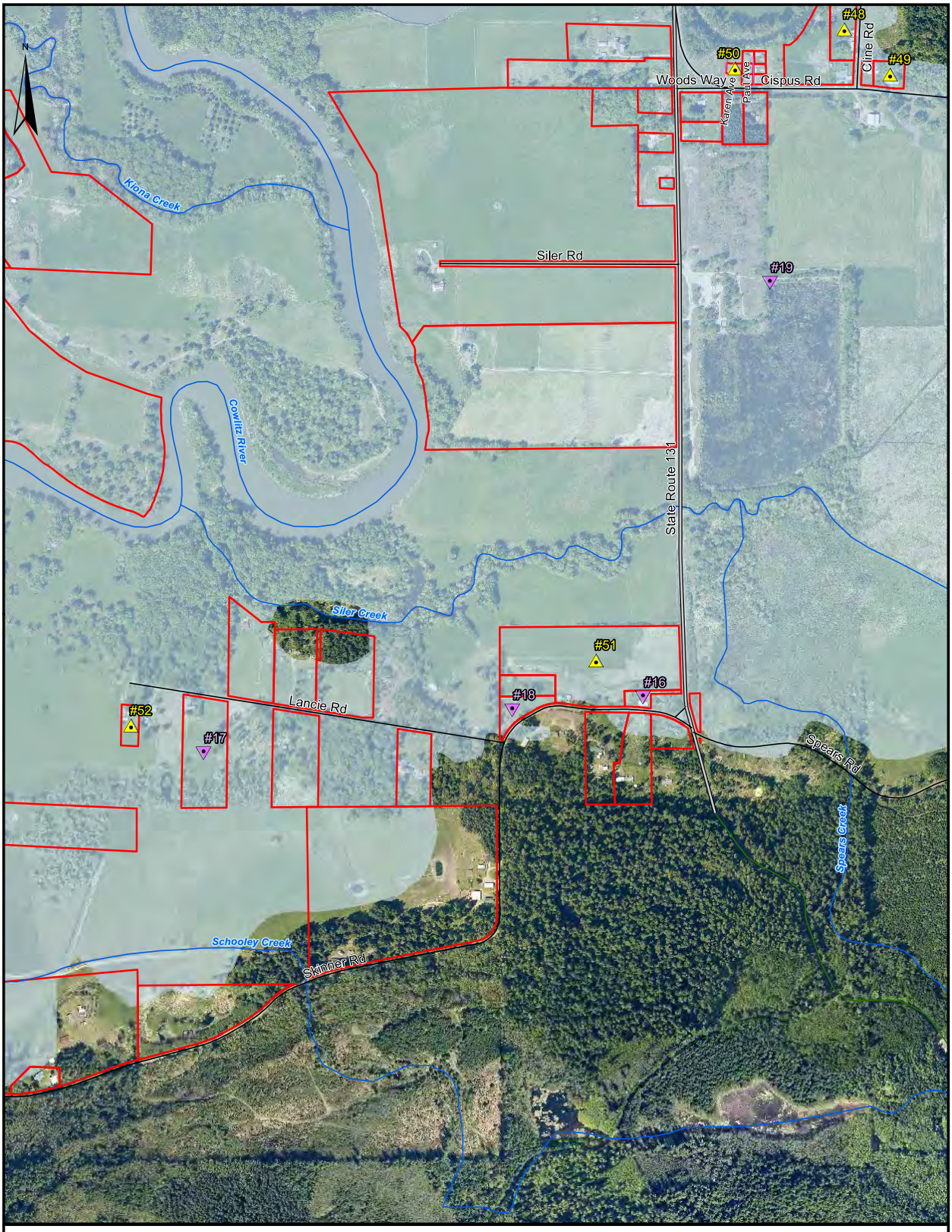

Repetitive Loss Area - Randle S Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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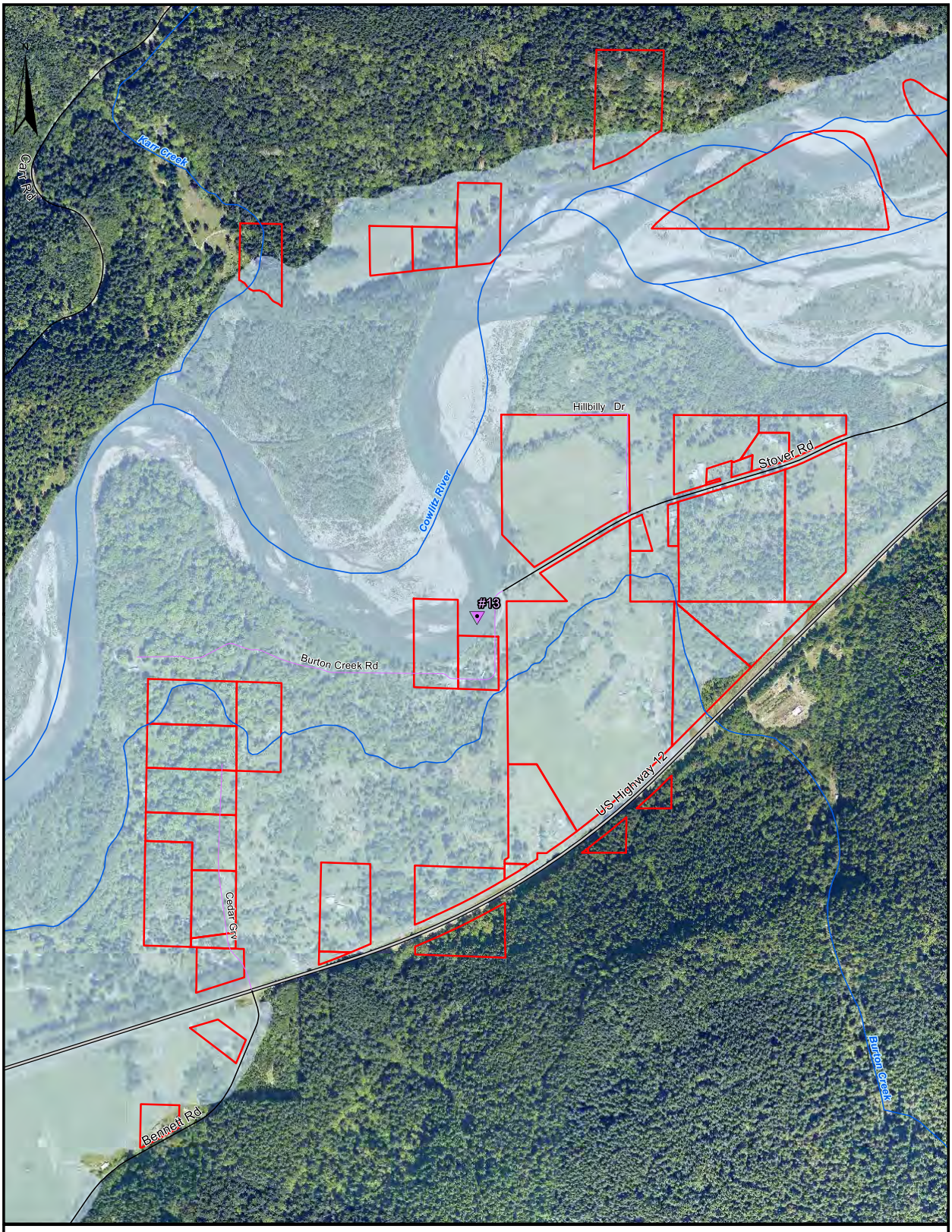

Repetitive Loss Area - Stover Rd Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

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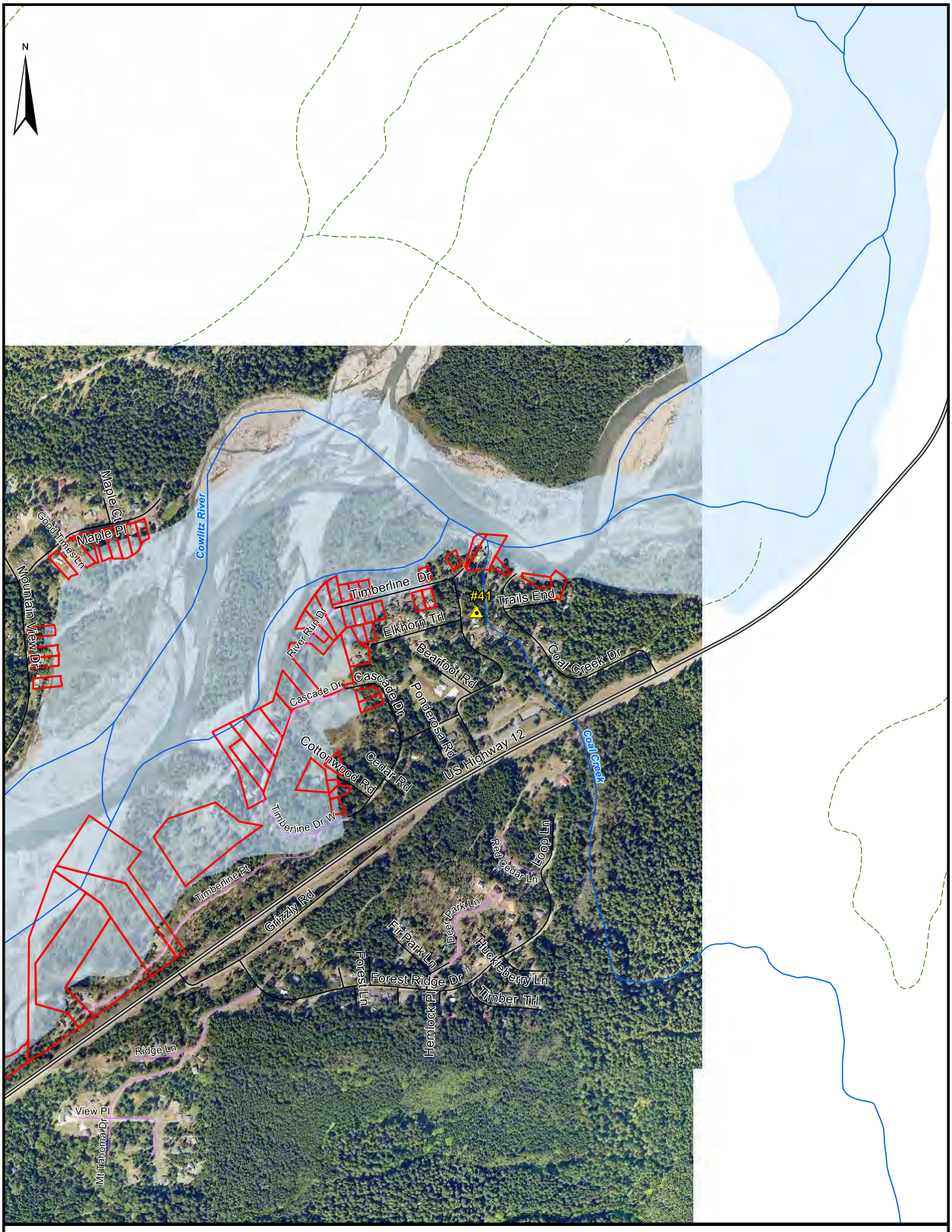


Repetitive Loss Area - Timberline Village Vicinity

Lewis County, Washington

Scale: 1 Inch = 700 Feet

Repetitive Loss sites from FEMA NFIP list, current as of December 31, 2011. The NFIP community of Lewis County has 54 sites total, all the result of riverine flooding, with 20 mitigated and 34 unmitigated locations. Of the 54 sites, 2 properties along Centralia Ave have been annexed by the City of Centralia since December 31, 2011.

Parcels in the SFHA w/structures were determined by matching the Assessor's structure and parcel data with GIS. There are 3,102 parcels in the NFIP community with greater than 9% of their total area contained by the SFHA. As per the CRS description for primary stuctures, there are 3,278 structures located on those parcels.

Repetitive Loss Area parcels were selected from within a half-mile buffer of each Repetitive Loss site. Each parcel on the list has a primary structure with more than 9% of the parcel area contained in the SFHA. Of the 447 parcels in the Repetitive Loss Areas, there are 509 primary structures located on those parcels.

- Repetitive Loss Site (With RL No.)
- Repetitive Loss Site - Mitigated (With RL No.)
- Parcel in SFHA w/Structure(s)
- FEMA Special Flood Hazard Area
- City Limits

The NFIP community of Lewis County includes all unincorporated portions of the county.

This map was compiled by Lewis County Geographic Information Services. Aerial photography from Pictometry and flown in 2013. The accuracy of the map has not been verified, and it should be used for informational purposes only. Any possible discrepancies should be brought to the attention of Lewis County Geographic Information Services.

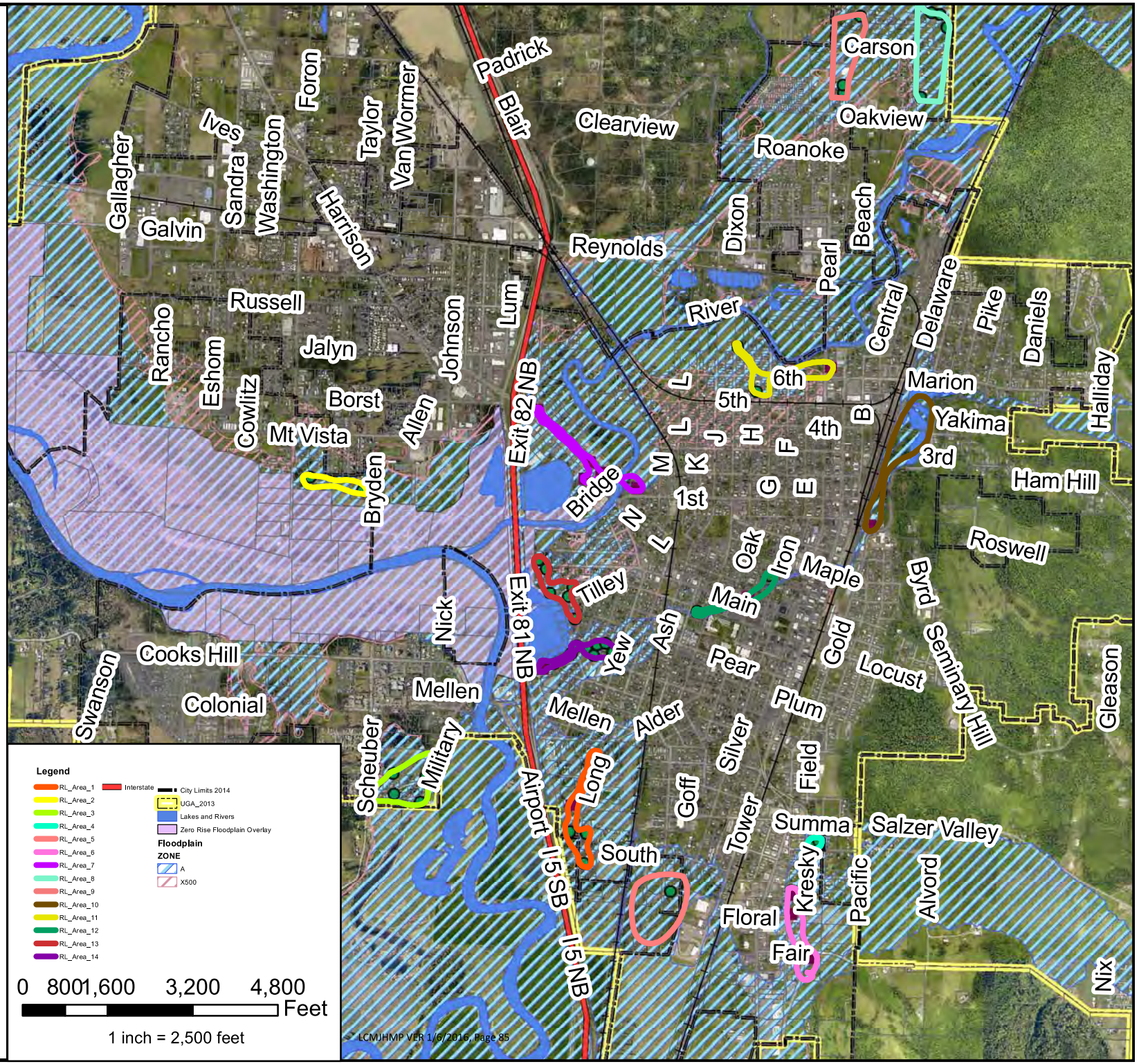
Projection: Lambert Conformal Conic
Datum: 1983 North American Datum
U.S.G.S. State Plane Zone 5626

LEWIS COUNTY G.I.S.

Activity 503
Repetitive Loss Areas
City Wide

Community Number 530103

Created September 19, 2014

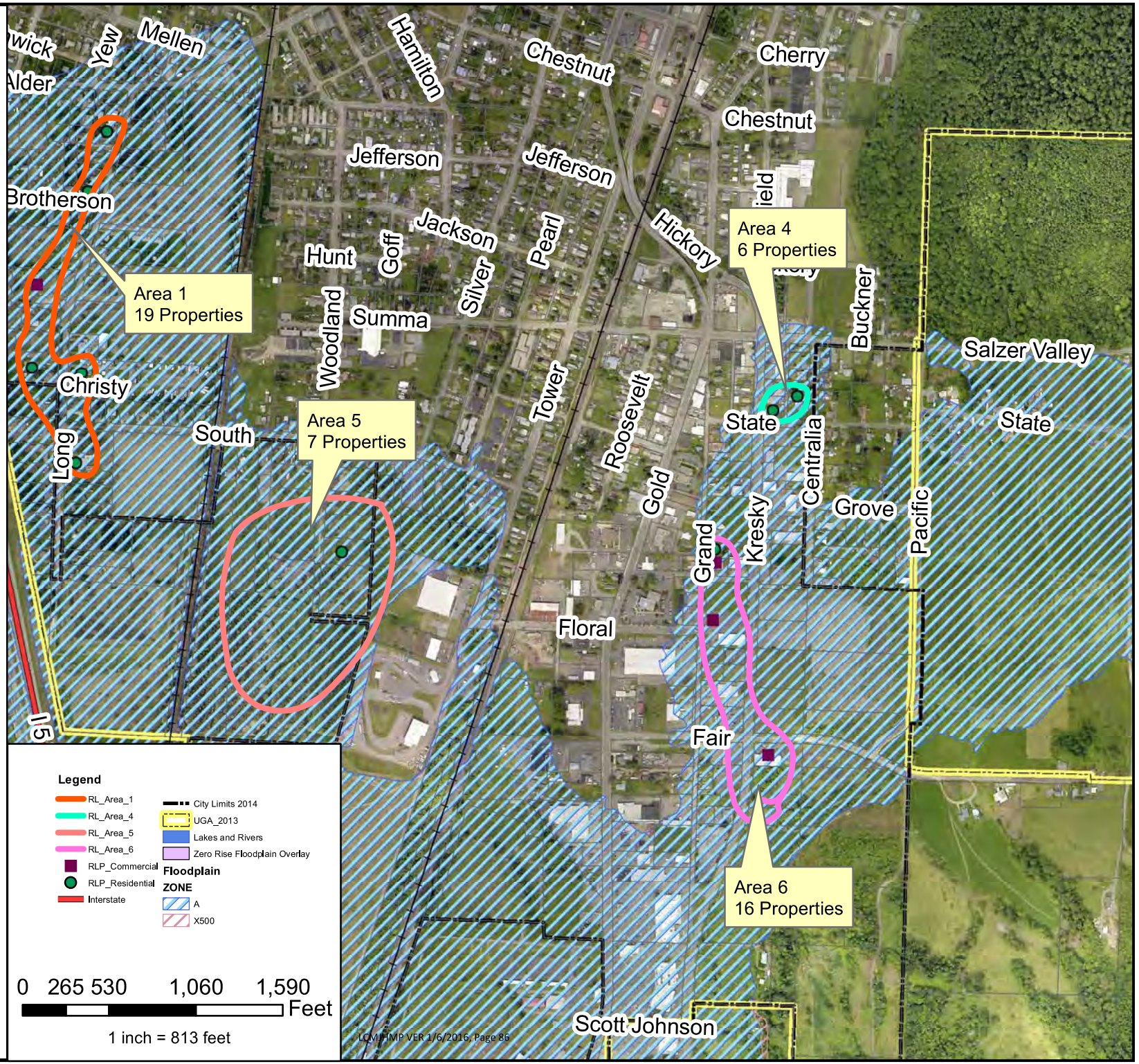


CENTRALIA
Community Development

Activity 503
Repetitive Loss Areas
RL Areas 1, 4, 5, 6

Community Number 530103

Created September 19, 2014

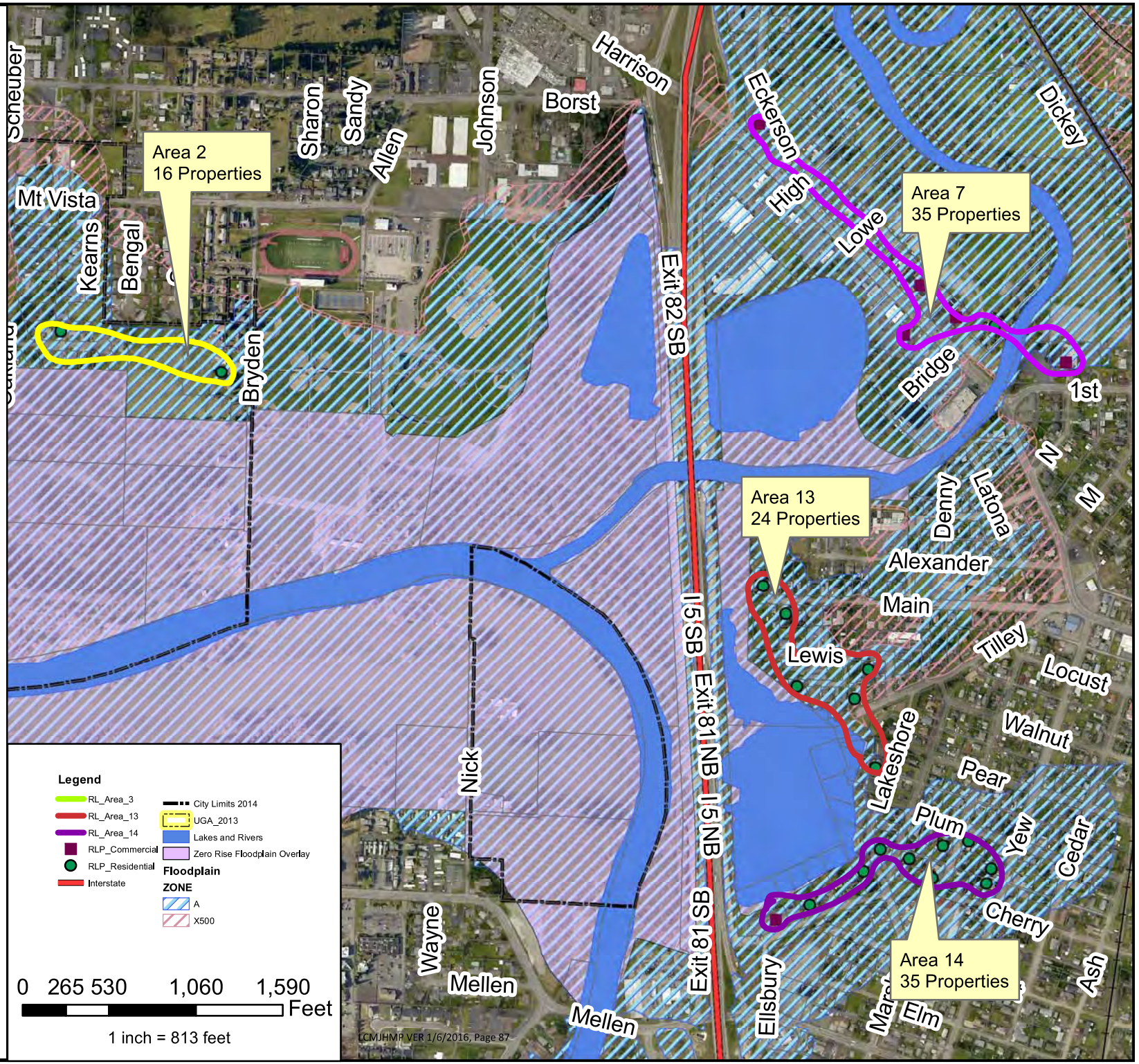


CENTRALIA
Community Development

Activity 503
Repetitive Loss Areas
RL Areas 2, 7, 13, 14

Community Number 530103

Created September 19, 2014

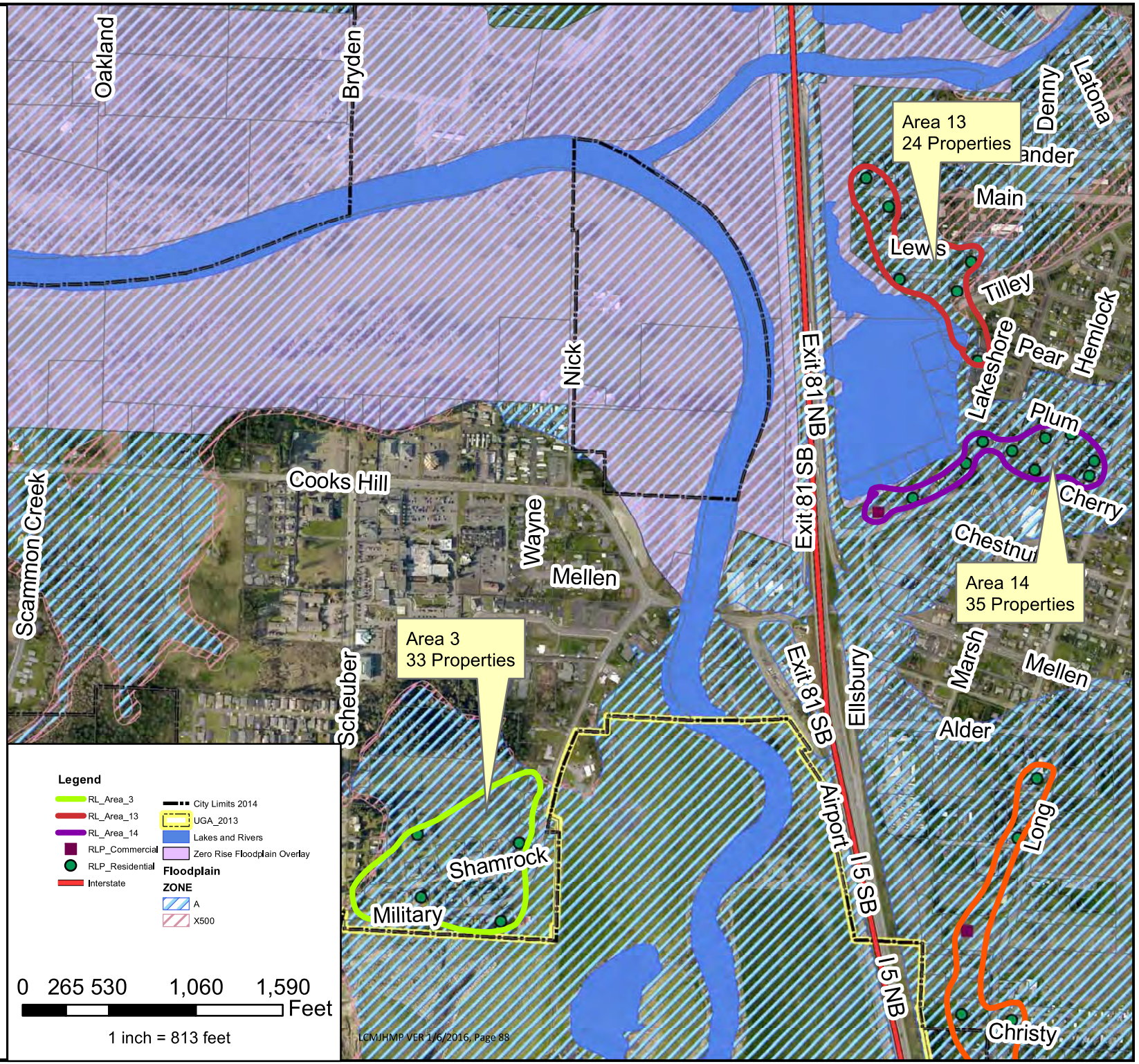


CENTRALIA
Community Development

Activity 520
Repetitive Loss Areas
RL Areas 3, 13, 14

Community Number 530103

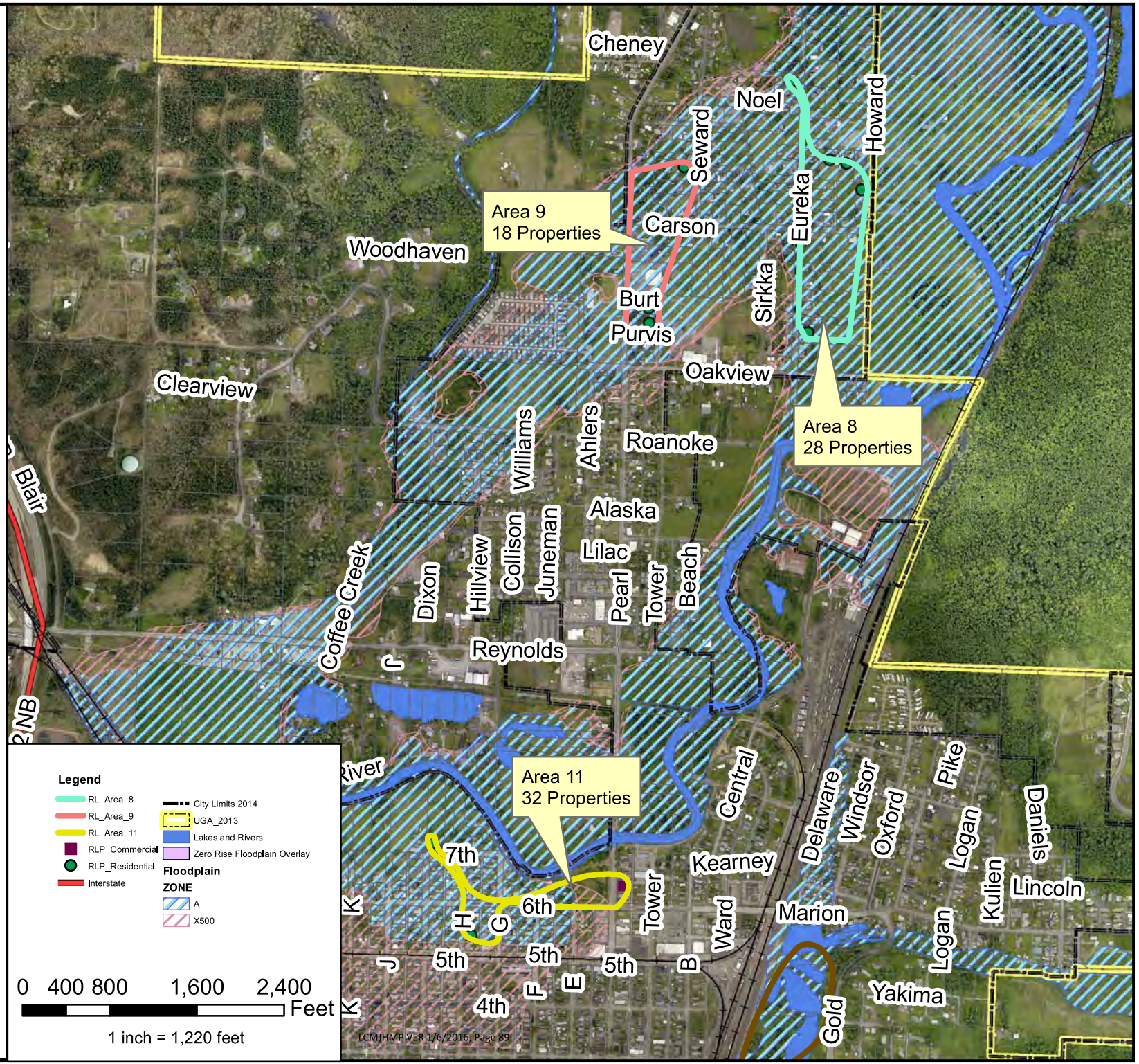
Created September 19, 2014



Activity 503
Repetitive Loss Areas
RL Areas 8, 9, 11

Community Number 530103

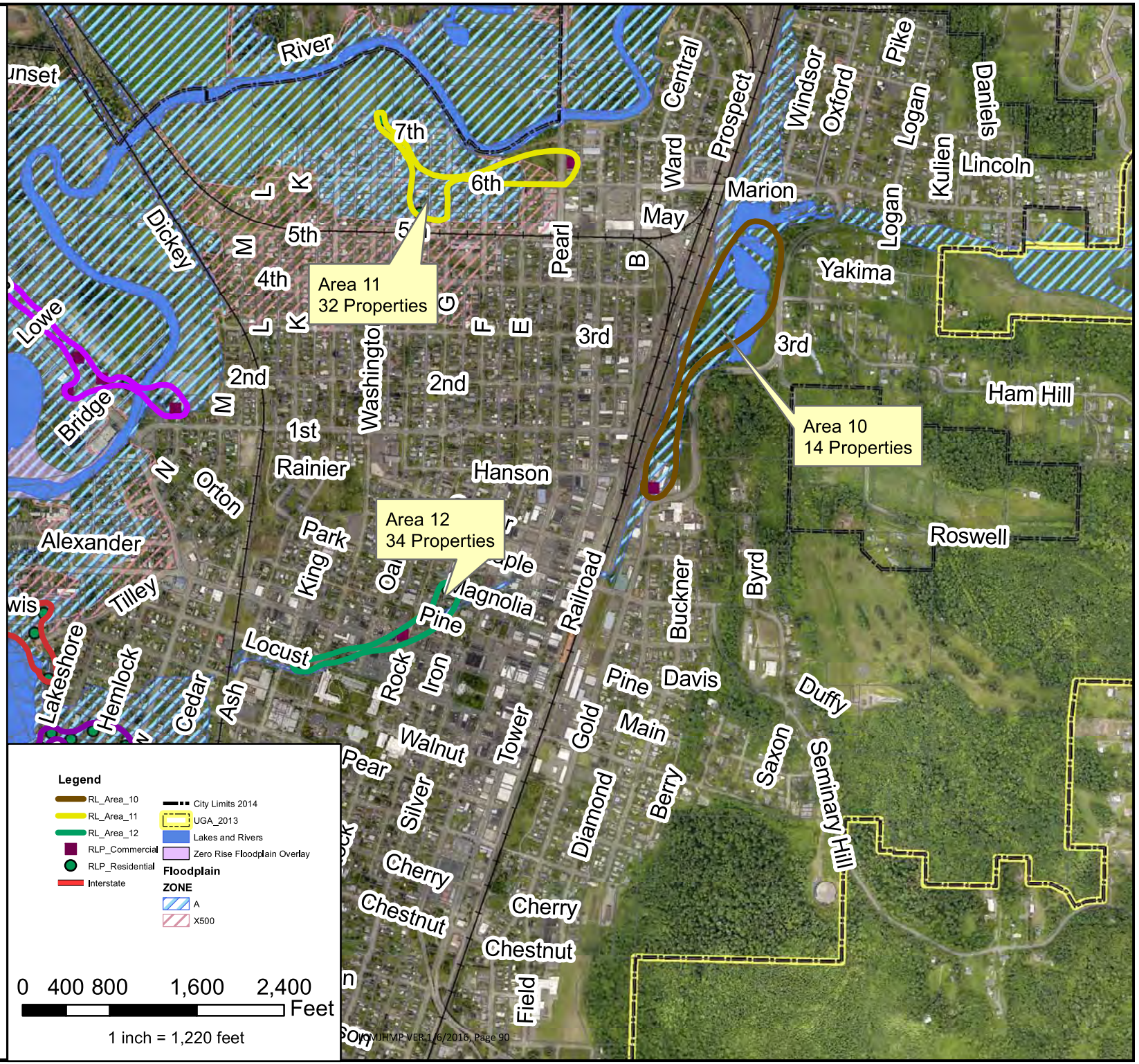
Created September 19, 2014

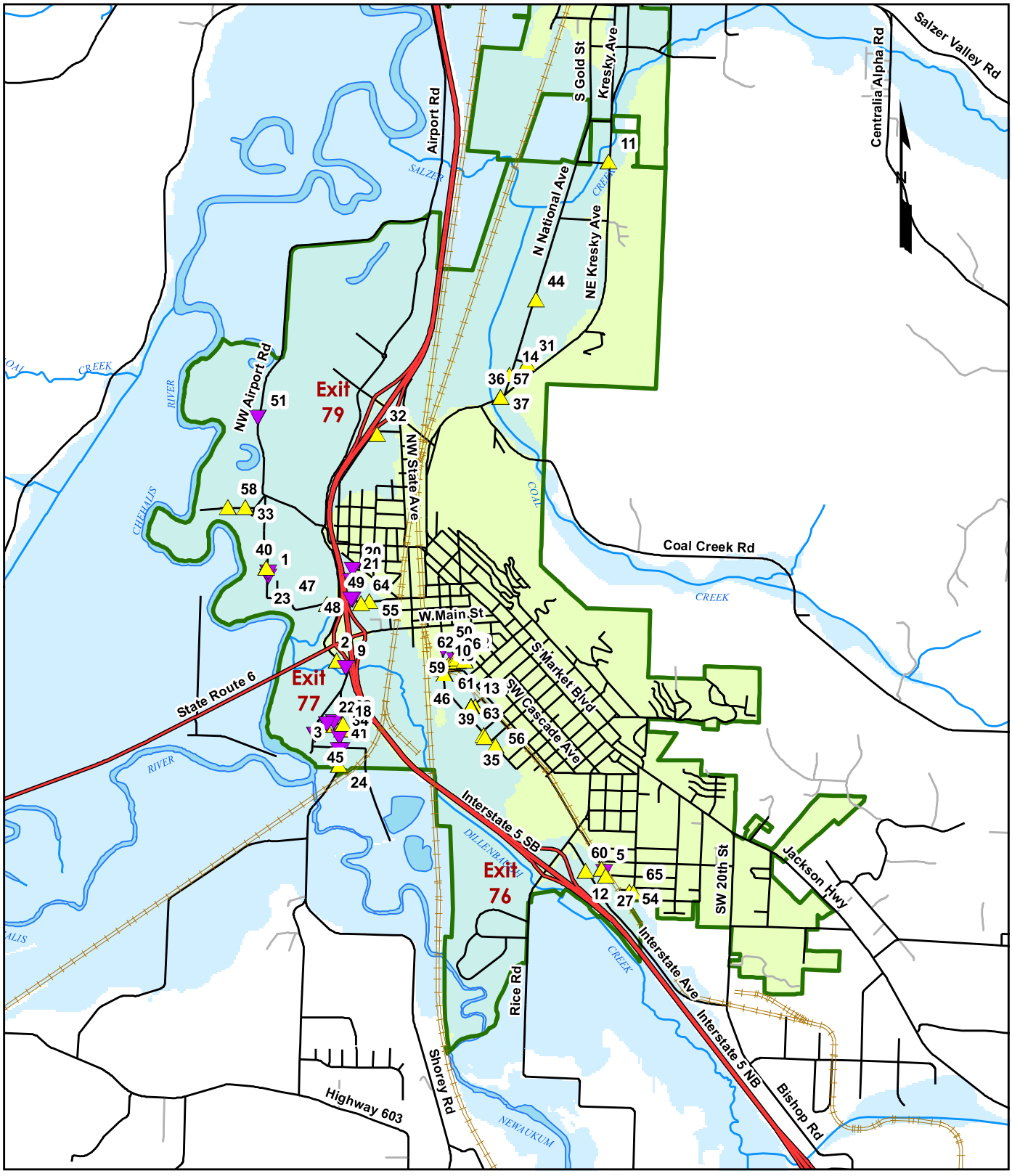


Activity 503
Repetitive Loss Areas
RL Areas 10, 11, 12

Community Number 530103

Created September 19, 2014





City Limits

Repetitive Loss Site

Repetitive Loss Site - Mitigated

(Rep Loss data per 2011 FEMA list)

Lewis County, Washington

2015 Multi-jurisdictional Hazard Mitigation Plan

Chehalis Repetetive Loss Sites

0 0.25 0.5 1 Miles

Date: June 17, 2015

4.2.7 Landslide

Hazard Profile

The USGS reports that landslides occur in all 50 states and U.S. territories and cause nearly $2 billion in damages and more than 25 deaths on average, each year. The threat of landslide to human life and property has increased with urban and recreational expansion into hillside areas. The likelihood of a landslide has also increased in connection with the frequency of other major natural disasters that destabilize the ground such as earthquakes, volcanoes, wildfires, floods, storms, and thawing of land as well as other natural phenomena that cause ground failure.

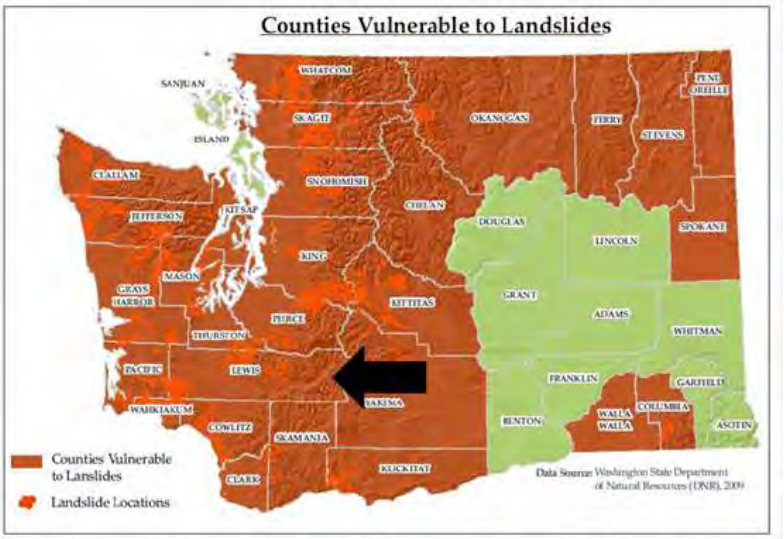


Figure 1 Counties Vulnerable to Landslides Map: Washington State Enhanced Hazard Mitigation Plan, October 2013.

FEMA describes landslides as masses of rock, earth, or debris that moves down a slope. The debris and mud flows that occur are essentially rivers of rock, earth, and other debris saturated with water, which can that move slowly or rapidly. They develop when water accumulates in the ground during heavy rainfall or rapid snowmelt and over saturates the underlying soil, causing it to slip and fall from the side of a slope. Landslides act like avalanches because they can strike with little or no warning, travel several miles from their source and grow in size as they pick up debris in the form of trees, boulders, cars and other materials.

It was deemed, by both the public input and factual research, that the planning area as a whole has had some occurrences of landslides. The probability of a landslide to occur again is 'likely' with between a 10 & 100% chance that they will occur every year within the planning area. The extent was determined to be 'limited', as 0 to 25% of the planning area could be affected by landslide. While landslides don't generally occur constantly in Lewis County, there are particular areas that are more vulnerable.

Landslides in the planning area generally occur along cuts in a hillside usually along a roads or highway. Land that lies along river bluffs is also susceptible to landslides and could cause damage to, or completely destroy, any structure built on it.

Landslides occur where certain combinations of geologic formations are present. For example, groundwater can accumulate and zones of weakness can develop when layers of sand and gravel lay above less permeable silt and clay layers. In the Puget Sound region, for example, this combination is common and widespread; glacial outwash, often Esperance Sand or gravel, overlies the fine-grained Lawton Clay or Whidbey formation (Source: www.emd.wa.gov/).

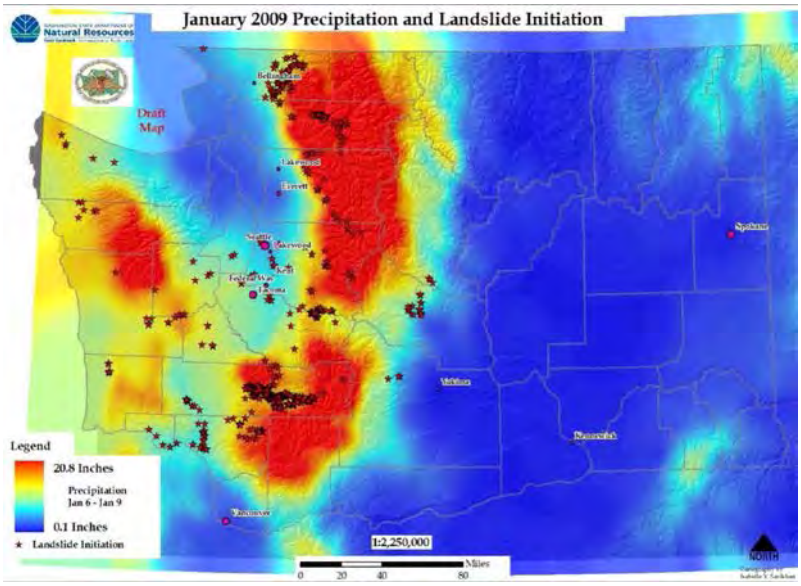
The two primary types of landslides are:

- *Earth flow* – This is the dominant form of landslide in the area. Both ancient and active earth flows are common, not only in the high and steep terrain, but also in the low, rolling hills of the

Chehalis-Centralia area. Stream erosion along the toes of the flow usually causes reactivation of these landslides. Excavations, such as those for freeway construction, also may reactivate dormant earth flows or start new ones.

- *Debris flow* – These types of landslides are locally a problem in the western Cascades and Olympic mountains; they tend to occur where the rocks are strong and relatively un-weathered. These rocks tend to have steep slopes and smooth surfaces overlain by thin soils. Intense rainstorms, or rain on the wet snow in the mountains trigger these landslides (Source: Washington State Hazard Mitigation Plan, 2013).

<u>Historical Occurrences</u>



- January 7-8, 2009 storm, over 500 landslides initiated in Lewis County, blocking roads and damaging houses. Rainfall totaled over 10 inches between January 7-8, triggering hundreds of debris flows between Morton and Randle. Near Glenoma, when the debris flows reached the valley, they transformed into hyper-concentrated flows, moving across fields and pirating on Highway 12 and into roads and driveways.
- December 2007 storm just west of Pe Ell, a massive debris avalanche along with numerous smaller landslides blocked State Route 6, from Pe Ell to Raymond, isolating 21 households without electricity and water. In addition, State Route 8, just west between Porter and Malone, and SR 508 near Onalaska were blocked by landslides. In the Chehalis headwaters area, the hardest hit area from the storm, nearly 20 inches of rain was recorded within a 48-hour period, most of that falling within the first 24 hours. Woody debris and sediment, including material from more than 1,000 landslides in the Chehalis headwaters basin, clogged channels at bridges, creating temporary dams and causing widespread deposition of logs and debris, especially around the Boistfort valley.
- The winter storms of January 29 thru March 11, 1999 – brought snow, heavy rains, high winds, and landslides. Heavy saturated soils and unstable conditions on the hillside above Kresky Avenue (Chehalis) resulted in a large mass land movement. It caused severe damage (over $100,000) to the Elks Lodge. During this same time frame, Pe Ell had a newly installed water line collapse from another mass land movement.
- February 1996 – Lewis County experienced its largest recorded landslide with an estimated 1.5 million cubic yards of debris. The event destroyed a house five miles east of Glenoma. Landslides blocked State Route 504 in two places by landslides in Kid Valley, and a landslide closed State Route 7 near Mineral Lake for two days.
- 1984 – A mudslide shut down the water supply intake to the reservoir of the cities of Centralia and Chehalis. In November 1990 and January 1991 muddy water was observed at the same location.

- November 1994 – After heavy rains, a mass land movement occurred approximately one-half mile west of Randle between Peters and Silverbrook Roads. An entire portion of a hill near State Route 12 rolled down on to the highway. The slide was about 30 feet high and more than 100 feet wide. The clean cost an estimated $1.2 million.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with landslides. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Landslide Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Highly Likely	Severe
City of Centralia	No	Yes	Likely	Limited
City of Chehalis	Yes	No	Possible	Limited
City of Morton	Yes	Yes	Likely	Limited
City of Mossyrock	No	No	Possible	Severe
City of Napavine	No	No	Unlikely	None
City of Toledo	Yes	Yes	Possible	Limited
City of Vader	No	No	Possible	Limited
City of Winlock	Yes	Yes	Likely	Severe
Town of Pe Ell	Yes	Yes	Likely	Limited

Probability:
- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:
- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

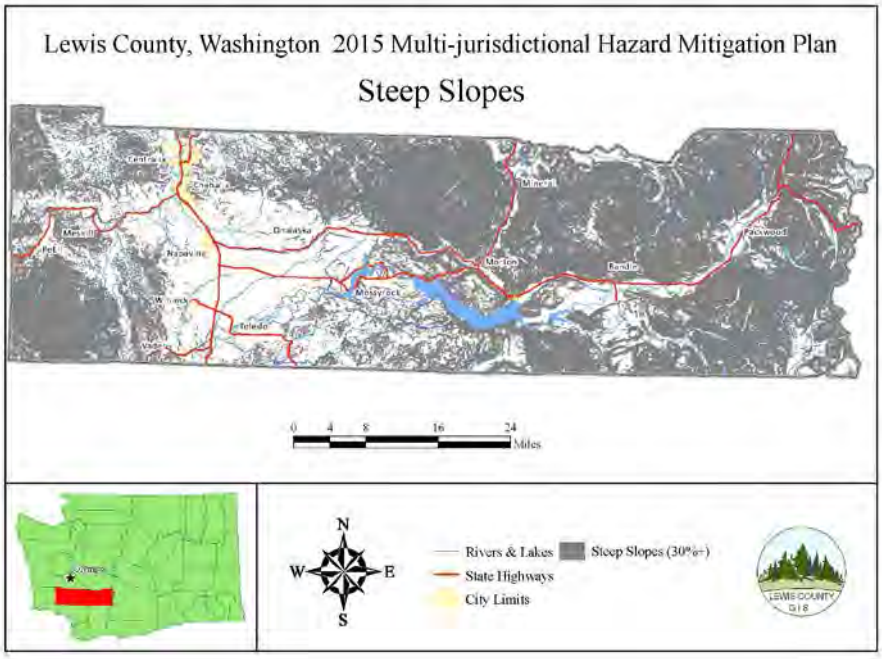
Assessing Vulnerability: Estimating Potential Losses

Potential losses from a landslide event vary greatly depending on the area affected. A landslide that occurs in an undeveloped rural area may cause no monetary damage at all. In other instances, there

may be extensive road damage or destruction of homes or other structures. Landslides also damage the land or the hillsides, making roadway conditions unsafe. Depending on the magnitude and severity of a landslide event, losses could reach well into the millions of dollars. Additionally, landslides can cause a disruption of commerce if a road closure results. In certain circumstances, there could also be a loss to human life as a result of a landslide. For more specific information regarding landslides in the jurisdictions within the planning area, refer to each jurisdiction's respective participant section found in their sections.

<u>Assessing Vulnerability: Analyzing Development Trends</u>

Enforcing development standards that limit or place conditions on development that occurs on slopes, river banks, and other landslide prone areas will limit the vulnerability of structures. Additional building that occurs in sensitive areas can increase the potential for loss due to landslides.



<u>Resources</u>

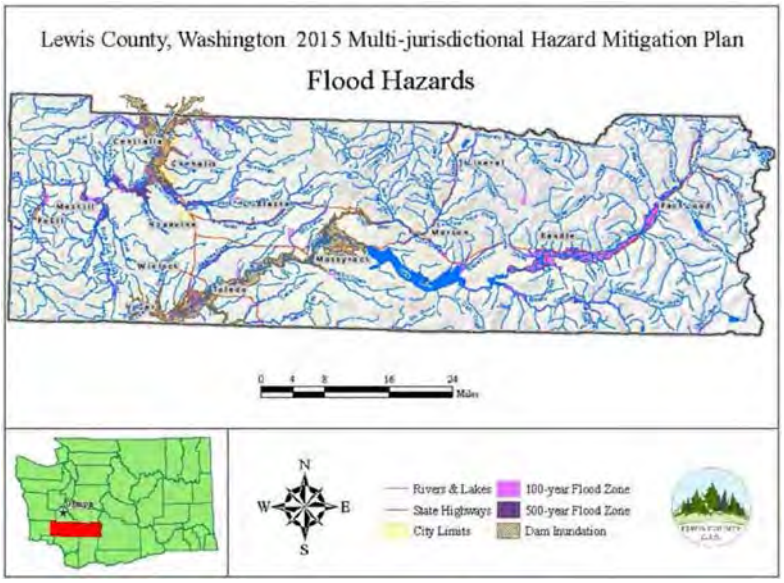
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Landslide_Hazard_Profile.pdf Accessed May 16, 2015.
- Hazard Fact Sheet, U.S. Geological Survey, Landslide Information Center, March 2002, http://landslides.usgs.gov/html_files/nlic/page5.html, (August 12, 2003)
- Washington Division of Geology and Earth Resources, Open File Report 2009-1. January 2009 Washington

4.2.8 Levee Failure

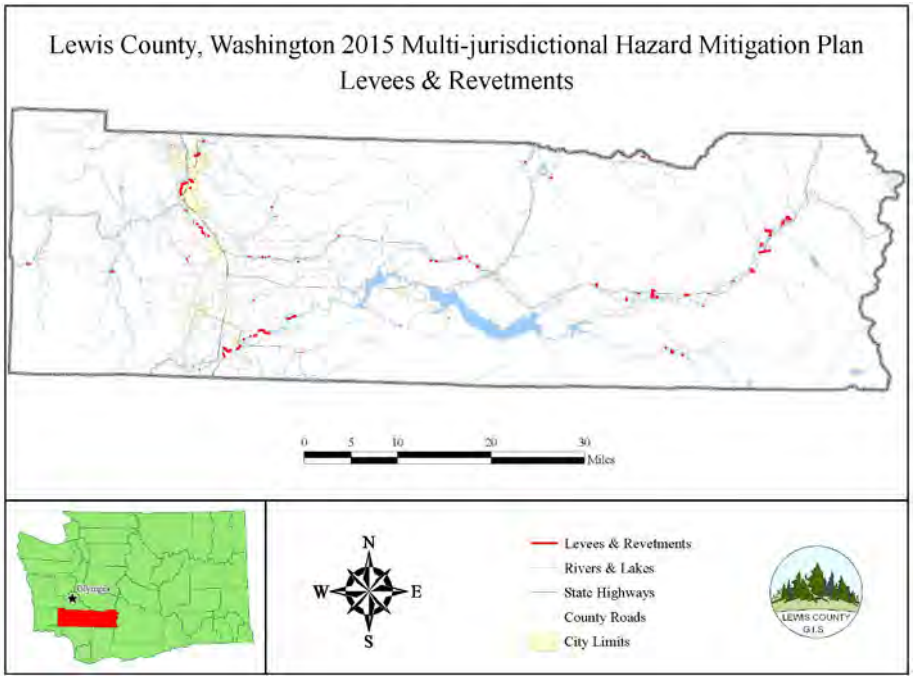
Hazard Profile

According to FEMA's website:

"The United States has thousands of miles of levee systems. These manmade structures are most commonly earthen embankments designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to provide some level of protection from flooding. Those levee systems designed to protect urban areas have typically been built to higher standards. Levee systems are designed to provide a specific level of flood protection. No levee system provides full protection from all flooding events to the people and structures located behind it. Thus, some level of flood risk exists in these levee-impacted areas."



Levee failure can occur several different ways. A breach of a levee is when part of the levee breaks away, leaving a large opening for floodwaters to flow through. A levee breach can be gradual by surface or subsurface erosion, or it can be sudden. A sudden breach of a levee often occurs when there are soil pores in the levee that allow water to flow through causing an upward pressure greater than the downward pressure from the weight of the soil of the levee. This under seepage can then resurface on the backside of the levee and can quickly erode a hole to cause a breach. Sometimes the levee actually sinks into a liquefied subsurface below.



Another way a levee failure can occur is when the levee overtops the crest of the levee. This happens when the flood waters simply exceed the lowest crest elevation of the levee. An overtopping can lead to significant erosion of the backside of the levee and can result

to a breach and thus a levee failure.

The primary levees in the planning area are the Centralia/Chehalis Airport Levee and the Skookumchuck Dike. However, there are many smaller levees and dikes in the area due to the large number of rivers and streams. Any community that has levees or dikes within the Planning Area has the chance to have the levee or dike fail. If proper levee maintenance is performed the structural integrate of the levee can be maintained.

Historical Occurrences

- Centralia/Chehalis Airport Levee – December 2007
- Cowlitz River Dike: November 2006
- Skookumchuck Dike: 1996

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with levee failures. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Levee Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Likely	Severe
City of Centralia	Yes	Yes	Likely	Limited
City of Chehalis	Yes	No	Possible	Limited
City of Morton	No	No	Unlikely	None
City of Mossyrock	No	No	Unlikely	None
City of Napavine	No	No	Unlikely	None
City of Toledo	No	No	Unlikely	None
City of Vader	No	No	Unlikely	None
City of Winlock	No	No	Unlikely	None
Town of Pe Ell	No	No	Unlikely	None

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

Due to the lack of resources and data deficiencies, potential losses were not calculated for a levee failure. Losses could be similar to those of a flood, damaging or destroying structures that are protected by the levee, displacing people and losses of functional down time, economic effects, or recovery and replacement costs. Because levee and dike failures are often part of a larger flood event, it is difficult to itemize potential losses in isolation.

HAZUS-MH

To assess risks and vulnerability, Lewis County GIS has run FEMA's loss-estimation model, HAZUS-MH (Version 1.3 MR3). The results using HAZUS-MR3 are summarized for the County and the individual municipal jurisdictions.

Assessing Vulnerability: Analyzing Development Trends

The areas at risk for loss in a levee failure are those lands downstream from the levee. Development standards that apply to the floodplain and other sensitive areas are enforced to limit the potential for future losses during these disasters. Specific development trends are analyzed in the participant section of this plan.

Resources

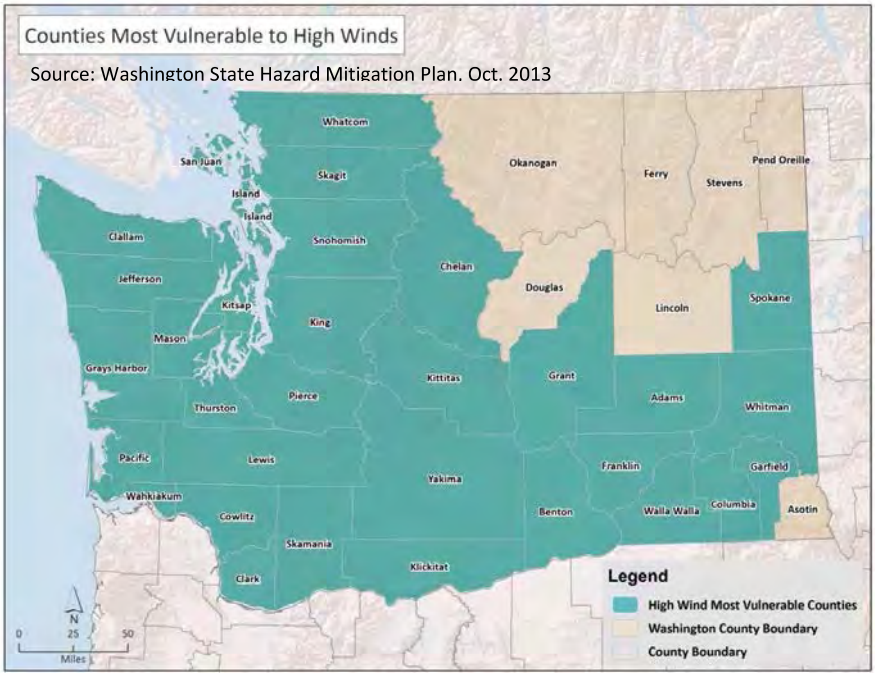
- FEMA: http://www.fema.gov/plan/prevent/fhm/lv_intro.shtm Accessed June 2015.

4.2.9 Severe Wind Storm

Hazard Profile

The National Weather Service defines high winds as sustained winds of 40 mph or gusts of 58 mph or greater, not caused by thunderstorms, expected to last for an hour or more. Areas most vulnerable to high winds are those affected by a strong pressure difference from deep storms originating over the Pacific Ocean; an outbreak of very cold, Arctic air originating over Canada; or air pressure differences between western and eastern Washington that primarily affect the Columbia River Gorge, Cascade Mountain passes, ridges and east slopes, and portions of the Columbia Basin.

Counties considered most vulnerable to high winds are 1) those most affected by conditions that lead to high winds, as described above, and 2) those with a high wind recurrence rate of 100 percent, meaning the county experiences at least one damaging high wind event every year. Counties that meet both criteria, or recommended for inclusion by Kerry Jones, Warning Coordination Meteorologist, National Weather Service – Spokane (Source: Washington State Hazard Mitigation Plan, October 2013).



Large wind events most often occur in the autumn and winter due a low pressure cyclone system takes over in the North Pacific Ocean, with air spiraling inward in a counter-clockwise fashion. This causes Washington's prevailing winds to come from the southwest, bringing relatively warm and moist air masses and a predictably wet season. The term Pineapple Express is used to describe the extreme form of this wet season pattern.

The most frequent surface winds in Washington are from the southwest. These widespread winds are associated with storms moving onto the coast from the Pacific Ocean. Winds coming from the south and west are the most destructive. The storm of December 14-15, 2006 and also the January 20, 1993 storm are examples of this type of windstorm.

West winds generate from the Pacific Ocean and are strong along the coast, but slow down inland due to the obstruction of the mountain ranges. Prevailing winds in Lewis County vary with the seasons. In summer, the most common wind directions are from the west or northwest; in winter, they are from the south and east. Local topography, however, plays a major role in affecting wind direction (Source: Office of the Washington State Climatologist, www.climate.washington.edu).

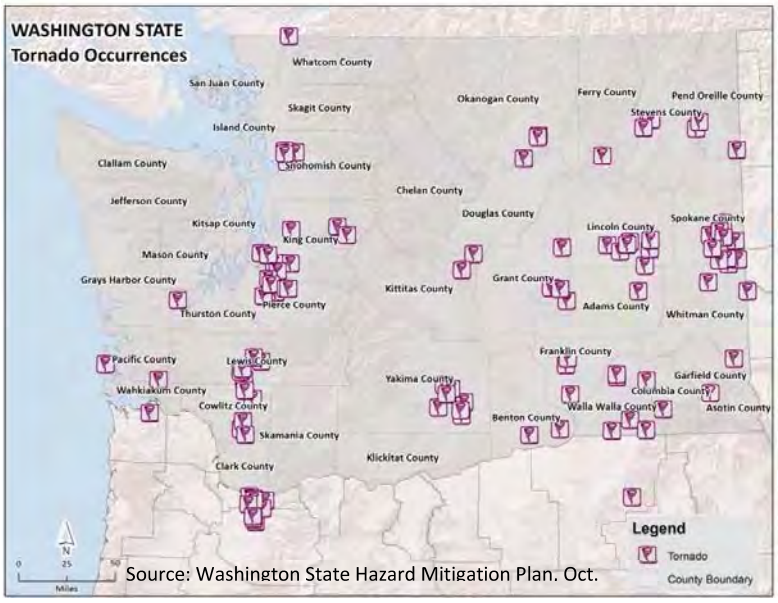
It was deemed, by both the public input and factual research, that the planning area as a whole has had previous occurrences of high winds. The probability of high winds to occur again is 'possible and likely' equaling somewhere between a 10 and 100% probability in the next year, or at least one chance in 10 years and between 1 and 10% probability in the next year, or at least one chance in next 100 years. This all depends on the specific location within the Planning Area.

High winds have the capability to affect an entire community within the planning area as there is no area within it void to their affects. The entire infrastructure, including all structures and critical facilities in the planning area is vulnerable and is at risk of being damaged by high winds.

High winds can cause structure loss, downed power lines, loss of electricity, obstruct traffic flow, and significantly damage trees. A catastrophic event could lead to major economic loss for the community.

Furthermore, high wind speeds and flying debris can pose a significant threat to human life.
The planning area as a whole may not be affected by a single event as high winds usually occur in one area at a time. This is why the planning area as a whole will experience 'limited' extent, while a single community could be entirely affected by a high wind, thus being 'severe.'

The unique characteristics of different jurisdictions allow high winds to impact them differently. Municipalities are very vulnerable in that residential, commercial, public and out buildings, as well as critical facilities, can be destroyed or damages significantly. Their power, cable and telephone lines can break. Residents in the rural areas of the county can be cut off for a more significant timeframe by the effects of wind storms. Power may not be restored for days, and sometimes even weeks, because of the distance from main power lines.



Source: Washington State Hazard Mitigation Plan. Oct.

Historical Occurrences

A few of the major wind storms to hit Lewis County include:

- December 1 - 3, 2007. The Great Coastal Gale. On November 29, 2007, a strong low pressure system, fed by the remnants of Typhoon Mitag and Typhoon Hagibis, formed in the central Pacific Ocean, and was carried via the Pineapple Express to the Pacific Northwest.
- October 18, 2007. Gale. This low developed from the remnants of tropical storm Linling. Another cyclone developed right on the heels of this tropically-fed low, cutting off a large supply of cold air that probably would have contributed to a much stronger storm.
- December 14-15, 2006. The Major Wind Storm (Hanukkah Eve Wind Storm)
- January 29-30, 2004. Minor Windstorm
- January 15-16, 2000. The Sou'wester

- December 12, 1995. The Major West Coast Windstorm
- January 20, 1993. The Devastating Inaugural Day Storm
- November 13-15, 1981. Double wind storms in 3 days. Gusts were 60 to 70 mph with Newaukum Hill station reporting 52 mph.
- October 12, 1962. Columbus Day Storm was a tropical storm named Freda formed 500 miles (800 km) from Wake Island in the central Pacific Ocean. The system became an extratropical cyclone as it moved into colder waters and interacted with the jet stream. The low moved northeastward, and then hooked straight north as it neared southwest Oregon. The storm then raced nearly northward at an average speed of 40 miles per hour (64 km/h), with the center just 50 miles (80 km) off the Pacific Coast.
- November 3, 1958. Wind came out of west with gusts around 60-80 mph.
- October 26-27, 1950. The Double Windstorms.
- October 21, 1934. The Major Windstorm. Wind gusts reported around 80-90 mph.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with severe wind storms. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Severe Wind Storm Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Likely	Severe
City of Centralia	Yes	Yes	Likely	Limited
City of Chehalis	Yes	No	Possible	Limited
City of Morton	No	Yes	Possible	Limited
City of Mossyrock	No	No	Likely	Limited
City of Napavine	Yes	Yes	Possible	Limited
City of Toledo	Yes	Yes	Possible	Limited
City of Vader	Yes	Yes	Highly Likely	Limited
City of Winlock	Yes	Yes	Likely	Severe
Town of Pe Ell	Yes	Yes	Likely	Limited

Probability:
- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:
- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See each Participant Section to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

The Planning Area could potentially receive damages reaching millions of dollars in the worst case scenario. It is difficult to accurately calculate damage from windstorms, but the damage will likely fall into the following categories:

- Falling trees or blowing debris cause most fatalities and cause severe damage to buildings and vehicles.
- Power pole and line damage cause widespread power outages.
- Failure of roof cover and structures can lead to additional damage and entry of wind and rain into a home or business.
- Garage doors are the weakest point in the outer structure of a house.
- Exterior, load-bearing walls of buildings can fail resulting in collapse of the roof.
- Weathered, loose window frames are exceptionally vulnerable during severe windstorms.
- Light metal buildings can totally collapse. Less sturdy shelters, such as bus stop shelters, are vulnerable and are probably not safe for taking cover.
- While a structure may be generally sound, broken windows can cause injures inside and outside the building and extensive damage to building contents.

Assessing Vulnerability: Analyzing Development Trends

There is no human behavior or activity that can modify the area affected by high winds, thus high winds will always be capable of affecting the entire planning area. Any structural growth which occurs within the area in the future will be vulnerable to the losses sustained from high winds.

Windstorms usually occur each fall and winter season, producing strong winds to 60 mph and causing power outages and property damage. Approximately once every 10 years, storms with winds of 70 mph or more pound the region and cause significant damage. These storms last an average of three to six hours of prolonged winds in one area before the storm moves on. Because a storm with winds in excess of 70 mph can happen often, preparedness and awareness are needed to avoid its disastrous effects.

See each respective 'participant section' for more information on the future vulnerability and losses of each jurisdiction within the planning area.

Resources

- Office of the Washington State Climatologist, www.climate.washington.edu
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Severe_Storm_Hazard%20profile.pdf Accessed May 16, 2015.

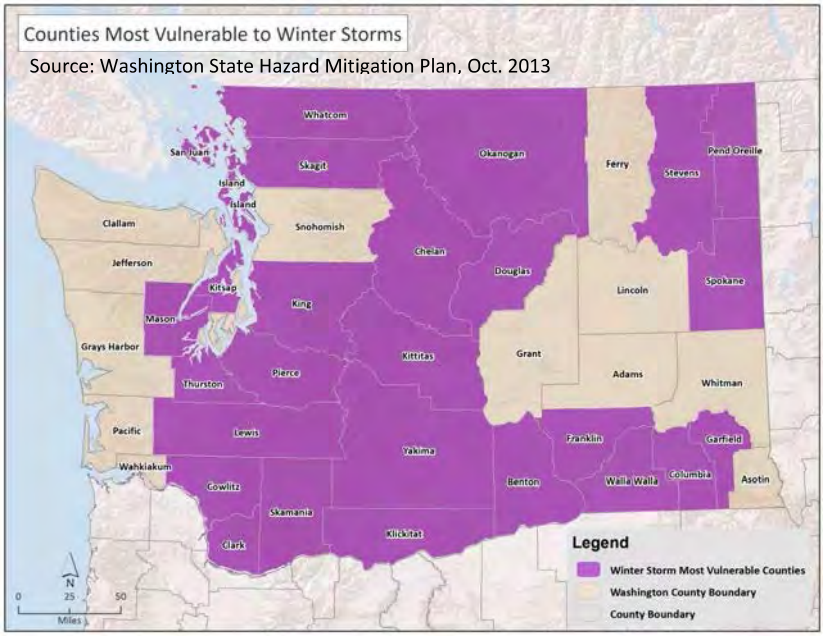
4.2.10 Severe Winter Storm

Hazard Profile

The National Weather Service defines a Severe Winter Storm as having significant snowfall, ice, and/or freezing rain; the quantity of precipitation varies by elevation. Heavy snowfall is 4 inches or more in a 12-hour period, or 6 inches or more in a 24-hour period in non-mountainous areas; and 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period in mountainous areas.

Areas most vulnerable to winter storms are those affected by convergence of dry, cold air from the interior of the North American continent, and warm, moist air off the Pacific Ocean. Typically, significant winter storms occur during the transition between cold and warm periods.

Counties considered most vulnerable to winter storm are 1) those most affected by conditions that lead to such storms, as described above, and 2) those with a recurrence rate of 50 percent, meaning the county experiences at least one damaging winter storm event every two years. (Source: Kerry Jones, Warning Coordination Meteorologist, National Weather Service – Spokane; Washington State Hazard Mitigation Plan, Nov. 2007).



According to the standards listed in the *Washington State Hazard Mitigation Plan*, Lewis County is not listed as one of the most vulnerable to severe winter storms. However, Lewis County has experienced severe winter storms and the plan participants have identified severe winter storms as a potential hazard.

It was deemed, by both the public input and factual research, that the planning area as a whole has had previous occurrences of severe winter storm events. There is no area in the planning area that is void from the effects of a winter storms. A winter storm can have the capability to affect the entire planning area during and after the event. The entire infrastructure, including critical facilities, is vulnerable and is at risk of being damaged or affected by severe winter storms. Winter storms can cause damage to structures, damage to pipes, downed power lines, loss of electricity, obstruct traffic flow, and significantly damage trees. A loss of electricity in combination with cold weather can pose a significant threat to human life.

The unique characteristics of different jurisdictions allow winter storms to impact them differently. Cities and utility districts are vulnerable in that their power, cable and telephone lines can accrue ice during a winter storm and break. Heavy snow buildup can cause structural damage to residential, commercial and public structures as well as critical facilities. Snow and ice can also endanger residents that travel on the roads. Residents in the rural areas of the county can be affected by severe winter

storms as snow and ice can greatly hinder travel. Also power can be cut off to residents in unincorporated areas for days and sometimes weeks.

Historical Occurrences

- The January 2012 Pacific Northwest snowstorm was a large extratropical cyclone that brought record snowfall to the Pacific Northwest. Interstate 5 near Centralia, Washington, was closed temporarily due to power lines brought down by snowfall; the standard detour route was also blocked by trees and power lines.
- January 6-16, 2009, Severe Winter Storm, Landslides, Mudslides, and Flooding: FEMA-1817-DR
- December 12, 2008 to January 5, 2009, Severe Winter Storm and Record and Near Record Snow: FEMA-1825-DR
- December 14-15, 2006, Severe Winter Storm, Landslides, and Mudslides: FEMA 1671
- January 1997, Severe Winter Storms/Flooding: FEMA 1159
- January 1997, Severe Ice and Snow Storms: FEMA 1152

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with severe winter storms. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Winter Storm Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Likely	Severe
City of Centralia	Yes	Yes	Likely	Limited
City of Chehalis	No	No	Possible	Severe
City of Morton	Yes	Yes	Likely	Limited
City of Mossyrock	Yes	Yes	Likely	Severe
City of Napavine	Yes	Yes	Possible	Limited
City of Toledo	Yes	Yes	Possible	Limited
City of Vader	Yes	Yes	Highly Likely	Limited
City of Winlock	Yes	Yes	Likely	Severe
Town of Pe Ell	Yes	Yes	Likely	Limited

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

It is difficult to determine the amount of damage and losses created by a winter storm event. A number of factors that would need to be considered include: structural damage due to snow and ice, displacement, functional downtime, economic loss, or loss of life and injury. Data limitations prevented detailed estimates of these losses. A loss of electricity due to downed power lines can cripple any jurisdiction's economy, cause loss of power to critical facilities, and pose a threat to human life.

Assessing Vulnerability: Analyzing Development Trends

There is no human behavior or activity that can modify the area affected by winter storms, thus winter storms will always be capable of affecting the entire Planning Area. Any structural growth which occurs within it in the future will be vulnerable to the losses sustained from winter storms. Building standards including load bearing regulations may reduce vulnerability to structural losses.

See each respective 'participant section' for more information on the future vulnerability and losses of each jurisdiction within the planning area.

Resources

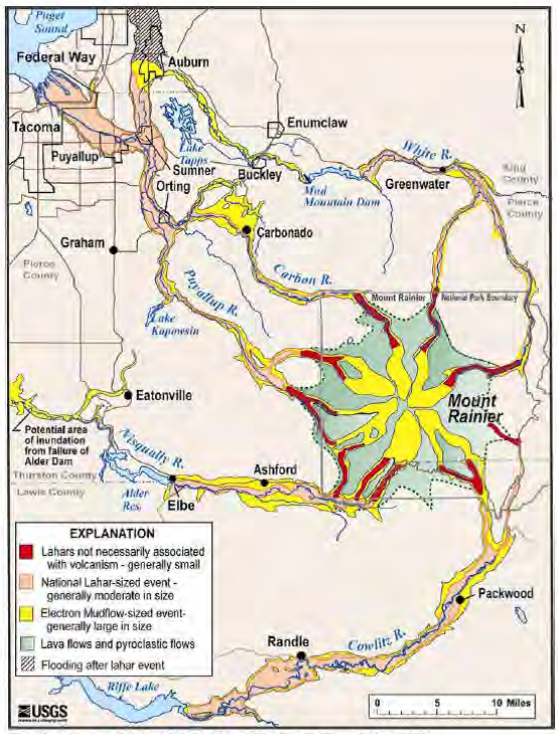
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Severe_Storm_Hazard%20profile.pdf Accessed May 16, 2015.

4.2.11 Volcano

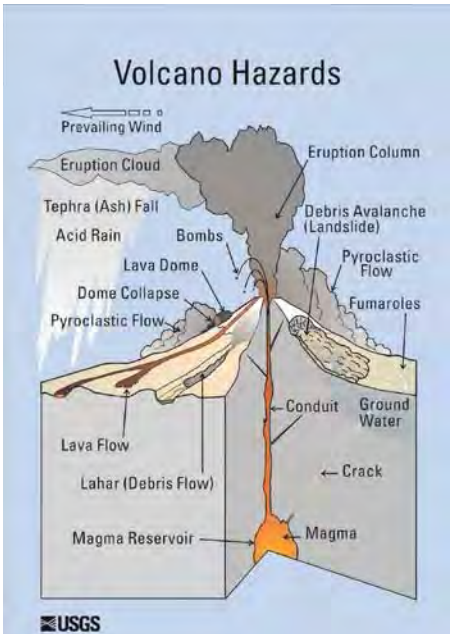
Hazard Profile

Lewis County is located in an area where volcanic events have occurred in both the ancient and recent past. Volcanoes produce a wide variety of hazards that can cause personal harm and destroy property. Large explosive eruptions can endanger people and property hundreds of miles away and even affect global climate. Some of the volcano hazards, such as landslides, can occur even when a volcano is not erupting. Volcano hazards include:

1. Eruption columns and clouds;
2. Volcanic ash;
3. Volcanic gases;
4. Lava flows and domes - lava erupts from vents that can form lava flows or steep-sided lava domes
5. Pyroclastic flows - a high-speed avalanches of hot ash, rock fragments, and gas;
6. Debris avalanches - a type of landslide consisting of rock, glacial ice, snow, and other debris;
7. Lahars - a flowing mixture of rock debris and water;
8. Volcano landslides - landslide consisting of rock, glacial ice, snow, and other debris;
9. Tephra falls - produced by explosive eruptions that blast fragments of rock and ash into the air.



Hazard zonation map for Mount Rainier. Map modified from Hoblitt and others, 1998; U.S. Geological Survey Open-File Report 98-48.



Washington State Hazard Mitigation Plan, Oct. 2013

If there is a volcanic event within Lewis County it would more than likely be from Mount St. Helens or Mt. Rainer. Mount St. Helens is one of a group of high volcanic peaks that dominate the Cascade Range between northern California and southern British Columbia. The distribution of these volcanic peaks in a broad band that roughly parallels the coastline is typical of the so-called "Ring of Fire," a roughly circular array of volcanoes located on islands, peninsulas, and the margins of continents that rim the Pacific Ocean.

A major issue following an eruption would be dealing with the large amounts of volcanic ash. Volcanic ash is pulverized rock ejected from a volcano. Unlike wood ash, newly ejected volcanic ash is sharp and abrasive. It can damage car finishes and scratch eyes. It can clog machinery, vents, and pipes, and can cause respiratory discomfort. In large enough quantities, its weight can be enough to collapse roofs, especially if it gets wet.

Even before it began its recent active eruption phase, Mount St. Helens, and at least six other volcanoes

in the Cascade Range, were known to be "active" - that is, to have erupted at least once during historical time. Few major Cascade volcanoes are known to have been inactive long enough to be considered "extinct" or incapable of further eruption. Most display some evidence of residual volcanic heat, such as fumaroles, hot springs, or hot ground where snow melt is unusually rapid.

Source: Washington State Hazard Mitigation Plan, 2007 Accessed: 7/2009.

Historical Occurrences

The catastrophic eruption on May 18, 1980 was preceded by 2 months of intense activity that included more than 10,000 earthquakes, hundreds of small phreatic (steam blast) explosions, and the outward growth of the volcano's entire north flank by more than 80 meters. A magnitude 5.1 earthquake struck beneath the volcano at 8:32 a.m. on May 18, setting in motion the devastating eruption.

Within seconds of the earthquake, the volcano's bulging north flank slid away in the largest landslide in recorded history, triggering a destructive, lethal lateral blast of hot gas, steam, and rock debris that swept across the landscape as fast as 1,100 kilometers per hour. The lateral blast, which lasted only the first few minutes of a 9-hour continuous eruption, devastated more than 150 square miles of forest and recreation area, killed countless animals, and left about 60 persons dead or missing.

Temperatures within the blast reached as high as 300 degrees Celsius. Snow and ice on the volcano melted, forming torrents of water and rock debris that swept down river valleys leading from the volcano. Within minutes, a massive plume of ash thrust 15 miles into the sky, where the prevailing wind carried about 490 tons of ash across 57,000 square kilometers of the Western United States.

The 9-hour eruption, the huge debris avalanche that immediately preceded it, and intermittent eruptions during the following 3 days removed about 4 billion cubic yards (0.7 cubic mile) of new magmatic material and of the upper and northern parts of the mountain, including about 170 million cubic yards (0.03 cubic mile) of glacial snow and ice. The eruption caused pyroclastic flows and mudflows, the largest of which produced deposits so extensive and voluminous that they reached and blocked the shipping channel of the Columbia River about 70 river miles from the volcano.

Following the 1980 explosive eruption, more than a dozen extrusions of thick, pasty lava built a mound-shaped lava dome in the new crater. The dome is about 1,100 meters in diameter and 250 meters tall.

The eastern side of Lewis County is at-risk to ash fall. Areas in Lewis County as shown on the map below have a 1 in 1,000 chance of receiving 10 centimeters (4 inches) of ash fall each year on the map to the right.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan dealing with a volcanic eruptions. According to the Washington State Enhanced Hazard Mitigation Plan and the U.S. Geological Survey hazard reports Lewis County should expect lahars and ash dust to be the main volcanic hazards to expect. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Volcano Eruption Composite Hazard Identification Table

Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County	Yes	Yes	Likely	Catastrophic
City of Centralia	Yes	Yes	Likely	Limited
City of Chehalis	Yes	No	Possible	Severe
City of Morton	Yes	Yes	Likely	Catastrophic
City of Mossyrock	Yes	Yes	Likely	Limited
City of Napavine	Yes	Yes	Possible	Limited
City of Toledo	Yes	Yes	Possible	Limited
City of Vader	Yes	Yes	Possible	Severe
City of Winlock	Yes	Yes	Possible	Catastrophic
Town of Pe Ell	Yes	Yes	Likely	Limited

Probability:

- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

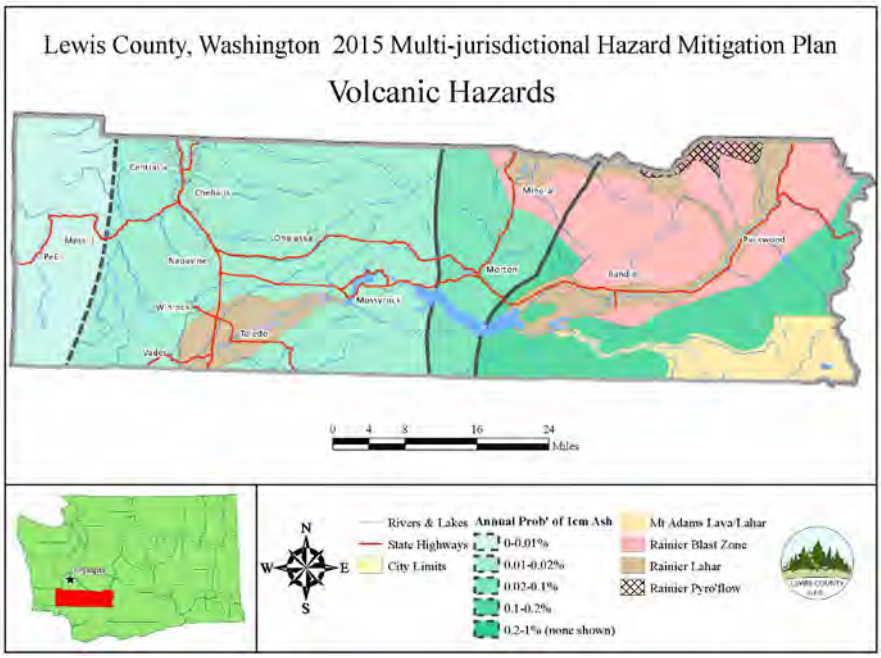
See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.

Assessing Vulnerability: Estimating Potential Losses

The loss from a volcanic disaster is largely dependent on the point of origin of the volcanic event, the direction of the eruption, and the prevailing wind pattern. Potential losses include: loss of life, loss of timber, loss of structures, loss of machinery and vehicles due to ash damage, and loss of agriculture due to ashfall. Volcanic disasters can also affect commerce and transportation. Other major disasters such

as flooding, debris flow, and earthquakes often occur in conjunction with volcanic disasters which increases the potential loss. For specific loss estimates, see the participant sections.

Assessing Vulnerability: Analyzing Development Trends



Preparedness and land use planning are important for mitigation of volcanic hazards. Reducing population growth in paths of lahars, implementing warning systems, and planning and practicing evacuations can lower the potential loss of life and property during future eruptions. These actions can reduce the risk from lahars and provide a measure of safety for those living, working, and recreating in valleys surrounding volcanic mountains.

Resources

- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/HAZ%20MIT%20PLAN/Volcano_Hazard_Profile.pdf Accessed June 2015.
- Washington State Department of Natural Resources, Geology and Earth Resources Division; http://www.wa.gov/dnr/htdocs/ger/index.html Accessed May 2015.
- University of Washington, Geophysics Program; http://www.geophys.washington.edu/
- United States Department of Agriculture; http://www.wsda.gov/ Accessed May 2015.
- United States Forest Service; http://www.fs.fed.us/ Accessed May 2015.
- National Weather Service; http://www.nws.noaa.gov/ Accessed May 2015.
- United States Department of Justice; http://www.usdoj.gov/ Accessed May 2015.
- United States Geological Survey, David A. Johnston Cascade Volcano Observatory; http://vulcan.wr.usgs.gov/ Accessed May 2015.

4.2.12 Wildfire

Hazard Profile

Wildfire is a general term for an uncontrolled fire that often occurs in wildland areas, but can consume agricultural resources and houses as well. Wildland areas include, but are not limited to, grasslands, agricultural land, and forests. The causes of wildfires vary, but most often include lightning, human carelessness, and arson.

According to FEMA, dry conditions during various times of the year greatly increase the potential for wildland fires; therefore drought is a major contributor to extreme wildfires. The USGS notes that wildfires are a growing natural hazard in most regions of the United States. These fires, on average, burn 4.3 million acres in the U.S. annually, causing the federal government to spend roughly $1 billion per year on fire suppression. Although fire is a natural occurrence that can be a beneficial process, the large buildup of vegetation used for fire suppression can act as extra fuel and increases the intensity and devastation of these fires.

FEMA stated, there are three different classes of wildland fires:

- A **surface fire** is the most common type, and burns along the floor of a forest, moving slowly and killing or damaging trees;
- A **ground fire** is usually started by lightning and burns on or below the forest floor, and
- A **crown fire** spreads rapidly by wind and moves quickly by jumping along the tops of trees.

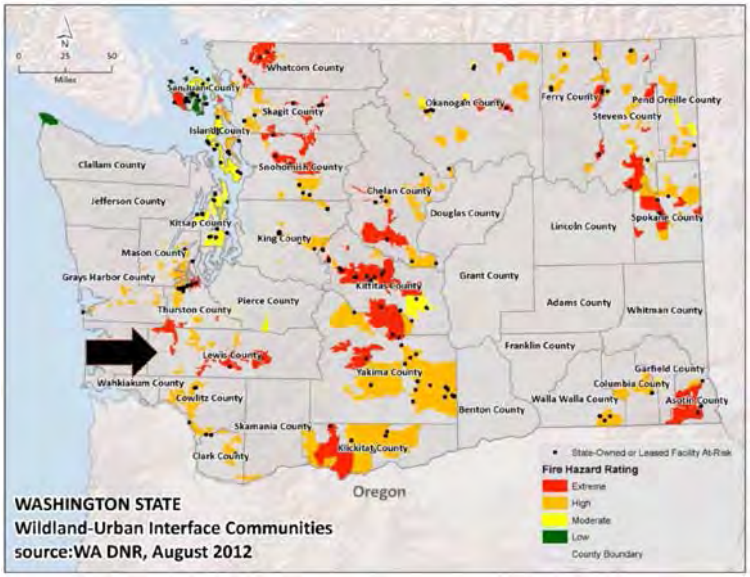
Wildfires generally occur in areas where climates are sufficiently moist to allow the growth of trees and vegetation, but also have long, dry, and hot periods. These hot periods allow branches and leaves to fall, and material to dry out, leaving highly flammable material to accumulate. During a severe drought, wildfires are common in grasslands and scrublands. During windy days, grassland fires can spread rapidly and become uncontrollable.

In recent years, the areas where wildlands border developing areas, wildfires have become more dangerous as they pose a threat to suburban homes located in transitions zones between rural and urban areas. In some extreme occasions, wildfires have caused numerous deaths and extensive damage as fires rapidly sweep through urban-fringe communities. The damage caused by wildfires goes beyond just smoldering piles of ash and includes the effects of erosion, landslides, the introduction of invasive species, and changes in water quality.

Lewis County's fire season runs from approximately mid-May through October. Dry periods can extend the throughout the season. The possibility of a wildland fire depends on fuel availability, topography, the time of year, weather, and activities such as debris burning, land clearing, camping, and recreation. In Washington, wildland fires start most often in lawns, fields, open areas, transportation areas, and wooded wildland areas. They are usually extinguished with less than one acre damaged, but can spread to over 100,000 acres and may require thousands of firefighters several weeks to extinguish. Wildland fire protection can be provided by federal, state, county, city, and private fire protection agencies.

The agencies responding to wildland fires depend on the location of the fire. If the fire is located in an area where human activity is the likely cause the fires are responded to by city and county fire departments if they are usually started by human causes. Included in the list of human causes are cigarettes, fireworks, and outdoor burning. Wildland fires started by heat spark ember or flames caused

the largest dollar loss, followed by debris burning and cigarettes. Loss per incident for debris fires is three times higher than any other fire cause.



The effects of wildland fires vary with intensity, area, and time of year. Factors affecting the degree of risk include rainfall, type of vegetation, and proximity to firefighting agencies. Short-term loss is the complete destruction of valuable resources, such as timber, wildlife habitat, scenic vistas, and watersheds. Vulnerability to flooding increases due to the destruction of watersheds. According to the Washington State Hazard Mitigation Plan long-term effects are reduced amounts of timber for building and recreational areas. Although crops and orchards are tenth on the list of properties damaged, these had the third highest dollar loss, the highest value, and the greatest potential loss.

Historical Occurrences

Lewis County Wildfires 2008-2013

2008 Fires	2008 Acres	2009 Fires	2009 Acres	2010 Fires	2010 Acres	2011 Fires	2011 Acres	2012 Fires	2012 Acres	2013 Fires	2013 Acres	Total County Fires	Total Acres Burned
19	37.74	29	15	11	7.46	15	7.22	34	41.11	25	105.45	133	213.69

The data was provided by Washington Department of Natural Resources and located in Washington State Enhanced Hazard Mitigation Plan, October 2013.

Assessing Vulnerability: Overview

Below is the Composite Hazard Identification Table for Lewis County and the municipalities participating in this plan for wildfires. The table addresses previous occurrences, whether or not the hazard is likely to occur, probability of occurrence, and the extent of damage that may occur for each participating jurisdiction. Differences in probability and extent are described further in the individual participant sections.

Wildfire Composite Hazard Identification Table				
Jurisdiction	Previous Occurrence (Yes or No)	Whether or Not Likely to Occur (Yes or No)	Probability Highly Likely/ Likely/Possible/ Unlikely	Extent Catastrophic/ Severe/Limited/ None
Lewis County				
City of Centralia	No	No	Possible	Limited
City of Chehalis	No	No	Possible	Limited
City of Morton	No	Yes	Possible	Severe
City of Mossyrock	No	No	Unlikely	Limited
City of Napavine	No	No	Unlikely	None
City of Toledo	No	No	Unlikely	None
City of Vader	No	No	Likely	Catastrophic
City of Winlock	No	No	Unlikely	None
Town of Pe Ell	Yes	Yes	Possible	Limited

Probability:

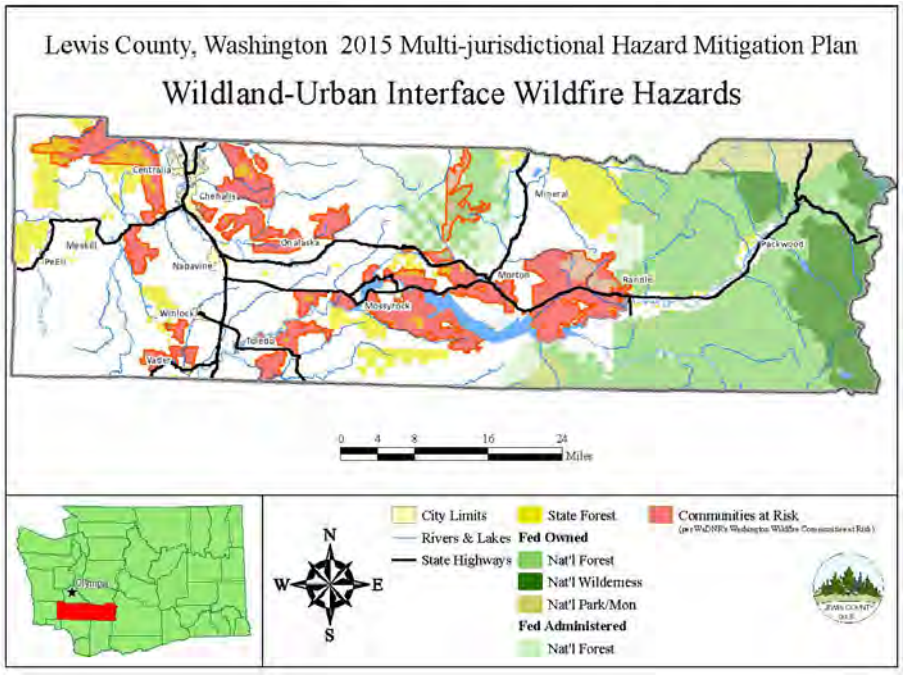
- **Highly Likely**: Near 100% probability in the next year.
- **Likely:** Between 10 and 100% probability in the next year, or at least one chance in 10 years.
- **Possible:** Between 1 and 10% probability in the next year, or at least one chance in next 100 years.
- **Unlikely:** Less than 1% probability in next 100 years.

Extent of damage is defined as follows:

- **Catastrophic:** More than 50% of the jurisdiction can be affected
- **Severe:** 25 to 50% of the jurisdiction can be affected
- **Limited:** 0 to 25% of the jurisdiction can be affected
- **None:** 0% of the jurisdiction can be affected

Assessing Vulnerability: Identifying Structures, Infrastructure, and Critical Facilities

See the Participant Sections to review the Asset Inventory Worksheet 2A, Asset Inventory Worksheet 2B, and Asset Inventory Worksheet 2C for detailed information on the structures, infrastructure, and critical facilities, as well as the potential losses to each community and the estimated dollar amount of damages from this hazard if it affected any of the participants.



Assessing Vulnerability: Estimating Potential Losses

The monetary loss of a wildfire varies greatly with the location and severity of the event and could change depending on the specific areas are included in the estimate. Potential losses could include timber and rangeland or structures, depending on the location of the fire. If a wildfire were to occur when the grasses and undergrowth are drier like in July-September, the losses could be greater. For these reasons, it would be appropriate to say losses could range from thousands to millions of dollars.

Assessing Vulnerability: Analyzing Development Trends

The likelihood of wildfires occurring in the future will decrease as land management gets better. Building near wildlands increases loss from fires. Often, structures are built with minimal awareness of the need for fire protection. Wildland fires occur with regularity in Washington State and in Lewis County. There are a number of ways to reduce wildland fires and minimize injury and property loss. Mitigation activities include:

- Develop ordinances and educate people
- Develop fire detection programs and emergency communications systems
- Exercise warning systems and evacuation plans
- Plan escape routes for personnel living in wildlands
- Road closures during fires
- Property owner precautions:
    - Maintain appropriate defensible space around homes;
    - Provide access routes and turnarounds for emergency equipment
    - Minimize fuel hazards adjacent to homes
    - Use fire-resistant roofing materials
    - Maintain water supplies
    - Ensure that home address is visible to first responders

Resources

- Originally published in *Federal Register*, Volume 66, Number 100, pages 43432-43433, August 17, 2001, and updated by the Washington Department of Natural Resources in *A Progress Report on The National Fire Plan in Washington,* 2002. List Revised, 2004.
- Washington State Enhanced Hazard Mitigation Plan, October 2013. Washington State Military Department. Available at: http://mil.wa.gov/uploads/pdf/wildland_fire_hazard_profile_2014-update.pdf Accessed May 15, 2015.